

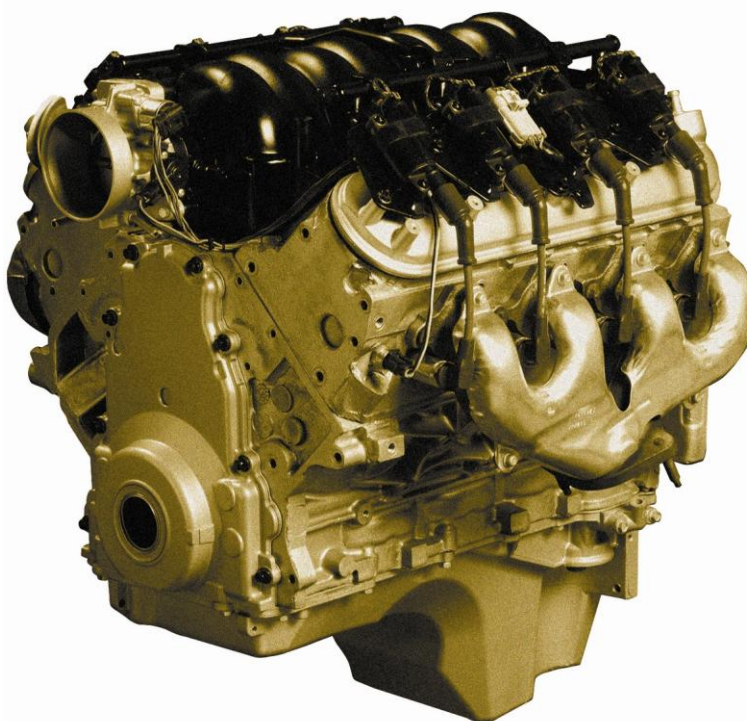


Wire Harness Installation Instructions

For Installing:

Part # 65106 – 1997-2004 (5.7L) LS-1 Engines

Part # 65206 – 1997-2004 (5.7L) LS-1 Engines



Manual # 90538

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1.0 INTRODUCTION

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

This kit is designed to be a complete system for fuel injection on all stock General Motors LS-1 engine (**non-throttle by wire motors**). This includes all wiring that is need by the computer to run and control the fuel injection system. Please note that the PERFECT computer does not have the capability to control an electronic transmission. If you are running a 4L60E transmission you will need to contact an aftermarket transmission company for that computer and wiring harness. If you are running a 700 R4 trans. and would like to have the lock-up functions you can purchase Painless Performance part # 60109 for that function.

Usually, the computer, fuse block, relays, ALDL and check engine light 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 is rated at 275°F and has been GM color-coded.

This harness has been broken down into three major groups:

Engine Group	Includes wiring for the fuel injectors, coil plugs, sensors, fuel pump and coil power wire.
Dash Group	Includes ignition feed and tach. wires, ALDL, check engine light
Fuse block and Relay Group	Includes wiring for the fuse block, fuel pump relay, a/c relay, ignition relay, cooling fan relay ground and alternative fuel ground wire.

2.0 ABOUT THESE INSTRUCTIONS

These instructions provide information for the installation of the 65106 LS-1 fuel injection wire harness kit. The contents of these instructions are divided into major **Sections**, as follows:

- 1.0 INTRODUCTION
- 2.0 ABOUT THESE INSTRUCTIONS
- 3.0 TOOLS NEEDED
- 4.0 PRE-INSTALLATION AND HARNESS ROUTING GUIDELINES
- 5.0 GENERAL INSTALLATION INSTRUCTIONS
- 6.0 GM LS-1 SYSTEM WIRING HARNESS INSTALLATION INSTRUCTIONS
- 7.0 TROUBLE SHOOTING INSTRUCTIONS AND TROUBLE CODES

Sections are further divided into **Paragraphs** and **Steps**. Throughout, the **figure** numbers refer to illustrations and the **Table** numbers refer to information in the 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**.

3.0 TOOLS NEEDED

You will at least, need the following:

Crimping Tool
Wire Stripper
Continuity Tester

Note: Use a quality tool to avoid over-crimping.

CAUTION: Do not use a test light to test the computer or sensor wiring or you will damage the computer.

Electric Drill
1 5/8" Hole Saw
Digital Volt Meter

(for rubber grommet in the firewall)

4.0 PRE-INSTALLATION AND HARNESS ROUTING GUIDELINES

The installation of your harness kit consists mainly of two parts:

- ~ The physical routing, positioning, and securing of the harness, wire groups, and individual wires and connectors.
- ~ The proper electrical connection of the individual circuits.

These two major tasks are not separate steps, but are integrated together. That is you, will route some wires and make some connections, route some more wires and make some more connections.

We cannot tell you how to physically route the harness in your vehicle. That depends a great deal upon the particular make of vehicle and what extent you want to secure and conceal the harness. We do offer some general guidelines and routing practices starting in **Paragraph 4.2**, GENERAL installation instructions concerning the electrical connections you will have to make beginning in **Sections 6.0**. To help you begin thinking though the installation of your wire harness, read the following sections:

4.1 You should get to know the particular engine that you are installing the harness on:

THIS KIT WILL ELIMINATE THE MASS AIR FLOW (MAF) SENSOR, BUT WILL KEEP THE MANIFOLD ABSOLUTE PRESSURE SENOR (MAP). IT WILL USE (1) OXYGEN SENSOR. THIS SYSTEM WILL ONLY WORK WITH A CABLE THROTTLE SYSTEM. IF YOU HAVE A LATER CORVETTE STYLE ENGINE YOUR WILL NEED TO CHANGE YOU THROTTLE BODY TO AN EARLIER STYLE.

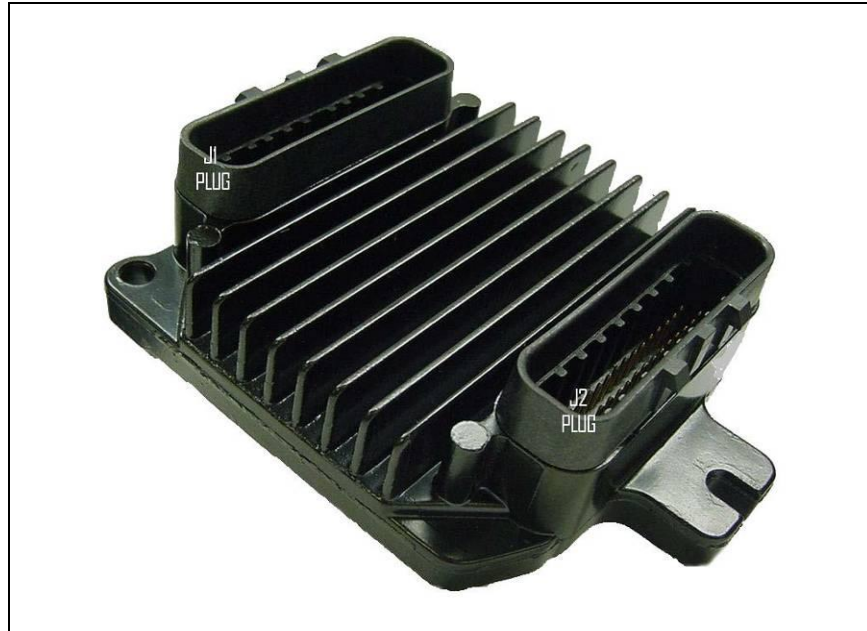


Figure 4.1 Engine Control Module (ECM)

- 4.1.1 PAINLESS PERFORMANCE recommends the use of all proper parts. See **Table 4.1** these parts will meet all requirements and are compatible with the Painless Performance harness and ecm. The numbers given are GM and AC Delco part numbers.
- 4.2 Familiarize yourself with the harness by locating each of the harness groups and by looking at the connectors on the wire ends.
- 4.3 Decide where and how the computer and relays will be mounted. Painless Performance wire harness kits are designed to mount either under the dash or on the lower kick panel. They must be no further apart than the wiring will allow (approx. 10 inches).
- 4.4 A good exercise is to lay out the wire harness on the floor beside your vehicle and identify all the connectors and wires. The harness must be routed from the inside of the vehicle out to the engine compartment.
- 4.5 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.
- 4.6 Route the harness away from sharp edges, exhaust pipes, the hood and door hinges.
- 4.7 Plan where harness supports will be located. Use support approximately every 6 inches unless the harness routes under the floor carpet.
- 4.8 Allow enough slack in the harness at places where movement could possibly occur (body to frame, frame to engine, ect.)
- 4.9 The harness should be bundled into harness groups. Use tape, nylon ties or poly-split loom.

LS-1 Fuel Injection Harness (1997-2004) Part # 65106

Engine Coolant Temp ...GM #12551708	Intake Air Temp Sensor ...Delco # 213-243
Throttle Position Sensor ...Delco #213-912	Oxygen Sensor ...Delco # AFS 105
MAP Sensor ...Delco # 213-331	IAC ...GM #17113391
Knock Sensors ...Delco# 213-362	Coils ...Delco #D580
CMP Sensors ...Delco # 213-335	CKP Sensor ...Delco # 213-354
Micro Relays ...Delco # D1703-A	

Table 4.1 Compatible Parts List

5.0 GENERAL INSTALLATION INSTRUCTIONS

CAUTION:

Do not disconnect the battery or computer connector(s) while the ignition is on.

Do not short any wire 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!

Notes:

- ~ There is a normal, small current drain on this fuel injection system.
- ~ 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 have become bent.
- ~ **The fuel pump and pressure regulator you use MUST maintain a constant pressure of 58 PSI (pound per square inch). If using a higher pressure pump you must add an inline regulator to bring the pressure down to the 58-60 range since the LS-1 fuel system does not 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 kit.

- 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 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 battery power from your vehicle by removing the negative battery cable from the battery.

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

- 5.2.1 Position the computer in its intended location.
- 5.2.2 Drill a 1 5/8" hole in the firewall near the computer for the engine group wires to pass through.
- 5.2.3 Route the engine group 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 section group to the driver's side of the car.
- 5.2.5 Route the fuse block and relays to the area where 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 installation. Please be patient and take your time.

- 5.3.1 Permanently mount computer. You should mount the parts (sensors, relays, etc.) that will be used for your engine at this time.
- 5.3.2 Mold harness groups to the connectors of the engine, frame and etc. Remember to route the 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, 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 instructions

Note: In the following steps you will be making the circuit connections for the fuel pump, A/C compressor, Ignition and electric fan relay ground. Before you start, you should carefully read Sections 6.0 through 7.0, as applicable, and continually refer to the wire connection charts, DOUBLE CHECKING your length connections. These directions are for the wires which do not have a connector already installed on them.

- 5.4.1 Have all needed 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 possibly occur.
DOUBLE-CHECK YOUR CALCULATIONS.
- 5.4.4 Strip insulation away from wire. Strip only enough length necessary for the type of terminal you are installing.

Note: In the following step, make sure that the terminal is crimped with the 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 repeating process. Make sure that each wire is first properly routed and then attached. **DO NOT ATTACH AND THEN ROUTE AFTERWORD.**
- 5.4.7 When all wires are attached, tighten the mounts and ties to secure harness permanently.
- 5.4.8 Attach the connectors to the computer **BEGIN CAREFUL NOT TO BEND ANY PINS**
- 5.4.9 Only 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.

6.0 GM LS-1 SYSTEM WIRING HARNESS INSTALLATION INSTRUCTIONS

6.1 Dash Section Installation

The wires in this group consist of the assembly line diagnostic link (ALDL) connector, the check engine light, ignition and tach wires (pre-mounted into a mounting bracket and four other wires).

CAUTION: Do not make any connections when the harness is plugged into the computer

Note: Wire color (example: BK/WT) is one wire with a stripe. The second color (The stripe) may not be bold. Observe all two-color wires closely.

- A. Find a suitable location to mount the ALDL connector that will allow access to the front Of the connector and still allow you to see the “check engine” light while driving.
- B. Mount the ALDL connector.
- C. Locate the Pink wire and attach it to the fuse block or the coil power wire. **POWER IS REQUIRED WHEN THE KEY IS IN THE RUN AND START POSITION.** This is the ignition power wire for the ECM.
- D. Locate the Tan/Black wire labeled ALT.FUEL. If you are running a Camaro/Firebird engine with stock 26.5 LB/HR injectors ground this wire to the chassis. If you are running a Corvette engine with stock 29 LB/HR injectors do not ground this wire. When running the Corvette style injector be sure to isolate this wire by crimping a red butt splice onto the wire. This is to prevent the wire from becoming grounded. If you are running the 29 LB/HR injectors in a Camaro engine **DO NOT USE THIS WIRE.**
- E. Locate the GRN wire labeled FAN #1 and attach this wire to your electric fan relay ground (if available). This wire will send ground reference to the fan relay.

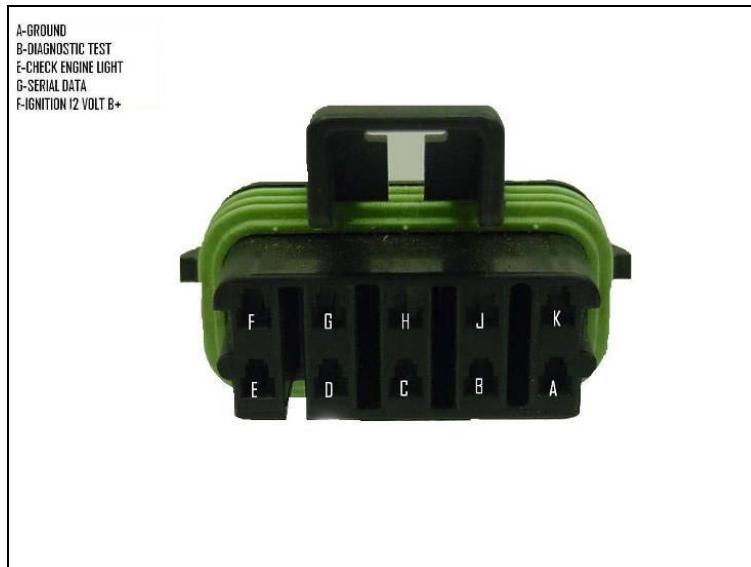


Figure 6.1 Assembly Line Diagnostic Link Connector (ALDL)

6.2 SENSOR AND RELAY GROUP 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.

6.2.1 Sensor and Relay Installation

Note: The single RED wire with the female terminal that comes out of the fuel pump and ignition relay base is a test lead only. It is not connected to anything. See note in Section 7.1

The three relays that have been supplied for you in the kit are for the following:

Fuel Pump Relay	This relay will supply the 12 V ignition hot power to your fuel pump when the key is on and in start.
A/C Signal Relay	This relay will supply a ground for the computer to increase engine RPM when the A/C compressor has been activated.
Ignition Relay	This relay will supply 12 V ignition hot power to the O2 sensor, check engine light and computer when the key has been turned to on or start position.

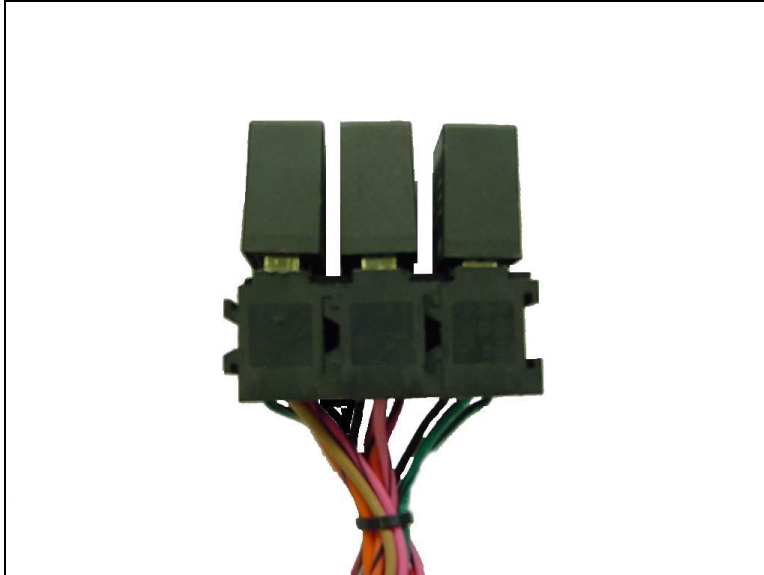


Figure 6.2 65106 Relays and Relay Bases

Note: You will have to install the relays in their housing after mounting the relay bases. All three relays are identical.

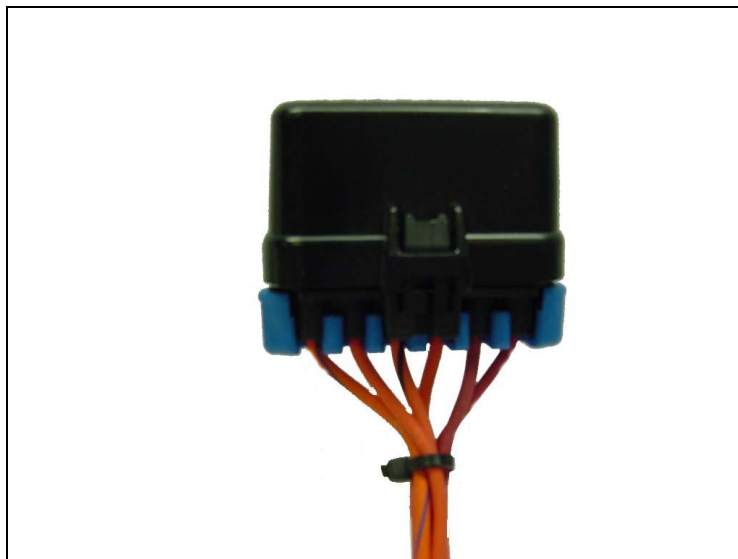


Figure 6.3 65106 Fuse Block

6.3 ENGINE GROUP INSTALLATION

The engine group is designed to be separated into the left side (driver) and the right side (passenger) sections. Each side is tie wrapped separately, BUT NOT LABELED. The right side of the engine has the connector for the IAC, TPS and ECT all of which ARE labeled. First separate the engine group into the left and right side sections and place them accordingly.

- 6.3.1 Before you connect any wires, separate the fuel pump and coil B+ wire from the engine group and place it out of the way.
- 6.3.2 Locate the two separate ring terminal grounds (labeled GRND#1 and GRND#2) in the harness. Place these wires on a ground source or engine bolt.
- 6.3.3 Using **Figure 6.4** and **Table 6.1** connect the wiring as directed.
- 6.3.4 Locate the PINK wire labeled COIL B+, connect this wire to a IGN. 12 V source that gets power in both start and run.

Wire Colors	# of Positions in Connector	Labeled	Connects to:
Blue, Lt. Blue	2	KNOCK	Knock Sensor
Bk/Wt, Pur.	4	OXY.	Oxygen Sensor
Blk. Pk/Bk			
Bk/Wt, Lt. Grn. Gray	3	MAP	MAP Sensor
Bn/Wt, Rd/Bk Yw/Bk	3	CMP	Cam Position
Yel., Yw/Bk Rd/Bk	3	CKP	Crank Position
Pk/Bk, Blue	2	Inj #1	Injector # 1
Pk/Bk, Green	2	Inj. #2	Injector # 2
Pk/Bk, Green	2	Inj. #3	Injector # 3
Pk/Bk, Blue	2	Inj # 4	Injector # 4
Pk/Bk, Green	2	Inj # 5	Injector # 5
Pk/Bk, Blue	2	Inj # 6	Injector # 6
Pk/Bk, Blue	2	Inj #7	Injector # 7
Pk/Bk, Green	2	Inj #8	Injector # 8
Bk/Wt, Blue Gray	3	TPS	TPS Sensor
Bk/Wt, Yel. Green	3	ECT	ECT Sensor
Bk/Wt, Tan	2	IAT	IAT Sensor
Lt.Grn/Bk, Lt.Bl./Bk. Lt.bl/Wt, Lt.Grn/Wt	4	IAC	IAC Sensor
Pur., Red, Green, Lt. Blue Brown, Bk/Wt, Pink	7	Drvr. Coils	Driver Side Coils
Rd/Wt, Pur./Wt, Lt. Bl/Wt Gr/Wt, Bk/Wt, Blk, Pink	7	Pass. Coils	Passenger Side Coils
Blk., Bk/Wt Red		GRND # 1 & # 2 Starter B+	Engine Ground Starter B+ Term.
Pink		Coil B+	Ign. Hot 12V
Tan/Blk		Alt. Fuel	Ground for F- Body engines

Table 6.1 GM LS-1 Engine Group Connections

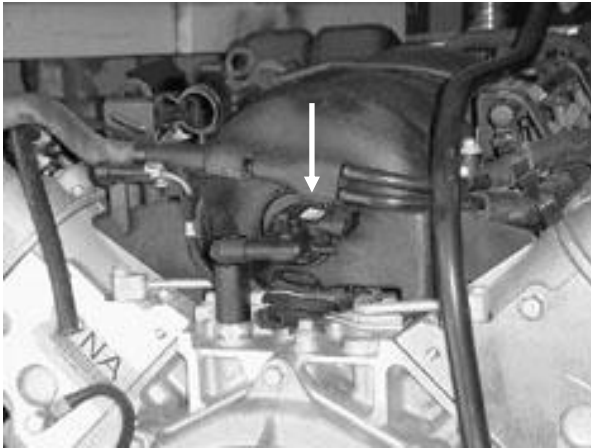


Figure 6.4 MAP Sensor

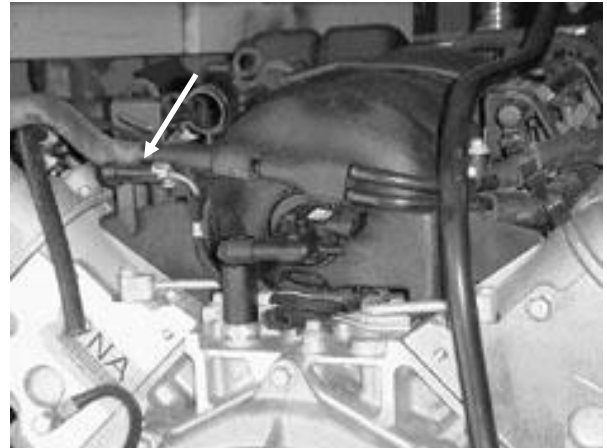


Figure 6.5 Knock Sensor

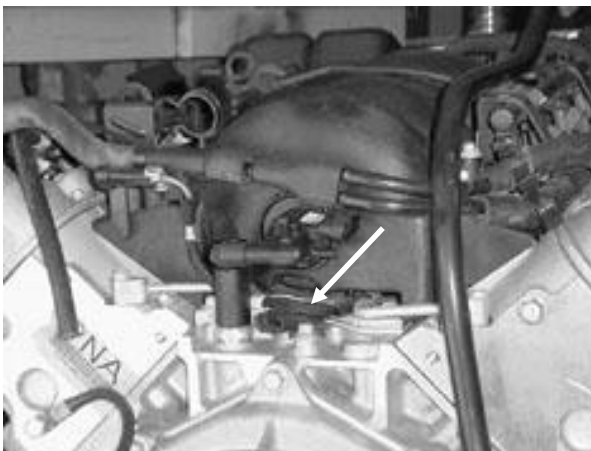


Figure 6.6 CMP Sensor

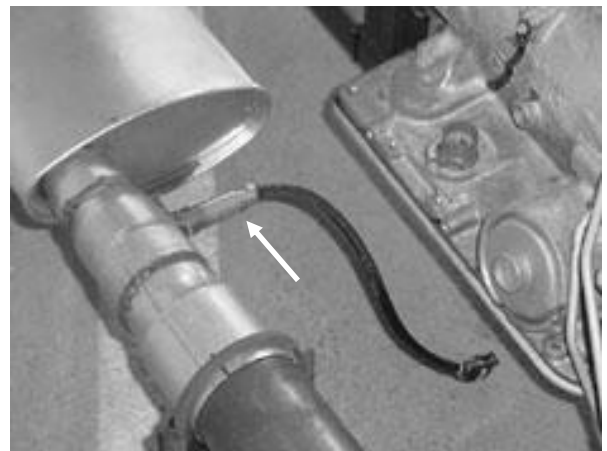


Figure 6.7 Oxygen Sensor

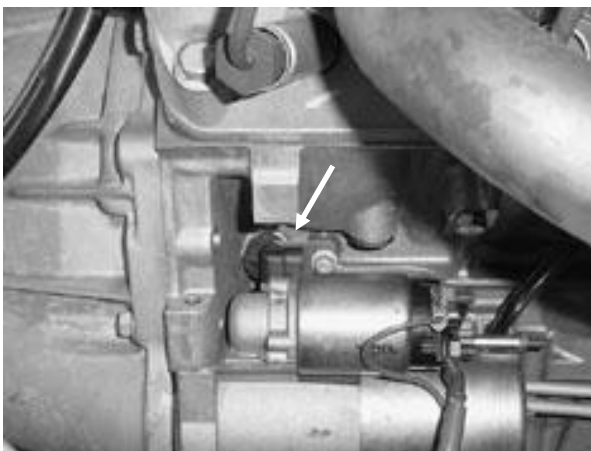


Figure 6.8 CKP Sensor

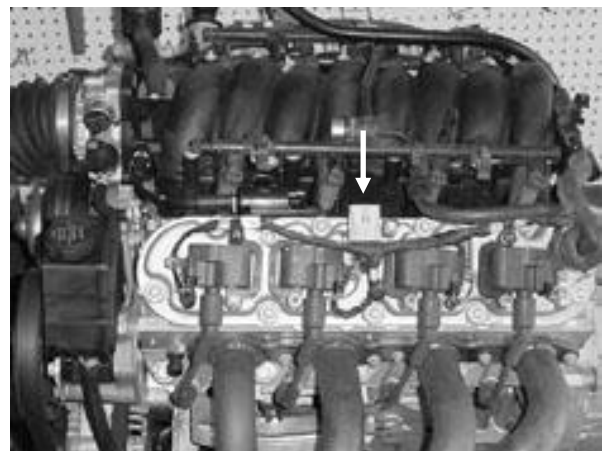


Figure 6.9 Drivers Side Coil

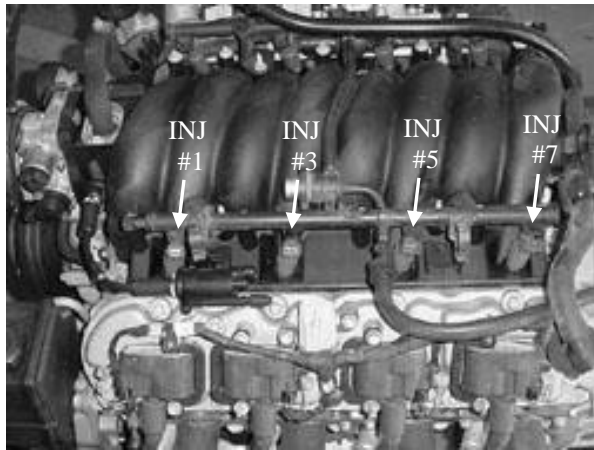


Figure 6.10 Drivers Side Inj.

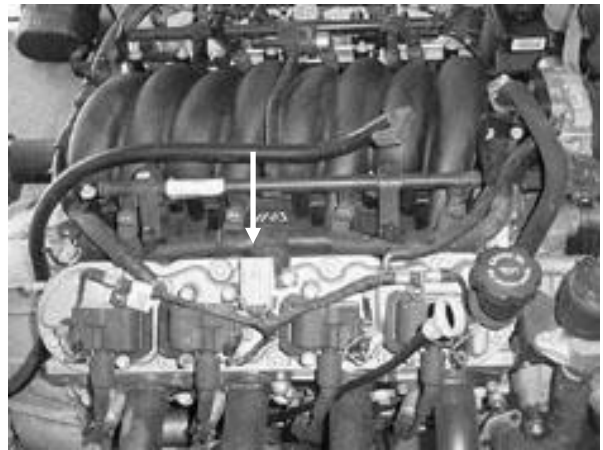


Figure 6.11 Pass. Side Coil

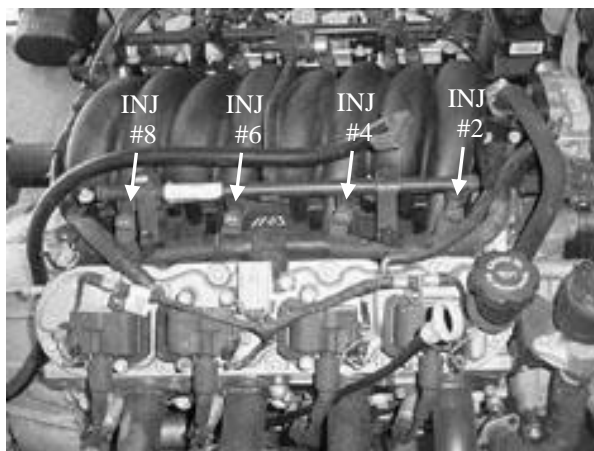


Figure 6.12 Pass. Side Inj.



Figure 6.13 TPS Sensor

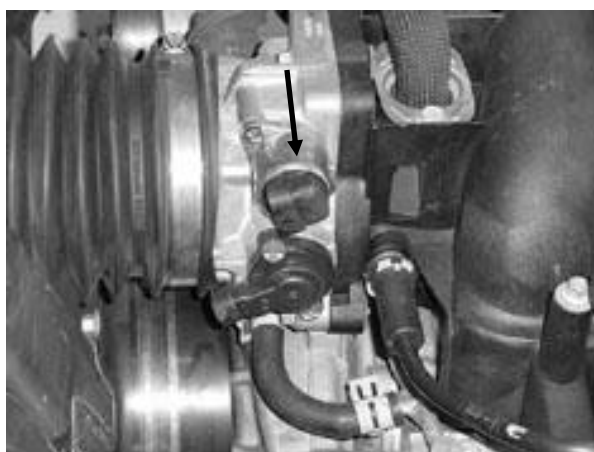


Figure 6.14 IAC Sensor

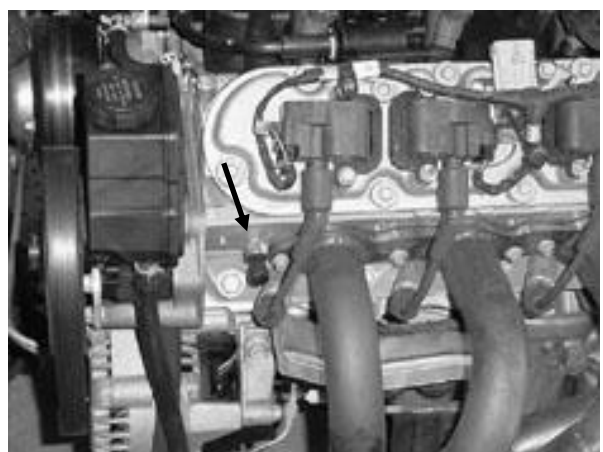


Figure 6.15 ECT Sensor



Figure 6.16 IAT Sensor

7.0 TROUBLE SHOOTING INSTRUCTIONS

Note: Only scanners with marine cartridges and marine cable plugs will communicate with the PERFECT computer.

If you are having trouble with your engine running badly or not at all, first perform basic trouble shooting(checking for faulty connections, spark, fuel pressure, etc.) then see if the computer has stored any trouble codes in its memory.(See 7.3 and 7.4)

7.1 THROTTLE POSITION SENSOR ADJUSTMENTS

Once you have installed the kit and are ready to start the engine for the first time you must first readjust the voltage that is going the Throttle Position Sensor.

- A. Turn on ignition but do not start engine.
- B. Check to insure throttle is not depressed.
- C. At the throttle position sensor, place a digitalis voltmeter's probes into the blue and black wires in the back of the sensors connectors, which is plugged into the sensor.
- D. Find the throttle stop screw that is located on the passengers side of the housing.
- E. Re-adjust the screws until your volt meter reads .8volts.

We are having you re-adjust the TPS to eliminate the chances of a stalling issue in long deceleration while driving. You should not have to worry about this issue, but if it occurs double check the voltage coming out of the TPS blue wire, and make adjustments accordingly.

7.2 THE FUEL PUMP RELAY CHECK

The small RED wire that is coming out of the relay is a TEST lead wire. If you do not hear your fuel pump prime when you turn on the ignition take a jumper wire and connect it from a 12 V power source to the RED wire coming our of the FUEL PUMP RELAY. By supplying 12 V to that wire you are bypassing the relay completely. You should hear the pump run. If you do not hear anything, make sure that all connections are good and the pump has a sufficient ground.

7.3 THE CHECK ENGINE LIGHT

Normally, the “check engine” light should come on when the ignition is initially turned on, and then go out a few moments after the engine starts running. If the computer has detected a problem and a trouble has been set the light will come back on.

7.3.1 The computer identifies particular trouble codes by flashing the “check engine” light in a certain way. The codes are read by counting the flashes:

- A: The first digit (the “tens” digit) of the code is flashed quickly, followed by a brief pause, then the second digit (or “ones”) is flashed, followed by a longer pause. For example, (3) three quick flashes followed by a brief pause followed by a two (2) flashes indicate code 32.
- B: The code will repeat itself two (2) times. The next code if any will be displayed in the same manner.

Note: When you access the codes from the computer a code 12 (one flash followed by two flashes) will first be displayed. **THIS DOES NOT INDICATE A PROBLEM.** Code 12 will be flashed 2 times, followed by the particular trouble codes, if any. If the computer merely flashes code 12 there are no trouble codes stored. Code 12 means the engine is not running.

7.4 RETRIEVING TROUBLE CODES FROM THE COMPUTER

7.4.1 In order to retrieve the trouble codes stored in the computer, locate the ALDL plug installed in **Section 6.2**. Turn the ignition on, **BUT DO NOT START THE VEHICLE**. Connect a jumper wire from the ALDL terminal “A” to terminal “B” see **Figure 6.1** and observe the check engine light.

7.4.2 After you have read any codes (remember the normal code 12) write them down for reference. Remove the jumper wire from the ALDL connector.

7.4.3 Take the codes one at a time and match them to the codes in **Table 7.1**. This will tell you in which circuit the computer has detected a problem.

Note: A code indicates a problem is a specific circuit, **NOT THAT A PARTICULAR PART IS BAD.**

7.4.4 Before taking more extensive corrective actions for any trouble codes, make sure that all connections on the indicated circuit, **INCLUDING THE COMPUTER**, are clean and tight. Inspect the wiring in the circuit for any broken, shorted, or exposed wires. Finally, insure all grounds wires are clean and secure.

7.4.5 If you are getting a code from your computer and need to clear the code, other than code 12, after you have replaced apart, readjusted a part, etc. You can do this by making the following steps:

- A: Install a jumper wire from terminal A to terminal B
- B: Ignition ON engine OFF
- C: Move throttle from 0% (idle) to 100% (WOT) and back to 0%
- D: Remove the jumper wire
- E: Turn ignition OFF for at least 20 seconds
- F: Ignition ON engine OFF
- G: Recheck for codes

CODE # CIRCUIT AFFECTED	
13-----	Oxygen Sensor Inactive
14-----	Coolant Sensor High Voltage (COLD)
15-----	Coolant Sensor Low Voltage (HOT)
21-----	Throttle Position Sensor (high voltage)
22-----	Throttle Position Sensor (low voltage)
23-----	Manifold Air Temp. (low temp.)
25-----	Manifold Air Temp. (high temp.)
33-----	MAP Sensor Circuit (high voltage)
34-----	MAP Sensor (high voltage)
41-----	EST Fault
42-----	EST/BYPASS fault
44-----	Knock Sensor inactive
51-----	Calibration checksum
54-----	Oxygen Sensor (lean reading)
55-----	Oxygen Sensor (rich reading)
81-----	TPS (out of range)

Table 7.1 Diagnostic Trouble Codes Chart

7.5 WHEN TO CALL PERFECT PERFORMANCE TECH LINE

- 7.5.1 This harness kit has been built with the highest regard to strict quality control and tested before shipment. Before calling us please double-check all connections and perform normal basic trouble shooting (fuel pressure, ignition power and spark, etc.)
- 7.5.2 If you have any questions concerning the installation of this harness or are having trouble in general; feel free to call Painless Performance tech line @ 800 423-9696. Calls are answered from 8AM to 5 PM CST, Monday-Friday, except holidays. Please leave a message if you are unable to reach us and we will return your call as soon as possible.

Note: Helpful information on the PERFECT PERFORMANCE ECM Calibration

The PERFECT ECM has been specifically calibrated for you particular engine. This computer will not work with any other type of engine, nor will it work with a modified engine (i.e. aftermarket parts). The computer has also been programmed to control your electric fan.

Painless Performance Limited Warranty and Return Policy

Chassis, fuel injection harnesses, and Striker ColdShot 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.

PERFECT

ENGINE MANAGEMENT SYSTEM[®]

PERFECTION CalTool

P/N: 65245

Manual #90549



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If you have any questions concerning use of this software or having trouble in general, please feel free to call Painless Performance Products' tech line at 1-800-423-9696. Calls are answered from 8am to 5pm central time, Monday thru Friday, except holidays.

We have provided as accurate instructions as possible, and are always concerned about improvements to be made. Any comments or suggestions concerning these instructions please send a fax to (817)244-4024 or e-mail is always welcome at painless@painlessperformance.com. We appreciate your business.

Perfect Performance Products, LLC shall in no event be liable in contract or tort (including negligence) for special, indirect, incidental, or consequential damages, such as but not limited to, loss of property damage, or any other damages, costs or expenses which might be claimed as the result of the use or failure of the goods sold hereby, except only the cost of repair or replacement.

P/N 90549

December 06, 2007

Revision #3 07/10

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Congratulations, on the purchase of the **Perfect Engine Management** fully tunable fuel-injection system. This booklet is designed as a guide through the tuning process. Tuning an injection system can be tricky and at times very complex, but with patience and some general guidelines, a superb running engine can be accomplished.

This kit contains the following parts:



- Instruction Manual #90549
- USB Key
- Software CD w/Case
- Gray communication cable
- NGK Wide Band Interface Cable

NOTICE: This kit is ONLY compatible with Windows XP. It will not work with Windows Vista or Windows 7.

This kit does not include a USB to Serial adaptor. Keyspan® company (www.keyspan.com) makes a very easy to use unit P/N USA-19HS. This is the ONLY adaptor which is compatible with this kit. This adaptor must be purchased for this kit and is available from most electronics suppliers.

Installing the Software

1. Start by placing the Software CD into the CD/DVD drive on the desired computer and close the drive door. The software will automatically start an installation wizard and walk you through the installation process.
2. Follow each step in the wizard and finish the software installation process. At the end when it asks if you would like to start the software, remove the check from the box and close the window.
3. Now that the software has been installed onto your computer; there is an icon on your computer titled, "InGenius Perfect v2.2."
4. **Now insert your purple USB key into a port on your computer.**
5. Double click on the InGenius Perfect v2.2 icon on the desktop or go to START>All Programs>Painless Performance>Ingenius Perfect v2.2>Ingenius Perfect v2.2.
6. Now you can navigate through the software as explained in these instructions. Please read about each section and what changes it allows.
7. If you are ready to connect to your car with the Perfect System installed (it won't work sitting on a workbench disconnected from your engine), place the CD that was included with your new KeySpan USB to Serial adaptor (P/N USA-19HS) and install the software as per the KeySpan software wizard.
8. Now connect the USB to Serial adaptor to the computer, connect the gray communication cable to the USB to Serial adaptor and then, with the ignition **OFF** plug the communication cable into the PERFECT engine harness.
9. After the software opens, turn the ignition to the **ON** position and watch for the red icon on the lower right hand corner of the screen to turn yellow and then green.

**If the icon did not change colors, the ECM and laptop are not communicating. Click the Run button on the top of the screen one time, wait three seconds and then click it again. If the icon on the bottom of the screen still does not change, go to OPTIONS>Settings>Communication>and pick a different COM port. If it was set to COM 1 then try COM 3. Try each different Com Port until the icon on the bottom of the screen turns green. Each time a different Com Port is tried, the RUN button on the top of the screen will need to be toggled on and then off.*
10. **IMPORTANT/IMPORTANT/IMPORTANT: ALWAYS CLICK RECEIVE FOR THE FIRST TIME WHEN THE SOFTWARE CONNECTS TO THE ECM. If you send a blank calibration to the ECM it will erase the ECM and it will be necessary to send it back to Painless to be recalibrated. THIS IS A VERY IMPORTANT DETAIL TO NOT MISS.**

11. On part numbers 65140, 65141, 65252, and 65253 it is necessary to save the calibration onto your computer once you have received it. These calibrations are not in the software package where they can be retrieved once they are modified.
12. In order to load a calibration into the ECM, go to Calibration>Open>Calibrations>
And then pick the appropriate calibration for your PERFECT SYSTEM. For example, A GM Tuned-Port Engine uses the L98 calibration.
13. Click on the desired calibration, open it and now click<SEND>. Do not turn off the ignition or try to start the vehicle until it's completed downloading the cal to the ECM.
14. Now cycle the ignition off, wait seven seconds and then turn it to the On position.
15. **Providing the engine, fuel system, and wiring installation is complete, turning the key to the start position should fire up the engine. Be sure to check the fuel pressure is at the specific pressures for your engine.**

Section 1: General Tuning Guidelines

The adjustments available in this software have the potential to seriously damage the engine, if not done in the proper way. If a leaner than required mixture or too much spark timing is programmed into the engine ECM, detonation leading to a damaged engine will most likely occur. The calibrations provided for each engine are a good base to start programming from. Most of the time the spark tables for each engine combo will not need to be changed from the ones provided. When larger than stock camshafts are installed into an engine the idle and just off idle spark timing may need to be slightly advanced. The fuel tables and idle setup are most often in need of tuning. However, if the fuel/air mixture is too lean engine damage is imminent under sustained heavy loads. A rich condition will usually just produce clouds of black smoke from the exhaust pipe or even foul spark plugs.

Section 2: Dashboard

This screen serves as a "Scan Tool" for the PERFECT systems. The Dashboard shows live sensor data, (RPM, TPS, MAP, O2, and ECT), etc, when the engine is running or the key is in the ON position. This sensor data is used to analyze engine performance, sensor functionality and monitor critical sequences of events. For example, with the key on engine off, if the accelerator is not being pressed at all, the TPS gauge should read "0%". Then with the accelerator pressed to the floor, the TPS gauge should read "99.6%". The throttle adjustment is explained in more detail in Section 3: Idle.

The Dashboard can be customized by adding different gauges with each displaying different parameters and controlling how each parameter is displayed. Simply right click the mouse, choose "Design mode", then right click the mouse again and select "New Gauge". A window displaying all of the available features for each gauge will popup. Simply click on each tab and make decisions based on the appearance and function of the gauge desired. Many of the most important gauges come preset in this software package and can be modified at anytime. Once any design changes have been made, simply go to File-Save Workspace and save any changes that have been made.

Section 3: Fuel

These screens contain the main Base Fuel Table with the fuel injector pulse width values. The values are in milliseconds of injector firing time or in other words, "How long the injector is open and allowing fuel to be sprayed into the engine". Other adjustments in this section are simply a multiplier being applied to the values in the Base Fuel Table to increase or decrease the amount of fuel under specific conditions. It is critical the base fuel table values are as accurate as possible.

See below for a description of how each adjustment is made in the Fuel screen:

1. Main – Base Fuel Table

- RPM (Revolution per Minute) vs. MAP (Manifold Absolute Pressure) Sensor values in KPA (Kilopascals) These are the “X” and “Y” coordinates of the table.
- How much fuel will the engine efficiently burn at a specific RPM? If the engine was held at a constant RPM and MAP(Load) listed on the Base Fuel Table, then the amount of fuel the injector will deliver is directly proportional to how many milliseconds the injector is command to be open.
- It is crucial, when making adjustments to these values; the Coolant and Intake Air Temperature Compensation multipliers are set to 1.00 and the Transient Fuel multipliers must be set to 0. Only then will the engine be running solely on off the Base Fuel Table numbers. The O2 sensor selection in the **Setup menu** must be set to either “No Fuel Trim” or when present “Wideband Monitor”. This is to prevent any Closed Loop O2 fuel trim. This fuel injection system is **only** compatible with the NGK AFX wideband system. Call your local Painless Performance dealer for more details.
- Painless has provided base calibrations for each engine supported, so be sure and start with the correct engine base calibration.

2. Compensation – Coolant Temperature and Intake Air Temperature

- Coolant Temperature – These values are multiplied to the Base Fuel Table values to richen the mixture when the engine coolant, hence the engine, is cold. Or another way of looking at it is, it leans out the mixture as the engine warms up. Generally speaking, the values warmer than 176deg F should be 1.00. This would mean there is no enrichment due to the engine not being at running temperature.
- Intake Air Temperature – These values are multiplied to the Base Fuel Table values to richen the mixture when the intake air is cool and to lean out the mixture when the intake air is hot. It’s best to use the Coolant Temperature to do most of the cold enrichment when the engine is cold and the Intake Air enrichment to fine tune fueling via air temperature.

3. Crank Fuel

- Crank Fuel Prime – This is the initial shot of fuel from the injectors, comparable to throttling a cold carbureted engine before startup. The amount of fuel needed will vary with each different engine combination. Generally, more fuel is needed for quicker starts on engines with larger lift and duration camshafts. Watch for an overly large puff of black smoke out of the tailpipe during startup for an indication if the values in these fields are too large.
- Crank Fuel – This is the amount of fuel sprayed into the engine from 0 rpm to 300 rpm. Colder temperatures require more fuel. Watch for an overly large puff of black smoke from the tailpipe for an indication of too much fuel during startup.
- Crank to Base Fuel Compensation – These values are multiplied to the Base Fuel Table values and are used to gradually pull out the overly rich mixture during cranking. Once the engine speed is greater than 300 rpm, these values will start tapering off the amount of fuel being injected into the engine. Think of this as the transition to the Base Fuel Table while the engine is firing up. It’s equivalent to the choke pull-off on a carburetor.

- Blend Time – This is the time it takes to transition from Crank Fuel to the Base Fuel Tables. Larger times here will slow down the transition and keep the fuel mixture rich longer. Smaller times here will speed up the transition and shorten the amount of time the mixture is richer. If the engine acts like it's about to die after it first fires up, this value may need to be increased dependent upon if the Air/Fuel ratio measured in the exhaust goes lean and the engine stumbles.

4. Transient Fuel

- MAP Acceleration Enrichment - These values are multiplied to the Base Fuel Table values to richen the mixture when there's a change in the amount of engine vacuum. Engine vacuum can be directly translated into the amount of load being applied to an engine. With increased load, the engine will need more fuel to continue to do the same amount of work. Only with a change in the engine vacuum (load) will these fuel multipliers be applied to the mixture.

Fuel Multiplier based on Delta Manifold Pressure (0 to 31.13 msec)

- "**Delta**" – means "**change in**"

- TPS Acceleration Enrichment – These values are multiplied to the Base Fuel Table values to richen the mixture when there's an increase in the amount of throttle being applied to the engine. Only on an increase in throttle will this adjustment be used by the ECM to richen the mixture. In carburetor terms, this adjustment would be the "accelerator pump". If under a hard stomp of the throttle the engine stumbles, slightly increasing these values may help to fix the problem. Watching the Air/Fuel ratio in the exhaust with a wide band O2 sensor, see if the mixture goes too lean. Under a hard acceleration, it would be normal to possibly see the AFR goes as far rich as 10 to 1.

Fuel Multiplier based on Delta Throttle Position (0 to 31.13 msec)

- "**Delta**" – means "**change in**"

5. Decel Fuel Cut-off

- This enables or disables the fuel to be cut-off during a deceleration. It helps prevent and control back-firing when decelerating. It also prevents the engine from loading up with fuel during a high rpm throttle release. In most street applications, it is recommended to enable this feature for best drivability.

6. Oxygen Sensor

- Idle Target A/F Ratio – This is the Air/Fuel Ratio the ECM will trim or add fuel to when in closed loop and the engine is idling. The ECM only has the authority for 20% more or less fuel. Before any closed loop fuel trim is used the Base Fuel table must be as accurate as possible.
- Target A/F Ratio – This is the Air/Fuel Ratio the ECM will learn to for each engine load (MAP) and engine rpm. The desired Air/Fuel Ratio entered in each box is where the fuel trim adjustment in the software will adjust the Air/Fuel Ratio to be. Weather conditions and Barometric pressure have an effect on how much fuel will need to be added or subtracted from the base fuel table. Understand these values are a "Target" for the ECM to reach with Fuel Correction. This is displayed on the Main

Dashboard under the O2 Sensor gauges. Fuel Correction is the percentage of fuel being added or subtracted by the ECM from the Base Fuel Table. The less fuel being added or subtracted from the Base Fuel Table the closer the values are to being correct for a given calibration.

- Enable RPM – This is the engine speed in which Closed Loop O2 Fuel control becomes active. Most stock, smooth idle engine combinations will want to enable the Closed Loop O2 control at around 600 rpm. Larger profile camshafts may require the enable rpm to be around 1500-2000 rpm.
- Disable RPM – This is the engine speed in which the Closed Loop O2 Fuel control becomes inactive.
- Coolant Temp Enable – This is the coolant temperature the engine must be up to in order to enter Closed Loop O2 control. It's best to enter Closed Loop O2 control after the engine is at operating temperature. Generally about 10-15 degrees before the thermostat opening temperature will cover most engine combos.
- Minimum Run Time – This is the minimum time the engine must be running before entering Closed Loop O2 control. The main purpose of this is for hot starts were the engine is still warmed up, but the O2 Sensor is not. If the O2 sensor is not warmed up it will not function properly and will most likely send the incorrect signal to the ECM.

Section 4: Spark

The Base Spark Tables are developed in these screens. The sky's the limit when configuring a spark table for ignition timing, so great care must be taken when modifying these tables. If too much spark advance is calibrated into the system, severe detonation will occur. Detonation will not only hinder engine performance, but can also severely damage the engine. Engine damage will result from too much spark advance and continual detonation.

The values in these tables are in degrees of spark advance before top dead center. In other words, "The number of degrees of crankshaft rotation the spark plug fires before each piston reaches Top Dead Center." It is critical the Base Spark Table values are as accurate as possible. If the engine has detonation under a load or hard acceleration, be sure to retard the spark appropriately. Knock detection can be enabled or disabled in this section. Knock detection is useful in determining if the Base Spark Table has too much advance calibrated in it. Spark compensation based on coolant temperature and engine load can be adjusted here as well.

1. Main – Base Spark Table

- RPM (Revolution per Minute) vs. MAP (Manifold Absolute Pressure) Sensor values in KPA (Kilopascals) These are the "X" and "Y" coordinates of the table.
- The MAP values are a direct translation to the amount of engine load. The higher the MAP value reading indicates a larger engine load.
- Base Spark Table values should only be calibrated when the engine is fully warmed up.
- Painless has provided base calibrations for each engine platform supported, so be sure and start with the correct engine base calibration.

- When the Knock System is enabled, a gauge showing the amount of Knock Retard on the Mini Dashboard can be used to determine if the Base Spark Table needs to be calibrated.
- Generally speaking, the specific spark table provided for each engine platform supported will not need to be adjusted. Some examples of when the timing will need to be advanced more would be when a very large duration/lobe separation camshaft has been installed. The advance from idle and up to about 1500rpm would be the area to slightly increase, so a more stable idle speed can be achieved.

2. Compensation – Altitude and Coolant Temp and MAP

- Altitude - This is used to add or subtract spark advance based on atmospheric pressure. The amount of atmospheric pressure is a measurement taken by the ECM every time the ignition is turned on. This directly relates to the amount of oxygen available to the engine to support combustion. Higher elevations have less atmospheric pressure; hence less air will be pushed into the engine with each piston stroke. SO, to maintain close to the same performance as in lower altitudes; advancing the timing slightly is one option.
- It is always a good idea to monitor the knock system while tuning the spark tables. If the engine is knocking/has detonation/pinging and more spark timing is added, severe engine damage will eventually occur.
- Coolant Temp and MAP – This table is designed to remove spark when both engine load and temperature are both at higher levels. As the engine is loaded and the engine speed decreases knock may occur. This is because the fuel sprayed into the cylinders is given a longer time to heat up before combustion. The amount of spark to be removed will depend on the engine combination, efficiency of the cooling system, and size/weight/gearing of the vehicle it is in. The base calibrations provided in this software package do not have values in this table.
- Knock – All systems supported with this software from Painless Performance use the knock system. It is highly recommended to leave the knock system enabled to prevent severe engine damage. The maximum amount of spark retard the knock system is allowed to enable is 10 degrees.

Section 5: Idle

1. Idle Speed – Desired Idle Speed and Vehicle Speed Enable

- Desired Idle Speed – This is where the idle speed of the engine is set based on coolant temperature. Higher idle speeds are recommended when the engine is cold to quicken the amount of time a cold engine takes to reach operating temperature. On the Dashboard there is an indicator called “Idle in Control of RPM” which tells if the ECM is in control of the idle speed. The throttle must be fully closed for this to occur.
- Vehicle Speed Enable – Where applicable, this tells the ECM when to go into loop idle control in relation to MPH. A good place to start is 25mph.

2. Throttle Setup – Throttle Zero and Throttle Scaler

- Throttle Zero – This is used to synchronize the throttle position sensor signal and what the ECM considers closed throttle. The calibration procedure for this is outlined on this screen. If this number is incorrect, Closed Loop Idle Air Control, Idle Spark Stabilizer and Stall Saver will not work properly.
- Throttle Scaler – This multiplier is used to scale up or down the TPS reading to achieve the correct throttle position percentage at WOT(wide open throttle). With the throttle fully depressed, adjust this value until the percentage at WOT is 99.6%. On this system 99.6% is wide open throttle. Always be sure to check the Throttle Zero value by using the procedure in the software after adjusting the Throttle Scaler.

3. Advanced Idle Calibrations

- Throttle Follower Intro – This value represents the number of steps per percentage of throttle opening the IAC (Idle Air Control) valve will open as the throttle is opened. This acts as a buffer when under a quick deceleration to help the transition from open throttle to closed throttle. Some carbureted applications had a dashpot to dampen a quick snap of the throttle. This adjustment does the same thing, only with the IAC. A value of 1 will cause the ECM to open the IAC one count per 1% of throttle position.
- Vehicle Speed Follower Intro – This value represents the number of steps per vehicle speed (MPH) the IAC valve will open. This is especially useful on a long deceleration down a hill where the throttle is closed and the engine is still above the Desired Idle Speed. Without the Vehicle Speed Follower, the ECM will try to bring the idle down to the set Desired Idle Speed and fully close the IAC. Once the vehicle came to a stop, the engine speed would droop below the Desired Idle Speed and almost die because of the time it takes to open the IAC from its fully closed position.
- Follower Decay – This is the rate in which the Throttle Follower is decayed out. How many seconds it takes to bring the IAC back to its Idle Speed Position. If the engines idle hangs or stays higher than normal, increase this value. If the engine idle droops and almost dies, decrease this value.
- Stall Saver – This is a multiplier used to set a RPM below the Desire Idle Speed in which the Stall Saver goes into effect. So if the idle speed is 750 rpm and the value in this field is set at 0.7500, then the Stall Saver will enable at 562 rpm. Stall Saver adds IAC counts (opens) and advances the ignition timing to keep the engine from stalling.
- Stall Steps – This is the number of IAC steps added by the ECM when in Stall Saver mode. This number will be added every .125 seconds or 8 times per second. The more steps added, the more aggressive the ECM will try to recover the engine from stalling.
- Crank IAC Position – This is the IAC cranking position based on coolant temperature. When the ignition is turned to the on position the ECM will move the IAC to this position to give the engine the correct amount of air to start. The larger the number the higher the engine speed will flare when it first fires up. This is why it is not necessary to hold the throttle open while cranking a fuel injected engine, as it most likely would be on a carbureted engine.
- IAC Max Position – This value is the upper limit for how many counts the IAC can open to. These values are setup at the factory and the Perfect System Calibrations

already have them. Under normal circumstances this value will not need to be changed.

- IAC Max Base Position – This is the maximum IAC position without throttle follower, stall saver or load anticipation added. These values are setup at the factory and the Perfect System Calibrations already have them. Under normal circumstances this value will not need to be changed.

Section 6: Setup

1. Sensors – IAT Sensor

- IAT Sensor – This is where the Intake Air Temperature Sensor input to the computer is enabled or disabled. If an IAT Sensor is present, enable this input. Calibration of the fuel via air temperature must be entered under the Fuel Screen. The IAT sensor calibration is useful to remove a slight amount of fuel as the air temperature increases or to add a slight amount of fuel as the air temperature decreases. On a really cold day, 32deg F and below, this adjustment can be used to enrich the fuel slightly.

2. Oxygen Sensor – Enable/Disable

- No Fuel Trim - This is exactly what it says, "No Fuel Trim" meaning the engine will run directly off of the Base Fuel Table values only. This means the O2 system has been completely disabled. When using an external wide band O2 sensor to monitor the exhaust air/fuel ratio, this will need to be selected.
- Stock Closed Loop – This is only used with a stock narrow band O2 sensor. All PERFECT systems use this type of sensor when no wide band O2 sensor is present.
- **These next two choices REQUIRE the use of a NGK AFX wide band Oxygen Sensor Kit P/N 91101.**

NOTE: Included in this kit is a wideband interface harness with the purpose of connecting a NGK Wideband Sensor P/N 91101 into the main engine harness. Simply match and connect the wires based on their colors and plug into the O2 connector on the engine harness. Be sure and follow the instructions on the Wideband display module to do a free-air calibration before inserting the NGK O2 Sensor into the exhaust pipe.

- Wideband Monitor – This is only used with the NGK AFX wide band kit. Its purpose is to accurately measure the oxygen content in the exhaust to indicate if the engine is receiving too much fuel or not enough fuel. More oxygen is lean and less oxygen is rich. The gauge on the Dashboard of the software that displays, "O2 Sensor" will indicate what the air/fuel ratio is in the exhaust. This gauge will not give an accurate measurement when a narrow band O2 sensor is being used.
- Wideband Closed Loop – This is to enable closed loop O2 fuel trim after the base fuel table has been thoroughly calibrated. The ECM will compare the Air/Fuel ratio value in the Target Air/Fuel ratio table to the actual value read in the exhaust. The ECM has the authority to change the amount of fuel plus or minus 20% of the

values in the Base Fuel table. This is why it is best to have the Base Fuel Table's values within at least 20% of the desired Air/Fuel ratio.

3. Fuel Pump – Prime Time at Keyup

- Prime Time at Keyup – This is the amount of time the fuel pump will run when the ignition switch is initially turned to the on position. Its how the computer primes the fuel rail with pressurized fuel before the engine is being cranked to lessen the amount of time for fuel to be delivered and the engine to start. Three seconds is usually more than enough time to prime the system.

3. Rev Limit

- Engine Speed Limit based on Coolant Temperature – This is the Rev Limiter on the Perfect System. Cold engines and overheating engines need to have a lower rev limit, than engines at normal operating temperature.

4. Aux Output – NOT SUPPORTED IN PERFECT APPLICATIONS

5. Fan 1 – On Temperature/Off Temperature

- On Temperature – On all PERFECT systems this is the temperature in which the ECM will provide a ground signal to an electric cooling fan relay. Set this temperature at approximately 20 degrees Fahrenheit lower than the normal engine operating temperature.
- Off Temperature – On all PERFECT systems this is the temperature in which the ECM will take away a ground signal to an electric cooling fan relay thus turning the fan off. Set this temperature at approximately 10 degrees Fahrenheit lower than the On Temperature set point in order for the fan to run continuously. In most cases, the electric cooling fan will not need to cycle on and off, but if such operation is desired the On and Off temperature set points will need to be adjusted.

6. Fan 2 - NOT SUPPORTED IN PERFECT APPLICATIONS

7. Set Timing – Enable/Disable

- By enabling the "Set Timing" mode, the ECM will force the spark advance to 10 degrees of base spark timing. At this point, adjust the distributor until the base timing tab is showing 10 degrees of advance. Lock down the distributor and then disable the Set Timing function. This function is used to synchronize the distributor advance to the ECM advance. In other words, the ECM and the Engine's distributor are now calibrated to each other. This function is only used on adjustable distributor ignitions engines.

The PERFECTION software has been designed specifically for use with the Delphi MEFI-4 engine control module supplied by Painless in the PERFECT Engine Management System. This programming software is not compatible with any other MEFI ECM.

Please note there are early and late versions of the PERFECT ECM. The early version only has the Delphi serial number on the label located on the back of the ECM. If you have this ECM you will need to send it in to Painless to have the latest base calibration flashed onto the ECM. Please contact Painless at 1-800-423-9696 for a return authorization and shipping instructions. There is no charge for this upgrade. **Be sure to send in the purple USB Key Number (as seen below) with your Purple USB key.**

The later version of the PERFECT ECM will have a USB key number in addition to the Delphi serial number. If you have this version of the ECM the USB dongle included in this software kit must be sent to Painless so it can be matched with the USB key number on the ECM. Again, please contact Painless for shipping instructions and make sure you send in the **purple USB Key Number (as seen below) with your Purple USB key.**

PERFECT software can only be used with the ECM and dongle for which each USB key number has been assigned.



Perfect Performance Products, LLC shall in no event be liable in contract or tort (including negligence) for special, indirect, incidental, or consequential damages, such as but not limited to, loss of property damage, or any other damages, costs or expenses which might be claimed as the result of the use or failure of the goods sold hereby, except only the cost of repair or replacement.