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How do we address the evolving landscape of vehicle electrical systems?

There are factors to consider when servicing electrical systems as this area of the vehicle becomes more complex.

Erica Schueller, Editor, *PTEN* magazine

WHAT COMES TO MIND WHEN YOU THINK OF servicing an "electrical system" in today's vehicle?

Besides the general terms associated with electrical systems: voltage, amperage, grounds, shorts, current draw, open circuits ... You may think about the vehicle's battery; or about hybrid electric vehicles on the road today. Or, you may first consider all the wiring that connects different areas of the vehicle.

All of these ideas fit into the realm of a vehicle's electrical system.

This supplement aims to provide information on the latest trends in electrical systems and electrical system testing – whether that cover batteries and battery servicing equipment, hybrid vehicles and the additional safety considerations for servicing this vehicle type or the tools and equipment necessary for properly diagnosing issues in electrical system testing.

One thing is certain with this area of the vehicle: the areas involved with this service continue to evolve, including the products needed to service electrical systems effectively.

I hope the information in the following pages can provide you with a high-level overview of the changing landscape of this area of the vehicle, and the products needed to service electrical systems properly and efficiently. ●

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Trends in vehicle batteries and battery service equipment

As batteries continue to power more systems in and on the vehicle, the tools and equipment needed to service these systems also continues to evolve.

by Erica Schueller, Editor, PTEN magazine

VEHICLE BATTERIES TODAY are required to handle more load and to cycle more deeply than before due to the amount of power needed for different vehicle modules and systems.

TODAY'S VEHICLE BATTERY

In the mid- to late-2000s, some vehicle manufacturers began to replace the standard flooded lead-acid battery and enhanced flooded battery with an AGM battery, to help address the increased load and need for deeper cycle.

"There are more than 20 million vehicles in the U.S. alone utilizing AGM batteries that require specialized charging different from traditional flooded lead-acid batteries," says Kimberly Cottle, president and CEO, Associated Equipment.

Associated Equipment is a provider of battery chargers, testers, analyzers and other battery servicing equipment (www.associatedequip.com).

AGM, or absorbed glass mat, refers to the construction of the battery. Unlike flooded lead-acid batteries which have plates that are submerged in an electrolyte solution, each plate in an AGM battery is wrapped in a fiberglass mat. This design allows for better battery cycling, allowing the battery to be discharged more deeply than a typical flooded battery.

Why is this important?

"If you look at starter draw, what does it take to start a vehicle today? Significantly less (power), because the vehicle is much more efficient," says



Smart chargers are micro-processor controlled and provide multi-stage charging to optimally charge a number of different battery types seen in repair shops today – including AGM, flooded lead-acid and enhanced flooded battery types.

Photo Courtesy of Clore Automotive

Jim O'Hara, vice president, marketing, Clore Automotive. "But, the battery is being asked to do much more. We're running navigation, DVD players, all kinds of modules on the vehicle that are demanding power at the same time."

Clore Automotive designs, develops and manufactures automotive service equipment (www.cloreautomotive.com).

In addition to the shift to a different battery type for new vehicles on the road today, many vehicle manufacturers have adopted, start-stop technology. This is mainly due to changes in CAFÉ standards to increase fuel efficiency in vehicle fleets. The location and type of battery for this technology is dependent on vehicle manufacturer, and is generally in addition to the standard vehicle battery found under the hood.

In general, AGM or enhanced flooded batteries are used in start-stop systems.

"Start-stop puts even greater demand on the vehicle," says O'Hara. "All of the original demands don't change, but now (when) I come to a stop at a traffic light or a railroad crossing, the engine shuts down, and now everything is running off the battery."

"Start-stop systems, and therefore AGM batteries, already are – and are going to increasingly be – an issue for aftermarket shops to deal with," adds O'Hara.

BATTERY SERVICE EQUIPMENT TYPES

Here's an overview of different products available to service batteries:

Jump starters

It is important to note that while a jump starter assists with starting a vehicle through the battery, the unit itself cannot recharge a vehicle's battery.

"The vehicle's charging system (alternator) will take care of re-charging the vehicle's battery, assuming it's in proper working order, after being jump started," Associated's Cottle explains.

A recent trend has been portable jump starters. These smaller devices – sometimes the size of a smartphone – assist with jump starting a battery. The units can also include additional features such as a light or USB port for charging small electronics.

Smart battery chargers

Smart chargers are micro-processor

controlled and provide multi-stage charging to optimally charge a number of different battery types seen in repair shops today – including AGM, flooded lead-acid and enhanced flooded battery types. This also refers to start-stop system batteries. How fast a battery charger works is dependent on amperage output. The higher the amperage, the faster the charge.

"The charger's role in the shop is changing. That's accelerating the shift away from wheel chargers and toward portable chargers, because now it's a charger in every bay – vehicle comes in, hood goes up, charger goes on the vehicle," says Clore's O'Hara.

He adds that the reasons for this shift are as follows: the need for maintenance charging for each vehicle's battery that comes into the shop, to ensure the battery is optimally mated to the vehicle system; to provide stable battery voltage for diagnosing electronic components; and for having a steady source of power on the battery for repairing electronic systems on a vehicle.

"Traditional lead acid battery chargers are not compatible with AGM batteries and, if used, will damage and severely reduce the life of the battery," Cottle says.

Memory savers

Memory savers are used during battery replacement to avoid resetting vehicle modules. They are connected to the vehicle through the OBD II port, or through the 12V power port, before the battery is removed. Memory savers are mainly used

to preserve programmed vehicle modules during battery replacements.

Battery maintainer

The function of a battery maintainer is to keep a fully charged battery continually charged. This is sometimes referred to as float voltage, according to Cottle.

While they may be similar to memory savers, battery maintainers are used when a battery is disconnected or removed from a vehicle completely. They are often used for batteries on vehicles in long-term storage, to prevent battery discharge.

Flashing power supply

Not to be confused with a maintainer, many battery service equipment manufacturers today offer units specially designed for maintaining proper vehicle voltage during a programming event.

The voltage needed is based on OE specifications, and can range anywhere from 55 amps to 100 amps.

Battery testers

Generally used for more vehicle system diagnosis, O'Hara explains battery testers test the battery's capacity, the starting system and the charging system (alternator).

Overall, trends will continue to shift as the vehicle battery plays a larger role in providing creature comforts to drivers, as well as operating necessary systems for the vehicle. This also means that the tools and equipment required to service batteries will continue to change. ●

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Best practices for vehicle battery storage

When properly stored, batteries will last longer and function appropriately when they are needed

by David A. Kolman, Editor, *Fleet Maintenance* magazine



When storing vehicle batteries for an extended period, instituting best practices will help ensure that batteries continue to operate efficiently.

Photo from Bigstock

THE FACT IS, ALL BATTERIES gradually lose their charge when stored over long periods of time. Therefore, to ensure the life and maximize battery capacity, batteries need to be properly stored.

How to do this is dependent upon a number of considerations, including: battery type, time of year, how the battery is stored and how long the battery will be in storage.

BATTERY TYPES

There are two main types of automotive batteries, says Jennifer Eirich, marketing manager, Odyssey Battery, specialty and rail, EnerSys: flooded, or wet cell, and Valve Regulated Lead Acid (VRLA), also known as a maintenance-free.

EnerSys (www.odysseybattery.com) is a global leader in stored energy solutions for industrial applications and the manufacturer of Odyssey batteries.

"Flooded or wet cell batteries are traditional lead-acid batteries and are available in many size and design options for many different applications," she says. "The most common design today is the maintenance-free, flat top, which the end user

cannot service. A few older designs may have removable vent plugs to allow water replenishment."

VRLA batteries come in two primary types: gel cell and absorbed glass mat (AGM). **Gel cell batteries** - These use a thickening agent to immobilize the electrolyte so that if the battery container cracks, the cell will continue to function, explains Eirich. Since gel cells are sealed and cannot be refilled with electrolyte, controlling the rate of charge is very important or the battery will be damaged.

AGM batteries - The latest technology in lead-acid batteries, an AGM battery uses a fiberglass separator to hold the electrolyte in place and make it spill-proof through a sealed pressure valve design, she says. This "makes AGM batteries superior to all other lead-acid battery types for vibration and impact resistance because of the plate compression design."

AGM batteries are available in traditional lead-calcium grid or pure lead, which offers extended service life. Being sealed with pressure valves, these types of batteries are environmentally safe and can be classified as non-spillable for unrestricted shipping.

They can use similar voltage-set points

as flooded cells and can be used as drop-in replacements for them. Pure lead AGM batteries can be charged with higher amperage alternators and chargers for faster charge recovery.

MAINTENANCE

Odyssey Battery's Eirich says AGM batteries are maintenance-free and electrolyte levels do not need to be maintained. She notes that these types of batteries should not be opened once in service "as permanent damage and failure may occur."

Flooded batteries, on the other hand, have an electrolyte level that must be maintained. This level must stay above the minimum and below the maximum level as indicated on the side of the battery. She says, "Check this level only when the battery is on a flat, level surface. If you need to increase the level, carefully add distilled water, avoiding any overfilling."

There aren't any primary differences regarding storage recommendations between flooded and AGM batteries if the vehicle is being stored with the battery still connected, says Gale Kimbrough, engineering and technical services manager, Interstate Batteries. An automatic maintenance charger should be attached to offset the vehicle's key-off drains.

"Be sure to attach a charger designed for the battery type," he says.

Interstate Batteries touts itself as the No. 1 replacement brand battery in North America (www.interstatebatteries.com).

Kimbrough notes if a vehicle is stored with the battery, but the cables are disconnected, the vehicle's computer may need to go through a re-learn after reconnection.

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10 storage tips

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"It's always important to follow the vehicle manufacturer's battery disconnection guidelines," he says.

STORAGE RECOMMENDATIONS

Some guidelines to adhere to when storing a battery:

Look for damage. Inspect the battery for damage, such as cracks and corrosion, says Kimbrough of Interstate Batteries. On flooded batteries, check for low electrolyte levels.

Clean the battery. Batteries should be cleaned prior to storage to remove any electrolyte deposits or corrosion, Kimbrough says. If electrolyte deposits and/or dirt/dust are present, batteries will often self-discharge quickly due to transient power loss between the negative and positive terminals.

He suggests cleaning the battery terminals with a baking soda/water mix or battery spray cleaner.

Brad Bisailon, director of strategic accounts, North America and Europe, Trojan Battery Company (www.trojanbattery.com)—a world-leading manufacturer of deep-cycle batteries—adds: "It is imperative to properly maintain the entire connection in a flooded battery because corrosion at either end of the connection can cause high resistance and potential battery failure."

Select an appropriate storage location. Because higher humidity areas can increase the battery's corrosion, battery manufacturers recommended choosing a dry location. If freezing

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temperatures are expected during the storage period, locations should be avoided. The battery manufacturer's guidelines should be consulted to find the lowest acceptable storing temperature. Further, they advise storing batteries in places with adequate ventilation and away from flammable liquids, as well as away from areas near heat sources since hot temperatures accelerate battery self-discharge.

Monitor and test. Batteries need to be monitored weekly, especially if you've left a charger connected to them, says Kimbrough of Interstate Batteries. Bisailon of Trojan Battery suggests monitoring battery voltage every six weeks while in storage and that the batteries be given a boost charge when they are at 70 percent SOC (state of charge) or less.

OUT OF STORAGE

Before taking a battery out of storage, check to make sure the batteries are fully charged, says Odyssey Battery's Eirich. Re-check for any corrosion or damage. If corrosion is present, it should be cleaned off.

When installing the battery in the vehicle, Interstate Batteries' Kimbrough recommends cleaning all battery attaching terminals and then connecting the positive cable first and the negative cable second. ●

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Hybrid vehicle servicing hazards



A major safety factor for those who service hybrid vehicles is to make sure the vehicle is "off" because the hybrid system is silent when running on battery.



Hybrid vehicle keys need to be kept a safe distance from the vehicle when serviced because many hybrids have a keyless ignition, with on/off sensitivity up to 20' away from the vehicle.

says Zaidel. A technician would have to touch pole-to-pole or become part of the circuit for an injury to occur. As a highly visible safety warning, all high-voltage circuits are encased and heavily insulated, and normally identified by the SAE standard color-coding of bright orange. Never cut into, touch, mangle or otherwise disturb the big orange cables that carry the high voltage from the batteries (in the back) to the controller (in the front), he warns. Always wear Class O heavy duty gloves (lineman's gloves) rated to withstand 1,000V when disconnecting high-voltage components, such as the battery. These gloves should be maintained in excellent condition and checked prior to each use to ensure there are no leaks, Zaidel emphasizes. Even a small opening can draw current that is seeking a ground. Always disconnect the high-voltage hybrid battery before doing any major repair work or electrical work, he adds. Most manufacturers also advise waiting at least 10 minutes before working on the vehicle after the battery has been isolated or disconnected. The high-voltage capacitors need time to discharge so there is no residual voltage to pose a shock hazard.

"Hybrid systems can automatically turn themselves off and on, switching between the high-voltage battery and the gasoline engine, so it is easy for the technician to be unpleasantly surprised that a vehicle thought to be 'off' is in fact 'on.'"
Peter Zaidel, KPA product manager

DIFFERENCES

"Hybrid vehicles may seem similar to gasoline-powered engine vehicles, and indeed there is much in common," concludes Zaidel. "But the differences are important ones from a safety perspective, bringing risks of injury and even death to the untrained or careless service technician. "Proper training, adherence to a company's service operations protocols and constant vigilance around these 'silent while on' vehicles will ensure a safe environment."

There are a number of safety precautions to consider when servicing hybrid vehicles. By David A. Kolman, Editor, *Fleet Maintenance* magazine

HYBRID VEHICLES BRING WITH THEM NEW dangers to the technicians who have to work on them. While hybrid vehicle manufacturers designed these vehicles with an eye on fuel efficiency, Peter Zaidel, product manager, KPA, notes that the manufacturers also focused on the safety of service technicians.

KPA (www.kpaonline.com) is a nationwide leader in environmental and safety compliance programs for vehicle and equipment dealers.

He recommends sharing these fundamental safety basics for serving hybrids with service technicians:

1. How to identify a vehicle as a hybrid.

Almost all hybrids share three common identifiers, Zaidel says. They are:

- Hybrid badging on the body of the vehicle, typically the rear right section and under-hood identifiers, including the extra motor and the inverter.
- The "Ready" indicator inside the vehicle in the ignition area.
- Orange high-voltage power cables.

2. How to determine if the hybrid vehicle is really turned off.

"This may be the single most important safety factor for service technicians working in a shop where there are hybrid vehicles, because

the hybrid system is silent when running on battery," Zaidel points out. "Hybrid systems can automatically turn themselves off and on, switching between the high-voltage battery and the gasoline engine, so it is easy for the technician to be unpleasantly surprised that a vehicle thought to be 'off' is in fact 'on.'"

He advises technicians to observe the following service protocols. However, "since each hybrid vehicle and model is different, always follow the manufacturer recommended service safety procedures."

- A hybrid is not necessarily powered off until it is verified that the vehicle is powered down.
- Keep vehicle keys a safe distance from the hybrid—more than 20'—as many hybrids have a keyless ignition, with on/off sensitivity up to 20' away from the vehicle.
- Always check the vehicle dashboard hybrid indicator to ensure the vehicle is truly "off" before any kind of work is performed on it.

3. How to protect one's self from high voltage.

While the amount of voltage and amperage in hybrid vehicles is enough to be fatal if a technician comes in contact with the high-voltage circuits, the high-voltage system does not ground to the body or the chassis, but rather is isolated from the vehicle body completely,

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An overview of tools used for electrical system testing

A look at the features and functions of common tools and equipment used for electrical system testing in the bay.

by Barry Hoyland, Contributing Editor, PTEN magazine

SINCE SO MUCH OF TODAY'S vehicles rely on electrically driven components, it is important to understand the role of different tools and equipment in diagnosing electrical systems correctly and efficiently.

Even though many of the tool categories are able to perform electrical tests on circuits and components, some types of tools are better than others by either improving efficiency or the quality of data the tool provides.

Overall, there are a number of different electrical system tools and equipment to assist with analyzing and diagnosing a vehicle's electrical system issues. The tools necessary for your shop are dependent on your needs and capabilities. ●



Technicians today need a number of electrical testing tools in their arsenal to fully perform electrical diagnosis on vehicles.

Electronic Specialties



Battery and charging system testers

First and foremost, in any electrical test it is important to evaluate the battery and charging system. Most late-model vehicles utilize the PCM to control battery charge rates based not only on load demands, but on the quality of the battery as well. It is necessary to utilize a quality battery/charging system tester to load test the battery and to determine if the charging system has the ability to perform under all conditions.

Many battery/charging system testers have the ability to print a record of the results that may be stored with the vehicle records and provided to the customer.

Clore Automotive



Battery monitor reset tools

Many late-model vehicles now require resetting the Battery Monitor System (BMS) after servicing the charging system or replacing the battery. The battery monitor works with the PCM to evaluate the battery and to adjust the charge rate to extend battery life.

Depending on the vehicle, resetting the BMS can be performed by using a scan tool, or a stand-alone tool designed specifically to the task.

CanDo International

Battery chargers

Not to be confused with battery and charging system testers, considerations for battery chargers today should include the types of batteries the unit services and how fast the unit can charge the battery. Due to different types of batteries (flooded, gel cell and glass mat) having different requirements for charging, it is necessary to have a battery charger that is capable of charging each type without damaging the battery. Glass mat and gel cell battery chargers typically utilize a slower charge rate and may be temperature regulated, while flooded batteries are able to use traditional chargers because they are not apt to overheat while charging.

An additional concern when purchasing a battery charger is to ensure it has the ability to deliver "clean" power in order to be useful when programming computer modules. Voltage spikes or varying voltages while charging during programming may cause damage to computer modules.



Associated Equipment

Oscilloscopes/lab scopes/waveform viewers

As a general rule, this category of tools will provide the most complete set of data, in most cases, when testing the functionality as well as the amount of current going to and through a circuit. Many accessories are also available for additional tests such as pressure transducers, ignition adapters, etc.

The benefits of using a scope or waveform viewer include the ability to:

- Adjust both the time and measurement scale to view the circuit
- Observe more than one circuit at a time
- Record waveform for comparison or future use
- Observe history and catch glitches (intermittent issues)
- Purchase and/or use accessories, such as pressure transducers, ignition adapters, etc., that can perform additional tests

Some drawbacks to using a scope or waveform viewer include:

- Additional time needed to set up tool
- After familiarity with the process, this takes less time
- An initial investment that may be considered expensive



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Digital multimeters (DMMs)

These tools are very good for measuring specific values such as voltage, amperage, resistance and pulse width. Consider these tools as viewing a snapshot, while a lab scope is a video of an event.

Benefits of multimeters include:

- Relatively inexpensive
- Fast test results
- Portable
- Various test leads and adapters available
- Able to test high-voltage hybrid vehicles (with appropriate test leads and meter classification)

Drawbacks of multimeters include:

- The readings given are digitized and are an average of the represented value, versus an exact value
- Difficult to capture intermittent issues



Electronic Specialties

Scan tools

Scan tools can be used to observe data the vehicle's computer modules are producing. This can be useful to quickly determine if normal voltages are present on many components at the same time without the need to connect a tester to each individual component. Graphing capabilities are available to obtain readings over a period of time and to compare multiple data graphs simultaneously.

Benefits to using a scan tool for electrical system testing include the ability to:

- Quickly obtain and compare multiple values in digital format
- Quickly obtain and compare multiple values in graphing format
- Observe data without intrusion into connectors or wires
- Observe data from multiple modules

Drawbacks to using a scan tool for electrical system testing include:

- Data interpreted by the PCM and tool may be different from actual measured values
- Depending on the quantity of PIDs observed, data may not be "live"
- Due to slower update rates, scan graphing values are not as precise as a lab scope



Snap-on Diagnostics

Continued on page 12 »



Specialty electrical system test tools

There are many specialty test products that can be used to test specific components. These include relay testers that replace a relay in a circuit and include a switch to provide power to the controlled circuit. This tester can be used to determine if a relay is faulty, if the circuit is faulty or to control a circuit for additional testing. Other relay testers allow test terminal access while the relay is in the circuit. These testers provide the ability to check power, ground and control, when combined with a circuit tester that provides power or ground. There are some self-contained relay testers that provide the ability to check control and function without the need of a circuit tester. There are numerous ways to test amperage in a circuit, but in many cases it is necessary to tap into the circuit with an amperage tester wired in series. The latest versions of amp testers allow the ability to obtain amp readings by accessing the fuse. Having the ability to test the actual amperage in a component is invaluable in determining if the circuit is functioning properly. For instance, knowing the amperage a fuel pump is using to operate at a specific pressure and comparing it to a known value is a great way to determine faults within the system. If the pressure is correct, but the amperage is higher than normal, that could indicate a faulty pump, high resistance in the circuit or a restriction in the fuel system.



Circuit testers

There are as many uses for circuit testers as there are different types of them. Circuit testers range from standard test lights to state-of-the-art units that can read digital values of volts, ohms or amps. Many testers have the ability to supply power or ground in order to test components.

Common causes of electrical system failures

Which tools are the most efficient to diagnose common vehicle electrical system issues?

by Barry Hoyland, Contributing Editor, PTEN magazine

ONE OF THE MOST FRUSTRATING THINGS A TECHNICIAN COMES ACROSS when diagnosing a vehicle are intermittent issues. When the issues are on an electrical system, it becomes even more difficult to determine the root cause. We'll cover some common issues technicians face when it comes to working on electrical systems.

Issue 1: Intermittent shorted or open circuits

Intermittent short circuits usually manifest themselves by blowing a fuse. This can be beneficial, as it gives you a starting point for your diagnosis. Obtaining both the power distribution and wiring diagrams will give you details of components and other possible areas of concern. Additional valuable pieces of information are TSBs and common fixes that have been compiled by repair information sources such as AllData, Mitchell 1 or Identifix.

If there are no known common issues it may be more difficult to locate the root cause of the problem. Some possible sources of intermittent failures are connections with high resistance or loose connecting pins that cause the fuse to heat up and melt. Close inspection of connectors to see if there are signs of overheating such as discoloration of either the pins or the plastic housing is useful. In order to provide a quality repair, it will be necessary to replace the connector pins and the plastic housings on both sides of the connection.

Other causes of intermittent shorts are components themselves. In this case, it may be helpful to measure the resistance within the component using a DMM. Another very effective test is to use an ammeter or other testers, such as the Cal Van Amp Hound 2 or the ESI Fuse Buddy, to measure the current the circuit is

actually consuming. If the component is operated with a relay, it will be necessary to activate the relay using either a relay activation tool, a Power Probe or with bi-directional commands using your scan tool.

The source of intermittent issues with either open or shorted wiring may be difficult to locate. In addition to TSBs, other tried and true methods to find them are to physically move wiring harnesses and connections to recreate the problem. It may be helpful to place the vehicle in gear with the brakes applied while lightly accelerating. By doing this the engine, transmission, exhaust and attached components move and may pull on connections or wiring to recreate the issue. This may need to be done in forward and reverse to find the cause of the short or open circuit.

Using short/open circuit detection tools can be very valuable in determining the root cause of these problems. These tools work by transmitting a signal down the wire while using a receiver to determine where the signal changes or disappears.



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Issue 2:

Multiple failures of a part after initial replacement

Another annoying situation occurs when a vehicle returns for the same failure, after an initial repair. Common examples range from a simple light bulb replacement to repetitive failures of an alternator or fuel pump.

In many cases, a technician will install an incorrect part resulting in a repeat failure. For instance, we have seen an incorrect bulb installed in a taillight when a technician replaced the bulb with the same part number rather than looking up the application to see if the correct part was originally installed. In those cases a small mistake can perpetuate repetitive failures.

The same thing can occur with any electrical part such as an alternator. You should not take any shortcuts during a “warranty repair,” whether it is looking up the part number or in the diagnosis. You should always start your diagnostic process from the beginning without assuming anything, especially relying on results of a test that was performed during the original repair.

Charging systems on many newer vehicles use the PCM to set the proper charge rate by assessing demand on the system. Adjusting the charge rate by need maximizes battery life and improves fuel economy by reducing engine load. Because of this it may be necessary to use your scan tool or a battery reset tool, such as the BATT+ from CanDo International, to perform a relearn when replacing a battery or alternator.

Failing to perform a relearn when replacing a battery or alternator may cause the system to overcharge and reduce battery or alternator life.

When any part fails, especially higher amperage parts like fans, fuel pumps or alternators, you should check to make sure there is no excessive resistance in the circuit by performing a voltage drop test.

A voltage drop will determine how much voltage is available to operate the component. If there is resistance in a circuit, it reduces available voltage and will manifest itself by having a dimmer bulb, slower starter or fuel pump, or less output from an alternator.

In order to perform a voltage drop the circuit needs to be “on” with current flowing. Reading voltage with a DMM and reading the voltage at any point will provide you with source voltage, but not necessarily give

you an idea of how much resistance is in a circuit. Using a DMM to read resistance (ohms) is helpful for determining how much resistance may be in a component, but will not always provide you with dependable information on wiring or connections. Simply put, an ohmmeter sends a small amount of voltage through one end of a circuit and determines how much the voltage changes (drops) at the other end and calculates the results in ohms. With higher amp circuits and large gauge wires, a more reliable test is a voltage drop.

One of the most efficient ways to perform a voltage drop is to use a Power Probe III or Power Probe IV, as they have a built-in capacity to read how much voltage drop is occurring in a circuit.

Another reliable way is to use your DMM. Let’s use a headlamp circuit as an example; start by turning the headlamps on. Next, set your DMM to a 20V scale and place the black lead of the meter at the positive battery terminal. Next, place your red lead at the positive terminal of the headlamp. The voltage reading should be as low as possible, and should be 0.2V or less. Repeat the process on the ground side by placing the black lead at the battery negative terminal and the red lead at the headlamp negative terminal. The result of this should also be less than 0.2V.

By reading the voltage in this manner you are able to determine the amount of “drop” that is occurring through the circuit. For example, if your source voltage (battery) is 12.5V and you read 1.0V on the positive side of the circuit and 1.5V on the negative side, your actual voltage drop is 2.5V, lowering your source voltage to 11.0V. In order to determine where the actual resistance issue is occurring, work backwards from the headlamp connections to the battery and perform the voltage drop test along the way paying close attention to connections, splices or grounds. When your reading goes back under 0.2V you have located the area of high resistance. It is important to remember to perform this test with the circuit activated.

Following complete diagnostic test procedures with every repair is necessary to perform quality service, but taking extra care on warranty issues can assure it will not be another comeback. ●



DIAGNOSE AND TRACE SHORT AND OPEN CIRCUITS QUICKLY

The **General Technologies FaultFinder short/open circuit finder and tracer**, No. FF310, is a tool specifically designed to trace and locate short and open circuits, broken wires and current leaks on any electrical circuit with voltages from 6V to 42V. The FF310 set includes one transmitter and one receiver (tracer). The FF310T (transmitter), when connected, injects a radio signal into the faulty circuit or wire, which allows users to trace it with the FF310R (receiver) from several inches away, even when the wires are inside conduits, harnesses, or behind panels and upholstery. The 8" flexible probe allows use in constrained spaces, and a set of fuse blade connectors is provided for convenient connection of the FF310 transmitter in the socket of blown fuses or open circuits.

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VIEW MEASUREMENTS WIRELESSLY

The **Lang CAT IV Wireless Clamp**, No. 13810, allows technicians to use a smartphone or tablet to view measurements wirelessly. It offers technicians the flexibility to choose from test lead measurements, standard clamp head, or low-amp clamp-on current head. Users can remotely measure and display AC/DC volts, up to 400A, or low amps with mA resolution. The 13810's transmitter communicates using wireless protocol compatible with smart phones and has an additional wireless RF module built-in for future expansion.

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BACK PROBE HARNESS CONNECTORS

The **S & G Tool Aid Corp. 20-piece Back Probe Kit**, No. 23500, is used to back probe harness connectors, fuel injectors and automotive sensors. The stainless steel probes come in straight, 45 degree and 90 degree profiles in 0.027" and 0.040" diameters. The probes are color-coded for easy identification and are compatible with the standard 4mm plug. Also included with the kit are 12" extension leads, color-coded the same as the back probes for use in recessed areas. All probes are designed to easily insert into automotive connectors. The kit is supplied in a durable, plastic storage case.

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MULTIPLE VEHICLE APPLICATIONS



The **Midtronics Battery Conductance & Electrical System Analyzer**, No. MDX-650P, features an integrated printer and provides quick, safe and easy-to-use battery testing capabilities with in-vehicle capabilities to analyze starting and charging systems. This system works on 6V and 12V batteries, and tests 12V and 24V charging systems. This system also offers a quick starter analysis without having to disable the ignition. The MDX-650P package includes the MDX-600 Series Analyzer with integrated printer, MDX-650 software (installed), manual, lead stud adapter set, 10' cable set and carrying bag.

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PORTABLE JUMP-STARTING POWER

The **Cal-Van Tools Boost Max**, No. 560, offers portable power for jump starting most diesel engines, trucks, cars and more. The 560 can also be used to charge electronic devices, and offers a high-capacity nano Lithium battery for fast charging with low self-discharge cycles (up to 1,500 charging cycles). This tool includes the Intelligent Clamp for jump starting, with built-in safety protection from overcharging and over discharging. This tool also offers live amperage reading. Four different types of charging modes are available, including 5V 2A, 5V 1A, 19V 3.5A and 12V 10A. The Boost Max weighs 1.5 lbs.

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WORKS WITH ANY 12V BATTERY TYPE



The **PulseTech 2-Station 12-Volt Battery Recovery Charger**, No. SC-2, is designed to recover, charge, maintain and desulfate as many as two 12V lead-acid batteries at a time. This compact and portable recovery charger works with any 12V battery type, including VRLA, AGM, gel and flooded cell. The dual recovery charging stations operate in isolation, allowing any combination of battery brands or types to be recharged simultaneously. The charger's patented Pulse Technology removes sulfate crystals from the battery plates, increasing the battery's ability to accept, store and release energy, extending battery life up to five times. The SC-2 features five LED battery-status indicators, replaceable cables, a case and a one-year warranty.

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MONITOR CURRENT OR AMPERAGE READINGS

The Innovative Products of America Relay Bypass Master Kit with Amp Loop, No. 9038A, makes DC motor activation and current monitoring easier than ever before, according to the company. The tool simplifies fuel injection testing and allows all 12V DC motors to be run with the push of a switch. By attaching an amp clamp or lab scope, technicians can monitor the current or amperage readings to judge the health of the DC electric motor, to identify if a motor is drawing more current than specified, or if the current load is inconsistent during operation. This set includes six spade relays compatible with most foreign and domestic applications.

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ENABLES CONNECTION TO MICRO 64 TERMINALS

The Electronic Specialties 18-pc Micro 64 Test Connector Kit, No. 147, features a selection of terminal adapter sets, which enable connection to Micro 64 terminals primarily found on GM vehicles, and some European, Asian and domestic vehicles. These adapters are designed to make a secure electrical fitting and connection for testing and diagnostic purposes. Adapters connect to most DMMs and scopes via the included 48" stacking banana plug test leads. The kit includes a total of 18 pieces in a clear window storage case, with four pieces each of both round and square types in both male and female configurations.

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PROVIDES POWER WHEN BATTERY IS DISCONNECTED

The AutoMeter SPS-12 Smart Power System provides power through the vehicle's OBD II port, or a 12V outlet with the optional adapter, to keep vehicle computer systems supplied with power when the battery is disconnected or removed. The SPS-12 also accurately monitors for parasitic electrical draw that could cause the battery to discharge when the vehicle is not in use. It preserves radio and infotainment settings, memory and engine/transmission adaptations as well.

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7' LONG DC CABLES

The Associated Equipment KwikStart Industrial Jump Starter, No. KS401, includes light diagnostics displaying voltage output of the vehicle battery, voltage output of the vehicle alternator and 7' long DC cables. The heavy duty portable power unit can be set on the ground and easily reaches the battery in most 4x4 pickups, sport utility and other high-profile vehicles. An ergonomic, impact-resistant case with rubberized base protects the unit. The 12V 22Ah sealed AGM battery delivers 1,700 peak amps and 360 CCA of cold crank power. The KS401 features a digital LED display with internal battery state of charge readings as well as a 12V power port and USB power port.

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INCLUDES UNIVERSAL MULTIMETER TEST LEADS

The Hickok Flex Probe Combo Kit, No. 77300, has a large assortment of matching male and female spade, round and micro terminal flexible probes. The kit includes universal multimeter test leads with male banana plug ends for hands-free, solid connection and testing. The flexible probes are a fit for most transportation industry connector pins, providing safe diagnostic testing for complex computer and electrical systems without piercing wires. A fit for pin-out testing modules and wire harness connectors, the kit can be used as a mini breakout box for closed circuit testing.

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SUPPLIES CONSTANT VOLTAGE FOR VEHICLE PROGRAMMING

The Schumacher Electric 4/20/70 Amp Automatic Charger, No. INC-700A, provides constant voltage output selectable from 13V to 14.8V DC, with an output current up to 70A. This micro-processor controlled unit provides clean power for flash reprogramming and provides power to vehicles on display. With fully automatic operation for 12V batteries, the INC-700A works with regular automotive, deep-cycle, AGM and gel cell battery types, providing digital volts and amps display, and a manual mode with digital timer. This charger includes an extra-long 9' line cord with 20A plug, extended reach 9' output cables and heavy duty clamps with replaceable jaws.

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CHARGES MOST LEAD ACID BATTERY TYPES

Clore Automotive offers the SOLAR PRO-LOGIX 2A by 4 channel 12V battery maintenance station, No. PL4020.

This unit combines fully automatic operation and the ability to properly charge most lead acid battery types, including conventional, AGM, spiral wound, start-stop, deep cycle and marine. The device can be used in automotive repair shops, collision repair facilities and fleet operation facilities. With each channel fully independent, a problem battery on one channel does not impact the rest of the batteries under charge, allowing charging of any combination of battery types across the four channels. The PL4020 adapts its approach based on the needs of each battery it services. It also incorporates numerous features to make charging safer for the operator and the vehicle and battery being charged.

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INCLUDES STANDARD TEST LEADS

The Monster Compact Digital Multimeter, No. MST12003, offers a 6,000 count backlit digital display. Featuring CATII 1,000V AC/DC max, 10 amps max current, 60 megaohms, CAT III 600V max resistance, capacitance and frequency, the multimeter maximizes efficiency for electrical testing. It has a min/max recording mode with data hold and includes standard test leads and a K-type thermocouple. The Compact Digital Multimeter is 5.91" high by 2.5" wide by 1.91" deep.

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MAIN MODULE COMMUNICATES VIA BLUETOOTH

The Snap-on Wireless Battery System

Tester, No. EECS550, allows technicians the freedom to move around a vehicle with the main module communicating via Bluetooth to the monitoring unit connected directly to the vehicle battery. Built-in magnets hold the tester in place, a back-lit screen displays information in eight languages and reports battery, starting and charging system conditions. The EECS550 works on standard AGM, gel and enhanced flooded batteries, and features patented conductance technology for battery systems ranging from 6V to 24V and rated 100 CCA to 2,000 CCA. The EECS550 detects discharged batteries down to 1V and comes with a two-year warranty.



TROUBLESHOOT AND DIAGNOSE CIRCUIT CONDITIONS

The Power Probe Master Combo Kit, No. PPKIT04, combines the company's Power Probe IV with the ECT3000 to troubleshoot and diagnose circuit conditions. The kit helps technicians save time by not tearing up wire harnesses, panels, carpets and more to locate open or shorted circuits with the ECT3000. The Power Probe IV allows users to diagnose fuel injectors, sensor signals, computer outputs, resistance readings and power up components. The kit offers the features of a DC voltmeter, AC voltmeter, ohmmeter, a fuel injector tester, computer driver tester, open circuit detector, short circuit detector, directional short circuit indicator and distance from source wire indicator. The ergonomic tools are available in red or green and the kit includes the company's Lead Set Gold Series (No. PPLS01).

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Klein Tools Auto Ranging TRMS Digital Multimeter

The reviewer is impressed by the multimeter's speed and accuracy.

by Mike Schmidt, Managing Editor, VehicleServicePros.com

This is a full-function multimeter that every technician needs," says Phil Fournier, owner of Phil's Auto Clinic in Hemet, Calif., of the Klein Tools Auto Ranging TRMS Digital Multimeter, No. MM700. "I found it to be accurate and fast enough for the majority of automotive-type uses."

Fournier used the meter for electrical troubleshooting, including the testing of the ground circuit on a 2004 GMC Yukon with an intermittent problem on the electronic throttle control. He also employed the MM700's min/max button to check the possibility of a volt drop on the TAC module ground wire, and he used the tool to check the operation of several oxygen sensors.

"This tool has all the functions needed by a technician, and even some rarely included in a tool of this price range," Fournier says. "The fact that it does duty cycle, frequency, both AC and DC volts and has a min/max feature make it an automotive winner."

The tool arrived in plastic packaging, and accessories included test leads and the thermocouple. Setup consisted of selecting the voltage, frequency, duty cycle, etc., that he wanted to view every time the tool was turned on.

Fournier found that using the MM700 saved him the same amount of time on jobs as similar multimeters he utilizes do, and he says it was "fairly intuitive and easy to use." He also appreciated the thermocouple's accuracy and usefulness for temperature measurement, saying that it was well-suited for

doing quick air conditioning diagnosis.

One suggested improvement Fournier has for the tool is that it should default to DC volts, as opposed to AC volts.

"You must press the SEL button to get to DC," he says. "The indication that it is on DC rather than AC is also too subtle for my liking. I'd rather have it be bigger and more obvious. I fiddled around several times trying to read voltage, and then I realized I was on the AC scale."

Fournier also says he thinks the lead set for voltage could use some improvement, as he feels the leads are too short and the clips are inappropriate for automotive use.

"For automotive use, it should come with a better lead set with some good banana jack type clips and connectors," he adds.

However, Fournier did come away impressed with the tool's thermocouple and expects the MM700 to last quite a long time.

"The tool seems sturdily built," he notes. ●



PRODUCT DESCRIPTION

The Klein Tools Auto Ranging TRMS Digital Multimeter, No. MM700, measures up to 1,000V AC/DC voltage, 10A AC/DC current and 40 mega ohms resistance, temperature, capacitance, frequency, duty cycle and continuity. It also has a low impedance (LoZ) mode for identifying and eliminating ghost or stray voltages. The MM700 is rated CAT-IV 600V for safety, rated IP42 for water and dust ingress protection, and is built to withstand a 6.6' drop.

Circle 245 at "e-inquiry" on VehicleServicePros.com

PRODUCT DESCRIPTION

The Power Probe IV activates components with battery power and ground for quick functional testing. The large, bright color-LCD screen allows for easy visibility for eight diagnostic testing modes. The Power Probe IV includes a 23' cable for greater reach and accessibility. Users can test the resistance of circuits in ohms, quickly read AC/DC and battery source voltage for instant voltage drop testing and easily identify the health of a fuel injector and circuit with one simple back probe. The Power Probe IV also supplies computer-safe voltage for testing PCM/ECM drivers.

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Power Probe IV

The reviewer says this tool is more powerful, accurate and easy to use than the previous model.

by Josh Smith, Contributing Editor, VehicleServicePros.com

Phil Fournier, owner of Phil's Auto Clinic in Hemet, Calif., liked the Power Probe III. However, he says the newer Power Probe IV is a big improvement to the former model, and it is easier to operate.

"The Power Probe III was great, but this is a much more powerful and accurate tool. It is a full-featured voltmeter and does significantly more than you can do with a voltmeter, in a very user-friendly fashion," Fournier says. "The added features of frequency, AC voltage peak-to-peak readings, injector pulse width, feed voltage, inductive kick and volt drop make it the ideal tool for testing a no-start."

"The basic functions of the tool are simple to use, and even the more advanced functions are not hard to learn if one uses the manual," he adds.

The included manual is well written and easy to follow, according to Fournier. But he adds that some electronics features need to be understood prior to reading the manual.

The Power Probe IV comes ready to use in a sturdy plastic case, which Fournier says could be slightly larger to allow the tool to be stored with the tip on. The Power Probe IV comes with clips for connecting the tool directly to the battery. The ECT3000 transmitter - which when used in conjunction with the Power Probe IV, can help find open circuits in wiring - is available separately.

"I like the backlit screen and the fact that the voltmeter now reads to hundredths of a volt," Fournier says, noting the Power Probe III could not, which limited its use as an accurate test meter.

"I like the new features of reading frequency, injector pulse width, peak-to-peak voltages and so forth," he says. "It is a great tool for checking a no-start out in the parking lot when you don't want to make multiple trips back to the shop for tools."

He adds that the new test for voltage drop, which shows the difference between battery voltage and voltage at the tip, is a great learning tool for techs to understand the concept.

As a possible improvement, Fournier suggests adding a true scope with the ability to adjust time base and amplitude. "As a dedicated scope user, I would prefer to see a pattern many times over a digital interpretation of the pattern," he says.

Because he has several lab scopes, Fournier says he will continue to use a variety of tools to diagnose vehicles. However, he says the Power Probe IV is the first tool he goes to for electrical diagnostics, particularly when testing power window components.

"In the old days, when power windows were simple, we used the old design Power Probe effectively. Now that we have electronics and networks involved, we can use this new Power Probe to check for voltage, frequency and duty cycle on the network wire going to the door or seat module quickly and simply, as well as the power and ground circuits that we always used it on before," Fournier says.

Beyond power windows, Fournier says the Power Probe IV saves time when checking output devices such as canister purge solenoids, cooling fans, transmission solenoids and more.

"It is a very useful tool with multiple uses, making it the first thing we grab for electrical issues, including no-starts," Fournier says. ●

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FLEET DOMINATOR



Model PL5100

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425A ENGINE START

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