

Delphi Direct Acting Diesel Common Rail System

The Delphi Direct Acting Diesel Common Rail System is an advanced fuel injection system that features an innovative injection technology. The injector needle is set in motion directly by a piezo ceramic actuator, rather than being moved via an electro-hydraulic circuit. This enables the injector to spray fuel into the combustion chamber faster and with much improved spray atomization and accuracy compared with current diesel fuel injection technologies. The result is a considerable reduction in nitrogen oxide (NO_x) emissions (approximately 30 percent versus current injection systems) and more torque and power for better drivability (approximately 10 percent).

Other major elements of the Delphi Direct Acting Diesel Common Rail System include:

- Tubular common rail with high pressure valve (up to 2000 bar)
- High pressure, modular pump (0.6 to 1.2 cm³/rev) with integrated inlet metering valve, pressure limiter, temperature sensor, and transfer pump
- Electronic control unit (ECU) with 32-bit processor



Delphi Direct Acting Diesel Common Rail System includes (clockwise from top left): DFI3 Piezo Injectors with Common Rail, Series 9 Modular Fuel Filter, DCM4 Light Duty Controller, and DFP3 High Pressure Pump.

▶ Benefits

- Improved injection fuel atomization and speed to help reduce emissions and engine noise, while providing unequalled driving performance
- No return flow improves efficiency, enables pump downsizing, and eliminates the need for a return flow fuel cooler
- Multiple injection capability
- Small, accurate, and stable delivery of fuel quantity during the life of the vehicle for consistent low emissions
- Flexibility in the choice of aftertreatment devices
- Delphi's high pressure modular diesel fuel pump and direct acting common rail enable operation up to 2000 bar
- Delphi's exclusive Flexible Injection Waveform Control provides engine designers with unprecedented combustion process capability
 - This ECU feature allows direct control of the needle lift in the nozzle and, therefore, provides direct control of the rate of injection into the combustion chamber

▶ Typical Applications

The Delphi Direct Acting Diesel Common Rail System is suitable for diesel engine programs for medium- and large-size vehicles to help manufacturers meet European Euro 5 requirements and beyond, and U.S. Tier II Bin 5 emissions standards. It reduces or eliminates the need for costly NO_x aftertreatment devices. The Delphi Direct Acting Diesel Common Rail System is scheduled for production in 2008.

▶ Performance Advantages

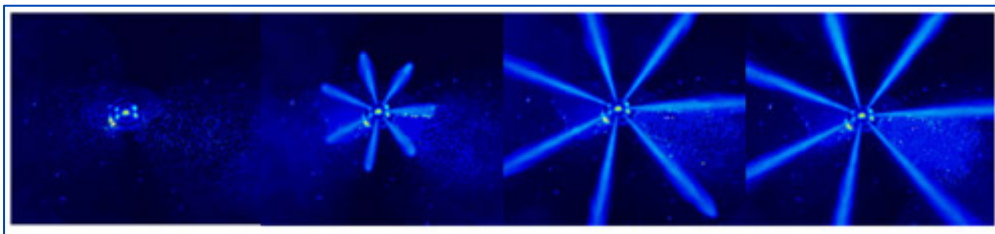
In addition to unmatched injection performances, the Delphi Direct Acting Diesel Common Rail System provides excellent packaging characteristics.

The radically new operating principle of Delphi's piezo injectors does not require a return flow to operate. Thus, all fuel is injected and no fuel is wasted in a return flow. This unique returnless design distinguishes Delphi's Direct Acting Diesel Common Rail System from competitive designs. It permits downsizing of the high pressure pump which also contributes to fuel economy improvement.

Delphi's Direct Acting Diesel Common Rail System also features Individual Injector Characterization (I3C), an exclusive Delphi technology that enables the ECU to be calibrated with the injection system to also contribute to accurate fuel delivery.

► **Spray: Direct Acting vs. Servo-hydraulic**

DFI3 Direct Acting Injectors



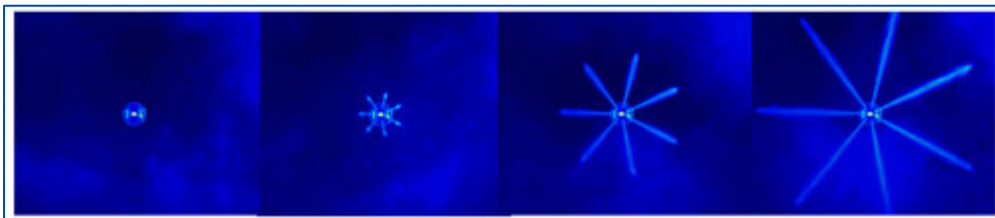
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Conventional Servo-hydraulic Injectors



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► **The Delphi Advantage**

Delphi offers a wide portfolio of diesel engine management systems and components. Delphi can integrate injection systems, air and fuel management systems, exhaust aftertreatment, and associated electronic controls and sensors to provide complete end-to-end diesel engine control systems that can help manufacturers meet emissions and fuel economy requirements around the world.

Delphi designs and manufactures complete diesel engine management systems for light duty, medium duty, and heavy duty applications. Delphi has 15 diesel design and engineering centers located in Europe, Asia, North America and South America, and 21 diesel manufacturing facilities in 13 countries enabling exceptional on-time delivery.