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A ConsuLab presentation

ELECTRICAL DIAGNOSTIC STRATEGIES FOR TODAY'S VEHICLES





2018 VERSION

REVIEW OF & INTRODUCTION TO ELECTRICAL DIAGNOSTIC STRATEGIES REQUIRED FOR TODAY'S VEHICLES

Vehicles today are more sophisticated than ever before. Technicians are faced with new challenges in learning new systems and methods of testing, diagnosing and measuring different values. Being an efficient and prosperous technician requires a lifetime commitment to learning. Although it is easy to become overwhelmed with all of the new technologies that seem to inundate us with every new vehicle model year, successful technicians will continue to be challenged by changes and do all they can to keep up to date and when possible, to obtain the required new test equipment needed to properly diagnose and repair these vehicles.

This presentation is designed to review the fundamental diagnostic skills that have been required for years and to touch on some new systems and technologies that are becoming more commonplace in today's vehicle repair industry. It is also designed as a teaching tool for instructors to use to help their students learn the importance of proper electrical diagnosis and in having the correct diagnostic equipment available to them.

TODAYS TOPICS

RELAYS – OPERATION & TESTING

ELECTRICAL TEST LIGHTS – TYPES & USE

VOLTAGE DROP TESTING – METHODS & IMPORTANCE OF

PARASITIC DRAW TESTING – METHODS & IMPORTANT OF

SPECIALIZED ELECTRICAL TEST EQUIPMENT – PRO'S & CON'S

TEST –
DON'T GUESS

From even in the early days, the vehicle repair industry has always subscribed to proper diagnosis of systems. Guessing as to the cause of a problem is a very inefficient and expensive strategy to use. Today, with the costs of repair parts being very prohibitive, making a proper and accurate diagnosis of the problem is more critical than ever. With today's vehicle systems being so inter-connected, replacing one part often mandates the reprogramming and re-learning of many others. Installing an unnecessary part due to a wrong diagnosis can often cause additional vehicle performance problems.

REQUIREMENTS OF SUCCESSFUL REPAIRS?

1- UNDERSTAND THE SYSTEM YOU ARE TRYING TO DIAGNOSE

2- HAVE VEHICLE SPECIFIC SERVICE INFORMATION

3- HAVE NECESSARY TOOLS & EQUIPMENT

4- HAVE THE RIGHT MENTAL ATTITUDE

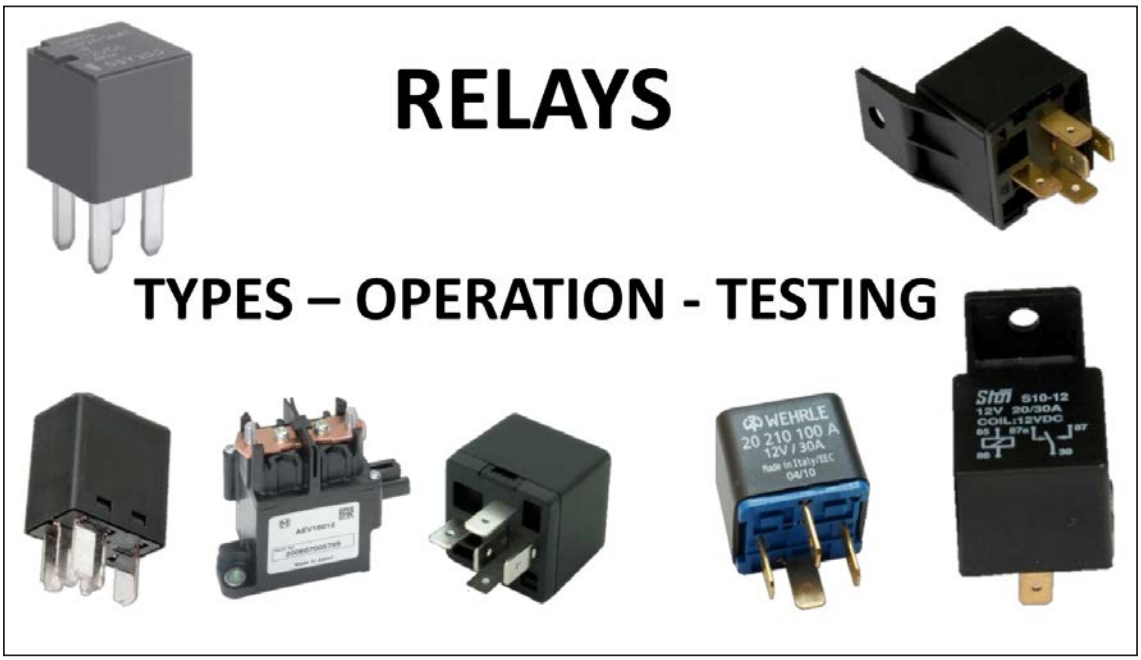
5- HAVE A PLAN TO DEAL WITH FRUSTRATION

6- HAVE A SOURCE TO GO TO FOR ASSISTANCE

7- OTHER? WHAT THINGS DO YOU SUGGEST??

TIPS & STRATEGIES

* NO ONE HAS ALL THE ANSWERS EVERYTIME
* NEVER ASSUME!!
* NEVER FORGET THE "BASICS"
* KEEP AN OPEN MIND TO NEW IDEAS
* DON'T ALWAYS DIAGNOSE ONLY BY "HISTORY" OF SIMILAR VEHICLES
* ALWAYS DO A THOROUGH VISUAL INSPECTION!!!!
* ALWAYS, ALWAYS VERIFY THE REPAIR TO CONFIRM IT IS INDEED FIXED!!!!



Today's vehicles have multiple relays installed in their electrical systems. Besides common locations like fuel pump, heater blower motor, A/C clutch, TCC, ABS and Lighting systems, vehicles now have many, many more relays and of many different sizes and styles. The International Standards Organization (ISO) relays are still very common and now come in three basic sizes (Standard, Mini & Micro). The advantage of the ISO relays is that there is a standardized method of identifying relay terminals using either numbers or letters or both. Besides ISO type relays, today's vehicles can use specialized application relays, relays made as in integral part of a circuit board or power distribution center or can be made as an integral part of a single component.

The importance of having a solid understanding of how relays operate is critical to being able to properly diagnose and repair relay systems. In the old days, a typical diagnostic approach to a relay circuit problem was to substitute the relay with a known good one and hope the problem was fixed. If not, you knew that you have to "get into the circuit" a bit more to identify the problem. Today, with so many different types of relays available, it is critical to fully understand how the affected circuit operates, any inter-connected circuits using the relay and more importantly, having the vehicle specific service information available to assist you in your diagnosis.

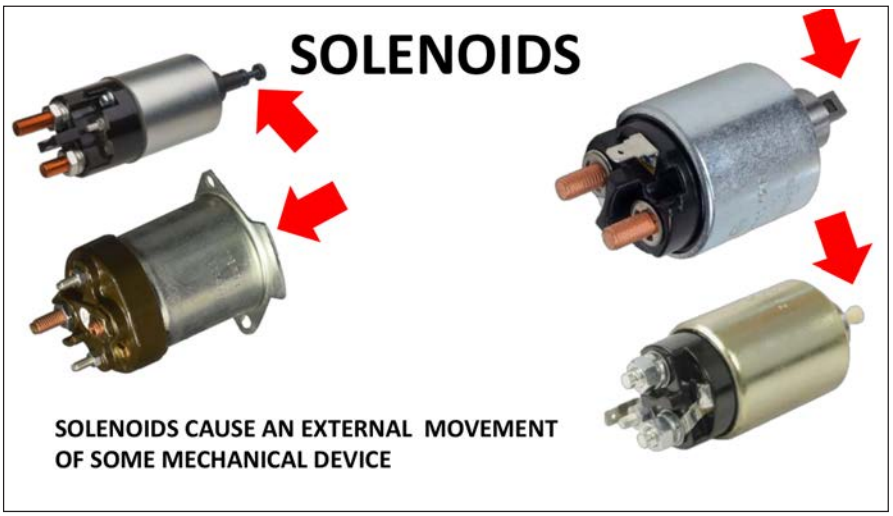
WHAT IS A RELAY?

WHAT IS A LATCHING RELAY?

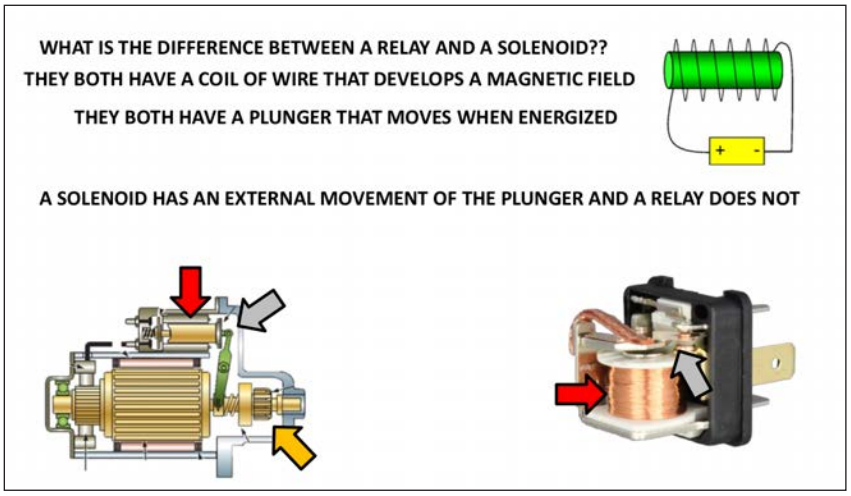
WHAT IS A SOLENOID?

WHAT DO THEY SHARE IN COMMON?

HOW ARE RELAYS TESTED?



Solenoids are like relays in that they both have coil windings that establish a strong magnetic field which causes a plunger inside the coil to move when energized. A solenoid also has an external connection from the plunger that moves another device outside of the solenoid. The most common application of a solenoid is the starter solenoid which causes the starter gear to move and engage with the engines flywheel.



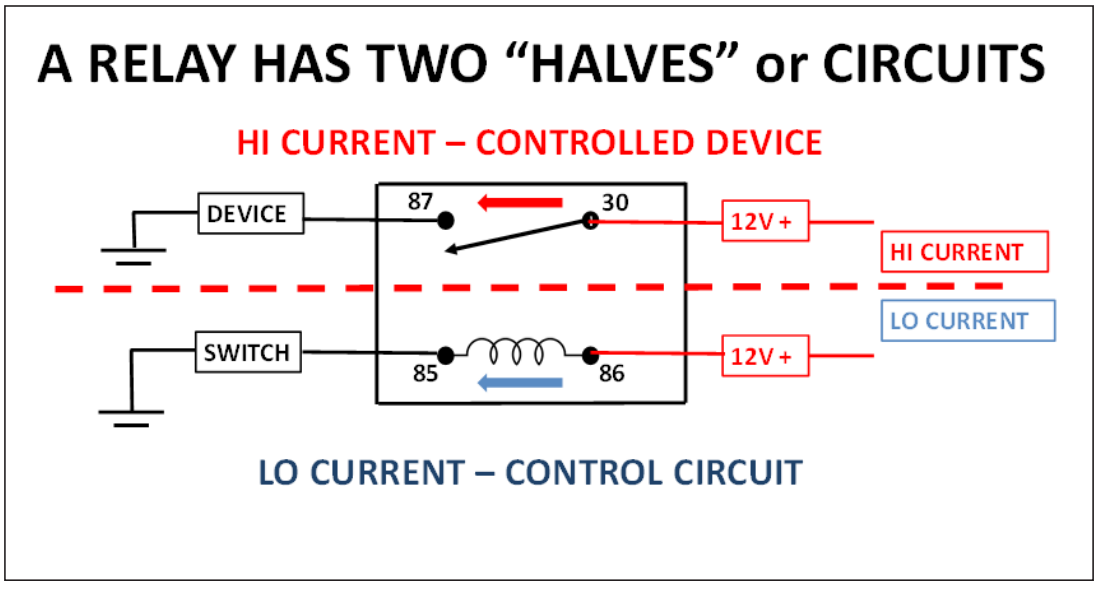
RELAYS

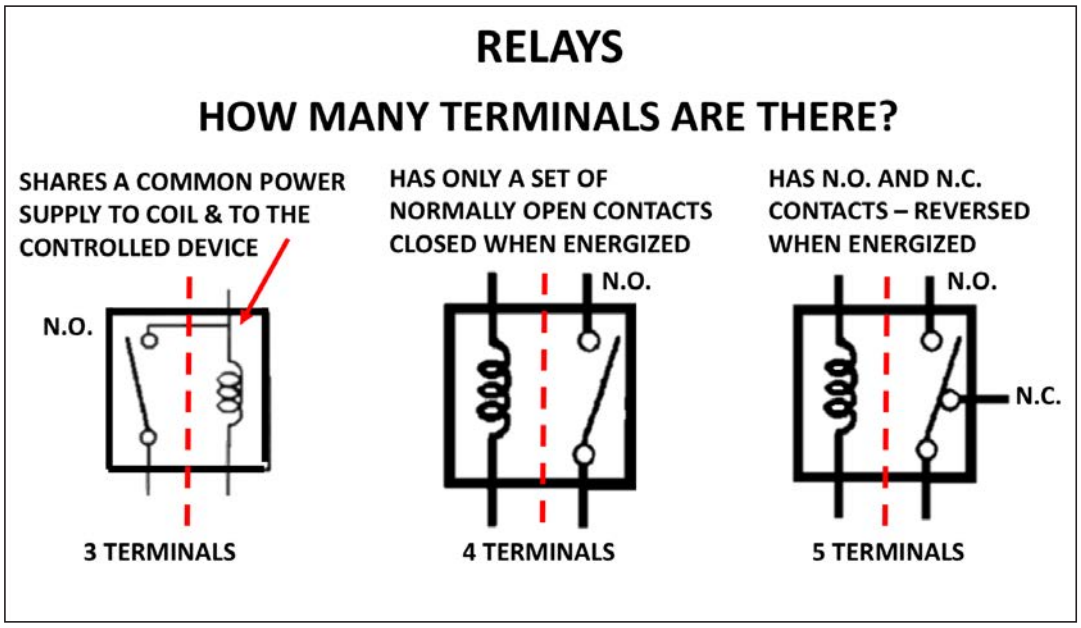
RELAYS ARE A HIGH CURRENT PASSING SWITCH THAT IS CONTROLLED BY A LOW CURRENT CIRCUIT – NO EXTERNAL MOVEMENT IS AVAILABLE

Relays are very common in today's vehicles are becoming more so with each vehicle model year that is released. It is extremely important that technicians have a strong understanding of relays and relay circuits to properly diagnose and repair vehicle systems.

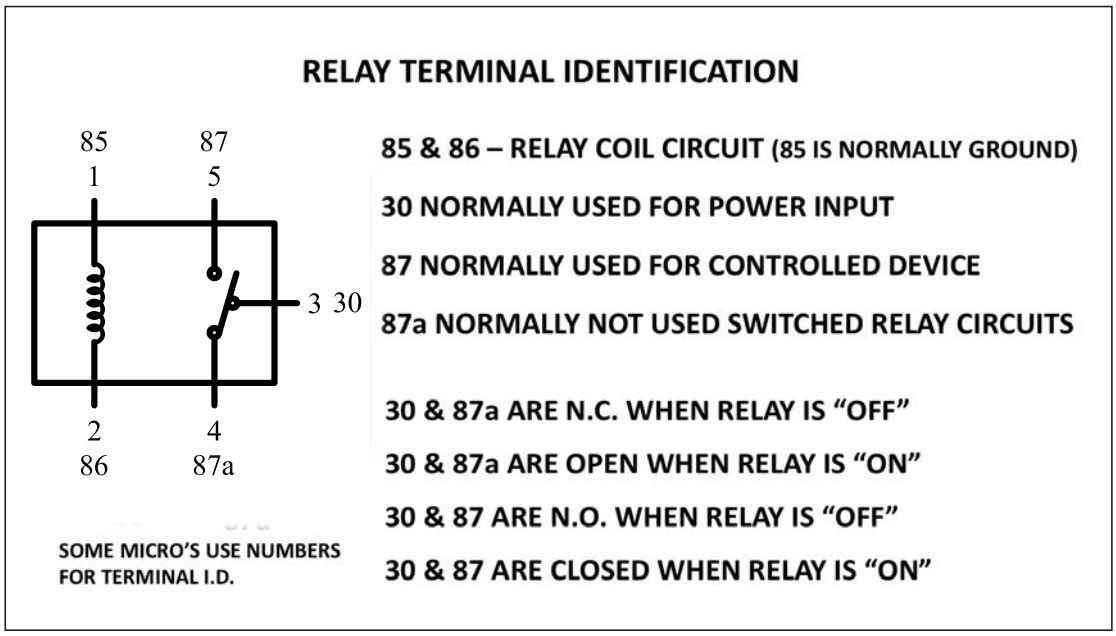
Relays are relatively reliable components, but can create system problems that will require proper diagnosis and replacement/repair. What is more important is the fact that technicians must also understand and be able to diagnose the entire circuit that the relay operates. These skills require proper understanding and use of correct service information, wiring schematics, proper diagnostic tools to perform efficient repair of relay systems used in the vehicle. Eliminating expensive guesswork will improve efficiency and develop great working relationships with customers.

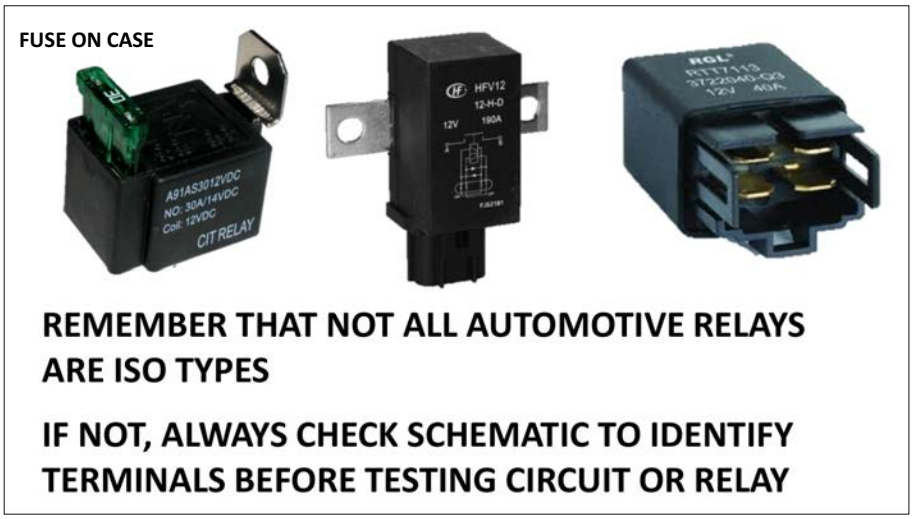
A RELAY HAS TWO "HALVES" or CIRCUITS



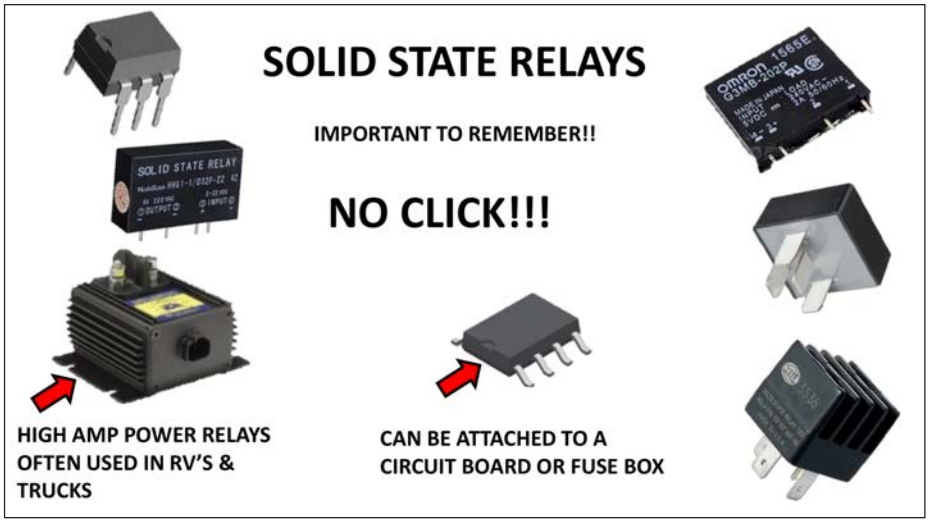


ISO (International Standards Organization) relays are very commonly used in today's vehicles of all types and brands. There are also many different types of non-ISO relays used, but it is fair to say that the majority of relays used today are ISO types. Relays can commonly have 3, 4 or 5 electrical terminals. The terminals each are identified with either numbers, letters or a combination of both.





Not all relays used in vehicles today are the ISO type. If you come across a non-ISO relay, be sure to obtain the vehicle specific wiring diagram for the relay before you test or diagnose the circuit. Some ISO relays or others can have dedicated fuses attached to the relay housing.



WHAT ARE SOLID-STATE RELAYS?

MOSFET'S – (metal oxide semiconductor – field effect transistor)

SCR'S – (silicon controlled rectifier)(not used much in DC)

TRIAC'S – (triode for alternating current) (not used much in DC)

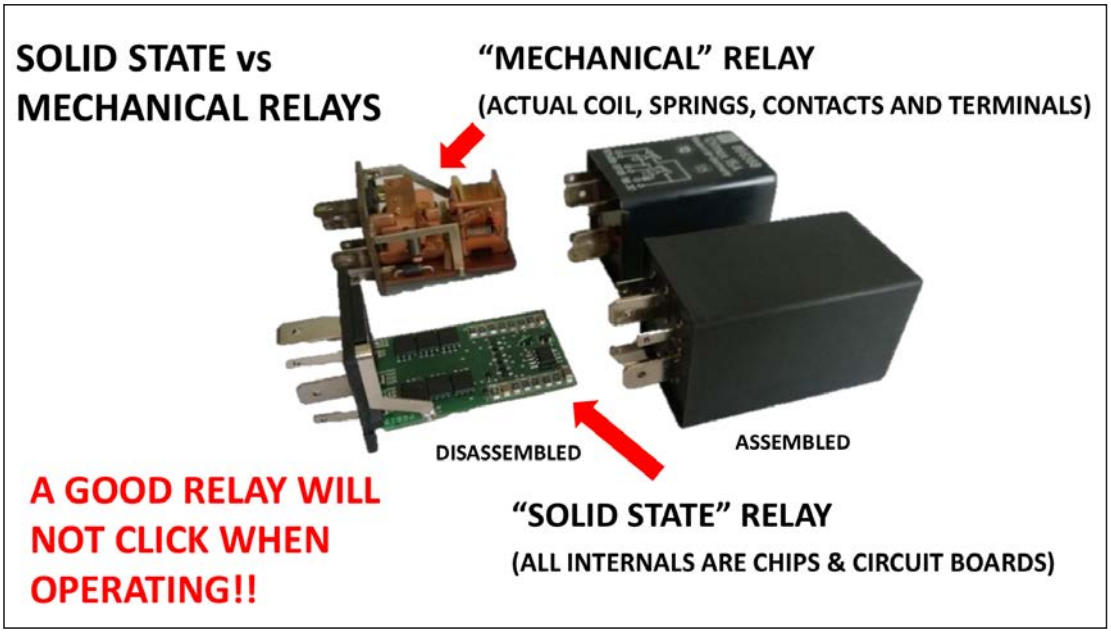
ADVANTAGES –

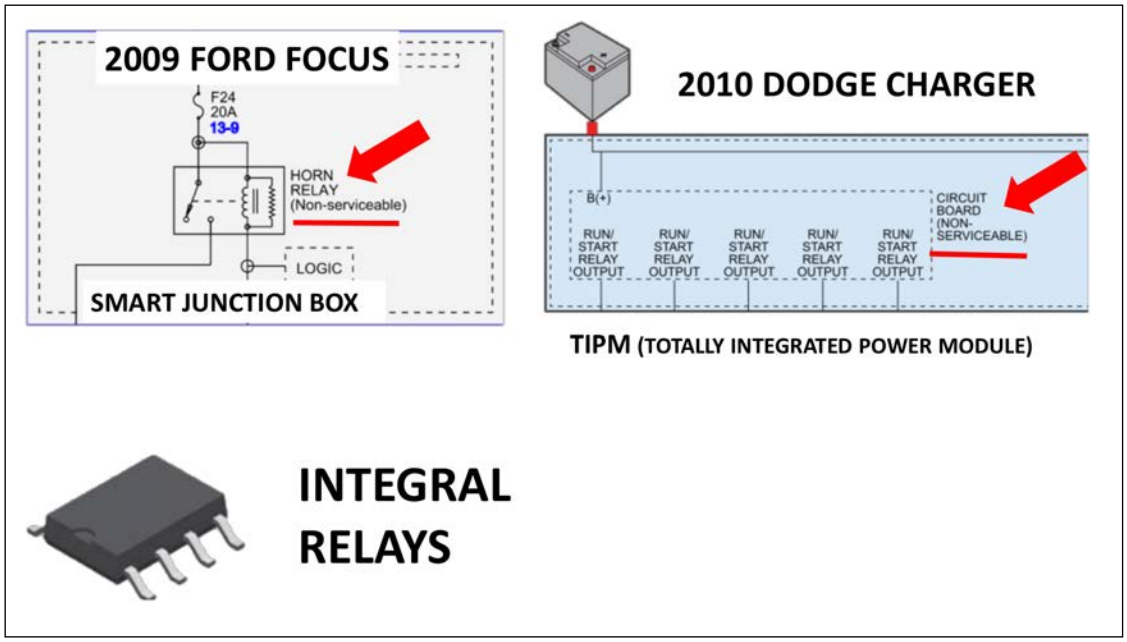
SILENT – NO ARCING ISSUES – CAN SUPPORT PWM CIRCUITS – NO VOLTAGE SPIKE ISSUES – CAN BE USED TO CONTROL VOLTAGES (EX: DAYTIME RUNNING LIGHTS) – VERY FAST SWITCHING – INTERNAL CIRCUIT PROTECTION W/O FUSES

DISADVANTAGES –

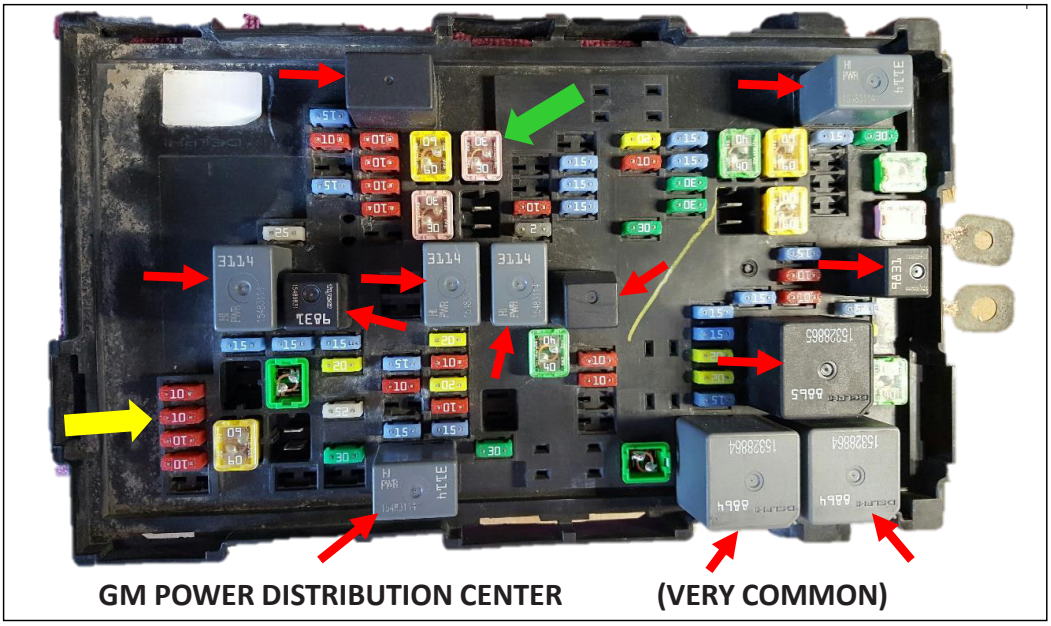
MORE COSTLY – CAN BE DIFFICULT TO DIAGNOSE – NON SERVICEABLE

Some of the newest types of relays are solid-state in design. Non-solid state relays have coils, mechanical contacts, springs, levers and other devices. Solid-state relays do not have the mechanical components inside that traditional relays have. They use circuit boards and electronic components to perform the same switching function in a circuit as a mechanical relay does. It is important to remember that solid-state relays do not typically have the "clicking" sound that is a common trait of standard relays. Be sure to follow OEM diagnostic routines to properly determining if the solid-state relay is functioning normally or not.

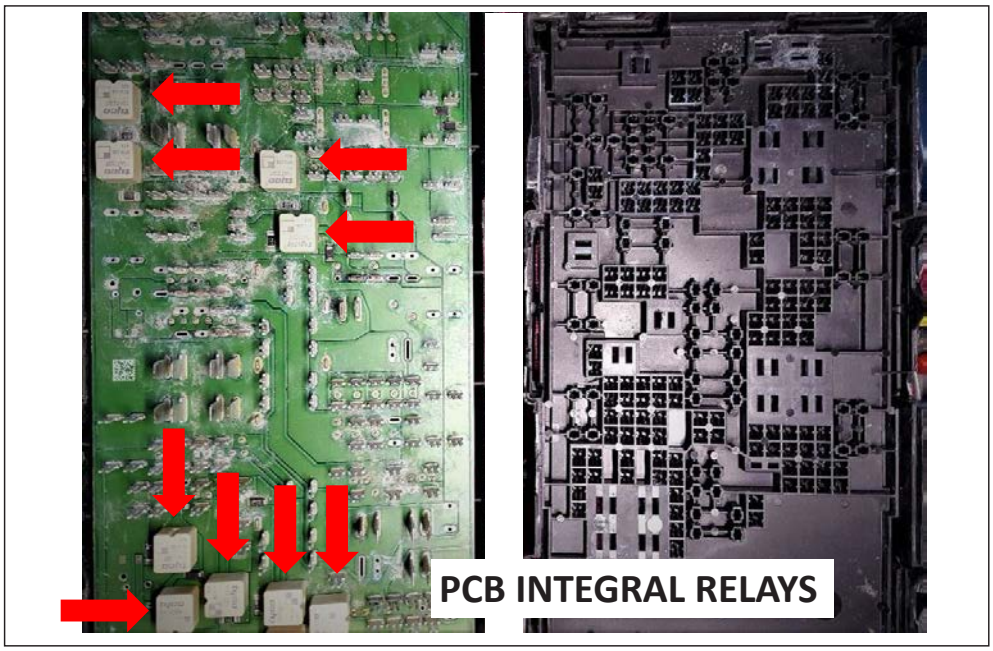




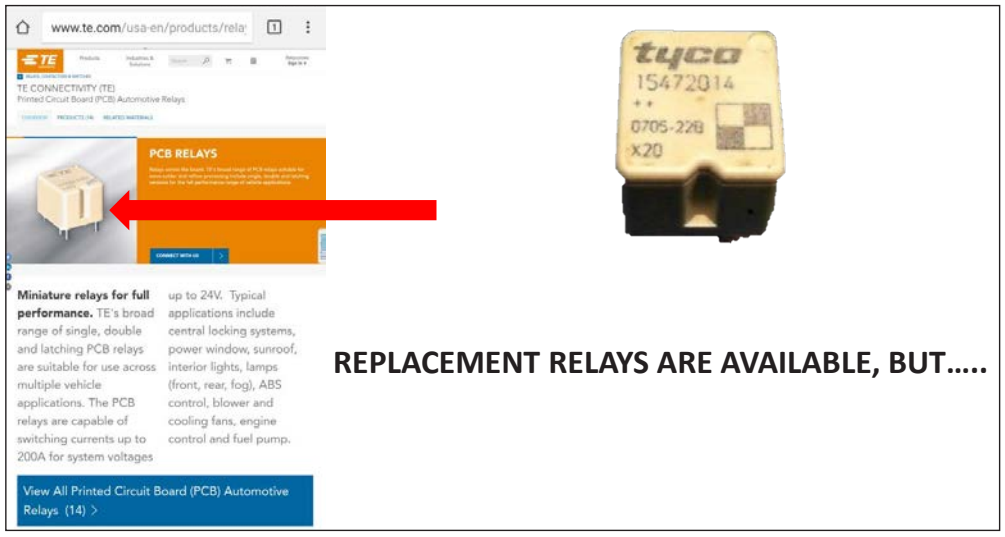
Many vehicles today use “integrated relays” installed in fuse boxes, power centers or other modules. These relays are identified as “non-serviceable” and replacement of the entire assembly is the only method of repair. These units are expensive and often must be programmed to the specific vehicle they are installed in.



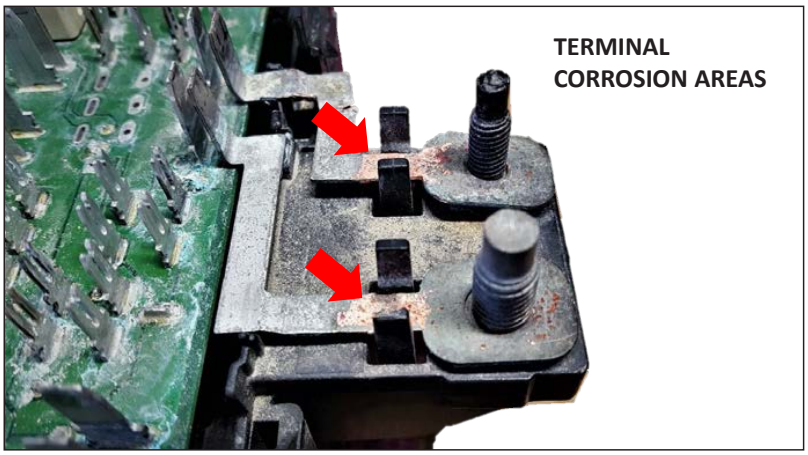
A typical Power Distribution Center on a GM product primarily used from 2007 and newer vehicles. The assembly is fed by B+ power and ground by the two large terminals (shown on right-side of picture) The **GREEN** arrow identifies cartridge fuses (30A, 40A, 60A), **RED** arrows identify all types of relays (replaceable) and **YELLOW** arrow identifies mini-fuses. This assembly also has integral relays on the under-side of the circuit board that are non-serviceable. (See below picture).



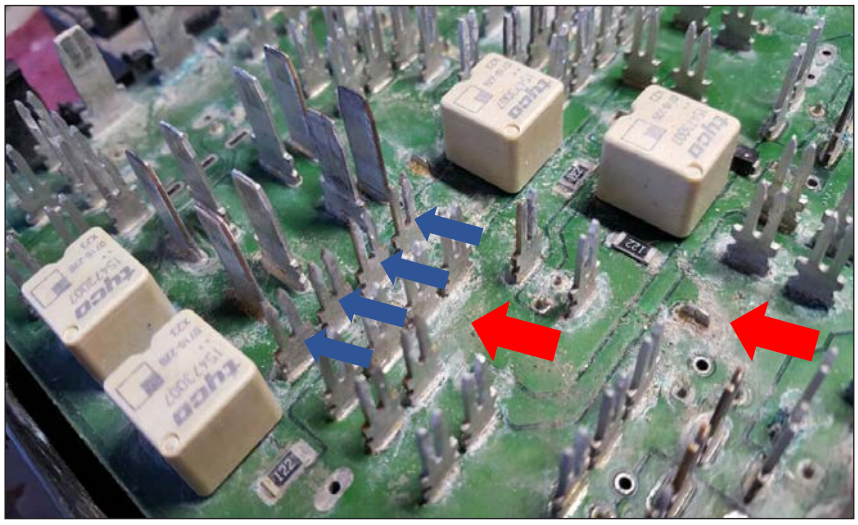
This picture shows the location of nine integral non-serviceable relays soldered onto the circuit board. This assembly is NOT designed to be taken apart and perform service on the relays. It is shown taken apart only for instructional purposes. The non-serviceable relays are classified as “PCB” relays which indicates that they are soldered on the “Printed Circuit Board”.



Although, the actual PCB relays can be located and purchased, GM does not recommend that this particular component be serviced. Some circuit boards (like FCA) can have the integral relays replaced, but this procedure takes a high degree of expertise, requires very detailed soldering work and often isn’t worth the financial savings considering the issues of customer warranties and support. Most commonly, if the component needs replacing, the entire assembly is exchanged.

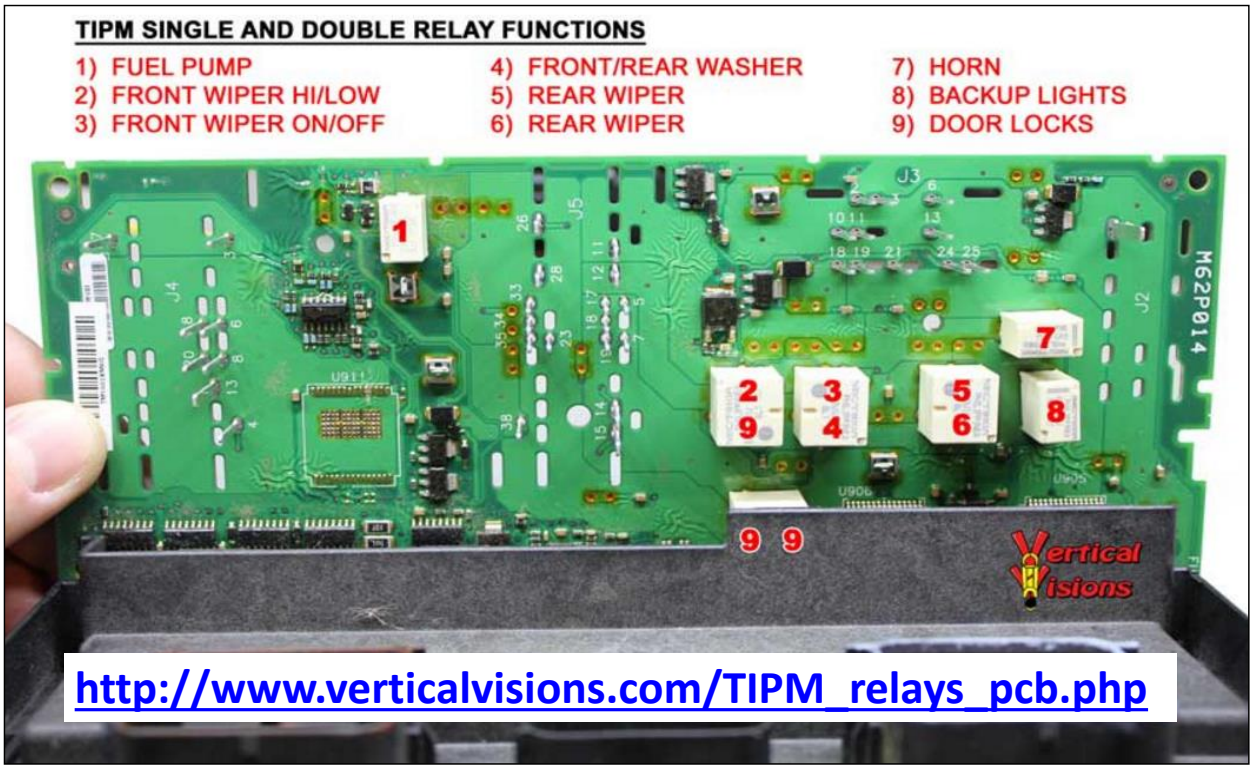


One of the biggest problems and concerns with sealed assemblies like power distribution centers is moisture intrusion. OEM components are carefully sealed and protected from moisture. However, oftentimes the incorrect removal and assembly of covers, weather-pack connectors, grommets, etc. can result in corrosion and internal electrical problems requiring replacement of the entire assembly. The main diagnostic issue with these conditions is that the damage cannot be viewed from the outside of the assembly and because disassembly is often not recommended, the only clue to this possible condition is improper component or circuit performance. It is extremely important that all covers are properly reinstalled when checking or servicing these components.



The red arrows point to circuit board corrosion caused from water intrusion. Normally, this portion of the circuit board is not visible to technicians as it is under non-serviceable assemblies. In this case, the notches or slots on the terminals identified by the blue arrows where the mini-fuses attach from above the circuit board cover.

Careful inspection and service procedures must be followed in order to prevent moisture intrusion and subsequent damage to fuse boxes, power distribution centers and other similar components. Failure to do can result in expensive repairs.



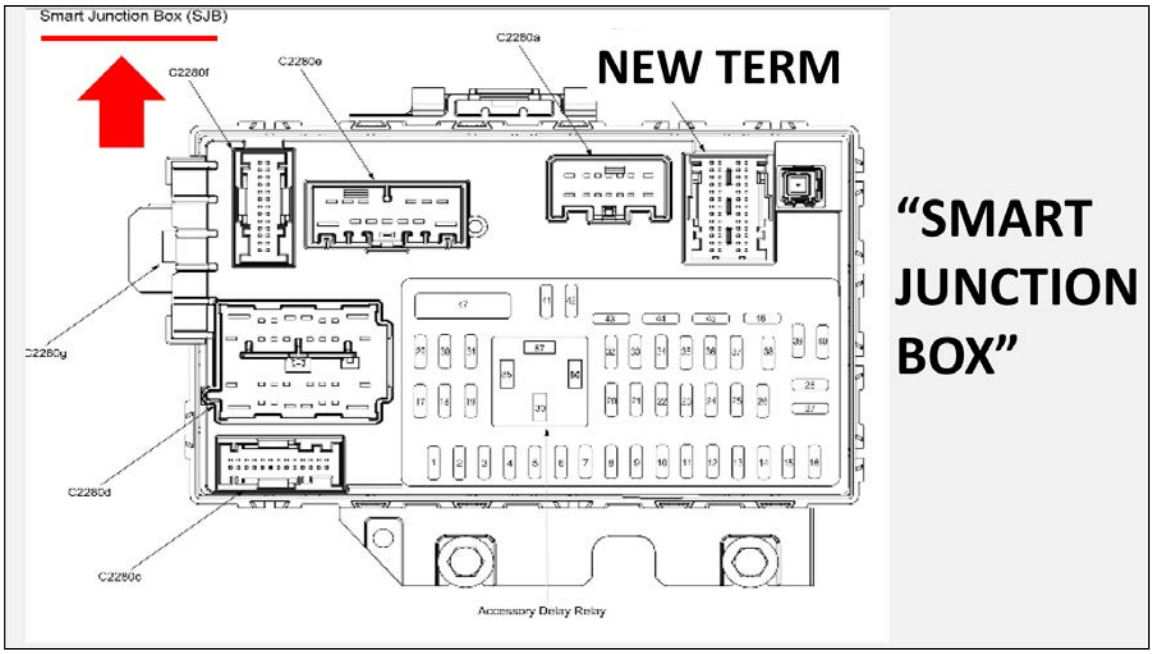
Integrated and solid state relays are tested differently than common mechanical relays. Always refer to OEM service information, but common diagnostic procedures of these components include:

1. Scan tool bi-directional control tests of relay function.
2. Scope testing of relay commands from input source.
3. Substitution of relay's controlled load with an equal sized load to check function of relay and control circuits.

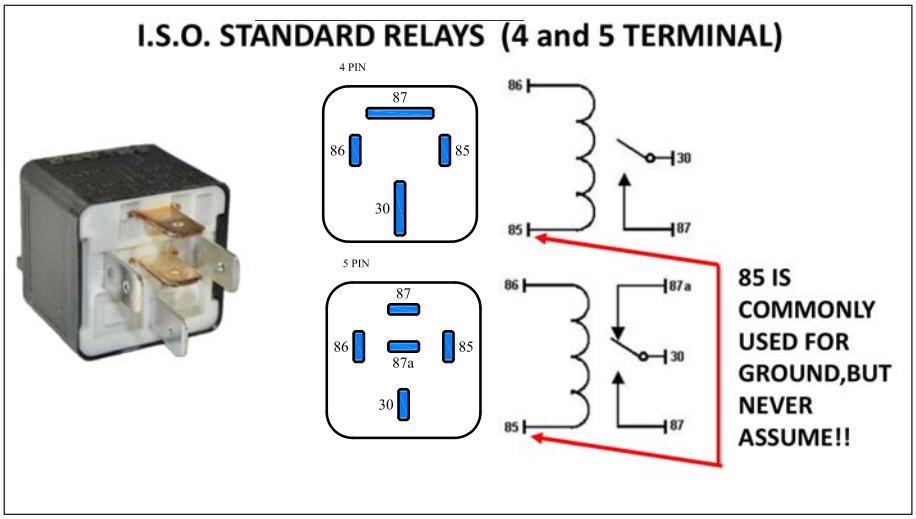
If a defective integrated relay is diagnosed and confirmed, replacement of the entire component (fuse box, Power Distribution Center, TIPM or other component) is often required. Check with other sources as to the other availability of alternative repair and replacement procedures for individual relays.

Be aware that this process often requires complicated disassembly and re-assembly of the circuit boards including the requirement of de-soldering and soldering of very small electrical connections and terminals. These procedures may not be suitable for every case.

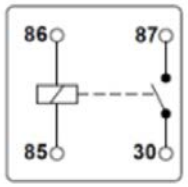
Many cars now use relays and other components that are integrated into one non-serviceable assembly. These can be called “Smart Junction Boxes” (Ford), or Power Distribution Centers (GM) and others. If the relay fails, the entire assembly must be replaced.



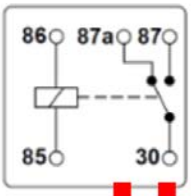
Proper diagnosis of relay controlled circuits requires that vehicle specific information is available. NEVER assume that all vehicles are the same from year to year as this often is not the case. Always learn the entire circuit before attempting to diagnose or repair it. Many times relays fail due to excessive current flowing through them. Defective controlled components can cause this such as bad cooling fans, fuel pumps, and other shorted or defective conditions. It is recommended that a current flow check be made of the controlled device prior to replacing only the relay. Voltage drop testing of the circuit can also identify other conditions that can cause negative performance issues.



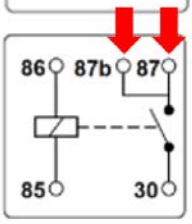
ISO (International Standards Organization) relays are extremely common in today's vehicles. The advantage to them is that they use a standardized method of identifying the electrical terminals. See below diagrams for specific terminal configuration and identification of all types of ISO relays.



COMMON RELAY – 4 POLE – 30 TO 87 N.O.
SPECIAL APPLICATIONS CAN BE N.C., BUT IS RARE.
85 & 86 IS COIL CIRCUIT
IS CALLED A "MAKE & BREAK" RELAY – SIMPLEST FORM

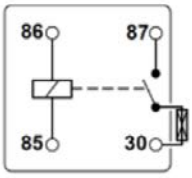


COMMON RELAY – 5 POLE – 30 TO 87a N.C.
30 TO 87 N.O.
IS CALLED A "CHANGE OVER " RELAY 87a IS NOT ALWAYS USED- IF NOT, IT IS A "MAKE & BREAK" RELAY – 85 & 86 IS COIL CIRCUIT

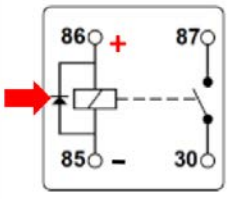


RARE RELAY – 5 POLE – 30 TO 87 & 87b N.O.

SWITCHES TWO CIRCUITS FROM A COMMON FEED – GERMAN CARS

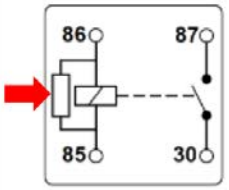


RELAY WITH REPLACEABLE FUSE – USUALLY PART OF MOLED HOUSING - SOMEWHAT RARE – NORMALLY FOUND IN AFTERMARKET APPLICATIONS, ALARMS, OPTION ADD-ON'S, ETC



RELAY WITH DIODE ACROSS COIL FOR SPIKE SUPPRESSION

The diode will always be installed in the relay with the band on the diode body facing towards terminal 86 (if "positive) (reverse biased) and it is important that +12V is connected this terminal, not 85!! THANKFULLY, DIODES ARE NOT COMMON ANYMORE

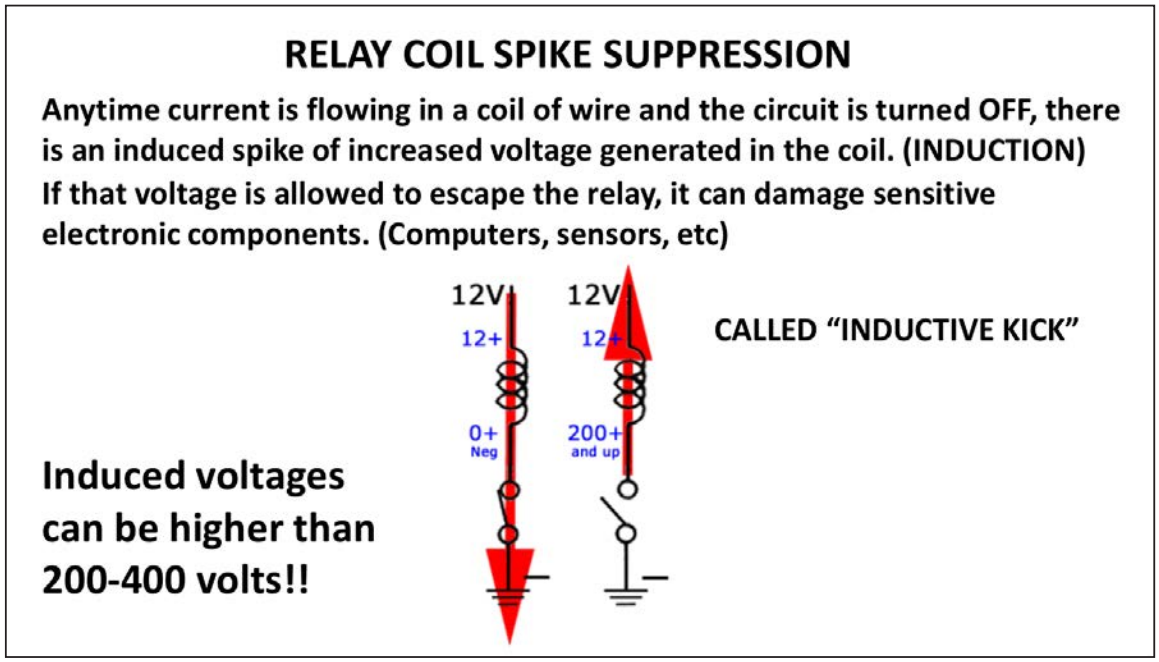


RELAY WITH RESISTOR ACROSS COIL FOR SPIKE SUPPRESSION

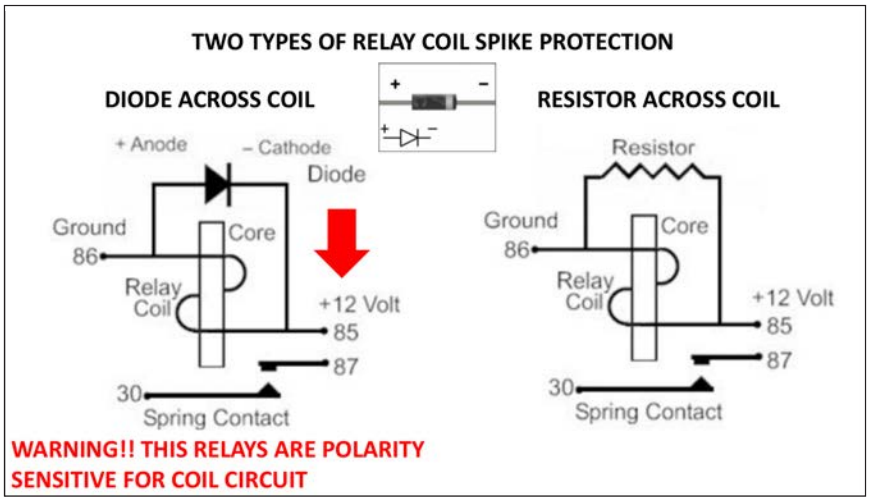
Not as efficient at blocking spikes as diodes, but is not polarity sensitive. Either 85 or 86 can be positive or negative.

Although becoming rare, some ISO and other relays use suppression diodes in the relay coil circuit. It is very important that technicians know how to determine if the relay has a diode and if so, how to properly test the relay both in and out of the circuit. Suppression is needed in the relay coil due to an induced voltage that is generated each time the relay coil is turned off. This induced voltage if allowed to leave the relay can cause serious damage to sensitive electronic components such as modules, computers and other devices. This induced voltage is often referred to as “voltage kick”.

Relay induced voltages are controlled today by either using a diode or a resistor in parallel with the relay coil winding. These components keep the induced voltage within the coil as it dissipates after each coil on/off cycle. It is important to note that if a relay has a diode in the coil, the relay is extremely sensitive to the proper polarity hookup of the relay coil circuit. Reversing terminals # 85 & # 86 will INSTANTLY damage the diode beyond use. The problem is that if this happens due to improper testing, oftentimes, the technician doesn’t realize this has happened and the relay in installed back into the circuit which can create damage to other components. Sometimes, the relay housing will have the relay schematic which MAY indicate that a diode is used. If not, always check the specific wiring diagram for the relay’s circuit or perform a “check test” of the relay to determine if it has a diode or not.

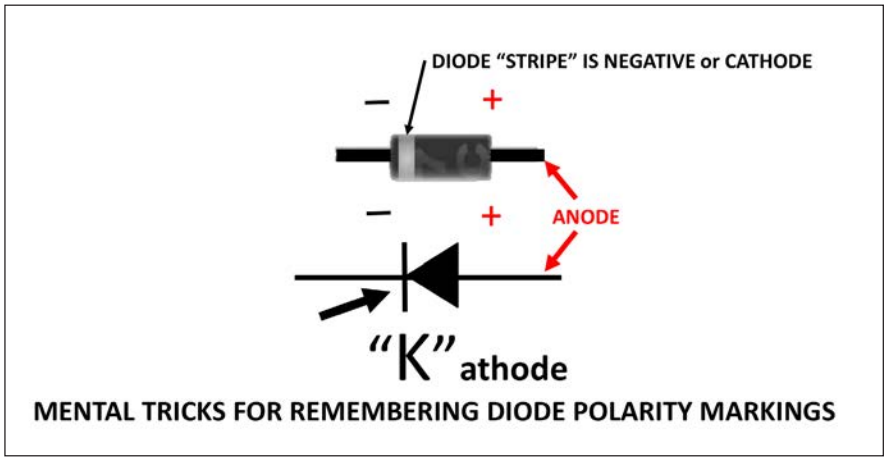


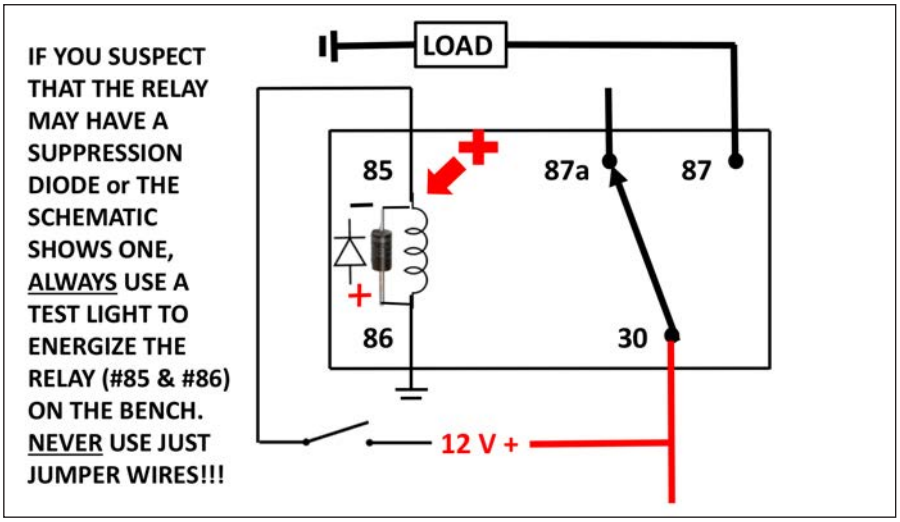
The diode will always be installed in the relay coil circuit with the cathode (-) band of the diode body facing towards terminal #86 (if it is connected to a positive source). This is called “reverse biased” and it is important that +12V is connected to this terminal and NOT terminal #85. In the example shown above, terminal #85 is connected to a positive source (which is rare). ALWAYS check vehicle specific wiring schematics for this information. Diodes are excellent for suppression of induced voltages, but due to their fragility and increased internal protection of the computer and module electronics, most relays today use resistors to perform this function.



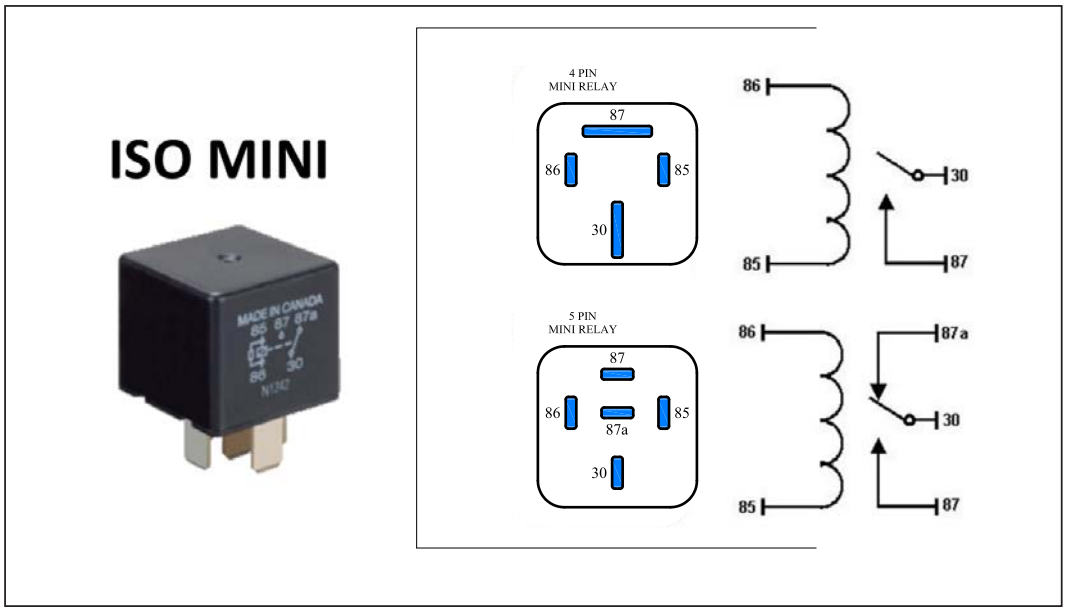
The diode "stripe" must ALWAYS face towards the "positive" connection of the coil relay winding. Connecting the relay coil "backwards" will result in the immediate destruction of the diode and loss of spike suppression.

CAUTION: The relay may continue to operate normally with the diode destroyed, but could result in damage to external components due to the loss of the diode's suppression operation.

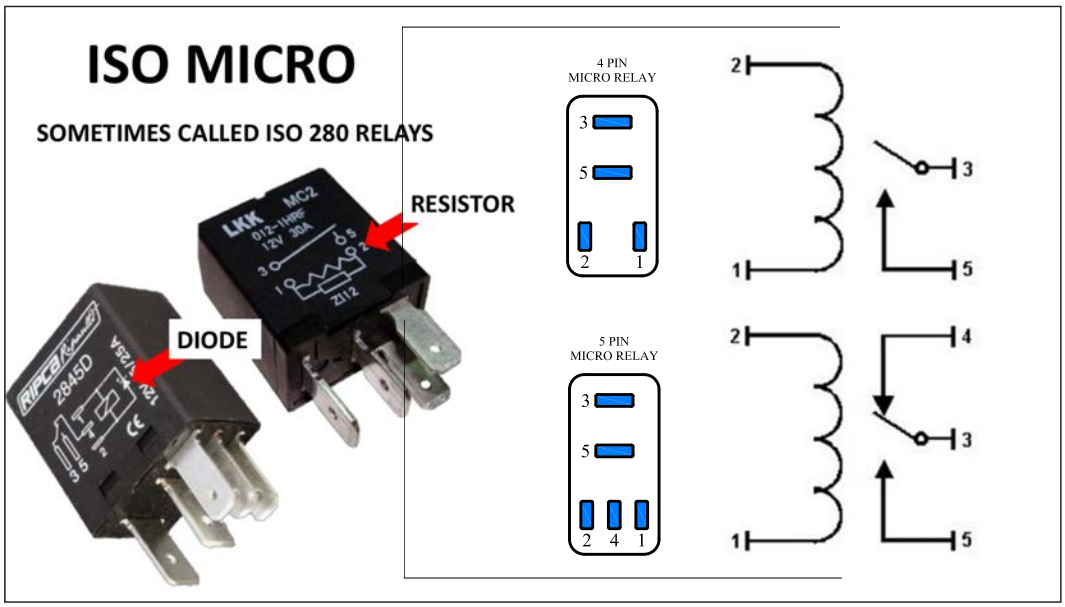




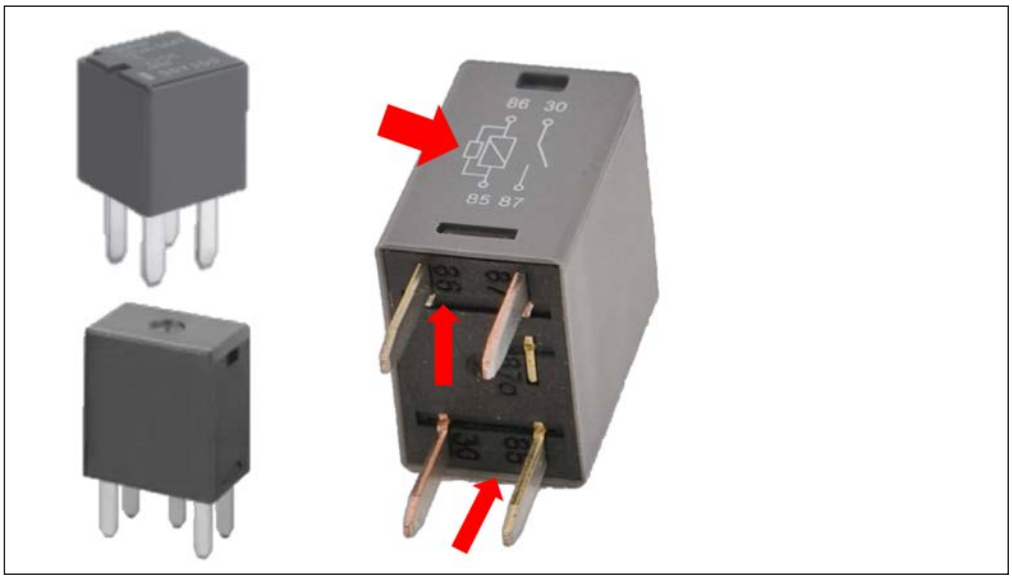
ISO "standard" relays have been used for years in vehicles, but with improvements in technology, they are being replaced with ISO "mini" relays primarily for their smaller sizes.



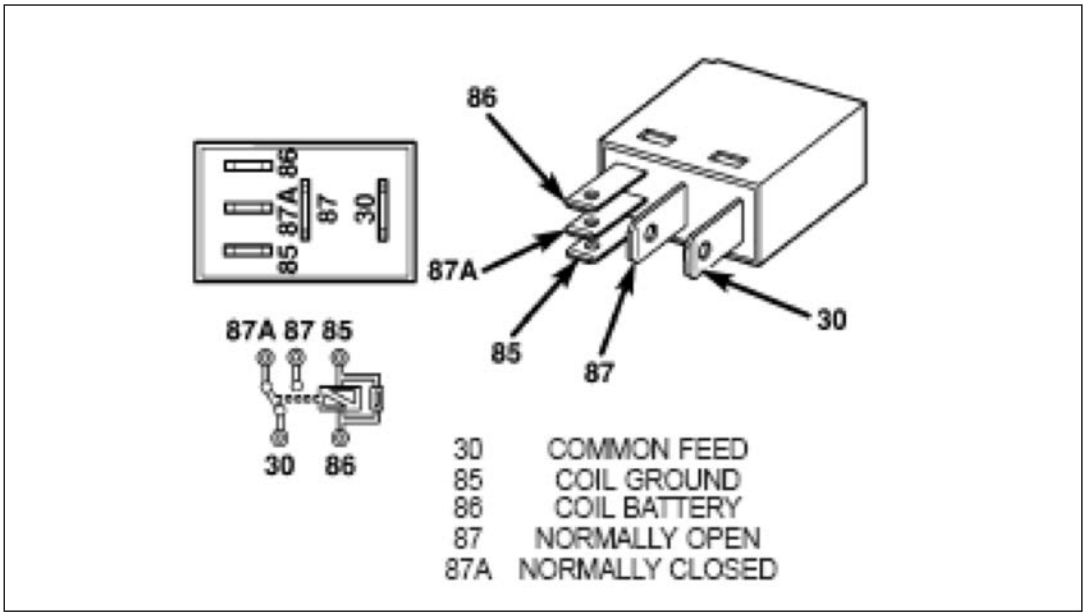
ISO relays are also available in a "mini" size which are smaller than the full-sized ISO relays. Terminal identification can be the same or may use numbers. Their advantage is simply to save space in the vehicle.

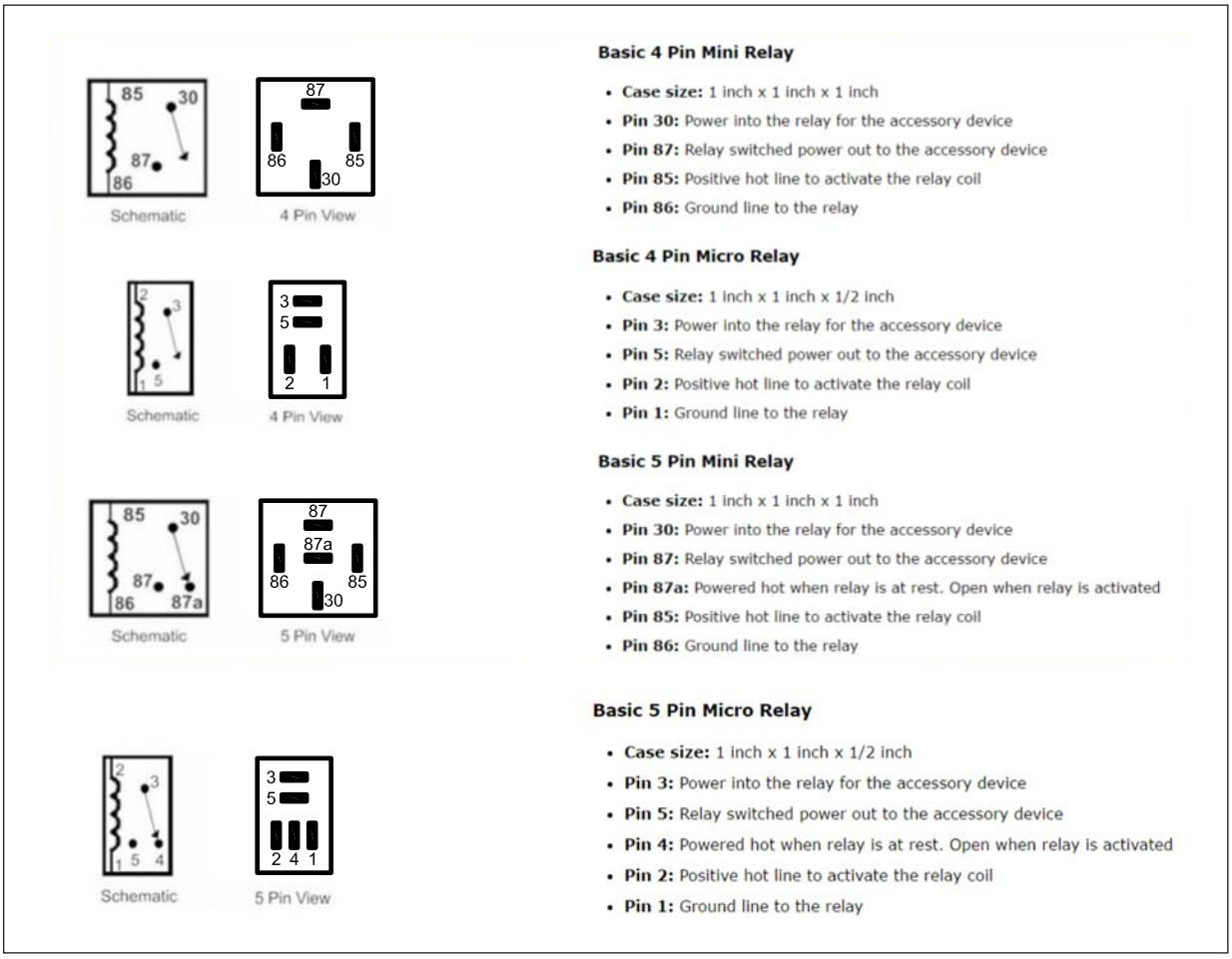


ISO relays also come in the MICRO size which are shaped somewhat rectangular and usually use numbers to identify electrical terminals. Notice in the examples shown, that one micro relay has a suppression diode and one uses a resistor.



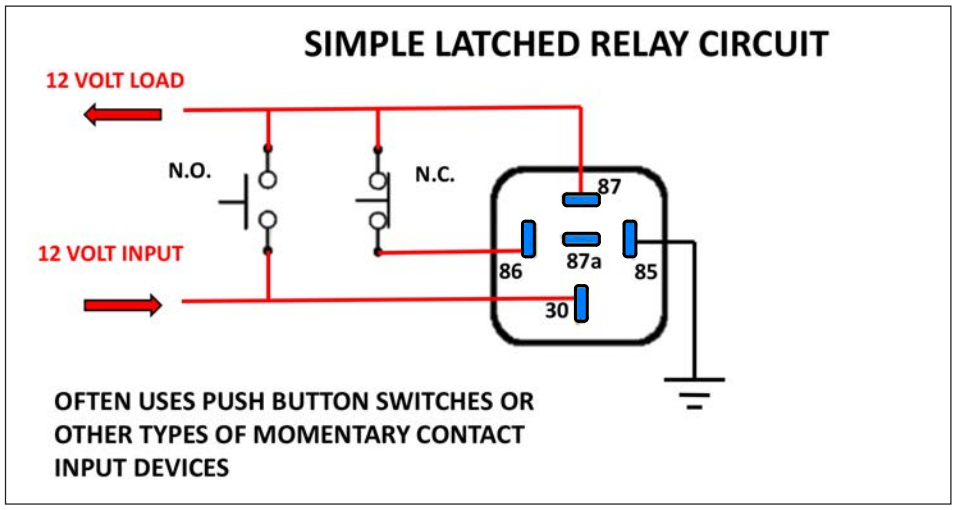
Note that on the four-terminal relay shown above, terminals # 85 & # 86 are on opposite corners of the relay's housing. This is a typical layout for micro relays and is important to note for purposes of bench testing. Always check the relay housing for a relay schematic or obtain vehicle specific wiring diagrams. Another reliable source of relay information is to obtain a document called a manufacturers BUYERS GUIDE. Buyers guides can be requested at any auto parts jobber store or can often be downloaded from the manufacturers website. An example would be Standard Motor Products. They have downloadable buyers guides and catalogs available. Buyers guides show pictures of the relay (and other components), gives the specific vehicle application and in most cases, shows a wiring diagram of the relay. This is a good resource for teaching and learning electrical components.





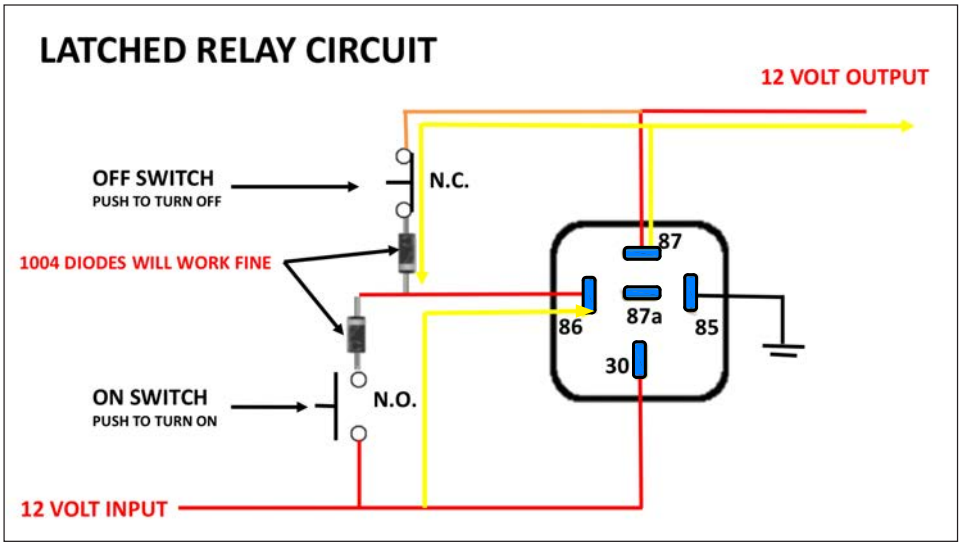
The above diagrams show the terminal configuration and identification of common ISO relays.

LATCHING RELAYS AND LATCHING RELAY CIRCUITS

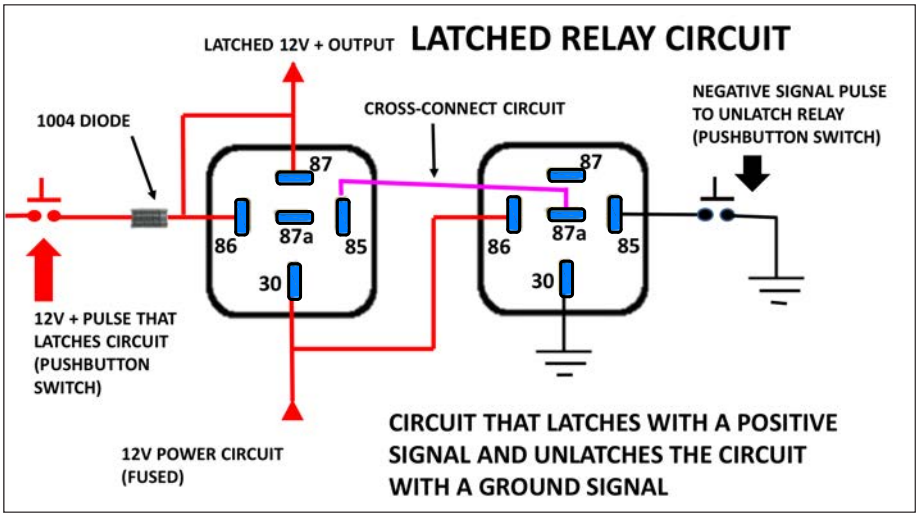


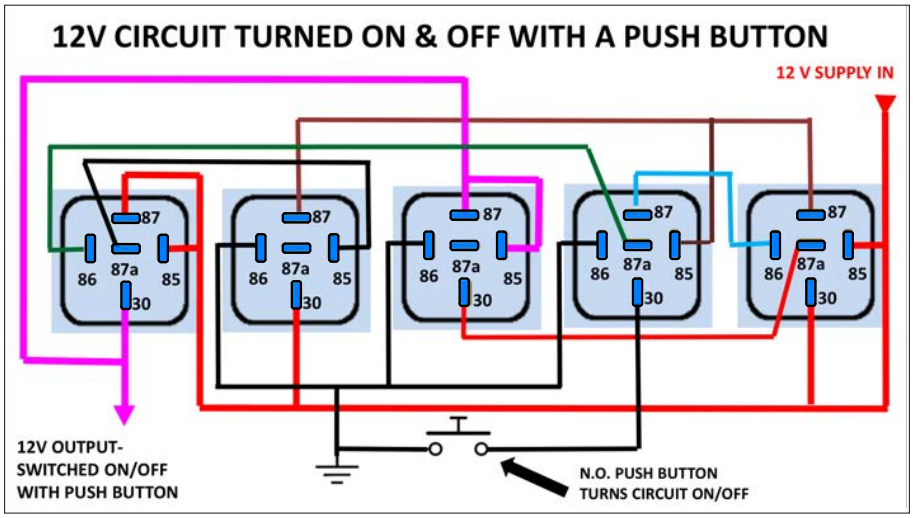
Some cars use relay "latching" circuits. Latching means that the relay stays in the switched position even after the switch is not long used. Most latched circuits use momentary switches of some kind with the most common being push buttons or momentary inputs from other modules, computers or processors. Many after-market custom system installers use latching relay circuits to accomplish their goals with add-on alarm, extra lighting and audio systems. There is a LATCHING relay available that without any external modifications will stay in the switched position even though the switch input is removed. The relay would have to receive an additional switch input to change back to its original position. These relays are somewhat rare in vehicles, but relay latching circuits are not.

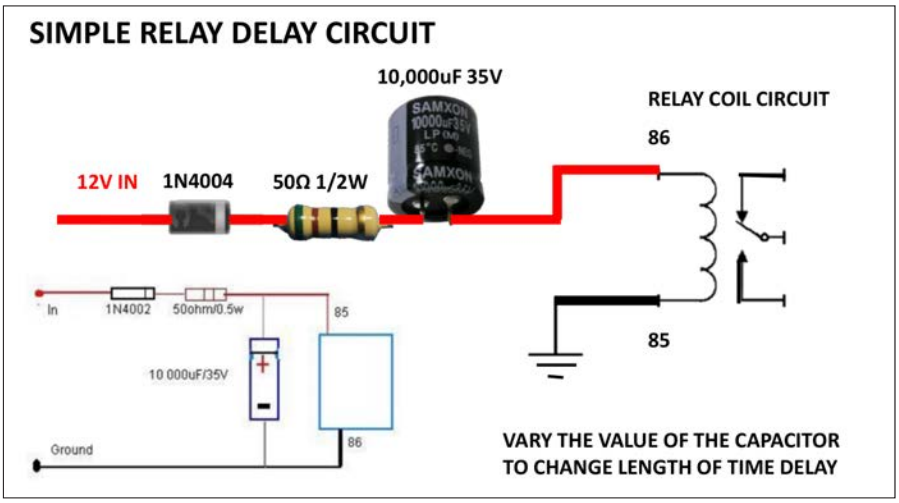
View the diagrams for common types of "custom" relay latching circuits that can be customized to any specific need or objective.



Switches can be push buttons, toggle, or other types used as switching devices to momentarily break the relay coil circuit.







It is possible to build a custom relay “timing circuit” by following the schematic above. Change to value of the capacitor to change the amount of switching time.

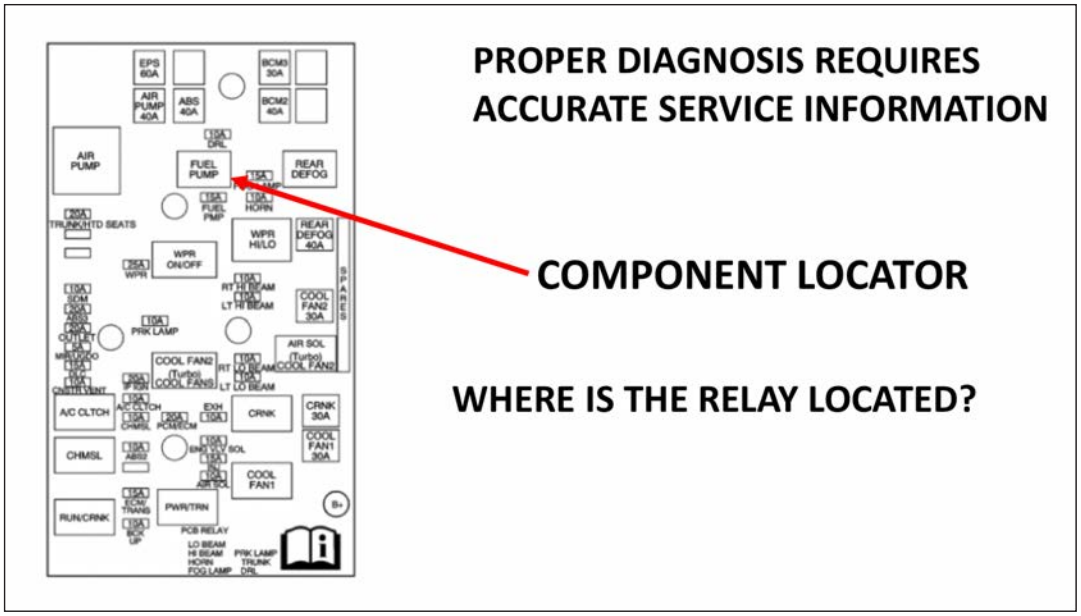
RELAY TESTING

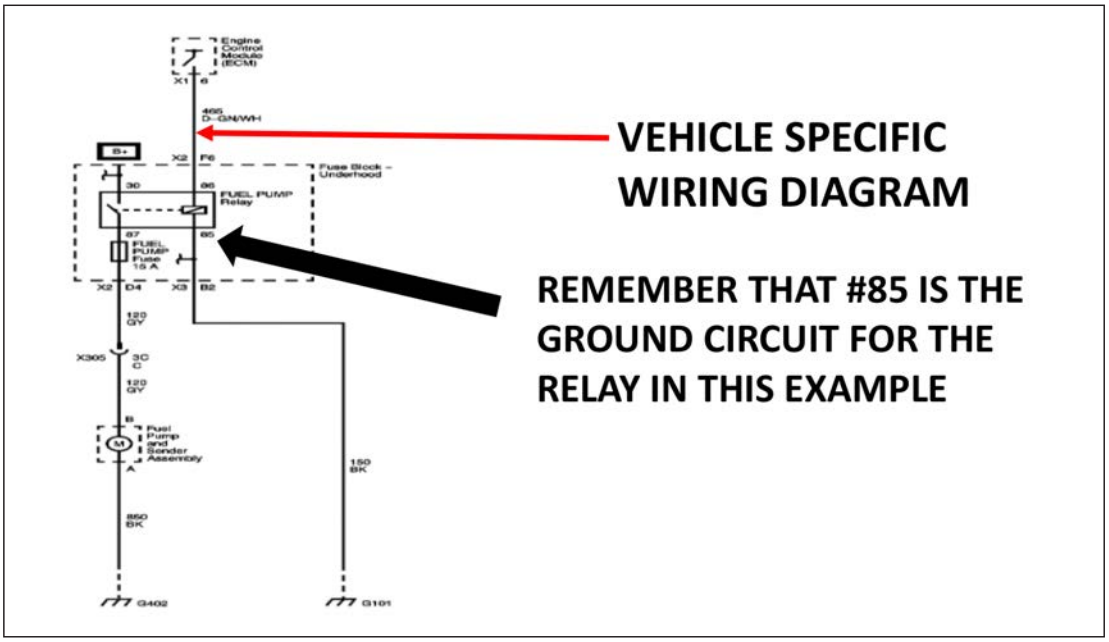
ABSOLUTELY NEED ACCURATE AND VEHICLE SPECIFIC SERVICE INFORMATION FOR PROPER DIAGNOSIS

IDENTIFIX
OnDemand5
SHOPKEY
ALLDATA

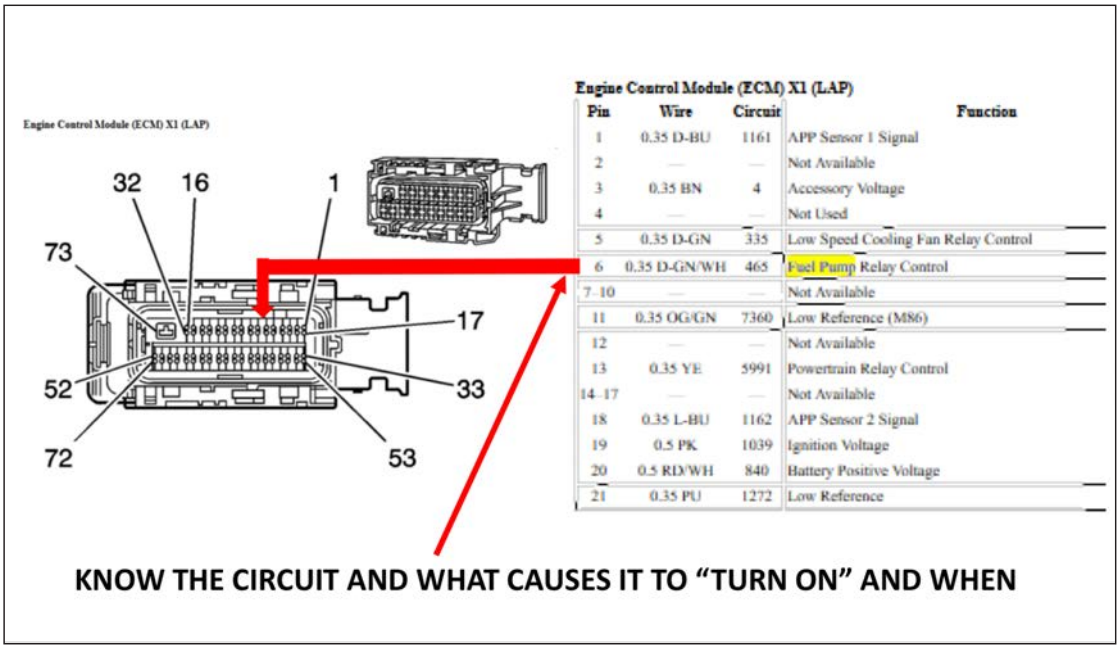
Relays and relay circuits often require accurate testing to identify the cause of a circuit malfunction. It is necessary for technicians to have a thorough understanding and ability to properly diagnose these components. One of the most important factors is to have accurate vehicle service information applied to a specific vehicle. Never assume that all relays and relay circuits are the same. They may be, but often can vary by model year and specific vehicle application.

It is important to have a full understanding of how a relay circuit operates, what input turns the relay on, the power and coil power ground circuits and when the relay operates. This information is available for OEM and some aftermarket service information resources.





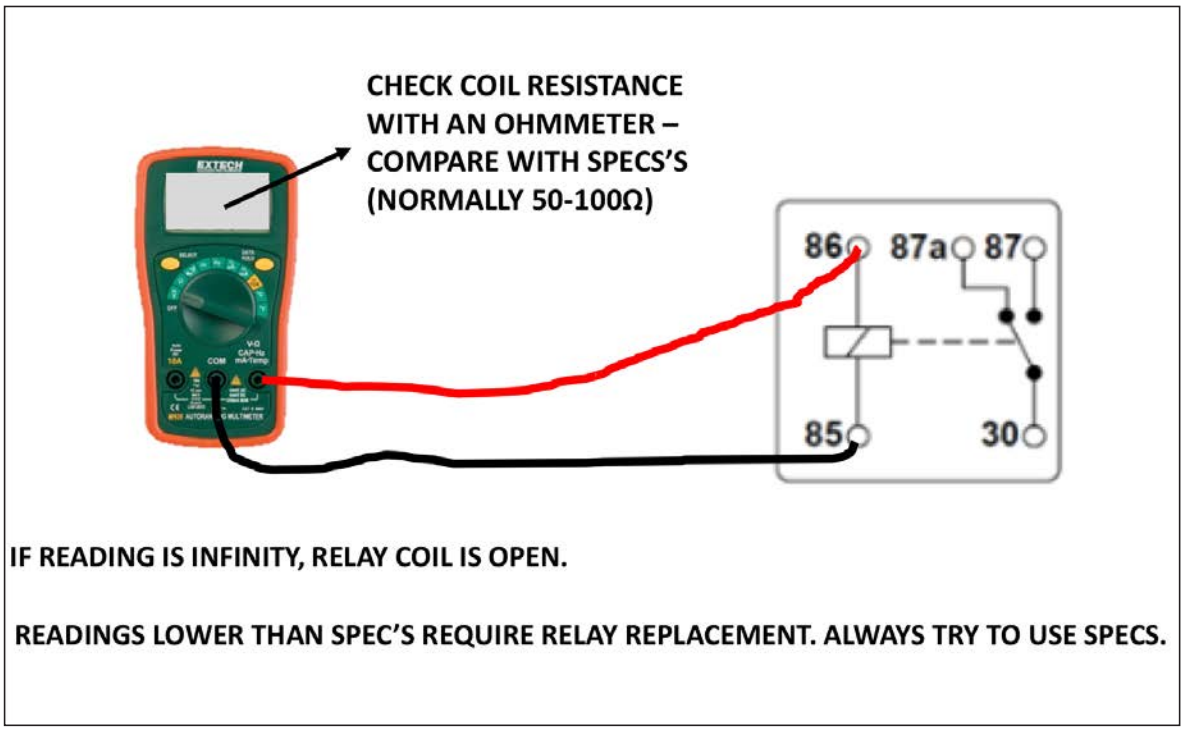
Having the correct wiring diagram is critical for correct repair of electrical circuits.



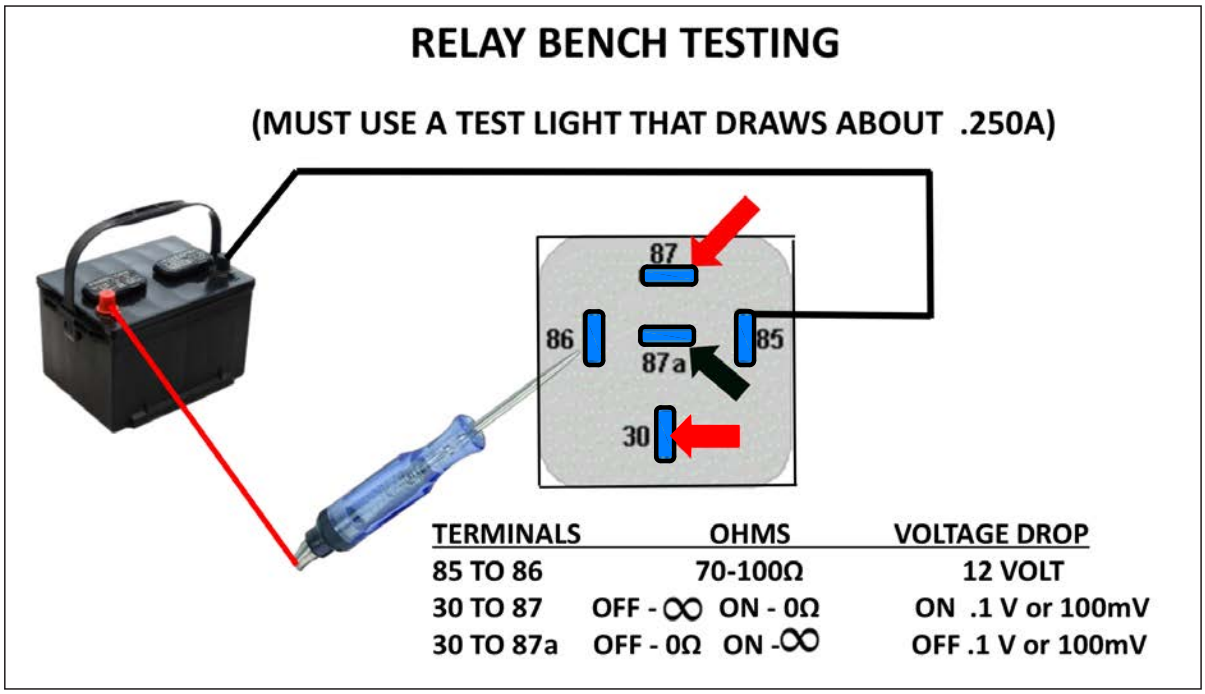
Engine Control Module (ECM) X1 (LAP)

Pin	Wire	Circuit	Function
1	0.35 D-BU	1161	APP Sensor 1 Signal
2	—	—	Not Available
3	0.35 BN	4	Accessory Voltage
4	—	—	Not Used
5	0.35 D-GN	335	Low Speed Cooling Fan Relay Control
6	0.35 D-GN/WH	465	Fuel Pump Relay Control
7–10	—	—	Not Available
11	0.35 OG/GN	7360	Low Reference (M86)
12	—	—	Not Available
13	0.35 YE	5991	Powertrain Relay Control
14–17	—	—	Not Available
18	0.35 L-BU	1162	APP Sensor 2 Signal
19	0.5 PK	1039	Ignition Voltage
20	0.5 RD/WH	840	Battery Positive Voltage
21	0.35 PU	1272	Low Reference

Understanding the circuit is also very important for the correct diagnosis to be revealed. You must understand what turns the relay on. What conditions have to be met before the relay is energized?



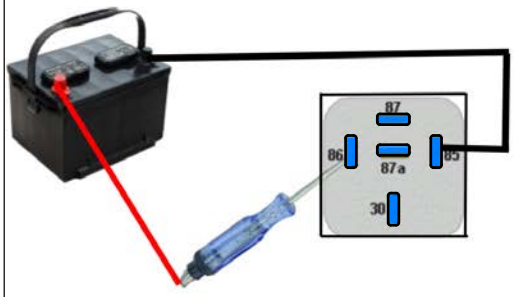
MANY TECHNICIANS STOP WITH ONLY THIS TEST. FOR ACCURATE RELAY TESTING, MORE TESTS NEED TO BE DONE. CONTACT VOLTAGE DROP AND RELAY SWITCHING PERFORMANCE SHOULD ALSO BE PERFORMED.

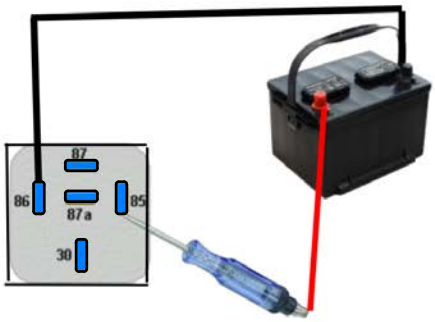


DOES RELAY HAVE A DIODE OR RESISTOR INSIDE???

REVERSE POLARITY OF TEST LIGHT HOOKUP
IF RELAY CLICKS IN ONE DIRECTION, BUT NOT THE OTHER, IT HAS A DIODE

IF RELAY CLICKS IN BOTH DIRECTIONS, IT HAS A RESISTOR

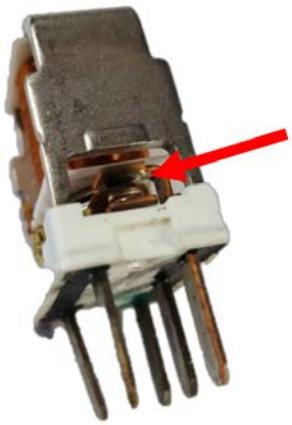




USE A .250A DRAW TEST LIGHT **#194 BULB WORKS WELL**

TO ENERGIZE A RELAY ON BENCH

1- CHECK IF RELAY HAS A DIODE
2- USE A TEST LIGHT THAT DRAWS MINIMUM OF 250mA
3- GROUND # 85 TO NEG BATTERY
4- CONNECT TEST LIGHT FROM POS BATTERY TO # 86
5- IF GOOD, RELAY MAY "CLICK"
6- IF DOESN'T "CLICK", REVERSE TEST LEADS AND POLARITY
7- IF RELAY "CLICKS", RELAY HAS A DIODE AND RELAY COIL IS GOOD
8- IF RELAYS "CLICKS" BOTH WAYS, RELAY HAS A RESISTOR AND COIL IS GOOD
9- IF RELAY DOESN'T "CLICK", COIL IS BAD
10- MUST NOT USE A "COMPUTER SAFE" TEST LIGHT TO CHECK FOR DIODE

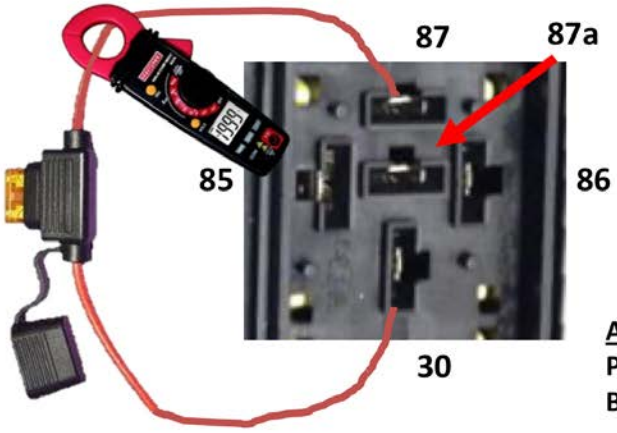


THESE RELAY CONTACTS ARE BURNED AND PITTED DUE TO A SHORTED BLOWER MOTOR. VOLTAGE DROP TEST REVEALED THE DEFECTIVE RELAY.

BLOWER MOTOR WAS REPLACED, BUT STILL DID NOT OPERATE PROPERLY DUE TO RELAY CONTACTS NOT ABLE TO PASS FULL CURRENT.

VOLTAGE DROP TEST REVEALED THE DEFECTIVE RELAY.

Always use fused jumper wires when testing relay circuits. Failure to do this can easily result in damage to computers, wiring harnesses and components. Choose a fuse equal or a bit lower than the circuit being tested.

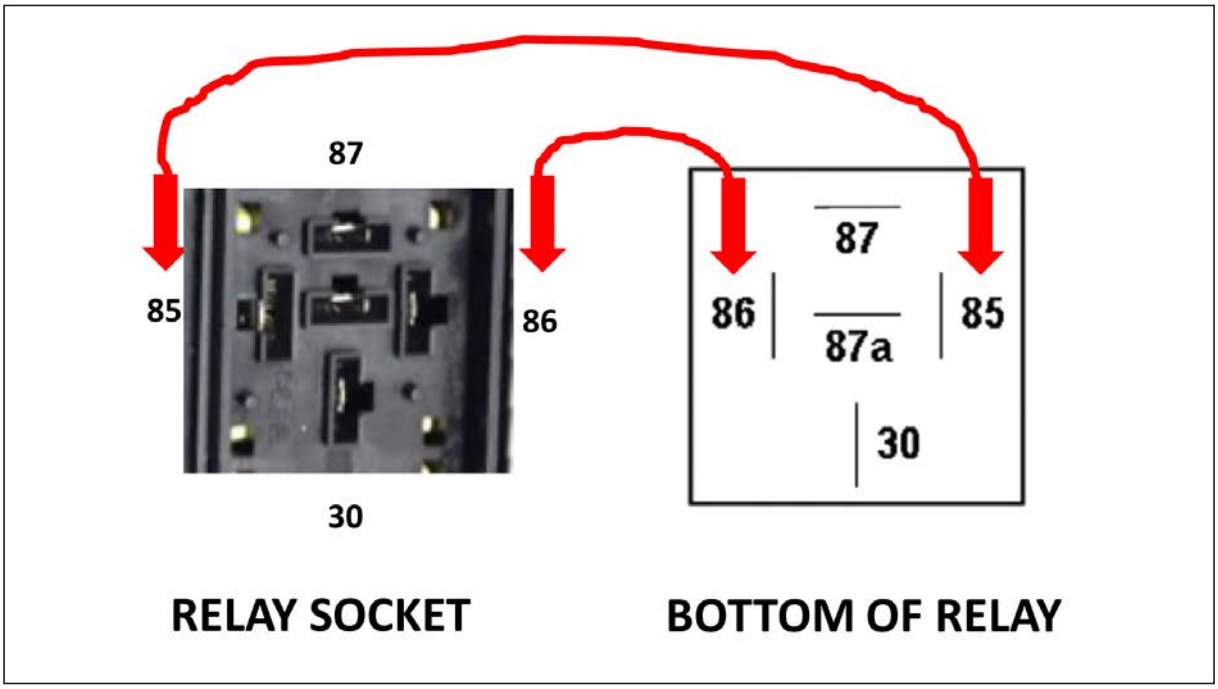


DYNAMIC TESTING

ALWAYS, ALWAYS, ALWAYS CHECK PROPER WIRING DIAGRAM FIRST BEFORE JUMPERING ANYTHING.

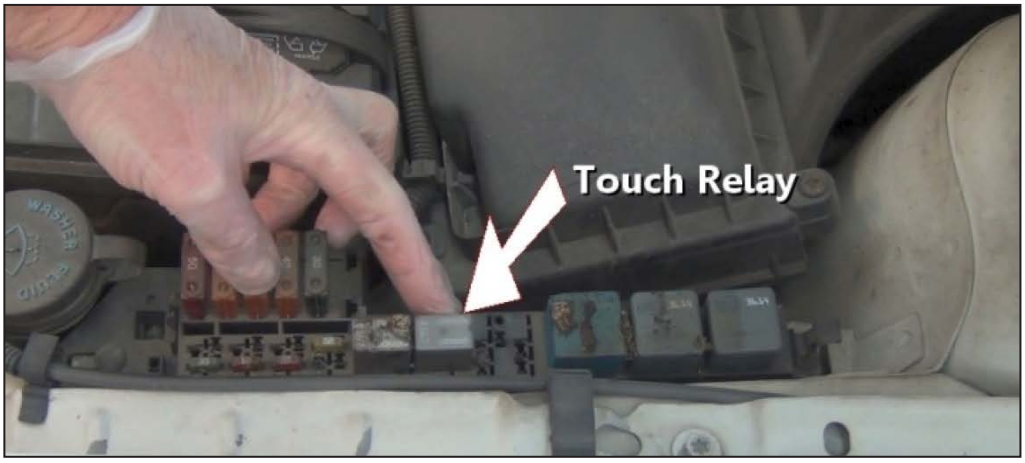
NEVER ASSUME THAT ALL RELAYS ARE THE SAME

IN THIS CASE, INSTALL A FUSED JUMPER WIRE BETWEEN #30 & #87 - CONTROLLED DEVICE SHOULD OPERATE



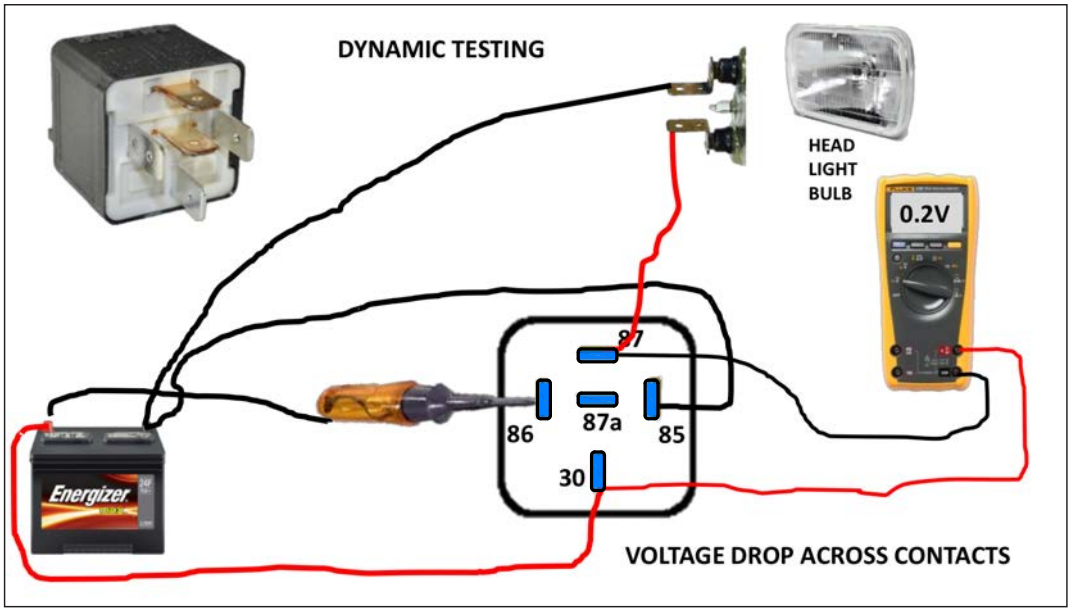
It is extremely important that you remember the proper configuration of relay terminals and more importantly, the difference in terminals # 85 and # 86 between the relay and the relay socket. (they are reversed).

AS ALWAYS, A CAREFUL VISUAL INSPECTION IS ONE OF THE BEST DIAGNOSTIC STRATEGIES A TECHNICAIN CAN PERFORM. IT DOESN'T TAKE MUCH CORROSION TO CAUSE PERFORMANCE PROBLEMS.

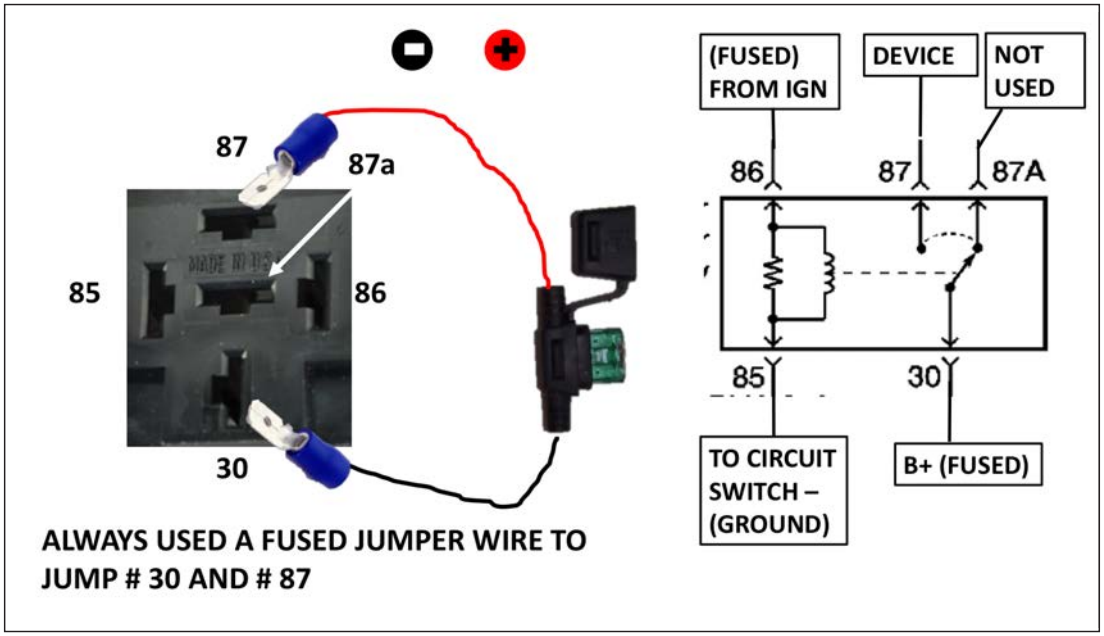


A "WIGGLE TEST" IS A VALUABLE DIAGNOSTIC CHECK. INTERMITTENT OPERATION CAUSED FROM CORRODED OR LOOSE TERMINALS. CHECK AND DOUBLE CHECK.

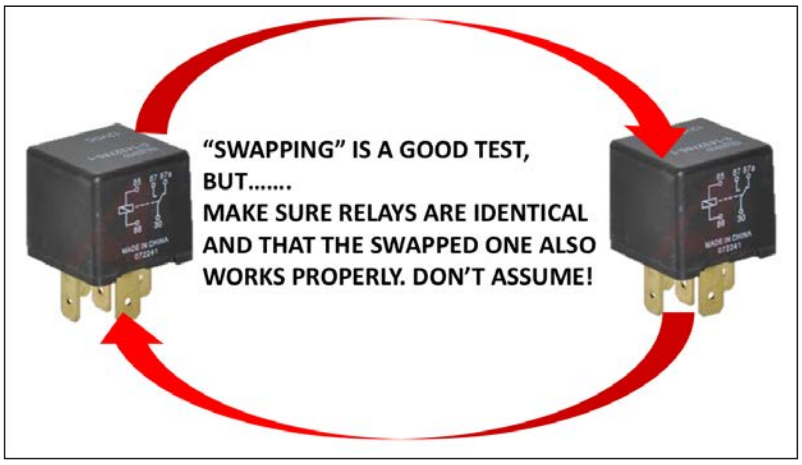
Performing the above tests is an important part of total relay circuit testing. Oftentimes, a mal-functioning circuit can be repaired by simply cleaning the relay terminals of corrosion and oxidation. Rarely, relay socket connectors need service or replacement.

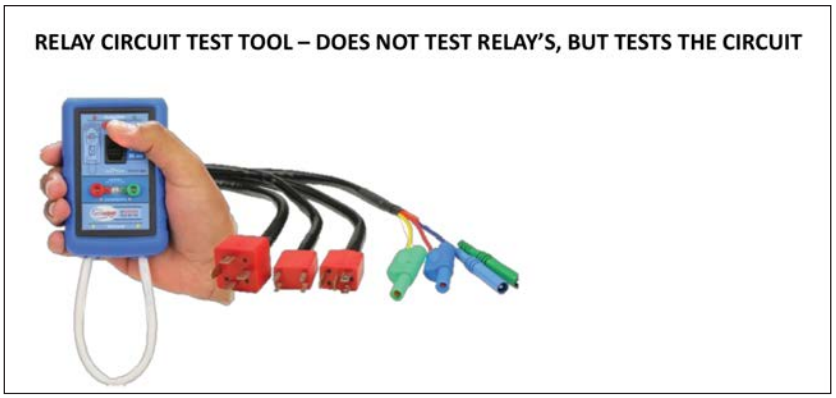


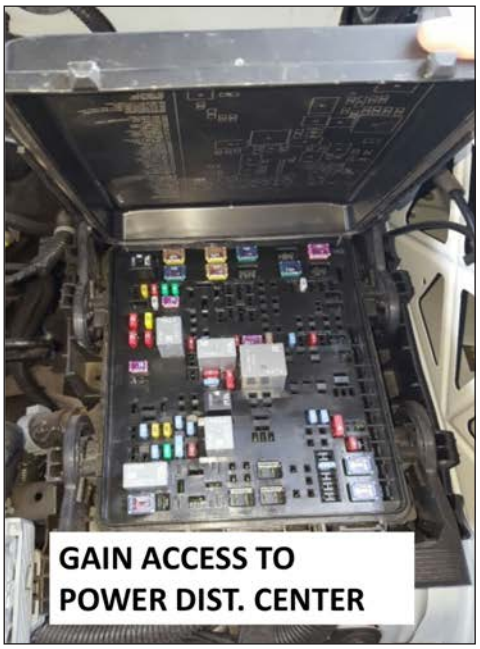
DYNAMIC testing of the relay circuit is extremely important to ensure a proper diagnosis and repair. To bench test a relay properly, a load should be applied to the relay and a voltage drop test of the relay contacts should be performed to determine their condition. Excessive current flow through the relay can damage, pit and corrode the contacts causing a voltage drop and this “current” being taken away from the controlled device. In this example, a headlight bulb is being used to create the load. When testing, try to match the current load of the controlled device as close as possible. Connecting head light bulbs in parallel increases the load.

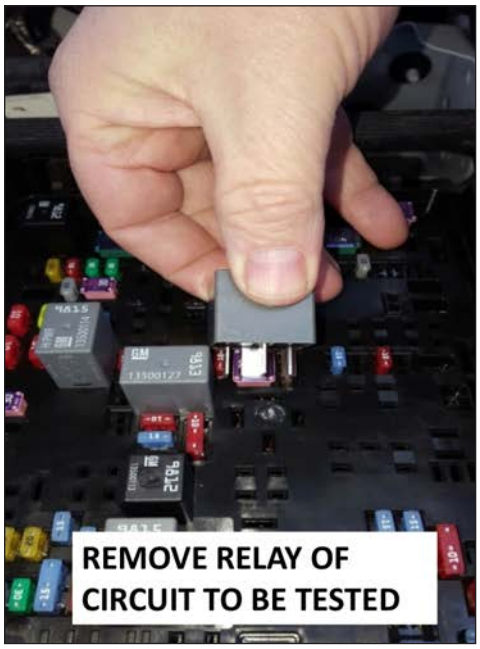


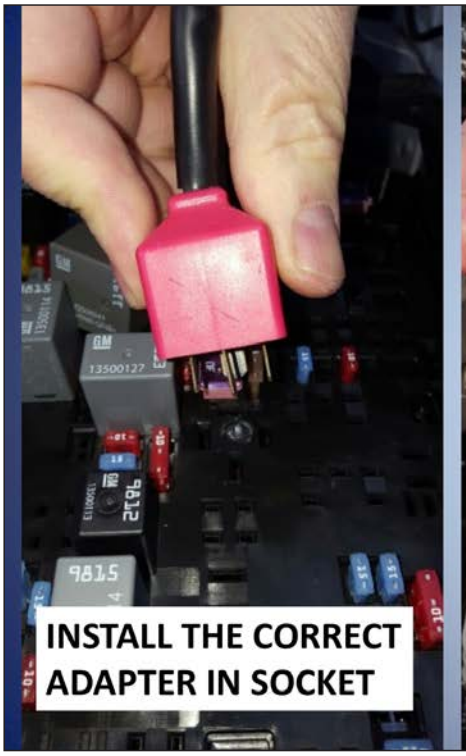
It is safe to always use a fused jumper wire when jumping B+ power to the controlled device. In addition, this gives a convenient spot to measure the amperage draw of the device and the circuit.






GAIN ACCESS TO
POWER DIST. CENTER


REMOVE RELAY OF
CIRCUIT TO BE TESTED


INSTALL THE CORRECT
ADAPTER IN SOCKET


CONNECT TESTER TO
HARNESS


TEST AMP DRAW OF
DEVICE & OTHER TESTS

SPECIALIZED RELAY CIRCUIT TEST TOOLS CAN PERFORM:

TESTS FUNCTIONALITY OF THE RELAY COIL CIRCUIT-RESISTANCE AND SWITCHING

TESTS FUNCTIONALITY CIRCUIT LOAD INCLUDING VOLTAGE DROPS, TOTAL CURRENT AND SCOPE PATTERNS IF DESIRED

IDENTIFIES POSITIVE AND NEGATIVE POLARITY OF COIL AND LOAD CIRCUITS

EASY ACCESS TO ALL RELAY CIRCUIT ELEMENTS FROM ONE LOCATION

EASY TEST ACCESS POINTS FOR OHMMETER, VOLTMETER, TEST LIGHT AND SCOPES

COVERS THE "WHAT IF'S" WHEN REPLACING THE RELAY DOESN'T FIX THE PROBLEM

LISLE LIS56810

LISLE LIS69300

Electronic Specialties ESI-191 Relay Buddy Pro Test Kit

PLUS QUIP EQP-018 EQP-109

EXTECH AUT-100

IPA #9038A

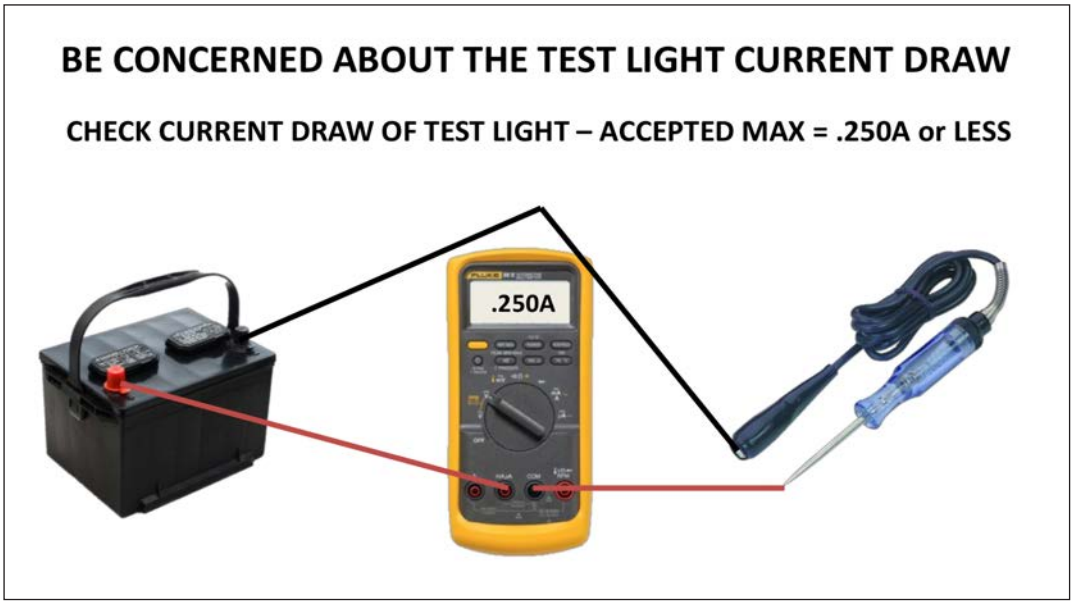
Lisle 69300 MASTER RELAY
CIRCUIT TEST KIT

Electronic Specialties 191 Relay
Buddy Pro Test Kit

ALBA ALB30933 4 & 5 PIN
RELAY TESTER

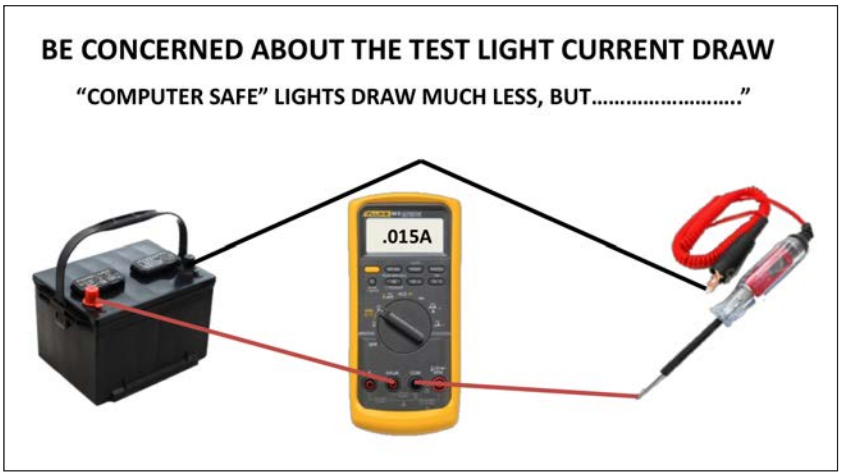
PLEASE, ALWAYS USE FUSED JUMPER WIRES WHEN TESTING, JUMPING or BYPASSING ANY COMPONENT


12V TEST LIGHTS & LOGIC PROBES
WHAT HAVE YOU HEARD ABOUT THESE?

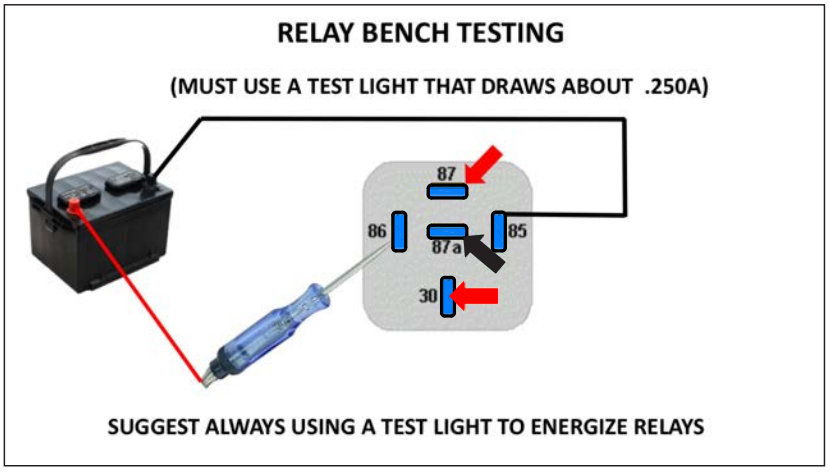

BE CONCERNED ABOUT THE TEST LIGHT CURRENT DRAW
CHECK CURRENT DRAW OF TEST LIGHT – ACCEPTED MAX = .250A or LESS
.250A

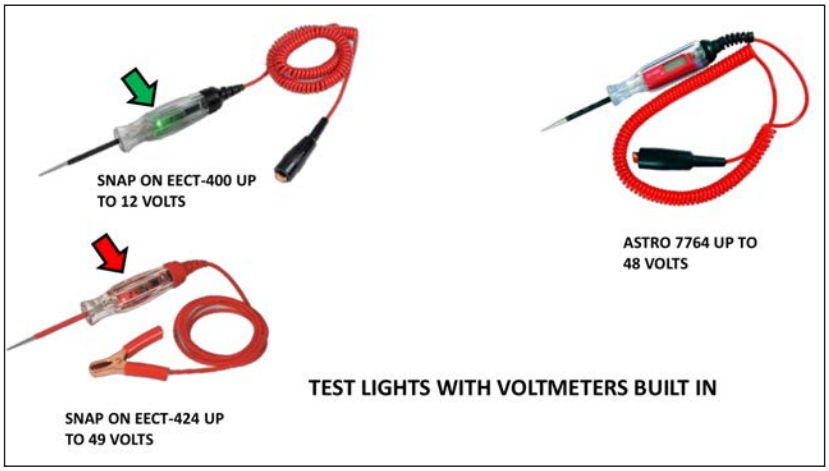

BE AWARE OF THESE!!!
SOME DRAW .800 to 1A

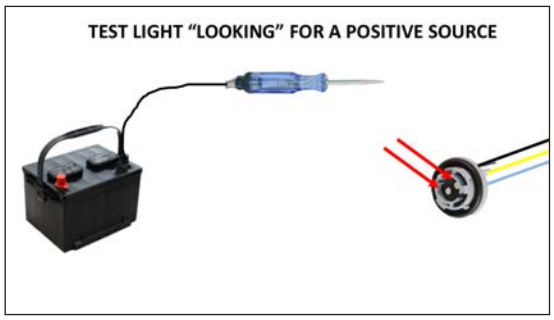
Be sure that any test light used on computer circuits draws no more than .250A or 250mA. Lights drawing more that this amount may damage sensitive computer components or circuits. Always check the amperage draw of the test light you are using following the above diagram.

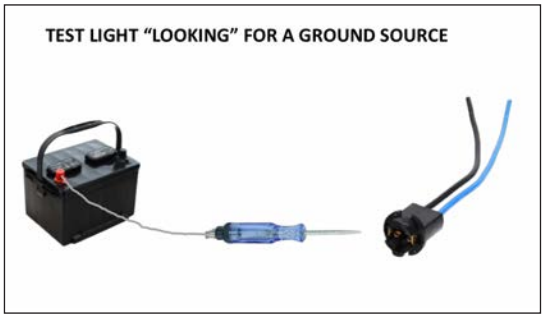


Computer "safe" test lights draw much less current, but often cannot be used to energize relays.

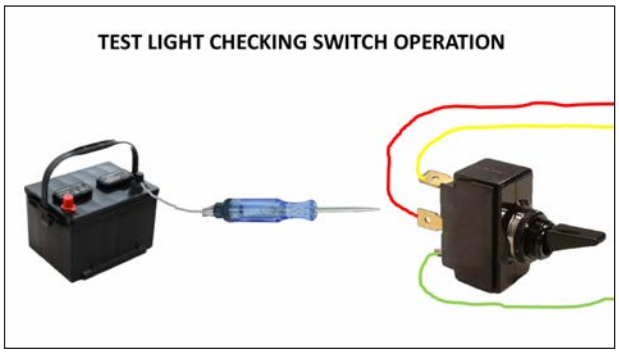


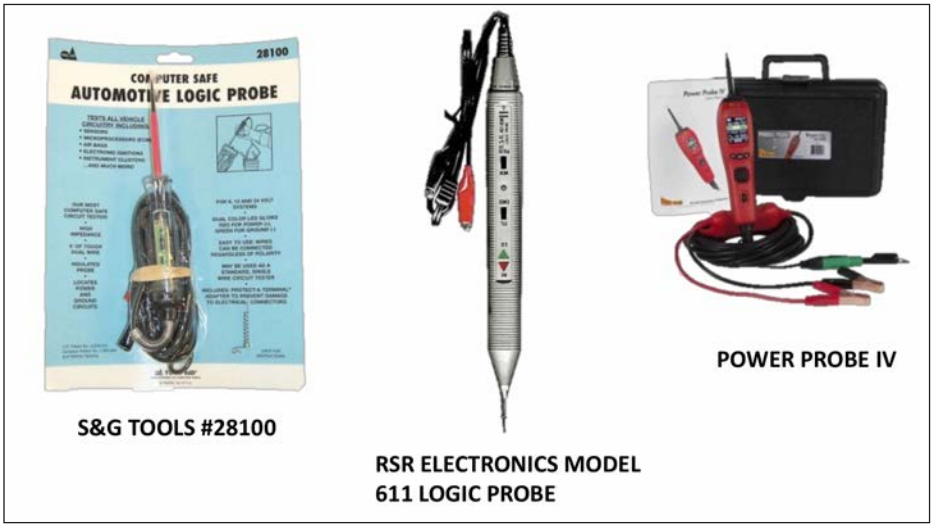






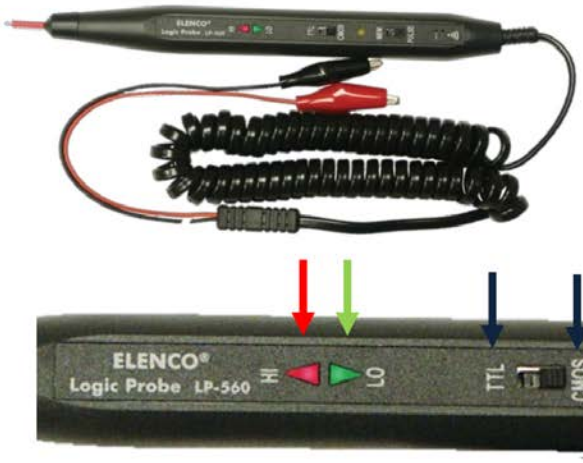
Examples of proper use of a test light. Test lights can be used for checking the presence of power and grounds in circuits.





The term LOGIC PROBE is now being used in the automotive repair industry. What the term means depends a lot on the manufacturer of each product that states it is a LOGIC PROBE. Common applications include those that indicate when the test light probe comes in contact with a positive or negative circuit point (red and green indicators), and some will flash an indicator light when the probe touches a pulse width circuit that is oscillating between positive and negative. The term LOGIC PROBE was borrowed from the electronics industry where true logic probes are commonly used to test for TTL (Transistor-To-Transistor) circuits or CMOS (Complimentary Metal-Oxide Semiconductor) switching circuits. These tests do not have normal application in the automotive repair industry.

THE TERM "LOGIC PROBE".....



IN ELECTRONICS, A LOGIC PROBE IS USED TO DETECT "TTL" & "CMOS" CIRCUIT OPERATION.

TTL – TRANSISTOR to TRANSISTOR

CMOS – COMPLIMENTARY METAL-OXIDE SEMICONDUCTOR

POWER PROBE – HOOK PPH-1

POWER PROBE – IV

The Power Probe product series are commonly by technicians in electrical circuit diagnosis. These tools have many features that save considerable time for the technician, but the testers MUST be used following all instructions.

It may be necessary to purchase different type of test light based on the specific purpose which you wish to use it for in diagnosis. There are countless options and wide differences in prices. Make your purchase decisions carefully and purchase only the features you anticipate needing.

TEST LIGHT PURCHASING CONSIDERATIONS

1. YOU MAY HAVE TO OWN MORE THAN ONE UNIT
2. TO ENERGIZE RELAYS, TEST LIGHT MUST DRAW ABOUT 0.250 A
3. DO YOU NEED A LOGIC PROBE?
4. HOW OFTEN DO YOU USE A TEST LIGHT?
5. WHAT DO YOU USE A TEST LIGHT FOR?
6. PRICES HAVE DROPPED, BUT BE MINDFUL OF QUALITY

PARASITIC DRAW

PARASITIC LOAD TESTING

Parasitic Draw testing

1. WHAT IS IT?
2. WHAT ARE SPEC'S?
3. DIFFERENT METHODS OF TESTING FOR IT?
4. HOW TO LOCATE SOURCES OR EXCESSIVE DRAW?
5. SPECIALIZED TESTING EQUIPMENT

PARASITIC DRAW or LOAD — WHAT IS IT?

THE AMOUNT OF CURRENT FLOW LEAVING THE BATTERY AFTER THE ENGINE HAS BEEN SHUT OFF AND A "MODULE SLEEP" TIME HAS PASSED

NOTE: ON VEHICLES WITH CAN Bus SYSTEMS, PARASITIC DRAW SHOULD ONLY BE MEASURED AFTER ALL MODULES HAVE TURNED OFF (SLEEP MODE) — CHECK WITH OEM SERVICE INFORMATION FOR TIME DURATION FOR WHAT TO OCCUR

MANY DIFFERENT METHODS OF MEASURING PARASITIC DRAW ARE AVAILABLE

WHATEVER METHOD IS USED, TRY TO NOT DISCONNECT BATTERY BATTERY TO INSTALL TEST EQUIPMENT OR BE SURE TO USE A BATTERY MEMORY SAVER HOOKED UP TO DLC

GENERAL SPECIFICATION — 30 mA — 50 mA MAX BUT ALWAYS CHECK OEM S.I.

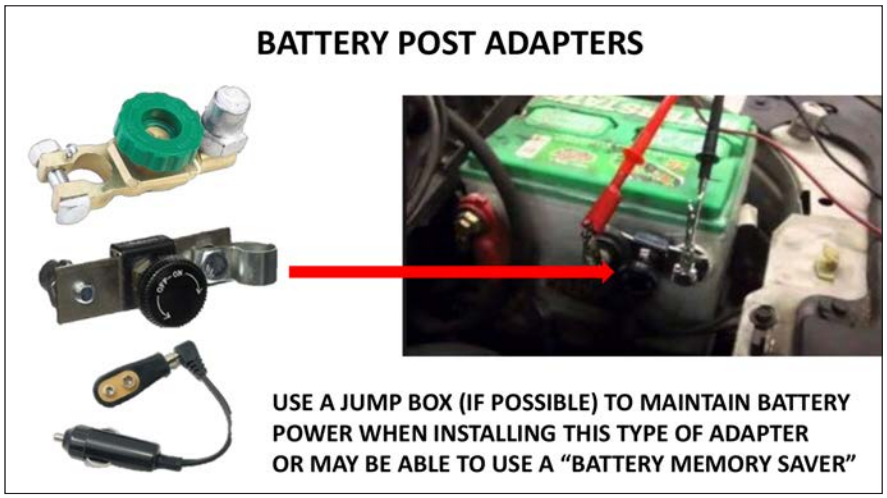
GM

GM HAS CHANGED THEIR METHOD FOR DETERMINING MAXIMUM PARASITIC LOAD VALUE

RESERVE CAPACITY (MINUTES) OF OEM BATTERY DIVIED BY 4 EQUALS MAXIMUM MILLIAMP PARASITIC DRAW ALLOWED

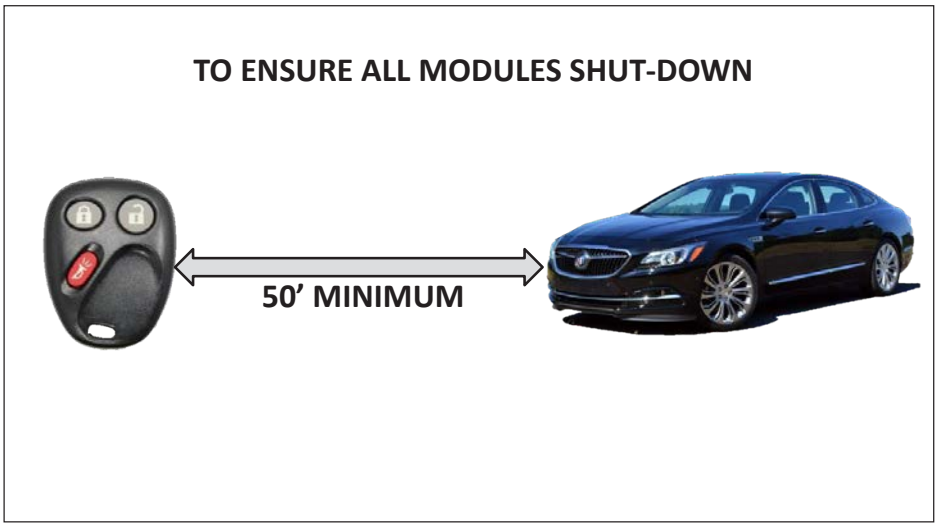
EXAMPLE: 100 RESERVE MINUTES ÷ 4 = 25 — THEREFORE 0.025 A or 25 mA

Whether a vehicle had a parasitic draw used to be determined by disconnecting a battery cable and installing a 12V test light between the battery post and the cable. If the test light was illuminated, there was sufficient draw present. Today, this test is invalid and should not be performed. With all of the electronics, computers, modules and communication devices talking to outside sources, every car has a normal constant battery draw. It is normal for this to happen as long as the amount of the draw stays below a certain specification. The draw is defined as "parasitic" when the load exceeds the maximum specification. This specification is usually given in milliamps or amps. For example, a specification of a maximum of 40 milliamps would be listed as: .040 amps or 40Ma. Every vehicle today will eventually have a dead battery if allowed to sit without running or charging the battery. How long this takes to happen depends on the size and condition of the battery, condition of the charging system and the amount of parasitic load. Another factor to remember about never testing for parasitic draw with the older method using a test light is that most of today's vehicles have one or more CAN Bus (Controller Area Network) systems. A CAN Bus system often communicates between individual modules both when the vehicle is operating and often after it has shut down and parked. The amount of time that communication activity is going on depends heavily on individual vehicle design and specifications. An average time for the communication to cease is usually between 30-45 minutes. If parasitic draw testing was attempted during this period, the test results would be unsatisfactory even though there is no problem with the vehicle. Always check with vehicle service information to determine the exact procedure and "wait times" when checking parasitic draw tests. Unnecessary work may be done and expensive components could be purchased if the test is conducted improperly.



One method of parasitic draw test requires installation of an adapter usually installed between the negative battery cable and battery post. This allows for a complete "break" in the electrical system. An ammeter is installed between the two halves which allows accurate measurement of any current flowing anywhere in the vehicles electrical systems.

When performing parasitic draw testing, it is wise to install some type of battery memory saver to the vehicle prior to disconnecting the battery. Doing this will keep all module and computer memories and will not require that all modules and computers not have to go through a re-learn process which can cause potentially serious performance problems. Also, all entertainment memories would be erased which often upsets vehicle owners. If battery disconnecting is required for the type of parasitic draw test you are performing, be sure to install a battery memory saver before disconnecting the vehicles battery. Early battery memory savers used a 9V battery installed in the vehicle power outlet receptacle (cigarette lighter), but today, it is recommended to use a battery memory saver that connects to the vehicles DLC (Diagnostic Link Connector). Another negative factor to using the 9V battery memory saver is that if any circuit is accidentally turned on, the 9V battery will be instantly drawn down low enough to erase all vehicle memories. If a vehicle door is opened during the test, this will happen.



Another important factor to remember when testing for parasitic draw on modern vehicles is to make sure that all vehicle key fobs are kept at least 50’ from the vehicle. Failure to do this may result in the battery draw staying above maximum specifications and wrong conclusions can be made by technicians thinking there is a problem, when in fact there isn’t. It is also extremely important to obtain the OEM vehicle specific test procedure before conducting the test. It is also a good idea to do a search for TSB’s (Technical Service Bulletins) to check if any pertain to a parasitic draw test procedure or results.

METHODS OF CHECKING PARASITIC DRAW ON VEHICLES

INDUCTIVE MILLI-VOLT CLAMPS & DMM

INDUCTIVE AMMETER

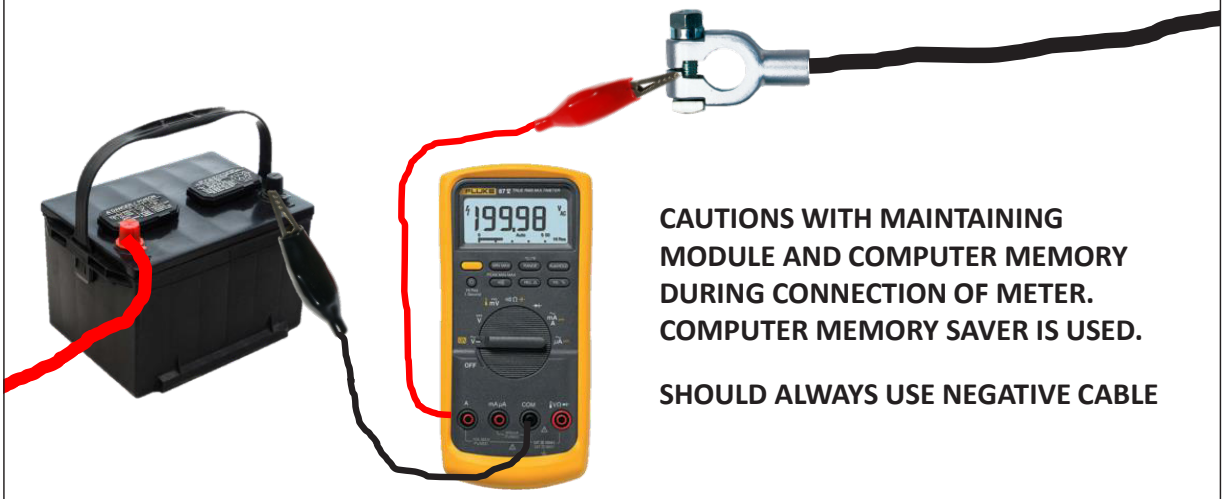
DIRECT AMP MEASURING IN SERIES WITH BATTERY POST & CABLE

VOLTAGE DROP TESTING ACROSS FUSES

There are four basic methods of checking for parasitic draw on vehicles:

1. Using an inductive amprobe that converts amperage to milli-volts that is read by a DMM (Digital Multi-Meter). This can be a very accurate test method. The disadvantage of this type of test conducted at the battery cable is that the amprobe that is large enough to fit over the diameter of the battery cable, may not have the sensitivity and accuracy to measure in small milli-amp increments. There are some amprobes capable of doing this, but it is a significant factor to keep in mind. There is also the factor of having to use a battery memory saver in order to conduct this test properly.
2. Inductive amprobe that directly reads amperage without the need of a digital multimeter. These tools are extremely easy to use and if the correct model is chosen, can accurately read down to .003A or 3mA of current. This is perhaps the easiest method of performing this test.
3. Direct ammeter hookup between the battery post and disconnected battery cable. This is an accurate method of performing this test. However, extreme care must be observed because if any circuit in the vehicle is turned on, the multimeter can be instantly ruined. It's a good idea to use fused test leads with the meter to prevent this from happening.
4. Once it has been determined that an excessive parasitic draw exists, using the voltage drop method of testing across fuses is becoming a very popular test method. This method requires a high quality digital multimeter and specific fuse type charts that give amperage equivalent for the millivolt reading observed at the fuse.

INSTALLING A DMM IN SERIES WITH THE BATTERY AND DISCONNECTED CABLE



CAUTIONS WITH MAINTAINING MODULE AND COMPUTER MEMORY DURING CONNECTION OF METER. COMPUTER MEMORY SAVER IS USED.

SHOULD ALWAYS USE NEGATIVE CABLE

The inductive ammeter being used on a battery cable to measure parasitic draw results

#PI0412B: NO CRANK/NO START, DEAD BATTERY DUE TO PARASITIC DRAIN/DISCHARGE (FEB 27, 2013)

Subject: No Crank/No Start, Dead Battery Due to Parasitic Drain/Discharge

Models: 2011-2013 GM Passenger Cars and Trucks (Except Cadillac STS, Chevrolet Volt) Equipped with OnStar®

This PI is being revised to add the 2012 and 2013 model years and add information to the Recommendation/Instructions and Parts Information sections. Please discard PI0412A.

Condition/Concern

In very rare cases, some customers may comment on a dead battery or a no start condition and there may also be no OnStar® LED light (after the vehicle has been restarted for at least a minute).

A 380♦mA drain from the OnStar® Module may be a cause of this condition.

Recommendation/Instructions

Perform the Battery Electrical Drain/Parasitic Load Test per the published procedure in SI.

If the parasitic draw is close to 380♦mA, remains for more than 10 minutes, the OnStar® LED light is not lit and there is no response to an OnStar® button press, even while the vehicle is running, pull the fuse on the OnStar® circuit or disconnect the OnStar® module connector (when OnStar® fuse powers multiple modules) and verify the parasitic current drops to normal levels. For vehicles that have the OnStar® module between other GMLAN modules in the LAN circuits, it will be necessary to jumper the LAN terminals at the OnStar® module connector. If the parasitic current drops to normal levels, replace the OnStar® communication interface module.

Note: The reason that the parasitic current must remain for at least 10 minutes is because the OnStar® module sometimes will connect to the OnStar® back office in power off mode to upload data for the OnStar® monthly emails.

An example of a TSB that specifically addresses a concern with parasitic load test results.

METHODS OD IDENTIFYING SOURCE OF DRAW

REMOVE FUSES ONE-AT-A-TIME (PROBLEMS WITH THIS)

MEASURE AMPERAGE ON MAIN CIRCUIT FEEDERS (DIFFICULT)

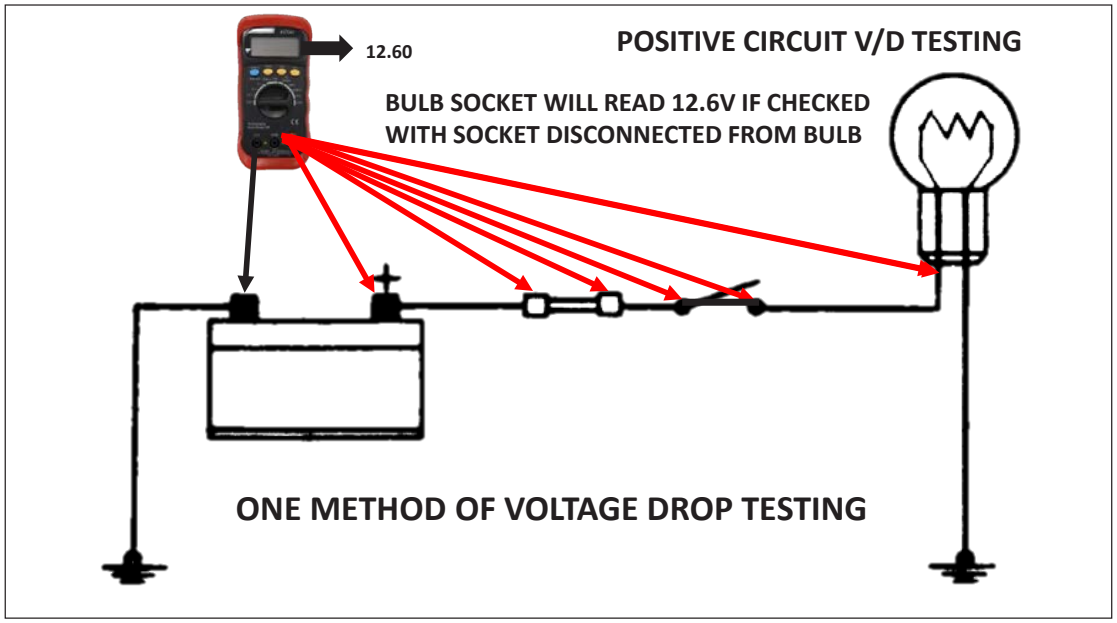
VOLTAGE DROP TESTING ACROSS FUSES

USE SPECIAL TOOLS DESIGNED FOR THIS TASK

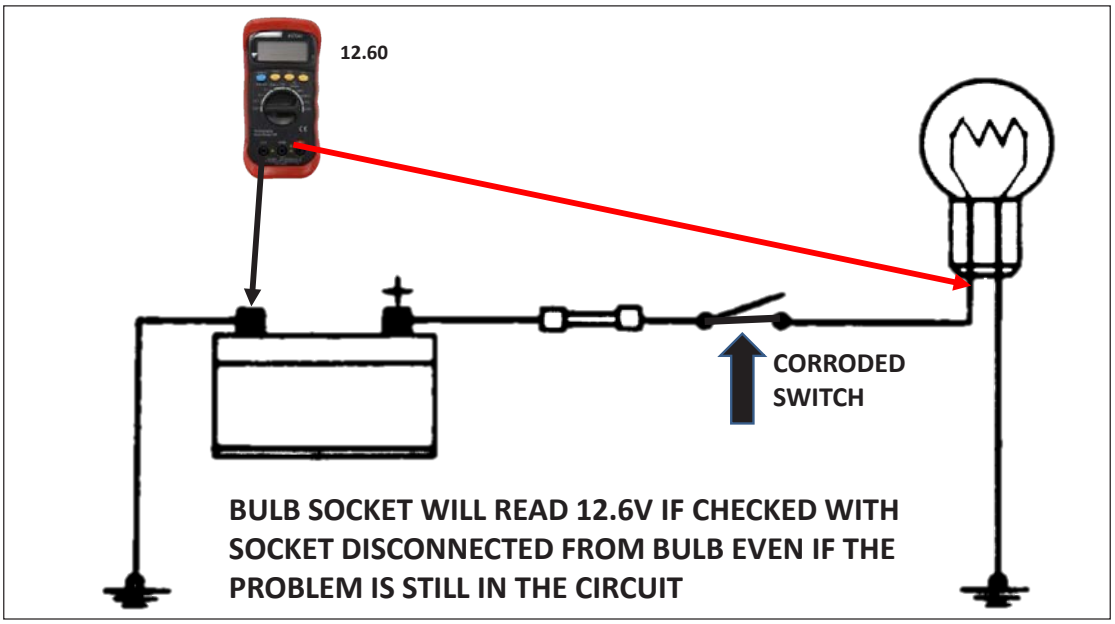
USING VOLTAGE DROP TESTING ACROSS FUSE TO MEASURE PARASITIC DRAW

NEED ACCURATE CHARTS TO PERFORM THIS TEST

VOLTAGE DROP TESTING REVIEW

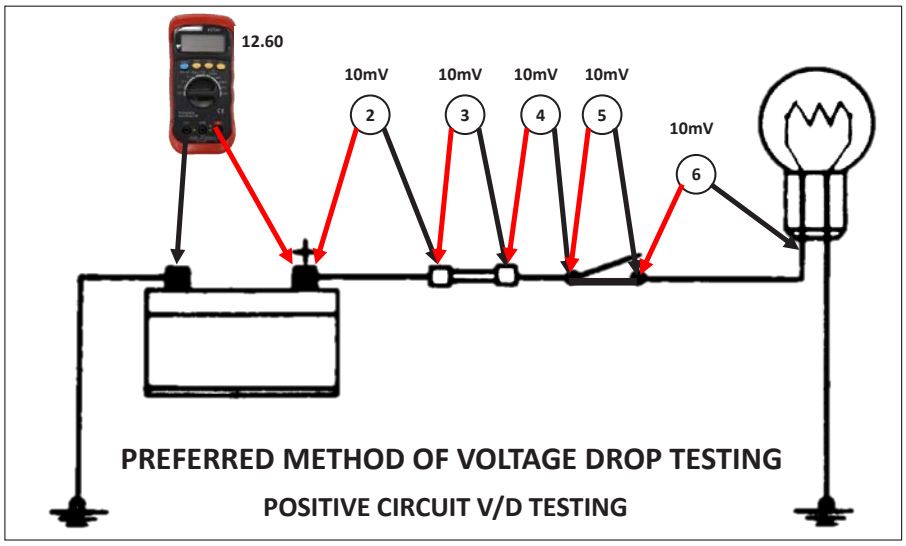


Although, one can perform voltage drop testing using this method, it is not the most accurate method of performing this test. This method can also be used on the ground side of the circuit. This method is often called the "point-to-point" procedure of testing for voltage drops. This method often requires extensions of the voltmeter leads which in itself, can increase resistance and give inaccurate readings.

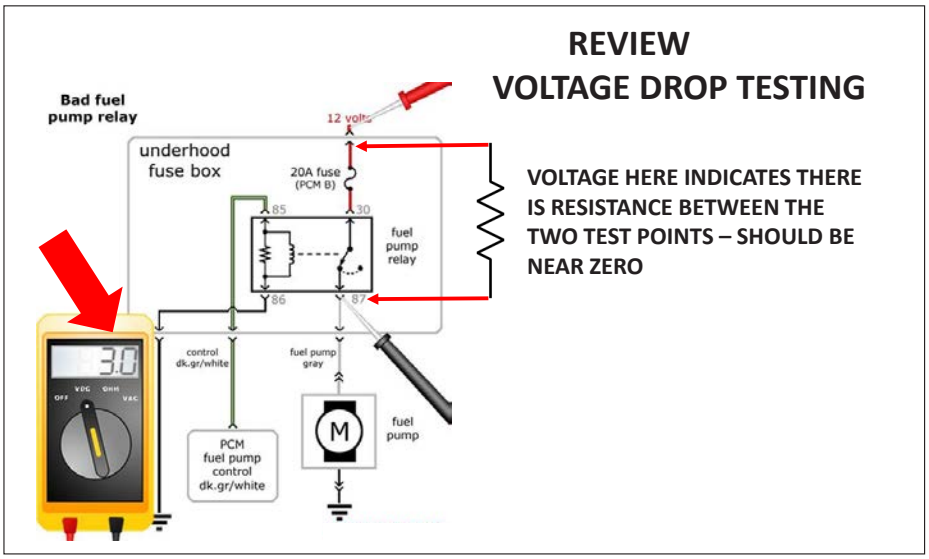


All voltage drop testing MUST be done with the entire circuit intact and full power and loads must be energized. If voltages are checked at sockets or other places in the circuit without full load flowing, readings will usually be "normal". This primarily due to the high impedance of the digital multimeter creating a very, very low current draw on the circuit and this, it will not detect corroded connectors, wire corrosion or other defective conditions. Also, check both the positive and ground circuits for voltage drops.

PREFERRED METHOD OF VOLTAGE DROP TESTING



This is the best method of testing for voltage drop in either the positive side (shown) or the ground side of a circuit. The voltmeter test leads are placed at each end of the portion of the circuit you wish to test. For normal circuits, "normal" amounts of voltage drops across terminal connections, switches, wires and other devices shouldn't exceed .1 of a volt. When voltage drop testing, the circuit MUST be operating under full circuit load. For example, if testing a heater blower motor, the motor should be operating at high speed before testing for voltage drops. Any test point exceeding .1V should be investigated for corroded connections, defective components, loose connections or causes of unwanted resistance in the circuit. Remember that a voltage drop means that there is some type of unwanted resistance located between the two voltmeter test leads.



In the example shown, a voltage drop test is being performed across terminals # 30 and # 87 with the relay energized and connected to the fuel pump. Probably due to corroded relay contacts or other abnormal conditions, there is a 3.0V drop from # 30 to # 87. The effect of this condition means that the fuel pump is trying to operate on about 9.0V. This will cause vehicle driveability concerns as well as seriously shorten fuel pump life.

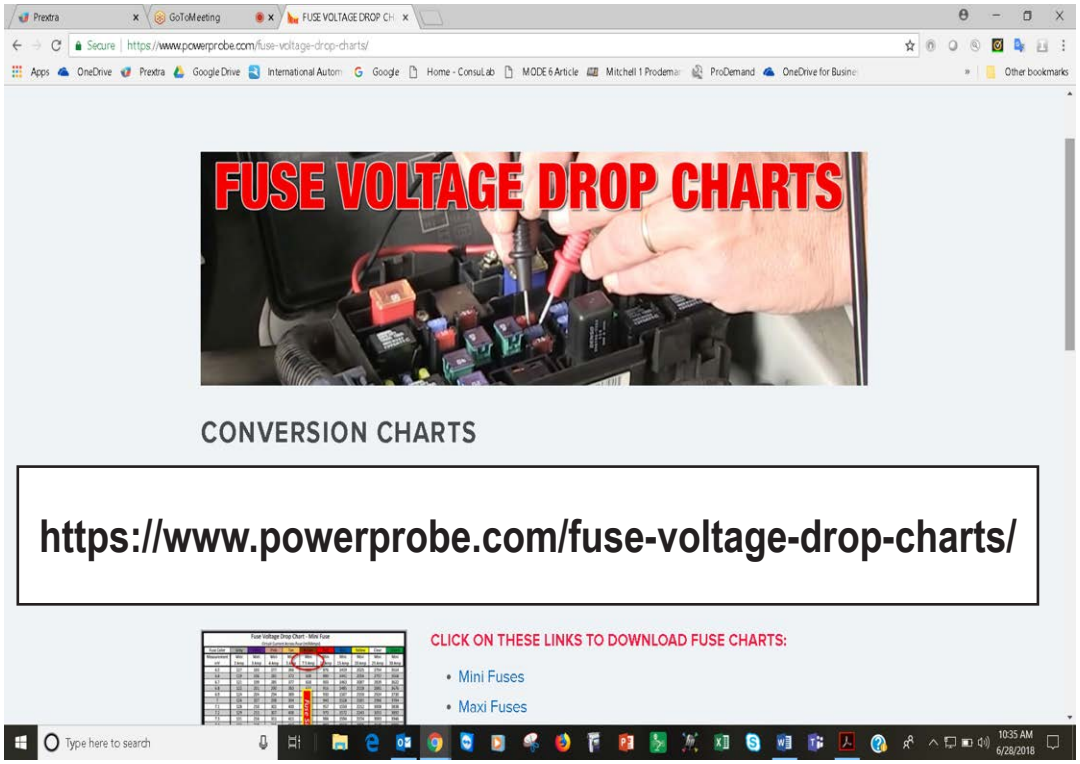
Fuse Voltage Drop Chart - Mini Fuse

Circuit Current Across Fuse (milliAmp)

Fuse Color	Grey	Violet	Pink	Tan	Brown	Red	Blue	Yellow	Clear	Green
Measurement mV	Mini 2 Amp	Mini 3 Amp	Mini 4 Amp	Mini 5 Amp	Mini 7.5 Amp	Mini 10 Amp	Mini 15 Amp	Mini 20 Amp	Mini 25 Amp	Mini 30 Amp
0.1	2	3	4	6	9	13	22	31	[illegible]	54
0.2	4	6	9	11	18	27	44	62	[illegible]	108
0.3	5	9	13	17	28	40	66	93	127	162
0.4	7	12	17	23	37	54	87	125	169	216
0.5	9	15	21	28	46	67	109	156	212	270
0.6	11	18	26	34	55	81	131	187	254	324
0.7	13	21	30	39	65	94	153	218	297	378
0.8	14	24	34	45	74	108	175	249	339	432
0.9	16	27	38	51	83	121	197	280	381	486
1	18	30	43	56	92	135	218	312	424	541
1.1	20	33	47	62	101	148	240	343	466	595
1.2	22	36	51	68	111	162	262	374	508	649
1.3	23	39	55	73	120	175	284	405	551	703
1.4	25	41	60	79	129	189	306	436	593	757
1.5	27	44	64	85	138	202	328	467	636	811
1.6	29	47	68	90	147	216	349	498	678	865
1.7	[illegible]	50	72	96	157	229	371	530	[illegible]	919
1.8	32	53	77	101	166	243	393	561	763	973

ABSOLUTELY NEED ACCURATE AND SPECIFIC CHARTS FOR CORRECT FUSES

When performing voltage drop testing across fuses, it is necessary to have accurate charts for each size and style of fuse being tested. Without the charts, accurate measurements are not possible.



One source for accessing fuse charts used for voltage drop testing across fuses to determine amount of current flowing through the fuse.

FUSE CHARTS

Fuse Voltage Drop Chart - Standard Fuse (ATO,ATC)

Circuit Current Across Fuse (milliAmps)

Fuse Color	Black	Grey	Violet	Pink	Tan	Brown	Red	Blue	Yellow	Clear	Green	Blu-Green	Orange
Measurement mV	Standard 1 Amp	Standard 2 Amp	Standard 3 Amp	Standard 4 Amp	Standard 5 Amp	Standard 7.5 Amp	Standard 10 Amp	Standard 15 Amp	Standard 20 Amp	Standard 25 Amp	Standard 30 Amp	Standard 35 Amp	Standard 40 Amp
0.1	1	2	3	4	6	9	13	21	30	40	51	62	69
0.2	2	4	6	9	11	18	26	42	59	79	102	124	139
0.3	2	6	10	13	17	27	39	63	89	119	152	186	208
0.4	3	7	13	18	22	37	52	83	118	159	203	248	278
0.5	4	9	16	22	28	46	65	104	148	198	254	311	347
0.6	5	11	19	26	34	55	78	125	178	238	305	373	417
0.7	6	13	23	31	39	64	91	146	207	278	355	435	486
0.8	7	15	26	35	45	73	104	167	237	317	406	497	556
0.9	7	17	29	39	50	82	117	188	266	357	457	559	625
1	8	19	32	44	56	92	130	208	296	397	508	621	694
1.1	9	21	35	48	62	101	143	229	325	437	558	683	764
1.2	10	22	39	53	67	110	156	250	355	476	609	745	833
1.3	11	24	42	57	73	119	169	271	385	516	660	807	903
1.4	11	26	45	61	78	128	182	292	414	556	711	870	972
1.5	12	28	48	66	84	137	195	313	444	595	761	932	1042
1.6	13	30	51	70	90	147	208	333	473	635	812	994	1111
1.7	14	32	55	75	95	156	221	354	503	675	863	1056	1181
1.8	15	34	58	79	101	165	234	375	533	714	914	1118	1250
1.9	15	36	61	83	106	174	247	396	562	754	964	1180	1319
2	16	37	64	88	112	183	260	417	592	794	1015	1242	1389
2.1	17	39	68	92	118	192	273	438	621	833	1066	1304	1458
2.2	18	41	71	96	123	202	286	458	651	873	1117	1366	1528
2.3	19	43	74	101	129	211	299	479	680	913	1168	1429	1597
2.4	20	45	77	105	134	220	312	500	710	952	1218	1491	1667
2.5	20	47	80	110	140	229	325	521	740	992	1269	1553	1736
2.6	21	49	84	114	146	238	338	542	769	1032	1320	1615	1806
2.7	22	50	87	118	151	247	351	563	799	1071	1371	1677	1875
2.8	23	52	90	123	157	257	364	583	828	1111	1421	1739	1944
2.9	24	54	93	127	162	266	377	604	858	1151	1472	1801	2014
3	24	56	96	132	168	275	390	625	888	1190	1523	1863	2083
3.1	25	58	100	136	174	284	403	646	917	1230	1574	1925	2153
3.2	26	60	103	140	179	293	416	667	947	1270	1624	1988	2222
3.3	27	62	106	145	185	302	429	688	976	1310	1675	2050	2292
3.4	28	64	109	149	190	312	442	708	1006	1349	1726	2112	2361
3.5	28	65	113	154	196	321	455	729	1036	1389	1777	2174	2431
3.6	29	67	116	158	202	330	468	750	1065	1429	1827	2236	2500
3.7	30	69	119	162	207	339	481	771	1095	1468	1878	2298	2569
3.8	31	71	122	167	213	348	494	792	1124	1508	1929	2360	2639
3.9	32	73	125	171	218	357	506	813	1154	1548	1980	2422	2708
4	33	75	129	175	224	367	519	833	1183	1587	2030	2484	2778
4.1	33	77	132	180	230	376	532	854	1213	1627	2081	2547	2847
4.2	34	79	135	184	235	385	545	875	1243	1667	2132	2609	2917
4.3	35	80	138	189	241	394	558	896	1272	1706	2183	2671	2986
4.4	36	82	141	193	246	403	571	917	1302	1746	2234	2733	3056
4.5	37	84	145	197	252	412	584	938	1331	1786	2284	2795	3125
4.6	37	86	148	202	258	422	597	958	1361	1825	2335	2857	3194
4.7	38	88	151	206	263	431	610	979	1391	1865	2386	2919	3264
4.8	39	90	154	211	269	440	623	1000	1420	1905	2437	2981	3333
4.9	40	92	158	215	275	449	636	1021	1450	1944	2487	3043	3403
5	41	93	161	219	280	458	649	1042	1479	1984	2538	3106	3472
5.1	41	95	164	224	286	467	662	1063	1509	2024	2589	3168	3542
5.2	42	97	167	228	291	477	675	1083	1538	2063	2640	3230	3611
5.3	43	99	170	232	297	486	688	1104	1568	2103	2690	3292	3681
5.4	44	101	174	237	303	495	701	1125	1598	2143	2741	3354	3750
5.5	45	103	177	241	308	504	714	1146	1627	2183	2792	3416	3819
5.6	46	105	180	246	314	513	727	1167	1657	2222	2843	3478	3889
5.7	46	107	183	250	319	522	740	1188	1686	2262	2893	3540	3958
5.8	47	108	186	254	325	532	753	1208	1716	2302	2944	3602	4028
5.9	48	110	190	259	331	541	766	1229	1746	2341	2995	3665	4097
6	49	112	193	263	336	550	779	1250	1775	2381	3046	3727	4167
6.1	50	114	196	268	342	559	792	1271	1805	2421	3096	3789	4236
6.2	50	116	199	272	347	568	805	1292	1834	2460	3147	3851	4306
6.3	51	118	203	276	353	577	818	1313	1864	2500	3198	3913	4375
6.4	52	120	206	281	359	587	831	1333	1893	2540	3249	3975	4444

Fuse Voltage Drop Chart - Standard Fuse (ATO,ATC)

Circuit Current Across Fuse (milliAmps)

Fuse Color	Black	Grey	Violet	Pink	Tan	Brown	Red	Blue	Yellow	Clear	Green	Blu-Green	Orange
Measurement mV	Standard 1 Amp	Standard 2 Amp	Standard 3 Amp	Standard 4 Amp	Standard 5 Amp	Standard 7.5 Amp	Standard 10 Amp	Standard 15 Amp	Standard 20 Amp	Standard 25 Amp	Standard 30 Amp	Standard 35 Amp	Standard 40 Amp
6.5	53	121	209	285	364	596	844	1354	1923	2579	3299	4037	4514
6.6	54	123	212	289	370	605	857	1375	1953	2619	3350	4099	4583
6.7	54	125	215	294	375	614	870	1396	1982	2659	3401	4161	4653
6.8	55	127	219	298	381	623	883	1417	2012	2698	3452	4224	4722
6.9	56	129	222	303	387	632	896	1438	2041	2738	3503	4286	4792
7	57	131	225	307	392	642	909	1458	2071	2778	3553	4348	4861
7.1	58	133	228	311	398	651	922	1479	2101	2817	3604	4410	4931
7.2	59	135	232	316	403	660	935	1500	2130	2857	3655	4472	5000
7.3	59	136	235	320	409	669	948	1521	2160	2897	3706	4534	5069
7.4	60	138	238	325	415	678	961	1542	2189	2937	3756	4596	5139
7.5	61	140	241	329	420	687	974	1563	2219	2976	3807	4658	5208
7.6	62	142	244	333	426	697	987	1583	2249	3016	3858	4720	5278
7.7	63	144	248	338	431	706	1000	1604	2278	3056	3909	4783	5347
7.8	63	146	251	342	437	715	1013	1625	2308	3095	3959	4845	5417
7.9	64	148	254	346	443	724	1026	1646	2337	3135	4010	4907	5486
8	65	150	257	351	448	733	1039	1667	2367	3175	4061	4969	5556
8.1	66	151	260	355	454	742	1052	1688	2396	3214	4112	5031	5625
8.2	67	153	264	360	459	752	1065	1708	2426	3254	4162	5093	5694
8.3	67	155	267	364	465	761	1078	1729	2456	3294	4213	5155	5764
8.4	68	157	270	368	471	770	1091	1750	2485	3333	4264	5217	5833
8.5	69	159	273	373	476	779	1104	1771	2515	3373	4315	5280	5903
8.6	70	161	277	377	482	788	1117	1792	2544	3413	4365	5342	5972
8.7	71	163	280	382	487	797	1130	1813	2574	3452	4416	5404	6042
8.8	72	164	283	386	493	807	1143	1833	2604	3492	4467	5466	6111
8.9	72	166	286	390	499	816	1156	1854	2633	3532	4518	5528	6181
9	73	168	289	395	504	825	1169	1875	2663	3571	4569	5590	6250
9.1	74	170	293	399	510	834	1182	1896	2692	3611	4619	5652	6319
9.2	75	172	296	404	515	843	1195	1917	2722	3651	4670	5714	6389
9.3	76	174	299	408	521	852	1208	1938	2751	3690	4721	5776	6458
9.4	76	176	302	412	527	862	1221	1958	2781	3730	4772	5839	6528
9.5	77	178	305	417	532	871	1234	1979	2811	3770	4822	5901	6597
9.6	78	179	309	421	538	880	1247	2000	2840	3810	4873	5963	6667
9.7	79	181	312	425	543	889	1260	2021	2870	3849	4924	6025	6736
9.8	80	183	315	430	549	898	1273	2042	2899	3889	4975	6087	6806
9.9	80	185	318	434	555	907	1286	2063	2929	3929	5025	6149	6875
10	81	187	322	439	560	917	1299	2083	2959	3968	5076	6211	6944

Fuse Voltage Drop Chart - Mini Fuse

Circuit Current Across Fuse (milliAmps)

Fuse Color	Grey	Violet	Pink	Tan	Brown	Red	Blue	Yellow	Clear	Green
Measurement mV	Mini 2 Amp	Mini 3 Amp	Mini 4 Amp	Mini 5 Amp	Mini 7.5 Amp	Mini 10 Amp	Mini 15 Amp	Mini 20 Amp	Mini 25 Amp	Mini 30 Amp
0.1	2	3	4	6	9	13	22	31	42	54
0.2	4	6	9	11	18	27	44	62	85	108
0.3	5	9	13	17	28	40	66	93	127	162
0.4	7	12	17	23	37	54	87	125	169	216
0.5	9	15	21	28	46	67	109	156	212	270
0.6	11	18	26	34	55	81	131	187	254	324
0.7	13	21	30	39	65	94	153	218	297	378
0.8	14	24	34	45	74	108	175	249	339	432
0.9	16	27	38	51	83	121	197	280	381	486
1	18	30	43	56	92	135	218	312	424	541
1.1	20	33	47	62	101	148	240	343	466	595
1.2	22	36	51	68	111	162	262	374	508	649
1.3	23	39	55	73	120	175	284	405	551	703
1.4	25	41	60	79	129	189	306	436	593	757
1.5	27	44	64	85	138	202	328	467	636	811
1.6	29	47	68	90	147	216	349	498	678	865
1.7	31	50	72	96	157	229	371	530	720	919
1.8	32	53	77	101	166	243	393	561	763	973
1.9	34	56	81	107	175	256	415	592	805	1027
2	36	59	85	113	184	270	437	623	847	1081
2.1	38	62	89	118	194	283	459	654	890	1135
2.2	40	65	94	124	203	296	480	685	932	1189
2.3	41	68	98	130	212	310	502	717	975	1243
2.4	43	71	102	135	221	323	524	748	1017	1297
2.5	45	74	106	141	230	337	546	779	1059	1351
2.6	47	77	111	146	240	350	568	810	1102	1405
2.7	49	80	115	152	249	364	590	841	1144	1459
2.8	50	83	119	158	258	377	611	872	1186	1514
2.9	52	86	124	163	267	391	633	903	1229	1568
3	54	89	128	169	276	404	655	935	1271	1622
3.1	56	92	132	175	286	418	677	966	1314	1676
3.2	58	95	136	180	295	431	699	997	1356	1730
3.3	59	98	141	186	304	445	721	1028	1398	1784
3.4	61	101	145	192	313	458	742	1059	1441	1838
3.5	63	104	149	197	323	472	764	1090	1483	1892
3.6	65	107	153	203	332	485	786	1121	1525	1946
3.7	67	110	158	208	341	499	808	1153	1568	2000
3.8	68	113	162	214	350	512	830	1184	1610	2054
3.9	70	116	166	220	359	526	852	1215	1653	2108
4	72	119	170	225	369	539	873	1246	1695	2162
4.1	74	121	175	231	378	553	895	1277	1737	2216
4.2	76	124	179	237	387	566	917	1308	1780	2270
4.3	77	127	183	242	396	580	939	1340	1822	2324
4.4	79	130	187	248	406	593	961	1371	1864	2378
4.5	81	133	192	254	415	606	983	1402	1907	2432
4.6	83	136	196	259	424	620	1004	1433	1949	2486
4.7	85	139	200	265	433	633	1026	1464	1992	2541
4.8	86	142	204	270	442	647	1048	1495	2034	2595
4.9	88	145	209	276	452	660	1070	1526	2076	2649
5	90	148	213	282	461	674	1092	1558	2119	2703

Fuse Voltage Drop Chart - Mini Fuse

Circuit Current Across Fuse (milliAmps)

Fuse Color	Grey	Violet	Pink	Tan	Brown	Red	Blue	Yellow	Clear	Green
Measurement mV	Mini 2 Amp	Mini 3 Amp	Mini 4 Amp	Mini 5 Amp	Mini 7.5 Amp	Mini 10 Amp	Mini 15 Amp	Mini 20 Amp	Mini 25 Amp	Mini 30 Amp
5.1	92	151	217	287	470	687	1114	1589	2161	2757
5.2	94	154	221	293	479	701	1135	1620	2203	2811
5.3	95	157	226	299	488	714	1157	1651	2246	2865
5.4	97	160	230	304	498	728	1179	1682	2288	2919
5.5	99	163	234	310	507	741	1201	1713	2331	2973
5.6	101	166	239	315	516	755	1223	1745	2373	3027
5.7	103	169	243	321	525	768	1245	1776	2415	3081
5.8	104	172	247	327	535	782	1266	1807	2458	3135
5.9	106	175	251	332	544	795	1288	1838	2500	3189
6	108	178	256	338	553	809	1310	1869	2542	3243
6.1	110	181	260	344	562	822	1332	1900	2585	3297
6.2	112	184	264	349	571	836	1354	1931	2627	3351
6.3	113	187	268	355	581	849	1376	1963	2669	3405
6.4	115	190	273	361	590	863	1397	1994	2712	3459
6.5	117	193	277	366	599	876	1419	2025	2754	3514
6.6	119	196	281	372	608	889	1441	2056	2797	3568
6.7	121	199	285	377	618	903	1463	2087	2839	3622
6.8	122	201	290	383	627	916	1485	2118	2881	3676
6.9	124	204	294	389	636	930	1507	2150	2924	3730
7	126	207	298	394	645	943	1528	2181	2966	3784
7.1	128	210	302	400	654	957	1550	2212	3008	3838
7.2	129	213	307	406	664	970	1572	2243	3051	3892
7.3	131	216	311	411	673	984	1594	2274	3093	3946
7.4	133	219	315	417	682	997	1616	2305	3136	4000
7.5	135	222	319	423	691	1011	1638	2336	3178	4054
7.6	137	225	324	428	700	1024	1659	2368	3220	4108
7.7	138	228	328	434	710	1038	1681	2399	3263	4162
7.8	140	231	332	439	719	1051	1703	2430	3305	4216
7.9	142	234	336	445	728	1065	1725	2461	3347	4270
8	144	237	341	451	737	1078	1747	2492	3390	4324
8.1	146	240	345	456	747	1092	1769	2523	3432	4378
8.2	147	243	349	462	756	1105	1790	2555	3475	4432
8.3	149	246	353	468	765	1119	1812	2586	3517	4486
8.4	151	249	358	473	774	1132	1834	2617	3559	4541
8.5	153	252	362	479	783	1146	1856	2648	3602	4595
8.6	155	255	366	485	793	1159	1878	2679	3644	4649
8.7	156	258	371	490	802	1173	1900	2710	3686	4703
8.8	158	261	375	496	811	1186	1921	2741	3729	4757
8.9	160	264	379	501	820	1199	1943	2773	3771	4811
9	162	267	383	507	829	1213	1965	2804	3814	4865
9.1	164	270	388	513	839	1226	1987	2835	3856	4919
9.2	165	273	392	518	848	1240	2009	2866	3898	4973
9.3	167	276	396	524	857	1253	2031	2897	3941	5027
9.4	169	279	400	530	866	1267	2052	2928	3983	5081
9.5	171	281	405	535	876	1280	2074	2960	4025	5135
9.6	173	284	409	541	885	1294	2096	2991	4068	5189
9.7	174	287	413	546	894	1307	2118	3022	4110	5243
9.8	176	290	417	552	903	1321	2140	3053	4153	5297
9.9	178	293	422	558	912	1334	2162	3084	4195	5351
10	180	296	426	563	922	1348	2183	3115	4237	5405

Fuse Voltage Drop Chart - Maxi Fuse

Circuit Current Across Fuse (milliAmps)

Fuse Color	Yellow	Grey	Green	Blu-Green	Orange	Red	Blue	Tan	Clear
Measurement mV	Maxi 20 Amp	Maxi 25 Amp	Maxi 30 Amp	Maxi 35 Amp	Maxi 40 Amp	Maxi 50 Amp	Maxi 60 Amp	Maxi 70 Amp	Maxi 80 Amp
0.1	32	42	51	58	70	91	112	156	185
0.2	65	84	103	117	141	182	225	313	370
0.3	97	126	154	175	211	273	337	469	556
0.4	129	167	205	234	282	364	449	625	741
0.5	161	209	256	292	352	455	562	781	926
0.6	194	251	308	351	423	545	674	938	1111
0.7	226	293	359	409	493	636	787	1094	1296
0.8	258	335	410	468	563	727	899	1250	1481
0.9	290	377	462	526	634	818	1011	1406	1667
1	323	418	513	585	704	909	1124	1563	1852
1.1	355	460	564	643	775	1000	1236	1719	2037
1.2	387	502	615	702	845	1091	1348	1875	2222
1.3	419	544	667	760	915	1182	1461	2031	2407
1.4	452	586	718	819	986	1273	1573	2188	2593
1.5	484	628	769	877	1056	1364	1685	2344	2778
1.6	516	669	821	936	1127	1455	1798	2500	2963
1.7	548	711	872	994	1197	1545	1910	2656	3148
1.8	581	753	923	1053	1268	1636	2022	2813	3333
1.9	613	795	974	1111	1338	1727	2135	2969	3519
2	645	837	1026	1170	1408	1818	2247	3125	3704
2.1	677	879	1077	1228	1479	1909	2360	3281	3889
2.2	710	921	1128	1287	1549	2000	2472	3438	4074
2.3	742	962	1179	1345	1620	2091	2584	3594	4259
2.4	774	1004	1231	1404	1690	2182	2697	3750	4444
2.5	806	1046	1282	1462	1761	2273	2809	3906	4630
2.6	839	1088	1333	1520	1831	2364	2921	4063	4815
2.7	871	1130	1385	1579	1901	2455	3034	4219	5000
2.8	903	1172	1436	1637	1972	2545	3146	4375	5185
2.9	935	1213	1487	1696	2042	2636	3258	4531	5370
3	968	1255	1538	1754	2113	2727	3371	4688	5556
3.1	1000	1297	1590	1813	2183	2818	3483	4844	5741
3.2	1032	1339	1641	1871	2254	2909	3596	5000	5926
3.3	1065	1381	1692	1930	2324	3000	3708	5156	6111
3.4	1097	1423	1744	1988	2394	3091	3820	5313	6296
3.5	1129	1464	1795	2047	2465	3182	3933	5469	6481
3.6	1161	1506	1846	2105	2535	3273	4045	5625	6667
3.7	1194	1548	1897	2164	2606	3364	4157	5781	6852
3.8	1226	1590	1949	2222	2676	3455	4270	5938	7037
3.9	1258	1632	2000	2281	2746	3545	4382	6094	7222
4	1290	1674	2051	2339	2817	3636	4494	6250	7407
4.1	1323	1715	2103	2398	2887	3727	4607	6406	7593
4.2	1355	1757	2154	2456	2958	3818	4719	6563	7778
4.3	1387	1799	2205	2515	3028	3909	4831	6719	7963
4.4	1419	1841	2256	2573	3099	4000	4944	6875	8148
4.5	1452	1883	2308	2632	3169	4091	5056	7031	8333
4.6	1484	1925	2359	2690	3239	4182	5169	7188	8519
4.7	1516	1967	2410	2749	3310	4273	5281	7344	8704
4.8	1548	2008	2462	2807	3380	4364	5393	7500	8889
4.9	1581	2050	2513	2865	3451	4455	5506	7656	9074
5	1613	2092	2564	2924	3521	4545	5618	7813	9259
5.1	1645	2134	2615	2982	3592	4636	5730	7969	9444

Fuse Voltage Drop Chart - Maxi Fuse

Circuit Current Across Fuse (milliAmps)

Fuse Color	Yellow	Grey	Green	Blu-Green	Orange	Red	Blue	Tan	Clear
Measurement mV	Maxi 20 Amp	Maxi 25 Amp	Maxi 30 Amp	Maxi 35 Amp	Maxi 40 Amp	Maxi 50 Amp	Maxi 60 Amp	Maxi 70 Amp	Maxi 80 Amp
5.2	1677	2176	2667	3041	3662	4727	5843	8125	9630
5.3	1710	2218	2718	3099	3732	4818	5955	8281	9815
5.4	1742	2259	2769	3158	3803	4909	6067	8438	10000
5.5	1774	2301	2821	3216	3873	5000	6180	8594	10185
5.6	1806	2343	2872	3275	3944	5091	6292	8750	10370
5.7	1839	2385	2923	3333	4014	5182	6404	8906	10556
5.8	1871	2427	2974	3392	4085	5273	6517	9063	10741
5.9	1903	2469	3026	3450	4155	5364	6629	9219	10926
6	1935	2510	3077	3509	4225	5455	6742	9375	11111
6.1	1968	2552	3128	3567	4296	5545	6854	9531	11296
6.2	2000	2594	3179	3626	4366	5636	6966	9688	11481
6.3	2032	2636	3231	3684	4437	5727	7079	9844	11667
6.4	2065	2678	3282	3743	4507	5818	7191	10000	11852
6.5	2097	2720	3333	3801	4577	5909	7303	10156	12037
6.6	2129	2762	3385	3860	4648	6000	7416	10313	12222
6.7	2161	2803	3436	3918	4718	6091	7528	10469	12407
6.8	2194	2845	3487	3977	4789	6182	7640	10625	12593
6.9	2226	2887	3538	4035	4859	6273	7753	10781	12778
7	2258	2929	3590	4094	4930	6364	7865	10938	12963
7.1	2290	2971	3641	4152	5000	6455	7978	11094	13148
7.2	2323	3013	3692	4211	5070	6545	8090	11250	13333
7.3	2355	3054	3744	4269	5141	6636	8202	11406	13519
7.4	2387	3096	3795	4327	5211	6727	8315	11563	13704
7.5	2419	3138	3846	4386	5282	6818	8427	11719	13889
7.6	2452	3180	3897	4444	5352	6909	8539	11875	14074
7.7	2484	3222	3949	4503	5423	7000	8652	12031	14259
7.8	2516	3264	4000	4561	5493	7091	8764	12188	14444
7.9	2548	3305	4051	4620	5563	7182	8876	12344	14630
8	2581	3347	4103	4678	5634	7273	8989	12500	14815
8.1	2613	3389	4154	4737	5704	7364	9101	12656	15000
8.2	2645	3431	4205	4795	5775	7455	9213	12813	15185
8.3	2677	3473	4256	4854	5845	7545	9326	12969	15370
8.4	2710	3515	4308	4912	5915	7636	9438	13125	15556
8.5	2742	3556	4359	4971	5986	7727	9551	13281	15741
8.6	2774	3598	4410	5029	6056	7818	9663	13438	15926
8.7	2806	3640	4462	5088	6127	7909	9775	13594	16111
8.8	2839	3682	4513	5146	6197	8000	9888	13750	16296
8.9	2871	3724	4564	5205	6268	8091	10000	13906	16481
9	2903	3766	4615	5263	6338	8182	10112	14063	16667
9.1	2935	3808	4667	5322	6408	8273	10225	14219	16852
9.2	2968	3849	4718	5380	6479	8364	10337	14375	17037
9.3	3000	3891	4769	5439	6549	8455	10449	14531	17222
9.4	3032	3933	4821	5497	6620	8545	10562	14688	17407
9.5	3065	3975	4872	5556	6690	8636	10674	14844	17593
9.6	3097	4017	4923	5614	6761	8727	10787	15000	17778
9.7	3129	4059	4974	5673	6831	8818	10899	15156	17963
9.8	3161	4100	5026	5731	6901	8909	11011	15313	18148
9.9	3194	4142	5077	5789	6972	9000	11124	15469	18333
10	3226	4184	5128	5848	7042	9091	11236	15625	18519

Fuse Voltage Drop Chart -JCase Cartridge Style

Circuit Current Across Fuse (milliAmps)

Fuse Color	Blue	Pink	Green	Red	Yellow	Black	Blue
Measurement mV	Cartridge 20 Amp	Cartridge 30 Amp	Cartridge 40 Amp	Cartridge 50 Amp	Cartridge 60 Amp	Cartridge 80 Amp	Cartridge 100 Amp
0.1	17	19	26	42	59	81	213
0.2	33	38	53	83	118	163	426
0.3	50	58	79	125	176	244	638
0.4	67	77	105	167	235	325	851
0.5	83	96	132	208	294	407	1064
0.6	100	115	158	250	353	488	1277
0.7	117	135	184	292	412	569	1489
0.8	133	154	211	333	471	650	1702
0.9	150	173	237	375	529	732	1915
1	167	192	263	417	588	813	2128
1.1	183	212	289	458	647	894	2340
1.2	200	231	316	500	706	976	2553
1.3	217	250	342	542	765	1057	2766
1.4	233	269	368	583	824	1138	2979
1.5	250	288	395	625	882	1220	3191
1.6	267	308	421	667	941	1301	3404
1.7	283	327	447	708	1000	1382	3617
1.8	300	346	474	750	1059	1463	3830
1.9	317	365	500	792	1118	1545	4043
2	333	385	526	833	1176	1626	4255
2.1	350	404	553	875	1235	1707	4468
2.2	367	423	579	917	1294	1789	4681
2.3	383	442	605	958	1353	1870	4894
2.4	400	462	632	1000	1412	1951	5106
2.5	417	481	658	1042	1471	2033	5319
2.6	433	500	684	1083	1529	2114	5532
2.7	450	519	711	1125	1588	2195	5745
2.8	467	538	737	1167	1647	2276	5957
2.9	483	558	763	1208	1706	2358	6170
3	500	577	789	1250	1765	2439	6383
3.1	517	596	816	1292	1824	2520	6596
3.2	533	615	842	1333	1882	2602	6809
3.3	550	635	868	1375	1941	2683	7021
3.4	567	654	895	1417	2000	2764	7234
3.5	583	673	921	1458	2059	2846	7447
3.6	600	692	947	1500	2118	2927	7660
3.7	617	712	974	1542	2176	3008	7872
3.8	633	731	1000	1583	2235	3089	8085
3.9	650	750	1026	1625	2294	3171	8298
4	667	769	1053	1667	2353	3252	8511
4.1	683	788	1079	1708	2412	3333	8723
4.2	700	808	1105	1750	2471	3415	8936
4.3	717	827	1132	1792	2529	3496	9149
4.4	733	846	1158	1833	2588	3577	9362
4.5	750	865	1184	1875	2647	3659	9574
4.6	767	885	1211	1917	2706	3740	9787
4.7	783	904	1237	1958	2765	3821	10000
4.8	800	923	1263	2000	2824	3902	10213
4.9	817	942	1289	2042	2882	3984	10426
5	833	962	1316	2083	2941	4065	10638

Fuse Voltage Drop Chart -JCase Cartridge Style

Circuit Current Across Fuse (milliAmps)

Fuse Color	Blue	Pink	Green	Red	Yellow	Black	Blue
Measurement mV	Cartridge 20 Amp	Cartridge 30 Amp	Cartridge 40 Amp	Cartridge 50 Amp	Cartridge 60 Amp	Cartridge 80 Amp	Cartridge 100 Amp
5.1	850	981	1342	2125	3000	4146	10851
5.2	867	1000	1368	2167	3059	4228	11064
5.3	883	1019	1395	2208	3118	4309	11277
5.4	900	1038	1421	2250	3176	4390	11489
5.5	917	1058	1447	2292	3235	4472	11702
5.6	933	1077	1474	2333	3294	4553	11915
5.7	950	1096	1500	2375	3353	4634	12128
5.8	967	1115	1526	2417	3412	4715	12340
5.9	983	1135	1553	2458	3471	4797	12553
6	1000	1154	1579	2500	3529	4878	12766
6.1	1017	1173	1605	2542	3588	4959	12979
6.2	1033	1192	1632	2583	3647	5041	13191
6.3	1050	1212	1658	2625	3706	5122	13404
6.4	1067	1231	1684	2667	3765	5203	13617
6.5	1083	1250	1711	2708	3824	5285	13830
6.6	1100	1269	1737	2750	3882	5366	14043
6.7	1117	1288	1763	2792	3941	5447	14255
6.8	1133	1308	1789	2833	4000	5528	14468
6.9	1150	1327	1816	2875	4059	5610	14681
7	1167	1346	1842	2917	4118	5691	14894
7.1	1183	1365	1868	2958	4176	5772	15106
7.2	1200	1385	1895	3000	4235	5854	15319
7.3	1217	1404	1921	3042	4294	5935	15532
7.4	1233	1423	1947	3083	4353	6016	15745
7.5	1250	1442	1974	3125	4412	6098	15957
7.6	1267	1462	2000	3167	4471	6179	16170
7.7	1283	1481	2026	3208	4529	6260	16383
7.8	1300	1500	2053	3250	4588	6341	16596
7.9	1317	1519	2079	3292	4647	6423	16809
8	1333	1538	2105	3333	4706	6504	17021
8.1	1350	1558	2132	3375	4765	6585	17234
8.2	1367	1577	2158	3417	4824	6667	17447
8.3	1383	1596	2184	3458	4882	6748	17660
8.4	1400	1615	2211	3500	4941	6829	17872
8.5	1417	1635	2237	3542	5000	6911	18085
8.6	1433	1654	2263	3583	5059	6992	18298
8.7	1450	1673	2289	3625	5118	7073	18511
8.8	1467	1692	2316	3667	5176	7154	18723
8.9	1483	1712	2342	3708	5235	7236	18936
9	1500	1731	2368	3750	5294	7317	19149
9.1	1517	1750	2395	3792	5353	7398	19362
9.2	1533	1769	2421	3833	5412	7480	19574
9.3	1550	1788	2447	3875	5471	7561	19787
9.4	1567	1808	2474	3917	5529	7642	20000
9.5	1583	1827	2500	3958	5588	7724	20213
9.6	1600	1846	2526	4000	5647	7805	20426
9.7	1617	1865	2553	4042	5706	7886	20638
9.8	1633	1885	2579	4083	5765	7967	20851
9.9	1650	1904	2605	4125	5824	8049	21064
10	1667	1923	2632	4167	5882	8130	21277

BEWARE OF TURNING CIRCUITS ON TO GAIN ACCESS TO FUSE PANELS. MAY HAVE TO BLOCK DOOR SWITCHES OR CAREFULLY REMOVE SOME CIRCUIT FUSES

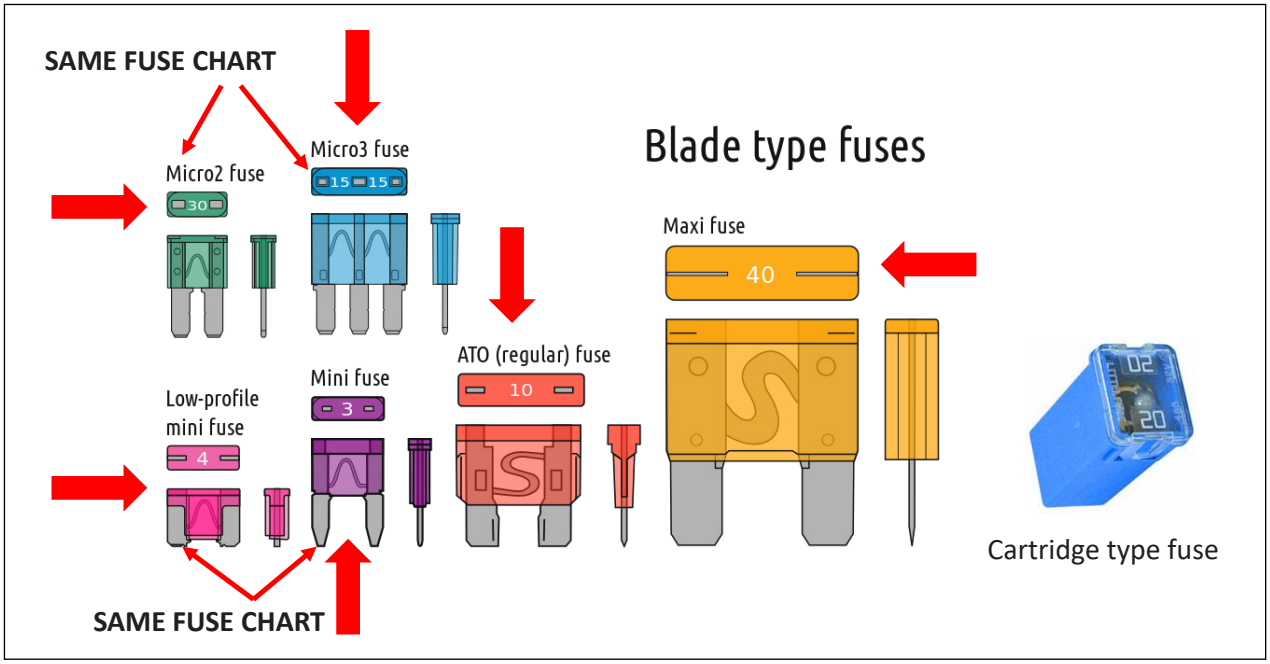
It's important to remember to not allow any electrical circuit to turn on during the parasitic draw testing procedure. Doing so will turn on all the modules and cause all of your readings to be void. If this happens, you must start over again and wait the entire time of modules to "go to sleep" again. If doors may have to be opened, perhaps blocking the door switches closed could be performed.

The AMP HOUND by Thexton

ADVANTAGE? NO NEED TO REMOVE FUSES TO MEASURE PARASITIC DRAW.

Or by SNAP-ON

There are many types of specialized testers designed to conduct voltage drop testing across fuses. The Amp Hound allows quick measurement of the voltage drop across fuses to first determine if there is current flowing in the circuit protected by the fuse, and if so, allows an accurate measurement of the amount of current flow by using voltage drops. The size and rating of each fuse is inputted into the tool with the corresponding readout being in milli-amps or amps.



Typical fuses used in today's vehicles

CAUTION ABOUT "IMPORT"FUSES!!

THESE "OFF BRAND" FUSES WILL NOT GIVE ACCURATE RESULTS WITH VOLTAGE DROP TESTING DUE TO THEIR INFERIOR DESIGN AND COATINGS USED ON THE METAL TERMINALS- STRONGLY SUGGEST THAT THEY NOT BE USED DUE TO QUALITY AND ACCURACY CONCERNS

THE CHESNEY METHOD OF CHECKING PARASITIC DRAW

Featured Article: Looking for a quick way to test parasitic draw?

by Brian Rooney | Apr 18, 2014

Looking for a quick way to test parasitic draw?

With today's vehicles having electronic modules that stay awake for extended periods of time, it can be time consuming waiting for them to go back to sleep after connecting an ammeter when you measure the parasitic draw. Here is a very different way of testing for excessive draw that doesn't require you to disconnect one of the battery terminals, or measure the mV drop across multitudes of fuses. It is very quick to do, and will allow you to immediately determine if an excessive draw is present. It is a bit controversial, but I think you will find it can save a lot of time and requires no special tools other than a DVOM.

It is named the Chesney parasitic draw test after its creator, Sean Chesney. Instead of using an ammeter to measure the draw, an ohmmeter is used. The first thing to do is measure the test leads "delta" (resistance above zero). Set the ohmmeter to ohms (the lowest scale), touch the meter leads together, and read the screen. The reading is the resistance of the meter leads and is the meter's true zero when used with those leads. Typically an ohmmeter will read about 0.1 ohms when the leads are touched together. Some meters have a delta feature that recalibrates the ohmmeter to zero when the leads are placed together and the delta button is pushed. If your meter has this delta feature, you can use it so that you will not have to remember the delta readir But for now, let's say your meter reads 0.2 ohms delta.

Next, with the battery terminals still connected to the battery, place the DVOM's black lead on the negative post of the battery a the red lead on an unpainted surface of the alternator housing. Read the ohmmeter and subtract the delta value from the readin This reading corresponds to the relative parasitic draw on the system. For example, if the DVOM now reads 0.9 ohms, subtrac the original 0.2 ohms reading of the leads. This leaves a reading of 0.7 ohms delta.

Through testing, Chesney found that a draw of about 35 milliamps equaled an ohm reading of about 0.3 ohms delta (above the delta value) on a DVOM with 10 megohms of impedance, and about 0.6 ohms delta on a DVOM with 20 megohms of impedanc Anything above those readings indicates an excessive parasitic draw. So in our example of 0.7 ohms delta, and a 10 megohm meter, the parasitic load is approximately 90 milliamps, which is well above the standard 35 milliamp limit, indicating an excessi parasitic draw.

If you are skeptical of this method like I was, go out and try it on several vehicles. Simulate a parasitic draw by opening the driver's door (make sure the dome light illuminates), and watch the ohmmeter reading. It went up substantially, right? Next, clos the door. As soon as the light goes off, the ohmmeter reading goes back down, right? If you use this test and find an excessive draw, pull fuses one at a time, watching for the ohmmeter reading to decrease. If it does not decrease after removing all of the fuses, suspect an unfused circuit such as the alternator diodes or the ignition circuit on some vehicles.

Now you have a quick, handy test for identifying excessive parasitic draws that require no wasted time waiting for modules to time out!

This is a relatively "new" alleged method of checking for parasitic draw. There are some technicians that can attest to the accuracy of the test and others who cannot. Personally, I have not conducted this test, but it is interesting to me. Should you choose, conduct your own experiments.

POWER POINT VIDEO CREDITS AND REFERENCES

SLIDE 76 Pete Meier discussing uActivate tool

Pete Meier – Motor Age:
https:/youtube.com/5Tx1rQn-K10

Pete Meier – Motor Age YouTube channel:
https://www.youtube.com/user/MotorAgeMagazine

SLIDE 76 Discussing Smart Test Lights:
https://www.youtube.com/watch?v=fByQLEu506M

SLIDE 108 Using an amp clamp

Jorge Menchu – AESwave.com:
https://www.youtube.com/watch?v=VNZgm0hatzU

AESwave YouTube channel:
https://www.youtube.com/user/AESwave

SLIDE 129 Using the Amp Hound

Cal-Van Tools:
http://www.cal-vantools.com/

https://www.youtube.com/watch?v=pM5qV6ge2vA

SLIDE 132 Testing off-brand fuses

Jeff Curtis – Bellingham College:
https://www.youtube.com/watch?v=UlyIsUgSw5Y

SLIDE 133 Paul Danner - Scanner Danner

Battery blows up
https://www.youtube.com/watch?v=h06xb6SC7Yc&list=PL0xMltqQHOLw8CfATGK54awngxhD80TBk&index=4

RESOURCES FOR ELECTRICAL DIAGNOSTIC STRATEGIES CLASS

VIDEOS

Multimeters — Types, Operation and Use:

How to Use a Multimeter 8:07 min
https://www.youtube.com/watch?v=TdUK6RPdIrA

Beginners Guide to Using Multimeter 19:04 min
https://www.youtube.com/watch?v=RtNMhCzq72M

How to Use a Multimeter to Diagnose Common Problems 14:08 min
https://www.youtube.com/watch?v=aDy9-IGNeQM

"The Best Multimeter in The World (How to Use Them)" Generic – Non-Automotive 41:28 min
https://www.youtube.com/watch?v=Io8MWr3NuuM

Mastering Meters & Advanced Electrical Diagnostics Dave Hobbs-Delphi 1:13:43 min
https://www.youtube.com/watch?v=QPl7gIijjNo

How to Use a Multimeter to Troubleshoot Common Problems BBB Industries 14:08 min
https://www.youtube.com/watch?v=aDy9-IGNeQM

How to use a Multimeter for beginners: Part 1 - Voltage measurement / Multimeter tutorial 32:56 min
https://www.youtube.com/watch?v=ZBbgiBU96mM

How to use a multimeter for advanced measurements: Part 2 - Current Probes / clamps / transducers 29:00 min
https://www.youtube.com/watch?v=Kqa51Femytw

How to use a Multimeter for beginners: Part 2a - Current measurement 42:35 min
https://www.youtube.com/watch?v=EVFkKBFJsZg

How to use a Multimeter for beginners: Part 3 - Resistance and Continuity 27:10 min
https://www.youtube.com/watch?v=InJhgwmj2So

How To Use a Clamp Meter 5:48 min
https:/ /www.youtube.com/watch?v=WDTVE7IxJQ8

Tutorial: How to use a clamp meter / current clamp 19:52 min
https://www.youtube.com/watch?v=nxhUwH70F_4

Multimeter Review / buyers guide: GTC CM100 1 mA to 100 A Low Current Clamp Meter 26:52 min
https://www.youtube.com/watch?v=1sq2WRGPABw

Multimeter basics, voltage and resistance tests (a free SD Premium video) Scanner Danner 39:42 min
https://www.youtube.com/watch?v=w0PpLTnKKZg

RESOURCES FOR ELECTRICAL DIAGNOSTIC STRATEGIES CLASS

VIDEOS

Understanding Electrical Diagrams & Schematics:

Eric The Car Guy – Electrical Troubleshooting – Part II — 24:03 min
https://www.youtube.com/watch?v=GVSvA0y-peA

How to Read a Wiring Diagram – Part I — 6:16 min
https://www.youtube.com/watch?v=KbvM5Tkc-UA

Electrical Diagrams – Part 2 — 1:33 min
https://www.youtube.com/watch?v=TFD8ZqXujsE

Electrical Diagrams – Part 3 — 13:54 min
https://www.youtube.com/watch?v=qXWhQxQXvsY

Electrical Diagrams – Part 4 — 14:46 min
https://www.youtube.com/watch?v=VXhMh9IOqMU

Electrical Diagrams – Part 5 — 16:39 min
https://www.youtube.com/watch?v=Sv1wO3qdRZI

Electrical Diagrams – Part 6 — 9:52 min
https://www.youtube.com/watch?v=DWRi_h251XA

How to Read an Electrical Block Diagram Motor Age — 23:20 min
https://www.youtube.com/watch?v=oww3zm8fGJU

Jorge Menchu – AESwave – Wire Color Coding — 30:59 min
https://www.youtube.com/watch?v=oC480VSLjBg

Electrical and Schematic Troubleshooting-based Diagnostics with Bill Fulton — 2:28:35 min
https://www.youtube.com/watch?v=D6k9ACOJ9sw

Electrical Diagnostics with “G” Jerry Truglia and Rich Peterson Part I — 2.57:16 min
https://www.youtube.com/watch?v=UgH8FtQZhNU

Electrical Diagnostics with “G” Jerry Truglia and Rich Peterson Part II — 2.33:57 min
https://www.youtube.com/watch?v=qnlJViS9M4A

Basic Electricity for Service Techs: Ohm’s law, Current Flow, Opens & Shorts BBB Ind. — 13:53 min
https://www.youtube.com/watch?v=WoN1nou5t1Q

Understanding Electrical Circuits and How To Test Them – Motor Age — 12:00 min
https://www.youtube.com/watch?v=SO-eKuhCOqc

Advanced Electrical Troubleshooting – Jerry Truglia — 24:26 min
https://www.youtube.com/watch?v=kZ5LaFaTDNc

Electrical Testing and Troubleshooting Tips With Vince Fischelli — 53:42 min
https://www.youtube.com/watch?v=mVJWuZ6XrwA

RESOURCES FOR ELECTRICAL DIAGNOSTIC STRATEGIES CLASS

VIDEOS

Understanding Electrical Diagrams & Schematics:

Electrical and Schematic Troubleshooting-based Diagnostics with Bill Fulton 2:28:35 min
https://www.youtube.com/watch?v=D6k9ACOJ9sw

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Electrical Diagnostics with "G" Jerry Truglia and Rich Peterson Part II 2.33:57 min
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https://www.youtube.com/watch?v=UgH8FtQZhNU

Electrical Diagnostics with "G" Jerry Truglia and Rich Peterson Part II 2.33:57 min
https://www.youtube.com/watch?v=qnlJViS9M4A

Basic Electricity for Service Techs: Ohm's law, Current Flow, Opens & Shorts BBB Ind. 13:53 min
https://www.youtube.com/watch?v=WoN1nou5t1Q

Test Lights:

Eric The Car Guy - Basic Test Light Use 29:52 min
https://www.youtube.com/watch?v=wLVu2HYtOhA

How to Test Automotive Grounds 1:56 min
https://www.youtube.com/watch?v=LGWhzTuJroQ&list=PLRmBBuJTdDw0Pi4SEjzQV9nKQEjfEIWhH

Test Light - regular vs logic probe 8:31 min
https://www.youtube.com/watch?v=vNe3E5ncZgA&index=5&list=PLRmBBuJTdDw0Pi4SEjzQV9nKQEjfEIWhH

How to use a automotive test light – (DIY & Basic, but good info) 20:14 min
https://www.youtube.com/watch?v=BjCjmwUxUSU&list=PLRmBBuJTdDw0Pi4SEjzQV9nKQEjfEIWhH&index=12

HOW TO USE AN AUTOMOTIVE TEST LIGHT TO FIND PROBLEMS!! 3:08 min
https://www.youtube.com/watch?v=Hlna_kUt7As

How to test for a short to ground (ohmmeter vs test light) (Scanner Danner) 39:23 min
https://www.youtube.com/watch?v=WVPFOru17-Q

How to Make an LED Test Light 18:04 min
https://www.youtube.com/watch?v=tDUJDVGyzrQ

RESOURCES FOR ELECTRICAL DIAGNOSTIC STRATEGIES CLASS

VIDEOS

Test Lights:

How to make your own short circuit detector — 10:06 min
https://www.youtube.com/watch?v=6aSClicvo6M&feature=youtu.be

How to measure the current draw of your test light (Incandescent vs. LED) (Scanner Danner) — 4:50 min
https://www.youtube.com/watch?v=gEQnKNLlcFQ

How to Make Your Own Test Light — 4:12 min
https://www.youtube.com/watch?v=sbzBFyn6V2c

Logic Probe Testing — 1:58 min
https://www.youtube.com/watch?v=QH8W6-U23vk

How to Make Your Own Logic Probe — 48:39 min
https://www.youtube.com/watch?v=4TH6zSdFIhA

Homemade Logic Probe Test Light — 11:28 min
https://www.youtube.com/watch?v=4TH6zSdFIhA

DIY LOGIC PROBE – Schematic — 3:35 min
https://www.youtube.com/watch?v=6CMeyYYGsaM

Not all test lights are created equal — 4:49 min
https://www.youtube.com/watch?v=ZPvJF7RP-yY

Battery Parasitic Load Testing:

How to Find a Battery Drain — 25:17 min
https://www.youtube.com/watch?v=tRYgzM3G8N4

Basic draw test using a multimeter. Very basic content — 7:53 min
https://www.youtube.com/watch?v=eXX8TfzRAKk

Parasitic Draw testing — 14:26 min
https://www.youtube.com/watch?v=jTECmj78ZOU

Pete Meier Motor Age - Parasitic draw test methods — 18:00 min
https://www.youtube.com/watch?v=P-wxG6U5TuY

Pete Meier Motor Age Voltage Drop testing across fuses — 6:19 min
https://www.youtube.com/watch?v=T6rDTtxaeJ4

Improved Methods of Battery Drain Testing — 18:12 min
https://www.youtube.com/watch?v=QRso1A0VScw

How To Locate and Identify a Parasitic Drain — 12:34 min
https://www.youtube.com/watch?v=YhC8xj5vHUg

RESOURCES FOR ELECTRICAL DIAGNOSTIC STRATEGIES CLASS

VIDEOS

Battery Parasitic Load Testing:

Eric the Car Guy parasitic load testing with multimeter (no battery saver used) 16:50 min
https://www.youtube.com/watch?v=KF1gijj03_0

Parasitic Current Draw: AMP Clamp Tech Tip – Dave Hobbs – Delphi 4:14 min
https://www.youtube.com/watch?v=EcFo35tyev0

Battery keeps going dead (what to test before replacing) – Scanner Danner 17:35 min
https://youtube.com/AA-vHbE1IA8

BATTERY DRAINS TECH TIP - Dave Hobbs 9:16 min
https://www.youtube.com/watch?v=M7fcj_R-2kY

How to test an Alternator (alternator not charging from a blown fuse) Scanner Danner Pt 1 29:38 min
https://www.youtube.com/watch?v=--AdY8z1QfU

How to find a short to ground (blown fuse) Part II - Scanner Danner 21:36 min
https://youtu.be/FK9STP4G9-I

How to locate a battery drain (parasitic drain test) Part 1 50:41 min
https://youtu.be/h06xb6SC7Yc

How to locate a battery drain (parasitic drain test) Part 2 - Scanner Danner 44:44 min
https://youtu.be/dgvIicgZRcQ

Voltage Drop Testing:

Voltage Drop Testing - Complete Topic Motor Age – Pete Meier & Jerry Truglia 1:23:51 min
https://www.youtube.com/watch?v=n7-YSsWXVq8

Voltage Drop Testing – Pete Meier & Jerry Truglia 1:26:45 min
https://www.youtube.com/watch?v=YaYtCVBodpw

Basic Voltage Drop Testing for Automotive Electrical Testing 13:56 min
https://www.youtube.com/watch?v=9aioZN33xsA

Understanding Voltage Drop 33:14 min
https://www.youtube.com/watch?v=DfLyh43iihM

What is Voltage Drop? Dan Sullivan 14:54 min
https://www.youtube.com/watch?v=ggKnH-95ty0

Voltage Drop – Part 1 3:40 min
https://www.youtube.com/watch?v=6Sqk_Gai59I

Voltage Drop – Part 29:28 min
https://www.youtube.com/watch?v=a1vR2BxJ9jQ

RESOURCES FOR ELECTRICAL DIAGNOSTIC STRATEGIES CLASS

VIDEOS

Voltage Drop Testing:

Voltage Drop – Part 3 — 9:42 min
https://www.youtube.com/watch?v=WONhgSxeZ2s

Voltage Drop – Part 4 — 9:38 min
https://www.youtube.com/watch?v=H8rl5w51fNo

Voltage Drop Test – Delco Remy TECH TIP (HD Truck) — 5:54 min
https://www.youtube.com/watch?v=UhT2cNCfTXc

Voltage drop testing with the Power Probe Hook — 3:28 min
https://www.youtube.com/watch?v=4EjwMpXBjKk

Relays, Operation, Wiring, Diagnosis & Testing:

VEHICLE RELAYS - Operation & Diagnosis - Dan Sullivan — 12:37 min
https://www.youtube.com/watch?v=Mru8BbTGDwM

VEHICLE RELAYS - Testing from the relay base – Dan Sullivan — 7:19 min
https://www.youtube.com/watch?v=6eZg3wLYsr0

DIY: How to Test a Relay BASIC LEVEL — 9:51 min
https://www.youtube.com/watch?v=clSSwXeezDo

Electrical Series: How To Test A Relay — 3:45 min
https://www.youtube.com/watch?v=GtWmYffMido

How to test a 4-pin Relay (Electronic on/off Switch) also with connector & led light — 10:40 min
https://www.youtube.com/watch?v=67fU_QrN0gg

How to wire up a relay — 16:39 min
https://www.youtube.com/watch?v=bb9rCtB_2HU

How to wire a relay – Tutorial — 3:11 min
http://cumminsengines.com/assets/pdf/4971166.pdf

What is a Relay? How a Relay works! (non-automotive) — 3:35 min
https://www.youtube.com/watch?v=hhYWEh4Dfoc

What is a Relay? How does a Relay works! (Silent) — 3:31 min
https://www.youtube.com/watch?v=1_YfuH_AcxQ

Understanding 12v DC Switches, Relays, Solenoids - Part 1 — 20:14 min
https://www.youtube.com/watch?v=jZoGC0BUk5c

Testing relays with the Power Probe — 6:00 min
https://www.youtube.com/watch?v=dsUm2INjURE

RESOURCES FOR ELECTRICAL DIAGNOSTIC STRATEGIES CLASS

VIDEOS

Relays, Operation, Wiring, Diagnosis & Testing:

Pete Meier Motor Age – Using the Uactivate relay tester — 4:22 min
https://www.youtube.com/watch?v=5Tx1rQn-K10

How to use Switches, Relays, Solenoids in your 12v Wiring Harness – Part 2 (Custom app.) — 21:58 min
https://www.youtube.com/watch?v=7vOVSst-SoY

How Does A Relay Work - Automotive Relay SPDT — 12:39 min
https://www.youtube.com/watch?v=xvFvJiiDD7w

Testing relay with and without a diagram (ohmmeter based only) — 14:10 min
https://www.youtube.com/watch?v=dsUm2INjURE

Wiring Products - How to Wire an Automotive Relay — 2:03 min
https://www.youtube.com/watch?v=Tw9QkkT2ptU

Basic Automotive Relay Operation and Simple Wiring
(Not perfect video quality and narrative, but good fundamentals) — 8:04 min
https://www.youtube.com/watch?v=hhduYLhUeK0

RELAYS - How to wire and how they work TUTORIAL !!
(Poor narration, but good fundamentals) — 20:52 min
https://www.youtube.com/watch?v=F1SGyN6Yp64

Switches, Relays and Wiring Diagrams 2 - ADP Training — 5:21 min
https://www.youtube.com/watch?v=Fxl1B0tpq6U

RESOURCES FOR ELECTRICAL DIAGNOSTIC STRATEGIES CLASS

VIDEOS

Youtube & Other Channels for Resources:

ADP VIDEO TRAINING YOUTUBE CHANNEL
https://www.youtube.com/user/ADPTraining

AESWAVE VIDEO YOUTUBE CHANNEL
https://www.youtube.com/user/AESwave

SCANNER DANNER (PAUL DANNER) YOUTUBE BASIC CHANNEL (OVER 100 FREE VIDEOS) (DETAILED)
https://www.youtube.com/results?q=scannerdanner+YOUTUBE

SCANNER DANNER PREMIUM YOUTUBE CHANNEL (HIGHLY RECOMMEND)
https://www.youtube.com/results?search_query=scannerdanner+premium

VINCE FISCHELLI YOUTUBE CHANNEL
https://www.youtube.com/results?search_query=vince+fischelli+

VIDEO – DAVE HOBBS – COMPREHENSIVE TESTING OF PARASITIC DRAW – 190 MINUTE VIDEO FOR PURCHASE AT: https://www.aeswave.com/Parasitic-Current-Draw-p9220.html $124.95

Other Resources:

ARTICLE: How to Locate a Parasitic Drain – Motor Magazine
https://www.motor.com/magazine-summary/proven-techniques-for-battery-drain-diagnosis/#

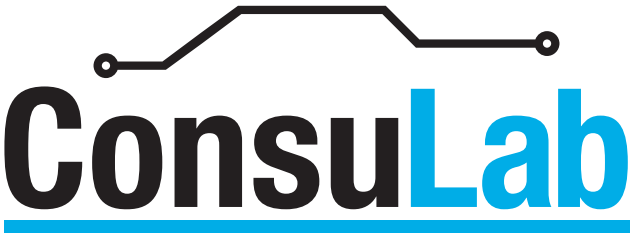
ARTICLE: Inductive Ammeter Conducting Parasitic Draw test
http://www.hotrod.com/articles/matco-tools-parasitic-drain-tester-and-low-current-probe/

WEBSITE: Complete online course on basic electrical systems. 10 major sections of content including one on relays. Author – Kevin Sullivan – San Bruno College – After getting to homepage, click on ONLINE INSTRUCTION
www.autoshop101.com

ARTICLE: JORGE MENCHU – AESWAVE – WIRE COLOR CODING PDF
http://resources.aeswave.com/articles/Jorge/2008_12_Motor_WDcolorCoding.pdf

ARTICLE: A New Approach to Parasitic Draw Testing – Motor Age
http://www.searchautoparts.com/motorage/technicians/scope-scan-service-repair/new-approach-testing-parasitic-draw

ARTICLE: Parasitic Load Testing at fuses using a voltmeter
http://www.gonzostoolbox.com/KnowledgeFolder/ParasiticDrawHunting.html



TRAINING AIDS

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