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Motor Age

January 2014

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AUTOPRO WORKSHOP

Vol. 133, No. 1

Advancing the Automotive Service Professional Since 1899

COMMUNITY

OFF TO CLASS: SMALL BUSINESS MARKETING

Simple plans will help your shop achieve desired success.

PRODUCTS

A NEW LOOK AT 2014 OFFERINGS

Start the New Year with a look at some of the hottest new products.

OPERATIONS

FINDING THE RIGHT ROLES FOR YOUR PEOPLE

Hiring correctly is crucial. Here are some HR tips that give you a fighting chance.



WHAT'S NEW IN HYBRID SYSTEMS?

ADVANSTAR AUTO

TRENDING

OHIO TRAINER EARNS TOP ASE HONOR

Lloyd Koppes was named Training Specialist of the Year.



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COMMUNITY

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Don't start out with plans that are too big for your shop and you could have success.



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Are you ready for this?

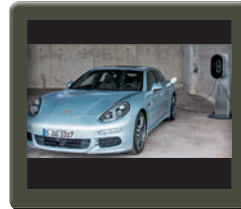
Hybrid sales are on the rise in the United States, and the trend is expected to continue. Will your shop be in tune with these changing times?

ONLINE COVERAGE



ONLINE VIDEO KNOW-HOW

MotorAge.com/video



The Trainer video series

Hybrid sales are on the rise. Will your shop be in tune with the changing times?

MotorAge.com/Jan14Trainer



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[/powersmoke](http://powersmoke)



WINNING RIDES

[/framwinner](http://framwinner)

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Workshop: Peter, CarGirl, BWrench, jatonymartin and more!





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- ▶▶ Ford DIS misfire diagnosis ▶▶ Your tax dollars at work

POWERTRAIN PRO



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THERE'S MORE ONLINE:

HF01234YF FOR CONSUMERS

The U.S. EPA issued a final rule under the Toxic Substances Control Act that will permit R-1234yf to be sold to consumers.

»» MOTORAGE.COM/EPAHF01234YF

ASA-OHIO SUPPORTS SHOP REGISTRATION LEGISLATION

Ohio SB 232 extends the jurisdiction of the Motor Vehicle Repair Board to anyone who performs mechanical repairs on vehicles.

»» MOTORAGE.COM/OHIOREGISTRATION

FEDERATED ACCEPTING SHOP OF THE YEAR NOMINATIONS

Nominated shops will be evaluated on a set of criteria established by Federated and found on the nomination form.

»» MOTORAGE.COM/FEDERATEDSHOP

RIGHT TO REPAIR NOW LAW

Gov. Deval Patrick signed the Massachusetts Right to Repair legislation into law in November.

»» AFTERMARKETBUSINESS.COM/R2RSIGN

DENSO EXECs DISCUSS REGIONAL GROWTH

Execs discussed several product line expansions and introduced a new diagnostic tool at AAPEX.

»» AFTERMARKETBUSINESS.COM/DENSO

ASA-MICHIGAN OBJECTS TO SOME INSURER MANDATES

ASA-Michigan's Collision Repair Forum covered State Farm's PartsTrader rollout and Most Favored Nation (MFN) clauses.

»» ABRN.COM/MICHIGANMANDATES

NABC NAMES LEADERSHIP

The National Auto Body Council announces new board members and officers for 2014.

»» ABRN.COM/NABCOFFICERS

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BREAKING NEWS

ACQUISITION

ADVANCE TO KEEP CARQUEST, WORLD PAC BRANDS

While Advance Auto Parts awaits the Federal Trade Commission's (FTC) required investigation into its acquisition of General Parts International Inc. to wrap up, some additional information about the future of the CARQUEST and WORLD PAC brands has come to the surface.

All three brands will remain after the acquisition is complete, which John Hanighen, vice president Commercial Marketing with Advance Auto Parts Professional, says should be in the first part of 2014. The acquisition, still in the agreement phase because of the FTC investigation, includes all aspects of GPI, including CARQUEST as a program group, TechNet councils, CARQUEST Training Institute and WORLD PAC.

"We've discussed the brands and how important they are in the customers' minds, and that's what's important to us — the customers' minds and what they're used to," Hanighen says, noting that the program distribution group is a new foray for Advance. "We've talked about the CARQUEST brand and how important that is, TechNet as well and WORLD PAC."

[Advance] CONTINUES / PAGE 6

Discussion is on-going in MotorAge.com forums



Lloyd Koppes (right) receives his award from James Hwang, *Motor Age Training* brand manager.

MOTOR AGE TRAINING

Ohio trainer earns top ASE tech honor

From learning in the classroom to teaching in one, a top training specialist received recognition for his lessons to better today's technicians.

In November, Lloyd Koppes of Cincinnati, was named the *Motor Age Training/ASE* Master L1 Training Specialist of the Year. He is a service training specialist for Toyota Motor Sales USA and has been with the company for 15 years. He previously spent 22 years as a technician.

"I primarily teach in my current role. This includes lab set up and bugging test vehicles for class," Koppes explains. "I also work on four course development teams aimed at keeping our courses up-to-date. I do a little field diagnosis/assessment of trouble vehicles, but that is no longer my primary role."

Koppes, a 1977 graduate of Lincoln Technical Institute, always has had a passion for teaching. "As a technician, shop foreman and team leader at various dealerships, I found the most satisfaction came from mentoring entry-level technicians that came my way," he recalls. "They learned to bring the repair manual and wiring diagram with them when asking for help."

When the trainer had the chance to work for Toyota in 1999, he started as a field technical specialist. But he quickly adds that he immediately began to cross-train as an instructor. He was ready to step up to the teaching role when a position opened in 2001.

[Ohio Trainer] CONTINUES / PAGE 6

Photo: Peter Jordan

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[Advance]

CONTINUED FROM PAGE 4

He adds that for store owners, Advance has discussed keeping the CARQUEST brand for them, and working very closely with them over time. The retailer recognizes the brand equity in both CARQUEST and WORLDPAAC, and in a couple of years, they will look “probably a lot like they look today.”

“It’s pretty much how they look today, especially the equity that’s been built by both of them in the commercial customers’ minds,” Hanighen states. “Bob Cushing (president and CEO of WORLDPAAC) has done an incredible job building that company. Why would you ever want to do anything negative to it or change it?”

“It’s pretty much how they look today, especially the equity that’s been built by both of them in the commercial customers’ minds,” — John Hanighen

In fact, O. Temple Sloan III, president of GPI, will continue in that role, reporting to Darren Jackson, CEO of Advance. He also is expected to join the Advance Auto Parts Board of Directors.

Advance Auto Parts is acquiring GPI in an all-cash transaction valued at

\$2.04 billion. Both boards of directors approved the acquisition last year, and Advance announced it in mid-October. This move comes on the heels of Advance’s acquisition of BWP at the end of 2012, a trigger for this year’s actions.

“We had an acquisition with BWP last year, which was a very large CARQUEST owner at the time, and things progressed from there,” Hanighen says. “What we’ve talked about publicly is the scope of it, how national it is and how much larger it is. That gives us some visibility in the West Coast and such, which is excellent, which we didn’t have before. That makes it strategically a very good fit for us.”

The move will make Advance the largest aftermarket parts provider in North America.

— *Tschanen Brandyberry, managing editor*

FEDERAL-MOGUL AIMS TO MAKE TECHS SMARTER

BY **TSCHANEN BRANDYBERRY** | MANAGING EDITOR

Federal-Mogul understands that not every shop can have its own IT department, developing new technologies to make servicing vehicles easier.

So it did just that for those shops. Federal-Mogul unveiled SmartChoice Mobile at AAPEX. The new free app, available in the Google Play and Apple stores, aims to make today’s technicians more efficient and professional.

Brent Berman, manager, e-Data Services Global Aftermarket, gave countless demonstrations of the app during AAPEX, showing off the simple-to-use interface. Upon downloading the app, the shop employee will fill out information about the shop and their roles. This information will be included later when the technician or service writer sends estimates and repair updates to the consumer.

The user also chooses which Federal-Mogul brands they use and install, such as ANCO, MOOG and Fel-Pro.

There are four main options within the app: look-up by VIN scan, look-up by application, send inspection results and product information. A technician will open the app, choose VIN scan and scan the vehicle. The app then will pull up all of the parts Federal-Mogul brands offer for that particular make and model. Only the parts of the product lines the user chose will appear.

Berman explains that the app pulls from information in the FME catalog, and lists parts alphabetically including photos. The technician, or service writer, chooses the parts needed for this repair, and they are kept in a running list.

After choosing the parts, Berman explains the user can complete an inspection template with repair information, price estimates and photos of the worn parts. They also can include brand information, which could offer the customer rebates during some times of the year.

The template uses the information to send an HTML form in both mobile and desktop formats, Berman notes, to the customer. They then can reply via phone or email to the shop about the repairs.

“For a two- or three-bay shop that doesn’t have a lot of IT support, we feel this is a nice free tool to help with credibility,” Berman states.

[Ohio Trainer]

CONTINUED FROM PAGE 4

“I am one of the privileged few who get to do what they love and be paid for it,” he says. Koppes’ region covers Michigan, Ohio, Kentucky and Tennessee, and he spends an average of 10 to 12 days per month teaching technicians. When he’s not in the field, he and his wife Jean spend as much time as they can on their 2008 Honda Goldwing (he learned to ride at age

50), or you can find him relaxing in the pool or “putzing in the ‘Man Cave’ garage.”

The lifestyle and love of teaching can be traced back through his career. He attended Lincoln Technical Institute after finding a love of the automotive industry, solving problems and working with his hands.

His family saw that first hand, as Koppes’ four now grown children — Stephen, Michelle, Jonathan and Christopher — grew up watching their father working at a dealership or on side jobs in the garage at home. “In our spare time, we would

travel in our 1955 GMC bus conversion, a retired Greyhound. Today two of them are in education and two of them work in the oil and gas industry.”

Koppes has come a long way, thanks to his love of teaching, his experience at Lincoln Tech and his dedication to staying ASE certified (he is a Master L1 Technician).

“In this business nothing is handed to you. But with hard work and consistency you can accomplish great things. Take the utmost pride in your work,” he wraps up.

— *Tschanen Brandyberry, managing editor*



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ASE GUIDES

QUESTION OF THE MONTH



SPONSORED BY **Federated Auto Parts**

✓ **SURVEY:** ASE recently announced it will offer a hybrid certification beginning next year. So while this isn't an "official" ASE question, it might help stimulate you into learning more about hybrid service. All of the following are acronyms for different hybrid vehicle designs EXCEPT:

- A. PHEV
- B. BEV
- C. DCEV
- D. E-REV

Go to MotorAge.com/jan14survey to answer this question and to enter our contest from our sponsor Federated Auto Parts.



Going to class: Small business marketing 101

Don't start out with plans that are too big for your shop and you could have success.

BY **TIM ROSS** | WORKSHOP MEMBER

If you're new to the small business marketing game or your previous attempts at marketing haven't been very effective, it's time for Marketing 101 for the Small Business.

- You're not a large corporation: If everything you know about marketing comes from big name brands like Procter & Gamble, you have to learn that size matters. Unlike a giant company with a huge marketing budget, you don't have unlimited funds to waste on campaigns that might not work. You won't be able to reach every person in your target audience.

Do some careful planning before you send out direct mail advertising or even a single email, and you'll find you build a far more effective presence for your company.

- Think local: While it's tempting to dream about using your marketing to build a nationwide presence, you need to tap into the local market. The key is to reach those who might come by your shop, not those who are at least 30 minutes from your location.

- Don't rely on just one approach: If you are only marketing through one channel, you're missing out on customers who get their messages from other vehicles. Some customers

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

ManagementSuccess

Every employee has a goal

Over the years, a shop owner friend of mine in Philly has spoken to hundreds of possible new hires, and I'm sure 50 of them were "really good potential employees." He had personally interviewed a lot of people. He hired some and didn't hire others. But here's the point. ... He could have turned 50 (of those several hundred people he interviewed) into really good employees. That's far more than he needed. The raw ingredients for a recipe of business success were right under his nose.

My friend's theory about finding good people is very common. And it leads exactly nowhere.

Here's the truth: You can hire a "really good potential employee," and if you don't have things properly in place to

bring them up to the level of being a "really good actual employee for YOUR SHOP," you won't actually get a really good employee at all.

And you might get one that winds up not liking you or having no respect for you. When that happens, they certainly won't do their best. It's not good for them; it's not good for you, the shop, customers, the cash or your peace of mind. And you might wonder what's wrong with your hiring practices when that wasn't the real problem.

This can be one of the toughest challenges for a shop owner to face.

Greg Miller

Inaugural FRAM tour a success

FRAM Filtration, a U.S. oil filter brand, recently announced a successful conclu-

sion to the 2013 cross-country tour that saw a new mobile education unit from FRAM® crisscross the nation, traveling more than 10,000 miles to visit popular automotive enthusiast events, training centers and retail locations.

The mobile education unit was introduced by FRAM and Prestone® in 2013 as a new means of cultivating meaningful relationships with individuals who care deeply about the maintenance and performance of their vehicles.

Equipped with interactive displays explaining oil and air filtration, touch-screen TVs with 3D renderings of the filters and cutaways of FRAM's products, the mobile unit emerged as a valuable training tool.

COMING UP IN MARCH
Cat converter efficiency codes



We take this webinar on the road, broadcasting live from VISION. In addition, we'll have a second webinar there on blue link diagnostics.

OHIO TRAINER
RECEIVES TITLE

LLOYD KOPPEL

Ohio man named L1 training specialist.

OPERATIONS
PROFIT MATTERS

CHRIS "CHUBBY"
FREDERICK

WHY DO I NEED A COACH?

Even the pro athletes & actors have help.

THE
TRAINER VIDEO

PETE MEIER

Making the case for hybrid service.

might hear about you from direct mail. Others might stumble on your website or learn about you from reviews on Yelp. Don't forget to execute a multi-channel marketing approach and carefully review the analytics

of each channel to figure out how to make your marketing more effective.

Marketing is often the toughest part of owning a small business, but with a little help and guidance, you'll find your marketing sea legs soon. *TM*

MotorAge TOP VIDEOS

MOST WATCHED VIDEO



A 2014 Industry Outlook

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MotorAge.com/2014outlook

Nissan pushes the envelope

Nissan BladeGlider is both a proposal for the future of EV development and a prototype of a production vehicle.

MotorAge.com/nissanev

MINI Cooper no start

In this video, you'll see variables involved with an engine that cranks very slowly.

MotorAge.com/minicooper

Why become a tech?

What draws the bright minds we need to this industry and what perceptions do we need to change to attract the next generation?

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MARCH

Blue link diagnostics

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MAY

EPA 609 certification

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JUNE

Using scopes

This webinar will be brought to you in cooperation with ATSG.



2014 WEBCAST SCHEDULE

WORLDPAAC's Bob Cushing

WORLDPAAC President and CEO Bob Cushing was greeted by a sold out crowd at the AASA Executive Breakfast at AAPEX. He discussed his operation, highlighted key features and some new technology WORLDPAAC is using to benefit its customers.

GAAS 2014 announcement

Denny Welvaert, chairman of the Global Automotive Aftermarket Symposium, talks about "Connected" the theme for the 2014 event.

How DIS ignition systems work

Check out this training video for your technicians.

Breaking down marketing

Tips to help you get started on the right foot as the new year gets underway.



STREAMING PROGRAMS

JAN. 16-18

MACS Worldwide Conference
New Orleans

MARCH 3-9

VISION Hi-Tech Training and Expo
Kansas, City, Mo.

MARCH 21-23

Automotive Training Expo
SeaTac, Wash.

MARCH 22

TST Technicians Big Training Event

Located in Fishkill, N.Y., the event features Bernie Thompson, Wayne Colonna, Scott Brown and Pete Meier.



2014 INDUSTRY CALENDAR



Noteworthy

comments from MotorAge's online communities

The best of what you're saying on Facebook.com/MotorAgeMagazine Twitter (@Motor_Age and @PeteMeier) and the AutoPro Workshop.

foleytech:

It does not diagnose the problem, it gives you direction to diagnose that area. Don't mislead people, it gives people false hope when they go to a repair shop and we tell them something else is wrong with there car other than what the code was.

MASTERMECH48:

First thought, With all this crap interest on global warming and CO2 emissions into the atmosphere, Long term wise where does this device set in the

priorities list to be banned for CO2 emissions? I would have thought that the EPA would have been all over this unit.

smracing:

The hardest thing we have to do as shop owners is find how to motivate and retain employees. There never seems to be a constant as to what they want. Creating a stable work environment and maintaining an upbeat mood in the shop seems to help, but it doesn't seem to work with every personality.

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OPERATIONS

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IN THIS SECTION

- 10 Management Feature
- 14 Profit Matters

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MANAGEMENT



FINDING THE RIGHT ROLES FOR YOUR PEOPLE

HIRING IS SO CRUCIAL, YOU NEED TO GET IT RIGHT. HERE ARE SOME WAYS TO GIVE YOURSELF A FIGHTING CHANCE.

BY **BRIAN CANNING** | CONTRIBUTOR

A BIG challenge to any business owner or anyone tasked with hiring and firing is keeping our stores fully staffed. Even worse is keeping our stores fully staffed with capable, competent people who know what is expected and know the policies and procedures that are unique to our operation. Often the perfect candidate is right there under our nose working for us. We just forgot they were there.

I would be the first to acknowledge that there are some employees out there who will never measure up and who will never live up to our expectations. We hired them based on their resume, but even with extensive training and clear

direction, they just never have made it and likely never will. We all have seen and experienced these lost souls. These are not the employees I will be talking about. The employees I want to discuss are those who have shown potential, even have had moments of brilliance but somehow have never blossomed into the hard chargers we thought we were hiring.

Knowing how busy most of us are and the state of training in our industry, I want us to look much closer to home the next time we find ourselves needing to fill a position. I have seen it again and again where we hire a seemingly perfect employee, with all of the right experience and skills, and within weeks of our hiring them we find ourselves frustrated and angry because they just aren't getting it done. They just don't get it. We give up on them, don't waste any additional time trying to train them and just let them drift



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“THE SECOND WE SHORT-CIRCUIT THE TRAINING PROCESS, THE SECOND WE MAKE ASSUMPTIONS ABOUT THEIR ABILITY, WE SET OUR NEWLY HIRED OR NEWLY PROMOTED EMPLOYEE UP FOR FAILURE AND SET OURSELVES UP FOR FRUSTRATION,”

BRIAN CANNING [CONTRIBUTOR]

through the day pretty much ignoring them.

We want you to take a hard look at yourselves and how you went about training them and setting expectations for their performance. Too often I find these new employees under-trained and clueless as to what we expect of them, and too often we, the shop owners and service managers, are to blame.

How It Usually Works Out

In many cases, we find ourselves hiring out of desperation. We have lost a key employee and though we were given notice or at least had a suspicion that they were on their way out, true to our long-standing habits, we didn't do anything toward placing an ad or otherwise responding to the need to hire somebody. Now we are down an employee and desperate to find somebody as soon as possible. We place an ad on Craigslist, by some miracle (given our inability to effectively interview) not only get a good response but actually interview and hire a “perfect” replacement. Life is good!

Unfortunately, we have no formal plan for training this new employee, and a good portion of the time we throw him or her on the counter or out in the shop. Despite our being armed with great intentions, by luck or by a miracle, some of these new staff members survive this baptism by fire for several hours or even a few days and we decide they're brilliant. They're our guy, and seeing how motivated and capable they are, we cease any effort toward training them. They obviously get it.

However, we have just short circuited their training by throwing them into the fray unprepared for what will be coming at them, unaware of what our expectations are, and setting them

While it's important to hire the right person, sometimes focusing on female candidates is a way to go.
MotorAge.com/hirewomen

up very nicely to fail. They are untrained, don't have the knowledge or skills specific to our operation, don't know what management wants, and have no chance of being all that we would have them be.

In putting together a training regimen, I like to combine a 60-day calendar

with a list of critical tasks that I would like for the employee to master before setting them loose on the world. I notate times and days that we would provide training in the indicated tasks and do everything humanly possible to live by this training calendar. During the training period, you can throw the employee where you will, hopefully attempting to train them along the way. But on the indicated days and times, they need to be getting the planned training and all else is secondary in the effort. This way we are assured that no matter what, our people are learning and exposed to the tasks that we have determined are most important. This assures that they have formal instruction in each applicable area. This more formal approach will go a long way toward assuring that our people are capable of doing the things we expect from them and are set up for success.

As leaders and as managers, it is extraordinarily important that we provide training and a work environment that will give our employees the greatest opportunity to succeed; success being their ability to live up to our expectations. The second we short-circuit the training process, the second we make assumptions about their ability, we set our newly hired or newly promoted employee up for failure and set ourselves up for frustration.

Assume they know nothing and give them every opportunity to learn and benefit from a well thought out

training process then get out of their way. Armed with this knowledge and experience, they might shock you with their ability and astound you by being all that you had hoped for and more. Redemption, in the form of training and clear expectations, might save you the cost of that ad and perpetuating an unfortunate cycle of hiring and eventually firing the wrong guy. Realigning the roles and responsibilities of existing staff members is much easier and more cost effective than recruiting and is also very good for the team.

You might not need to hire new employees, but if you take the time to evaluate and rearrange your staff, your productivity and sales could skyrocket.

This scenario is very similar to what I see shop owners do with marketing. Though we are cash starved, just barely able to pay our bills, we dig around in our couch and underneath the seats in our cars and scrape together enough money to purchase the latest and greatest marketing tool, because goodness knows we need more cars. In this case, we decide we need a new service advisor or a new B tech and without a thought toward the people we already have on staff, we are all over Monster or Career Builder looking for staff members that as likely as not already are there on staff, right under our nose.

If you have a staffing need, fill it and fill it quickly. But when you start out on that search, before you look anywhere else, look close to home. *TM*



BRIAN CANNING
CONTRIBUTOR

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

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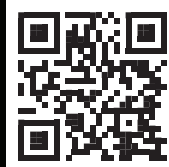
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WHY IN THE WORLD DO I NEED A COACH?

EVEN THE BEST ATHLETES, ACTORS AND OTHER PROS HAVE COACHES. FINDING THE RIGHT ONE CAN STEP UP YOUR GAME.

BY CHRIS "CHUBBY" FREDERICK | CONTRIBUTOR



MOST OF us sleep with a great coach; but if you won't listen to him or her, let me give you some suggestions before you hire a coach. Whether you want to stay the best shop owner or the best athlete, remember you are in the game, and you can't see the whole field or the big picture when you are in it. We all have blind spots, and a good coach will enhance your strengths and reduce weaknesses. Successful athletes, shop owners, CEOs and actors all have coaches.

If you want to increase profits, the right coach could decrease the time it

would take you to achieve greater profits while reinforcing what many owners need to hear, which is that it is OK to make money in your business. If you are comfortable and just want more free time, a coach can work with your employees and keep an eye on your money while you are on vacation, plus help you grow your second in command. Most owners have difficulty transferring their own skills because they have never been trained to teach. If you are in a slump and stressed out, a coach can help you make the right decisions.

If you don't like change and just want things to stay the way they are, you

really need a coach because this industry is changing rapidly. If you don't like change, you might have developed a bad habit of not taking anyone's advice, including the coach you sleep with, who probably knows you better than anyone.

I can tell you that I never would have been able to grow my business to where it is today if it were not for my three coaches. I am guilty of all the above and fought hiring my first coach until about 10 years ago. I rarely listened to my wife, and that was a big mistake as well! Today, there is not any important decision I make without asking for advice. I also have seen tens of thousands of owners accomplish things that they never thought possible with a coach's help and in less time than they ever imagined.

What Kind of Coach to Hire?

You want to hire a coach who works for a company that guarantees results. Then you want coaches with at least 18 to 20 years of automotive management experience. They need to have walked the talk and understand exactly what it takes to be successful in a repair shop.



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“IF I KNOW I HATE CHANGE IS A COACH A GOOD IDEA? YES, BECAUSE YOU ARE LESS LIKELY TO CHANGE ON YOUR OWN OR FROM FAMILY INFLUENCE,”

CHRIS “CHUBBY” FREDERICK [ATI CEO]

I have seen many well-intentioned accountants that understand accounting well but know nothing about automotive service, so they make many mistakes on operational practices. Because your problems might move from finance to sales to hiring to advertising to marketing to management to leadership, what do you think the odds are a coach could be an expert in all of them? Slim, right! So, you want a coach that works with coaching and training specialists in the same company so they can fix your entire operation, not just one part of it.

Because you need hands-on training to become perfect, you want a coach connected to a school where trainers can teach you accounting, finance, sales, marketing, recruiting, advertising and leadership, just to name a few.

Most importantly, because you will need tune-up training in every category every year for you and all your people, make sure the training is unlimited and all-inclusive. If you pay a la carte, you never will buy enough training and you will overpay for the training.

You also want a coach with lots of experience coaching, not just success fixing their shop. Most professionals do not realize how they do things and therefore cannot transfer their skills. Successful shop owners are like successful quarterbacks, they might not make great coaches. New coaches need to shadow successful coaches for six months, implementing more than 40 different strategies a week before they



are allowed to fly solo. Unless a coach has worked successfully with at least 80 clients, don't let them learn on you.

You also don't want a coach with the same personality as you! If you are a directive leader and act fast under pressure, it is extremely important to have a strategic coach to slow you down to make sure you are making the right decision. If you are a strategic leader and overthink everything, a directive coach would hold you accountable and make you take action.

Finally, you want to hire a coach with a proven track record of success in the field as a practitioner and as a coach. They should be coaching lots of clients, so talk to as many as you can to ensure they will fit you and your business.

What to Look For in a Coach

You want a coach that is assertive and will hold your feet to the fire. A good listener, one that cares about your success and can think outside the box to help you. A good coach will always tell you the truth even if you don't want to hear it. One that keeps you in balance and focused, gives direction and encouragement but stands on principle, knowing what works and is workable for you.

Also, look for a coach with a boss, a head coach and interview their head coach. Your coach needs to be held accountable for your satisfaction and return on investment. You might want a second opinion or want a coach change to someone stronger in the area you lack the most, so work with a company that has lots of coaches to choose from.

This leads us to your board of directors. You might not think you are big enough, but if you join a 20 Group of successful shop owners, they can give you advice like a board. But you only want to be part of a group that is highly successful; otherwise, you will get lousy advice or none at all. And the 20 Group should be included in the coaching fee.

Finally, you need a training and coaching company that will create a five-year roadmap to get you where you want to go and will help you make the investment monthly in a total plan, so you don't have to shell out the money all at once or load up your credit card.

Most of us are sleeping giants, and with effective coaching we can accomplish everything in life we have not yet succeeded in. If you want to see whether you are coachable, for a limited time you can download an “Are You Coachable?” test at www.atonlinetraining.com/2014-01 and find out whether an investment in a coach is for you or not. Everyone needs a coach. The question is, are you coachable, or have you decided to stop growing? **TL**

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Chris “Chubby” Frederick, CEO



CHRIS “CHUBBY” FREDERICK
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Chris “Chubby” Frederick is the CEO and founder of the Automotive Training Institute. ATI's 108 associates train and coach more than 1,150 shop owners every week across North America to drive profits and dreams home to their families. Our associates love helping shop owners who are having the same struggle as many of them have had, and who are looking for the same answers — and in some cases looking for a lifeline.

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- 24** Drivability

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The Chrysler RFE

CHANGES TO THIS SETUP AIM TO MEET INCREASED TORQUE DEMANDS AS WELL AS THE ABILITY TO BECOME A 5-SPEED.

BY **WAYNE COLONNA** | POWERTRAIN PRO PUBLISHER

CHRYSLER'S family of RFE transmissions (Figures 1 and 2) began as a 4-speed and currently is a 6-speed transmission. The RFE means it is a rear wheel drive, fully electronic transmission.

In 1999, the 4-speed version called the 45RFE was put into the Jeep Grand Cherokee 4.7L vehicles, followed by Dodge Dakota and Durango 4.7L in

2000. By 2002, it found its way into Jeep Liberty and Dodge Ram 1500.

With slight changes to some internal parts and programming, the design of the transmission allowed for it to easily become a 5-speed, and it was called the 545RFE transmission. This occurred as early as 2001 in Jeep Grand Cherokees.

To handle increased torque demands for later model diesel applications, internal components were modified and gear ratios and shift strategies were

changed to produce a 6-speed version of this transmission called the 68RFE. The 2007 Ram 2500 and 3500 full chassis pickups with the 6.7L Cummins Diesels were the first to receive this 6-speed transmission.

In 2012, the 545RFE transmission was re-calibrated to provide six speeds in the Electronic Range Select mode only. In the normal drive range, it will shift as a 5-speed unit. In Dodge Ram 1500 models, this transmission is referred to as a 65RFE. In 2500 and 3500 gas models, it is called the 66RFE. Some improvements were made to the torque converter with these two transmissions as well.

Regardless of whether it is a 4-, 5- or 6-speed transmission, all of them utilize the same six clutch pack assemblies: three that drive the gear train, three that hold and one low sprag.

As with any automatic transmission, there are times where it would be quite helpful to check clutch pressures in a diagnostic approach to a problem. This step, however, is often time bypassed for one reason or another. Legitimately, once installed into the vehicle, the taps on various transmissions become inaccessible. In some instances, the time it takes to make those taps accessible the transmission is near out of the car. Sometimes these taps are only inches away from the catalytic converter.



Figure 1

WAYNE COLONNA

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

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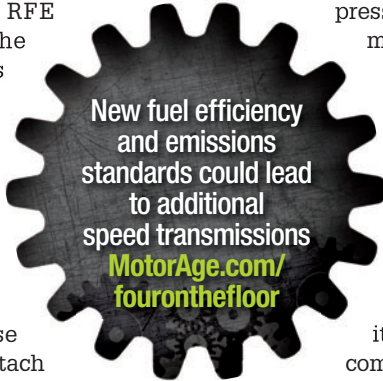
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With Chrysler's RFE transmissions, all the clutch pressure taps have been placed on the valve body itself (Figure 3). This requires having a special pan with access ports and pressure pipe fittings (Miller Special Tool 8258A) to reach those taps with which to attach gauges (Figures 4 and 5).



Removing the pan and the pressure taps, then installing the special service pan, the pressure pipe fittings, gauges and fluid is without a doubt a time-consuming process. As a result, I know only a few shops that have made this investment. So clutch pressure rarely is ever checked.

Checking main line pressure is another challenge with this transmission. In fact, there really is not a dedicated line

pressure tap on this transmission. What it does have is an external line pressure sensor (transducer) located on the right rear side of the case (Figure 6).

As with any transducer used on or in a transmission, it reports back to the computer the pressures it is monitoring; in this case (or should I say "on this case"), main line pressure.

The parameter display provided to the scan tool from the computer for this transducer is referred to as "Actual" line pressure and usually can be observed in volts DC or pressure psi. The "Desired" line pressure parameter is what the computer is commanding line pressure to be based on load and temperature and other

pre-determined factors. This parameter can be viewed in psi as well as duty cycle percent (Figure 7).

With line pressure being sent to the transducer for it to be monitored, it's a great place to be able to check line pressure with a gauge (Figure 8). Although the transducer is supposed to monitor line pressure, and the scan tool calls it "Actual" line pressure, this doesn't mean it's true. A pressure gauge on the port will tell you if the transducer is working correctly or not.

Attaching a pressure gauge to this port however requires a special tool as seen in Figure 9 (Miller Special Tool 8259). The transducer is removed from the transmission and the tool installs into the port. A mounting block at the end of the hydraulic line of the tool provides a location for the transducer to be installed as well as a pressure gauge. This allows the transducer to remain plugged in both electrically and hydraulically. If it remained unplugged, a code would set and line pressure would remain elevated.

When all things are working correctly, desired and actual pressure readings in the scan tool are usually within 3 psi of each other. Here are typical readings taken from a good working 2007 Dodge Ram Truck (4WD) 5.7L V-8:

- Idle in Drive stopped**
 Actual Line Pressure 1 (PSI) ___ 38.1
 Desired Line Pressure (PSI) ___ 40.0
 Line Pressure Duty-Cycle (RFE) (%) ___ 29.1
- Stall in Drive stopped**
 Actual Line Pressure 1 (PSI) ___ 157.8
 Desired Line Pressure (PSI) ___ 160.1
 Line Pressure Duty-Cycle (RFE) (%) ___ 5.1
- Medium acceleration**
 Actual Line Pressure 1 (PSI) ___ 118.0
 Desired Line Pressure (PSI) ___ 118.0
 Line Pressure Duty-Cycle (RFE) (%) ___ 19.67
- Cruising in 5th with TCC On**
 Actual Line Pressure 1 (PSI) ___ 77.0
 Desired Line Pressure (PSI) ___ 77.0
 Line Pressure Duty-Cycle (RFE) (%) ___ 22.67

With a special service tool being required to check line pressure, this diagnostic check often is never performed, causing unnecessary guesswork that equates in wasted time and money. The danger here is there have been times where we have seen transducer data matching the desired command when in actuality it is not. You could discover this only by matching

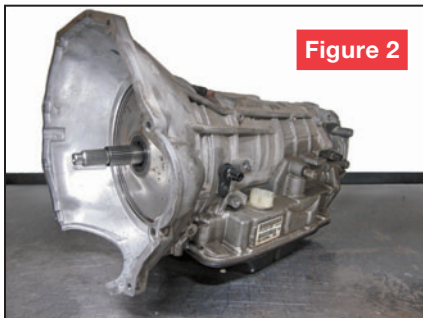


Figure 2

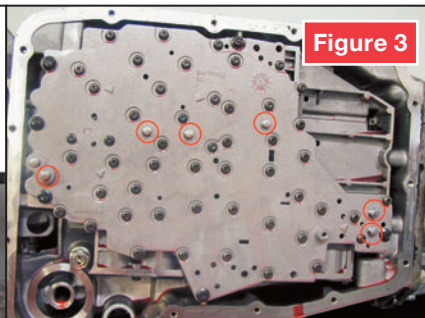


Figure 3

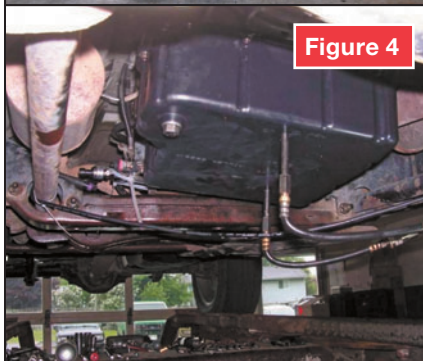


Figure 4

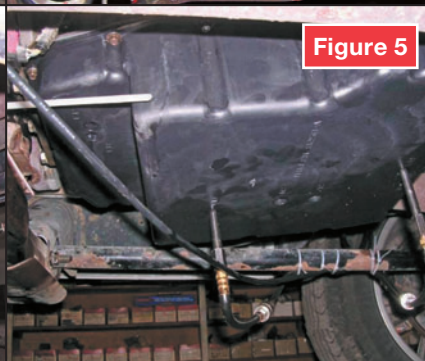


Figure 5



Figure 6



Figure 7



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the data from a scan tool with a real pressure gauge.

When the transducer fails yet matches the desired command, the result has been repeated Overdrive Clutch failure. With other common reasons for Overdrive Clutch failure (such as a worn bore with the solenoid switch valve line up (Figure 10) in the valve body), combined with not having the special tool, line pressure is never checked to see if the transducer is faulty. Eventually the sensor gets

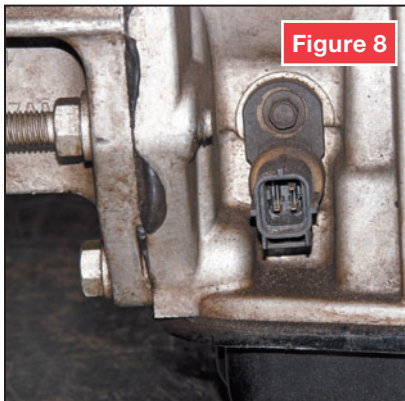


Figure 8



Figure 9

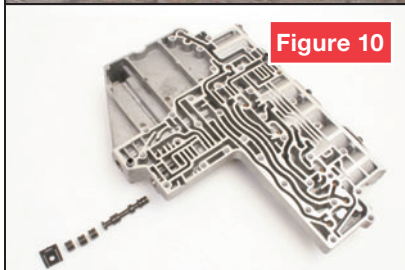


Figure 10

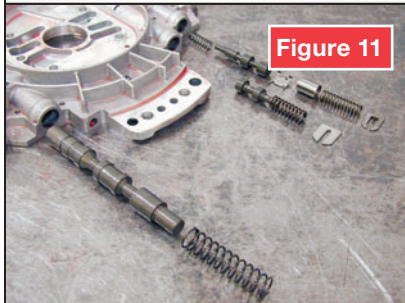


Figure 11

replaced and the problem is resolved.

The upside is this pressure transducer usually works well, and when it does, it can be used to diagnose other issues. For example, when cold, the desired and actual pressure readings match but when it warms up, baseline pressure drops. At idle, the desired pressure command shows 40 psi yet actual says 25. As soon as you step into the throttle, actual sensor readings ramp up immediately and match the desired command. This is indicative of a worn pump.

If transducer data (actual) is lower than desired when cold at an idle but begins to match as it warms up, a defective or substandard filter usually is the cause. When it fails badly, actual never matches desired.

There have been occasions when substandard filters became loose in the filter to pump seal. This allows the pump to suck in excessive air, causing the actual data in the scan tool to fluctuate erratically.

Speaking about a worn pump, these pumps contain the primary pressure regulator valve and all the valves related to converter clutch control (Figure 11 – TCC Switch Valve not shown).

One common problem with this pump is with the springs breaking. Another is severe bore wear with the Torque Converter Clutch Limit Valve (Figures 12 and 13).

We have seen this occur frequently with 2005 to 2007 models. The typical complaint that accompanies wear in this area is a stalling of the engine when it is placed into gear. This is because of a lack of converter charge pressure, which is used in part to push the clutch away from the cover. With a lack of charge (release) pressure, the clutch makes contact with the cover. When the transmission is placed into gear, it will act as if you didn't depress clutch as with a manual shift transmission.

Both the converter clutch apply and release pressure can be inspected with a pressure gauge without the use of any special tools. The two taps are located on the right side of the transmission behind the converter housing and between the cooling lines (Figure 14). The upper tap is TCC Release Pressure while the lower is the apply pressure.

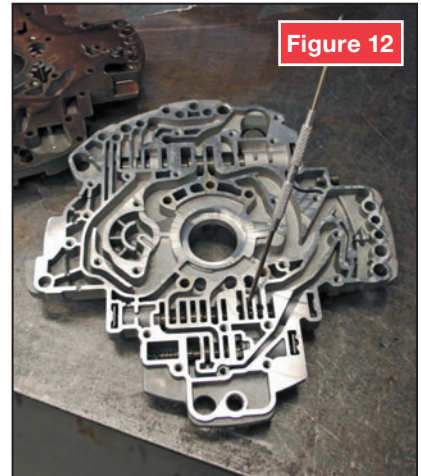


Figure 12

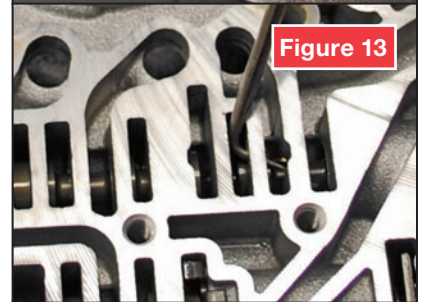


Figure 13

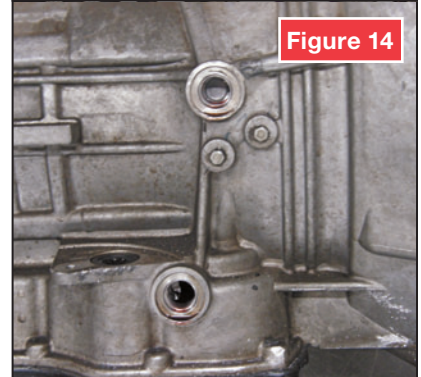


Figure 14

When driving the vehicle, apply pressure can range between 15 to 80 psi, while release pressure can be between 35 and 118 psi. Once the converter clutch is commanded fully on, release pressure should drop to zero psi.

Beware the first time you ever handle a 68RFE converter. Not only does it have several notable differences in design from the 545RFE, it's heavy. At around 65 pounds, it is one of the heaviest converters in the industry. Interestingly enough, this beefy converter is only supported by a pilot in the crank shaft and the inner pump gear through the converter's impeller hub. So a well fitting pilot is critical with this set up. **ZZ**

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↘ DRIVABILITY



The IMA Motor and housing is located between the ICE and the CVT transmission.

HONDA IMA SERVICE AND REPAIR

HONDA'S INTEGRATED MOTOR ASSIST (IMA) HAS BEEN IN PRODUCTION FOR NEARLY 15 YEARS, AND CHANCES ARE YOU ALREADY HAVE HAD SOME OF THESE VEHICLES IN YOUR BAYS.

BY **DAVE MACHOLZ** | CONTRIBUTING EDITOR

Entering the realm of hybrid repair can be a daunting venture for many technicians and shop owners. Servicing Honda Integrated Motor Assist (IMA) vehicles is a great way to get your feet wet, as the technology on these vehicles intentionally is not as evolved as competing manufacturers' hybrid platforms.

The heart of the IMA system is a brushless three-phase AC motor-generator contained in a housing that bolts up between the ICE and the Constantly Variable (CVT) transmission. The rotor is a permanent magnet type bolted to the crankshaft, which means anytime the crankshaft turns, so does the rotor. The IMA motor provides power assist when needed, and takes on the role of the conventional starter motor and alternator. The rotor includes a tone ring, and the IMA position sensor contained within the IMA housing monitors it.

Control of the motor takes place in the Integrated Power Unit (IPU), which is located along with the HV battery behind the rear seat. The IPU is the brain of the IMA system and includes the Motor Control Module (MCM), which monitors HV system data and controls the motor-generator through a series of contactors that act as oversized relays to allow the flow of high voltage to and from the IMA motor to power the motor during assist or recharge the HV battery.

The IPU also controls the HV air conditioning compressor and charges the 12-volt battery via the Motor Power Inverter (MPI). The 12-volt battery powers all control modules and related components including the HV system modules. It's required to provide power to the 12-volt backup starter motor.

Keep in mind that Honda ISIS has technical service bulletins (TSBs) that are updated daily, which can play a key

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role in helping you get IMA concerns fixed right the first time. Honda also provides some subscription based e-learning style training here that is extremely helpful in understanding hybrid related vehicle systems.

What You'll Need

Servicing these vehicles requires some must-have equipment, but starting might not be as expensive as you think.

Safety Equipment – Always follow the repair manual guidelines and recommendations for when to use appropriate safety equipment. As with all HEV/EV service, you will need to have

Photos: Dave Macholz

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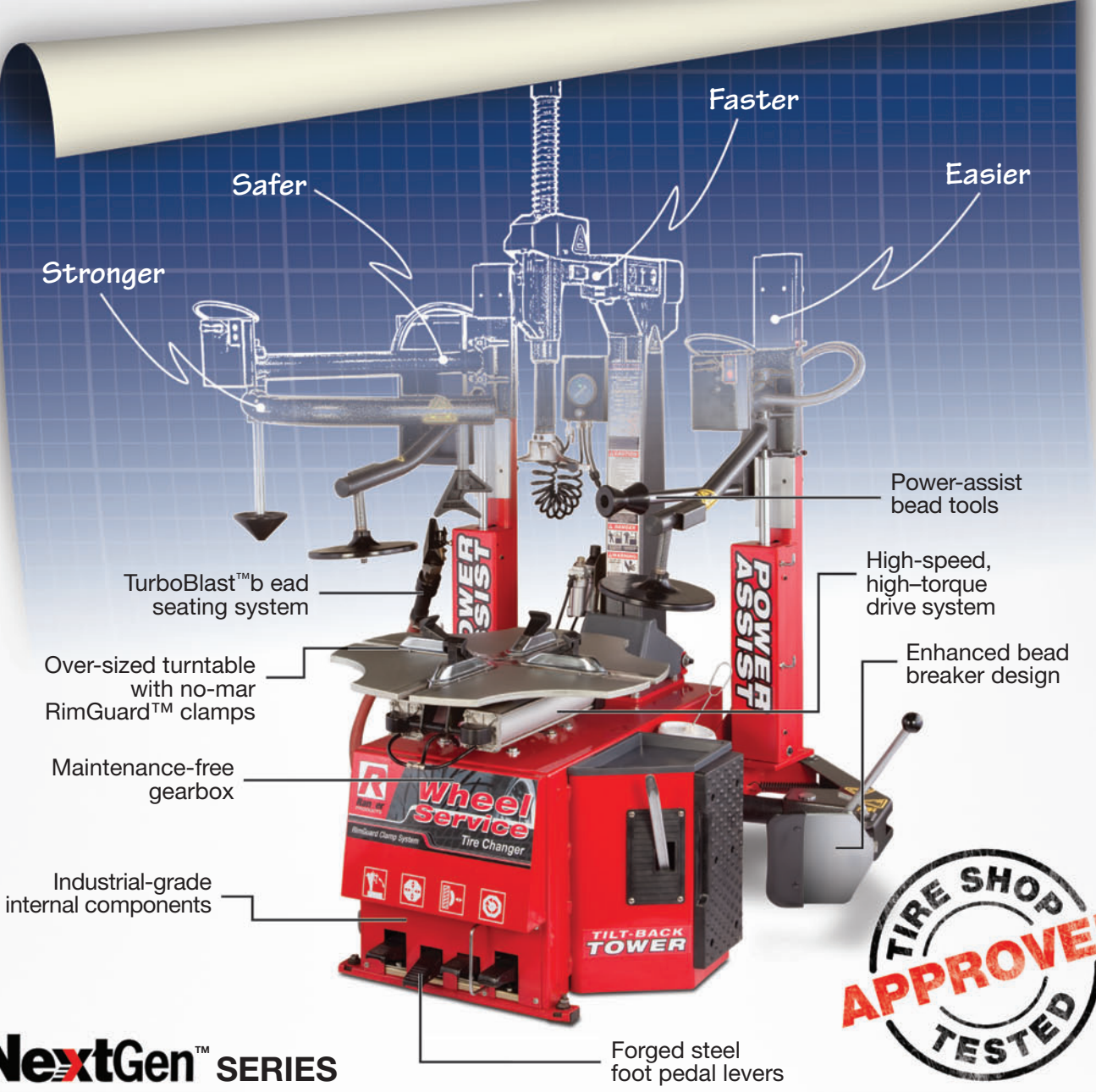
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a good set of high voltage lineman's gloves with leather glove shells to go over them. Be sure that the gloves are rated to 1,000 volts and are within the acceptable six-month certifications date found on the cuff.

Check the gloves for pinholes and cracks. Do not blow into the glove, but instead roll the glove up at the cuff and listen for leaks. If you are unsure as to the condition of the gloves, don't take a chance. On hot and humid days, keep sweat from dripping from your arms and down the gloves. Sweat is a capable conductor of electricity and can enable high voltage to find a path to ground through your body. Wear cotton glove liners and long sleeves if necessary to prevent this from occurring. Also be sure to wear protective eyewear and keep loose jewelry, keys and lanyards in your toolbox.

Insulated tools – Honda recommends the use of insulated tools for hybrid battery service. Even when the HV system is switched off there is a chance for electric shock, as some of the hardware on the battery is still considered "live."

Digital meters – A good meter is essential in hybrid service. You will want to have a meter (and leads) rated at 1,000 Volts Cat III/600 Volts Cat IV.

Scan tools – It's important to make sure you have the scan tools and subscriptions to get the job done. If you are using an aftermarket scan tool, be sure it can communicate with the Motor Control Module and Battery Control Module. Having Honda's Modular Vehicle Communications Interface (MVCI, available through SPX), a laptop and a subscription to the Honda Diagnostic Software (HDS) would be helpful and in some cases necessary. In many cases, IMA repairs will require reprogramming that is not possible with J-2534, so be sure you verify that your tool can do the job.

Common Service Issues

Once you have the essential tools and training, you can feel confident in approaching IMA service. When working with high voltage components

Educate yourself on the Honda IMA system with this feature from Tony Martin.
MotorAge.com/hondaima

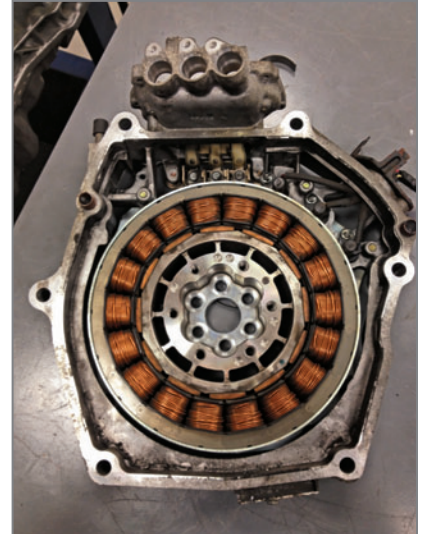
such as the HV battery, IPU assembly, IMA motor or HV wiring (identifiable by its bright orange loom), you will need to deactivate the high voltage system. This can be done by removing the rear seat back, removing the switch cover bolt with a 10 mm socket and flipping the switch to the "off" position.

The HV shutdown will need to be performed when removing or installing the engine or transmission. If you are unsure of when to perform the HV shutdown, consult the service information. HV shutdown for routine maintenance is not required, and you can feel comfortable working safely on other systems around the vehicle. Keep in mind that the brake system does not require any special shutdown procedure for service.

Honda had some early issues with its HV batteries and battery monitoring strategies. HV battery concerns are not all that different from concerns with 12-volt batteries. Generally speaking, low temperatures result in poor battery performance, and high temperatures result in reduced battery service life.

For this reason, Honda uses the Battery Control Module (BCM) to monitor battery voltage and temperature. Several updates to the software have been issued since the introduction of IMA in 1999, and improved BCM strategy has markedly improved battery life, yet here are still some concerns surrounding the control strategy. The BCM looks to see ideal battery temperatures, typically around room temperature. If temperatures are too cold or too hot, the BCM will disable the IMA system and the vehicle will rely strictly on the ICE.

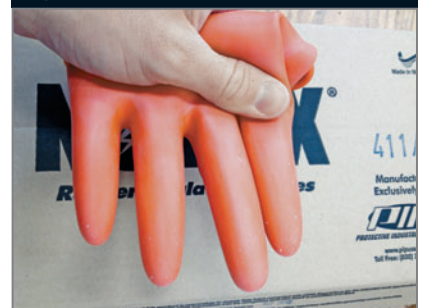
Often customers will complain of poor fuel economy in extreme cold or hot conditions. Unfortunately what they are experiencing is considered a normal condition and is a designed BCM strategy to prolong battery life. The battery relies on the vehicles HVAC system to warm or cool the battery and cabin air is ducted from the passenger compartment to the battery via a fan motor. Once the battery module sees the desired temperatures, the IMA system resumes its normal functions.



The IMA motor-generator is the heart of Honda's IMA System.



Lineman's gloves are essential personal protective equipment for HV repairs.



To check gloves for pinholes, roll gloves from the cuff as shown and listen and look closely for leaks.

Another concern for independent shops is what to do with customer vehicles with battery complaints. Honda does not require specific testing or charging equipment. Instead it relies on the algorithm within the MCM and BCM

to monitor battery condition and will illuminate the IMA warning icon on the instrument cluster when there is an IMA fault. If a customer complains of poor fuel economy but there are no codes, you typically have a fault other than the IMA system. The module strategies are fairly reliable and even will generate codes as specific as DTC — P0A7F “REPLACE BATTERY.” The concern for shops is what to do when they get this code.

When choosing to repair, rebuild or replace a battery, there are a few things to take into consideration. The powertrain warranty on Honda vehicles does not cover the IMA battery. However, the battery is covered under the emissions

warranty much in the same way that catalytic converters are. That warranty covers the battery for eight years/80,000 miles, and in some cases the batteries are covered under the California emissions standards warranty of 10 years/150,000 miles. Honda has a TSB addressing this from December 2012, and it has extended the warranties of some batteries to as much as 170,100 miles.

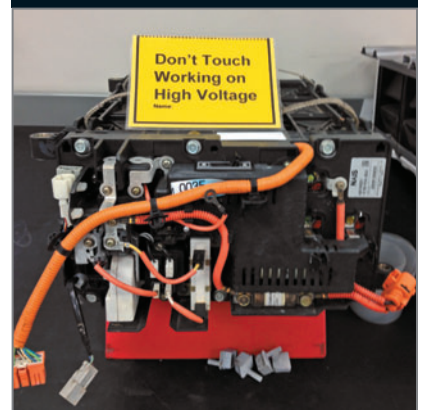
If battery replacement is necessary, you have a couple of options. You can repair your existing battery with known good parts from a donor battery, but this option leaves the most to chance in that you are asking your customer to rely on used parts. You could recondition the battery if you own the equipment. Another option is to go with a remanufactured battery, either through your local parts house or through Honda. Honda offers only remanufactured replacement batteries, so keep that in mind when making your decision. The cost of the battery from Honda is right around \$2,000 depending on year, make and model. The replacement of the battery is not labor intensive, but requires the transfer of the junction board from the old battery. After the battery is installed, you will have to program the specific battery software into the BCM.

When performing the replacement of the engine, transmission or IMA motor, keep in mind that to remove the IMA rotor you will need a special puller tool (Honda PN – 08AAF-RCJA100). The tool comes with a case designed to store both the tool and the permanent magnet rotor while it’s removed and is intended to protect it from attracting metal particles or shavings that can damage or interfere with the motor or motor position sensor upon reinstallation. Removal of the rotor without the tool is nearly impossible and extremely dangerous. Keep in mind that if the permanent magnet rotor is spun within the stator, you will induce high voltage into the windings of the motor that can result in serious injury or component damage. After engine, transmission or motor replacement, the motor position sensor will need to be relearned.

Over the summer a friend was complaining about a significant drop in fuel economy. He went to the local Honda dealership, which found nothing wrong with the battery or IMA system. He recently had the tires replaced with



IMA rotor removal requires a special pulling tool and includes a case to store the rotor while it’s removed.



Once removed, the HV battery and IPU assembly are on the bench and ready for parts transfer to the remanufactured battery.

some high-quality, name brand tires and found out they were not the low rolling resistance (LRR) tires Honda and other manufacturers use on hybrid platforms. LRR tires strike a balance between traction and low rolling resistance and are designed to further improve fuel economy. To be certain that the tires were the issue, he switched the wheels and tires for a set off another Honda IMA vehicle and fuel economy was restored. **ZZ**



DAVE MACHOLZ
CONTRIBUTING EDITOR

Dave Macholz is an instructor for the Toyota T-TEN, Honda PACT and general automotive programs at Suffolk County Community College in Selden, N.Y. He is an ASE CMAT and L1 technician and holds a NY State teaching certification in vehicle repair.

E-mail Dave at liautotraining@gmail.com



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THE NUTS AND BOLTS OF AUTOMOTIVE REPAIR



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Right to Repair legislation has been reconciled in Massachusetts.
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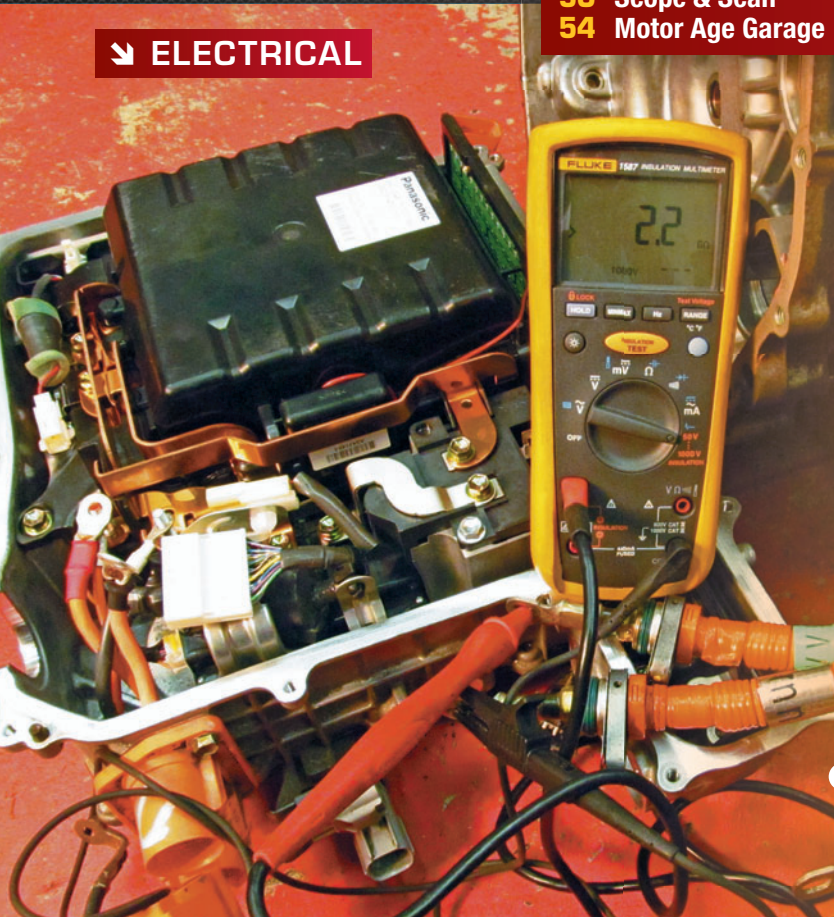
A NEW APP

Dayco's new app can look up parts based on plate number and state.
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RELATIVE VIEW

Check out this view of relative compression from the driver's seat.
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↘ ELECTRICAL



MEGOHM TESTING IN HYBRID VEHICLES

Two tests need to be made for the MG stator; short to ground and short to each of the three windings. This is a good reading for short to ground.

MOVING INTO HYBRID ELECTRICAL REPAIR? THEN YOU'LL BE DOING A LOT OF THIS.

BY **JERRY "G" TRUGLIA** | CONTRIBUTING EDITOR

Many technicians might not be familiar with a Megohm, aka Megger meter, but it's not that different from a Digital Multimeter's (DMM) ohm meter. Let's take a look at what the DMM's Ohm and Diode functions actually do.

We all know that the Diode function of the meter is used to check a diode, but what's the difference? When we connect our leads properly to the diode, we should see a reading on the meter. When we reverse the meter leads on the diode, we should not get a reading if the diode is good. If the meter pro-

vides reading on both sides, the diode is shorted; if there is no reading on both ends the diode is open. Now with that out of the way, let's see the difference from the Ohm, Diode and the Megger meter functions. The difference is voltage. Each of the functions on a meter will supply a different voltage.

A typical DMM will apply about 2.5 to 3.0 volts to a component when performing a normal Ohm or resistance test. However, when testing a diode using the Diode test selection, the meter will apply more than 7.0 volts. You would not use the Ohms selection to check a Diode, just like you would not use either

the Ohm or Diode selection to properly test a high voltage cable or hybrid motor-generator (MG). Both the Ohm and Diode tests cannot provide enough "pressure" to properly test HV cables or MGs. The Megohm meter can supply

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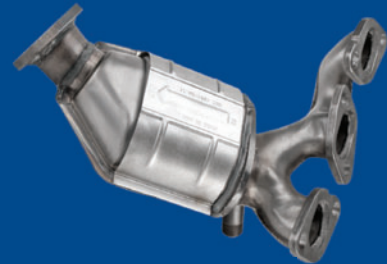
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1,000-plus volts, a voltage level necessary to provide enough pressure to uncover a voltage leak in a cable or MG.

Like both the Ohm and Diode test, the Megger meter is a resistance test. Like any other Ohm test, the circuit being tested must be off and disconnected from its power source while being tested. The vehicle being tested must have its high voltage (HV) systems disconnected before performing any test with the Megger.

Check out this collection of Automotive Research & Design informational videos in the AutoPro Workshop. MotorAge.com/hybridvideos

you can work near them. Follow the procedures outlined by the manufacturer. Verify with a capable high voltage multimeter that there is no voltage present on the cable connections.

Follow all safety procedures anytime you're dealing with HV components; wear protective gloves that are current and have been properly inspected; wear leather overlays over those; and make sure there is someone near by that knows where the shop's safety hook is and how to use it, just in case.

Insulation Testing

Knowing how to perform an insulation test is vital in order to detect any HV cable or MG problems. The Megohm test will provide results on if there is damage to the cables or MGs that are leaking voltage. Think of the insulation test like a water pressure test on a pipe where the pressure is increased to 125 percent of the pipe's working pressure. While pressure testing a pipe, you look for water leaks by increasing pressure to a point where you see water shooting out somewhere, right? In testing hybrid vehicle cables, instead of water pressure, there's electrical pressure (voltage) that the Megohm meter supplies.

This is why you need to use a Megohm meter since it allows the user to select 1,000 volts, which is just a bit under the 125 percent of the water pressure we would use in testing a pipe. The working voltage on most hybrid systems is about 500 AC volts. The insulation test uses nearly double of the required high-test voltage to detect leaks for us.

We would select the 1,000 volt test range on the Megohm tester, since that would be about double of the working system voltage as recommended by the OE. Whether or not cables or MGs pass an insulation test tells us if there is damage. Providing the proper test voltage is important when working on hybrid vehicles in order to confirm that the HV system is leak free.

Start any testing of the HV systems by first powering down the high voltage components and isolating the HV battery assembly. Keep in mind that many hybrid systems use HV capacitors that need time to bleed off before

Testing HV Cables

Take a look at the following test where the black lead of the meter is on the cable terminal end and the red (special lead that allows the user to press the white button to supply 50 to 1,000 volts) is on the shield and cable. The first test is checking the shield to the cable making sure they are not shorted.

The meter display of 2.2 gigohms/1,000 volts shows us the shielding and the cable are not shorted. The next cable I tested displays a different reading: 0 ohms of resistance/1,000 volts. This result shows us the cable is shorted to the shielding. Any reading under specification spells failure for the cable and requires the cable to be replaced.

HV Motor Generator Windings

We used to do Ohm resistance tests of the windings in a traditional three-phase alternator. Testing the windings in a hybrid motor-generator is pretty much the same thing. We need to check for voltage leaks to ground and between each winding and its partners.

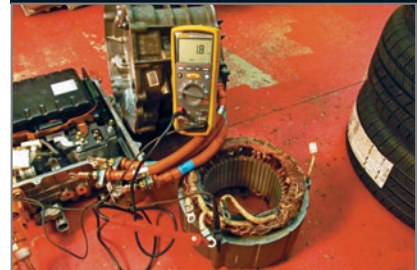
You don't have to take the MG out to perform this test. Just disconnect the cables from the Inverter/Converter after powering down the system. Start by connecting the black Megger meter lead to the MG's ground. Then, using the red meter lead, check the insulation resistance on each lead. On the Prius MG2, the three leads are labeled U, V and W. As with the cable test, a good reading should be near 2.2 gigohms/1,000 volts. Any reading under the specification listed by the manufacturer is a fail.



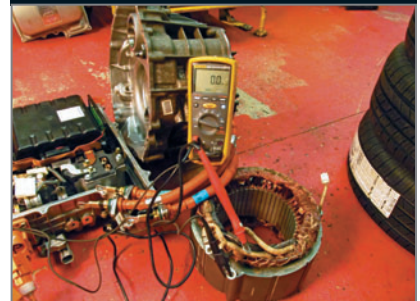
Here we're testing the cable and making sure it's not shorted to the shielding. Meter reading is 2.2 Gigohms.



Here I wanted to simulate a bad (shorted) cable reading. Replace cables that have failed; never try to repair one.



Here is an MG stator that is known bad, testing for short to ground and using the stator core as the ground point just like we used to use when testing alternators.



The MG has three windings (three phase), and each pair of windings needs to be tested to see if any of them are shorted to another. This is a bad reading.

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Parameter	Value	Units
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U PHASE AMPS	-2	A
MPV MDC AMPS	2	A
BATV MDC AMPS	6.0	A
SOC	26.0	%
TARGET AMPS	0	A
BMV VOLTAGE	151	V
BATTERY	11.48	V
MOTORS SPD	0	RPM
VEHICLE SPEED	0	km/h
D.C. TEMP.	22	°C
H.V. VOLT	400	V
MPV Voltage	156	V
MAX REQUEST	0.0	W
MPV MDC TEMP.	25	°C
MOTOR ECU POWER SOURCE VOLTAGE	11.48	V
METER SOC	61	%
PTC VOLTAGE	0.06	V
IMA BATTERY TEMPERATURE SENSOR 1 VOLTAGE	2.58	V
IMA BATTERY TEMPERATURE SENSOR 2 VOLTAGE	2.73	V
IMA BATTERY TEMPERATURE SENSOR 3 VOLTAGE	3.06	V
ASSIST LIMIT CMD	OFF	
RE SRC LIMIT CMD	OFF	

Scan tool data can be helpful in identifying insulation resistance issues. Just keep in mind that some PIDs are inferred and not actual measurements.



Like any resistance test, be sure the tested part is isolated for accurate results.

If the individual windings pass the ground insulation test, move on to the windings themselves. Connect the leads to the meter in pairs. It's not a good practice to test the cables while they are connected to the Inverter/Converter.

Our Megger is checking one of the two HV battery cables to check if the cable is compromised from the shield to cable or body ground (when tested on the vehicle). If the meter displays the 2.2 gigaohms, the wiring is good. Our in-vehicle test from the HV battery pack cables and Inverter (disconnected) are being tested to ground with our black meter lead on ground and the red lead on the cable connector(s), both cables have to be tested. The next test is making sure that the shield to ground is OK and the last test is the cable to shield test to make sure that the cables are in good shape.

To perform this test in the vehicle, remove the cables from the Inverter and HV battery and then install your Megohm meter to each of the three

MG winding cables (the U, V and W) and ground. Connect the black lead to the case and the red lead to one of the cables from the converter and press the white button to see if the reading are good or bad. You need to perform the same test from every cable to the case ground and from each terminal to the others to make sure the wirings are not shorted to one another.

Scan tool Parameter Identifiers (PIDs) might be available that will display the resistance of the cables. The normal reading is about 400,000 (400K) ohms. Lower readings indicate a cable is leaking or grounded. Any scan tool data that has a Diagnostic Trouble Code (DTC) with a description of a decrease in resistance or short circuit indicates a HV cable or MG problem. The cables might have been compromised by debris, obstructions in the road or an accident.

In case you are thinking that you can tape or repair a damaged HV cable, remember these cables carry a lot of punch and are exposed to rain, snow, dirt and salt. There are no acceptable repairs other than complete replacement. **ZZ**



G. JERRY TRUGLIA
CONTRIBUTING
EDITOR

G. Jerry Truglia, president of Technicians Service Training, has been in the auto repair business for a long time as a tech, shop owner and nationally recognized trainer/author. He founded TST to bring affordable training to his fellow techs and shop owners.

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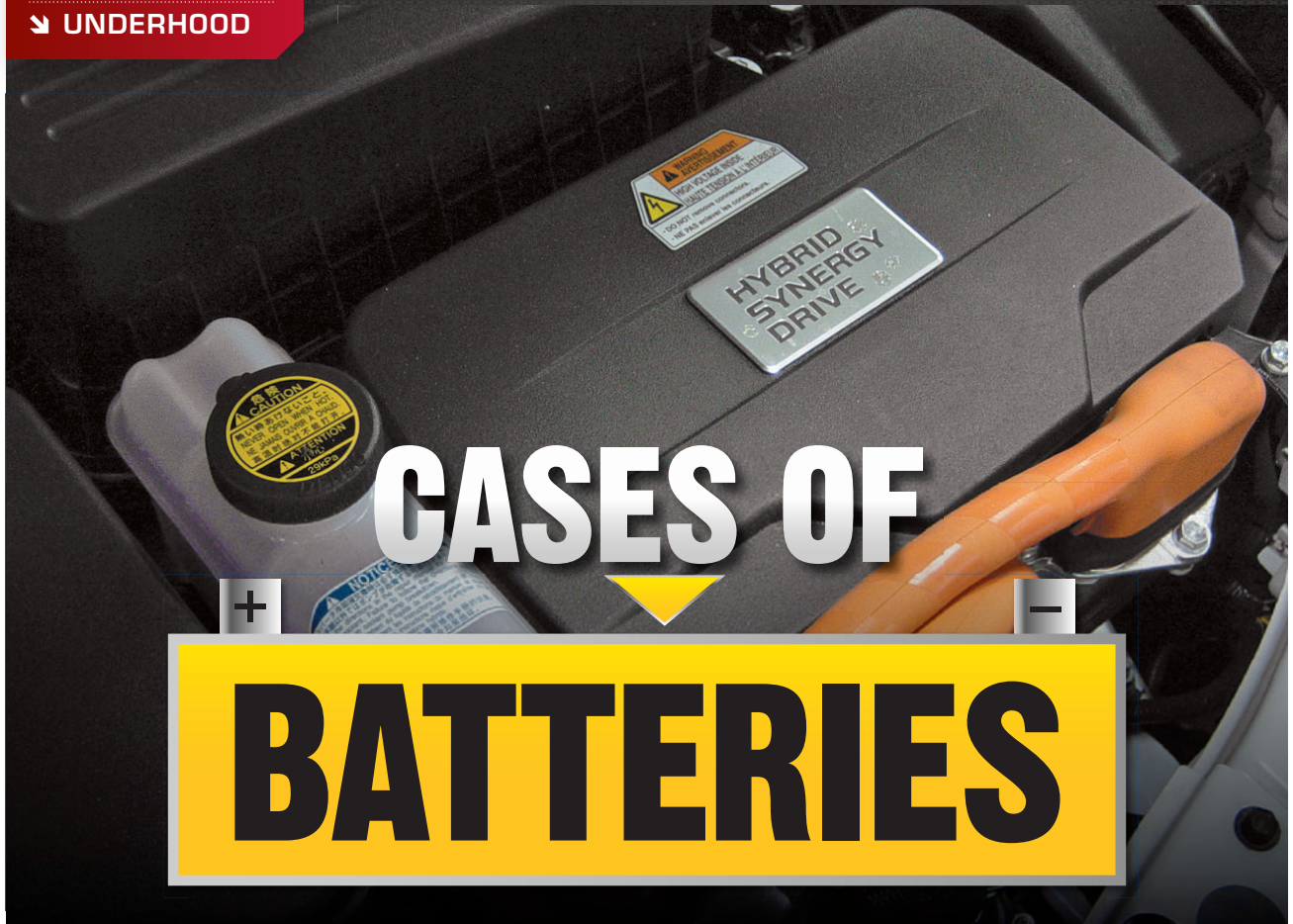
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A FIRST LOOK AT CASE STUDIES FOR HEV BATTERY SERVICE.

BY **MARK QUARTO** | CONTRIBUTING EDITOR

Editor's note: In part one of this two-part series, Mark Quarto explains the importance of proper testing and the testing methodology used in his case study, as well as sharing the testing results noted on the first of three battery modules analyzed. This feature is available in its entirety online, or you can enjoy the second half in print in our February issue.

Hybrid electric vehicle (HEV) nickel-metal hydride (NiMH) battery service or replacement is a topic often written about or discussed today. Many of the discussions focus on the proper analysis, diagnosis, rebuilding or conditioning of the HEV battery pack. There also is high interest in how to determine the quality of the battery packs commercial rebuilders offer or where to purchase them.

There are evolving discussions about the difference between remanufactured, rebuilt and conditioned battery packs – or a battery pack that utilizes a combination of rebuilt and conditioned. A remanufactured unit is a component/

sub-system (i.e., transmission, engine, battery pack, etc.) that meets or exceeds the original equipment manufacturer (OEM) specification, requirements and overall performance. A remanufactured component also receives a full spectrum of documented component testing including end-of-line testing. This includes the system controller. Rebuilt is a component/sub-system that has only defective, malfunctioning or worn components replaced.

A conditioned battery pack is defined as a battery that has had its NiMH modules balanced and capacity increased through the use of a cycling process, or lithium ion battery capacity recovered



through basic cycling. However, in the conditioning process, no battery modules or other supporting components are replaced. Within the conditioning process, the battery modules will be cycled. Cycling is a meticulous process of discharging the battery modules to 0 percent state-of-charge (SOC) and recharging them to 100 percent SOC to determine the current energy capacity and recover its (NiMH only) overall energy capacity capability.

NiMH battery modules might need to be cycled two to four times to recover or “grow” the battery module capacity. The conditioning or cycling process typically can recover a battery module to 88 to 95

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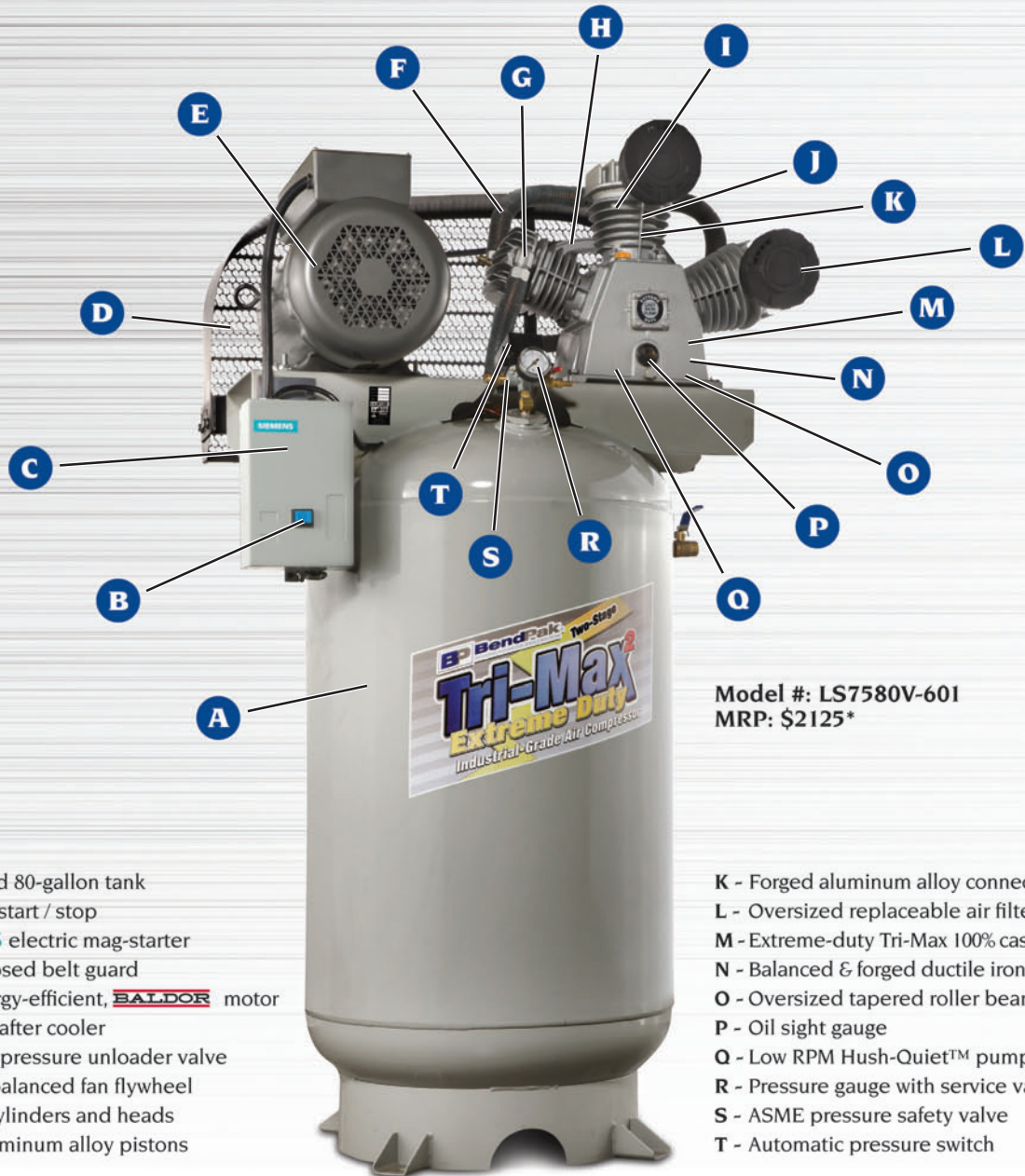
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percent of its rating when it was new. Conditioning will not recover battery module cells that have been damaged by over-temperature, over-charge, electrolyte leakage or over-discharge, but it might recover capacity in batteries with long stand-time (i.e. long storage time).

All battery packs in this study were removed due to faults reported by the vehicle's Controller Area Network (CAN) to the battery controller. However, it should be noted that the battery controller is capable of triggering a CAN fault message only if there is a gross battery pack or battery module failure through using dynamic direct measurement of battery pack or battery module terminal voltages. Battery pack energy (capacity) or state-of-charge percentage (SOC) is a complex software calculated value that is not directly measured. It can vary from 2 to 15 percent, depending on vehicle operating variables such as drive cycle (highway or city), ambient temperature, geographic location, terrain and frequency between drive cycles (stand time).

There is minimal correlation between NiMH terminal voltage and capacity. The voltage vs. capacity curve of a NiMH battery module is relatively flat. Therefore, using terminal voltage to determine SOC percentage is not viable or recommended.

The SOC percentage value also can become skewed as mileage increases. However, skewed (inaccurate) SOC percentage is not reserved for only high mileage vehicles. Depending on operat-

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ing variables (mentioned earlier), Automotive Research & Design has tested battery packs with less than 50,000 miles and model year ages of less than four years with severely depleted capacity (SOC percentage) without battery pack or module DTCs. Any battery pack with reduced energy (or power) capability can cause vehicle fuel economy and acceleration performance to degrade during its service life.

As an example, some vehicle owners that have had battery conditioning or rebuilding who reported combined city/highway fuel economy numbers of 46 mpg when their vehicle was new also reported 33 to 35 mpg after five or more years of driving. Fuel economy numbers after battery pack conditioning/rebuilding are derived from customers using their usual drive cycle, gallons of fuel/fill, and number of miles driven as the data points. None of the owners report intermittent or hard fault DTCs, while their fuel economy numbers were decreasing over time. It should be noted here that none of the owners changed any other vehicle metrics after their batteries were serviced (i.e., tire pressure, engine, ignition system, fuel system or filters).

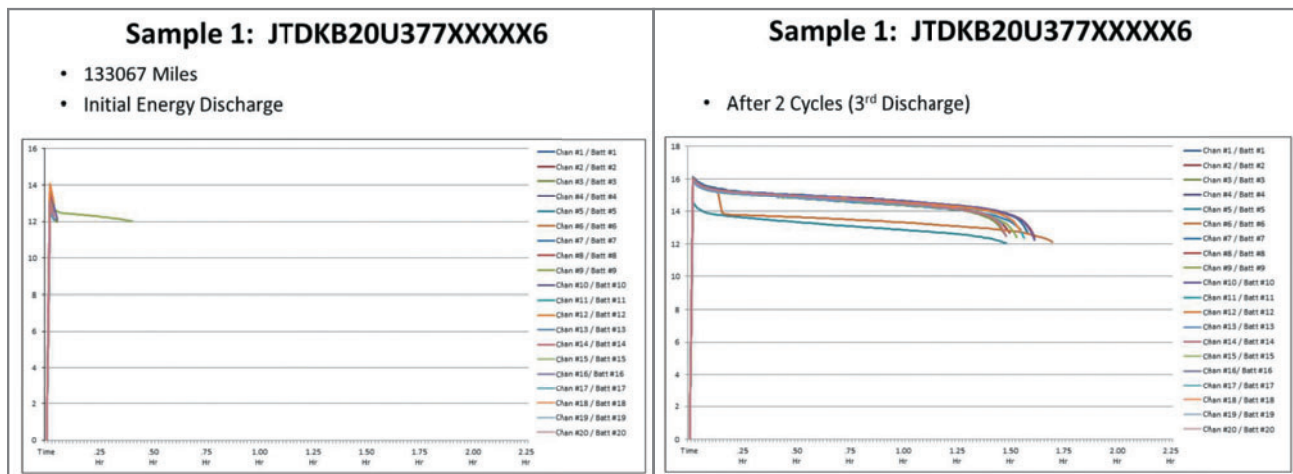
What does the aforementioned information have to do with a case study? The answer is relevance. First, the case study results mirror and support the AR&D historical data/experiences that have been documented on customer battery packs in past years. Second is

applying the case study data to after-market battery pack rebuilders and/or distributors of rebuilt battery pack systems. Specifically, technicians might be relegated to relying on suppliers that may or may not have the expertise to properly test, analyze or repair the battery pack modules or related systems.

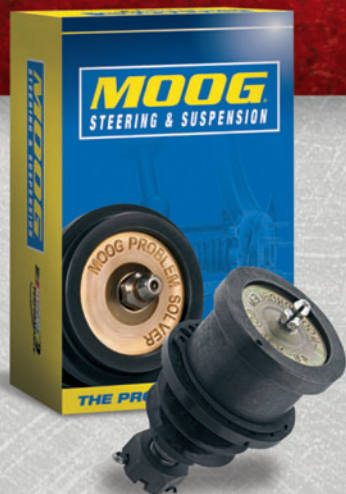
With the aforementioned definitions and rationale baseline information, we can move into our battery case study. The case study focuses on battery packs that have been conditioned and rebuilt as part of a larger NiMH research study project conducted at the AR&D lab at the request of a large OEM hybrid manufacturer. The case study data utilized for this article was garnered from testing three Toyota Prius battery packs. The battery packs in the study were extracted from vehicle model years 2004 to 2009 with mileages that ranged from 80,436 to 133,067.

Data Discussion

The data discussion will begin with describing testing and the data analysis for each battery pack in this case study. Though power testing for each battery pack had been completed as part of the entire testing protocol, the power test data will not be included as part of this case study article discussion because this case study focused on recovering battery module capacity (amp-hours) and identifying battery modules that are not performing or delivering the necessary capacity and needed replacement. All batteries were power tested as part of the normal battery testing and analysis process, and each battery provided excellent electrical power output after conditioning and rebuilding.



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The case study battery packs provided to AR&D had less than 60 days of time since removal from a vehicle. Therefore, capacity loss due to self-discharge is negligible (≤ 1 percent amp-hour loss/month at ≤ 50 percent SOC) for a Panasonic prismatic battery module. In a Toyota Generation II Prius battery pack, the battery pack contains a total of 28 battery modules.

Each module contains six battery cells rated at 1.2 volts/cell or a total of 7.2 volts (50 percent SOC) nominal voltage. The 7.2 volt modules are connected in groups of two modules or voltage (V) blocks for a total of 14.4 volts nominal per V-Block for a total of ≈ 202 volts dc. Therefore, when testing the battery pack modules, the testing will be performed by testing the 14 V-Blocks. In the event that one of the two battery modules in each V-Block is not performing, it easily can be monitored and identified during testing to determine that it is under-performing.

Sample 1 Prius Battery Pack

Sample 1 battery pack was tested with 133,067 miles. Because the total battery pack amp-hour counting data was not available from battery pack controller CAN data, actual amp-hour data is not known. The total capacity on the initial energy capacity test was < 0.15 hours. What this means is that the battery pack capacity was severely depleted.

Based on AR&D experience, the vehicle in which the battery pack was removed would have had significant fuel economy reduction and poor acceleration performance. The voltage cut-off level (12 volts/V-Block or 1 volt/cell) for each of the battery module groups was reached very quickly and was low during discharging. The terminal voltage of the 14 V-Block battery module testing channels was ≈ 12 volts at 0.15 hours total discharge time. Therefore, the total amp-hours for the initial discharge is 0.35 amp-hours.

A typical battery pack with good energy capacity health would have registered a minimum of 2.40 to 3.0 amp-hours or 40 to 50 percentage SOC. Channel No. 9 did have more capacity than all other channels (≈ 0.40 amp hours), but its voltage was extremely low for the entire discharge. This would mean limited capacity due to severe cell crystal growth or permanent cell damage could cause the module voltage.

After two cycles (third discharge), the battery modules have begun to recover most of their energy capacity. Most of the modules have near 1.5 hours of discharge time (or 5.25 amp-hours) of capacity. This is ≈ 87.5 percent of new module capacity. There is approximately 13 percent difference between the highest capacity and lowest capacity module. Though it is optimum to maintain < 10 percent capacity variance between modules, the capacity of 12 of the 14 V-Block groups of this battery pack have excellent capacity coupled with good terminal voltage.

The remaining 12 V-Blocks, if used in the same battery pack, would provide good energy production resulting in good vehicle performance. The key to rebuilding an excellent battery pack is to maintain < 5 percent variance between V-Block energy capacities with no variation in terminal voltage. A good battery pack will possess a ≥ 5 percent but ≤ 10 percent variance in V-Block capacities and less than 5 percent variance in terminal voltages.

At this point, the cycling process has not been finished, but we can see there are two channels that have near the capacity of the cluster of battery modules. These two V-Block groups have good capacity, but notice that the terminal voltages are much lower than the group cluster.

The voltage of these two channels drops to ≈ 1 volt lower than the major group cluster before 0.25 amp-hours has elapsed. This is indicative of major cell damage that cannot be recovered by cycling the modules any further. Though this battery pack has failure of the two V-Blocks, the energy (capacity) in the remainder of the battery modules can be recovered and reused. \mathbb{Z}



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

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WHAT'S NEW IN HYBRID SYSTEMS?

Taking a closer look at Honda's "Earth Dreams" technology.

OEMs CONTINUE TO DEVELOP NEW HYBRID OFFERINGS. ARE YOU TAKING NOTICE?

BY JOHN D. KELLY | CONTRIBUTING EDITOR

What's new in hybrid systems? The hybrid world changed in the last year because of totally new plug-in hybrid powertrain designs from Honda and Ford. Similar systems are being designed by other carmakers.

Who cares? As an automotive professor, I have a hard time finding anyone who does. Hybrids seem like a foreign concept to the majority of the people I talk to, and they almost laugh at me for even asking. The concept of using a hybrid-electric vehicle seems almost cult-like, only for tree huggers. Some people find the hybrid idea interesting, but do not like the additional cost of a hybrid. The majority of people I talk to about hybrid and alternative-fueled

vehicles seem to concentrate only on the cost of the vehicle, not the money saved in decreased fuel costs with the increase in fuel economy or the possible environmental benefits. Hybrids have been available in the United States for 13 years now, but still are far from a vehicle the general population would consider purchasing.

It was predicted that more 15 million vehicles would be sold in the United States in 2013; more than half of them were trucks and SUVs that average less than 20 mpg. It seems to me few people care enough about high fuel prices and energy independence to even consider a hybrid or alternative-fueled vehicle for their next purchase. Last summer, Toyota announced that it had sold its 5 millionth hybrid vehicle

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worldwide; just a little more than 2 million of them have been sold in the U.S. in the last 13 years. All other manufacturers of hybrid vehicles fall short of Toyota's 5 million hybrid milestone.

So once again I ask, "Who cares?" You should. Why? Because you are going to see a lot more hybrids in the next few years due to U.S. Environmental Protection Agency (EPA) tailpipe emissions regulations and National Highway Traffic Safety Administration (NHTSA) Corporate Average Fuel Economy (CAFE) fuel economy regulations.

Hybrids and electric vehicles are an easy way for a car company to balance the scales to compensate for the low

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fuel economy and high tail-pipe emissions from all the trucks and SUVs sold. Without the clean and efficient hybrid and electric vehicles, they would not be able to sell as many not so clean or fuel efficient trucks and SUVs. Almost every car manufacturer now has hybrids or electric cars available, even the Chrysler Group.



Honda

The new Honda Accord Hybrid and Honda Accord Plug-in Hybrid are what really have interested me this year. In my opinion the new Accord is not as good looking as Ford's new Fusion hybrids, but it does have a higher mpg rating, especially in the city (50 mpg).

Until now, Honda's hybrid systems consisted of its Integrated Motor Assist (IMA) system, a single electric motor-generator sandwiched between the internal combustion engine (ICE) and the transmission. Honda's IMA system is not as efficient or as powerful as Toyota's hybrid systems. Many other carmakers use an IMA clone for their hybrids (Hyundai, Kia, Audi, Mercedes, VW, etc.).

The new Accord Hybrid/Plug-in Hybrid system (called E-Drive) is totally different than the old IMA system. It has a 320-volt Lithium-Ion battery (compared to Honda's 144V or 158V IMA systems), and it uses two electric motors/generators. At first glance, I thought it was another variant of the Toyota Hybrid Drive system (two elec-

tric motors with a single or double planetary gear set in between them), but I was wrong.

The new Honda two-motor hybrid is a totally unique design that has some great benefits.

The E-Drive trans-axle contains two electric motors-generators. The smaller motor-generator functions primar-

ily as a generator for the high voltage battery, but it also is the starter motor. The larger motor-generator functions primarily as a drive motor to propel the vehicle, but it also functions as a generator for the high voltage battery when the vehicle decelerates or brakes (regenerative braking).

You might ask yourself, "How is the new Honda E-Drive any different than the Toyota hybrid system?" The big difference is that Honda's two electric motors are not connected together inside the transaxle, while Toyota's are. This means the speed of one electric motor has no effect upon the speed of the other motor in the Honda E-Drive system. (One motor can be totally stopped while the other is rotating.) Why does that matter?

The Toyota hybrid system electric motors have maximum rotational speed limits. Toyota hybrids have the two motors connected together; one motor over-drives or under-drives the other. This means the gasoline engine in Toyota hybrid systems must start at a certain vehicle speed (62 mph) to prevent one of the motors from going over the speed limit. The Honda Accord does not. The Accord



This C-Max window sticker will be updated to reflect a slightly lower mpg rating, brought on by customer complaints.



If you're working on hybrids, you're getting used to the underhood appearance.

hybrid can drive on battery power up to 80 mph (Ford's Fusion top EV mode speed is 85 mph). This results in increased fuel economy for the Honda design (47 mpg) versus the Toyota design, especially when compared to the Camry and Avalon hybrids.

“By the way, proposals for CAFE requirements beyond the year 2025 already are underway and they will make 54.5 mpg look low.”

The new Accord Plug-in hybrid is the only hybrid vehicle I know of that has three truly different modes of operation. Honda's E-Drive system can run on battery power only (EV Mode), combined engine and electric motor power (Hybrid Mode) or at higher vehicle speeds with low load, gasoline engine power only (Engine Mode). The Accord Plug-in hybrid can even charge its own high voltage battery while driving if the driver presses the right button. I am not aware of any other plug-in hybrid that can do that.

Ford

This year, the 2013 Ford Hybrid and Electric Vehicle lineup is very impressive. Ford, of course, is the king of truck and SUV sales. It needs to offset its trucks' higher emissions and lower fuel economy with hybrid and electric vehicle sales. Even if Ford loses money selling hybrid and electric vehicles, it can make more money selling more trucks and SUVs because



A sign of times to come: Not a gas door, but an electrical connection for direct charging of the HV battery pack.

of them. I am sure it is a balancing act that adds to the bottom line.

The new Fusion Hybrid and Fusion Energi Plug-in Hybrid are beautiful cars, in my opinion. They both have the new 2.0L Duratec powertrain with a new Lithium-Ion (Li-Ion) battery pack (1.4kWh in Hybrid and 7.6kWh in the plug-in hybrid). These vehicles have an average combined city and highway fuel economy rating of 47 mpg. That is 12 mpg above the 2015 NHTSA CAFE fuel economy requirement for passenger cars, but still short of the 2025 54.5 mpg fuel economy requirement.

You might recall that Ford recently had to revise its mpg estimates for its C-Max Hybrid because of customer complaints of lower-than-advertised fuel economy. Honda and Hyundai have gone through similar sticky situations.

I can tell you from seven years of personal experience with three hybrids and an electric vehicle that you can get very close to, if not exceed the rated mpg ratings on almost any vehicle by driving the speed limit and using the cruise control; it is not that difficult. Many people speed while driving, and speeding always results in lower fuel economy, even in hybrids and electric vehicles.

The Fusion Energi can drive approximately 21 miles on battery power before switching to hybrid mode. Unlike the Chevrolet Volt's powertrain, the Fusion Energi can drive on electric power only or combined engine and electric motor (hybrid mode). The Volt has no hybrid mode, only a generator mode.

The 2013 Ford C-Max Hybrid and C-Max Plug-in Hybrid have almost identical powertrains to the Fusion models. The C-Max had the same 47



Both the Fusion hybrid and the Fusion Energi use the 2.0 Duratec engine package.

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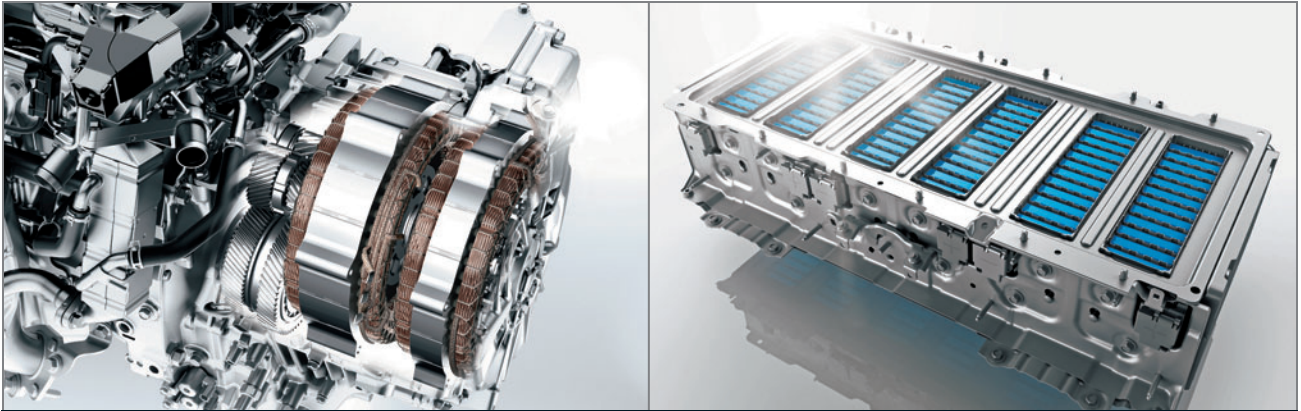
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(Left) Honda's two motor-generators have no connecting planetary gear set like we've come to know in the Prius. (Right) In addition to the new MG design, Honda has updated and increased the capacity of the HV battery pack.

mpg rating when it came out, but has been modified lower because of customer complaints.

To complete the Ford hybrid lineup, the Focus Electric Vehicle (EV) is a zero carbon dioxide (CO₂) emissions vehicle. The Focus EV came out last year, but I wanted to remind you that with every EV sold, every EV mile driven, large amounts of CO₂ credits are generated for Ford to help offset truck and SUV CO₂ levels.

Chrysler, Regulations and CO₂ Games

Chrysler has a hybrid? Not yet, but it might finally have to make one. First, I am not trying to pick on Chrysler in this section. It has just been kind of humorous to watch Chrysler over the years trying to get around the EPA and CAFE rules and sell almost nothing but trucks, SUVs and cars with HEMIs. From my point of view, the old (pre-Fiat) Chrysler seemed to think it didn't need hybrids or cars that get good gas mileage (though it did try to sell a 2008 Durango 2-Mode Hybrid HEMI for about three months before it was forced to declare bankruptcy). Chrysler has a history of choosing to pay the EPA and CAFE fines for not

complying with the regulations rather than developing the technology needed to meet the requirements.

The EPA has now changed the rules to help close loopholes in the CAFE law that allowed fines to be paid instead of complying with regulations. The loophole closing law is the regulation of CO₂ emissions; you must comply or not sell cars. You cannot have low CO₂ emissions without also having good fuel economy unless you purchase CO₂ credits from someone else. This put Chrysler (as well as several other carmakers) in a tight spot.

For 2013, the new Fiat-owned Chrysler (The Chrysler Group) now has a new Fiat 500 Electric Vehicle for sale in California. The 500e will be good for some CO₂ offset credits. The new Dodge Dart is also helping with the credits. In addition to these efforts, Chrysler is using R1234YF air conditioning refrigerant in some new vehicles in an attempt to obtain even more CO₂ credits without using hybrids to offset its truck and SUV CO₂ emissions. Chrysler is not the only carmaker playing the R1234YF CO₂ credit game, joining GM in using the new refrigerant for this purpose. (R1234yf as a replacement for R134a is only required in new vehicle platforms offered for sale in the European Union.)

There are other games carmakers play with CO₂ credits. Electric car company Tesla Motors actually sells its CO₂ credits to carmakers that need them because it does not need them. Much of Tesla's profits come from the sale of its CO₂ credits. Other companies also sell their credits.

I recently read that Chrysler is developing a new small turbocharged 4-cylinder engine with a U.S. Department of Energy grant that should be capable of meeting the EPA Tier-2, Bin 2 emissions requirement. Tier-2, Bin 2 is the same clean tailpipe exhaust emissions level as the Honda Civic dedicated Compressed Natural Gas (CNG) vehicle, just one Bin above Electric Vehicles (Bin 1). The Toyota Prius is Tier-2, Bin 3 (dirtier than Bin 2). I hope Chrysler can pull it off soon.

The new hybrids and plug-in hybrids from Ford and Honda are game changers that could put the rest of the industry in catch-up mode. We even might see a better, more efficient hybrid or battery design appear in the next few years as we approach the year 2025 and its looming higher CAFE fuel economy and CO₂ requirements. By the way, proposals for CAFE requirements beyond the year 2025 already are underway and they will make 54.5 mpg look low. *ZZ*



JOHN D. KELLY
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EDITOR

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

Email John at jkelly@vibratesoftware.com



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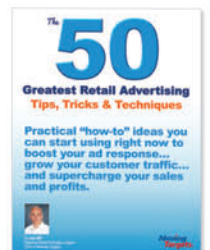


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BY JERRY "G" TRUGLIA | CONTRIBUTING EDITOR

The Digital Multimeter (DMM) and Digital Storage Oscilloscope (DSO) both can be used to measure voltage, but the way each displays that voltage reading, and what you can learn from it, is very different. If you can use a multimeter, you can use a scope, so hold on and let's see where you might want to use the scope over the meter during your troubleshooting.

Try taking your DMM and your DSO and connecting both of them to the battery post until you see a straight line of voltage. Now you get to see the number from the meter and the straight line of voltage on the scope, so what's the difference? While both use digital processors to sample the voltage being measured, the meter shows only the average of the samples while the scope shows voltage over time.

Additionally, most DMMs sample the input voltage at a significantly lower rate than even the cheapest scopes do. Today, many handheld and PC-based scopes are checking the input signal millions of times per second. That means that even momentary losses of the voltage signal will be seen and displayed in a form that is easy for the user to recognize.

Scopes measure time horizontally and voltage vertically. You might be wondering what good does this do you, and why would you want to use a scope. Hang in there and see where it would be beneficial using a scope.

Let's take a look at a common sensor that produces a square wave like a Hall Effect sensor. Now you will get to

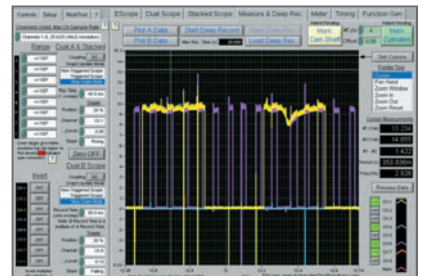
see the difference between the DMM and DSO first hand. Take a look at the square wave voltage on the voltmeter. Do you notice that the voltage is about 2.5 volts? Now take a look at the scope reading that you measured from the zero line noting that each line is 2 volts per division going up from zero. Now you are looking at the true voltage of the sensor that is being displayed.

The other difference between the scope and meter is clearer when we are trying to find out why the engine is dropping out. A meter can update only 40 samples per second depending on the meter, while a scope typically can sample 25 million samples per second. When you are trying to locate a drop out in a sensor you need a tool that is fast enough.

So with all the theory out of the way let's take a look at the example. The problem here is not that hard to see if you look at the cam signal to the left that is good and the one to the right that is bad. The top of the waveform was dropping down in the middle of the square wave causing a drivability problem. The fix for this vehicle was to replace the defective sensor.

Relative Compression from the Driver's Seat

This easy concept came to me as I was explaining relative compression to a class I was teaching in Massachusetts. I was showing and explaining relative compression with the scope connected to the battery B+ and Neg- post while cranking the engine over. I continued to explain that this test also can be performed using an amp clamp attached to one of the battery cables.



The computer doesn't know that the sensor signal dropped out for a millisecond or two. It only knows it didn't see what it needed to see.

Then one of my students asked the following question.

"Since you said this was testing a voltage drop that we were observing with the scope, how about if we connected the scope directly to the Diagnostic Link Connector (DLC) using the breakout box you showed us?" I thought about it and responded back to Jeffery Allan Clark, the tech who asked the question, that I believed he was onto something. I had never really thought about performing the test using a DLC breakout box. In fact, I have never seen anything about this in print or knew of anyone performing this test. I always say in all my classes and seminars that there is no such thing as a stupid question, and everyone knows something that we don't know yet. If we share our ideas we all can learn, and we did.

This test is so easy if you own a DLC breakout box and a scope and can be accomplished with a couple of minutes with any other equipment. First couple (select) your scope to AC volts

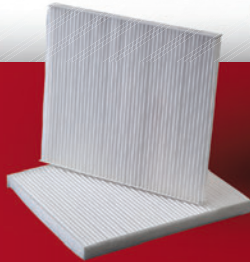
Photos: Jerry "G" Truglia

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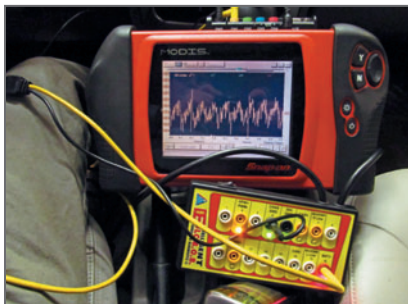
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Any scope platform (like the one in the Snap-on Modis shown here) can be used to perform this relative compression test right at the DLC.



Unusual but not improbable, this air injection system code was a simple carbon clean to correct.

followed by selecting a range on your scope of 500mv AC per division and a time base of 50 ms per division. Many of today's automotive scopes are set up as voltage and time per screen instead of division, so you might have to take the settings I gave you and multiply them by 10.

Next, insert the red (B+) to pin 16 (that's B+) and the black (-) to pin 4 (that's ground) of the breakout box. If the model you're testing uses "Clear Flood" mode, you can disable the fuel system for testing by pressing the gas/throttle pedal. If the vehicle does not have a "Clear Flood" fuel management strategy, you will need to remove the fuel pump relay or fuse to prevent the engine from starting. Take a look at the waveform shown to the left. What

we are looking for is an equal voltage height (amplitude) and time. If there is a difference in height or time, this will indicate a problem in one of the cylinders.

This test can tell you quickly if there is an engine mechanical issue requiring further diagnosis. If you are wondering how you can tell what cylinder has the problem, you will need to remove your butt from the driver's seat and open the hood. Your next step would be to connect another channel of the scope to one of the cylinders, preferably an ignition source, so you can sync the relative compression signal to the engine's firing order.

For example, if the firing order is 1-6-5-4-3-2, and you're second channel is attached to the number 2 cylinder's secondary lead, you can use this as a landmark for precisely locating the weak cylinder. In our case, if the weak peak is two to the left of the peak we've synced as cylinder number 2, the weak cylinder would be number 6. If you add this quick test to your diagnostic game plan you can quickly check to make sure that the engine is good or bad before proceeding with your diagnosis. This test is so important that Ford and Toyota both have included this test in their factory scan tools.


A No Parts Repair

This 1999 Saturn SL 1.9L vehicle came in with an illuminated Malfunction Indicator Lamp (MIL) and a P0410 (AIR Pump System Performance). This DTC can be caused by a blown 30 amp fuse that is located in the underhood fuse box, vacuum line, air hose, check valve and possible restriction in the air hoses or pipes. Where do you start? Using a scan tool that supports bi-directional testing of these components is one option. The GM Tech II is the factory scan tool and certainly has the functionality to check the operation of the secondary air injection system. Unfortunately, not all aftermarket scan tools have the bi-directional functionality to perform these tests.

The next easiest place to start is at the load. In this case, the electric air pump is the main component in this system. First turn the ignition key off and remove the connector at the pump, turn the ignition key back on and test which side of the connector has

power. If either side is "hot," you just confirmed that the fuse is good. With power to the pump confirmed, it's time to check the PCM side that supplies the ground needed to complete the circuit and operate the pump. To check to see if the pump can operate, connect a Power Probe or a set of fused jumper wires to supply power and ground to the AIR pump. This should confirm if the pump is good or bad.


"This test can tell you quickly if there is an engine mechanical issue requiring further diagnosis. If you are wondering how you can tell what cylinder has the problem, you will need get out of the driver's seat and open the hood."

In the case of this SL, the pump was good. Our quick test eliminates a short to ground or a faulty pump, all in less than a minute. Because the pump was able to supply air pressure we checked the hose and pipes to the check valve to make sure they were free and clear. Next we removed the hose from the other side of the check valve and found the problem. Take a look at the carbon buildup on the check valve port that goes to the cylinder head in the included photo. The fix for this vehicle was to use intake cleaner along with a drill and pick to clean the passages of carbon. 



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G. Jerry Truglia, president of Technicians Service Training, has been in the auto repair business for a long time as a tech, shop owner and nationally recognized trainer/author. He founded TST to bring affordable training to his fellow techs and shop owners.

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HANDLING A TRIAGE UNIT

A GOOD MECHANIC HAS TO APPLY CRITICAL THINKING TO DETERMINE WHAT NEEDS DOING, GUMPTION TO GET IT DONE AND INTEGRITY TO DO THE JOB RIGHT.

BY **RICHARD MCCUUSTIAN** | CONTRIBUTING EDITOR

Driving a vehicle and expecting things to go well is one thing, but when repairs are necessary, the customer calls the shots. However, we have to guide them to make decisions that are right for them. To start, we have to determine as accurately as possible what they expect to get out of an aging vehicle after the repairs are done. Will they be making long trips, pulling heavy trailers or just pattering around town on the weekend?

First we have to find out what the problem is, and that's where it all started on this F150.



A MISSING MIL

1998 FORD F150

Vehicle Year/Make/Model

4.6L

Engine

4R70W TRANSAXLE

Transmission

201,054

Mileage

CHECK ENGINE SKIP — NO MIL

Vehicle complaint

Coming Back for More

When customers have a good experience at a shop, they generally return to that shop. This customer was no exception. We have worked on her vehicles for a while, and this particular truck was one we had replaced the wires and spark plugs on a few months earlier. She asked if she could bring it to us, and I gave her the green light.

When the truck arrived and the paperwork was done, it had a P0305 code and a dead skip, but no MIL at all. Upon hearing this report from my guys, I sat in the seat and switched the ignition on to find that the MIL was inoperative. That dark and dead MIL would need fixing to be sure, but it wasn't our primary concern. No. 5 was a dead hole, but the injector was clicking, spark was present and the spark plug didn't look greasy. With the obvious out of the way, it was time to put on our detective hats. When Webb and Kelley, a pair of students, came into my office and put the known facts on the whiteboard, I put on my Horatio Caine "CSI Service Bay" sunglasses and said, "OK, this is what I want you to do. Get a compression

gauge screwed into that hole and let's see how far that No. 5 will push the needle. Spin the starter through for at least six puffs."

As I heard them cranking the engine over, it was obvious to my practiced ear that the crank was picking up speed during one of the eight compression strokes, and I knew which one it was. But the cause of the dead cylinder had to be further pinpointed, and we needed more data to complete our forensics.

After the six puffs, the needle pointed to 70 pounds of compression. Their questioning glances said, "What now?" The next logical step was a no-brainer.

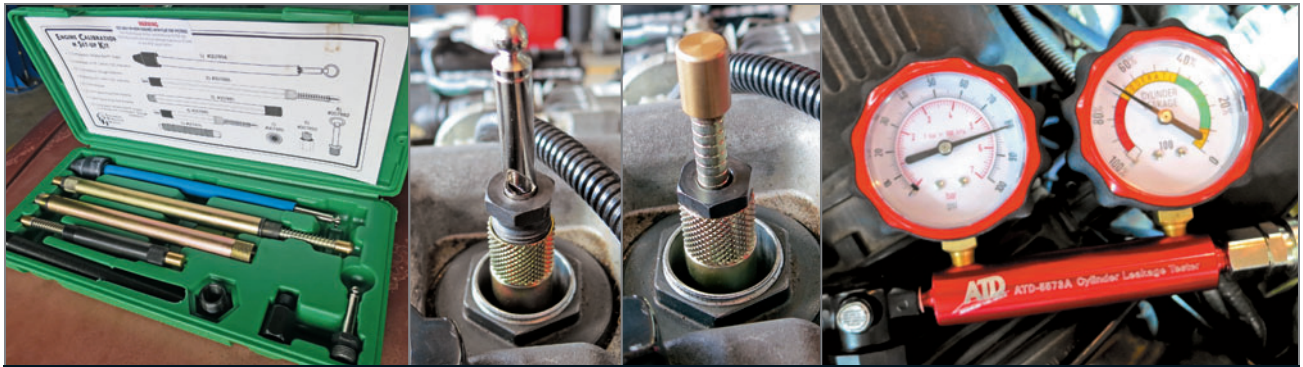
"Now," I told them, "we find Top Dead Center (TDC) compression stroke on that cylinder and do a cylinder leak-age test."

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This engine calibration kit (left) is a tremendous help in finding TDC on unmarked cylinders to do an accurate leak test, which was a necessity when we were gathering solid data on the skipping 4.6L (right).

There are a number of ways to do this on a cylinder that has any compression, and it's especially easy when the cylinder in question is the No. 1 hole or its companion. But what about the unmarked cylinders? Since we have an IPA Tools® Calibration and Set Up kit (No. 7891), finding TDC is a snap on just about any cylinder. First we screwed the IPA whistle adapter into the spark plug hole, and the 70 psi of compression that piston was pushing was plenty to make the whistle tweet as the cylinder was coming up with valves closed. That got us on the right stroke, but we needed to TDC that piston or else the air we were about to apply during the cylinder leakage test might blow it back down, driving the train to open a valve and invalidate our test.

To bring No. 5 to exactly TDC, we applied the spring-loaded IPA TDC finder and brought the piston squarely to the top of its travel. With those tools put away, we did a cylinder leakage test and found just under 70 percent cylinder leakage. It should have been a lot less than that, and now we had two rock-solid bits of data, three if you count the DTC.

"OK, guys, ordinarily we'd do some listening exercises with the air flowing through the leakage tester, but why don't we apply smoke to that cylinder and see where it makes its exit?" I asked the students.

With the throttle propped wide and the smoke flowing through the leakage tester hose into the chamber, we saw smoke immediately come wafting out of the throttle body. We obviously had an intake valve that was compromised for some reason, and I would need to talk to the customer about this one. If the intake valve had been totally open — 100 percent leakage — exploratory surgery might have been in



This tattletale smoke trace from our Evap Tester pointed to a compromised intake valve. Capping the intake and pumping smoke into it wafted smoke out the feed fitting, too.

order to check for a broken valve spring. As it was, this head would seem to be a candidate for a valve job, and that's a pricey repair on a 200,000-mile 4.6L. Timing chain kits, gaskets and everything would put this repair estimate in the stratosphere. A used engine might be in order if they weren't planning on using the truck for another 20 years, and I called LKO, which priced me a used one for \$650. I left the F150 in a holding pattern and left a message for the owner to call me.

Dribbling Green

We had replaced the radiator and repaired the A/C in a 2003 Chrysler 300 at about the same time we did the plugs and wires on the troubled F150, and now the 300 had pushed its



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temp needle high again, but for a different reason. We also had a transmission swap under way on a 2002 PT Cruiser and would need to check that one for an overheating problem, too. I had a couple of guys working on the PT, but I re-assigned the guy who was assisting with the Cruiser and had him tackle the 300, which, when we pressure tested it, turned out to have coolant leaking in a thin stream from behind the balancer. This one needed a water pump and a

timing belt, and Garrett, another student, needed to do a timing chain and a water pump anyway.

We also diagnosed a 2007 Altima with a delayed reaction blower motor issue. The owner would start the car and for five minutes the blower was inoperative, then it would come online. We duplicated that concern quite easily and did some voltage checks at the fuses. After we transposed the blower and defog relays, the problem went away. I ordered a replacement relay (\$30), but it's still laying on my desk; a delayed defogger just isn't as noticeable as a windless fan. I'm still foggy about how a relay can cause that problem.

Speaking of fans, a guy came in with a Mustang that day because he wanted us to replace his cooling fan motor, which was fresh fried and stinking.

This episode of The Trainer shows different scope techniques used to assess engine mechanical condition

MotorAge.com/nov11trainer

The reason for the fried fan was a distorted shroud, which had fouled the fan and kept it from turning until the windings were cooked. We had to explain that he needed every part of the fan, not just the motor, and more money would need to change hands to make that happen, but the bill wasn't too bad.

Back to the 300. Because Garrett had to jerk the fan and radiator to access the timing cover properly, we decided to check the cooling fan motor for open commutator segments, because a bad fan can be famously intermittent, and it's smart to do that.

The Dirty Hand is Dealt

The F150 owner called back and opted for the used LKO powerplant, and the real adventure began.

Replacing the engine in a 1998 F-150 isn't for the lazy, wimpy or faint-hearted, and that's why I gave the job to Willie, who is a Vietnam veteran, older than I am and tough as nails. Willie got the engine installed, but not before we had to buy a \$30 eight-bolt flywheel from a local salvage yard because the original engine had a six-hole crankshaft and the original flywheel wouldn't fit. I called LKO, which verified that the vehicle in question could have either a six- or eight-bolt crank on a Romeo 4.6L. It would be several days before he could get us the right flywheel, so we patronized the local salvage yard.

When the replacement engine was in place, we found it spinning with almost no compression along with intermittent backfiring through the intake. After checking and re-checking the spark plug wire routing, we measured the compression and found one cylinder with 99 psi and 40 to 60 psi on all the others. Adding oil to the cylinders did nothing to improve the compression, and while we didn't do exploratory sur-



Here was the original engine coming out. Some techs raise the body off the frame to do this, and Willie opted to remove the transmission first – both times.



This flywheel issue kind of blind-sided me. I wondered briefly if we had received a Windsor engine instead of a Romeo, because the crankshaft and flywheel must have come from two different vendors in that year model F150.

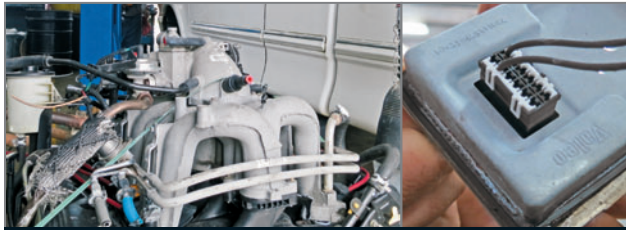


Here is the 300 with its leaking water pump. Garrett managed to break one of the 6 mm water pump bolts off and had to center drill and work the broken piece back out of the aluminum housing with an extractor. It was pretty dicey on a bolt that small at that angle.

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(Left) This is the second replacement engine, which was a lot cleaner and ran like a dream once Willie got it planted. (Right) The high-dollar HID headlamp driver from the Cadillac is mounted in the bottom of that housing. It is just made to capture any water that manages to get in.



(Left) This situation grew from a P0128 code on a 2006 Mountaineer that came in while the F150 was there. The engine was running at normal temperature, but the ECT sensor was reading about 50 degrees cooler than the truth. (Right) Willie was making his final tweaks here, and the owner took possession of the truck the next morning. It had been one grand adventure.

gery, it was evident that the replacement engine had spun out of time for some reason. It was dead on arrival, and Willie would need to change it out again.

Back on the Phone

I called LKQ and spoke to the sales guy about it. He asked for the vehicle mileage and installation date, and had his warranty engineer call me on my cell phone. The call came in while I was at the grocery store late Friday afternoon. The guy was nice enough when I explained what we had done and how we had determined the engine was bad, and he wheedled a bit to try and get us to dig deeper to see what the problem with the engine actually was, but I dug in my heels. This was a bad engine and we needed another one. It was as simple as that. He agreed.

With iron resolve, Willie went right to work yanking the bad unit back out. The following Tuesday, the LKQ truck delivered another 4.6L with 6,000 fewer miles on it, and the engine looked a lot cleaner overall. Oh yeah, it had an eight-bolt crankshaft like the first replacement, too, so we would be able to use our \$30 flywheel. Willie re-did the engine swap in a third of the time it took the first time around.

While that second engine swap was under way, I wrote a ticket on a welding student's 2003 Cadillac CTS that was blowing the right hand low beam headlight fuse. The headlamp assembly was awash with internal condensation, and the owner had replaced an inoperative HID bulb on that side, which is no small feat since the bumper cover has to be removed for access. What we found was that the HID bulb's very expensive driver module had collected water.

That module is mounted in the bottom of the lamp housing and tends to gather water that way. He put that repair off for a bit to explore other options.

While Willie was putting the finishing touches on the F150, a 100,000-mile 2007 Hyundai Tucson came wheeling in with a harsh shift. Unless the owner feathered off the throttle at the point of the shift, the transmission would make a hair-raising slam shift from second to fourth, feeling like the Tucson had been rear-ended.

With my MaxiDas online via the Diagnostic Link Connector (DLC), I analyzed the live data while the owner drove, and reasoned that the transaxle actually did shift right when she feathered the throttle, and pegged the problem as a software concern. I had her stop the vehicle and kill the engine, then switch the key on so I could reset the transmission adaptive tables. It was pretty amazing to both of us, but that fixed that problem.

And the ending that made for a perfect day, Willie fired up the Ford and the second replacement engine was purring like a kitten when it left. *ZZ*



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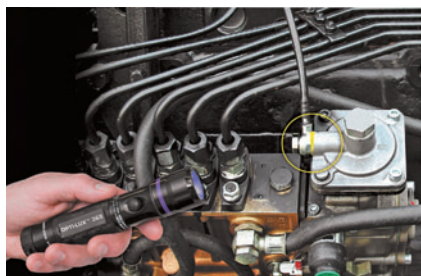
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DIGITAL BATTERY TESTER

Clore Automotive introduces Model No. BA327, a digital battery and system tester with integrated printer, from SOLAR. This model offers a complete testing solution for 6- and 12-volt batteries and 12- and 24-volt charging systems. With an expanded range, the tester is now optimized to test four distinct battery types: SLI (flooded), AGM Flat Plate, AGM Spiral Wound and Gel Cell batteries, the company reports. It features easy, intuitive operation with quick, accurate assessment of battery condition and starting and charging system performance. Testing is quick, allowing the operator to perform either a battery test, system test or both from the home screen. It walks through the test sequence, prompting for key pieces of information and guiding the operator from one step to the next.



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WIPER BLADES

Federal-Mogul's ANCO Wipers brand has expanded its line of premium Contour profile-type ("beam") wiper blades to include coverage for the 19 mm bayonet and side-pin connections featured on several popular late-model European passenger applications. The new ANCO Contour "Narrow" ("N") Series blades are available in nine lengths ranging from 14 to 26 inches, the manufacturer states. ANCO Contour "N" Series blades are available for late-model Volkswagen Beetle, Jetta and Passat and several Audi models equipped with 19 mm bayonet connections, as well as BMW applications with 19 mm side-pin connections. Contour wipers are engineered to provide premium, all-season performance and represent the latest technology in profile-type blades. The advanced one-piece design, featuring Articulated Contact™ Technology, helps prevent corrosion and freezing, while the original equipment-style directional spoiler prevents wind lift and provides superior blade-to-windshield contact for optimal visibility.



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AMSOIL Silicone Spray has undergone a reformulation and packaging redesign. The product is delivered by means of an aerosol spray that effectively lubricates and protects nonmetal surfaces with a dry lubricating film, making it ideal for applications that may be damaged by conventional lubricants such as grease or oil. AMSOIL Silicone Spray provides outstanding protection where light-duty or silicone lubricants are recommended, including rubber, plastic, nylon, upholstery, vinyl, wood, cardboard and other nonmetal surfaces, the company says. Silicone Spray's special non-staining formula also is excellent for waterproofing and protecting leather boots, shoes, jackets, suede and more. For leather and sensitive surfaces, initially apply to a small area. Silicone Spray might



slightly alter the color or hue of the leather. It leaves a clear, odorless film and locks out water while keeping applications contaminant free.

www.amsoil.com
AMSOIL Inc.

WRENCH, DRIVER, LIGHT KIT

Two new ACDelco-licensed 18V 3-in-1 combo kits provide a solution for technicians' needs. The ARZ18CSP1 18V combo kit includes the ARI2061 Li-ion ½-inch impact wrench, drill/driver (ARD2081) and foldable LED light (ARL2025). The ARZ18CSP4 combo kit includes the ARI2060 Li-ion ½-inch super-torque impact wrench with digital clutch, ½-inch drill/driver and foldable LED light. According to the company, the ARI2060 super-torque impact wrench with digital clutch delivers 1,100 foot-pounds of maximum breakaway torque, 700 foot-pounds of maximum reverse torque and 500 foot-pounds of maximum tightening torque. An LCD display shows torque stage, battery indication and torque stage memory functions. The Li-ion 18V ½-inch drill/driver, included in both combo kits, delivers 444 in.-lbs. of maximum torque. The foldable LED light includes a six-position pivot torch for long-distance illumination and LED light for short-distance illumination.



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Champion Oil develops "High-Margin & Profitable" synthetic motor oils for the passenger car, racing, diesel, classic, vintage, hot rod, muscle car, street, commercial, industrial, and the engine builder markets. These "purpose-built" motor oils contain Champion's TVS (Thermal Viscosity Stabilizer), which extends oil film capacity for better protection at high temperatures, according to the company. The Champion oils also contain special lubricity modifiers to reduce friction, and unlock the full potential of any engine by providing increased compression, horsepower and torque.



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EXHAUSTS

SuperTrapp WaveTech Exhausts are designed for four- and six-cylinder sport compact imports. They are tunable, disc-based mufflers with a polished T-304 stainless steel body that includes a polished stainless steel closed end cap, according to the manufacturer. The core is perforated stainless steel. Four different colors of optional end caps are available and sold separately including polished aluminum TrappCaps. Select models of SuperTrapp's WaveTech automotive exhausts include 12 four-inch discs. WaveTech exhausts are available in different lengths and inlet diameters.



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DG511	FD508	IC617	4.6, 5.4L 6.8L 2005-9		\$28.95	24.95
DG512	UF-537	IC558	4.6/5.4L DOHC 97-04		\$31.95	27.95
DG515	FD506	IC518	3.9L Ford T-bird (05-02)		\$24.95	21.95
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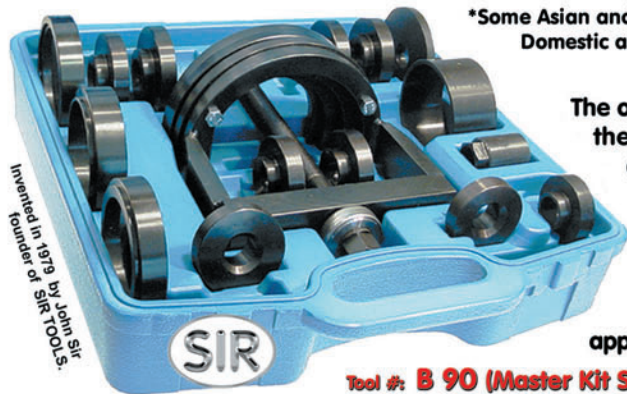
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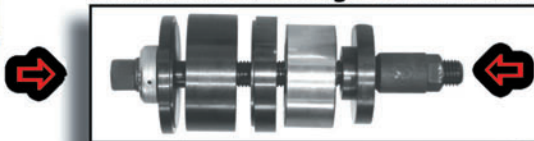
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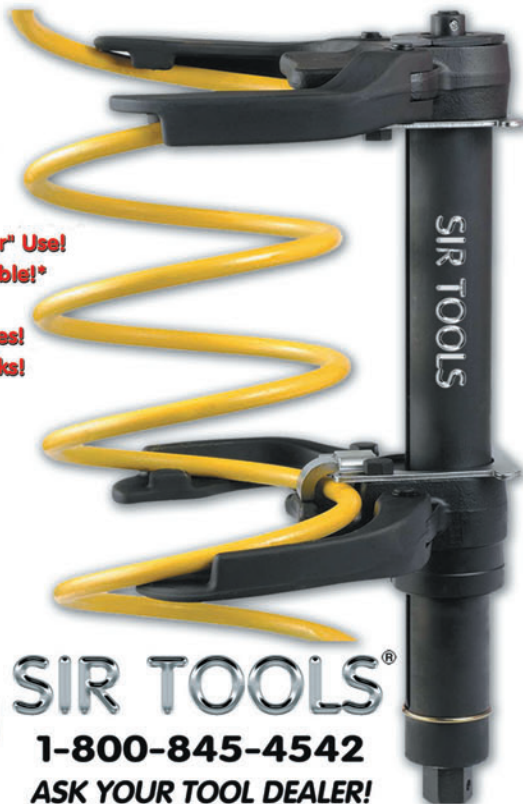
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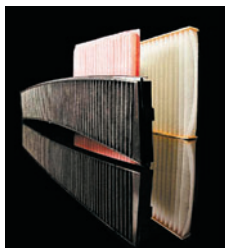
Federated Auto Parts has developed an addition to its friction offering with a new co-label line developed and supplied by Wagner Brake. The new product line is a premium offering designed for professionals that was designed exclusively for Federated members and their customers. The line uses the highest performing formulas specific to each application and includes System Synergy Technology (SST), which is an OE approach to brake design that ensures the interaction of all brake components to provide the ultimate performance.



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Denso

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THE ULTIMATE MOTORSPORTS JACK

Ranger Products recently unveiled its new QuickJack™ portable jack system that makes vehicle maintenance on the track and off convenient and lightning fast. The 3,500-pound capacity lightweight QuickJack can go anywhere, and a 5,000-pound version will be available in early 2014. Simply position the lightweight jack frames under the vehicle, push the raise button on the remote hand-held pendant control and in less than 10 seconds the entire car is almost two-feet off the ground. It features open-center design, rugged safety lock bars, remote pendant control on a 20-foot cord, quick-connect hoses and a built-in flow divider for precisely equalized lifting.



Bendpak

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The new TechSmart® Application and Illustrated Parts Guide for import and domestic cars and trucks is a printed, full-line catalog that features all current TechSmart parts covering more than 75 product categories. Search by make, model and year as well as locate parts in an easy-to-read, full-color illustrated buyer's guide. Visit www.TechSmartParts.com.



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ES 550 INSULATION TESTER

Advance Auto Parts Professional offers the Electronic Specialties 550 Insulation Tester, a quality product ideal for checking voltage leaks on hybrid vehicles. The ES 550 features a large dual display with LED backlighting and can supply test voltages of 250V, 500V and 1,000V for complete insulation testing. For more information on hybrid products, call the Advance tool and equipment hotline at 800-228-9819 or contact your local Advance delivery store.



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BY **PETE MEIER**

Technical Editor

Do you know when the first hybrid traveled American roadways? Your first thought might be the introduction of the Honda Insight, the first mass-produced hybrid offered for sale in 1999. But hybrid and electric vehicle technology actually dates back to 1839, when Robert Anderson of Aberdeen, Scotland, built the first electric vehicle.

In 1898, Dr. Ferdinand Porsche at age 23 built his first car, the first to use front wheel drive. His second car could be considered the first hybrid, as it used an internal combustion engine to spin a generator that provided power to electric motors located in the wheel hubs. On battery alone, the car could travel up to 40 miles.

Sound familiar? Sounds like the same performance offered by the Chevy Volt.

In 1900, American car companies made 1,681 steam-powered cars, 1,575 electric cars and only 936 with a gasoline engine. At this point in American automotive history, only the wealthy could afford a car, and the majority preferred electric. The reasons? Less noise, less mess and they were easier to start.

Beginning in the late 1960s, the U.S. government encouraged electric




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and hybrid designs as a means to reduce air pollution. With the oil embargo of 1973, interest in these designs received an added government boost as a way to reduce dependence on foreign oil. Every administration since has enacted programs to fund research in hybrid technology, especially in the area of battery development.

Today, the United States hosts the largest hybrid fleet in the world with nearly 3 million sold since 1999. During the first nine months of 2013, hybrid sales represented 3.32 percent of total new car sales. Back in 2000, you had two to choose from, and today nearly every automaker offers at least one hybrid model.

With the hybrid fleet aging and warranties expiring, the aftermarket possibilities are beginning to grow. In this

edition of The Trainer, we take a departure from our normal technical how-to and talk to some industry experts on what that means to your shop's bottom line and the right way to enter this potentially lucrative market segment. **ZZ**

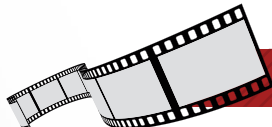
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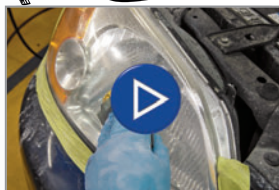
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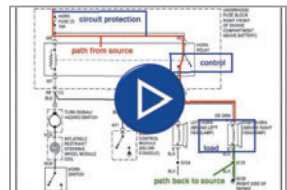
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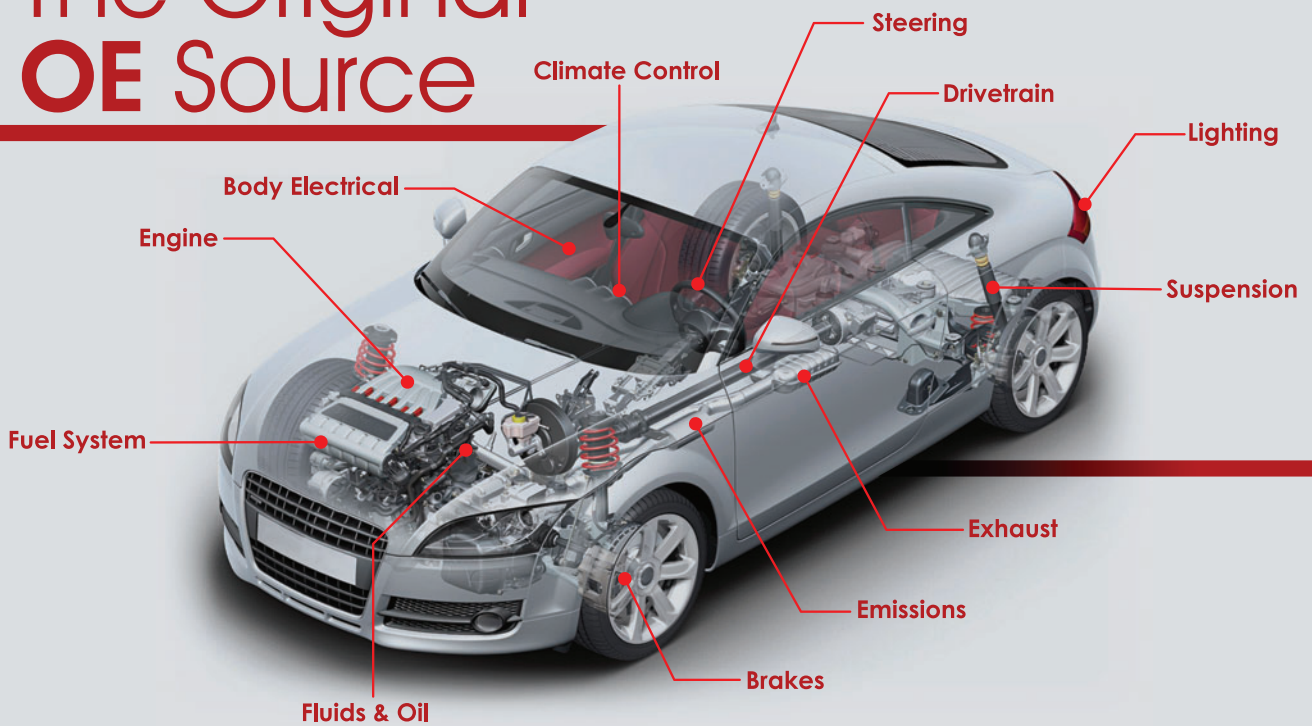
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