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August 2013

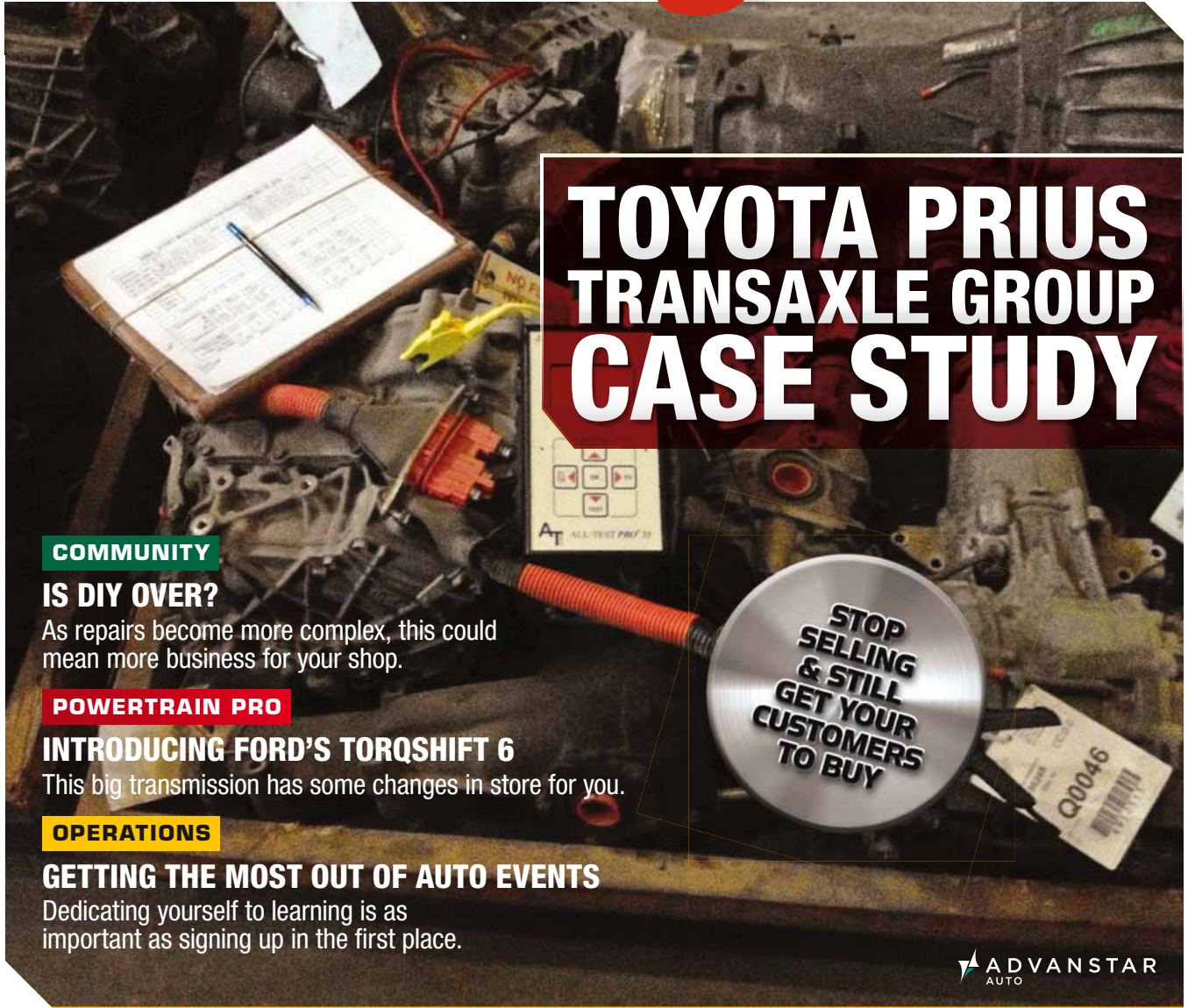
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Vol. 132, No. 8

Advancing the Automotive Service Professional Since 1899



## TOYOTA PRIUS TRANSAXLE GROUP CASE STUDY

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#### IS DIY OVER?

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### POWERTRAIN PRO

#### INTRODUCING FORD'S TORQSHIFT 6

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#### GETTING THE MOST OUT OF AUTO EVENTS

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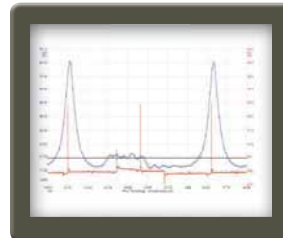
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ATTENDEE REGISTRATION OPEN FOR ASRW 2013

6 Both online attendee registration and housing reservations are open. The first 250 registrants with the promo code "vegas13" will receive a free Expo Pass.

IDENTIFIX, AUTOLAND PARTNER ON TECH SUPPORT

6 Autoland Scientech subscribers now can receive technical support through the Identifix Repair Hotline.

MAGNETI MARELLI OPENS NEW U.S. AUTO LIGHTING PLANT

8 The new Tennessee facility is the company's first lighting production plant in the United States.

SAE: HONEYWELL REFRIGERANT SAFE FOR USE IN VEHICLES

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Motor Age (Print ISSN: 1520-9385, Digital ISSN: 1558-2892) is published monthly, by Advanstar Communications Inc., 131 W. 1st Street, Duluth, MN 55802-2065. Periodicals postage paid at Duluth, MN 55806 and additional mailing offices. POSTMASTER: Send address changes to Motor Age, P.O. Box 6019, Duluth, MN 55806-6019. Please address subscription mail to Motor Age, 131 W. 1st Street, Duluth, MN 55802-2065. Canadian G.T.S. number: R-124213133RT001. Publications Mail Agreement Number 40612608. Return Undeliverable Canadian Addresses to: Pitney Bowes PO Box 25542 London, ON N6C 6B2 CANADA One-year rates for non-qualified subscriptions: U.S. \$70.00; Canada/Mexico \$106.00; International surface \$106.00. For information please call (866) 529-2922 (Domestic inquiries); (218) 740-6395 (Canadian/Foreign). Printed in the U.S.A.

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ONLINE COVERAGE

## THERE'S MORE ONLINE:

### A NEW WEBSITE LOOK

ASA and Autoshop Solutions Inc. have launched a major redesign of the ASA website.

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### MUDLIK MAIL UNVEILS NEW ROI TOOL

The Mudlick Analytics Program (MAP) is designed to help repair shop owners better evaluate their direct mail campaigns.

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### SNAP-ON ADDS TRAINING

ETHOS<sup>®</sup> Plus Training Solutions modules have been added to Snap-on's website.

»» [MOTORAGE.COM/ETHOSTRAINING](http://MOTORAGE.COM/ETHOSTRAINING)

### CONSUMER ATTITUDE STUDY

The sluggish economy has impacted how long consumers plan to keep their vehicles and their likelihood of price shopping for auto parts.

»» [AFTERMARKETBUSINESS.COM/CAS](http://AFTERMARKETBUSINESS.COM/CAS)

### MINN. COMPANY ACQUIRES NEVADA BRAKE & AUTO

Nevada Brake & Auto Inc., based in Las Vegas, has been acquired by Factory Motor Parts, based in Eagan, Minn. The sale was finalized on June 4.

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### CONTROLLING TOXIC SPILLS

Shops should have an emergency spill plan in place to best protect their employees and workplace.

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### STRENGTH IN TEAM BUILDING

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Now is the time to register for the 2013 ASRW, comprised of NACE and CARS.

## EVENTS

# Attendee registration opens for ASRW 2013

Online attendee registration and housing reservations are open for Automotive Service & Repair Week (ASRW). The first 250 attendees who register using the promo code "vegas13" will receive a free Expo Pass. ASRW will take place Oct. 17-18 with education sessions beginning Oct. 16 at the Mandalay Bay Convention Center in Las Vegas.

Show floor Expo Passes can be purchased for \$15 each; individual 90-minute conference sessions are available for \$70 per session; a Wednesday Day Pass is \$240; and a full-access Super Pass is \$335. All prices noted reflect early-bird pricing, which is in effect thru Aug. 22. Add-On Education from I-CAR and PCI also is available at an additional charge.

New this year, all registration options include one ticket to the ASRW Welcome Party and the Opening General Session/Industry Forum.

"As the industry's premier networking event, we are so pleased to include the Welcome Party and Opening General Session/Industry Forum in every registration this year as it reflects our desire to create an event that fosters networking and community interaction among our attendees," states Darrell Amberson, ASA chairman.

Discount pricing is available for Automotive Service Association (ASA) members and attendees can obtain free Expo Passes from ASRW exhibitors.

## BREAKING NEWS SERVICES

# IDENTIFIX, AUTOLAND SCIENTECH PARTNER FOR TECH SUPPORT

Identifix has partnered with Autoland Sciencetech USA to offer Autoland subscribers technical support through the Identifix Repair Hotline. This service is available to any dealership or aftermarket customer who purchases an Autoland scan tool and maintains his or her subscription.

A manufacturer of diagnostic solutions for more than 20 years, Autoland Sciencetech's line of scanners is custom tailored to the needs of automotive technicians and mechanics on large and small scales for both domestic and imported vehicles.

"Despite the availability of numerous online and tool-based diagnostic and repair information resources, many techni-

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**[Identifix]**

CONTINUED FROM PAGE 6

cians prefer to work through tough vehicle issues with a live expert," said Jeff Sweet, president of Identifix. "Our carline specialists currently take more than 20,000 calls each month, and we're excited for the opportunity to provide added value to Autoland's line of products with our Repair Hotline support."

"We know how frustrating it is when a customer purchases any diagnostic equipment and is unable to fully understand the issue with the vehicle. That's why we've partnered with Identifix to launch our new

**"We know how frustrating it is when a customer purchases any diagnostic equipment and is unable to fully understand the issue with the vehicle. That's why we've partnered with Identifix to launch our new Repair Hotline"**

— Richard Zenteno

Repair Hotline," said Richard Zenteno, Autoland's marketing director for the Americas. "Autoland has always been known for outstanding scan tool operational support. Now we're the only diagnostic system company that also provides expert diagnostic and repair hotline support with Identifix."

Autoland subscribers have a dedicated phone number for the Identifix Repair Hotline at 888-472-2644 where Identifix's ASE Master, L1 technicians are available to help diagnose complex vehicle issues. Additional Repair Hotline details are available on Identifix's website.

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## MAGNETI MARELLI INAUGURATES NEW U.S. AUTO LIGHTING PLANT

A new Magneti Marelli automotive lighting plant for the production of headlamps and rear lights was inaugurated June 16 in Pulaski, Tenn.

This is the company's first lighting production plant in the United States. The new production unit was built with an investment of approximately \$54 million. The plant currently employs 90 people but Magneti Marelli anticipates that number to reach to approximately 850 employees within the next four years.

"Today is particularly significant because it marks the successful completion of an ambitious project, as well as a new beginning and a new life for this plant," Sergio Marchionne, CEO of Fiat S.p.A and Chairman and CEO of Chrysler Group LLC, said during the inauguration celebration. "What has been achieved here demonstrates the strong commitment and sense of purpose of everyone involved to create value for the future, and to generate growth and prosperity for this area."

"The inauguration of the new plant in Pulaski shows the intention of Magneti Marelli to respond quickly to the growth of this market, while at the same time guaranteeing quality, a technological level of excellence and the satisfaction of our key customers, in a context that is rich in opportunity yet at the same time highly challenging," said Magneti Marelli CEO Eugenio Razelli. "The expansion of our footprint in the NAFTA region further equips us to respond appropriately and adequately to these challenges in an area that is vital for the growth of Lighting and Magneti Marelli as a whole."

"I want to congratulate Magneti Marelli for the opening of its new facility and its continued investment in Tennessee," Tennessee Gov. Bill Haslam said. "Magneti Marelli chose the Pulaski plant as its first Automotive Lighting facility in the U.S., and I want to thank them for helping bring us another step closer to achieving our goal of becoming the No. 1 location in the Southeast for high quality jobs."

The industrial area dedicated to lighting covers approximately 161,500 square feet, which will be further extended to just over 213,000 square feet in 2014. The plant has a production capacity of 2.5 million lighting units a year, which will gradually increase to 5 million in 2016.

The new site has already won orders from Chrysler Group, Mercedes and GM. The first headlights will be produced for Chrysler Group's all-new 2014 Jeep Cherokee.

## SAE: Honeywell refrigerant safe for use in vehicles

Honeywell reports SAE International has concluded that Honeywell's new low-global-warming-potential mobile air conditioning refrigerant, HFO-1234yf, is safe for use in vehicles after completing an expanded and extensive evaluation.

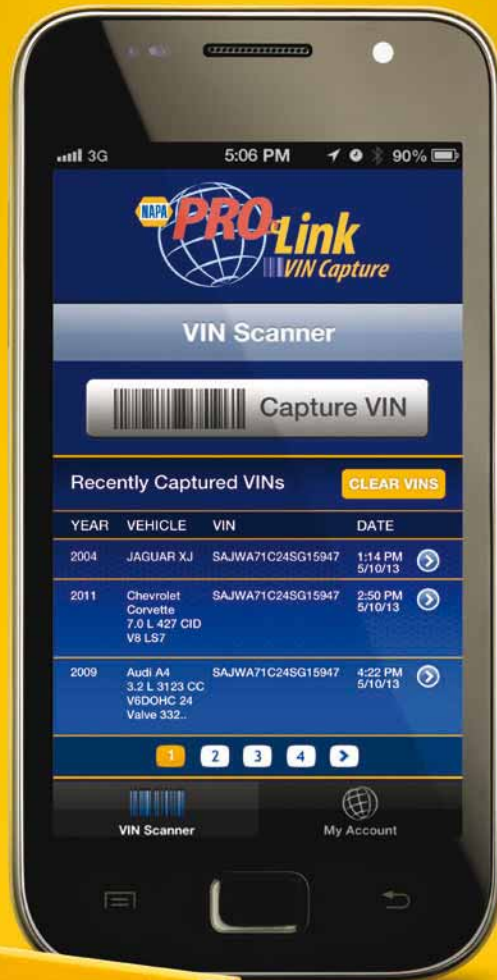
The SAE International Cooperative Research Project (CRP) said all 11 glob-

al automakers that participated in the project "have indicated agreement with these conclusions" and called testing by Daimler that raised questions about the refrigerant's flammability "unrealistic."

"After extensive testing and analysis, the new CRP concluded that the refrigerant release testing completed by Daimler was unrealistic," the SAE CRP said in its final summary. "Their testing created extreme conditions that favored ignition while ignoring many mitigating factors that would be pres-

ent in an actual real-world collision."

"The conclusions from SAE's latest expanded evaluation, combined with years of extensive testing in the U.S., Europe and elsewhere, again leaves no doubt that HFO-1234yf is safe for automotive applications," said Ken Gayer, vice president and general manager for Honeywell Fluorine Products. "The fact that all 11 global automakers participating in the project agreed with the SAE CRP's conclusions is further proof that this product can be used safely."



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## ASE GUIDES

### QUESTION OF THE MONTH



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☑ **SURVEY:** This issue features an article on learning how to read a wiring diagram, so we chose the question from the ASE A6 study guide.

Technician A says a short circuit to ground will decrease circuit resistance. Technician B says a short circuit to ground will increase current flow. Who is correct?

- A. Technician A
- B. Technician B
- C. Both A and B
- D. Neither A nor B

Visit [MotorAge.com/aug13survey](http://MotorAge.com/aug13survey) to answer the question and register for the monthly drawing from Federated Auto Parts.



## As repairs become more complex, is DIY over?

These trends toward complexity could mean more business for your shop.

BY JIM055 | WORKSHOP MEMBER

**W**hile testing a new generation of our BA327 Digital Battery and System Tester last week, we ran our new prototypes through their paces on a wide variety of vehicles at our corporate offices. The prototype performed well, which was great. The fifth vehicle we tested was a 2013 Chevy Malibu. The battery and system testing went fine, but we had a bit of a surprise when we first accessed the vehicle's battery compartment.

Seeing this, one member of our team remarked, "There goes one of

the last maintenance or repair applications that your average car owner could still do themselves." When the day comes to replace a depleted battery in this vehicle, most vehicle owners will likely decide it isn't worth the hassle and turn to their shop or dealer for this service.

This trend toward complexity can be found throughout today's vehicle systems. Even within the starting and charging system, alternators and charging processes have become much more sophisticated, now making constant adjustments for battery voltage, electrical demand and temperature. Other

[MotorAge.com](http://MotorAge.com)

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**BEST OF THE BLOGS** are articles written by bloggers on Motor Age's community pages

**BrianAlbright / Ohio**

### NHTSA distracted driving guidelines

U.S. Transportation Secretary Ray LaHood has been on a campaign against distracted driving for several years. As part of that continuing effort, the National Highway Traffic Safety Administration (NHTSA) has released voluntary guidelines covering the use of in-car infotainment and communication devices, that have some bearing on connected car technologies and telematics.

Proposed items include disabling manual text entry and video-based systems prohibiting the display of text messages, social media or Web pages while the car is in motion or in gear. The goal: Don't take the driver's eyes off the road for more than two seconds at a time, or 12 seconds in total by limiting drivers to six inputs or touches to the screen in 12 seconds.

The Alliance of Automobile Manufacturers already has a limit of 20 seconds in place, although that guideline is also voluntary. According to NHTSA, distracted drivers accounted for about one third of all accident fatalities in 2011.

**Junius / Alabama**

### A what the heck concern

Sometimes even the simplest electronics can be aggravatingly devious. I'm thinking of a 1994 Mazda B3000 I encountered at the Ford dealer. With the radio on and the wipers operating on intermittent, the radio would wink off each time the wiper motor swept the blades to the park position. Power and ground feeds to the radio terminals showed no loss of power and no spikes on the oscilloscope. The radio didn't respond this way to the operation of any other accessory.

We searched and actually found a loose ground at the wiper motor, repaired it and thought for a few minutes that the problem was solved. Raising the wiper arms off the windshield appeared to make a bit of a difference, but the problem still occurred with clock-like regularity. Plugging in a new wiper motor and letting it run while holding it in my hand made no difference either. Finally we made a trip to the boneyard and robbed a radio out of an abandoned Contour. When we plugged it in, the problem was gone.

Like so many other electronics problems, the only way to be sure is to try a known-good unit. And if we can't find a succedaneum for the component in the boneyard, do we go to the trouble of replacing the radio in hopes that it'll take care of the problem?



Aug. 22<sup>nd</sup> 2012  
@ 8:00 PM

## Cooling System Service & Testing

Do you know the trouble signs to look for in your inspections? If not, we'll help you learn.



PAGE

6

## REGISTRATION OPENS

ASRW

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PAGE

14

## Q+A WITH SONNY REEVES

ASE EDUCATION ALLIANCE MGR.

Did you know you have a farm team?

PAGE

88

## THE TRAINER VIDEO

PETE MEIER

In-cylinder pressure tests can speed work.

vehicle applications that were once tackled by the average DIYer are also becoming difficult to handle. Two that come immediately to mind are fluid changes and tire rotation/replacement.

Visit MotorAge.com/DIYover to read more examples in this blog, and to share your own stories of fixes you've done in the bays that either DIYers erred on or weren't able to fix themselves. **ZZ**



## MotorAge TOP VIDEOS

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### 'Stretchie' belt install tips

These belts do not use an independent tensioner and require special procedures and/or tooling to remove and install them.

[MotorAge.com/stretchie](http://MotorAge.com/stretchie)

### New Car Care Council video

Entitled "Explore an Auto Parts Store," this video opens the door to the neighborhood parts store for all vehicle owners.

[MotorAge.com/councilvideo](http://MotorAge.com/councilvideo)

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AUGUST 2013

### Cooling System Service and Testing

Produced in cooperation with TST.

AUGUST 2013

### Reading Wiring Diagrams

Produced in cooperation with ATSG.

OCTOBER 2013

### Get Familiar with the DCT450/470 Transmission

Produced in cooperation with ATSG.

NOVEMBER 2013

### Electrical Testing Techniques

Produced in cooperation with TST.



2013 WEBCAST SCHEDULE

### Management Success tips

In the first of the series, check out these tips on handling the customer from the phone call through the initial estimate process.

### ASA's five areas of focus

After a recent association assessment, ASA has identified five areas of service will lead the strategic direction going forward.

### Trust for your female customers

Women make a large number of purchases, so making sure they're comfortable in your shop is key. Just like other aspects of your shop, it boils down to trust.

### Talking engines

This is a short discussion on engine removal and disassembly.



STREAMING PROGRAMS

SEPT. 9-11

### AAIA Fall Leadership Days

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SEPT. 18

### 8 Steps to a More Profitable Auto Repair Shop

Bloomington, Minn.

SEPT. 20-22

### ASA-IL CAN Conference

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OCT. 16-18

### ASRW - NACE and CARS

Mandalay Bay, Las Vegas



2013 INDUSTRY CALENDAR



## Noteworthy

comments from MotorAge's online communities

Each month, we scan the Workshop, the *Motor Age* Facebook page and our Twitter feeds to see what you're saying. Comment today to be heard.

Deranger:

To prevent a comeback on those you should very carefully flex the wiring harness for about 2 feet of its length from each speed sensor. Do that while you watch for continuity and you just might catch a problem. It's fairly often that a wire breaks inside the insulation and opens intermittently, usually on a turn.

robert501:

We have the same problem here, and I have two sons who avoid this shop at all cost and have no idea what they want to do when they

get out of school. They just don't want to do this.

AutoMobile:

I am an automotive technician. I have 13 years of experience in the industry. I consider myself to be fairly solid in my skill set. I have been attempting to find a quality job where my skills can be put to good use. But along the way I have found that people want to offer peanuts and expect the world.

Hoffy62:

It is a huge stretch... but what if there was a regular

TV series (not so much a reality show) about an independent auto/truck repair with a lot of action, drama and something to bring out the testosterone in young men?

Bryant Sheldon via Facebook:

Here is a problem the good techs face. It took me almost two years to find a job out of school. Why? Because everyone wants experienced techs. But in most situations, the experienced guys aren't going anywhere.



the community—  
join the discussion

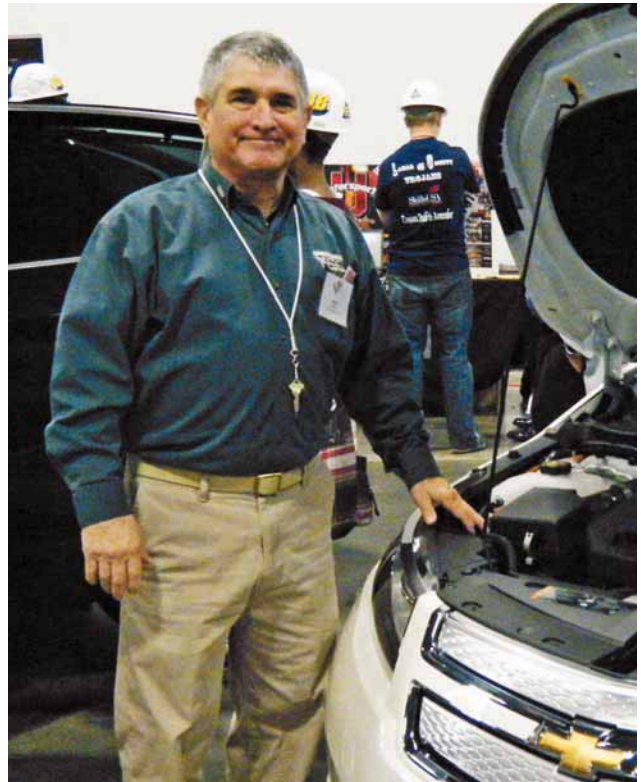
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# Q+A WITH SONNY REEVES

INDUSTRY EDUCATION ALLIANCE MANAGER  
FOR THE SOUTHEASTERN UNITED STATES,  
ASE

## DID YOU KNOW THAT YOU HAVE RESOURCES FOR NEW TECHNICIANS IN YOUR BACK YARD? IT'S LIKE YOUR OWN FARM SYSTEM.

BY PETE MEIER | TECHNICAL EDITOR



**D**id you know that you have a technician “farm team” in your own backyard? Odds are you do, in the form of a local high school or post secondary automotive technician training program.

Sonny Reeves is the ASE industry education alliance manager for the Southeastern United States. Reeves explains the need for shop owners on the local level to get involved in the advisory boards of these local programs, and the benefits they can expect.

**MA:** Now you can travel across the Southeast, how do you help schools?

**SR:** Volkswagen and Audi donated 150-some Volkswagen Passats for distribution to our schools, so we gave those to the NATEF-accredited schools across the nation. That's quite a donation, and we really appreciate Volkswagen's participation.

**MA:** Some of today's new techs are coming from your local schools.

**How do you put the techs and jobs together?**

**SR:** We keep the records on our database of the students that are graduating from our NATEF-accredited programs that have AYES interns. The AYES intern is qualified, they meet a

certain level of standards and they're eager to find a job and a career in the automotive industry. But getting them together on the local level, that's the problem. You may have a student in Jacksonville, Fla., that graduates from the program at Jac-Dade or something like that and there's not a job in that community. That's hard to believe, but sometimes those students have trouble locating a position that they can go into.

We're asking the shop owners and dealerships to reach out in their local community to find out if they have an automotive program in a local public school system or technical college and contact the instructor. Find out if they have an advisory committee and sit on that advisory committee. It will probably cost you an hour of time every three or four months at the most. Of course you can get involved more, but I know your time is valuable to you. You can find an accredited school. You type in your zip code and it brings up your location and shows you the accredited schools that are nearby. And if you're not already on an advisory committee, get on that advisory committee and offer job interviews and job training to young people trying to come into our industry. Coming out onto a shop floor



as a 17-, 18-, 19-year-old is pretty scary, compared to other jobs out there.

**MA:** What else can shop owners do to get involved?

**SR:** The thing about looking at the school from a shop owner or dealership perspective is you should look at it as where you're growing your farm team. They should look at that as how they bring up people in major league sports. These schools are your tax dollars at work. These schools are using your property tax, your sales tax, your tax on motor vehicles, all of this money is either coming back to the school in federal or state dollars. It's your money, you might as well give them input on how it's spent. If that program is producing young people, then you should be stepping up to the plate so you can get your fair share of that talent. *ZZ*



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## OPERATIONS

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OF YOUR BUSINESS

## IN THIS SECTION

- 16** Management
- 22** Profit Matters
- 26** Financial Figures
- 32** Shop Profile

read it on **MotorAge.com**

## STAFFING SHOPS

It's time to make sure the balance of technicians matches the workload.

/staffing

## TECH SALARIES

A recent iATN poll found the average 2012 salary for U.S. techs was \$51,000.

/salary

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## MANAGEMENT



## GETTING THE MOST OUT OF AN AUTOMOTIVE EVENT

## DEDICATING YOURSELF TO LEARNING AND MEETING NEW PEOPLE IS JUST AS IMPORTANT AS SIGNING UP FOR THE EVENT IN THE FIRST PLACE

BY **BRIAN CANNING** | CONTRIBUTOR

**IF THE** inside of a bar is the thing you look forward to above all others at the automotive repair and tire industry events you attend, I am guessing there is not an awful lot I could advise that would add to your experience. Well, maybe I could suggest you do a Google search or check Yelp to line up the best places to find your favorite Scotch, or which bars offer drop-off service so when you overindulge you don't have to worry about driving under the influence or ending up in a fountain somewhere in your rental car. If, however, you have flown halfway across the country to actually learn something or to check out what is new and possibly could benefit you and your shop operation, I might have a suggestion or two that could help.

The most important step is to have a plan. Even if in signing up for an event you have no particular reason for attending, the moment you commit to going, it is very important that you have some compelling reason or objective in being there. At a lot of these types of events, the reasons can be obvious, with shop equipment or marketing being central themes. But before you show up, have a plan of action. If you are there for a specific reason, you are much more likely to get involved, much more likely to search out answers, much more likely to ask questions and much more likely to talk to other attendees.

Every event has a theme or represents some aspect of the industry, and there are always learning opportunities, even if it is just trying to understand what is new and different out there. Just as they say you should not shop for groceries when you are hungry, you should not attend one of these events without some purpose in mind. Take the time to research the event, the speakers and the various vendors. See if peers or colleagues have ever attended this particular event, what their thoughts are on it or if they are going. Understand where you are going so you will be able to plan what you will do once you get there. If you don't, you are very likely to come home with a lot of things that you don't need and cannot afford and are just as likely to have wasted the huge learning opportunity that these events can represent.

## Stick to Your Plan

Armed with your plan, the next important step is total immersion. To do so, I would suggest you arrive early, get acclimated, get mentally prepared and do that pre-event recon so you know where you are going, where the classes or demonstrations that you plan on attending are located, when they start and what you might need to bring. Let all of the other guys show up unprepared and late; you are there with a specific purpose in mind. Maybe you are looking for a company to help you develop a broad marketing plan or to upgrade your online presence or to handle your search engine optimization (SEO). Maybe you are looking at shop equipment or a financial services company that can help you better plan and afford all that equipment. Have a plan and stick to it.

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An important side note to all of this is avoiding the separation anxiety you are likely to suffer when you are away from your shop. For these couple of days, it is very important that you dive in and engage, and that means not calling back to your shop 20 times a day and not getting involved in every little issue as though you were sitting in your office. Hang up the phone, disconnect and focus on the great event happening around you. Your shop will be there when you get back (hopefully), with all of the hassles and headaches that go with it. For these couple of days, dig in and explore the possibilities.

Probably the best event of this type that I have ever attended was the Salesforce.com technology event in San Francisco called Dreamforce. These people take over the whole downtown area including the Moscone Center and conference rooms in most of the nearby hotels. For several days, they present classes on business process, marketing, sales trends, emerging technology and so much information that is presented by business and industry giants, you could not possibly take in or absorb it all. I can promise you that if I did not show up in town armed with priorities and a plan, I would have been overwhelmed, with 25,000 or 30,000 other attendees in a strikingly beautiful city like San Francisco.

These people know how to put on a great event and anticipate your every need, and will wow you with a super slick event, cutting edge technology and celebrities (Bill Clinton, Eric Schmidt (Google him), Stevie Wonder, Metallica and MC Hammer) even if you are not sure why you are there. If you show up without some sort of an agenda and priorities, the event will overwhelm your senses and you will not get as much out of it as you could and should. I carefully scrutinized the classes and presentations offered long before I arrived in town and always came away from this event excited and much better for the experi-



ence. Trying to decide on where to go and what to see once you are there, with all of the distractions, is nearly impossible.

### Get to Know Others

Once the event has started, mingle and make new friends and contacts and participate.

Seems like pretty basic and simple advice, but sometimes when faced with a room full of strangers, flashing lights and being a long way from home, many of us (we men in particular), will tend to search out quiet corners and avoid human contact.

There is no doubt that these events can be a bit overwhelming, but for these couple of days I am going to strongly advise you to strip off your inhibitions and dive into the deep end of that pool. Meet people, introduce yourself, shake hands, and share lunch with total strangers. Do not limit yourself to handing out your business card, get in the habit of starting a collection of your own. You never know when one of these chance meetings will turn into an important contact.

Getting out of your comfort zone certainly is going to be scary, but it also is going to give you the rare opportunity to see what is new and improving in the industry and give you the very real opportunity to make great contacts and identify viable solutions to the things that are affecting your operation. I certainly am going to suggest you be cautious, but get out there, ask questions, make friends and find ways to make your good shop even better.

Away from the flashing lights and polished presentations, you are likely to discover other shop owners and service managers just like you, that have challenges just like you but also have solutions that you hadn't thought about or suggestions on things they have tried and been successful with. You are not going to find these men and women sitting in that quiet corner.

Go find them. I promise they are out there and I promise they are looking for somebody just like you to share this event with. Only you can make that happen!


## Implement What You Learn

In the midst of all this human interaction and learning, you need to find the time to make a success of the event. You need to attend the classes you had identified coming in as being important, you need to see the demonstrations, meet with those targeted vendors and you need to accomplish the things you had set out to accomplish. Constantly remind yourself why you are there.

A sobering reality I used to run into in the aftermath of these types of events is in that far too often nothing changes. We diligently went into the event with a plan, fully participated, made some great contacts and friends and when we get back to our shop we dive back into our daily routine and forget about our big plans and new strategies. Michael LeBoeuf, an American writer, management consultant and professor said, "Waste your money and you're only out of money, but waste your time and you've lost a part of your life."

When do you think would be a good time to get serious about what we are doing here and what we are trying to accomplish? I vote for right now.

The only difference between you and that great shop owner across town is that he is committed, in everything he does, to getting better. What are you committed to?

That bar and that Scotch will be there whether or not you are committed to doing something better for yourself, or for your staff and or even for your business. Changing your results might be no more complicated than changing your actions. What could be the benefit if you went to one of these events to learn or to explore ways to improve your operation? I'm just saying... 



**BRIAN  
CANNING**  
CONTRIBUTOR

Brian Canning is 30-year veteran of the automotive repair industry. He has been a leadership coach, Goodyear service manager, retail sales manager for a distributor, run a large fleet operation and headed a large multi-state sales territory for an independent manufacturer of automotive parts.

 Email Brian at [brimarc@hotmail.com](mailto:brimarc@hotmail.com)

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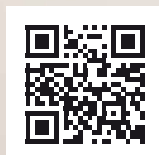
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# STOP SELLING & GET CUSTOMERS TO BUY

REWORKING THE PROCESSES USED AT THE FRONT COUNTER CAN MAKE THE REPAIR BUYING EXPERIENCE BETTER FOR SERVICE WRITERS AND CUSTOMERS.

BY CHRIS "CHUBBY" FREDERICK | CONTRIBUTOR

**OVER THE** past decade, many of you have noticed a major change in customers' buying habits. This month, our senior team leader to our coaches and instructors, George Zeeks, has several suggestions to help your customers invest in their vehicles.

We all know that the aftermarket auto shop scene has changed yet again. The way you present recommendations is different now than it was in 2007 or even 2011, and many

of the sales staff out there haven't caught up with the change yet. Top shops have a major reason they are top shops. They stopped trying to sell their customers and now they have conversations with them. Way too often I see "salespeople" who are great at "selling" the customer. In fact, they are so great at overcoming objections that they shortcut the sales process just to get to the end so they can start doing what they are great at. The issue is that they don't even realize they are creating their own problems.

## The Short Sell

I understand what it's like at the counter when the world is crazy busy. The temptation to hurry through the presentation can be overwhelming. But the idea that you're really doing the customers a favor by giving "fast" customer service is the beginning of the end.

Customers deserve a complete explanation of what is going on with their car. The biggest problem comes when you don't fully explain what you are talking about. Car repair and maintenance isn't cheap and it's not going to get any cheaper. Your customers want and deserve a complete, clear description of the things that they need. I cringe when I hear a service advisor recite a laundry list of the things that are needed on a car, with no explanation, and then quote the price. It's no wonder that people start asking a ton of questions or say "I need to think about it."

Of course they do; you have failed to tell them what they need in a way they can understand. The salesperson now goes into full sales mode and begins to launch into a litany of reasons why the customer has to have the repairs done right now. This is their idea of overcom-



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# The "Race For The Chase" Is On..... Federated Will Be There



Federated Auto Parts is honored to once again sponsor NASCAR's "Last Race Before the Chase."

This year's Federated Auto Parts 400 Sprint Cup race is being held Sept. 7 at the Richmond International Raceway and will be seen nationally on ABC-TV.

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## “WHO WOULD MAKE A BETTER SERVICE ADVISOR, AN EXTROVERT OR AN INTROVERT? ACTUALLY THE ANSWER IS AN AMBIVERT: SOMEONE RIGHT IN THE MIDDLE WITH THE BEST QUALITIES OF BOTH.”

CHRIS “CHUBBY” FREDERICK [ATI CEO]

ing the objection; but they fail to realize that by not doing their job right the first time, they have created the quagmire they are stuck in.

### The Technocrat

In my youth, I once tried to impress a young woman by taking her to a French — down to the menu in a foreign language — restaurant. With the false confidence of my four semesters of high school French, I felt sure I could navigate this strange new dining adventure. During our pre-meal small talk, I paid close attention to the plates arriving at the tables nearby. I sort of remembered one word that I saw on the menu, poulet, but no amount of head scratching would bring back a clear picture.

I asked the waiter if this was chicken. He did a fantastic job of making me feel foolish and out of my league when he replied, “Oui, poulet,” in the worst fake French I’ve ever heard. And he did a great job of looking at me like an unwashed peasant. So I did what I do best. I caused a minor scene by flipping \$5 on the table for the rolls we had eaten, thanked him for the drinks that never came and we left.

What does this have to do with an auto shop? Everything. Your customers don’t want a technical answer, they want to understand. They don’t want or need to know that the fuel injector should be open for 4 to 7 milliseconds and theirs is allowing too much fuel to pass through. Try painting a word



picture that reflects things people see every day and you’ll have better results. How about this: “Have you ever tried to use a bottle of Windex and instead of the fine mist you were looking for, it just kind of ran down your hand? That’s sort of what your fuel injectors are doing.”

Everyone wants to understand what they are buying or they just won’t buy it. If you continue to give technical answers, you end up with a bunch of questions and will hear the “I have to think about it” reply. Try as you might, you can’t overcome this objection since you really don’t get what is wrong.

### I’m Here, But Not for You

Ever buy something at a store and the clerk puts the purchase exactly halfway between you and them, so you have to reach for it to pick it up? That employee is more interested in the transaction and collecting the money than in you as a person. Everyone needs to remember we are not in the shop for the owner or the technicians or even for our own agenda. We are there for the customer.

In automotive, we can get so wrapped up in doing the paperwork just right or getting it done really fast that we fool ourselves into thinking

we are providing good service. Your customer wants to be appreciated as a person, not seen as just another car to work on. They crave conversation so they can tell you their concerns and feel that you have listened and understood.

Ask questions about how they drive and how far, and what they use the car for. This makes it clear that you want to understand them and their needs. Eye contact lets them know that “I see you and I’m here for you.” Staring down at your computer screen while you talk to them can’t ever do that. A smile gives them a feeling of warmth and value a nod of the head can’t provide on its own.

### Failure or Not: The Choice

It doesn’t feel like failure, since we checked all of our boxes and did the right things in the right order and in the time allotted, but it is. I’ve heard it said that it’s harder now to get people to fix their cars and people aren’t buying like they used to. Well, your customers want and are demanding more from you and your staff. The time has come when a simple laundry list of things that are needed just isn’t cutting it.

It might seem like this is going to take more time, but it really doesn’t. One of the best side effects of having conversations with your customers is that you’re going to enjoy your day and the job a whole lot more. If you would like a quick and simple checklist that will help you communicate better with your customers and have them buy more, go to [www.ationlinetraining.com/2013-8](http://www.ationlinetraining.com/2013-8). This is a limited time offer. **ZZ**

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Chris “Chubby” Frederick, CEO



CHRIS “CHUBBY” FREDERICK CONTRIBUTOR

Chris “Chubby” Frederick is the CEO and founder of the Automotive Training Institute. ATI’s 108 associates train and coach more than 1,150 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 George Zeeks, team leader and senior coach at ATI.

E-mail Chubby at [cfrederick@autotraining.net](mailto:cfrederick@autotraining.net)

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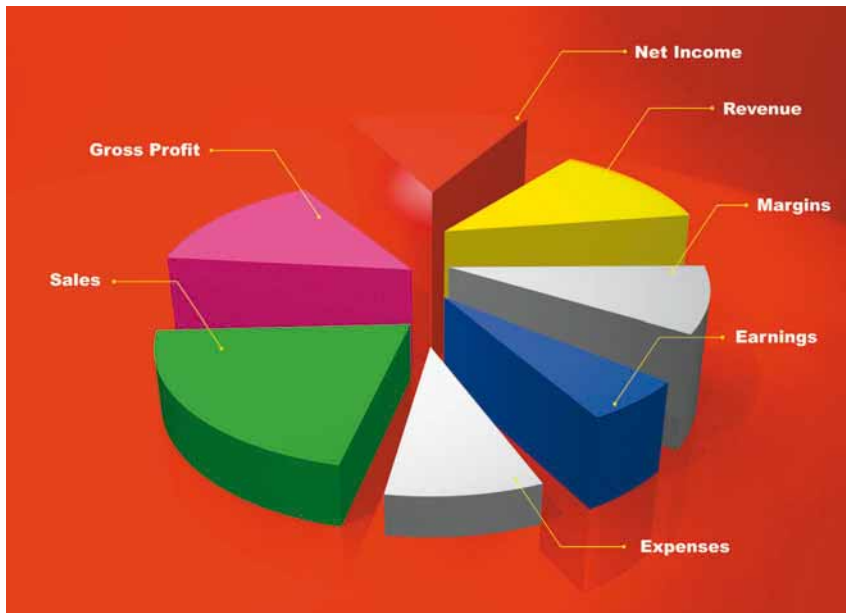
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# PIECES OF THE PIE

PARTS MARGINS AND MANAGING FOR SUCCESS — DO THE MATH AND YOUR SLICES WILL COME OUT CORRECTLY.

BY **BOB GREENWOOD** | CONTRIBUTOR



**SERVICE** shops and their jobbers are guilty of continuously cutting their prices without understanding the impact on their business.

At all levels, the industry is feeling enormous pressure from the margin squeeze on hard goods that has arrived at their doorstep.

The fact is the entire industry is in a race to the bottom in its pricing. This proves that the industry is more concerned about creating activity for today rather than building and sustaining profitability to ensure they are here tomorrow. Unless companies start changing their way of going to market, the industry fallout will continue, with thousands of people getting hurt. Remember we are in the people business. That is who we are. Yet the decisions being made on price, and the

actions being taken, are harming the very soul of our industry.

It seems that in too many service shops there is always some person who wants to cut prices. They perceive that if business is good, a lower price will help capture an even greater share of the marketplace. They also reason that if business is bad, cutting prices will help retain their existing share of the market.

Shops must clearly acknowledge one very important point: they cannot cut prices without cutting service or quality. It is impossible in our sector of the industry to be the very best and be the cheapest. In the service provider business we counsel that there are three things to base a business on: price, service and quality — pick two.

In either case, once you land on price, you have to give something that is critical to your business success up.

The fact is that most shop owners and most jobber owners do not charge enough for their products or services. When business is good, you need cash to fuel growth, cash that could be generated by higher margins. When business is bad, cutting prices often makes matters even worse. You have to increase sales significantly just to recover the dollars lost by the price cuts.

Cutting prices, or charging too little, can have a very disastrous effect on your business. Please consider the following example, and study the math:

Suppose that you sell 100 units of a certain item per month at \$1 each. They cost you 55 cents each, giving you a total gross profit of \$45 and a gross profit margin of 45 percent. Now, suppose you cut the price by 15 percent and your unit volume stayed the same. Your sales would now drop to \$85, your gross profit to \$30, and your gross profit margin to 35 percent.

To maintain your original \$45 gross profit after your price cut of 15 percent, you would have to increase your sales by 50 percent. Is it easy to increase sales by 50 percent in this industry? I don't think so. Is this line of thinking forcing people to work too hard? Absolutely! This is the mathematical formula to calculate the unit volume increase required if you reduce your

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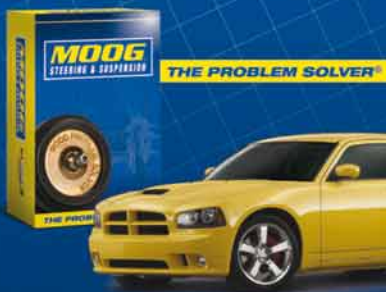


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price by 15 percent, with GPM representing gross profit margin:

*GPM percentage divided by (GPM percentage ± Price Change percentage) - 1 = Unit Volume percentage Change*

OR

*.45 (current margin) Divided by .30 (which is .45 margin - .15 price decrease) - 1 = .50 percent Unit Volume Increase*

With this price-chopper scenario, you would need to sell 150 units instead of the 100 units per month you are currently selling just to stand still. This is working harder rather than working smarter.

Slow down and do the math. It most likely would make more sense to invoke a price hike and bring value. If instead of lowering the price of the item, you raised it by 15 percent, and your unit volume stayed the same, your sales would go up to \$115 and your gross profit to \$60. To calculate out how much your sales would have to fall off before your gross profit in dollars would drop below the original \$45, you use the same formula, but this time add, rather than subtract the price change percentage.

*.45 (current margin) Divided by .60 (which is .45 margin + .15 price increase) - 1 = .25 percent Unit Volume Decrease*

In other words, you were selling 100 units before the price increase, and the mathematical formula is now telling you that you could let your unit volume drop to 75 units (100 - 25 = 75) if need be in worst case scenario, and you would end up making the same dollars by selling less.

That is working smart rather than hard. Price cuts must generate large, often impossibly large, increases in unit volume to regain lost gross profit dollars.

Working smart allows you to spend time with the client and build the relationships that are required today to secure all his/her business. When you are too busy because you have to move a significant volume to recover lost dollars, you do not have the time for your client. There is no way you can develop a professional business relationship on the fly. If the unit volume dropped to 80 units after the price increase, you are actually making more by selling less with the price increase. Once again I must ask, are you interested in creating activity or sustainable long-term profitability?

By using this formula, you quickly can calculate the changes you would need in sales volume to maintain the gross profit dollars after a price increase or decrease. This exercise should be a must before any service shop, or jobber, lowers his prices or has a sale.

You will see that price cuts must generate large — often impossibly large — increases in unit volume to regain lost gross profit dollars you are giving up.

On the other hand, price increases can sustain large decreases in unit volume and still improve gross profits of the business. I don't know about you but I have to pay out my expenses out of "gross profit" not "sales." In spite of this example, many service providers and many jobbers continue to under-price their products and services to remain "price competitive." This is a habit and common practice with many shop owners and jobbers in financial trouble. They just don't get it yet.

When sales are slower than you would like, it takes knowledge and creativity to turn a situation around without sacrificing margins. The main question must still be asked: who are we selling to, and what value do we bring to the table for the price we are charging?

The better business people in our industry look to price cuts as the last resort, not the first point of attack. Do the math in your shop and get off the emotional bank account. Math does not lie.

A successful entrepreneur is motivated by the desire to achieve excellence in business quality, service and building long lasting relationships, not by the desire to beat others on price. Reconsider your position, and truly evaluate where your company stands. **ZZ**



**BOB  
GREENWOOD**  
CONTRIBUTOR

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 AAM approved instructors.

E-mail Bob at [greenwood@aaec.ca](mailto:greenwood@aaec.ca)



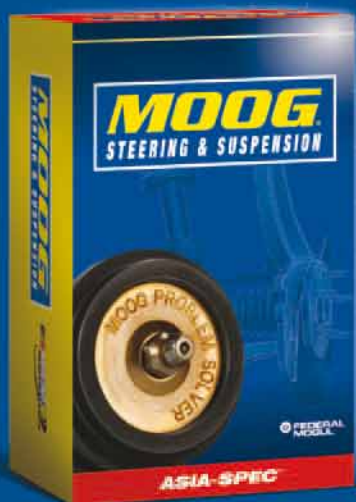
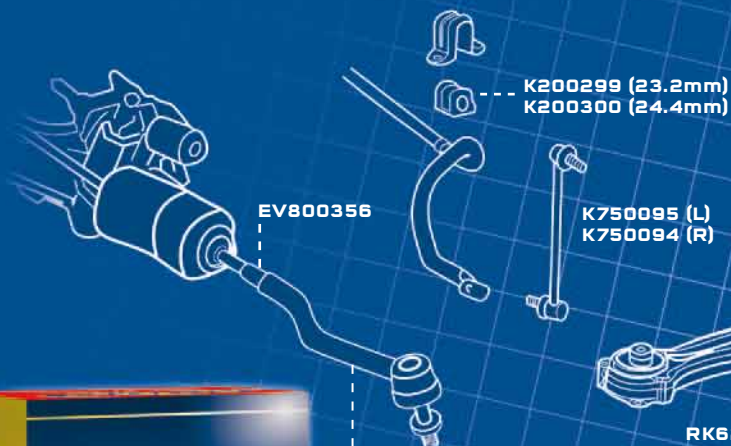


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- K750095 (L)
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- K200299 (23.2mm)
- K200300 (24.4mm)

EV800356

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ES800512 (L, HYBRID)

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RK620195 (L, INC. BALL JOINT)

RK620196 (R, INC. BALL JOINT)

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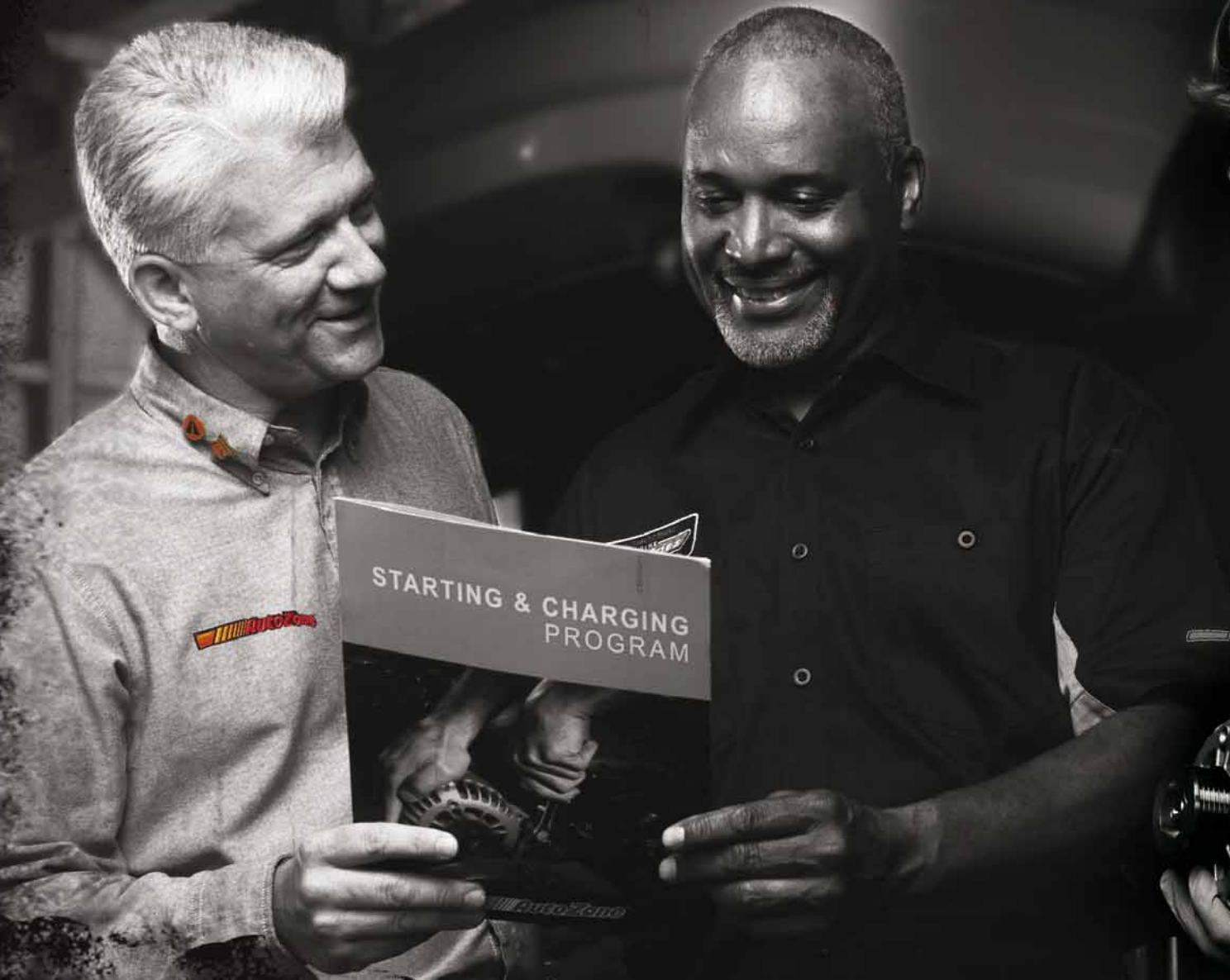


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## OPERATIONS

## SHOP PROFILE

A snapshot of one of the industry's leading shops

BRITISH AMERICAN AUTO CARE / COLUMBIA, MD.



# Their finest hour

British American is the perfect reflection of its owner.

BY **ROBERT BRAVENDER** | CONTRIBUTOR

It's somehow gratifying to go into a shop named British American Auto Care and be greeted by an owner/manager named Brian England, who indeed sports an accent from across the pond. But besides enchanting the inner Anglophile, the shop has a solid rep for repairing European and Asian autos.

Located outside Washington, D.C., in Columbia, Md., this former Range Rover tech not only expanded his service line, but has refined his understanding of the market to the point where his company earned the Maryland Business of the Year and the Maryland Businessman Award in 2003 and 2004, respectively.

For one, England has promoted the importance of preventive maintenance with consistent, quality automotive repairs "from day one," he affirms. "We want to be responsible for the maintenance of our customer's vehicles and to make sure they are safe and reliable."

Shop productivity is monitored via three reports generated by noon daily. "The whole shop has a breakeven target to reach," he says. "When that has been reached, each technician (as well as office staff and service writers) can earn a bonus based on their efficiency."

Secondly, England has focused on "inbound marketing," as outlined in a book of the same name by Brian Halligan and Dharmesh Shah. As he puts it,

traditional marketing might entail putting an ad in the local paper, but inbound marketing is based on a strong web presence, drawing customers to you through search engines and social networking.

"Anyone who does things like Facebook and Yelp or searches for recommendations, that is inbound marketing," England explains. "I'll give you an exact example: I write a blog on the Maryland state inspection, and what happens is we have a landing page of that on our website. As people search for Maryland state inspection, they will find my blog, then we will draw them in, just like fishing. There they can download a little booklet about how to get the state inspection done and the process for getting your car titled and taxed; it's a whole way for bringing people inward as opposed to the traditional 'outbound' way."

Implemented about three years ago, British American's website was updated utilizing programs like Groupon, Yelp, the aforementioned blog, and HubSpot (from a namesake company founded by

## AT A GLANCE

**British American Auto Care**

Shop name

**Brian & Jenifer England**

Owner

**Columbia, Md.**

Location

**1**

Number of locations

**35**

Years in business

**18**

Total number of employees

**6**

Number of technicians

**13,600 square feet**

Shop size

**18**

Number of bays

**110**

Average vehicles per week

**\$400**

Average weekly repair ticket

**\$2.2 million**

Annual gross revenue

**ASA, WMDA, ACDelco, Bosch**

Shop affiliations

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Halligan and Shah). In a two-year span, website visits per month doubled.

Photos: British American Auto Care

But with all the changes wrought over the years, does the name British American still make sense? "Not if you talk to our marketing people," he laughs. "We've discussed trying to change it, but we've been in business in Columbia under that name since 1978, so why change it? If someone asks why it's British American, I say, 'Well I used to be British, now I'm American.'"

Early on, their lease actually stated they had to specialize in British and American cars, but that's because of the planned community of Columbia.

Founded in 1967 by visionary developer James Rouse, every aspect of the town was thought out before construction began. "It's a very inclusive com-



The customer waiting area.

munity," England says. "(Rouse) would not allow anyone to redline anything. It was one of the first places which became a magnet for all people, all races."

Shortly after emigrating to the U.S., England and his wife moved to Columbia in 1973. They incorporated their shop in 1976, but didn't open until 1978; it took two years just to find a location. "It's not very easy when you have a planned city," he admits. "You could go into the little industrial areas, but they weren't very suitable for auto repair."

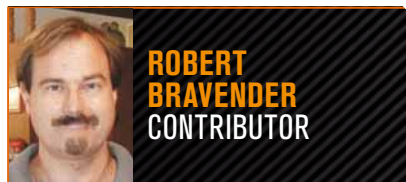
Then the city adopted an idea used in California: automotive services gathered together in an auto park. Specialties were arranged like a shopping mall; one garage might work on German makes, another shop might do detailing. England did business there until the city built another auto park; they moved there for a decade before they had the opportunity to build a shop in an area zoned for auto repair.

"In the last two auto parks, we were tucked away," says England. "(The increased visibility) helps somewhat, but we're still in an industrial park; it's not like being on a highway."



There are 18 bays in all at the shop.

"It levels the playing field for all of us," he maintains. Location has not been an issue or a factor of doing business in Columbia. *ZZ*



**ROBERT BRAVENDER**  
CONTRIBUTOR

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

Email Robert at [rbravender@comcast.net](mailto:rbravender@comcast.net)



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Beginning with 2009 MY, GM replaced the external NSBU switch.

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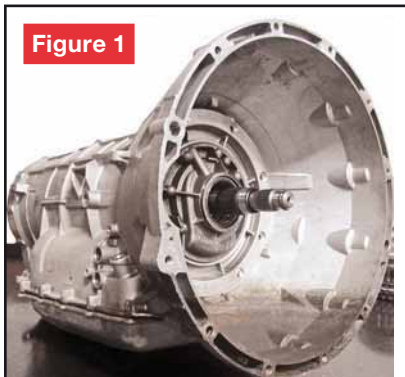
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# Introducing Ford's Torqshift 6 Transmission

**THIS BIG TRANSMISSION HAS SOME CHANGES IN STORE FOR YOU.**

BY **WAYNE COLONNA** | POWERTRAIN PRO PUBLISHER

**A RECENT** transmission by Ford to hit the streets is an upscale version of their 5R110W transmission called the 6R140W. This transmission is also referred to as the Torqshift® 6 (Figure 1).



**Figure 1**

Introduced at the start of 2011 MY production, this newly designed, full-time, six-speed transmission found its way into the F250 to F550 Super Duty truck models with the 6.2L Gas Flex Fuel engine or the 6.7 Turbo Diesel engine.

These vehicles are available in both 2WD and 4WD configurations along with a Power Take-Off option.

This is one beefy transmission weighing in at around 350 pounds using the Lepelletier gear-train.

The 6R140W is electronically controlled by seven pulse width modulated (PWM) solenoids and uses an external Transmission Control Module (TCM) in diesel powered applications or an external Powertrain Control Module (PCM) for gasoline powered applications.

When the TCM/PCM detects a fault, Failure Mode Effect Management (FMEM) is initiated and the transmission enters fifth and reverses gear limp mode. The transmission system is capable of Tow Haul Mode, which provides all six speeds at higher shift points and also has manual shift capability.

**Failsafe**

If an electronic, hydraulic or mechanical transmission malfunction occurs, the PCM or TCM will turn off any current to the transmission. This leaves reverse and fifth gear as the only available gears and TCC will be unlocked. With SSB, SSE and the LPC Solenoids being normally high, fifth gear with maximum line pressure is achieved hydraulically when current is removed from the transmission (Figure 2, page 36).

**Calibrated Solenoids**

An interesting departure from its 5R110W predecessor is the use of calibrated solenoids. Each of the seven solenoids mounted on the rear of the valve body (Figure 3, page 36) will have a band number on the solenoid to indicate its calibration (Figure 4, page 36).

The seven solenoids used are:

- SSA is a Normally Low (NL) solenoid that operates the Forward Clutch for first through fourth gears.
- SSB is a Normally High (NH) solenoid that operates the Direct Clutch for third, fifth and reverse gears.
- SSC is a Normally Low (NL) solenoid that operates the Intermediate Clutch for second and sixth gears.
- SSD is a Normally Low (NL) solenoid that operates the Low and Reverse Clutch for first, manual low and reverse gears.
- SSE is a Normally High (NH) solenoid that operates the Overdrive Clutch for fourth, fifth and sixth gears.
- TCC Solenoid is a Normally Low (NL) solenoid used to control the apply and release of the torque converter clutch.
- LPC Solenoid is a Normally High (NH) solenoid used to control main line pressure via the pressure regulator valve in the valve body.

In totality there are three Normally High (NH) solenoids and four Normally



**WAYNE COLONNA**

is President of the Automatic Transmission Service Group (ATSG) in Cutler Bay, Fla., and a frequent speaker/instructor for transmission training around the globe.

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Low (NL) solenoids. If a new solenoid is needed, it is imperative that the correct style solenoid (NH or NL), and its correct location, is exchanged with the same band calibration number of the solenoid being replaced. The band number printed on the solenoid will be 2, 3, 4 or 5.

There are four part numbers for NH solenoids and four part numbers for NL solenoids. They are as follows:

Solenoid Band Number	Normally High Solenoid part No.	Normally Low Solenoid part No.
2	BC3Z-7G383-K	BC3Z-7G383-S
3	BC3Z-7G383-L	BC3Z-7G383-T
4	BC3Z-7G383-M	BC3Z-7G383-U
5	BC3Z-7G383-N	BC3Z-7G383-V

All solenoids measure 4.8 to 5.4 Ohms

### Solenoid Body and Strategy Identification

The flow rate calibrations of these solenoids are not the only items to be attentive to when rebuilding this transmission.

There are two labels on the outside of the case. The left side of the case has the transmission ID tag (Figure 5), while the right side has a solenoid body tag (Figure 6). This solenoid body tag contains an 8-digit solenoid body



ID number and a 13-digit solenoid body strategy ID number. This tag needs to be compared with the tag mounted on the valve body next to the solenoid closest to the manual valve (Figure 7). This tag contains an 8- and 13-digit number, and they must be the same as the outside tag.

If the tag on the valve body does not match the solenoid body tag on the outside of the transmission, the solenoid body strategy will need to be programmed into the PCM/TCM as shift feel may be compromised. Likewise, a reprogramming will be necessary if the solenoid body (valve body) assembly is exchanged with a new or used one as part of the rebuild or repair.

In all honesty, I am reporting to you what has been written about these tags so you can avoid shift problems after a rebuild.

But what I would really like to write about is why Ford has chosen this method. I have asked others about this so I could better appreciate its strategy but I have yet to find someone who really knows.

I only have received speculation as to the purpose of such a design. It has been suggested that specific combinations of calibrated solenoids have been assembled together as a set and are identified by the 8-digit number. The 13-digit number represents the necessary computer strategy to match that particular solenoid combination.

It sounds logical and should it have merit, why is there a need for a vari-

ety of solenoid sets and related shift programming since the transmission is only behind two different engines? Could it be related to GVW as well? If and when I receive insight to this method of calibration and shift strategy matching I will certainly pass it on.

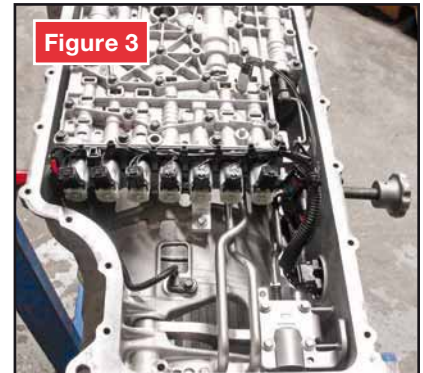


Figure 3



Figure 4

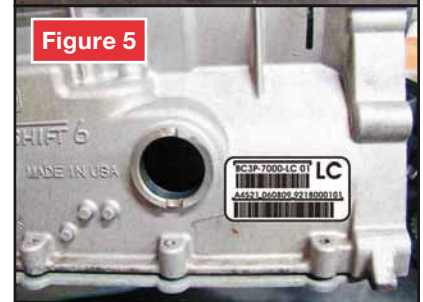


Figure 5



Figure 6

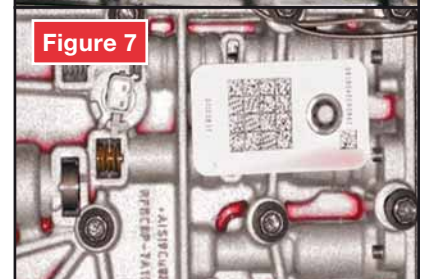


Figure 7

SOLENOID APPLICATION CHART							
Selector Lever Position	Commanded Gear	1-2-3-4 (SSA) NL	3-5-Rev (SSB) NH	2-6 (SSC) NL	1-Rev (SSD) NL	4-5-6 (SSE) NH	Torque Converter Clutch NL
P	P	Off	On	Off	On	On	Off
R	R	Off	Off	Off	On	On	Off
N	N	Off	On	Off	On	On	Off
D	1	On	On	Off	Off*	On	On/Off*
	2	On	On	On	Off	On	On/Off*
	3	On	Off	Off	Off	On	On/Off*
	4	On	On	Off	Off	Off	On/Off
	5	Off	Off	Off	Off	Off	On/Off
L	L	On	On	Off	On	On	Off





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### Adaptive Drive Cycle

The 6R140W utilizes an adaptive drive cycle to insure continuous shift quality and therefore must have the shift adapts reset when repairs are completed and/or when the solenoid strategy is changed. The Adaptive Drive Cycle is as follows:

1. Using a scan tool, clear the TCM KAM, Do NOT clear the PCM KAM.
2. Make certain transmission temperature is between 180°F and 200°F (82°C to 93°C).
3. With the engine running and the brakes applied, move the selector lever in the following sequence paus-

ing between each position for four seconds beginning in neutral as follows: N-R-N-D-R-D-N. Repeat this sequence two more times.

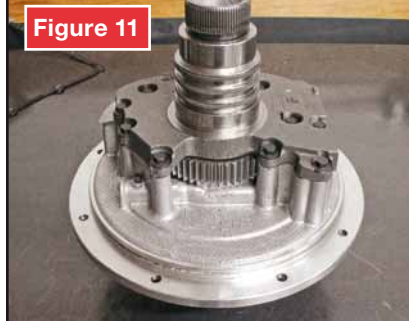
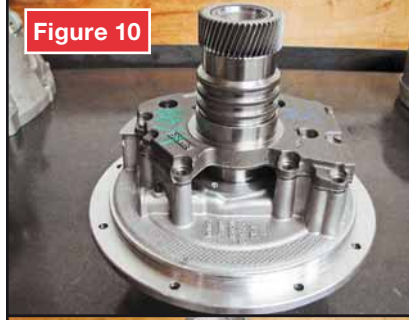
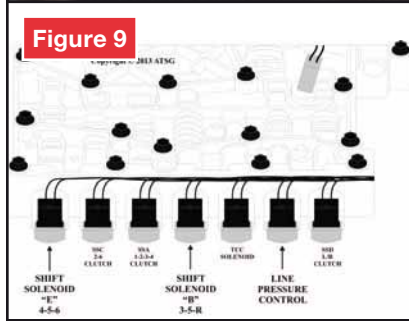
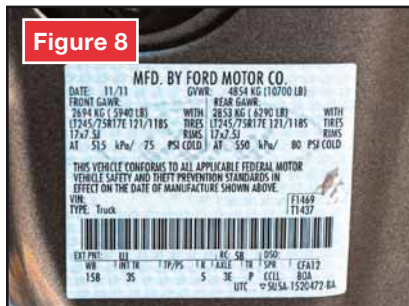
4. Accelerate at moderate throttle so each shift occurs around 2,000 rpm for gas engines and 1,500 rpm for diesel engines up to 65 mph (105 k/mh). Brake moderately to a stop, repeat this sequence two more times.

5. Accelerate at moderate throttle so each shift occurs around 3,000 rpm for gas engines and 2,250 rpm for diesel engines up to 65 mph (105 k/mh). Repeat this sequence two more times.

6. Come to a complete stop.

7. With the engine running and the brakes applied, move the selector lever in the following sequence pausing between each position for four seconds beginning in neutral as follows: N-R-N-D-R-D-N. Repeat this sequence two more times.

8. Cycle is complete



### 2-3 Flare Concern

Ford trucks using the 6.7 Turbo Diesel engine with the 6R140W transmissions has been known to develop a 2-3 shift flare concern. The wrench light may be lit along with a possible delayed engagement into reverse and a third gear ratio code P0733 stored.

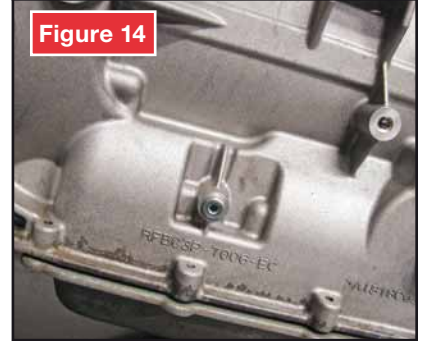
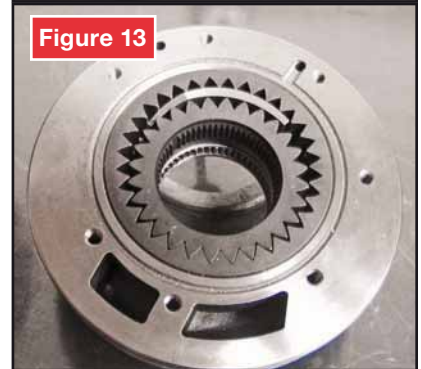
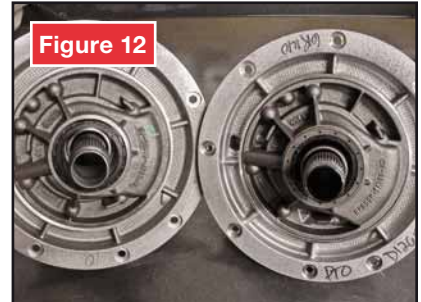
Ford has identified two possibilities for the cause of this concern. One cause may be due to mechanically faulty solenoids while another may be related to computer programming.

To identify the cause and proper repair, locate the build date on the door jam sticker (Figure 8). If the build date is on or before 11/19/10, three of the transmission solenoids will require replacement. The faulty solenoids are:

1. The 4-5-6 Solenoid (SSE)
2. The 3-5-Reverse Solenoid (SSB)
3. The Line Pressure Control Solenoid (LPC)

These three solenoids (Figure 9) are the NH type and cannot be interchanged with a NL type of solenoid. Remember each solenoid has a Band Number on the solenoid body (Figure 4). The replacement solenoid must have the same Band Number as the one being replaced because they are calibrated to the valve body and the vehicle computer programming.

If the build date is between Nov. 20, 2010, and April 11, 2011, then all that



will be required is a reprogramming using IDS Release 73.02 or higher.

### PTO or Non PTO – Delayed engagement concern

These vehicles may be equipped with a Power Take-Off option. The pumps are designed to provide this option by simply adding a gear to be driven by a clutch in the torque converter (Figures 10, 11 and 12). For greater durability, the converter neck is supported by a caged needle bearing in the pump body. The inner pump gear is a spline drive design as well (Figure 13).

Some pumps built on or before July 25, 2012, can cause a delayed engagement into drive or reverse due to a loss of prime. The delay occurs only during the initial engagement after sitting for two or three hours.

To further verify this condition being caused by the pump, place a gauge on the line pressure tap located on the left



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**Figure 15**

Gear Position	Actual Line Pressure - PSI (KpA)			Line Pressure Control (L/EPC) - PSI (KpA)		
	Idle Gas & Diesel	WOT Gas Only	WOT Diesel Only	Idle Gas & Diesel	WOT Gas Only	WOT Diesel Only
P/N	90 (619)	—	—	14 (94)	—	—
R	90 (619)	240 (1675)	260 (1790)	14 (94)	60 (410)	70 (480)
D	90 (619)	230 (1600)	225 (1550)	14 (94)	55 (375)	55 (375)
3	90 (619)	180 (1230)	160 (1100)	14 (94)	40 (275)	35 (240)
2	90 (619)	240 (1675)	235 (1650)	14 (94)	60 (410)	60 (410)
1	90 (619)	230 (1600)	225 (1550)	14 (94)	55 (375)	55 (375)

*Actual and commanded pressures can vary based on calibrations and adaptive strategies.*

side of the case (Figure 14). Caution: The line pressure tap is an M10 X 1.00 thread. Do not use a National Pipe Thread (NPT) fitting when installing a pressure gauge. If a NPT fitting is used, damage to the transmission case will occur.

After the vehicle has been parked for three or more hours, step on the brake, keep an eye on the pressure gauge, start the vehicle and immediately select the reverse gear. If a delay into reverse took place while simultaneously the pressure gauge read less than 10 psi, the pump will need to be replaced.

A pump with the PTO gear part number is BC3Z-7A103-E.

A pump without the PTO gear part number is BC3Z-7A103-F.

**Intermittent Harsh Shifts**

Figure 15 is a pressure chart that can be used to verify proper operating transmission pressure. This can be a bit tricky if you are dealing with intermittent harsh up-shifts or downshifts. Some trucks built on or before Jan. 9, 2012, might exhibit this condition and will require re-programming the control module (PCM/TCM) to the latest calibration using IDS release 81.01 and higher.

**Transmission Range Sensor is a Duty Cycle Signal**

As was the 5R110W, the 6R140W also uses a transmission range sensor that provides a duty cycle signal to the computer for it to know what gear range has been selected. It is a three-wire device that has a 12-volt supply, a ground and

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**Figure 16**

**Figure 17**

TRANSMISSION RANGE SENSOR LOGIC	
Selector Lever Position	TRS Range (% Duty Cycle)
P	13.3 - 15.5
R	33.2 - 34.5
N	40.0 - 46.6
D	58 - 60.5
M	69.0 - 70.5
2	80.0 - 90.5
1	85.5 - 95.0

**Figure 18**

TFT RESISTANCE CHART		
DEGREES (F)	DEGREES (C)	RESISTANCE (K)
-40 to -4	-40 to -20	967 - 284
-3 to 31	-19 to -1	284 - 100
32 to 68	0 to 20	100 - 37
69 to 104	21 to 40	37 - 16
105 to 158	41 to 70	16 - 5
159 to 194	71 to 91	5 - 2.7
195 to 230	91 to 110	2.7 - 1.5
231 to 266	111 to 130	1.5 - 0.8
267 to 302	131 to 150	0.8 - 0.54

the duty cycle signal line. The transmission has a 19-pin pass-through case connector with all of the internal electrical components going to the 50 pin PCM C175T connector or the 60 pin TCM C1750 connector. Use the chart in Figure 17 of duty cycle values along with the pin identification provided below:

TRS Sensor	19 Pin Case Connector	50 Pin PCM C175T Connector	60 Pin TCM C1750 Connector
Power Supply	12	3	20
Ground	10	41	46
Duty Cycle Percent	13	12	45

If a vehicle is used where snow or mud can get up into the shift lever area of the transmission, moving the selector lever in and out of gear may become difficult. In these cases, Ford has made available a bracket with shield to prevent this from reoccurring. Refer to Ford's TSB 11-11-24. The bracket is part No. BC3Z-7B229-B and clip 4C3Z-7H181-AA

### Speed Sensors

The Turbine (TSS) and Output (OSS) Speed Sensors are both Hall Effect Types and share the same power and ground circuits as the TRS.

The 0 to 5 volt pulsed signal for the TSS is sent to terminal 1 at the PCM or 50 at the TCM from terminal 11 in the case connector. The 0 to 5 volt pulsed signal for the OSS is sent to terminal 14 at the PCM or 51 at the TCM from terminal 17 in the case connector.

### Transmission Fluid Temperature Sensor

The transmission fluid temperature sensor is a negative coefficient type sensor being a two wire thermistor containing a ground circuit and a 5 volt signal circuit. The 5 volt signal will drop as the thermistor's resistance drops with heat. A voltage drop on this sensor can be observed at the PCM terminal 20 or the TCM terminal 54. Typically 4.50 volts is observed when cold to approximately 1.2 volts at operating temperature.

Figure 18 provides a sensor resistance chart in relationship to temperature.

### Transmission Fluid Spec

Fluid level is to be checked at normal operating temperature (180-200°F). Factory recommended fluid is Mercon® LV.

Early Build – Diesel, 18 quarts (17 Liters); Gas, 19 quarts (18 Liters)

Late Build – Diesel, 16.2 quarts (15.3 Liters); Gas, 17.2 quarts (16.3 Liters)

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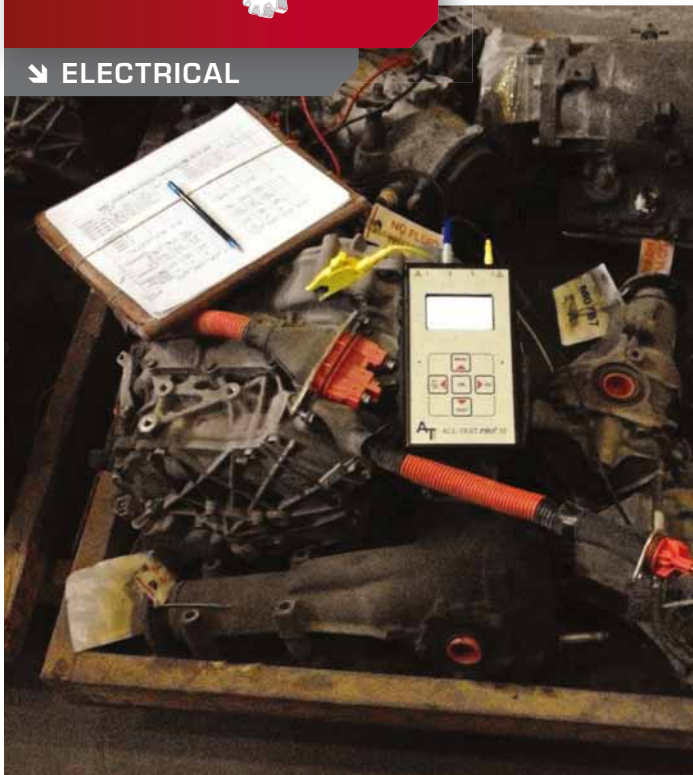
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**MOTOR-GENERATOR WEAKNESSES MIGHT HIDE FROM  
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BY **MARK QUARTO** | CONTRIBUTING EDITOR

**A**s hybrid and electric vehicle systems age after more than 12 years in the market, determining electric transaxle or transmission state-of-health (SOH) and/or confirming that a catastrophic event has occurred is becoming a more important aspect of the aftermarket service industry and those who service electric transmissions.

As the aftermarket continues to become more of an option to hybrid owners for service, it becomes more important to ensure that determining SOH or confirming an electric motor-generator unit (MGU) has reached its end-of-life (EOL) becomes a repeatable and reliable process.

Just as the calendar time or mileage (aging) that an engine failure occurs can vary dramatically due to a variety of factors (drive cycle, geographic loca-

tion, or maintenance performed, for example), so too can the overall life of an MGU be similarly affected.

However, many of the factors impacting the useful life of an MGU can statistically be used to help determine general EOL expectations. In my 26 years of developing, testing and servicing electric drive and battery pack systems, rarely is there an opportunity to test MGUs with a wide range of mileage and chronological ages in one location that can be tested in a single day. When presented with the opportunity to acquire this type of test data, I immediately agreed to perform the testing.

**Background Information**

- Test date: Nov. 15, 2012
- Test & Data Acquisition Engineer: Mark Quarto
- Test Location: Midwest recycling/

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salvage business that specializes in hybrid electric vehicle components

- Toyota Prius Transaxle Type: Generation II
- All transaxles tested were removed from the vehicle and stored in a warehouse on pallets. (Note: The MGUs could have been tested with the transaxle installed in vehicle or out of vehicle.)
- Number of transaxles in test population: 20
- Mileage ranges of test population: 28,000 to 148,000
- Model Year ranges of test population: 2004 to 2009
- MGUs tested: MG1 and MG2
- Number of tests on each MGU to acquire data: One (1)
- Testing temperature: 5.5°C (42°F)
- Humidity: 58 percent

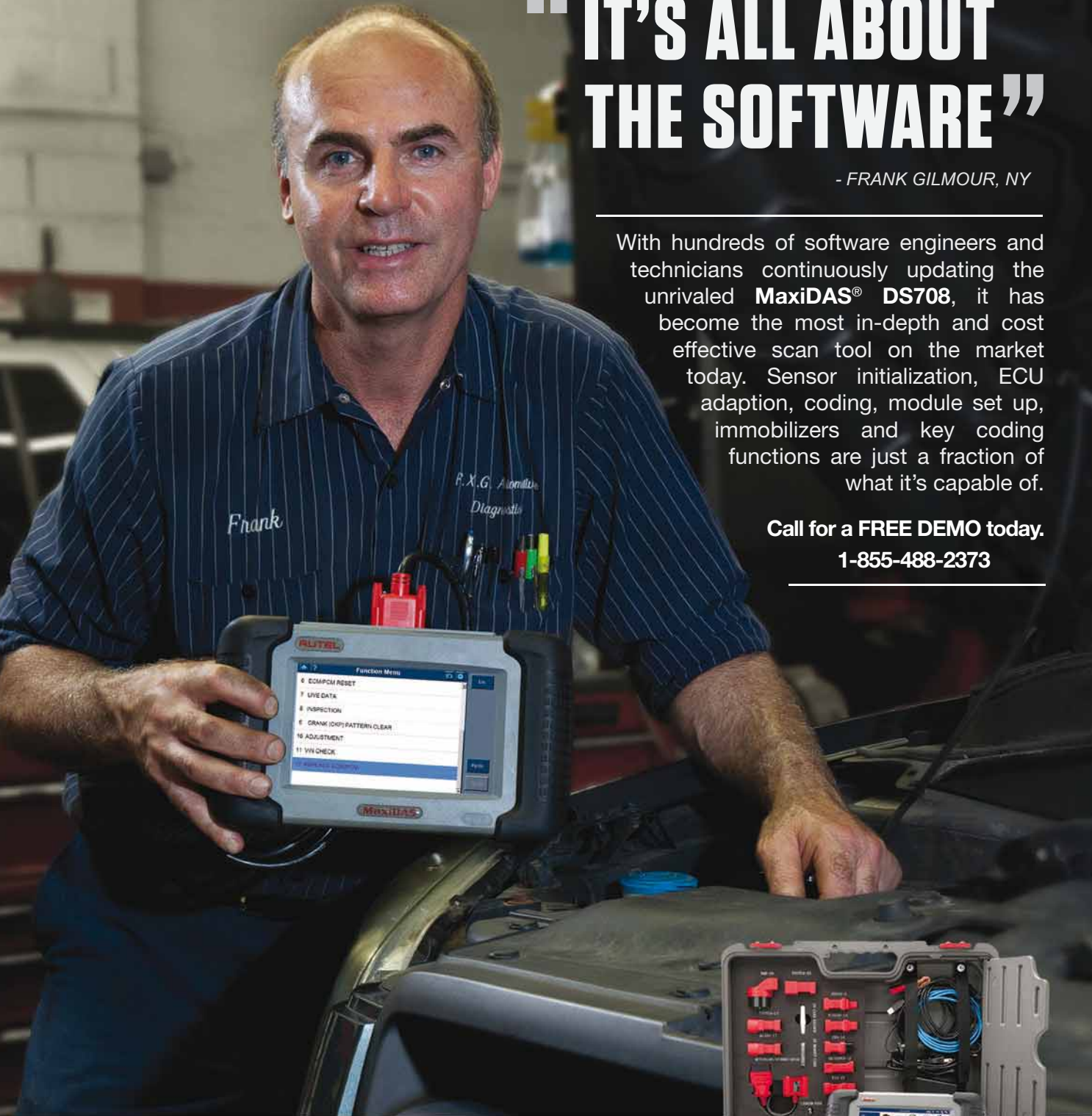
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## Instrumentation and Data Acquisition

- MS Excel – Entering/compiling test data and calculating statistical values.
- All Test Pro 33EV (AT33EV) – Motor Circuit Analysis tool to acquire motor test data.
- IEEE 56, 118 and 120 cover Motor Circuit Analysis testing methods, including how data is collected by instrumentation.
- Rationale for instrument selection: AT33EV scored the highest of five (5) MGU testing methodologies in a General Motors (GM) internal study of MGU test instrument prognostic and testing capabilities. It also scored the highest in a study performed by an external GM electric motor testing supplier when the study was replicated to ensure repeatability of test results and instrument performance. The study results were summarized in two articles and can be downloaded and reviewed at <http://www.autoresearchanddesign.com/techinfo.php>.
- Instrument testing parameters acquired by instrument to determine MGU SOH: Direct Current (dc) Resistance (milliohms), Inductance, Impedance, Capacitance, Phase Angle, Current-Frequency Ratio, Dissipation Factor (contamination), and Insulation Resistance.

- Test results provided by instrument:
  - o Phase winding dc resistance expressed in Ohms of Resistance – this data will be utilized to test for internal motor connections (i.e., corrosion, loose crimp connections, etc.). The dc resistance can also be used to indicate very severe internal coil (copper-to-copper) shorting or more severe phase-to-phase shorting (intra or inter phase winding failures). The dc resistance test is ineffective in identifying less invasive copper to copper shorting and will not



The TVS value, as a comparison to a reference value, can measure the SOH of the stator and rotor.

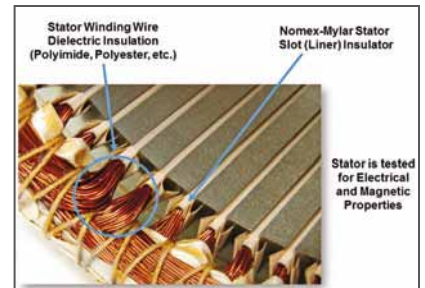
assist in determining winding/stator slot aging.

- o Insulation Resistance (IR) Testing expressed in Ohms of Resistance – the IR test is observed and compared to the elapsed time to achieve its highest resistance level to determine the insulation to ground resistance barrier.

- o Dissipation Factor (DF) – expressed in percentage (derived from inductance, impedance and phase angle and capacitance measurements) is the measure of the dielectric (insulating) losses in an electrical insulating material in an alternating (current) field and the resulting energy dissipated as heat. DF is used as a means of measuring changes in MGU phase winding wire coating (dielectric varnish or enamel) quality state, wire-to-wire and phase-to-phase dielectric quality state, and stator slot liner insulation (dielectric) quality state to identify any insulating losses due to contamination and/or deterioration (aging).

Contamination is/can be a cumulative effect and is derived from micro elements of aluminum, steel, friction material, oil contaminants, plastics, moisture, etc. that provides a medium in which energy can transfer between phase wires, phase windings, between phase windings and stator slot liner insulation, or between phase winding wires the slot liner insulation and MGU back-iron (i.e., stator lamination stack) that is electrically common with the vehicle chassis. This results in weakened/aged phase winding coating and/or slot insulator (dielectric) materials. Since a (final) catastrophic failure of an MGU can be the result of cumulative contamination during the course of its service life, DF test data results are an important prognostic/diagnostic metric to the user to assist in determining MGU insulation SOH.

- o Test Value Static (TVS) – a dimensionless number comprised of a sub-set of the aforementioned instrument testing parameters. The 3-Phase winding parameter test data is then calculated by software algorithms that provide a resulting numerical value to the user for determining 3-Phase MGU stator and rotor electrical and magnetic performance. The user compares the dimensionless number to a reference number (provided with the tester) for determining numerically how far the tested MGU data has drifted (or not)



The DV percent figure is a measurement of the insulating losses in the motor-generator.

from new MGU test data of the same type or generation of transmission. The TVS value also eliminates the need for rotating the MGU by rotating a wheel or pushing a vehicle to test the 3-Phase stator windings, rotor magnets or rotor bars, and shorting rings.

- o MGU sub-system testing: AT33EV can test MGU rotor and stator SOH without rotating (spinning) the rotor.

- o Connection of AT33EV to MGU cables was accomplished by using three 0.375-inch diameter pure copper adapters with resistance in the low micro-Ohm range, knurled surfaces, and external threads (two adapters three inches in length and one adapter four inches in length) to permit repeatable instrumentation connection to MGU cables.

## Case Study Data Presentation

The MGU test data is presented in the two tables on page 58. The first table provides test data for transaxle MG1 (generator) while the second table provides test results on transaxle MG2 (drive motor). The table columns provide the following data (from left to right):

- Transmission sample number
- Vehicle Odometer reading from which transmission was removed
- Resistance 3-2 / 2-1 / 1-3: Resistance values when measuring Phases 3 to 2, 2 to 1, and then 1 to 3. The results of the resistance test are the comparison of the phase winding values to determine the overall resistance balance. The Institute of Electrical and Electronic Engineers (IEEE) Standards Document 1415-2006 states “the three (resistance) values are compared – all readings should be within 3 percent to 5 percent of the average of the three readings.” The standard values ensure that there is electrical dc (resistance) balance between all of the MGU phase windings.



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2004-2009 Toyota Prius MG1 Condition/SOH Based on Ω, DF, TVS							
Trans Sample#	Odometer	R32mΩ	R21mΩ	R13mΩ	DF%	TVS	Result
19-MG1	23,000	99.00	99.00	98.20	5.31	5.78	OK
17-MG1	28,000	98.50	98.30	98.10	1.25	5.92	OK
18-MG1	32,000	99.50	99.20	99.20	4.55	5.87	OK
12-MG1	34,000	98.00	97.00	98.00	3.08	5.66	W
14-MG1	42,000	98.30	98.40	98.90	2.55	5.83	OK
16-MG1	46,000	99.30	98.20	98.40	5.99	5.80	OK
13-MG1	48,000	99.30	98.70	98.30	7.06	5.76	OK
20-MG1	57,000	98.70	98.50	99.40	4.78	5.77	OK
15-MG1	59,000	98.10	99.50	98.90	1.56	5.97	OK
11-MG1	66,000	99.30	98.70	99.10	4.19	5.32	F
7-MG1	74,000	98.40	97.90	98.10	3.1	5.74	OK
1-MG1	88,000	98.40	98.90	98.60	2.98	5.75	OK
4-MG1	94,000	97.20	97.50	97.40	2.98	5.99	OK
8-MG1	97,000	96.90	96.40	96.70	3.32	5.97	OK
6-MG1	109,000	97.00	97.40	97.20	3.16	5.76	OK
5-MG1	110,000	98.10	97.60	97.80	3.14	5.69	W
2-MG1	113,000	97.60	98.10	98.00	3.14	5.94	OK
3-MG1	129,000	97.90	97.30	97.60	3.15	5.98	OK
9-MG1	130,000	97.80	98.30	98.10	3.15	5.87	OK
10-MG1	148,000	98.30	98.90	98.70	2.98	5.73	OK

**TVS values are used for determining 3-Phase MGU stator and rotor electrical and magnetic performance.**

▪ DF percentage (Dissipation Factor) – Is a number derived from AT33EV software algorithms that provide resulting contamination test data in a percentage (%) format for the user. The data utilized to determine MGU DF is capacitance (the primary element for DF testing), Inductance, Impedance, phase angle, and current-to-frequency ratio as additional electrical elements used by the software to scrub the data. In the data, DF is presented in percentage and capacitance units (%). However, to simplify data reporting in this article percentages will be utilized in three ranges:

- o ≤ 6 percent = Good (OK) – contamination within acceptable limits
- o 6 percent to 10 percent = Warning (W) – contamination is high but not out of limits
- o ≥ 10 percent = Failed/Failure (F) – contamination is excessive, out of limits

MGU winding contamination testing is covered in IEEE Standard 43-2000. IEEE 56, 118 and 120 cover Motor Circuit Analysis testing methods, including how data is collected by instrumentation.

▪ TVS (Test Value Static) – The TVS value permits testing of MGUs by comparing the test data to a reference (new) unit. (Editor’s note: The base reference values for the Gen. II units tested are 5.80 for MG1 and 13.30 for MG2). By utilizing a qualified reference number any MGU SOH can be determined by using this comparison method. Specially, the TVS value can

assist in determining the level of MGU aging (deterioration) of windings, stator slot insulation, rotor/stator magnetic condition, etc., or if the unit itself has already failed. The key concept of using the TVS metric is being able to test a transaxle/transmission on the vehicle whether it uses direct connection to the final drive, single or multiple planetary gear sets or internal hydraulic clutch systems. However, TVS data will not determine if a 3-Phase MGU problem is the stator or rotor. It can only determine whether there is an electrical or mag-

netic unbalance in the rotor or stator.

- TVS data results are reported and compared to the reference value:
  - o ≤ 3 percent variance from reference = OK - Good Stator and Rotor balance
  - o ≥ 3 percent but ≤ 5 percent variance from reference = WARNING that Stator or Rotor is beginning to become electrically or magnetically out of balance
  - o > 5 percent variance from reference = FAILURE – Stator or Rotor electrical or magnetic properties out of balance.

In automotive systems, it is irrelevant whether the problem is the rotor or stator because the transaxle/transmission must be disassembled in the vehicle or removed from the vehicle. In either case, the rotor and stator are removed and a new or known good stator and rotor assembly (tested prior to use) can be used to replace units that have failed testing or indicate data consistent with advanced aging. Replacing both the stator and rotor would alleviate a possible misdiagnosis or more costly testing.

### Data and Results Discussion

There were a total of 20 Generation II (2004-2009) electric transaxles as part of this study. Although not reported in the data, each transaxle was tested for insulation resistance (IR) at 500Vdc. There were zero (0) transaxles that failed the IR test. However, two of the transaxles (sample 12 and 16) were slow to achieve the 500Vdc IR level @ > 10 seconds)

2004-2009 Toyota Prius MG2 Condition/SOH Based on Ω, DF, TVS							
Trans Sample#	Odometer	R32Ω	R21Ω	R13Ω	DF%	TVS	Result
19-MG2	23,000	132.00	132.00	133.50	4.89	13.25	OK
17-MG2	28,000	130.00	130.00	132.00	1.88	13.28	OK
18-MG2	32,000	129.00	129.00	131.00	2.58	13.32	OK
12-MG2	34,000	129.00	129.00	129.00	4.77	12.92	OK
14-MG2	42,000	130.00	128.00	130.00	5.22	13.36	OK
16-MG2	46,000	126.00	125.00	128.00	5.66	12.93	OK
13-MG2	48,000	130.00	129.00	129.00	3.55	12.87	W
20-MG2	57,000	128.00	129.00	130.00	1.87	13.19	OK
15-MG2	59,000	128.00	128.00	127.00	2.56	12.55	F
11-MG2	66,000	130.00	130.00	130.00	2.98	12.83	W
7-MG2	74,000	120.00	120.00	120.00	1.36	12.97	OK
1-MG2	88,000	122.00	122.00	122.00	1.60	12.90	W
4-MG2	94,000	120.00	120.00	120.00	1.63	12.84	W
8-MG2	97,000	120.00	120.00	120.00	1.47	12.92	OK
6-MG2	109,000	121.00	121.00	121.00	1.47	13.12	OK
5-MG2	110,000	121.00	122.00	121.00	1.83	12.94	OK
2-MG2	113,000	121.00	121.00	121.00	1.48	12.90	W
3-MG2	129,000	120.00	121.00	121.00	1.41	13.30	OK
9-MG2	130,000	121.00	121.00	121.00	1.82	13.03	OK
10-MG2	148,000	122.00	122.00	122.00	1.65	12.91	W

**There seemed to be no correlation between the age and/or mileage of the tested units and TVS or DV percent.**

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which, from testing experience, indicates the commencement of above normal insulation leakage and a weakness in the MGU winding insulation or stator slot insulation materials.

This type of data result will evolve into a MGU failure, but predicting time to failure is not in the scope of this article. There are quality statistical methods available (Weibull analysis or using Reliability statistics) that can assist in predicting time to failure of the MGU based on the results of electrical test properties, operating environment, etc.

### Odometer Data

The odometer data in this case study is very wide and has been rounded to the nearest 1,000 miles for ease of reporting. The transaxle with the lowest odometer data point is 23,000 miles and the highest data point of 148,000 miles.

### Phase Resistance Measurement Data

Phase resistance data is reported as dc milliohms (mOhms). Transaxle MG1 sample 8 reported the lowest resistances of 96.40 – 96.90 mOhms. Transaxle samples 3, 4, 7 and 8 reported the lowest resistances for MG2 of 120.00 – 121.00 mOhms. All transaxle sample phase resistance measurements were < 3 percent resistance variation for phase resistance balance and, therefore, were within the IEEE 1415 to 2006 standard for dc resistance balanced electric machines.

### Dissipation Factor Measurement Data

Dissipation Factor percent (DF%) data indicates that transaxle MG1 sample 13 was the only unit not scoring in the normal range with 7.06 percent (WARNING range). Transaxle MG1 sample 16 data at 5.99 percent nearly placed it in the WARNING category with sample 13. None of the Transaxle MG2 unit data resulted in a DF percent resulting in a WARNING or FAILED test result. However, Transaxle sample 16 DF percent of 5.66 is within the con-



Hosted by Weber University, this video breaks down how the Toyota eCVT works. [MotorAge.com/toyotaecvt](http://MotorAge.com/toyotaecvt)

finer of acceptable test but, is on the border of WARNING data. Both MG1 and MG2 data for sample 16 nearly place it in the WARNING data category for both MGUs.

### TVS Measurement Data

The Test Value Static (TVS) (dimensionless number) measurement is the most complex measurement data numerical value to report. The target TVS reference value for a Generation II MG1, as noted earlier, is 5.80 while the TVS reference value for MG2 is 13.30.

Data acquired for the MG1 transaxle samples indicated that samples 12 and 5 were in a WARNING state ( $\geq 3$  percent but  $\leq 5$  percent variance from the reference data target), while sample 11 indicated a FAILED state ( $\geq 5$  percent variance from the reference data target). Data acquired for the MG2 transaxle samples indicated that sample 1, 2, 4, 10, 11 and 13 were in a WARNING state ( $\geq 3$  percent but  $\leq 5$  percent variance from the reference data target), while sample 15 indicated a FAILED state ( $\geq 5$  percent variance from the reference data target).

### Case Study Conclusions

Though this case study involves a small sample size of 20 the data is consistent with testing that has been completed on hundreds of MGUs (whether Toyota product or their competitors) using the methodology outlined in this article. It is understood that if there was a Generation II vehicle population in the field of  $\approx 1.5$ M vehicles, the sample size necessary to provide a 95 percent data confidence (with  $\pm 3$  percent Confidence Interval) level would be  $\approx 1,100$  transaxles.

The sample size in this study is far from the number necessary to attain a reliable statistical modeling of 2004-2009 MG1 and MG2 MGU electric machines. A large enough statistical population pool (sample size) coupled with a high confidence level and confidence interval to achieve statistical numbers that are reliable to drive a statistical conclusion were outside of this case study scope. However, the preponderance of the testing evidence from this case study (and others like it) have been consistent with other case

study results for providing prognostic and diagnostic value to field technicians in testing the SOH of an MGU. This data assists the technician by indicating the onset of conditions that would lead to a catastrophic failure.

The data further indicates that, based on the data provided in this case study, it can be concluded that winding resistance data does not trend (or track) with other MGU SOH failure modes. All phase resistance testing on the MGUs in this case study indicated that there was balance between all of the MGU phases and each complied with the IEEE 1415-2006 standard. The DF data acquired from each of the MGUs did not trend or track with dc resistance testing data nor did it trend to TVS data. Therefore, an MGU can contain balanced phase resistances and DF percent data that is within the tolerance bands but fail TVS testing.

This testing complies with IEEE 56, 118 and 120 covering Motor Circuit Analysis testing methods, including how data is collected by instrumentation. Also, based on the case study data, it is possible to contain balanced phase resistances, TVS data that is within the tolerance band but, acquire warning levels for the DF percent. This testing complies with MGU winding contamination testing contained in IEEE Standard 43-2000.

Resistance data, DF percent data and TVS data are decoupled in the failure modes or SOH of an MGU. By using fundamental electrical engineering principles, combined with advanced math and software algorithms to scrub the data, a total picture of MGU SOH or the confirmation of a catastrophic failure is possible. This is good news for technicians, because in the past many MGU operational/performance problems, winding or slot insulation aging measurement or trying to identify difficult intermittent conditions has been unreliable or impossible. **TM**



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EDITOR

Dr. Mark Quarto is Chief Technology Officer (CTO) for Automotive Research and Design, LLC. He retired from General Motors Co. after 28 years, the last 16 years in Advanced Vehicle Development, including development of control and diagnostics systems and service solutions for the Chevrolet Volt.

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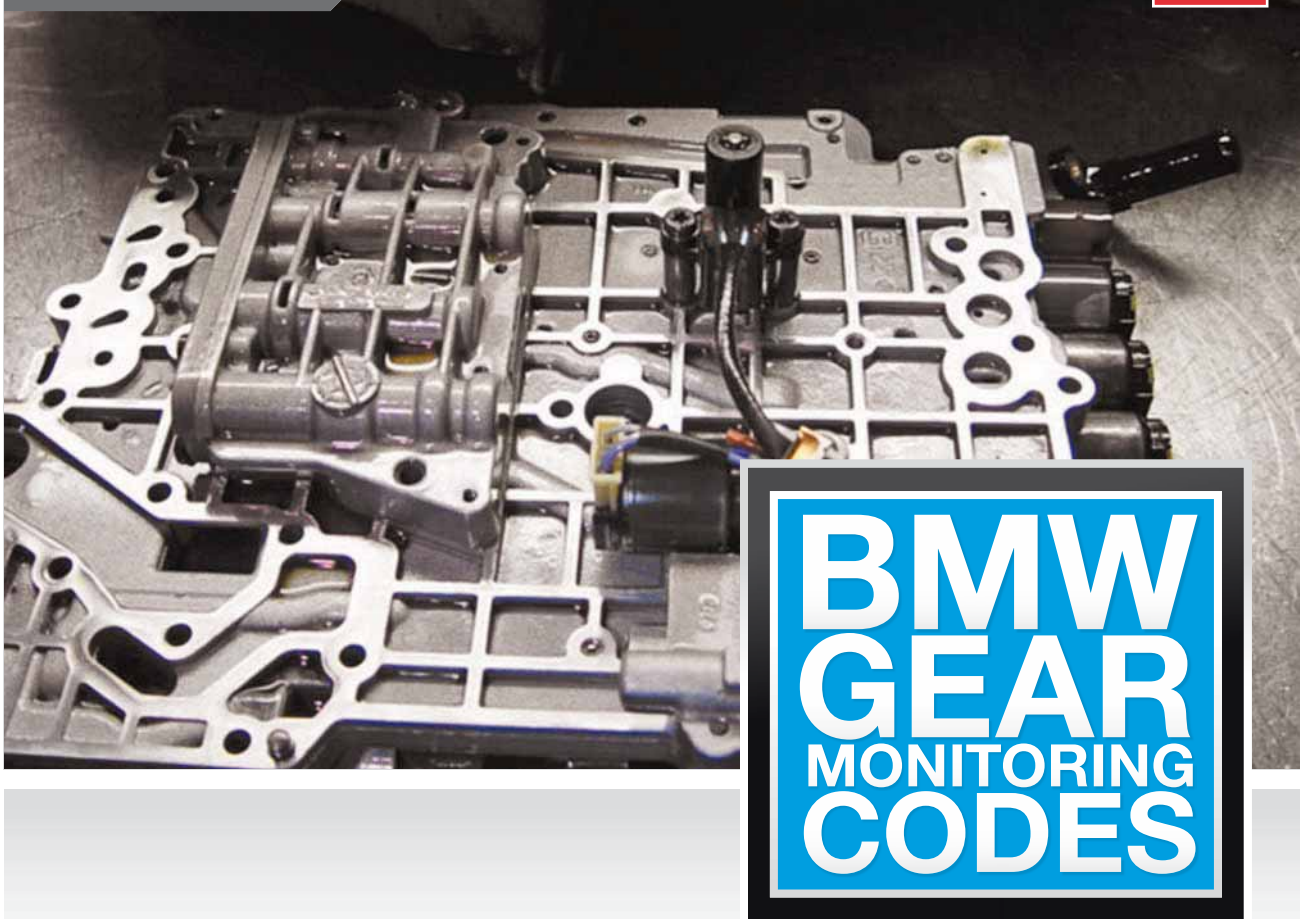
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**WORKING WITH DIFFERENT 'A' CLUTCH HOUSINGS IS JUST ONE PIECE OF THIS PUZZLE.**

BY **WAYNE COLONNA** | POWERTRAIN PRO PUBLISHER

**M**ike Beglitsoff, owner of the Automatic Transmission Center in San Francisco, took in a 2003 BMW 325i with a ZF5HP19 transmission stuck in 4th gear only fail-safe. The double digit OE codes pulled were:

- 33 – Input/Turbine Speed Sensor (ISS/TSS) “A” Circuit Range/Performance
- 49 – Gear Monitoring
- 55 – Gear Ratio Error in 5th
- 65 – Gear Monitoring 4 at Electrical Substitute Program – ISS/OSS Ratio

Typically, whenever I deal with code 33 on ATSC’s technical support line, it is a code that comes up after a rebuild. It wasn’t the customer’s original complaint to be resolved. In these situa-

tions, the cause is usually due to the use of incorrect parts. To explain this requires a short history lesson with the ZF5HP19 transmission.

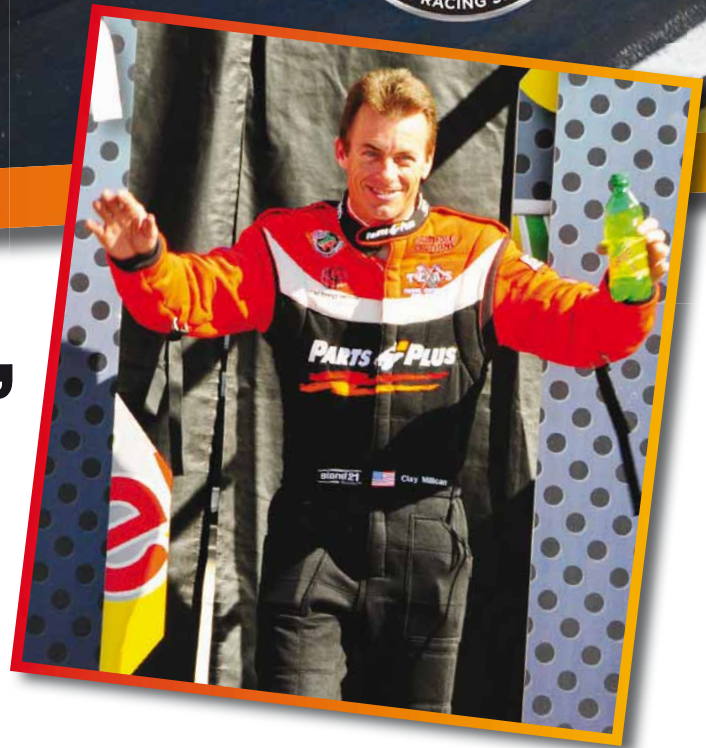
This unit was used in Audi vehicles as early as 1996. At that time, the ISS/TSS was a pulse generator type mounted on the top side of the valve body (Figures 1 and 2). This sensor was excited by sheet metal windows integrated into the spider clutch bell as seen in Figures 3 and 4 (page 54). Around 1998 a change was made to use an ISS/TSS Hall Effect type sensor. The sensor location was changed from being on the top side of the valve body to being mounted on the case (Figure 5, page 54). This was done so it could

be excited by a magnetic band of 36 magnets now placed around the “A” clutch drum. Since the A clutch drum sat inside the sun-shell, for the ISS/TSS hall effect sensor to read the magnets on the A clutch drum, the material of the sun-shell was changed from metal (a ferrous material) to a non-ferrous type shell.

This change affected only some models in 1998 and was implemented over time to as late as 2002 in all the other Audi vehicles equipped with the ZF5HP19 transmission. Volkswagen Passats from 1999 to 2001 also were part of this change.

As a result of this switch over, there now becomes two different A clutch





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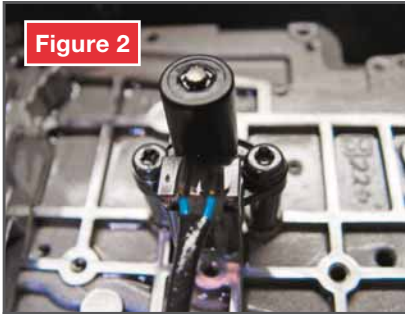


Figure 2



Figure 3



Figure 4



Figure 5



Figure 6



Figure 7



Figure 8

housings (Figure 6), two different spider clutch bells (Figure 7) and two different sun-shells (Figure 8). These parts are not interchangeable in any way. A mismatch of these parts will render the ISS/TSS ineffective; in other words, no signal. The same problem can occur by simply installing an incorrect exchanged transmission. The pass through connectors for either type sensor has the same configuration allowing for such an error to occur.

Getting back to BMW, they began using the ZF5HP19 transmission in 2000. Vehicles using this transmission only received the Hall Effect type sun-shell and/or A clutch drum be used, code 33 would immediately pop up after a rebuild. Once code 33 is set, all other ratio errors/gear monitoring codes should be secondary in the diagnostic process as they may be a by-product of code 33.

But this was not the case with Beglitsoff's 2003 325i. It arrived with these codes and it was not previously

worked on. An initial check of the ISS/TSS was performed and it had a clean 5-volt pulse all the way to the TCM. He then ran checks on all the circuits and each check passed. The only discrepancy was the battery voltage PID he saw in his scan tool with what he was seeing with his meter. The scan tool PID showed erratic voltage, especially when driving. It would go from 14.5 down to 12.5. But an actual volt meter checking battery voltage at the TCM it remained steady at 14.7.

One of Beglitsoff's employees named Andy owns and drives a 2000 323i which uses the same type transmission. Looking at his vehicle with a scan tool revealed a steady battery voltage PID. It took some pleading but he convinced Andy to let him try the 2003 TCM in his vehicle. When he did, he noticed the battery voltage PID in his scan tool remained erratic as it was in the 2003 325i. Yet the volt meter monitoring TCM battery remained steady. In fact, at one point the scan tool PID jumped up well past 15 volts while the volt meter remained steady.

With that, it finally was decided to obtain a new TCM which indeed fixed the problem. It was this erratic battery voltage PID compared to the actual power supply that offered up a possible reason (a faulty TCM is shown in Figure 9) for all the ratio/gear monitoring related codes the 325i was experiencing. A good tip to remember should one roll into your shop like this. **ZZ**



Figure 9

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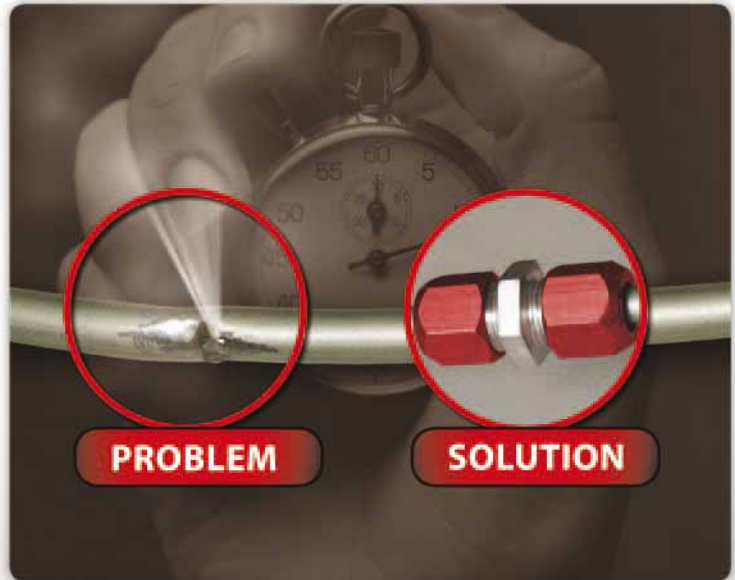
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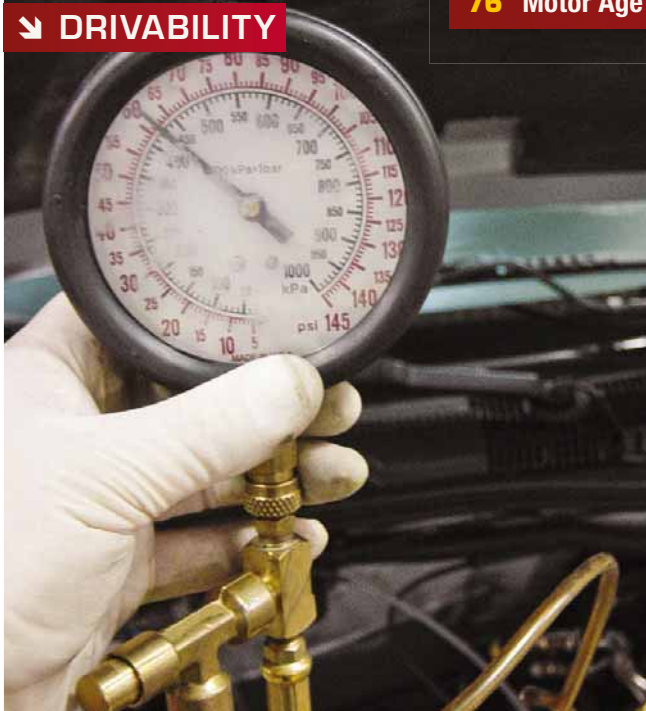
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## DRIVABILITY



# NO CODE? NO PROBLEM

While there is nothing wrong with traditional system testing, don't rely on them to find intermittent problems.

## HOW DO YOU TACKLE A DRIVABILITY COMPLAINT WHEN NO CODE IS STORED?

BY **PETE MEIER** | TECHNICAL EDITOR

It seems we as an industry have become dependent on computer-generated Diagnostic Trouble Codes (DTCs). When faced with a drivability complaint where no Malfunction Indicator Lamp (MIL) is lit, do you scribble a quick “No Problem Found” on the repair order and send the customer on his or her way?

DTCs never were intended to take the place of a logical diagnostic process. They are merely aids that inform you of what the Engine Control Module (ECM) saw that it didn't like. Even the use of an OEM diagnostic flow chart is flawed if you don't understand what it is you're testing and, more importantly, why you are performing a given test.

### Why the Light Comes on

According to industry stats, the average age of cars and light trucks in the U.S. is approximately 11.5 years. That

means that most of the cars on the road today are certified to OBDII standards (1996 MY to present). These standards, in part, require that the onboard engine management system be able to monitor all systems related to emissions and warn the driver should any system fail in a manner that would cause emissions to increase beyond what the vehicle originally was certified to. How does the ECM know if a failure has occurred that will result in increased emissions? By performing its own tests on all the emissions-related systems, that's how.

Testing by the ECM can be grouped into three basic categories. The first is the circuit integrity test, which, as the name implies, tests the input/output circuits for shorts to ground, shorts to power and opens in the circuit path. The second is the rationality test. In this test method, the ECM compares the data from two different inputs to see if they

are in agreement for the given operating condition. For example, if the Throttle Position Sensor (TPS) suddenly reported a huge change in throttle opening, but the ECM didn't see a corresponding rapid change from the Manifold Absolute Pressure (MAP) sensor, it might trigger a code P0105 (MAP Circuit Malfunction).

The third type of test is the functionality test. The ECM monitors the actual performance of an output component or entire system and compares it to what it

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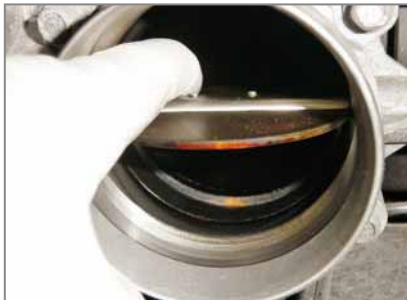
Photos: Pete Meier

knows to be good. If the ECM conducts this type of test from the sidelines, it's a non-intrusive test. An example would be an Exhaust Gas Recirculation (EGR) system test that uses the MAP signal as the feedback to the ECM. When the EGR valve opens when it is supposed to, the manifold absolute pressure will change and the ECM will see that in the changing MAP input. If not, the ECM will consider this as a failure and log the event.

If the ECM actively alters the normal operating conditions and then looks for a corresponding change, it is an intrusive test. Still using EGR as the example, if the ECM commands the EGR to close when it is supposed to be open, the upstream oxygen sensor will respond by going momentarily lean. If the ECM sees the voltage shift from the O<sub>2</sub> sensor, it knows the EGR did, in fact, close.

This is one method Chrysler uses and sets a P0400 (EGR System Malfunction). It is an example of how a code description alone is not enough to troubleshoot from. Failure to understand the ECM's testing methods often leads to unnecessary time spent chasing ghosts and unneeded parts replacements.

Remember the tests you took in school? They all had a pass/fail line, didn't they? The tests the ECM runs are no different. They all have parameters that are the allowable variances for any given test.



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Misfire monitors are one example. We've all had a misfiring engine we could feel on a test drive, yet the MIL light never came on. That's because the amount of misfires per engine revolution did not exceed the programmed parameters contained in the ECM's software. Input sensors are another example. They can read erratically, yet not be caught by the ECM because the range of readings is within normal specifications or happens too quickly for the ECM to catch in the act. A spiking TPS is an example of a fault that can result in a drivability complaint, yet not set a related DTC.

## Going 'Old School' with a Twist

Even with all the developments in engine technology, the engine still has to "suck, squeeze, bang and blow" to work. And the range of acceptable performance has gotten smaller as engineers squeeze as much efficiency as they can from the powerplant. That means even small variances from the norm can result in a drivability complaint. And finding those small

faults takes a logical approach, starting with broad general tests to home in on the specific sub-system causing the problem and then more precise testing to isolate the root cause.

One of the first steps I take when dealing with a no-code drivability complaint is to verify the integrity of the engine itself. I start with a relative compression test using a Digital Storage Oscilloscope (DSO) and high amp current clamp. This is a two-minute test that monitors starter current draw while the disabled engine is cranked over. Electric motors



Simple problem. Aged secondary wires intermittently allowing high voltage to leak to ground. Visual inspections come first!

require more current when a load is applied so a healthy cylinder will cause a higher current draw than a weak one will. By adding a second channel to trace a reference pattern (usually an ignition event), I easily can use the firing order to pinpoint the weak cylinder and move forward from there.

For the scopes I have used this technique with, I have found I can pick out a cylinder with as little as a 10 percent compression loss with consistency. Even that, though, might not catch those intermittent seals. For that, I need a more sophisticated technique.

If the car's engine management system is on a Controller Area Network (CAN) protocol, I'll peek into Mode \$06 to see if there are any misfires recorded there. Mode \$06 contains the ECM's test results for all the non-continuous monitors. Pre-CAN Ford ECMs have misfire data there and all CAN vehicles do. Those misfires might not happen often enough to trigger a MIL, but if any are happening, they will be counted and recorded here. Check your service information provider for the appropriate test identifiers and what cylinders they reference.

Watching the secondary ignition pattern on a scope can reveal a lot to the trained eye and is useful not only for checking the mechanical integrity of the engine, but the health of the ignition and fuel systems. I, for one, still am learning the art of secondary waveform analysis, but one area that I have become very familiar with is the concept of combustion chamber turbulence caused by poorly sealing valves.

The clue is in the ignition pattern's "burn line," or that portion of the pattern



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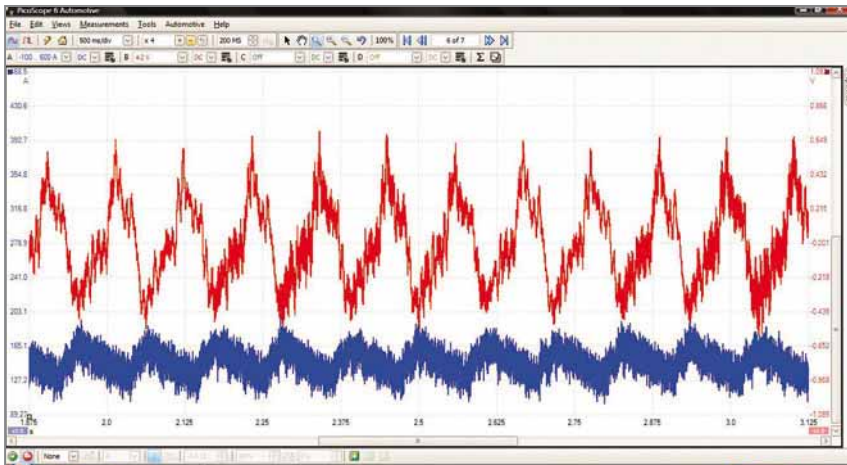


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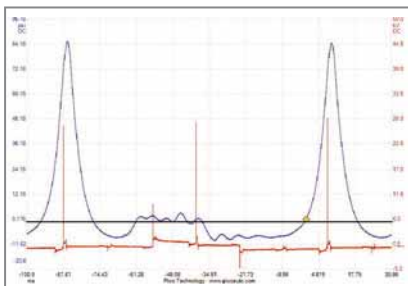
A relative compression test done two ways. One is starter current draw, the other is exhaust pulses recorded at the tailpipe. Remember holding a dollar bill to the tail pipe?

representing the time the spark is actually traveling across the plug gap. When a valve is sealing poorly (but enough to pass a static compression test), the high pressures present force themselves past the valve and cause a literal whirlwind in the combustion chamber that bends and bows the spark like a candle flame moves with the breeze. In effect, the spark distance is constantly changing and you'll see it in the burn line at idle.

The best method to incorporate into your diagnostic routine is the in-cylinder running pressure test. This uses the DSO mated to a pressure transducer that is installed in place of the spark plug. The engine is run and the varying pressure in the tested cylinder can be viewed on the scope's display. Intermittently sealing cylinders can be identified by variations in peak pressure and irregularities in the portion of the pattern referred to as the "exhaust pocket."

**Engine's Good!**

Once I verify that the engine itself is not to blame, I move on to what the engine



Mating a pressure transducer to your scope allows you to 'see' what's happening inside.

needs to run and run properly (air, gas and something to get the mixture to burn in the right amount and the right time). The problem is, if the problem I'm hunting is not bad enough for the ECM to notice, odds are conventional testing methods won't find it either.

Weaknesses in the ignition system, for the most part, are caused by lack of maintenance, so a visual inspection of the plug condition and gap is one of the first things I do. Ignition system integrity is best tested with a DSO and monitored under the same engine conditions where your customer is experiencing their complaint. Capturing a secondary ignition pattern need not be complicated on Coil-On-Plug (COP) ignitions, either.

On two-wire systems, you can place your scope lead on the ground side of the coil primary and get a mirror-image of the secondary. Just be sure to use an attenuator to avoid overloading your scope by exceeding its maximum input voltage. The primary can kick out a few hundred volts of its own. Another option is to use a secondary probe; a pick-up that is designed to capture the signal by simply placing the probe on top of the coil you want to test. I prefer a scope capable of storing a lot of data points when hunting intermittents, because I can log a lot of information and then review the stored frames in detail. Odds are I'm not going to be watching the live capture when the culprit shows himself.

I can look for timing issues (ignition and cam/crank) easily by adding a second channel to the in-cylinder pressure test and using it to record that cylinder's ignition event. The peak of the in-



A scope mated with a few accessories can make no code diagnostics a lot easier.

cylinder test will always be Top Dead Center (TDC) of the tested cylinder's compression stroke and a pattern capture that starts and ends here gives me an accurate representation of the entire 720° cycle. This also is an excellent way to check the operation of variable valve timing systems. By adding a third channel to the ground side (control side) of the injector, I can monitor its timing and pulse width at the same time.

Keep in mind that the ECM determines ignition timing and injector pulse width. The ECM, in turn, makes those decisions based on the information a variety of sensors provide. And they don't always tell the truth. Use the graphing and recording features of your scan tool to log key data at the time the concern is presenting itself and then review that data, looking for readings that just don't seem to fit. How will you know what isn't right? Many OEMs provide scan data range values in their service information, but the best way to learn what isn't right is to first learn what is. You do that by hooking up your scan tool to known good cars and taking the time to review that recording. If you can, save them for future reference.

Facing a no code complaint can be a blessing. In the end, it can make you a stronger (and valuable) diagnostician. **ZZ**



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

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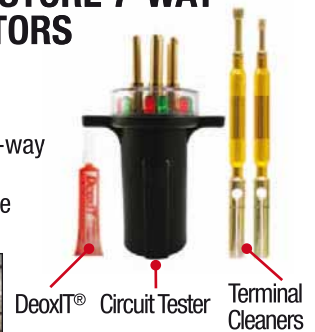
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## TECHNOLOGY

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# IT'S ALL IN THE TIMING

On the simpler side of diagnostics, feeling for a firm click will verify the operation of the oil control solenoid.

## VARIABLE VALVE TIMING SYSTEMS BRING THEIR OWN VARIABLES TO DRIVABILITY TROUBLESHOOTING.

BY **DAVE HOBBS** | CONTRIBUTING EDITOR

**V**ariable valve timing and variable displacement systems have been on the road and continuously evolving for years. They go by different names, including Toyota and Honda VTEC, GM Cam Phasing, GM DoD (Displacement on Demand aka Active Fuel Management), Chrysler MDS (Multiple Displacement System), Nissan VVEL (Variable Valve Event and Lift) and the Fiat Multi Air System.

Each year we see advances in electronics allowing for the control of intake and exhaust valves with increased accuracy. Despite this, though, they still are susceptible to failures.

### Why Vary Valve Timing?

Anyone who has built a performance engine knows the benefits of changing valve timing from the stock settings. At higher rpms, the need to scavenge the cylinder of exhaust gasses to make more room for fresh air/fuel in the intake stroke

is essential for performance. Contrary to the most basic traditions of teaching 4-stroke Otto cycle theory, each stroke does not exist for one-quarter of the 720° required to produce a complete engine 4-stroke cycle. Depending on the application/camshaft profile, the intake cam lobe may allow its valves to open as early as 48° Before Top Dead Center (BTDC) on the exhaust stroke and close as late as 84° BTDC into the compression stroke.

Hybrid Electric Vehicles (HEVs) using a modified Atkinson cycle action can take advantage of the extra torque assist of the electric motor(s) to allow for a more fuel efficient concept of limiting the compression stroke by drastically delaying intake valve closure during low torque demand conditions.

On the flip side are the full race cams that allow for more volumetric efficiency (VE) by delaying intake valve closure during the early periods of the compression stroke to aid in filling the cylinder



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to take advantage of the inertia of air moving into the cylinder during the downward piston movement portion of the intake cycle.

Thinking emissions instead of performance, engineers in recent years have established that exhaust gas recirculation (EGR) can be managed without the problematic external valve that has been the tradition since 1973. With external EGR, the distribution of exhaust into the intake to provide the quenching effect of inert gas to a hot cylinder typically results in uneven doses of exhaust gas to some cylinders. That means some cylinders receive the needed amount of EGR while others get a bit overdosed. Not the case with internal EGR where the exhaust valve is closed later into the intake stroke effectively pulling some exhaust gas (called reversion) back into the cylinder during the intake event.

Photos: Dave Hobbs

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## Toyota/Lexus

Toyota has been modifying camshaft timing on the fly for more than two decades, beginning in 1991 with its two position cam phaser Variable Valve Timing (VVT) system. That system evolved to the VVT-i system which included the “i” in the acronym for “Intelligence” in determining cam timing position as well as allowing for continuous cam position variations.

These systems typically have used an oil spool valve moved against a spring by an electromagnet. As the spool valve moves, it controls the flow of oil to a vane style cam phaser, which moves the camshaft to a more advanced or retarded position in relationship to the sprocket driving it. By the early 2000s, Toyota used a VVT-i system to accomplish an Atkinson cycle on their hybrid engines. Gen I Prius engines (01-03) will vary intake cam positions by as much as 43° while the Gen II models (04-09) vary cam angle positions by as much as 33°.

Keep in mind these cam phasers reduce the effective compression ratio of the engine when doing a compression test. When performing a compression test on any hybrid that starts the engine with a HV motor-generator, keep in mind that the engine is being cranked at more than 1,000 rpms, much faster than the traditional 12-volt cranking motor. This higher cranking speed is almost a running (idle) compression test which normally means



Read more in this Motor Age Garage about a Ford and variable timing issues  
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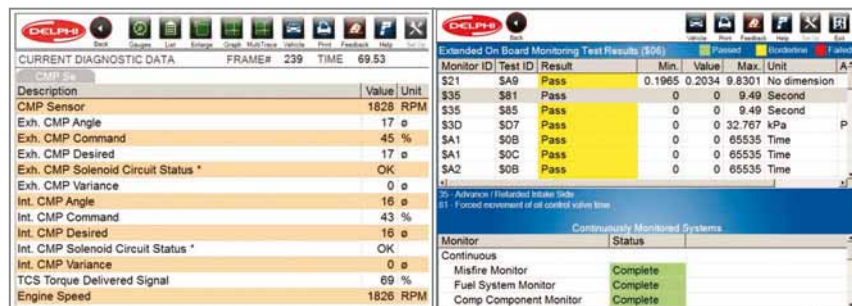
about half the normal pressure on your compression tester.

You will need to enter into the reduced cranking speed compression test mode that most scan tools allow you to initiate with HEVs. Expect a good compression reading to be between 90 and 120 PSI on these hybrid engines.

Next in evolution for Toyota was their Lexus division’s introduction of their VVT-iE system.

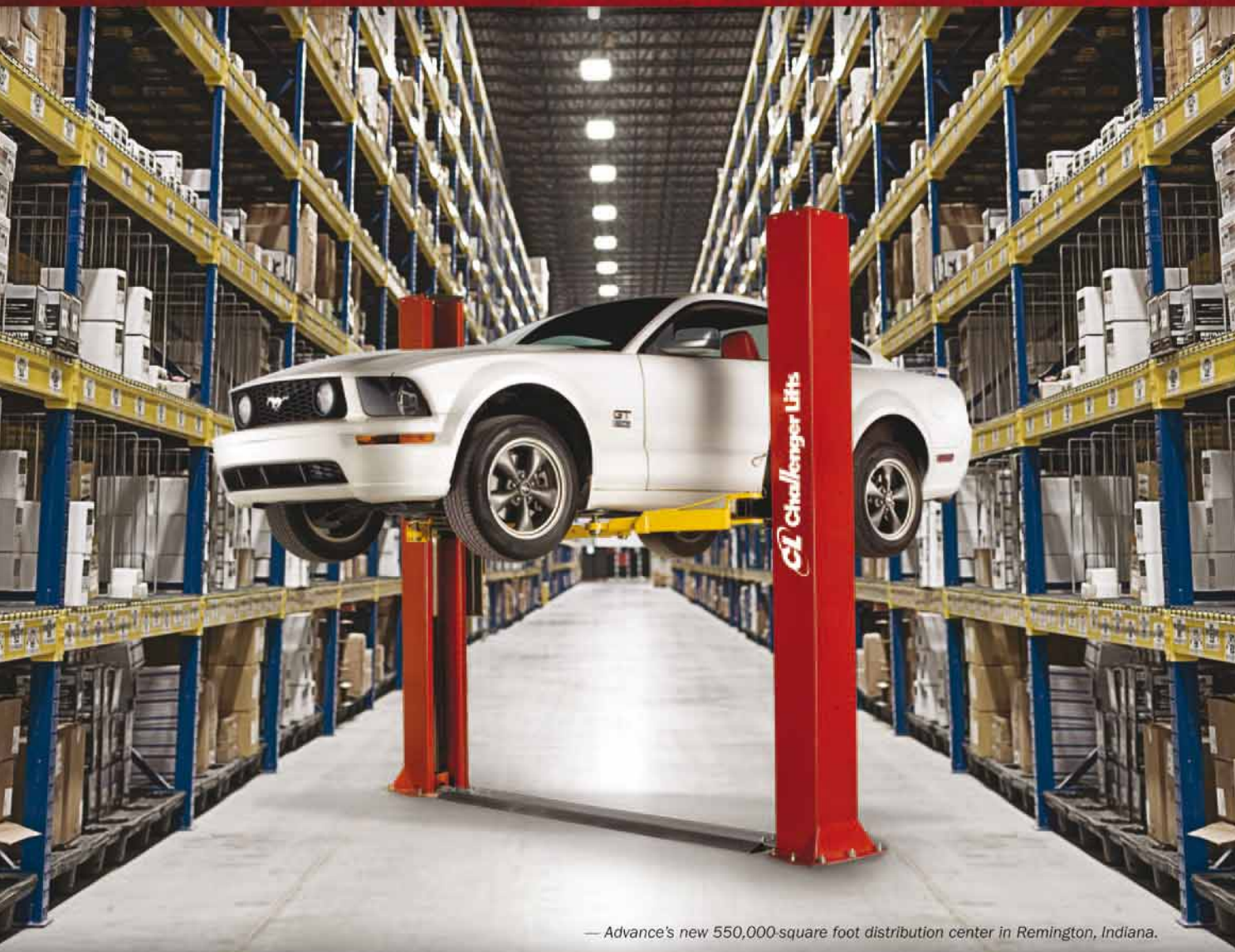
The last letter “E” stands for electric, which in this case means an electric motor changes cam timing instead of an electrically actuated hydraulic valve. Some models used an electric motor between the camshaft and sprocket for both intake and exhaust cams while a newer design Lexus system utilized the electric VVT-iE electric motor system on the intake cams only and the conventional oil controlled VVT-i system for the exhaust cams.

Negating the need for oil pressure to change cam timing means the engine can be started with modified cam timing. The electric motor spins the cam faster than the crank driven sprocket and then locks into an advanced position. Conversely, if no intake valve advance timing (increased valve overlap) is desired, the electric motor runs at the same speed as the driving cam sprocket. More traditional systems only allow cam timing changes to be made after the engine is running and oil pressure established.



(Left) Reading scan data PIDs for VTEC operation is essential in any diagnosis. Camshaft variance is particularly useful. (Right) Don't pass up the opportunity to look at Mode \$06 data when diagnosing intermittent variable cam timing problems.

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## GM – Same Idea but Different Hardware

GM's earliest variable cam timing systems came out in the 2002 Trailblazer/Envoy models sporting an inline 6 cylinder DOHC engine. This engine applied a cam phaser of a splined gear design. The single phaser located between the exhaust camshaft and sprocket can vary cam timing by as much as 25° (50° crank angle). A spring applied between the two splined gears to hold the phaser to 0° where a lock pin holds it in place after engine shut down.

The electrical connections for achieving variable valve timing are located on the solenoid used for controlling pressurization of oil that controls the movement of the splined phaser. Later models utilized a vane style phaser design similar to what most other OEMs use including the previously discussed Toyota VVT-i systems. For push rod engine applications, GM took the route of advancing the single cam in block with a vane style phaser controlled by a solenoid actuated oil control valve. The electrical portion of the control valve system is located on the front of the timing chain cover and electromagnetically pulls the oil control valve that has the double duty of being a cam sprocket retaining bolt.

When replacing a timing chain/gear set, camshaft or the cam phaser actuator, special care must be exercised. On the front of the cam sprocket/actuator assembly is a reluctor wheel held in place with three roll pins. Don't pull on the reluctor wheel. Remove the sprocket by pulling on the sides of the sprocket while holding the reluctor wheel up to it and in place. When removed, hold these components together by inserting a plastic wire tie into the hole in the



**Improper maintenance and a torn screen in this MDS oil control valve resulted in an intermittent hard misfire on a Dodge Hemi.**



**Customers who ignore their engine's oil maintenance may be saving pennies but setting themselves up for expensive repairs.**



**The use of a pressure transducer in the cylinder is the best way to inspect variable valve timing operation.**

center to tie everything together. The actuator assembly contains springs that could hurt you or at least make a useless puzzle of the actuator should you disassemble the assembly accidentally.

## The Common Ailments

All of the variable cam timing and cylinder deactivation systems mentioned regardless of design variations seem to suffer from many of the same ailments. By far the most common problems revolve around lubrication issues. Owners who neglect regular oil changes or engage in continuous heavy-duty/high-performance engine operation are the most likely candidates for drivability problems and DTCs.

Not every variable valve timing problem that creates a drivability symptom results in a DTC. Honda is one prime example. Unlike other variable valve timing systems, Honda's VTEC system utilizes rocker arms that can connect overhead cam lobes with greater lift and duration when rpms rise upward of 5,800. This operation is accomplished



This GM system can be tested much like you would a transmission valve body.

with locking pins actuated by oil pressure control solenoids. The cam lobe with greater lift is situated between two lobes with lesser lift and is fixed into motion with the locking pins. The pins can become stuck when the customer reaches VTEC application rpms and not move back to the lower profile cam lobe valve actuation mode at lower speeds. The result is an unstable idle.

Though there are plenty of scan tool PIDs for rocker arm solenoid oil control status and rocker arm oil pressure (switch status) the no code problem occurs when Honda's PGM-FI com-

puter doesn't see a change in rocker arm oil control pressure switch status after commanding the higher lift VTEC mode. The PGM-FI assumes there is a problem with oil pressure in the VTEC oil passages and commands a fuel cut off condition. Sludge build up from neglected engine oil maintenance can delay but eventually allows some oil pressure to change the switch status. The driver, however, feels the fuel cut off which causes a severe hesita-

tion. DTC P1259 will eventually set if the problem occurs long enough or frequently enough but a non DTC idle complaint after running at high rpms is not uncommon.

Again, getting your customer to change oil more frequently and use the correct type and weight is paramount to preventing VTEC and Multi-Displacement system failures. GM released a calibration update last year for close to 800,000 2010-2012 Equinox,



Vane-style is the most common design for a VVT actuator. Locking pins can become stuck due to lack of proper oil maintenance.



## First choice.

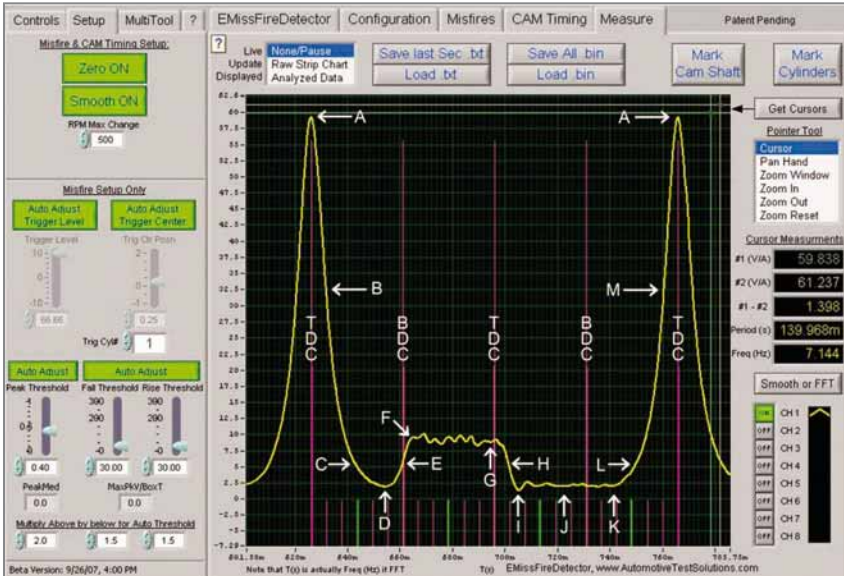


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The potential uses of an in-cylinder pressure test for diagnostics includes verifying VVT operation.

Terrain, Lacrosse and Regal models using the 2.4 inline 4 cylinder engines. The software update reduces the oil change intervals that are automatically calculated via an oil life monitor.

Regardless of oil type the newer intervals can alert the driver to a needed oil change on the average of 5,000 to 7,000 miles based on driving characteristics. The original interval was longer and was suspected of a causing premature wear on timing chain components and other internal engine parts. Nissan's complex VVEL system requires engine's sporting that technology to run 5W30 API SM Ester Oil. That certainly is a unique motor oil you won't find in many stores frequented by the DIY oil changer!

Chrysler's required 5W-20 weight oil is often ignored by the DIYer and some pros. The Chrysler PCM's unique software will calculate incorrect oil weight by using data from oil pressure and temperature inputs to set DTC P1521 to prevent a mechanical problem with their cam phasers or MDS systems.

I encountered a 2005 Dodge Magnum with the 5.7 Hemi that was having severe misfires intermittently at highway speeds. It was determined that the MDS had a lifter sticking in the cylinder deactivation mode. An examination of the oil control solenoid that affected that MDS lifter showed a broken screen that allowed sludge to lodge

in the solenoid. Intermittently when that cylinder went into deactivation mode the sludged up MDS oil control solenoid would keep the oil flowing and maintain deactivation of the lifter long after the MDS system commanded the cylinder to reactivate.

The engine showed obvious signs of neglected oil changes. Keep in mind that when sludge and other contaminants in an engine's motor oil reaches these types of components, they may not circulate in and out. They may simply reach their destination and lodge in that location resulting in a cam timing or variable displacement problems.

### Diagnostics – As Simple or Complex as You Desire

My first advice obviously is to retrieve trouble codes and follow the published trouble trees. Sometimes, however, the book doesn't lead to a clear solution so let's go over some common diagnostic methods for VTEC and AFM / MDS problems. After pulling DTCs, always first and foremost in your diagnostic process is to determine the correct type and amount of clean motor oil and proper engine oil pressure. After establishing that baseline keep in mind the importance of watching the camshaft variance PID in powertrain data. Some OEMs allow for no more than 4 degrees for variance from where the cam is being commanded to move to

(positive or negative degrees) and where the camshaft position sensor (CMP) actually says it is in reference to crank angle.

Also watch for duty cycles commanded to the solenoids being excessive compared to what you consider normal for a particular engine. This takes some experience in VTEC PID observation. If the powertrain control module (PCM) can't get the cam to advance / retard to a certain number of degrees desired angle it may keep increasing the pulse width modulated (PWM) duty cycle to try to get it there. Actuating solenoids via your scan tool or with jumper wires is a simple way to determine system operation. Simply watch cam angle with your scan tool or scope CMP to see if a change occurs. The engine should run poorly (or at least differently) when performing this test as well.

If there is no change, remove the oil control solenoid and activate it again – watching for physical movement and/or listening for a click. Some OEMs only allow mode 8 scan tool bi-directional commands for VTEC solenoids to operate at key on-engine off (KOE0) so simply listening or feeling for a solid click is of value as is removing the actuator / solenoid to watch for a physical movement when activated. Shop air can be used to blow into cam phaser or variable displacement solenoid oil circuits to see if the expected mechanical result occurs.

These simple steps help to determine whether the problem is strictly hydraulic-mechanical or electro-mechanical. Before you brush off of these more routine diagnostic processes and grab a lab cope and pressure transducer remember to see if the vehicle has a variable cam timing OBD II monitor. Most that do are non-continuous so you'll find valuable info in Mode \$06 data. **ZZ**



**DAVE HOBBS**  
CONTRIBUTING EDITOR

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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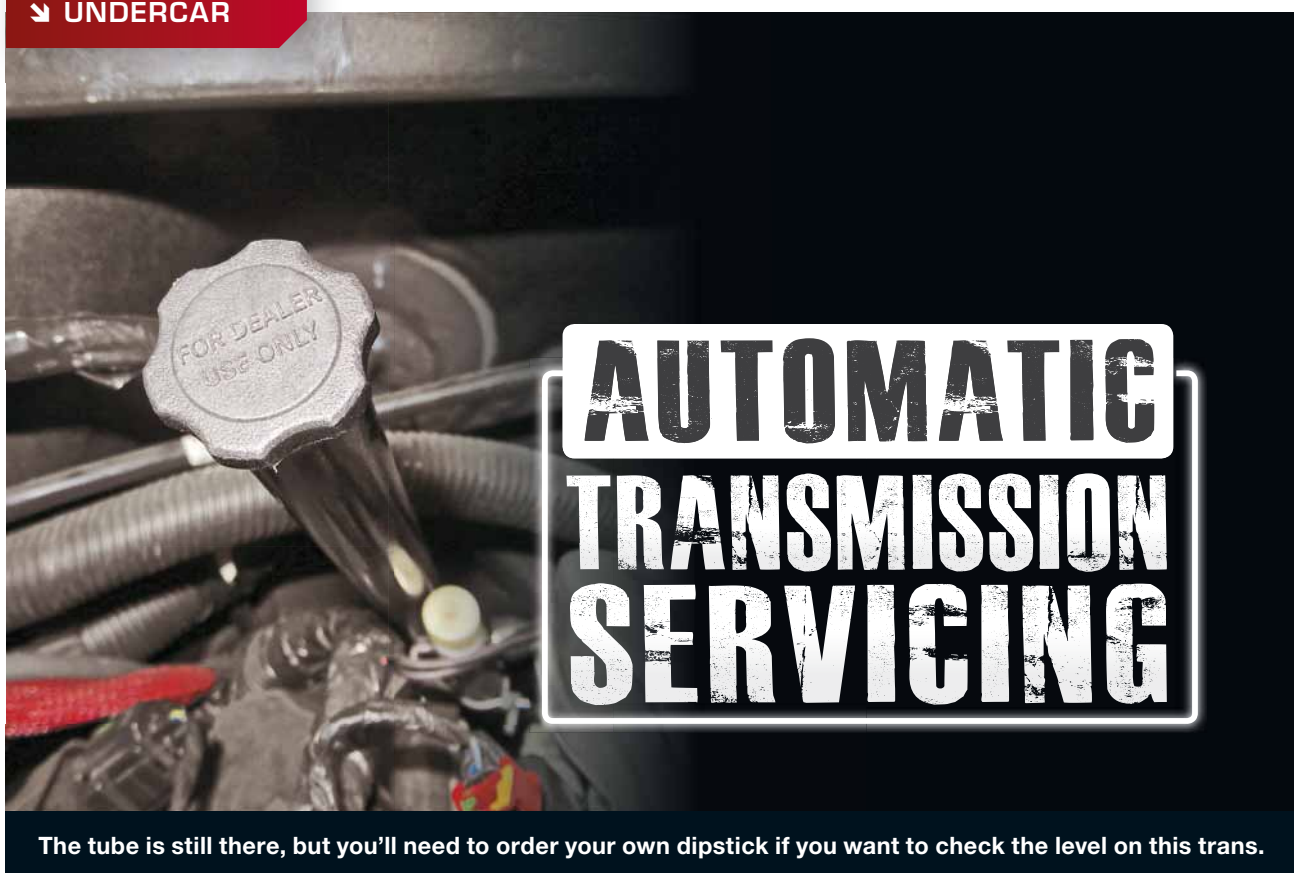


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## TECHNOLOGY

## ↗ UNDERCAR



The tube is still there, but you'll need to order your own dipstick if you want to check the level on this trans.

## HOW TO AVOID SOME COMMON, AND POTENTIALLY COSTLY, SERVICE MISTAKES

BY JOHN D. KELLY | CONTRIBUTING EDITOR

I own two vehicles that do not have an automatic transaxle dipstick to check the fluid level. One of these vehicles is a General Motors product; the other is a Toyota product. And they are not the exception. Ford also has automatic transmissions without dipsticks as do Chrysler, Mercedes and other OEMs. The lack of a dipstick is no accident; the transmission manufacturer does not want the customer to have access to the fluid. They call it "lifetime fluid," and it supposedly never needs changing, but it does need to be checked when there is a sign of leakage, if the transmission is having problems or if the transmission was opened for any reason. Some transmissions are so sensitive to improper fluid levels and fluid types that transmission problems or even damage can occur with the slightest under fill or over fill.

If your shop is in the business of servicing or repairing automatic transmissions or if you are just performing quick services such as an engine oil change or a transmission fluid flush, you better not tell a customer that their fluid level is "OK" unless you really checked it the proper way.

Checking an automatic transmission's fluid level requires four resources: access to the proper service information, up-to-date training, adequate time to perform the fluid level check and access to special tooling if required.

### Adventures In Reality

My first vehicle without an automatic transaxle dipstick, a Toyota Highlander Hybrid, was purchased new in 2008. I received free oil changes every 5,000 miles for the first 75,000 miles as part of the purchase, so I had this vehicle



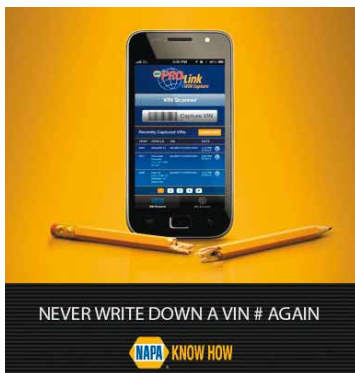
serviced at the dealership for the last five years (83,000 miles). The green-yellow-red colored multi-inspection check sheets I receive with each service always show all of the fluid levels as being OK. The problem is the fluid level check plugs appear to have never been removed, as evidenced by the factory paint marks on them.

I recently asked a technician from a different Toyota dealership what his dealership does regarding checking transmission fluid levels on vehicles without dipsticks. He said they do not check the fluid level unless there is a sign of leakage. I asked him if they mark the fluid level as "OK" on the multi-point inspection sheet the customer receives, and he said some technicians do. I told him that I thought that was a huge problem and a possible liability.

Photos: John D. Kelly

# NAPA PROLINK: NEVER WRITE DOWN A VIN NUMBER AGAIN

**W**ith over 20 years of service, the NAPA Commercial Systems Group continually seeks to bring best in class software services to the automotive aftermarket, including installers seeking to become more profitable, grow their business and better service their customers. NAPA TRACS and PROLink are essential to shop success by providing a one-stop shop that assists installers in running all aspects of their business from estimating, to profit control, electronic parts ordering and invoicing. TRACS and PROLink also allows installers to streamline the parts buying process by providing a real-time connection between the shop computer and their servicing NAPA store. This connection improves efficiency, streamlines the work order flow process, increases order accuracy and improves the response time from order to delivery.



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- 2. SEND** the fully decoded VIN instantly to the PROLink desktop. You may even name the vehicle or enter a brief description of what service the vehicle is in for.
- 3. START** your NAPA PROLink catalog search or begin building an estimate, looking up labor times or optional technical repair data.
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## NAPA PROLink VIN Capture FAQs

**Q:** Does the PROLink VIN Capture App fully decode the VIN?

**A:** Yes, the VIN is instantly decoded and displayed on your phone as well as on the PROLink Desktop on your PC in a new area called "Recently Scanned VINs."

**Q:** After I scan a VIN, can I associate a customer or vehicle name with it?

**A:** Yes, a customer or vehicle name may be entered and associated with each VIN. This also appears on the PROLink Desktop.

**Q:** What can I do with a VIN after it's scanned?

**A:** Once scanned, the VIN immediately appears on the PROLink desktop in a new area called "Recently Scanned VIN's." From here you may view the fully decoded VIN, start a NAPA part search, estimate or access flat rate or optional Mitchell PRODemand technical data.

**Q:** Do you need a special login and password to use the PROLink VIN Capture App?

**A:** Yes, after loading the app on your phone, you will enter the same PROLink login and password credentials you use on your PROLink desktop to begin using the PROLink VIN scanner.

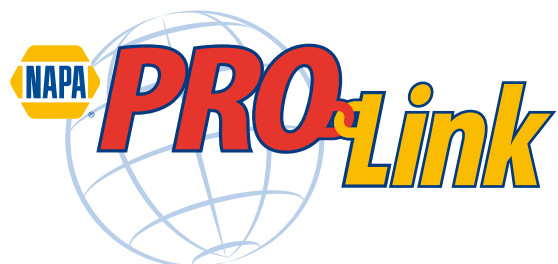
**Q:** How many captured VIN's can I save on my phone?

**A:** There is no limit and you may delete VIN's from your phone once you are done using them.

**Q:** How long does it take for a scanned VIN to appear on the PROLink desktop?

**A:** Scanned VIN's will appear immediately after the PROLink screen is refreshed or another PROLink option clicked.

Have additional questions or need help loading or using the PROLink VIN Capture App? Call the NAPA PROLink Support Team Monday through Saturday at 800-742-3578 or email us at [support@napatracs.com](mailto:support@napatracs.com).



I suggest that it is a better idea to tell the customer that you did not check the automatic transmission fluid level because of whatever the reason is for that particular vehicle. If a customer's automatic transmission does not have a dipstick, consider selling them a proper fluid level check at an additional cost and time. Isn't it commonplace to charge more to service some types of vehicles because of the additional expense for fluids, filters or labor? Automatic transmissions without dipsticks are an additional labor issue.

My other vehicle without an automatic transaxle dipstick, a 2002 Chevrolet Cavalier, was purchased three years ago for my teenagers to drive. I have had this vehicle serviced at a local national chain quick lube business. The multi-inspection check sheets I receive with each service show all of the fluid levels as being "OK." The problem with the 4T45-E is the fluid level cannot be checked properly in this transaxle if the fluid temperature is above 104° F. If you remove the fluid level check plug on this transaxle and the fluid temperature is above 104°, the fluid will have expanded and it will appear to be overfilled and fluid will spill out of the check plug hole. This actually will cause the fluid level to be too low when checked properly.

I asked a technician that works for this national chain quick lube business what they do about checking fluid levels on automatic transmissions without dipsticks. He said unless there is a leak, they also mark the level as "OK" even if they never checked it. He also told me the company was making efforts to address this issue because of the many vehicles that come through their doors without transmission dipsticks.

### Transmissions With Dipsticks

Let's start our discussion with the easiest to check transmissions first. Every technician I know thinks they know how to check the transmission fluid level on an automatic transmission with a dipstick. After all, it is just a dipstick, how hard can it be?

Transmissions with dipsticks need to be checked under the proper



operating conditions. Transmission fluid temperature has always been critical for proper level checking as well as the vehicle being on a level surface.

For many years, the typical transmission's fluid level was supposed to be checked at full operating temperature (a minimum 180° F), but does anyone really check the temperature of the fluid when they check its level?

Some technicians have told me that they assume the transmission fluid is hot enough when the upper radiator hose is hot or if the radiator cooling fans come on. I personally have run experiments on front-wheel drive vehicles. It takes about 40 minutes of engine idling before the transmission fluid temperature reaches 180° while the engine thermostat opened at 12 minutes and the cooling fans came on at 20 minutes.

My experiment on a rear-wheel drive vehicle without an electric cooling fan resulted in the transmission fluid temperature reaching 150° after 60 minutes of engine idling while the engine thermostat opened and made the upper radiator hose hot at 12 minutes. Obviously, relying on the engine temperature to indicate transmission fluid temperature at an idle is inaccurate. You must actually drive the vehicle for several miles to adequately heat up the transmission fluid. Next, you check the fluid temperature with a scan-tool or multimeter with a fluid temperature probe to accurately adjust the fluid level.

Some transmissions and transaxles have a dipstick tube, but no dipstick. There is a cap on the top of the dipstick tube that reads "For Dealer Use Only." There is a special service tool universal dipstick (Miller Tool No. 9336A). This special universal dipstick has a 120mm long ruler attached to a flexible cable. The ruler has increments every 10mm to read the fluid level from the bottom of the transmission pan. The universal dipstick is typically longer than the tube and will protrude beyond the top. The level can then be compared to a temperature verses fluid level chart in the service information to determine if the fluid level is correct for that particu-

lar fluid temperature. I like this method, because it lets you quickly check the fluid level over a very wide range of fluid temperatures. Read the proper vehicle specific service information for this procedure because it does vary from make to make and model to model.

### Transmissions Without Dipsticks

When a customer brings their vehicle in for a quick service, they do not want to have to wait for more than 30 minutes to an hour. Transmissions without



This is a GM check plug. Seems easy enough, but if the fluid temperature isn't right you may actually let fluid out that needs to stay inside.

CCA:Actual	☺	☹	☹	☹	Throttle Body
CCA:Spec	☺	☹	☹	☹	Induction Syst
<b>FLUIDS &amp; CONDITION</b>					
Oil	☺	☹	☹	☹	<b>STEERING</b>
Coolant	☺	☹	☹	☹	Bushings
Transmission	☺	☹	☹	☹	Gear Box
Power Str.	☺	☹	☹	☹	C.V. Boot
Brake Fluid	☺	☹	☹	☹	
Fluid Leaks	☺	☹	☹	☹	Strut & Sh
Other	☺	☹	☹	☹	
QTY					DESCR

Every time I took my car in for service, I was told my fluid level was OK. Was it really?



This is the tool used to check Chrysler and Daimler products that have a tube but no dipstick.

dipsticks typically need to have their fluid levels checked at a cold or warm temperature (between 68 and 130° F). If a customer brings their vehicle into your shop for service with a hot transmission, you cannot accurately or safely check the fluid level unless you let it cool down first and this can take a considerable amount of time.

You may want to keep the car overnight to allow a cold start. The transmission fluid level checking procedure on transmissions without a dipstick can be a lengthy procedure. Here are a few examples just to show you how involved some models can be. That's why I recommend that shops charge accordingly for checking and adjusting the fluid level on "sealed" trannies.

**GM 4T40-E and 4T45-E:** This transaxle is used in the 1995 and above small GM front-wheel drive vehicles. It has a



On some Toyota transmissions, you have to open the thermostat valve to insure a proper fluid level check.



The Toyota tool makes fluid inspection and adjustment relatively painless.

two-page long set of instructions just to check the fluid level properly. My interpretation of the basic procedure for checking this transaxle's fluid level follows but always be sure to look up the procedure for your specific vehicle as there may be minor differences:

1. Connect a scan tool and read the transaxle fluid temperature. If the fluid temperature is above the specified temperature for fluid adjustment, allow the fluid to cool until it is at spec. This could take several hours dependent upon the current fluid temperature.

2. Place the vehicle on a level hoist

3. Locate the fluid level check plug on the far right side of the transaxle just a few inches above the transaxle oil pan. Place a suitable drain container under the fluid level check plug to catch any fluid that may come out when the plug is removed. **WARNING:** Do not confuse the transaxle fluid level check plug with the line pressure plug that is located on the front of the transaxle, they are identical in appearance.

4. Locate the plastic transaxle fluid fill cap that is located on top of the transaxle. Unscrew the fill plug and install a funnel in preparation for adding fluid.

5. Start the engine and move the transaxle shift lever through all of the gear ranges stopping for a few seconds in each position.

6. With the engine idling in the Park position, carefully remove the fluid level check plug. Be careful not to spill fluid on yourself, especially if the fluid is hot, you may get burnt.

7. If fluid comes out of the level check hole, let it drain until it stops to a very slow drip and then reinstall the fluid level check plug. The transaxle fluid is now at the proper level.

8. If no fluid comes out of the level check hole, add Dexron IV fluid to the transaxle through the long funnel until it comes out of the level check hole. Let the fluid drain from the hole until it stops to a very slow drip and then reinstall the fluid level check plug. The transaxle fluid is now at the proper level.

**Toyota AB60E and AB60F:** These six-speed transmissions are used in the 2007 and above Tundra Trucks and Sequoia SUVs. They have a 14-page long set of instructions just to check and adjust the fluid level properly and a special tool (Toyota Special Service Tool No. 00002-11100-02 Transmission Fill system or

equivalent) is required. The transmission pan on these vehicles has two plugs, one is a drain plug, one is a overfill plug. The drain plug is the lower of the two. The procedure for this transmission is similar to the GM transaxle discussed above with the following exceptions:

1. The fluid level check plug is in the transmission oil pan

2. The transmission refill plug is on the left side of the transmission in a difficult to reach location. The plug has the letters "WS" stamped on its head. It can be removed with a 24mm wrench.

3. The fluid temperature required for proper level checking is 115-133° F.

4. Vehicles with a factory-towing package include a transmission thermostat valve that regulates the volume of fluid through the transmission cooler depending upon fluid temperature. This thermostatic valve is located on the right side of the transmission and must be pinned open during the fluid level check to insure that the cooler lines and cooler are full of transmission fluid.

5. Adding fluid to the transmission through the refill hole is made a lot easier if you have the Toyota special tool. A suction gun can also be used to install the fluid if it is clean and not cross-contaminated with other fluids.

6. These transmissions require Toyota World Standard "WS" fluid

Methods for inspecting and adjusting the fluid levels on sealed transmissions will differ from one make to another, even one model to another. Always reference the vehicle-specific service information and be sure you understand the procedure before attempting to do so. Failure to do these inspections properly may result in a transmission that is over- or under-filled, and could result in expensive transmission damage. **ZZ**



**JOHN D. KELLY**  
CONTRIBUTING  
EDITOR

John Kelly began his automotive career as a technician in 1979, moving on to be a GM automotive trainer for 13 years. He joined Weber State University in 2004, and is both an Associate Professor and Program Manager for its automotive technology department. In 1998, he developed what is now Vibration 5.1, a software program that aids in the diagnosis of vibration-related complaints.

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# WHAT'S MISSING?

WHAT IF A MISFIRE REALLY ISN'T A MISFIRE? THAT COULD DERAIL YOUR PROGRESS.

BY "G" JERRY TRUGLIA | CONTRIBUTING EDITOR

**T**his month's story features Edwin Hazzard, owner of Automotive Tech Systems, a mobile diagnostic and repair service serving shops in the Hudson Valley in New York. He holds ASE certifications T1 and T2 and is a Certified Master Automotive Technician with more than 25 years of experience.

## When a Miss isn't

When a shop calls me and wants me to diagnose a problem vehicle, I treat it as a "call to arms." Usually they have exhausted all possible means of repairing the vehicle based on their capabilities.

The vehicle in question is a 2002 Chevrolet S-10 4WD with a 4.3L (vin X) engine. It has 120,000 miles on the clock. The customer complaint is a Check Engine light that is on steady and flashes while driving. But on the test drive, the vehicle exhibited no drivability issues at all. Based on this preliminary information, I hooked up my scan tool and proceeded to see what code or codes were stored in the Powertrain Control Module (PCM). I retrieved a P0300 and P0304. Code P0300 is a random misfire, and code P0304 is a misfire on cylinder No. 4.

Based on my experience and training, an engine misfire is usually one of four possibilities. It's a fuel delivery problem, an ignition (spark) problem, an engine mechanical problem or an electrical problem. Sometimes it's a combination

of those mentioned, but it is definitely one of those. Because code P0304 is a cylinder specific code, I'm going to focus on that code first.

I asked the shop owner what was done to the vehicle so far. He explained his guy had replaced the distributor cap and rotor, tried an OEM cap, then a complete distributor assembly. In addition to all those parts, they also had installed an ignition wire set, new spark plugs, an injector spider kit (one aftermarket and one OEM), a Crankshaft Position Sensor (CKP) and intake manifold gaskets. The shop performed a cylinder leak down test and a compression test as well as a running compression test. None of these tests revealed a mechanical concern.

So with a lot of parts replaced, it doesn't leave me much left but a lot of questions. Why were all these parts changed and what tests were performed to warrant the parts replaced?

I hooked up my scan tool and went for a test drive. This truck ran very well, but after a few minutes driving the Malfunction Indicator Lamp (MIL) started flashing. Strange, I didn't feel any engine miss and it didn't skip a beat. I looked at the recorded scan data when I returned to the shop and nothing looked out of the ordinary. The only thing I saw was the misfire counters ramping up for cylinder 4 and a couple of other cylinders that were barely showing any misfires. That would explain why I have a P0300.

I asked myself, "If a cylinder was misfiring, wouldn't I see an issue in either the front oxygen sensor voltage or a skewed fuel trim reading for that bank in either a lean or rich direction?" After all, if a cylinder isn't firing then the combustion process would be inaccurate and the lack of or excess of fuel would show up, right? Now I'm thinking this isn't going to be as easy as I hoped.

I decide to break out the big guns. I'm going to look at this cylinder up close. I grabbed my scope and proceeded to hook up to the PCM connector to check the CKP signal, the Camshaft Position (CMP) signal and the number 4-injector signal. Remember, the CKP sensor is the one the PCM monitors to detect misfires (on most vehicles). Based on the waveforms that I saw, though, there doesn't appear to be any erratic signal or signal drop out. I hook up to the No. 4 plug wire and look at the ignition waveform. That, too, looks fine. I did perform my own compression and leak down test as well as a visual inspection of the ignition



Using the OEM tool is one way to be sure you get to see everything the factory will let you see.



Who knew a failed bearing would cause a misfire code to set? (Sample failure shown.)

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Most OEMs use crank speed as a way to detect misfires. Anything (key word) that causes that signal to vary in speed can set a code. (Toyota example shown.)

components and injector connector pins. Even though the shop did those tests, I like to do them myself for my own peace of mind.

But now my mind was getting a little frazzled. Time to take a much needed break and recoup my thoughts.

Let's see, the CKP sensor reports to the PCM, right? Could the PCM not be reading the data correctly? (I had already veri-

fied the CKP signal was OK). I removed the CKP sensor and visually inspected it to see if any damage was evident. It looked good. The next thing I tried was to check crankshaft free play. Maybe the crankshaft reluctor wheel is moving too far away from the CKP sensor? Nope; no excessive end play was found.

The one tool that everybody has is the tool to be able to see and to hear. When I was running this engine at 2,000 rpm, I didn't hear anything that sounded out of the ordinary. But with the accessories on the front of the engine, it does add some extra noise to the engine noise. I wanted to hear the engine without the belt noise and the accessory noise.

I removed the belt and started the vehicle up. Wow, the engine was quiet and the misfires were no longer counting up on the scan tool! Are my eyes playing tricks on me? I reinstalled the belt for my own sanity and the misfires returned. How could this be? I removed the belt again and sure enough, the misfires disappeared. Increasing engine speed to 2,000 rpms with the belt off, I could here the sound of a rod-bearing knock.

I had the shop remove the oil pan and inspect the bearings for excessive wear. They told me that the No. 4 rod bearing journal was wiped. It all started to make sense. Misfires are detected by monitoring the speed of the crankshaft via the CKP signal to the PCM. I can only think that the worn rod bearing play was enough to impact the speed of the crank whenever the No. 4 cylinder hit its power stroke and that effect was more noticeable when the crank was additionally loaded with all the accessory drag. *TLZ*



**G. JERRY TRUGLIA**  
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# GOING ON A BUG HUNT

THERE WERE PLENTY OF BUGS ON THIS VOLKSWAGEN BUG TO KEEP EVEN A VETERAN TECH BUSY. IF ONLY THIS VET HAD LISTENED EARLY ON.

BY **RICHARD MCCUUSTIAN** | CONTRIBUTING EDITOR

**C**ertainly, the most notable adventures we've braved in the past several years happened when I agreed to take on a 2001 VW Beetle with a start-and-die problem. Nobody else had worked on the car; she simply went out one morning to start the bug and it simply started and died repeatedly.

For new Beetle buggers, that points to an immobilizer (passive anti-theft) problem, but all we had to work with on



## BUGGED BY A BUG

### 2001 VOLKSWAGEN BEETLE

Vehicle Year/Make/Model

### 2.0L NATURALLY ASPIRATED 4 CYLINDER

Engine

### 01M 4 SPEED AUTOMATIC

Transmission

115,542

Mileage

### THE VEHICLE WILL START AND JUST DIE

Vehicle complaint

that platform was an OBDII scan tool. I had never purchased the European software for any of my tools, because we see maybe one European car a year and too many Asian and domestic models to count. Besides that, the guy I assigned to this job was a second semester student who was fairly sharp, but had no idea what the bug-shaped flashing light on the cluster meant.

Because he didn't mention anything about it and I didn't look at the dash indicators myself, we wound up going after the crank sensor code we pulled from the Nemisys. There were no immobilizer codes that came out of that DTC retrieval, but then, you won't get those from the OBDII generic interface on this car anyway.

Checking the spark, we found that it would start popping and then go away while the engine still was spinning. Identifix® posts spoke at great length of checking the AC voltage generated by the Crank Sensor, which was just less than the minimum of 800 mv. We replaced the sensor and got that voltage up to 1,500 mv. That probably fixed the stored crank sensor code, but it didn't fix the car. So we called the hotline and spoke to the European car expert.

My discussion with him about the code and the spark issue led the engineer to send me after the ECM, because, in his words, "They like to burn up." He said if the ECM was destroyed, you could see it by removing the ECM and opening it to eyeball the circuit board.

The ECM on this car is located under the top dash panel right behind the cluster. We did that, and it was fine as far as we could see (but I wondered if maybe it could fail in some less evident fashion). Further testing at the ECM connectors proved that the crank sensor signal was making it all the way to the ECM the whole time. We sewed up that part of our investigation quickly and moved on. Everybody reading these words knows how catastrophic it can be to replace an engine controller



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on a hope and a prayer.

I mentioned to the hotline guy my concern that the problem might be immobilizer related, and he said the immobilizer typically doesn't shut off the spark; it simply kills the fuel injectors. I found out that was hooey. This one did indeed kill the spark and the injectors on this particular Beetle.

Because we now (too late) recognized the flashing bug/key light for what it was, I called Mike, a very sharp guy from a shop across town, and he brought his Snap-On box that had all the bells and whistles. While he did get immobilizer-related codes from the ECM, he couldn't talk to the instrument cluster. Not at all. This was a quid-pro-quo deal, so I thanked him, promised him a favor in return, and he headed back to his shop. In the Snap-On tester's defense, I later discovered that unless you have a battery charger connected to this car so as to have really strong supply voltage, the ECM will communicate, but the cluster won't talk to a scanner.

In cases like this, I like to use the Midtronics ripple-free charger that I bought for flashing engine controllers. Because the battery was weak, I kept

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it connected for most of this job.

I called the big gunner who sold me that charger – Joey Hendrich of AETools.us. If he doesn't have the answer, he'll find it for you. (Incidentally, his tech support is free if you buy tools from him, and I do). Hendrich and I met in Massachusetts at Craig VanBatenburg's hybrid training. We were on the same four-man team in that class, and I found out just what a dynamo he is at solving really tough problems. During one of the 12-hour shop sessions, I even saw him enter the "back door" of a failed Hybrid Battery ECU with his laptop, determine the protocol it was supposed to be using and wake that controller up to bring it back to life. We all were stunned by that accomplishment.

He told me three very important pieces of information about the Beetle.

The best tool to talk to a VW the right way is the VCDS from Ross-Tech®, which he just so happened to have. I bought one.

Even after yanking the codes, if the problem turned out to be an immobilizer problem, I'd be out of business if I couldn't extract the four-digit pin from

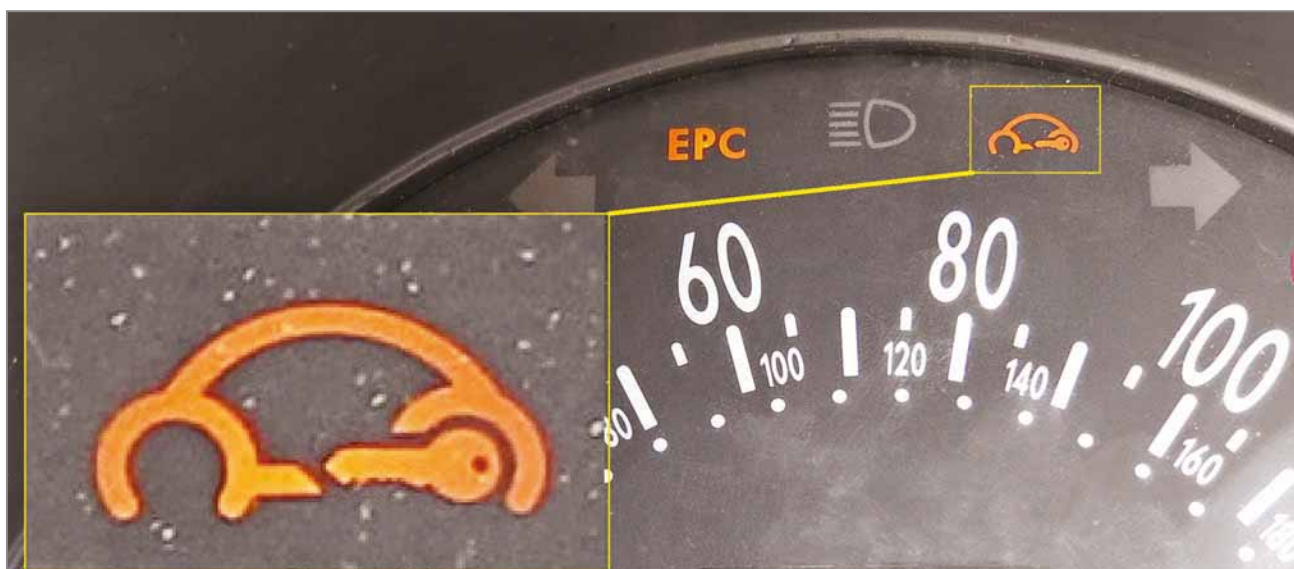
the cluster (needed for programming a new key or cluster if one was needed). He had a tool for that, too.

The cluster frequently is the problem on these platforms, and a replacement cluster would be the wisest first choice.

I should have listened to Hendrich's third piece of advice. As it was, I was boneheaded enough to get sidetracked by DTCs that told me the key signal was weak and/or the lock cylinder pickup coil was bad.

**“The dealer probably was right. They must have had old data, because the VW dealer turned out to be right in the end, but my doubts drove me to snag a used 2001 Beetle steering column (complete with a chipped switchblade key) just for grins.”**

We had an immobilizer problem of some kind to be sure, because the cluster was complaining that it couldn't



Today's vehicles have a lot of peculiar warning lights, some that flash and some that simply illuminate. This isn't an ISO symbol (although it looks like one). It's bug-shaped with a key in the wheel well and it flashes when it thinks somebody is stealing the car with a bogus key.



With the Ross-Tech software, you have to know which measuring blocks you need to select. But once you learn that, extracting codes from the various modules is simple. These were the first codes we got from the cluster.



This was the initial message we got from the ECM after we finished with the rabbit trail of chasing the generic OBDII crank sensor code Nemisys gave us. Note that this code actually pointed to the cluster as a possible problem.



After attempting to start the car, we got these two codes, leading me astray. I kept assuming the key was a problem and initially had them fetch me a new key from the dealer.



At the same time, we got these codes from the Engine Controller, which muddled our thinking even further.

see the key. The pickup coil seemed like a logical possibility — after all, it receives and transmits the code. Further, as we used the VCDS we discovered that while this 2001 Beetle had a serial number beyond the 430000 VIN threshold that separates Immobilizer 2 from Immobilizer 3 platforms, it was outfitted with Immobilizer 2, which made no sense at all, until later.

## Just Wait

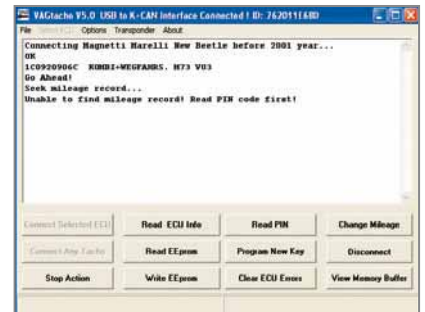
Little did I know at this point that the cluster's funky little brain had lost its ability to see the key, even with a good key and a good pickup coil.

I had the customer get me another key just for grins, which they obtained from the Pensacola, Fla., VW dealer for \$60. Having made the discovery during my wait for the key that it was an Immo 2 system in spite of the serial number, I called the Pensacola VW parts department, and the associate I spoke with assured me that the same key would work with either Immo 2 or Immo 3, because both part numbers were now the same.

But while one of Hendrich's sources refuted that, he told me the dealer probably was right. They must have had old data, because the VW dealer turned out to be right in the end, but my doubts drove me to snag a used 2001 Beetle steering column (complete with a chipped switchblade key) just for grins. I was trying to cover all my bases in my own misguided, silly way. And now I would need the second, more expensive cable-and-dongle package to retrieve the PIN. I gave Hendrich my credit card number and he zipped it out to me overnight via FedEx.

Using the second cable Hendrich sent, I plugged in the dongle, loaded the software with some remote help from Hendrich's guy at AETools and proceeded to retrieve the cluster's pin number, which turned out to be 2886. I then used the Ross-Tech software (which is tricky to use, but there are videos on Ross-Tech's website) to attempt to erase all preexisting keys and program the new one. Big problem — it wouldn't work, so I caved in and ordered a cluster from the local salvage yard for \$125, smacking myself for not listening to Hendrich in the first place.

With the cluster on its way, I first installed the used ignition lock cylinder



With the VAGtacho software and cable, we hacked into the cluster, chose the appropriate cluster from a long list (process of elimination) and read the pin code. But this cluster still couldn't read the key even after I retrieved the pin and entered it into the Ross-Tech software during the key programming process. You won't get anywhere without the PIN, and the VAGtacho is the best way I've found to get it. The very next week, I fixed a diesel Jetta with it. Sometimes VWs just forget their key and have to have programming done to fix it.

from the salvage yard column thinking the antenna on the original lock cylinder might be an issue. An attempt to program the used key and cylinder to the original cluster was a dismal failure, and now neither of the other keys would fit. I was hung using the one that came with the used lock cylinder.

The salvage yard asked when I was ordering the cluster if it was manual or automatic transmission. It had a PRNDL stick in the floor, so I told them automatic. While that was true, it turned out to be a bad question where the cluster for this particular car was concerned. The cluster they sent immediately threw a bunch of DTCs about a missing transmission controller and whatnot. The replacement cluster's part number ended in 901, and the original cluster's part number ended in 906, a fact that I noticed even before I installed it.

When I called the salvage yard and gave them that part number information, they informed me this car had been outfitted with cluster for a manual transmission Beetle (PRNDL stick notwithstanding), and I ascertained that the automatic transmission on this one

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This is the disassembled salvage yard key (I had to buy the whole steering column to get it and a lock cylinder). The chip was damaged in this key for some unexplained reason, even though there was no external damage to the housing.



This is her original key and chip; we removed this chip (very carefully – it's glued in there).



Then we taped it to the salvage yard key. It programmed perfectly with the PIN and the Ross-Tech software.

must be fully hydraulic. The bug guys had stuffed the Immo 2 cluster on it because it had no transmission electronics. Then there was that 430000 VIN threshold that turned out to be wrong. This was a circumstantial land mine of the first magnitude, and now the customer had a car rented because the job was taking so long.

I seemed to be stuck on stupid or something, but I gritted my teeth determined not to give up, because that's what real mechanics do, isn't it? After all, I had students watching this whole exercise with intense interest, and if my own professionalism wasn't enough to motivate me, the desire to set an example should be. And it was. I tightened my gloves and stayed in the fight.

I got the right cluster, but still couldn't get it to take the key, even though measuring blocks 21, 22 and 23 in the cluster indicated the key was OK – I hadn't received those results before. Another call to Hendrich sealed the deal. He said to disassemble the key I was using and use just the blade of that key with the head of the new key held near to it. As it was, I found that the stupid chip in the used salvage yard key was cracked (how it got that way is kind of amazing since it's so protectively mounted), and I felt sort of silly for obtaining it to begin with. I

taped the good chip from the customer's original key to the blade of the key that fit the replacement cylinder and the programming went like a song. Had I ordered a replacement cluster to begin with, my journey (and the fight) would have been over quickly, but now I know things I would never have learned otherwise.

Then I went the extra mile by reassembling her original key with the good chip, swapped out the girl's lock cylinder so her original key and the new one they bought would fit, and programmed them both. Now she had two good keys, no flashing bug light and a car that would start and run. In the end, I was a heck of a lot smarter about how to handle old VW Immobilizer systems. What I learned from this exercise was something I already knew, and it was quite simple. Pay attention when somebody with more experience is talking. You'd think I would have learned that after nearly 40 years in this business, but we all take wrong turns from time to time.

I got a visit from the Beetle owner two days later. She said her car was running and starting fine, but that within seven miles, the speedometer needle was wagging wildly all over the dial. I put in a call to the salvage yard and told them to get me another cluster, and that one worked fine. With my freshly earned experience, I whizzed through marrying the new cluster with the keys in record time.

Sometimes salvage yard parts save our bacon – sometimes they make it so we can't afford to even buy bacon. In this case, it seems that both were true. One way or another it feels good to win in the end. And God bless an extremely patient customer. She trusted me during phases of this operation when I didn't even trust myself. **ZZZ**



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

**E-mail Richard at [rwm19@mail.com](mailto:rwm19@mail.com)**

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For more information, visit  
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AMSOIL INC. has repositioned two of its synthetic automatic transmission fluids to be included in the company's Signature Series family. This reflects the premium quality of AMSOIL Multi-Vehicle Synthetic Automatic Transmission Fluid and AMSOIL Fuel-Efficient Synthetic Automatic Transmission Fluid. AMSOIL Signature Series ATF is recommended for twice the vehicle manufacturers' severe-service drain interval. Signature Series ATF provides outstanding high and low temperature performance and oxidation stability. AMSOIL Synthetic ATF is formulated to improve fuel efficiency, reduce transmission temperatures and increase equipment life, according to the company.

For more information, visit  
[www.amsoil.com](http://www.amsoil.com).  
AMSOIL Inc.



### OXYGEN SENSOR LINES

Bosch has expanded its line of oxygen sensors to cover applications through the current 2013 MY. These 82 new OE-fit sensors cover 21.9 million vehicles in the U.S. and Canada, including a variety of domestic and import applications. Besides a host of passenger cars, minivans and SUVs, the new coverage also includes several hybrid vehicles. These part numbers, per Bosch, cover General Motors, Ford, Chrysler, Nissan, Lexus, Mazda, Toyota, Infiniti, Kia, Mitsubishi, Hyundai, Volvo, BMW and other makes. The majority of these late model applications can be found in Bosch's last ACES/PIES catalog for April 2013 and are available immediately through regular distribution channels.

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Hunter Engineering

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### DENSO WIPER BLADES

DENSO's First Time Fit Wiper Blade program offers a wide range of wiper blades to meet your needs. The program offers conventional, beam and designer styles, allowing a direct replacement of your original equipment blades. DENSO's wiper blades provide quiet, streak-free performance with its durable design. Quick and easy installation makes replacing your wiper blades a snap. Bottom line — DENSO First Time Fit Wiper Blades deliver the engineering, quality and performance that makes them the best choice when it's time to see clearly.



Denso

### FEDERATED OFFERS PREMIUM BRAKING PERFORMANCE FOR TODAY'S VEHICLES

Federated Auto Parts has developed an addition to its friction offering with a new co-label line developed and supplied by Wagner Brake. The new product line is a premium offering designed for professionals that was exclusively designed for Federated members and their customers. The line uses the highest performing formulas specific to each application and includes System Synergy Technology (SST), which is an OE approach to brake design that ensures the interaction of all brake components to provide the ultimate performance.



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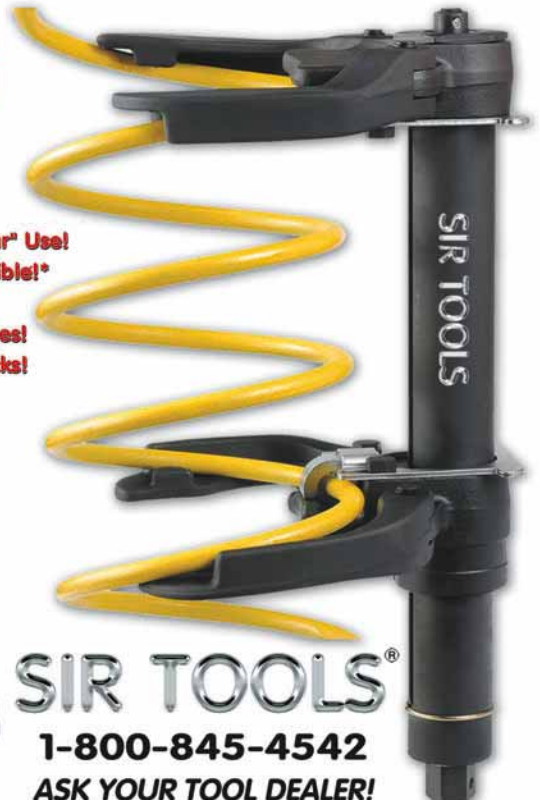
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# TAKING A PEEK

## SPEED UP YOUR DRIVABILITY DIAGNOSTICS WITH AN IN-CYLINDER PRESSURE TEST.

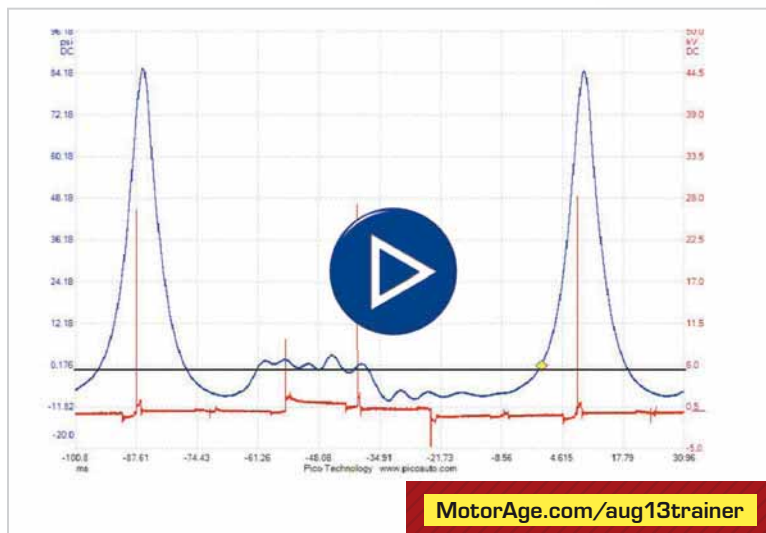
BY **PETE MEIER**  
**Technical Editor**

Have you ever stood at a vehicle, peering into the engine compartment, scratching your head and wishing you could see inside the engine when faced with a drivability complaint? Wouldn't so many problems be easier to find if you could?

Imagine being able to see exactly when the ignition event actually happened or confirm a valve that wasn't sealing as it should? How about verifying cam/crank synchronization without the need for a "known good" cam/crank sensor waveform or tearing the engine apart to access the physical timing marks? You could do all this and more in minutes if you were using in-cylinder pressure testing as part of your diagnostic assault.

This test uses a pressure transducer and a digital storage oscilloscope (DSO) to monitor pressure changes in the cylinder while the engine is running. A transducer differs from a sensor in that the transducer is able to accurately measure the pressure while a sensor simply reacts to pressure change. The transducer converts the pressure measurements into a voltage signal that your scope can use to paint a picture of these changes on the scope's screen, bringing the idea of a traditional running compression test into the 21st Century.

In this edition of The Trainer, we'll show you what accessories you'll



need and how to set up a scope to perform this test. We'll also show you the basic elements of the in-cylinder running pressure waveform and what they have to tell you. After viewing this video, we're sure you'll see how valuable a technique this is and how it can save you hours of time in the shop.

Bernie Thompson, if not the father of this technique is certainly one of the most well versed in its use, recently authored an excellent introduction to this testing method that was featured in July's issue. If you missed the print, you can always access the digital version at [MotorAge.com/incylinder](http://MotorAge.com/incylinder).

And don't forget to check out past editions of The Trainer. We produce these monthly, as a how-to resource for

your shops. Free training you can look at any time of day always is helpful. And let us know if you have any maintenance or repair processes you'd like to see highlighted in this monthly series. [www.mazda.com](http://www.mazda.com)

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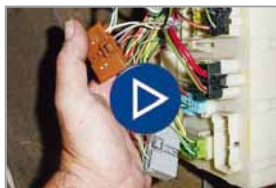
Do cat codes equal cat failure?

[MotorAge.com/jul13trainer](http://MotorAge.com/jul13trainer)



Let's say hello to Mr. DSO

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Electrical need-to-know foundations

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Testing battery faults (Is it even the battery?)

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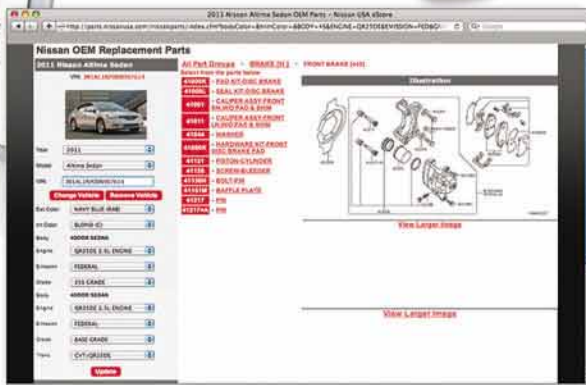
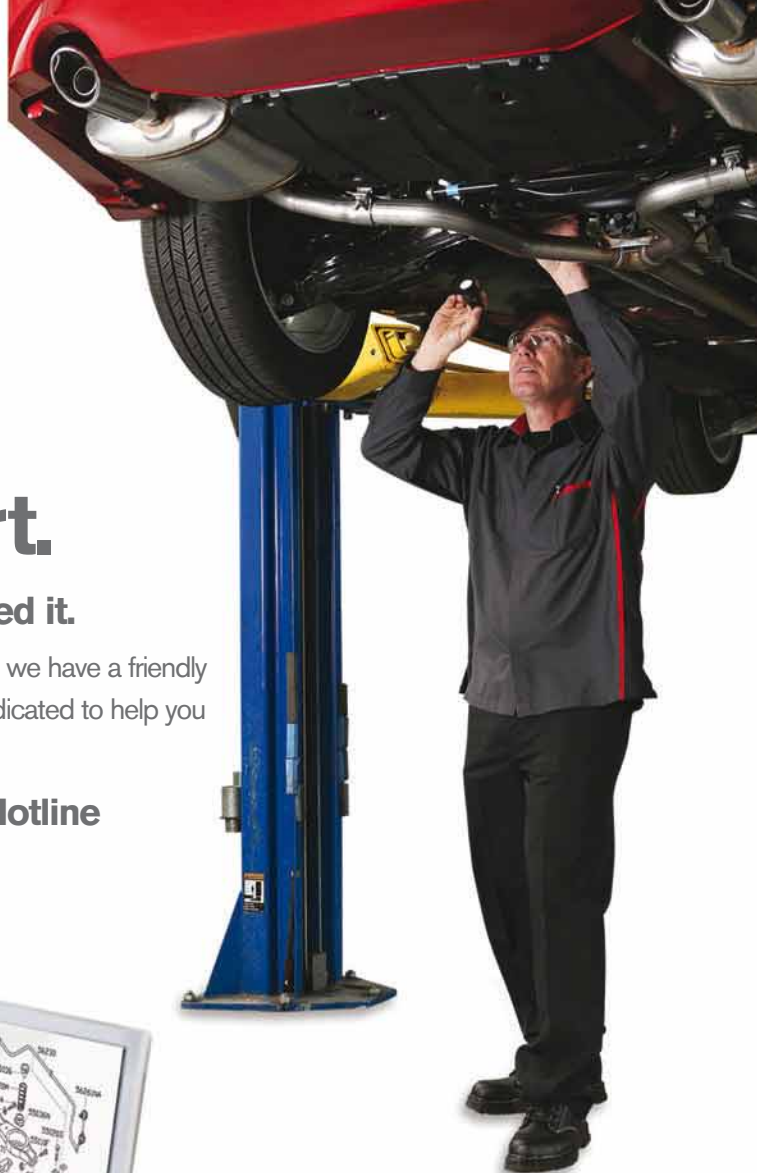
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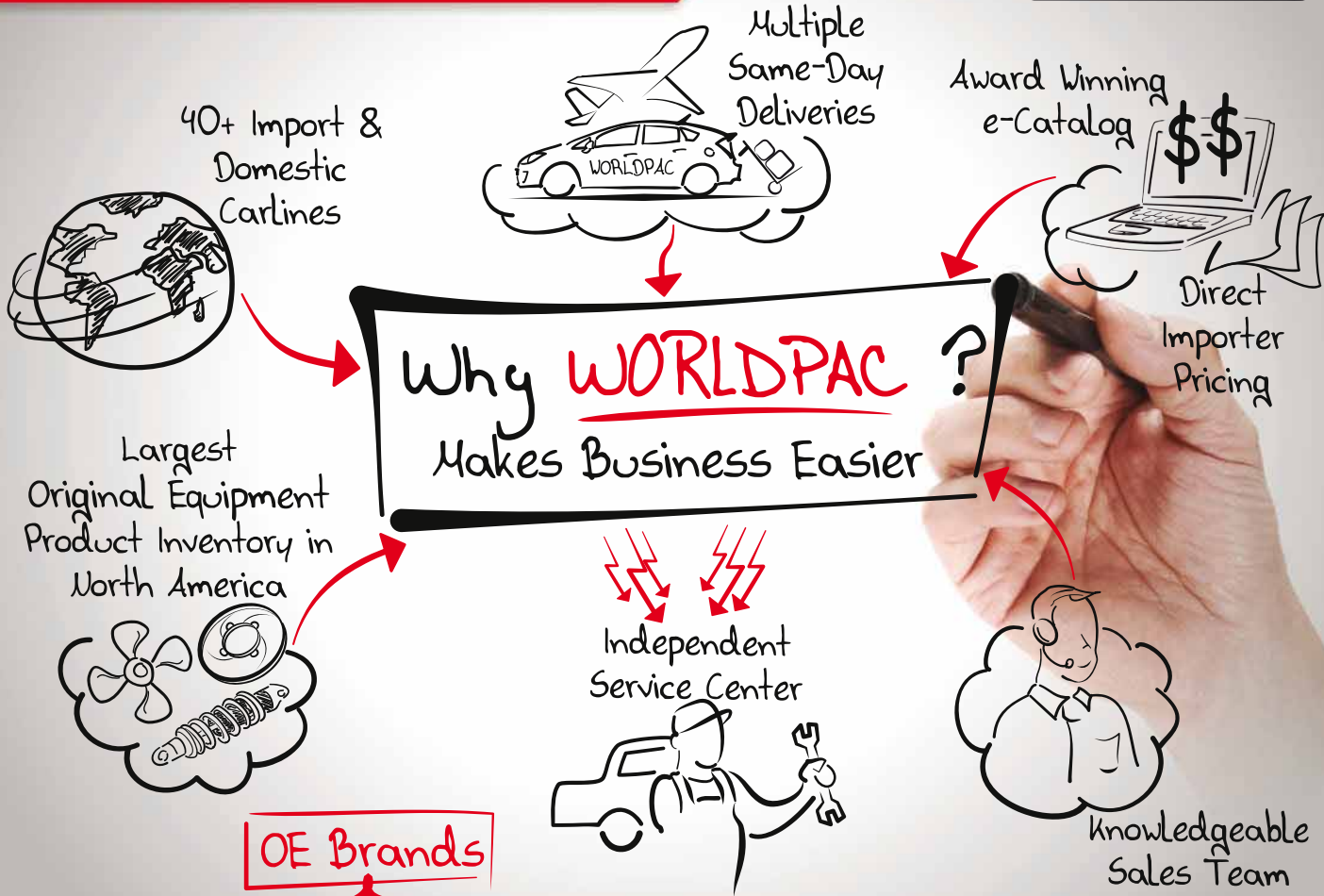
Parts diagrams and VIN-verified part numbers are available in our digital parts catalog at [parts.NissanUSA.com](http://parts.NissanUSA.com).

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## **Proper Adjustment**

Vehicle-specific maintenance

## **Refined Steering**

Replacing the intermediate steering shaft

## **Engine Protection**

Genuine Kia oil filters

2014 KIA CADENZA with packages shown with optional features. Initially only available in certain markets with limited availability. Not all optional features are available on all trims. [www.kia.com](http://www.kia.com)



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# New Model Launches Promise Continued Service Opportunities

**K**ia is on a hot streak with record-breaking new vehicle sales and fresh new designs for 2013. Kia Motors America (KMA) continues its mission to create an outstanding customer experience throughout the life of every vehicle—a value stream that extends all the way to maintenance and repair. Continued record-setting sales foreshadow increased future demand for maintenance and accessory sales.

Kia has rolled out what is arguably its best ever vehicle designs. Sleek, eye-catching and in tune with the market, the all-new 2014 Cadenza and Forte sedans joined the 2014 Sorento CUV as three of seven all-new or significantly redesigned vehicles scheduled to launch this calendar year. Each of these new products furthers Kia's efforts to advance value to new levels of sophistication by combining European-influenced styling with cutting-edge technology.



2014 Forte sedan

New product launches combined with strong demand for vehicles already in the line contributed to KMA's best ever April sales of 47,556 units. The Optima midsize sedan led Kia's sales for the 17th consecutive month with 14,678 units sold, and together with the Sorento CUV, accounted for nearly 50 percent of total sales for the month. The Soul urban passenger vehicle also recorded robust monthly sales of 11,311 units.

As the Kia brand continues to resonate well with consumers and create

record sales, Kia's success bodes well for maintenance and repair business now and down the road. And Kia makes it easy with Genuine Kia parts and expert technical advice from local Kia dealers.

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The same passion and dedication that drives our innovative vehicle design is also built in to every Genuine Kia Part. Look to your Authorized Kia Dealer for replacement parts to keep your customers satisfied mile after mile.

**Kia Motors America, Inc.**

## In This Issue

VOL. 8 | NO. 2 FALL 2013 | *Quality Connection* is published by Kia Motors America



### Proper Adjustment

Vehicle-specific maintenance for the 2009 Kia Rio



### Refined Steering

Replacing the intermediate steering shaft



### Engine Protection

Genuine Kia oil filters deliver premium performance

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# Right Now.

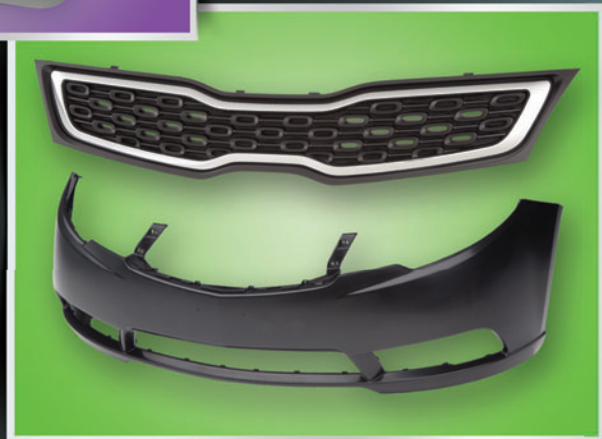
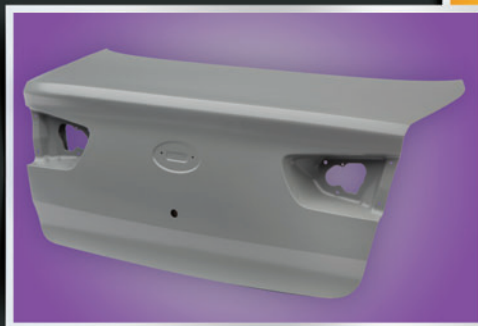
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# Proper Adjustment

Vehicle-specific technical information from your local Kia dealer offers opportunities to provide total customer satisfaction during maintenance.

When your customers bring their Kia Rio in for maintenance, it's the perfect time to check for issues that can help to ensure complete customer satisfaction. On 2009 Rio's built during production dates from 7/12/2008 to 9/10/2008, check the fuel door and rear door glass for minor adjustments, which may be needed. Quick and easy, the following procedures provide steps to ensure your customer's Rio is properly adjusted.

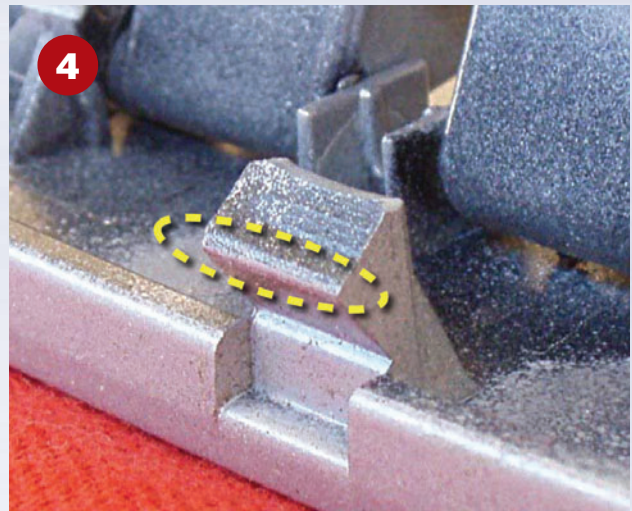
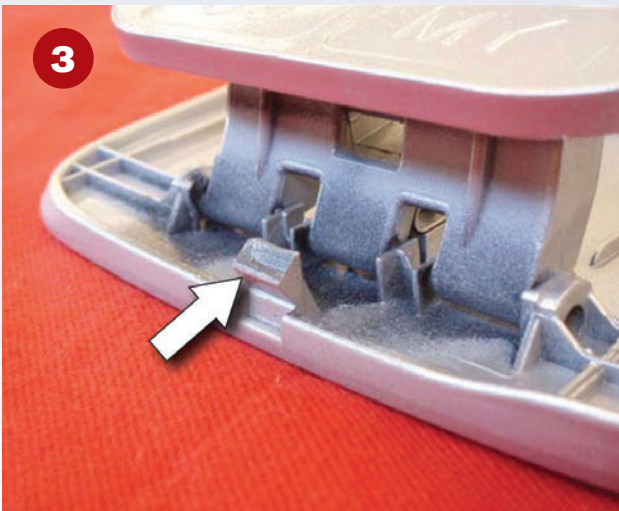
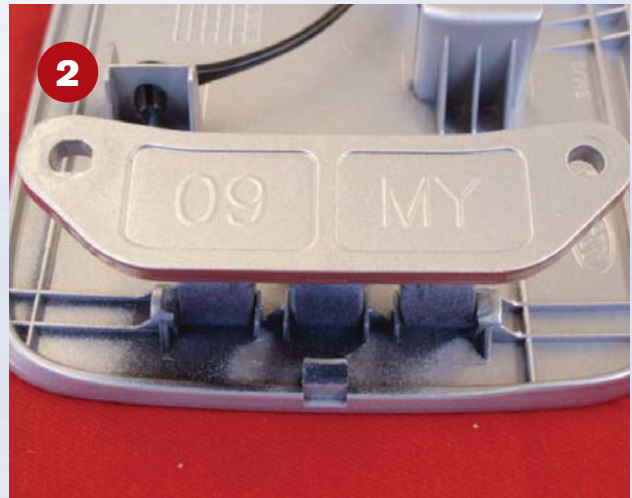
MODEL FEATURED:  
2009 Rio  
(4 door)

## Fuel Door Adjustment

Inspect the fuel door to ensure it remains in the open position for refueling. If it does not, the condition is easily remedied with a quick procedure to adjust the open door detent tab on the fuel door assembly. The adjustment decreases the detent height, enabling it to lock securely in place.



» See your local Kia dealership for model application and product availability.



**1.** Open the fuel filler door to gain access to the fuel door mounting bolts, and remove the fuel cap tether hook from the fuel filler cap.

**2.** Remove the fuel door mounting bolts from the body. Take care not to scratch the paint when removing the bolts.

**3.** Perform the procedure on a covered surface to prevent scratches to the painted fuel door surface.

**4.** Using a file, remove approximately 1 mm of plastic material from the end of the locking detent tab. Remove only enough material until the door has a slight noticeable detent.

**5.** Install the fuel door and tighten the retaining bolts to 35~44 inch lbs (4-5 Nm), and reattach the tether to the cap.

**6.** Check to make sure the fuel door is centered and adjusted properly.

— Rear door glass alignment begins on next page



» This and other technical information is available at [www.Kiatechinfo.com](http://www.Kiatechinfo.com).

## Door Glass Adjustment

A slight gap in the left rear quarter door glass may cause wind noise at high speeds. Inspect for a gap, and follow this quick procedure to set the door glass and weather strip in the proper position.



- 1.** To determine if the condition exists, check for a 0.5 – 1.5 mm gap between the weather strip and window frame on the left door quarter glass.
- 2.** Loosen and remove the upper quarter window track retaining screw, and partially remove the weather strip to gain access. Take care not to scratch the paint.
- 3.** Pull the rear quarter glass assembly rearward, using the vertical window track as indicated. This will seat the glass run and eliminate the slight gap.
- 4.** Align the vertical window track to the upper doorframe, and reinstall the screw, tightening to 35–44 inch lbs (4–5 Nm).
- 5.** Reinstall the weather strip, and ensure it is properly routed into the channel and secured.
- 6.** When complete, clean the window glass before returning the vehicle to your customer. **KIA**

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# ***Refined Steering***



Intermediate Steering Shaft - PN OK52Y 32550

The steering wheel is the place where a driver gets most of his feedback on the performance of a number of vehicle systems, including the tires, suspension and brakes. As simple as the steering column seems to be, issues may arise that require close investigation.

**I**n areas where heavy road salt is used, owners of some 2002-05 Kia Sedonas have identified increased steering effort and noise from the intermediate steering shaft. Initial signs of this condition present as noise or rattle at low speeds. This condition is remedied by replacing the intermediate steering shaft with Kia part number OK52Y 32550 and following the procedure detailed at below.

MODEL FEATURED:  
2002-2005  
Sedona



## Intermediate Steering Shaft Removal

**1** Prior to beginning the replacement procedure, road test the vehicle and establish that the steering wheel is centered while driving straight. If it is off-center, note the direction and the approximate number of degrees. A preexisting alignment issue must be addressed separately prior to performing replacement of the intermediate steering shaft.

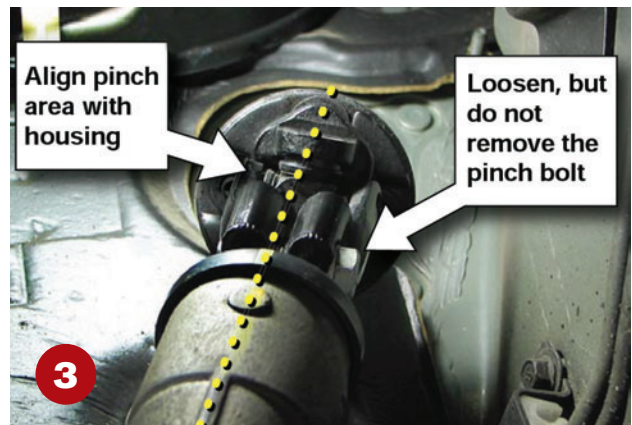
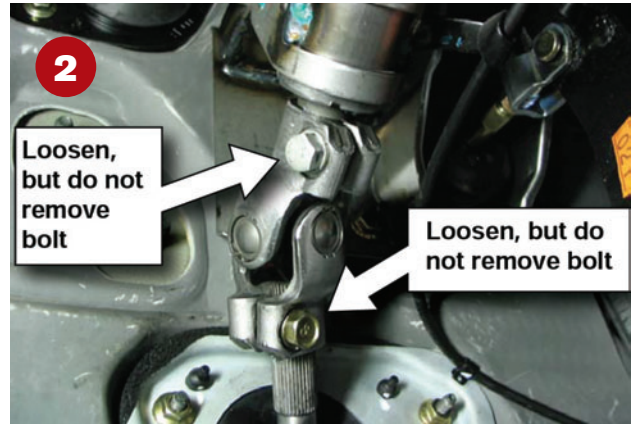
**2** Use the ignition key to unlock the steering column. It must remain unlocked throughout the procedure. Under the dash, loosen but do not remove the two upper joint pinch bolts that attach to the steering column and intermediate shaft. Ensure the pinch bolts grasp the shaft tight enough that no play is felt.

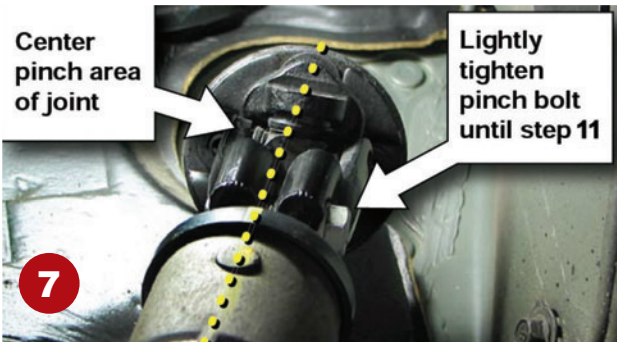
**3** Raise the vehicle on a lift, and loosen but do not remove the lower intermediate shaft pinch bolt. With the wheels pointing straight forward, center the pinch area of the lower intermediate shaft joint on the raised rib and/or circular reference point of the steering rack housing. You may need to clean and re-mark this area with a paint marker for reference.

**4** Lower the vehicle so the tires firmly contact the floor. Without moving the steering wheel, carefully install a steering wheel holding device.

*Note: For any number of reasons, the steering wheel may no longer be centered once the lower intermediate shaft joint is aligned to the steering rack as outlined in step three. The steering wheel must be locked in the position resulting from alignment of the lower intermediate shaft joint to the steering rack, and may not necessarily be centered. Do not allow the steering wheel to spin freely while replacing the intermediate steering shaft. This may cause damage to the clock spring and will affect centering of the steering wheel following replacement.*

**5** Remove the previously loosened upper intermediate shaft joint bolts. Slide the joint down onto the splines of the intermediate shaft. This will allow the joint to be removed from the bottom of the steering column shaft. Do not allow either the steering wheel and/or intermediate shaft to turn. Remove the upper intermediate shaft joint from the intermediate shaft and set aside for reinstallation.





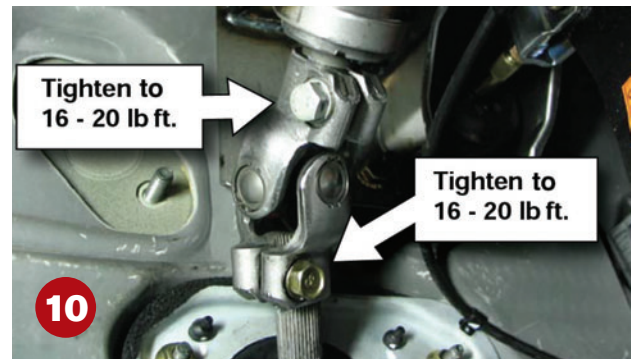
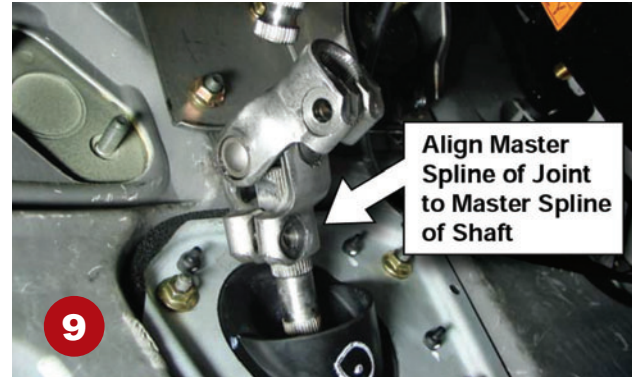
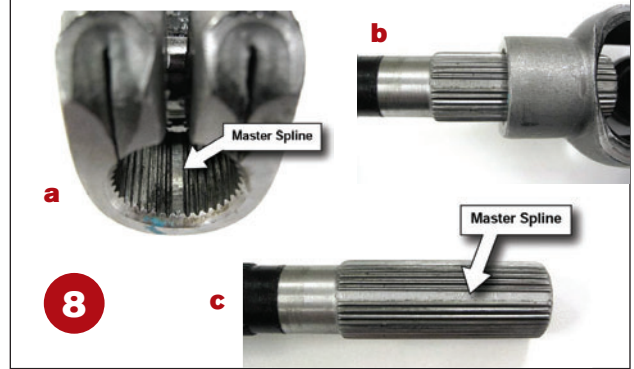
**6** Raise the vehicle on the lift and remove the loosened pinch bolt from the lower intermediate shaft joint. Then remove the intermediate shaft from the steering gear shaft. Do not allow the joint to turn when removing the bolt and/or intermediate shaft.

### Intermediate Steering Shaft Installation

**7** Install the new intermediate shaft, aligning the pinched area of the lower joint with the raised rib and/or circular reference point of the steering gear housing. Lightly tighten the pinch bolt, making sure not to rotate the steering gear shaft. Do not fully tighten the pinch bolt. Lower the vehicle so the tires firmly contact the floor.

- 8 A:** The shaft's upper joint has a master spline on its lower joint section that ensures proper phasing of the two joints of the intermediate shaft. Note that the upper section of the joint does not have a master spline.
- B:** The intermediate shaft has a master spline that ensures proper phasing of the two joints of the intermediate shaft.
- C:** The upper joint master spline must be aligned with the intermediate shaft master spline as indicated to ensure proper phasing of the two joints of the intermediate shaft. Only the bottom section of the upper joint has a master spline.

**9** Under the dash, reinstall the intermediate shaft upper joint, paying close attention to the master spline alignment between the joint's lower section and intermediate shaft.



**10** Fully install the upper intermediate shaft joint and tighten to 16 – 20 lb. ft.


**11** Raise the vehicle and tighten the joint at the steering gear shaft to 16 – 20 lb. ft. Lower the vehicle and remove the steering wheel holding device, then road test the vehicle to confirm that the customer concern has been addressed. Additionally, check that the steering wheel is still aligned as it was prior to shaft replacement. **KIA**



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