

# Delphi Direct Acting Light Duty Diesel Common Rail System

The Delphi Direct Acting Light Duty Diesel Common Rail System is one of the most sophisticated fuel injection technologies in the world. It is a premium fuel injection system designed especially for premium diesel engine applications.

The system provides engine manufacturers with excellent performance and high power and torque, while helping them reduce fuel consumption and emissions. The system's exceptional injection performance is enabled by a unique piezo ceramic actuator that directly activates the injector needle, rather than by a servo-hydraulic circuit used in conventional systems. This revolutionary concept allows direct control of the nozzle needle and makes possible opening and closing speeds up to three times faster than conventional servo-hydraulic actuated systems, which provides greater injection accuracy and improved mixture preparation. The system also features zero backleak and a rail pressure capability of 2,000 bar, which helps contribute up to a three to four percent reduction of CO<sub>2</sub> emissions.

Major elements of the Delphi Direct Acting Light Duty Diesel Common Rail System include:

- Innovative, patented direct acting piezo injectors
- Tubular common rail with high pressure valve (up to 2,000 bar)
- High pressure, modular pump (0.6 to 1.2 cm<sup>3</sup>/rev) with integrated inlet metering valve, pressure limiter, temperature sensor, and transfer pump
- Electronic control unit (ECU) with 32-bit processor

### ► Benefits

- Improved injection fuel spray atomization and injection accuracy to deliver a considerable reduction of nitrogen oxide (NOx) emissions and soot emissions (approximately 30 percent versus current injection technologies), with more torque and power (approximately 10 percent) for unequalled driving performance
- No return flow improves efficiency, enables pump downsizing and eliminates the need for the additional expense of a return flow fuel cooler
- Multiple injection and rate shaping capability
- Small, accurate and stable delivery of fuel quantity during the life of the vehicle for consistently low emissions
- Reduces or eliminates the need for costly NOx aftertreatment devices
- Delphi's high pressure modular diesel fuel pump and direct acting common rail enable operation up to 2,000 bar
- Helps manufacturers meet European Euro 6 and U.S. Tier II Bin 5 and beyond emissions standards
- 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



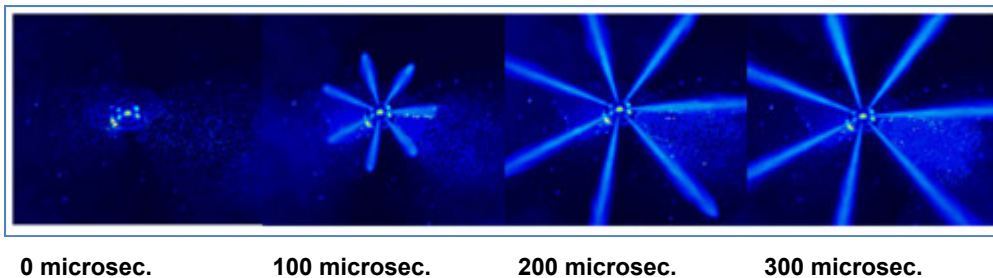
**Delphi Direct Acting Light Duty Diesel Common Rail System includes (clockwise from top): Injectors with Common Rail, Modular Fuel Filter, Light Duty Diesel Engine Controller, and High Pressure Fuel Pump.**

### ▶ Typical Applications

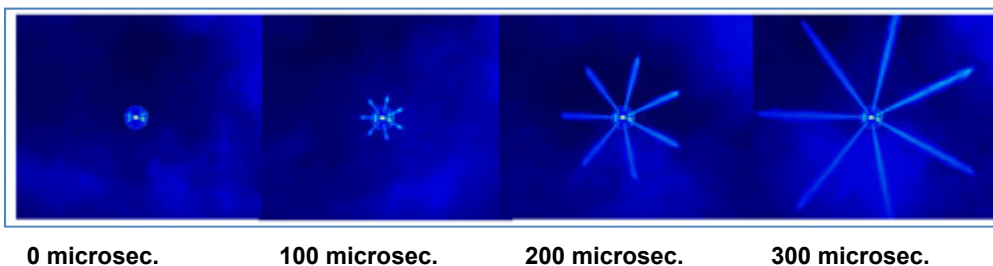
The Delphi Direct Acting Light Duty Diesel Common Rail System is suitable for premium diesel engine programs for medium- and large-size automobiles.

### ▶ Spray: Direct Acting vs. Servo-hydraulic

#### DFI3 Direct Acting Injectors



#### Conventional Servo-hydraulic Injectors



### ▶ Performance Advantages

In addition to unmatched injection performances, the Delphi Direct Acting Light Duty Diesel Common Rail System provides excellent packaging characteristics and is directly interchangeable with Delphi's fast servo solenoid injector.

The revolutionary 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 Light Duty Diesel Common Rail System from competitive designs. It permits downsizing of the high pressure pump which also contributes to fuel economy improvement. The system allows fuel injection to be adapted to all engine loads and speeds with tremendous accuracy. This enables the system to help reduce emissions and improve fuel economy. It also creates no perceptible noise above the engine itself. Further, the system enables a 4-cylinder engine to match the performance characteristics of a 6-cylinder engine, especially if the engine is equipped with a twin turbo-charger.

Exceptionally high speed opening and closing of the injector is achieved at both high and low pressure, which allows higher pressure efficiencies. The system has a rail pressure rating of 2,000 bar, but due to the speed of the injector needle it performs like a 2,200 bar servo system.

Delphi's Direct Acting Light Duty 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.

▶ **The Delphi Advantage**

Delphi is a world leader in innovation, design and manufacture of diesel engine management systems and components. Our revolutionary direct acting light duty diesel common rail system and best-value conventional solenoid light duty diesel common rail system are examples of our ingenuity. Delphi offers a wide portfolio of diesel engine technologies for light duty, medium duty and heavy duty applications.

As a global leader in engine management systems technology, Delphi can help manufacturers meet emissions requirements, improve fuel economy and enhance performance. Delphi is a source for high value solutions and our systems approach is built into every product. Delphi's flexible engineering approach encourages collaboration. And Delphi has a thorough understanding of markets around the world and a global network of resources.