Holley

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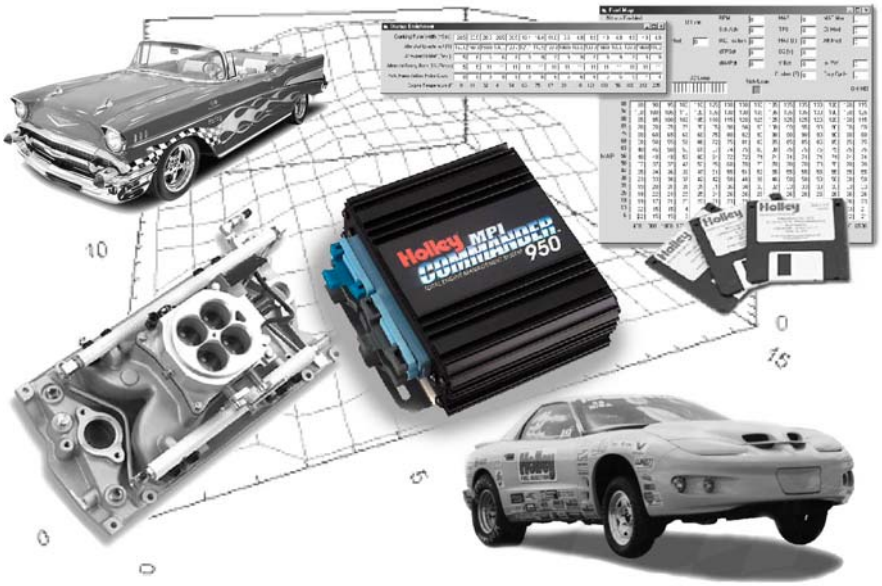

COMMANDER 950

UNIVERSAL MULTI-PORT EFI SYSTEM

1000 CFM—P/N 534-183
2000 CFM—P/N 534-184

INSTALLATION INSTRUCTIONS
199R-10263

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 may result in subsequent system failure.**

TABLE OF CONTENTS

OVERVIEW

The Holley Universal Multi-port EFI system (P/N 534-183 & 534-184) is designed for engines that have no off-the-shelf port fuel injection manifold available. It comes with almost all the components necessary for complete installation. Other components required are listed in this manual with guidelines for them.

SKILLS AND EQUIPMENT REQUIRED

Various skills and tools are required for the complete installation and successful use of this kit. Machining for the fuel injector bungs and fuel rails requires the use of a Bridgeport mill or similar piece of machining equipment. It is nice to have a digital X/Y axis readout. The injector bungs ideally should be TIG-welded to the intake manifold, which requires an experienced aluminum TIG-welder. They can also successfully be epoxied, but welding will guarantee good durability. The fuel rails will also require tapping and/or machining depending upon the fittings chosen. Hold-downs for the fuel rails will also have to be fabricated. These should be welded to the manifold, but they can be designed to be bolted down.

The tuning of the fuel injection system requires that an individual have basic computer and engine tuning skills. A manual is included that includes detailed and comprehensive tuning instructions.

NOTE: This kit is a universal kit. The level of skill and fabrication required will vary for every application.

COMPONENTS REQUIRED FOR INSTALLATION

The following components are not included with this kit and are necessary to complete the installation of an EFI system. Any of these components that are available from Holley can be found at the end of this manual under “List of Accessories”.

- ❑ Intake Manifold for Specific Application (see comments in the manual)
- ❑ Fuel Pump (needs to be sized to application, see guidelines in this manual)
- ❑ Fuel Injectors (needs to be sized to application, see guidelines in this manual)
- ❑ Various Fasteners
- ❑ Material to Fabricate Fuel Rail Hold-Downs
- ❑ Plumbing
- ❑ 30-100 Micron Coarse Fuel Filter (before the fuel pump)
- ❑ 10 Micron High-Pressure EFI Fuel Filter (after the fuel pump)
- ❑ Throttle Linkage

INTAKE MANIFOLD SELECTION

This kit is designed to retrofit Multi-port electronic fuel injection on an intake manifold that is designed for a carburetor. The throttle body included is designed for a square bore 4150 manifold (PN 534-183) or a Dominator flange manifold (PN 534-184). If a different flange is used, an adapter will be necessary.

The easiest style of manifold to convert is a single-plane type intake manifold. A single plane intake manifold is not recommended with mild engines with carburetors, as they usually experience a loss in low-speed torque. Some of this is due to a poor vacuum signal to the carburetor. This is not a problem with EFI, as the EFI is programmable and the proper amount of fuel is easily programmable.

A dual-plane intake manifold has longer runners that enhance lower rpm torque. However, it is difficult and usually impossible to use a solid length fuel rail with a dual plane intake.

Testing shows that EFI overcomes much of the typical loss in low rpm torque that usually occurs with a carburetor and a single plane intake.

INJECTOR BUNG INSTALLATION

It is critical that the injector bungs be installed correctly to ensure proper injector alignment. The following list must be considered before any machining starts:

- Fuel rail clearance with respect to:
  - Alternator, air conditioning, and other accessories
  - Rail to Throttle Body Clearance (It is very important to check throttle body linkage to rail clearance.)
  - Rear fitting clearance with firewall
  - Distributor
  - Valve cover clearance

- Clearance with any throttle cable and transmission cable brackets.

- Injector angle. Ideally the injector should point towards the intake valve. This is not possible or easy to do most of the time. Having the fuel injectors vertical (with respect to the ground) is acceptable and allows for the simplest machining. The steeper the angle of the intake manifold runner, the more difficult it becomes to maintain a good angle.

- Position the injector bung, so that the bungs won't protrude through the intake manifold reducing airflow. This is constrained by the lower injector o-rings. They must be contained by the bung. The bungs WILL have to be ground down, as they are intentionally extra long.

WARNING: If the bottom injector o-rings are not contained by the bung and do not seal, you will have a vacuum leak that will cause major tuning problems.

- Generally the injectors are centered in the port for best injector spray and atomization.

1. Determine positions for the injector bungs, keeping the information above in mind. It is best to mount the throttle body and as many other items as possible when doing this to eliminate future clearance problems.

2. After the positions are determined, fixture the intake manifold on a milling machine. Make sure the intake is level and positioned straight. Machine holes, so that ideally a slight press fit (.0005-.001") is achieved with the bung. This will make it easier when welding or epoxying the bungs in. Record the center-to-center dimensions of the injector bungs. They will be needed when machining the fuel rails. The bungs will be attached after the fuel rails are machined.

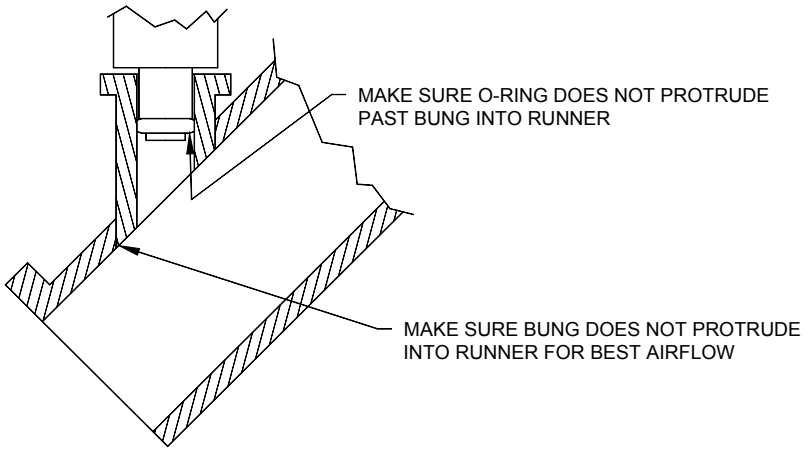

Figure 1

FUEL RAIL MACHINING

NOTE: See the back page for fuel rail machining drawings.

Once the manifold is machined, the fuel rails can be machined next.

1. If the rails need to be shortened, perform this task first. The rails included are extra long for any application and will likely need to be shortened. The length will depend on injector spacing, fittings, and the crossover-line design used.

2. Mount the rail in the Bridgeport and square it up.

3. Select a starting point for the first hole.

4. Determine the proper diameter for the injectors you are using. For Holley injectors, machine the hole to a diameter of .535 inches (See Figure 6 in the back). The bore must be smooth for the injector o-ring surface, or leaks will result.

5. If this bore diameter is machined completely through, injector-retaining clips must be used, so that the injector o-ring does not protrude through and cause a leak. The retaining clip is not needed if a step is machined in the bottom of the injector bore in the fuel rail, so that the o-ring can not protrude into the passage.

6. Using the exact same dimensions that you machined the intake manifold, machine the injector holes in the fuel rails.

7. The ends of the rails must then be machined, so that a fitting can be installed. There are generally two methods to do this. These methods are: 1) an AN thread and an o-ring 2) or tapping the ends to an NPT thread.

   (1) The AN thread and o-ring seal is the preferred method, although more complicated to machine. The AN thread uses the o-ring to seal. The drawings at the end show the proper machining for this method (See Figure 8 in the back).

   (2) The second would be to use a NPT thread. The rail must be drilled to the proper drill size for the tap first. Then tap per specifications.

INJECTOR BUNG INSTALLATION AND FUEL RAIL MOUNTING

1. After the manifold and rails are machined, the injector bungs need to be welded or epoxied and the hold-downs for the fuel rails must be attached. The recommended method is TIG-welding. This ensures a safe and long-lasting part. However, a person experienced with aluminum TIG-welding must perform this operation. Epoxying the bungs is acceptable, but is not advised on high-vibration race engines or for used intake manifolds.

2. The bungs can either be welded in from the bottom or on the top. Welding on the bottom provides a cleaner look. If this is done, the bungs should be pre-machined, so that they are flush with the inside of the manifold runner. If they aren't they can't be welded easily. If they are welded from the top, the bung can be ground off flush in the intake manifold runner after they are welded. If they are epoxied they should be ground to fit inside of the runner first.

WARNING! Do not perform any welding with the injectors in the bungs, as the heat will damage them.

3. The fuel rail hold-downs must be designed to keep the fuel rails stable and in place. The best method is to weld them to the manifold.

4. The fuel rails will then bolt to the fuel rail hold-downs. The rails will have to be machined for the fastener type used.

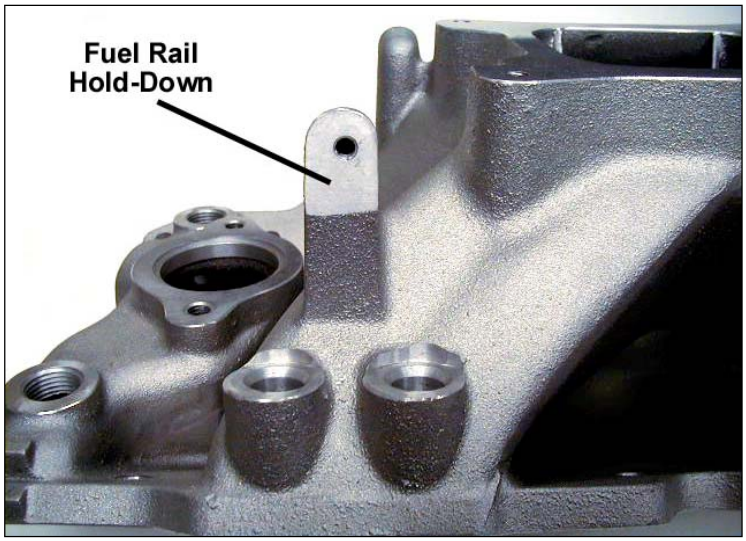

Figure 2

WARNING! EFI systems are run at high pressures. Make sure that the hold-down design securely fastens the fuel rails. If they don't, leaks and potential fire hazards can occur.

FUEL SYSTEM DESIGN

Several main components, not included with this kit, are the fuel injectors, fuel pump, and fuel filters. Proper selection of these components is critical to proper system operation. Engine horsepower and intended application are the critical variable in selecting these items.

Fuel Pump

The fuel pump must be selected to flow enough fuel and maintain the desired pressure. It is important to understand that with any fuel pump, as pressure is increased, flow decreases. This is especially important with EFI systems that operate from 40 to 60+ PSI.

Most fuel pumps are rated in gallons per hour. Gallons per hour (GPH) required can be calculated from the following equation:

(Maximum Engine Horsepower) x (Brake Specific Fuel Consumption)/6 lbs. = Minimum Pump GPH required

Brake Specific Fuel Consumption (BSFC) is basically a measure of how much fuel is required for each HP produced. A lower number indicates that less fuel is needed for a given amount of power. High-compression race engines generally require less fuel than supercharged, turbocharged, and nitrous engines for the same HP.
The following are some BSFC number guidelines:

	BSFC
Naturally aspirated street engines:	.45-.55
Naturally aspirated race engines:	.4-.5
Supercharged, Turbo, and Nitrous engines:	.6-.65

Never size a pump to theoretical calculations. Pressure drop through lines and variations in pump tolerances require a safety margin. It is good to increase calculated pump size by about 30%.
Two Examples follow:

Example 1

950 Horsepower naturally aspirated race engine:
(950 HP) x (.42 BSFC)/6 = 66.5 GPH
Add the 30% margin
66.5 x 1.3 = 86.45 GPH

Example 2

1,200 Turbocharged engine:
(1,200 HP) x (.63 BSFC)/6 = 126 GPH
Add the 30% margin
126 x 1.3 = 163.8 GPH

As you can see, the BSFC has a significant role in an engine's fuel demand.

Fuel Injectors

Fuel injectors use some of the same variables as the fuel pump. Again, it is very important to size the injectors properly. Most fuel injectors are rated at about 43-45 PSI. For a complete list of injectors available, see the List of Accessories at the end of this manual.

The following formula is used to calculate the injector size needed:

Injector Size = Engine Horsepower x BSFC / # Cylinders x % Duty Cycle

Engine HP = Gross Flywheel HP
BSFC = Brake Specific Fuel Consumption, examples are given above with the fuel pump sizing
# Cylinders = Number of cylinders if using Multi-port EFI and 1 injector per cylinder
% Duty Cycle = This number is used in the calculation so that the injector is not open 100% of the time (static) at peak power. Normally a number of 80%-90% is used.

Some examples follow:

Example 1

600 HP V8 street engine
600 HP x .5 BSFC / 8 x .9 duty cycle = 42 lb./hr.

Example 2

900 HP naturally aspirated race engine
900 HP x .42 BSFC / 8 x .9 duty cycle = 52.5 lb./hr.

Example 3

1200 HP Turbo-charged engine
1200 HP x .6 BSFC / 8 x .9 duty cycle = 100 lb./hr.

You usually round the size up to the closest injector available. However, you can raise the fuel pressure to increase the flow of an injector. The following equation shows the formula to calculate injector flow when the pressure is increased:

New Flow = Rated Flow x square root (New Pressure/Rated Pressure)

Rated Flow = Flow the injector is rated at by the manufacturer
Rated Pressure = Flow the injector is rated at by the manufacturer (usually 43-45 PSI)
New Flow = Flow at new pressure
New Pressure = New pressure

Example:

An injector is rated at 30 lb./hr. at 45 PSI. Increasing the pressure to 55 psi results in the following flow:

30 x square root (55/45) = 33.2 lb./hr.

Increasing the fuel pressure will increase the fuel flow through the injectors.

Remember that although increasing pressure increases injector flow, it DECREASES fuel pump flow. Make sure the fuel pump has enough flow when the pressure is raised.

Fuel Filters

Fuel filters are an essential part for the life of the fuel pump and fuel injectors. Two fuel filters are required when running an in-line fuel pump. A coarse filter is required on the inlet of the fuel pump. This filter is generally 30-100 microns. A high-pressure EFI filter is required on the outlet of the fuel pump. These filters usually have about a 10 micron filtration rating.

Both filters must be sized for the flow of the particular application. Consult the filter manufacturer for specifications.

VACUUM LINES

There are two vacuum lines that should be connected for use with the fuel injection. Try to keep the vacuum lines, especially the MAP sensor line, as short as possible for best operation. Make sure there are no kinks in the lines. Use only a hose meant for vacuum and not pressure applications.

1. Connect a vacuum line from the MAP sensor to a vacuum port on the throttle body. Do not connect any other vacuum accessories to the MAP sensor port.
2. Connect a vacuum line from the fuel pressure reference port to a vacuum port on the throttle body. There are two small vacuum ports on the throttle body.

WARNING! The MAP sensor should be mounted upside down, so that it is not contaminated by fuel vapor.

PLUMBING

Plumbing the EFI correctly is very important to proper operation. There are two basic ways that an EFI system can be plumbed with a V8 with a dual inlet remote regulator such as the one supplied with this kit. One is simpler and is recommended for lower HP applications. The second requires more plumbing, but is used at higher HP and fuel flow levels to ensure uniform fuel delivery.

The first method (see Figure 3) is recommended with engines that use 36 lb./hr. injectors and less. These engines are typically less than 600 HP. Fuel is fed into one rail. A crossover line links the first rail to the second. Fuel passes through the second rail. It then exits to the regulator into one of the two inlet ports on the side. The other inlet is plugged. The fuel returns to the tank through the bottom outlet port in the regulator.

The second method (see Figure 3) is recommended with engines with 42 lb./hr. and larger injectors. These engines are typically 600 HP and more. Engines with less power can also use this plumbing method. The main fuel inlet line is split, preferably with a "Y" type fitting into two lines before the fuel rail. Each line is routed to one bank of injectors. An outlet line from each rail is then routed to each regulator inlet port.

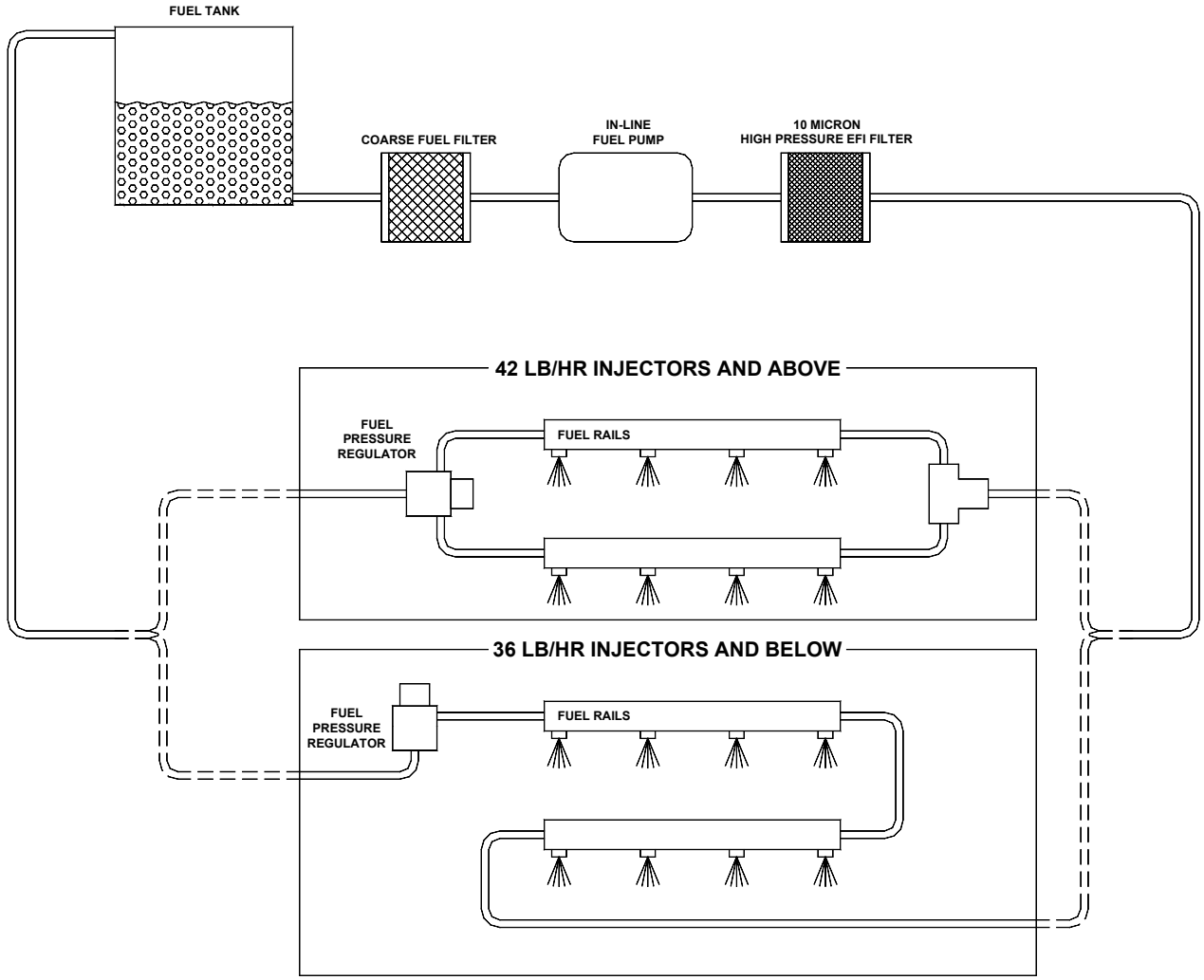

Figure 3

Fuel Line Sizes

Fuel line size is important with EFI, but there is a tendency to oversize feed lines. A high pressure EFI system does not need the same size lines as a low-pressure carbureted engine. A 3/8" diameter line (-6 AN) line is adequate for engines to at least 750 HP. This is a conservative number. A ½" diameter line (-8) line should be used on engines over 750 HP.

The regulator included with this kit includes –8 inlet fittings. The line used to go from the fuel rail(s) to the regulator should be –8 if these fitting are used. If different lines are desired, different fittings for the regulator need to be obtained. It is ok to use –8 lines to the regulator, but different sized inlet lines to the rails such as a –6.

The return fitting on the regulator has a –6 fitting. Use a 3/8" diameter return line for most applications.

NOTE: On very high horsepower applications (1000+ HP), follow the guidelines given by the fuel pump manufacturer for fuel system design.

THROTTLE BODY INSTALLATION

Your kit comes with either a 1000 or 2000 CFM throttle body. They fit 4150 and Dominator style flanges respectively. Both throttle body kits come with two gaskets and metal plate. These gaskets and plates should be used. Some manifolds do not have enough material in the back of the mounting pad to seal the IAC (idle air control) motor passages. If this occurs and the plates are not used, a vacuum leak will occur that will make tuning the engine impossible.

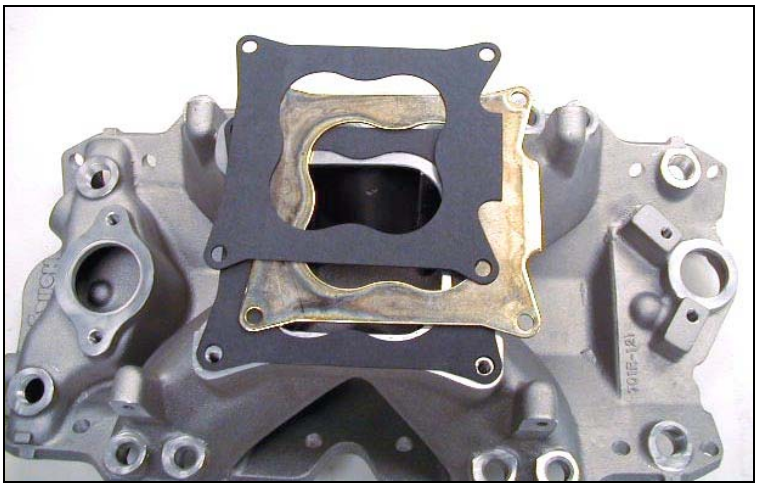

Figure 4

LIST OF ACCESSORIES

The following is a list of products that can be used to complete the installation of you multi-port EFI system.

Plumbing Accessories – Earls Performance Products has a complete product line of fittings and high performance hoses to plumb any EFI system. Please see the Earl's catalog or an Earl's dealer for a complete listing of components.

Fuel Pump – Holley PN 12-920 is an excellent in-line fuel pump for applications up to 700 HP at 50 PSI. This pump comes with 3/8" barbed hose fittings. PN 26-160 includes two –6 AN fittings for this pump. PN 26-180 includes two –8 AN fittings for this pump.

Throttle Cable Bracket – Holley PN 20-113 mounts to 1000 and 2000 CFM Holley throttle bodies and mounts both the throttle cable and 700R4 transmission TV cable.

MAP Sensor Bracket – Holley PN 9902-104 allows for the MAP sensor to be mounted using one of the throttle body bolts.

The following are a list of fuel injectors available. The packages include 8 injectors. For packages of 6 or 4, substitute a 6 or 4 for the last digit in the part number. All injector flows are rated at 43.5 PSI.

P/N	Flow Rating	Impedance*
522-1408	14 lb./hr.	High
522-1908	19 lb./hr.	High
522-2408	24 lb./hr.	High
522-3008	30 lb./hr.	High
522-3608	36 lb./hr.	High
522-4208	42 lb./hr.	High
522-5008	50 lb./hr.	High
522-5508	55 lb./hr.	Low
522-6508	65 lb./hr.	Low
522-7508	75 lb./hr.	Low
522-8508	85 lb./hr.	Low
522-9508	95 lb./hr.	Low

*When running 8 low-impedance injectors, you must use PN 534-122, which expands the Commander 950 to allow for the use of 8 low-impedance injectors.

For NOS fuel injectors, for which Holley pays contingency in some drag racing classes, change the 522 to a 922.

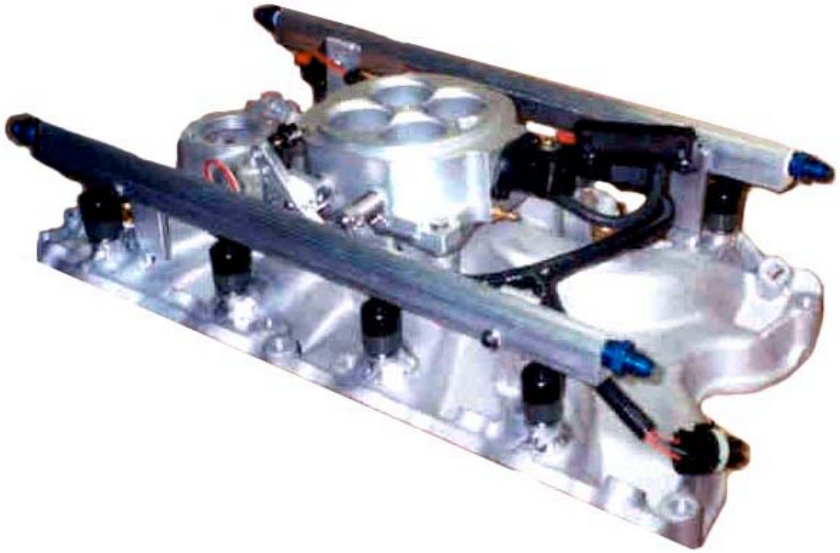

Figure 5—Example of Completed Manifold

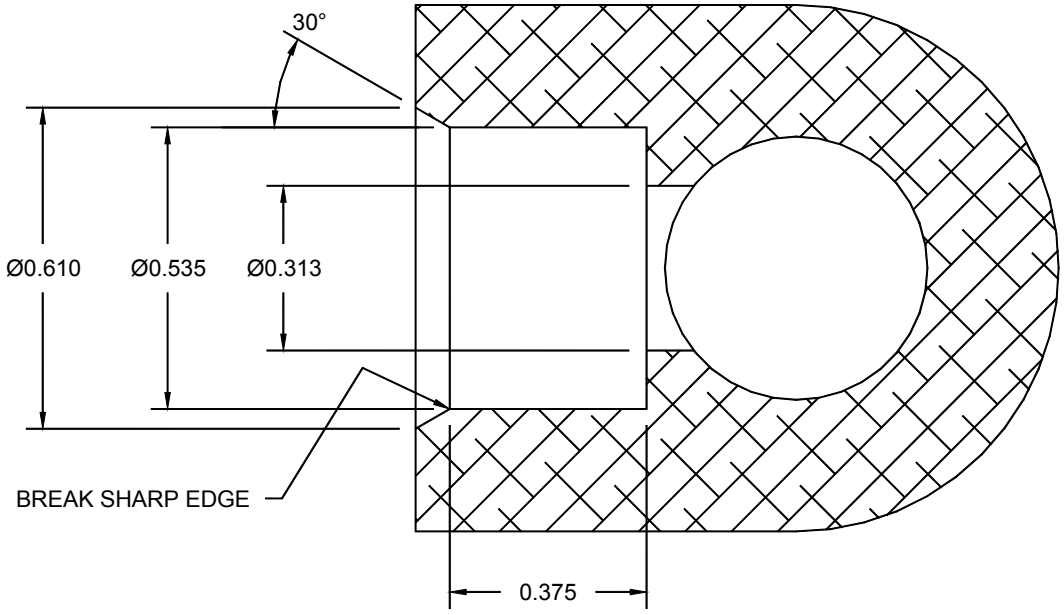

Figure 6

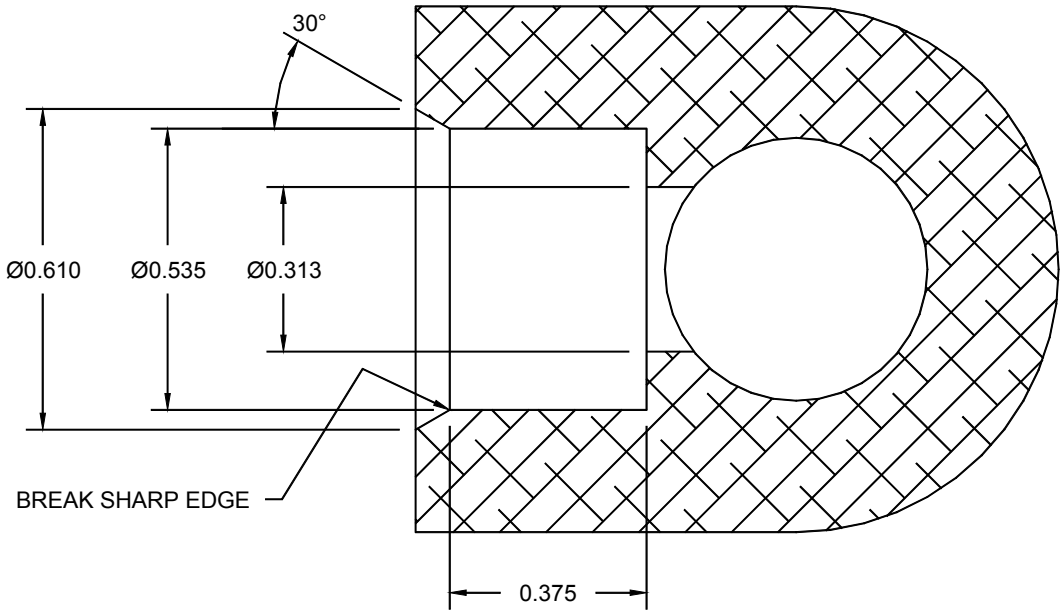

Figure 7

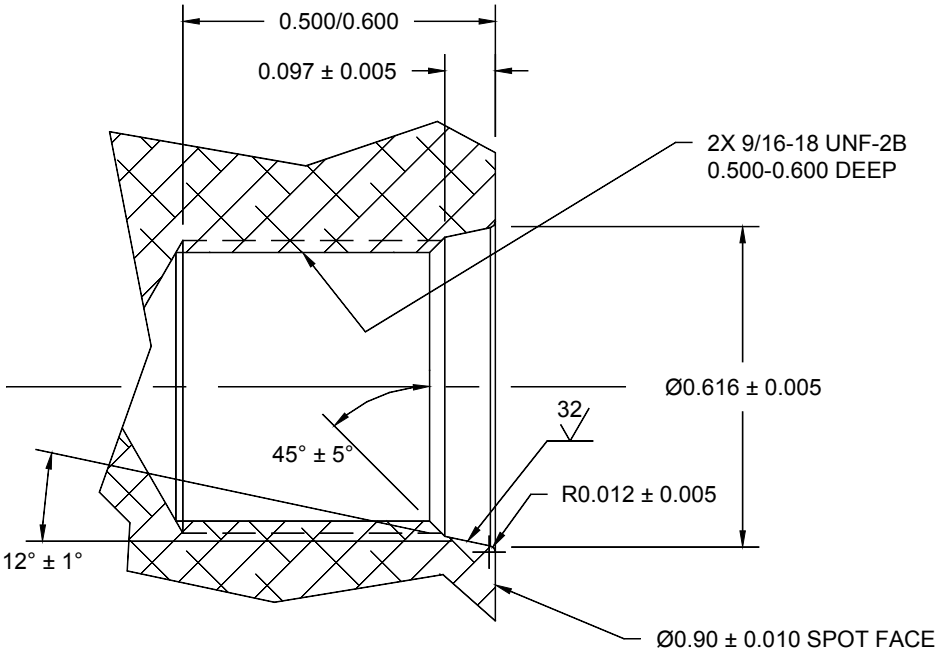

Figure 8

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For online help, please refer to the Tech Service section of our website: www.holley.com

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