**Product benefits**

- Cost-effective and versatile due to modular design
- Reduced fuel consumption and emissions thanks in part to idle stop/start (ISS) and hybrid capability
- Can be used in downsizing and downspeeding concepts
- Suitability for Euro 6 ff. and equivalent standards
- Closed-loop control of injection volume and timing
- Shorter injection intervals possible

**Vehicle segments**

1. HFR-25 high-pressure rail
2. CP4-25/1 high-pressure pump
3. MDG1 electronic engine control unit
4. CRI2-25 solenoid valve injector

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**Common-rail injection systems**

CRS2-25 diesel common-rail system with solenoid valve injectors and 2,500 bar
CRP4-25 high-pressure pump

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 to- gether with metering unit or electric suction valve, or else an oil-lubricated CP4 plug-in pump. The CP4 consists of a high-pres- sure element, which is integrated into a housing with its own camshaft. The belt- or chain-driven pump camshaft moves the pump plunger to generate the required high pressure. CP4 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 en- gine’s camshaft or crankshaft. Using the optional spring-opened electric suction valve significantly improves filling of the high pres- sure 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.

CR12-25 solenoid valve injector

Product benefits
- Extremely short injection dwell time possible
- Lower fuel consumption and emissions
- Reduced noise

Task
CRS2-25 are built around fast-switching solenoid valve injectors with short injection dwell times, which inject the optimum amount of fuel for the driving situation into the cylin- ders, thereby ensuring clean and economical combustion. The se- cond-generation, high-performance solenoid valve injectors allow a high degree of freedom when designing the injection pattern and permit up to eight individual injections per power cycle. The- se multiple injections reduce the engine’s fuel consumption as well as its CO₂ pollutant, and noise emissions.

Function
Thanks to its pressure-balanced solenoid valve, the CR12-25 injector enables system pressure to be increa- sed to 2,500 bar. The valve’s fast switching times make it possible to achieve very short injection dwell times, facilitating highly flexi- ble injection patterns for multiple injections. Optionally, a sensor can be integrated into the CR12-25, which can then measure char- acteristic injector variables such as the closing times of the nozzl e needle. In addition, the CR12-20/22-25 injectors have an inte- grated high-pressure volume that reduces pressure pulsations and also increases hydraulic efficiency through reduced return flow.

High-pressure pumps available

<table>
<thead>
<tr>
<th>CP4i</th>
<th>Oil lubricated, without housing</th>
</tr>
</thead>
<tbody>
<tr>
<td>CP4 with metering unit</td>
<td>Fuel lubricated, with housing</td>
</tr>
<tr>
<td>CP4 with electric suction valve</td>
<td>Fuel lubricated, with housing</td>
</tr>
</tbody>
</table>

CRI2-25 common-rail system

HFR-25 high-pressure rail

Electronic engine control unit

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 solenoid valve injectors.

Function
The high-pressure rail communicates with the control unit via the attached rail pressure sensor. Its measure- ment values are used by the pressure control valve to regulate 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 quantity, which goes a considerable way toward reducing emissions and fuel consumption.

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 electro- nic engine control unit was developed for use in diesel and gaso- line 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 soft- ware platform also guarantees maximum functional flexibility, as the previous-generation application software can be used with AutosarR4-compatible basic software.

Bosch components
- Fuel pressure sensor
- High-pressure rail
- Pressure control valve
- Electronic engine control unit
- Solenoid valve injector
- Fuel return line
- Non-return valve
- High-pressure pump
- Electric pre-supply pump
- Pre-filter

Other components
- Fuel filter

Pre-supply pressure
- High pressure
- Return line pressure
- Electrical connection
- Fuel

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

Product benefits
- Reduced emissions
- to meet current and future requirements of exhaust gas legislation worldwide.

Over 60,000 pressure checks a minute for optimum fuel injection control

Reduced emissions for quieter combustion plus reduced fuel consumption and emissions

High-pressure pumps

CP4i
- Oil lubricated

CP4
- With metering unit
- Fuel lubricated

CP4 with electric suction valve
- Fuel lubricated

CRS2-25 diesel common-rail system with solenoid valve injectors and 2,500 bar

CRS2-25 common-rail system
The individual components in a networked system.
Rising fuel prices and more stringent emissions limits have increased demand for diesel engines as economical, environmentally friendly drive systems. Bosch’s modular CRS2 common-rail systems offer performance-optimized solutions that reduce vehicles’ operating costs with their impressive fuel economy. The systems can be used in diesel engines with up to eight cylinders and a wide range of power and torque. In addition, they can be adapted to a large number of engine types. CRS2 systems have proved themselves in practice, with millions currently in use. The CRS2-25 system builds on the CRS2-20 and uses up to 2,500 bar injection pressure. Through this increase and further technical modifications, the system plays an important part in helping vehicles meet current and future emissions targets.

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

<table>
<thead>
<tr>
<th>Description</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of engine cylinders</td>
<td>3 to 8</td>
</tr>
<tr>
<td>Max. system pressure</td>
<td>2,500 bar</td>
</tr>
<tr>
<td>Max. number of injections per power cycle</td>
<td>8</td>
</tr>
<tr>
<td>Min. injection interval</td>
<td>150 µs</td>
</tr>
<tr>
<td>Supply voltage</td>
<td>12 V</td>
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<tr>
<td>Emissions standards compliance</td>
<td>Euro 6 ff.</td>
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<tr>
<td>Service life</td>
<td>300,000 km</td>
</tr>
</tbody>
</table>