DOWNLOAD PDF GENERAL MOTORS FUEL INJECTION SYSTEMS

Chapter 1 : FUEL INJECTION SYSTEM - General Motors Corporation

*Troubleshooting General Motors Fuel Injection Systems and Computerized Engine Controls [Jeffrey Lynch] on calendrierdelascience.com *FREE* shipping on qualifying offers. This text is designed specifically for General Motors vehicles.*

It is to the best of our knowledge accurate. The only differences were the addition of the TPI and improvements in the valve train Several modifications have been made to the TPI system introduced in In the cold start injector was deleted from the system. The primary injectors were used for cold starts via a fuel enrichment program in the newer EPROM calibrators. In GM introduced the speed density system. The LT1 was also introduced in 92, as the basic engine in the Corvette. Opti- Spark also made its entry on the LT1 engine in This was the 1st year for Sequential port Injection in these cars. It looks the same as the LT1, however the heads and valve train have been modified. The valves are larger 2. Air passages are larger to enhance volumetric efficiency, hollow valve stems, aluminum roller rocker arms and stronger valve springs have also been added. The camshaft has more lift and a slight overlap at the end of the combustion cycle eliminating the need for EGR. The compression ratio is Premium Gas Only We flowed the heads on both the LT1 and LT4. Sequential Central Port Injection is a standard on the 4. They will fit the old engines, but heads would also have to be changed on the , and engines. Retrofit kits are available from FIS. This unit must be programmed before being placed in service. That is a will not plug in to a harness and operate. The wiring for these systems is not interchangeable, without modifying the wiring harness. The CK truck engines use a crank shaft sensor and camshaft position sensor to provide timing information to the engine. It is this device that provides specific information for the ECM and allows for different timing characteristics, and injector pulse width for the 5. A Calpak, a separate chip on the Calibrator Modules, normally provides the information to the ECM for rear axle gear ratio on pre 90 models. To allow for the various Engines, transmission, gear ratio combinations and to meet national, international and state standards for emissions, a wide variety of these Calibrators are available from GM. After some calibrators incorporate a vehicle anti theft system VATS. There are two learning features. The I and BL feature is normal with a value of around If this value is higher than , it indicates that the ECM is adding fuel to the base fuel calculation because the system is running lean, a value lower than indicates that the ECM is taking out fuel because the system is running rich. The integrator is a short term corrective action while the BLM is along term correction. The BLM value will change if the integrator has seen a condition which lasts for a longer period of time. The ECM learns how much adjustment is required in each cell, retains it in memory, and applies these adjustments when the engine operates in that cell or RPM - Load Range. When the vehicle power is disconnected for repair or to clear diagnostic codes, the learning process has to begin all over again. Performance Calibrations typically change the parameters for fuel flow, fuel cut- off and spark advance- timing and will allow increased fuel flow and modify the spark advance curves during rapid acceleration. The TPI system utilizes the following sensors and devices to control the engine: They are intended for off- road or racing use only. Fuel Injection Specialties is not responsible for products and services it provides for racing or off- road use vehicles that may be driven on the street.

Chapter 2 : Bosch CP4 Fuel Pump Failures Cause Lawsuit | calendrierdelascience.com

It was a system consisting of a throttle body, 8 fuel injectors mounted on a fuel rail directing fuel into the intake, a crude analog computer and various sensors. It had been developed between Bendix, Bosch and General Motors.

Modern digital electronic fuel injection systems optimize these competing objectives more effectively and consistently than earlier fuel delivery systems such as carburetors. Carburetors have the potential to atomize fuel better see Pogue and Allen Caggiano patents. Fuel injection also dispenses with the need for a separate mechanical choke , which on carburetor-equipped vehicles must be adjusted as the engine warms up to normal temperature. Furthermore, on spark ignition engines, direct fuel injection has the advantage of being able to facilitate stratified combustion which have not been possible with carburetors. It is only with the advent of multi-point fuel injection certain engine configurations such as inline five cylinder gasoline engines have become more feasible for mass production, as traditional carburetor arrangement with single or twin carburetors could not provide even fuel distribution between cylinders, unless a more complicated individual carburetor per cylinder is used. Fuel injection systems are also able to operate normally regardless of orientation, whereas carburetors with floats are not able to operate upside down or in microgravity, such as encountered on airplanes. Environmental benefits Fuel injection generally increases engine fuel efficiency. With the improved cylinder-to-cylinder fuel distribution of multi-point fuel injection, less fuel is needed for the same power output when cylinder-to-cylinder distribution varies significantly, some cylinders receive excess fuel as a side effect of ensuring that all cylinders receive sufficient fuel. Exhaust emissions are cleaner because the more precise and accurate fuel metering reduces the concentration of toxic combustion byproducts leaving the engine. The more consistent and predictable composition of the exhaust makes emissions control devices such as catalytic converters more effective and easier to design. Fuel injection was in widespread commercial use in diesel engines by the mids. An early use of indirect gasoline injection dates back to , when French aviation engineer Leon Levavasseur installed it on his pioneering Antoinette 8V aircraft powerplant, the first V8 engine of any type ever produced in any quantity. They are often started on gasoline and then switched to diesel or kerosene. German direct injection petrol engines used injection systems developed by Bosch from their diesel injection systems. Later versions of the Rolls-Royce Merlin and Wright R used single point fuel injection, at the time called "Pressure Carburettor". Due to the wartime relationship between Germany and Japan, Mitsubishi also had two radial aircraft engines using fuel injection, the Mitsubishi Kinsei kinsei means "venus" and the Mitsubishi Kasei kasei means "mars". The engine had six electrically operated injectors and were fed by a semi-high-pressure circulating fuel pump system. The invention of mechanical injection for gasoline-fueled aviation engines was by the French inventor of the V8 engine configuration, Leon Levavasseur in The first post-World War I example of direct gasoline injection was on the Hesselman engine invented by Swedish engineer Jonas Hesselman in The Hesselman engine was a low compression design constructed to run on heavy fuel oils. Immediately following the war, hot rodder Stuart Hilborn started to offer mechanical injection for race cars, salt cars , and midget racers , [9] well-known and easily distinguishable because of their prominent velocity stacks projecting upwards from the engines on which they were used. The first automotive direct injection system used to run on gasoline was developed by Bosch , and was introduced by Goliath for their Goliath GP automobile, and Gutbrod in This was basically a specially lubricated high-pressure diesel direct-injection pump of the type that is governed by the vacuum behind an intake throttle valve. Modern diesels only change the amount of fuel injected to vary output; there is no throttle. This system used a normal gasoline fuel pump, to provide fuel to a mechanically driven injection pump, which had separate plungers per injector to deliver a very high injection pressure directly into the combustion chamber. The Mercedes-Benz W Formula 1 racing car engine used Bosch direct injection derived from wartime aircraft engines. Following this racetrack success, the Mercedes-Benz SL , the first production sports car to use fuel injection, used direct injection. The Bosch fuel injectors were placed into the bores on the cylinder wall used by the spark plugs in other Mercedes-Benz six-cylinder engines the spark plugs were relocated to the cylinder head. Later, more mainstream applications of fuel injection favored the less-expensive indirect injection methods. A Corvette small-block 4. This system directed the inducted engine air across a "spoon shaped" plunger that moved in proportion to the air volume. The plunger connected to the fuel metering system that mechanically dispensed fuel to the cylinders via distribution tubes. This system was not a "pulse" or intermittent injection, but rather a constant flow system, metering fuel to all cylinders simultaneously from a central "spider" of injection lines. With its own high-pressure fuel pump driven by a cable from the distributor to the fuel meter, the system supplied the necessary pressure for injection. This was a "port" injection where the injectors are located in the intake manifold, very near the intake valve. In , Lucas developed its injection system, which was first used for Jaguar racing cars at Le Mans. The system was subsequently adopted very successfully in Formula One racing, securing championships by Cooper , BRM , Lotus , Brabham , Matra , and Tyrrell in the years through This mechanical system was used by some Maserati , Aston Martin , and Triumph models between and However, they were a favorite in the aforementioned competition trials in which essentially wide-open throttle operation was prevalent. Constant-flow injection systems continue to be used at the highest levels of drag racing, where full-throttle, high-RPM performance is key. Another mechanical system, made by Bosch called Jetronic , but injecting the fuel into the port above the intake valve, was used by several European car makers, particularly Porsche from until in the production range and until on the Carrera 3. Porsche continued using this system on its racing cars into the late seventies and early eighties. Porsche racing variants such as the RSR 2. This was designed to meet the U. When working together, these electronic components can sense variations and the main system computes the appropriate amount of fuel needed to achieve better engine performance based on a stored "map" of optimal settings for given requirements. Most of the 35 vehicles originally so equipped were field-retrofitted with 4-barrel carburetors. The Electrojector patents were subsequently sold to Bosch. Lucas licensed the system for production in Jaguar cars, initially in D-Jetronic form before switching to L-Jetronic in on the XK6 engine. Bosch superseded the D-Jetronic system with the K-Jetronic and L-Jetronic systems for , though some cars such as the Volvo continued using D-Jetronic for the following several years. In Rover fitted Lucas electronic fuel injection, which was based on some L-Jetronic patents, to the S-Series engine as used in the model. Chevrolet Cosworth Vega engine showing Bendix electronic fuel injection in orange. Nissan also installed multi-point fuel injection in the Nissan Y44 V8 engine in the Nissan President. In the s, the Isuzu Piazza and the Mitsubishi Starion added fuel injection as standard equipment, developed separately with both companies history of diesel powered engines. The limited production Chevrolet Cosworth Vega was introduced in March using a Bendix EFI system with pulse-time manifold injection, four injector valves, an electronic control unit ECU , five independent sensors, and two fuel pumps. The EFI system was developed to satisfy stringent emission control requirements and market demands for a technologically advanced responsive vehicle. L-Jetronic first appeared on the Porsche , and uses a mechanical airflow meter L for Luft, German for "air" that produces a signal that is proportional to "air volume". This approach required additional sensors to measure the atmospheric pressure and temperature, to ultimately calculate "air mass". L-Jetronic was widely adopted on European cars of that period, and a few Japanese models a short time later. The Motorola technology was installed in Ford North American products. Elimination of carburetors In the s and s in the U. During that time period, the vast majority of gasoline-fueled automobile and light truck engines did not use fuel injection. To comply with the new regulations, automobile manufacturers often made extensive and complex modifications to the engine carburetor s. While a simple carburetor system is cheaper to manufacture than a fuel injection system, the more complex carburetor systems installed on many engines in the s were much more costly than the earlier simple carburetors. To more easily comply with emissions regulations, automobile manufacturers began installing fuel injection systems in more gasoline engines during the late s. Later closed-loop fuel injection systems improved the airâ€"fuel mixture control with an exhaust gas oxygen sensor. Although not part of the injection control, a catalytic converter further reduces exhaust emissions. Fuel injection was phased in through the latter s and 80s at an accelerating rate, with the German, French, and U. Since the early s, almost all gasoline passenger cars sold in first world markets are equipped with electronic fuel injection EFI. The carburetor remains in use in developing countries where vehicle emissions are unregulated and diagnostic and repair infrastructure is sparse. Fuel injection is gradually replacing carburetors in these nations too as they adopt emission regulations conceptually similar to those in force in Europe, Japan, Australia, and North America. Many motorcycles still use carburetored engines, though all current high-performance designs have switched to EFI. Early injection systems used mechanical methods to meter fuel, while nearly all modern systems use electronic metering. Determining how much fuel to supply The primary factor used in determining the amount of fuel required by the engine is the amount by weight of air that is being taken in by the engine for use in combustion. Modern systems use a mass airflow sensor to send this information to the engine control unit. Data representing the amount of power output desired by the driver sometimes known as "engine load" is also used by the engine control unit in calculating the amount of fuel required. A throttle position sensor TPS provides this information. Other engine sensors used in EFI systems include a coolant temperature sensor, a camshaft or crankshaft position sensor some systems get the position information from the distributor , and an oxygen sensor which is installed in the exhaust system so that it can be used to determine how well the fuel has been combusted, therefore allowing closed loop operation. Supplying the fuel to the engine Fuel is transported from the fuel tank via fuel lines and pressurised using fuel pump s. Maintaining the correct fuel pressure is done by a fuel pressure regulator. Often a fuel rail is used to divide the fuel supply into the required number of cylinders. The fuel injector injects liquid fuel into the intake air the location of the fuel injector varies between systems. Unlike carburetor-based systems, where the float chamber provides a reservoir, fuel injected systems depend on an uninterrupted flow of fuel. To avoid fuel starvation when subject to lateral G-forces , vehicles are often provided with an anti-surge vessel, usually integrated in the fuel tank , but sometimes as a separate, small anti-surge tank. Parallels to fuels other than gasoline can be made, but only conceptually. Animated cut through diagram of a typical fuel injector. Click to see animation.

Chapter 3 : Throttle Body Injection | Chevy GMC TBI Trucks | GM TBI Chevrolet

Engineering, manufacturing, sales, service, calibration, testing, and modification, of mechanical and electric fuel injection systems and components for all types of racing and performance.

Has a number like is used here. Inside is the chip On the chip is the bin file which is the program for running that engine. We will have another page for programming equipment, software and accessories needed for changing bin files on chips and another on Tuning! The injectors are different sizes. The is larger with close to 2 inch bores. It is recommended a TBI from about the same size engine to be used in your conversion or larger for high performance built engines. Wire harness can be pulled from the factory car and reworked for a conversion. There are also aftermarket options to buy one new already made. More Detailed wiring information at this link: Must be mounted in flowing coolant near thermostat. You could pull from donor but a new one is cheap. The universals just splice onto the wire from the harness. For headers It is recommend a 3 wire heated sensor mounted in collector behind the header, not in the header. They have a built in heater to keep the sensor hot when it is mounted down in the collector. Fuel pumps Lots of choices! You have a choice to modify your tank for an in tank pump or mount one external to the tank. E There is also a Carter PN that is similar with fittings and brackets. Other part numbers for inline tanks are: You can also do an in tank pump The way most new cars come from factory. There are many ways to do this. Here is a link to a write up using one of the best factory in tank pumps available at junk yard for cheap. Parts are easy to come by at any parts store. Greg aka greags78cam did an excellent article on how to do this here:

Chapter 4 : Fuel Injection Conversion using a GM TBI EFI system!

Fuel injection is the introduction of fuel in an internal combustion engine, most commonly automotive engines, by the means of an injector.. All diesel engines use fuel injection by design.

Carpenter, Et Al J. A fuel injection system for an internal combustion engine having a group of longitudinally spaced combustion chambers, each of said combustion chambers having air and fuel inlet means, said engine further having an intake manifold including air induction passage means extending to said air inlet means for said combustion chambers, said fuel injection system comprising: This invention relates to a fuel injection system having numerous advantages of construction and operation over those available heretofore. Particular advantages may be noted in the provision of a bracket interconnecting the air inlet body and the fuel rails. This allows the air metering components carried on the air inlet body and the fuel metering components carried on the fuel rails to be tested and shipped as a single unit. If desired, the bracket may be removed during installation of the air inlet body and fuel rails on an engine. The details as well as other objects and advantages of this invention are set forth in the remainder of the specification and are shown in the drawings in which: Throughout the drawings, some portions of the electrical wiring and the air and vacuum hoses are illustrated but most portions of such have been omitted for a clearer illustration of other components of the fuel injection system. Referring to the drawings, the fuel injection system includes an air inlet body 10 and a pair of extruded fuel rails 12 and Mounted on an inlet manifold 16 which in turn is mounted on cylinder heads 18 and 20, air inlet body 10 has a pair of air inlet passages 22 and 24 which register with the induction passage 26 extending through inlet manifold 16 and heads 18 and 20 to the combustion chamber inlet ports Throttles 28 and 30 are disposed in inlet passages 22 and 24 on a rotatable shaft 32 for controlling air flow through induction passage Air inlet body 10 also is provided with a transducer 34, such as that described in U. Air inlet body 10 also has provision for a curb idle adjustment 36 and a fast idle control valve 38 such as those shown in U. If desired, air inlet body 10 also may include provision for a transducer 40 which provides an electrical signal indicative of a sudden increase in pressure in air inlet passages 22 and 24 and induction passage 26 downstream of throttles 28 and 30 and thus indicative of engine acceleration. In addition, air inlet body 10 includes provision for mounting a thermistor 42 which senses the temperature of the air entering air inlet passages 22 and 24 and induction passage Further, air inlet body 10 may include provision for an electrical switch 44 which is opened and closed by a throttle lever 46 secured on throttle shaft 32 and which thus indicates the position of throttles 28 and An adjusting screw 48 may be provided to limit throttle closing movement of throttle lever A heat conducting pad 50 extends horizontally from air inlet body 10 toward the rear of the engine. As shown in FIG. Other fittings 56 also shown in FIG. Other vacuum taps, such as that shown at 58 in FIG. As shown in FIGS. Electronic package 60 receives electrical signals from the components, such as transducers 34 and 40, throttle switch 44, and thermistor 42, which meter air flow to the engine and controls energization of the injectors which meter fuel flow to the engine as described below. The lower surface of pad 50 has a plurality of elongated recesses 64 which define a plurality of fins 66 therebetween. Fins 66 radiate heat from pad 50 into the atmosphere ambient pad 50, space being provided between the lower portion of pad 50 and inlet manifold 16 to permit air circulation. Recesses 64 and fins 66 are generally parallel and their major axes extend longitudinally toward air inlet body 10, thus facilitating heat conduction to air inlet passages 22 and Heat generated during operation of electronic package 60 also is dissipated, therefore, into the air flowing through inlet passages 22 and 24 to induction passage Still referring to FIGS. Manifold vacuum passage 52 extends from chamber 74, while manifold pressure transducer 34, idle air controls 36 and 38, and acceleration transducer 40, as well as other desired components, are associated with chamber Fuel rail 12 extends longitudinally along the right-hand bank of combustion chambers while fuel rail 14 extends longitudinally along the left-hand bank of combustion chambers. Rails 12 and 14 are shown in FIG. Air galleries 78 have fittings 80 provided with hoses 82 to receive air from an air cleaner Each rail 12 and 14 has a plurality of injectors 88 retained, by clamps 90 as shown in FIG. Sockets 92 intersect fuel passages 76, and "O" rings 94 surrounding injectors 88 above and below passages 76 prevent leakage of fuel from sockets Fuel passes from screen 96 through an opening 98 in the injector body and then through a central bore in the nozzle A valve plunger controls flow of fuel from bore through nozzle opening When energized by electronic package 60, a solenoid coil lifts a magnetically responsive member secured on the end of valve plunger , thus metering and delivering fuel from fuel passage 76 through injector socket 92, screen 96, opening 98, bore , and opening into the base region of socket Nozzle opening sprays the fuel through a critical flow orifice member which is disposed in the outlet opening from base region of socket Orifice members are aimed through induction passage 26 toward the inlet ports 27 for the combustion chambers located at the ends of induction passage Branch passages extend from air galleries 78 to base regions of sockets 92 to provide atmospheric pressure regions at the outlets of injectors 88 and to supply a constant flow of air through orifice members Branch passages receive plugs at the outer ends. As best shown in FIG. Filter housing supplies fuel to fuel passage 76 in rail 14 and, through a crossover pipe , to a similar fuel passage in rail A fitting may be provided on the rearward end of rail 12 to receive fuel from crossover pipe At the forward end of rail 14, a fitting houses a fuel temperature responsive thermistor and provides a connection between fuel passage 76 in rail 14 and a crossover pipe which extends to a fitting at the forward end of rail Fitting includes means for bleeding fuel vapor from fuel passages 76 in rails 12 and 14 as set forth in, U. A central arm carries a bolt which is received in a hole tapped in body 10 to receive air cleaner stud 87, thereby securing bracket to air inlet body By this means, air inlet body 10 and rails 12 and 14 are secured in a single package whereby both air and fuel metering components of the fuel injection system may be tested and shipped as a single unit. If desired, the bracket may be removed during installation of the air inlet body 10 and rails 12 and 14 on the engine.

Chapter 5 : Fuel injection - Wikipedia

General Motors Fuel Injection Systems: Diagnosis & Repair of GM Cars, Light Trucks, SUVs & Vans () Technical Training Manual Unknown Binding - Be the first to review this item See all formats and editions Hide other formats and editions.

In a fuel injection system on an internal combustion engine having a plurality of longitudinally spaced combustion chambers, each of said combustion chambers having an air and fuel inlet passage: This invention relates to a fuel injection system having numerous advantages of construction and operation over those available heretofore. Particular advantages may be noted in the provision of extruded rails which extend along each bank of combustion chambers. Each rail contains a fuel passage and an atmospheric air gallery formed during extrusion and provides for mounting the injectors and other fuel injection system components in an easily handled unit. The details as well as other objects and advantages of this invention are set forth in the remainder of the specification and are shown in the drawings in which: Throughout the drawings, some portions of the electrical wiring and the air and vacuum hoses are illustrated but most portions of such have been omitted for a clearer illustration of other components of the fuel injection system. Referring to the drawings, the fuel injection system includes an air inlet body 10 and a pair of extruded fuel rails 12 and Mounted on an inlet manifold 16 which in turn is mounted on cylinder heads 18 and 20, air inlet body 10 has a pair of air inlet passages 22 and 24 which register with the induction passage 26 extending through inlet manifold 16 and heads 18 and 20 to the combustion chamber inlet ports. 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The lower surface of pad 50 has a plurality of elongated recesses 64 which define a plurality of fins 66 therebetwen. Fins 66 radiate heat from pad 50 into the atmosphere ambient pad 50, space being provided between the lower portion of pad 50 and inlet manifold 16 to permit air circulation. Recesses 64 and fins 66 are generally parallel and their major axes extend longitudinally toward air inlet body 10, thus facilitating heat conduction to air inlet passages 22 and Heat generated during operation of electronic package 60 also is dissipated, therefore, into the air flowing through inlet passages 22 and 24 to induction passage Still referring to FIGS. 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If desired, the bracket may be removed during installation of the air inlet body 10 and rails 12 and 14 on the engine.

Chapter 6 : GM Marine Engines | GM Powertrain Marine

HISTORY OF GM PORT INJECTION. The first production TUNED PORT INJECTION (TPI) appeared on General Motors vehicles in The GM vehicles built with these systems were Corvette, Pontiac Firebird & Trans AM, and the Chevrolet Camaro.

Brief History of Fuel Injection Although Chevrolet fuel injection had been around as early as , the progress leading up to it began as early as with Edward Butler, Duetz and other pioneers. During that time, however, Great Britain and the United States combined efforts to build a system to use in the Patton tank. Electronic fuel injection had its beginnings in Italy by a engineer named Ottavio Fuscaldo incorporated an electrical solenoid as a means to control fuel flow, this was a modern electronic fuel injection development. After the war, most aircraft industries turned away from further development and towards jet engines, fuel injection was basically put on the back burner. Even the automotive manufacturers were content to make minor progressive developments to the inexpensive carburetor. Then in an Indy race featured a fuel injected Offenhauser. The system was developed by Stuart Hillborn and featured an indirect injection system. Later Chevrolet introduced the Rochester Ramjet in It was also used in the Pontiac Bonneville, it used a lot of systems designed by Hillborn. The system was not popular with the general public and it was dropped after , except for the Corvette which used it as an option until GM then in introduced the first mass produced domestic fuel injection system on the model Cadillac Seville. It was a system consisting of a throttle body, 8 fuel injectors mounted on a fuel rail directing fuel into the intake, a crude analog computer and various sensors. It had been developed between Bendix, Bosch and General Motors. It was at that time that it was necessary for the industry to developed specialized troubleshooting techniques and flow charts which are now taken for granted. A ecm from a Cadillac Seville, this was a rudimentary analog computer at best. Note the baro "MAP" sensor with vacuum line on the circuit board center picture. Later in the first digital computerized control was introduced for Cadillac called Digital Fuel injection DFI , originally conceptualized as a multipoint injection, cost constraints again limited it as a throttle body system with two fuel injectors. The introduction of a digitally controlled system made it possible for a finer refinement of fuel control via various sensors, and to make minor adjustments on the fly and to be able to store trouble codes indicating malfunctions that can be recalled by a technician in troubleshooting. In , Pontiac introduced the single injector throttle body system on its 2. This system had two single throttle bodies mounted on opposite ends of a special manifold and allowed for better fuel atomization and velocity. It was good for a 20 hp gain over a carbureted 5. The system was not perfect, and suffered from some of the same problems as its carbureted cousin such as manifold wetting and poor fuel distribution, and special problems such as icing of the throttle body bores under certain conditions, and a leaky air intake seal. A technological milestone was reached in with the introduction of the Multiport Fuel Injection on its 2. Compared to the cross fire, with various valve train improvements was good for a 40 hp gain on the 5. The system with its specially designed intake, elegant long runners and tightly controlled fuel management was good for powerful low end torque and mid range power. Why is it called Tuned Port: The term "tuned port" has to do with taking advantage of the engines particular volumetric efficiency. By sizing the length and diameter of the intake runners to the resonance or "pulse" of intake valve opening, the flow can move uninterrupted with little or no interference, this helps fill the cylinders more efficiently. Unlike the carburetor or tbi manifold which must handle wet mixture, the tpi manifold only has to handle air, thus allowing for a more flexible design in the manifold. There has been minor changes over the years. The system is a one year only, as it has a separate "piggyback" mass air flow MAF control module on the ecm, and a one year only ecm, It will not electrically interchange with the harness. In , however the cold start injector was eliminated. It required a different harness and computer. This system was used all the way up , where it was replaced by the shorter runner designed LT1 and LT4 power plants. Although these later engines produce more stock horsepower, the TPI system is superior in low end power and torque.

Chapter 7 : Diesel Repair Manual by Haynes - Ford and General Motors

TBI Fuel Injection Conversion using a GM TBI EFI system! One of the most popular EFI conversions to older Chevy engines or any engine for that matter is the GM TBI system using the ECM.

Get them back on the road, and your customers will appreciate the increased fuel mileage, power output, torque and engine longevity. It is available in three versions: General Motors debuted this new engine design on the model year trucks and although the 6. The EcoTec3 was designed with towing, hauling and pickup truck grunt work in mind, not pulling 1G on the skid pad. The EcoTec3 engines introduced a tremendous amount of new technology for a truck engine and involved major internal architecture changes over its V6 and V8 predecessors. The EcoTec3 5. These new technologies and design changes were needed to achieve increased fuel mileage and reduced emissions output while raising power output, torque and increasing engine longevity. The EcoTec3 engine was equipped with gasoline direct injection, or GDI, replacing the old port style fuel injection used in different versions for many years. Shown here is the General Motors 4. Directly injecting the fuel into the cylinder optimizes combustion over a wide range of operating conditions, allows for increased compression ratios without knock and providing increased power output and fuel economy with lower emissions. These trucks and SUVs are popular and many are starting to show up at our shops with fuel system-related issues. No-starts, driveability glitches, illuminated malfunction indicator lamp MIL and other fuel system-related concerns are common and when that happens you are going to need a plan of attack for efficient diagnostics. Each system has its own operational characteristics, and understanding those characteristics is important for effective diagnostics, repairs and personal safety. The low-pressure system utilizes a fuel pump control module FPCM to control the low-pressure fuel pump operation. A serviceable inline fuel pressure sensor three wire, five volt sensor mounted on the output fuel line from the fuel tank reports low-pressure fuel system information to the FPCM so that it can maintain the pressure desired PCM commanded pressure. The pressure will increase to almost 90 psi to psi during initial cranking. The FPCM is used to lower the electrical system load on the vehicles and increase the fuel pump longevity by reducing the fuel pump speed when the engine is under low load situations. During heavy load or hard acceleration, the FPCM will increase the fuel pump speed as required to make sure the engine gets the fuel needed. Wiring to the low side fuel pressure sensor, circuit issues to the FPCM, the low-pressure fuel pump operation and fuel pressure concerns are just a few of the factors that can set DTCs. The FPCM can be easily overlooked and is a major cause of no-starts and stalling conditions, so it should always be checked for trouble codes when diagnosing a fuel system concern. Low-pressure concerns GM started using the FPCM back on some full-size pickups in , as corrosion and water intrusion of both the connector and module have been an ongoing issue. The FPCM comes blank and needs to be programmed to function There were some factory manufacturing issues that installed the incorrect fuel pressure regulator inside the MRA resulting in hard starts, stalling and stumble concerns, and this repair requires a MRA replacement. It shows the high-pressure fuel pump, high-pressure fuel pressure sensor, stainless steel fuel rails, lines and injectors. The high-pressure system The GDI system is injecting the fuel directly into the combustion chamber and has a small window of opportunity to deliver it more on this later so it requires a fuel pressure that is much higher than the old port fuel injection pressure values we are accustomed to dealing with. These high pressures are achieved using a PCM-controlled mechanically actuated high-pressure fuel pump assembly that is driven by a special three-lobed section on the camshaft. It is capable of a producing a maximum 3, psi before the mechanical internal relief valve opens. The normal operating pressure range is lower, typically in the psi to 2, psi range depending on what the PCM is requesting to meet actual vehicle operating conditions. The PCM regulates the output pressure of the high-pressure fuel pump by controlling an integral electronic using a 12V PWM control signal. The PCM regulates fuel pressure by opening and closing this electronic pressure control solenoid each time the piston is being stroked three times per cam revolution allowing for the fine-tuning of the fuel pressure in the fuel rail. The high-pressure fuel pump is connected to the fuel rail assemblies using two intermediate stainless steel fuel feed pipes. This high-pressure sensor uses four wires and contains two analog pressure sensors and a 5V reference signal this sensor is our window to the high-pressure side as there is not a test port. When the pressure is low, the output signal voltage is low and when the pressure is high the output signal voltage is high. The sensor is serviceable separately from the rail and the proper torque is required if replacement is needed. Great care must be taken when dealing with the high-pressure side for safety reasons. Proper service information procedures must be followed carefully and all the proper safety precautions must be followed when any service is to be performed. Proper fuel depressurization procedures and personal safety equipment are essential as there is more than enough fuel pressure to cause serious harm. This shows the inside of a GDI combustion chamber. You can see the intake and exhaust valves, spark plug and GDI fuel injector locations. High-pressure concerns Proper depressurization is essential before any service can be performed on the high-pressure side and the service manual information will commonly tell you to remove the fuel pump fuse and start the engine. After it stalls work can be performed. But I have had these engines keep running! There can be enough pressure from the low-pressure side system to allow the engine to idle, and run like it is in a limp-in mode. I hook up a scanner and look at the high-pressure fuel sensor value; it should show psi or less and I consider that a safe pressure to begin repairs. If the high-pressure fuel pump has to be removed, the retaining bolts have to be replaced when reinstalling the pump as the bolts are torque to yield. This is a GDI injector. Note the carbon build-up on the bottom seals that will need to be replaced and resized if this injector was being reused. The cam needs to be set so that the pump is not in stroke on the base circle, off the lobe before installation. There is a factory tool available to verify this position but I use a dial indicator and slowly rotate the engine to locate the off-lobe position. Any time any of the high-pressure feed lines are removed or loosened, they need to be replaced. Just a drop of clean engine oil is all that is needed. A Photos A and B are photos of low-pressure fuel sensors. The top photo is a sensor on a GMC Tahoe. The lower photo shows a low-pressure sensor on a GMC Sierra. Both are three-wire sensors. B There are TSBs for noises, buzzing and vibration concerns from bad check valves and high-pressure fuel pumps that may give off a fuel smell or actually leak. Both require replacement of the high-pressure fuel pump assembly, mounting bolts and fuel line. Another concern is in the engine harness connector X at the rear of the engine. This connector provides the high and low side circuits to pressure control solenoid and it may blacken or corrode causing intermittent opens in the circuit and low fuel pressure. The fuel pump diver lobe on the camshaft can suffer accelerated wear and scuffing from a lack of maintenance, improper oil they recommend Dexos or if the engine is continually low on oil. The FPCM is mounted in front of the spare tire exposed to all the elements and is a common cause of driveability or no-start concerns. The high-pressure fuel injectors: Engine design changes were needed. Special pistons, combustion chamber shape and a GDI fuel injector had to be developed to meet these conditions. But getting these injectors to open under such extreme operating conditions requires more than 12V. Once opened, 12V is all that is needed to hold it there. Providing the engine with the correct volume of needed fuel is another issue. In this photo, note the three-peak lobe located at the rear of the camshaft. The tri-lobe provides the drive for the GDI fuel pump. Port style injectors had an on time of 1. The volume of fuel delivered to each cylinder on these truck engines is now controlled by the fuel pressure. The higher the pressure, the more fuel that is injected. Again, similar to dealing with the high-pressure fuel pump and its components these injectors have enough fuel pressure and voltage to do serious harm, so be sure to follow all the proper safety and service precautions when working on or near them. This screen capture was taken during engine cranking on a 5. Note that the desired fuel rail high-pressure reading is at 1, psi almost maximum , yet the low side is at This screen capture features the same 5. These injectors have a low resistance of 1. Attention to the noise deadening materials and its proper placement is important to limit comeback complaints. Because the injector tips are in the combustion chambers they are susceptible to carbon build-up, and this can prevent removal issues with potential damage think Ford Triton 3V spark plugs. Applying penetration oil at the sealing surface and carbon remover solution inside that cylinder via the spark plug hole is a recommended procedure. There are special puller tools that apply even pulling pressure along the entire fuel rail during removal to prevent damage to the injectors and the cylinder head. Any time the injectors are removed, the retainer clips holding them to the fuel rail, the plastic spacers and dust and combustion chamber seals and fuel feed pipe must be replaced. The combustion chamber seals require specific tools for installation and no lubricants should be used to install them. After installation on the injector body, the seals need to be resized to provide a leak-proof seal. Using GDI and firing the fuel directly into the combustion chamber certainly has its advantages, including better fuel economy, more torque and power from higher compression ratios and leaner cold start emissions. But it also has some disadvantages, including higher soot levels when cold, additional specialty tools, many single-use components and the issue of carbon on intake valves. Lack of proper maintenance, poor fuel quality and improper oils are all enemies of the GDI system. They can lead to accelerated wear and a host of other issues, but these systems are robust. Safety procedures and depressurization steps have to be followed and the use of 65V requires careful attention to detail before any back-probing of circuits is performed during testing. The use of GDI in combination with other technologies like active cylinder management, variable valve timing and adaptive exhaust systems has made these engines and the trucks that use them smooth running, durable and reliable.

Chapter 8 : fuel injection history

Bosch CP4 fuel pump failures have caused a lawsuit that alleges General Motors, Ford, Chrysler and Bosch conspired to equip diesel vehicles with pumps the companies knew would fail.

The Haynes manual is designed for DIY mechanics or beginners and features a progressive format that starts with basic repairs and works its way up to more complex tasks. The manual is written with simple step-by-step instructions to walk the home mechanic through the repair process to ensure perfect results. The fully illustrated guide includes everything from simple repairs through complex maintenance procedures to keep your Ford or General Motors vehicle running its best. The included pictures, illustrations and diagrams are intended to enhance the instructions and help beginner mechanics or those less familiar with diesel engines locate and replace components as needed. This manual covers the following General Motors and Ford vehicles: The high-pressure system consists of the injection pump, the injection nozzles and the metal lines between the pump and the nozzles. The high-pressure system performs many functions, many more than a carburetor or fuel injection system on a gasoline-powered vehicle. Not only must it meter - in accordance with the load and speed of the engine - the quantity of fuel required for each cycle of the engine. It must also develop the high pressure necessary to inject fuel into each cylinder at a precisely determined instant in its operation cycle firing order. And it must control the rate at which the fuel is injected, atomize and distribute the fuel throughout the combustion chamber, and start and end each injection cycle abruptly. Obviously, the high-pressure system is fairly complex. The following are fluid level checks to be done on a mile or weekly basis. Additional fluid level checks can be found in specific maintenance procedures which follow. Regardless of intervals, be alert to fluid leaks under the vehicle which would indicate a fault to be corrected immediately. Fluids are an essential part of the lubrication and cooling systems. See Recommended lubricants and fluids at the beginning of this Chapter before adding fluid to any of the following components. The vehicle must be on level ground when fluid levels are checked. The purpose of this manual is to help you service and overhaul the Ford 6. Fully-illustrated for the home mechanic. From simple maintenance to major repairs, including engine overhaul. This manual also covers: Engine repairs and overhaul. Cooling, fuel and electrical systems.

Chapter 9 : General Motors Fuel Pump(GM) by A&S Fuel Injection System Company

We are a trusted name for over 30 years in the remanufacturing of OEM carburetors and fuel injection systems for both the automotive and marine industries. Our complete one year warranty guarantees trouble free operation and our customer service is always available either online or by toll free phone at