Fuel Pressure Sensor

Some Spitronics Products have the ability to control fuel pressure by speed controlling the fuel pump with Pulse Width Modulation (PWM). This is achieved by pulsing the driver at 300 Hz with a required duty cycle and then measuring the actual fuel pressure with an electronic fuel pressure sensor. The duty cycle is then adjusted to reach the required fuel pressure in loop control.

Settings

Preparation

At setup for the first time, disconnect the output connectors of your ECU till you have set up the controls properly. Reason is that the ECU may start the pump at full pressure and damage the fuel lines. Note: this feature will only be for selected firmware as some of the other features will be sacrificed to make drivers available. Ask your dealer on this feature before you buy.

The advantage of this feature is that the ECU can compensate injector time for pressure fluctuations as this will vary the fuel amount going through the injector. It also eliminates the need for a fuel pressure regulator and return line to the tank. It can also compensate for turbo engines to increase fuel pressure above manifold pressures.

There are a few requirements to ensure stability of the fuel pressure. The fuel pressure sensor must be mounted higher than the fuel line where it is connected. The pipe must go downwards from the sensor to the fuel line. This will ensure a pocket of air between the sensor and fuel which will have a damping effect and isolate the sensor from the fuel to enhance reliability. Use high quality fuel hoses and clamp them properly to the sensor and fuel line. Note: The ECU has a built-in shutdown protection should the pipe come off and pressure signal falls below a certain level. There will however be petrol spillage as the pump has momentum and the one-way valve will prevent the fuel in the rail to return to the tank. This fuel is under pressure so it will spill at the severed line. Do not mount the fuel pump close to the exhaust as it will heat up and the fuel in the pump will percolate. The air pockets will cause the cavitation in the pump resulting in erratic pressure. The air bubbles can only be pushed through the injectors which also result in incorrect mixtures.

To use this feature, proceed with the following steps. Start by switching the sensor on. Click on show graph.

Click the calibrate  button and type in 100. Click OK.

If you have an accurate fuel pressure gauge or a different fuel pressure sensor you may calibrate it with this value. It is a percentage correction which allows for range calibration only. That means calibration is accurate at the working pressure. The sensors supplied are calibrated according to the manufacturer signal specs.

Now set up the following parameters.

Fuel sensor value

Type in the Fuel sensor value that you are using. They come in 4 Bar MAP, 5.5 Bar Differential pressure, and 7 Bar MAP. The most popular sensor is the 5.5Bar DP. Note: The low pressure side of the DP sensor must be tied to the intake manifold pressure just as a normal fuel pressure regulator. This sensor will automatically compensate for the intake manifold pressure.
The fuel pressure real-time gage will also be scaled to this Fuel Sensor value setting.

Fuel Control sensitivity

This setting will adjust how the ECU will react to pressure changes. Fast or slow reaction will control the pressure range. ‘1’ is for the fastest reaction. If it is set too fast the fuel pressure will become erratic. Select the fastest value which will stabilize the pressure against hunting.

Fuel Safety Pressure

This setting is the protection feature that will cut the fuel pump in case of fuel line breakage. Especially to the sensor as this is a thin line. Use a 1 Bar setting.

Fuel Pump Low

This setting is to control the minimum duty cycle of the pump. If it is too low the pump will stop start and make the fuel erratic. Some fuel pumps need to do a minimum RPM or their veins will not deploy to pump fuel. If this is the case the pump will start to make funny noises and the fuel pressure becomes erratic. Sometimes it helps to turn the pump position so that the veins protrude downwards. Set the minimum duty cycle so that the pump runs smooth at lowest pressure. If it is too high the pump will not be able to control at the lowest pressure. A value out of 254 will make up 100% of duty cycle, it means that 127 will be 50% duty cycle.

Fuel Pump High

This setting is to control the maximum duty cycle of the pump. The high setting will limit the pump at a certain pressure. This is handy to prevent the pump from over pressure on the thinner fuel lines to the sensor. Make sure that the pump can supply the right pressure at full load high RPM. Always go for the lowest setting and keep a note on the fuel pressure at high load.

Driver Output

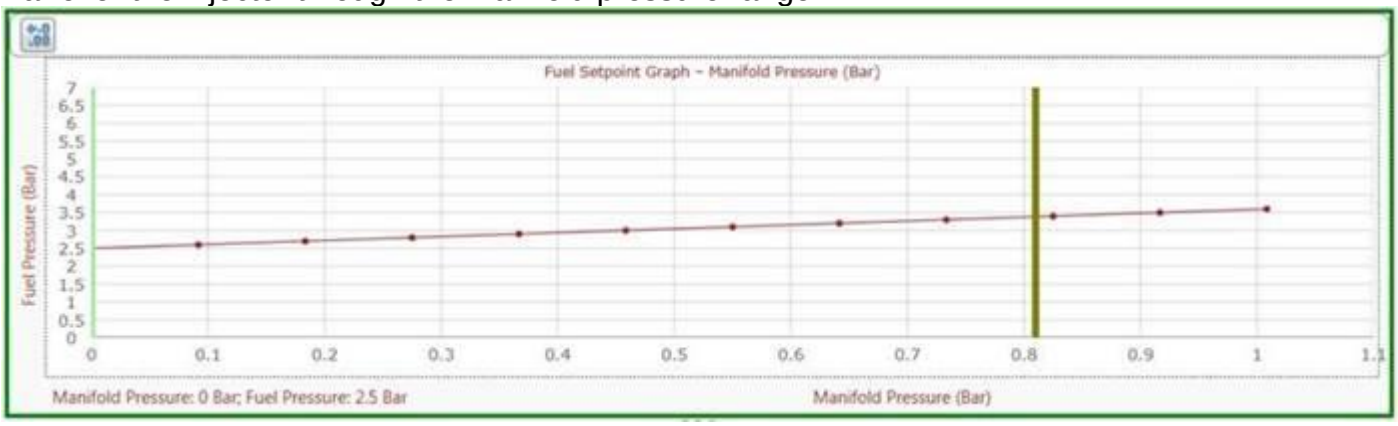
This setting will indicate to the installer which output is dedicated to the pump. This output must be positive and is used with the Spitronics Electronic relay. Make sure on the wiring connections.

Setting the Graphs

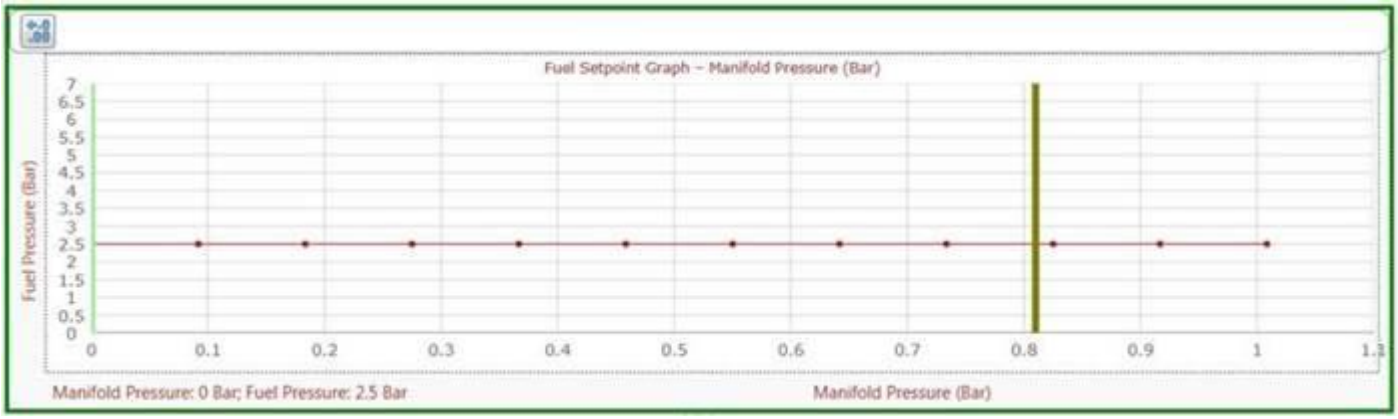
Click the page button Fuel Pump Graph tab.

Fuel Setpoint Graph – Manifold Pressure (Bar)

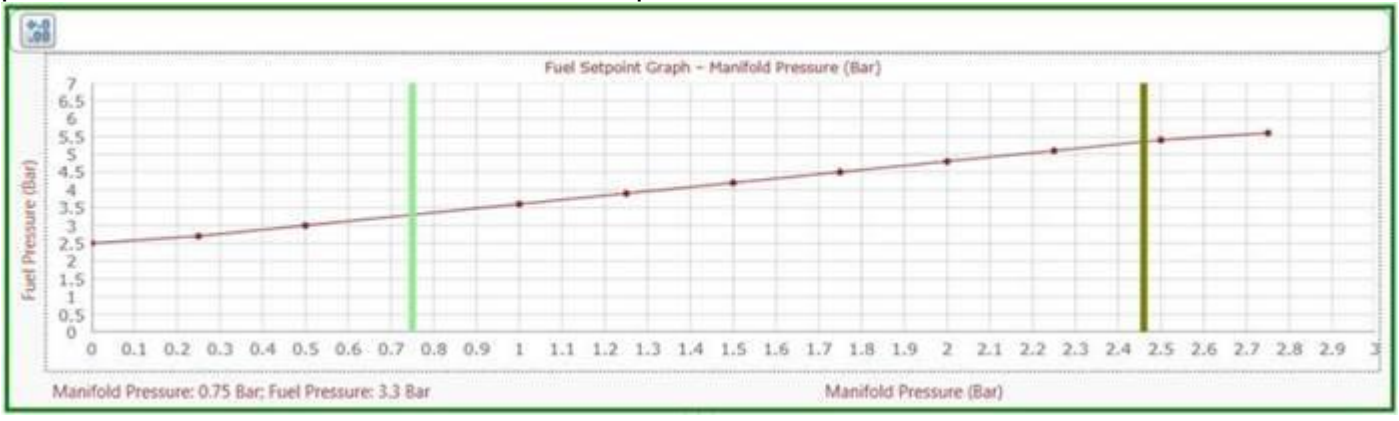
There are different ways to set-up this control system. With the 4 & 7 Bar MAP, (Mean Absolute Pressure) sensors, you need to compensate on the graph for manifold pressure fluctuations. The reason is that the Map sensor does not compensate for manifold pressure like a fuel pressure regulator. The fuel pressure needs to be adjusted with manifold pressure to keep a constant fuel pressure over the injectors. These settings in the graph below will keep a constant pressure of 2.5 Bar over the injector through the manifold pressure range.



For the 5.5 Differential pressure sensor the compensation is automatic as the open line is connected to the intake manifold. These settings in the graph below will keep a constant pressure of 2.5 Bar over the injector through the manifold pressure range. If you leave the line open to atmospheric pressure it will result in fuel pressure variations with altitude and will influence tuning of the engine.



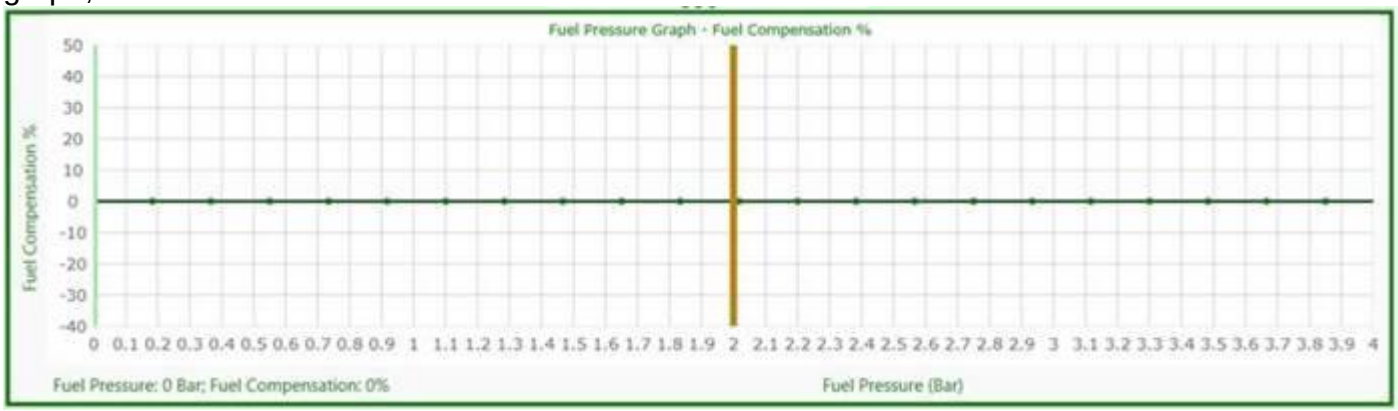
For Turbo engines with the 7 bar Map sensor the graph below will keep a constant pressure of 2.5 Bar over the injector through the manifold pressure range. Note: The graph below how the pressure increases to 5.5 Bar at 2 Bar boost pressure.



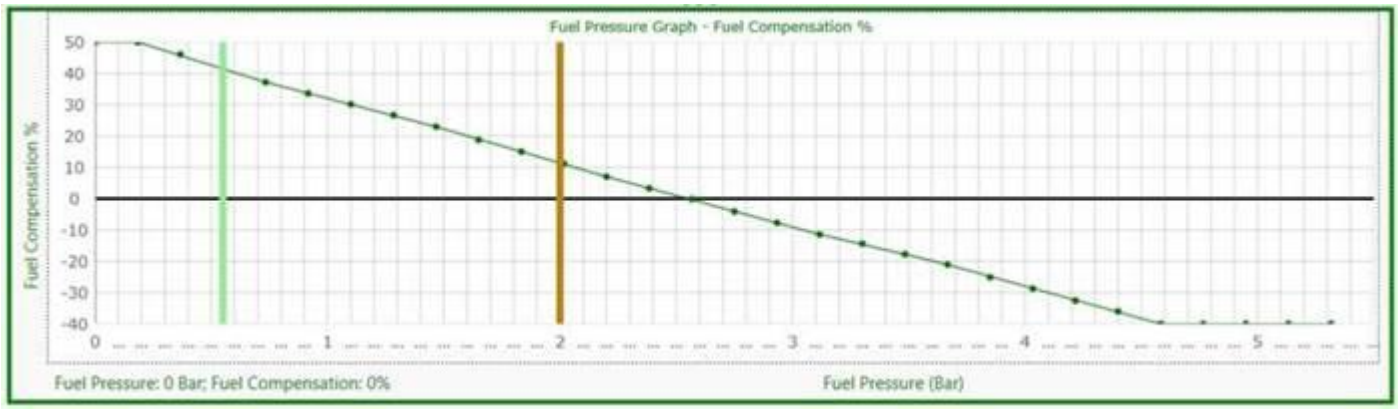
For the 5.5 DP sensor the compensation graph will be flat as the DP graph above. Even if the total pressure is above 5.5 bar the DP sensor will only see 2.5 bar over it. (Fuel pressure minus boost pressure).

Fuel Pressure Graph – Fuel Compensation %

The Fuel pressure graph will allow the ECU to compensate for fuel pressure variations during blip conditions when the injectors suddenly require more fuel. The fuel pressure signal will react faster than the pump can be sped up or slow down at due to mechanical delays. Here the injector opening times will be manipulated in order to add or reduce fuel for pressure variation. To set this graph, start with a flat line.



Load the engine at light cruise settings like 2000 RPM and say 20% throttle. This may be varied as the type of engine may be smother at different RPM's. Now adjust the fuel mix to be in stoic area. Now increase the fuel pressure by half a bar increment. Do not go too high as the fuel lines may burst. Every time adjust the graph lower to maintain the same AFR mixtures. Now reduce the pressure and increase the graph again to stay in the right mixtures. Put the pressure settings back to normal.

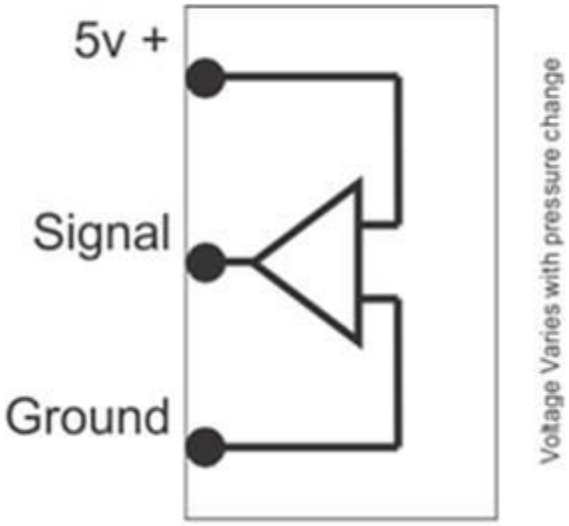


Now if fuel pressures vary, the injector times will be compensated for and the AFR will remain constant. These graphs are interpolated.

Fuel Sensor Hardware

The fuel pressure sensor relays the fuel pressure back to the ECU to control the fuel pump with PWM and keep a constant pressure over the injectors. This is important for the ECU to supply an accurate amount of fuel per engine stroke. The ECU can vary the speed of the fuel pump to increase or decrease fuel pressure accordingly. The sensor gives a continual feedback of fuel rail pressure so that the ECU can make pressure adjustments almost instantaneously. This setup allows the engine to run without a manual fuel pressure regulator or return line. The 4 Bar Map sensor, 5.5 Bar DP sensor, or 7 Bar Map sensor can be used as a fuel pressure sensor. The setting differs for each of them and is discussed in the software.

Operation



The Pressure Sensor requires 5 volts DC which is supplied to sensor by the ECU. It then generates a signal from 0 to 5 volt equivalent to the pressure range of the sensor.

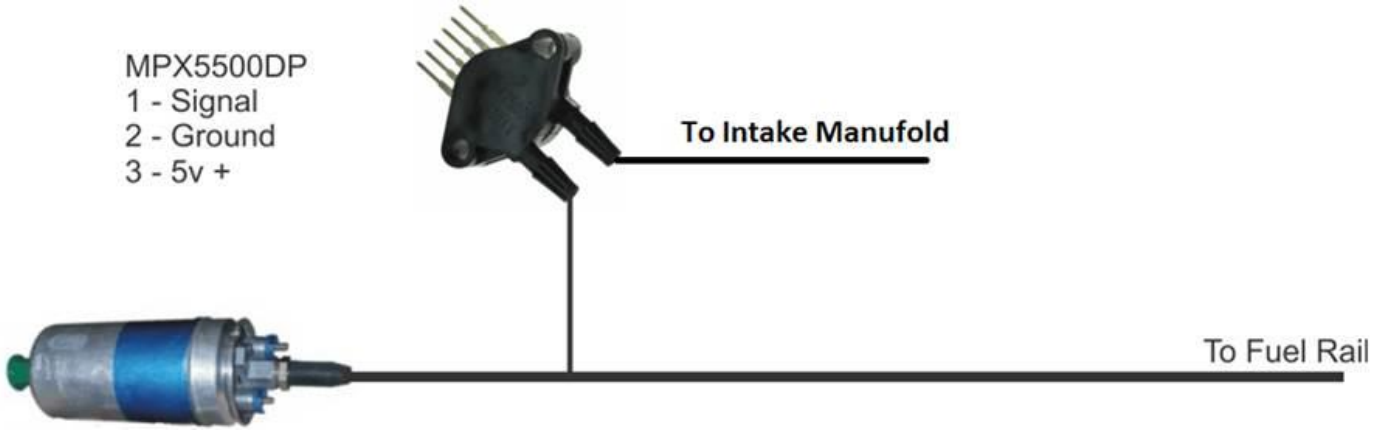
Sensor Location

The fuel pressure sensor must be mounted inside the engine bay. The pressure input pipe must be securely connected to the high pressure fuel line with a T piece. The sensor must be mounted higher than the fuel line with the pressure nipple facing downwards. This will produce an air bubble between the sensor and the fuel to prevent damage. The fuel does not actually contact the sensor element and the bubble acts as a damper to the pulsing fuel. The other pipe of the DP sensor must be connected to the intake manifold. It could be joined with the MAP sensor line if the takeoff pipe has a large enough hole to prevent delays in the signal.

Pressure sensor types

The fuel pressure sensor available from Spitronics is the Motorola series sensor
The fuel pressure sensor is rated at 5.5 bar differential pressure (DP) and the aluminum one is 4 or 7 Bar MAP.

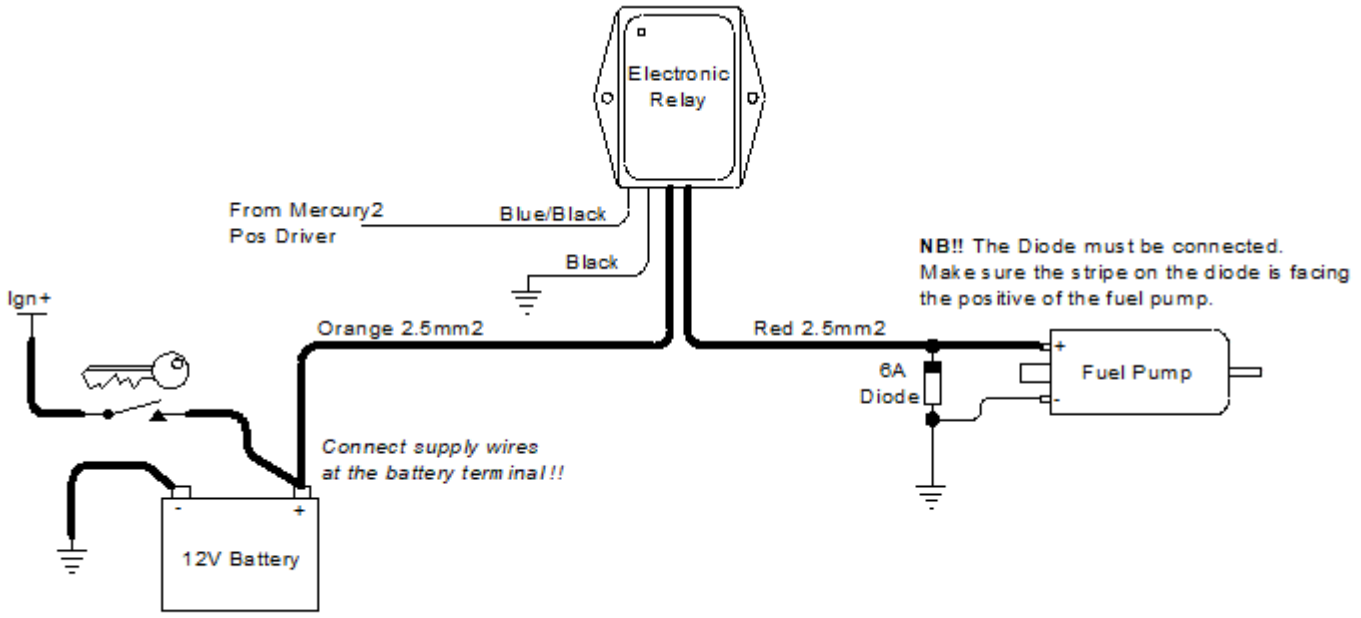
Sample Sensor Pinout and layout



Fuel Pressure Control

Fuel pumps are earthed inside most of the time. This means it can only be powered by 12 Volt from the controller. Spitronics use an amplifier in the form of the Spitronics Electronic Relay. The relay is pulsed in PWM and then does all the hard work and protects the ECU. **Note**: All inductive loads that are pulsed requires the free wheel diode over the power wires. This diverts generated currents back through the inductive loads eliminating electrical interference.

Note: Cathode or the stripe on the diode must always be on the positive side, otherwise it will act as a short circuit and may damage itself and other components. Always put a fuse inline to protect the circuit and as close to the battery as possible.



Fuel system Trouble Shooting

Fuel supply line to the pump is too thin. This will cause the fuel pump to draw a very low pressure on the inlet. When the fuel becomes hotter it will percolate due to the low pressure. This gas will then enter the pump making the pressure erratic. The gas is then pressurized at the injector tip and will reduce petrol flow and cause lean mixtures. The gas bubbles can also damage the pump.

Fuel pump heats up. It could be mounted too close to the exhaust or the pump is too large for the fuel rail system. The fuel flowing through it is too little to cool it off. It could be a dirty fuel pressure filter down stream that causes the pump to pump at too high pressures. If the pump is hot it will also cause the fuel to percolate and make gas bubbles. Do not bring the return line to the front of the fuel pump. The fuel must be cooled off in the tank.

Mechanical fuel pressure failure. Inside is diaphragms that could rupture or become soft with heat. Then accuracy may be a factor in cold and hot conditions. The vacuum line to the intake manifold can leak causing pressure differences.

Fuel lines are too thin. If the line to the fuel rail is too thin, the fuel pressure will drop before it reaches the injectors. If the return line is too thin the fuel pressure regulator cannot regulate properly and the pressure will be too high.

Erratic fuel pressure. This is usually caused by batch fueling as all the injectors open and close all at once. This makes for differences in pressure and fuel supply between the cylinders upstream and downstream.

Fuel pump is noisy and makes uneven sounds. These pumps get damaged by dirt, water and air bubbles. It is good practice to put an inline filter in front of the pump to ensure that dirt does not go through the pump. This will also indicate if air is in the system as most filters are see-through. It may pull in air through the connections.