



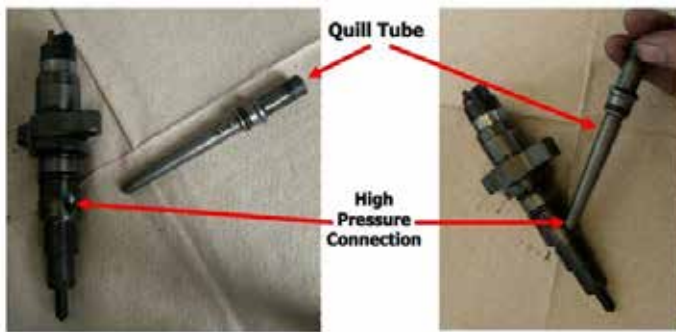
# Fuel system control valves ID and diagnostics



By Clinton Brett

**Part 2 of this special training series will focus on the Bosch Common Rail Diesel (CRD) fuel injectors and the components in which influence their operation.**

## Bosch electromagnet solenoid injector (heavy applications)



Bosch heavy including Quill tubes

This design of heavy application Bosch injectors are used in agricultural, earthmoving, transport, marine, and plant. It uses an external rail with an external connection pipe a fitting in the head referred to as a Quill Tube. The Quill tubes are designed to properly align the injector to reduce the possibility of losing pressure. To ensure no leak occurs, it is very important the correct alignment tools and procedures are used during the repair process for this system.



Cummins CRD rail

The only things that can affect the pressure are the high-pressure pump, the relief valve, or a problem with the fuel supply to the high-pressure pump. The fuel returns from the smaller holes just below the seal, along an internal gallery within the cylinder head,

to a pressure limiter valve which is mounted on the rear of the cylinder head. This pressure limiting valve adjusts the pressure of the fuel returning from injectors to 1.3 to 2.0 bars (18.9 to 29 psi.). By maintaining this pressure to the return fuel, the fuel vapor formation inside the injectors is avoided, optimizing fuel spraying and combustion.

## Bosch electromagnetic solenoid injector (light applications)

This more compact injector located external of the tappet cover, is mostly fitted to light commercial and passenger car applications. One of the distinctive features of this design, is the removable fuel inlet fitting which can easily become loose when removing the injector pipe nut. When loosening the injector pipe, make sure you secure the inlet fitting, otherwise if left loose, a fuel pressure loss can occur.

Compared to some of their competitors, I have found the Bosch design injector is the more reliable and robust design. I believe the key feature, is the independent injector valve assembly. Whereas other injector designs use the main body as part of the valve structure which has affected the reliability of the injector, especially after incorrect installation.



Bosch light application sectioned injector

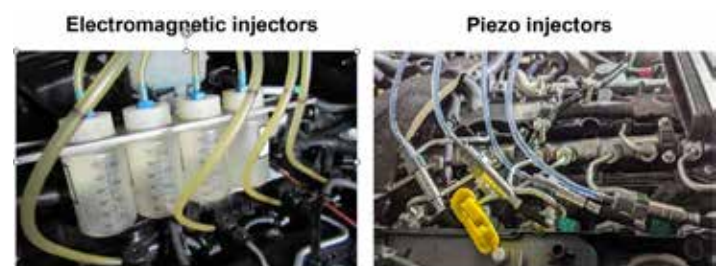
## Common fault 1- Engine not starting when hot

A common cause of any injector failure is fuel contamination. The first sign of contamination often results in the loss of fuel pressure causing a no start situation. This can be more evident when the engine is warm due to reduced fuel viscosity. During cranking, no exhaust smoke is present, and the rail pressure will be slow to increase or possibly none.



Bosch injector 2 piece valve

When observing the scan tool, desired fuel rail pressure is between 250 and 450 bar and therefore actual fuel rail pressure should be reached within 5 seconds. But since my early days of working with CRD, we can confirm inadequate pressure when we don't achieve 200 bar within 2 to 5 seconds of cranking the engine. A reliable test is injector back leakage.



Injector back-leakage test



Some scope gurus try to convince me this test is out of date and there is only one test and that's using a scope and pressure transducer I agree to some point but from what most have shown me, is a quick reference to evaluate the entire injector return. When I am diagnosing injectors, I must determine which injector has failed and what has caused the pressure loss? Combustion entering the injector nozzle or an internal injector valve leak? This also assists with evaluating the engine condition before replacing the injectors. Also, not everyone can afford a scope let alone the time to learn its capabilities. BTW I'm not anti-scope, I just prefer to have alternative test methods. I welcome the opportunity for the explanation of your scope test to assist with my findings.

### Common fault 2- Injector washer failure

Injector washer failure can cause a loss of engine compression, and that nasty stuff referred to as black death. But a failure often overlooked is the injector nozzle over heats causing it to seize closed or open.



Failed injector washers

### Identifying Bosch electromagnetic injector

To recognise this design injector, the fuel return outlet in the centre top of the electronic solenoid along with the Bosch logo and 10-digit part number in this format- 0 445 ### ##.

To assist distinguishing the difference between Electromagnetic and Piezo, the Bosch Electromagnetic use the centre return outlet whereas the Piezo uses the centre for the fuel inlet which is a larger steel pipe coming from the rail.

Hyundai Santa Fe Electromagnetic



Hyundai Santa Fe Piezo



Hyundai Bosch Piezo and solenoid

The injectors in image 7 are both Bosch. Left is the 2009 Hyundai Santa Fe electromagnetic solenoid and the right, a 2014 Piezo actuator. The Piezo returns out one side of the injector.

Bosch Piezo fitted to the 2021 6.7L Cummins engine has a high output injector capable of pressures up to 2000 bar. The injectors

perform multiple injections at a time including pilot and post injection events and are fed with approximately 89-108 volts and operate at 4-8 amps. A digital oscilloscope must be used to view the electrical operation. The actuator generates approximately ten times the force of solenoid valves. Therefore, is less sensitive against particle contaminated fuel. The maximum number of injections per power cycle is 10, the minimum injection interval is 100  $\mu$ s and requires a low supply of 12 volts.

### Fuel pressuring return valve

Fitted to most Bosch Piezo injector systems, the fuel pressuring return valve is used to maintain a minimum fuel pressure in the hydraulic coupler. When removing injectors avoid damaging as driveability issues can result. Ensure it has been noted of its location and direction when carefully removed from the injector return piping. Cap the outlets and keep in a secure place ready for reinstallation. If contamination of the fuel system is why the injectors are being replaced, ensure this valve and the return line are also replaced.

### Identifying Bosch Piezo Injector

Bosch Piezo come in different shapes and sizes. Inspect for damage on injectors, especially the Oring for the return. Most Bosch Piezo injectors use this design return fitting. Take note of the special procedure to remove this return pipe to prevent damaging the Oring.



Euro 6 Bosch Piezo electric actuator injector



Bosch Piezo euro 6 fitted to Peugeot

In part 3 of this series, I will continue with the subject of injectors, covering Continental/Siemens, Denso and Delphi injectors. I will explain injectors coding and the bleeding process of Delphi injectors.