



COMMANDER 950

TBI HARDWARE INSTALLATION MANUAL

NOTE: These instructions must be read and fully understood before beginning installation. If this manual is not fully understood, installation should not be attempted. Failure to follow these instructions, including the pictures may result in subsequent system failure.

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1.0 INTRODUCTION

Holley Performance Products has written this manual for the installation of the **COMMANDER 950** TBI fuel injection system. This manual contains the information necessary for the hardware installation. Please read all the **WARNINGS, NOTES** and **TIPS**, as they contain valuable information that can save you time and money. It is our intent to provide the best possible products for our customer; products that perform properly and satisfy your expectations. Should you need information or parts assistance, please contact our technical service department at 1-270-781-9741, Monday through Friday, 7 a.m. to 5 p.m. Central Time. By using this number, you may obtain any information and/or parts assistance that you may require. Please have the part number of the product you purchased when you call.

NOTE: This manual is for the hardware installation of a Holley Throttle Body Fuel Injection System and instructions specific to it. Instructions on wiring harness installation, software operation, sensor operation, and tuning is contained in the supplied additional manual 199R-10149-2.

NOTE: A laptop computer with a serial communications port is required for the installation and tuning of this system.

WARNING! The **COMMANDER 950** systems consist of a number of sophisticated components. Failure of any one component does not constitute, nor does it justify, warranty of the complete system. Individual service items are available for replacement of components. If assistance is required or if you need further warranty clarification, you can call Holley Technical Service at the number shown above.

WARNING! To preserve warranty, these instructions must be read and followed thoroughly and completely before and during installation. It is important that you become familiar with the parts and the installation of the **COMMANDER 950** system before you begin. Failure to read and understand these instructions could result in damage to **COMMANDER 950** components that are not covered by the warranty and could result in serious personal injury and property damage.

WARNING! For closed loop systems using an oxygen sensor, use only unleaded fuels with this product. Use of leaded fuels will destroy the oxygen sensor and will result in incorrect exhaust gas oxygen readings and improper fuel delivery. Failure to follow these directions does not constitute the right to a warranty claim.

WARNING! Failure to follow all of the above will result in an improper installation, which may lead to personal injury, including death, and/or property damage. Improper installation and/or use of this or any Holley product will void all warranties.

WARNING! Use of some RTV silicone sealers will destroy the oxygen sensor used with this product. Ensure the RTV silicone sealant you use is compatible with oxygen sensor vehicles. This information should be found on the oxygen sensor package.

2.0 CHOOSING THE RIGHT SYSTEM:

To ensure that you have purchased the correct **COMMANDER 950** kit for your application, check to be sure that the kit you purchased is listed beside your engine's horsepower.

For best results in the event of an application overlap, the correct kit choice is the one that the engine horsepower is more centered in the application. For example, if your engine is rated at 275 hp, look at the chart below, you will notice that there are 2 kits that could fit your application. 275 hp. is near the upper limit of Kit # 950-23S. 275 hp. is more centered in the horsepower range of Kit # 950-22S. The correct choice would be one of the kits listed in the 225 to 400 horsepower range.

<u>HORSEPOWER</u>	<u>KIT PART NUMBER</u>
150 - 300 hp	950-23S COMMANDER 950 TBI , 650 CFM
225 - 400 hp	950-22S COMMANDER 950 TBI , 700 CFM
350 - 500 hp	950-21S COMMANDER 950 TBI , 900 CFM

3.0 WARNINGS, NOTES, AND NOTICES

WARNING! For the safety and protection of you and others, the installation, adjustment, and repair must be

performed only by a trained mechanic having adequate fuel system experience. It is particularly important to remember one of the very basic principles of safety: fuel vapors are heavier than air and tend to collect in low places where an explosive fuel/air mixture may be ignited by any spark or flame resulting in property damage, personal injury, and/or death. Extreme caution must be exercised to prevent spillage and thus eliminate the formation of such fuel vapors.

WARNING! This type of work **MUST** be performed in a well-ventilated area. Do not smoke or have an open flame present near gasoline vapors or a explosion may result.

4.0 PARTS IDENTIFICATION

<u>ITEM</u>	<u>DESCRIPTION</u>	<u>QTY</u>	<u>SERVICE PART</u>
1	TBI Assembly 650 CFM Complete	1	534-171
	TBI Assembly 700 CFM Complete	1	534-172

2	TBI Assembly 900 CFM Complete	1	534-173
2	Commander 950 ECU	1	534-120
3	Commander 950 Software	1	534-144
4	Commander 950 TBI Wiring Harness	1	534-146
5	Commander 950 Communications Cable	1	534-140
7	Fuel Pump	1	512-105
8	Fuel Pump Clamp	1	N/A
9	Metal Fuel Filter	1	562-1
10	Plastic Fuel Filter	1	562-3
11	Fuel Filter Clamp	1	108-10
12	Fuel Pump Block-Off Plate & Gasket	1	12-813
13	Oxygen Sensor	1	43-106
14	MAP Sensor	1	538-24
15	Coolant Temperature Sensor	1	534-2
16	Air Cleaner Adapter	1	17-14
17	Air Cleaner Gasket	1	108-4
18	Distribution Ring	1	508-12
19	Flange Gasket	1	108-10
20	Manifold Flange Studs	4	N/A
21	Heat Insulator Gasket	1	108-12
22	Oxygen Sensor Weld Ring	1	534-49
23	40 AMP Relay	2	534-26
24	Throttle Bracket	1	N/A
25	Throttle and Cruise Control Stud	1	N/A
26	Throttle Lever Ball	1	N/A
27	Throttle Lever Bracket	1	N/A
28	Throttle Lever Shipping Spring	1	N/A
29	Throttle Lever Stud	1	N/A
30	Transmission Kickdown Stud	1	N/A
31	Hose Clamp	8	N/A
32	Grommet	3	N/A
33	Assorted Parts & Terminals	1	534-42
34	Cable Ties	12	N/A
35	Silicon Grease	1	N/A
36	Tube Cap	1	N/A
37	Lockwasher	2	N/A
38	1/4-28 Nut	2	N/A
39	5/16-24 Nut	4	N/A
40	5/16" Vacuum Line	1	N/A
41	Fuel Pump wiring Harness	1	N/A
<u>TBI Service Parts:</u>			
	Air Charge Temperature Sensor	1	534-46
	Fuel Injector 650 CFM	4	522-81
	Fuel Injector 700 CFM	4	522-80
	Fuel Injector 900 CFM	4	522-43
	Fuel Pressure Regulator Diaphragm	1	512-1
	Idle Air Control (IAC) Motor	1	543-105
	Throttle Position Sensor (TPS)	1	543-29
<u>Optional Parts:</u>			
	GM Distributor Wiring Adapter	1	534-138
	Ford Distributor Wiring Adapter	1	534-139



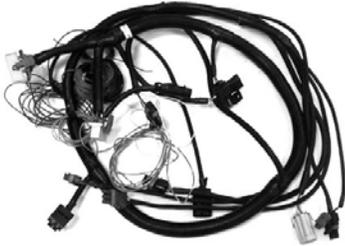
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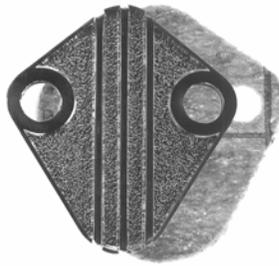
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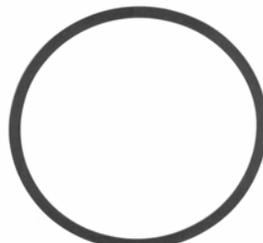
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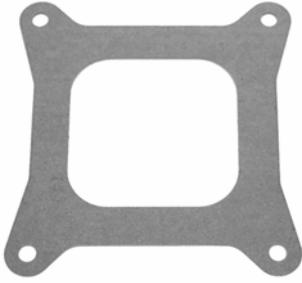
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Item 30



Item 31



Item 32



Item 33



Item 34



Item 35



Item 36



Item 37



Item 38



Item 39



Item 40



Item 41

5.0 ADDITIONAL ITEMS REQUIRED FOR INSTALLATION

- 3/8" fuel hose (must meet SAE J30)
- 5/16" steel fuel line (must meet SAE J526)
- Tee fitting for fuel gauge
- 5/16" fuel hose (must meet SAE J30)
- 0-30 psi fuel gauge

In addition to the above list, the engine must be equipped with a four barrel intake manifold and the vehicle must be in good operating condition.

6.0 TOOLS REQUIRED FOR INSTALLATION

- Standard wrench set
- Medium blade screwdriver
- Drill and assorted bit sizes
- Engine tachometer
- Factory Service Manual for your vehicle
- An assistant is necessary for some installation and adjustment procedures and should be present for safety reasons.
- Small blade screwdriver
- #2 Phillips screwdriver
- Hole saw (2")
- 10" adjustable wrench
- Windows compatible laptop PC
- 5/32" allen wrench
- Digital Volt-Ohm meter
- Terminal crimping tool
- Utility knife

7.0 REMOVAL OF EXISTING FUEL SYSTEM

- 1 - Disconnect the battery and remove the air cleaner.
- 2 - Before disconnecting any vacuum hoses, it is a good idea to sketch out the vacuum hose routing. Using masking tape and a permanent marker, mark all the vacuum hoses, vacuum sources, and ports before removing the old fuel delivery system.
- 3 - Remove and discard the fuel line that connects the fuel delivery system from the fuel pump. This will not be needed in the installation.
- 4 - Disconnect and plug the inlet fuel line that runs from the gas tank to the fuel pump. This will prevent fuel spillage and foreign matter or dirt from entering the fuel line.

DANGER! BEFORE DISCONNECTING OR REMOVING FUEL LINES, ENSURE THE ENGINE IS COLD. DO NOT

SMOKE. EXTINGUISH ALL OPEN FLAMES. AN OPEN FLAME, SPARK, OR EXTREME HEAT NEAR GASOLINE CAN RESULT IN A FIRE OR EXPLOSION CAUSING PROPERTY DAMAGE, SERIOUS INJURY, AND/OR DEATH.

- 5 - The fuel delivery system can now be removed. Holley recommends removing the mechanical fuel pump, if so equipped, and blocking-off the fuel pump mount using the provided fuel pump block off plate. The **COMMANDER 950** system kit includes a block-off plate that will fit small and big block Chevrolet and Chrysler engines. If the block-off plate does not fit your engine, a block-off plate may have to be purchased from a local performance parts supplier.
- 6 - If required, replace the intake manifold at this time. Proceed to step seven if this is not required. **A 4-BARREL STOCK OR AFTERMARKET INTAKE MANIFOLD IS REQUIRED FOR THE INSTALLATION OF THE HOLLEY COMMANDER 950 TBI system.**
- 7 - Place clean shop towels or rags into the manifold opening to prevent dirt or debris from entering the engine. Keep exposed ends of the vacuum and fuel lines free from dirt.

WARNING! Failure to cover the intake opening with a clean towel could result in dirt or debris entering the engine. Dirt or debris in the induction system can cause engine damage, which may necessitate in a complete engine overhaul.

- 8 - Remove all traces of the old gasket material from the TBI mounting flange. **DO NOT** gouge the intake manifold sealing surface during removal of old gasket material. Failure to remove all traces of the old gasket material will result in vacuum leaks that will be difficult to detect later. Sealing flanges must be clean and dry before installation.
- 9 - Remove the shop towels from the intake and vacuum out the intake channel to ensure no dirt or debris is left in the intake system. Place a shop towel over the entire intake opening until you are ready to install the new **COMMANDER 950** TBI.

8.0 COMMANDER 950 SYSTEM INSTALLATION

8.1 Throttle Body

NOTE: A 4 barrel intake is required for the installation of the Holley **COMMANDER 950** TBI system.

NOTE: Some GM and Chrysler engines require the use of a manifold adapter Holley Part Number 17-6. This adapts the spread bore carburetor manifold to the Holley square flange.

- 1 - Install the heat spacer between the manifold and the 4 barrel throttle body injection unit. Check for sufficient thread engagement of the throttle body hold down studs and nuts. It may be necessary to purchase and install longer studs in the manifold for proper nut engagement. Gasket sealant may be used to ensure that no vacuum leaks occur.

NOTE: If using a heat spacer, the flange gasket is not required.

DANGER! CHECK FOR PROPER CLEARANCE BETWEEN ENGINE COMPONENTS, SUCH AS THE DISTRIBUTOR, COIL, ETC., AND THE THROTTLE BODY. IF ANY INTERFERENCE IS FOUND, CORRECT THE CONDITION BEFORE CONTINUING. FAILURE TO DO SO CAN RESULT IN DAMAGE TO ENGINE COMPONENTS OR THE THROTTLE BODY.

DANGER! CHECK FOR PROPER CLEARANCE BETWEEN THE AIR CLEANER AND THE ENGINE COMPARTMENT COVER HOOD. IF ANY INTERFERENCE IS FOUND, CORRECT THE CONDITION BEFORE CONTINUING. FAILURE TO DO SO CAN RESULT IN DAMAGE TO THE COMPARTMENT COVER OR ENGINE COMPONENTS.

- 2 - Place the throttle body in position over the manifold flange studs with the IAC motor facing the front of the vehicle and the regulator/fuel connections towards the rear of the of the vehicle.
- 3 - Tighten the throttle body down in a criss-cross pattern being careful not to over-tighten. Proper torque is 5-7 ft lbs.

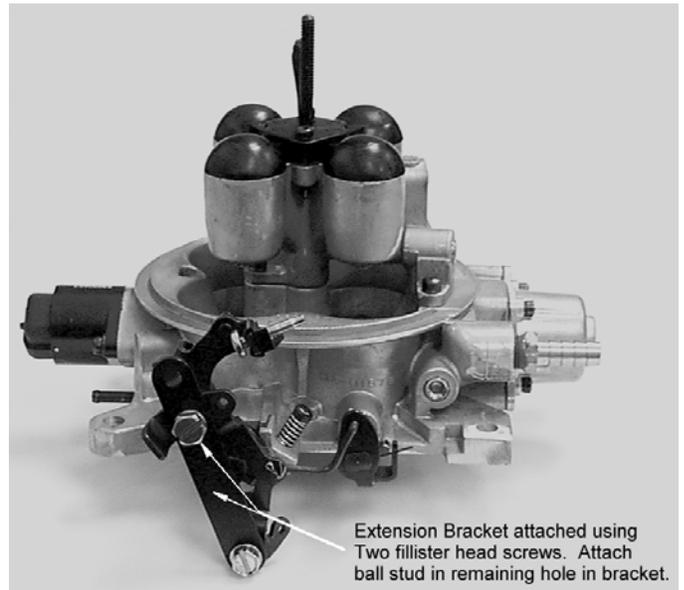
WARNING! Over tightening the TBI manifold flange hold-down-nuts may result in a warped or cracked throttle body. The TBI hold down nuts should be tightened down progressively in a criss-cross pattern to 5-7 ft lbs., to prevent leaks and avoid causing damage to the throttle body. A TBI that has been damaged due to negligence of the owner will void the warranty.

8.2 Throttle Connections

- 1 - Measure the length of the throttle lever arm on the

carburetor removed from the vehicle. Compare the length of the existing throttle lever arm with the one on the **COMMANDER 950** throttle body. If the two throttle lever arms are similar in length (within $\frac{1}{2}$ " of each other), the throttle lever arm hole on the **COMMANDER 950** throttle body can be used without the extension bracket. Use the throttle lever arm extension bracket, if the old throttle lever arm is significantly longer than the new throttle lever arm. Before installation of the bracket, check the diameter of the throttle cable stud. Some systems may use a $\frac{1}{4}$ " stud that will require drilling of the appropriate hole in the extension bracket to a $\frac{1}{4}$ " diameter. Attach the extension bracket using two fillister head screws as shown in the figure to the right. The extension lever length can be adjusted using the four sets of holes.

- 2 - Attach throttle linkage and have an assistant get in the vehicle and fully actuate the throttle controls. Make the necessary adjustments to the throttle linkage to ensure that the throttle plates are vertical when the throttle control is wide open. Work the throttle linkage back and forth several times to ensure it operates smoothly with no binding or sticking.



Extension Bracket attached using Two fillister head screws. Attach ball stud in remaining hole in bracket.

DANGER! STICKING THROTTLE MAY RESULT IN UNCONTROLLED ENGINE OR VEHICLE SPEED. THIS COULD CAUSE PROPERTY DAMAGE, PERSONAL INJURY, OR DEATH. A STICKING THROTTLE MAY BE CAUSED BY IMPROPERLY INSTALLED THROTTLE CABLES, LACK OF CLEARANCE FOR ANY OF THE THROTTLE LINKAGE, OR BY A BINDING THROTTLE LINKAGE. CHECK ALL THROTTLE CABLES FOR PROPER INSTALLATION AND ALIGNMENT AND ACTUATE THE THROTTLE TO CHECK FOR ANY POTENTIAL BINDING OR CLEARANCE PROBLEMS. REPAIR ANY PROBLEMS BEFORE CONTINUING.

- 3 - Locate the $\frac{1}{4}$ -28 throttle stud from the parts provided and attach to the throttle lever with the nut provided. Connect the accelerator linkage to the throttle stud on the throttle body. If the vehicle is equipped with an automatic transmission, connect the transmission kickdown rod to the linkage on the throttle body. The transmission kickdown may have to be adjusted. Follow the vehicle manufacturer's procedure for the correct adjustment procedure.

NOTE: On late model GM and Ford overdrive transmissions, the transmission electronic lockup must be changed to a mechanical lockup by a competent transmission shop. Failure to do so will result in premature transmission failure.

NOTE: On Chrysler vehicles, a lever extension will be needed, Holley Part Number 20-7. Van applications may require the use of throttle lever extension Holley Part Number 20-14.

- 4 - Attach throttle linkage and throttle return spring. Have an assistant get in the vehicle and fully depress the accelerator pedal. Make the necessary adjustments to the throttle linkage to insure that the throttle reaches wide open position when the accelerator is depressed. Work throttle linkage back and forth several times to insure it operates smoothly with no binding or sticking.

DANGER! FAILURE TO ATTACH THE THROTTLE RETURN SPRING OR A STICKING THROTTLE MAY RESULT IN UNCONTROLLED ENGINE OR VEHICLE SPEED, WHICH COULD CAUSE PERSONAL PROPERTY DAMAGE, SERIOUS INJURY, OR DEATH.

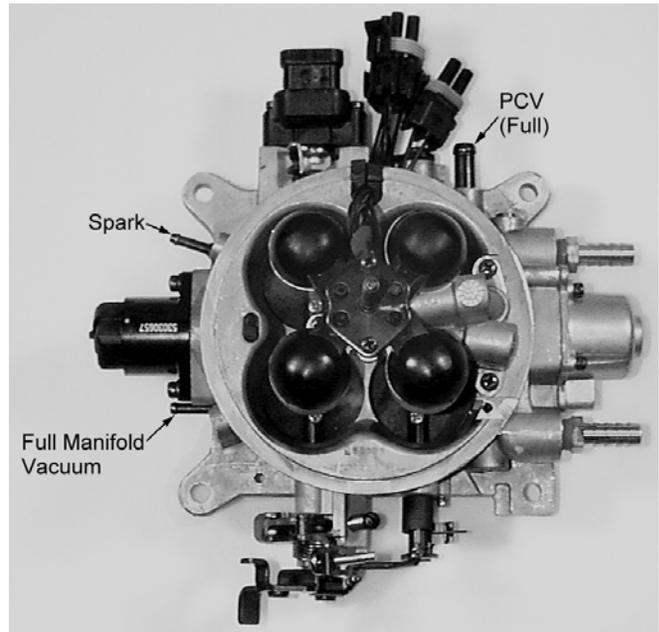
8.3 Vacuum Line Connections

- 1 - Install vacuum hoses to the appropriate port on the throttle body. Use the diagrams made during removal of the existing fuel system to locate the correct port. The vacuum ports of the throttle body are labeled in the figure below.

8.4 Fuel Pump Installation

- 1 - Do not mount the fuel pump higher than the lowest point of the fuel tank
- 2 - Mount the fuel pump as close as possible to the fuel tank.
- 3 - Make sure fuel tank is properly vented.

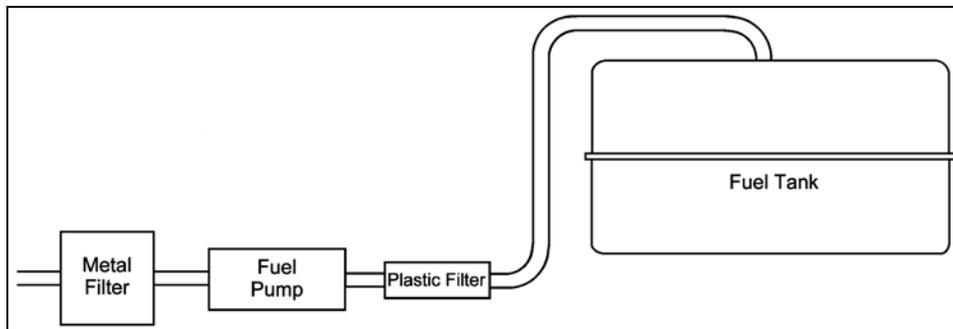
DANGER! NEVER GET UNDER A VEHICLE SUPPORTED ONLY BY A JACK. SERIOUS INJURY OR DEATH CAN RESULT FROM VEHICLES FALLING OFF OF JACKS. BEFORE WORKING UNDERNEATH A VEHICLE, SUPPORT SOLIDLY WITH JACK STANDS.



- 4 - Mount the electric fuel pump as close to the fuel tank outlet as possible with the bracket provided. Mounting the fuel pump in this manner will insure that the pump will prime easily and purge fuel vapors in the TBI quickly to ensure faster starts.

DANGER! TAKE PRECAUTIONS TO ENSURE THAT ALL FUEL LINE ROUTINGS ARE AWAY FROM HEAT SOURCES, SUCH AS THE ENGINE OR EXHAUST PIPES. A FIRE OR EXPLOSION HAZARD COULD CAUSE SERIOUS INJURY OR DEATH.

DANGER! ENSURE THAT THE FUEL PUMP MOUNTING LOCATION WILL NOT INTERFERE WITH ANY UNDER THE VEHICLE COMPONENTS, ESPECIALLY AT THE EXTREME LIMITS OF THE SUSPENSION TRAVEL. A FIRE OR EXPLOSION HAZARD COULD CAUSE SERIOUS INJURY OR DEATH.



- 5 - Connect the pump to the tank using 3/8" I.D. fuel hose. Connect the outlet of the pump to the steel line, which runs to the front of the vehicle with 3/8" I.D. fuel hose, depending on the diameter of the steel fuel line. All fuel hoses used must meet SAE J30 performance standards.

DANGER! FAILURE TO USE A FUEL HOSE THAT MEETS SAE J30 STANDARDS COULD RESULT IN FUEL LEAKS. A FUEL LEAK MAY RESULT IN A FIRE OR EXPLOSION HAZARD, WHICH COULD CAUSE SERIOUS INJURY OR DEATH.

- 6 - If using existing fuel lines, inspect and replace any hose, clamps, or fuel line showing **ANY** sign of aging. If you are not using existing fuel lines, you will need a fuel line routed to the engine compartment and **COMMANDER 950** throttle body. Use a 3/8" steel fuel line available at any auto parts store. All steel fuel line must meet SAE J526 standards.

DANGER! FAILURE TO USE STEEL A FUEL LINE THAT MEETS SAE J526 STANDARDS COULD RESULT IN FUEL LEAKS. A FUEL LEAK MAY RESULT IN A FIRE OR EXPLOSION HAZARD, WHICH COULD CAUSE SERIOUS INJURY OR DEATH.

DANGER! TAKE PRECAUTIONS TO ENSURE THAT ALL FUEL LINE ROUTINGS ARE AWAY FROM HEAT SOURCES, SUCH AS THE ENGINE OR EXHAUST PIPES. A FIRE OR EXPLOSION HAZARD COULD CAUSE SERIOUS INJURY OR DEATH.

DANGER! RIGID FUEL LINE TUBING SHOULD BE USED FOR UNDER VEHICLE RUNS, SUCH AS ALONG VEHICLE FRAME RAILS OR UNDER FLOOR PANS. FAILURE TO DO SO IS A POTENTIAL FIRE OR EXPLOSION HAZARD, WHICH COULD CAUSE SERIOUS INJURY OR DEATH.

7 - Anchor all fuel lines securely to solid chassis members at 1 ½ foot intervals using rubber coated steel clamps. Use of only approved steel fuel line tubing will afford maximum fuel line protection against road hazards and premature wearing due to flexing, temperature extremes, road salt, weather, etc.

8.5 Dual Tank Installation

The following are special instructions for vehicles equipped with dual fuel tanks. Holley **COMMANDER 950** fuel injection systems require a fuel return line and in dual tank applications, the fuel must be returned to the tank from which it was drawn. The items listed below are recommended to properly install your **COMMANDER 950** TBI system on a dual tank vehicle. A separate fuel pump and filter for each tank will be necessary.

Holley offers these items in a kit, part number **534-37**.

Item	Part Number
Selection valve	42-149
Valve Connector	42-203
Toggle switch	34-576
Relay	534-26
Fuel pump	512-103
10 amp in line fuse	-
Fuel filter	562-3

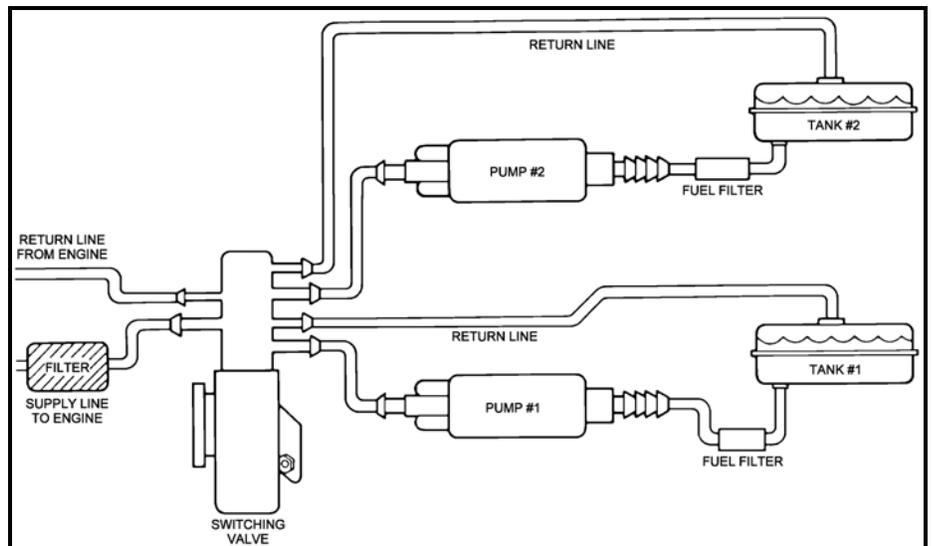
This is a recommended list and except for the fuel pump, equivalent parts may be substituted. In addition, fuel hose, clamps, 18 gauge wire, and assorted terminals will be needed. The selection valve recommended switches tanks by reversing the polarity of the “D” and “E” terminals. Many trucks equipped with dual tanks already have this type of selection valve along with the associated hardware.

1 - Mount the selection valve in a protected location close to the existing fuel lines and near the fuel tanks. Position the valve so the side with the four hose nipples points toward the fuel tanks. Mount the fuel pumps along the fuel supply lines and next to each fuel tank. Fuel filters (Holley Part Number 562-3) **MUST** be located between each tank and pump. Make sure pump inlets point toward the tanks. (See FIGURE below).

WARNING! The supply and return hoses from the same tank must be connected next to each other on the selection valve.

- 2 - All hoses should be secured with worm gear type clamps. Avoid sharp bends in the fuel lines.
- 3 - Mount the double position, double throw toggle switch along with the relay under the dash if the vehicle is not already equipped with this type switch. Connect the electrical wiring, as shown in the FIGURE on the next page.

NOTE: All wiring should be 18 gauge or heavier automotive wire that meets SAE J1560 standards. Wire the toggle switch as illustrated with one pair of terminals wired to ground and the other pair to a 12 volt power source through the relay and a 10 amp fuse.

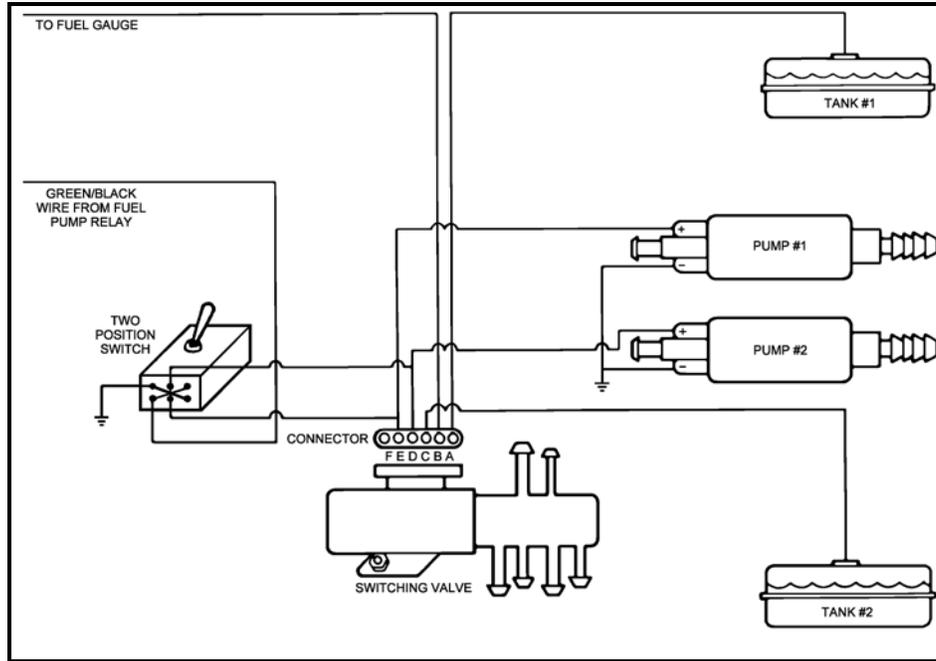


The terminals on the plug-in connector are labeled A - F and should be wired to the following items:

- A** Fuel sending unit, tank #1
- B** Fuel gauge at dash

- C Fuel sending unit, tank #2
- D Fuel pump #2 (+12v) and switch
- E Fuel pump #1 (+12v) and switch
- F Not used

4 - Plug the connector into the selection valve. Double check all fuel and electrical connections to be sure they are installed properly. Electrical connections should be insulated and sealed to prevent arcing and corrosion. Check the operation of the selection valve when the **COMMANDER 950** TBI system installation is complete.



8.6 Fuel Pump Filter

A filter **MUST** be installed between the fuel tank and the fuel pump inlet. The purpose of this filter is to protect the fuel pump from particles of dirt or other foreign material. The filter should be installed with the arrow on the filter pointing in the direction of the fuel flow. Secure the ends of the fuel lines with hose clamps.

8.7 Throttle Body Fuel Filter

The fuel filter that is included with the **COMMANDER 950** TBI system should be installed between the electric pump outlet and the inlet fitting of the TBI. Position the filter, so the fuel hoses can be routed without kinks or sharp bends. The filter should be installed with the arrow on the filter pointing in the direction of the fuel flow. Secure the ends of the fuel lines with hose clamps. Conveniently mount the fuel filter and clamp assembly using the hole provided in the clamp.

WARNING! Ensure both filters are installed in the proper direction. A flow direction arrow is stamped on the side of the filter to indicate the direction of fuel flow. Failure to do so will result in a system malfunction.

DANGER! TAKE PRECAUTIONS TO ENSURE ALL FUEL LINE ROUTINGS ARE AWAY FROM HEAT SOURCES, SUCH AS THE ENGINE OR EXHAUST SYSTEM. A FIRE OR EXPLOSION HAZARD COULD CAUSE PROPERTY DAMAGE, SERIOUS INJURY, AND/OR DEATH.

8.8 Return Line Installation

The Holley **COMMANDER 950** TBI system requires a return fuel line to the fuel tank. Some late model vehicles that were originally equipped with a throttle body injection system may already have a return line to the fuel tank that can be utilized. If a return fuel line must be installed, a minimum size of 5/16" I.D. is recommended.

DANGER! DO NOT USE THE VAPOR CANISTER LINES AS A FUEL RETURN LINE. POSSIBLE FUEL LEAKS MAY CREATE A FIRE OR EXPLOSION HAZARD, CAUSING SERIOUS INJURY OR DEATH.

WARNING! Use only approved steel fuel line. The return fuel line should enter the fuel tank at the "fuel level sending unit flange" or at the "filler neck". The filler neck or sending unit must be removed from the

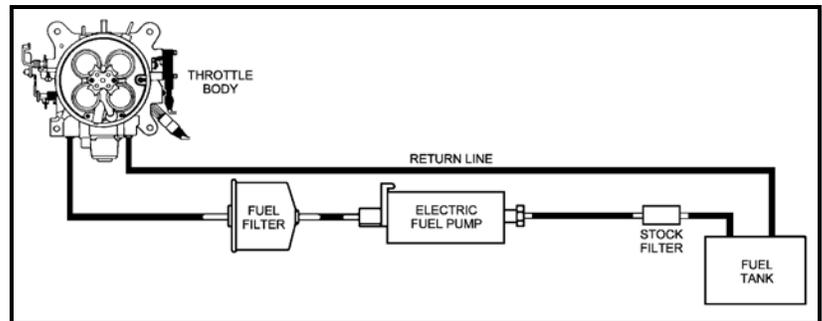
tank to perform this operation.

DANGER! PROPER INSTALLATION OF THE FUEL RETURN LINE MAY NECESSITATE COMPLETE REMOVAL OF THE FUEL TANK. THIS WORK SHOULD BE DONE BY A FUEL TANK SPECIALIST, WHO REGULARLY DOES THIS WORK AND IS FAMILIAR WITH SAFETY REGULATIONS AND PRECAUTIONS NECESSARY TO DO THIS WORK. IF A PERSON ATTEMPTS THIS WORK, WHO IS NOT FAMILIAR WITH THE SAFETY REGULATIONS AND PRECAUTIONS, AN EXPLOSION HAZARD MAY RESULT CAUSING SERIOUS INJURY OR DEATH.

8.9 Return to fuel tank system

- 1 - Install a 5/16" return line hose from the 5/16" return fitting in the throttle body to a fitting in the fuel tank. Use the supplied hose clamps to ensure that the fuel line fittings are tight at both ends of the hose.

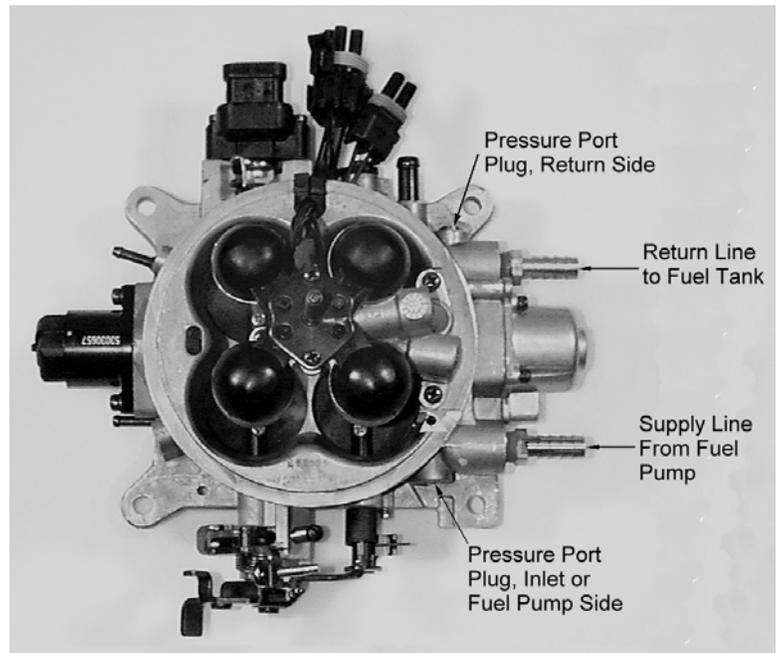
The system tuning and checkout process requires a fuel pressure gauge be installed in the return line system. This is a good time to consider how this pressure gauge will be installed. There are two plugs in the throttle body, one in the return line area and one in the supply side area. See the figure below for the pressure port plug locations. These make a very good location to install a pressure gauge. Attach a section of 5/16" hose to the outlet of the throttle body and secure with a hose clamp. Run the other end to either the fuel tank or the inlet of the pump at the tee fitting as previously discussed in earlier text. Secure with a hose clamp.



NOTE: The return line pressure should be as close to "0" zero as possible. The fuel pressure should be no higher than 3 psi.

8.10 Inlet Fuel Line Installation

- 1 - Route a 3/8" hose from the **COMMANDER 950** electric fuel pump outlet to the metal fuel filter inlet. Then install a 3/8" hose from the filter outlet to the TBI inlet. The fuel line connection on the left side of the throttle body (or linkage side) is the connection for the supply line. The remaining fuel line connection on the TPS side of the throttle body is for the return fuel line. Properly secure all hoses with hose clamps.
- 2 - If you plan to install fuel pressure gauges, do so at this time. If you do not plan to install fuel pressure gauges, a temporary gauge will have to be installed on the return fuel line. To install a temporary gauge to the return fuel line, a short length of 3/8" I.D. fuel hose, a tee fitting, and a 0 - 30 psig fuel gauge are needed. Screw the gauge into the center of the tee fitting. Attach the short length of hose to one end of the fitting. Attach the free end of this hose to the throttle body fuel return fitting. Attach the return fuel hose to the remaining side of the tee fitting.



WARNING! Ensure there is a fuel filter between the fuel tank and pump(s). If one must be added, use Holley replacement filters only.

8.11 Oxygen Sensor Installation

8.11.1 Oxygen Sensor Function, Theory, and Use

The **COMMANDER 950** allows the user to operate their engine in a closed loop fuel management mode using the oxygen sensor. The oxygen sensor monitors the exhaust gases and outputs a voltage that corresponds to the fuel/air mixture. The

range of voltage output from the oxygen sensor is 0.0 to 1.0 volts. A lean air/fuel mixture gives a lower oxygen sensor output voltage, while a rich air/fuel mixture gives a higher oxygen sensor output voltage. The stoichiometric or chemically perfect air/fuel mixture gives an oxygen sensor output of approximately 0.5 volts. The engine ECU reads this output from the oxygen sensor and adjusts the fuel delivery to maintain a stoichiometric fuel/air mixture. Most automobiles, both currently and for the past 20 years, are using oxygen sensors to monitor the engine fuel/air mixture. This is done primarily to improve engine emissions. It also gives the advantage of maintaining a stoichiometric fuel/air mixture under varied operating conditions giving generally better engine performance and fuel economy.

Holley includes oxygen sensor feedback capability with the **COMMANDER 950** system and recommends the user to use the oxygen sensor. For most user applications, better performance and fuel economy will be obtained by using the oxygen sensor. In addition, the oxygen sensor can make the tuning process much easier, since the user can monitor the ECU functions as it adjusts the fuel to meet a stoichiometric fuel/air mixture.

The mounting location of the oxygen sensor is extremely important for the proper operation of the engine. The exhaust gas temperature (EGT) in the exhaust, where the sensor is mounted, is very important for proper closed loop operation. If the EGT is too low, two undesirable conditions can result. First, the ECU may sense that the O₂ sensor is not up to proper temperature and will not activate closed loop operation. Second, the sensor could emit a false low voltage, even if the air/fuel ratio is rich. The ECU will see this as a lean condition and add fuel to compensate in closed loop mode. This makes the rich condition even worse, which will lower the EGT and complicate the problem. The lower the EGT the sensor sees, the slower the sensor will react, reducing the benefits of closed loop operation. The minimum recommended temperature for reasonable closed loop operation is 800°F (Fahrenheit) at the sensor. Maximum continuous temperature at the sensor is 1500°F. Most engines idle with an EGT of 800-1100°F near the cylinder head exhaust port. If the sensor is mounted far away, such as in the collector of long tube headers, the temperature may drop to as low as 300°F at idle. If the oxygen sensor attempts to control the air/fuel ratio when the EGT it sees is between 300 and 600°F, the problems mentioned above can occur.

It is recommended to mount the oxygen sensor as close as possible, where one bank of cylinders merge together. If an OEM mounting location is available, use it. With stock cast iron manifolds, the sensor can be mounted in the exhaust pipe, right after the cast iron manifold in the exhaust pipe or possibly in the end of the manifold itself. If the vehicle has "shorty" headers, the sensor can be mounted in the collector of the headers.

If the vehicle has long tube headers, the sensor can be mounted in the collector, but the temperature will likely be too low at idle for proper operation. A fix for this, if proper closed loop operation does not occur, is to run open loop at lower engine speeds, until enough heat is available for proper operation. This is programmable in the ECU. Other factors, such as camshaft specifications, will effect how well closed loop operation occurs at low engine speeds and loads.

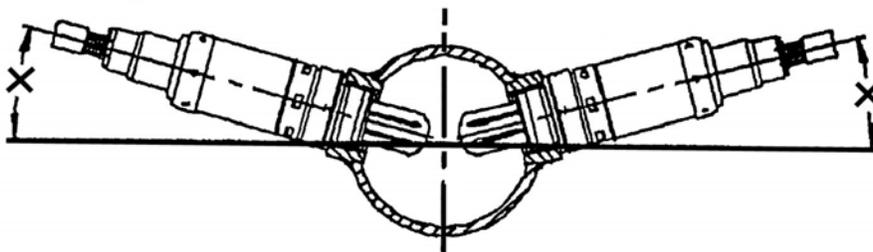
8.11.2 Oxygen Sensor Mounting Procedure

NOTE: The oxygen sensor boss should be installed by someone with experience in welding exhaust systems. Any competent exhaust shop is able to perform this task at a minimum cost.

WARNING! Use only unleaded fuel when operating an oxygen sensor. Use of leaded fuels will destroy the oxygen sensor and will result in incorrect exhaust gas oxygen-content readings.

WARNING! Use of some RTV silicone sealers will destroy the oxygen sensor used with this product. Ensure the RTV silicone sealant you use is compatible with oxygen sensor vehicles. This information should be found on the oxygen sensor package.

- 1 - Locate a position for the oxygen sensor as close to the engine as possible. If your vehicle has catalytic converters, the oxygen sensor MUST be located between the engine and the catalytic converters



NOTE: The oxygen sensor should be mounted in such a way that the condensation in the exhaust tubing will not enter the sensor. Mount the O₂ sensor in the upper half of the exhaust tubing, with the angle "x", shown above, being greater than 10°. The picture above indicates that the sensor can be mounted on either side of the exhaust tubing.

- 2 - Drill a 7/8" hole in the location picked for the sensor. Weld the threaded boss into the 7/8" hole. Weld all the way around the boss to insure a leak proof connection. Install the oxygen sensor into the threaded boss and tighten securely. It is a good idea to add anti-seize to the threads to aid in removal.

3 - On vehicles equipped with an AIR pump, the oxygen sensor must be mounted before the AIR injection into the exhaust, or the AIR pump must be disconnected. Holley recommends that if the AIR is injected into both exhaust manifolds, mount the oxygen sensor into the pipe immediately after the exhaust manifold. Disconnect the AIR pump tube from the exhaust manifold and plug both ends. Check with local ordinances for the legality of this procedure in your area.

WARNING! Failure to disconnect the AIR pump or locating the oxygen sensor downstream from AIR injection will result in an extremely rich mixture, which could cause driveability problems and severe engine damage.

WARNING! It is important that the distribution ring is properly installed and fastened to the throttle body. Failure to do so will cause an inadequate seal between the throttle body and air cleaner and may be a fire hazard in the event of a backfire. Fire hazard can result in property damage, serious injury, and/or death.

9.0 THROTTLE BODY INJECTION SPECIFIC TUNING

The throttle body injection (TBI) systems have several items to note. The factory should have preset the fuel pressure at 21 psi. This should be checked, if possible, before the tuning is performed. The injectors can operate down to 10 psi. The pressure can safely be raised above 21 psi.

Next check the throttle body linkage to determine if it is progressive or a 1 to 1 linkage. If it is progressive, the front plates will open first. After some travel, the rear plates will open. If the linkage is a 1 to 1, the front and rear plates will open at the same time.

NOTE: The software must be set differently depending on the linkage type. Perform the following, depending on the type.

1 to 1 Linkage

For most efficient operation, the rear injectors should be shut off at idle and very light throttle. This ensures that the pulse width is not too low during very low fueling demands. To do this, obtain the TPS value at idle. Add 20 to this number and enter it as the "TBI Switch 2-4" value under the "Engine Parameters" screen. Enter 5 for the "TBI Switch Hysteresis" value. Both of these values can be changed to optimize each particular combination.

Progressive Linkage

For progressive linkage, the rear injectors must be shut off, until the rear throttle plates start to open. With the key on and the engine off, open the throttle plates, until the rear plates start to open. Open the throttle slightly more (at least 10 TPS units over when the rear plates just start to open). You want the rear plates to be slightly open before the injectors turn on. Look at the position of the TPS at this point on the computer. Enter this value as the "TBI Switch 2-4" value under the "Engine Parameters" screen. A good value for the "TBI Switch Hysteresis" is 5. This means that when the TPS goes 5 units below the "TBI Switch 2-4" value, the rear injectors turn back off.

The wiring harnesses should be wired such that only the front two injectors will operate below the "TBI Switch 2-4" value. The back two should turn on after the programmed TPS setting is reached. Verify that the front two injectors are operating at idle. If they are not, extremely poor operation will result.

Idle Fuel Pulse Width

Ideally the injector pulse width at idle should not be below 1.7 milliseconds (ms). This value is seen on the data monitor. If the value is less than this, the fuel pressure can be lowered. This allows for the pulse width to be increased to a value above 1.7 ms.

NOTE: For wiring harness installation and tuning information, please see the supplied additional manual.

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