# Content

1. System overview
2. Common Rail Components
3. DPF
4. EGR
5. Total engine management
System overview

Common Rail overview

Possible for extreme high pressure injection few times in 1/1000 sec.
### Features and advantages

**- Feature -**
- Extra High Pressure (160MPa)
- Multiple Injection (3 to 5/stroke)
- Injection Timing Control
- Independent Cylinder Control
- Advanced Electronic Control

**- Advantage -**
- Cleaner Exh. Gas Emission (NOx & PM Reduction together by Combination with EGR)
- Lower Noise
- Lower Fuel Consumption
- Better After Treatment Control
- Minimize Unbalance between each Cylinders
- Diagnosis, Fail Safe

---

### Fuel consumption

**Lower Fuel Consumption**

**Estimated Value of 3L-Class NA Engine (Engine Only – No DPF)**

- Rated Fuel Consumption
- Excavator Pattern Fuel Consumption

![Graph showing fuel consumption comparison](image)

<table>
<thead>
<tr>
<th>Engine Type</th>
<th>BSFC (9%)</th>
<th>BSFC (3%)</th>
<th>BSFC (6%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>IDI (Mech)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DI (Mech)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DI (CR)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note:** In case these emission levels are same

---

The information and figures in this document are the exclusive property of YANMAR Corporation. Unauthorized copying and reprinting prohibited.
Common Rail Components
Common Rail Fuel System Components

1. Fuel Tank

2. Primary Fuel Filter/Water Separator

3. Fuel Pump(s)
   Low Pressure Feed Pump – High Pressure Supply Pump

4. Fuel Rail

6. Fuel Rail Pressure Sensor and Control Valve

7. Injectors

8. Fuel Return Manifold

9. Engine Sensors
   Engine Speed (Crank and Cam)
   Accelerator (Throttle) Position
   Intake Manifold (Pressure and Temperature)
   Engine Coolant Temperature
   EGR Valve Sensors (Pressure and Temperature)

10. ECU (Engine Control Unit)

11. ECU Outputs
Fuel Tank

1. Fuel Tank
   Fuel Storage
   De-aeration
   Cooling
   Tank to Supply Pump is called the ‘low pressure’ system (In green)
   Drain the fuel tank every 250 hours to remove condensation and debris
2. **Filter and Water Separator**
Remove any water that may have accumulated in the tank due to condensation or at delivery.

Check and drain the primary filter and water separator daily.

Clean the primary filter and water separator every 500 hours.

---

3. **Fuel Feed Pump**
Mechanical or electric

Keeps a head pressure on the supply pump to prevent fuel starvation.
Fuel Filter

4. **On Engine Fuel Filter**
   Smaller mesh than the primary filter
   
   Final filter before the supply pump
   
   Replace fuel filter every 500 hours

---

Fuel Supply Pump – Bosch CP4

5. **Fuel Supply Pump**
   Able to supply fuel at up to about 240 MPa (29,400 psi)
   
   One (1) piston/cylinder
   
   Does not feed separate injectors, provides fuel to Common Rail
   
   Equipped with an intake or suction control valve to adjust the volume of fuel delivered to the rail
Fuel Rail

6. Fuel (Common) Rail

Provides a continuous supply of fuel to injectors at high pressure

Acts as snubber to dampen supply pump pressure pulses

Equipped with a rail pressure sensor, pressure relief valve, and fittings for attaching high pressure lines

Do not exchange individual components on the fuel rail, replace the entire rail assembly

High pressure fuel lines MAY NOT be reused

Fuel Rail Pressure Sensor

7. Fuel Rail Pressure Sensor

Provides feed-back signal of the current fuel rail pressure to the ECU

Located on the front of the rail

Pin 1 – 5VDC reference voltage

Pin 2 – 0 – 4.8VDC pressure signal

Pin 3 – Circuit ground
8. **Rail Pressure Regulator Valve**

   Located at the back of the rail

   Controls the rail target pressure as determined by the ECU

   Solenoid valve is activated by the ECU when the rail pressure exceeds the target for any given set of conditions

9. **Injectors**

   Located in the engine cylinder head

   Controlled by the ECU to maintain the best fuel volume and injection event timing for all operating conditions

   The injectors, fuel rail, fuel lines into and out of the rail are sometimes referred to as the ‘high pressure’ fuel system

   Possible to inject fuel more than one time in the injection event. Bosch uses one injection event (Main) during normal operation and two events (Main and Post) during cold engine situations to reduce smoke and emissions.

   Trim data recorded at time of manufacture – Must be updated if injector is replaced
**Injectors**

**Common Rail Injection System**

On common rail injection system...

- Pressurized fuel is stored in common rail.
- Solenoid not activated

---

On common rail injection system...

- Solenoid activated
Injectors

Common Rail Injection System

On common rail injection system...

- Solenoid activated allows nozzle needle to lift.

Common Rail System Action

• Amount, timing and pressure can be controlled independently.  
  ⇒ flexible control
• Fuel injection is controlled by electronic solenoid valve.
  • Pressurized fuel is stored in common rail.
  • Multiple injection available by activating solenoid valve several time.
The trim data for guaranteeing predetermined injection quantity for every individual injector is indicated. And these data are registered in the ECU.

**Top of injector (Bosch)**

ECU has an injector Trim data for each cylinder. At the time of injector exchange, the trim data in ECU needs to be rewritten using the Yanmar SmartAssist-Direct (SA-D).
10. Fuel Return Manifold
Located at the top of the injectors

Injectors are connected to both the high pressure system (Red) and the fuel return system (Blue)

Fuel return manifold carries away fuel that was not injected for combustion

Injector fuel return manifold connects to a filter and pump bypass system which carries fuel back to the pump inlet or back to the tank for cooling

11. Engine Sensors
Engine Speed
   Crankshaft and Camshaft Sensors

Operator Demand
   Accelerator (Throttle) Position Sensor

Intake Air
   Intake Manifold Pressure and Temperature Sensors

Engine Coolant
   Engine Coolant Temperature Sensor
DPF overview

Diesel Particulate Filter (DPF)

- **DOC (Diesel Oxidation Catalyst)**
  - Oxidize HC, CO
  - Generate NO→NO₂

- **SF (Soot Filter)**
  - Trap PM

**<Mission>**
- Comply to PM Regulation
- Guarantee 3,000hrs Maintenance Interval

**<Value>**
- Higher Reliability for Industrial Use
- Lower Fuel Consumption
- Easier Installation

Optimized Structure  Original Regeneration Control  Optimized Layout
**DPF Overview**

**Optimized Structure**

![Diagram of DPF system with components labeled](image)

**YANMAR Regeneration System**

**Regeneration by Assist Device**
- Intake Throttle
- Intake Air Control
- Common Rail
- Injection Timing

**Regeneration by Common Rail Injection**
- Common Rail
- Post Injection
DPF overview

- Original Regeneration Control
  - High temp. regeneration (approx. 550-600°C) each 100hr

- Assist Regeneration
  - Minimization of Oil dilution
  - Minimization of catalyst deterioration
  - Rest (Active) Regeneration
  - Accuracy improvement of PM/Ash Accumulation
  - To create emergency mode

- Reset Regeneration
  - High Reliability and durability for Industrial usage

Disadvantages:
- DPF Damage by uncontrolled burning
- Catalyst Deterioration
- Impossible to Completely Burn PM
- Impossible to Create Emergency Mode
- Oil Dilution
- Higher Fuel Consumption

[Image: SIC Active Regeneration Threshold]

- PM Accumulation g/L
- DPF Temp. °C
- Running time

The information and figures in this document are the exclusive property of YANMAR Corporation. Unauthorized copying and reprinting prohibited.
EGR overview

Exhaust Gas Re-circulation

- Advantage: Reduction of NOx Generation
- Disadvantage: Bad Combustion (higher fuel consumption, smoke)

- Lowered Combustion Temp.
- Reduced Fresh Air

Intake: Fresh Air, Exhaust: Exh. Gas
EGR overview

Cooled EGR System

- Intake
- Fresh Air
- EGR Cooler
- Exhaust
- Exh. Gas (Emission)

- Lowered EGR Gas Temp.
- Further Lowered Temp.
- Reduced EGR gas Volume
- More Fresh Air (vs. no cooler)

Advantage:
- Further NOx Reduction Possible
- Improved Performance

EGR overview

- EGR Valve
- DPF
- Running time
- Back Pressure
- EGR Ratio (Amount of EGR-gas)

- Minimization of Frequent Regeneration
- Low fuel consumption and High reliability
- Downsizing of DPF size

Advantages:
- Control of Rapid Accumulation
- EGR Valve Control
- PM

The information and figures in this document are the exclusive property of YANMAR Corporation. Unauthorized copying and reprinting prohibited.
THANK YOU FOR YOUR ATTENTION.

YANMAR