

PAINLESS[®]

PERFORMANCE PRODUCTS



Wire Harness Installation Instructions

For Installing Harness Numbers:

60217: 99 – 06 GM Gen III 4.8/5.3/6.0L EFI Harness

60218: 99 – 06 GM Gen III 4.8/5.3/6.0L EFI Harness Extra Length

**60714 & 60716: 99 – 06 GM Gen III 4.8/5.3/6.0L EFI Harness & VATS
Removed ECM**

Manual P/N 90530

Painless Performance Products recommends you, the installer, read this installation manual from front to back before installing this harness.

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If you have any questions concerning the installation of this harness, feel free to call Painless Performance Products' Tech Line at 1-800-423-9696. The Tech Line can be reached from 8 A.M. to 5 P.M. central time, Monday through Thursday, and 8 A.M. to 4:30 P.M. on Fridays.

We have attempted to provide you with as accurate of instructions as possible and are always concerned about corrections or improvements that can be made. If you have found any issues or omissions, or simply have comments or suggestions concerning these instructions, please write us at the above address, send us a fax at (817) 244-4024, or email us at support@painlessperformance.com. We sincerely appreciate your business.

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CAUTION: BEFORE THE REMOVAL OF YOUR ORIGINAL HARNESS AND/OR THE INSTALL OF YOUR NEW PAINLESS HARNESS, DISCONNECT THE POWER FROM YOUR VEHICLE BY REMOVING THE NEGATIVE OR POSITIVE BATTERY CABLE FROM THE BATTERY.

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1. INTRODUCTION

You have purchased what we at Painless Performance Products believe to be the most up-to-date and easiest-to-install automotive fuel injection harness on the market. It is designed for easy installation, even if you have no electrical experience.

This harness is designed to be a complete wiring system for the fuel injection system on General Motors 1999 - 2002 4.8L, 5.3L, & 6.0L Vortec injected engines and to control the 4L60E, 4L65E, 4L80E, 4L85E automatic or manual transmissions using the computer Service #12200411. This includes all wiring that is needed by the computer to run and control the injection system and transmission.

NOTE: This harness is not emissions legal unless used with kit #60322 or 60323.

To overcome the vehicle anti-theft programming in the computer, the installer must have the ECM re-programmed. This should be done by a qualified programmer with experience in programming for engine transplants. If the ECM is programmed by someone who is not familiar with transplant programming it could result in check engine lights, and even possible damage to your engine.

NOTE: This harness has provision for operating cooling fans. If you wish to operate the fans automatically, you must provide fan relays, and have your programmer activate this function when he programs the ECM. If this function is properly programmed, the harness will activate your fan relays via ground trigger from the ECM according to the on/off temperatures set in the ECM.

NOTE: If you need your GEN III Vortec to be emission legal, the computers program must match the emissions package to that specific engine.

NOTE: Most likely the check engine light will come on and stay on when using a computer without removing the programming for any unused devices.

NOTE: The program in your computer must match the transmission that you plan on using, the manual, 4L60E, 4L65E, 4L80E, or 4L85E. **This will be done when the ECM is programmed.**

Usually the computer, relays and fuse block can easily be mounted under the dash. Most of the wiring in the harness has been pre-terminated to the proper connector and all wire has been GM color-coded. All wiring is TXL, 600 volt, and 125 degree centigrade with cross-link insulation.

This fuel injection system harness has been divided into three major groups:

- | | |
|---------------------|---|
| ENGINE GROUP | Includes wiring for the fuel injectors, ignition & charging systems, power/ground and sensors. |
| DASH GROUP | Includes wiring for the ignition feed, assembly line diagnostic link (DLC) connector, check engine light, computer connectors, brake switch, tachometer, electric speedometer, fuse block, fuel pump relay connector and emissions devices. |
| TAIL GROUP | Include wiring for the VSS, park neutral position sensor, transmission and power wire for fuel pump. |

2. ABOUT THESE INSTRUCTIONS

These instructions provide information for the installation of the 60217 & 60218 Vortec Fuel Injection Harness Kit. The contents of these instructions are divided into major **Sections**, as follows:

1. INTRODUCTION
2. ABOUT THESE INSTRUCTIONS
3. TOOLS NEEDED
4. PRE-INSTALLATION AND HARNESS ROUTING GUIDELINES
5. GENERAL INSTALLATION INSTRUCTIONS
6. 60217 or 60218 VORTEC FUEL INJECTION HARNESS KIT
8. TROUBLE-SHOOTING INSTRUCTIONS

Sections are further divided into **Paragraphs** and **Steps**. Throughout, the **Figure** numbers refer to illustration and the **Table** numbers refer to information in table form. These are located in or near the sections or paragraphs to which they correspond. Always pay careful attention to any notes or any text labeled **CAUTION**.

3. TOOLS NEEDED

In addition to your regular tools, you will need, at least, the following:

Crimping tool	NOTE:	USE A QUALITY TOOL TO AVOID OVER-CRIMPING.
Wire stripper		
Continuity tester	CAUTION:	DO NOT USE A TEST LIGHT TO TEST THE COMPUTER OR SENSOR WIRING OR YOU WILL DAMAGE THE COMPUTER.
Tech II or equivalent scanner	NOTE:	For presetting and diagnostic purposes
Electric drill		
1 5/8" Hole saw	NOTE:	For the rubber grommet in the firewall

4. PRE-INSTALLATION AND HARNESS ROUTING GUIDELINES

The installation of your harness kit will consist of two parts:

- The physical routing, positioning, securing, group/ individual wires and connectors.
- The proper electrical connection of the individual circuits.

We cannot tell you how to route the harness in your automobile. That depends a great deal upon the particular make of the automobile and what extent you want to secure and conceal the harness. We do offer some general guidelines and routing practices starting in **Section 5.3**, general installation instructions in **Section 5**, and precise instruction concerning the electrical connections you will have to make beginning in **Section 6**. To help you begin thinking through the installation of your wire harness, read the following sections:

4.1 TRANSMISSION FUNCTION

If you are using a manual transmission, read **Paragraph 4.1.1**, then skip to the note at the end of the section. If you are using the 4L60E, 4L65E, 4L80E, or 4L85E, then skip **Paragraph 4.1.1**, and start at **Paragraph 4.1.2**.

- 4.1.1 If you are using a **manual transmission**, tape off and store the purple and pink (brake switch) wires, the park neutral position plugs/ wires and the 13-position (transmission) round connector in the tail section.
- 4.1.2 If you **ARE** going to use a **4L60E, 4L65E, 4L80E, or 4L85E transmission**, you must use the vehicle speed sensor (VSS), transmission connector, park neutral position connectors and correct brake switch. These are necessary to make the transmission work correctly. The brake switch should be closed (electrically connected) when the brakes **ARE NOT** being applied and open (not electrically connected) when the brakes **ARE** being applied. This is the opposite of a standard brake light switch. If you are using a pressure brake switch, a **SPDT** relay must be installed to unlock the converter when the brakes are applied. The vehicle speed sensor lets the computer know how fast the wheels are turning. The park neutral position sensor tells the PCM if the transmission is in park or neutral.

NOTE: Emission devices. This harness has provisions for the emission devices. We have rolled up the canister purge and canister vent, air pump, and air bleed solenoid wiring in the dash section. It may be left there if these items are not to be used. If you plan on using these items route these wires out to the engine compartment.

4.2 GET TO KNOW THE ENGINE YOU ARE USING:

NOTE: The 99–02 4.8L, 5.3L & 6.0L Vortec engines had four oxygen sensors from the factory, but we have provisions for only two, one on the driver side and one on the passenger side of the engine. We removed the two rear oxygen sensors since they originally were behind the catalytic converters and most people don't want to run more than two oxygen sensors. This system has two rectangular connectors at the computer. A 12200411 computer is required for proper operation.

- 4.2.1 PPPI recommends the use of the following parts. See **Table 4.1**. These will meet all requirements and are compatible with PPPI harnesses. The numbers given are GM and AC Delco part numbers. **You must use the computer part #12200411.**
- 4.2.2 Familiarize yourself with the harness by locating each of the harness groups and by looking at the connectors on the wire ends.
- 4.2.3 Decide where and how the computer, fuse block, and relays will be mounted. PPPI wire harness kits are designed to mount either under the dash or in the kick panel on the right side.
- 4.2.4 A good exercise is to lay out the wire harness on the floor beside your vehicle and identify all the connectors and wires.
- 4.2.5 You will want to route the harness through and around open areas. Inside edges provide extra protection from hazards and also provide places for tie wraps, clips, and other support.
- 4.2.6 Route the harness away from sharp edges, exhaust pipes, and the hood, trunk, and door hinges.
- 4.2.7 Plan where harness supports will be located. Use a support approximately every 6 inches unless the harness routes under the floor carpet.

4.8L, 5.3L & 6.0L Vortec Fuel Injection Harness (99 - 02) Part # 60217 & 60218

Main Computer	Service# 12200411	MAP Sensor	Delco# 213-796
Fuel Pump Relay	Painless# 80130	Idle Air Control Motor	GM# 17113598
Brake Switch	Painless# 80176	Knock Sensor	Delco# 213-362
MAF/ IAT Sensor	Delco# 213-364	EGR Valve	GM# 17113575
Engine Coolant Temperature	Delco# 213-953	Coils	GM# 10457730
Oxygen Sensor (Pass. Side)	Delco# AFS106	Cam Position Sensor	GM# 12561211
Oxygen Sensor (Dvr. Side)	Delco# AFS106	Crankshaft Position Sensor	Delco# 213-354
TPS Sensor	Delco# 213-912	Air Pump Relay	Delco# 15-8271

Table 4.1 Compatible Parts

4.2.8 Allow enough slack in the harness at places where movement could possibly occur (body to frame, frame to engine, etc.).

4.2.9 The wires should be bundled into harness groups. Use tape, nylon ties, or poly split loom.

5. GENERAL INSTALLATION INSTRUCTIONS

- **DO NOT DISCONNECT THE BATTERY OR THE COMPUTER CONNECTORS WHILE THE IGNITION IS ON.**
- **DO NOT SHORT ANY WIRES IN THIS HARNESS TO GROUND (WITH THE EXCEPTION OF LABELED GROUND WIRES) OR DAMAGE TO THE COMPUTER WILL RESULT.**
- **GIVING OR RECEIVING A "JUMP START" MAY DAMAGE THE COMPUTER.**
- **DO NOT USE A TEST LIGHT WHEN TESTING COMPUTER SENSORS OR COMPUTER CIRCUITS. DAMAGE TO THE COMPUTER WILL RESULT!**
- **WHEN ROUTING THE WIRES FOR THE VEHICLE SPEED SENSOR (IF USED) MAKING CERTAIN THAT THEY ARE AT LEAST 12 INCHES AWAY FROM ANY IGNITION WIRING (SPARK PLUG WIRES, ETC.).**

NOTES:

- There is a normal, small current drain on these fuel injected systems.
- Each connector in this harness is different and will not fit in the wrong place. **NEVER FORCE ANY CONNECTOR.**
- When connecting the plugs to the computer **USE EXTREME CARE** to make sure none of the pins in the computer are or become bent.
- The fuel pump you are using **MUST** maintain a constant pressure of **55-62 P.S.I.** (pounds per square inch). The Vortec fuel system does have a built-in regulator on the fuel rail as in many earlier GM fuel injection systems.

5.1 GROUNDING THE VEHICLE

A perfectly and beautifully wired automobile will nevertheless have problems if everything is not properly grounded. Don't go to the effort to installing a quality wire harness only to neglect proper grounding.

Note: The installer of this harness is responsible for all ground wires not provided with this part.

- 5.1.1 Connect a ground strap or cable (minimum of a 4 Ga. wire) from the negative battery terminal to the chassis (frame).
- 5.1.2 Connect a ground strap (minimum of a 4 Ga. wire) from the engine to the chassis (frame). **Do not rely upon the motor mounts to make this connection.**
- 5.1.3 Connect a ground strap from the engine to the body.

5.2 ROUGH INSTALLATION

CAUTION: DISCONNECT THE POWER FROM YOUR VEHICLE BY REMOVING THE NEGATIVE BATTERY CABLE FROM THE BATTERY.

Note: Make no wire connections or permanent mounting of any kind at this time.

- 5.2.1 Position the computer and sensors in their intend locations.
- 5.2.2 **Drill a 1-5/8"** hole for the firewall grommet near the computer for the engine group and tail section to pass through.
- 5.2.3 Route the engine group and tail section through the hole. Push the grommet (already installed on the harness) into the hole until it is seated.
- 5.2.4 Route the dash group over to the driver's side of the car.
- 5.2.5 Route the fuse block and relays to the place they will be mounted.

5.3 HARNESS ATTACHMENT

Note: Harness routing and shaping will be a time-consuming task. Taking your time will enhance the beauty of your vehicle. Please take your time and be patient.

- 5.3.1 Permanently mount your computer. You should mount the fuse block and relays at this time.
- 5.3.2 Mold harness groups to the contour of the dash, engine, frame, etc. Remember to route harness away from sharp edges, exhaust pipes, hinges, and moving parts.
- 5.3.3 Attach harness groups to your automobile with clips or ties starting at the computer and working your way outward.

Note: Do not tighten tie wraps or mounting devices at this time. Make all harness attachments LOOSELY.

- 5.3.4 When used every 1-1/2" or so on the visible areas of the harness, colored plastic wire ties make a very attractive assembly. Otherwise, a tie installed in other areas every 6" or so will hold the wires in place securely. **REMEMBER TO TAKE YOUR TIME.**

5.4 TERMINAL INSTALLATION INSTRUCTION

Note: In the following steps you will be making the circuit connections. Before you start, you should carefully read Sections 6.0, and continually refer to the wire charts, DOUBLE CHECKING your length calculations before cutting any wire or making any connections. These directions are for the wires, which do not have a connector already, installed on them.

- 5.4.1 Have all tools and connectors handy.
- 5.4.2 Select the correct terminal for the wire and application.
- 5.4.3 Determine the correct wire length and cut the wire. Remember to allow enough slack in the harness and wires at places where movement could occur. **DOUBLE CHECK YOUR CALCULATIONS.**

5.4.4 Strip insulation away from wire. Only strip as much insulation off as necessary for the type of terminal lug you are using.

Note: In the following step, make sure that the terminal is crimped with proper die in the crimping tool. An improper crimp will not make a good connection. **DO NOT OVER-CRIMP.**

5.4.5 Crimp the terminal onto the wire.

5.4.6 Connecting the wires and connectors throughout the harness is a simple process. Make sure that each wire is properly routed and then attached.

5.4.7 When all the wires are attached, tighten the mounts and ties to secure the harness permanently.

5.4.8 Attach the connectors to the computer. **BE VERY CAREFUL NOT TO BEND ANY PINS.**

5.4.9 After all connections have been made throughout the harness, connect the battery to the vehicle.

CAUTION: **BE SURE THE IGNITION IS OFF WHEN YOU RECONNECT THE BATTERY OR YOU WILL DAMAGE THE COMPUTER.**

6. INSTALLATION INSTRUCTIONS

6.1 KIT CONTENTS

Take inventory to see that you have everything you are supposed to have in this kit, if anything is missing, contact the dealer where you obtained the kit or contact Painless Performance at (800) 423-9696 or (817) 244-6898.

The kit should contain the following items:

- The main wire harness with the connectors already on the ends of most of the wires
- Fuel Injection Installation Instructions P/N 90530 (This Booklet)
- 4" & 7" tie wraps

6.2 DASH SECTION INSTALLATION

Note: If you have not already done so, read sections 4.0 and 5.0 of these instructions and think through the installation of the harness before securing or cutting any wires.

The wires in this group consist of the diagnostic link connector (DLC) (**SEE FIGURE 6.1**), the check engine light (pre-mounted into a mounting bracket), fuel pump relay, emissions devices (optional) and 6 other wires.

CAUTION: **DO NOT MAKE ANY CONNECTIONS WHILE THE COMPUTER IS PLUGGED INTO THE HARNESS.**

Note: Wire color (Example: BLK/WHT) is one wire with a stripe. The second color (the stripe) may not be bold. Observe all two-color wires closely.

6.2.1 AC REQUEST – (GRN/WHT) This is not a power supply for the compressor

A. This circuit is used to inform the PCM that the AC compressor has been turned on. This wire is to be spliced into and receive 12V from the circuit from the AC switch to the AC compressor when the AC is activated.

6.2.2 The secondary Air Injection (**AIR**) system helps reduce hydrocarbon (HC), carbon monoxide (CO), and oxides of nitrogen (NOx) exhaust emissions.

- A. **AIR PUMP (not equipped on all models)** - The AIR pump assembly is mounted in the right rear corner of the engine compartment and supplies the air to the AIR system. The electric air pump sends air to the check valves near the exhaust manifolds. The AIR pump is controlled by the Powertrain Control Module (**PCM**) through the AIR pump solenoid relay. Battery voltage to the AIR pump is controlled by the AIR pump solenoid relay. A vacuum operated shut off valve prevents air flow during OFF periods. When the PCM provides a ground circuit for the secondary AIR pump solenoid relay, battery voltage applies power to the AIR pump and the solenoid. Intake manifold vacuum is then applied through the solenoid to the vacuum operated shut off valve. The vacuum operated shut off valve then opens up and allows air to be delivered to the check valves. **See Figure 6.7**
 - B. **AIR RELAY (not equipped on all models)** - The PCM controls the operation of the AIR system through the AIR pump solenoid relay. When the PCM provides a ground circuit for the secondary AIR pump solenoid relay, battery voltage is allowed to power up the AIR pump and the solenoid. **See Figure 6.4**
 - C. **AIR SOL (not equipped on all models)** - The AIR solenoid is activated by the AIR pump solenoid relay. The AIR solenoid allows intake manifold vacuum to the shut off valve. The shut off valve then opens allowing air flow. **See Figure 6.8**
 - D. **CAN VENT (not equipped on all models)** - The Evaporative Emissions (**EVAP**) control system used on all vehicles is the charcoal canister storage method. This method transfers fuel vapor from the fuel tank to an activated carbon, charcoal, storage device, canister, to hold the vapors when the vehicle is not operating. When the engine is operating, the fuel vapor is purged from the carbon element by intake air flow and consumed in the normal combustion process. **See Figure 6.6**
 - E. **CANISTER PURGE (not equipped on all models)** - The Evaporative Emissions (**EVAP**) control system is the charcoal canister storage method. This method transfers fuel vapor from the fuel tank to an activated carbon charcoal storage canister, to hold the vapors when the vehicle is not operating. When the engine is operating, the fuel vapor is purged from the carbon element by intake air flow and consumed in the normal combustion process. **See Figure 6.5**
- 6.2.3 BRAKE SW (optional)** - These circuits are used to provide power to the TCC solenoid in the automatic transmission. If you are not using the electronic automatic transmission, you may stow these wires. If you are using the electronic automatic transmission, these wires will connect to the brake switch terminals that are normally used for cruise control or TCC solenoid (normally closed). **These wires do not connect to the terminals for the brake lights.** See table 4.1 for the recommended brake switch. If you are using the recommended brake switch then you will wire it according to **Figure 6.2**. The pink wire to the back of the switch in the illustration is the wire that has power on it whether or not the brake is being applied. If your vehicle has a pressure type brake switch, you may use a relay as shown in **Figure 6.3**. The relay must be a **SPDT Relay** and wired correctly or it could result in a dangerous situation with the vehicle. The torque converter may not unlock.
- 6.2.4 DLC** - The Data Link Connector (**DLC**) **Figure 6.1** is used to communicate with the PCM. The Powertrain on Board Diagnostic (**OBD**) System Check is an organized approach to identifying a problem created by an electronic powertrain control system malfunction. The Powertrain OBD System Check is the starting point for any drivability concern diagnosis. The Powertrain OBD System Check directs the installer to the next logical step in diagnosing a drivability concern. Understanding and using the Powertrain OBD System Check correctly will reduce the diagnostic time and prevent the replacement of good parts. Mount the DLC connector using the bracket that the light is mounted in allowing access to the front of the connector allowing you to see the light while driving. **See Figure 6.1**
- 6.2.5 FUEL TEST (GRAY use as needed)** - This circuit is used to power the electric fuel pump for test purposes only. Temporarily apply fused positive power to this wire for testing the fuel pump.

- 6.2.6 **FUSE BLOCK IGNITION (PINK mandatory)** - This circuit is used to provide power to the injection system. Connect this wire to a terminal/ wire from the ignition switch that is hot in the **RUN** and **CRANK** positions. Failure to provide power in the crank position will result in PCM shutdown while the engine is trying to start. *Note: You will know this circuit is properly connected if the **Check Engine Light** is on when the ignition switch is on and while starting.*
- 6.2.7 **TACH (WHITE optional)** - This circuit is used to provide a signal from the PCM to the tachometer. Connect this wire to the signal input on the tachometer.
- 6.2.8 **VSS OUTPUT (GRN/WHT optional)** - This circuit is used to provide a signal from the PCM to the electric speedometer. Connect this wire to the signal input on the electric speedometer (not all aftermarket electric speedometers use the same signal for operation. Consult the tech dept of the speedometer manufacture for compatibility).

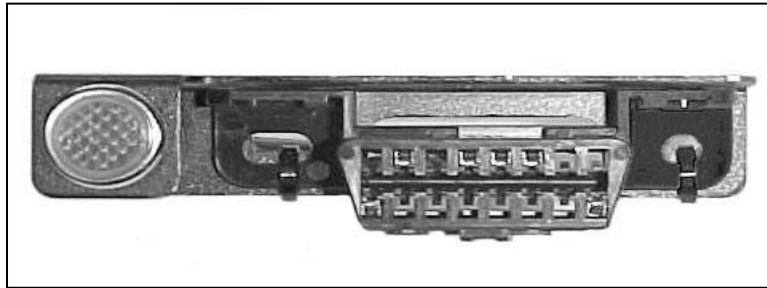


FIGURE 6.1 DLC Connector & Check Engine Light

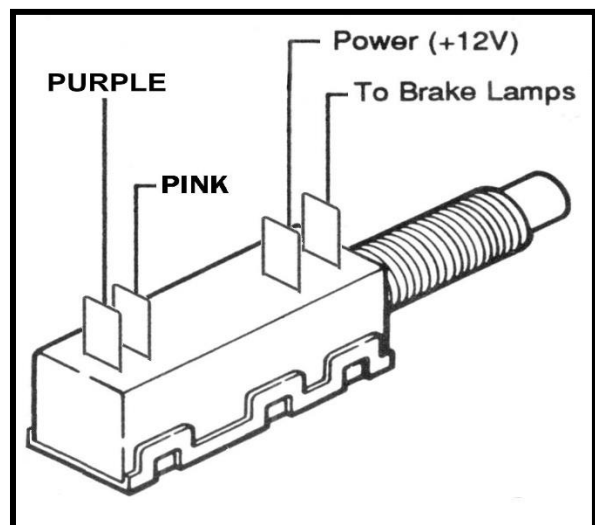
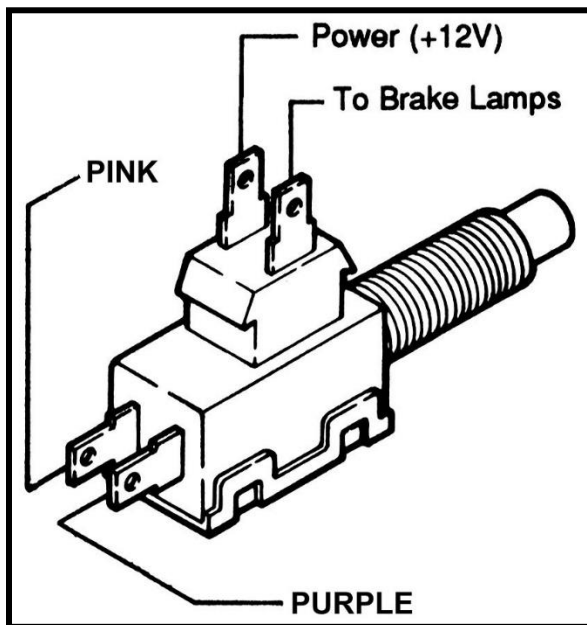


FIGURE 6.2 Brake Switch Connections

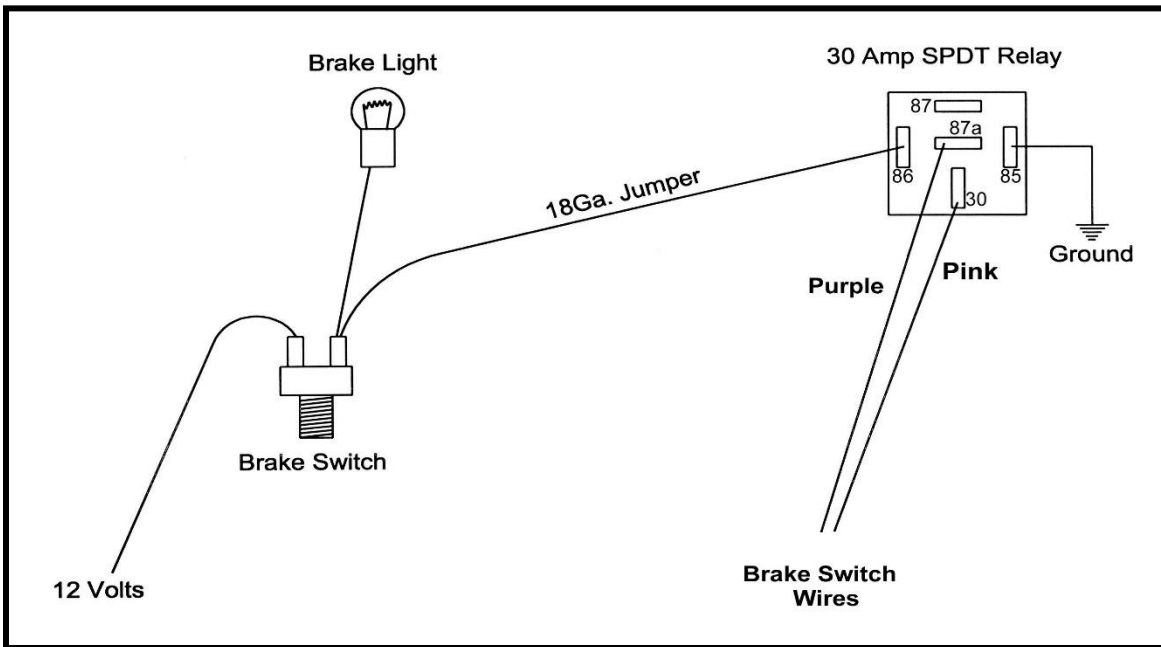


FIGURE 6.3 Brake Switch Relay

<u>WIRE COLOR</u>	<u># OF WIRES IN CONNECTOR</u>	<u>LABELLED</u>	<u>CONNECT TO:</u>
BROWN, RED, ORANGE, PINK	4	Air Relay	Relay
PINK, GREEN/WHITE	2	Canister Purge	Canister Purge Solenoid
PINK, WHITE	2	Canister Vent	Canister Vent Solenoid
BLACK, RED	2	Air Sol	Air Bleed Solenoid
BLACK, RED	2	Air Pump	Air Pump
GRAY, GREEN/WHITE, BLACK, ORANGE	4	Fuel Relay	Fuel Pump Relay
GREEN/WHITE		VSS Output	Speedometer
WHITE		Tach	Tachometer
PINK, PURPLE		Brake Switch	Brake Switch
PINK		Fuse Block Ignition	Ignition Power
GREEN/ WHITE		AC Request	Compressor B+
GRAY		Fuel Test	see Paragraph 6.2.1

TABLE 6.1 Dash Section Connections

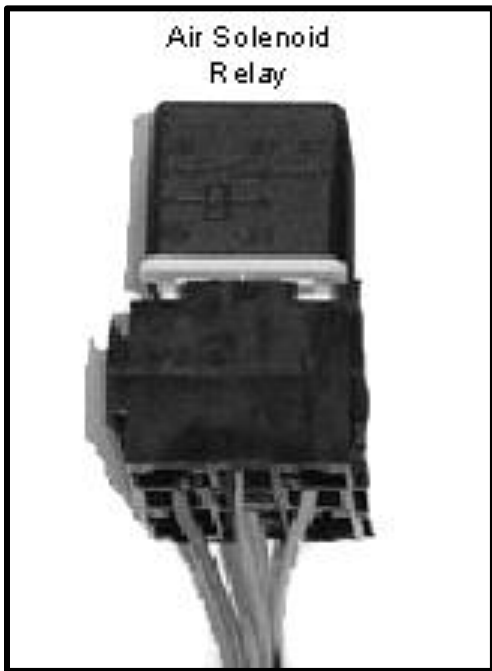


FIGURE 6.4 Air Pump Relay

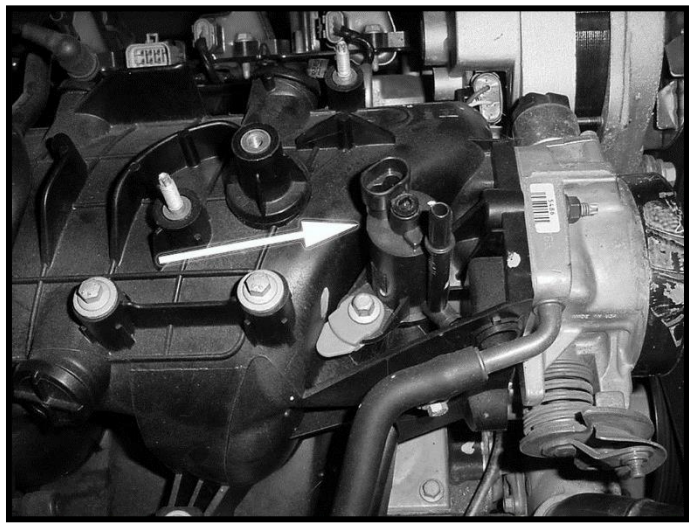


FIGURE 6.5 Canister Purge Solenoid

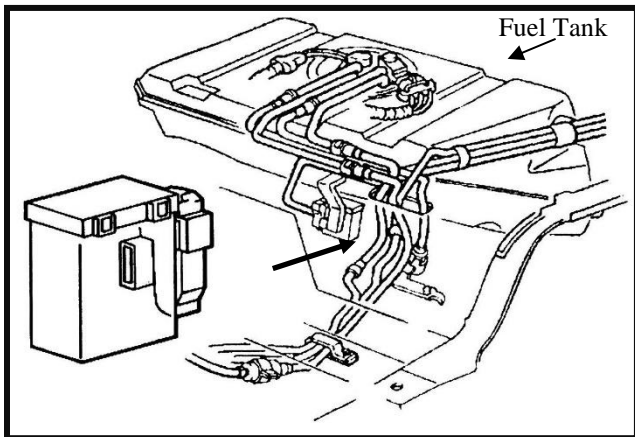


FIGURE 6.6 Canister Vent Solenoid

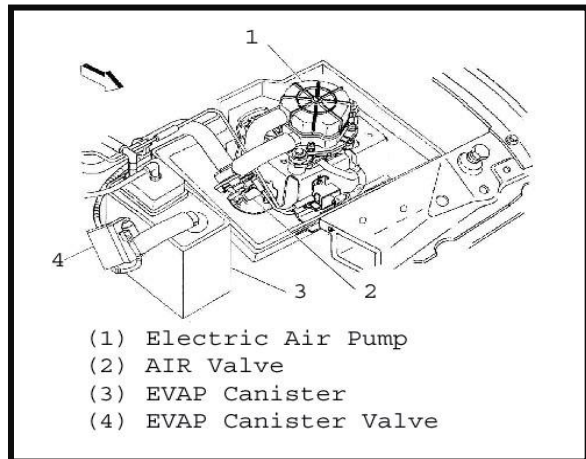


FIGURE 6.7 Air Pump Connections

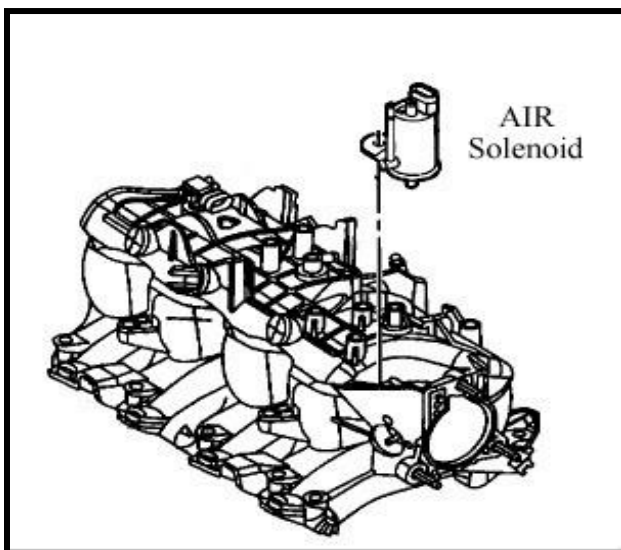


FIGURE 6.8 Air Solenoid

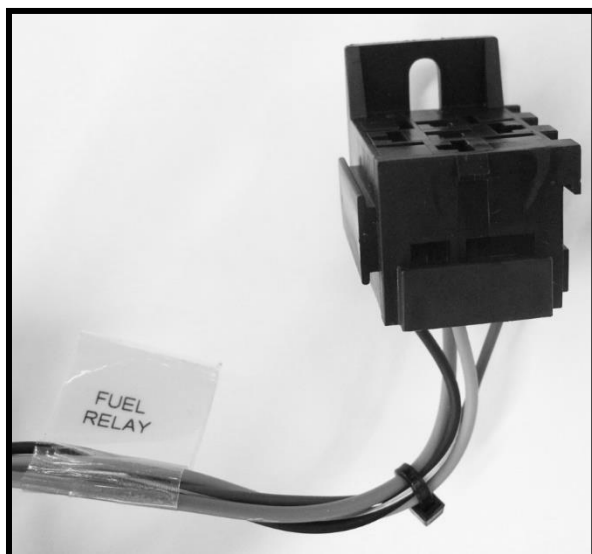


FIGURE 6.9 Fuel Pump Relay Connector

6.3 ENGINE GROUP INSTALLATIONS

The engine group is designed to be separated into left (driver) and right (passenger) sections. Each side is tie-wrapped separately, BUT NOT LABELED. The left side of the has the connectors for the idle air control, throttle position sensor, mass air flow sensor, and engine coolant sensor, all of which ARE labeled. When you begin routing, FIRST separate the engine group into left and right sections, and place them accordingly.

NOTE: The air pump, air bleed, canister purge, and canister vent solenoid connectors are rolled up in the dash section and must be routed out to the engine compartment if these items are to be used. Note: Before you connect any wires, separate the tail section from the engine group and place it out of the way.

- 6.3.1. ALT (Brown optional)** – This circuit is used to excite (turn on) the voltage regulator. When using the stock alternator equipped on the 4.8, 5.3 or 6.0L Vortec engines, this wire will connect to the L terminal in the voltage regulator plug. You must add either a small indicator light or suitable voltage reducer (82 Ohm/ 5 Watt resistor). Painless offers a replacement alternator pigtail that includes the proper resistor, part #30705. For any other charging system combinations, contact the Painless tech dept.
- 6.3.2. CKP (mandatory)** – The Crankshaft Position (CKP) sensor provides the PCM with crankshaft speed and crankshaft position. The PCM utilizes this information in order to determine if an engine misfire is present. The PCM monitors the CKP sensor for momentary drop in crankshaft speed in order to determine if a misfire is occurring. See Figure 6.15
- 6.3.3. CMP (mandatory)** – The Camshaft Position (CMP) sensor provides the PCM with camshaft speed and position. The PCM monitors the CMP sensor for any momentary drops in camshaft speed in order to determine if a misfire is occurring. See Figure 6.14
- 6.3.4. DRVR. & PASS COIL (mandatory)** – The ignition system on this engine is a multiple coil configuration called coil per plug. The ignition coil mounting bracket is attached to the rocker cover. The secondary ignition wires are short compared to a distributor ignition system wire. See Figure 6.21 & 6.22
- 6.3.5. ECT (mandatory)** – The (PCM) supplies a 5-volt signal to the Engine Coolant Temperature (ECT) sensor through a resistor in the PCM and measures the voltage. The voltage is high when the engine is cold. The voltage is low when the engine is hot. The PCM calculates the engine coolant temperature by measuring the voltage. The engine coolant temperature affects most systems the PCM controls. See Figure 6.23
- 6.3.6. EGR (optional)** – An Exhaust Gas Recirculation (EGR), system is used to lower oxides of nitrogen (NOx) emission levels. The EGR system accomplishes this by feeding small amounts of exhaust gas back into the combustion chamber. High combustion temperatures cause NOx. Combustion temperatures are reduced when the air/fuel mixture is diluted with the exhaust gases. See Figure 6.10
- 6.3.7. GROUND (mandatory)** – These circuits are used to provide ground for the entire injection system. Connect these wires to different bolts in the engine block, transmission, or cylinder head. Under no circumstances should all of these grounds be connected to the same grounding point. For best results from your EFI system, be certain your grounding surfaces are clean and your connections are secure.
- 6.3.8. IAC (mandatory)** - The purpose of the Idle Air Control Motor (IAC) is to control engine idle speed. The IAC valve, mounted in the throttle body, controls the amount of bypass air. See Figure 6.19
- 6.3.9. INJ #1 - #8 (mandatory)** – The Multec 2 fuel injector assembly is a solenoid operated device, controlled by the PCM that meters pressurized fuel to a single engine cylinder. An injector that has been sitting for more than 6 months will need to be cleaned/ replaced as the varnish residue in the fuel will cause the injector to stick closed. This will keep the injector from delivering fuel as needed by the injection system. See Figure 6.16 & 6.17

- 6.3.10. KNOCK (mandatory)** – To control spark knock, a Knock Sensor (KS) system is used. This system is designed to retard spark timing up to 20 degrees to reduce spark knock in the engine. This allows the engine to use maximum spark advance to improve drivability and fuel economy. See Figure 6.11
- 6.3.11. LEFT & RIGHT O2 SEN. (mandatory)** – The PCM uses the signal voltage from heated oxygen sensors in a Closed Loop to adjust the fuel injector pulse width. In Closed Loop, the PCM adjust fuel delivery to maintain an air to fuel ratio which allows the best combination of emission control and drivability. See Figure 6.12
- 6.3.12. MAF-IAT (mandatory)** – The Mass Air Flow (MAF) sensor measures the amount of air which passes through the sensor. The PCM uses this information to determine the operating condition of the engine in order to control the fuel delivery. A large quantity of air indicates acceleration. A small quantity of air indicates deceleration or idle. See Figure 6.20
- 6.3.13. MAP (mandatory)** – The Manifold Absolute Pressure (MAP) sensor responds to changes in the intake manifold pressure as a result of engine load and speed. The map sensor converts this to a voltage output. See Figure 6.13
- 6.3.14. STARTER B+ (mandatory)** – These circuits are used to maintain memory in the PCM and provide power to all heavy amp circuits. Connect these wires to the battery post on the starter solenoid (the same post as the positive battery cable) or to a positive battery source.
- 6.3.15. TPS (mandatory)** – The TP sensor attaches to the side of the throttle body opposite the throttle lever. The TP sensor senses the throttle valve angle and relays that information to the control module. The control module requires knowledge of throttle angle in order to generate the required injector control signals, or pulses. See Figure 6.18
- 6.3.16. FAN#1 (GRN) FAN#2 (BLUE)** – These wires connect to the ground wire from the relays used for the cooling fans. The installer MUST inform the ECM Programmer that he is going to use one or both of these wires so they can be activated when the ECM is programmed.

<u>WIRE COLOR</u>	<u># OF WIRES IN CONNECTOR</u>	<u>LABELED</u>	<u>CONNECT TO:</u>
BLACK, RED, GREEN, BROWN, LT. BLUE, PURPLE, PINK	7	DRVR COIL	Driver's Coil
BLACK, RED/ WHITE, GREEN/ WHITE, BROWN/ WHITE, LT. BLUE/ WHITE, PURPLE/ WHITE, PINK	7	PASS COIL	Passenger Coil
WHITE, PURPLE, BROWN, GRAY, RED	5	EGR	EGR Valve
BLACK, TAN, BLACK/ WHITE, PINK, YELLOW	5	MAF – IAT	Mass Air Flow Sensor
LT. GREEN/ BLACK, LT. GREEN/ WHITE, LT. BLUE/ BLACK, LT. BLUE/ WHITE	4	IAC	Idle Air Control Motor
TAN/ WHITE, PURPLE/ WHITE, BLACK, PINK	4	LEFT O2 SEN	Left Oxygen Sensor
TAN, PURPLE, BLACK, PINK	4	RIGHT O2 SEN	Right Oxygen Sensor
BLACK/ WHITE, YELLOW/ BLACK, LT. GREEN	3	CKP	Crankshaft Position Sensor

<u>WIRE COLOR</u>	<u># OF WIRES IN CONNECTOR</u>	<u>LABELED</u>	<u>CONNECT TO:</u>
BROWN/ WHITE, PINK/ BLACK, RED	3	CMP	Camshaft Position Sensor
ORANGE/ BLACK, LT. GREEN, GRAY	3	MAP	Manifold Absolute Pressure Sensor
GRAY, BLACK, BLUE	3	TPS	Throttle Position Sensor
GRAY, YELLOW	2	ECT	Engine Coolant Temperature Sensor
BLACK, PINK	2	INJ #1	Driver Side Front Injector
LT. GREEN/ BLACK, PINK	2	INJ #2	Passenger Side Front Injector
PINK/ BLACK, PINK	2	INJ #3	Driver Side 2 nd Injector
LT. BLUE/ BLACK, PINK	2	INJ #4	Passenger Side 2 nd Injector
BLACK/ WHITE, PINK	2	INJ #5	Driver Side 3 rd Injector
YELLOW/ BLACK, PINK	2	INJ #6	Passenger Side 3 rd Injector
RED/ BLACK, PINK	2	INJ #7	Driver Side Rear Injector
BLUE/ WHITE, PINK	2	INJ #8	Passenger Side Rear Injector
BLUE, LT. BLUE	2	KNOCK	Knock Sensor
BROWN		ALT	Alternator Exciter
RED (2)		STARTER B+	Starter Solenoid Batt. Terminal
BLACK (3), BLACK/ WHITE (3)		GROUND	Engine Ground

TABLE 6.2 Engine Section Connections



FIGURE 6.10 EGR Valve

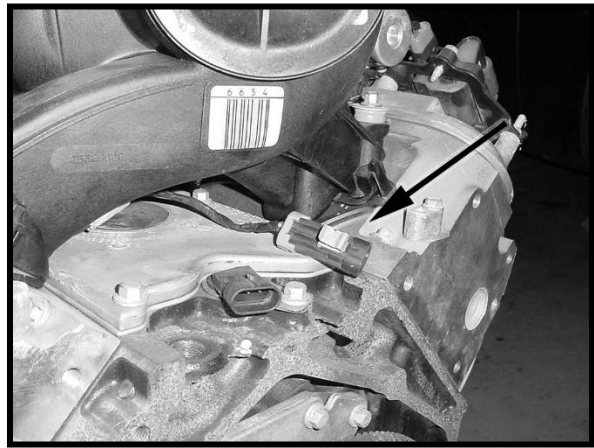


FIGURE 6.11 Knock Sensor Connector

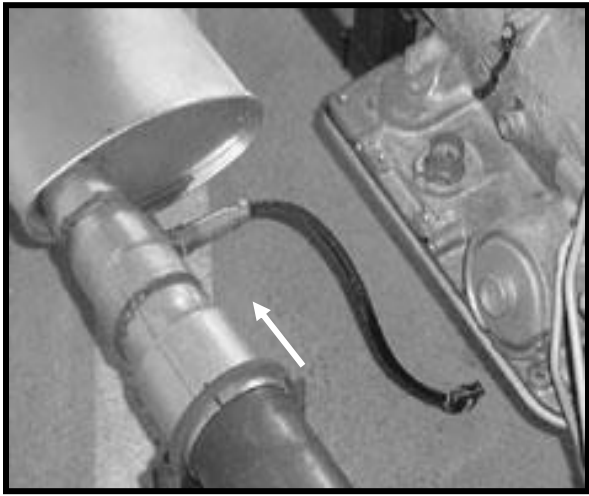


FIGURE 6.12 Oxygen Sensor



FIGURE 6.13 MAP Sensor

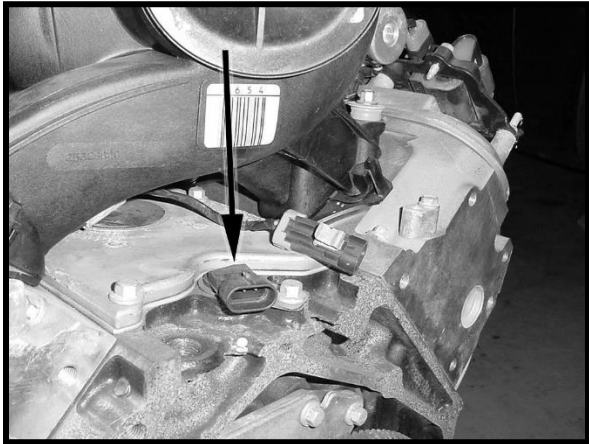


FIGURE 6.14 CMP Sensor

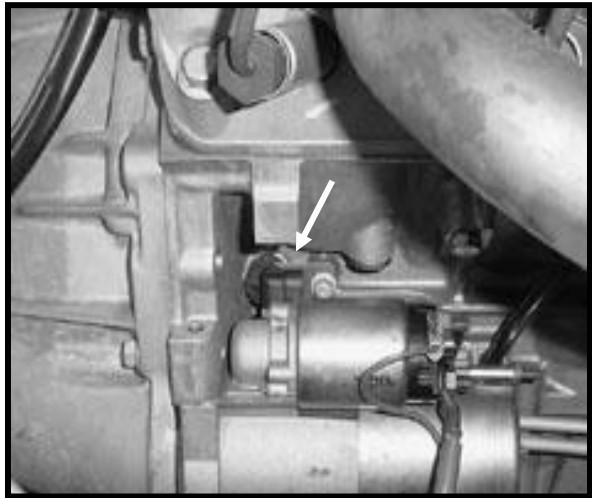


FIGURE 6.15 CKP Sensor

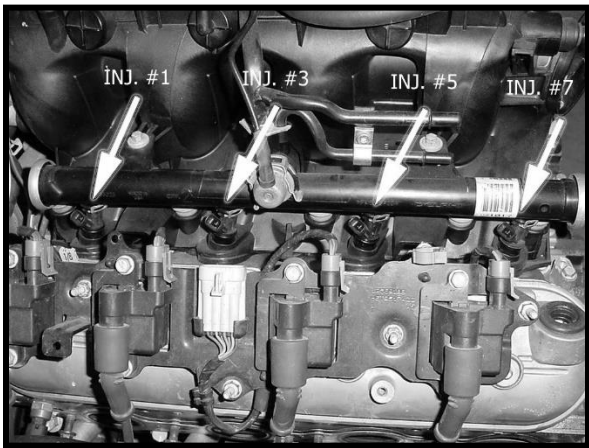


FIGURE 6.16 Injectors 1, 3, 5, 7

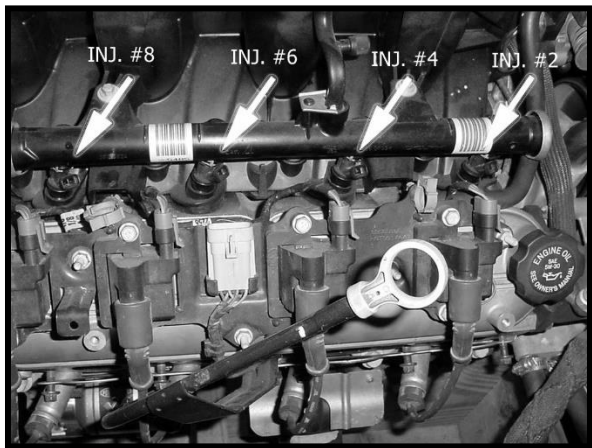


FIGURE 6.17 Injectors 2, 4, 6, 8

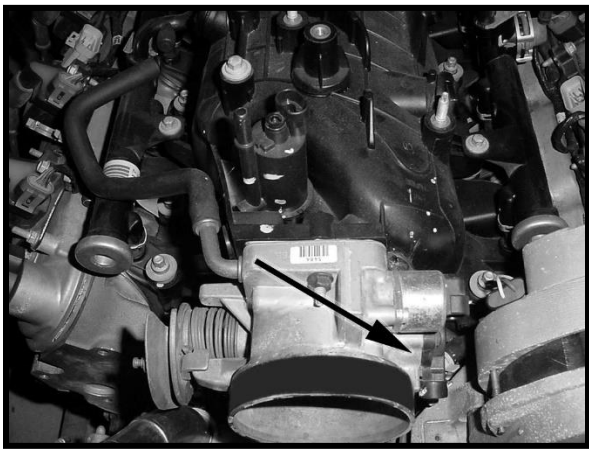


FIGURE 6.18 TPS Sensor



FIGURE 6.19 IAC Sensor



FIGURE 6.20 MAF-IAT Sensor

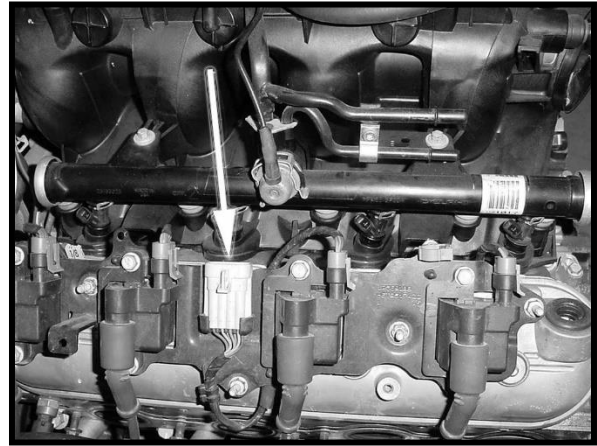


FIGURE 6.21 Driver Side Coil Connector

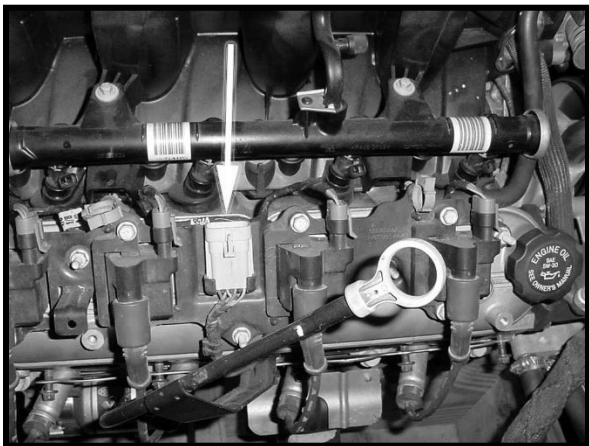


FIGURE 6.22 Passenger Side Coil Connector



FIGURE 6.23 ECT Sensor

6.4 TAIL SECTION INSTALLATION

Locate the tail section that you earlier separated from the engine group. Begin routing it towards the rear of the vehicle. Be sure to avoid all sharp edges, moving or hot parts, or anything else that may damage the harness.

If you **ARE** using a manual transmission, tape-up the 13-position connectors labeled TRANS, PNP (2) and store them in the harness.

- 6.4.1. BACK-UP (Lt. GRN optional)** – This circuit is used to power the back-up lamps. This wire will connect directly to the back-up light socket. You will need to splice a wire into this circuit in order to accommodate two back-up lights.
- 6.4.2. FROM START SWITCH (PPL/WHT optional)** – This circuit is used to connect the start switch to the neutral safety switch (omit this circuit if using anything other than an electronic automatic transmission). Connect this wire to a circuit from the ignition switch start position. This wire should only have power in the start position.
- 6.4.3. FUEL PUMP (mandatory)** – This circuit provides power to the electric fuel pump. Connect this wire to the positive side of the electric fuel pump. **This wire only has power for a few seconds when the ignition switch is turned on. It will have constant power while the engine is cranking/ running.**
- 6.4.4. INPUT SPEED SEN (optional) (not equipped on all models)** – This connection is only used on the 4L80E/ 4L85E transmissions. This will rarely be used and can be stowed if not needed.
- 6.4.5. OUTPUT SPEED SEN (optional)** – The Vehicle Speed Sensor (**VSS**) is a pulse counter type input that informs the PCM how fast the vehicle is traveling. The VSS system uses an inductive sensor, mounted in the tail housing of the transmission, and a toothed reluctor wheel on the tail shaft. The teeth of the reluctor wheel alternately interfere with the magnetic field of the sensor creating an induced voltage pulse as the reluctor rotates.
- 6.4.6. PNP (optional)** – The Transmission Range Switch (**PRND**) switch is mounted to the side of the transaxle and is part of the Park Neutral Position (**PNP**) switch. The PRND switch is used by the PCM to indicate the actual gear selected. The PRND is made up of 4 individual switches. The scan tool indicates ON or OFF for each switch depending on the position of the gear selector lever. The combination of ONs and OFFs will indicate the gear selected. If the combination of ONs and OFFs is invalid, a DTC is set. If you are not using this switch, you must inform your programmer so that they can turn it off in the programming.
- 6.4.7. TO STARTER RELAY (Yellow optional)** - This circuit provides power from the neutral safety switch to a starter relay; typically, terminal #86 on the relay. Omit this circuit if using anything other than an electronic automatic transmission. **DO NOT CONNECT THIS CIRCUIT DIRECTLY TO THE STARTER SOLENOID.** You can substitute Painless part #30202 (Hot Shot Relay) if the stock starter relay is not available.
- 6.4.8. TRANS (optional)** – These circuits are used by the PCM to determine vehicle speed, gear position and control shift patterns.

<u>WIRE COLOR</u>	<u># OF POSITIONS IN CONNECTOR</u>	<u>LABELED</u>	<u>CONNECT TO:</u>
BLUE, PINK/WHITE, LT. GREEN, RED, YELLOW/BLACK, BLACK, TAN/BLACK, BROWN, LT. BLUE/WHITE, RED/BLACK, YELLOW, PINK, WHITE	13	TRANS	Transmission
PINK, BLACK/WHITE, PURPLE/ WHITE, YELLOW, LT. GREEN	5	PNP	Park Neutral Position Sensor
BLACK/ WHITE, GRAY, WHITE, YELLOW	4	PNP	Park Neutral Position Sensor
RED/ BLACK, BLUE/ WHITE	2	INPUT SPEED SEN	Input Speed Sensor
LT. GREEN/ BLACK, PURPLE/ WHITE	2	VSS SEN	Output Speed Sensor
GRAY		FUEL PUMP	Fuel Pump B+
PURPLE/ WHITE		FROM START SWITCH	Start Switch
LT. GREEN		BACK-UP	Back-up Light Bulbs
YELLOW		TO START RELAY	Starter Relay Activation

TABLE 6.3 Tail Section Connections

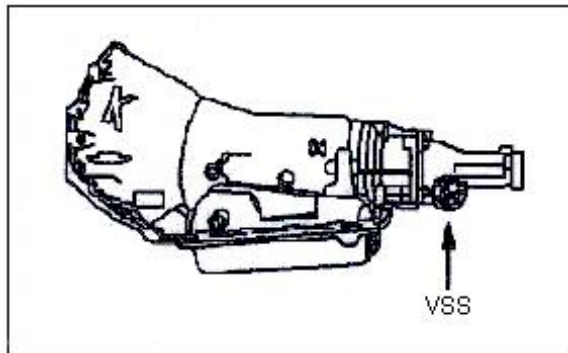


FIGURE 6.24 VSS Sensor (4L60E)

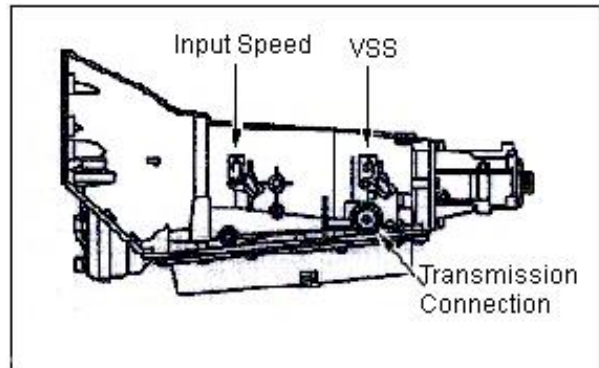


FIGURE 6.25 VSS & Input Speed Sensor,
Transmission Connection(4L80E)

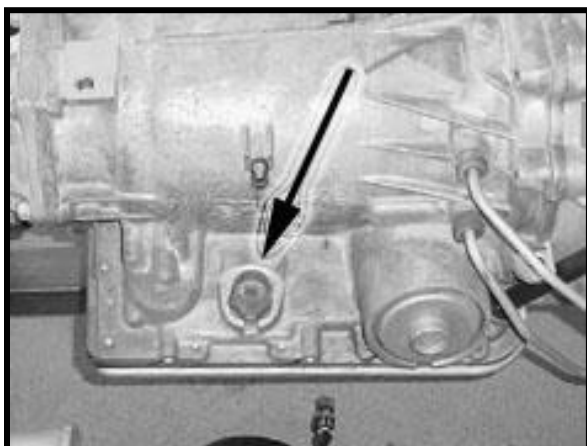


FIGURE 6.26 Transmission Connection

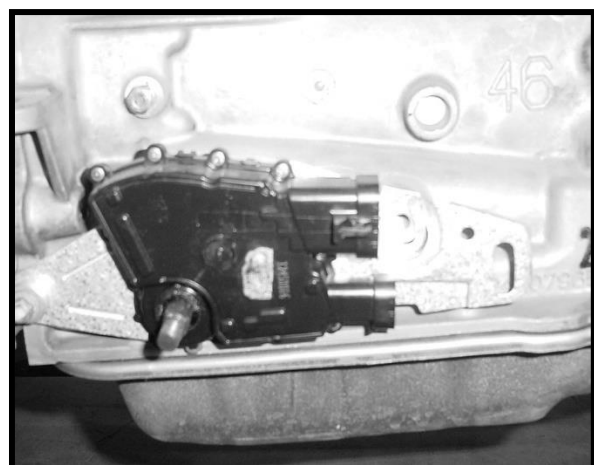


FIGURE 6.27 Park Neutral Position Sensor

6.5 CONVERTING THE 4L60E TRANSMISSION CONNECTOR TO A 4L80E CONNECTOR

NOTE: Harness numbers 60217 and 60218 have been wired for both the 4L60E and the 4L80E. All harnesses have the transmission connector pre terminated to allow use of the 4L60E transmission. In applications where a 4L80E is to be used, follow this procedure to change your transmission connector to ensure all functions of the transmission work properly. See Figure 6.28 for repinning the transmission connector

- 6.5.1.** With the terminal end of the connector and the arrow on top pointing towards you, carefully remove the white retaining lock located in the center of the connector.
- 6.5.2.** Locate the white wire located in terminal location S. Using a paper clip or small screwdriver, gently lift the locking tab inside the connector and pull the wire from its location.
- 6.5.3.** Now locate the brown wire located in terminal location U. Using the same method, remove the brown wire from its location
- 6.5.4.** Gently insert the brown wire into terminal location "S."
- 6.5.5.** The white wire has no function with the 4L80E transmission; it needs to be taped up and stowed in the harness in case a 4L60E is ever to be used.

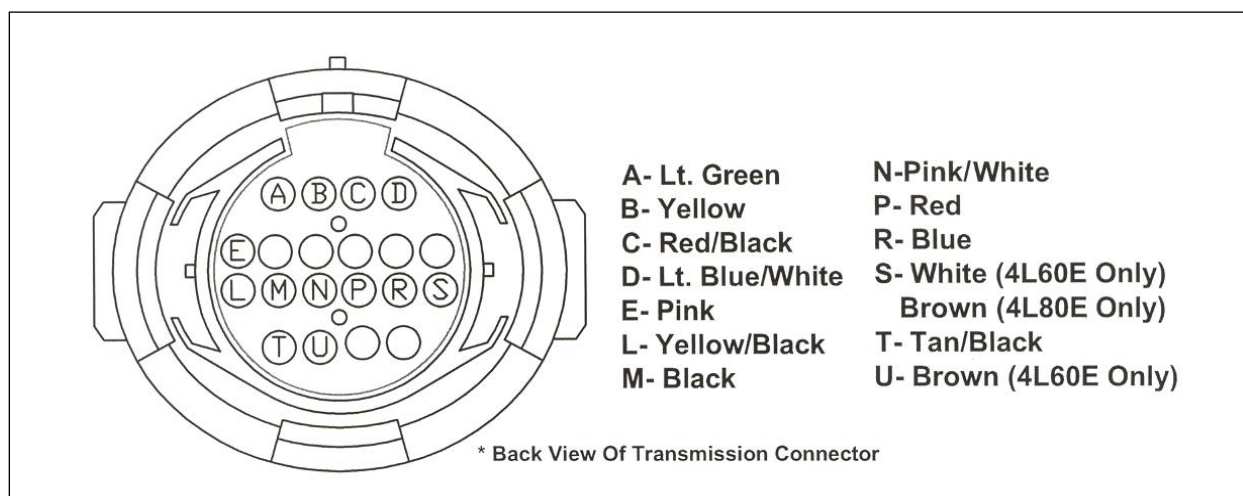


Figure 6.28 Transmission Connector Pin-Out

7. TROUBLESHOOTING INSTRUCTIONS

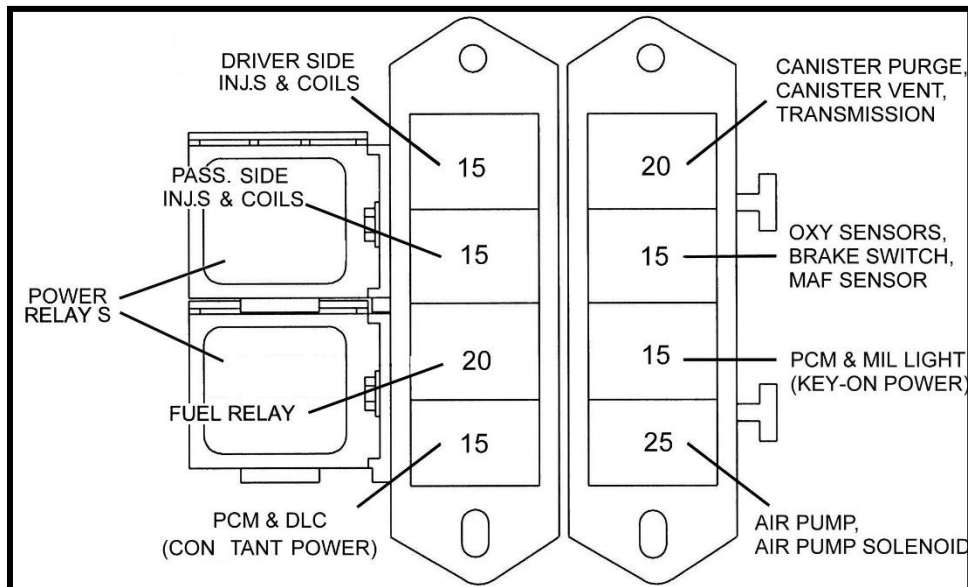


FIGURE 7.1 Fuse Identification

7.1 THE "CHECK ENGINE" LIGHT

Normally, the "check engine" light should come on when the ignition is turned on, and then go out a few moments after the engine starts running. If it reappears, or stays on while the engine is running, the computer has detected a problem and a trouble code has been set.

NOTE: Most likely the check engine light will come on and stay on when using a computer with the original factory programming. This is why we recommend that the computer be reprogrammed to remove any items that the factory vehicle had that aren't being used in the vehicle you are installing the engine into.

7.2 RETRIEVING TROUBLE CODES FROM THE COMPUTER

Diagnosing problems in modern automobiles can sometimes be very frustrating and confusing, especially when it involves computer-controlled systems. The fact is, for the most part automotive electronics have been proven quite reliable, and the greatest number of problems with new cars is the same kinds of problems that older cars without computer controls have.

Begin all troubleshooting by checking the basics. Certain basic faults may be undetectable by the Powertrain Control Module (PCM) self-diagnostic system and can actually interfere with self-checking and fault memory operation. Low battery voltage, for example, can cause erroneous faults to set in PCM memory or can cause a system to go "Fail Safe" without setting a fault in memory. Because system faults memory is cleared whenever PCM or battery are disconnected, fault codes should be read prior to any vehicle power interruption or troubleshooting.

Before suspecting a computer problem, perform a careful visual inspection. Check under the hood for the same kinds of problems you would look for on a non-computer-controlled engine. These include fluid leaks, vacuum leaks, dirty filters, overheating, oil burning, poor connections or loose wires, bad spark plug wires and/or spark plugs, restricted mufflers and exhaust systems, worn mechanical parts, exhaust leaks, and other familiar kinds of problems. Be thorough! You may save a lot of time.

The PCM is designed to withstand normal current draws associated with vehicle operations. Avoid overloading any circuit. When testing for opens or shorts, do not ground any of the PCM circuits unless instructed. When testing for opens or shorts, do not apply voltage to any of the PCM circuits unless instructed. Only test these circuits with a DMM while the PCM connectors remain connected.

7.2.1 PROCEDURE A Tech II or equivalent Scan tool **must be used** to check or clear Diagnostic Trouble Codes (**DTCs**) from the PCM memory. When clearing DTCs, follow the instructions supplied by the Scan tool manufacturer.

NOTES: Do not clear the DTCs unless directed to do so by the service information provided for each diagnostic procedure. All of the diagnostic data that was saved along with the DTC (freeze frame data and/or malfunction history records) which may be helpful for some diagnostic procedures will be erased from the memory when the DTCs are cleared. Interrupting PCM battery voltage to clear DTCs is NOT recommended and will not turn off the check engine light.

Once a DTC has been identified, contact the Painless tech dept. or a GM Service Manual for a procedure to identify why a particular code is being set. Do not assume a code for a component is the result of the component being faulting and its replacement will solve the reason for the code. This could result in unnecessary replacement of functioning components.

7.3 IDLE LEARN PROCEDURE

Anytime the Powertrain Control Module (PCM) or the battery is disconnected, the PCM loses power, or the PCM is reprogrammed, the PCMs learned idle position is lost. The engine idle is unstable when the learned idle position is lost. Perform the following procedure in order to return the learned idle to the correct position:

7.3.1 AUTOMATIC TRANSMISSION

- A. Turn OFF the ignition.
- B. Restore the PCM battery feed.
- C. Turn OFF the A/C controls.
- D. Set the parking brake and block the drive wheels.
- E. Start the engine.
- F. Ensure that the engine coolant temperature is more than **80°C (176°F)**.
- G. Shift the transmission into Drive.
- H. Allow the engine to idle for **5 minutes**.
- I. Shift the transmission into Park.
- J. Allow the engine to idle for **5 minutes**.
- K. Turn OFF the engine for **30 seconds**.

7.3.2 MANUAL TRANSMISSION

- A. Turn OFF the ignition.
- B. Restore the PCM battery feed.
- C. Turn OFF the A/C controls.
- D. Set the parking brake and block the drive wheels.
- E. Place the transmission in Neutral.
- F. Start the engine.
- G. Ensure that the engine coolant temperature is more than **80°C (176°F)**.
- H. Allow the engine to idle for **5 minutes**.
- I. Turn OFF the engine for **30 seconds**.

7.4 TROUBLE SHOOTING GUIDE FOR YOUR PAINLESS PERFORMANCE HARNESS

If you have installed your harness, made all the connections as outlined in the installation manual, and utilized the correct components as shown in the compatible parts list, the engine should start and run. If you are experiencing difficulties in getting the engine started, this trouble shooting guide should help you in diagnosing the problem.

- **FIRST AND FOREMOST, DO NOT TRY AND START YOUR ENGINE WITHOUT INSTALLING AND CONNECTING ALL OF THE COMPONENTS.** Attempting to do so will result in a “no start” situation. This includes things like the O2 sensors, knock sensors, the “PRNDL” switch (if it applies to your harness), relays, and the ECT. It’s easy to try and skip connections just to see the engine fire up, but this could cause countless difficulties trying to diagnose the issue.
- Before you attempt to start the engine, be sure that you have the correct ECM for your harness. The correct ECM is listed in the “compatible Parts List” on **page 8**. Also, make sure that the ECM you are using has been programmed by someone who is familiar with the programming procedures required for the ECM used in an engine transplant. There is more involved in programming for an engine transplant than just turning off the vehicle anti-theft. It is important to have someone who knows these tuning procedures so that you can be confident your ECM’s programming is correct for your application.

The first things to check if you are experiencing a “no start” situation, and your ECM has been programmed properly, are the battery (+) power to the harness and the grounds. Make sure the grounds are not stacked with each other. They can be on the same head or block area but should be bolted separately, not on top of each other. Also make sure that your vehicle is grounded properly, or your grounds will not do you any good. This means the negative battery cable should be bolted to the block or the frame using a star washer. The star washer allows your ground cable to cut through any paint and makes direct contact with the metal. Then, a ground strap (also using star washers) should be bolted from the block to the frame. Last, there should be a small ground strap from the block or head to the firewall. Only when these grounds are in place will the grounds for your harness be correct.

The battery (+) power to the harness should only come straight from one end of the positive battery cable, either at the battery or at the starter. The constant battery power is what provides power to the harness for the computer (ECM) memory. If it is not going to the positive battery cable, the ECM will have to relearn initial startup procedures every time you start it.

Last, make sure that the wire tagged “**12v IGN.**” wire is connected to an ignition hot source that has power **BOTH** in the ON/RUN position as well as the START position. An easy way to tell if you connected the wires to the correct power source is to look at the check engine light.

The check engine light has a direct correlation with the “**12v IGN.**” wire. If this wire is connected to the correct power source, the check engine light will come on when the key is turned to the ON/RUN position and will stay on when the key is turned all the way to the START position. If the light goes out in either of these ignition switch key positions, this means you are losing power to the “12v IGN” wire and must find another power source for it. The engine will never fire and start if this wire does not have the proper power source.

Also, make sure your check engine light is connected to the harness at the ALDL bracket. If you think you have connected the “**12v IGN.**” wire properly, and still do not have a check engine light when you turn the key on, check to see if the light is connected to the harness. Sometimes, the harnesses are not plugged into the light. The wires that connect to the light (**PINK** and **BROWN**) are tied together near the light. They are terminated so you can connect them to the 2 **BLACK** wires coming from the light.

FUEL PRESSURE: If you have checked all of the constant/switched power and your grounds but still have a “no start” problem, move onto the fuel system. The fuel pump should come on for a few seconds when you turn the key on and then shut off. This is to pressurize the fuel system, prepping it for start. If you turn the key on and do not hear the fuel pump come on and cycle, you need to check the fuel pump relay.

Make sure (as mentioned earlier) that the relay is plugged into the base. If it is plugged in properly, check to see if the relay might be defective. To do this, put 12 volts to the short wire marked “Test” coming out of the relay base. This wire is the same color as the wire providing power to the fuel pump. This “Test” wire will bypass the relay and apply 12 volts directly to the pump. If the fuel pump comes on when the 12 volts is applied, this tells you the relay is defective and needs to be replaced.

If your fuel pump does cycle with the key on you should check the fuel pressure. The fuel pressure should be about 58 to 60lbs. If it is not, you need a fuel pump that will deliver enough pressure to the injectors and the engine to run.

INJECTORS: LS injectors are susceptible to gumming up and sticking when the engine is left sitting for long periods of time (a year or more) with old fuel sitting in them. It is suggested that you clean the injectors if you do not know how long the engine has set.

If your injectors are clean and free, check to see if you have injector pulse. The best way to do this is to use a “NOID LIGHT” which can be found at any auto parts store. They are inexpensive and easy to use; you can buy a single light for the fuel injection system you are working on. Or you buy a set of 8 that will have a light for many different types of injectors. OEM offers singles (#25143 for the LS injectors) and Performance Tool offers a set of 6 (#W89500).

The light plugs into the injector connector. If you are getting an injector signal from the ECM, the light will flash. If the noid light does not flash, you are not getting the proper injector pulse signal from the ECM. This could be because the ECM is not getting the proper signal from the crankshaft position sensor, the ECM may have a bad driver, or one of the relays is either defective or not installed in the fuse block properly. These relays also control the coil power, and that is the next thing to check.



FIGURE 7.2 Noid Light

SPARK: if you have checked and cleared all of the previously mentioned components and still have a “no start” condition, you need to check for spark at the coils. You will need to test for 12 volts at the colored wire going to each coil. Then, check for continuity of the ground on the black wire going to each of the coils. If you do not have continuity to ground on the black wires, check the harness to the coils and the plug in the Painless harness to the coils. If all looks good there, you need to follow that wire back to its splice and then to the ground at the back of the block. Also, make sure the ground at the block is not stacked with any other ground on that bolt.

If all these things check out, you should be getting air/spark/fuel and that is what it takes to fire your engine. Remember, it does not pay to try and start your engine without everything installed and connected as it leads to undue frustrations.

Painless Performance Products, LLC **Limited Warranty and Return Policy**

Chassis harnesses, fuel injection harnesses, and Trail Rocker units are covered under a lifetime warranty.

All other products manufactured and/or sold by Painless Performance are warranted to the original purchaser to be free from defects in material and workmanship under normal use. Painless Performance will repair or replace defective products without charge during the first 12 months from the purchase date. No products will be considered for warranty without a copy of the purchase receipt showing the sellers name, address, and date of purchase. You must return the product to the dealer you purchased it from to initiate warranty procedures.

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