

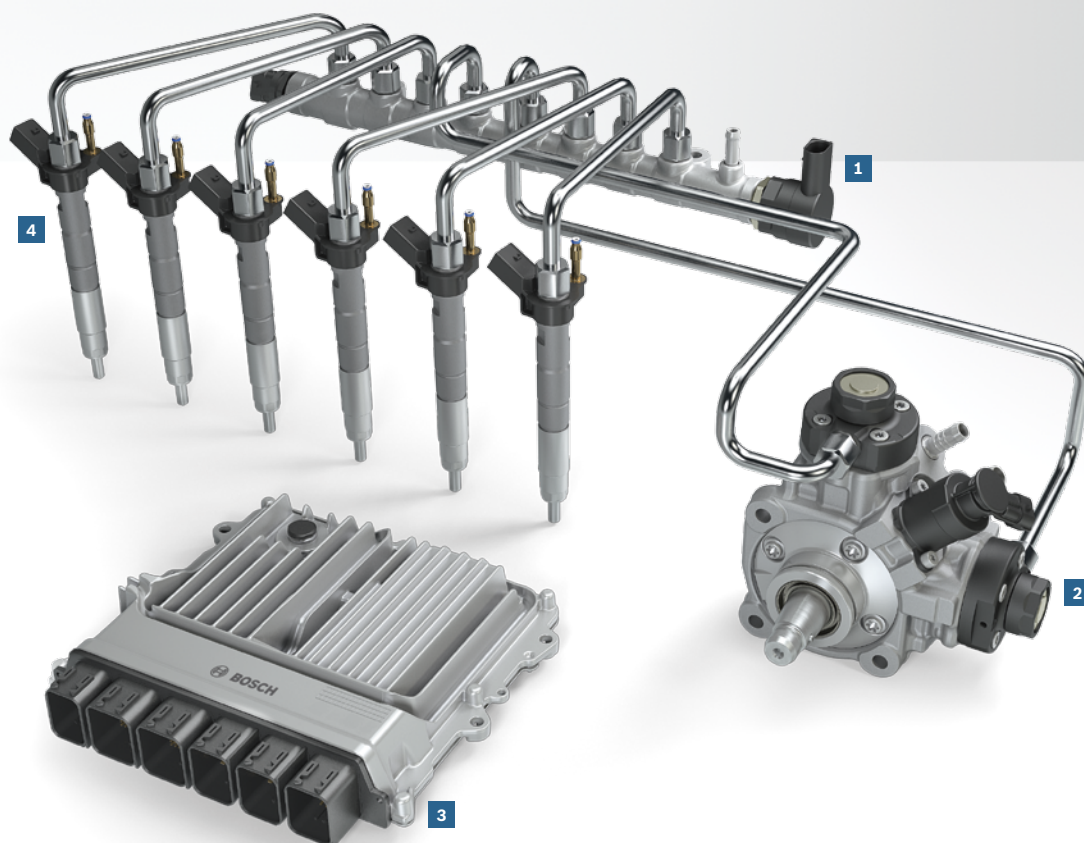
Common-rail injection systems

CRS3-27 diesel common-rail system with piezo injectors and 2,700 bar



BOSCH

Invented for life



Product benefits

- ▶ Cost-effective and versatile due to modular design
- ▶ Reduced fuel consumption and emissions due to multiple injection with very short injection intervals
- ▶ Suitability for Euro 6 ff. and equivalent standards
- ▶ Closed-loop control of injection volume and timing
- ▶ For maximum specific engine outputs
- ▶ High mileage with stable injection volume
- ▶ Idle stop/start (ISS) and hybrid capability

- 1** HFR-27 high-pressure rail
- 2** CP4-27/2 high-pressure pump
- 3** MDG1 electronic engine control unit
- 4** CRI3-27 piezo injector

Vehicle segments



CP4-27 high-pressure pump

up to **2,700** bar

for **high engine power** combined with low fuel consumption

Product benefits

- Increased hydraulic efficiency with electric suction valve
- Ideal for idle stop/start applications without the need for additional add-on components

Task The high-pressure pump delivers fuel at high pressure to the connected rail.

Variants The system can be configured with different high-pressure pumps: the options are a fuel-lubricated CP4 together with metering unit or electric suction valve or else an oil-lubricated CP4i plug-in pump. The CP4 consists of a high-pressure element, which is integrated in housing with its own camshaft. The belt- or chain-driven pump camshaft moves the pump plunger to generate the required high pressure. CP4i is a plug-in pump that does not have its own housing; it is integrated directly into the engine block and is driven, for example, by the engine’s camshaft or crankshaft. Using the optional spring-opened electric suction valve significantly improves filling of the high-pressure pump compared to the metering unit version, particularly in the upper speed range. This permits a reduction in inlet pressure, which enables energy demand to be reduced without affecting the required filling efficiency. A further advantage of the CP4 with electric suction valve is that, for start-stop applications such as restarting after having stopped at a traffic light, it can start even with pressure stored in the rail. This saves engine components from the high stresses to which they are otherwise subjected.

High-pressure pumps available

CP4i	Oil-lubricated, without housing
CP4 with metering unit	Fuel-lubricated, with housing
CP4 with electric suction valve	Fuel-lubricated, with housing

CRI3-27 piezo injector

up to **10**

individual injections for quieter combustion plus reduced fuel consumption and emissions

Product benefits

- Extremely short injection intervals possible
- Lower fuel consumption and emissions
- Reduced noise

Task CRS3-27 are built around fast-switching piezo injectors that always inject the optimum amount of fuel into the cylinders for clean and economical combustion. The CRI3-27 piezo injectors lead the way in multiple injection technology due to their capability for smallest pilot injection quantities, fast injection sequences, and low injection quantity drift over system lifetime. Because the piezo actuator is integrated into the injector body, the injectors are slim and require much optimized packaging than their solenoid valve counterparts. Due to their robust piezo principle, the injectors are compatible with various fuel qualities for various fuel qualities. The piezo actuator generates approximately ten times the force of solenoid valves. Therefore the piezo injector is less sensitive against particle contaminated fuel.

Function Thanks to their high switching speeds, the piezo injectors attain very small pilot injection volumes. The coupling of actuator and nozzle needle permits extremely short response times. The new CRI3-27 piezo injector generation facilitates multiple injection with very short dwell times between the individual injections. Through the digital rate shaping strategy, pilot injection can be executed very shortly before the main injection in order to achieve a gentle combustion process and therefore less noise. This yields significant reductions in emissions, fuel consumption, and combustion noise. Optimized injector characteristic curves permit quantity corrections over the system’s service life by means of learning functions. Innovative needle closing control (NCC) delivers significant improvements in injection accuracy in particular. The injector design accommodates the integration of a sensor to measure characteristic variables such as the opening and closing times of the nozzle needle. The engine control software is able to calculate the actual injector behavior based on the measured variables. This allows injection volumes and timing to be controlled in a closed loop over the vehicle’s entire lifetime.

HFR-27 high-pressure rail

over **60,000**

pressure checks a minute for optimum fuel injection control

Product benefits

- Less weight means reduced CO₂ emissions
- Extreme pressure resistance thanks to high-tech manufacturing technologies

Task As a key hydraulics component connecting the pump and the injectors, the high-pressure rail lends its name to the common-rail system. It stores the fuel and supplies it to the piezo injectors.

Function The high-pressure rail communicates with the control unit via the attached rail-pressure sensor. Its measurement values are used by the pressure control valve to control system pressure. A new pressure control valve design reduces the noise that can develop. Pressure pulsations are generated in the system during the injection process. The stored high-pressure volume reduces this to a minimum and thereby increases the accuracy of the injection volume, which goes a considerable way toward reducing emissions and fuel consumption.

Electronic engine control unit

Reduced **emissions**

to meet current and future requirements of exhaust gas legislation worldwide.

Product benefits

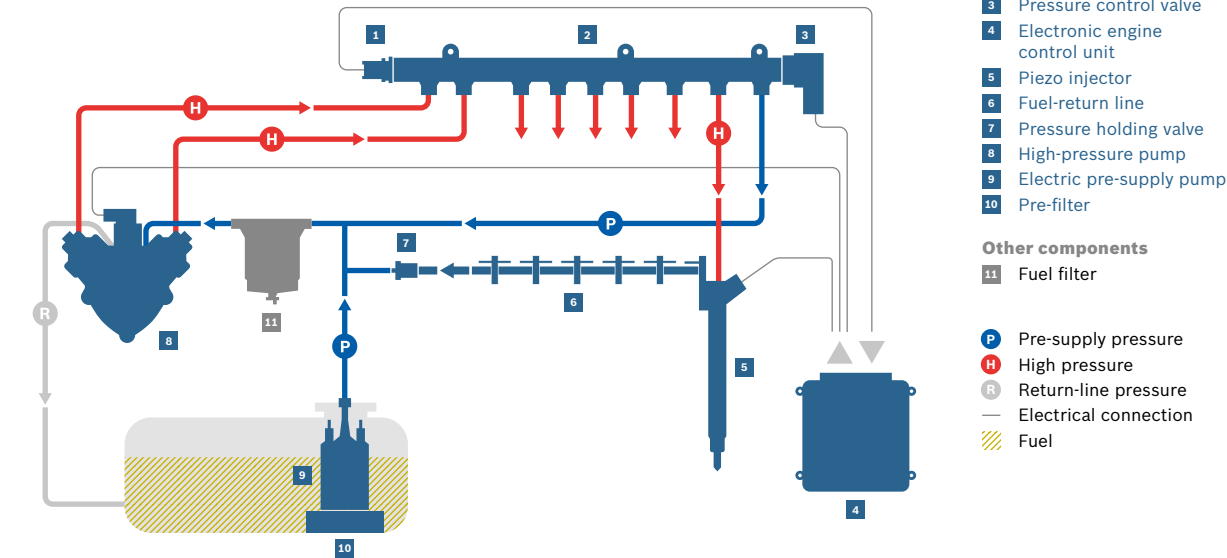
- Enhanced performance and scalability for current and future customer requirements
- Supports safety requirements (ISO 26262) and offers new kinds of access and tuning protection

Task The electronic engine control unit is the heart of the engine management system. It controls fuel supply, air control, fuel injection, and ignition. In addition, it is able to actuate the exhaust system, the gears, and/or vehicle functions. The electronic engine control unit was developed for use in diesel and gasoline engines as well as for those using alternative fuels.

Function Software inside the electronic engine control unit processes the incoming system information and controls the various functional groups; the unit networks the individual functions to form an efficient overall system. To do this, it uses a new generation of high-performance microcontrollers. The software platform also guarantees maximum functional flexibility, as the previous-generation application software can be used with AutosarR4-compatible basic software.

CRS3-27 common-rail system

The individual components in a networked system



2,700 bar

injection pressure is used by the CRS3-27 for efficient combustion.

Closed-loop control

for **optimum combustion** throughout the vehicle's lifetime.

Task Rising fuel prices and increasingly stringent emissions limits make modern, economical, environmentally friendly diesel engines the powertrains of choice. With its CRS3 series common-rail systems, Bosch offers modular and scalable solutions for the injection system in order to further reduce the emissions, fuel consumption, and combustion noise of diesel engines. By using piezo injectors, Bosch increases the system pressure of common-rail systems to 2,700 bar. Higher injection pressure is a key lever for reducing an engine's untreated nitric oxide and particulate emissions. The reason for this is that the higher the pressure, the finer the fuel can be atomized and the better it mixes with the air in the cylinder. This makes the combustion process as thorough and clean as possible. CRS3 systems are suitable for diesel engines with up to twelve cylinders and a wide range of power and torque. The modular systems can be adapted to a large number of engine types. Bosch has extensive series production experience for passenger cars with the CRS3 series: millions of CRS3 systems are already in use and delivering outstanding results. CRS3-27 common-rail systems with pressures up to 2,700 bar build on the CRS3-20 piezo system on a modular basis. The increased pressure and technical modifications make it possible to further optimize diesel engines and make a significant contribution toward fulfilling current and future emissions targets.

Function In the common-rail system, the fuel is always provided with the required pressure for injection. The system consists of a high-pressure pump, a high-pressure rail, an injector for each cylinder, and an electronic control system. Injection timing and fuel volume are calculated and controlled individually for each cylinder.

Technical characteristics

Number of engine cylinders	4 to 12
Max. system pressure	2,700 bar
Max. number of injections per power cycle	10
Min. injection interval	100 µs
Supply voltage	12 V
Emissions standards compliance	Euro 6 ff.
Service life (cars/LD)	300,000 km / 400,000 km