Volume 16, Issue 1

January 2019

Technicians Service Training

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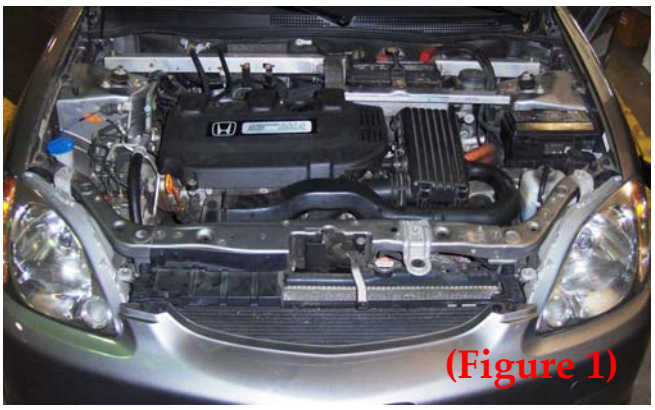
Editor
"G" Jerry Truglia

"Hybrid Vehicle Issues And Fixes"

Hybrid vehicles have been on our roads since the model year 2000 and are now developing problems just as non-hybrid vehicles do. In this article, we will cover a couple of hybrid vehicles that we've diagnosed and repaired. Let's start with the first hybrid vehicle that hit U.S. roads, the Honda Insight. The Honda Insight is not a real common vehicle, but its hybrid system was the foundation that is still used today on the 2018 Acura NSX.

The Problem Insight

This 2001 Honda Insight (Figure 1) came in with a code "78" Honda DTC (Figure 2) that translates to a P1449 (High Voltage (HV) Battery Deterioration). This common code is related to Honda's weak link in the IMA system — the HV battery. The HV battery used on this vehicle is a Nickle Metal Hydride cylindrical cell that has had issues maintaining a balanced charge. Since our problem vehicle is an Insight that only has a 3-cylinder ICE, it is important that the HV battery does its job in supplying power to the overall powertrain output.

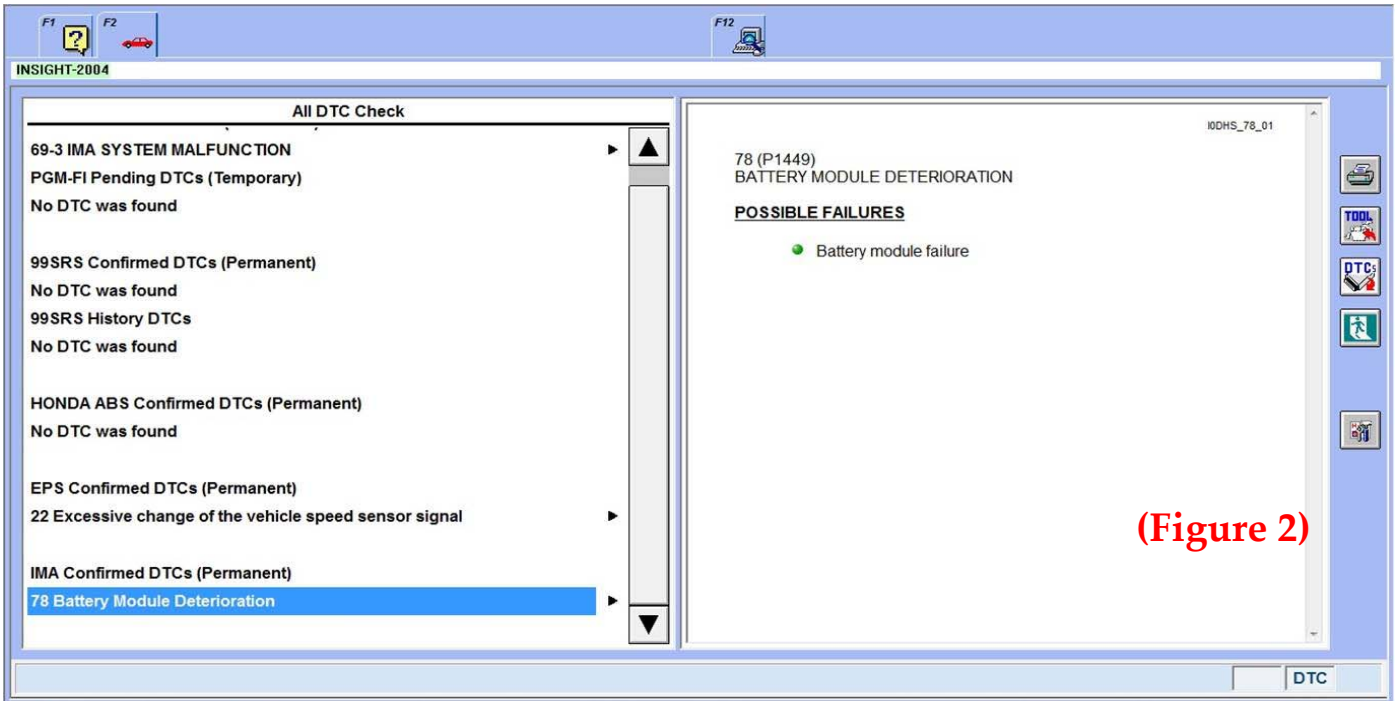


(Figure 1)

(Con't on page 2)

"Hybrid Vehicle Issues And Fixes" *(con't from p. 2)*

The owner of the problem Insight normally does not start or drive the vehicle for over a month. She arrived at our shop complaining of a loss of power and the check engine light illuminated. We performed a visual inspection after speaking to the Insight owner and found a gym bag behind the right front seat. Normally, no big deal, but on a Honda Insight Gen 1 this is where the HV battery vent is located and the bag was blocking air flow to the HV



(Figure 2)

battery. We showed the Insight owner where the vent was located and asked her not to place her gym bag behind the passenger seat anymore. I explained that blocking the vent was causing the problem with the HV battery. I told her that the HV battery needed to be cooled or it would be damaged.

Next, I opened the Insight's hood and proceeded to show her the HV battery label (Figure 3) that states the 144 volt HV battery can become damaged if the vehicle is not driven at least 30 minutes a month. Since the Insight owner purchased this vehicle used about 3 years ago she did not receive any information on how the vehicle operated. She, like many of our customers, thought that you just get in and drive the vehicle like any other.

(Con't on page 6)

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"Hybrid Vehicle Issues And Fixes" *(con't from p. 2)*

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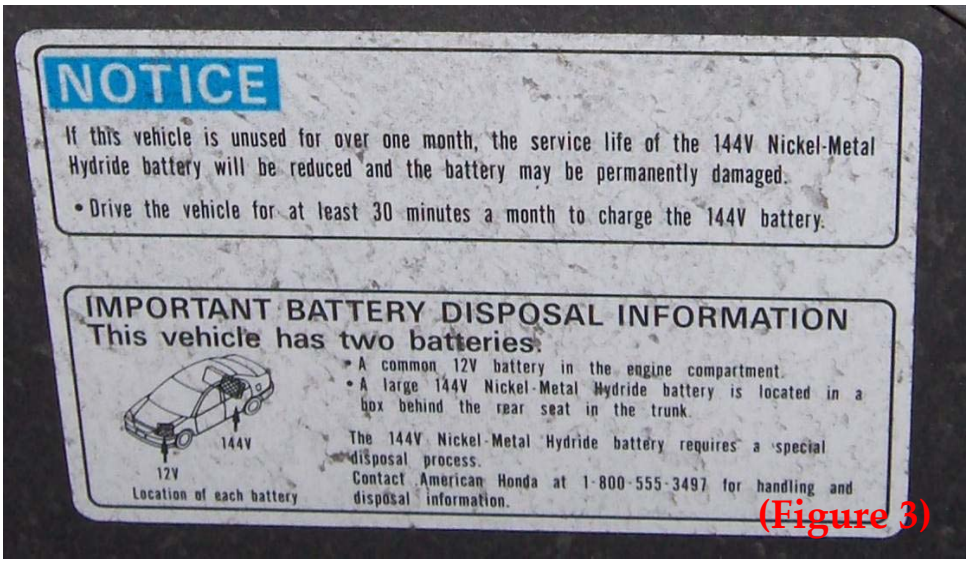

(Figure 3)

After performing a diagnosis, we uncovered an out of balance HV battery so we tried the easiest fix first and performed the MCM (Motor Control Module) Reset. This reset requires starting the engine and holding the RPM at 3500 with no load (in neutral) until the IMA Battery Level Indicator (BAT) on the gauge displays a normal level. Since this HV battery was so far out of balance, we performed three MCM resets only to find that there was little to no improvement. The next step was to recommend and perform a HV battery reconditioning.

(Figure 4)

(Con't on page 7)

"Hybrid Vehicle Issues And Fixes" *(con't from p. 6)*

The process of reconditioning an HV battery begins with removal from the vehicle and cleaning all the vents in the HV battery case. Then we connect the HV battery to our reconditioning machine and set it up for discharge and charge cycles. The HV battery sticks are connected to the NuVant EVc-30 (Figure 4) in parallel. This type of connection ensures that each battery stick (which contains 6 D-size cells) can accurately be discharged, charged and finished to the correct battery level. The NuVant EVc-30 HV battery unit is operated by a PC that graphs and compares all the different sticks, so the user can see if any stick needs to be replaced.

ou need to know that the HV battery in this vehicle had been replaced by Honda three years prior under warranty, making it a good candidate for a battery reconditioning. If a battery is more than 10 years old, it's life as a vehicle battery has come to an end and it needs to be replaced. This is true of all NiMH (nickel metal hydride battery) packs that are over 10 years old.

After the NuVant EVc-30 battery unit discharged and charged the HV battery pack for six plus hours, the Insight battery pack came back to life. The next step was to install the battery pack in the Insight, clear the DTC and test drive the vehicle. We kept the vehicle for two weeks since the vehicle owner was on vacation, providing us additional time to make sure the Insight was back to normal. Now the Insight was running great along with an educated hybrid owner who understood to put her gym bag somewhere else so the HV battery could get the cool air it needed to stay healthy.

Ford Escape Hybrid Problem

Our next hybrid issue is a 2008 Ford Escape with 110K on the odometer. It had a bunch of problems preventing it for being driven to our shop. We got this vehicle through a recommendation from John Anello, also known as the AutoTech On Wheels. He had diagnosed a no-start issue for the Escape owner, who had the vehicle towed from New Jersey to our

(Con't on page 10)

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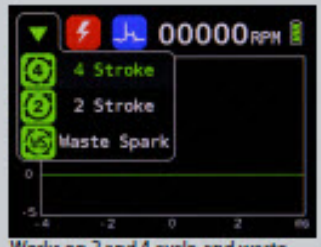
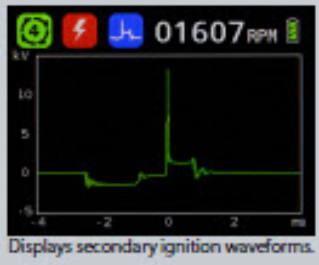
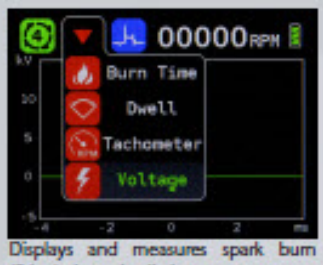


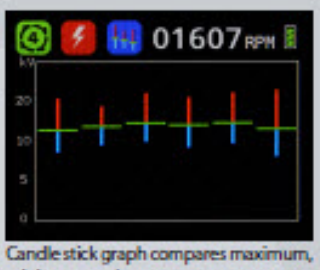
Works on 2 and 4 cycle, and waste spark ignition systems engines.



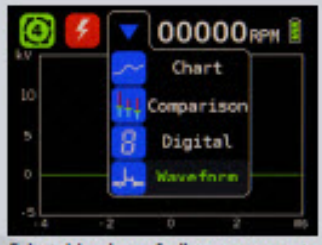
Displays secondary ignition waveforms.



Displays and measures spark burn (firing) time, dwell time, current ramp time, RPM, and spark plug peak voltage.



Candle stick graph compares maximum, minimum and average measurements of several cylinders.



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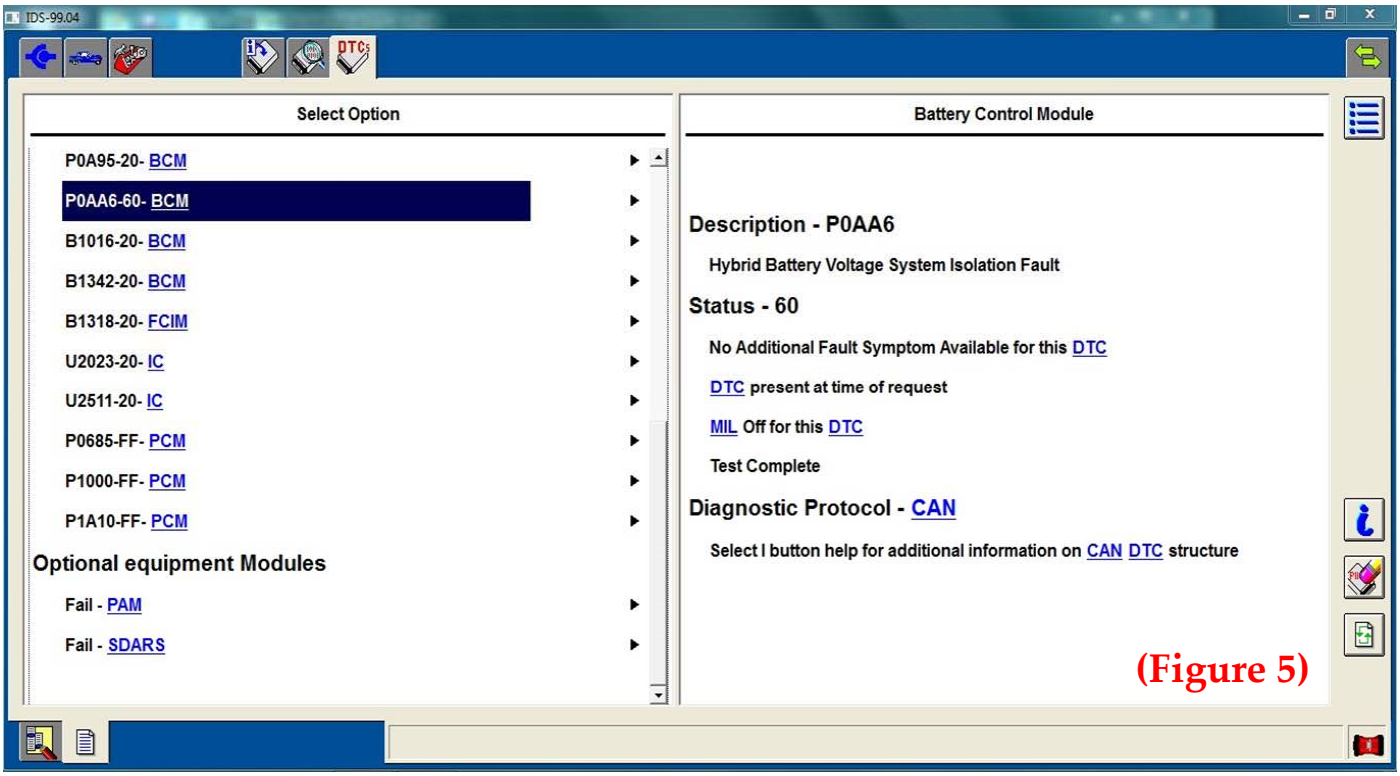
"Hybrid Vehicle Issues And Fixes" *(con't from p. 7)*

shop in New York based on John's referral.

The first thing I checked was the HV inertia switch since the vehicle had a no start condition. I found the inertia switch in the normal state and also found the shut off/service plug installed correctly. Since they were both in their normal state, my next step was to perform a visual inspection of the remaining HV components. I followed that up with connecting the Ford IDS scan tool to check for DTCs and PID information.



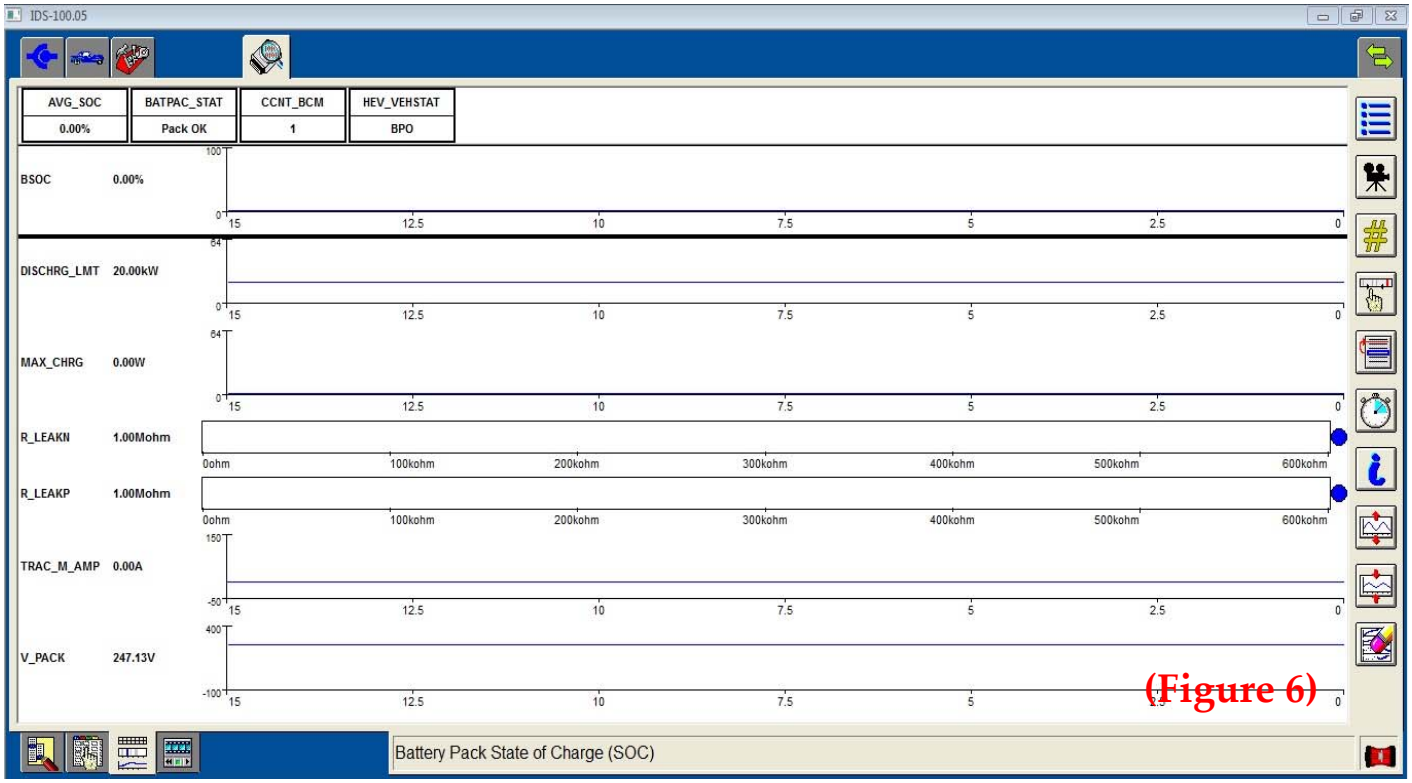
(Figure 5)

The scan data revealed over eleven DTCs (Figure 5) but the one that attracted my immediate attention was a P0AA6-60 (High Voltage System Isolation Fault) DTC. This was the main cause of the no start condition. When you encounter a hybrid vehicle that displays an isolation fault, you could be in for big problems. Since this Ford Escape does not have an electric air conditioning compressor I could rule out the isolation fault being caused by an A/C compressor that had been contaminated with PAG oil. My next step was to look at scan data for the HV battery and see if the scan tool data would reveal anything else besides the P0AA6-60 DTC.

(Con't on page 11)

"Hybrid Vehicle Issues And Fixes" *(con't from p. 10)*

I found that the HV battery pack (Figure 6) was at a 0 percent and R_LeakN and R_Leak P at 1 Mohm of resistance that was off the scale indicated by a blue dot at the right side of the data PID. The battery pack voltage was down to 247.13 volts, very low since it should be somewhere in the 300 volt SOC (State Of Charge) range. The average SOC at 0 percent, but yet the Bath-Pac_Stat stated OK along with one CCNT_BCM DTC. I now knew this was



(Figure 6)

going to be a big mess after reviewing the scan tool data. I had never come across a Ford Escape hybrid with so many issues. Ford took their time making sure they built a robust hybrid, so they could launch their way into the hybrid business. I should also state that this is a second generation Escape hybrid that if anything was an improvement over the Gen 1 models.

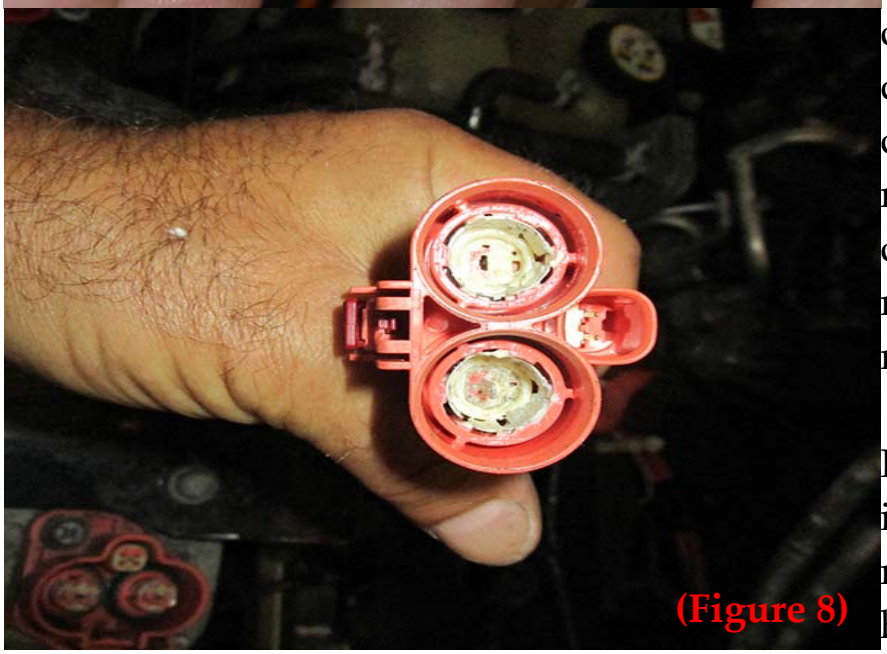
With my work cut out for me I started with the service disconnect fuse (Figure 7) that I checked carefully, discovering an issue with it. Looking at the fuse I notice it had a black stain on the white band that I had never seen before. Knowing that the fuse condition was not normal even though it had continuity, I knew there had to be something that caused

(Con't on page 14)

"Hybrid Vehicle Issues And Fixes" *(con't from p. 11)*

this issue, such as low electrical resistance that caused too much current flow. I moved the service plug disconnect in to the Service Shipping position then proceeded to remove the HV wires from the right side of the HV battery pack. I followed that up by removing the HV wire connector from the motor generator that is located under the air filter box on the left front of the vehicle. With both ends of the HV wires disconnected I could now use my Fluke 1587 Meg Ohm meter to check the wiring. You can see what I saw in (Figure 8). One of the pins of the HV wire was burnt and missing.

(Figure 7)


(Figure 8)

This now led me to believe that there was one serious problem that I have never seen before. As I continued checking the rest of the HV system out I found that the HV MG/ transmission, inverter and the converter wires had also been affected. Remember that this hybrid was at another shop before it was towed in so I could not be sure what was done or touched before I checked it out. To burn the main HV fuse and the wire connector, there had to be a major event that caused so much damage.

I proceeded to remove the inverter cover from the traction motor and found that the unit had had an electrical melt down (Figure 9). This now made sense why the main HV wire from the HV battery to the traction motor had a

(Con't on page 20)

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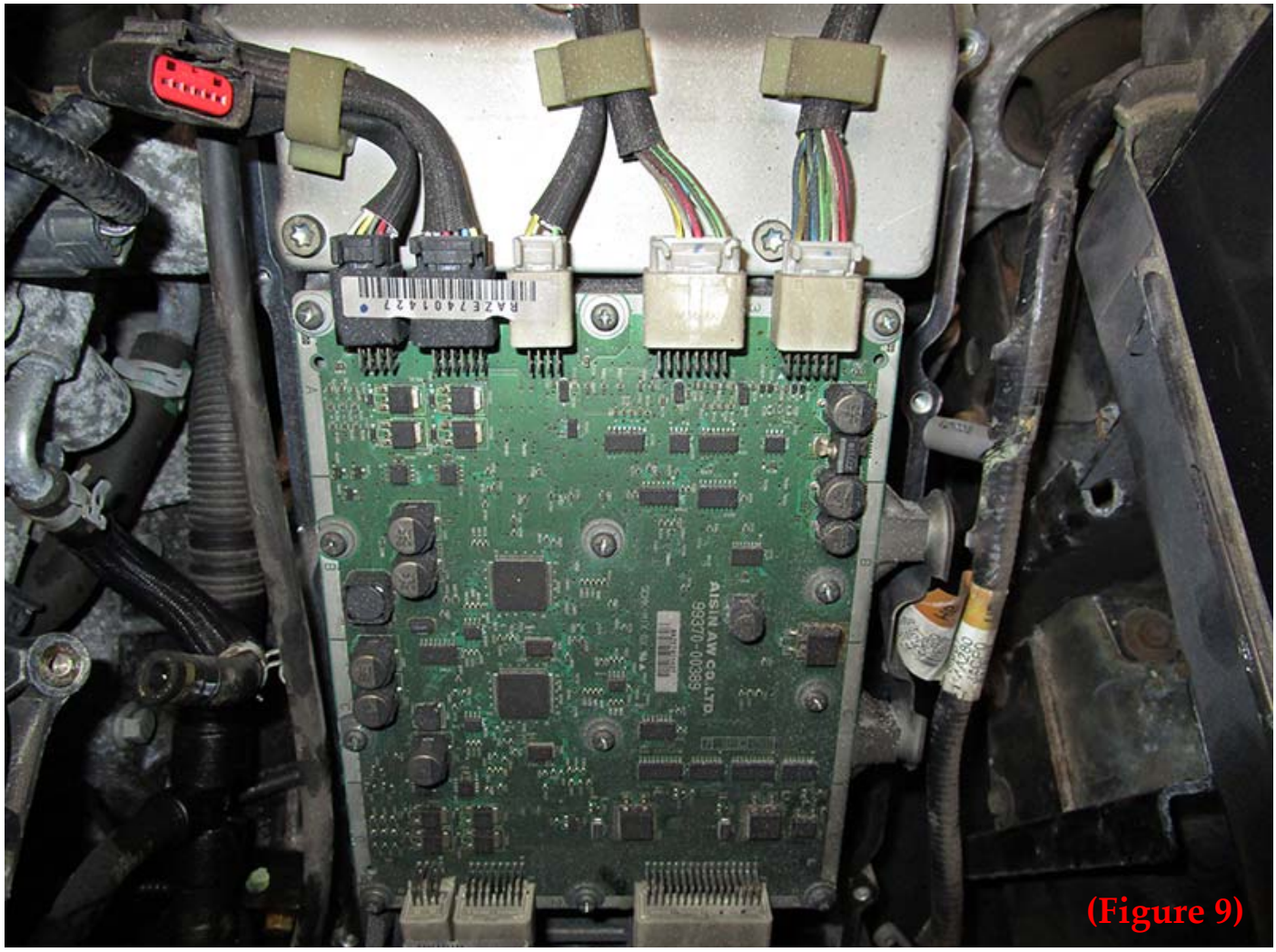
"Hybrid Vehicle Issues And Fixes" *(con't from p. 14)*

completely burnt terminal. Since the traction motor and inverter were toast, most likely the converter was not in good shape either. My next step was to check the HV wire from the traction motor to the converter with the Meg Ohm meter. My testing revealed that the wires did not meet the required specifications, so they also needed to be replaced.



(Figure 9)

I priced out all the parts and called the vehicle owner to explain what would be needed to get this hybrid back on the road. Since the traction motor and converter could be purchased from a salvage yard, this would help keep the cost down. The fuse alone for the HV battery is only sold as a one-piece service disconnect unit from the dealer for $855. The high voltage wires from the HV battery to the traction motor were over $1,300 and the wire from the traction motor to converter was about $490.

(Con't on page 21)

"Hybrid Vehicle Issues And Fixes" *(con't from p. 20)*

A used traction motor was difficult to find but I found one that had only had 45K on it for $500. I continued to do a bit more research online finding that LKQ had a used converter for $150 making the repair parts somewhat reasonable. Since the service disconnect was so expensive from the dealer I decided to look for a used HV battery from LKQ online. I only saw one of them had the service disconnect plug pictured with the HV battery. I emailed LKQ inquiring about the HV battery that had 250K on it that was being sold with the service disconnect connector that listed for $500. With all the parts lined up and priced out, I just had to add the labor to come up with a total price for the repair. As you can imagine this was going to be one expensive repair for this hybrid. I called the customer with the estimate and explained that the price to repair the vehicle.

When the owner arrived at our shop I showed him what we uncovered and explained what would be needed to get the hybrid running again. The owner, Harold, explained to me that he had just spent over $800 at the other shop in New Jersey and another couple of hundred plus bucks getting the Escape towed to me. I felt really bad for Harold because he was such a nice guy that was also going through chemotherapy treatment. After showing him what the vehicle was worth with 110K miles on it, he realized that it would not be worth repairing. He offered to pay my fee of $1,200 and said he had to decline repairing the Escape because of his financial and health situation.

Feeling bad for Harold I offered him some money for the vehicle, along with waving the charges for my diagnostic and components testing. Harold was extremely happy that I made such an offer and sold me the vehicle. I thought what the hell did I just do, the work and money involved to get this hybrid up and running was going to be extensive. The only saving grace was that I helped a person in need along with having a good project on a major hybrid problem.

(Con't on page 24)

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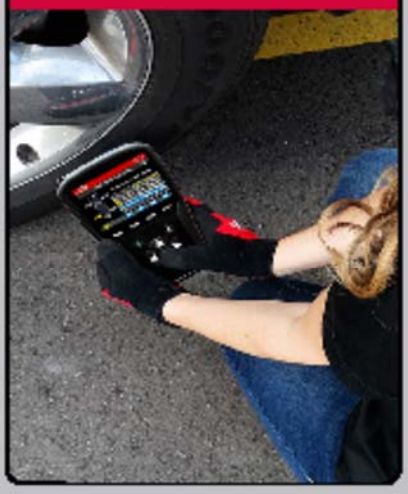

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"Hybrid Vehicle Issues And Fixes" *(con't from p. 21)*

Repairing the Escape

Our next step was to consult the SI systems and read through ALLDATA, ProDemand and Moto Logic for the recommend removal of the traction motor. The HV wiring was a no brainer-just time consuming because we would have to remove the HV wire from the HV battery that runs along the unibody of the vehicle to the firewall and on to the traction motor. The HV wire from the traction motor to the converter was not going to be that hard, but the inverter/MG removal and installation would make up for that. With a game plan in place we ordered all the needed parts and proceeded to remove the engine and transaxle/MG assembly.

(Figure 10)

On this Escape hybrid along with many other modern vehicles, the engine and traction motor is a bottom drop (Figure 10).

(Con't on page 25)

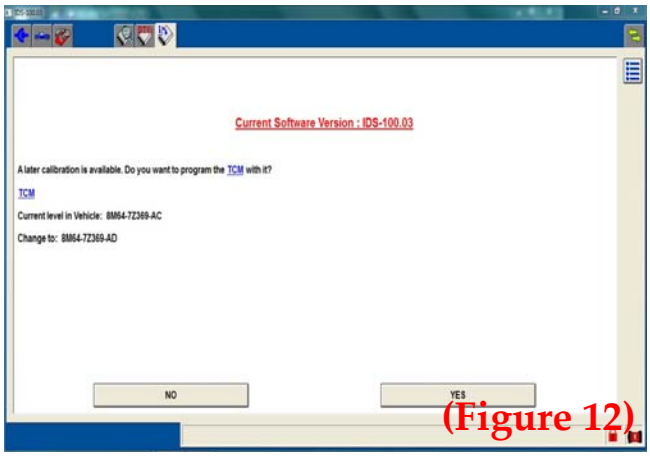
"Hybrid Vehicle Issues And Fixes" *(con't from p. 24)*

The first thing we do when removing any transmission, engine or differential is to strap the vehicle to the lift using heavy duty ratchet straps. This ensures that the vehicle will not move when any heavy component is removed. Safety is an important part of the job, we like to go home at night all in one piece.

(Figure 11)

Once the engine and traction motor were removed we disconnected the traction motor from the engine and installed the engine on our engine stand (Figure 11). We made sure to check the engine over, cleaned and tighten all bolts along with replacing spark plugs, thermostat, valve cover gasket, etc. while the engine was out. With everything out of the way, we removed and installed the HV wires from the HV battery to the traction motor. We waited to install the inverter to converter HV wires until we installed the engine and transaxle. The installation of the ICE and traction motor generators went well since we had everything planned out and ready to go back in.

With all the heavy lifting out of the way the next step would be to program the vehicle since the traction MG inverter unit had been replaced. I used the Ford IDS factory scan tool then proceeded to program the unit (Figure 12) since the traction control unit is on the CAN Bus. The vehicle would need the security update, aka PATS system programmed, or the vehicle will not become Ready and start. The programming was successful, so we started the vehicle up to make sure it ran then shut it down. We changed the oil using synthetic oil and filter followed by replacing the inverter pump as a precautionary measure.

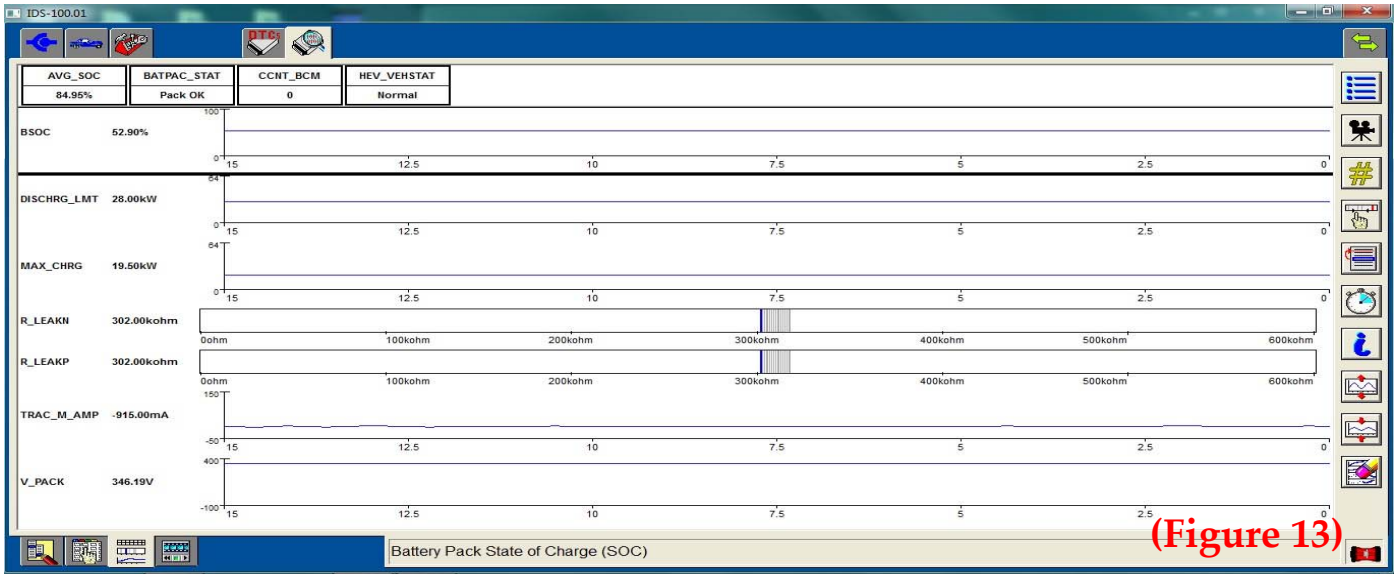


(Figure 12)

(Con't on page 26)

"Hybrid Vehicle Issues And Fixes" *(con't from p. 25)*

The inverter pump is the heart of the HV electronics cooling system and is a weak link that can cause major problems. We installed the required Ford Motorcraft coolant/antifreeze both into the HV and engine cooling systems using Airlift followed up with the coolant burping funnel. One of the last tasks that needed to be performed was a HV battery rebalance. The rebalance of the HV battery was desperately needed since the HV pack was so out of specification. With all task completed it was time for a good test drive followed by performing a full system scan (Figure 13) to make sure that there were no issues. Since everything came up normal we started using the vehicle as a shop



(Figure 13)

loaner without encountering any issues. We recently loaned the Escape Hybrid to one of our good customers who lives in Ohio. The Escape hybrid averaged 30 mpg and now has about 158k on it without issues.

In closing I hope that these two stories from the bays helps you diagnosis and repair hybrid vehicles. One quick note, please make sure you get the proper hands on training and have all the required equipment before you start working on hybrid and electric vehicles. Be safe and smart!

Article By
"G" Truglia
TST Founder and President
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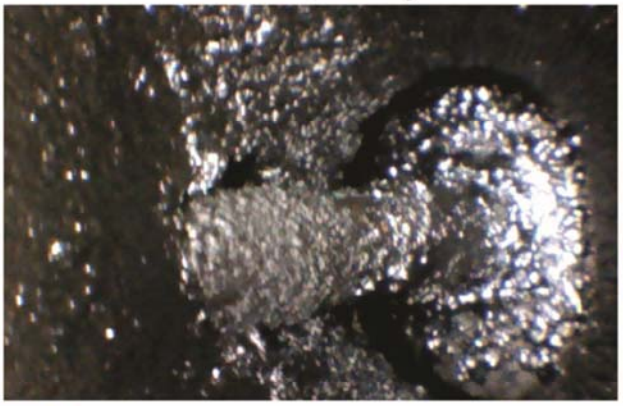
1.6L Turbo Mini Cooper at 83,000 miles

Before Cleaning



After Cleaning

3C Intelligent Induction Cleaner

Patent Pending

3C Intelligent Induction Cleaner (Patent Pending) removes heavy carbon deposits from the internal combustion engine's induction system in just 20 minutes.

Air Assist Injection Nozzle (Patent Pending) delivers chemical in small droplets that are suspended and carried to the carbon deposits by the engine's air flow. This air assisted nozzle is superior to any other nozzle available for carbon removal.

Chemical Layering (Patent Pending) removes more carbon because it alters the application of chemical mixtures between chemical A and Chemical B in on/off cycles, then washes the induction system with Chemical C.

Micro-Burst Injection Technology (Patent Pending) delivers the maximum amount of chemical during the cleaning process while still allowing the engine to run well.

3C Chemical A, 3C Chemical B, 3C Chemical C (Patent Pending) are laboratory proven to remove more carbon weight from different carbon types than any other commercially available induction carbon cleaning chemical, while having a low HMIS heath rating of (2).

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Featuring:

1. ***Kris Lewis – ATG "Direct Injection & Systems Diagnostics"***
2. ***John Anello – ATOW "Advanced Driver-Assistance Systems (ADAS)"***
3. ***John Thornton –Autotrain, Inc. "In Cylinder Pressure Transducer Diag"***
4. ***Vin Waterhouse – The Waterhouse Group "Keynote Speaker"***

Topic 1: ***"Direct Injection & Systems Diagnostics"***

Gasoline Direct Injection (GDI) is simple in design but difficult to diagnose. This is why ATG has adapted a 'High Level Indicator' approach for ruling out possible causes before parts come off. This seminar was built by analyzing actual diagnostic struggles and documenting the shortest diagnostic paths for these systems. Because of this practical approach, you won't be buried in useless engineering detail – only useful facts that you can measure and that will help guide your diagnostic path.

Kris Lewis: Kris brings a unique combination of experience to teaching, including 'almost everything'. In addition to decades in a shop focusing on drivability and electrical, he worked with an automotive radio program and mentored many technicians through in-shop training before transitioning into local training and a hotline service in the mid-2000s. In 2011 Kris joined The Automotive Training Group as a part time trainer. Since then he has traveled the US and Canada delivering ATG training seminars, focusing on practical strategies that he feels are best learned through great interaction with the audience. Kris is the of Director of Training since 2016 and is a ASE Master L1 A9.

Topic 2: ***"Advanced Driver-Assistance Systems (ADAS)"***

This seminar will familiarize you with information on current and future vehicles. System information and a high energy presentation with a detailed case study.

John Anello: John owns "Auto Tech On Wheels" his passion for automotive vehicles has driven him to work on cars for close to 40 years. John's business provides repair garages with on-site diagnostic support for problem vehicles in their shop without having to tow the vehicle to a dealership. In the last 24 years my business has grown to support 1200 plus repair shops, 400 body shops and 50 transmission shops. ASE Master L1

Topic 3: ***"In Cylinder Pressure Transducer Diagnostics"***

Today, in-cylinder pressure transducers are changing how technicians evaluate the mechanical condition of an engine. John will discuss how to interpret cranking and running compression patterns captured by an in-cylinder pressure transducer. Both good and bad will analyzed. Exhaust path restrictions, intake path restrictions, cam timing issues, leaking valves, broken valve springs and much more.

John Thornton: John operates a mobile diagnostic business in the Chicagoland area. John assists his repair shop customers with both engine and transmission driveability concerns, module programming, BUS communication issues, and electrical diagnosis. John has over 30 years of diagnostic experience and is an ASE certified Master Technician with L1 certification.

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(Check in - food at 7:00 am)

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800 882-1042

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