SEPTEMBER 2017
VOL. 136, NO. 9 // MOTORAGE.COM

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UBM

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SPECIAL SUPPLEMENT

KIA QUALITY CONNECTION

Take a look at the Summer 2017 Kia Quality Connection, which is available online now at *MotorAge.com/KQCSummer2017.*

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LOOKING FOR A SILVER BULLET FOR REPAIRS?

Mitchell 1 and *Motor Age* partnered for a free whitepaper about asking the right questions, gathering complete information the first time, combating cost and working with educated customers. This is the guide you need in your shop to work smarter, not harder.

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DIGITAL MARKETING: BEST PRACTICES, TIPS AND INSIGHT

Mastering your shop's digital profile can be overwhelming, but NAPA sits down with Sharon Anderberg and Joe Sevart, two shop owners who have mastered their business approach online. Listen to the Napa AutoCare Center podcast now!

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Motor Age (Print ISSN: 1520-9385, Digital ISSN: 1558-2892) is published monthly, by UBM LLC 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: IMEX Global Solutions 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.

AD DEADLINES: Insertion orders–1st of month preceding issue date. Ad materials–5th of month preceding issue date.

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SHOP SAFETY

PREPARING FOR AN ACTIVE SHOOTER IN YOUR SHOP

KRISTA MCNAMARA //
Content Channel Director

The news peppers us with more stories every day of businesses and lives destroyed by active shooters, whether they be disgruntled employees, angered spouses or someone off the street.

You can't predict when and where this may happen, but you can prepare your business.

The ALICE Training Institute offers a way for shop owners to train themselves and their employees on how to respond, react, and most importantly, stay alive in these scenarios.

Developed in the aftermath of the school shooting at Columbine High School in Columbine, Colo., in 1999, ALICE training has proven effective in helping to keep people alive, says Joseph Hendry, a trainer at the Institute. Lt. Hendry is a 27-year veteran of the Kent State University Police Department and was named an expert consultant to the Ohio Department of Homeland Security for civilian response to active shooter incidents.

ALICE — which stands for Alert, Lockdown, Inform, Counter and Evacuate — is a flexible acronym, Hendry says. The steps do not need to go in order, but you respond using the skills

>> **ALICE** CONTINUES ON PAGE **10**

BREAKING NEWS

INDUSTRY MEETING

NASTF TO KICK OFF FALL MEETING DURING APPEX

The National Automotive Service Task Force (NASTF) will kick off its Fall 2017 General Meeting at AAPEX on Wednesday, Nov. 1, with a presentation to emphasize the value of OEM technical information websites for technicians working outside franchised dealerships. AAPEX represents the $740 billion global automotive aftermarket industry and is held annually at the Sands Expo in Las Vegas.

The session, "The Most Underused OEM Service Info Resources," will familiarize attendees with the 40 light vehicle and heavy-duty OEMs that provide service information resources for access by technicians outside their franchise dealership. It will help independent technicians realize the full value of information provided on any one of the OEM technical information websites.

>> **NASTF** CONTINUES ON PAGE **6**

TRENDING

ZF AFTERMARKET LAUNCHES MOBILE TECHNICAL TRAINING

Mobile training unit allows certified ZF trainers to travel cross country and share educational programming covering new technologies and trends in the industry.
MOTORAGE.COM/ZFMOBILE

THREATS TO REPAIR SHOPS ANALYZED

The latest IMR Insight, "Threats to General Repair Shop Business," is now available and features in-depth analysis of research recently conducted with repair shops and current and future threats.
MOTORAGE.COM/THREATS

MITCHELL 1 NAMES OUTSTANDING STUDENT

Travis Krueger was named the 2017 Mitchell 1 Automotive Technology Outstanding Student during the 44th annual North American Council of Automotive Teachers held recently.
MOTORAGE.COM/KRUEGER

GABRIEL INTRODUCES NEW WEBSITE TRAINING

Gabriel's new website training menu introduces a series of training options as an expansion of its Answerman offerings, including videos, technical bulletins, online catalogs and FAQs.
MOTORAGE.COM/GABRIEL

AAPEX INTRODUCES 2017 MOBILE APP

AAPEX has introduced its 2017 mobile app that lets attendees register for the event, get the latest news, learn about new products and search for exhibitors by name, product and brand.
MOTORAGE.COM/APP2017

PHOTO: GETTYIMAGES / EPOXYDUDE

>> NASTF CONTINUED FROM PAGE 4

The meeting will also feature two additional sessions. During “TechForce Foundation is on the Road to GREAT Techs,” attendees will learn about a coordinated solution for the long-debated shortage of qualified technicians. This session will accelerate the industry on the road to recruiting young adults into the technician profession, developing them into great technicians and keeping them with a lifetime of opportunities.

The session, “Changes are Coming to the SAE J1962 DLC,” will discuss the simple 16-pin data link and what’s in store for the future. Since 1996, all new light vehicles in the American marketplace have connected to the outside world with this data port, but with progress of advanced vehicle technology, change is inevitable.

The meeting will take place from 1 p.m. to 4 p.m., PDT, Casanova 606, at the Sands Expo. It does not require registration; however, registration and industry credentials are required to attend AAPEX. For more information, visit: www.nastf.org/GeneralMeetings.

To register for AAPEX, visit attendee registration at www.aapexshow.com/news. MA

RETIREMENT

SKIP POTTER RETIRES, NASTF SEEKS REPLACEMENT EXECUTIVE

Skip Potter, Executive Director of the National Automotive Service Task Force (NASTF) since June 2012, retired on Aug. 31. He has been working with NASTF leadership for the transition to new management. NASTF Board Member Donny Seyfer will assume duties as Interim Executive while the not-for-profit organization seeks a new executive.

“I have had a wonderful and rewarding career in the automotive parts, tool and service industry,” said Potter. “To end it as the executive director of such a valued organization as NASTF is an honor that makes me very humble and proud.”

Steve Douglas, who recently assumed the role of NASTF Chair when Mark Saxonberg resigned to lead NASTF’s Registry Rebuild project, recognized Potter’s service, saying: “Skip has worked tirelessly over half a decade to serve not only NASTF but also the entire automotive industry. His hard work, professionalism, and can-do attitude resulted in the largest membership growth in NASTF’s history, a dramatic expansion of the vehicle security registry and the resolution of countless information requests. The entire NASTF Board sincerely appreciates all of Skip’s hard work and wishes him the very best in his well-earned retirement.”

Potter served more than 45 years in many segments of the automotive industry including parts distribution, tool sales, service, the motorsports press and the industry’s not-for-profit sector.

Immediate Past Chair Allen Pennebaker notes, “Skip’s dedication and leadership helped to move NASTF from an all-volunteer organization to an efficient and professional mainstay of the automotive industry.”

Potter was recognized by Babcox Publications in 1999 as an “Aftermarket Influencer” and received the Education Award from Northwood University that same year. His syndicated radio broadcast, Virginia Race Line, won six awards from the National Motorsports Press Association during the 1970s and the Old Dominion Speedway in 2011 named Potter to their list of “Legends” for his work there in the ’70s and ’80s. Potter earned the professional designation as a Certified Association Executive from the American Society of Association Executives in 2001 and holds a bachelor’s degree in economics from George Mason University.

NASTF has posted the qualifications and position description for the NASTF Executive on the NASTF website at www.nastf.org/ExecPositionOpen. MA

DATA ACCESS

SAE COMMITTEE FOCUSES ON OBDII PORT ACCESS

As OBD-II port access plays a larger role in a number of new and traditional connected vehicle applications, concerns about security have grown. Tests have shown that hackers could potentially take control of vehicle systems using infotainment or telematics systems as a gateway.

SAE International, a global association of engineers and technical experts in the automotive, aerospace and commercial-vehicle industries, has formed a Data Link Connector Vehicle Security Committee (SAE J3138) to develop standards for access, as well as best practices and reports to help automakers and third-party providers establish secure methods of utilizing OBD-II port access in their solutions.

The committee will leverage the work already conducted by SAE, which published its J3061 Cybersecurity Guidebook for Cyber-Physical Automotive Systems in 2016.

SAE's actions were spurred, in part, by a letter sent last year from the U.S. House Committee on Energy and Commerce to the National Highway Traffic Safety Administration (NHTSA) to address these cyber-security concerns.

According to SAE, J3138 will focus on securing the in-vehicle network environment, including open access to communication busses, communication busses isolated via a gateway, and any hybrid approaches. The organization may also develop joint standards with ISO.

OEMs have increasingly cited security concerns in their efforts to close off access to OBD-II port data, which could potentially restrict the use of third-party scan tools and other solutions. Potter says this poses a risk to the aftermarket.

According to Greg Potter, executive manager and COO of the Equipment and Tool Institute, if the OEMs are able to limit connectivity, then legitimate access for everything from diagnostics, prognostics, fleet management and insurance monitors will only be provided by the vehicle manufacturer. "This will impede competition in the marketplace, and only the manufacturer will control the access to your vehicle," Potter says.

ETI would like to see open standards that follow the Secure, Managed, Bounded Domain approach, as is being developed for vehicle-to-vehicle and vehicle-to-everything communications for the Intelligent Transport Systems (ITS) model. MA


Daniel

>> ALICE CONTINUED FROM PAGE 4

based on the scenario.

Hendry breaks down the steps:

ALERT: "We teach people what the alerts are that they should be looking for — what they see, hear. If there is an announcement, picking up on sounds, and the things happening around them," he says. This helps people to decide how to react to the scenario.

LOCKDOWN: "Lockdown is part of it — where you lock the doors and turn off the lights — but not the traditional response. We teach barricading, how to prepare a room, or set it up during an event, but that is all a secondary response," he says.

INFORM: "During an incident we want to keep people aware of what is going on. If police are clearing the building, if you should stay where you are, or it could be updates on where the gunman is so you can make decisions on how to react," Hendry says.

COUNTER: "It is not fighting the gunman. Counter is a last resort in direct contact. Movement, noise and distraction are things that all human beings can do. We have used scientific methods on the human response to stimulus and how the brain reacts," he says. It is difficult for a person to focus on a specific task in the midst of many distractions. "For a shooter, this task is shooting. If you have many people moving and throwing things, it makes it difficult for a person to focus on what they are doing. There is an order to action: Observe, Orient, Decide and Act. If a shooter is constantly observing and orienting, they are not pulling the trigger, which increases survival."

EVACUATION: "Evacuation is the primary response, to get everyone out of and away from the facility. That is the goal. We recommend that people not stay at the scene with a gunman."

Get training at your shop

The ALICE Institute conducts training all over the world. It starts with eLearning, which provides a baseline for the ALICE method. Trainers can also come to a facility for a 4-8 hour course, which includes a review of the eLearning principles and then running live scenarios to reinforce the training learned.

There is also a separate facility assessment process. The ALICE Institute has an online tool shop owners can use to provide information about their building that can help trainers to develop plans of action during a potential incident, Hendry says.

Active shooter response training does fall under OSHA as a general duties clause, Hendry says. "It used to be considered low probability, high impact, but the probability is going up. Not having a plan puts you under more liability. Plus, it is just good business."

Shop owners and technicians can go through state courses to carry a weapon, but it is not one The ALICE Institute recommends as a response to an active shooter in the workplace.

"Having to shoot in an active shooter event is a skillset that perishes. This is true even for police officers, who are actively trained, but may not be using the skill regularly," Hendry says. "Then you talk about having to shoot in an environment where you have employees, people and a lot of distractions. People may think their skillset is better than it actually is. This type of shooting requires extensive ongoing training." MA

CONNECTED CARS

INDUSTRY LEADERS FORM CONSORTIUM FOR CONNECTED CARS, BIG DATA

DENSO Corporation, Ericsson, Intel Corporation, Nippon Telegraph and Telephone Corporation, NTT DOCOMO, INC., Toyota InfoTechnology Center Co., Ltd. and Toyota Motor Corporation announced that they have initiated the formation of the Automotive Edge Computing Consortium. The objective of the consortium is to develop an ecosystem for connected cars to support emerging services such as intelligent driving, the creation of maps with real-time data and driving assistance based on cloud computing.

It is estimated that the data volume between vehicles and the cloud will reach 10 exabytes per month around 2025, approximately 10,000 times larger than the present volume. This expected increase will trigger the need for new architectures of network and computing infrastructure to support distributed resources and topology-aware storage capacity. The architectures will be compliant with applicable standards, which requires collaboration on a local and global scale.

The consortium will focus on increasing network capacity to accommodate automotive big data in a reasonable fashion between vehicles and the cloud by means of edge computing and more efficient network design. It will define requirements and develop use cases for emerging mobile devices with a particular focus on the automotive industry, bringing them to standards bodies, industry consortiums and solution providers. The consortium will also encourage the development of best practices for the distributed and layered computing approach recommended by the members.

In the coming months, the aforementioned companies will initiate activities to invite relevant global technology leaders and expand the consortium. MA

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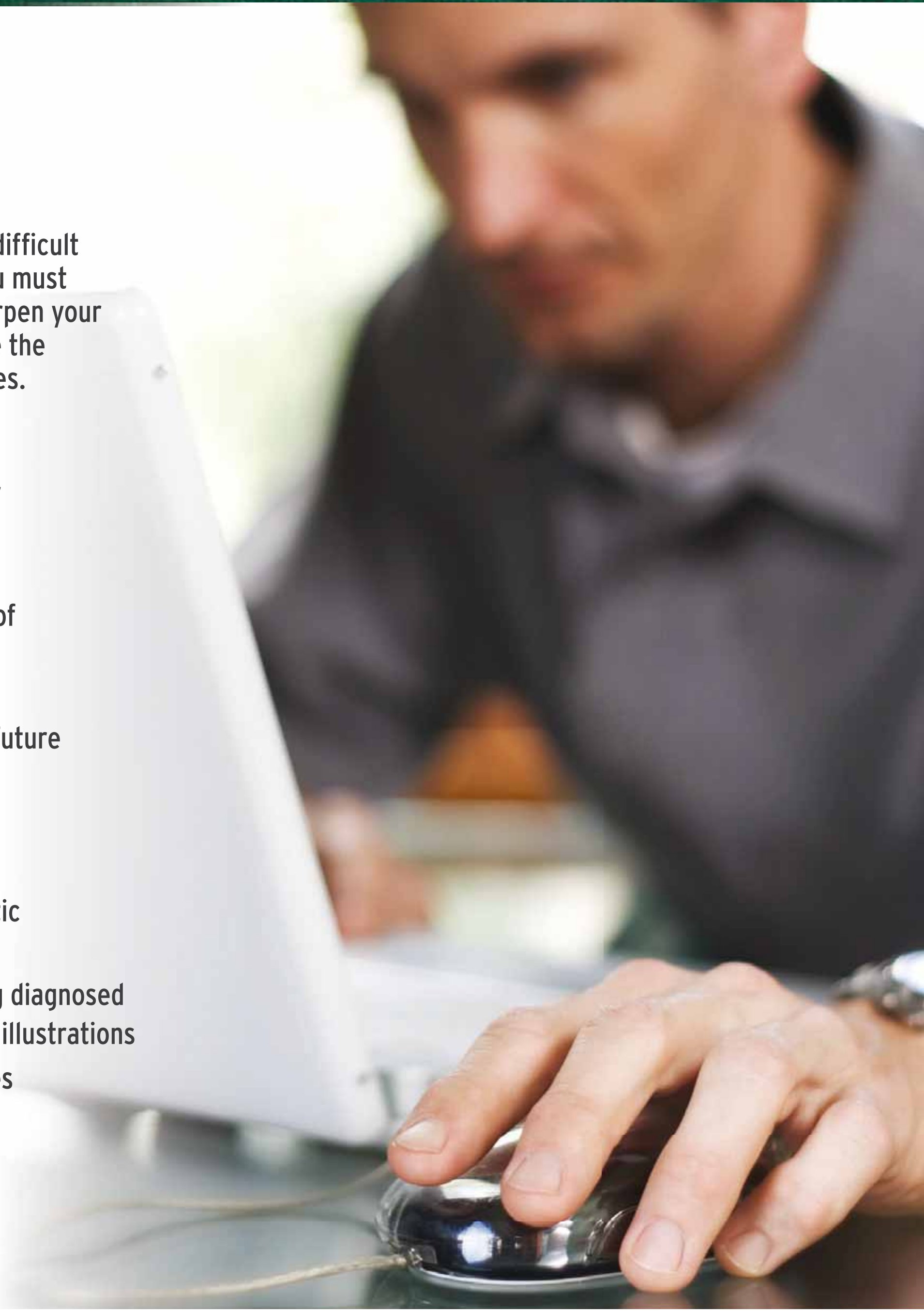

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LEAVE IT ALL BEHIND

Develop a shop owner exit strategy

W. SCOTT WHEELER // Contributing Editor

Do you remember all the excitement and enthusiasm you had when you first started your repair shop? Maybe it was when you got your business cards. Shiny, new, freshly printed with your official company name on them! Or maybe it was when you had your company sign installed on your building? Or perhaps the freshly printed stack of new company checks? All the activity, the work, the unfulfilled dreams — that was then. But this is now!

Now, after however many years of running your operation, you're ready to call it quits. Whether you've been wildly successful or have just been able to keep the bills paid and the customers happy, you're still ready to "call it a day." If you're at that point, please pay attention; you'll learn some basic strategies to help you navigate the waters ahead. The first and most important aspect of getting out is to determine what the business is worth, or valuation.

Scenario 1: You own the property, the real estate and building

This example is the most complicated, and most certainly will require the assistance of either a real estate agent, banker, or perhaps a business broker. The options here are almost limitless! You may decide to sell only the "business entity itself," i.e. the name, equipment, all contents, and most importantly — the customer database. The beauty of this approach may not be self-evident. When a prospective buyer is reviewing his options, he only has a couple. He can do as you did, and start from scratch. He can buy some land, which is properly zoned, get the necessary permits, erect a building, buy many tens of thousands of dollars in equipment, hire the staff, and so on. He would then do the necessary advertising to get the first paying customer in the doors. But why would he do that? After all, your cash register is already ringing! Theoretically, you both could close on the sale of your business on a Friday, and he could start earning profits come Monday morning. When negotiating with a serious buyer, it's crucial you point this out.

You could sell only the actual business, business name, customer database and equipment. You could then choose to lease the building and property back to the new owner. This is smart for a number of reasons, which a prudent real estate agent or broker can help you to realize. Demographic analysis and market studies will tell you if the values of commercial property are trending up or down. If trending up, it might be wiser to maintain control over the property. If analysis indicates otherwise, it might be best to "cut and run."

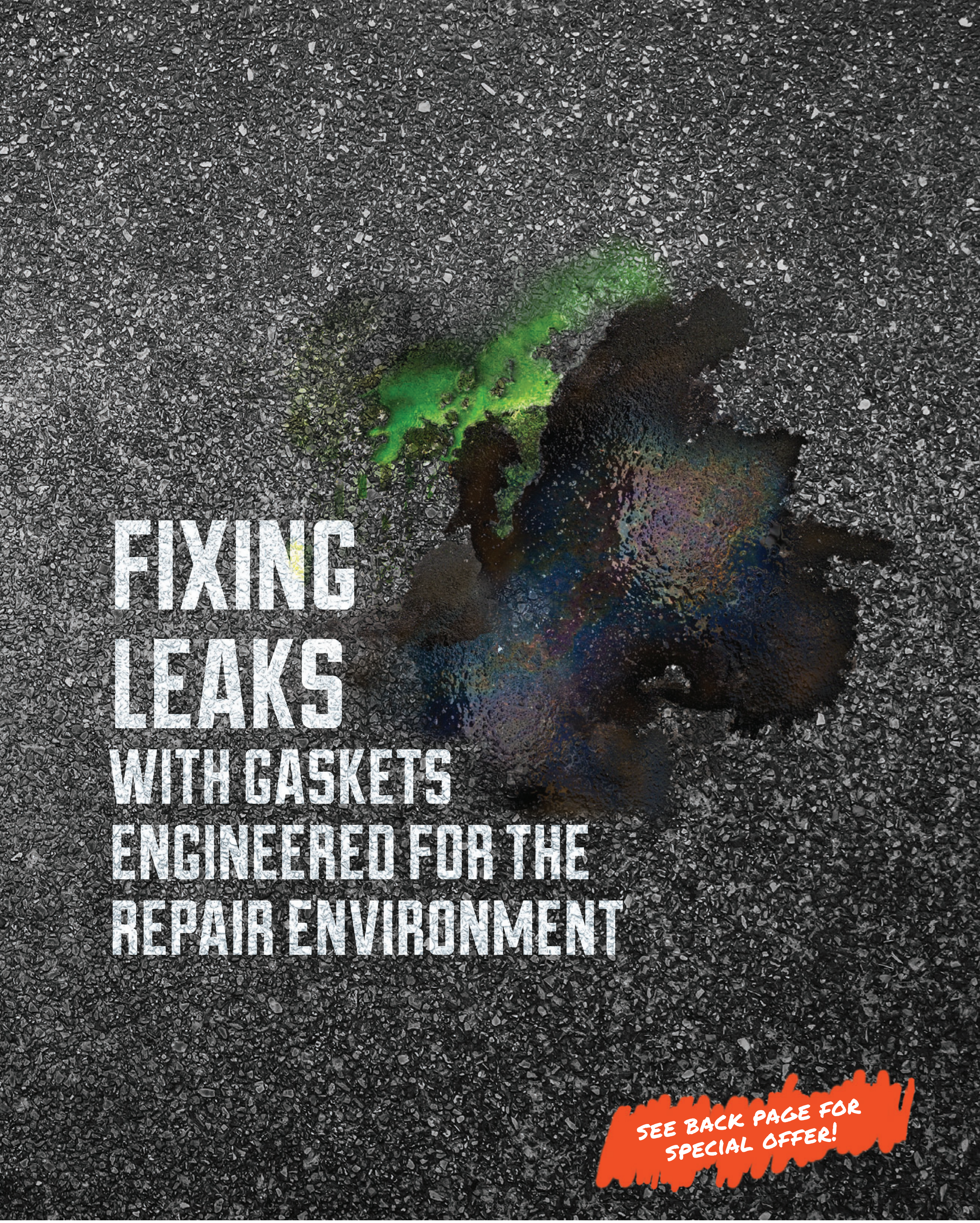
Scenario 2: You do not own the dirt or the building

In many ways, this is a much simpler sale, requiring transfers of tenancy, responsibility of all utilities, etc. Should this be the case, the new owner will most certainly have to qualify and agree to the landlord's requirements for occupancy. Should the new owner wish to change the name of the business (generally not a good idea unless there is negativity surrounding the existing business name), they'll have to get concurrence on it, at least from the city or county, as well as the landlord.

So what is my business worth?

1. Add up the value of all the assets such as cash, stock, plant and equipment, and receivables.

PHOTO: GETTYIIMAGES



FEL-PRO®

THE LEAK STOPPER

COOLANT LEAKS

Typical Leak Symptom(s):
Coolant Visible, Low Coolant Level, Overheating

Probable Leak Source(s):
Intake Manifold Gasket, Water Pump Gasket, Water Outlet Gasket, Thermostat Gasket

OIL LI

Typical Leak Symptom(s):
Oil Visible, Oil Burning Smell, Low Engine Oil Level

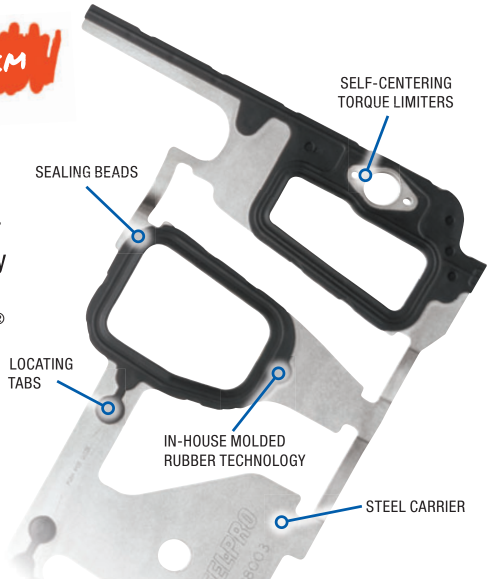
FEL-PRO® THE LEAK STOPPER

STOP LEAKS WITH FEL-PRO® GASKETS

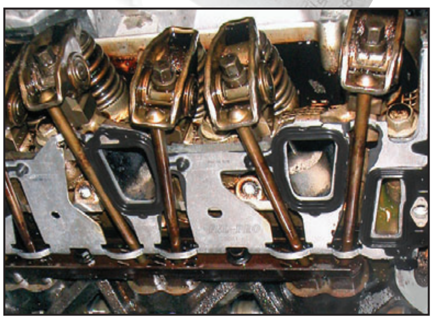
Unlike other gas
for the unique s
provide a leak-f

COOLANT LEAKS *NOT A PROBLEM*

It's important to choose a sealing solution that's up to the challenge of sealing coolant leaks in the repair environment. Fel-Pro offers a variety of materials – PermaDryPlus® rigid carrier / molded rubber, Blue Stripe® composite and several types of molded rubber seals – to successfully tackle even the most troublesome applications.



Fel-Pro PermaDryPlus® intake manifold gaskets feature problem-solving innovations such as a metal carrier and proprietary rubber edge molding that is resistant to all coolant types, sealing beads that eliminate leak paths and torque limiters to prevent over-compression and deformation of sealing surfaces.



Problem-solving PermaDryPlus® intake manifold gasket installed.

OIL LEAKS *DON'T SWEAT 'EM*

Fel-Pro PermaDryPlus® oil pan and valve cover gaskets feature problem-solving innovations such as precisely located molded rubber sealing beads that eliminate leak paths and torque limiters to prevent over-compression of a gasket and deformation of sealing surfaces.

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EAKS

Probable Leak Source(s):

Oil Pan Gasket, Valve Cover Gasket, Timing Cover Gasket, Crankshaft and / or Camshaft Seal(s)

TRANSMISSION LEAKS

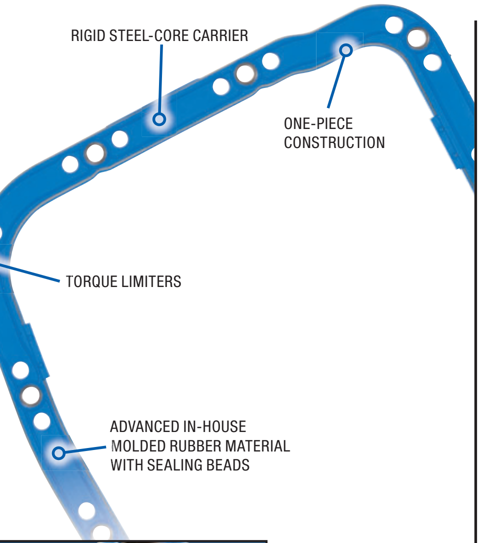
Typical Leak Symptom(s):

Transmission Fluid and / or Gear Oil Visible, Low Fluid Levels

Probable Leak Source(s):

Automatic Transmission Gasket / Seal, Transaxle Gasket / Seal, Differential Gasket / Seal, Transfer Case Gasket / Seal

sket brands, Fel-Pro's proprietary molded rubber formulations and other premium materials are designed sealing requirements of the repair environment. Each part undergoes our strict validation process to free seal.



PermaDry® valve cover gasket pressed in place in valve cover.

TRANSMISSION LEAKS

PIECE OF CAKE

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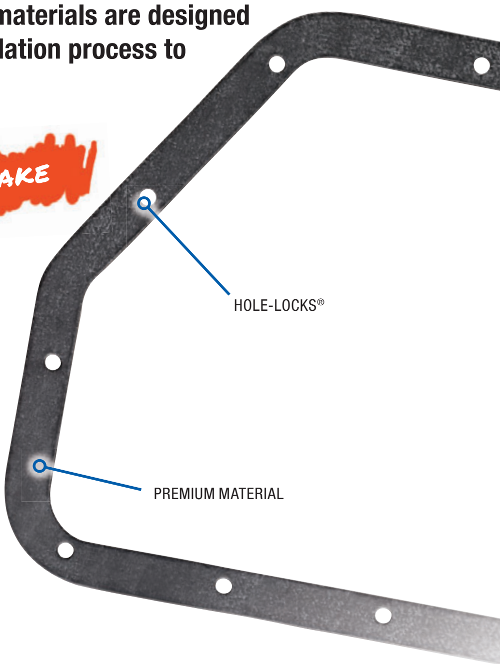

Hole-Locks® hold bolts in place for easy installation.

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  - **Posters (2)**
  - **Countermat (2)**
  - **Leak Checklist Pad (1)**

FEL-PRO® THE LEAK STOPPER

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LED OPEN SIGN (23.5"x10")

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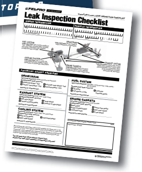

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2. Add up liabilities, such as any bank debts and payments due.

3. Subtract the liabilities from the assets to get the net asset value.

Similar to bond or real estate valuations, the value of a business can be expressed as the present value of expected future earnings.

There are a lot of ways to value a business. There's no "right" way, though you could probably come up with several wrong ones. Ultimately, the business is worth whatever you think it's worth, based on the criteria you set forth. But you can make your estimation by using several different ways to value the business and then choosing the mix that reflects your final value estimate.

You can start by looking at the value of the business's assets. What does the business own? What equipment? What inventory? After all, a new owner would have to buy all the same stuff if they were starting a teashop from scratch, so the business is worth at least the replacement cost. The balance sheet can give you a good indication of the value of the company's assets. If the company doesn't have a good set of books, a prospect might think twice about buying it.

The other valuation approaches all think of a business as a stream of cash. They value a business by trying to come up with a value for that stream of cash.

Revenue is the crudest approximation of a business's worth. If the business sells $100,000 per year, you can think of it as a $100,000 revenue stream. Often, businesses are valued at a multiple of their revenue. The multiple depends on the industry. For instance, a business might typically sell for "two times sales" or "one times sales." If you have a good stockbroker, he or she may be able to help you research typical sales multiples for your industry. A good business broker can also help you if he or she has done valuations for your industry.

But alas, revenue doesn't mean profit. If you're in doubt, just look at Amazon.com: It had 2002 sales of almost $4 billion, but no profit. In fact, it hasn't made one cent of profit since the day it was founded. How much would you pay for an ongoing $4 billion per year that you have to pump an additional $380 million per year into just to keep it afloat?

Warren Buffett uses what's called a discounted cash-flow analysis. He looks at how much cash the business generates each year, projects it into the future and then calculates the worth of that cash flow stream "discounted" using the long-term Treasury bill interest rate. There's no room to explain the theory or calculation here, but you can do it in Excel using the NPV "net present value" function.

Accurately valuing a small business is often the most challenging part of the process for prospective business buyers. However, it doesn't have to be an overwhelming or difficult undertaking. Above all, you should realize that valuation is an art, not a science. A buyer should always keep in mind that the "Asking Price" is NOT the purchase price. Quite often it does not even remotely represent what the business is truly worth.

There are several ways to calculate the value of a business:

Asset Valuations: Calculates the value of all the assets of a business and arrives at the appropriate price.

Liquidation Value: Determines the value of the company's assets if it were forced to sell all of them in a short period of time (usually less than 12 months).

Income Capitalization: Future income is calculated based upon historical data and a variety of assumptions.

Income Multiple: The net income (profit/owner's benefit/seller's cash flow) of a business is subject to a certain multiple to arrive at a selling price.

Rules of Thumb: The selling price of other "like" businesses is used as a multiple of cash flow or a percentage of revenue.

Naturally, a buyer's valuation is usually quite different from what the seller believes their business is worth. Sellers are emotionally attached to their businesses. They usually factor their years of hard work into their calculation. Unfortunately, this has no business whatsoever being in the equation.

I hope these ideas give you a head start in valuing the business. I'd also recommend you get your banker involved in the valuation. Since your banker may be helping finance the business, he or she will have a good sense of how to do a good valuation for shops in your area.

Determine what's best for your business

Asset-based valuations do not work for small business purchases. Assets are used to generate revenue and nothing more. If a business is "asset rich" but doesn't make much money, how valuable is the business altogether? Conversely, if a business has limited assets, such as computers and office equipment, but makes a ton of money, isn't it worth more?

Income Capitalization is generally applicable to large businesses and most often uses a factor that is far too arbitrary.

The "Rule of Thumb" method may be too general since it's hard to find any two businesses that are exactly the same. The Multiple Method is clearly the way to go. You have probably heard of businesses selling at "x times earnings." However, this can be quite subjective. When selling a small business, every buyer wants to know how much money he or she can expect to make from the business. Therefore, the most effective number to use as the basis of your calculation is what is known as the total "Owner Benefits."

The Owner Benefits amount is the total dollars that a buyer can expect to extract or have available from the business based upon what the business has generated in the past. The beauty is that unlike other methods (i.e. Income Cap), it does not attempt to predict the future. Nobody can do that. Owner Benefit is not cash flow! It is, however, sometimes referred to as Seller's Discretionary Cash Flow (SDCF).

The theory behind the Owner Benefit number is to take the business's profits plus the owner's salary and benefits and then to add back the non-cash expenses. History has shown that this methodology, while not bulletproof, is the most effective way to establish the valuation basis of a small business. Then, a multiple, based upon a variety of factors, is applied to this number and a valuation is established.

Owner benefit formula

The owner benefit formula to use is: Pre-Tax Profit + Owner's Salary + Additional Owner Perks + Interest + Depreciation less Allocation for Capital Expenditures

Why add back depreciation?

Depreciation is an expense that allows a business to deduct a certain amount of money each year from an asset so that its purchase value is reduced by its overall useful life. For example, if the business buys a $25,000 truck and its useful life is estimated at 5 years, then each year the company can deduct $5,000 off its income to lessen its tax burden. However, as you can see, it is not an actual cash transaction. No money is physically leaving the business or changing hands. Therefore, this amount is added back.

Why add back interest?

Each business owner will have separate philosophies for borrowing for the business and how to best use borrowed funds, if necessary at all. Furthermore, in nearly all cases, the seller will pay off the business's loans from their proceeds at closing; therefore, you will have use of these additional funds.

A note about add-backs

After completing any add-backs, it is critical that you take into consideration the future capital requirements of the business as well as debt-service expenses. As such, in capital intensive businesses where equipment needs replacing on a regular basis, you must deduct appropriate amounts from the Owner Benefit number to determine both the true value of the business as well as its ability to fund future expenditures. Under this formula, you will arrive at a "net" Owner Benefit number or true Free Cash Flow figure.

What multiple?

Typically, small businesses will sell in a one-to three-times multiple of this figure. Now, this is a wide range, so how do you determine what to apply? The best mechanism I have found is that a one-time multiple is for those businesses where the seller is "the business." In other words: "as out the door goes the seller, so too can go the customers." Consulting businesses, professional practices, and one-man businesses come to mind.

Businesses that have a strong track record, repeat clients, historical pattern of growth, more than 3 years in business, perhaps some proprietary item, or an exclusive territory, a growing industry, etc., will sell in the 3-times ratio. The others fall somewhere in-between.

So now the big question: what number/multiple do you apply to the Owner's Benefit number? The answer is simple: nearly all small businesses will sell in the 1-to-3 times Owner Benefit window.

Also, the actual total Owner Benefit figure will impact the multiplier. As the Owner Benefit number increases, so too will the multiple. For example, a business generating $200,000 in OB may be worth a 3 times multiple, but one generating $500,000 or $1,000,000 can be worth a four or five times multiple.

Wise advice

A wise and successful businessman once told me the following formula: "A business is worth 2X gross, or 4X net." Stands to reason. However, does this apply to our type of business — an automotive repair shop? Well, yes and no. Variables that yield value changes could be:

- Newer equipment, computers, building fixtures, signage, or other, such as parking lot upgrades and so on
- Newer high-tech scan tools and current software, such as Autologic loaded with the most current Asian and European software
- Significant inventory that is still current (not obsolete), especially tires
- Current and accurate customer database
- A super-clean Profit & Loss Statement combined with an accurate Business Summary Report which reflects ALL methods of payments received – especially cash!
- A valuation summary that accurately depicts the shop's current fiscal condition including such things as Effective Labor Rate, the value of one billable hour, the cost of hourly operations based upon current expenses, and so on.

Key points to remember

- The time to determine when to "get out" is NOW!
- Clean up your P & L statement and balance sheets.
- Determine the true value of your business using some of the methods listed within this article.
- Last but not least — dream of what you'll do during your retirement! MA

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BOLSTERING THE COUNT

Team roles and responsibilities that will bring cars into your shop

DAVID ROGERS // Contributing Editor

Car count is about much more than advertising.

This entire article is built on that fact, so I'm not going to bury it down the page. In successful shops, the money spent by the owner on marketing is only responsible for a fraction of the car count in that shop.

This might strike you as insane. After all, we tend to refer to "car count" and "advertising" interchangeably. Need more cars? Buy this! Send that!

But what causes good car count? What do we do as a repair shop to keep customers coming through the doors?

We retain our existing customers with excellent customer service. We do quality inspections and repairs so customers know they can trust the quality of our work. We grow our production capacity so we can service more vehicles effectively while providing superior customer service.

And then — finally — we attract new, quality customers with our marketing efforts.

I'm not here to tell you marketing is unimportant. Quality marketing is critical for the health and success of a shop, and anybody who tells you a shop can survive on referrals, word of mouth and internal marketing is wrong at best, and lying at worst.

Quality marketing — critical as it is — is one piece of your car count, and it's supported and enhanced by your employees, which is why the employees in our shop know they're responsible for 80 percent of the car count.

80 percent!?

Why? How? And how do you possibly get your team to take that level of responsibility for your shop's car count?

PHOTO: SHUTTERSTOCK.COM/ MICHAELJUNG

Why it's the team's responsibility

The short answer: attrition.

Attrition might be the most misunderstood concept in our industry, and while I don't want to spend a lot of space on it, a quick primer is important.

Attrition is the rate at which you're losing customers. Every shop has attrition, which is why a shop that doesn't advertise to attract new customers will die.

But there are a couple of ways to look at attrition.

The first is uncontrollable attrition — when a customer moves away or loses their job, they stop coming to your shop through no fault of your own. This number can vary wildly from market to market. A shrinking city like Cleveland has a very different uncontrollable attrition than Houston, the fastest growing metropolitan area in the U.S.

The other type of attrition is controllable — when we lose a customer because of something we did. Poor customer service, mistakes in communication, an experience that didn't match marketing promises and even employee apathy all drive customers away.

While losing a customer is bad enough, controllable attrition is like an infection, destroying the shop from the inside. Because the shop doesn't just lose a single customer; they lose that customer's friends and family, and everyone they know on social media. When that customer leaves a bad review, the shop also loses potential new customers, and their marketing becomes less effective.

In other words, unless the entire team is engaged every day in the work of attracting and retaining quality customers — unless they're responsible for car count — you'll go broke trying to do enough advertising to attract new customers to replace those who have been burned.

Now that we know everybody in your shop is responsible for car count, the more important question is: what can each member of your team do?

The technicians

Your technicians may never interact with a customer, but they still have a large role in how your shop is perceived.

Obviously, they must fix cars well. If they can't diagnose the customer's concern and complete the repair, your customers will lose all trust in you. But the tech's ability to attract and retain your best customers goes far beyond their basic job responsibility.

Are they pencil whipping inspections to find the jobs they like to do? Are they dogging it on Fridays and letting cars sit in the bays over the weekend? Are their notes unclear, making it harder to communicate at the front counter?

The thoroughness and efficiency of your technicians is a significant part of how your shop is perceived, which is why they must be measured and held accountability daily for hitting appropriate benchmarks.

Lube/tire/general service technicians

The lube technicians in our shop do as much to attract and retain quality customers when they're not working on vehicles as when they are.

Yes, they must absolutely do an excellent job caring for the car in the lube lane. But in our shop, when they're not changing oil or helping with other preventive maintenance, they're tasked with keeping the shop clean and maintained. If your shop's image doesn't match your marketing and advertising, your customers are

less likely to trust you. That makes both referrals and marketing measurably less effective.

The courtesy driver

If your shop has a driver to bring customers to and from work or home, you have an incredible opportunity to set yourself apart from the competition, build trust and create loyalty.

Does the driver see their job the same way?

They must be trained to dress, act and communicate professionally, accommodate all reasonable requests, and present your shop's image appropriately. All it takes is one car ride where they gossip with a customer about the shop or the owner to ruin the customer's trust.

If they're gossiping about the company (or you), if they're not dressed professionally, or if they're not providing superior customer service, chances are they're contributing to attrition.

The service writers

The service writer is responsible for 60 percent to 80 percent of the total car count in every shop. That's true whether they know it or not. It is also true whether you give them the tools they need to succeed or not.

That's because service writers are on the front lines both with your technicians and your customers. They oversee the workmanship quality and production quantity from the technicians. Hopefully, you're measuring the technicians daily so your service writers can hold them accountable daily.

They're also the ones on the front lines communicating with the customers, providing excellent customer service and getting jobs closed. Hopefully you're measuring their performance so you know how effective they are at educating customers.

And they're the ones on the front lines when the customer leaves, making them say "wow" about your shop's customer service so they plan to and also look forward to coming back one day. Hopefully you are also measuring your customer loyalty to know whether your customers truly trust your shop.

THE BEST WAY TO GET YOUR TEAM TO TAKE RESPONSIBILITY FOR CAR COUNT IS THE SAME AS ANY OTHER NUMBER YOU WANT TO IMPROVE: MEASUREMENT, TRAINING AND ACCOUNTABILITY. WHEN YOUR TEAM ACCEPTS THAT RESPONSIBILITY AND HAS THE TOOLS TO SUCCEED, YOUR GROWTH WILL BE CONSISTENT.

The whole staff

The culture in your shop is evident in everything you do.

If you have a culture of training and accountability, your team will communicate well, answer customer questions effectively, inspect thoroughly and complete repairs efficiently and accurately.

Your customers can sense a toxic shop culture. Are you measuring your shop performance on all levels daily to create the accountability that leads to success?

The owner

From the service writers down to part-time employees who might never speak to a customer, attracting and retaining quality customers is an entire team effort. They must work together to earn trust, overdeliver on expectations and earn referrals.

What does that leave for the owner?

The owner is responsible for the marketing budget, of course. He or she must be willing to spend enough to grow the shop (at least 7 percent of gross sales, according to the Small Business Administration), and invest in marketing that attracts high quality customers who trust and are ready to buy.

But the owner is also responsible for measuring the team daily, holding them accountable for hitting benchmarks, and creating a chain of command that allows employees to hold each other accountable for attracting and retaining quality customers.

After all, it's impossible to simply tell a team they're responsible for 80 percent of a shop's car count. Yes, it's an accurate assessment. But unless they know how they're performing and what performance standards they should be aiming for, it's just guesswork. At best, your team's success will be unsustainable...at worst, they'll turn away customers with inconsistency.

In other words, you can't manage what you don't measure. The best way to get your team to take responsibility for car count is the same as any other number you want to improve in your shop: measurement, training and accountability.

The good news? When your team accepts that responsibility and has the tools to succeed, your growth will be sustainable and consistent. No more big peaks and valleys in your car count — the secret to growth year after year! MA

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Are customers taking a swing at you?

Instead of punching back, you may need to rethink how you run your business

All of us have encountered unhappy customers from time to time. Some of us can recover quickly and some seem to make it worse. I was listening to Coach Geoff Berman tell a story he learned from his kids that usually works for anyone.

Geoff began the story by saying: I bet you remember as a kid playing the "Punch Buggy" game. How awesome was that for Volkswagen's marketing! I'll save that for another article. For this one I want you to think about what the "Punch Buggy" game was really about, and how it relates to customer service. "Punch Buggy" relates to customer service? Really, Geoff? Are you kidding me? Bear with me and I promise I'll get you there.

So let's look at what the kids are really doing with the "Punch Buggy" game. This game gave me a legitimate reason to punch my sister and it was OK. How cool is that! If I didn't hit her too hard, it probably went undetected by my parents. It didn't take her long to figure out she can punch back, and she did. That is when I learned to add "No punch backs!"

No punch backs

Now I want you to think about your customers and the service you provide. Don't we play the "Punch Buggy" game with them? Here's an example. Let's say a first-time customer comes in and you quote her a price on brakes that she feels is more than she should pay. You came very highly recommended so she decided she could trust you and let you do the job. After she got the vehicle back, whatever the original problem was (squeak, grind, pull, whatever), it's still there. What is she going to do? She is going to "punch." "I spent $450 on my brakes, and it is still doing the same thing I brought it in for. I knew I should have taken it somewhere else. That's the last time I let John give me any auto advice." So now it's your turn. What are you going to do? I'm guessing you didn't hear the customer say "no punch backs" so that is exactly what you do. "Can you bring it back so we can take a look at it?" Is that what they really want? To be inconvenienced and bring the car back to you only to hear you say it will be another $200 to really fix the problem?

HOW DO YOU TURN PUNCHES INTO KISSES? WHEN YOUR CUSTOMER SWINGS AT YOU, DON'T SWING BACK. KISS THEM.

Now I have to tell you that I am the luckiest man on earth because I married the most incredible woman in the world. She has made it her life's mission to be the best mom she can be. There is no question that has rubbed off, and it has helped to make me a much better father than I ever thought I could be. She has always hated the "Punch Buggy" game. It promotes the kids hitting each other. Me, I'm the dad. This is fun. Until someone gets hurt and I get a lecture. So one day she decides to play along and see if she can fix the game. She tells us that instead of a "Punch Buggy," what if you try a "Kiss Buggy" instead? My seven-year-old loved the idea and, seeing where my wife was going with this, I decided to play along. The next thing that happened absolutely blew me away. As soon as my daughter saw a "Kiss Buggy" she said "Kiss Buggy. No kiss backs!" When she realized what she had said, she immediately took it back and said "I mean Kiss Buggy. Kiss back!" No more punching. Everyone got in on this and it became a really fun game where we were sharing love with each other and not violence. One kiss was never enough and boy did I love finding a "kiss buggy."

Turning punches into kisses

So now I ask you, how do you turn punches into kisses? When your customer swings at you, don't swing back. Kiss them. If you fight back with kisses, they will start kissing back. Let me demonstrate. The situation is the same. The customer is upset because the car is doing the same thing it did before you fixed it. Your previous response did not focus on the customer, it focused on the car. "Can you bring it back so we can take a look at it?" What you need to do is respond to the emotions she is feeling and just let her know you understand and that you care.

This can be easily accomplished by remembering four very simple things: thank them, empathize, apologize or agree. We'll get to the car, but not until we make them feel better. She feels violated, and we must fix this first. A better response might be "I am horrified that this has happened. I can't imagine how you must feel. This is very unusual, and we take these things very seriously. Thank you so much for taking the time to bring this to my attention. Can you tell me where the car is so we can come and get it?"

Now I want you to take a minute and be that customer. In the first scenario, you put the burden on her. In the second scenario, you showed empathy and you thanked her. You put the responsibility on yourself. Which one makes you feel better? Isn't that what you really want? Someone to listen and make you feel better. Of course you do. We are all consumers and have had this happen to us. Our doctor sent us to a specialist and the referral wasn't there. No one told you you needed a referral and were unwilling to help. Now it's your problem. Ever upgrade your cell phone only to find out they changed your service without telling you and then told you you should have known that. "This happens with all upgrades," they tell you. Why would you know this? If they had just taken responsibility and showed a bit of concern, you would have been fine. "I'm so sorry that happened. I know how frustrating this must be for you. Unfortunately, this does happen from time to time. The good news is it only takes a few minutes for me to fix that for you. Do you have a few minutes right now or can I call you at a more convenient time?" If businesses responded in a similar way (addressing your needs first or in other words, giving you a kiss) wouldn't it be very hard for you to keep punching?

Can you change?

This technique requires you to make a mental change in how you think of your shop and your customers. You may need to rethink how you handle a lot of things that happen in the shop. If you're curious about how well you or your associate can handle a change like this, download our Ability to Change Assessment Form, available for a limited time at *www.ationlinetraining.com/2017-09*. It will let you know how open you are to change and what types of change. It's a great place to start moving in new directions, just like how you react to customers.

Start practicing how you respond to your customer using these four principles. It doesn't matter if they are new to your business or have been a customer for 30 years, if they are male or female. Everyone wants to feel wanted, appreciated and heard. If you always remember to respond with a kiss, everyone will want to come to your shop. MA

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All are not created equal

Review the six questions of capability to determine your shop's shortcomings

The independent shops in our industry too often believe that they are of the same caliber as the business down the street. Nothing could be further from the truth. Why can one business charge $110 per hour and the shop is constantly full, and a shop within two blocks charges $75 per hour and is struggling to find work?

ALL SHOPS MUST LOOK AT THE QUALITY OF THE STAFF TO MAXIMIZE ITS POTENTIAL.

One would think that the potential for business with the higher-priced, busy shop must be different than the potential for business with the lower-priced shop. That assumption is wrong.

All shops within a market trading area have the same potential, which is dictated by the population base of the given marketplace. As the population increases, the potential for business increases. As the population decreases, the potential for business decreases. What is distinctly different for each shop in the marketplace is their capability to maximize their potential. Every shop has different capabilities, and by measuring the capability, it becomes clearer why some shops are steady and more profitable than others.

There are six items we consider in examining a shop — the six questions of capability. Every problem in a shop falls within one of these six categories; therefore, it allows one to focus on resolving the problem once it is clearly defined.

The first question is attitude. What is the attitude of the shop owner/manager and the staff? Is the attitude positive or is it negative? A negative shop will never reach its potential in business. The owner/manager is usually complaining about cheap customers, lack of business and quality of staff. When the owner/manager is in this frame of mind, I can guarantee the staff will have a negative feeling about the entire business.

The second question is personnel. What is the quantity and quality of the people working within the shop? Every November the shop is extremely busy, so busy in fact we could use double the staff. We don't have that quantity on board, so we rush the cars in and out to ensure all clients are looked after. The rushed process ensures that we don't maximize our potential for business because we didn't have the time to properly inspect the vehicles.

The third question is inventory. Is the shop carrying the right inventory to serve the current client base? Does the shop inconvenience clients by making them wait for parts to arrive because they didn't carry the obvious inventory they should have to serve the client? Is the inventory management system tight enough to ensure the right inventory turns are being met each year, and that the proper quantity of stock is re-ordered on time? A poor inventory management system can create inefficiency within a shop and create lost potential sales for the business.

The fourth question is equipment. Is the shop properly equipped to meet the demands in automotive maintenance/repairs of its current clientele? If the shop does not have the right equipment, then in time the reputation of the shop goes down as word travels among clients that the shop is not competent enough to handle my vehicle. Once again, without the right equipment, technicians are forced to be inefficient with their work and usually management is blaming the technician for low productivity instead of management incompetencies.

The fifth question is facility. Does the facility look professional; is it set up to properly accommodate the clientele it is selling to? Stand across the street for 10 minutes and look at your facility and honestly answer this question: I am new in town; I am looking for a competent automotive maintenance/repair outlet. What would make me WANT to turn into my location and check it out? Is your facility set up the way your clients want it or the way you want it? Pay attention to your clients' views.

The sixth question is finance. Without the proper financing in place, you cannot create a professional facility, purchase or lease the right equipment required, stock the correct inventory at the right levels or hire and train the most capable personnel in your trading area.

Out of the six questions, the most important one is your attitude, which affects all the other questions being examined. Without the correct attitude in place, you can't get started solving any problem in your shop. MA

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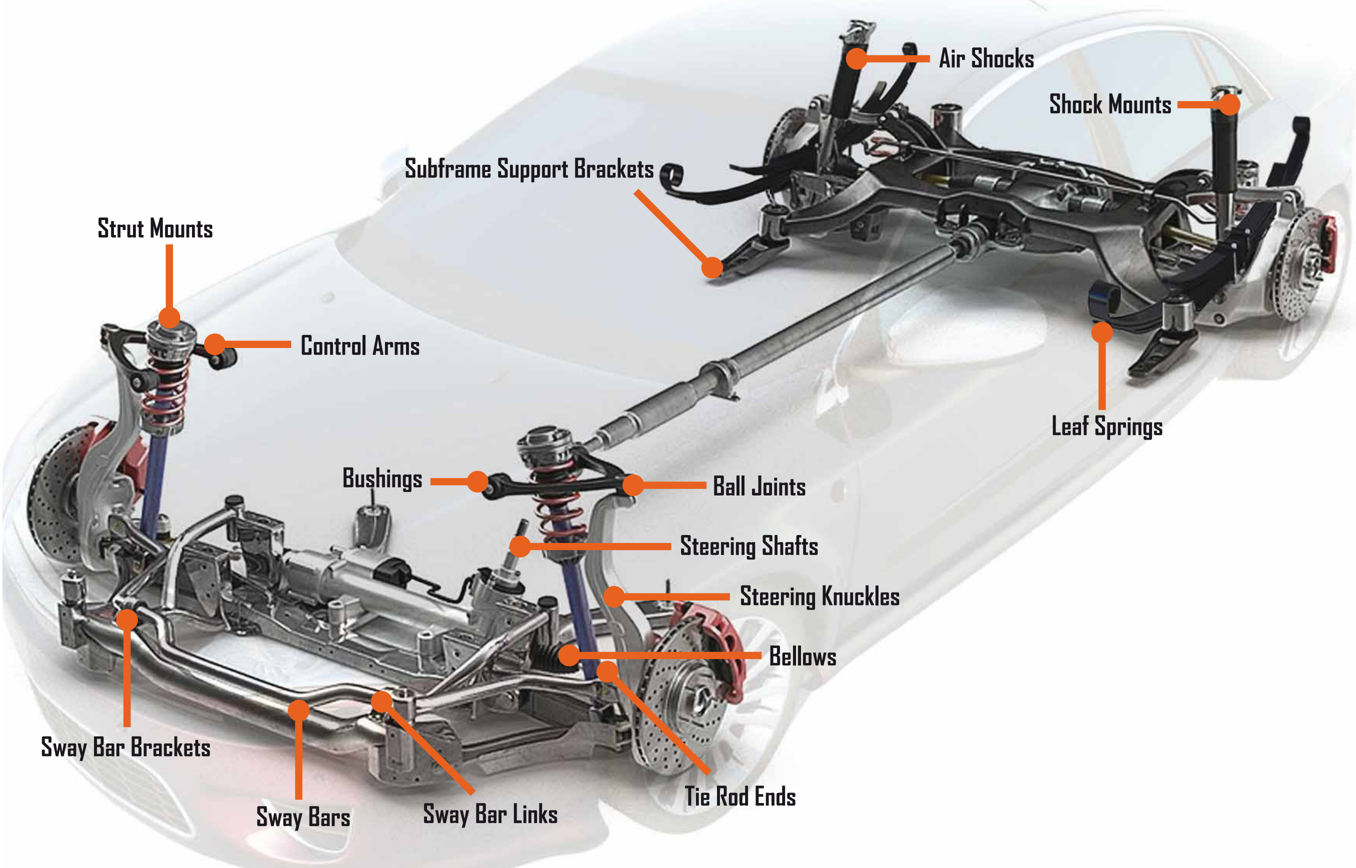

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Lexington, Mass. // www.accuratebrake.net

Rob and **Jim Shimanksy** Owners	**3** No. of bays
1 No. of shops	**$240** Average repair order
50 Years in business	**60** No. of customer vehicles per week
4 No. of employees	**$650,000** Annual gross revenue
1,400 Total square footage of shop	

Most Americans have heard of the "shot heard round the world" and the role the Massachusetts town of Lexington played in kicking off the American Revolution. But the history doesn't stop there; Lexington is so rich in it that Accurate Brake & Alignment operates out of building that has been continuously operated as a service to transportation since about 1840.

"It had started off as a blacksmith shop," states current proprietor Rob Shimansky, who ows the business with his father, Jim. "They were shoeing horses in there. When we put our second lift in we dug up the floor and actually found the foundation from the original forge. In addition, upstairs in the loft was a wagon. We brought it down, put it together and had 'wheel alignment and brake service' as a sign on the side of it. For many years we wheeled that in and out every night; it was definitely a conversation piece."

The notorious Northeastern weather eventually forced them to return the wagon to storage, but by then Accurate Brake had a solid reputation in the community. "Everybody knows who we are and how long we've been here," says Rob. "Our word is our warranty. If you have a problem, you come back, and I'll take care of you. That's the way we've always done business; everyone is like family."

Founded in 1967 by Jim's father, the shop originally was Lexington Automotive, a full-service gas station in another locale. By the time the '80s rolled around, Jim sensed changes in the industry and restructured his business to focus on tires, brakes and suspension.

"Eighty percent of our market is undercar," Jim relates. "My father realized that cars were running a lot longer and didn't have as many engine problems. He got ahead of the curve by doing (this kind of maintenance) — basically what cars are dealing with today — so we changed our name."

Before he did that, however, Jim also changed locations. For many years Jim drove past this quaint old garage nestled amid colonial-style homes and was intrigued. "He always looked at it and said, 'man, if that place ever went up for sale,'" recalls Rob. "When it did he snapped it up, and we've been here for the last 37 years."

Apparently there are no special problems operating out of a 170+ year-old building. "We re-did the roof back in the '80s," Rob admits. "We had a fire in 2001 so we had to pull out all the electrical and re-do that; other than that you can run a garage in a metal box — you just have to get power in there."

It's a small shop; Rob estimates 1,300-1,400 square feet. "We have two lifts inside, one outside, and a Hunter alignment machine. We do wholesale alignment for most of the shops in the area. If they put a tie rod on, they bring it down and we line it up for them. Our alignment guy, Jimmy Wiggins, has been with us about 37 years. We're going all day long with alignments, so a lot of it is off the street; if you get tires, you need an alignment."

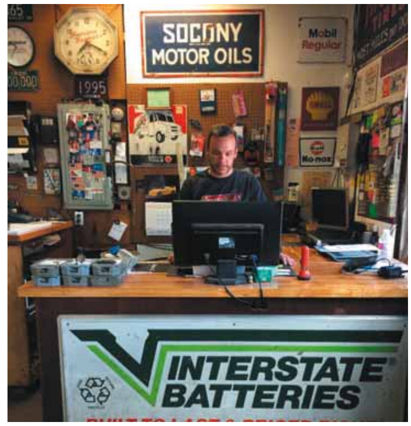
That infamous weather? It also accounts for bad roads. "Alignments are constantly being knocked out," confirms Rob. "My customer base is — well, I don't even know — it's thousands and thousands, and with cars running longer, people keeping them longer, they're going through 2-3 sets of tires in the life of the car.

"My issue is space," he continues. "I just don't have enough to have one of my bays tied up that long. There's like 12 customer cars here every day besides all my wholesale alignments. I get here at 7 a.m., ready to go, and I do my damnedest to get out of here by 5:30 p.m."

A small portion of their business is the restoration market, perhaps 10-15 percent. "Everybody around here who restores old cars, they end up here," proclaims Rob. "This is their last stop before they put their Deuce Coupe, '57 Chevy or '69 'Cuda on the road — they make sure Jimmy lines them up.

"We had a '53 Buick in the other day from two towns over," recalls Rob. "He had heard about us and had had some work done (by someone else) that he wasn't happy with. We banged it out for him — Jimmy did the alignment, and he was never happier. Now two guys from his car club have already called to make appointments. That's what our foundation is built on: we'll give you a good deal, do great work and stand behind it. That's our marketing."

Other than that there's their website, which is clean, easy to use and mobile-friendly. "I have a Google AdWords Express so I can keep my FEO (front end optimization) at the top," Rob points out. "If anybody wants a tip, get this; they have a $150 limit, and when you're doing business with Google, it's in their best interest to keep you at the top. When you spend money with other people, a lot of times they're just getting you to Google, so I kind of cut out the middle man."



In such ways Rob has succeeded his father. "We've already transitioned" he notes, "Everything is in my name now and I'm going to go as long as my knees let me. Thanks to my father, we've been in business for 50 years, and he set a great foundation for it. For 25 years my father and I worked side by side; I taught him some of the newer technology, and he showed me everything else."

Of course Rob couldn't help but go into the business; he was eight years old when his parents moved into the house next to the garage, 10 when he began working in the shop, 12 when he began practically living there. "The shop was my backyard," he smiles. "As much time as I spent swinging a baseball bat or kicking a soccer ball, I was in this garage." MA

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.
rbravender@comcast.net

Upgrade your title from employee to business owner

FEDERAL LOAN PROGRAM CAN HELP EMPLOYEES LOOKING TO MAKE THE TRANSITION

ROB WILSON // Contributing Editor

More than half — 56 percent — of independent shop owners plan to sell their businesses by 2020 (according to a 2015 survey by Hiscox Insurance). Just as in many other industries, retiring baby boomers are making way for new owners and entrepreneurs in the auto repair sector.

Yet these aren't mega corporate merger and acquisition deals like Icahn Automotive' s recent $35 million acquisition of Precision Auto. And the owners and employees aren't billionaire hedge fund managers like Carl Icahn, either. But they are important to their retiring owners and the employees who remain.

Given long-term trends in the auto repair business, and the fact that the skills to repair cars and trucks are beyond most consumers' abilities to manage themselves, prospects for the industry look good.

One category of potential buyers is close to home: key employees. We're seeing a lot of employee interest in taking over the shops where they work. It certainly makes sense for someone who knows the business to take it over.

The benefits to employees buying out the boss work both ways and apply to franchises and independent shops alike. For owners looking for a predictable exit from their business (most often to retire), employee ownership makes for an ideal succession plan. The staff already has the skills, understands the operation and has a relationship with the client base. Employees buying the business not only preserve the business and the associated jobs, but can also build equity and create their own long-term wealth.

But how do employees become business owners? Few, if any, are wealthy enough to write a check. In fact, the Hiscox Insurance survey cited above reveals a third of independent shop owners find bank financing to be "tight."

The Small Business Administration's (SBA) 7(a) loan program can be the answer. It's a federal loan guarantee program that helps lenders on qualifying loans be more flexible, and it focuses on operating businesses, like auto shops. In general, the 7(a) program can provide more reasonably priced loans, over longer terms than online lenders, and with more flexibility than regular bank financing.

In a couple of recent examples, as far apart as Idaho and Maine, we at C7a helped long-time employee managers buy out their retiring bosses. In neither case did the employee have the resources to make the purchase without a loan.

Both worked with the respective owners to plan for the transition. Experts advise that for the best odds of a successful transition, start planning well ahead. Because of this, both borrowers had some savings to provide some "money down."

Both had worked with business advisors or local economic development organizations, Montana and Idaho CDC and a CEI Maine Small Business Development Center business advisor, respectively, to prepare plans for the financing, the transition and the longer term.

"It made sense for all of us," says Jared Scofield, one of the two long-time employees of Garry's Automotive in Boise, Idaho, who bought the business from its retiring owners. "We started the process years ago, saving money and learning the business. We not only want to be here for our customers, but for our staff, too, providing a good living for all of us."

Similarly, James Chattley, an experienced and trusted employee of a Meineke franchise in Topsham, Maine, was approached by the shop's owners to discuss their plans to retire as well as the possibility of him buying the business.

Chattley worked with W. Bradshaw Swanson, a certified Business Advisor at the Small Business Development Center at CEI. Through dedicated customer business advising, Swanson introduced Chattley to the SBA 7(a) lenders at C7a. As Chattley says, "The team at CEI and C7a structured the loan with terms that made sense for me and the future success of this business. They really understood me and my goals for the shop."

Swanson agrees that a 7(a) loan was the best fit for Chattley's situation, and says, "The acquisition of the franchise

>> CONTINUES ON PAGE 32

>> CONTINUES FROM PAGE 30

was a great opportunity for James. He had successfully managed the shop for more than a decade. He had the cash from savings for the down payment and needed to borrow the balance to buy the business. When the bank turned him down, we approached C7a because of the customer-focused, flexible financing option they offered. It was a terrific fit. From the outset, when we contacted them, we got the sense that they saw the opportunity for James. They said, 'We see the potential here. Let's see what we can do to make this deal work.'"

Both Scofield and Chattley had approached local banks, which should be the first port of call for any borrowers, but in their cases the banks were not willing to help, as the deals didn't quite fit their credit criteria or current portfolio requirements. Consequently, their advisors introduced them to C7a.

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As a mission lender (not a bank), we at C7a look at the big picture when analyzing a borrower's credentials- where the business is located, does it have a history of profitability and what is the potential for future revenue.

It is our mission to support entrepreneurship and opportunity for all and therefore, we support the mechanic or supervisor that has extensive experience in the industry to make the leap to business owner. It is good for the business and beyond when an experienced employee, invested in the community, can buy out the boss, keeping ownership on Main Street instead of Wall Street. MA

ROB WILSON is CEO, CEI 7(a) Financing LLC, one of a small number of non-bank lenders licensed by the Small Business Administration to participate in the SBA's flagship 7(a) loan guarantee program. C7(a) shares a mission with its non-profit parent organization, Coastal Enterprises Inc., to help individuals and communitites reach their full potential. *rwilson@cei7a.com*

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MECHANICAL MOMENT

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

HYUNDAI VELOSTER SETS DTC P0106 AFTER CLOSE ENCOUNTER (OF SOME KIND) WITH THE SNOW

VEHICLE: 2012 Hyundai Veloster, L4-1.6L, Automatic Transaxle

MILEAGE: 65,030

PROBLEM: The customer brought his car to the shop because he noticed a significant loss of power and the malfunction indicator light (MIL) was ON.

DETAILS: The tech connected a scan tool and retrieved a P0106 DTC – Manifold absolute pressure (MAP) circuit/performance out of range. Acting on advice from the Tech-Assist consultant, he monitored the MAP sensor and throttle position sensor (TPS) voltages with his scan tool.

At idle, the MAP sensor voltage was 1.35V and the TPS read 0.546V, which was within factory specifications. While accelerating though, he noticed that the MAP sensor voltage did not increase at the same rate as the TPS voltage.

The Tech-Assist consultant suggested checking the intake system next. When the tech opened the air box, it was packed with snow.

CONFIRMED REPAIR: After removing the snow, drying out the intake system and installing a new air filter, the code was cleared and the vehicle was taken on a test drive. The power was restored and the MIL remained off. By the way, the vehicle owner had no idea how the snow got into the air intake system, but his son drove the car the night before.

This tech tip and others come from ALLDATA Tech-Assist, a diagnostic hotline of ASE-Certified Master Technicians. Whatever technicians need — from creating alternative diagnostic strategies to providing step-by-step repair assistance — the Tech-Assist Team can deliver. Learn more at ***ALLDATA.com.***

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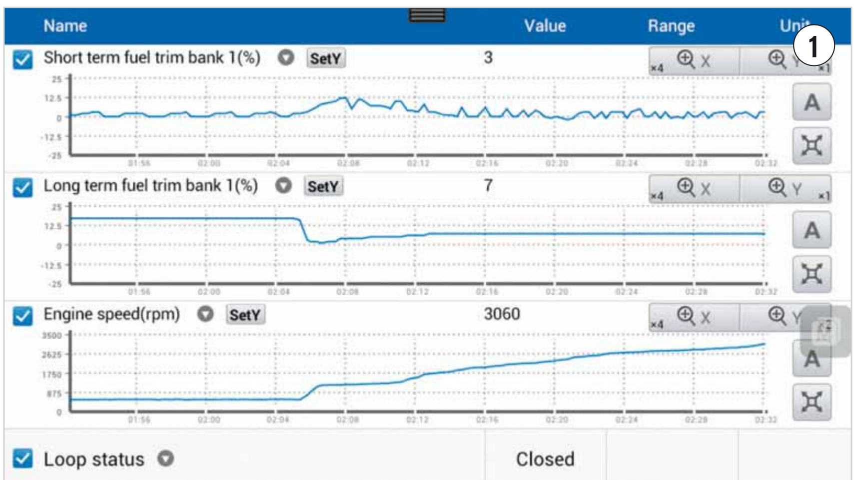
TURBOCHARGING FUEL TRIM

THE INCREASED USE OF TURBOCHARGERS BRINGS NEW LESSONS TO USING FUEL TRIMS FOR DIAGNOSTICS

SCOTT SHOTTON // Contributing Editor

For many years, technicians have been using fuel trim numbers to diagnose vehicle issues. It does not matter if the complaint is a performance, code or no code issue. Personally, I base many of my diagnostic decisions on fuel trim numbers, and I think that many technicians in the industry feel the same. For lack of a better term, fuel trims are akin to a crystal ball. What they allow us to do is see how the PCM is strategically correcting for fuel issues and allow us to narrow down the areas where we need to focus our testing. For example, for a vehicle with positive fuel trim numbers, or a PCM that is adding fuel, the technician would focus his or her efforts on faults that would make an engine run lean. Conditions such as vacuum leaks or low fuel pressure might be the culprit. Conversely, a ruptured fuel pressure regulator diaphragm or higher than normal fuel pressure would not warrant any diagnostic time. Negative fuel trim values, on the other hand, would suggest issues previously mentioned as a possibility.

One of the effective ways to use fuel trim values is to observe them under different engine operating conditions. This is accomplished by observing fuel trim values while changing engine speed and loading the engine by driving the vehicle on a road test. In addition, total fuel trim correction (short-term fuel trim + long-term fuel trim) is the number we should be most concerned with. There are few cases where observing short-term fuel trim or long-term fuel trim individually will be valuable. It should also be noted that while using fuel trim numbers for diagnosis the vehicle should be operating in closed loop.



An example

That being said, knowing how different faults effect fuel trim numbers under different conditions then becomes the key to an efficient diagnostic process. In order to illustrate this point, we will take a look at a 2000 Chevrolet Tahoe with a 5.3 liter engine. The vehicle has a vacuum leak, and a scan tool is connected to view live data (Figure 1).

For the sake of visibility, loop status, engine speed and bank 1 fuel trim numbers are all that have been included. For reference, the fuel trim numbers on bank 2 are about the same as bank 1. On the left side of the capture the engine is idling. The short-term fuel trim is bumping +5 percent while the long-term fuel trim is at +17 percent. The total fuel trim correction (short term + long term) is +22 percent. As we change the engine's operating conditions by increasing the engine speed, the fuel trim numbers move closer to a normal value. At higher RPMs, the total

PHOTOS: SCOTT SHOTTON

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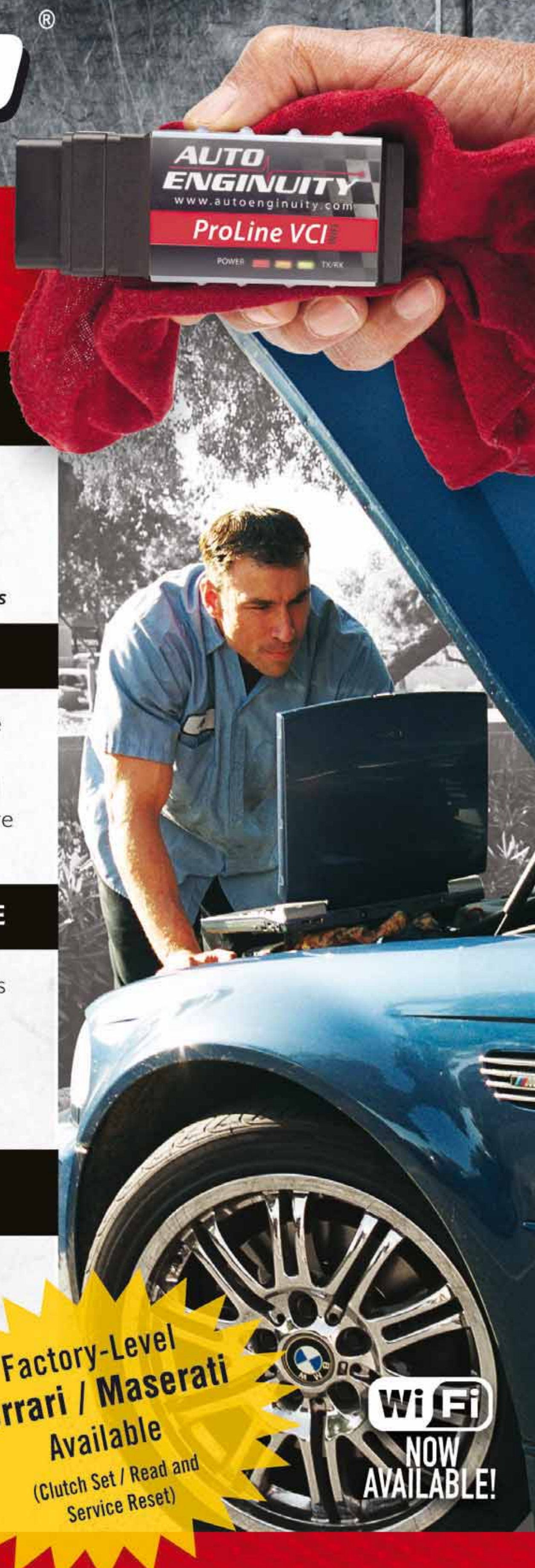

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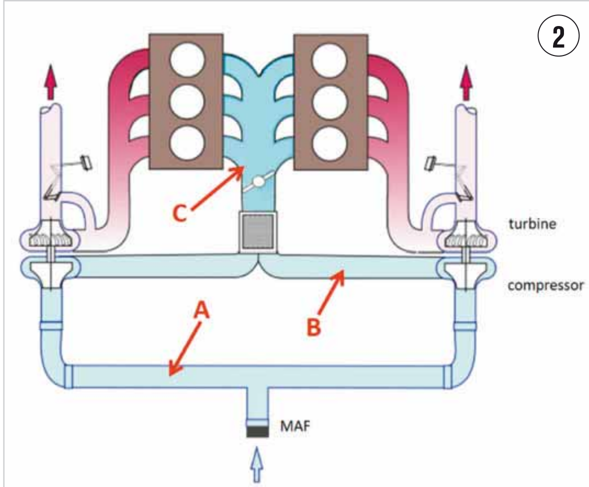
fuel trim correction is now +10 percent. This is not a perfect number, but much closer to an acceptable reading. This is classic fuel trim behavior when a vacuum leak is present.

Why do the trim numbers behave this way? At idle the throttle plates are closed and there is low pressure, or vacuum, inside the intake manifold. A vacuum leak would then allow un-metered air to be forced in through the relatively small vacuum leak. If 20 percent of the air that is entering the engine is bypassing the MAF sensor and entering through the leak, then the MAF is only measuring 80 percent of the air entering the engine. Because the un-metered air is not accounted for by the PCM, the fuel that is then injected is 20 percent less than what the engine needs. The result is the appropriate positive total fuel trim correction.

Second, when the engine RPMs are elevated, the small vacuum leak becomes an insignificant percentage of the air entering the engine. The vast majority of the air that is entering the engine is now metered by the MAF more accurately, the PCM injects a quantity of fuel that is more appropriate for conditions and fuel trim values move closer to normal. If we understand how a vacuum leak affects fuel trim numbers under different conditions then the question "Why?" has been answered. More importantly, we can use this knowledge for diagnosis.

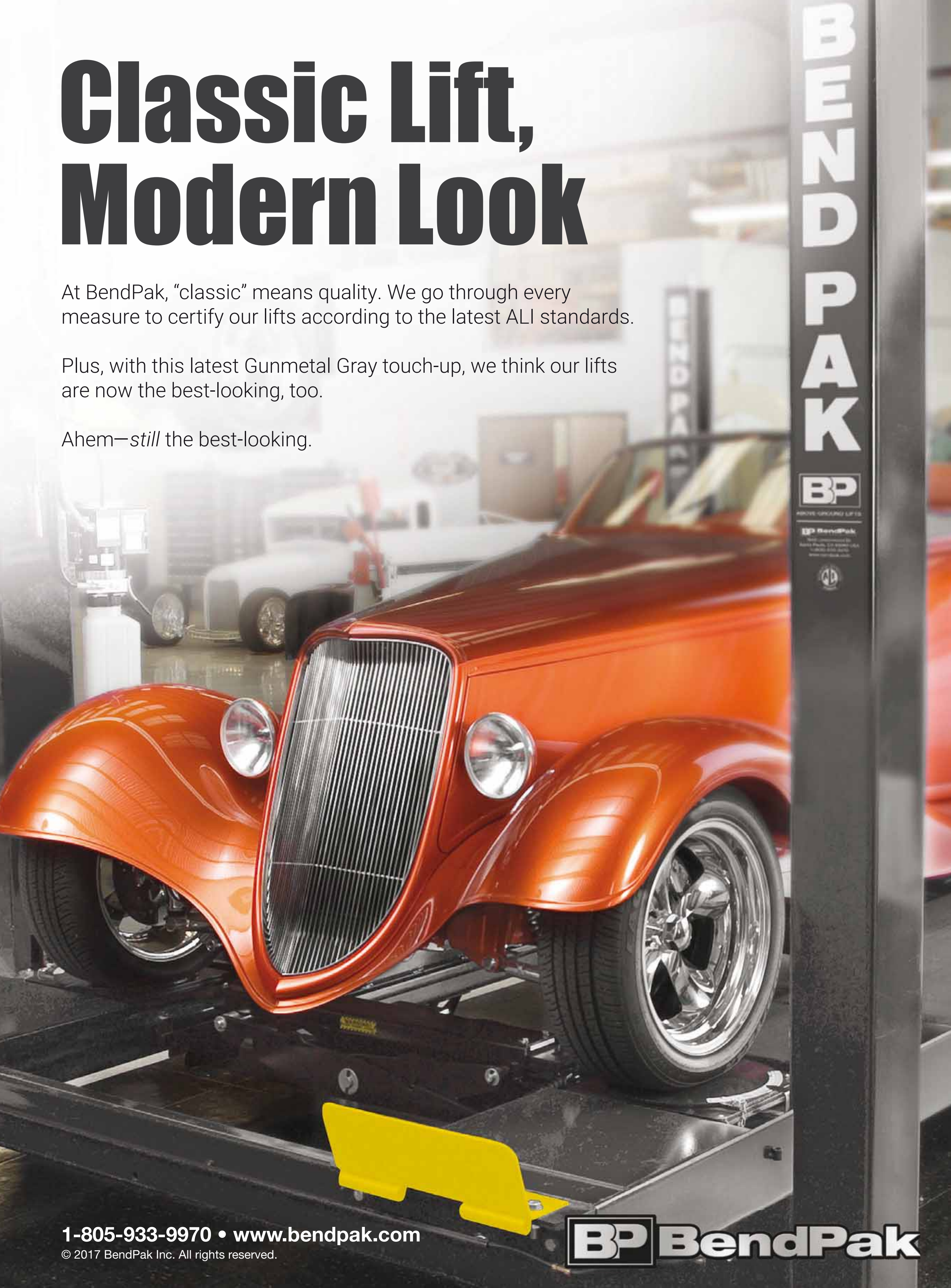


Turbochargers

In recent years, we have been presented with a new situation that is changing how fuel trim numbers behave: turbocharged engines. First of all, it is not fair for me to call it "new" because turbochargers have been around for a long time. Some of us probably remember turbocharged four-cylinder Chrysler products from the 1980s or early 1990s. I think it would be fair to say that turbocharged vehicles have not been a major part of the average technician's "bread and butter" for the past two decades or so. Things are changing.

With the introduction of gasoline direct injection over a decade ago, turbocharged vehicles have become more common as the model years tick by. GDI has allowed manufacturers to take full advantage of forced induction capabilities to reduce emissions, increase fuel economy and improve performance. In many cases these technologies can be implemented using lower octane gasoline. All of which are positive aspects enjoyed by the consumer and more beneficial to the environment.

These advancing technologies have caused technicians to adapt to new tooling and diagnostic procedures. However, the basics of fuel trim remain the same. What has changed is increased airflow and, more importantly, positive pres-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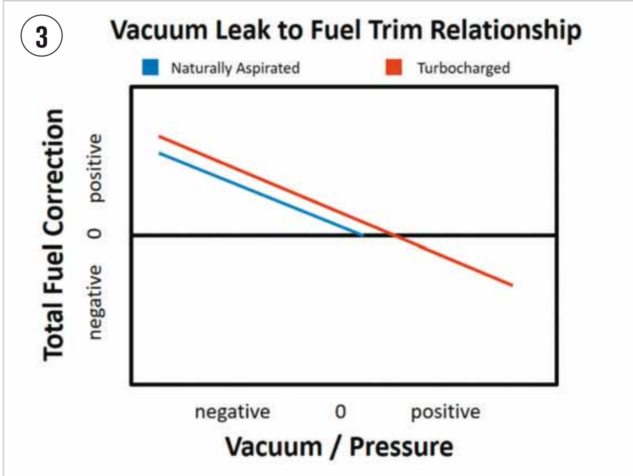
sures in the intake manifold and parts of the induction system. These physical changes affect how fuel trim numbers behave when faults are present.

Given our collective technical experience with fuel trim numbers pertaining to MAF sensor-equipped naturally aspirated vehicles, this article will make some comparisons between naturally aspirated engines and forced-induction applications that are also equipped with MAF sensors.

There are three labels on the turbocharged induction system diagram shown here (Figure 2). Label A represents an air metering issue. This would include a leak in the induction tubing between the MAF sensor and the turbo charger. This condition would also include an inaccurate MAF sensor signal. Label B represents a boost leak. Naturally aspirated engines would never have this condition. Finally, label C represents a vacuum leak. Let's attack the vacuum leak first.

Vacuum leaks

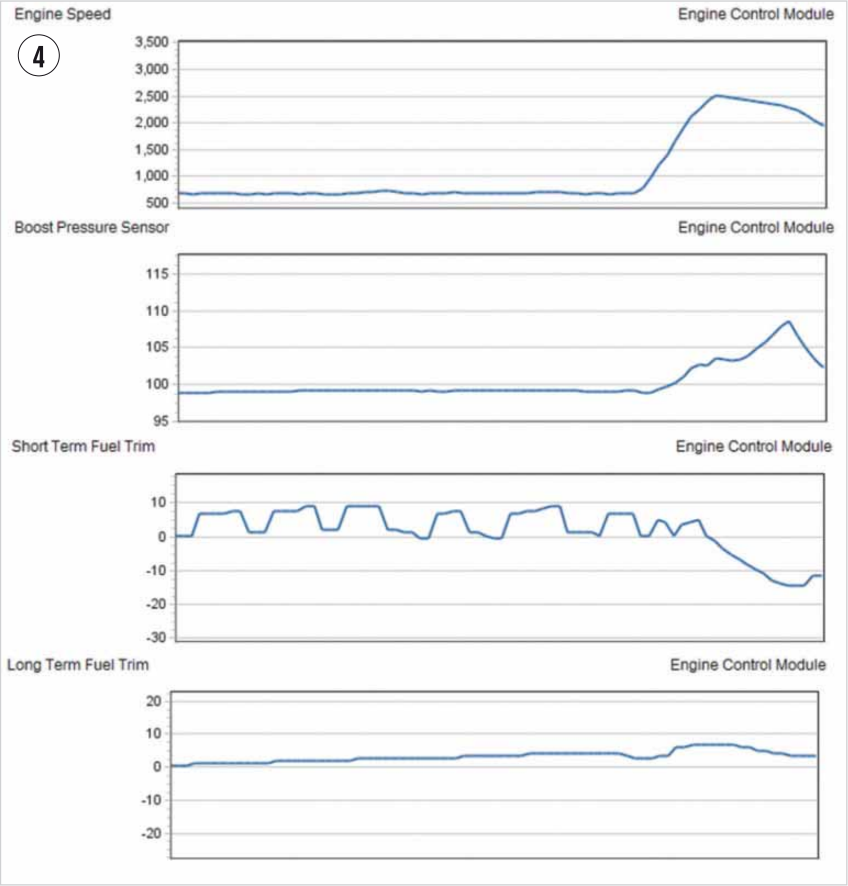
As illustrated earlier by the 2000 Tahoe, vacuum leaks on naturally aspirated vehicles usually result in positive fuel trim corrections when the engine is operating under high engine vacuum conditions. Unlike a naturally aspirated engine that will never see positive pressure in the intake manifold, a turbocharged application will have positive pressures during boost situations (Figure 3). This positive pressure will allow air to leak out of the intake instead of into it. The typical vacuum leak on a turbocharged vehicle (label C) will behave as follows: during a high vacuum condition, the fuel trims will be positive, the same as a naturally aspirated application, but fuel trim numbers will be negative during boost. The reason for the negative numbers is because the MAF sensor is measuring all the air the turbocharger is trying to push into the engine, but some of it is escaping through the "vacuum leak." The PCM is still injecting the amount of fuel appropriate for the mass of air that had been measured, but not all the measured air mass is making it into the engine. The result is a rich condition and negative fuel trim values.



Air metering issues

Air metering issues, sometimes called pirate air or false air, refer to anything between the MAF sensor and the throttle plate on a naturally aspired vehicle. On turbocharged applications (label A), it refers to anything between the MAF sensor and the turbocharger fresh air inlet. In both cases, this also refers to the MAF sensor itself. In both applications fuel trim numbers behave about the same.

For example, if a naturally aspirated engine is drawing in 100 grams of air per second, but the MAF sensor is only measuring 90 grams, then 10 percent of the air is not being measured, or 10 grams per second. The PCM then injects the appropriate amount of fuel for the 90 grams per second of air that it measured. As engine revolutions increase, we may now have 200 grams per second entering the engine. In this case, a greater mass of air is un-metered (or inaccurately metered by a faulty MAF sensor) and greater fuel trim corrections will be required to maintain the correct stoichiometric air fuel ratio. The overall result is higher engine airflow requires greater positive fuel trim correction. On a turbocharged application, more air mass will flow than its non-forced induction counterpart, but the fuel trim behavior would still be the same. During boost conditions, the total fuel trim correction would continue to climb. In addition, many technicians like to use volumetric efficiency for an air metering diagnosis. We will touch on this aspect at the end of the article.



Boost leaks

Boost leaks refer to a leak between the turbocharger fresh air outlet and the engine's throttle body (label B.) Obviously, this is not a concern on a naturally aspirated vehicle. Boost leaks affect fuel trim numbers differently based on how big the boost leak is. A small leak may behave like an air metering issue until boost occurs. In this case, when there is no boost, un-metered air is sneaking into the engine and slightly positive fuel trims are the result. During boost conditions, air is being forced out of the leak instead of into the engine. This causes a rich condition and negative fuel trim numbers.

Figure 4 is from a 2011 Chevrolet Cruze Eco with a 1.4 liter engine. Sometime during a previous service operation, the clamp that holds the intake tube to the throttle body was left loose.

The left side of the capture shows relatively normal fuel trim values when the engine was not boosting. The intake tube was not allowing un-metered air to get into the engine. As we move to the right of the capture, and boost begins to increase, we can see a different result. The fuel trim values dip negative as boost pressure is expanding the intake tube and forcing some of the air out to the atmosphere. The exiting air was included in the MAF sensor's measurement and the fuel that belongs to that air was still being injected. The resulting rich condition caused the fuel trim corrections to move negative.

A larger boost leak — let us call it "mid-sized" — would appear the same as an air metering issue with positive fuel trim numbers when the intake is in the vacuum to atmospheric pressure ranges while moving negative under boost conditions. The larger the leak is, the greater the fuel trim swings should be.

If a boost leak gets too large, we may never get the chance to monitor fuel trim numbers. In these cases, the vehicle may never attain closed loop or may not even run. One example of this might be some Volkswagen and Audi products. During cranking, when engine airflow is extremely low, the PCM uses the MAP sensor to calculate fuel delivery until the engine starts. Once the engine is running, the PCM begins to use the MAF sensor to calculate fuel delivery. On one of these applications, if the air tube between the turbocharger and the throttle body were to have a large break, or be completely disconnected, the engine would exhibit a start and stall condition. Warning: the scan

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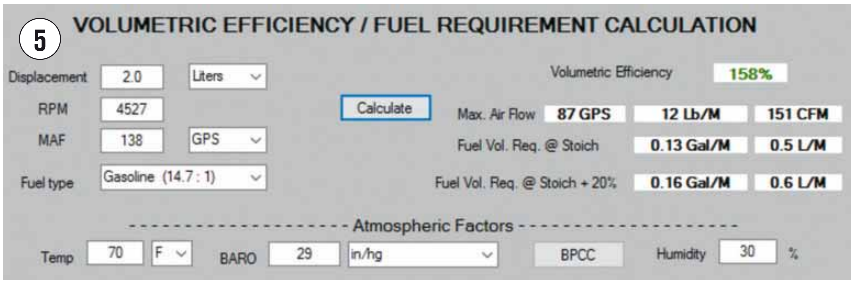
data could be deceiving. The MAF PID might actually display the airflow calculated from the MAP sensor input until the engine is running and then switch to the actual MAF value. Disconnecting the MAF sensor will allow the engine to run off the MAP sensor input continuously. Using the "old school" technique of disconnecting the MAF to see if the vehicle runs better is only valuable if one understands the PCM's strategy. Replacing the MAF sensor in this case would be an act of futility.

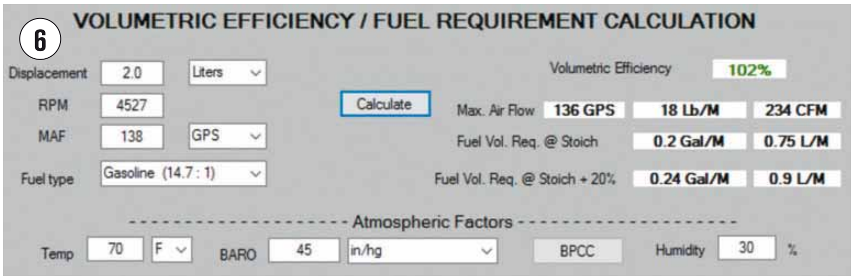
Volumetric efficiency

Volumetric efficiency is a measurement of how well an engine pumps air. An easy way to think of volumetric efficiency is to equate it to the engine's ability to breath. Many articles and classes have covered this technique in the past. However, the majority of them revolve around naturally aspirated engines that, if good, will yield VE numbers in the 75 percent to 100 percent range. Forced induction applications are different. Because air is being forced into the engine, VE numbers exceed 100 percent. One of the problems with VE is that manufacturers do not provide known good numbers for their applications. On known good turbocharger-equipped vehicles, I have seen VE numbers range from 120 percent to 300 percent. So, what can we do if we do not know what good is?

There is a way to get a usable volumetric efficiency number on a forced induction vehicle if you have two things: a VE calculator that allows for a barometric pressure input and the ability to do a little additional math. The calculator we are using is called DECS and is available from AESwave.com. There are other calculators out there, but this is the only one that I am aware of that allows for a barometric pressure input.

The vehicle we will use to illustrate this technique is a 2.0 liter turbocharged





application that has been taken on a wide-open throttle test drive (Figure 5). The peak numbers, 4527 RPM and 138 GPS, have been entered. The actual barometric pressure of 29 inches of mercury have been entered as well. The calculator yields a VE result of 158 percent. Is this a good number for this vehicle?

In order to find out, we need one more thing from the scan tool recording: boost pressure. In this case our boost pressure PID indicated 8 lbs. per square inch at the same moment in time that the other data PIDs were captured. Now comes the math. Our starting barometric pressure was 29 inches of mercury (pressure, not vacuum). Our boost pressure is 8 lbs per square inch. One pound per square inch is equal to two inches of mercury. Therefore, 8 psi = 16 inHg (8 x 2.) At that moment in time the intake manifold pressure was 16 inches of mercury above the atmospheric pressure of 29 inches of mercury. What this means is that our intake pressure is now 45 inches of mercury (29 + 16.) If we change our barometric pressure input in the calculator to 45 instead of 29, we get a VE calculation of 102 percent (Figure 6). What this tells us is that the engine is operating at approximately 100 percent efficiency given the current amount of boost. This number now becomes much more manageable and valuable to our diagnostic process.

Of course, there are other issues that can skew fuel trim values that are not mentioned here. One such possibility could be a malfunctioning positive crank case ventilation, or PCV, system that may cause fuel trim issues depending on the design of the PCV system and the system's particular failure. Regardless, the basics of fuel trim diagnostics on turbocharged induction systems have been outlined. My only hope is to build the ground work required for technicians to effectively diagnose these applications, as they become more common each year. If these vehicles are not rolling into your bay now, they will be. Embrace the differences and move forward with your diagnostics. MA

SCOTT SHOTTON is owner of The Driveability Guys, and he performs mobile diagnostics, reprogramming, industry training and has been a college instructor for the past 14 years. With a degree in Automotive Service Technology, Scott holds more than 21 ASE certifications. *scott@driveabilityguys.com*

DEALING WITH EUROPEANS

DIAGNOSTICS AND SOLUTIONS FOR TODAY'S VEHICLES

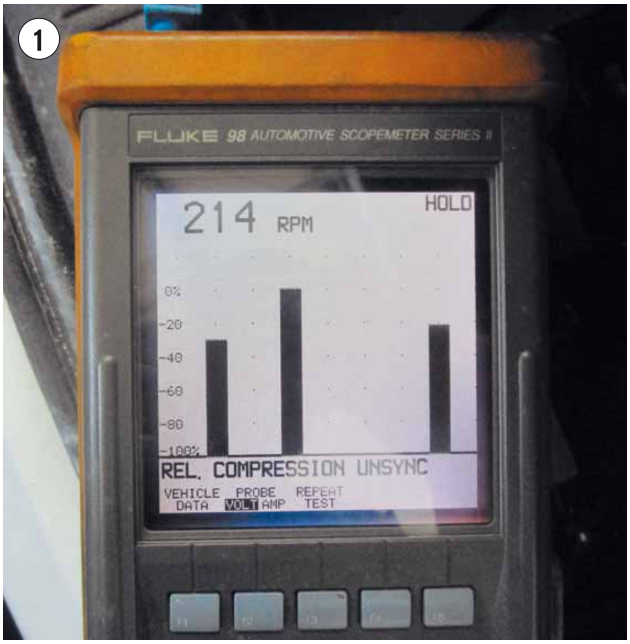
G. JERRY TRUGLIA //
Contributing Editor

A 2013 Audi A4 came in with a complaint of low power along with an illuminated Check Engine light that we were asked to diagnose. After we listened and questioned the owner about his A4, we sold him our basic diagnostic check. The check includes a search of applicable TSBs and connecting the ODIS, the factory scan tool, to the vehicle so we could perform a complete vehicle health check. The results of our vehicle check uncovered a P0302 DTC that most likely was the cause of the power loss concern and no TSBs. The next step was to confirm that the misfire was indeed from cylinder #2.

My tech Franklin used the GTC505 ignition analyzer to test the ignition system and confirm the misfire. Franklin also noticed that the ignition coil on #2 cylinder had severe burn marks on it that could be the result of the ignition coil being fired in a cylinder that had a wide spark plug gap or lean air fuel mixture. Franklin's next step was to remove the ignition coil and spark plug from the engine only to find that the spark plug electrode was severely worn.

You missed a step!

Since the engine only had 63,000 miles on it, he recommend the replacement of all the spark plugs and the #2 ignition coil, as they displayed signs of wear. Unfortunately for the Audi owner and us, the problem was not just the spark plugs and ignition coil. An important first step was overlooked and not performed, and we missed the root cause of the P0302 misfire. After the plug and coil replacement was completed, Franklin realized that he should have not taken for granted the mechanical condition of the engine. Since the engine was now only running slightly better than before and the P0302 returned, Franklin decided to perform a Relative Compression test (Figure 1) followed by a cranking pressure transducer compression test (Figure 2) that both resulted in displaying a cylinder problem.



Now Franklin needed to confirm what was causing the mechanical problem, so he proceeded to perform a cylinder leak down test. With the air being pumped into the cylinder pouring out of the intake manifold, it was evident the loss of compression was in the top end. Franklin informed the Audi owner of the test results along with the information from our inspection camera pictures. The pictures displayed a piece of one intake valve missing that was most likely causing the misfire problem. Franklin explained to the Audi owner that there was a possibility of a piston or cylinder wall issue as well, due to the missing piece potentially bouncing around in there. The Audi owner was told the price of a replacement motor both new and used so he could decide which way he would like to proceed.

The A4 owner decided to approve the cylinder head re-

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moval, so we proceeded to remove the cylinder head and checked for the broken pieces of the valve. We carefully checked all the cylinder walls (Figure 3), especially cylinder #2 for any damage. We looked everywhere possible for any remnants (Figure 4) from the damaged valve, including in the front catalytic converter. Since no scratches or marks were found we continued to clean everything up, then sent the cylinder head out to the machine shop. When we received the cylinder head back, we aligned the complex timing chains up, making sure that we were right on the marks. As you can see by the picture (Figure 5), this engine has one hell of a chain system that you need to make sure is right on the money. We used our special Audi/VW tools that hold the engine and chains in place to prevent the engine from moving. After we were done, we double and triple checked the timing marks and proceeded to very carefully rotate the engine, making sure it moved freely without interference. With the engine totally back together we connected the ODIS scan tool and checked for any and all DTCs, along with checking the exhaust readings (Figure 6) that confirmed the engine was running as good as new. We test drove the vehicle until the monitors were completed to make sure that there were no problems before we returned it to the owner.

VW Golf tire out

Nowadays it is not always a drivability problem that requires using service information, scan tools and your diagnostic experience. Sometimes something so simple as a TPMS sensor can turn into a complicated diagnosis and repair. We recently had such a problem on a 2010 VW Golf that the vehicle owner had sitting around since last summer. When he came in with the vehicle, he wanted us to check the Golf out, change the oil, extinguish the TPMS light and perform a New York state inspection.

The Golf only had 3,096 miles on it since the vehicle is only used in town in the summer. Sometimes — as we know — it's not mileage but time that may dictate service and/or a repair. When we tested the battery life of all the TPMS sensors they reported a 60 percent level, indicating that the TPMS battery was not the problem. Most likely the TPMS light was illuminated due to the vehicle's 12-volt battery going dead, and the module losing its learned connection. We followed the TPMS system directions and drove the vehicle until the TPMS light went out.

After we returned the vehicle to the owner he started to drive it home but did not make it more than 5 miles

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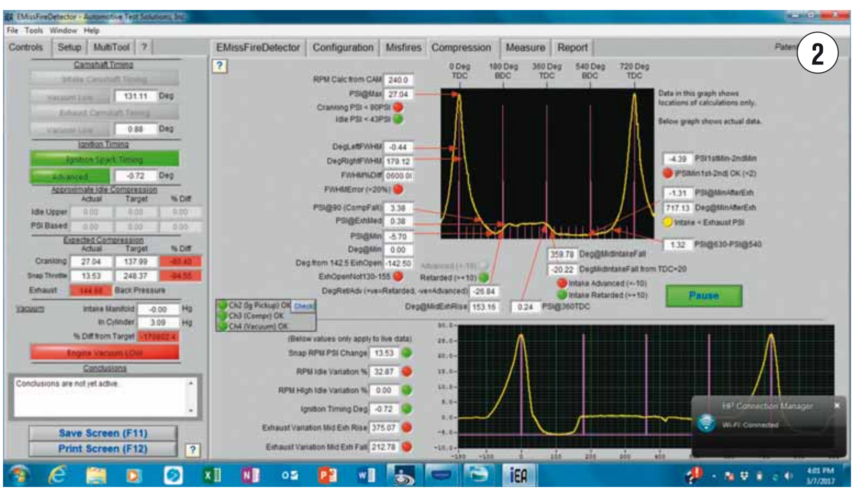
when the TPMS light illuminated again. He returned to the shop and left the Golf with us to check out the problem. We started our diagnosis by connecting our scan tool and found a DTC 01325 Tire Pressure Monitoring No or Incorrect Basic Settings/Adaptation and 01044 Gateway Control module incorrectly coded. Since the scan tool provided us with DTCs, we used our newest Autel TPMS tool only to come up with the same results that we had discovered previously — one tire not connected or learned. We tried to reset and relearn the problem sensor, but were unable to register the tire or turn the TPMS light off.

Next, we decided to move on to the other three TPMS tools we have only to come up with the same results. We even diagnosed the TPMS system with the VW ODIS factory scan tool and utilized the factory service information. The VW service information was similar to the aftermarket in that it stated to press the reset button in the glove box or in the center console. The only problem was that this 2010 Golf did not have a reset button in either place or for that matter anywhere on the vehicle. After all three of us looked everywhere and even called a friend who worked for VW, we came to the conclusion that this Golf had a TPMS system that must have been designed in a model year that did not have a reset button. We went back to our new aftermarket scan tool because it was easier to use, saving us time over using the ODIS. We followed the in-



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structions for the TPMS system that does not utilize a reset button to get the system back to normal. The procedure is making sure the vehicle is in a KOEO state followed by at least 20 minutes of wait time. It is important that the vehicle is not disturbed during the wait time — that means not even opening the door. After the 20 minutes of wait time, a test drive of 7 minutes must be completed so the sensors go into relearn mode. The next step is to use a scan tool capable of setting the tires to winter or regular wheels use; on our Golf we selected regular. This is followed by checking the tire pressure and making sure they all read 2.4 bar/ 34 psi. Once we confirmed that the tire pressure was correct, we made sure the Tire Pressure Security Adaptation code was also correct. Since the code was not correct, we entered the correct code of 015403 and the adaptation was complete.

Once the coding was complete, the vehicle had to be driven again to make sure all the wheels would transmit the proper information. The drive is an important part of the reset procedure so that the computer can automatically recognize and read the wheel speed sensors then log them into the control module. After we completed the lengthy procedure, the TPMS light went out and the vehicle was returned to the customer.

The possessed X5

A 2008 BMW X5 came in to us on a cold, wet December day with all four windows completely down. The vehicle owner informed us that she was unable to get the windows to go back up in the closed position. She stated that when she parked her vehicle the previous night, all the windows were fully closed in the up position. After listening to the BMW owner, we drove the vehicle in the bay and connected our scan tool to perform a complete vehicle scan. The X5 had some of the normal codes that we expected to see such as telephone and radio DTCs but none that pertained to our problem at hand with the windows.

We decided to check all the window switches and read up on how the system works. What we found was that the window switch on the left rear door seemed to have a problem as well as the master driver door switch (Figure 8). We proceeded to remove the window switches and blow them dry with shop air then reinstall them to see if they would work. The result was that the master switch started to work, allowing us to get the windows in the up position. After the windows were back in the closed position, we tried to select the down position only to find that some of the windows would go down while the left rear door stayed up. We tried directly using the window switch on the left rear door, but the window refused to go down. We decided that we would remove the left rear switch and replace it with the right rear switch to confirm that the left door switch was defective. The results were that the left rear switch needed to be replaced so we now concentrated on the master door switch making sure that all the functions operated as designed.

As we were testing the master switch, we found too many inconsistences that led us to the decision of or-


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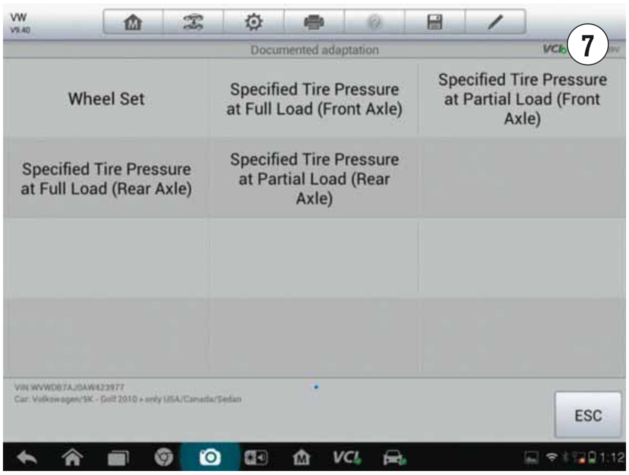
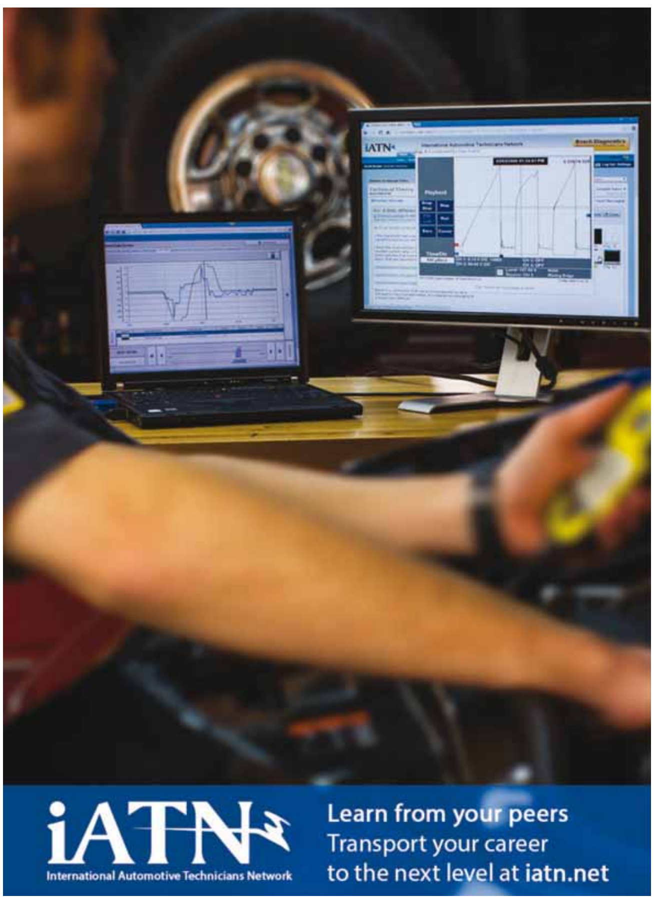
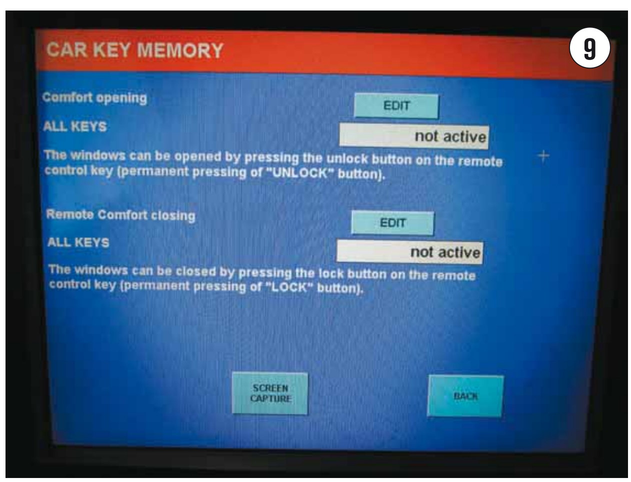
dering a master door switch along with one window switch. The switches were installed allowing the windows to work properly and were no longer just going all the way down on their own anymore. The X5 owner left happy, but was not certain that the windows would no longer go down on their own. We called her twice, once a week after the repair and the other time about a month later to check and make sure that she no longer experienced any problems.





Six months forward we received a call from the BMW owner explaining that her X5 windows went half way down while she was in line at Whole Foods. This was the first time that the windows have not stayed in the closed position, she explained. We asked her if she was in close proximity of the vehicle when this happened, our thinking was that she had her key fob in her bag, something hit the key fob down window command. She replied that the key fob was in her hand with some groceries that she was purchasing. She continued stating that we did not fix her BMW correctly since the windows were not staying closed. We tried to calm her down and explain that it seems like a different problem than the one we repaired since all the windows now only went halfway down. She proceeded to tell us that all the windows returned to the fully closed position when she selected the up position on the master switch. She would not accept the explanation and stated that she was unhappy since we did not fix her vehicle correctly.

After some time on the phone, Bill finally convinced her to bring the vehicle in and leave it with us so we could observe the windows. We told her we would run a complete scan of all the computer systems on her vehicle and monitor the windows. After checking the X5 out with our scan



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tool, we found that all the systems were working as designed and the windows did not go down on their own. We suggested that we remove a function from her key fob that allows for the windows to go halfway down. She disagreed with us and insisted that her key fob could have not caused the windows to go down until we told her that we could prove it to her, since it is a function on her BMW X5. We once again asked her for approval to remove the function from the key fob we had for the vehicle. Bill told her that when she came to pick the vehicle up we would show her with the other key fob she had for the BMW that we could command the windows half way down repeatedly. Finally, she agreed to grant us permission to remove the command from the fob and body controller. We connected our scan tool (Figure 9) and removed the Comfort opening from the vehicle Car Key Memory (Figure 10) options.

When she arrived at the shop to pick the BMW up we showed her what most likely happened when she was in Whole Foods. The owner stated that she was not aware that the vehicle had that function and thought it best to remove it. We granted her request and returned the X5 to her at no charge since she was previously so upset. In the automotive business, it's not always black and white, and as a shop owner sometimes we cannot fix the customer, but rather we have to make them happy to retain them as a customer. Since she was now satisfied, we were able to sell her a 12-volt battery after explaining it was weak, along with showing her the results of the battery test we performed. In this case, even though we did not make money on her windows, we were able to retain the customer and make money on a battery that she needed.

2012 Mercedes-Benz not blowing

A good customer of ours came in with his 2010 MB C300 that had a complaint of his blower fan not working. As you know, it's not the days of your father's Oldsmobile where it would be a 10-minute job to check the resistor or blower motor. Working on a newer vehicle is a different story where there are sensors, actuators, control heads and a computer that now controls the operation of the blower fan. Bill started his diagnosis by connecting the scan tool to the Benz and checking for body DTCs, but found none. He followed this by going into the bi-directional part of the scan tool to see if the blower fan could be commanded on. Since there was no action from the blower motor, Bill decided to go to the load first, ruling out the blower motor by applying power and ground from his Power Probe. As luck would have it, the motor was blowing but not at full force, so Bill tapped it and heard a difference of air volume. Just to make sure it was the motor, he removed it and tapped on the side of the motor with a screwdriver handle. The results: the blower motor would sometimes stop or blow at a speed that did not seem to be its maximum. We ordered a new MB blower from WorldPac and when it arrived we compared the new against the original one. Watch the results at MotorAge.com/MBblower, and you can see that a resistance test and a dynamic test that confirmed the blower motor was in fact defective. The difference with the Power Probe connected to each is easily displayed. Bill installed the new blower motor (Figure 11) and tested all of the settings before returning the vehicle to the owner. Now the Benz blows just fine. MA

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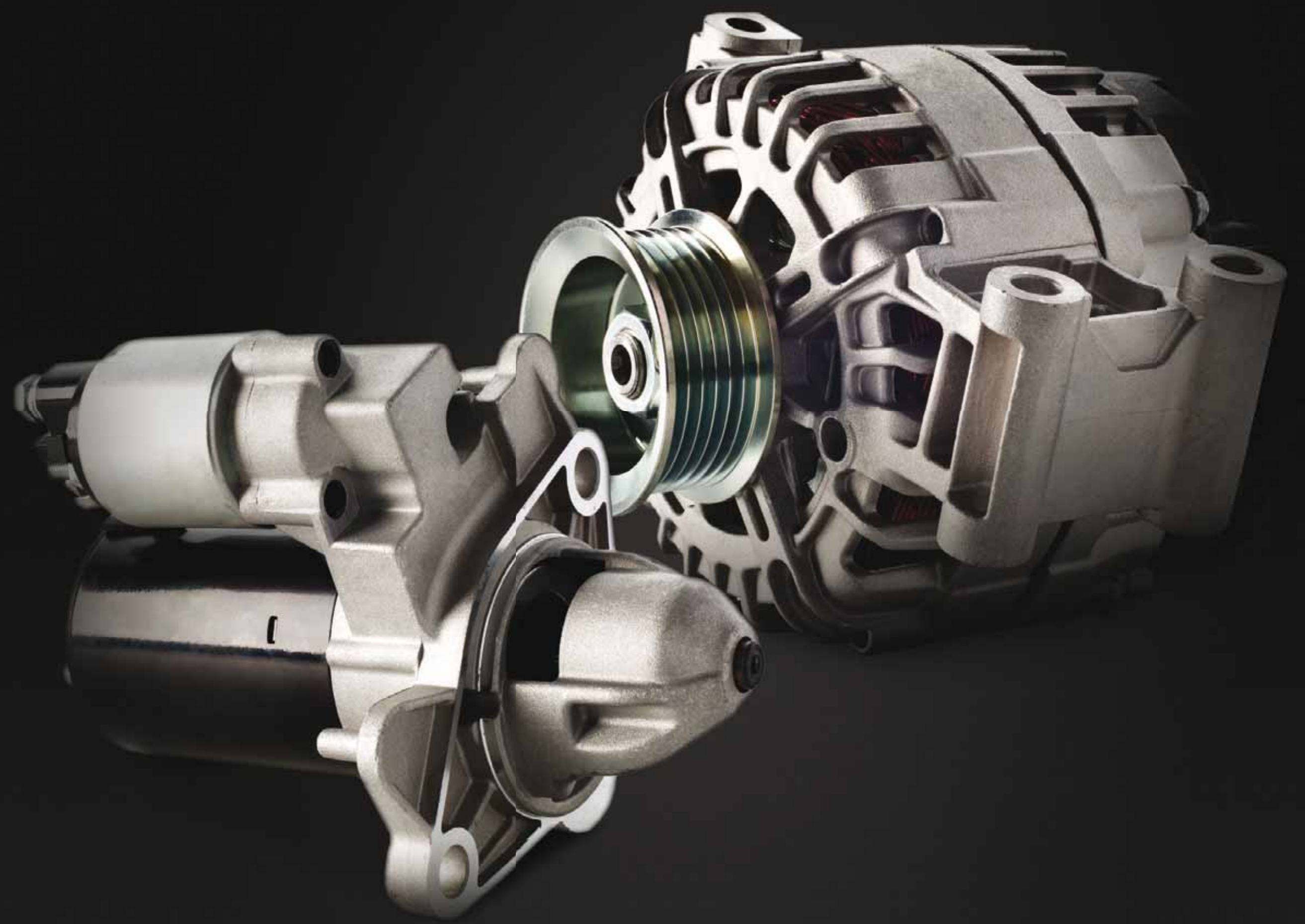
gtruglia@tstseminars.org



NETWORK COMMUNICATION DIAGNOSTICS

IS YOUR CUSTOMER'S VEHICLE EXPERIENCING A FAILURE TO COMMUNICATE?

DAVE HOBBS // Contributing Editor

You're probably an old movie buff if you remember Paul Newman's 1967 movie *Cool Hand Luke*. There's a famous line in that classic prison film where the captain of the prison guard (Strother Martin) beats the rebellious inmate Luke (played by Paul Newman) and says, "What we're dealing with here is a failure to communicate!" If you've ever felt beaten, figuratively speaking, by a vehicle experiencing a "failure to communicate" this article is for you!

Brief history of automotive multiplexing

Serial data bus communications, or multiplexing as it's sometimes referred to, has been on vehicles dating back earlier than the 1980s. The entire point of multiplexing (or MUX for short) is to eliminate the need for a wire for every component's purpose on the vehicle. An instrument cluster, for example, could have dozens of circuits connected to it to provide information such as VSS, RPMs, fuel level and engine temperature. To lighten the wiring harnesses throughout the vehicle, the instrument cluster, in this example, could simply connect to a serial bus, transmitting the needed sensor values with one or two data bus circuits. Besides weight reduction, more complex system interactions can happen as in the case of stability controls. When the ABS module senses wheel slip on acceleration, it can notify the PCM of the lack of traction. The PCM then reduces the electronic throttle body's throttle blade angle to lessen torque applied to the wheels until the wheel slip condition has ceased.

Pin	Size	Color	Circuit	Function	Terminal Type ID	Option
1	0.35	D-BU	655	Cellular Telephone Microphone Signal	I	=-UE1
	0.35	GY/YE	5149	Voice Recognition Audio Signal		UE1
2	0.35	BK/BN	654	Cellular Telephone Microphone Low Reference	I	=-UE1
	0.35	BK/GY	5152	Voice Recognition Audio Low Reference		UE1
3 - 4	-	-	-	Not Occupied	-	-
5	0.35	WH/D-BU	5986	Serial Data Communication Enable	I	-
6	-	-	-	Not Occupied	-	-
7	0.5	RD/VT	340	Battery Positive Voltage	I	-
8	0.5	BK	1750	Ground	I	-
9	0.35	L-GN/WH	7527	Linear Interconnect Network Bus 5	I	-
10	-	-	-	Not Occupied	-	-
11	0.35	D-BU	2500	High Speed GMLAN Serial Data (+) (1)	I	-
12	0.35	WH	2501	High Speed GMLAN Serial Data (-) (1)	I	-
13	0.35	D-BU	2500	High Speed GMLAN Serial Data (+) (1)	I	-
14	0.35	WH	2501	High Speed GMLAN Serial Data (-) (1)	I	
15-16	-	-	-	Not Occupied	-	-

1

Regarding operation and diagnostics, today, if you press a button to pop an SUV's hatch, your switch is likely sending a LIN bus message to the BCM to broadcast another message on CAN to a lift gate module so it can activate an output driver circuit that provides the voltage to the hatch release solenoid. If you long for the "good ol' days" when you could just trace the wires from the switch to the lift gate release solenoid, you've not been taking advantage of technology. You may be able to use your scan tool's ability to monitor the lift gate switch's status, BCM lift gate activation request input and lift gate module output status. Furthermore, you may also be able to use your scan tool's bi-directional capability to send a request to the lift gate module to power the lift gate release solenoid. A few button presses and you've pinpointed the most likely problem for the lift gate not working. If you like fast diagnostics, data buses make these days the good ole days!

Bus architecture and commonly used terms

1. Nodes

Modules that are connected to a serial

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bus are sometimes referred to as "Nodes." Remember: when a scan tool is connected to the DLC, it becomes a "node on the bus," too. That also applies to those aftermarket telematics dongles that insurance companies provide to customers in order to track mileage/times on the road to verify vehicle use behaviors that afford better rates. The problem is these "nodes" can sometimes corrupt the bus messages, causing a very wide variety of possible symptoms.

Pin	Size	Color	Circuit	Function	Terminal Type ID	Option
1	0.35	WH/VT	3999	MOST Control	I	-
2	0.35	WH/L-GN	3997	MOST Serial Data (-)	I	-
3	0.35	GY/VT	3998	MOST Serial Data (+)	I	-
4	-	-	-	Not Occupied	-	-
5	0.35	GY/YE	6972	Camera Signal #2 +	I	-
6	0.35	WH/D-BU	6973	Camera Signal #2	I	-
7	-	-	-	Not Occupied	-	-
8	0.35	GY/VT	3998	MOST Serial Data (+)	I	-
9	0.35	WH/L-GN	3997	MOST Serial Data (-)	I	-
10 - 12	-	-	-	Not Occupied	-	-

2

2. Protocols & Gateway Modules

The protocol of the bus pertains to the structuring of bits of data. You might say protocols are like languages. Many written languages use the A through Z alphabet. Data buses simply use 0s and 1s of voltage shifts or light (for fiber optic buses) states. In language, the same alphabet can be arranged in many different manners to present words and phrases in English, French or German while the same binary states (1s and 0s) in a data bus can be used for UART, CAN, Flexray, MOST, etc. Gateway modules (Figures 1, 2, 3) are comparable to language translators; they can communicate on more than one protocol/language.

3. U-Codes

If P-Codes are Powertrain, B-Codes are Body, C-Codes are Chassis, what are U-Codes? U-Codes are communications DTCs that are set in a module when that module determines that another module is not communicating on the bus. It's important to remember in diagnostics that the least likely module to suspect as the cause of a U-Code is the module that set the U-Code.

4. Bus Architecture – Loops and Stars

Understanding how modules are wired is helpful in the diagnosis of a problem. Buses that connect all the modules to a single point/shorting bar are referred to as a Star Configuration. Buses that connect all of the modules in a chain are referred to as a Loop Configuration. A combination of both is often used. Regardless, all modules are connected in a parallel fashion, electrically speaking. However, when trying to isolate a bus circuit with a suspected short within a module or section of wiring, the star configuration provides a faster method. With star configurations, you simply go to the one or two shorting bars and remove branches/modules from the bus one at a time to see if the condition is corrected. In loop configurations, you must locate individual modules and disconnect them at their connectors to isolate them from the bus.

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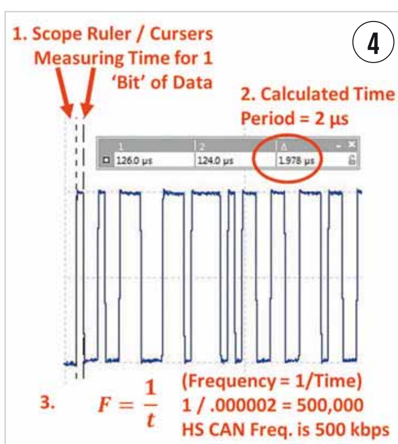

Data bus ABCs

CAN is CAN right? Not exactly. Data buses are divided into three speeds starting from the slowest to the fastest. Meaningless tech trivia? Not re-

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ally. Chrysler and Mercedes are two examples of OEMs that use bus speed classifications in their service information to differentiate high speed from medium speed CAN bus circuits (Figure 6).

Note: Bus speeds can be expressed in baud (i.e. 8192 baud) or 8.192 kbps (thousand bits per second).

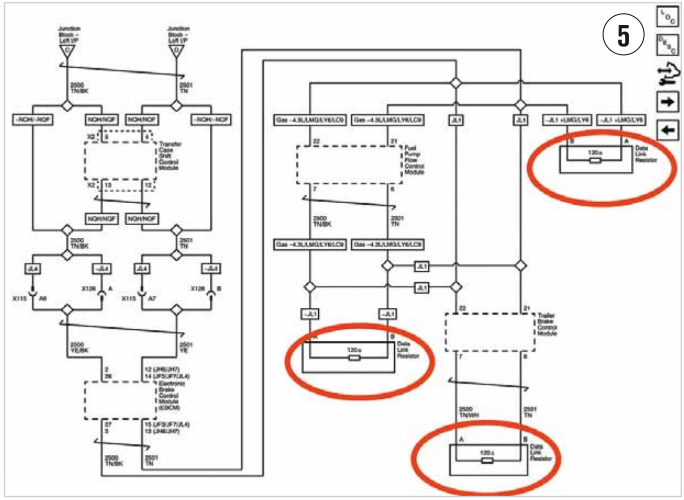
Class A — Mostly older vehicles, 160 up to 10 kbps. Older GM UART (160 and 8.192 kbps) and Chrysler CCD (Chrysler Collision Detection) at 7.8125 kbps are examples.

Class B —Current vehicles. Communicates module to module from over 10k baud of up to 125 kbps. GM, Ford and Chrysler J1850 (GM Class 2, Chrysler PCI and Ford SCP), GM LS (Low Speed) LAN (CAN), Ford MS (Medium Speed) CAN and Chrysler IHS (Interior High Speed) all work within this speed classification.

Class C — Current vehicles. Communicates module to module from 125 kbps up to 1 Mbps (1 million) for powertrain and chassis modules.

Diagnostic Tech Tip: If you're not sure which bus is which on a vehicle (schematics aren't always 100 percent accurate) you can use a DSO (Digital Storage Oscilloscope) to clock out the bus's speed (Figure 4).

5



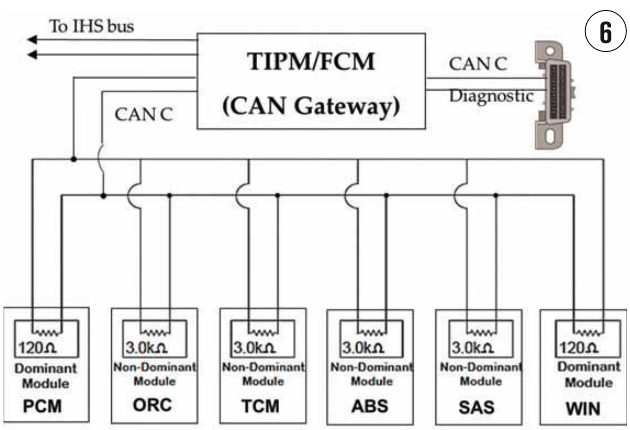
Arbitration – Data bus hierarchy

Each module on a data bus is referred to as a node and has a unique identifier. All modules on the bus are electrically wired in parallel and see the same messages sent but only respond when a message is pertinent to them. To prevent modules from attempting to communicate simultaneously, nodes and select types of messages are assigned priority levels. For safety (stability controls), powertrain and chassis modules are given highest priority (1); audio and navigation devices are often medium (2) priority; and simple activation of lighting may be lowest priority (3). A process known as arbitration is used to give the module with the longest dominant status (pulling the bus low) the priority to speak first. Because the speed of CAN is so high, everything seems instant.

Understanding and diagnosing CAN bus errors

A major player on any vehicle's CAN bus is the CAN controller chip in each module on the CAN bus. Each module (or node) on the network can communicate with other modules on the vehicle with messages that are relative to it. The signal is differential: each of the CAN lines is referenced to

6

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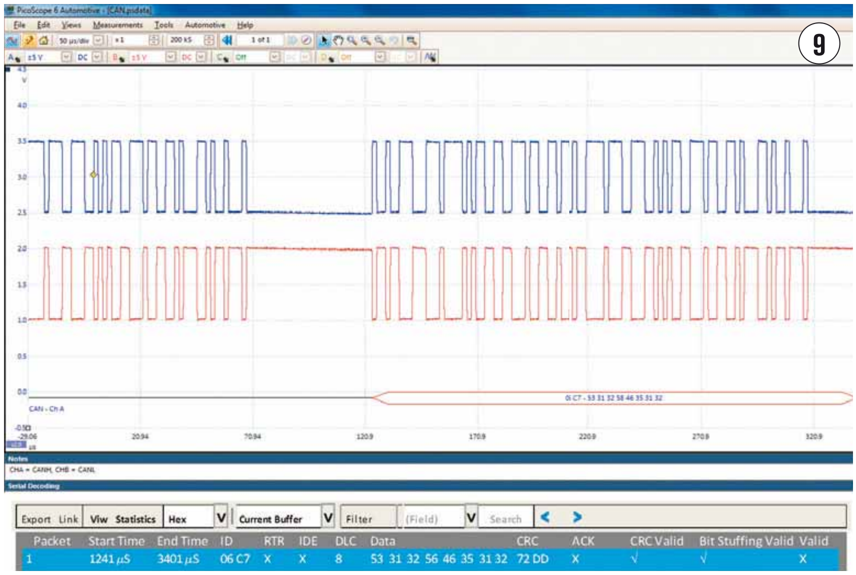
the other line, not to vehicle ground. This has significantly better noise rejection when used in electrically noisy environments like vehicles. However, in order for a CAN bus chip inside an electronic module to work flawlessly at transmitting and receiving messages, a few things must be right.

1. Good Power and Ground Feeds — Power and ground circuits to modules on the bus must be capable of sourcing sufficient current for the module to work correctly. Ensure this by checking for excessive voltage drops via a substitute load in place of a module that's being checked for communications problems.

2. Proper EMI (Electro Magnetic Interference) Housekeeping — Use a scope to test the power/ground circuits connected to a module suspected of causing bus problems to check for transient voltage spikes and excess AC (ripple voltage). Also inspect the wiring on HS CAN bus circuits to ensure the two bus wires are in a twisted pair arrangement to prevent data corruption. Twisted pair wiring allows dual wire CAN bus signals to not run parallel to other circuits that are in close physical proximity and might have



EMI-inducing potential. About one twist per inch for dual wire CAN bus circuits seems to be the average.

3. COP (Computer Operating Pulse) Free of Resets — Use a scope to monitor for complete data bus signal drop outs. On vehicles such as Chryslers, using an ASD (Auto Shut Down) relay ensures that relay is not turning off and on rapidly as COP resets occur. Bus signal drop outs that appear as if the ignition was switched off are also indicators of COP resets.

4. Proper Terminating Resistors on High Speed Buses — High speed buses such as 2-wire Class C CAN use a terminating resistor at each end of the bus (Figures 5, 6) in order to reduce reflected power. If the resistance is not correct, CAN signal errors become more likely. With the ignition off and the bus asleep, CAN buses should have approximately 60 ohms measured between pins 6 & 14.

5. Corrupted Software — Sometimes a communications bus experiences intermittent issues due to software problems. Searching for software updates via TSBs applies to most vehicles. Frequently on GM models and occasionally on some other OEMs, there are software updates for modules that are not documented in normal TSBs. This is where some reprogramming prep knowledge comes in for knowing the various OEM websites that give you the ability to look up the most current software p/n's for any module in question.

Diagnostic help

1. Using a DMM (Digital Multi Meter) at the DLC can be useful in detecting a bus that is:

a. Experiencing a continuous short to ground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b. Experiencing a continuous short to power

c. Totally inactive

d. Not connected to correct value termination resistors (high speed CAN applications)

2. DSO use is preferred for conditions where the bus is intermittent:

a. Intermittent loss of signal

b. Ground offsets (intermittent ECU ground issues)

c. Intermittent single or double opens on the bus

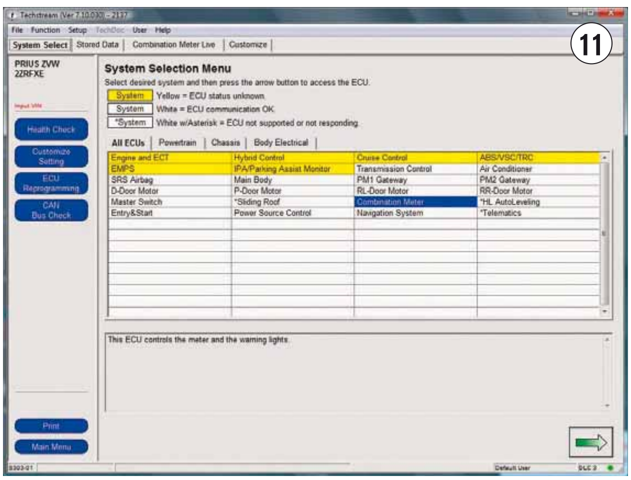
d. Intermittent bus shorts to power or ground

e. Error Messages. Sometimes bus errors don't set DTCs, but might be identified with a bus decoding device such as the one built into Pico Scope software (Figure 9).

With both scopes and meters, a BOB (Break Out Box) for the DLC makes good sense to prevent DLC terminal damage while testing (Figures 7, 8).

3. Using a factory scan tool

A factory OEM dealer scan tool is preferred in cases where your aftermarket "OE level" scan tool will not communicate with more than one module. Building your vehicle as a year older or newer might shed light on the issue but sometimes you just have to have the OEM dealer scanner. While a few aftermarket OE-level scan tools can shed light on what modules are communicating and what ones are not (Figure 10), many dealer tools do a decent job with bus diagnostics. Many OEM tools provide:



a. Higher degrees of vehicle bus communications reliability

b. Utility features that perform data bus diagnostics (Figures 11, 12, 13)

c. Bus activation/pinging

Advanced Diagnostic Tip: This tip for those who are fortunate enough to own a micro amp clamp (the $700 kind – NOT the less expensive milliamp clamp). A module that is intermittently corrupting the bus can sometimes be identified by the fact that it will draw more current (in micro amps) on its branch of the data bus circuit than other modules operating properly draw on their branches of the data bus.

Future bus challenges

Going forward, you're going to see more wired (GM) and fiber optic (European) MOST buses, along with buses such as Flex Ray, giving manufacturers a stop gap towards simplified Ethernet networks to further reduce wiring weight and complexity in the vehicle. Rest assured that *Motor Age* will be keeping you updated as technology changes so you can deal with that *Cool Hand Luke* "failure to communicate" without feeling like you've taken a beating! MA

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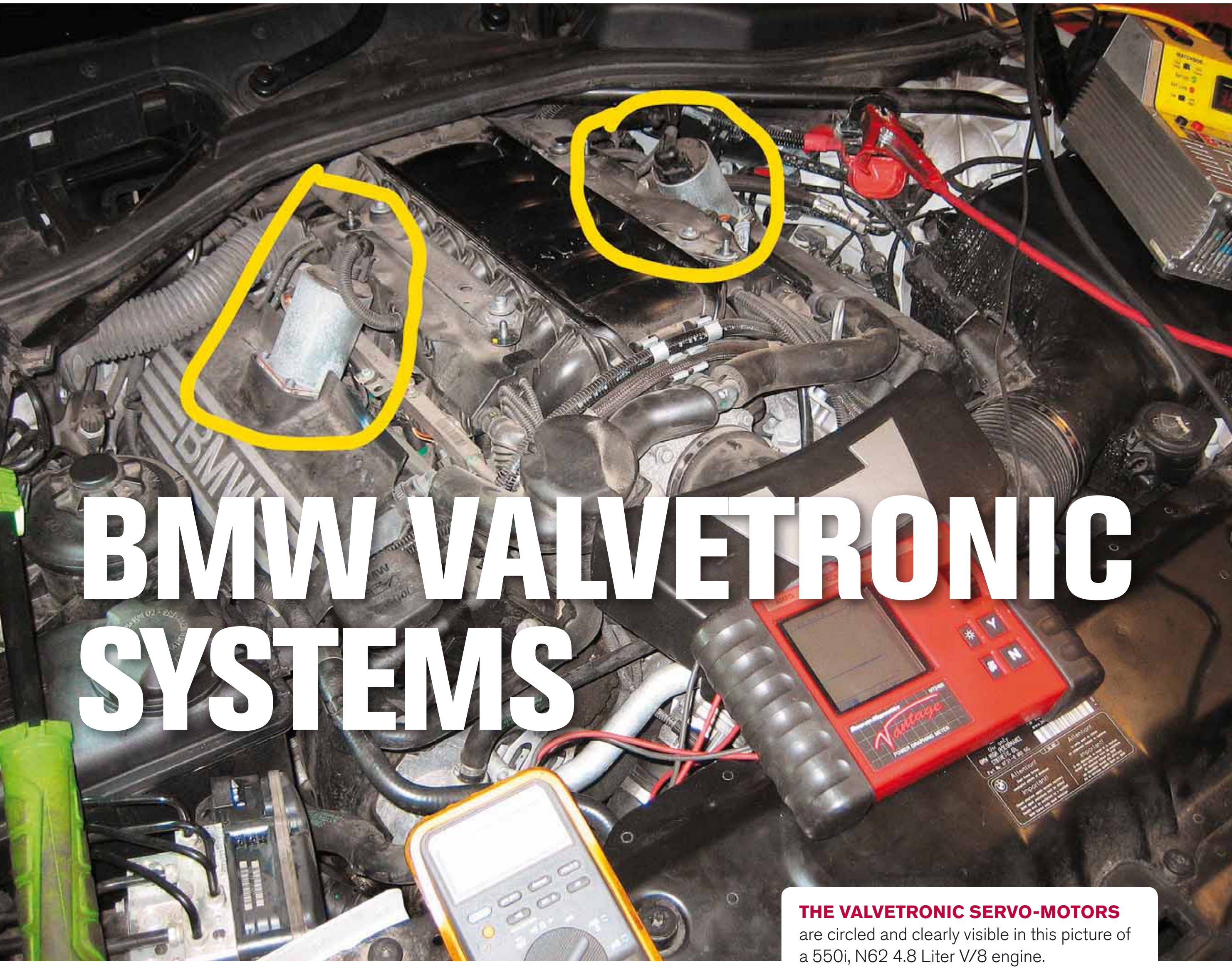

BMW VALVETRONIC SYSTEMS

THE VALVETRONIC SERVO-MOTORS are circled and clearly visible in this picture of a 550i, N62 4.8 Liter V/8 engine.

HOW THEY FUNCTION AND HOW TO FIX THEM

SCOT MANNA // Contributing Editor

The Otto-cycle 4-stroke internal combustion engine has been around for well over a century and continues to be the main source of propulsion for the automotive and light truck industries. While the basic engine concept has served the needs of the industry so far, there is constant pressure to improve efficiency, emissions and performance of the engines that are used to power vehicles. This article will discuss the refinements that BMW has engineered to the intake system of the gasoline internal combustion engine, or ICE for short.

The need

If you have studied basic engine design you are aware that a camshaft opens and closes the intake and exhaust valves and that a throttle is used to control engine load, or airflow, through the engine. A typical intake camshaft lobe will open the intake valve around 3/8 of an inch or .375" (9-10mm). This valve lift amount is actually only required for wide-open throttle engine operation or full-load. During any other load situation the throttle controls airflow and the maximum valve lift is unnecessary. BMW has demonstrated that 80 percent of an engine load map can be accomplished with 3mm or less of valve lift.

Additionally, as a camshaft turns,

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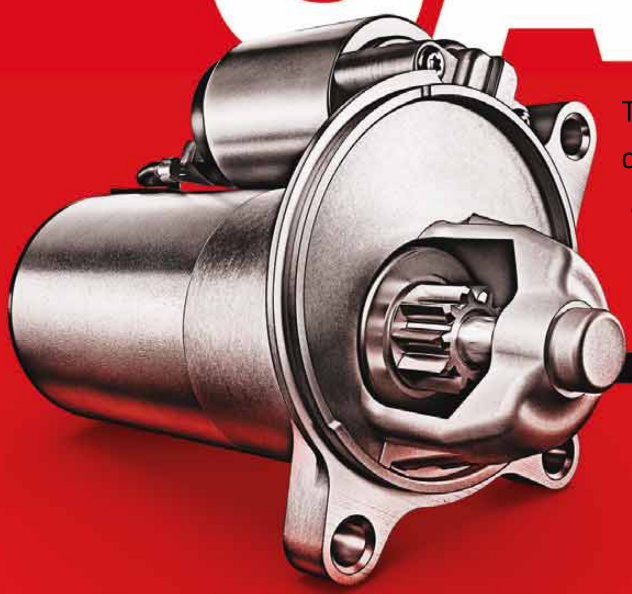


its rotation is hindered by the force needed to compress the valve spring. This restriction creates a need for engine power to overcome this restriction. Engineers consider this a "mechanical" loss. Another problem when operating a throttle-controlled engine in the low- or partial-load range is called "pumping" loss, which can be defined as the pressure difference above and below the piston on the intake stroke. The crankcase is under only a very slight vacuum controlled by the crankcase ventilation system, say 13.5 to 14 psi. When the intake valve opens at idle or low load, the top of the piston is exposed to intake manifold pressure, which may be only 4-5 psi. The difference in pressure would want to move the piston up if it were not connected to the crankshaft. But in a running engine, the crankshaft will pull the piston down against this pressure differential and uses some of the engine's power to do so.

Background and operation

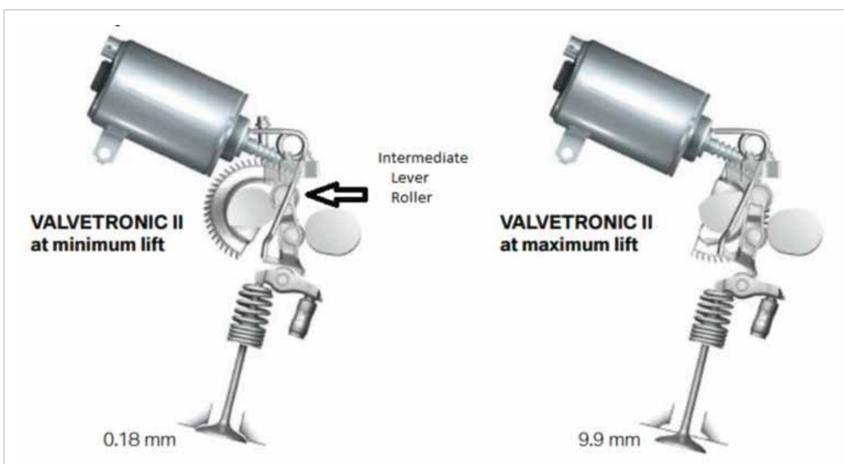
BMW has developed a fully mechanical system using an electronically driven eccentric shaft and an intermediate lever to control intake valve lift and duration, thereby greatly reducing these losses during partial load conditions. This system is called Valvetronic and to date there are

GEN 2 INTERMEDIATE LEVER with roller interface at top, against the retainer called a gate block.

three generations of the system.

BMW first introduced Valvetronic in 2002 on the N62 V\8 engine and the N73 V\12 engine. In 2006, the newly redesigned inline 6 cylinder — dubbed the N52 — was fitted with the second generation Valvetronic system. In 2010, the system saw an extensive redesign for the inline 6-cylinder N55 engine and the new 4-cylinder N-20 engine, which is considered the third generation Valvetronic design.

Valvetronic has been adapted to 4-, 6-, 8- and 12-cylinder engines and can be found on most current production BMW cars and SUVs. The system operates on the "lost motion" principle,



THE GEN 2 VALVETRONIC SYSTEM, the intermediate lever roller is shown. The lever is seen in min and max lift positions.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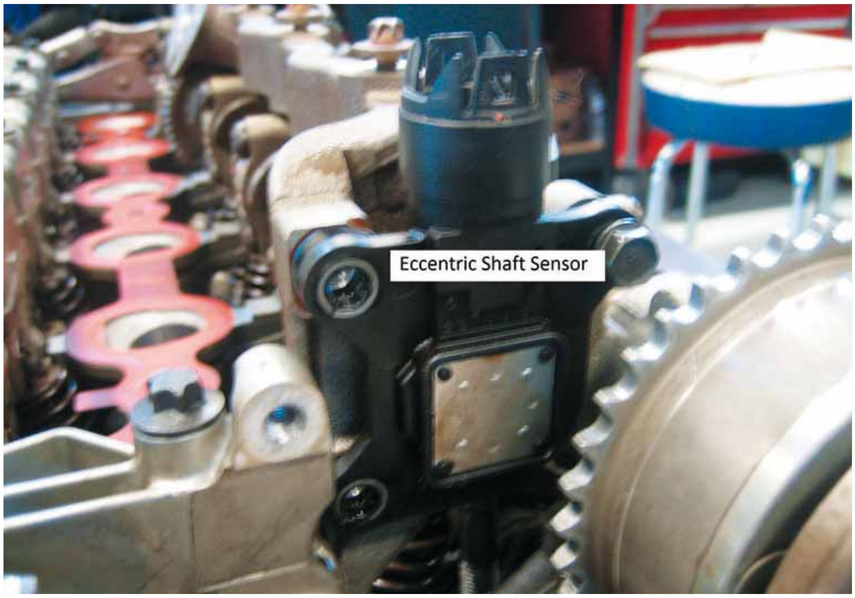


ECCENTRIC SHAFT mounted on N52 head with valve cover removed.

meaning that there is a conventional intake camshaft, but through the use of the added eccentric shaft and intermediate lever only a portion of the effective cam lobe profile may be used during any given intake stoke. If only a partial portion of the cam lobe is utilized, the intake valve lift and duration will be reduced. The intake valve will open later, close sooner and the valve lift will be less. This allows the engine airflow, and hence load, to be controlled at the intake port by the amount of valve lift rather than by the amount of throttle opening. BMW calls this throttle-free load control.

This changes the pivot point of the intermediate lever that acts upon the roller follower that opens and closes the valve. The special tapered profile of the bottom of the intermediate lever allows the valve lift to vary between 0.3 millimeters and 9.85 millimeters. The reversible, high-speed direct current servo-motor can vary from minimum lift to maximum lift in 300 milliseconds and operates at a frequency of 16khz. Because the cylinder charge airflow is being controlled by how far the valve lifts from its seat and not by the position of the throttle plate, valve lift differences between cylinders is critical and must be held to a very close tolerance to avoid a rough idle or misfire at idle.

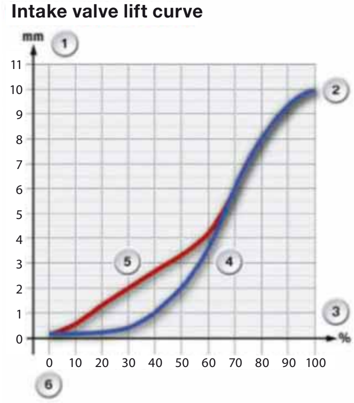
One of the main problems with the first generation Valvetronic system was the contact point between the intermediate lever and eccentric shaft. This point is a sliding contact pad and was susceptible to wear if oil maintenance was neglected. This contact point is subjected to the pressure applied by the closing pressure of the valve spring pushing up on the roller follower and intermediate lever. As this contact point wears, the actual valve lift will decrease and cylinder-to-cylinder air intake quantities will vary and cause idle roughness.

Because of this wear issue there was a BMW scan tool function that would allow the technician to change the minimum lift setting of the Valvetronic system from .3mm to .8mm to see if the engine ran smoother. This change effectively made the engine a throttle-controlled engine at idle. If the engine ran better, a thorough inspection of the Valvetronic system was necessary. In order to eliminate this problem, the intermediate lever was redesigned and a roller was added at this interface point. This is the primary difference between first and second generation systems.

The other primary difference is a lowering of the minimum valve lift setting to .18mm or about 7 thousandths of an inch. With the engine running at minimum lift during idle operation the actual intake valve movement is almost imperceptible.

The Valvetronic system also incorporates phasing into the valve opening event to improve charge motion in the cylinder and allow for better air\ fuel mixing. Phasing can differ slightly among different generations of Valvetronic. At minimum lift, one valve can open while the other stays closed. As lift increases, the valves may open together then one valve can lead, or open further than the other and then the second valve will catch up to the

Intake valve lift curve



Index	Explanation
1	Valve lift (in mm)
2	Maximum valve lift at full power
3	Output (in %)
4	Inlet valve 2
5	Inlet valve 1
6	Minimum valve lift when idling

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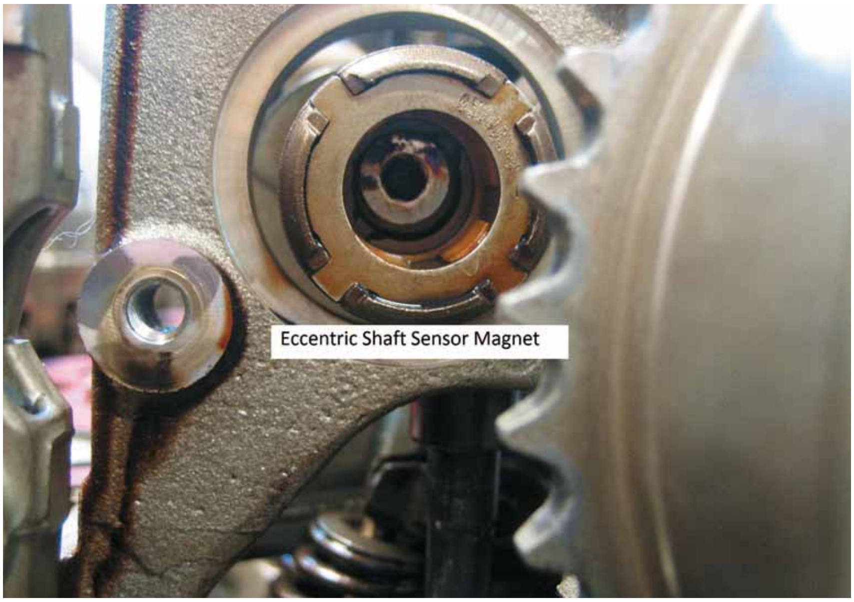
first near the end of the opening event.

The Valvetronic eccentric shaft has minimum and maximum end stops built into the cylinder head to limit rotation. On the 6-cylinder N52, the minimum stop is screwed into the cylinder head and the maximum stop is a cast portion of the head. The Digital Motor Electronics, or DME, computer will learn the end stops when an implausible value is determined during the start procedure. A scan tool may also be used to run the limit learn procedure. This should be done anytime the valvetrain is disturbed or serviced.

SERVICE NOTE: Keep in mind the servo-motor must be removed to replace a valve cover gasket on these engines. The motor is under a preload with the engine off and the eccentric shaft should be placed in the minimum lift position prior to removing the servo-motor. The scan tool can command this position on first generation systems. On second generation systems there is a 4mm Allen socket built into the end of the motor armature and is accessible at the rear of the servo-motor. The motor should be unplugged and the armature turned clockwise to the minimum lift position prior to removing. If the motor retention bolts are removed without performing this step the motor could be shot out of the cylinder head cover and the eccentric shaft gear teeth may be damaged, causing a very expensive mistake.

The DME must know the position of the eccentric shaft at all times. This is accomplished with the use of an eccentric shaft position sensor. V engines will have two sensors, one for each bank, while only one is needed on the inline six engine. This sensor is a complex magneto-resistive device with two sensors monitoring the position of a magnetic wheel mounted on the end of the eccentric shaft. One sensor is called the measuring sensor and the other the evaluation sensor. The measuring sensor is checked more frequently and the evaluation sensor is used for plausibility. This sensor transmits data and is not a linear device like a throttle position sensor, so scope testing the sensor will not reveal the eccentric shaft position to a technician although it is an interesting device to scope. The scan tool can be used to monitor eccentric shaft position, which is usually displayed in degrees of rotation from zero degrees, (min stop) to about 225 degrees, (max stop).



ECCENTRIC SHAFT sensor magnetic wheel seen with sensor removed.

SERVICE NOTE: This sensor protrudes through the valve cover and is easily damaged during valve cover service. They are expensive, so be very careful during service. Many of the N52 6-cylinder engines have problems with oil intrusion into the sensor, so a good idea during any service requiring valve cover removal is to check for oil in the sensor wiring plug connection. If oil is found, then sensor replacement is recommended.

The third generation Valvetronic system saw major changes in design. Gone is the large DC servo-motor, replaced by a much smaller AC current brushless motor that is more efficient and responsive. Also gone is the eccentric shaft position sensor. The brushless servo-motor has an integral position sensor. The third generation design is more compact and the servo-motor sits in a well in the cylinder head and is exposed to engine oil. The rapid response of the brushless motor allows BMW to claim cylinder selective lift adjustment to improve engine smoothness and idle quality along with idle speed control.

Additional service notes

As already mentioned, the concept of throttling the engine at the intake port allows for high manifold pressure, or low vacuum, at idle or low load conditions, which reduces pumping losses. While the engine could run with atmospheric pressure in the intake at idle, there is a requirement to have a small vacuum present to allow for crankcase ventilation and charcoal canister purging. The DME targets 50 millibar of vacuum at idle, which is equal to about 1.5 in/hg of manifold vacuum. This vacuum is maintained by adjusting the throttle angle to about 3.5 percent to 4 percent at idle. While the throttle appears mostly closed, the airflow through the engine at idle is a

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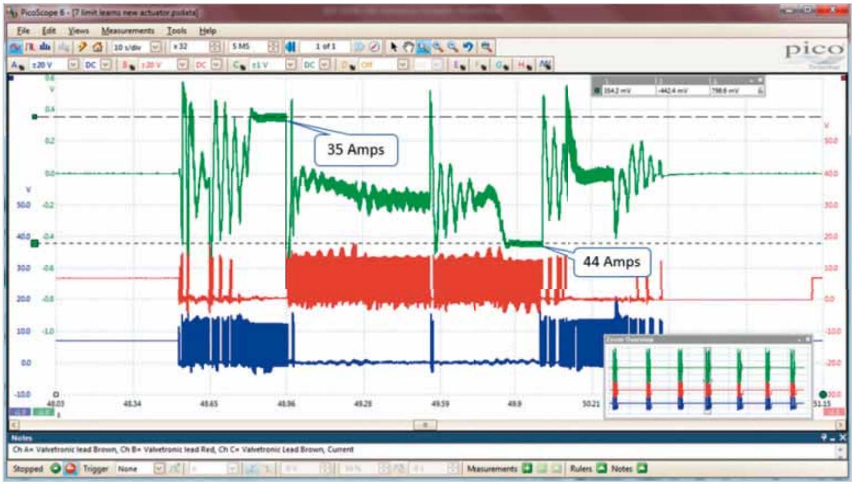
function of valve lift, not throttle opening.

There is a differential pressure sensor on the intake manifold that reads actual vacuum, not Manifold Absolute Pressure like most manifold pressure sensors. The scan tool will display 0 to 1 millibar at key on engine off, not 980 to 1000 millibar, which would be atmospheric pressure. Normal idle should produce 40-50 millibar readings.

If the engine is a turbo, the pressure sensor will read like a MAP sensor and show almost 1000 millibar at key on engine off, so pay attention to what the manifold pressure reading is with the engine off to determine which type of sensor is used on the engine you're working on. This is important because the pressure sensor value will let you know if the engine is running in Valvetronic control or throttle control. If an engine fault occurs, such as a VANOS problem, the engine will default to throttle load control and the manifold sensor will read approximately 600 to 690 millibar of vacuum, the eccentric shaft will be close to maximum lift. While idling, if the eccentric shaft position reads less than 30 degrees and manifold pressure is 50 millibar, then the engine is running in Valvetronic control. It is crucial to understand the difference when diagnosing running problems on this system.

When a Valvetronic-equipped engine is shut off, the eccentric shaft will reset to a position that will allow greater valve opening than the minimum lift position to aid in starting. This is similar to how the idle air control motor is reset to a mid-travel position for the next start when the engine is shut off on GM fuel-injected engines. This eccentric shaft position for starting is about 57 degrees on the inline 6-cylinder engines.

One more area of interest to mention is compression testing a Valvetronic-equipped engine. Because the valve lift is controlled by the position of the eccentric shaft, one would assume that BMW has a procedure to set the valve lift at a certain point to reach the expected compression pressure, and this is a correct assumption. There is a compression test procedure in the ISTA factory scan tool that has you adjust the eccentric shaft by turning the servo-motor with an Allen wrench until the eccentric shaft is at 176 degrees. This is done with the motor unplugged. Once the eccentric shaft is set you continue with testing as you would any other engine. Normal compression values on the N52 engines are about 200-210 psi. Higher compression values can be seen with the eccentric shaft set at a lower lift position because the valve can close sooner and this will raise the effective compression stroke. I have measured over 220 psi at lower lift settings of around 100 degrees on the N52 engines.



WAVEFORM of a Valvetronic system learning the end stops.

Scoping Valvetronic

The scope pattern seen in the above illustration is the scan tool commanding a valvetronic limit learn procedure. The two lower waveforms are the voltage patterns from each of the two motor wires and the upper waveform is motor current captured from one of the wires.

As the waveform shows, the bottom channel voltage is pulsed and the other channel above is held to ground to spin the motor to the end stop. When the current flatlines at the point marked 35 amps, the minimum end stop is learned. The polarity is then reversed, the middle waveform is pulsed to voltage while the bottom waveform is held at ground. The motor spins until the shaft reaches the maximum end stop and current flatlines again at 44 amps. These are known good values from a new servo-motor. The whole procedure lasts about 1.5 seconds.

The most common failures I have seen are bad eccentric shaft sensors. The servo-motors can go bad and will probably set over temperature codes for the motor drivers in the DME. Always check for service bulletins if a car sets Valvetronic system codes, as there have been many programming updates to cure system codes. Get to know these systems, because it seems they will be around for the foreseeable future on BMW engines.

SCOT MANNA is the owner of MB Automotive Inc. He is a contract trainer for the State of Illinois Emission Program, WORLDPAC and Autowares. He is ASE Master Certified with L-1 and L-2.
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SAVING TIME ON YOUR DIAGNOSTICS

TIPS THAT CAN SAVE YOU TIME AND MAKE MONEY

PETE MEIER // Technical Editor

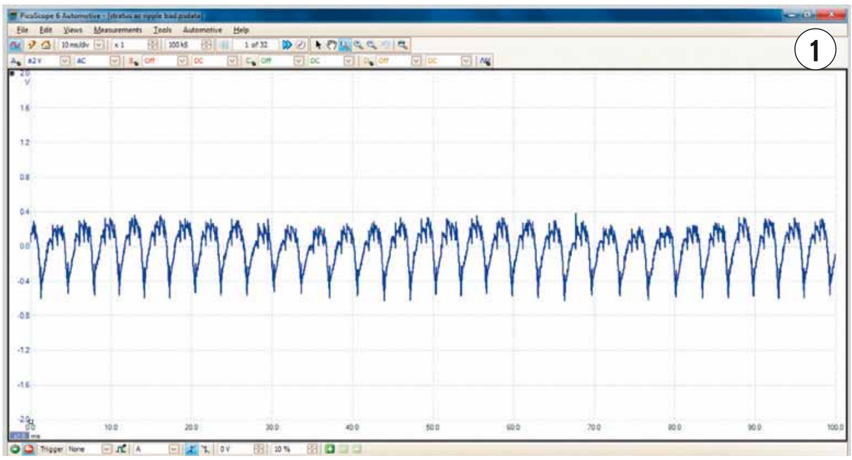
For most of us sweating away in the service bay, being fast and efficient means earning a bigger paycheck by the end of the week. I've always maintained that "fast" comes with experience and encourage younger techs to first focus on "right." But becoming efficient, at least in my mind, is more about taking knowledge and applying it to a given situation. This may be system specific, or it may be one of technique, or a combination of both. Knowing what you're doing, no matter how many years you have in the business, goes a long way in making the job go smoothly.

This month, I'd like to share a few tips that may help you add efficiency to your diagnostics, and as a result, add some cash to your wallet.

Testing engine mechanical condition

I learned from being bitten once too often that ensuring the engine is mechanically strong before looking elsewhere for the cause of a drivability concern was a good idea. However, testing compression conventionally with a mechanical gauge is time-consuming and certainly not efficient! A better way is to use the relative compression test using your scope.

Now, we've written and discussed the process for relative compression testing many times in the pages of this magazine, so I'm not going to rehash it all here. Typically, though, the contributors who have demonstrated this test method always use a high amp clamp to capture the starter current pattern — one basis for this test method.



THIS SCREEN SAVE is an example of excessive AC ripple that would be hard to see on most scopes without using the "AC coupling" feature.

But it's not the only one, and owning an amp clamp is not a prerequisite to performing the test. All you need is a single channel of any scope that allows you to select "AC Coupling" as an input for the voltage scale. What does that do? It eliminates the DC component from the waveform and allows you to see just the AC component of the voltage signal you're attached to. This comes in handy, for example, when inspecting the alternator diodes for failure by measuring the amount of AC voltage present in the DC output. Figure 1 is an example of AC ripple. The leads are attached directly to the battery and if the normal DC signal were present, we would see a somewhat fuzzy line across the scope at around the 13.5v level. But to zoom in and see the reason for the "fuzz" would be nearly impossible for most scopes. Notice, too, how the AC signal remaining is passing over the "0" line, providing us with a measurement of just how much AC ripple there is. Anything over 0.50 VAC is too much and indicates a failed diode.

But I'm getting off track a bit. There is some AC ripple present even on healthy charging systems and since the alternator is being turned by the

PHOTOS: PETE MEIER

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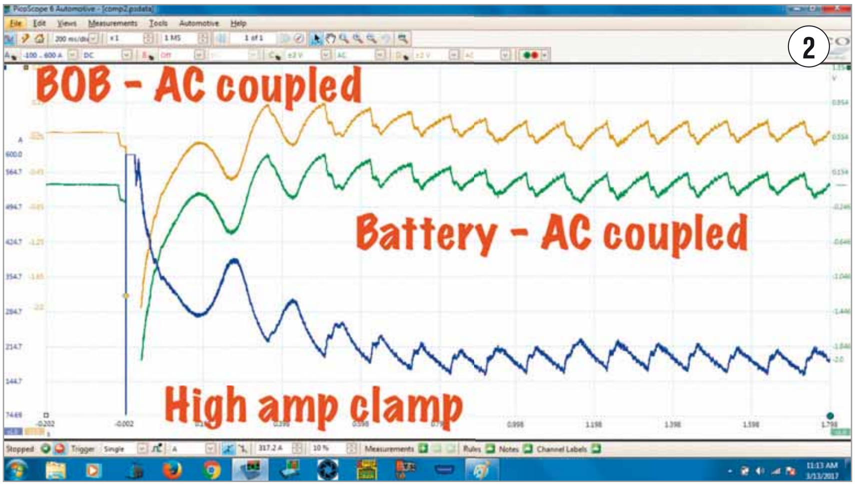
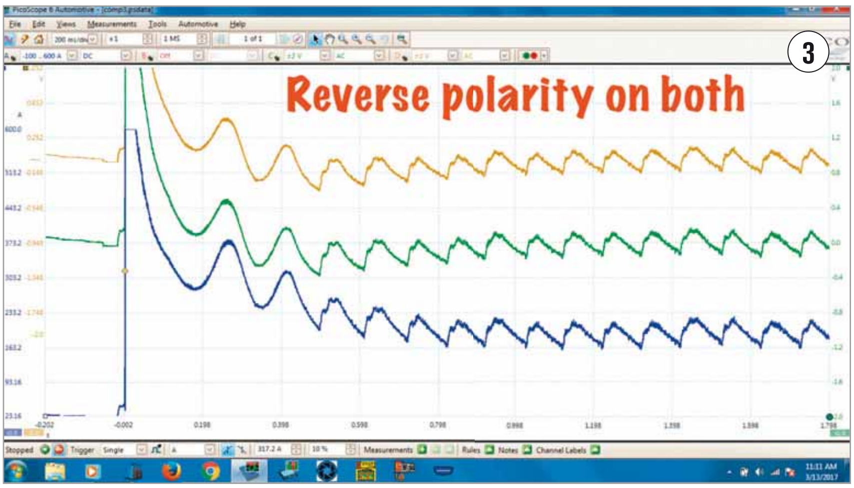
With a 101-year reputation of trust and reliability, ACDelco knows quality parts make all the difference when it comes to taking care of your vehicle.

That's why they're the true GM original equipment replacement parts brand.

For more information about ACDelco, go to www.acdelco.com.



THE HIGH-AMP PATTERN (blue) and the two AC Coupled patterns are somewhat similar, aren't they?



BY INVERTING THE VOLTAGE LEADS (neg-pos, pos-neg), we've reversed the AC Coupled patterns. Look how similar they are to the current pattern.

engine, we can use that signal the same way we use the starter current. And we can track the signal from a variety of sources to make our lives even easier!

Take a look at Figure 2. The blue trace is a conventional starter cranking current test using a high-amp current clamp at the battery. The green trace is also directly at the battery but is a voltage reading that is AC coupled, showing the AC ripple produced by the alternator. The third trace, the gold one, is at the Diagnostic Link Connector by way of a breakout box (or "BOB"), and the leads are connected to pin #5 for ground and pin #16 for B+.

When most of us perform any kind of current test using our scopes, we tend to orient the pattern so any current "draw" appears as a positive reading up from the "0" line. Actually, it's a negative number, isn't it? But that would be harder to relate to, for me anyway, and I hate making anything harder than I have to. I have enough trouble as it is!

Rather than get used to a whole new way of viewing a relative compression pattern, let's cheat and simply reverse the leads for the two AC Coupled channels and see what happens. That's what you see in Figure 3.

Note now that all three patterns are nearly identical.

So next time you do a relative compression test, try this method. And if you have never performed a relative compression test because you don't own a high-amp clamp, you're welcome!

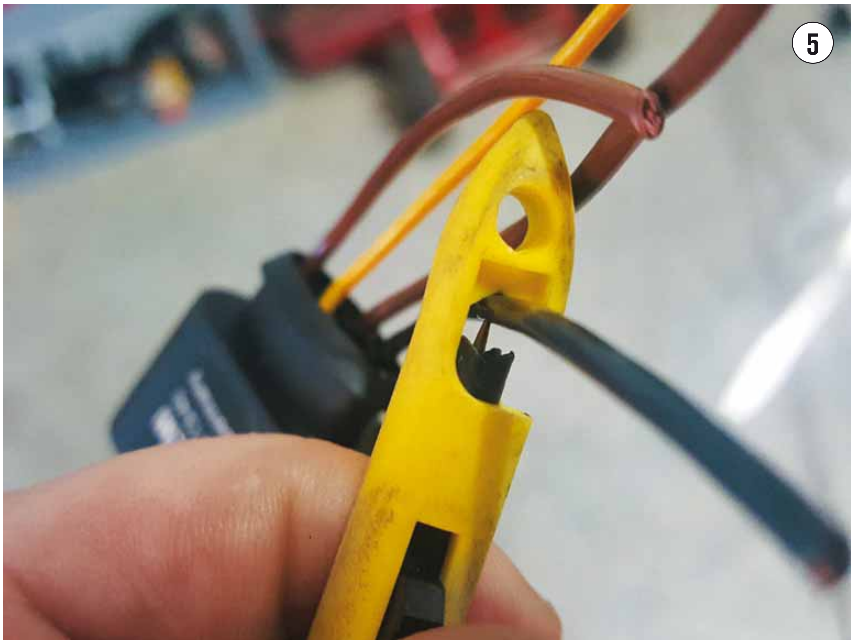
Backprobe or pierce?

Continuing on the scope theme, let's talk about acquiring a basic signal. The first thing we need to do is decide on how to connect to the circuit we want to test. Typically, that boils down to two choices: backprobe or pierce.

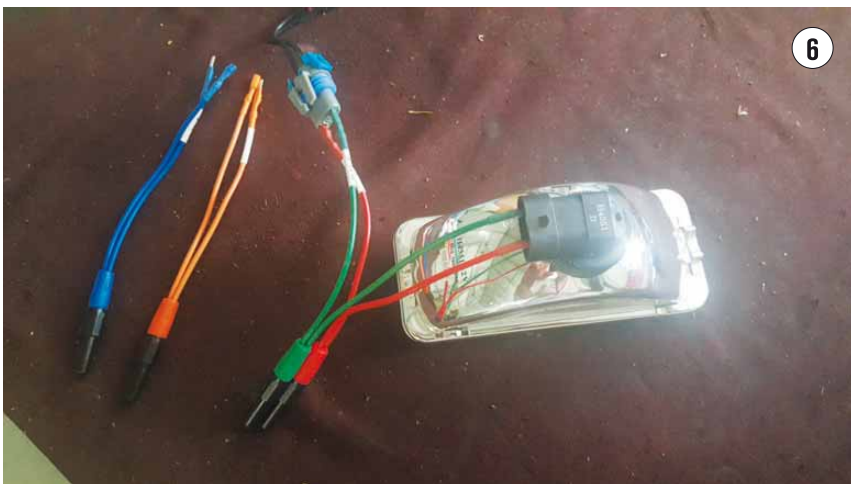
I was recently told by a GM factory employee that GM is telling their dealer technicians that backprobing is a "no-no" and should not be performed. And there are some drawbacks to the technique. First is proper placement of the probe. Take a look at an example of a bad placement in Figure 4. Notice how the probe is puncturing the weather seal, between the seal and the connector body. This is no different from piercing the insulation and left as it is, it will allow moisture to enter the connector and cause problems down the road. It is imperative to place the probe carefully by following the outside of the wire you want to connect to, pushing the seal aside as you press through to the connector.

This also helps ensure that you come into contact with the connector you intended to, and that leads to potential drawback No. 2. What I mean is that on some connector blocks it is easy to place

IT'S A BIT HARD TO SEE, but in this example the backprobe is on the outside of the weather seal – not good.



IT IS ONLY NECESSARY TO PIERCE the insulation enough to make contact with the wiring. Too much pressure could cause some of the wire strands to break.



THESE BREAKOUT LEADS ALLOW you to tap into a circuit without harm to the wiring or the connection (as long as you select the correct lead, that is).

your probe in pin #13 but end up skewed a little sideways and actually come into contact with pin #14 or #12. In some rare cases, you could even short two together and that could be a very bad thing!

A third drawback to backprobing is that a connector is dependent on what you are testing the circuit for. If you are looking for a source of voltage drop, or otherwise testing the integrity of the connection at the connector, backprobing could allow you to bypass the internal connection and lead you to a false test result.

Piercing is certainly easier but has drawbacks, too. First, make sure you only apply enough pressure with your piercing probe to come into contact with the wire strands underneath as shown in Figure 5. No need to crank it down! If you do, you could actually break some of the wire strands and that adds a source of voltage drop to the circuit.

Second, you are obviously going to leave a hole in the insulation when you're done. It is critical that you seal the hole you made with some liquid electrical tape. In a pinch, nail polish will also work.

No matter what technique you use, there is a risk of damage to the wiring and with so many circuits under ECU control, carrying vital information on low current lines, any introduction of added resistance could spell trouble. There is, however, an alternative.

My friends at AESWave.com sent me a set of breakout leads (made by Pico) that can be used to tap into most circuits with no damage to the wiring insulation or the connector. The kit contains a variety of sizes to accommodate most any terminal design in use, and they are simple to install. I grabbed my test headlight to give you an idea of how they work — take a look at Figure 6.

You can even make your own. Long ago, I made a set of six test leads with replaceable male/female connector ends so that I could adapt to whatever connector I wanted to tap into. When I ran into one that I didn't have the ends for, it was a simple matter to make them.

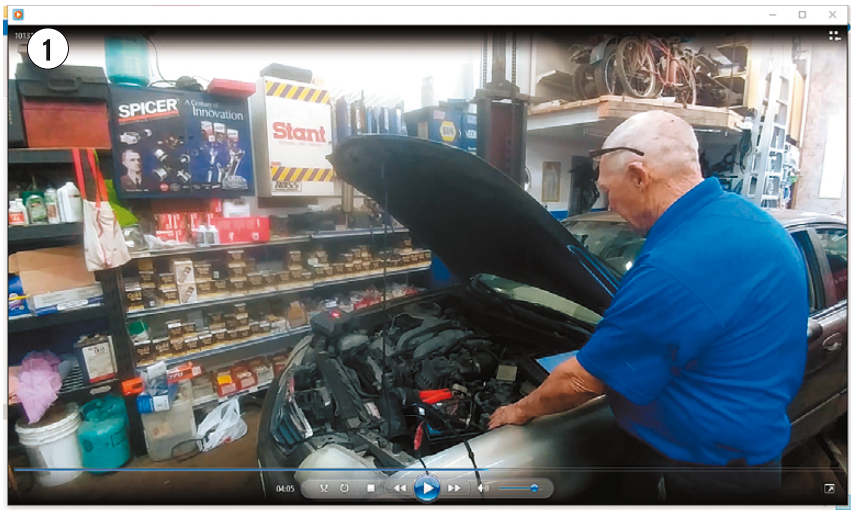
So, if your intent is the testing of a component or acquiring a signal, the use of breakout leads will make life easier for you and less painful for the wiring. Like any other technique we've shared, it is ultimately the focus of your test that will determine the best process to use.

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

MAKING A GAME OF ELECTRICAL TROUBLESHOOTING

DO YOU ENJOY THE CHALLENGE OF ELECTRICAL PROBLEM ANALYSIS?

ALBIN MOORE // Contributing Editor



ALBIN MOORE at work on the Mazda electrical problem.

Over the years, I have learned some very good electrical diagnostic routines that have made finding electrical problems both fun and fulfilling.

With the things I learned from training and experience, I was able to turn "the finding of electrical problems" into a game. So, how do you play the game; what are the rules?

Rules of the game

Many years ago, Mr. Ohm and Mr. Kirchhoff wrote down some really cool stuff about electricity. These laws deal with voltage, resistance and current flow and how they all play together. Once you gain an understanding of these rules (electrical principles), playing the game can be fun.

When I got into this business in 1992, I was told to throw away my conventional test light, since using it on the electrical systems of "today" would kill computer sensors and drivers. Here we are 25 years later, and I have a very good selection of test lights using a variety of bulbs. Do I use them for testing today? You bet I do. Although, I have learned there is a time and a place for every tool, and if these test lights are used in the proper places, they can be great tools.

Admittedly, one of the tools that I have replaced test lights with is the Power Probe. This is a wonderful tool, but it, too, can be used in the wrong places. If it is used improperly, computer drivers magically go away. Every tool has its place and knowing the place to use the tools can be a mark of a true craftsman.

Equip yourself

When it comes to finding electrical problems, the first piece of information you need is a wiring diagram. We have all heard wiring diagrams called "electrical road maps" and this seems like a good description, since not only does the diagram show you where the electricity flows but also information like how the circuit is designed and what components are in the circuit are also included in the diagram. Without a wiring diagram, you have no way of knowing which wires power the component or which wires are ground or control wires. These few pieces of information are very crucial to the operation of any electrical component.

If you want to test the powers and grounds in a circuit, you can use a volt meter, a bulb test light or an LED test light, but stop and consider what you are testing. It doesn't do much good to use a volt meter to test the voltage on a circuit that is not loaded, since the voltage of a

PHOTOS: ALBIN MOORE

non-grounded circuit will always be system voltage, regardless of the resistance in the circuit. The circuit needs to have a load put on it for the test to be accurate. This will require you to either turn the circuit on, or simulate a load with a bulb test light, or even a variable load tool I built that uses #1157 bulbs. With this tool, I can regulate a load from 2.5 amps through 15 amps. It is sort of like a test light on steroids. With a circuit properly loaded, you can get an accurate voltage and volt drop measurements.

Another valuable piece of equipment needed to make testing of electrical circuits easy is a scan tool that will communicate with the modules on the vehicles and have the capability of bi-directional control of the components. Being able to turn components on and off without having the engine running or the vehicle in operation can be very valuable. Let's say you are working on an A/C compressor clutch that will not lock up — being able to have the engine off and using the scan tool to activate the clutch while testing the power and ground can be a real time saver.

Last but not least on the list of time savers is having such a simple thing as a package of colored highlighters to identify the different parts of the circuit. Being able to identify the different parts of the circuit with different colors can make it simple to just glance at a wiring diagram and see which part of the circuit is powered, grounded or switched, or even if there is a different voltage other than vehicle system voltage. All this information can be found in a wiring diagram, if you spend the time to print it out and study it.

Let's play!

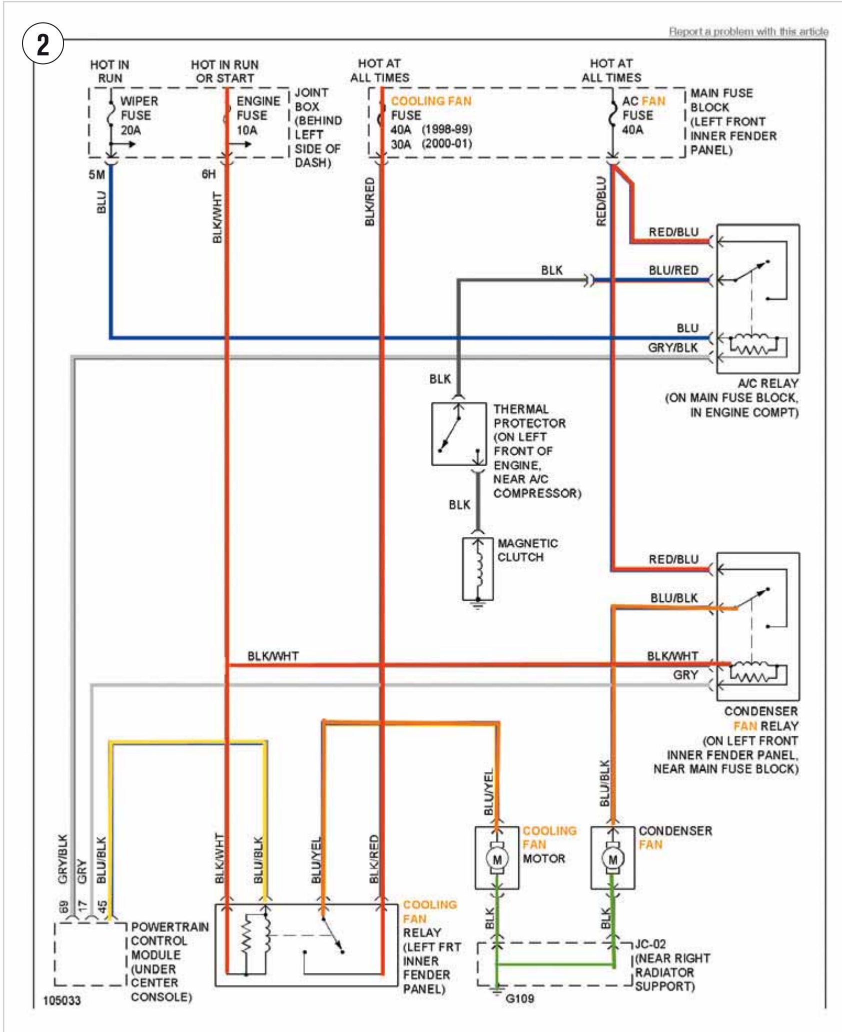
In the shop is a nice-looking 2001 Mazda 626 with an overheating problem. The vehicle is powered with a 2.5 V6 engine with automatic transmission. The odometer has recorded 205,000 miles and the vehicle is nice and clean. This is a vehicle I have serviced in my shop for a few years.

The vehicle came to the shop with an overheating complaint. When interviewing the person who drives the vehicle, I found the temperature gauge would climb when the vehicle was climbing steep grades. More questioning found the problem to also be after the vehicle was driven for an extended period of time.

Checking the basics, I found the cooling system low on coolant. Any time I see this condition, my thoughts turn to combustion chamber or head gasket leaks or a plugged up radiator. Before I can condemn the engine, I first need to check for any external coolant leaks. If there are external leaks, they need to be fixed and then the engine tested for combustion leaks.

Pressure testing the cooling system revealed a heater hose with a pinhole leak that was loosing coolant. This repair was simple, with just a piece of heater hose. The other coolant hoses were inspected with no problems found.

Being thorough with testing prob-



COOLING FAN WIRING DIAGRAM OF THE 2001 MAZDA 626. This simple diagram shows not only the circuit routing to the fans, but it also shows what controls the fans, and what makes them work. I have added colors to each part of the circuit: Red = B+ power, Green = ground, yellow is switched ground and orange is switched power. With this color coding, I can look at the circuit at any place and know what the proper voltage should be.

lems like this is very important, since there are several things that can cause an overheat problem. The low coolant is a sure bet to cause an overheating problem, but is there more? Is the leaking hose a symptom of another problem, or is it the cause of the problem?

With the cooling system holding pressure and full of coolant, the engine was ran until it reached operating temperature. The cooling system was tested for combustion gasses with none found. The next place to test is to verify proper cooling fan operation. This is easily done by running the engine until it reaches the proper temperature to turn the cooling fans on. To know this information, a scan tool must be used to verify engine coolant temperature and the cooling fan operation.

Before I get ahead of myself, I need some information on how the cooling fans on this vehicle work. The quickest place to find this information is with a wiring diagram. The wiring diagram shows two electric fans on the vehicle. One is labeled cooling fan and the other is the condenser fan. If needed, more information on the fan operation could be found in the service information; although, at this time the wiring diagram information told me all I wanted to know. The wiring diagram shows both the cooling fan and the condenser fan are operated by separate relays, which are controlled by the PCM.

ELECTRICAL LOAD AND CURRENT LIMITING TOOL. This is made from a steel electrical box, six switches and six light sockets for 1,157 bulbs. This can be set to draw between 2.5 amps up through 15 amps. It makes for a wonderful test light when wanting to either limit the current in a circuit or apply a load to a circuit for volt drop testing.

This is great information. Since the PCM is controlling the fan relays, there should be some scan data PIDs and possibly some bidirectional controls for these relays. By using the scan tool data, I found the right side fan (condenser fan) would come on when the ECT (Engine Coolant Temperature) reached 245-248°. When the A/C is turned on, only the condenser fan runs. By watching the scan tool, I can see the relays for both the cooling fan and condenser fan are being commanded on.

Since the scan tool tells me both the condenser fan and the radiator cooling fan relays are being commanded on by the PCM, I need to know one more thing before I do any testing. I need to know where the relays are located. Service information says the relays are behind the battery and in front of the fuse box. Looking at the vehicle there are three relays in that location and they all look the same. These relays are plain mechanical/electric relays. Any time these relays are turned on or off, they make a "click" noise, and will also make a small vibration. All that is needed to determine which relay is which is to use the scan tool and cycle the relays. By feeling the relays with my hand while they are activated, it is an easy, quick and accurate way to find which relay is the cooling fan relay.

With the relay located and the relay removed from its socket, I find the relay is a four-pin relay. By using the wiring diagram, I find two of the terminals should be powered when the ignition key is turned on. Testing the terminals in the relay socket, I found power at these two terminals. All that is left to test is to verify the ability of the PCM to ground the relay, and the ability of the circuit to flow current to the cooling fan motor. By using the scan tool to command the cooling fan relay on, I found a path to ground for the relay coil, but

THE CAUSE OF THE INOPERATIVE COOLING FAN was a poor connection at the motor plug. The use of the electrical diagram and a logical diagnostic approach led me to the problem without having to chase any wild rabbits.

there is no path to ground on the terminal that powers the cooling fan motor.

The problem is now narrowed down to either an open circuit in the cooling fan motor, or an open in the power supply circuit between the cooling fan motor and the relay terminal. The problem was found at the harness plug that connected to the cooling fan motor. The positive wire terminal had overheated and had to be replaced.

By using a scan tool, a wiring diagram and a logical diagnostic process, this problem was quickly and easily found.

With the electrical problem fixed and the cooling fans operating as designed, the vehicle was test driven up a mountain pass with a 6 percent grade. The engine performed well, and the cooling system cooled the engine properly.

When problems like this come in, it is too easy to jump to conclusions at the first problem found, which in this case the cooling system was low on coolant. Be thorough with the diagnostic process and test the complete system and let the system test itself, by making it work as it was designed to work. MA

ALBIN MOORE spent 21 years in logging before opening in 1992 a shop that specializes in drivability problem analysis. He is an ASE CMAT L1 technician with 40 years of analyzing and fixing mechanical and electrical issues.
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AD INDEX

AD INDEX

PRODUCTS

MAKING SENSE OF VW/AUDI PIDS

MEASURING BLOCKS? WHAT THE HECK IS A MEASURING BLOCK?

PETE MEIER // Technical Editor

Do you hesitate tackling VW/Audi drivability concerns?

When I was a full-time technician, I was one of those guys who preferred to send them to the nearest dealer. The German manufacturers just do things a little differently, and I wasn't used to those differences. I chose to stick to the domestic and Asian makes I was comfortable with.

And that cost me money. So, I decided one day to give it a shot.

Depending on your service information source, the first time you pull up any kind of DTC information for an Audi or VW product, you may see references to "measuring blocks" and "groups." If your scan tool is equipped with OEM-style software, you may see the data displayed in a way that you've never seen before.

Unlike the listing of all Parameter Identifiers (PIDs) you're used to seeing on most automobiles, VW/Audi list their data parameters in related "groups." The PIDs themselves are called "measuring blocks" but fill the same purpose, providing you with the data you need to fix the car.

It's not an overly complicated system, and in this edition of The Trainer, I'll show you how to learn a little bit of German — and add more revenue potential to your days in the bay! MA

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