

<b>4 Areas of use for diesel engines</b>	<b>82 Overview of discrete cylinder systems</b>
4 Suitability criteria	82 Single-plunger fuel-injection pumps PF
4 Applications	84 Unit injector system (UIS) and unit pump system (UPS)
8 Engine characteristic data	88 System diagram of UIS for cars
<b>10 Basic principles of the diesel engine</b>	90 System diagram of UIS and UPS for commercial vehicles
10 Method of operation	<b>92 Overview of common-rail system</b>
13 Torque and power output	92 Areas of application, Design
14 Engine efficiency	93 Method of operation
17 Operating statuses	96 System diagram for cars
21 Operating conditions	98 System diagram for commercial vehicles
24 Fuel-injection system	<b>100 Electronic diesel control EDC</b>
25 Combustion chambers	100 Requirements, System overview
28 Diesel fuels	101 System structure
32 Alternative fuels	102 Application-related adaptation of car engines
<b>34 Cylinder-charge control systems</b>	106 Application-related adaptation of commercial-vehicle engines
34 Overview	111 Calibration tools
35 Intake-air filters	<b>114 Open- and closed-loop electronic control</b>
38 Swirl flaps	114 Open- and closed-loop control
38 Turbochargers and superchargers	114 Data processing
49 Exhaust-gas recirculation	<b>116 Actuators</b>
<b>50 Basic principles of diesel fuel-injection</b>	116 Electropneumatic converters
50 Mixture distribution	117 Continuous-operation braking systems
52 Start of injection and delivery	117 Fan control function
54 Injected-fuel quantity	118 Start-assist systems
55 Injection characteristics	<b>120 Nozzles</b>
60 Injection pressure	122 Future development of the nozzle
61 Injection direction and number of injection jets	<b>124 Nozzle holders</b>
<b>62 Overview of diesel fuel-injection systems</b>	<b>126 Exhaust-gas treatment systems</b>
62 Requirements	126 Diesel oxidation-type catalytic converter
64 Designs	126 Particulate filter
<b>70 Overview of in-line fuel-injection pump systems</b>	127 NO <sub>x</sub> accumulator-type catalytic converter
70 Areas of application, Types	129 SCR principle
71 Design, Control	129 Combination systems
<b>74 Overview of distributor fuel-injection pump systems</b>	<b>130 Index of technical terms</b>
74 Areas of application, Designs	131 Abbreviations
76 Port-controlled systems	
78 Solenoid-valve-controlled systems	

The diesel engine is enjoying a period of increased popularity among motorists. Its traditional strengths are economy, reliability and high-torque output. That is why it became established as the engine of choice for commercial vehicles a long time ago. The continuing development of the diesel engine – and particularly of the direct-injection design – coupled with the rapid advances made in high-pressure fuel-injection systems have consistently brought about further improvements in performance and consumption.

Furthermore, modern diesel engines with high-pressure fuel injection have made substantial progress in respect of driving smoothness and pollutant emission. They need no longer fear comparison with any other type of internal-combustion engine. This has led to the diesel engine becoming a much more popular choice for cars – including sports cars and luxury-performance cars.

With the increasingly widespread use of the diesel engine, the desire to understand more about it has also grown.

This manual in the “Automotive Technology” series offers an up-to-date insight into the workings of the diesel engine. It also describes the various Bosch fuel-injection systems. Consequently, it provides a comprehensive view of components in diesel-engine management systems.

This series of publications also includes other titles that examine in more detail the diesel fuel-injection systems and the electronic diesel-control system EDC outlined in this manual.

## System diagram for commercial vehicles

Figure 4 shows all the components of a fully equipped common-rail system for a six-cylinder diesel commercial-vehicle engine. Depending on the type of vehicle and application, some of the components may not be used.

For the sake of clarity of the diagram, only the sensors and desired-value generators whose true position is necessary to the understanding of the system are shown in their fitted locations.

Fig. 4

### Engine, engine control unit and high-pressure injection components

- 22 High-pressure pump
- 29 Electronic engine control unit
- 30 Fuel rail
- 31 Fuel-rail pressure sensor
- 32 Fuel injector
- 33 Relay
- 34 Auxiliary equipment (e.g. retarder, exhaust flap for engine brake, starter motor, fan)
- 35 Diesel engine (DI)
- 36 Flame glow plug (alternatively grid heater)
- M Torque

### A Sensors and desired-value generators

- 1 Accelerator-pedal sensor
- 2 Clutch switch
- 3 Brake switches (2)
- 4 Engine brake switch
- 5 Parking brake switch
- 6 Control switch (e.g. cruise control, intermediate speed control, engine speed and torque reduction)
- 7 Starter switch ("ignition switch")
- 8 Charge-air speed sensor
- 9 Crankshaft speed sensor (inductive)
- 10 Camshaft speed sensor
- 11 Fuel temperature sensor
- 12 Engine-temperature sensor (in coolant system)
- 13 Charge-air temperature sensor
- 14 Charge-air pressure sensor
- 15 Fan speed sensor
- 16 Air-filter differential-pressure sensor

### B Interfaces

- 17 Air-conditioning compressor with control
- 18 Alternator
- 19 Diagnosis interface
- 20 SCR control unit

Data exchange with a wide range of other systems (e.g. transmission control system, traction control system TCS, electronic stability program ESP, oil quality sensor, tachograph, radar sensor ACC, vehicle management system, brake co-ordinator, fleet management system) involving up to 30 control units is possible via the CAN bus in the "Interfaces" section (B). Even the alternator (18) and the air-conditioning system (17) can be connected to the CAN bus.

For exhaust-gas treatment, three alternative combination systems are shown (a, b and c).

### 21 Air compressor

CAN Controller Area Network (vehicle's serial data bus)  
(up to three data busses)

### C Fuel supply system (low-pressure system)

- 23 Fuel pump
- 24 Fuel filter with water-level and pressure sensors
- 25 Control unit cooler
- 26 Fuel tank with filter
- 27 Pressure limiting valve
- 28 Fuel level sensor

### D Air intake system

- 37 Exhaust-gas recirculation cooler
- 38 Control flap
- 39 Exhaust-gas recirculation actuator with exhaust recirculation valve and position sensor
- 40 Intercooler with bypass for cold starting
- 41 Turbocharger (in this case with variable turbine geometry) with position sensor
- 42 Charge-air pressure actuator

### E Exhaust-gas treatment systems

- 43 Exhaust-gas temperature sensor
- 44 Oxidation-type catalytic converter
- 45 Differential-pressure sensor
- 46 Particulate filter
- 47 Soot sensor
- 48 Fluid level sensor
- 49 Reducing agent tank
- 50 Reducing agent pump
- 51 Reducing agent injector
- 52 NO<sub>x</sub> sensor
- 53 SCR catalytic converter
- 54 NH<sub>3</sub> sensor
- 55 Blocking catalytic converter
- 56 Catalyzed soot filter Type CSF
- 57 Hydrolyzing catalytic converter

4 Common-rail diesel fuel-injection system for commercial vehicles

