Mobility as it is commonly practiced nowadays is not least a question of environmental awareness and economic efficiency.

In future, the techniques which permit these considerations concerning personal mobility to become a practical proposition will become of decisive importance particularly with regard to the diesel engine.

The increasing needs for higher fuel economy, less-toxic exhaust-gas emissions, together with the never-ending demands for reductions in diesel-engine noise can no longer be complied with using mechanically governed fuel-injection systems. Very high injection pressures, coupled with a precise rate-of-discharge curve and exactly metered injected fuel quantities are needed to comply with the above requirements.

This Technical Instruction contains all the worthwhile knowledge concerning the Common Rail fuel-injection system, its components, its design, and its method of functioning, together with details of how this new system is highly successful in fulfilling the above requirements.

New developments in the system are the fuel accumulator, the so-called “rail”, which is permanently under pressure, a special high-pressure fuel supply system, the injectors, and an electronic control which precisely copes with the most complicated control tasks: This system will have no trouble in complying with the more severe exhaust-gas legislation and stipulations of the future.
Rail-pressure sensor

Assignment
In order to output a voltage signal to the ECU which corresponds to the applied pressure, the rail-pressure sensor must measure the instantaneous pressure in the rail
− With adequate accuracy, and
− As quickly as possible

Design and construction
The rail-pressure sensor (Fig. 12) comprises the following components:
− An integrated sensor element welded to the pressure fitting,
− A printed-circuit board (pcb) with electrical evaluation circuit, and
− A sensor housing with electrical plug-in connection.

The fuel flows to the rail-pressure sensor through an opening in the rail, the end of which is sealed off by the sensor diaphragm. Pressurized fuel reaches the sensor’s diaphragm through a blind hole. The sensor element (semiconductor device) for converting the pressure to an electric signal is mounted on this diaphragm. The signal generated by the sensor is inputted to an evaluation circuit which amplifies the measuring signal and sends it to the ECU.

Function
The rail-pressure sensor (Fig. 12) operates as follows:
When the diaphragm’s shape changes, the electrical resistance of the layers attached to the diaphragm also change. The change in shape (approx. 1 mm at 1500 bar) which results from the build-up of system pressure, changes the electrical resistance and causes a voltage change across the 5 V resistance bridge. This voltage change is in the range 0…70 mV (depending upon the applied pressure) and is amplified by the evaluation circuit to 0.5…4.5 V.

The precise measurement of rail pressure is imperative for correct system functioning. This is one of the reasons for the very tight tolerances which apply to the rail-pressure sensor during pressure measurement. In the main operating range, the measuring accuracy is approx. ± 2% of full-scale reading. If the rail-pressure sensor should fail, the pressure-control valve is triggered “blind” using an emergency (limp-home) function and fixed values.
**Pressure limiter valve**

**Assignment**
The pressure limiter valve has the same job as an overpressure valve. In case of excessive pressure, the pressure limiter valve limits the rail pressure by opening an escape passage. The pressure limiter permits a short-time maximum rail pressure of 1500 bar.

**Design and construction**
The pressure-limiter valve (Fig. 13) is a mechanical device comprising the following components:
- Housing with external thread for screwing to the rail,
- A connection to the fuel-tank return line,
- A movable plunger, and
- A spring.

At the connection end to the rail, the housing is provided with a passage which is closed by the cone-shaped end of the plunger coming up against the sealing seat inside the housing. At normal operating pressures (up to 1350 bar), a spring forces the plunger against the seat and the rail remains closed. As soon as the maximum system pressure is exceeded, the plunger is forced up by the rail pressure against the force of the spring. The fuel under high pressure can now escape, whereby it flows through passages into the plunger’s interior from where it is led through a collector line back to the fuel tank. When the valve opens, fuel leaves the rail so that the rail pressure drops.

**Flow limiter**

**Assignment**
It is the job of the flow limiter to prevent continuous injection in the very unlikely case that one of the injectors remains open permanently. To comply with this task, as soon as the amount of fuel leaving the rail exceeds a defined level, the flow limiter closes the line to the injector in question.

**Design and construction**
The flow limiter (Fig. 14) comprises a metal housing with external thread for screwing onto the rail (high pressure) and an external thread for screwing into the injector lines. The housing has a passage at each end which provides the hydraulic connection to the rail and to the injector lines.

There is a plunger inside the flow limiter which is forced in the direction of the fuel accumulator by a spring. This plunger