MSD™ FUEL MANAGEMENT

MSD FUEL MANAGEMENT

INJECTOR FUEL FLOW

Electronic injectors have two masters to satisfy. They must accurately match the fuel demands of an engine while meeting the electronic commands of the engine management computer. We'll concentrate here on the mechanical side of matching injector static fuel flow (which is the rating at non-pulsed, wide-open flow) to a gasoline engine's airflow. See the Tech Note: "Matching injectors to the ECU" on page 5 for tips on making sure the injector's electronic specifications are compatible with an engine management system's computer electronics.

Obtaining the correct fuel flow amount from a group of injectors in an EFI system is similar to determining the right size jets for a carbureted engine. The fuel flow of both systems must be matched to the airflow requirements of the engine over a broad rpm operating range.

A carburetor may have three or more separate fuel circuits like idle, mid-range, and power to deliver a fuel curve over the engine's operating range. An electronic injector must be elastic and yield one fuel curve that typically supplies fuel to an individual cylinder from 500 - 8000 rpm (or higher). This wide operating boundary demands that an injector have a wide "dynamic range" or operation.

This injector must be able to supply a small amount of fuel to support engine idle, a large amount at wide-open throttle to prevent high-rpm lean-out, and transitional amounts to cover all of the operating conditions in between. Turbo/supercharged engines in particular place even more rigorous demands on an injector's range because of their increased airflow capability. The amount of fuel delivered by an electronic injector is controlled by how long it is held open by the Engine Control Unit (ECU). It is "pulsed or energized" open for short periods of time at idle, and held open longer as rpm and airflow increase.

Just as the wrong-sized jets in a carb can cause driveability problems such as rough idle, surging, poor throttle response or even high-rpm lean-out causing scattered engine parts, so can incorrectly-sized injectors. The MSD Injector Selector program (PN 2000) precisely matches the MSD Competition Fuel Injectors' static fuel flow capacity to the maximum airflow demands of a gasoline fueled engine, be it naturally aspirated or turbo/supercharged. Following is a guideline equation for approximating fuel flow per injector based on estimates on engine Horsepower (HP) and Brake Specific Fuel Consumption (BSFC). Take note of these conditions for equation accuracy:

(1) Engine HP must be realistic estimate of engine output.
(2) BSFC is determined from engine dynamometer measurements. It typically ranges from 0.4 - 0.6 for gasoline powered engines. A BSFC of 0.5 is a reasonable initial estimate for most engines.
(3) The 0.8 multiplier of the "Number of Injectors" helps us derive a practical, maximum "Injector Flow Rate" for each injector based on an effective real world injector operating pulse time and fuel flow. It's unrealistic to establish the fuel flow to the engine based on an injector operating pulse time of 100% (wide open all the time). This formula uses an injector operating cycle based on 80%. Some full race engine management systems may operate at 85 - 95% duty cycle, but doing so for some time increases the likelihood of overheating the injectors which may cause irregular fuel rates or a decrease in low rpm operation.

$$\text{Injector Flow Rate (lb/hr)} = \frac{\text{Engine HP x BSFC}}{\text{Number of Injectors x 0.8}}$$

For example, to calculate the individual injector size for a 650 HP V8 using 8 injectors and assuming a BSFC of 0.5:

$$\text{Injector Flow Rate (lb/hr)} = \frac{650 \times 0.5}{8 \times 0.8} = 50.78 \text{ lb/hr}$$

Use MSD Competition Fuel Injector PN 2013, rated at 50 lb/hr static flow at 43.5 psi (3 bar) fuel system pressure.

If you have a known injector fuel flow rate you can solve the above equation for a rough estimate of fuel system capacity like this:

$$\text{Engine HP} = \frac{\text{injector Flow Rate x Number of Injectors x 0.8}}{\text{BSFC}}$$

For example, using the same estimated values from above:

$$\text{Engine HP} = \frac{50 \times 8 \times 0.8}{0.5} = 640 \text{ HP}$$

It's also useful to keep in mind a few other mechanical considerations when sizing injectors to an engine.

Alcohol Fuels

MSD Competition Fuel Injectors are compatible with alcohol based fuels. If you are running 100% methanol, flush the entire fuel system with mineral spirits or gasoline to purge it of the methanol after every race. Any residual methanol will harbor water that will corrode any part that isn't stainless steel. The internals of MSD injectors will withstand long term use with alcohol fuels, but the external O-rings will swell after prolonged use. Keeping a few spare O-rings (PN 2100) is inexpensive replacement insurance. Note too, that using methanol fuel requires about twice the comparable gasoline fuel flow; therefore, double the injector size when determining the correct injector required.

Bigger Isn't Always Better

Stock, street driven EFI engines using an O_2 feedback, closed loop control system rarely exhibit a performance gain just by installing injectors with a higher flow rating. During closed loop control, the stock ECU will try to adjust for the greater amount of fuel that the larger injectors deliver per each pulse. The ECU will decrease the injector on-time to decrease the amount of fuel available per pulse. If the replacement injector is not too large (about 10 - 20% greater flow, at most) the ECU may be able to control the larger injector during closed loop operation.

If the ECU cannot compensate for the increased volume of fuel from the bigger injector, and the induction system has been kept stock, be prepared to measure the hydrocarbon (raw gasoline) emissions at idle with a cup at the tailpipe. Unburned fuel will pour into the exhaust, the "Check Engine" light will probably come on and the catalytic converter will overheat or be fuel poisoned because of the raw fuel.

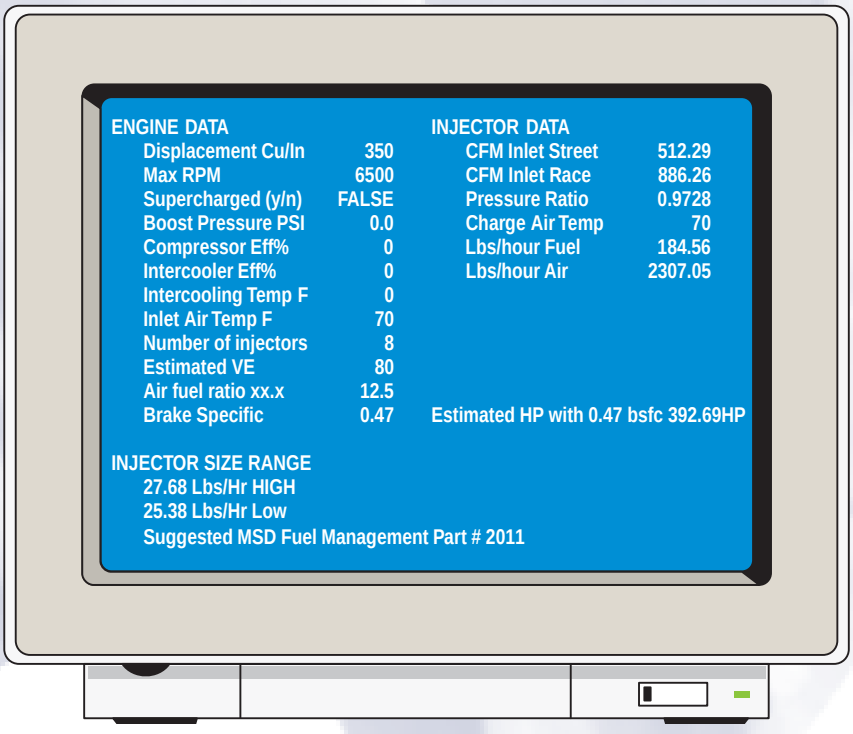
Balancing Injectors

There is some performance merit in matching or balancing injector flow rates among cylinders on a stock engine. There may be a fuel economy improvement, or a slight performance gain by having all the injectors as equal as production tolerances will allow. Certainly, an injector that is flowing 10 - 20% more or less fuel that the others is going to affect engine efficiency.

MSD Competition Fuel Injectors have been balanced to a flow rate tolerance between individual injectors of the same static (wide open) flow rate of 1.5 - 3%. This close tolerance is particularly useful in high performance racing engines where maximum performance for each cylinder is required. Even the direct stock replacement injectors for GM 5.OL Multi Port Fuel Injection (PN 2016) and GM 5.7 MPFI (PN 2017) systems, adhere to this tolerance range for precise injector balancing in stock engines.

Injector Selector Computer Software, PN 2000

Precisely matching electronic fuel injector flow rates to an engine's operating characteristics is critical for maximum performance. MSD offers this easy-to-use software to determine the engine's fuel requirements and electronic fuel injector size based on 12 engine parameters including:



- **Displacement**
- **Engine RPM**
- **Turbo/supercharging boost pressure**
- **Intercooler Efficiency**
- **Engine Volumetric Efficiency**
- **Brake Specific Fuel Consumption (BSFC)**

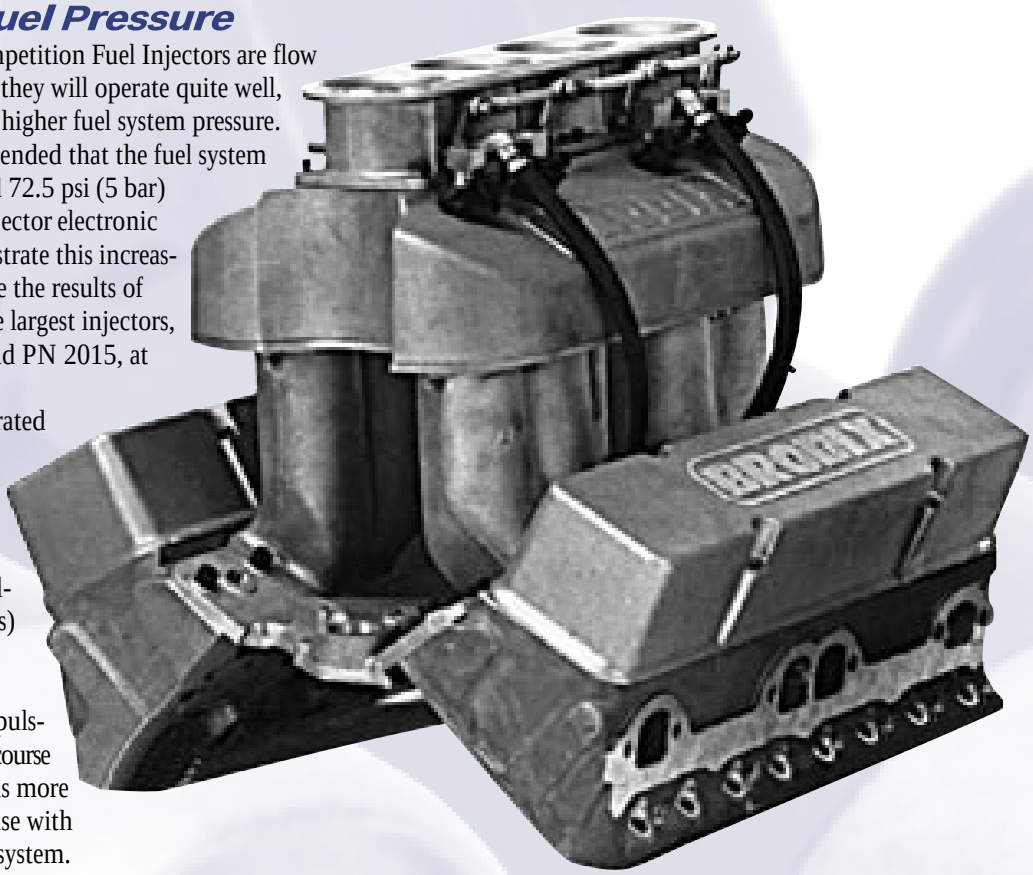
To obtain an injector recommendation, just ENTER the parameters requested on the left side of the screen and the Injector Selector immediately calculates the values on the right, and recommends the appropriate MSD Competition Fuel Injector. The software includes on-line HELP functions for quick learning, and calculates in U.S. or Metric units. Requires IBM™ PC/XT/AT or equivalent IBM Computer, a monitor using CGA/EGA/VGA/Hercules graphics, and at least 256K RAM. Available in 5 1/2-in. or 3 1/4-in. floppy disk format.

MSD FUEL MANAGEMENT INCREASING FUEL PRESSURE

Increasing Fuel Pressure

Although MSD Competition Fuel Injectors are flow rated at 43.5 psi (3 bar) they will operate quite well, and flow more fuel, at a higher fuel system pressure. How high? It is recommended that the fuel system pressure does not exceed 72.5 psi (5 bar) and that the specified injector electronic drivers are used. To illustrate this increased flow capacity, here are the results of pulsed fuel testing of the largest injectors, PN 2014, at 72 lb/hr and PN 2015, at 96 lb/hr.

Both injectors were operated with their specified electronic driver (4 amp current turn on, 1 amp hold open) at an 85% duty cycle equaling 10.4 millisecond (ms) on-time at 5000 rpm. Fuel specific gravity was 0.73. Wide open, non-pulsed (static) flow would of course be higher, but this data is more accurate for real world use with an engine management system.



Fuel Pressure (PSI)	Pulsed Flow (lb/hr)* PN 2014	Pulsed Flow (lb/hr)* PN 2015
30	56	72
40	64	84
50	71	93
60	76	101

*** @ 10.4 milliseconds.**

Increasing the fuel pressure also better atomizes the injector's fuel spray and improves its uniformity. Our PN 2220 adjustable fuel pressure regulator is useful for setting fuel system pressure, and our PN 2225 High Pressure electric fuel pump can also be used to increase overall fuel system pressure.

If you know an injector's static (non-pulsed) fuel flow at one system pressure you can derive its static flow at another pressure with the equation at right.

$$F2 = \left(\sqrt{\frac{P2}{P1}}\right) \times F1$$

F2 is the calculated injector static flow (lb/hr) at the higher pressure.
P2 is the fuel system pressure (psi) you want to use.
P1 is the fuel system pressure (psi) the injector is rated for.
F1 is the injector's static flow (lb/hr) at its rated fuel system pressure in psi.

For example, our PN 2018 injector is static flow rated at 38 lb/hr at 43.5 psi. If we want to know what its static flow will be at 60 psi then:

$$F2 = \sqrt{\frac{60}{43.5}} \times 38 = \qquad F2 = 1.1747 \times 38 = 44.6 \text{ lb/hr}$$

Determining the right amount of injector fuel flow required by an engine is only part of selecting the correct injector. Now we'll examine how to make sure the injector's electronic specifications are compatible with an engine management system's electronics.

Energizing An Electronic Injector

Electronic fuel injectors operate like a miniature starter solenoid. Just as a starter solenoid's engaging action occurs when it is energized, the internals of an injector are physically moved to let pressurized fuel flow through it when it is energized. In the case of our "top feed" MSD Competition Fuel Injectors, an internal "ball" is lifted off a "seat" when the injector is energized. The pressurized fuel flows around the ball and through a "director plate" with six holes to spray the fuel in a tight 10° -15° cone. This narrow spray angle (other injectors' spray angle can be as wide as 30°) delivers a fully atomized fuel charge that is suspended in the intake and is kept from wetting the intake and cylinder walls.

The amount of fuel delivered by an electronic injector is controlled by how long it is held open by the Engine Control Unit (ECU). This time is usually specified in milliseconds (ms). An injector is "pulsed" open for short periods of time at idle, and held open longer as rpm and the engine's airflow increases, which requires a corresponding increase in fuel flow.

Keep in mind that electronic injectors don't respond instantaneously when they are given an ECU command to open. It takes a little time for any injector's mechanicals to move after receiving an electronic signal by the ECU. MSD Competition Fuel Injectors have an average reaction time of 1.5 - 2.0 ms before opening at their rated fuel pressure of 43.5 psi (3 bar) when using their specified injector driver. If you substantially increase the fuel pressure to the injector, or change its driver type, this reaction time and the usable operating rpm range of the injector will be affected.

The ECU controls injector pulsing with an electronic "driver circuit," and it is important to match the injector's electronic specifications to the ECU's driver electronics. What can happen if they aren't compatible? The injector's fuel delivery rate can be slowed down or made nonlinear, or the injector may overheat and its fuel flow characteristics will then change (decrease) or it may fail entirely. At best the engine will experience poor driveability or misses at high rpm; at worst you char the driver circuits in the ECU and break some engine parts.

Injector Resistance

The resistance of the primary injector is the major electronic specification to be concerned about when assembling an injection system. Electronic fuel injectors are manufactured in two ranges of resistance; Low and High. Low is typically in the 2-5 ohms range, and High is 12-16 ohms. You can measure an injector's resistance with a Digital Volt-Ohm Meter(DVOM) by connecting it across the injector's electrical plug contacts.

The injector's resistance indicates what kind of driver it should be matched with in the ECU. Page 8 details what type driver to use with MSD Competition Fuel Injectors, as well as the resistance of each injector. There are two classes of injector drivers in general use in production and aftermarket ECUs; saturated circuit and peak and hold. Before matching any electronic fuel injector with an ECU, it's prudent to find out from the ECU manufacturer what kind of injector drivers are in it.

High Resistance Injectors

Most U.S. production EFI systems use an ECU with 12 volt saturated circuit drivers. These are very inexpensive, simple, and reliable. This type of driver works by supplying 12 volts to the injectors and the ECU turns it on and off to establish a fuel injector pulse. In general, if an injector has a high resistance the ECU uses a 12v saturated circuit driver to control it. This means that the current flow in the driver and injector circuit stays low and keeps all the components nice and cool for long life.

One downfall of a saturated circuit driver is that it has a slower response time (and closing time) than a peak and hold type. This slower time can somewhat decrease the usable operating range of the injector energized by this driver. An injector operating on a saturated circuit driver typically has a reaction time of 2 ms while one operating on a peak and hold driver typically responds in 1.5 ms.

MSD offers two higher flow injectors that are particularly designed for quick response time with a 12 volt saturated circuit driver. The PN 2018 Injector is rated at 38 lb/hr with 12 ohms and the PN 2013 is a 50 lb/hr, 12 ohm injector.

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MATCHING THE INJECTORS

Ohm's Law can be applied to calculate the current in the injector and driver circuit when using a high resistance injector like the PN 2018 (38 lb/hr static flow, 12 ohm). Remember, Ohms's Law is I = E/R, where I = the circuit's current in amps, E = battery voltage in volts available to the injector, and R = injector resistance in ohms. So, for our 12 ohm injector being supplied 12 volts, I = 12v /12 ohms, which is 1 amp of current in the circuit to operate the injector.

Low Resistance Injectors

On the other hand, if an injector's resistance is low (2-5 ohms), the ECU is probably controlling it with a peak and hold injector driver. This type of injector driver is also called a current sensing or current limiting driver. These are more expensive and complex than saturated circuit drivers, and are not generally used in domestic production ECUs but are found in some aftermarket high performance systems. With this type of driver, 12 volts is still delivered to the injector, but due to the injector's low resistance, the current in the driver circuit is high.

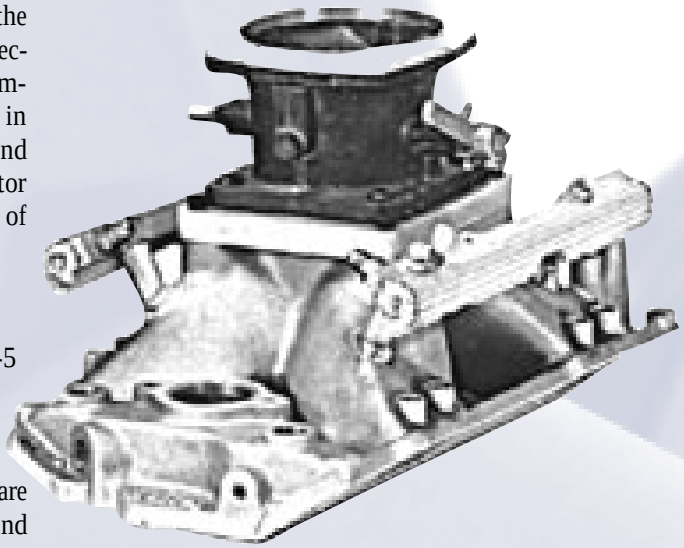
How high? Using Ohms's Law again: 12v /2 ohms = 6 amps. This is substantial current flow and a peak and hold driver is used to manage it. These drivers come in two values; 4 amp peak/1 amp hold, and 2 amp peak/0.5 amp hold. The "peak" current is used to quickly jolt the injector open, and then the lower "hold" current is used to keep it open for as long as the ECU commands. Even though 6 amps may be available to operate the injector (see above), the maximum it is allowed to reach is 2 or 4 amps, depending on the driver's current limit.

Most high flow injectors are low resistance and use a peak and hold driver to activate them. They require that extra kick from the higher current to keep the opening and closing time of the injector stable at the higher fuel flow rate. Note that the MSD PN 2014 (72 lb/hr, 2 ohm) and PN 2015 (96 lb/hr, 2 ohm) injectors require a 4/1 amp driver.

Injector/ECU Unity

There is one cardinal rule to keep in mind about mixing and matching injectors to an ECU and its injector drivers: Do not install a low resistance injector (2-5 ohms) on a 12 volt saturated circuit driver. The resulting 6 amps (ohms law) creates a lot of heat in the injector and driver circuit and will reduce their lifespan. If you're lucky this combination will not work at all, but it will probably cook the driver and or heat up the injector. Insist on peak and hold drivers for low resistance injectors and preferably use the 4/1 amp version.

A high resistance injector, normally used with a 12 volt saturated circuit driver, can be installed in a peak and hold system. For example, if the PN 2013 (50 lb/hr, 12 ohm) injector is installed with a 4/1 amp peak and hold driver, the current in the circuit will only reach 1 amp (12v /12 ohm = 1 amp). The current peak of the driver (4 amps) is never reached,



so in effect, the peak and hold driver in this case activates the injector like a standard saturated system.

Larger Injectors and Stock ECUs

Remember that installing larger flow injectors only has technical merit if substantial modifications have been made to the entire induction system. Plus, the stock ECU will undoubtedly have to be programmed for the increased injector fuel flow. It's usually easier and more cost effective to raise the fuel system pressure to get a 10%-20% fuel flow increase at the injectors.

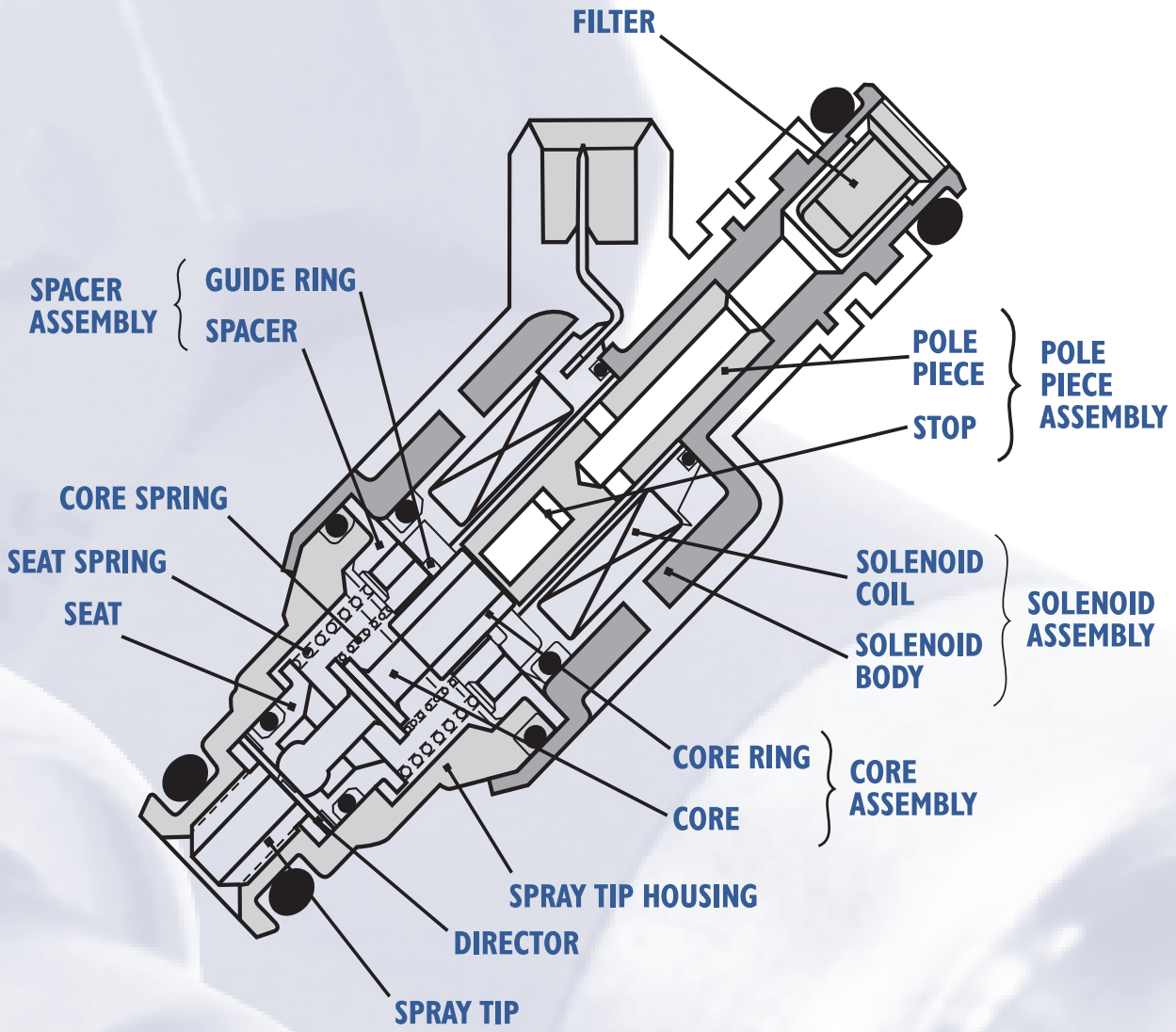
For example, the PN 2018 (38 lb/hr, 12 ohm) injector has been successfully used on supercharged GM 350 CID engines using stock ECU with a reprogrammed calibration chip (PROM). The stock replacement injector for this engine is available as PN 2017 (22 lb/hr, 16 ohm), but with this thoroughly modified induction system, that fuel flow is inadequate at full boost pressure. The larger injector, with its high resistance is compatible with the injector drivers in the stock ECU. Of course, reprogramming the PROM is required to adjust the injector fuel pulse to the new engine airflow demands.

Another popular modified engine application for a larger injector is the 3.8L Buick turbocharged engine used in the Grand National and GNX. The stock injector is rated 27 lb/hr at 43.5 psi (3 bar), and has a resistance of 15 ohms. Users of this engine typically raise the stock turbo boost pressure and run out of fuel at high rpm. The MSD PN 2018 injector, with its high resistance and high fuel flow will also work with the stock saturated circuit drivers in this ECU with a reprogrammed PROM for highly modified applications.

The PN 2013 (50 lb/hr, 12 ohm) injectors are also electronically compatible in either of the above applications, but considerable induction system modifications are required to take advantage of that much fuel.

COMPETITION FUEL INJECTORS

MSD FUEL MANAGEMENT

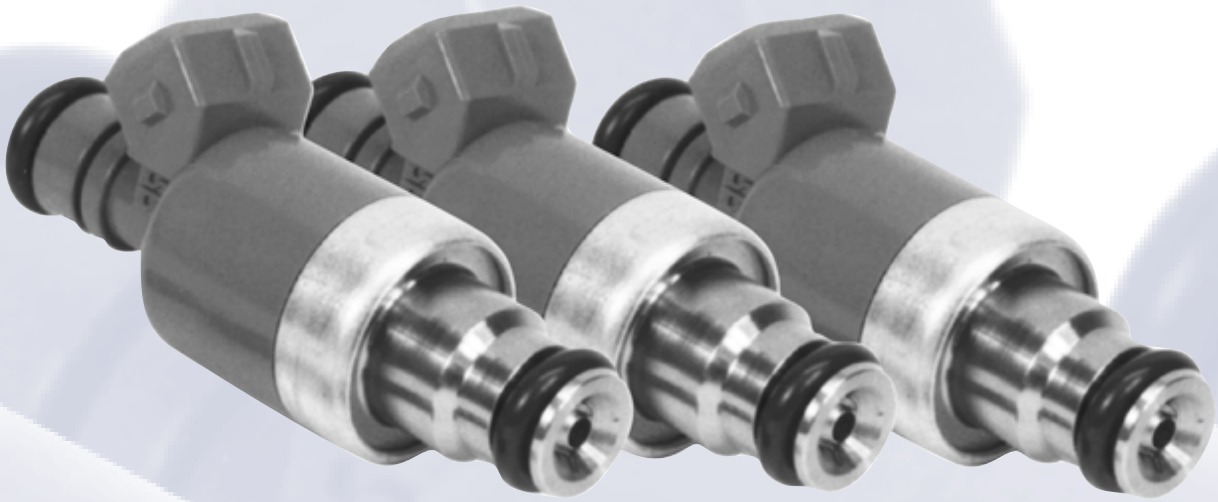


A performance EFI system is only as powerful and reliable as its injectors. Elaborate engine management electronics are useless if its injectors cannot accurately meter fuel on command. MSD Competition Fuel Injectors are available in flow rates to power high performance and racing engines from 250 - 1300 HP (V8). Made in the U.S.A. by AC Rochester, these injectors are engineered and manufactured to racing specifications for tough high-performance applications in auto, motorcycle, and marine applications. MSD Competition Electronic Fuel Injectors all feature:

- **Pretested to establish excellent linear fuel flow from narrow to wide pulse widths to ensure accurate fuel metering at during racing conditions and throughout the entire rpm band.**
- **MULTEC™ metering design with a stainless steel "ball and seat" fuel metering method. This design creates a superior fuel charge flow, and maximum internal sealing with consistent fuel delivery through the engine's rpm span.**
- **Injector metering orifice has six holes producing a totally atomized and compact 10° - 15° spray pattern. These recessed delivery holes resist fuel clogging and injector deposit formation, so no injector cleaning is required.**
- **High fuel flow rates and standard injector driver requirements are compatible with stock, high performance, and racing EFI control units. Fuel flow rates are set and calibrated by computer-control during manufacturing to guarantee precise flow volume rate.**

MSD FUEL MANAGEMENT

FUEL INJECTOR FLOW RATES



The following static flow rates (lb/hr) are approximate at 43.5 psi (3 bar) fuel pressure; test fuel specific gravity is 0.788. Flow rate tolerance between individual injectors of the same static flow rate is 1.5 - 3.0%.

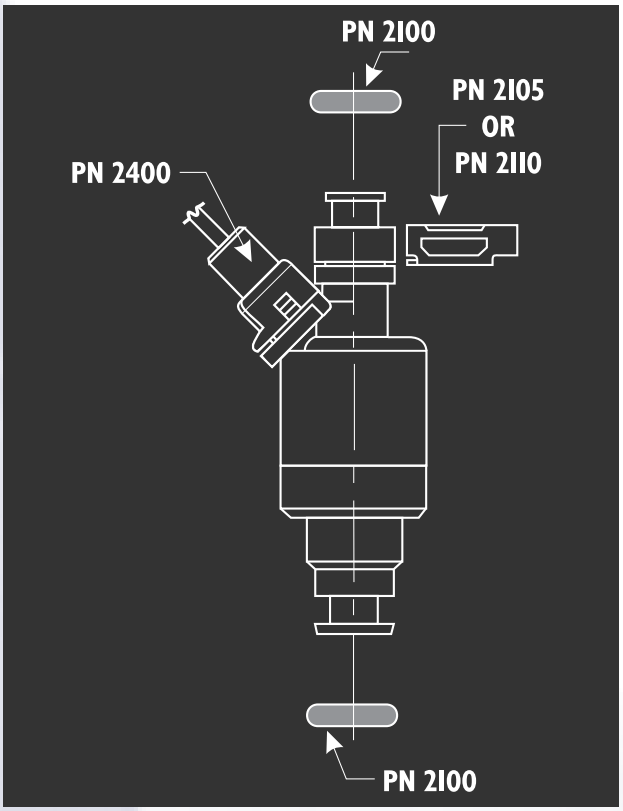
Part No.	Static Flow (lb/hr)	Driver Type	Resistance (ohms)
2010	21 lb/hr	12v Saturated Circuit	12
This is a direct replacement injector for the secondary injector on the GM ZR-1 Corvette.			
2011	26 lb/hr	2/0.5 Amp Peak & Hold	2
This is a direct replacement injector for the GM Quad IV 2.3 HO DOHC.			
2012*	34 lb/hr	2/0.5 Amp Peak & Hold	2
2013*	50 lb/hr	12v Saturated Circuit	12
2014*	72 lb/hr	4/1 Amp Peak & Hold	2
2015*	96 lb/hr	4/1 Amp Peak & Hold	2
2016	19 lb/hr	12v Saturated Circuit	16
This is a direct replacement injector for GM 5.0L MPFI, and also the stock flow rate for injectors used in the Ford 5.0L HO engine.			
2017	22 lb/hr	12v Saturated Circuit	16
This is a direct replacement injector for GM 5.7L MPFI.			
2018*	38 lb/hr	12v Saturated Circuit	12
2019	24 lb/hr	12v Saturated Circuit	12
This is a direct replacement injector for late model LT-1 engines.			

*These products are for Racing Use Only and not legal for use on emission-controlled vehicles.

Injector O-ring Seals, PN 2100

Leaking O-rings cause intake air or fuel leaks and hardened ones don't fully isolate a fuel injector from surrounding engine vibration. These are OE factory replacement O-rings for all MSD Competition and stock GM MPFI injectors. They also fit any production or aftermarket "top feed" fuel injector. Formed of Viton, a fluoro-carbon material, they resist high underhood temperatures and chemicals. Two are required per injector.

2 per injector, (Pack of 16)



Injector Fuel Rail Clip, PN 2105

These are OE factory replacement retainer clips to secure MSD Competition Fuel Injectors to a fixed fuel rail mount. Use them with top mount MSD Injectors, PN 2115, 2135, and 2140 or to replace injector retainer clips on stock GM MPFI fuel rails.

1 per injector, Slide-on, U-style, (Pack of 8)

Injector Fuel Rail Clip, PN 2110

These are OE factory replacement retainer clips to secure injectors to a fixed fuel rail. Typical applications are 1985 - present GM 5.0L & 5.7L V8 MPFI fuel rails.

1 per injector, Rotating, Sickle-style, (Pack of 8)

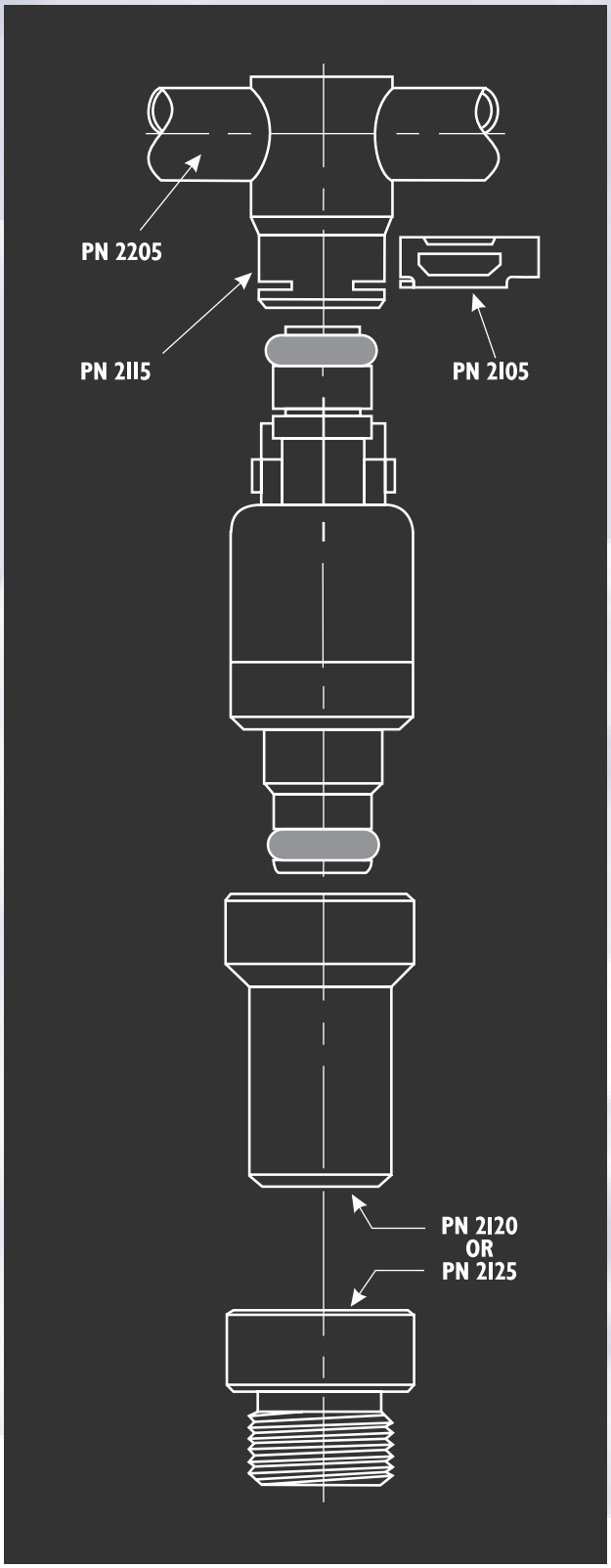
EFI Injector Weathertight Connectors, PN 2400

Securing a reliable electronic signal to an injector is as important as reliably routing fuel to it. Our EFI Injector Connectors use a locking spring to firmly fasten the connector to the injector's plug, yet it can be conveniently disconnected with a firm pinch. The injection molded nylon connector body withstands -40°F to 260°F and has inner and outer silicone seals to protect the electrical connections at the plated terminal pins. These connectors plug directly to most multiport, "top feed" injectors.

Pack of eight connector bodies with 20 terminal pins.

MSD FUEL MANAGEMENT FIXED FUEL RAIL HARDWARE

Custom and racing EFI installations using fixed (stationary) fuel rails are accurate, durable, and easy to fabricate with MSD's stainless steel fuel delivery and mounting components. They are for the installer with a manifold and throttle body preference for a multiport EFI engine, and are ideal for any high performance EFI system.



Injector Top Mount, PN 2115*

These Injector Top Mounts are CNC-machined from #304 stainless steel for superior durability, accurate fuel delivery and versatile installation. They slide into place over our 1/2" stainless steel fuel rail (PN 2205) then are brazed or TIG welded into a final mounting position.

Fuel routing is accomplished through a 5/16" hole made in the rail and aligned to the Injector Top Mount's feed hole. The injector is secured to the top mount with Retainer Clip, PN 2105.

For fixed rail/tube delivery to MSD Competition Fuel Injectors. Requires PN 2105 Fuel Rail Clip and PN 2205 Fuel Rail Tubing. (Pack of 8)

Injector Manifold Pocket: Epoxy-In, PN 2120*

Correct positioning of a fuel injector in an intake tract is just as important as getting fuel to it. For multiport EFI systems, these Manifold Pockets offer a simple method to secure an MSD Competition Fuel Injector when using a fixed fuel rail to hold the injector.

These 3/4" OD Injector Manifold Pockets are CNC-machined from 6061 aluminum for a stable mounting location. Each pocket is precisely cut to accept the contours and bottom sealing O-ring of MSD fuel injectors. Simply drill the manifold to size and epoxy the Pocket into the manifold.

Requires fixed fuel rail/tube delivery to MSD Competition Fuel Injectors. (Pack of 8)

Injection Manifold Pocket: Threaded, PN 2125*

These injector pockets thread into an intake tract forming a solid injector mount for fixed fuel rail delivery systems. They are CNC-machined from 6061 aluminum to accurately direct the fuel injector. They install in a 3/4" - 16 threaded hole and are supplied with a #8- AN O-ring to seal the pocket to the manifold. Each pocket is precisely cut to accept the contours and bottom sealing O-ring of MSD Competition Fuel Injectors.

Requires fixed fuel rail/tube delivery to injector, includes #8-AN pocket-seating O-ring. (Pack of 8)

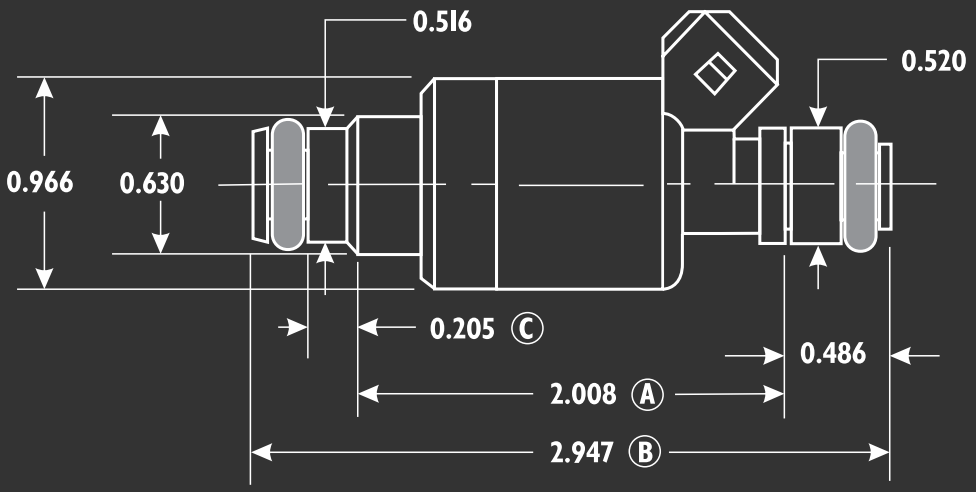
*These products are for Racing Use Only and not legal for use on emission-controlled vehicles.

Injector Manifold Pocket Cutting Tool, PN 2130

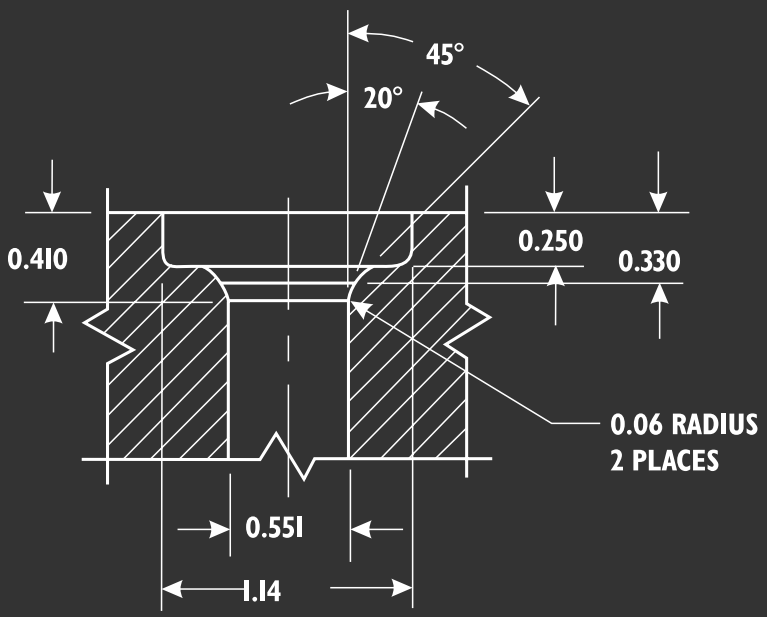
If the intake manifold you are modifying has enough material to directly mount the injectors, a manifold pocket is not necessary. This high speed cutting tool machines an injector mounting pocket directly into the intake manifold for custom multiport EFI systems. It is correctly sized to cut the exact contours and bottom sealing O-ring of MSD Competition Fuel Injectors.

For fixed fuel rail delivery systems only.

MSD Competition Fuel Injector and Injector Pocket Dimensions



FOR PN 2014/2015
Ⓐ= 2.843
Ⓑ= 1.947
Ⓒ= 0.224



MSD FUEL MANAGEMENT FLEXIBLE FUEL HOSE HARDWARE

90° Injector Top Mount, PN 2135*

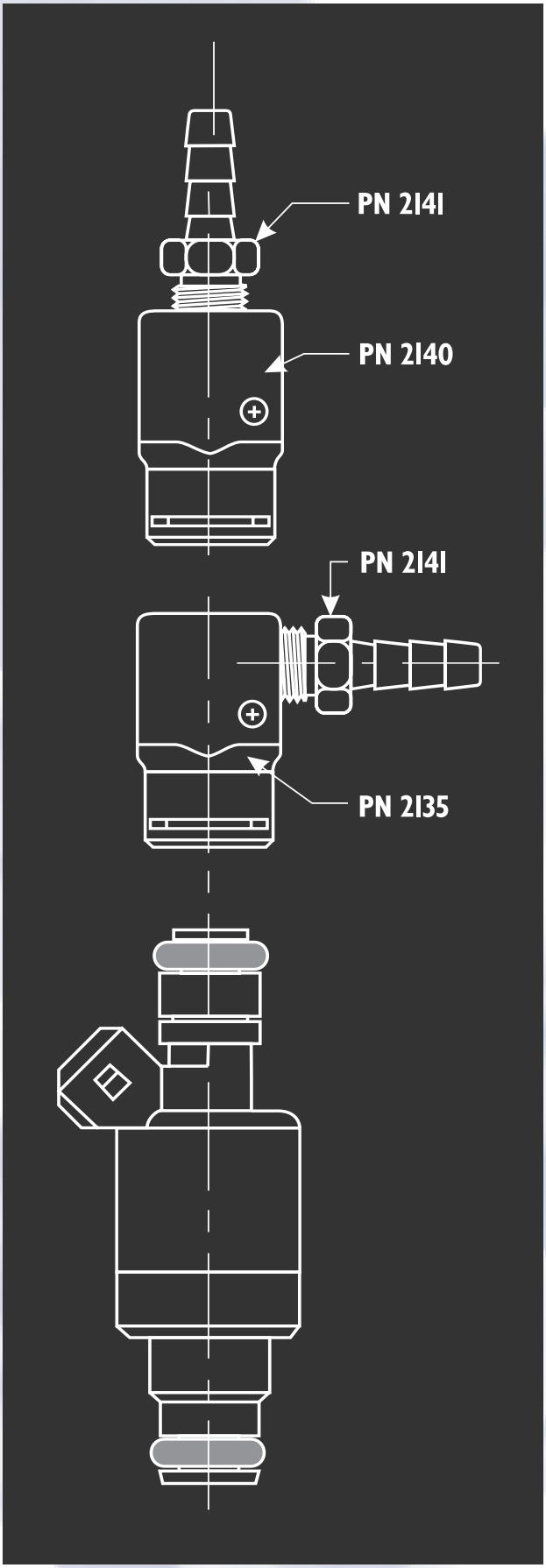
If your custom multiport injection system doesn't allow clearance for a fixed rail fuel delivery system, these Top Mounts can be used with individual flexible fuel hose. These individual Injector Top Mounts are CNC-machined from free cutting brass and snug down over the top O-ring of MSD Competition Fuel Injectors. The Mounts are drilled and tapped to accept 1/8"-NPT fuel hose fittings from one side.

For flexible fuel hose delivery: 90° inlet, 1/8"-NPT, Requires Injector Retainer Clip, PN 2105. (Pack of 8)

180° Injector Top Mount, PN 2140

This Injector Top Mount is the same as PN 2135 except it features a 180° (straight) fuel delivery inlet to accept a fuel hose fitting from above.

For flexible fuel hose delivery: Straight inlet, 1/8"-NPT, Requires Injector Retainer Clip, PN 2105. (Pack of 8)



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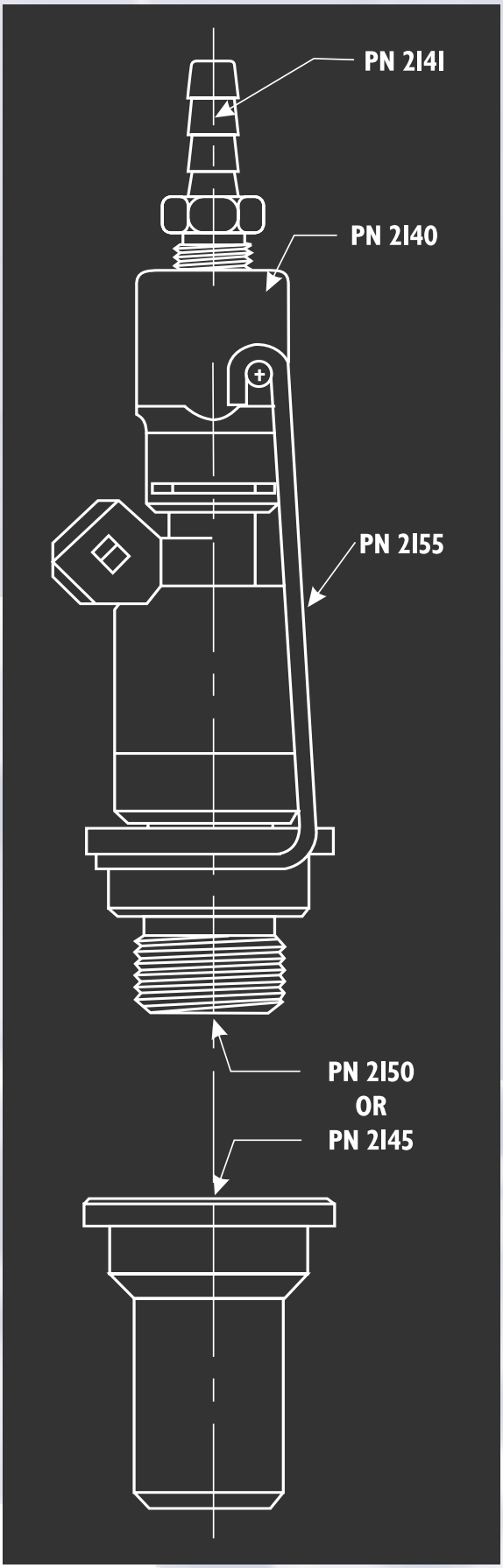

Injector Manifold Pocket: Epoxy-In, PN 2145

Securing an individual injector into an intake manifold is just as important as getting fuel to it. If you plan on using a flexible fuel line delivery EFI system, these epoxy-in Manifold Pockets will provide a solid and easy to install injector mount.

These 3/4"-OD Injector Manifold Pockets are CNC-machined from 6061 aluminum to provide a stable mount location for the injector. They are precisely cut to match the contours of MSD Competition Fuel Injectors. Each Pocket includes an interior cushioning O-ring to isolate the injector from vibration and heat. Retaining Clip PN 2155 must be used to hold the injector and its top mount to the pocket.

Flexible fuel hose delivery systems only. Includes 5/8"-ID X 7/8"-OD injector O-ring cushions. (Pack of 8)

Injector Manifold Pocket: Threaded, PN 2150*

These injector pockets thread into an intake tract forming a solid injector mount for flexible fuel hose delivery systems only. Each Pocket is CNC-machined from 6061 aluminum to accurately hold and direct the fuel injector in the manifold. They fit a 3/4"-16 threaded hole and are supplied with a #8-AN O-ring to seal the pocket to the manifold and an interior cushioning O-ring in the pocket to isolate the injector from vibration and heat. Retaining Clip PN 2155 must be used to hold the injector and its top mount to the pocket.

Flexible fuel hose delivery systems only. Includes 5/8"-ID X 7/8"-OD injector O-ring cushion and #8-AN pocket sealing O-ring. (Pack of 8)

Retaining Clip, PN 2155*

These sturdy spring wire clips make securing a free standing injector to its manifold pocket a snap and keep it stable on top of the engine. The injector is held in place by clamping it between its top mount and manifold pocket. The clips must be used with either MSD's Epoxy-in, PN 2145, or Threaded Manifold Pockets, PN 2150.

Flexible fuel hose delivery systems and top mount injectors only. (Pack of 8)

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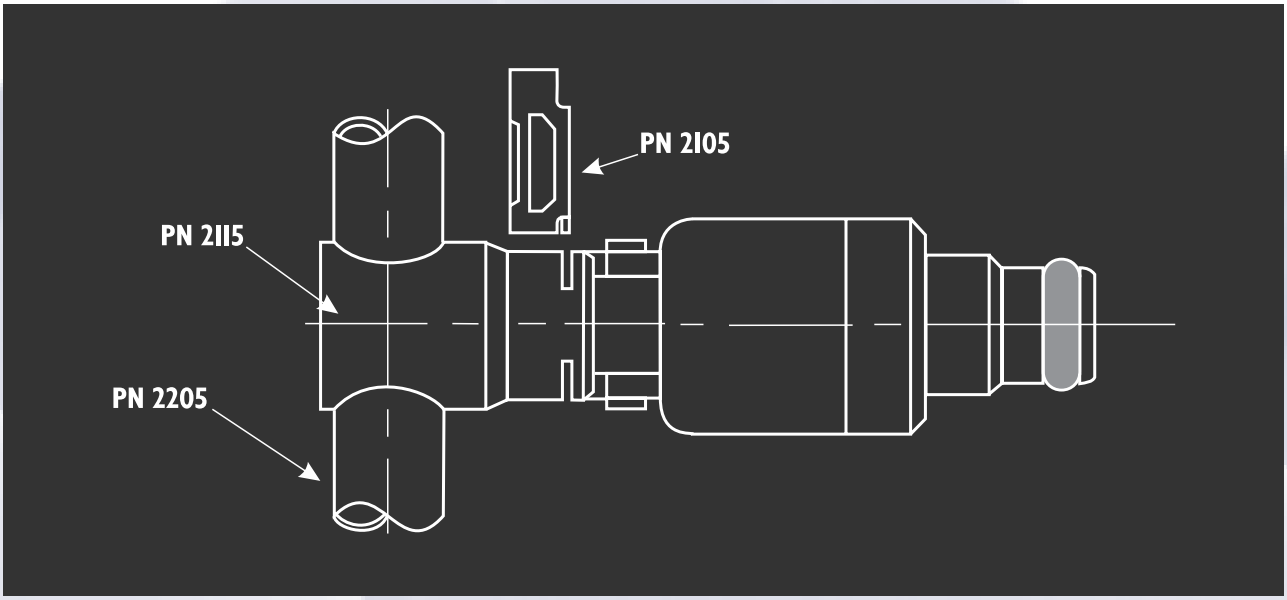
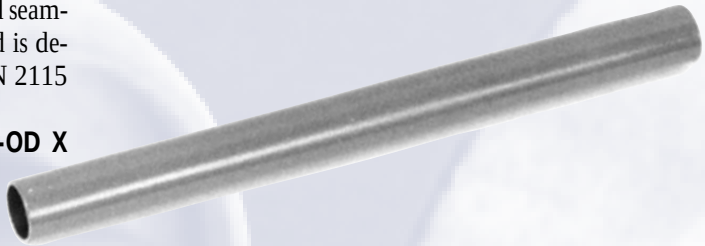
MSD FUEL MANAGEMENT EFI FUEL DELIVERY HARDWARE



Fuel Distribution Block, PN 2200*

MSD's 304 stainless steel rail/tubing is for fabricating fixed fuel rails in multiport EFI systems. This pressure tested seamless tubing comes in 4 feet, plain finished lengths and is designed to be used with MSD Injector Top Mounts, PN 2115



Fixed fuel rail delivery systems. Sized 1/2"-OD X 0.035"-wall. (Pack of two 4-ft. lengths)

Fuel Distribution Block, PN 2200*

Directing fuel to each injector is straightforward in multiport, flexible fuel hose delivery installations with this CNC-machined Fuel Distribution Block. The Block is machined from a billet of 6061 aluminum then is hard-anodized to prevent corrosion. Eight 1/8" holes are tapped and threaded yet it can also be used on 4, or 6-cylinder engines by blocking off the extra holes.

Flexible fuel hose delivery systems only. Includes two 3/8"-NPT for inlet and outlet.

High Pressure In-line Electric Fuel Pumps

Multiport EFI systems require a stable fuel supply to maintain best performance throughout the engine's rpm range. Our high pressure and high flow EFI fuel pumps made in the U.S.A. and use a roller vane pump mechanism, which is extremely resistant to clogging and jamming. They mount in-line (out of the fuel tank) with two supplied cushioned clamps for a quick and sturdy installation. They are ideal for use as a "booster" pump for nitrous oxide applications, or as a stand alone pump for multiport EFI systems on engines up to approximately 500 HP.

PN 2225
Inlet nipple is 3/8" with a 5/16" outlet.

PN 2226 Pump

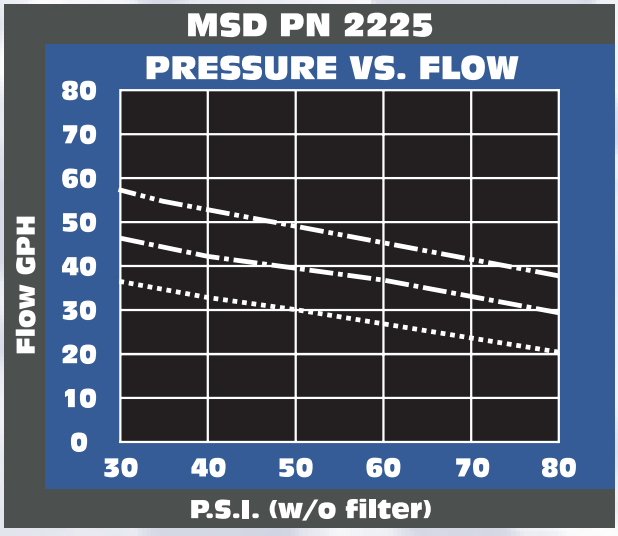
This pump shares many of the internal features of the above PN 2225 pump, however is U.L. approved for marine use. It also produces more volume and P.S.I. for applications that need even more fuel.

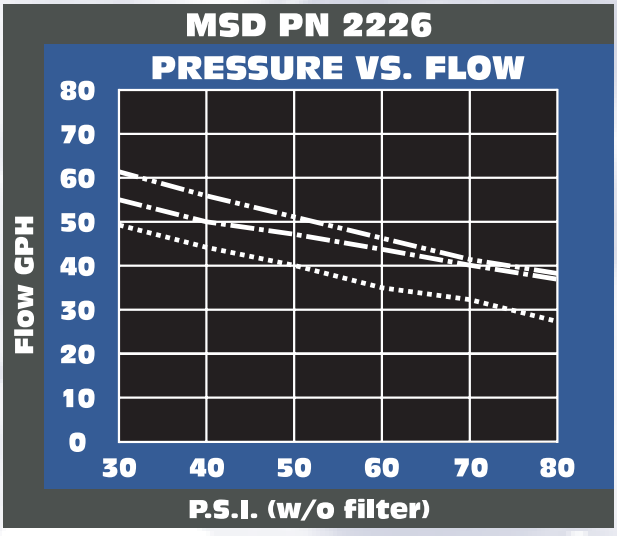
PN 2226

Note: Available Summer 1996.

Supply Voltage

— ·· — ·· — @ 13.5v
— · — · — · @ 12v
..... @ 10v





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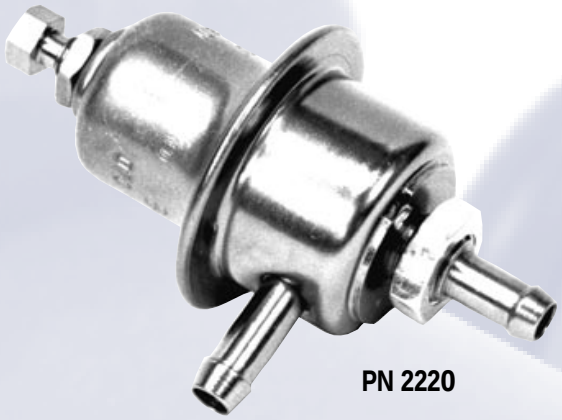
MSD FUEL MANAGEMENT

FUEL DELIVERY HARDWARE

Fuel Pressure Regulators, PN 2220 - PN 2222

Maintaining accurate fuel system pressure on any multiport EFI system is crucial to performance. These Adjustable Fuel Pressure Regulators allow you to fine tune the fuel pressure to meet the demands of your engine and EFI system.

These rugged Regulators are free standing so they don't have to be mounted directly to a fuel rail and can be installed in any position. Fuel pressure is set with an adjusting bolt and is locked in position with a locking nut. A jam nut is supplied so the bottom threads can be secured to a mounting bracket.



PN 2220

Turbos or Superchargers

The PN 2222 Regulator is designed for turbocharged and supercharged engines. As boost pressure increases, more fuel is required. This regulator features a boost reference circuit that adds more fuel automatically as boost pressure increases.

Adjustable from 36 - 45 psi with a flow rate of 9.2 - 10.5 gal/hr. Inlet and Outlets are 5/16" nipples.

PN 2222

High Pressure In-Line Fuel Filter, PN 2230

An EFI fuel delivery system cannot be kept too clean. MSD's In-Line Filter is a low restriction, high pressure filter with 140 square inches of filtering material area to ensure total entrapment of particles as small as five microns. Each filter is leak tested to 75 psi, and has a burst strength of 300 psi. The pressure drop across this filter is only 1.2 psi at 35 gal/hr (229 lb/hr) fuel flow. It mounts in-line in any position and features 5/16" hose Inlet and Outlet nipples. It will also resist 100% methanol.

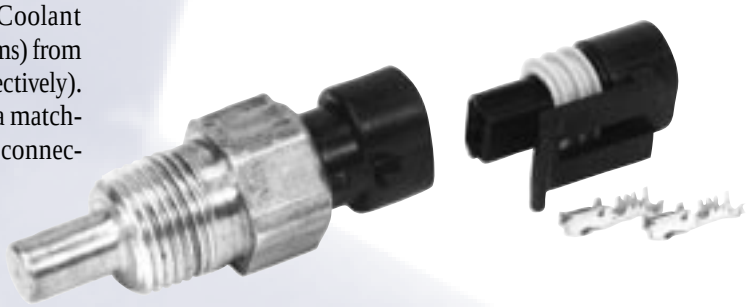
ENGINE MANAGEMENT SENSORS

MSD FUEL MANAGEMENT

Electronic fuel management computers rely on many sensors to supply engine parameter information for fuel (and sometimes ignition) computations. MSD Engine Management Sensors offer the custom-EFI installer stable and reliable signals for factory or aftermarket fuel management computers.

Coolant Temperature Sensor (CTS), PN 2310

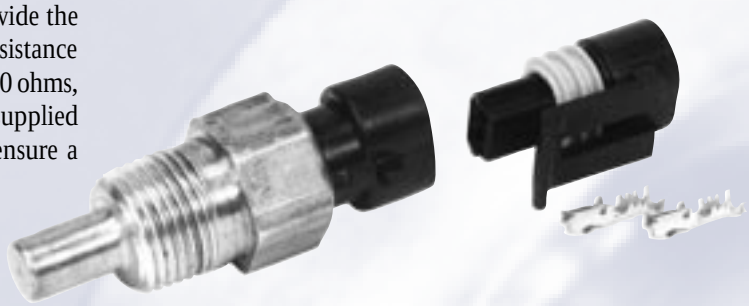
Coolant temperature is a primary input for electronic fuel management computers. This OE replacement Coolant Temperature Sensor produces a variable resistance (ohms) from 40°F to 302°F (approximately 100K to 50 ohms, respectively). It threads into a 3/8"-NPT hole and is supplied with a matching 2-pin Weathertight connector to ensure a reliable connection to the engine harness.



Supplied with 2-pin Weathertight Connector.
Pack of six connectors with 15 terminal pins - PN 2401.

Oil Temperature Sensor, PN 2315

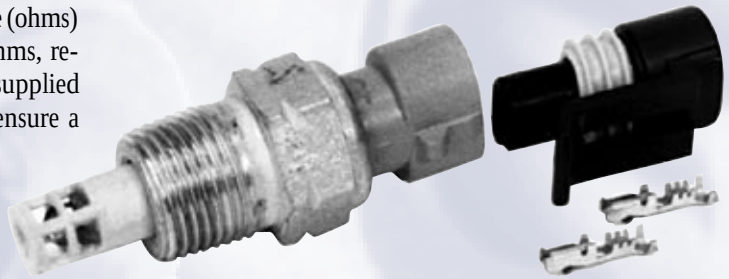
If your engine management computer has the ability to monitor oil or fuel temperatures, this sensor will provide the information. This 2-pin sensor produces a variable resistance (ohms) from -40°F to 302°F (approximately 100K to 50 ohms, respectively). It threads into a 3/8"-NPT hole and is supplied with a matching 2-pin Weathertight connector to ensure a positive locking connection.



Supplied with 2-pin Weathertight Connector.
Pack of six connectors with 15 terminal pins - PN 2401

Intake Air Temperature Sensor, PN 2320

Many engine management computers measure intake air temperature to calculate fuel delivery. This OE replacement sensor measures intake air temperature in an air cleaner assembly or the manifold. It produces a variable resistance (ohms) from -40°F to 302°F (approximately 100K to 50 ohms, respectively). It threads into a 3/8"-NPT hole and is supplied with a matching 2-pin Weathertight connector to ensure a positive locking connection.



Supplied with 2-pin Weathertight Connector.
Pack of three connectors with 10 terminals - PN 2402

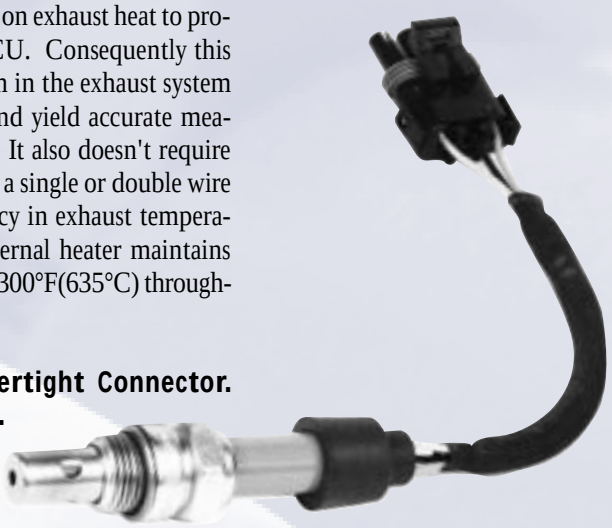
EXHAUST GAS SENSOR

All OE EFI management systems, and some aftermarket ones, use Oxygen (also called O_2, or Lambda) sensors to measure the oxygen content of exhaust gases. The O_2 sensor sends a voltage signal to the ECU based on the amount of oxygen in the exhaust, which then uses it to calculate how much fuel to deliver to maintain an ideal (for catalytic converter operation) air/fuel ratio of 14.7:1. These fast response OE sensors are direct replacements for factory supplied ones, and bolt right in place on stock vehicles. For custom applications, use our PN 2335, Mounting Boss, to place the sensor in the exhaust gas stream.

Heated Oxygen Sensor (Three-wire), PN 2330

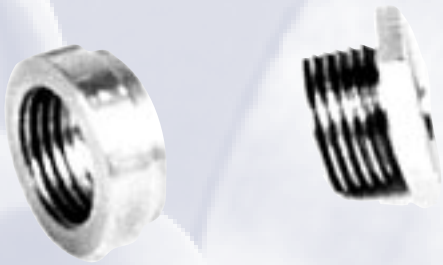
A Heated 0_2 Sensor doesn't depend on exhaust heat to produce reliable voltage signals to the ECU. Consequently this 0_2 sensor can be mounted downstream in the exhaust system (before, or in a catalytic converter) and yield accurate measurement of exhaust gas composition. It also doesn't require reference air from the atmosphere like a single or double wire 0_2 sensor, and operates at full efficiency in exhaust temperatures up to 1,562°F(850°C). The internal heater maintains the sensing element at approximately 1,300°F(635°C) throughout the operation of the engine's.

Supplied with 3-pin Weathertight Connector. Requires Mounting Boss, PN 2305.



Oxygen Sensor Mounting Boss, PN 2335

To install an MSD Oxygen Sensor, this mount in boss must be used. Simply drill a hole at the desired location and weld the threaded hole in place. A chromate coated sealing plug to block off the sensor hole is also supplied.



Tach Adapter, PN 8920

If your injection system normally connects to the coil negative (-) terminal to receive the trigger signal, this Adapter is required when an MSD Ignition Control is used. With the MSD Ignition Control, the coil negative terminal does not receive the trigger signal any more, therefore, the terminal cannot be used. This Adapter installs easily and produces a spike voltage trigger signal that is 250-300 volts, and 80 microseconds long (@14 volts) for the ECU.

SYNCHRONIZATION SIGNAL DISTRIBUTORS

MSD FUEL MANAGEMENT

Some OE and aftermarket EFI management computers index (or synchronize) the fuel injection pulse to the ignition firing order of the engine. These sequential injection systems require a synchronization signal to reference the fuel injector "firing" pulse to the ignition triggering of a particular cylinder. MSD offers two Sync Distributors for Chevrolet V8 engines which supply a referencing signal to the ECU. Each Distirbutor provides a magnetic trigger signal for the number one cylinder for EFI engine management computers that use a sync signal for fuel delivery computation.

SYNC SIGNAL CRANK TRIGGER DISTRIBUTOR, LOW PROFILE, PN 2340*

This Billet Chevrolet V8 distributor produces an injection sync signal for the ECU at a fixed 45° BTDC on the number one cylinder. The ECU uses this signal as a reference point to trigger the injector sequence. This Billet Distributor features an extra low profile to fit in tight areas due to exotic injection systems and intake manifolds. The housing is CNC-machined from a billet of aluminum for incredible strength and accuracy. A sealed ball bearing and extra long sintered bushing guides an oversized steel shaft for high rpm stability. The special wide spaced brass terminals of the cap ensure full spark delivery to the plugs.

The Distributor must be used with a Crank or Flywheel Ignition Trigger System to supply the ignition trigger signal. A high quality alkyd cap, rynite rotor and bronze gear are included.

ADJUSTABLE SYNC SIGNAL BILLET DISTRIBUTOR, PN 2345

UNIVERSAL SYNC PICKUP KIT, PN 2346

This kit allows you to make an injector sync device for custom injection systems. A non-magnetic pickup with Weather-tight connectors, magnet and retainer are included.

This Billet Chevrolet V8 Distributor produces both an injector synchronization signal, and a magnetic ignition trigger signal. The sync signal is adjustable so it can be used with a variety of ECUs.

A high output magnetic pickup delivers an accurate trigger signal to an MSD Ignition Control and never needs adjustment. The distributor also features an adjustable mechanical advance assembly so the ignition curve can be tuned to the engine's applications. Different advance springs and stop bushings are supplied for a variety of curves.

The housing is CNC-machined from a billet of 6061-T6 aluminum and features an adjustable slip collar to adjust its mounting depth in the block. This adjustability ensures correct mesh with the camshaft and distributor drive gears when the engine has been modified with angle milled heads or intake manifolds.

The Distributor must be used with an MSD Ignition Control and is supplied with a high quality alkyd cap, rotor and iron gear.