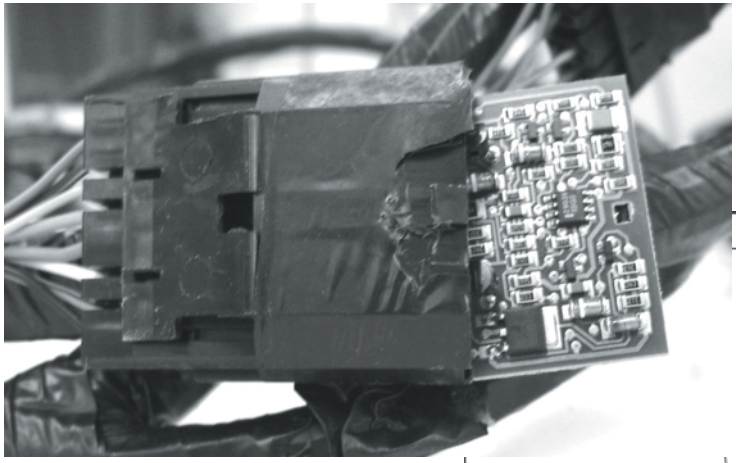
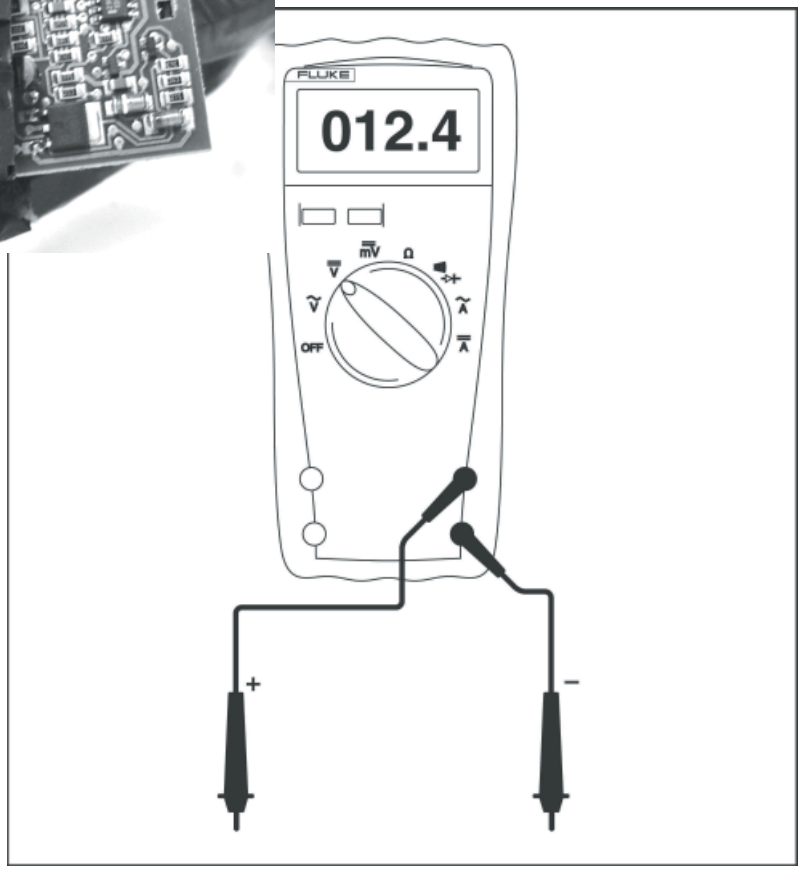
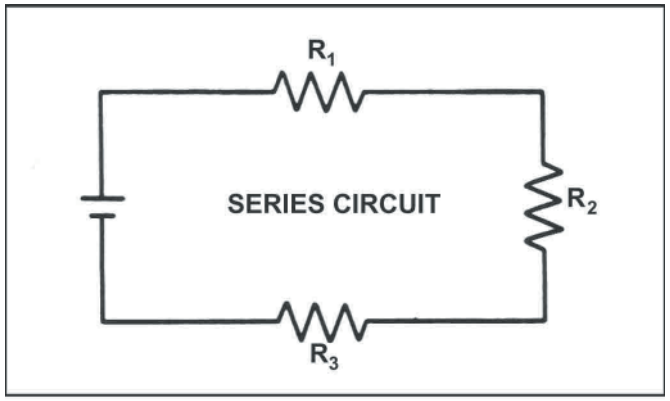
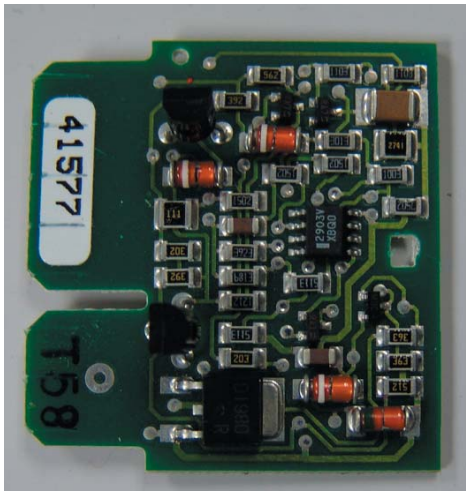
2007
ELECTRICAL SYSTEMS









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DESCRIPTION AND OPERATION

DIAGNOSTIC LINK CONNECTOR DESCRIPTION

All 2006 Model Year (2006MY) W-Series chassis are equipped with two Diagnostic Link Connectors (DLC). The 16-pin DLC is used to connect a scan tool or laptop for the purpose of performing engine/transmission and Kelsey-Hayes (when equipped) anti-lock brake system (ABS) diagnostics. The 9-pin “Deutsch” DLC is used to connect a scan tool or laptop for the purpose of performing transmission and/or anti-lock brake system (ABS) diagnostics.

16-Pin DLC

The 16-pin DLC is used to connect a scan tool for the purpose of performing engine, Hydra-Matic transmission (when equipped), and Kelsey-Hayes (when equipped) ABS system diagnostics. Establishing communication allows the operator to monitor the systems for diagnostic purposes. Only 4 of the 16 pins are used. The pin assignments are:

- Pin 2 – Class 2 Serial Data link to instrument cluster/ PCM/ECM
- Pin 4 – Ground terminal 12
- Pin 5 – Ground terminal 37
- Pin 16 – Battery voltage feed to DLC.

9-Pin DLC

All 2006 W-Series chassis will also be equipped with a 9-pin Diagnostic Link Connector (DLC). This DLC allows the technician to access the Allison Transmission Control Module (TCM) (when equipped) and/or the Electronic Control Unit (ECU) for the WABCO (when equipped) anti-lock brake system (ABS).

7 of the pins in the connector are used. The pin assignments are:

- Pin A – chassis ground via ground terminal 12
- Pin B – Battery voltage to DLC
- Pin C – J1939 Hi
- Pin D – J1939 Lo
- Pin E – J1939 Shield (ground)
- Pin F – J1587 Hi
- Pin G – J1587 Lo.

LIGHTING SYSTEMS DESCRIPTION

Headlamps

The headlamps will turn on when the headlamp switch is placed in the ON position. When the low beam headlamps are on, the headlamps can be switched to the high beams by pulling the headlamp dimmer switch toward the driver until it clicks. When the headlamp dimmer switch is again pulled until it clicks, the headlamps will then switch to the low beams from the high beams.

Daytime Running Lamps

The optional Daytime Running Lamps (DRL) illuminate the high beam headlamps at a reduced intensity. The DRL will operate when the ignition switch is in the RUN or START position and the gear selector lever is out of the PARK position. DRL is a programmable feature for vehicles sold in the United States. Turning on the headlamps will disable the DRL system.

Flash-To-Pass

When the headlamp dimmer switch is pulled toward driver, but does not click, the high beam headlamps will light for as long as the switch is held. This will occur in any headlamp state (off, DRL, low beams).

Park Lamps

The park lamps will turn on when the headlamp switch is placed in the PARK or ON position.

Turn Lamps

The turn lamps can only be activated with the ignition switch in RUN or START. When the turn signal switch is placed in a position to indicate a left turn or a right turn, the respective turn lamps will flash. The respective turn indicator will flash on the Instrument Panel Cluster (IPC).

Hazard Lamps

When the hazard switch is pressed, all turn lamps will flash. Both turn indicators will flash on the Instrument Panel Cluster (IPC).

Stoplamps

When the brake pedal is pressed, all stoplamps illuminate.

Backup Lamps

When the ignition switch is in RUN and the gear selector lever is in REVERSE, the backup lamps light. Instrument Cluster Dimming The instrument cluster lamps light when the park lamps are on. The brightness of the instrument cluster lamps is controlled by the instrument cluster dimmer switch located on the instrument panel.

WINDSHIELD WIPER/WASHER SYSTEM DESCRIPTION

Voltage is supplied to the wiper motor via the WIPER fuse when the ignition switch is in the ACC or RUN position. Different speeds and functions of the wiper motor are achieved by completing different ground paths through the wiper pulse control module. The windshield wiper relay feed coil is used to keep the wiper motor running. When the windshield wiper relay feed coil circuit is not grounded, the motor will not turn. Closing the various contacts in the wiper/washer switch will provide ground for this circuit and allow the motor to turn.

LOW or MIST Position

With the wiper/washer switch in the LOW or MIST position:

- Power is supplied to the Pulse Wiper Control Module via circuit 143 (YEL)
- Ground is provided to the Pulse Wiper Control Module via circuit 150 (BLK)
- Low signal is supplied by the Pulse Wiper Control Module to the body builder wiper system via circuit 97 (LT BLU)
- Coil feed signal is supplied by the Pulse Wiper Control Module to the body builder wiper system via circuit 91 (GRA)
- Multifunction switch signal is provided to the Pulse Wiper Control Module via circuit 112 (GRA)

HIGH Position

With the wiper/washer switch in the HIGH position:

- Power is supplied to the Pulse Wiper Control Module via circuit 143 (YEL)
- Ground is provided to the Pulse Wiper Control Module via circuit 150 (BLK)
- Low signal is supplied by the Pulse Wiper Control Module to the body builder wiper system via circuit 97 (LT BLU)
- Coil feed signal is supplied by the Pulse Wiper Control Module to the body builder wiper system via circuit 91 (GRA)
- Multifunction switch signal is provided to the Pulse Wiper Control Module via circuit 112 (GRA)
- High signal is supplied by the multifunction switch to the body builder wiper system via circuit 92 (PPL).

DELAY Operation

With the multifunction switch in one of the delay positions:

- Power is supplied to the Pulse Wiper Control Module via circuit 143 (YEL)
- Ground is provided to the Pulse Wiper Control Module via circuit 150 (BLK)
- Coil feed signal is supplied by the Pulse Wiper Control Module to the body builder wiper system via circuit 91 (GRA)
- Multifunction switch signal is provided to the Pulse Wiper Control Module via circuit 112 (GRA).

Washer Pump

When the contacts of the wash switch in the wiper washer switch close:

- Power is supplied to the Pulse Wiper Control Module via circuit 143 (YEL)
- Ground is provided to the Pulse Wiper Control Module via circuit 150 (BLK)
- Low signal is supplied by the Pulse Wiper Control Module to the body builder wiper system via circuit 97 (LT BLU)

- Coil feed signal is supplied by the Pulse Wiper Control Module to the body builder wiper system via circuit 91 (GRA)
- Multifunction switch signal is provided to the Pulse Wiper Control Module via circuit 112 (GRA)
- Output signal is supplied by the Pulse Wiper Control Module to the body builder wiper/washer system via circuit 94 (PNK).

HORNS DESCRIPTION

The HORN fuse applies voltage at all times to the horn relay. When the horn button is depressed, the contacts for the horn switch close to ground. The horn relay energizes and the contacts for the horn relay switch close. This supplies voltage directly to the right and left horns. Both horns are grounded through ground terminal 19.

CRUISE CONTROL SYSTEM DESCRIPTION

The cruise control system maintains the desired vehicle speed under normal driving conditions. The cruise control system has the following capabilities:

CRUISE

RESUME SPEED

ACCELERATE

COAST

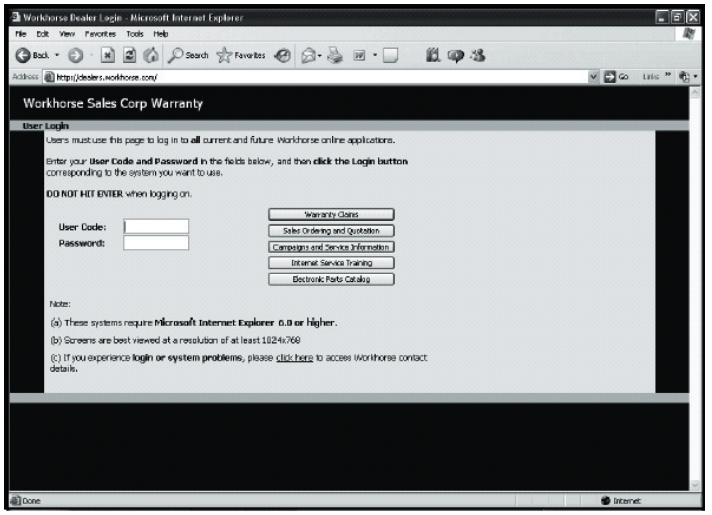
Depressing the SET and the R/A switches simultaneously will cancel the cruise control operation. Canceling the cruise control operation will not cancel the speed memory.

WIRING SYSTEMS DESCRIPTION

SCHEMATIC INFORMATION

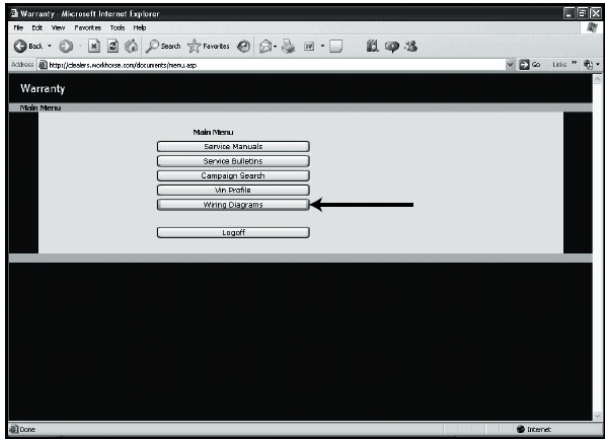
Where to Find Schematics

The electrical schematics for the 2006 W-Series are not included in the service manual itself. Instead, the schematics reside on the Workhorse Dealers website (www.dealers.workhorse.com).

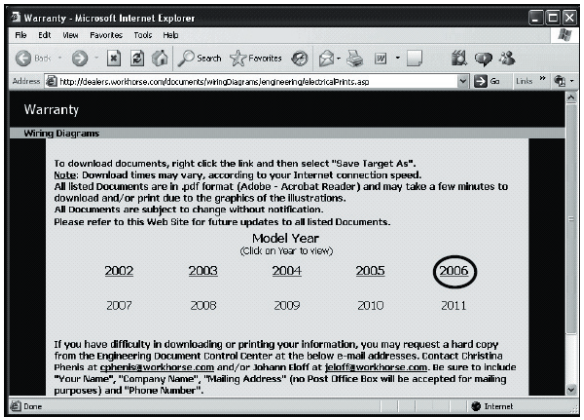


Using the dealer's user code and password, the technician can access the engineering drawings. Type the user code into the User Code field and the password into the Password field. DO NOT press the enter key. Use the mouse, and left click on the Campaigns and Service Information box in the center of the screen.

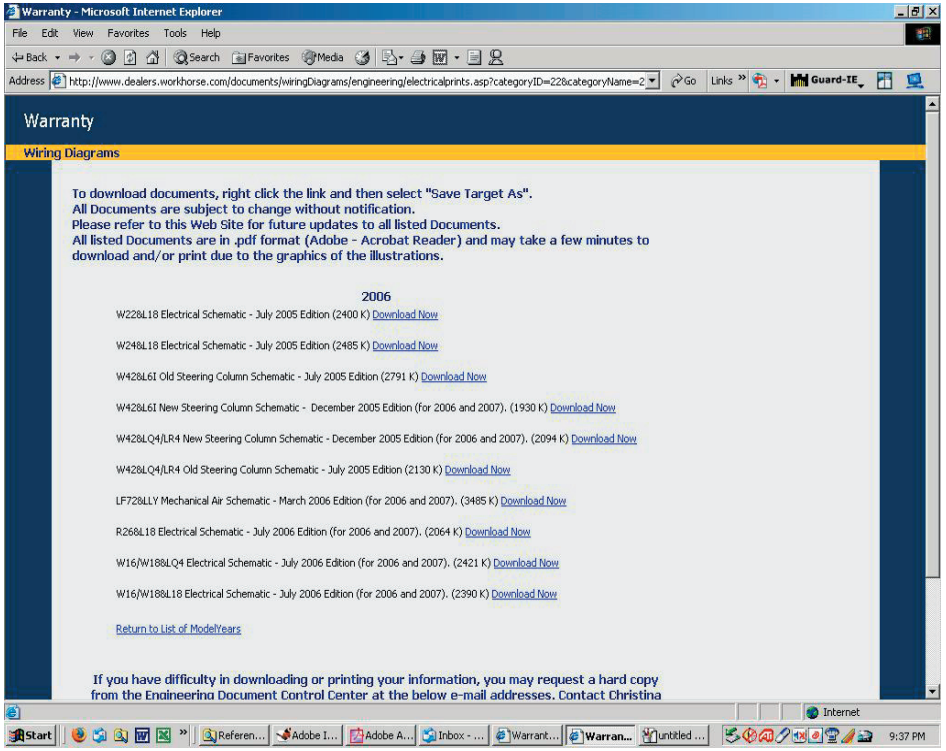
When the main menu screen appears, click on the Wiring Diagrams button.



After clicking on the Wiring Diagrams button, the technician will be presented with a screen showing with several model year links. Clicking on the 2006 link, will result in the page with the links for all of the electrical schematics for the 2006 MY being displayed.



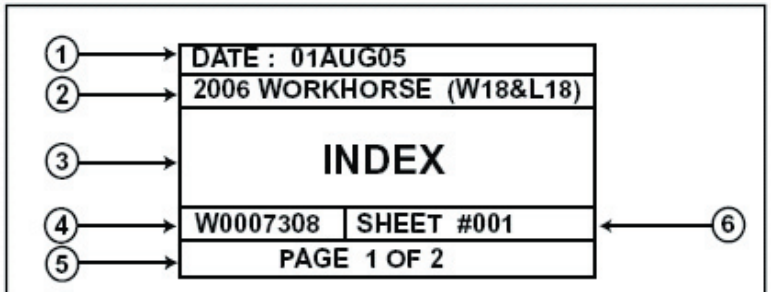
After selecting the 2006MY link, a page will be displayed that shows all of the drawings available for the 2006MY.



How to Use Schematics

In the lower right corner of each page of the wiring diagram is a box containing information on the page's contents.

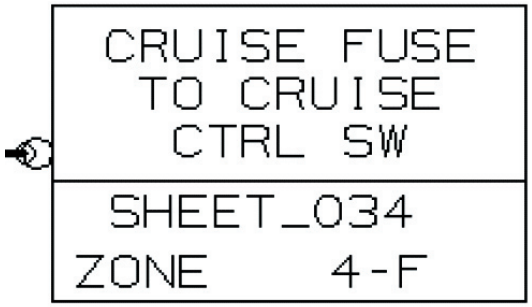
Note: As with other engineering documents a "sheet" contains information specific to a system or subsystem. Sheets may have more than one page.



1 - Drawing Date	4 - Drawing Number
2 - Model Year/Chassis/Engine	5 - Page Number
3 - Sheet Contents	6 - Sheet Number

Navigation Box

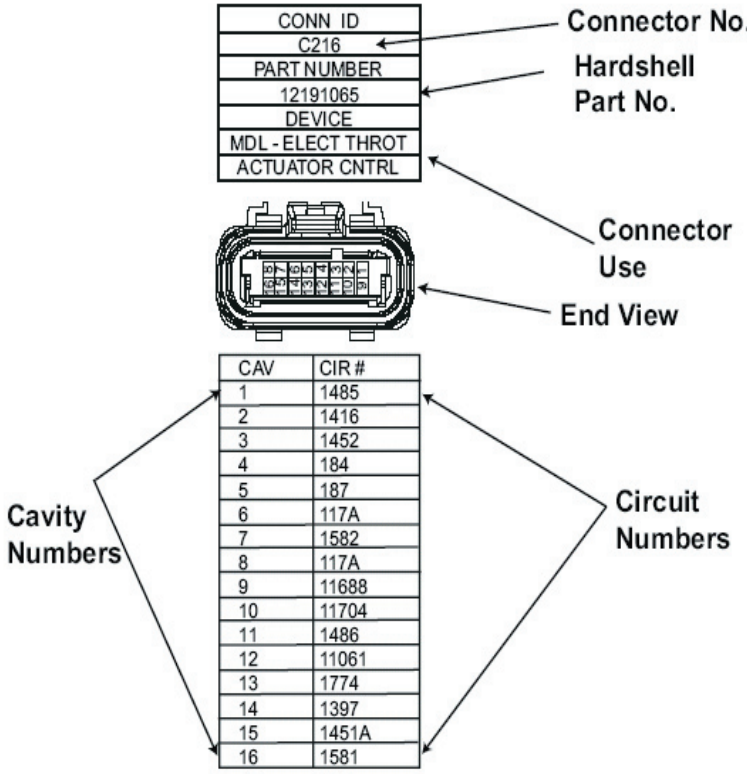
When a circuit continues elsewhere on the same page or on another page, a Navigation Box is shown to help you locate the continuation of the circuit.



The top portion of the box gives you the details of the circuit. Below the line, the point where the circuit continues is shown along with the grid locator. Use the grid locator in the same way that a road map is used to pinpoint the location.

Connector End Views

Connector End Views show the cavity or terminal locations for all the related connectors shown in the system schematics. The drawings show the connector face as seen after the harness connector has been disconnected from a component or mating connector. Unused cavities are left blank in the table.



CAV	CIR #
1	1485
2	1416
3	1452
4	184
5	187
6	117A
7	1582
8	117A
9	11688
10	11704
11	1486
12	11061
13	1774
14	1397
15	1451A
16	1581

CIRCUIT PROTECTION

Electrical circuits are protected from damage to overload by several means including:

- Fuses
- Circuit breakers
- Fusible links

Fuses

There are three basic types of fuses: glass or ceramic fuses, blade-type fuses, and bullet or cartridge fuses. Glass and ceramic fuses are found mostly on older vehicles and in many body builder accessories. Sometimes, however, you can find them in a special holder connected in series with a circuit. Glass fuses are small glass cylinders with metal caps. The metal strip connects the two caps. The rating of the fuse is normally marked on one of the caps.

Blade-type fuses are flat plastic units and are available in three different physical sizes: mini, standard, and maxi. The plastic housing is formed around two male blade-type connectors. A metal fuse strip connects these connectors inside the plastic housing. The amp rating of these fuses is on top of the color-coded plastic housing.

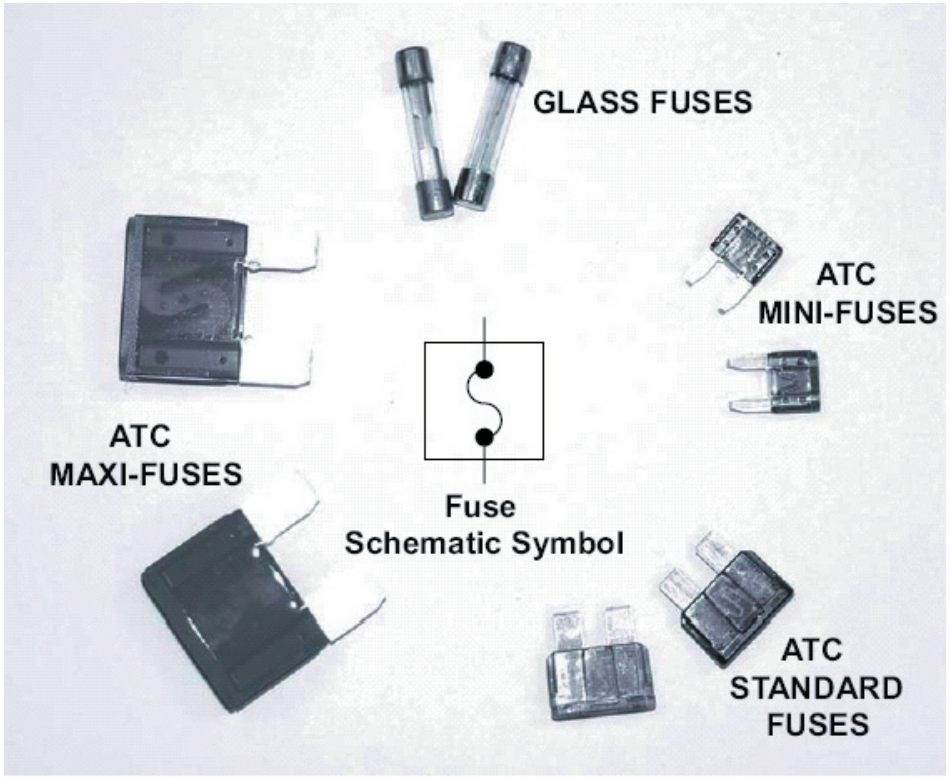
The color of the plastic coating will vary, based on the type of fuse and its amp rating.

Standard and Mini Fuse Color Designations

3 amp – Violet
5 amp – Tan
7.5 amp – Brown
10 amp – Red
15 amp – Blue
20 amp – Yellow
25 amp – Clear (colorless)
30 amp – Green

Maxi Fuse Color Designations

20 amp – Yellow
30 amp – Green
40 amp – Amber
50 amp – Red
60 amp – Blue
70 amp – Brown
80 amp – Clear (colorless)

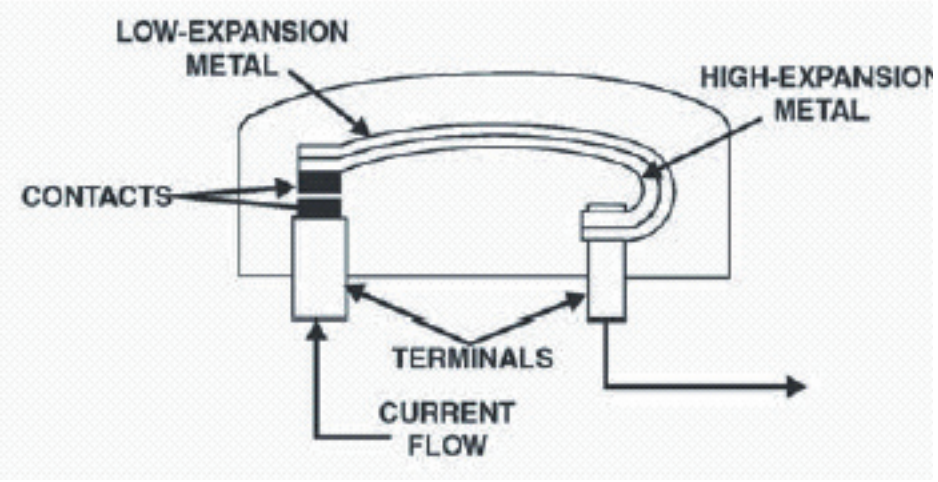


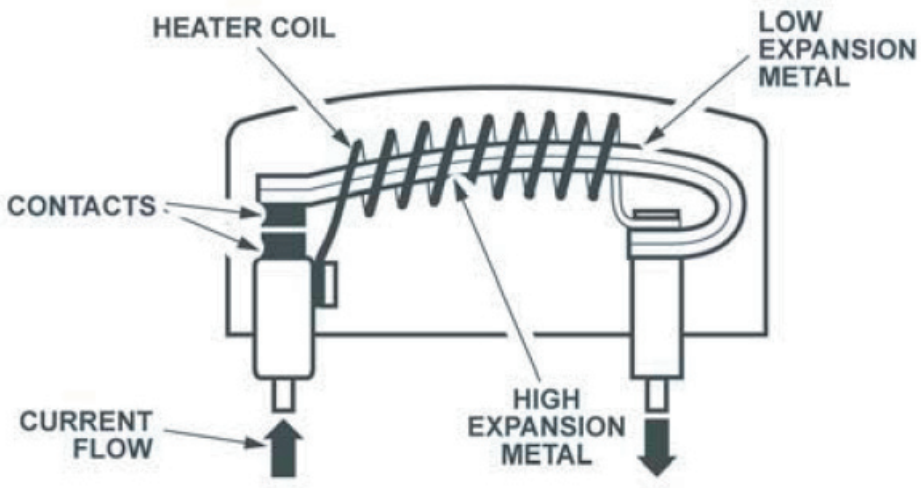
CAUTION:

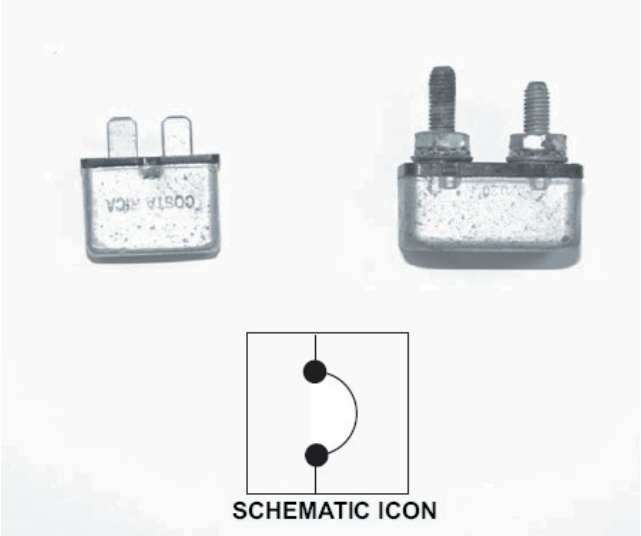
NEVER replace a fuse with one of a higher amperage rating. Serious wiring harness or component damage may occur.

Circuit Breakers

A circuit that is susceptible to an overload on a routine basis is usually protected by a circuit breaker. A circuit breaker uses a bimetallic strip that reacts to excessive current. A bimetallic strip consists of two different types of metals. One strip will react more quickly to heat than the other, causing the strip to flex in proportion to the amount of current flow. When an overload or circuit defect occurs that causes an excessive amount of current draw, the current flowing through the bimetallic strip causes it to heat. As the strip heats, it bends and opens the contacts. Once the contacts are opened current can no longer flow. With no current flowing, the strip cools and closes again. If the high-current cause is still in the circuit, the breaker will open again. The circuit breaker will continue to cycle open and closed as long as the overload is in the circuit. This type of circuit breaker is self-resetting or a “cycling” circuit breaker. Some circuit breakers require manually resetting by pressing a button while others must be removed from the power to reset.







Fusible Links

A vehicle may use one or several fusible links to provide protection for the main power wires. A fuse link is made of meltable material with a special resistant insulation. When there is an overload in the circuit, the link melts and opens the circuit. To properly test a fusible link, perform a voltage drop test.

NOTICE:
Measuring resistance of the fusible link may give erroneous results. Always perform a voltage drop test to confirm the condition of a fusible link.

Fusible links are usually located in the main wiring harness from the battery to the underhood fuse block. The current capacity fusible link is determined by its size. A fusible link is usually four wire sizes smaller (four numbers larger) than the circuit it protects.

Repairing a Fusible Link

CAUTION

If the size of the damaged fusible link is unknown, use a gauge size that is four sizes smaller that the circuit being protected. If the wrong size is used, serious vehicle damage could result.

NOTICE:
Fusible links longer than 9 inches (225 mm) may not provide sufficient overload protection.

WIRING REPAIRS

When repairing wires on the Workhorse chassis, the technician will need to follow the correct procedure to repair the wire, depending on the type of wire it is. Using the correct procedures will make wiring repair faster and easier. A few of the repairs required will be.

- Repairing damaged wire insulation
- Replacing seriously damaged wire segments
- Entire harness replacement
- Heated Oxygen Sensor (HO2S) wiring repairs.

Repairing Damaged Wire Insulation

If the conductive portion of the wire is not damaged, locate the problem, and apply tape around the wire, and repair the cause of the damage. If the wire damage is more extensive, replace the faulty segment of the wire.

Wiring Harness Replacement

If the damage to a section of the harness is extensive, replace the entire harness. When making a harness replacement, ensure that the original routing and attachments are maintained to protect the new harness from damage.

Heated Oxygen Sensor (HO2S) Wiring Repairs

If the wiring for the HO2S sensors becomes damaged, the wire cannot be repaired in the same fashion as other circuits on the chassis. Crimping, or kinking will interrupt the reference air supply to the sensor. Solder and heat shrink tubing sealant can contaminate the reference air supply to the sensor. If the wires on the pigtail for the sensor become damaged, replace the sensor. If the wiring in the harness becomes damaged, replace the entire wire (pin-to-pin). Make sure that when doing this, the correct size and color wire is used.

Diagnosis Using The Wiring Schematics

Proper diagnosis using a wiring schematic requires technique and discipline. Begin your diagnosis following instructions in the Workhorse Service Manual. If diagnosing a concern not covered in the Service Manual begin by determining if the suspect circuit or component is receiving power. If not, use the wiring diagram to locate the power source for the circuit.

Schematic Icons

All Workhorse schematics use similar symbols or icons to represent electrical and electronic components. A full list of the symbols can be found in the first few pages of the wiring diagrams.

Connector Reference Zone Numbers

To aid in your diagnosis and simplify the process of locating various connectors on the chassis, Sheet 009 in the wiring schematics provides a vehicle zoning graphic.

DIAGNOSTIC INFORMATION AND PROCEDURES

GENERAL ELECTRICAL DIAGNOSIS PROCEDURES

Basic Knowledge Required

Without a basic knowledge of electricity, it will be difficult to use the diagnostic procedures contained in this section. Every technician should understand the basic theory of electricity and know the meaning of voltage (volts), current (amps) and resistance (ohms). The technician should understand what happens in a circuit with an open or a shorted wire. The ability to read and understand the wiring diagrams is critical.

It is important to understand the fundamental behavior of electricity before attempting to troubleshoot an electric or electronic problem. There is no mystery to electricity, and how it behaves under any given circumstance is entirely predictable.

Electromotive Force

To flow current through a circuit requires an action which organizes all of the randomly drifting electrons and pushes them in one direction. This action is known as electromotive force (EMF), or voltage. Voltage can be measured as the potential difference that exists between two points in a circuit, such as the two terminals of a battery. One of these points must have a negative charge, and the other must have a positive charge. The strength of the force depends upon the strength of the charges at each point.

Voltage

Voltage is a force that is applied to a circuit and can exist even when there is no current flowing. In automotive applications, voltage is supplied by the battery and the generator.

Chemical reaction creates a difference in electromotive force between the positive and negative terminals of a battery, while mechanical energy is converted to electrical energy in a generator to keep the battery charged. A voltmeter is used to measure voltage and results are recorded in units called volts. The actual value of a volt is the amount of energy required to move one amp from the point of lower potential to the point of higher potential. In practical terms, one volt is the amount of force required to move one ampere of current through one ohm of resistance.

Resistance

Voltage forces current through a conductor, but all conductive materials oppose current flow to some extent. This opposition, known as resistance, exists in some degree in all electrical devices. If you know how much resistance a circuit should have, you can quickly determine the overall condition of the circuit by measuring its resistance. There are five factors, or characteristics, that determine how much resistance is present in an electrical circuit. These are:

1. The atomic structure of the material. All conductors have some resistance, but the low resistance in a good conductor will flow current when a fraction of a volt is induced.
2. The length of the conductor. The longer a piece of wire or cable, the higher its resistance.
3. The cross-sectional area of the conductor. The thinner a piece of wire or cable, the higher its resistance.
4. The temperature of the conductor. In most cases, the higher the temperature of the conducting material, the higher its resistance. However, some sensors are designed to operate exactly the opposite.
5. The condition of the conductor. Broken strands of a cable or a partially cut wire reduces the cross-sectional area of the conductor and raises resistance. Loose, dirty, or corroded connections have the same effect and are a major cause of electrical problems.

Ohms

An ohm is the unit established to measure electrical resistance. One ohm is equal to the amount of resistance present when one volt of electromotive force pushes one ampere of current through a circuit. The resistance of any electrical device or circuit can be measured two ways:

- Directly with an ohmmeter measuring the resistance offered by the device or circuit in ohms.
- Indirectly with a voltmeter, measuring the voltage drop across the device or circuit.

Since every electrical device, or load, in a circuit offers some resistance, voltage is reduced as it pushes current through each load. Voltage drop testing was detailed earlier in this chapter.

Tips for Using an Ohmmeter

An ohmmeter is a self-powered test instrument that can only be used when there is no voltage applied to the circuit device being tested. Any current flow from an outside source will damage the meter. Before testing with an ohmmeter, make sure the circuit is not under power, or remove the component to be tested from the circuit.

Ohmmeters, whether analog or digital, operate on the voltage drop principle. When you connect the leads of an ohmmeter to a device for testing, the meter directs a low-voltage current from its power source through the device. Since the source voltage and the internal resistance of the meter are known, the resistance of the test device can be determined by the amount of voltage dropped as current flows through it. The ohmmeter makes this calculation and directly displays the resistance of the test device in ohms.

Be aware, ohmmeter testing may not always be conclusive. Resistance faults in wiring and connections often generate heat, which further increases the resistance of an operating circuit.

In these cases, the fault may not be apparent unless the circuit is under power. The device may be able to relay

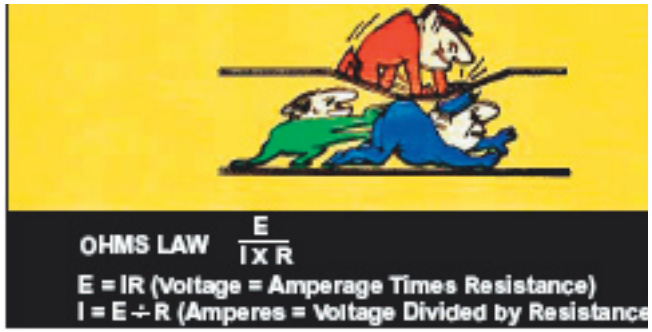
the low-voltage signal of an ohmmeter, but not be able to carry the signal when system voltage is applied to it. Another consideration is the fact that most ohmmeters will only read as low as 0.1 ohm, yet smaller amounts of resistance can cause problems, especially on electronic circuits. These low-resistance faults can only be determined through voltage drop testing. However, an ohmmeter has definite advantages for many test situations and is particularly useful to:

- Measure the resistance of parts that have specific resistance values that fall within the usable range of the meter.
- Measure high-resistance items, such as secondary ignition cables and electronic pickup coils.
- Test internal parts of components that require disassembly to reach the test points.
- Bench test parts such as switches, circuit breakers, and relays before assembly or installation.
- Check circuit continuity of components.

Ohm's Law

The relationship between current flow, electromotive force (voltage), and resistance is predictable for any electrical, or electronic, circuit or device. This relationship was first stated as a theory by George Ohm in 1827 and has since become known as Ohm's Law. Ohm determined that there are three characteristics at work in an electrical device: voltage, amperage, and resistance. If you know two of them you can always calculate the third, since the relationship of these three never changes.

According to Ohm's Law, when a force of one volt pushes one ampere of current through a circuit, the resistance present is 1 ohm. This establishes and gives a value to the ohm, the unit with which resistance is measured. Now, you can use one of three simple mathematical equations to calculate the missing factor:



Although it may never be necessary to use one of these equations to figure out the missing characteristic, it is important to understand the logic behind them.

Suppose you are dealing with a fused circuit operating on system voltage that keeps blowing the fuse after a short period of time. A quick check tells you 12 volts are available on either end of the circuit, and you know the fuse is rated at 10 amps. Therefore, Ohm's Law tells you there is low resistance in the circuit because amperage is equal to voltage divided by resistance. So, if voltage is constant, a drop in resistance is the only condition that will allow enough current to flow through the circuit to overload the fuse.

Very few, if any, automotive problems will require Ohm's Law equations to repair them. However, it will be much easier to locate faults in electric and electronic circuitry once the relationships of current, voltage, and resistance expressed in Ohm's Law are understood.

In an automotive electrical system, DC voltage originates at the battery, and the open-circuit, or no-load, voltage of a good battery will be about 12.6 volts. With the engine running, a typical charging system regulates output between 13.5 and 14 volts. This is the source, or system, voltage that provides power to all of the circuits on the vehicle. Therefore, voltage should remain fairly stable, unless there is an unexpected change in resistance. Low voltage in a vehicle electrical system is often the result of either a charging system problem or a bad battery. If resistance is unchanged, a drop in system voltage results in less current flow, and a rise in system voltage will increase amperage, or current flow, as well. Ohm's Law says:

- Voltage and amperage are directly proportional to each other as long as resistance remains the same. Both must move in the same direction.

Resistance in an electrical circuit should only be that of the load devices specified by the engineer. This includes all switches, relays, motors, solenoids, lamps, and other parts that create resistance to perform usable work. The resistance of all the loads determines the circuit amperage. Remember, system voltage should remain stable and within its designed range unless there is a battery or charging system problem. Therefore, the circuit with the greatest total resistive load will flow the least amount of current, and the circuit with the least resistance will allow the greatest amperage flow. According to Ohm's Law:

- Amperage and resistance are inversely proportional to each other as long as voltage remains the same. They move in opposite directions.

Under normal circumstances, you will not see a situation where amperage is held constant while voltage and resistance change. Amperage is the strength of the electrical charge moving through a conductor, and it responds to changes in voltage or resistance. Although high amperage is the cause of many blown fuses, it is most often the effect of low circuit resistance rather than the cause of the problem.

Understanding the inverse relationship of amperage to resistance at a steady voltage is an important diagnostic aid. Any circuit damage, whether an open or short, poor or corroded connection, frayed wire, broken insulation, or a defective component, will change the designed resistance of the circuit. When the battery and charging system are in good condition, a change in resistance will increase or decrease amperage in the circuit. Excessive amperage will cause blown fuses, while reduced amperage can cause slow motor operation, dim bulbs, sluggish solenoid or relay response, and less than peak performance from other circuit devices.

Electrical Current

Electricity is a form of energy that results when electrons, which are negatively charged atomic particles, transfer from one atom to another. Electron transfer occurs most readily in materials known as conductors and can be activated by an external force, such as heat, friction, or a magnetic field. Electrons tend to move at random but can be organized and directed. Electric current is the controlled flow of electrons from atom to atom within a conductor.

To control the flow of electrical power a path must be provided for the current to follow. These pathways, or circuits, route the electrical charge to various points where it is used to perform work. For a circuit to function, it must form a complete loop so that electron transfer remains uninterrupted. Automotive circuitry begins at one battery terminal, travels through the wiring harnesses, and returns to the other battery terminal. If there is a break, or open, in the circuit, current cannot flow since the electrons have nowhere to go, and no work can be performed.

Amperage

The amount of current flowing through a circuit, conductor, or electrical device is rated in amperage or amps. Amperage is determined by counting the number of electrons that move past a certain point in the circuit in a given amount of time. The ampere is the unit of measure for current flow.

Ammeter

An ammeter is a gauge that is used to measure the current flow in a circuit. Typical ammeters are connected in series with the circuit or component to be tested. The meter bridges the gap in an open circuit so that all the current flows through the meter. The second type of ammeter uses an inductive pickup clamp around the circuit being tested. The meter reads the strength of the electromagnetic field created by the current passing through the inductive clamp. Digital ammeters have high input impedance that results in an extremely low amount of current being drawn off the circuit when connected in series. Since all ammeters have low resistance, they will act as a jumper wire to short a circuit if connected in parallel.

An ammeter function is typically included in most DMMs.

THE DIAGNOSTIC PROCESS

The following six-step troubleshooting procedure is recommended:

1. Verify the customer concern
2. Identify the symptoms
3. Analyze the symptoms
4. Isolate the concern
5. Repair the concern
6. Verify the repair

Step 1: Verify The Customer Concern – Verifying the customer concern is the first step in the six-step diagnostic process. This step actually begins with the Service Writer/Advisor. The Service Writer/Advisor must obtain as much information as possible from the customer. It is important to know if the condition is constant or varies with road speed, is weather or temperature dependent (happens when cold or when raining, etc.), or only occurs when certain equipment is being used such as the air conditioning or radio with power booster.

As a technician, the first thing that must be done to accurately interpret the information. This may require talking to the customer and Service Writer/Advisor. Always duplicate the concern before attempting to correct it. Understanding and duplicating the symptom is important. It may be necessary to have the customer help duplicate the concern. Nothing is more frustrating than correcting a concern in the rear of the vehicle, only to learn that the customer was concerned about a light in the vehicle's instrument cluster.

Step 2: Identify The Symptoms – The next step in the six-step diagnostic process is to determine if there are any related symptoms. The goal of this step is to gather information and associate the concern with a specific component group.

Once the primary symptom is identified, check to see if there are other customer concerns which may be related. For example, if the primary concern is a turn signal not working, but the customer also states the brake lamps are inoperative, there is a good possibility that the concerns are linked. Check the vehicle's service history to determine if any other repairs were performed for similar symptoms. Review any Technical Service Bulletins (TSBs) to determine if any relate to the symptoms described by the customer. Perform a thorough visual inspection, including checking for non-factory installed accessories that may be causing the concern. Road testing a vehicle also may be necessary. Before road testing, though, it is important to complete the visual inspection.

Step 3: Analyze The Symptoms – The next step in the six-step process is to analyze the symptoms. The goal of this step is to justify the customer's claim and to classify the symptoms.

Confirming the vehicle has a concern is important. Attempting to repair a normal condition can convince the customer that a true problem exists when it doesn't. Knowing correct system operation helps to satisfy the customer when the condition is normal.

Step 4: Isolate The Concern – The next step in the six-step diagnostic process is to isolate the concern. The goal of this step is to use the results of the road and in-shop tests to help identify the actual cause and location of the customer concern.

Isolating components from each other to determine which component is the cause of a vehicle concern is the basis of most diagnostic tests. Isolation may be as simple as listening to a suspect component with a

mechanic's stethoscope, or it may require running the vehicle with the suspect component removed.

Use the Diagnosis Charts in the Service Manual to develop an action plan to determine which checks to make. Document any additional problems with the customer's vehicle. Pay particular attention to other concerns and problems that can cause an unsafe condition.

Step 5: Repair The Concern – The fifth step in the six-step diagnostic approach is to make the necessary adjustments and repairs to correct the concern. The Service Manual may help when performing these operations.

Always look for the cause of component damage. If the component that is causing the symptom is replaced, but no steps are taken to determine what caused that component to fail, the failure is likely to reoccur. For example, a customer's turn signal is inoperative. After performing the required tests, it is determined that the fuse is blown. Further steps determine that an intermittently shorted wire caused the fuse to blow. If no steps had been taken to find the cause of the failure, a new fuse may have blown again in a short amount of time.

Step 6: Verify The Repair – The last step in the six-step diagnostic approach is to verify the vehicle operates properly. Eliminating or isolating the concern is the optimal goal. If the customer must tolerate the concern, thoroughly explain to the customer why the condition exists. It is possible that fixing one concern may reveal another. Take the time to road test and verify no further problems exist. Studies show almost one out of three service visits requires a return visit to fully correct the problem.

GENERAL ELECTRICAL DIAGNOSIS

Troubleshooting with a Digital Multimeter (DMM)

NOTICE:
Do not insert test equipment probes (DMM etc.) into any connector or fuse block terminal. The diameter of the test probes will deform most terminals. A deformed terminal will cause a poor connection, which will result in a system failure. Always use the J-35616 GM-Approved Terminal Test Kit in order to front probe terminals. Do not use paper clips or other substitutes to probe terminals.

When using the J-35616 GM-Approved Terminal Test Kit, ensure the terminal test adapter choice is the correct size for the connector terminal. Do not visually choose the terminal test adapter because some connector terminal cavities may appear larger than the actual terminal in the cavity. Using a larger terminal test adapter will damage the terminal. Refer to the J-35616 GM-Approved Terminal Test Kit label on the inside of the J-35616 GM-Approved Terminal Test Kit for the correct adapter along with the connector end view for terminal size.

IMPORTANT:

Circuits which include any solid state control modules, such as the powertrain control module (PCM), should only be tested with a 10 megohm or higher impedance digital multimeter such as the Digital Multimeter (DMM).

The DMM instruction manual is a good source of information and should be read thoroughly upon receipt of the DMM as well as kept on hand for future reference.

A DMM should be used instead of a test lamp in order to test for voltage in high impedance circuits. While a test lamp shows whether voltage is present if the impedance is low enough, a DMM indicates how much voltage is present. In other words, if there is not enough current, the test lamp will not illuminate even though voltage is present.

The ohmmeter function on a DMM shows how much resistance exists between 2 points along a circuit. Low resistance in a circuit means good continuity.

IMPORTANT:

Disconnect the power feed from the suspect circuit when measuring resistance with a DMM. This prevents incorrect readings. DMMs apply such a small voltage to measure resistance that the presence of voltages can upset a resistance reading.

Diodes and solid state components in a circuit can cause a DMM to display a false reading. To find out if a component is affecting a measurement take a reading once, then reverse the leads and take a second reading. If the readings differ the solid state component is affecting the measurement.

Following are examples of the various methods of connecting the DMM to the circuit to be tested:

- Backprobe both ends of the connector and either hold the leads in place while manipulating the

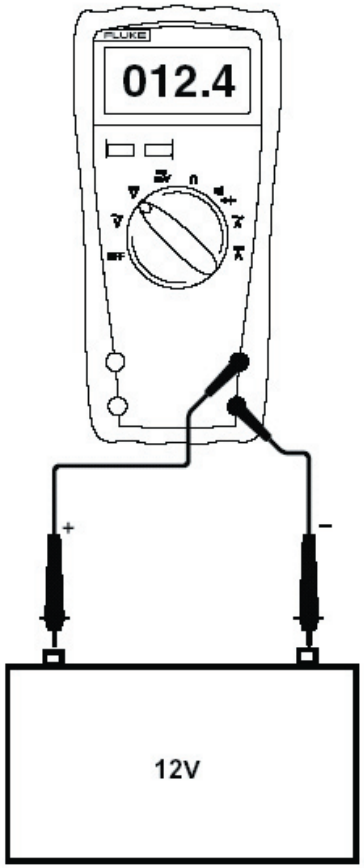
connector or tape the leads to the harness for continuous monitoring while you perform other operations or test driving. Refer to Probing Electrical Connectors.

- Disconnect the harness at both ends of the suspected circuit where it connects either to a component or to other harnesses.
- If the system that is being diagnosed has a specified pinout or breakout box, it may be used in order to simplify connecting the DMM to the circuit or for testing multiple circuits quickly.

Measuring Voltage

NOTICE:
Do not insert test equipment probes (DMM etc.) into any connector or fuse block terminal. The diameter of the test probes will deform most terminals. A deformed terminal will cause a poor connection, which will result in a system failure. Always use the J-35616 GM-Approved Terminal Test Kit in order to front probe terminals. Do not use paper clips or other substitutes to probe terminals.

When using the J-35616 GM-Approved Terminal Test Kit, ensure the terminal test adapter choice is the correct size for the connector terminal. Do not visually choose the terminal test adapter because some connector terminal cavities may appear larger than the actual terminal in the cavity. Using a larger terminal test adapter will damage the terminal. Refer to the J-35616 GM-Approved Terminal Test Kit label on the inside of the J-35616 GM-Approved Terminal Test Kit for the correct adapter along with the connector end view for terminal size.



The following procedure measures the voltage at a selected point in a circuit.

1. Disconnect the electrical harness connector for the circuit being tested, if necessary.
2. Enable the circuit and/or system being tested. Use the following methods:
   - Turn ON the ignition, with the engine OFF.
   - Turn ON the engine.

- Turn ON the circuit and/or system with a scan tool in Output Controls.
- Turn ON the switch for the circuit and/or system being tested.

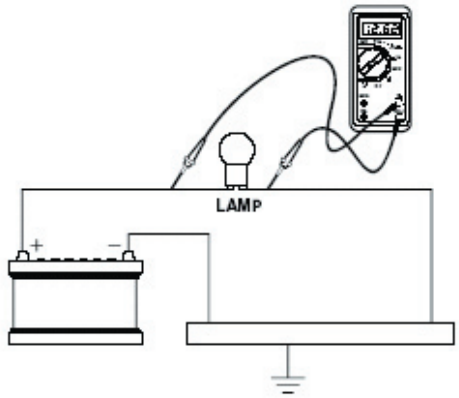
3. Select the V (AC) or V (DC) position on the DMM.
4. Connect the positive lead of the DMM to the point of the circuit to be tested.
5. Connect the negative lead of the DMM to a good ground.
6. The DMM displays the voltage measured at that point.

Measuring Voltage Drop

NOTICE:
Do not insert test equipment probes (DMM etc.) into any connector or fuse block terminal. The diameter of the test probes will deform most terminals. A deformed terminal will cause a poor connection, which will result in a system failure. Always use the J-35616 GM-Approved Terminal Test Kit in order to front probe terminals. Do not use paper clips or other substitutes to probe terminals.

NOTICE:
When using the J-35616 GM-Approved Terminal Test Kit, ensure the terminal test adapter choice is the correct size for the connector terminal. Do not visually choose the terminal test adapter because some connector terminal cavities may appear larger than the actual terminal in the cavity. Using a larger terminal test adapter will damage the terminal. Refer to the J-35616 GM-Approved Terminal Test Kit label on the inside of the J-35616 GM-Approved Terminal Test Kit for the correct adapter along with the connector end view for terminal size.

The following procedure determines the difference in voltage potential between 2 points.



1. Set the rotary dial of the DMM to the V (DC) position.
2. Connect the positive lead of the DMM to one point of the circuit to be tested.
3. Connect the negative lead of the DMM to the other point of the circuit.
4. Operate the circuit.
5. The DMM displays the difference in voltage between the 2 points.

Measuring Frequency

NOTICE:
Do not insert test equipment probes (DMM etc.) into any connector or fuse block terminal. The diameter of the test probes will deform most terminals. A deformed terminal will cause a poor connection, which will result in a system failure. Always use the J-35616 GM-Approved Terminal Test Kit in order to front probe terminals. Do not use paper clips or other substitutes to probe terminals.

When using the J-35616 GM-Approved Terminal Test Kit, ensure the terminal test adapter choice is the correct size for the connector terminal. Do not visually choose the terminal test adapter because some connector terminal cavities may appear larger than the actual terminal in the cavity. Using a larger terminal test adapter will damage the terminal. Refer to the J-35616 GM-Approved Terminal Test Kit label on the inside of the J-35616 GM-Approved Terminal Test Kit for the correct adapter along with the connector end view for terminal size.

The following procedure determines the frequency of a signal.

IMPORTANT:

Connecting the DMM to the circuit before pressing the Hz button will allow the DMM to autorange to an appropriate range.

1. Apply power to the circuit.
2. Set the rotary dial of the DMM to the V (AC) position.
3. Connect the positive lead of the DMM to the circuit to be tested.
4. Connect the negative lead of the DMM to a good ground.
5. Press the Hz button on the DMM.
6. The DMM will display the frequency measured.

Testing for Continuity

NOTICE:

Do not insert test equipment probes (DMM etc.) into any connector or fuse block terminal. The diameter of the test probes will deform most terminals. A deformed terminal will cause a poor connection, which will result in a system failure. Always use the J-35616 GM-Approved Terminal Test Kit in order to front probe terminals. Do not use paper clips or other substitutes to probe terminals.

When using the J-35616 GM-Approved Terminal Test Kit, ensure the terminal test adapter choice is the correct size for the connector terminal. Do not visually choose the terminal test adapter because some connector terminal cavities may appear larger than the actual terminal in the cavity. Using a larger terminal test adapter will damage the terminal. Refer to the J-35616 GM-Approved Terminal Test Kit label on the inside of the J-35616 GM-Approved Terminal Test Kit for the correct adapter along with the connector end view for terminal size.

The following procedures verify good continuity in a circuit.

With a DMM

1. Set the rotary dial of the DMM to the ohm position.
2. Disconnect the power feed (i.e. fuse, control module) from the suspect circuit.
3. Disconnect the load.
4. Press the MIN MAX button on the DMM.
5. Connect one lead of the DMM to one end of the circuit to be tested.
6. Connect the other lead of the DMM to the other end of the circuit.

7. If the DMM displays low or no resistance and a tone is heard, the circuit has good continuity.

With a Test Lamp

IMPORTANT:

Only use the test lamp procedure on low impedance power and ground circuits.

1. Remove the power feed (i.e. fuse, control module) from the suspect circuit.
2. Disconnect the load.
3. Connect one lead of the test lamp to one end of the circuit to be tested.
4. Connect the other lead of the test lamp to battery positive voltage.
5. Connect the other end of the circuit to ground.
6. If the test lamp illuminates (full intensity), then the circuit has good continuity.

Testing for Short to Ground

NOTICE:

Do not insert test equipment probes (DMM etc.) into any connector or fuse block terminal. The diameter of the test probes will deform most terminals. A deformed terminal will cause a poor connection, which will result in a system failure. Always use the J-35616 GM-Approved Terminal Test Kit in order to front probe terminals. Do not use paper clips or other substitutes to probe terminals.

When using the J-35616 GM-Approved Terminal Test Kit, ensure the terminal test adapter choice is the correct size for the connector terminal. Do not visually choose the terminal test adapter because some connector terminal cavities may appear larger than the actual terminal in the cavity. Using a larger terminal test adapter will damage the terminal. Refer to the J-35616 GM-Approved Terminal Test Kit label on the inside of the J-35616 GM-Approved Terminal Test Kit for the correct adapter along with the connector end view for terminal size.

The following procedures test for a short to ground in a circuit.

With a DMM

1. Remove the power feed (i.e. fuse, control module) from the suspect circuit.
2. Disconnect the load.
3. Set the rotary dial of the DMM to the ohm position.
4. Connect one lead of the DMM to one end of the circuit to be tested.
5. Connect the other lead of the DMM to a good ground.
6. If the DMM does NOT display infinite resistance (OL), there is a short to ground in the circuit.

With a Test Lamp

1. Remove the power feed (i.e. fuse, control module) from the suspect circuit.
2. Disconnect the load.
3. Connect one lead of the test lamp to battery positive voltage.
4. Connect the other lead of the test lamp to one end of the circuit to be tested.

5. If the test lamp illuminates, there is a short to ground in the circuit.

Fuse Powering Several Loads

1. Review the system schematic and locate the fuse that is open.
2. Open the first connector or switch leading from the fuse to each load.
3. Connect a DMM across the fuse terminals (be sure that the fuse is powered).
   - When the DMM displays voltage the short is in the wiring leading to the first connector or switch.
   - If the DMM does not display voltage refer to the next step.
4. Close each connector or switch until the DMM displays voltage in order to find which circuit is shorted.

Testing for a Short to Voltage

NOTICE:
Do not insert test equipment probes (DMM etc.) into any connector or fuse block terminal. The diameter of the test probes will deform most terminals. A deformed terminal will cause a poor connection, which will result in a system failure. Always use the J-35616 GM-Approved Terminal Test Kit in order to front probe terminals. Do not use paper clips or other substitutes to probe terminals.

When using the J-35616 GM-Approved Terminal Test Kit, ensure the terminal test adapter choice is the correct size for the connector terminal. Do not visually choose the terminal test adapter because some connector terminal cavities may appear larger than the actual terminal in the cavity. Using a larger terminal test adapter will damage the terminal. Refer to the J-35616 GM-Approved Terminal Test Kit label on the inside of the J-35616 GM-Approved Terminal Test Kit for the correct adapter along with the connector end view for terminal size.

The following procedure tests for a short to voltage in a circuit.

1. Set the rotary dial of the DMM to the V (DC) position.
2. Connect the positive lead of the DMM to one end of the circuit to be tested.
3. Connect the negative lead of the DMM to a good ground.
4. Turn ON the ignition and operate all accessories.
5. If the voltage measured is greater than 1 volt, there is a short to voltage in the circuit.

Troubleshooting with a Short Finder

The J 8681-A can locate hidden shorts to ground. The short finder creates a pulsing magnetic field in the shorted circuit and shows the location of the short through the body trim or sheet metal.

Troubleshooting with a Test Lamp

NOTICE:
Do not insert test equipment probes into any connector or fuse block terminal. The diameter of the test probes will deform most terminals. A deformed terminal can cause a poor connection, which can result in system failures. Always use the J 35616-A. Connector Test Adapter Kit or the J 42675 Flat. Wire Probe Adapter Kit in order to frontprobe terminals. Do not use paper clips or other substitutes as they can damage terminals and cause incorrect measurements.

A test lamp can simply and quickly test a low impedance circuit for voltage.

The J 34142-8 Test Lamp is Micro-Pack compatible and comprised of a 12 volt light bulb with an attached pair of leads.

To properly operate this tool, use the following procedure.

1. Attach one lead to ground.
2. Touch the other lead to various points along the circuit where voltage should be present.
3. When the bulb illuminates, there is voltage at the point being tested.

Probing Electrical Connectors

IMPORTANT:

Always be sure to reinstall the Connector Position Assurance (CPA) and Terminal Position Assurance (TPA) when reconnecting connectors or replacing terminals.

Frontprobe

Disconnect the connector and probe the terminals from the mating side (front) of the connector.

NOTICE:
Do not insert test equipment probes into any connector or fuse block terminal. The diameter of the test probes will deform most terminals. A deformed terminal can cause a poor connection, which can result in system failures. Always use the J 35616-A Connector Test Adapter Kit or the J 42675 Flat Wire Probe Adapter Kit in order to frontprobe terminals. Do not use paper clips or other substitutes as they can damage terminals and cause incorrect measurements.

Backprobe

Do not disconnect the connector and probe the terminals from the harness side (back) of the connector.

IMPORTANT:

- Backprobe connector terminals only when specifically required in diagnostic procedures.
- Do not backprobe a sealed (Weather Pack®) connector, less than a 280 series Metri-Pack connector, a Micro-Pack connector, or a flat wire (dock and lock) connector.
- Backprobing can be a source of damage to connector terminals. Use care in order to avoid deforming the terminal, either by forcing the test probe too far into the cavity or by using too large of a test probe.

- After backprobing any connector, inspect for terminal damage. If terminal damage is suspected, test for proper terminal contact.

Using Connector Test Adapters

NOTICE:
Do not insert test equipment probes into any connector or fuse block terminal. The diameter of the test probes will deform most terminals. A deformed terminal can cause a poor connection, which can result in system failures. Always use the J 35616-A. Connector Test Adapter Kit or the J 42675 Flat. Wire Probe Adapter Kit in order to frontprobe terminals. Do not use paper clips or other substitutes as they can damage terminals and cause incorrect measurements.

Using Fused Jumper Wires

IMPORTANT:

A fused jumper may not protect solid state components from being damaged.

The J 36169-A fused jumper includes small clamp connectors that provide adaptation to most connectors without damage. This fused jumper wire is supplied with a 20 A fuse which may not be suitable for some circuits. Do not use a fuse with a higher rating than the fuse that protects the circuit being tested.

Measuring Voltage

NOTICE:
Do not insert test equipment probes into any connector or fuse block terminal. The diameter of the test probes will deform most terminals. A deformed terminal can cause a poor connection, which can result in system failures. Always use the J 35616-A Connector Test Adapter Kit or the J 42675 Flat Wire Probe Adapter Kit in order to frontprobe terminals. Do not use paper clips or other substitutes as they can damage terminals and cause incorrect measurements.

The following procedure measures the voltage at a selected point in a circuit.

1. Apply power to the circuit.
2. Set the rotary dial of the DMM into the V (AC) or V (DC) position.
3. Connect the positive lead of the DMM to the point of the circuit to be tested.
4. Connect the negative lead of the DMM to a good ground.
5. Operate the circuit.
6. The DMM displays the voltage measured at that point.

Measuring Voltage Drop

NOTICE:
Do not insert test equipment probes into any connector or fuse block terminal. The diameter of the test probes will deform most terminals. A deformed terminal can cause a poor connection, which can result in system failures. Always use the J 35616-A. Connector Test Adapter Kit or the J 42675 Flat. Wire Probe Adapter Kit in order to frontprobe terminals. Do not use paper clips or other substitutes as they can damage terminals and cause incorrect measurements.

The following procedure determines the difference in voltage potential between two points.

1. Set the rotary dial of the DMM to the V (DC) position.
2. Connect the positive lead of the DMM to one point of the circuit to be tested.
3. Connect the negative lead of the DMM to the other point of the circuit.
4. Operate the circuit.
5. The DMM displays the difference in voltage between the two points.

Testing for Continuity

The following procedures verify good continuity in a circuit.

With a DMM

NOTICE:
Do not insert test equipment probes into any connector or fuse block terminal. The diameter of the test probes will deform most terminals. A deformed terminal can cause a poor connection, which can result in system failures. Always use the J 35616-A Connector Test Adapter Kit or the J 42675 Flat Wire Probe Adapter Kit in order to frontprobe terminals. Do not use paper clips or other substitutes as they can damage terminals and cause incorrect measurements.

1. Set the rotary dial of the DMM to the R position.
2. Disconnect the power feed (i.e. fuse, control module) from the suspect circuit.
3. Disconnect the load.
4. Press the MIN MAX button on the DMM.
5. Connect one lead of the DMM to one end of the circuit to be tested.
6. Connect the other lead of the DMM to the other end of the circuit.
7. If the DMM displays low or no resistance and a tone is heard, the circuit has good continuity.

With a Test Lamp

NOTICE:
Do not insert test equipment probes into any connector or fuse block terminal. The diameter of the test probes will deform most terminals. A deformed terminal can cause a poor connection, which can result in system failures. Always use the J 35616-A. Connector Test Adapter Kit or the J 42675 Flat. Wire Probe Adapter Kit in order to frontprobe terminals. Do not use paper clips or other substitutes as they can damage terminals and cause incorrect measurements.

IMPORTANT:

Only use the test lamp procedure on low impedance power and ground circuits.

1. Remove the power feed (i.e. fuse, control module) from the suspect circuit.
2. Disconnect the load.
3. Connect one lead of the test lamp to one end of the circuit to be tested.
4. Connect the other lead of the test lamp to battery positive voltage.
5. Connect the other end of the circuit to ground.
6. If the test lamp illuminates (full intensity), then the circuit has good continuity.

Testing for Short to Ground

The following procedures test for a short to ground in a circuit.

NOTICE:
Do not insert test equipment probes into any connector or fuse block terminal. The diameter of the test probes will deform most terminals. A deformed terminal can cause a poor connection, which can result in system failures. Always use the J 35616-A Connector Test Adapter Kit or the J 42675 Flat Wire Probe Adapter Kit in order to frontprobe terminals. Do not use paper clips or other substitutes as they can damage terminals and cause incorrect measurements.

With a DMM

1. Remove the power feed (i.e. fuse, control module) from the suspect circuit.
2. Disconnect the load.
3. Set the rotary dial of the DMM to the R position.
4. Connect one lead of the DMM to one end of the circuit to be tested.
5. Connect the other lead of the DMM to a good ground.
6. If the DMM does NOT display infinite resistance (OL), there is a short to ground in the circuit.

With a Test Lamp

1. Remove the power feed (i.e, fuse, control module) from the suspect circuit.
2. Disconnect the load.
3. Connect one lead of the test lamp to battery positive voltage.

4. Connect the other lead of the test lamp to one end of the circuit to be tested.
5. If the test lamp illuminates, there is a short to ground in the circuit.

Fuse Powering Several Loads

1. Review the system schematic and locate the fuse that is open.
2. Open the first connector or switch leading from the fuse to each load.
3. Connect a DMM across the fuse terminals (be sure that the fuse is powered). When the DMM displays voltage the short is in the wiring leading to the first connector or switch. If the DMM does not display voltage refer to the next step.
4. Close each connector or switch until the DMM displays voltage in order to find which circuit is shorted.

Using Connector Test Adapters

NOTICE:
Do not insert test equipment probes (DMM etc.) into any connector or fuse block terminal. The diameter of the test probes will deform most terminals. A deformed terminal will cause a poor connection, which will result in a system failure. Always use the J-35616 GM-Approved Terminal Test Kit in order to front probe terminals. Do not use paper clips or other substitutes to probe terminals.

When using the J-35616 GM-Approved Terminal Test Kit, ensure the terminal test adapter choice is the correct size for the connector terminal. Do not visually choose the terminal test adapter because some connector terminal cavities may appear larger than the actual terminal in the cavity. Using a larger terminal test adapter will damage the terminal. Refer to the J-35616 GM-Approved Terminal Test Kit label on the inside of the J-35616 GM-Approved Terminal Test Kit for the correct adapter along with the connector end view for terminal size.

INTERMITTENTS AND POOR CONNECTIONS

Testing for Intermittent Conditions and Poor Connections

Tools Required

- J 35616 GM-Approved Terminal Test Kit
- J-38125 Terminal Repair Kit

When the condition is not currently present, but is indicated in DTC history, the cause may be intermittent. An intermittent may also be the cause when there is a customer complaint, but the symptom cannot be duplicated. Refer to the Symptom Table of the system that is suspect of causing the condition before trying to locate an intermittent condition.

Most intermittent conditions are caused by faulty electrical connections or wiring. Inspect for the following items:

- Wiring broken inside the insulation

- Poor connection between the male and female terminal at a connector
- Poor terminal to wire connection – Some conditions which fall under this description are poor crimps, poor solder joints, crimping over the wire insulation rather than the wire itself, and corrosion in the wire to terminal contact area, etc.
- Pierced or damaged insulation can allow moisture to enter the wiring causing corrosion. The conductor can corrode inside the insulation, with little visible evidence. Look for swollen and stiff sections of wire in the suspect circuits.
- Wiring which has been pinched, cut, or its insulation rubbed through may cause an intermittent open or short as the bare area touches other wiring or parts of the vehicle.
- Wiring that comes in contact with hot or exhaust components
- Refer to Inducing Intermittent Fault Conditions in order to duplicate the conditions required, in order to verify the customer concern.
- Refer to Testing for Electrical Intermittents for test procedures to detect intermittent open, high resistance, short to ground, and short to voltage conditions.

Testing for Proper Terminal Contact

It is important to test terminal contact at the component and any inline connectors before replacing a suspect component. Mating terminals must be inspected to ensure good terminal contact. A poor connection between the male and female terminal at a connector may be the result of contamination or deformation.

Contamination may be caused by the connector halves being improperly connected. A missing or damaged connector seal, damage to the connector itself, or exposing the terminals to moisture and dirt can also cause contamination. Contamination, usually in the underhood or underbody connectors, leads to terminal corrosion, causing an open circuit or intermittently open circuit.

Deformation is caused by probing the mating side of a connector terminal without the proper adapter. Always use the J 35616 when probing connectors. Other causes of terminal deformation are improperly joining the connector halves, or repeatedly separating and joining the connector halves. Deformation, usually to the female terminal contact tang, can result in poor terminal contact causing an open or intermittently open circuit.

Testing for Proper Terminal Contact in Bussed Electrical Centers (BEC)

It is very important to use the correct test adapter when testing for proper terminal contact of fuses and relays in a bussed electrical center (BEC). Use J-35616-35 to test for proper terminal contact. Failure to use J-35616-35 can result in improper diagnosis of the BEC.

Follow the procedure below in order to test terminal contact:

1. Separate the connector halves.
2. Inspect the connector halves for contamination. It may appear as a white or green build-up within the connector body or between terminals. This causes high terminal resistance, intermittent contact, or an open circuit. An underhood or underbody connector that shows signs of contamination should be replaced in its entirety (terminals, seals, and connector body).
3. Using an equivalent male terminal from the J-38125, test that the retention force is significantly different between a good terminal and a suspect terminal. Replace the female terminal in question.

Flat Wire (Dock and Lock) Connectors

There are no serviceable parts for flat wire (dock and lock) connectors on the harness side or the component side.

Follow the procedure below in order to test terminal contact:

1. Remove the component in question.
2. Visually inspect each side of the connector for signs of contamination. Avoid touching either side of the connector as oil from your skin may be a source of contamination as well.
3. Visually inspect the terminal bearing surfaces of the flat wire circuits for splits, cracks, or other imperfections that could cause poor terminal contact. Visually inspect the component side connector to ensure that all of the terminals are uniform and free of damage or deformation.
4. Insert the appropriate adapter from the on the flat wire harness connector in order to test the circuit in question.

Control Module/Component Voltage and Grounds

Poor voltage or ground connections can cause widely varying symptoms.

- Test all control module voltage supply circuits. Many vehicles have multiple circuits supplying voltage to a control module. Other components in the system may have separate voltage supply circuits that may also need to be tested. Inspect connections at the module/component connectors, fuses, and any intermediate connections between the voltage source and the module/component. A test lamp or a DMM may indicate that voltage is present, but neither tests the ability of the circuit to carry sufficient current. Ensure that the circuit can carry the current necessary to operate the component.

- Test all control module ground and system ground circuits. The control module may have multiple ground circuits. Other components in the system may have separate grounds that may also need to be tested. Inspect grounds for clean and tight connections at the grounding point. Inspect the connections at the component and in splice packs, where applicable. Ensure that the circuit can carry the current necessary to operate the component.

Temperature Sensitivity

- An intermittent condition may occur when a component/connection reaches normal operating temperature. The condition may occur only when the component/connection is cold, or only when the component/connection is hot.
- Freeze Frame, Failure Records, Snapshot, or Vehicle Data Recorder data may help with this type of intermittent condition, where applicable.
- If the intermittent is related to heat, review the data for a relationship with the following:
  - High ambient temperatures
  - Underhood/engine generated heat
  - Circuit generated heat due to a poor connection, or high electrical load
  - Higher than normal load conditions, towing, etc.
- If the intermittent is related to cold, review the data for the following:
  - Low ambient temperatures – In extremely low temperatures, ice may form in a connection or component. Inspect for water intrusion.
  - The condition only occurs on a cold start.
  - The condition goes away when the vehicle warms up.
- Information from the customer may help to determine if the trouble follows a pattern that is temperature related.
- If temperature is suspected of causing an intermittent fault condition, attempt to duplicate the condition. Refer to Inducing Intermittent Fault Conditions in order to duplicate the conditions required.

Electromagnetic Interference (EMI) and Electrical Noise

Some electrical components/circuits are sensitive to electromagnetic interference (EMI) or other types of electrical noise. Inspect for the following conditions:

- A misrouted harness that is too close to high voltage/high current devices such as secondary ignition components, motors, generator etc – These components may induce electrical noise on a circuit that could interfere with normal circuit operation.
- Electrical system interference caused by a malfunctioning relay, or a control module driven solenoid or switch – These conditions can cause a sharp electrical surge. Normally, the condition will occur when the malfunctioning component is operating.

- Improper installation of non-factory or aftermarket add on accessories such as lights, 2-way radios, amplifiers, electric motors, remote starters, alarm systems, cell phones, etc – These accessories may lead to interference while in use, but do not fail when the accessories are not in use.
- Test for an open diode across the A/C compressor clutch and for other open diodes. Some relays may contain a clamping diode.
- The generator may be allowing AC noise into the electrical system.

Inducing Intermittent Fault Conditions

Tools Required

J 25070 Heat Gun

Many intermittent open or shorted circuits are affected by harness/connector movement that is caused by vibration, engine torque, bumps/rough pavement, etc. In order to duplicate the customer's concern, it may be necessary to manipulate the wiring harness if the malfunction appears to be vibration related. Manipulation of a circuit can consist of a wide variety of actions, including:

- Wiggling the harness
- Disconnecting a connector and reconnecting
- Stressing the mechanical connection of a connector
- Pulling on the harness or wire in order to identify a separation/break inside the insulation
- Relocating a harness or wires

All these actions should be performed with some goal in mind. For instance, with a scan tool connected, wiggling the wires may uncover a faulty input to the control module. The snapshot option would be appropriate here. Another option is, with the component commanded ON and OFF by the scan tool, move related connectors and wiring and observe the component operation. With the engine running, move related connectors and wiring while monitoring engine operation. If harness or connector movement affects the data displayed, component/system operation, or engine operation, inspect and repair the harness/connections as necessary.

You may need to load the vehicle in order to duplicate the concern. This may require the use of weights, floorjacks, jackstands, frame machines, etc. In these cases you are attempting to duplicate the concern by manipulating the suspension or frame. This method is useful in finding harnesses that are too short and their connectors pull apart enough to cause a poor connection. A DMM set to Peak Min/Max mode and connected to the suspect circuit while testing can yield desirable results.

Certainly, using the senses of sight, smell, and hearing while manipulating the circuit can provide good results as well.

There may be instances where circuit manipulation alone will not meet the required criteria for the fault condition to appear. In such cases it may be necessary to expose the suspect circuit to other conditions while manipulating the harness. Such conditions would include high moisture conditions, along with exceptionally high or low temperatures. The following discusses how to expose the circuit to these kinds of conditions.

Salt Water Spray

Some compounds possess the ability to conduct electricity when dissolved in water such as ordinary salt. By mixing table salt with water in sufficient quantities, you can enhance the conductive properties of water so that any circuit which may be sensitive to moisture will more readily fail when liberally sprayed with this mixture.

Mixing 0.35L (12 oz) of water with approximately 1 tablespoon of salt will yield a salt solution of 5 percent. Fill a normal spray bottle with this mixture. This mixture is sufficient to enhance the water's own conductivity. This may cause the circuit to fail more easily when sprayed. Once the mixture is completed, spray the suspect area liberally with the solution. Then, while monitoring either a scan tool or DMM, manipulate the harness as discussed previously.

High Temperature Conditions

If the complaint tends to be heat related, you can simulate the condition using the J 25070.

Using the heat gun, you can heat up the suspected area or component. Manipulate the harnesses under high temperature conditions while monitoring the scan tool or DMM to locate the fault condition.

The high temperature condition may be achieved simply by test driving the vehicle at normal operating temperature. If a heat gun is unavailable, consider this option to enhance your diagnosis. This option does not allow for the same control, however.

Low Temperature Conditions

Depending on the nature of the fault condition, placing a fan in front of the vehicle while the vehicle is in the shade can have the desired effect.

If this is unsuccessful, use local cooling treatments such as ice or a venturi type nozzle (one that provides hot or cold air). This type of tool is capable of producing air stream temperatures down to -18°C (0°F) from one end and +71°C (160°F) from the other. This is ideally suited for localized cooling needs.

Once the vehicle, component, or harness has been sufficiently cooled, manipulate the harness or components in an effort to duplicate the concern.

Duplicating Failure Conditions

- If none of the previous tests are successful, attempt to duplicate and/or capture the failure conditions.
- Freeze Frame/Failure Records data, where applicable, contains the conditions that were present when the DTC set.

1. Review and record Freeze Frame/Failure Records data.
2. Clear the DTCs using the scan tool.
3. Turn the key to OFF and wait 15 seconds.
4. Operate the vehicle under the same conditions that were noted in Freeze Frame/Failure Records data, as closely as possible. The vehicle must also be operating within the Conditions for Running the DTC. Refer to Conditions for Running the DTC in the supporting text if a DTC is being diagnosed.
5. Monitor DTC Status for the DTC being tested. The scan tool will indicate Ran, when the enabling conditions have been satisfied long enough for the DTC to run. The scan tool will also indicate whether the DTC passed or failed.

- An alternate method is to drive the vehicle with the DMM connected to a suspected circuit. An abnormal reading on the DMM when the concern occurs, may help you locate the concern.

Testing for Electrical Intermittents

Perform the following procedures while wiggling the harness from side to side. Continue this at convenient points (about 6 inches apart) while watching the test equipment.

- Testing for Short to Ground
- Testing for Continuity
- Testing for a Short to Voltage

If the fault is not identified, perform the procedure below using the MIN MAX feature on the DMM. This feature allows you to manipulate the circuit without having to watch the DMM. The DMM will generate an audible tone when a change is detected.

IMPORTANT:

The DMM must be used in order to perform the following procedure since the DMM can monitor current, resistance or voltage while recording the minimum (MIN), and maximum (MAX) values measured.

1. Connect the DMM to both sides of a suspected connector (still connected), or from one end of a suspected circuit to the other. Refer to Troubleshooting with a Digital Multimeter for information on connecting the DMM to the circuit.
2. Set the rotary dial of the DMM to the V (AC) or V (DC) position.
3. Press the range button of the DMM in order to select the desired voltage range.

4. Press the MIN MAX button of the DMM. The DMM displays 100 ms RECORD and emits an audible tone (beep).

IMPORTANT:

The 100 ms RECORD mode is the length of time an input must stay at a new value in order to record the full change.

5. Simulate the condition that is potentially causing the intermittent connection, either by wiggling the connections or the wiring, test driving, or performing other operations. Refer to Inducing Intermittent Fault Conditions.
6. Listen for the audible Min Max Alert which indicates that a new minimum or maximum value has been recorded.
7. Press the MIN MAX button once in order to display the MAX value and note the value.
8. Press the MIN MAX button again in order to display the MIN value and note the value.
9. Determine the difference between the MIN and MAX values.
   - If the variation between the recorded MIN and MAX voltage values is 1 volt or greater an intermittent open or high resistance condition exists. Repair the condition as necessary.
   - If the variation between the recorded MIN and MAX voltage values is less than 1 volt an intermittent open or high resistance condition does not exist.

DIAGNOSTIC LINK CONNECTOR DIAGNOSTICS

Data Link Communications System Check

1. Test the scan tool operation on a known good vehicle in order to ensure proper operation of the scan tool.
2. Inspect for proper connection of the scan tool to the Data Link Connector (DLC).
3. Inspect for proper installation of the aftermarket electronic equipment, Improper installation of aftermarket electronic equipment may affect the integrity of other systems.
4. Verify power and ground at the data link connector (DLC).
5. Verify the integrity of the serial data wires.

Scan Tool Does Not Communicate with Components

Scan Tool Does Not Communicate with Components			
Step	**Action**	**Yes**	**No**
1	Was the Data Link Communications System Check performed?	Go to Step 2	Refer to Data Link Communications System Check
2	1. Remove the Scan Tool from the Data Link Connector (DLC). 2. Inspect the DATA fuse. Is the fuse open?	Go to Step 3	Go to Step 4
3	Locate and repair the source of the overload in CKT 540 (ORN) and replace the fuse. Is the repair complete?	System OK	—
4	Connect a test light from the DATA fuse to ground. Did the test light illuminate?	Go to Step 6	Go to Step 5
5	Locate and repair the open in the power supply circuit between the junction block and the DATA fuse. Is the repair complete?	System OK	—
6	Connect a test light from the DLC, terminal 16 to ground. Did the test light illuminate?	Go to Step 8	Go to Step 7
7	Locate and repair the open in CKT 540 (ORN) between the DATA fuse and the DLC. Is the repair complete?	System OK	—
8	Connect a test light from the DLC, terminal 16 to terminal 5. Did the test light illuminate?	Go to Step 10	Go to Step 9
9	Locate and repair the open in CKT 451 (BLK/WHT) between the DLC and G108. Is the repair complete?	System OK	—

Scan Tool Does Not Communicate with Components			
Step	**Action**	**Yes**	**No**
10	Connect a test light from the DLC, terminal 16 to terminal 4. Did the test light illuminate?	Go to Step 12	Go to Step 11
11	Locate and repair the open in CKT 250 (BLK) between the DLC and G200. Is the repair complete?	System OK	—
12	1. Install the scan tool. 2. Turn the ignition switch to the RUN position. Will the scan tool communicate with the powertrain control module (PCM)?	Go to Step 16	Go to Step 13
13	Perform the Scan Tool to PCM Diagnostics. Refer to Scan Tool Does Not Communicate with PCM. Are these diagnostics complete?	System OK	—
14	1. Install the scan tool. 2. Turn the ignition switch to the RUN position. Will the scan tool communicate with the powertrain control module (PCM)?	Go to Step 16	Go to Step 15
15	Perform the Scan Tool to PCM Diagnostics. Refer to Scan Tool Does Not Communicate with PCM. Are these diagnostics complete?	System OK	—
16	1. Keep the ignition switch in the RUN position. 2. Attempt to communicate with the electronic brake control module (EBCM). Will the scan tool communicate with the EBCM?	Go to Step 18	Go to Step 17
17	Perform the Scan Tool to EBCM Diagnostics. Refer to Scan Tool Does Not Communicate with EBCM. Are these diagnostics complete?	System OK	—

Scan Tool Does Not Communicate with Components			
Step	**Action**	**Yes**	**No**
18	1. Keep the ignition switch in the RUN position. 2. Attempt to communicate with the transmission control module (TCM). Will the scan tool communicate with the TCM?	System OK	Go to Step 19
19	Perform the Scan Tool to TCM Diagnostics. Refer to Scan Tool Does Not Communicate with TCM. Are these diagnostics complete?	System OK	—

Scan Tool Does Not Communicate with EBCM (W20/W22)

Scan Tool Does Not Communicate with EBCM (W20/W22)				
Step	**Action**	**Value(s)**	**Yes**	**No**
1	Was the Data Link Communications Systems Check performed?	—	Go to Step 2	Go to Data Link Communications System Check
2	1. Inspect the data link connector (DLC) and repair any damaged terminals if required. 2. Verify that the Scan Tool is firmly connected to the DLC. 3. Turn the ignition switch to the RUN position. Attempt scan tool communications with the electronic brake control module (EBCM). Does the scan tool communicate with the EBCM?	—	System OK	Go to Step 3
3	1. Turn the ignition switch to the OFF position. 2. Connect a test lamp between pin 12 and pin 4 of the DLC. 3. Turn the ignition switch to the ON position. Does the test lamp illuminate?	—	System OK	Go to Step 4
4	Remove the test lamp ground probe from pin 4 of the DLC and connect it to chassis ground. Does the test lamp illuminate?	—	Go to Step 6	Go to Step 5
5	Locate and repair the short to ground in CKT 1807 (PPL). Is the repair complete?	—	System OK	—
6	Locate and repair the open in circuit 150 (BLK). Is the repair complete?	—	System OK	—

Scan Tool Does Not Communicate with PCM

Scan Tool Does Not Communicate with PCM				
Step	**Action**	**Value(s)**	**Yes**	**No**
1	Was the Data Link Communications Systems Check performed?	—	Go to Step 2	Go to Data Link Communications System Check
2	1. Inspect the data link connector (DLC) and repair any damaged terminals if required. 2. Verify that the Scan Tool is firmly installed. 3. Turn the ignition switch to the RUN position. 4. Attempt scan tool communications with the powertrain control module (PCM). Can communications be established?	—	System OK	Go to Step 3
3	1. Turn the ignition switch to the OFF position. 2. Disconnect the PCM connector J1. 3. Disconnect the electronic brake control module (EBCM) connector C1. 4. Use a DMM to measure the resistance on the DLC from terminal 2 to terminal 5. Is the resistance greater than the specified value?	10 megohm	Go to Step 5	Go to Step 4
4	Locate and repair the short to ground in CKT 1807 (PPL). Is the repair complete?	—	System OK	—
5	Use a DMM to measure the voltage on the DLC from terminal 2 to terminal 5. Is the voltage greater than the specified value?	1.0 volt	Go to Step 6	Go to Step 7
6	Locate and repair the short to B+ in CKT 1807 (PPL). Is the repair complete?	—	System OK	—
7	Use a DMM to measure the resistance from the DLC terminal 2 to the PCM connector C1, cavity 58. Is the resistance greater than the specified value?	1.0 ohm	Go to Step 8	Go to Step 9

Scan Tool Does Not Communicate with PCM				
Step	**Action**	**Value(s)**	**Yes**	**No**
8	Locate and repair the open in CKT 1807 (PPL). Is the repair complete?	—	System OK	—
9	1. Connect the PCM. 2. Connect the EBCM. 3. Turn the ignition switch to the RUN position. 4. Install the scan tool. 5. Attempt to communicate with the PCM. Can communications be established?	—	System OK	Go to Step 1

Scan Tool Does Not Communicate with TCM

Scan Tool Does Not Communicate with TCM				
Step	**Action**	**Value(s)**	**Yes**	**No**
1	Was the Data Link Communications Systems Check Performed?	—	Go to Step 2	Go to Data Link Communications System Check
2	1. Inspect the data link connector (DLC) and repair any damaged terminals if required. 2. Verify that the Scan Tool is firmly connected to the DLC. 3. Turn the ignition switch to the RUN position. 4. Attempt scan tool communications with the transmission control module (TCM). Can communications be established?	—	System OK	Go to Step 3
3	1. Turn the ignition switch to the OFF position. 2. Disconnect the TCM. 3. Use a DMM to measure the resistance on the DLC from terminal 6 to terminal 5. Is the resistance greater than the specified value?	10 megohm	Go to Step 5	Go to Step 4
4	Locate and repair the short to ground in CKT 6105 (DK BLU). Is the repair complete?	—	System OK	—
5	Use a DMM to measure the resistance on the DLC from terminal 14 to terminal 5. Is the resistance greater than the specified value?	10 megohm	Go to Step 7	Go to Step 6
6	Locate and repair the short to ground in CKT 6106 (BLU/WHT). Is the repair complete?	—	System OK	—
7	Use a DMM to measure the resistance from the DLC terminal 6 to terminal 14. Is the resistance greater than the specified value?	10 megohm	Go to Step 9	Go to Step 8
8	Locate and repair the short between CKT 6105 (DK BLU) and CKT 6106 (BLU/WHT). Is the repair complete?	—	System OK	—

Scan Tool Does Not Communicate with TCM				
Step	**Action**	**Value(s)**	**Yes**	**No**
9	Use a DMM to measure the voltage from the DLC terminal 6 to terminal 5. Is the voltage greater than the specified value?	1.0 volt	Go to Step 10	Go to Step 11
10	Locate and repair the short to B+ in CKT 6105 (DK BLU). Is the repair complete?	—	System OK	—
11	Use a DMM to measure the voltage from the DLC terminal 14 to terminal 5. Is the voltage greater than the specified value?	1.0 volt	Go to Step 12	Go to Step 13
12	Locate and repair the short to B+ in CKT 6106 (BLU/WHT). Is the repair complete?	—	System OK	—
13	Use a DMM to measure the resistance from the DLC terminal 6 to the TCM connector, cavity 6. Is the resistance greater than the specified value?	1.0 ohm	Go to Step 14	Go to Step 15
14	Locate and repair the open in CKT 6105 (DK BLU). Is the repair complete?	—	System OK	—
15	Use a DMM to measure the resistance from the DLC terminal 14 to the TCM connector, cavity 27. Is the resistance greater than the specified value?	1.0 ohm	Go to Step 16	Go to Step 17
16	Locate and repair the open in CKT 6106 (BLU/WHT). Is the repair complete?	—	System OK	—

Scan Tool Does Not Communicate with TCM				
Step	**Action**	**Value(s)**	**Yes**	**No**
17	1. Connect the TCM. 2. Turn the ignition switch to the RUN position. 3. Install the scan tool. 4. Attempt to establish communications with the TCM. Can communications be established?	—	System OK	Go to Step 1

LIGHTING SYSTEMS

Courtesy or Dome Lamps Always On

Courtesy or Dome Lamps Always On			
Step	**Action**	**Yes**	**No**
1	Disconnect connector C253. Does the dome lamp remain on?	Go to Step 2	Go to Step 3
2	Repair the short to ground or to B+ in the wiring beyond connector C253.. Is the repair complete?	System OK	—
3	1. Disconnect the instrument panel (IP) lamps dimmer switch. 2. Connect a test light from connector C253, pin A to B+. Did the test light illuminate?	Go to Step 4	Go to Step 5
4	Repair the short to ground in CKT 156 (WHT). Is the repair complete?	System OK	—
5	Replace the IP lamps dimmer switch. Is the repair complete?	System OK	—

Courtesy or Dome Lamps Inoperative

Courtesy or Dome Lamps Inoperative			
Step	**Action**	**Yes**	**No**
1	Inspect the LIGHTING/HORN maxi fuse in the underhood fuse block. Is the fuse open?	Go to Step 2	Go to Step 3
2	Locate and repair the source of overload in CKT 42 (RED) and replace the fuse. Does the dome lamp illuminate?	System OK	—
3	Inspect the condition of ground terminal 12 on the driver's island. Is it clean and tight?	Go to Step 5	Go to Step 4
4	Repair the ground as necessary. Is the repair complete?	System OK	—
5	Inspect the CTSY mini fuse in the I/P extension fuse block. Is the fuse open?	Go to Step 6	Go to Step 7
6	Locate and repair the source of overload in CKT 240 (ORG) and replace the fuse. Does the dome lamp illuminate?	System OK	Go to Step 7
7	1. Disconnect the IP lamps dimmer switch connector (C253). 2. Using a DMM, check for the presence of 12 VDC at pin B of the IP lamps dimmer switch connector (C253). Is voltage present at pin B of the IP lamps dimmer switch connector?	Go to Step 9	Go to Step 8
8	Locate and repair the open in circuit 156 (WHT). Is the repair complete?	System OK	—

Courtesy or Dome Lamps Inoperative			
Step	**Action**	**Yes**	**No**
9	1. Disconnect the IP lamps dimmer switch connector (C253). 2. With the switch in the off position, use a DMM and check for continuity between pins B and C on the switch. Is there continuity between pins B and C?	Go to Step 10	System OK
10	Replace the IP lamps dimmer switch. Is the repair complete?	System OK	—

Instrument Panel Lighting Issues

For any issues related to the lighting for the instrument cluster, the only thing covered in this manual is the wiring up to the cluster. For cluster specific diagnostics, refer to the Actia Service Manual for Model Year 2006 Gas and Diesel Clusters.

Instrument Panel Dimmer Diagnosis			
Step	**Action**	**Yes**	**No**
1	Check the ILLUM fuse in the IP extension fuse block. Is the fuse open?	Go to Step 2	Go to Step 3
2	Correct the overload condition that caused the fuse to blow. Is the repair complete?	System OK	—
3	Check for available voltage to pin A of C253 of the IP Lamp Dimmer switch. Is voltage available to the switch?	Go to Step 5	Go to Step 4
4	Repair the open in circuit 9. Is the repair complete?	System OK	—
5	Check for continuity through the dimmer switch. 1. Disconnect the switch connector. 2. Make sure the switch is any position, other than OFF. 3. Connect a DMM between pins A and D of on the switch. Is there continuity through the switch?	Go to Step 6	Go to Actia Manual.
6	Replace the dimmer switch. Is the repair complete?	System OK	—

WINDSHIELD WIPER/WASHER DIAGNOSIS

Washer Always On

Washer Always On			
Step	**Action**	**Yes**	**No**
1	1. Turn the ignition switch to the RUN position. 2. Disconnect the wiper/washer switch connector from the windshield wiper pulse control module. Does the washer pump continue to operate?	Go to Step 3	Go to Step 2
2	Replace the multifunction switch. Is the repair complete?	System OK	—
3	1. Turn the ignition switch to the OFF position. 2. Disconnect the wiper/washer wire harness from the windshield wiper pulse control module. 3. Turn the ignition switch to the RUN position. Does the washer pump stop operating?	Go to Step 4	Go to Step 5
4	Replace the pulse wiper control module. Is the repair complete?	System OK	—
5	Repair the short to ground in CKT 94 (PNK) between the pulse wiper control module connector, cavity B and the wiper/washer body builder provision connector. Is the repair complete?	System OK	—

Washers Inoperative

Washer Pump Inoperative			
Step	**Action**	**Yes**	**No**
1	Verify the condition. Does the washer pump operate?	System OK	Go to Step 2
2	Check to see if the windshield wipers will operate. Do the windshield wipers operate?	Go to Step 3	Go to Windshield Wipers Inoperative
3	Check the WIPER fuse in the IP extension fuse block. Is the fuse open?	Go to Step 4	Go to Step 5
4	Repair the short to ground condition in circuit 143 (YEL) and replace the fuse. Is the repair complete?	Go to Step 1	—
5	Check for available voltage at the washer pump. 1. Turn the ignition switch to the ON position. 2. Connect a DMM between terminal A of the Body Builder supplied washer pump and chassis ground. 3. Have a helper turn the washer pump switch to the ON position. Is voltage available to the washer pump?	Go to Step 7	Go to Step 6
6	Repair the open condition in circuit 94 (PNK). Is the repair complete?	Go to Step 1	—

Washer Pump Inoperative			
Step	**Action**	**Yes**	**No**
7	Check for output voltage from the Pulse Wiper Control Module. 1. Turn the ignition switch to the ON position. 2. Connect a DMM between terminal J of the Pulse Wiper Control Module and chassis ground. 3. Have a helper turn the washer pump switch to the ON position. Is there output voltage from the Pulse Wiper Control Module?	Go to Step 9	Go to Step 8
8	Replace the Pulse Wiper Control Module. Is the repair complete?	Go to Step 1	—
9	Check for available voltage to the Pulse Wiper Control Module. 1. Turn the ignition switch to the ON position. 2. Connect a DMM between terminal J of the Pulse Wiper Control Module and chassis ground. Is power available to the Pulse Wiper Control Module?	Go to Step 11	Go to Step 10
10	Repair the open circuit in circuit 143 (YEL). Is the repair complete?	Go to Step 1	—
11	Replace the body builder supplied washer pump. Is the repair complete?	System OK	—

Wipers Inoperative – All Modes

Wipers Inoperative – All Modes				
Step	**Action**	**Value(s)**	**Yes**	**No**
1	1. Turn the ignition switch to the RUN position. 2. With a test light, probe the pulse wiper control module connector, C234 from cavity F to ground. Does the test light illuminate?	—	Go to Step 3	Go to Step 2
2	Repair the open in CKT 143 (YEL) between the instrument panel fuse block, cavity E4 of the multifunction switch pigtail and the wiper pulse control module connector, cavity F. Is the repair complete?	—	System OK	—
3	1. Backprobe the windshield wiper pulse control module with a DMM from cavity K to B+. 2. Measure the voltage. Is the voltage more than the specified value?	10.0 volts	Go to Step 5	Go to Step 4
4	Repair the open in CKT 250 (BLK) between the windshield wiper pulse control module, cavity D and ground terminal 12. Is the repair complete?	—	System OK	—
5	1. Backprobe the multifunction switch pigtail with a DMM from cavity D to B+. 2. Measure the voltage. Is the voltage more than the specified value?	10.0 volts	Go to Step 7	Go to Step 6
6	Replace the windshield wiper pulse control module. Is the repair complete?	—	System OK	—
7	Replace the multifunction switch. Is the repair complete?	—	System OK	—

Wipers Delay Mode Inoperative

Step	Action	Value(s)	Yes	No
1	1. Turn the ignition switch to the ACCY or RUN position. 2. Turn the wiper/washer switch to the PULSE position. 3. Move the wiper/washer delay rheostat to the maximum delay position. 4. Probe the wiper/washer switch pigtail connector with a DMM from cavity E4 to cavity E5. 5. Measure the resistance. Is resistance outside the specified range?	30 K-ohm to 430 K-ohm	Go to Step 3	Go to Step 2
2	Replace the multifunction switch. Is the repair complete?	—	System OK	—
3	1. Probe the multifunction switch pigtail connector with a DMM from cavity E3 to cavity E5. 2. Measure the resistance. Is the resistance greater than the specified value?	5 ohms	Go to Step 4	Go to Step 5
4	Replace the multifunction switch. Is the repair complete?	—	System OK	—
5	Replace the windshield wiper pulse control module. Is the repair complete?	—	System OK	—

Wipers High Mode Inoperative

Wipers High Mode Inoperative				
Step	**Action**	**Value(s)**	**Yes**	**No**
1	1. Turn the ignition switch to the ACCY or RUN position. 2. Turn the wiper/washer switch to the HIGH position. 3. Backprobe the wiper/washer switch pigtail with a DMM from cavity E3 to ground. Is the voltage greater than the specified value?	4.0 volts	Go to Step 3	Go to Step 2
2	Replace the multifunction switch. Is the repair complete?	—	System OK	—
3	1. Backprobe the windshield wiper pulse control module with a DMM from cavity F to ground. 2. Measure the voltage. Is the voltage greater than the specified value?	10.0 volts	Go to Step 4	Go to Step 5
4	Replace the windshield wiper pulse control module. Is the repair complete.	—	System OK	—
5	Repair the open in CKT 92 (PPL) between the multifunction switch, cavity E3 and the wiper/ washer provision connector, C207. Is the repair complete?	—	System OK	—

Wipers Low or Mist Modes Inoperative

Wipers Low or Mist Modes Inoperative				
Step	**Action**	**Value(s)**	**Yes**	**No**
1	1. Turn the ignition switch to the ACCY or RUN position. 2. Turn the multifunction switch to the LOW position. 3. Backprobe the multifunction switch pigtail connector with a DMM from cavity E4 to E5. 4. Measure the resistance. Is the resistance approximately the specified value?	680 k-ohm	Go to Step 3	Go to Step 2
2	Replace the multifunction switch. Is the repair complete?	—	System OK	—
3	1. Turn and hold the multifunction switch in the MIST position. 2. Backprobe the multifunction switch pigtail connector with a DMM from cavity E4 to E5. 3. Measure the voltage. Is the voltage greater than the specified value?	680 k-ohm	Go to Step 5	Go to Step 4
4	Replace the multifunction switch. Is the repair complete?	—	System OK	—
5	1. Turn the multifunction switch to the LOW position. 2. Backprobe the multifunction switch pigtail connector with a test light from cavity E5 to ground. 3. Measure the voltage. Does the lamp illuminate?	—	Go to Step 7	Go to Step 6
6	Repair the open in CKT 112 (GRA). Is the repair complete?	—	System OK	—
7	1. Turn and hold the multifunction switch in the MIST position. 2. Backprobe the multifunction switch pigtail connector with a test light from cavity E5 to ground. Does the lamp illuminate?	—	Go to Step 9	Go to Step 8

Wipers Low or Mist Modes Inoperative				
Step	**Action**	**Value(s)**	**Yes**	**No**
8	Replace the multifunction switch. Is the repair complete?	—	System OK	—
9	1. Use a DMM to backprobe the wiper/washer provision connector C 207, from cavity A to B+. 2. Measure the voltage. Is the voltage greater than the specified value?	10.0 volts	Go to Step 11	Go to Step 10
10	Repair the open in CKT 91 (GRY) between the windshield wiper pulse control module connector, cavity E and the wiper/washer provision connector C207, cavity A. Is the repair complete?	—	System OK	—
11	1. Use a DMM to backprobe the wiper/washer provision connector C207, from cavity D to B+. 2. Measure the voltage. Is the voltage greater than the specified value?	10.0 volts	Go to Step 13	Go to Step 12
12	Repair the open in CKT 97 (LT BLU) between the windshield wiper pulse control module connector, cavity F and the wiper/washer provision connector C207, cavity D. Is the repair complete?	—	System OK	—
13	Repair the windshield wiper motor or the wiring beyond the wiper/washer provision connector. Is the repair complete?	—	System OK	—

CRUISE CONTROL DIAGNOSTICS

Cruise Control System Check

Cruise Control System Check			
Step	**Action**	**Normal Results**	**Abnormal Results**
1	1. Drive the vehicle at a speed greater than 40 km/h (25 mph). 2. Move the cruise control switch to the ON position. 3. Press and hold the SET/COAST switch for 2 seconds.	The cruise control engages and maintains the desired speed.	• Cruise control does not set. • The vehicle accelerates.
2	Press and hold the RESUME/ACCEL switch.	• The vehicle will resume (accelerate or decelerate) the previous speed setting. • The vehicle accelerates when the switch is pressed.	• Does not resume. • Vehicle slows, or fails to accelerate.
3	Press and hold the SET/COAST switch.	• The vehicle decelerates when the switch is depressed. • When the switch is released, the vehicle maintains the speed at which it was released.	• The vehicle does not decelerate. • The vehicle accelerates. • The vehicle does not maintain speed.
4	1. Depress the brake pedal. 2. Press and release the RESUME switch.	• The cruise control disengages and the vehicle decelerates. • The cruise control re-engages. The vehicle returns to the previously set speed.	• The cruise control does not disengage when the brake pedal is pressed. • The vehicle does not return to the previously set speed when the resume button is pressed.
5	TAP-UP Press the RESUME/ACCEL switch for 1 second and release.	The vehicle accelerates in 1 mph increments for each tap of the switch.	The vehicle does not accelerate, or it slows down when the switch is tapped.
6	TAP-DOWN Press the SET/COAST switch for 1 second and release.	The vehicle decelerates in 1 mph increments for each tap of the switch.	The vehicle does not decelerate, or it accelerates when the switch is tapped.

Cruise Control Does Not Set or Accelerate

Cruise Control Does Not Set or Accelerate			
Step	**Action**	**Yes**	**No**
1	Was the Cruise Control System Check performed?	Go to Step 2	Go to Cruise Control System Check
2	1. Connect a Scan Tool. 2. Turn the ignition switch to the RUN position. 3. Inspect for powertrain control module (PCM) diagnostic trouble codes (DTC's). Are there any DTC's found?	Go to Powertrain OBD System Check in Engine Controls	Go to Step 3
3	Inspect the condition of the CRUISE fuse. Is the fuse open?	Go to Step 4	Go to Step 5
4	Locate and repair the overload condition that caused the CRUISE fuse to blow. Is the repair complete?	System OK	—
5	1. Connect a DMM between pin A12 of C711 and ground. 2. Place the cruise control switch in the ON position. Is B+ present?	Go to Step 7	Go to Step 6
6	Correct the open condition in circuit 397 (GRA). Is the repair complete?	System OK	—
7	1. Connect a DMM between pin A15 of C711 and ground. 2. Place the cruise control switch in the ON position. 3. Press and hold the SET/COAST (S/C) switch. Is B+ present?	Go to Step 9	Go to Step 8
8	Correct the open condition in circuit 87 (GRA/BLK). Is the repair complete?	System OK	—

Cruise Control Does Not Set or Accelerate			
Step	**Action**	**Yes**	**No**
9	1. Connect a DMM between pin A14 of C711 and ground. 2. Place the cruise control switch in the ON position. 3. Press and hold the RES/ACC (R/A) switch. Is B+ present?	Go to Step 11	Go to Step 10
10	Correct the open condition in circuit 84 (DK BLU). Is the repair complete?	System OK	—
11	Check for continuity on circuit 397 (GRA) between the multifunction switch and the TAC module. Is the circuit open?	Go to Step 12	Go to Step 13
12	Repair the open in circuit 397 (GRA). Is the repair complete?	System OK	—
13	Check for continuity on circuit 87 (GRA/BLK) between the multifunction switch and the TAC module. Is the circuit open?	Go to Step 14	Go to Step 15
14	Repair the open in circuit 87 (GRA/BLK). Is the repair complete?	System OK	—
15	Check for continuity on circuit 84 (DK BLU) between the multifunction switch and the TAC module. Is the circuit open?	Go to Step 16	Go to Step 17
16	Repair the open in circuit 84 (DK BLU). Is the repair complete?	System OK	—
17	1. Connect the scan tool to the DLC. 2. Check the brake pedal switch input status. If the brake pedal status is applied when the pedal is not being pressed, the brake pedal switch will need to be adjusted or replaced. Is the repair complete?	Go to Step 18	Go to Step 19

Cruise Control Does Not Set or Accelerate			
Step	**Action**	**Yes**	**No**
18	Replace the brake pedal switch. Is the repair complete?	System OK	—
19	Replace the multifunction switch. Is the repair complete?	Go to Step 35	Go to Step 13
20	1. Connect a DMM between pin 14 of C216 and ground. 2. Place the cruise control switch in the ON position. Is B+ present?	Go to Step 22	Go to Step 21
21	Repair the open in circuit 397 (GRA). Is the repair complete?	System OK	—
22	1. Connect a DMM between pin 4 of C216 and ground. 2. Place the cruise control switch in the ON position. 3. Press and hold the SET/COAST (S/C) switch. Is B+ present?	Go to Step 24	Go to Step 23
23	Repair the open in circuit 94 (DK BLU). Is the repair complete?	System OK	—
24	1. Connect a DMM between pin 5 of C216 and ground. 2. Place the cruise control switch in the ON position. 3. Press and hold the RES/ACC (R/A) switch. Is B+ present?	Go to Step 26	Go to Step 25
25	Repair the open in circuit 97 (GRA/BLK). Is the repair complete?	System OK	—

Cruise Control Does Not Set or Accelerate			
Step	**Action**	**Yes**	**No**
26	Replace the TAC Module. Is the repair complete?	System OK	—

HORNS

Horns Always On

Horn Always On			
Step	**Action**	**Yes**	**No**
1	Remove the horn relay. Do the horns continue to sound?	Go to Step 2	Go to Step 3
2	Repair the short to B+ in CKT 29 (DK GRN). Is the repair complete?	System OK	
3	Connect a test light from the horn relay connector cavity 86 to B+. Did the test light illuminate?	Go to Step 4	Go to Step 5
4	1. Disconnect the turn signal switch harness connector at the base of the steering column. 2. Connect a test light from cavity G (column side of connector), to B+. Did the test light illuminate?	Go to Step 6	Go to Step 7
5	Replace the Horn relay. Is the repair complete?	System OK	—
6	Replace the horn switch. Is the repair complete?	System OK	—
7	Repair the short to ground in CKT 28 (BLK) between the horn relay connector cavity 86 and the turn signal switch connector. Is the repair complete?	System OK	—

Horns Inoperative

Horns Inoperative				
Step	**Action**	**Value(s)**	**Yes**	**No**
1	Inspect the HORN fuse. Is the fuse open?	—	Go to Step 2	Go to Step 3
2	Locate and repair the source of the overload in CKT 40 (ORN) and replace the fuse. Is the repair complete?	—	System OK	—
3	Inspect the condition of ground terminal 19. Are the grounds clean and tight?	—	Go to Step 5	Go to Step 4
4	Repair ground terminal 19 as necessary. Is the repair complete?	—	System OK	—
5	Are both horns inoperative?	—	Go to Step 7	Go to Step 6
6	1. Disconnect the inoperative horn connector. 2. Connect a test light from the horn connector cavity B to ground. 3. Press the horn button. Did the test light illuminate?	—	Go to Step 9	Go to Step 8
7	1. Remove the horn relay. 2. Connect a test light from the horn relay connector cavity 85 to ground and cavity 87 to ground. Did the test light illuminate?	—	Go to Step 12	Go to Step 10
8	Locate and repair open in CKT 29 (DK GRN) between the horn connector, cavity B and the horn relay connector. Is the repair complete?	—	System OK	—

Horns Inoperative				
Step	**Action**	**Value(s)**	**Yes**	**No**
9	Connect a test light from the horn connector cavity A to B+. Did the test light illuminate?	—	Go to Step 20	Go to Step 11
10	Locate and repair the open in CKT 40 (ORN) between the HORN fuse and the horn relay connector. Is the repair complete?	—	System OK	—
11	Locate and repair the open in CKT 150 (BLK) between the horn connector cavity A and ground terminal 19. Is the repair complete?	—	System OK	—
12	1. Connect a test light from the horn relay connector, cavity 86 to B+. 2. Press the horn button. Did the test light illuminate?	—	Go to Step 13	Go to Step 14
13	1. Disconnect either inoperative horn connector. 2. Connect a fused jumper wire between the horn relay connector cavity 87 and cavity 30. 3. Connect a test light from the horn connector cavity B to ground. Did the test light illuminate?	—	Go to Step 19	Go to Step 16
14	1. Disconnect the turn signal switch connector at the base of the steering column. 2. Use a DMM to measure the resistance between the horn relay connector cavity 86 and ground of the disconnected wire harness. Is the resistance greater than the specified value?	1.0 ohm	Go to Step 17	Go to Step 15
15	Repair the ground path. Is the repair complete?	—	System OK	—
16	Locate and repair the open in CKT 29 (DK GRN) between the horn relay connector cavity 30 and the horn connector cavity B. Is the repair complete?	—	System OK	—

Horns Inoperative				
Step	**Action**	**Value(s)**	**Yes**	**No**
17	Locate and repair the open in CKT 28 (BLK) between the horn relay connector cavity 86 and cavity G of the turn signal switch connector. Is the repair complete?	—	System OK	—
18	Replace the horn switch. Is the repair complete?	—	System OK	—
19	Replace the horn relay. Is the repair complete?	—	System OK	—
20	Replace the horn(s). Is the repair complete?	—	System OK	—

Adjustable Pedals Diagnosis

Adjustable Pedals Inoperative			
Step	**Action**	**Yes**	**No**
1	Check the THROT ADJUST fuse in the IP extension fuse block. Is the fuse open?	Go to Step 2	Go to Step 3
2	Locate and repair the overload condition that caused the fuse to blow. Is the repair complete?	System OK	—
3	Connect a DMM between pin 2 of the Pedal Adjust switch and ground. Is power available to the Pedal Adjust switch?	Go to Step 5	Go to Step 4
4	Repair the open in circuit 1239 (PNK). Is the repair complete?	System OK	—
5	1. Connect a DMM between pin 2 of the motor connector and ground. 2. Press the Pedal Adjust switch to the forward position and monitor the DMM. Is voltage available?	Go to Step 6	Go to Step
6	1. Connect a DMM between pin 1 of the motor connector and ground. 2. Press the Pedal Adjust switch to the reverse position and monitor the DMM. Is voltage available?	Go to Step 7	Go to Step
7	1. Connect a DMM between pin 1 of the Pedal Adjust switch and pin 2 of the motor pigtail and pin 6 of the Pedal Adjust switch and pin 2 of the motor pigtail. 2. Check for continuity on the circuit. Is the circuit open?	Go to Step 9	Go to Step

Adjustable Pedals Inoperative			
Step	**Action**	**Yes**	**No**
8	1. Connect a DMM between pin 3 of the Pedal Adjust switch and pin 1 of the motor pigtail and pin 4 of the Pedal Adjust switch and pin 1 of the motor pigtail. 2. Check for continuity on the circuit. Is the circuit open?	Go to Step 9	Go to Step
9	Repair the circuits as necessary. Is the repair complete?	System OK	—
10	Check switch function. 1. With the switch in the forward position, there should be continuity between pins 1 and 2, and between pins 4 and 5. 2. With the switch in the reverse position, there should be continuity between pins 2 and 4, and between pins 5 and 6. Is there continuity as described?	Go to Step 12	Go to Step 11
11	Replace the Pedal Adjust switch. Is the repair complete.	System OK	—
12	Replace the Pedal Adjust motor. Is the repair complete.	System OK	—

REPAIR INSTRUCTIONS

WIRING REPAIRS

Repairing Damaged Wire Insulation

If the conductive portion of the wire is not damaged, locate the problem, and apply tape around the wire, and repair the cause of the damage. If the wire damage is more extensive, replace the faulty segment of the wire.

Splicing Copper Wire

Copper wire can be spliced using either splice clips or splice sleeves.

IMPORTANT:

When making a splice in an area that may be exposed to moisture use a crimp and seal splice sleeve instead of a Splice Clip. Refer to Splicing Copper Wire Using Splice Sleeves.

Tools Required

J-38125 Terminal Repair Kit

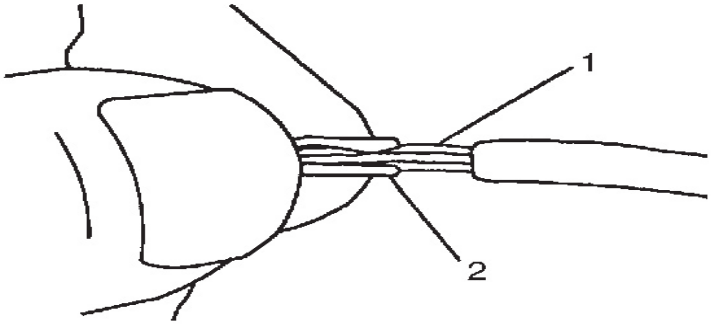
1. Open the harness.
   - If the harness is taped, remove the tape.
   - To avoid wiring insulation damage, use a sewing ripper in order to cut open the harness.
   - If the harness has a black plastic conduit, pull out the desired wire.
2. Cut the wire.
   - Cut as little wire off the harness as possible.
   - Ensure that each splice is at least 40 mm (1.5 in) away from other splices, harness branches and connectors. This helps prevent moisture from bridging adjacent splices and causing damage.
3. Select the proper size and type of wire.
   - The wire must be of equal or greater size than the original (except fusible link).
   - The wire insulation must have the same or higher temperature rating.
     - Use general purpose insulation for areas that are not subject to high temperatures.
     - Use a cross-linked polyethylene insulated wire for areas where high temperatures are expected.

IMPORTANT:

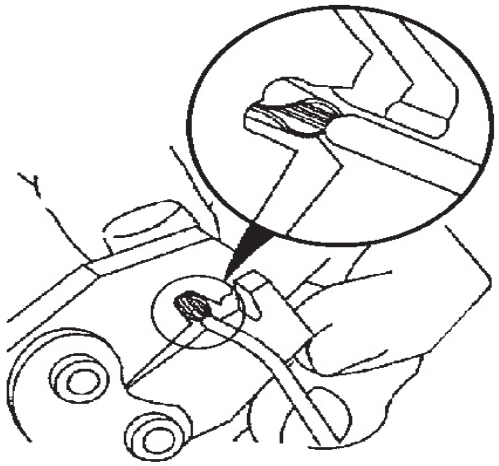
Use cross-linked polyethylene wire to replace PVC, but do not replace cross-linked polyethylene with PVC.

4. Strip the insulation.
   - Select the correct size opening in the wire stripper or work down from the largest size.
   - Strip approximately 7.5 mm (5/16 in) of insulation from each wire to be spliced.
5. Select the proper clip to secure the splice. Follow the instructions in the J-38125 in order to determine the proper clip size crimp tool and anvil.

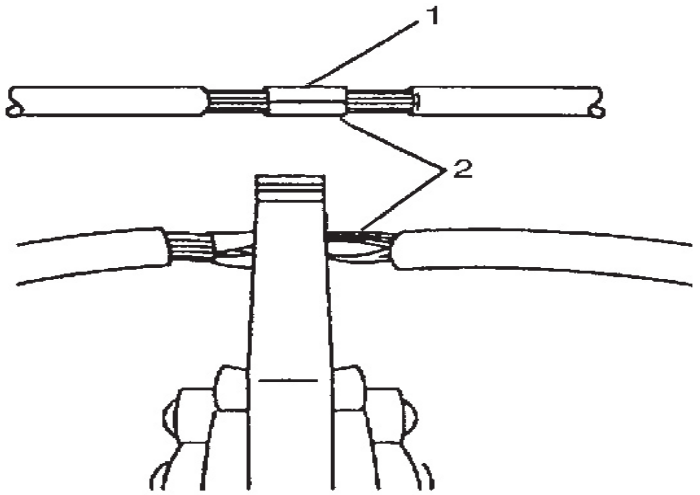
6. Overlap the 2 stripped wire ends and hold them between thumb and forefinger.



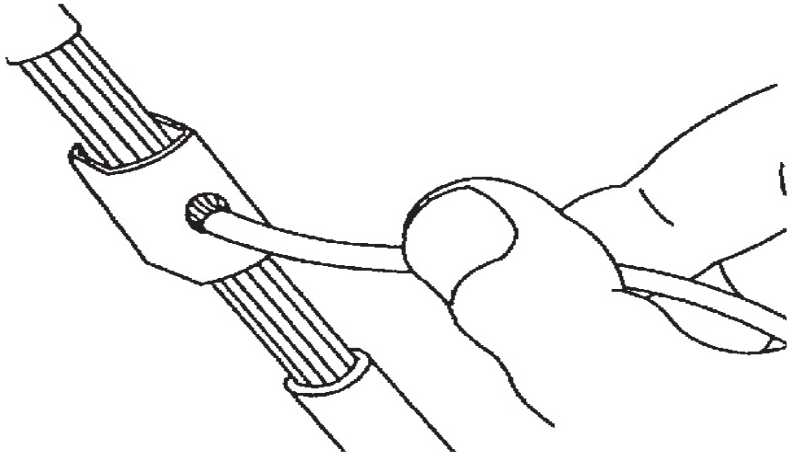
7. Center the splice clip (2) over the stripped wires (1) and hold the clip in place.
   - Ensure that the wires extend beyond the clip in each direction.
   - Ensure that no insulation is caught under the clip.



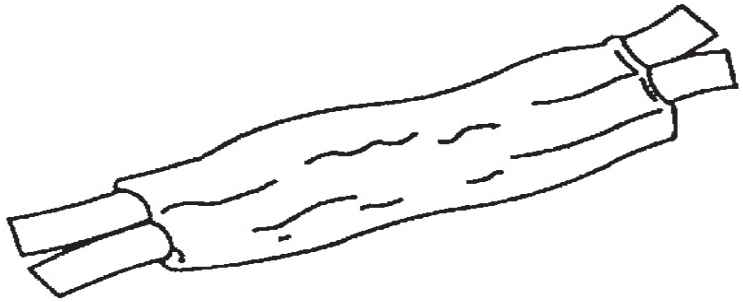
8. Center the crimp tool over the splice clip and wires.
9. Apply steady pressure until the crimp tool closes. Ensure that no strands of wire are cut.



10. Crimp the splice on each end (2).



11. Apply 60/40 rosin core solder to the opening in the back of the clip. Follow the manufacturer's instructions for the solder equipment.



12. Tape the splice. Roll on enough tape in order to duplicate the thickness of the insulation on the existing wires.

13. Additional tape can be applied to the wire if the wire does not belong in a conduit or another harness covering. Use a winding motion in order to cover the first piece of tape.

Splicing Copper Wire Using Splice Sleeves

Tools Required

J-38125 Terminal Repair Kit

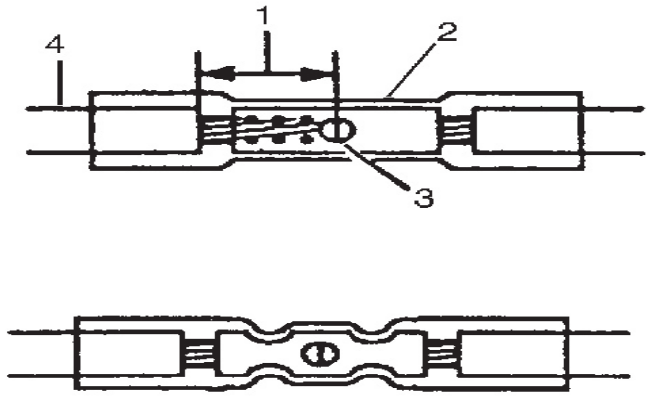
IMPORTANT:

Use only duraseal splice sleeves. Other splice sleeves may not protect the splice from moisture or provide a good electrical connection.

Use duraseal splice sleeves to form a one-to-one splice on all types of insulation except tefzel and coaxial. Use duraseal splice sleeves where there is special requirements such as moisture sealing. Follow the instructions below in order to splice copper wire using duraseal splice sleeves.

Splice Sleeve Color	Crimp Tool Nest Color	Wire Gage AWG/ (Metric)
Salmon 12089189	Red	20,18/(0.5, 0.8)
Blue 12089190	Blue	16, 14/(1.0, 2.0)
Yellow 12089191	Yellow	12, 10/(3.0, 5.0)
Green 88988379	Red (1)	0.22-0.35/(22-24)

1. Open the harness.
   - If the harness is taped, remove the tape.
   - To avoid wiring insulation damage, use a sewing ripper in order to cut open the harness.
   - If the harness has a black plastic conduit, pull out the desired wire.
2. Cut the wire.
   - Cut as little wire off the harness as possible.
   - Ensure that each splice is at least 40 mm (1.5 in) away from other splices, harness branches, and connectors. This helps prevent moisture from bridging adjacent splices and causing damage.



3. Select the proper size and type of wire.
   - The wire must be of equal or greater size than the original.
   - The wires insulation must have the same or higher temperature rating (4).
   - Use general purpose insulation for areas that are not subject to high temperatures.
   - Use a cross-linked polyethylene insulated wire for areas where high temperatures are expected.

IMPORTANT:

Use cross-linked polyethylene wire to replace PVC, but do not replace cross-linked polyethylene with PVC. Cross-linked polyethylene wire is not fuel resistant. Do not use to replace wire where there is the possibility of fuel contact.

4. Strip the insulation.
   - Select the correct size opening in the wire stripper or work down from the largest size.
   - Strip approximately 7.5 mm (5/16 in) of insulation from each wire to be spliced (1).
5. Select the proper duraseal splice sleeve (2) and the required crimp nest tool.
6. Place the duraseal splice sleeve in the J-38125-8 (GM P/N 12085115) crimp tool nest so that the crimp falls at point 1 on the splice.
7. Close the hand crimper handles slightly in order to hold the duraseal splice sleeve firmly in the proper crimp tool nest.
8. Insert the wires into the duraseal splice sleeve until the wire hits the barrel stop. The splice sleeve has a stop in the middle of the barrel in order to prevent the wire from passing through the splice (3).
9. Close the handles of the J-38125-8 (GM P/N 12085115), until the crimper handles open when released. The crimper handles will not open until the proper amount of pressure is applied to the splice sleeve.
10. Shrink the insulation around the splice.
    - Using the heat torch, apply heat to the crimped area of the barrel.
    - Gradually move the heat barrel to the open end of the tubing.
    - The tubing will shrink completely as the heat is moved along the insulation.
    - A small amount of sealant will come out of the end of the tubing when sufficient shrinkage is achieved.

Splicing Twisted Pair Wiring

Two-conductor cable of this construction is primarily used for speed sensor circuits. Twisted pair wiring is spliced using the same method as copper wire. Do not increase or decrease the number of twists in the wire.

HO2S Wiring Repairs

Tools Required

J-38125 Terminal Repair Kit

NOTICE:
Do not solder repairs under any circumstances as this could result in the air reference being obstructed.

If the heated oxygen sensor pigtail wiring, connector, or terminal is damaged the entire oxygen sensor assembly must be replaced. Do not attempt to repair the wiring, connector, or terminals. In order for the sensor to function properly it must have a clean air reference. This clean air reference is obtained by way of the oxygen sensor signal and heater wires. Any attempt to repair the wires, connectors or terminals could result in the obstruction of the air reference and degrade oxygen sensor performance.

The following guidelines should be used when servicing the heated oxygen sensor:

- Do not apply contact cleaner or other materials to the sensor or vehicle harness connectors. These materials may get into the sensor, causing poor performance. Also, the sensor pigtail and harness wires must not be damaged in such a way that the wires inside are exposed. This could provide a path for foreign materials to enter the sensor and cause performance problems.
- Neither the sensor nor vehicle lead wires should be bent sharply or kinked. Sharp bends, kinks, etc., could block the reference air path through the lead wire.
- Do not remove or defeat the oxygen sensor ground wire (where applicable). Vehicles that utilize the ground wire sensor may rely on this ground as the only ground contact to the sensor. Removal of the ground wire will also cause poor engine performance.
- To prevent damage due to water intrusion, be sure that the peripheral seal remains intact on the vehicle harness connector.

The engine harness may be repaired using the J-38125.

Headlamp Switch Replacement

Removal Procedure

1. Remove the mounting hardware for the switch.
2. Disconnect the harness connector from the switch.
3. Remove the switch.

Installation Procedure

1. Connect the harness connector to the switch.
2. Position the switch.
3. Install the mounting hardware for the switch.

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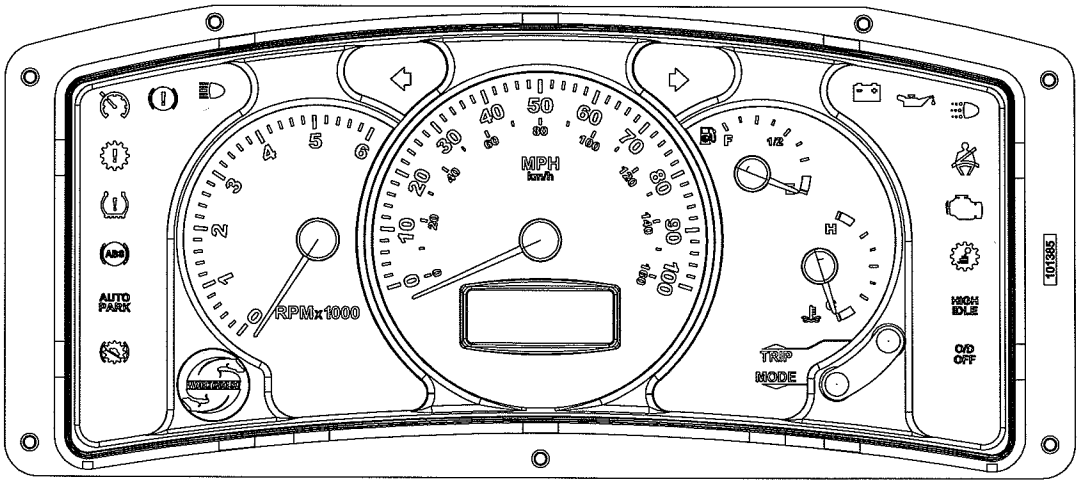
SERVICE MANUAL



MODEL YEAR 2006

Gas and Diesel Clusters

	By	Date		ACTIA Ref.	Revision
Written	Ron Sayles	2-1-06	**Workhorse Custom Chassis Gas and Diesel Cluster Service Information**	**103388**	**D**
Reviewed					
Approved					
				Page 1	Format US Letter

Table of Contents

1. CLUSTER PART NUMBERS AND FEATURES

Table 1 identifies WCC and Actia cluster part numbers as they relate to chassis, model year and software options.

New part numbers for MY03i replaced the Model Year 2003 cluster part numbers effective 11-1-02 with VIN breakpoint 5B4MP67G533363924. The new part numbers reflect a software change only.

New part numbers for Model Year 2004 superseded Model Year 2003 part numbers. The new part numbers are not backward compatible. MY03 clusters cannot be replaced with MY04 clusters.

New part numbers for MY04iii replaced Model Year 2004, 2004i and 2004ii cluster part numbers. The new part numbers reflect a software change only.

New part numbers for MY05 replaced Model Year 2004 cluster part numbers.

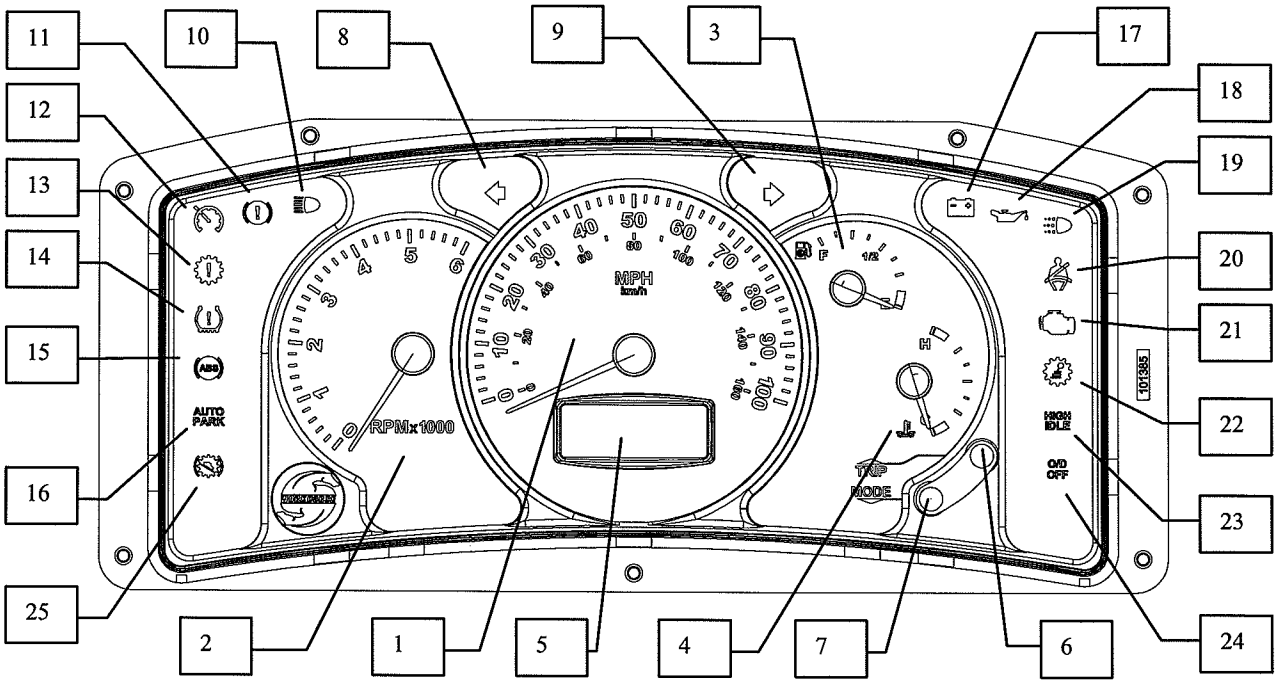
New part numbers for MY06 replaced Model Year 2005 cluster part numbers.

Project	WCC Model	WCC P/N	Actia P/N	03	03i	03ii	04	04i	04ii	04iii	05	06	Bootload	Application	Gas	Diesel	LF72	CTC	Metric	PRNDL	CTP
SB1	P32 LI8	W0002900	101733	X									102035v01_01	101615v01_38	X						
		W0003612	101734	X									102035v01_01	101615v01_38	X			X			
		W0004984	102700		X								102035v01_02	101615v01_39	X						
		W0004986	102703		X								102035v01_02	101615v01_39	X			X			
		W0004984	102700			X							102035v01_02	101615v02_39	X						
		W0004986	102703			X							102035v01_02	101615v02_39	X			X			
		W0005142	103294				X						102035v01_02	101615v01_56	X						
		W0005143	103295				X						102035v01_02	101615v01_56	X			X			
		W0006237	104349					X					102035v01_06	104348v01_01	X						
		W0006238	104351					X					102035v01_06	104348v01_01	X			X			
		W0006739	104965						X				102035v01_06	104348v02_01	X						
		W0006740	104964						X				102035v01_06	104348v02_01	X			X			
		W0006913	105295							X			102035v01_06	104348v03_01	X						
		W0006914	105296							X			102035v01_06	104348v03_01	X			X			
		W0006466	104630								X		102035v01_06	104966v01_02	X						
		W0006467	104629								X		102035v01_06	104966v01_02	X			X			
	P42 LR4/LQ4	W0002900	101733	X									102035v01_01	101615v01_38	X						
		W0004984	102700		X								102035v01_02	101615v01_39	X						
		W0004984	102700			X							102035v01_02	101615v02_39	X						
		W0005142	103294				X						102035v01_02	101615v01_56	X						
		W0006237	104349					X					102035v01_06	104348v01_01	X						
		W0006739	104965						X				102035v01_06	104348v02_01	X						
		W0006913	105295							X			102035v01_06	104348v03_01	X						
		W0006466	104630								X		102035v01_06	104966v01_02	X						
		W0006467	104629								X		102035v01_06	104966v01_02	X			X			
		W0008039	106511									X	102035v01_06	OBSOLETE	X					X	
		W0008729	106655									X	102035v01_06	106546v01_06	X				X	X	
		W0008040	106512									X	102035v01_06	106546v01_06	X			X		X	
	P42 L6I	W0008050	106514									X	102035v01_06	106575v01_15		X		X	X		
		W0008037	106513									X	102035v01_06	106575v01_15		X		X			
		W0008771	106652									X	102035v01_06	106575v01_15		X		X			
		W0008772	106653									X	102035v01_06	106575v01_15		X		X	X		
	P42 LU3	W0006469	104627								X		102035v01_06	104966v01_02	X				X		

Cluster Identification				Model Year									Software Number		Vehicle Type			Configuration settings			
Project	*WCC Model*	*WCC P/N*	*Actia P/N*	*03*	*03i*	*03ii*	*04*	*04i*	*04ii*	*04iii*	*05*	*06*	*Bootload*	*Application*	*Gas*	*Diesel*	*LF72*	*CTC*	*Metric*	*PRNDL*	*CTP*
SB2	W18 L18	W0008041	106587									X	102035v01_06	106546v01_06	X			X		X	
	W18 LQ4	W0008041	106587									X	102035v01_06	106546v01_06	X			X		X	
LF72	LF72 L5B	W0005137	104427								X		102035v01_06	105033v02_01		X	X	X		X	
		W0009355	106654									X	102035v01_06	Not Released		X	X	X	X	X	
		W0008038	106586									X	102035v01_06	Not Released		X	X	X			
BASE	W22 L18	W0003520	101730	X									102035v01_01	101615v01_38	X					X	
		W0003614	101731	X									102035v01_01	101615v01_38	X			X		X	
		W0004985	102699		X								102035v01_02	101615v01_39	X					X	
		W0004987	102701		X								102035v01_02	101615v01_39	X			X		X	
		W0004985	102699			X							102035v01_02	101615v02_39	X					X	
		W0004987	102701			X							102035v01_02	101615v02_39	X			X		X	
		W0005145	103296				X						102035v01_02	101615v01_56	X			X		X	
		W0006239	104350					X					102035v01_06	104348v01_01	X			X		X	
		W0006741	104963						X				102035v01_06	104348v02_01	X			X		X	
		W0006915	105297							X			102035v01_06	104348v03_01	X			X		X	
		W0006468	104628								X		102035v01_06	104966v01_02	X			X		X	
		W0008041	106587									X	102035v01_06	106546v01_06	X			X		X	
	W24 L18	W0006468	104628								X		102035v01_06	104966v01_02	X			X		X	
		W0008041	106587									X	102035v01_06	106546v01_06	X			X		X	
	W52 L18	W0002900	101733	X									102035v01_01	101615v01_38	X						
		W0004984	102700		X								102035v01_01	101615v01_39	X						
		W0004984	102700			X							102035v01_01	101615v02_39	X						
		W0005142	103294				X						102035v01_01	101615v01_56	X						
		W0006237	104349					X					102035v01_06	104348v01_01	X						
		W0006739	104965						X				102035v01_06	104348v02_01	X						
		W0006913	105295							X			102035v01_06	104348v03_01	X						
		W0006466	104630								X		102035v01_06	104966v01_02	X						
		W0008729	106655									X	102035v01_06	Not Released	X				X	X	
		W0008039	106511									X	102035v01_06	Not Released	X					X	
SSC	W24 L18	W0007575	106588									X	102035v01_06	106546v01_06	X			X		X	X

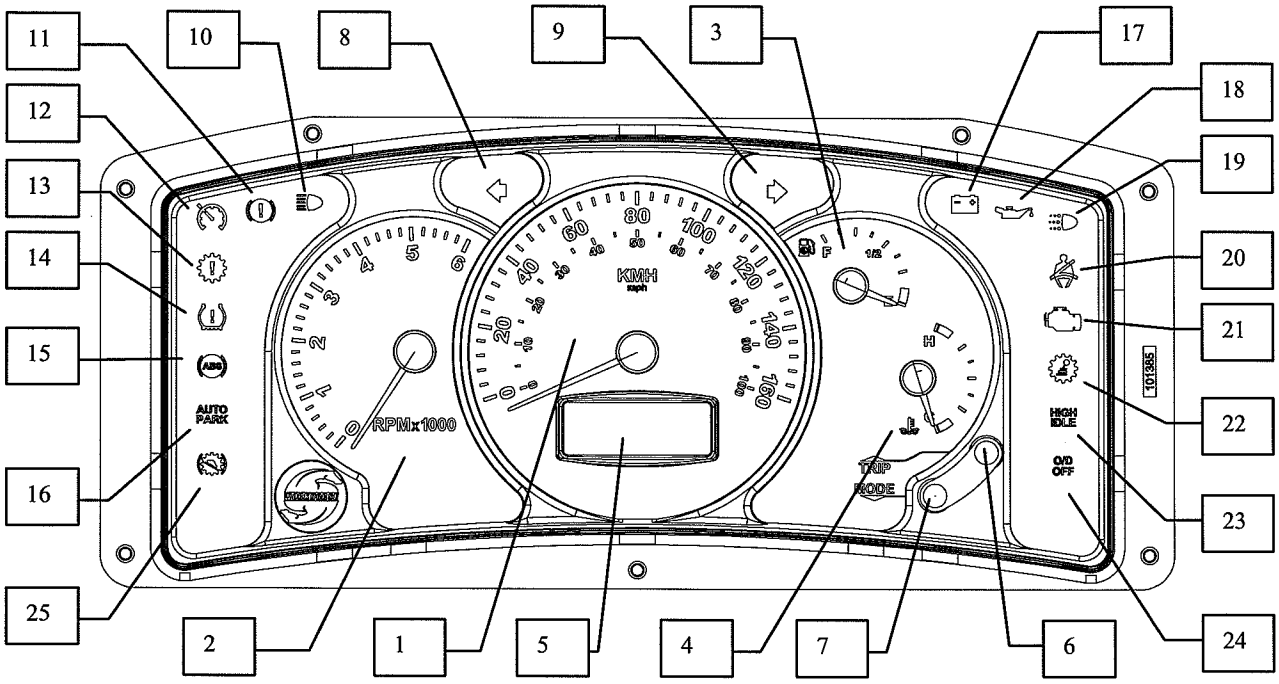
2. CLUSTER ELEMENTS

Figure 1: MY06 CLUSTER – GAS / US



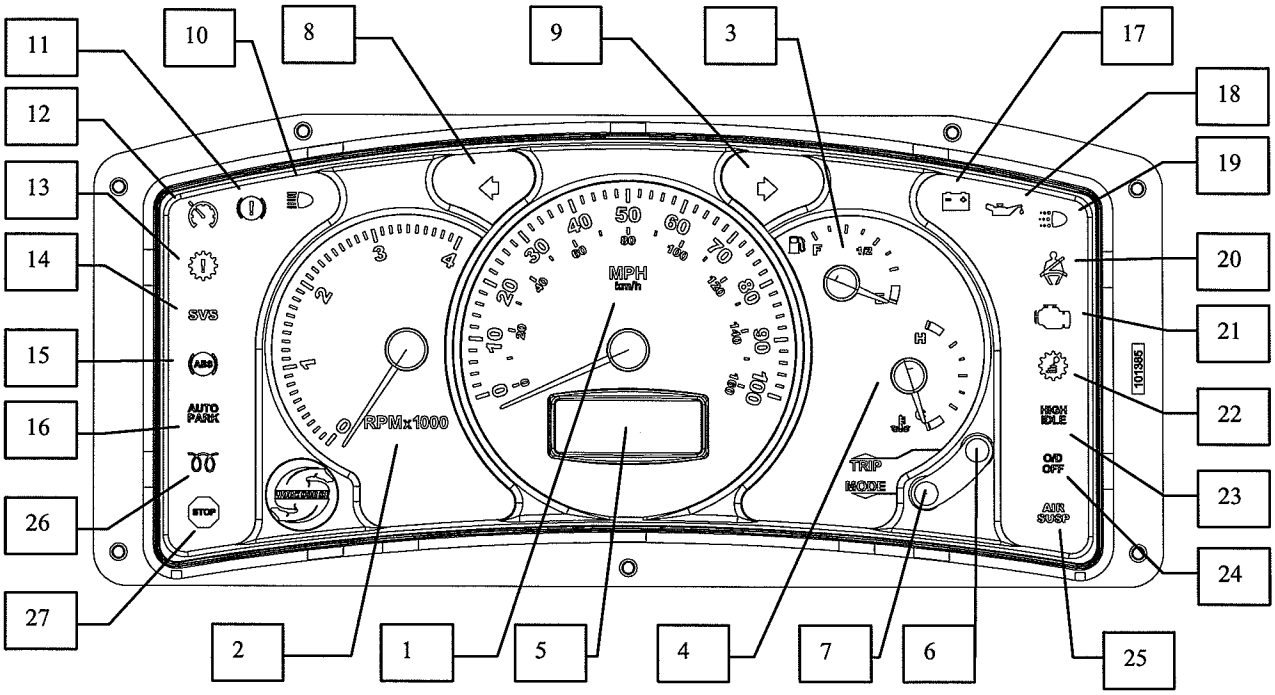
1	Speedometer Gauge	14	Tire Pressure Monitoring Warning Light
2	Tachometer Gauge	15	Anti-lock Brake System Warning Light
3	Fuel Gauge	16	Auto Park Brake Engaged Warning Light
4	Engine Coolant Temperature Gauge	17	Battery Charging System Warning Light
5	LCD Screen	18	Engine Oil Pressure Warning Light
6	Trip Button	19	Daytime Running Lamps On Warning Light
7	Mode Button	20	Seat Belt Reminder Warning Light
8	Turn signal LH turn active	21	Service Engine Warning Light
9	Turn signal RH turn active	22	Transmission Range Inhibit On Warning Light
10	Headlight High Beam On Warning Light	23	High Idle Enabled On Warning Light
11	Brake fail and Park Brake Warning Light	24	Overdrive Off Warning Light
12	Cruise Control Active Warning Light	25	Grade Braking Warning Light
13	Transmission Fail Warning Light		

Figure 2: MY06 CLUSTER – GAS / METRIC



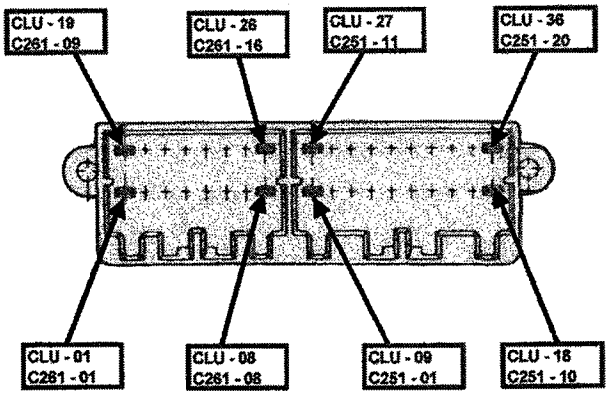
1	Speedometer Gauge	14	Tire Pressure Monitoring Warning Light
2	Tachometer Gauge	15	Anti-lock Brake System Warning Light
3	Fuel Gauge	16	Auto Park Brake Engaged Warning Light
4	Engine Coolant Temperature Gauge	17	Battery Charging System Warning Light
5	LCD Screen	18	Engine Oil Pressure Warning Light
6	Trip Button	19	Daytime Running Lamps On Warning Light
7	Mode Button	20	Seat Belt Reminder Warning Light
8	Turn signal LH turn active	21	Service Engine Warning Light
9	Turn signal RH turn active	22	Transmission Range Inhibit On Warning Light
10	Headlight High Beam On Warning Light	23	High Idle Enabled On Warning Light
11	Brake fail and Park Brake Warning Light	24	Overdrive Off Warning Light
12	Cruise Control Active Warning Light	25	Grade Braking Warning Light
13	Transmission Fail Warning Light		

Figure 3: MY06 CLUSTER – DIESEL



1	Speedometer Gauge	15	Anti-lock Brake System Warning Light
2	Tachometer Gauge	16	Auto Park Brake Engaged Warning Light (not used at this time)
3	Fuel Gauge	17	Battery Charging System Warning Light
4	Engine Coolant Temperature Gauge	18	Engine Oil Pressure Warning Light
5	LCD Screen	19	Daytime Running Lamps On Warning Light
6	Trip Button	20	Seat Belt Reminder Warning Light
7	Mode Button	21	Service Engine Warning Light
8	Turn signal LH turn active	22	Trans Range Inhibit On Warning Light
9	Turn signal RH turn active	23	High Idle Enabled On Warning Light
10	Headlight High Beam On Warning Light	24	Overdrive Off Warning Light
11	Brake fail and Park Brake Warning Light	25	Air Suspension Warning Light
12	Cruise Control Active Warning Light	26	Wait to Start Warning Light
13	Transmission Fail Warning Light	27	Engine Stop Warning Light
14	Service Vehicle Soon Warning Light		

3. CLUSTER CONNECTOR INPUTS AND OUTPUTS



CLU Pin	Description	Input	Output	Diesel	Gas
1	Diesel fuel sender -	45Ω 220Ω	Fuel gauge indicates Empty. Fuel gauge indicates Full.	X	
2	Diesel fuel sender +			X	
3	Outside temperature sender	29 kΩ 2.9 kΩ 980 Ω	Message center displays -20 °C (-4 °F). Message center displays 25 °C (77 °F). Message center displays 50 °C (122 °F).	X	X
4	Backlighting (dimming)	0 volts 13.8 volts	Backlighting is off. Backlighting is on full bright.	X	X
5	Water in Fuel	ON (Low) OFF (High)	Message "Water in Fuel" is on. Message "Water in Fuel" is off.	X	
5	Antenna / Jacks	ON (Low) OFF (High)	Message "Antenna!!Jacks!!" is on. Message "Antenna!!Jacks!!" is off.		X
6	Ignition voltage	13.8 volts	Powers up cluster when ignition is on.	X	X
7	Signal Ground	Ground		X	X
8	Not used				
9	Battery Charge Indicator	ON (Low) OFF (High)	Warning light "Battery Charge Indicator" is on. Warning light "Battery Charge Indicator" is off.	X	

10	J1939 +	Data bus	If the data bus is not active in the vehicle, the message center will display "No J1939 Activity".	X	X
11	J1939 -	Data bus			
12	J1850	Data bus	If the data bus is not active in the vehicle, the message center will display "No J1850 Activity".		X
13	Tachometer	Frequency	1 Hz = 30 RPM (gas) or 15 RPM (diesel)	X	X
14	Speedometer	Frequency	1.11 Hz = 1 mph (gas only)		X
15	Door ajar	ON (Low) OFF (High)	Door open. Door closed.	X	X
16	Overdrive off	ON (Low) OFF (High)	Warning light "Overdrive off" is on. Warning light "Overdrive off" is off.	X	X
17	Remote Trip Reset switch	Low High	Switch open. Switch closed.	X	X
18	Remote Mode switch	Low High	Switch open. Switch closed.	X	X
19	Left turn	OFF (Low) ON (High)	Warning light "Left turn" is off. Warning light "Left turn" is on.	X	X
20	Right turn	OFF (Low) ON (High)	Warning light "Right turn" is off. Warning light "Right turn" is on.	X	X
21	High beam	OFF (Low) ON (High)	Warning light "High beam" is off. Warning light "High beam" is on.	X	X
22	Headlights on	OFF (Low) ON (High)	Headlights are off. Headlights are on.	X	X
23	ABS	< 2.6 volts > 4.5 volts	Warning light "ABS" is on. Warning light "ABS" is off.	X	X
24	Park Brake on	ON (Low) OFF (High)	Park Brake is set. Warning light "Brake" is on. Park Brake is not set. Warning light "Brake" is off.	X	X
25	Brake system failure	< 2.0 volts > 4.0 volts	Warning light "Brake" is on. Warning light "Brake" is off.	X	X
26	Seat belt	OFF (Low) ON (High)	Seat belt is unfastened. Warning light "Seat Belt" is on. Seat belt is fastened. Warning light "Seat Belt" is off.	X	X
27	Service engine soon	ON (Low) OFF (High)	Warning light "Service engine soon" is on. Warning light "Service engine soon" is off.	X	X
28	Key in ignition	ON (Low) OFF (High)	Ignition key is in. Ignition key is out.	X	X

29	Wait to Start	ON (High) OFF (Low)	Warning light "Wait to Start" is on. Warning light "Wait to Start" is off.	X	
29	Grade Brake	ON (High) OFF (Low)	Warning light "Grade Brake" is on. Warning light "Grade Brake" is off.		X
30	High Idle	ON (Low) OFF (High)	Warning light "High Idle" is on. Warning light "High Idle" is off.	X	X
31	Check Tires	ON (Low) OFF (High)	Warning light "Check Tires" is on. Warning light "Check Tires" is off.		X
31	SVS	ON (Low) OFF (High)	Warning light "SVS" is on. Warning light "SVS" is off.	X	
32	Buzzer enable MY03	Low High	Buzzer active with warning messages on message center. Buzzer inactive with warning messages on message center.		X
	Buzzer call MY04, MY05	ON (Low) OFF (High)	Buzzer on. Buzzer off.	X	X
33	Daylight Running Lamps	ON (Low) OFF (High)	Warning light "Daylight Running Lamps" is on. Warning light "Daylight Running Lamps" is off.	X	X
34	Auto park	OFF (Low) ON (High)	Warning light "Auto park" is off. Warning light "Auto park" is on		X
34	Air Suspension	OFF (Low) ON (High)	Warning light "Air Susp" is off. Warning light "Air Susp" is on	X	
35	Chassis Ground	Ground		X	X
36	Direct battery input	13.8 volts	Always connected directly to battery.	X	X

4. CLUSTER DIAGNOSTICS

4.1. Test at Turn On

When ignition voltage is first applied to the cluster, all the tell-tales, except turn signals, turn on for 2 seconds, then, turned off. Simultaneously, all the gauges reference themselves and then go to the position corresponding to their current reading.

4.2. Access to diagnostic menus and menu operation

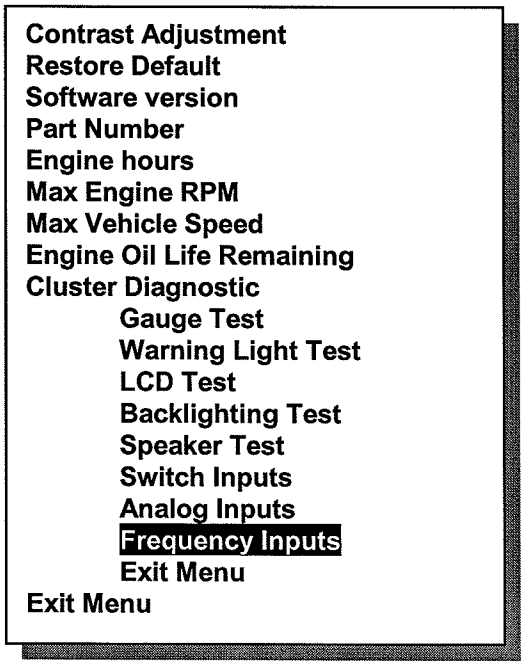
4.2.1. Access to diagnostic menus

On-board diagnostic functions are displayed in the message center. They can be accessed if the vehicle transmission is in PARK or if the vehicle PARK BRAKE is set and the MODE switch is pressed and held for at least 5 seconds. To exit diagnostics, select "EXIT MENU" or turn the vehicle ignition off then back on.

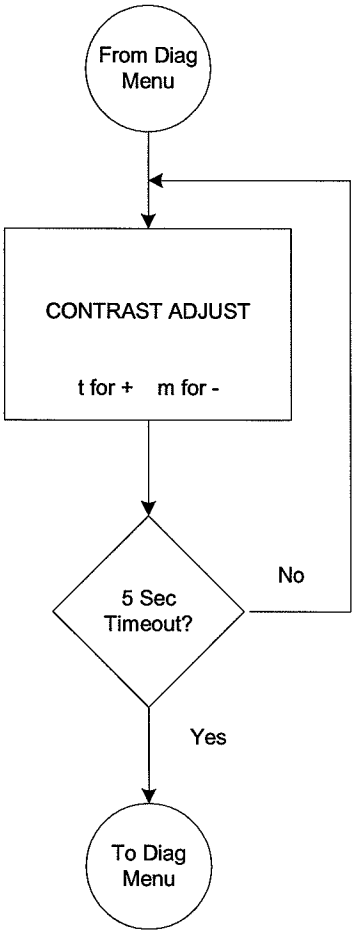
4.2.2. Menu Operation

Menus have 4 lines. To make a selection, a line must first be highlighted. To highlight a line, the trip switch is used to scroll up and the mode switch is used to scroll down. The highlighted line is shown in reverse video. Once highlighted, the line can be selected in either of two ways. Depressing and then releasing both the trip and mode switches at the same time chooses the line. Or, after 3 seconds of inactivity, the line shown in reverse video is automatically chosen.

A summary of all menu lines available in self-diagnostic mode is shown below.

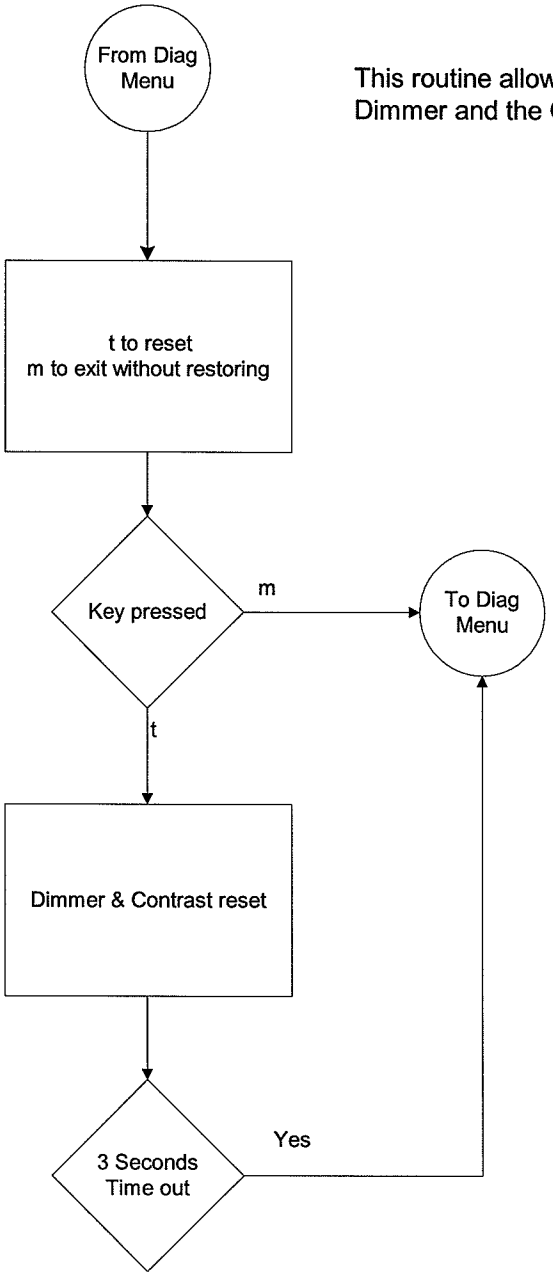


4.3. Contrast Adjustment



This routine adjusts the contrast of the LCD display. The new setting is stored in non volatile memory

4.4. Restore Default



This routine allows the user to restore the settings of the Dimmer and the Contrast to the original factory values.

4.5. Software version

Displays the software part number and version programmed into the micro controller.

Pressing the mode switch exits to the diagnostic menu. (The message "m to exit" appears on the screen).

Note: The software version can also be seen by holding in either the Trip or Mode buttons while turning the ignition switch to the "ON" position.

4.6. Part Number

Displays the hardware part number.

Pressing the mode switch exits to the diagnostic menu. (The message "m to exit" appears on the screen).

Note: The part number can also be seen by holding in either the Trip or Mode buttons while turning the ignition switch to the "ON" position.

4.7. Engine hours

Displays the engine hours that are accumulated in the cluster.

Pressing the mode switch exits to the diagnostic menu. (The message "m to exit" appears on the screen).

4.8. Max Engine RPM

Displays the maximum engine RPM that was sustained for > 3 seconds.

Pressing the mode switch exits to the diagnostic menu. (The message "m to exit" appears on the screen).

4.9. Max Vehicle Speed

Displays the maximum vehicle speed that was sustained for > 5 seconds.

Pressing the mode switch exits to the diagnostic menu. (The message "m to exit" appears on the screen).

4.10. Engine Oil Life Remaining

On gas engines engine oil life remaining is displayed as a percent from 0 to 100.

Pressing the mode switch exits to the diagnostic menu. (The message "m to exit" appears on the screen).

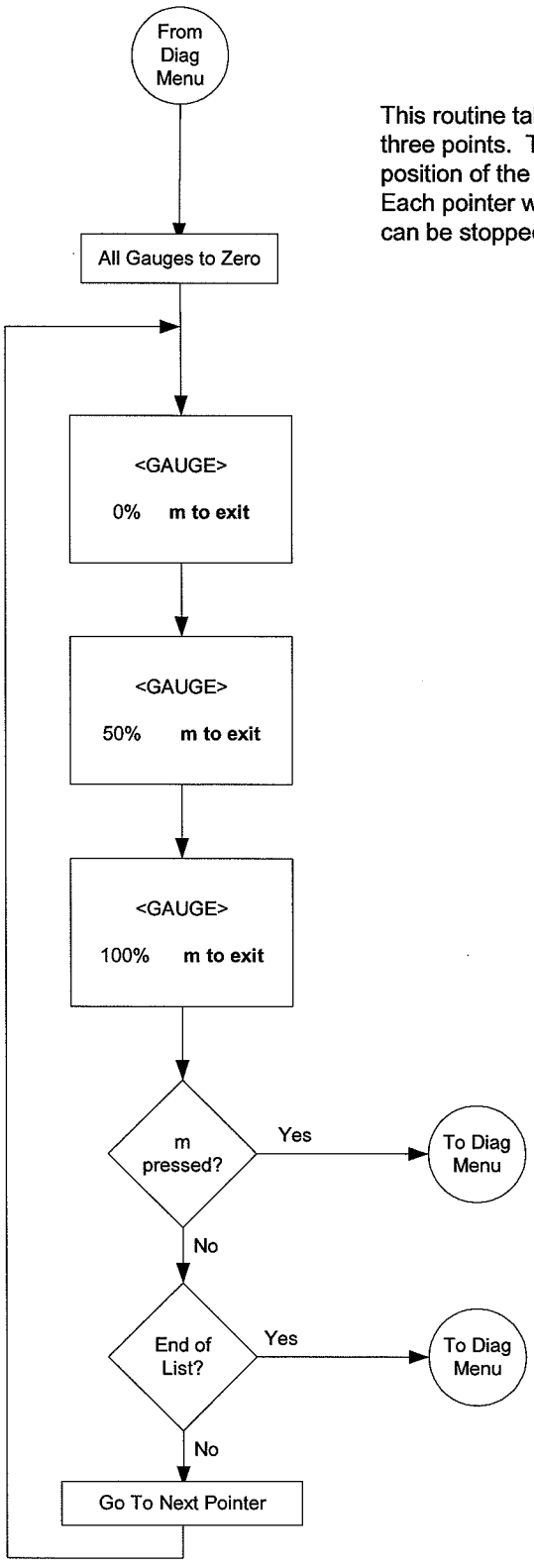
4.11. Cluster Diagnostic

Cluster diagnostic gives the technician two powerful tools for determining whether or not a cluster is defective and needs replacement.

The first tool, Master Mode, gives the technician control over the outputs of the cluster. The technician can individually test all four gauges, all 17 gas or 20 diesel warning lights, the LCD pixels, backlighting and speaker.

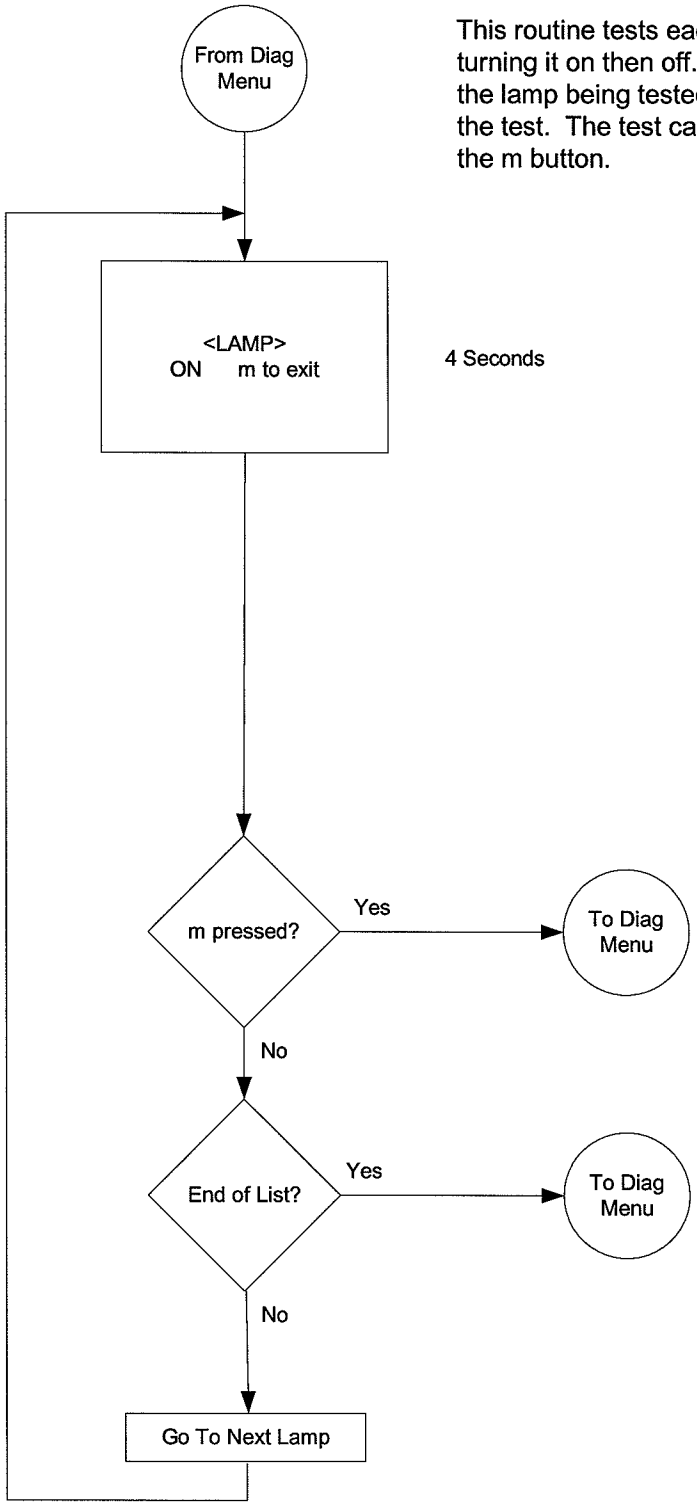
The second tool, Current Value Monitor, shows the technician in real time the status of the cluster inputs. The technician can test switch inputs, analog inputs and frequency inputs.

4.11.1. Gauge Test

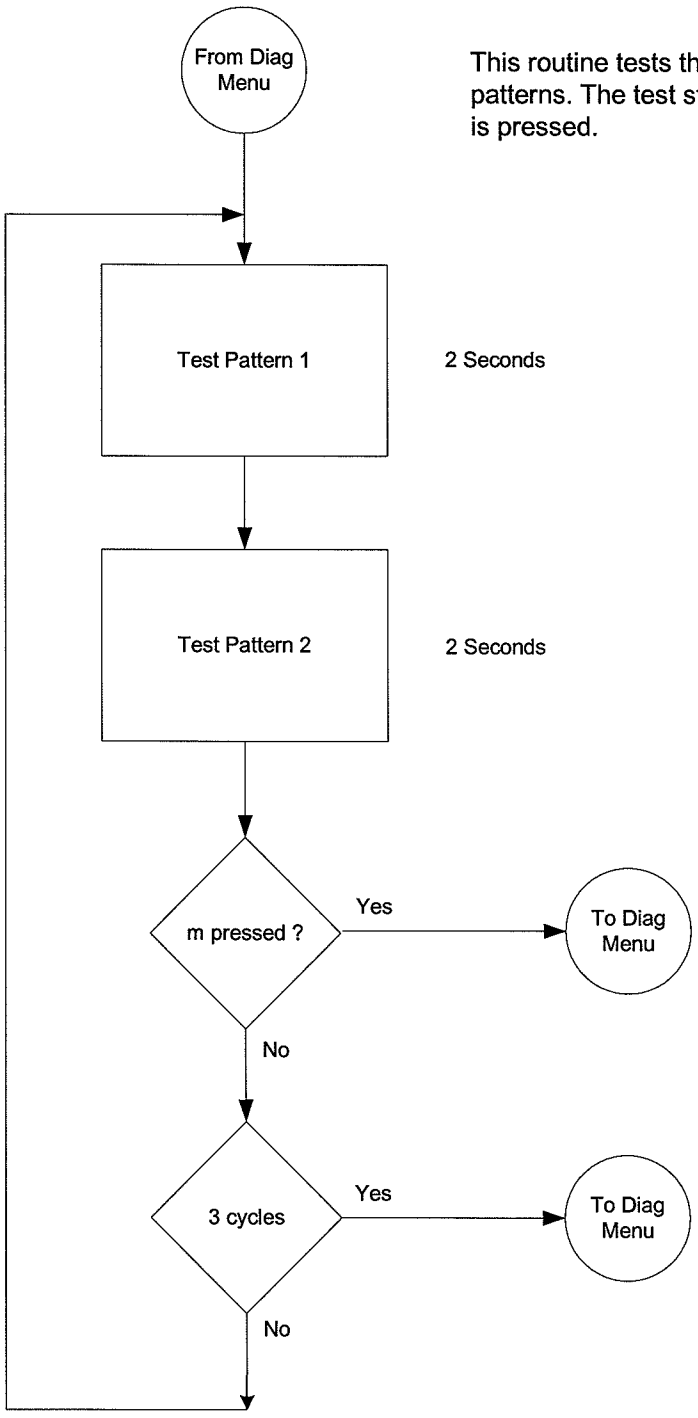


This routine takes each pointer through three points. The display indicates the position of the pointer during the test. Each pointer will be checked. The test can be stopped by pressing the m button.

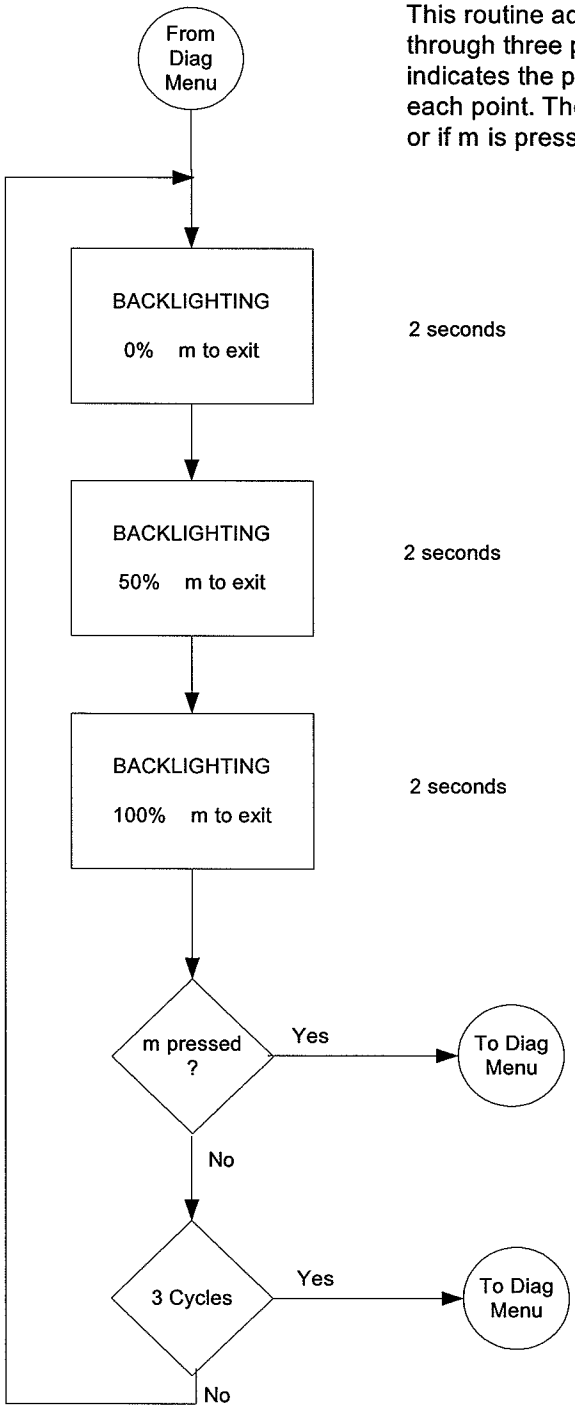
4.11.2. Warning Lamps Test



4.11.3. LCD Test

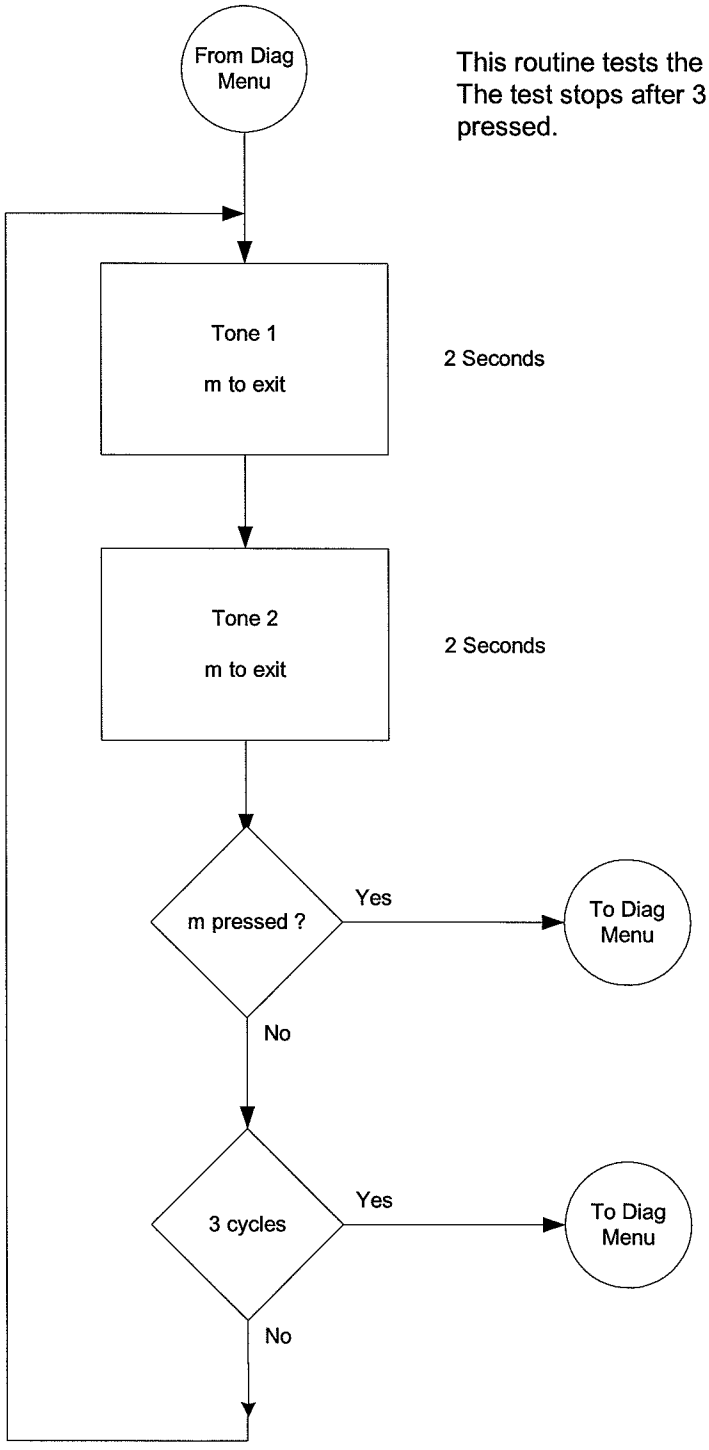


4.11.4. Backlighting Test

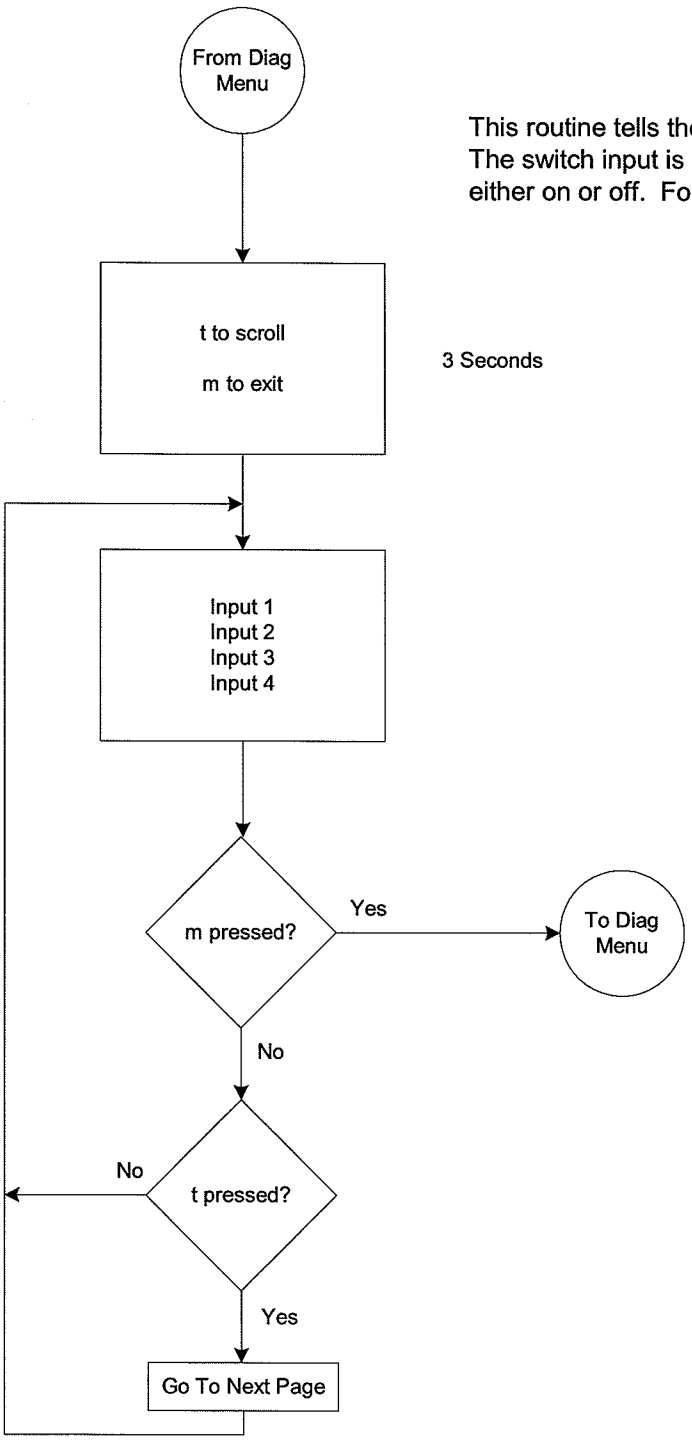


This routine adjusts the backlighting through three points. The display indicates the percentage of backligting at each point. The test stops after 3 cycles or if m is pressed.

4.11.5. Speaker Test

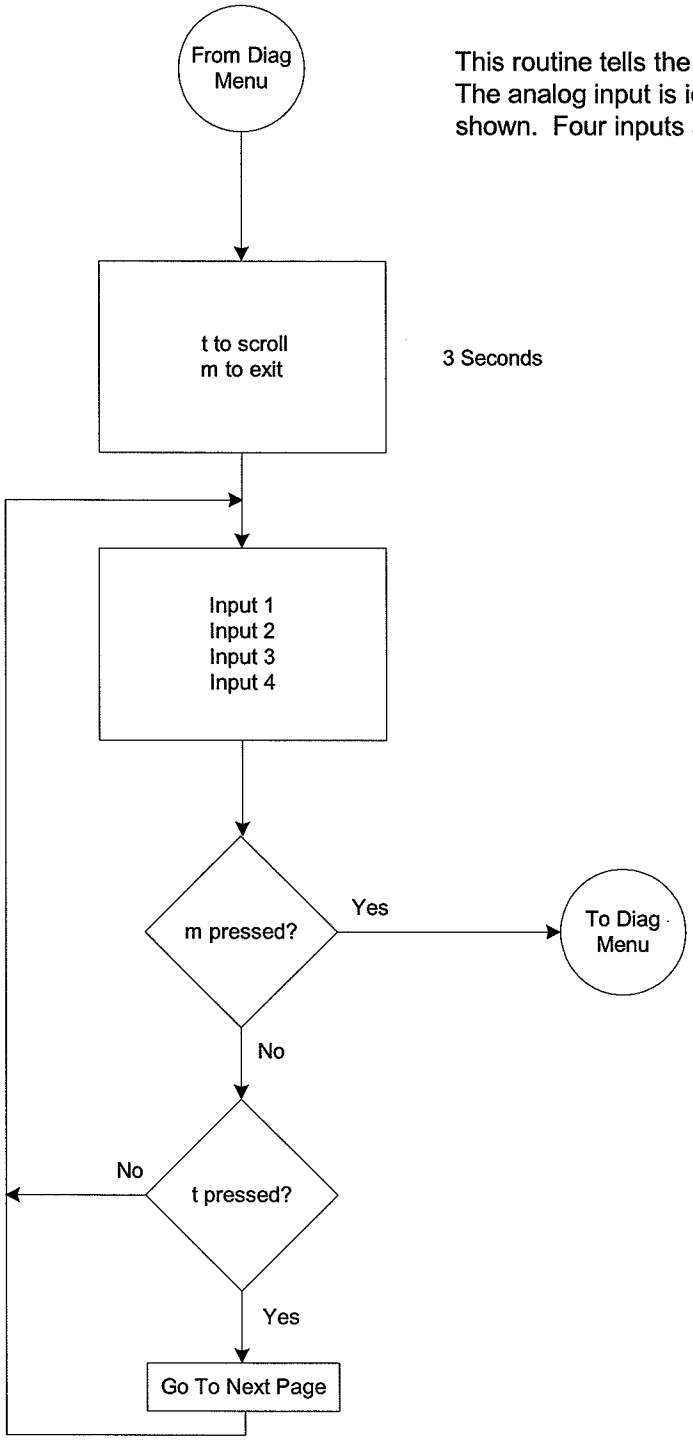


4.11.6. Switch Inputs



This routine tells the operator the status of each switch input. The switch input is identified by name and its status is shown as either on or off. Four inputs are shown per screen page.

4.11.7. Analog Inputs



This routine tells the operator the status of each analog input. The analog input is identified by name and its voltage level is shown. Four inputs are shown per screen page.

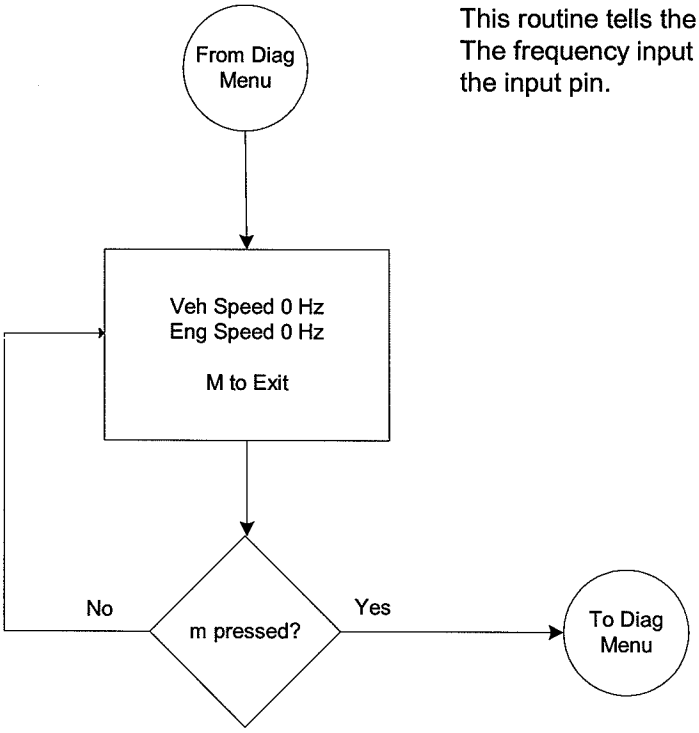
Inputs List (gas engines):

Dimmer	0.0 V
Ignition	13.7 V
Brake Fail	5.0 V
External T	0.0 V
ABS	5.0 V

Inputs List (diesel engine):

Fuel Level	5.030V
Dimmer	13.7 V
Ignition	14.0 V
Brake Fail	5.0 V
External T	5.030 V
ABS	5.0 V

4.11.8. Frequency Inputs



This routine tells the operator the status of each frequency input. The frequency input is identified by name and the frequency at the input pin.

5. TROUBLE SHOOTING GUIDE

5.1. Gauges

5.1.1. Tachometer

Gas Engines

Engine speed is read from a frequency input (pin 13). On board diagnostics can report the tachometer frequency input where 1 Hz = 30 RPM. If the frequency input to the cluster is missing, the cluster will display engine speed by reading it from the J1850 data bus.

Diesel Engines

Engine speed is read from a frequency input (pin 13). On board diagnostics can report the tachometer frequency input where 1 Hz = 15 RPM. If the frequency input to the cluster is missing, engine speed is read from the J1939 data bus.

5.1.2. Speedometer

Gas Engines

Vehicle speed is read from a frequency input (pin 14) at the rate of 4000 pulses/mile. On board diagnostics can report the speedometer frequency input where 1.11 Hz = 1 MPH. If the frequency input to the cluster is missing, the cluster will display vehicle speed by reading it from the J1850 data bus. In this case, the needle movement can be jumpy due to the slow rate of transmission on the bus.

Diesel Engines

Vehicle speed is read from the J1939 data bus.

5.1.3. Fuel

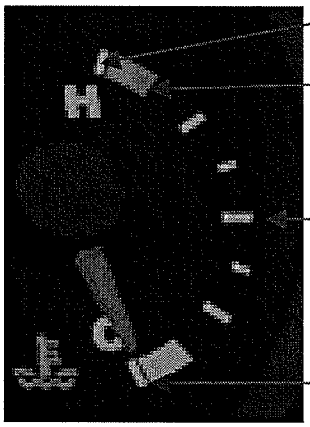
Primary source, fuel levels are read from the J1850 data bus.

Secondary source, fuel levels are read from the sender input on pins 1 and 2.

Fuel Tank Volume	Diesel Sender Resistance	Fuel Gauge Pointer Indication	Cluster Diagnostics Fuel Level Analog Input
0%	≤ 40 Ω ±5%	-3° below E	≤ 0.501 V
10%	45 Ω ±5%	E	0.540 V
20%	66 Ω ±5%	Low fuel warning	0.806 V
25%	80 Ω ±5%	1/4	0.978 V
45%	127 Ω ±5%	1/2	1.563 V
70%	180 Ω ±5%	3/4	2.217 V
90%	225 Ω ±5%	F	2.768 V
100%	≥ 235 Ω ±5%	+3° above F	≥ 2.881 V

5.1.4. Coolant Temperature

Gas Engines Temperature is read from the J1850 data bus.



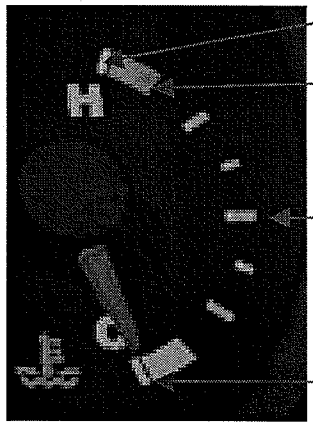
White line at top = 150 degrees Celsius

Start of amber = 127 degrees Celsius

Centerline = 87 to 107 degrees Celsius

Bottom line = 40 degrees Celsius

LF72 Diesel Engines Temperature is read from the J1939 data bus.



White line at top = 124 degrees Celsius

Start of amber = 121 degrees Celsius

Centerline = 88 to 104 degrees Celsius

Bottom line = 40 degrees Celsius

5.2. Warning lights

5.2.1. Battery charge indicator

The warning light is turned on from a J1850 data bus message or a switch input.

On board diagnostics can report the status of the switch input at pin 9:

ON (low) = warning light is on.

OFF (high) = warning light is off.

5.2.2. Low oil pressure

The warning light is turned on from a J1850 or a J1939 data bus message.

5.2.3. Check transmission

The warning light is turned on from a J1850 or J1939 data bus message.

5.2.4. Cruise control

The warning light is turned on from a J1850 or J1939 data bus message.

5.2.5. Left turn

On board diagnostics can report the status of the switch input at pin 19:

OFF (low) = warning light is off.

ON (high) = warning light is on.

5.2.6. Right turn

On board diagnostics can report the status of the switch input at pin 20:

OFF (low) = warning light is off.

ON (high) = warning light is on.

5.2.7. High beam

On board diagnostics can report the status of the switch input at pin 21:

OFF (low) = warning light is off.

ON (high) = warning light is on.

5.2.8. Check tires/SVS

On board diagnostics can report the status of the switch input at pin 31:

ON (low) = warning light is on.

OFF (high) = warning light is off.

5.2.9. ABS

On board diagnostics can report the status of the analog input at pin 23:

< 2.6V = warning light is on.

> 4.5V = warning light is off.

5.2.10. Brake

The brake warning light can be turned on from two different sources: the Park Brake input or Brake Failure inputs (wire or J1939 message).

On board diagnostics can report the status of the switch input for Park Brake at pin 24:

ON (low) = warning light is on.

OFF (high) = warning light is off.

On board diagnostics can report the status of the analog input for Brake Failure at pin 25:

< 2.0V = warning light is on.

>4.0V = warning light is off.

5.2.11. Seat belt

On board diagnostics can report the status of the switch input at pin 26:

OFF (low) = seat belt is unfastened (warning light is on)

ON (high) = seat belt is fastened (warning light is off)

5.2.12. Service engine soon

On board diagnostics can report the status of the switch input at pin 27:

ON (low) = warning light is on.

OFF (high) = warning light is off.

5.2.13. Daylight running lamp

On board diagnostics can report the status of the switch input at pin 33:

ON (low) = warning light is on.

OFF (high) = warning light is off.

5.2.14. High idle

Gas Engines

On board diagnostics can report the status of the switch input at pin 30:

ON (low) = warning light is on.

OFF (high) = warning light is off..

Diesel Engines

The warning light is turned on from a J1939 data bus message.

5.2.15. Range inhibit

The warning light is turned on from a J1850 or J1939 data bus message.

5.2.16. Auto park

On board diagnostics can report the status of the switch input at pin 34:

OFF (low) = warning light is off.

ON (high) = warning light is on.

Not used on Diesel.

5.2.17. Overdrive off

On board diagnostics can report the status of the switch input at pin 16:

ON (low) = warning light is on.

OFF (high) = warning light is off.

5.2.18. Wait to Start

The warning light is turned on from a J1939 data bus message or switch input.

On board diagnostics can report the status of the switch input at pin 29:

ON (low) = warning light is off.

OFF (high) = warning light is on.

5.2.19. Engine Stop

The warning light is turned on from a J1850 or a J1939 data bus message.

5.2.20. Grade Braking

On board diagnostics can report the status of the switch input at pin 29:

ON (low) = warning light is off.

OFF (high) = warning light is on.

5.2.21. Air Pressure Warning

On board diagnostics can report the status of the switch input at pin 34:

ON (low) = warning light is off.

OFF (high) = warning light is on.

5.3. Backlighting

5.3.1. Backlight LCD & display odometer (Headlights On input, Trip or Mode inputs)

The odometer is readable with the ignition off if the vehicle headlights are on or if the trip or mode buttons are pressed. If the headlight switch is used, the odometer turns on and off with the switch without a delay. If the trip or mode switches are used, the odometer will be visible for 15 seconds.

On board diagnostics can report the status of the switch input for Headlights On at pin 22:

OFF (low) = headlights are off.

ON (high) = headlights are on.

(Note: The MY03 clusters will also display the odometer when the key is inserted into the ignition if the vehicle is equipped with a "key-in" switch connected to cluster pin 28).

5.3.2. Backlight gauges (Headlights On input, Dimmer input)

When the headlights are on, the gauges, gauge pointers and LCD dim together in accordance with the dimmer input. (Note: If the headlights are off, then the LCD backlighting will be on full bright.)

On board diagnostics can report the status of the switch input for Headlights On at pin 22:

OFF (low) = headlights are off.

ON (high) = headlights are on.

On board diagnostics can report the status of the analog input for Dimmer at pin 4:

0 V = backlighting is off.

13.8 V = backlighting is on full bright

5.4. Misc.

5.4.1. Key in Ignition Reminder Mode

When the ignition goes from on to off and the key is left in the ignition switch, for a 60 second period the chime will sound if the door ajar input is low (door open). The chime will continue to sound until either the driver's door is closed or the key is removed from the ignition or the 60-second period has elapsed.

During the 60-second period the odometer is visible.

On board diagnostics can report the status of the switch input for Key in Ignition at pin 28:

ON (low) = key is in ignition.

OFF (high) = key is out of ignition.

(Note: For the MY03 clusters, the 60-second time out period does not apply).

5.4.2. Outside temperature

The message center will display outside temperature if the vehicle is equipped with a temperature sender. This menu selection is unavailable if the temperature sender is not installed. (MY03 clusters display -35°C when the temperature sender is not installed).

On board diagnostics can report the status of the analog input at pin 3. The table below shows the relationship between temperature, sender resistance and the voltage displayed on pin 3.

Outside Temperature	Temperature Sender Resistance	Cluster Diagnostics Temperature Analog Input
N/A	OPEN	5.030 V
0°C (-32°F)	9400 Ω	2.674 V
10°C (50°F)	5660 Ω	2.035 V
20°C (68°F)	3500 Ω	1.475 V
30°C (86°F)	2300 Ω	1.066 V
40°C (104°F)	1500 Ω	0.742 V
51°C (124°F)	1000 Ω	0.506 V

5.4.3. Door ajar

The message center will display Door Ajar if the vehicle is so equipped.

On board diagnostics can report the status of the switch input at pin 15:

ON (low) = door open.

OFF (high) = door closed.

5.4.4. Buzzer enable

MY03 clusters: A continuous buzzer alerts a driver to specific warning conditions. Activation requires the "buzzer enable" input grounded and appropriate message input. The buzzer is normally associated with an activated warning message or warning lamp.

On board diagnostics can report the status of the switch input at pin 32:

Low = buzzer enabled.

High = buzzer disabled.

MY04-05 clusters: Activation requires the "buzzer call" input grounded.

On board diagnostics can report the status of the switch input at pin 32:

ON (low) = buzzer on

OFF (high) = buzzer off

5.4.5. Change Units, Metric or U.S.

Any time the user is in normal operating mode, the units displayed in the message center can be toggled back and forth from Metric to U.S. by pressing and releasing both the TRIP and MODE buttons.

5.4.6. No Bus Activity

Gas Engines

If the cluster cannot detect J1850 data bus activity, the message "No J1850 Activity" is displayed on the message center. J1850 enters the cluster on pin 12.

Gas & Diesel Engines

If the cluster cannot detect J1939 data bus activity, the message "No J1939 Activity" is displayed on the message center. J1939 enters the cluster on pins 10 and 11.

5.4.7. Engine Oil Change Reminder (Gas engines only)

Resetting the engine oil change reminder message:

Perform oil change as normal.

Turn ignition switch to "ON" position, but do not start engine.

Fully press and release the accelerator pedal three times within 5 seconds, and turn ignition "OFF" for at least 10 seconds.

The oil life counter on the engine controller will be reset to start a new cycle.

5.4.8. Current Draw

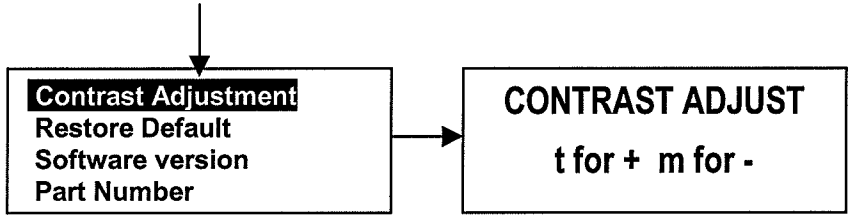
Nominal current draw at 13.8 V:

Cluster asleep	< 3 mA
Cluster awake	≈ 250 mA

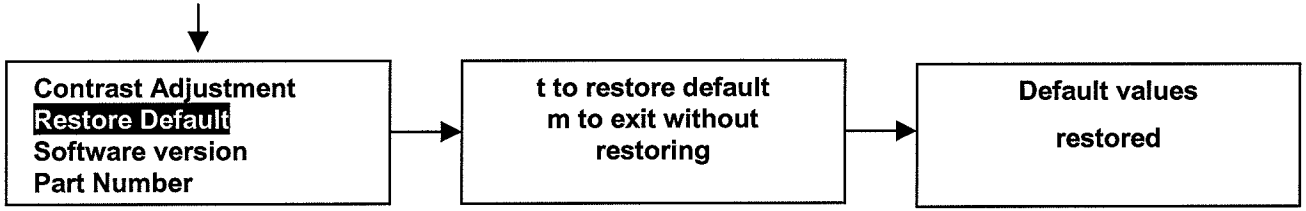
6. CLUSTER DIAGNOSTIC MENU TREE

Default message center screen.

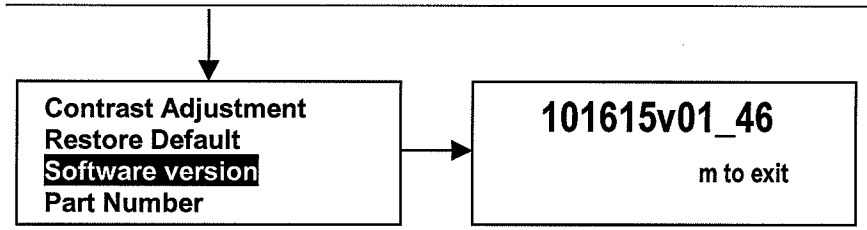
Press and hold MODE for > 5 seconds with transmission in PARK or PARK BRAKE set.



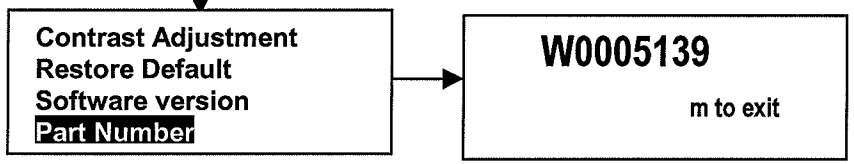
Press MODE to scroll down.



Press MODE to scroll down.

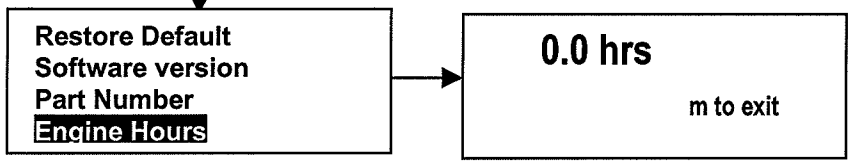


Press MODE to scroll down.

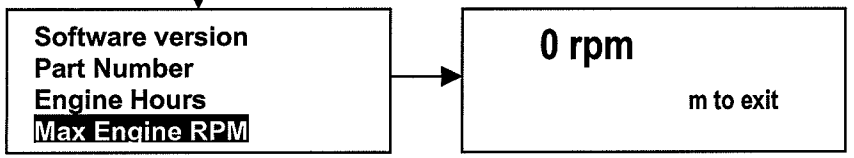


Part number is not available in MY03 clusters.

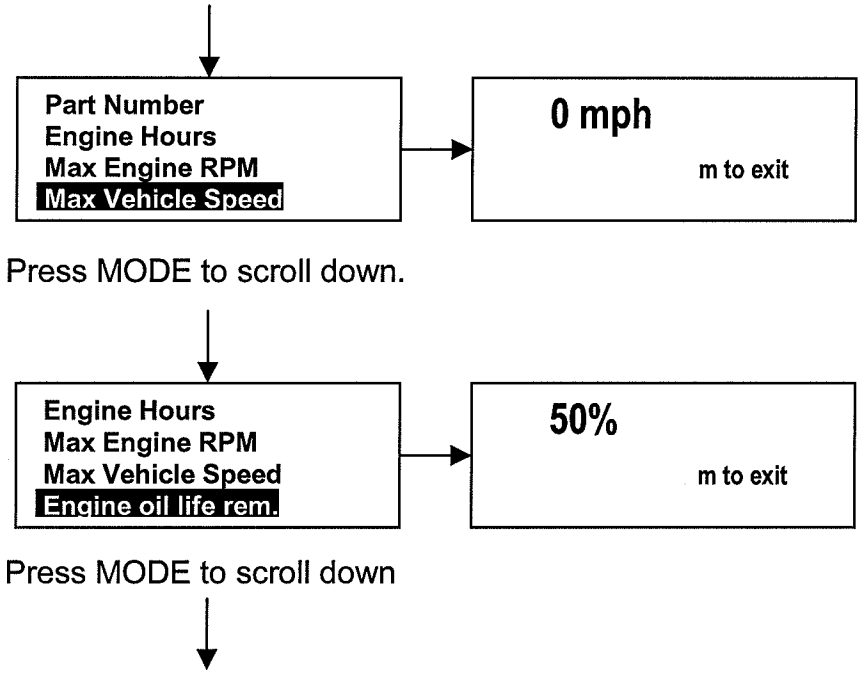
Press MODE to scroll down.

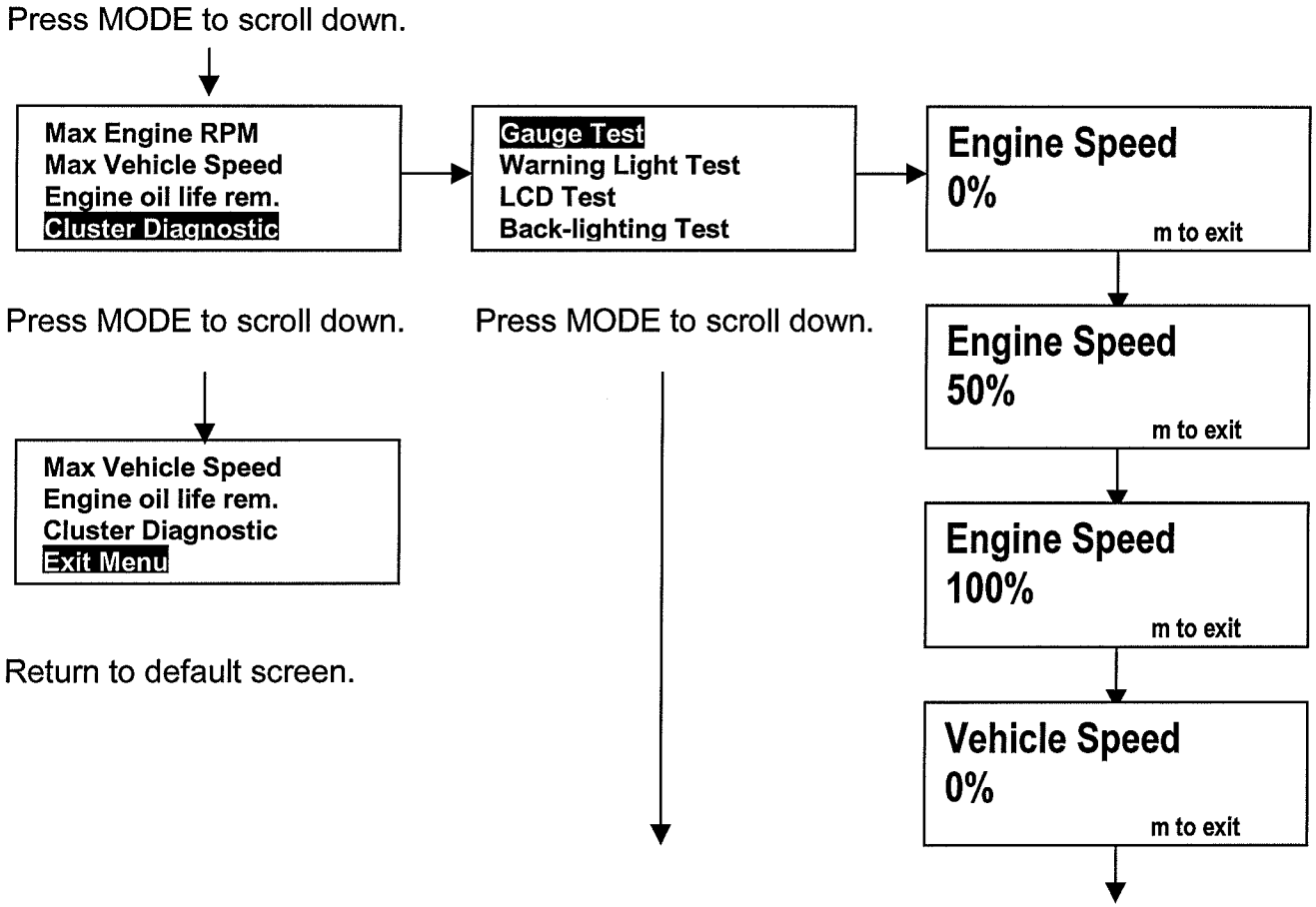


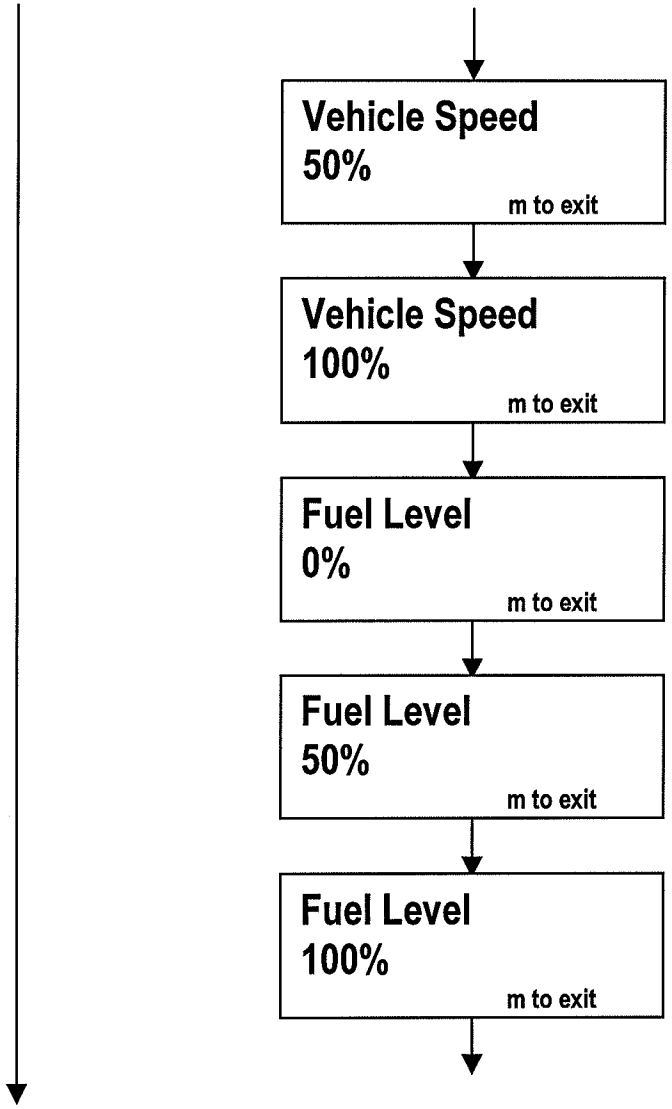
Press MODE to scroll down.

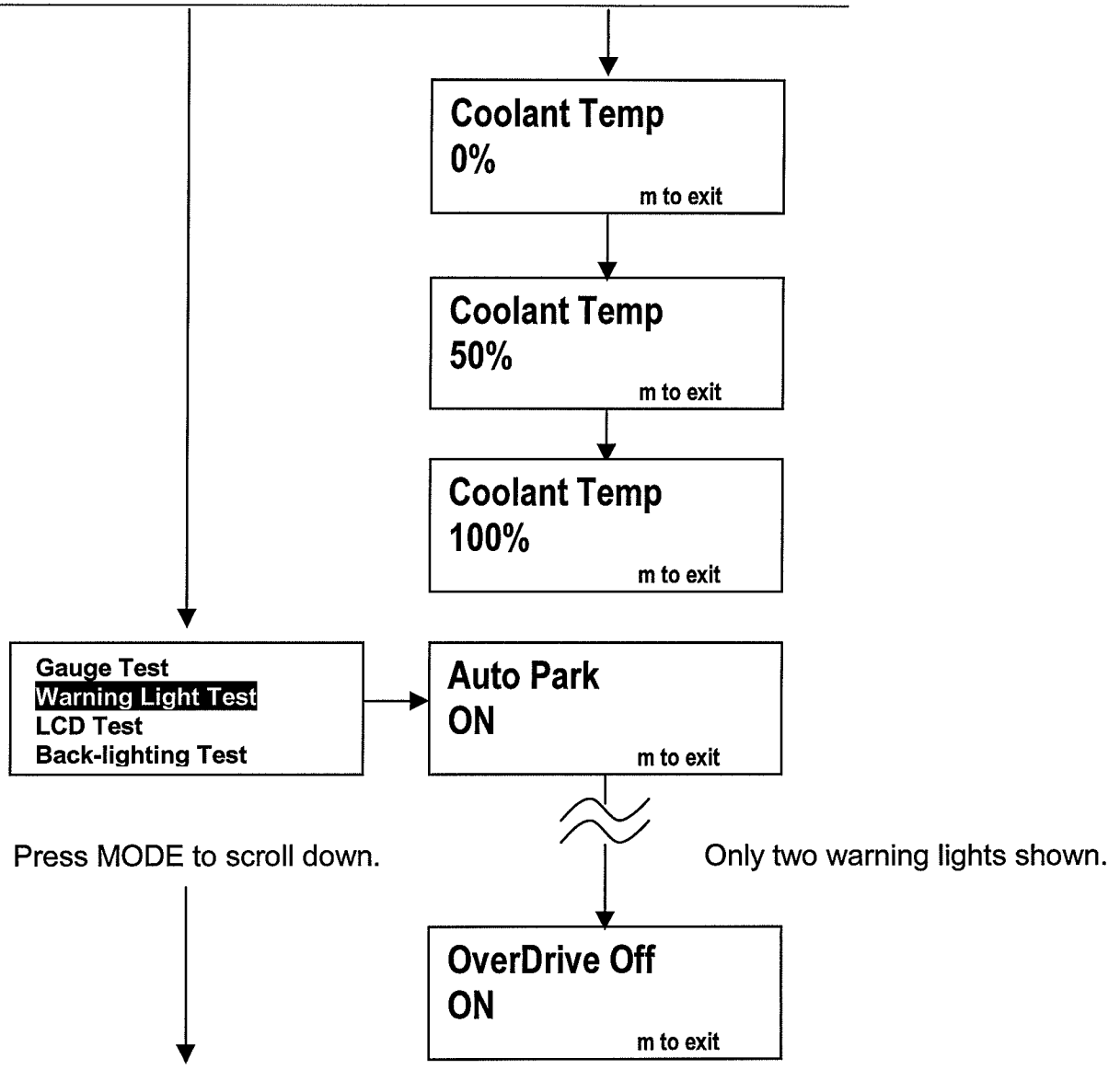


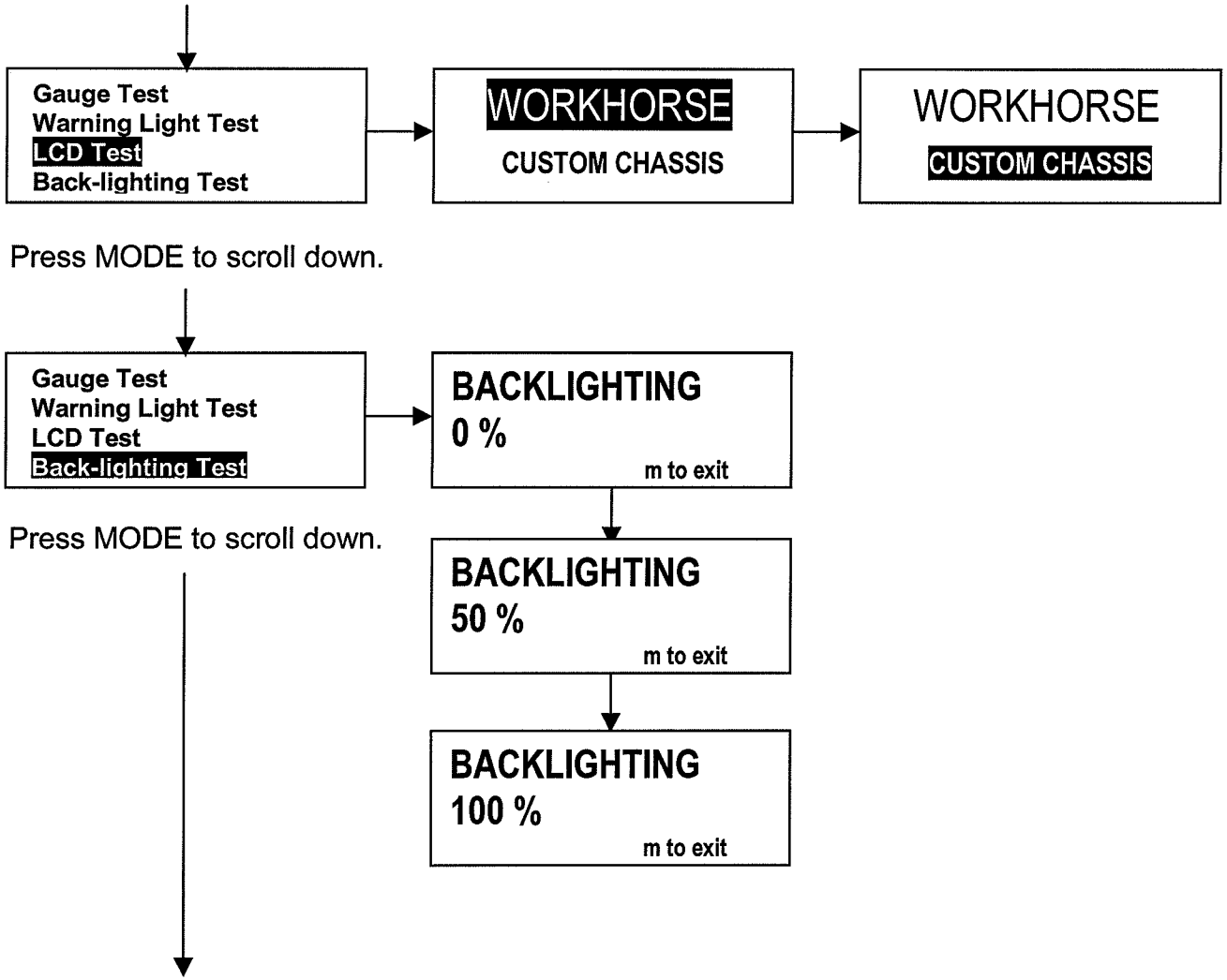
Press MODE to scroll down.

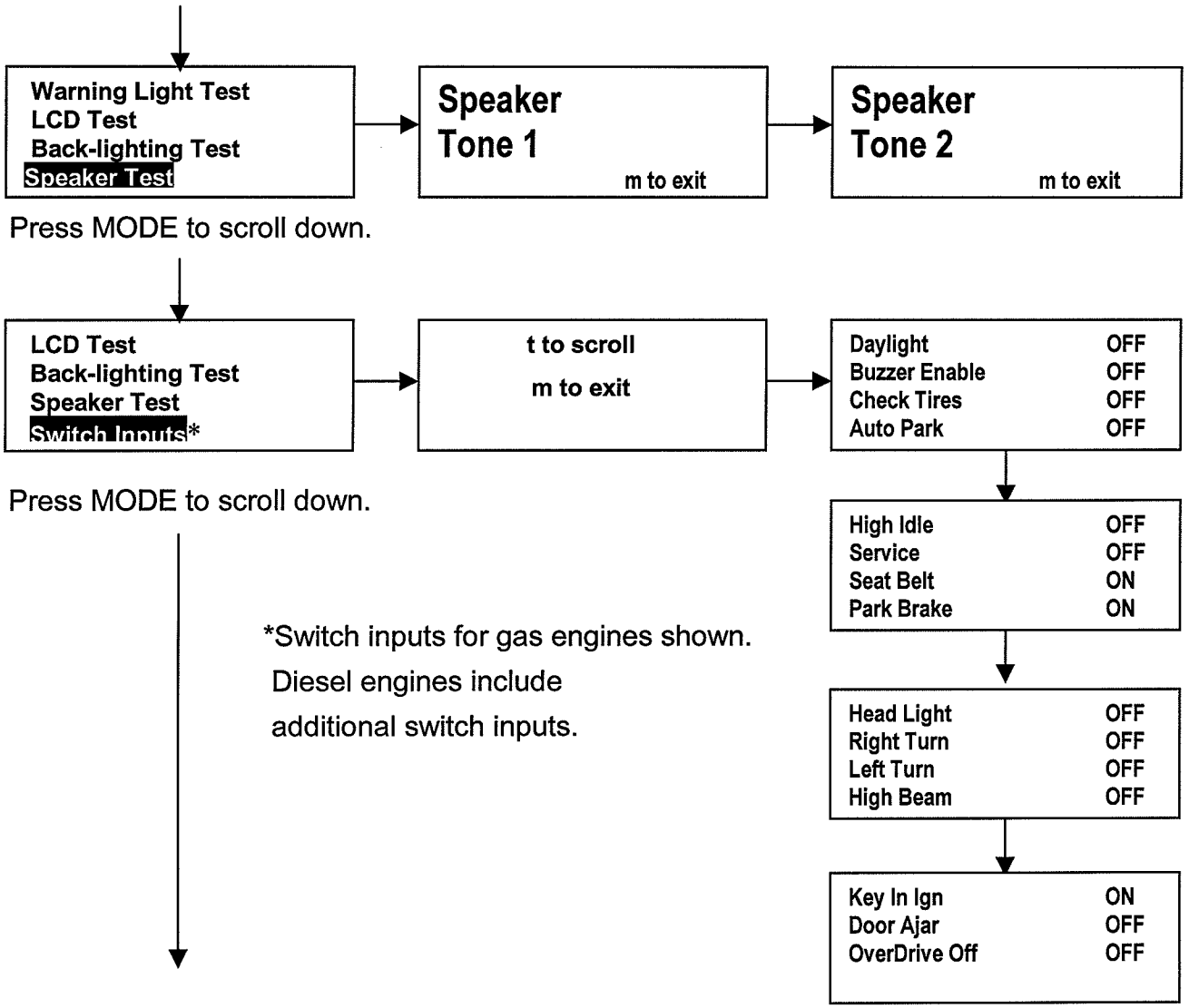

Part Number
Engine Hours
Max Engine RPM
Max Vehicle Speed
0 mph
m to exit
Press MODE to scroll down.
Engine Hours
Max Engine RPM
Max Vehicle Speed
Engine oil life rem.
50%
m to exit
Press MODE to scroll down

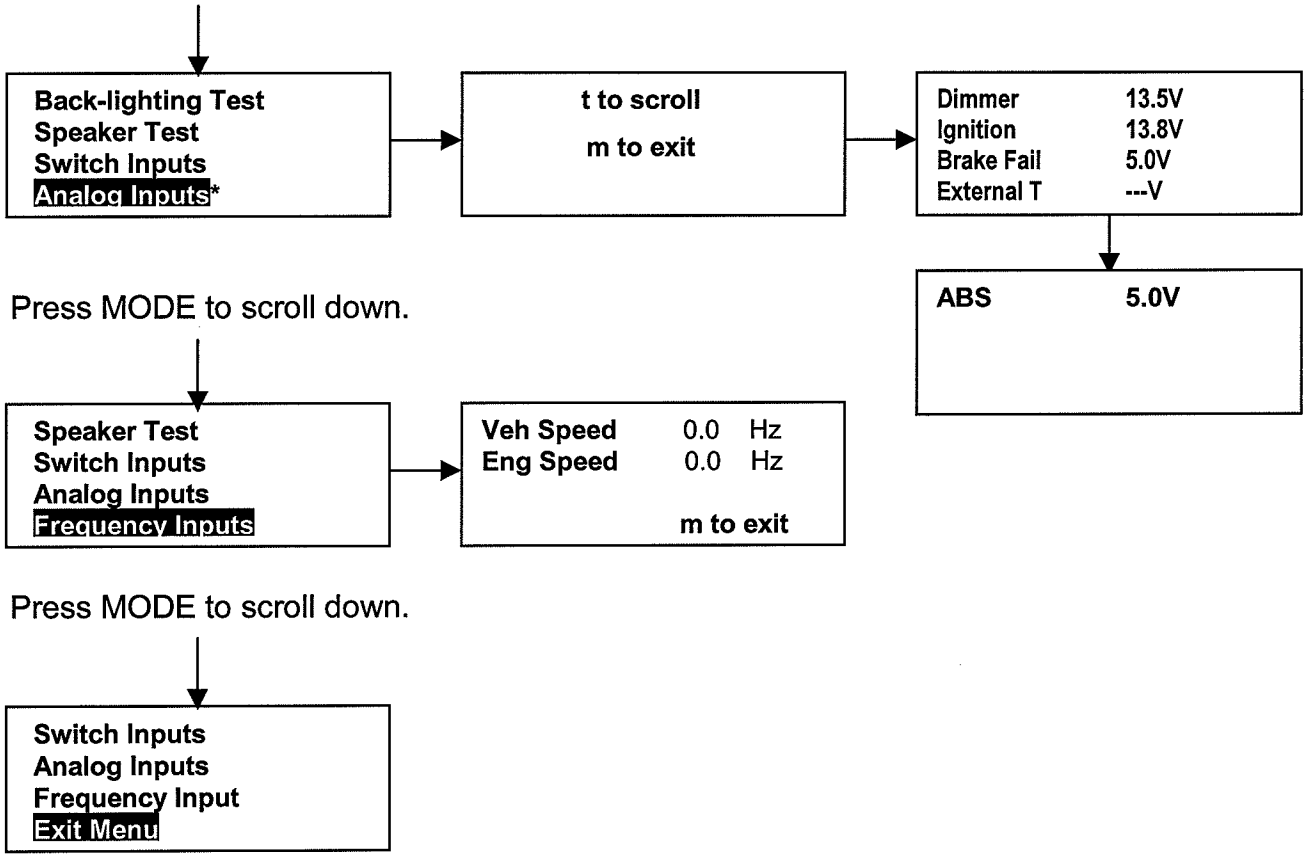

Press MODE to scroll down.
Max Engine RPM
Max Vehicle Speed
Engine oil life rem.
Cluster Diagnostic
Gauge Test
Warning Light Test
LCD Test
Back-lighting Test
Engine Speed
0%
m to exit
Press MODE to scroll down.
Press MODE to scroll down.
Engine Speed
50%
m to exit
Max Vehicle Speed
Engine oil life rem.
Cluster Diagnostic
Exit Menu
Engine Speed
100%
m to exit
Return to default screen.
Vehicle Speed
0%
m to exit


Vehicle Speed
50%
m to exit
Vehicle Speed
100%
m to exit
Fuel Level
0%
m to exit
Fuel Level
50%
m to exit
Fuel Level
100%
m to exit


Coolant Temp
0%
m to exit
Coolant Temp
50%
m to exit
Coolant Temp
100%
m to exit
Gauge Test
Warning Light Test
LCD Test
Back-lighting Test
Auto Park
ON
m to exit
Press MODE to scroll down.
Only two warning lights shown.
OverDrive Off
ON
m to exit


Gauge Test
Warning Light Test
LCD Test
Back-lighting Test
WORKHORSE
CUSTOM CHASSIS
WORKHORSE
CUSTOM CHASSIS
Press MODE to scroll down.
Gauge Test
Warning Light Test
LCD Test
Back-lighting Test
BACKLIGHTING
0 %
m to exit
Press MODE to scroll down.
BACKLIGHTING
50 %
m to exit
BACKLIGHTING
100 %
m to exit


Warning Light Test
LCD Test
Back-lighting Test
Speaker Test
Speaker
Tone 1
m to exit
Speaker
Tone 2
m to exit
Press MODE to scroll down.
LCD Test
Back-lighting Test
Speaker Test
Switch Inputs*
t to scroll
m to exit
Daylight OFF
Buzzer Enable OFF
Check Tires OFF
Auto Park OFF
High Idle OFF
Service OFF
Seat Belt ON
Park Brake ON
Head Light OFF
Right Turn OFF
Left Turn OFF
High Beam OFF
Key In Ign ON
Door Ajar OFF
OverDrive Off OFF
Press MODE to scroll down.
*Switch inputs for gas engines shown.
Diesel engines include
additional switch inputs.



*Analog inputs for gas engines shown.
Diesel engines include **Fuel Level**.