

## Detalles del nuevo motor GD - Printable Version

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### Detalles del nuevo motor GD - [awarenica](#) - 21-04-2016



#### Range of application

GD engines introduced at 2015 as the replacement of obsolete KD series, the most popular diesels of Toyota. Initially installed for LC Prado and HiLux family models. With this engine Toyota returns diesel passenger cars to the domestic market.

#### Specifications

Engine  
 Displacement, cm<sup>3</sup>/<sup>sup</sup>  
 Bore x Stroke, mm  
 Compression ratio  
 Output, hp  
 Torque, Nm  
 -  
 1GD-FTV  
 2755  
 92.0 x 103.6  
 15.6  
 177 / 3400  
 450 / 1600-2400  
 -  
 2GD-FTV  
 2393

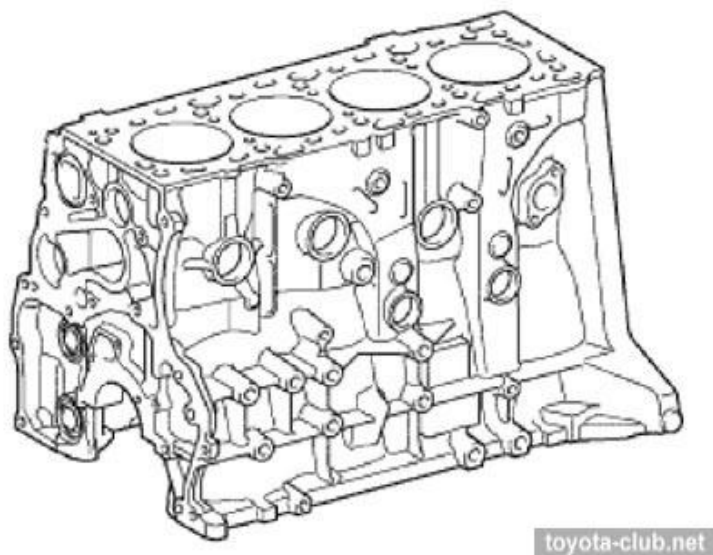
92.0 x 90.0  
15.6  
150 / 3400  
400 / 1600-2000

-  
Note. Engine weight with fluids filled - 270-300 kg.

Previous diesel series after fifteen years of production has become obsolete for a number of parameters - economy, ecology, output, noise... and was involved in the infamous story of cracking pistons. GD engines are better in all respects, however, the expected improvement in dynamic performance did not happen - nominal torque up "disappeared" somewhere in eco-systems and eco-settings. The most noticeable advantage of new diesel - reducing the vibrations and noise.

#### Engine mechanical

The series has retained a traditional cast-iron cylinder block without liners.



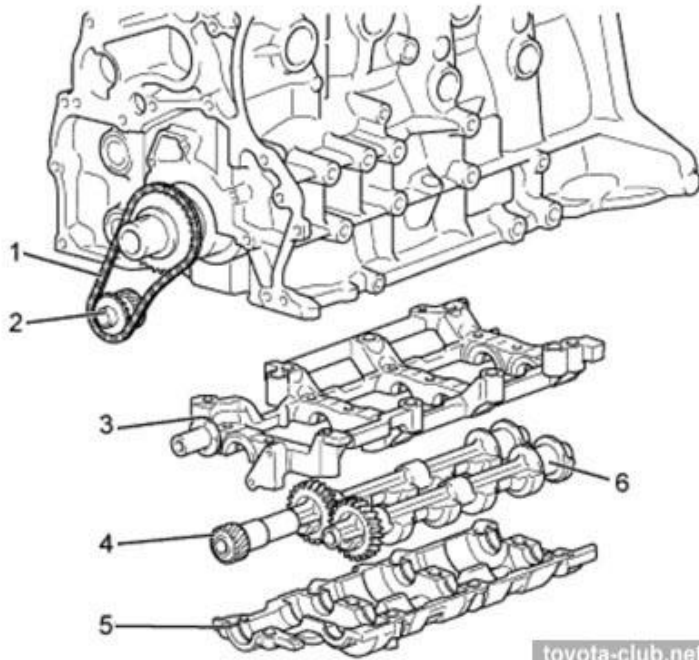
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Note. "But russian dealers advertise aluminium block with nikasil coating" - this is what you need to know about Russian dealers grade. While the official sources (toyota-tech.eu) are available to everyone:

#### d. Cylinder Block

- i. The cylinder block sub-assembly is constructed of liner-less cast iron alloy.

Top versions (for Prado) have balance shafts driven by chain from crankshaft. Unlike KD, balancers located in a separate case under block. Versions for HiLux have not balancers.

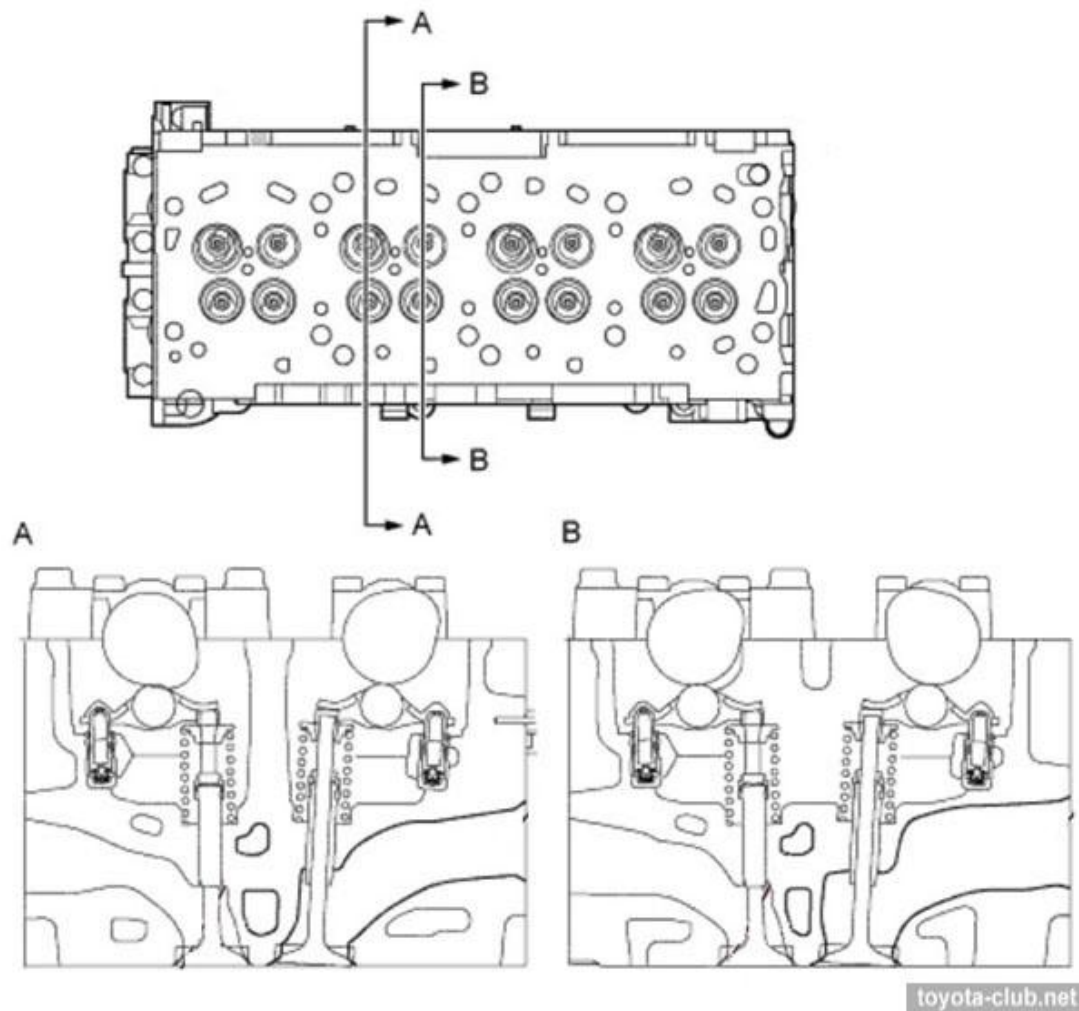


1 - chain, 2 - balancer sprocket, 3 - upper case, 4 - balance shaft 1, 5 - lower case, 6 - balance shaft 2.

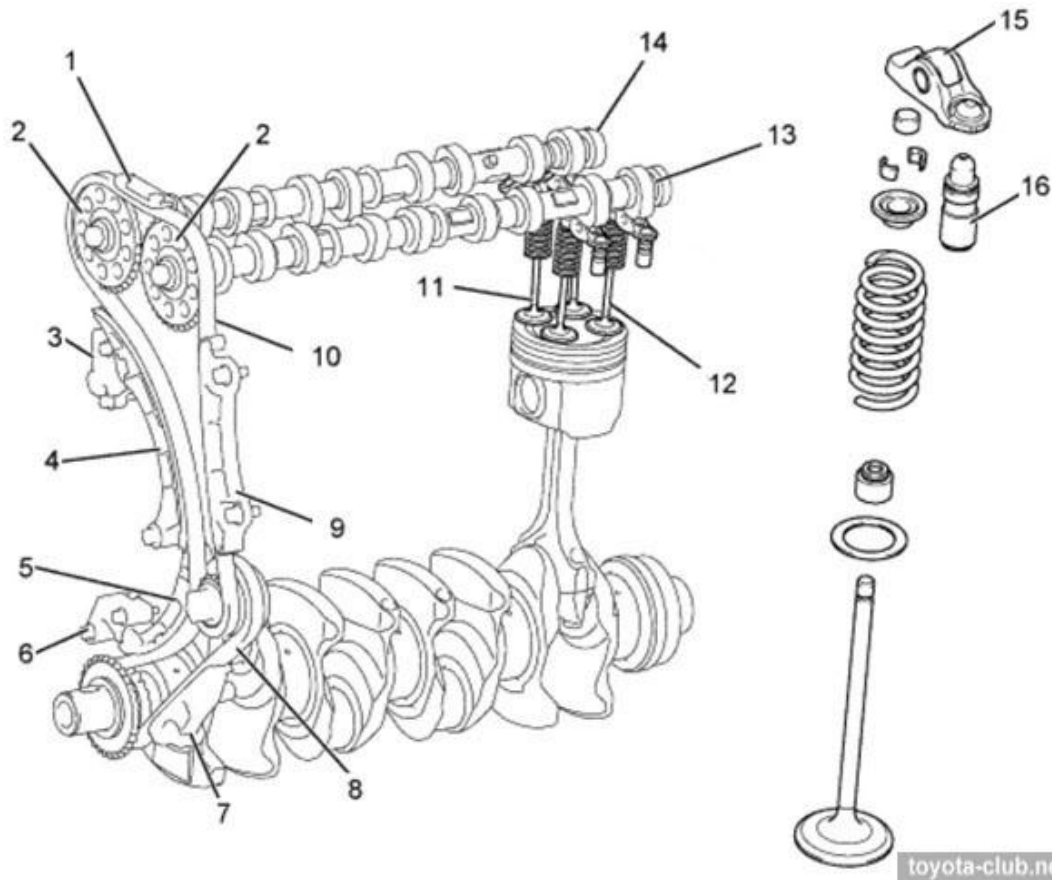
Pistons - aluminium, with full-length skirt and advanced combustion chamber. The groove for the upper compression ring has ni-resist insert, there are cooling channel inside the piston head and friction reducing polymer coating is applied on the skirt. The upper side of piston coated with insulating coating (Toyota's designation - "SIRPA", in fact - the film of a porous anodic aluminium oxide, hardened by Perhydropolysilazane). The pistons are connected to the rods with fully floating pins.



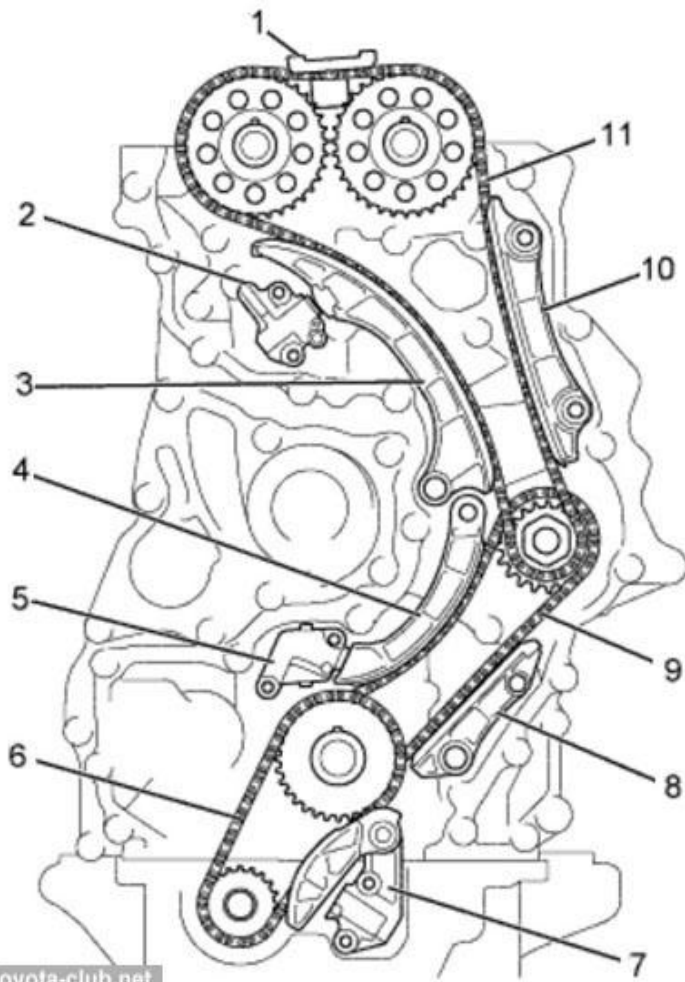
Cylinder head made of alloy. There is the tip of vertically mounted nozzle in the center of the combustion chamber and glow plug between the intake ports. The head cover is made of plastic and provided with oil delivery pipe for the rockers lubrication.



Valve mechanism - DOHC 16V: double camshafts in the head and four valves per cylinder. Drive is "two-step" - from the crankshaft by the primary roller chain (pitch 9.525 mm) to fuel pump shaft, and then by secondary chain (pitch 8.0 mm) to camshafts. Chain tensioned by spring enforced hydraulic tensioner with ratchet mechanism. Vacuum pump is driven by rear side of camshaft. There are valve adjusters and roller rockers in the valve mechanism.



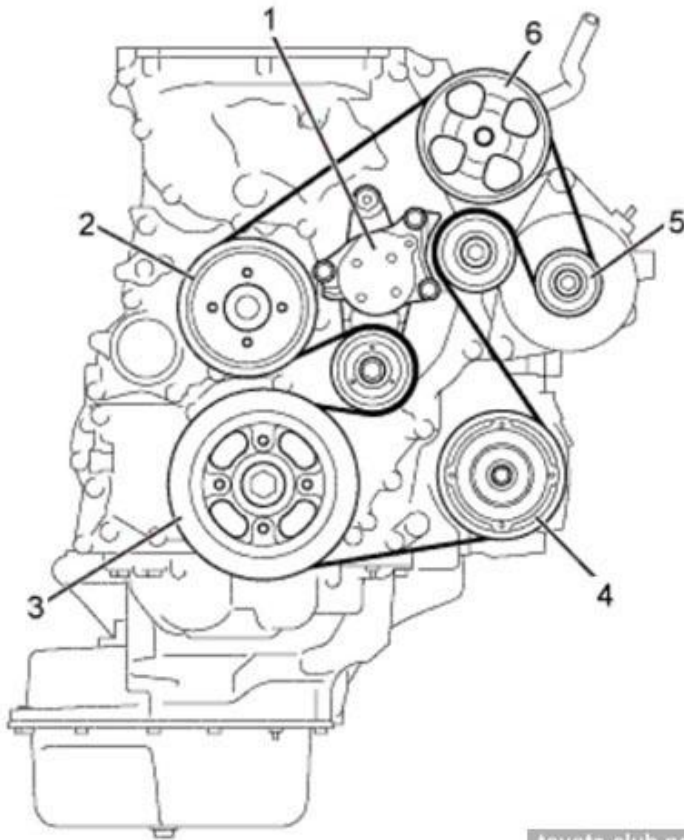
1 - chain 2 guide, 2 - camshaft sprocket, 3 - chain 2 tensioner, 4 - chain 2 tensioner slipper, 5 - chain 1 tensioner slipper, 6 - chain 1 tensioner, 7 - chain 1 damper, 8 - chain 1, 9 - chain 2 damper, 10 - chain 2, 11 - exhaust valve, 12 - intake valve, 13 - intake camshaft, 14 - exhaust camshaft, 15 - rocker, 16 - lash adjuster.



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1 - chain 2 guide, 2 - chain 2 tensioner, 3 - chain 2 tensioner slipper, 4 - chain 1 tensioner slipper, 5 - chain 1 tensioner, 6 - balancers chain, 7 - balancers chain tensioner, 8 - chain 1 damper, 9 - chain 1, 10 - chain 2 damper, 11 - chain 2.

Auxiliary driven by common belt with automatic tensioner.

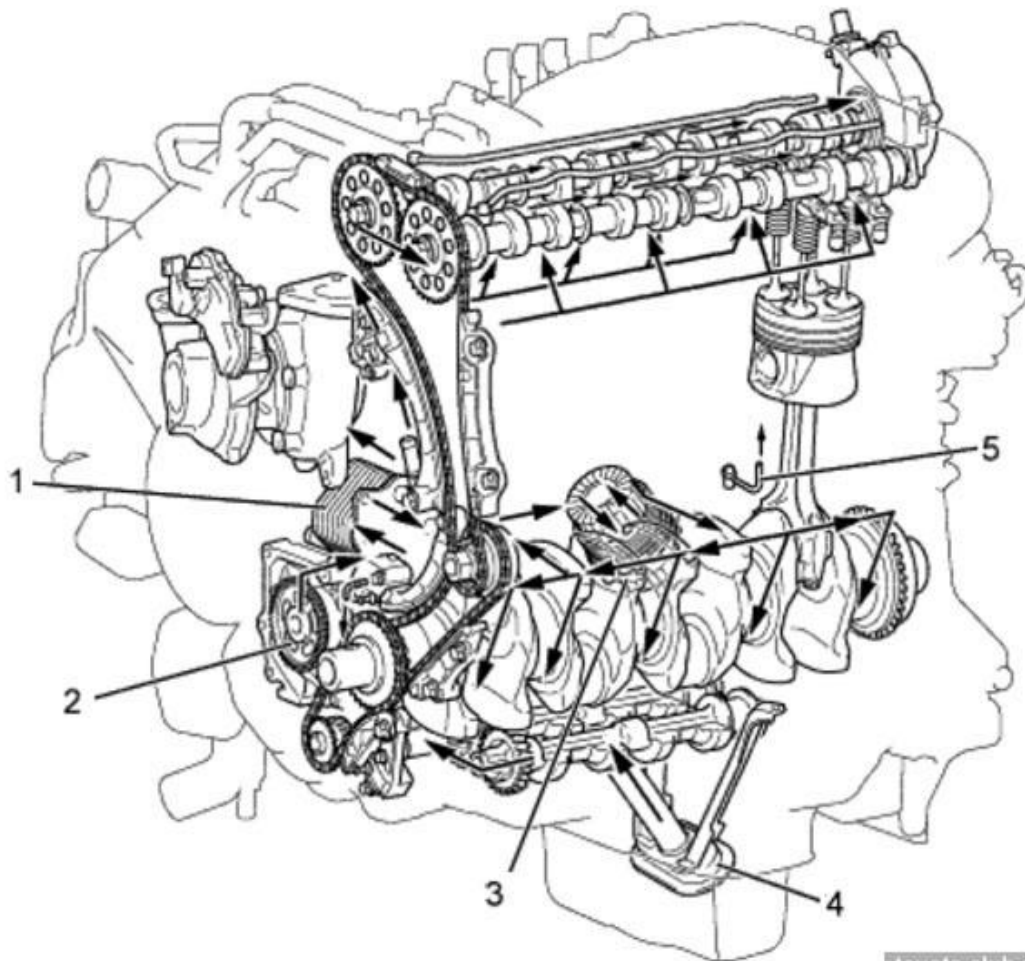


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1 - belt tensioner, 2 - water pump, 3 - crankshaft, 4 - compressor, 5 - alternator, 6 - power steering pump.

#### Lubrication system

Trochoid oil pump is gear driven from crankshaft. Oil cooler installed on front side of the block. Oil nozzles that lubricate and cool the piston are provided.

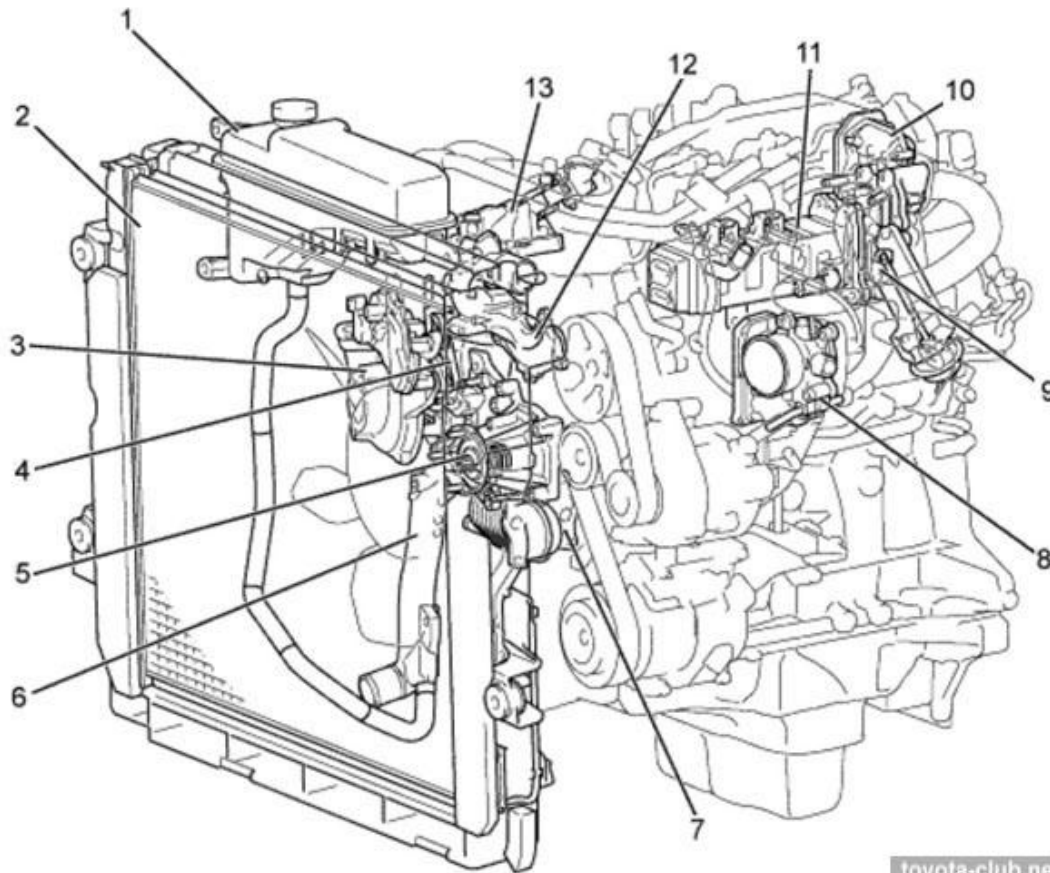


1 - oil cooler, 2 - oil pump, 3 - oil filter, 4 - oil strainer, 5 - oil nozzle.

### Cooling system

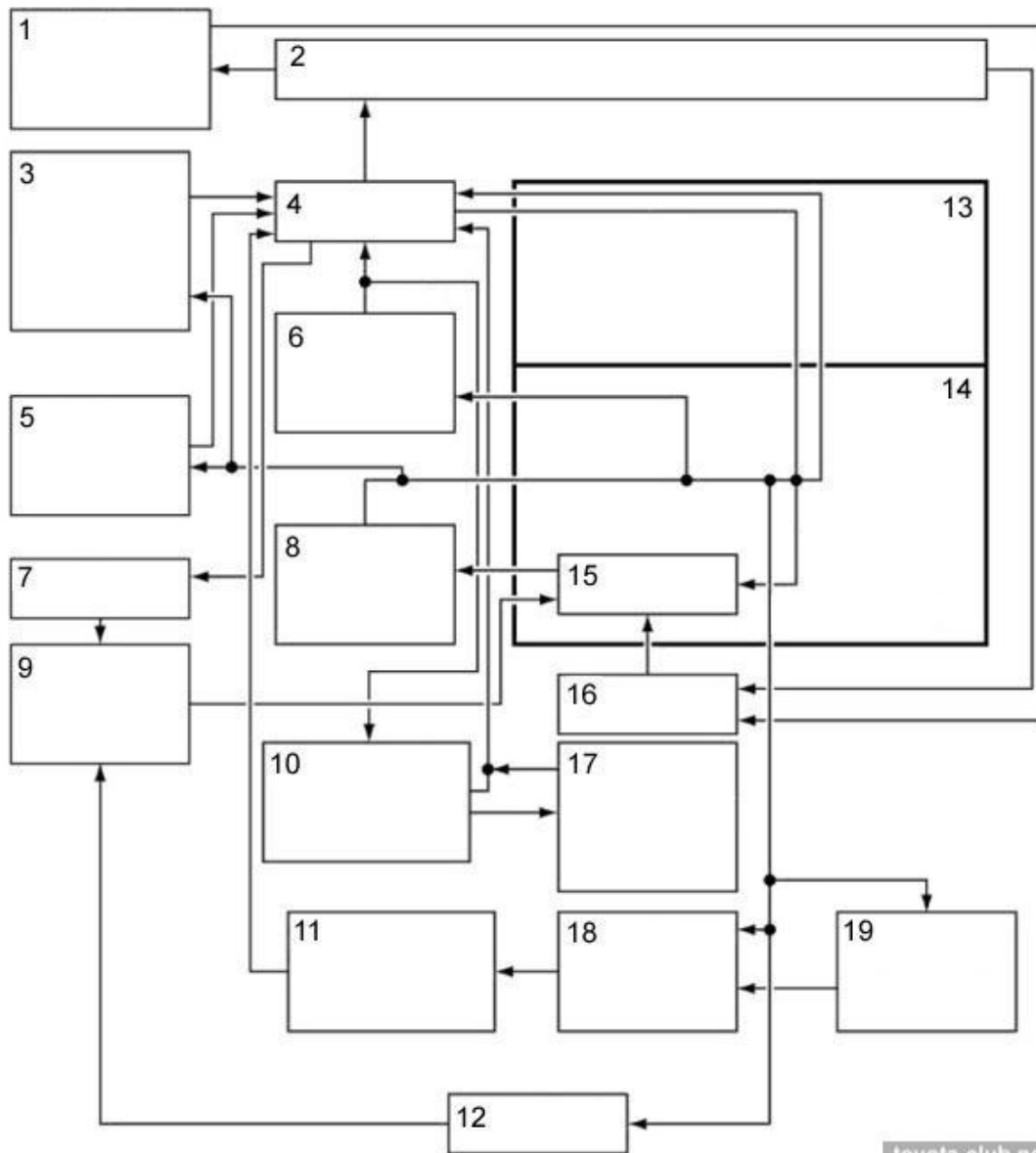
Coolant remarkable by number of components requiring cooling or heating. Pump and fan drive - by serpentine belt, thermostat - "cold" (80-84°C) mechanical.





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1 - reservoir tank, 2 - radiator, 3 - turbocharger, 4 - turbo water pipe, 5 - thermostat, 6 - water inlet, 7 - oil cooler, 8 - throttle body, 9 - EGR cooler by-pass valve, 10 - EGR control valve, 11 - EGR cooler, 12 - water outlet, 13 - injector 1 holder .

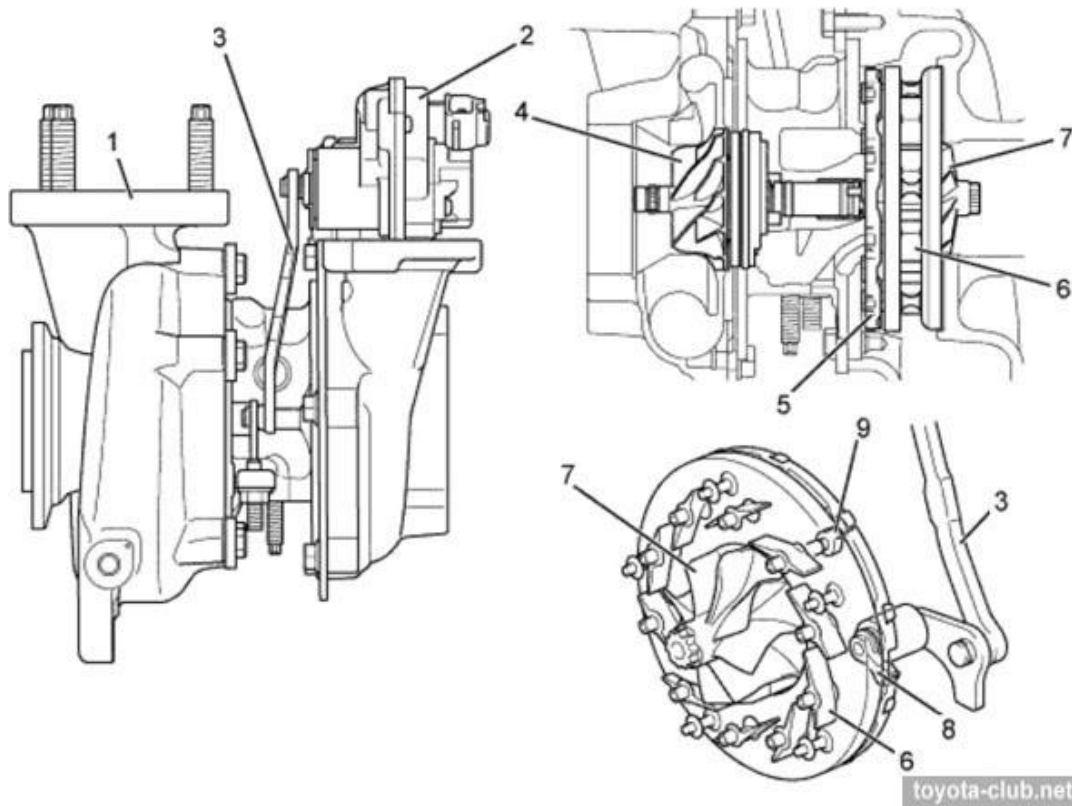


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1 - reservoir tank, 2- radiator, 3 - injector 1 holder, 4 - water outlet, 5 - turbocharger, 6 - oil cooler, 7 - aux heater, 8 - water pump, 9 - heater, 10 - turbo inlet, 11 - EGR control valve, 12 - EGR cooler, 13 - cylinder head, 14 - cylinder block, 15 - thermostat, 16 - water inlet, 17 - crankcase ventilation pipe, 18 - EGR cooler by-pass valve, 19 - throttle body.

### Intake system

- GD engine uses turbocharger with variable nozzle (VGT or VNT) of 2nd generation (electric actuator). Advantages - the maintenance of optimum boost pressure over a wide rev range, lowering back pressure at high speed, increased output at low speeds, no need for the bypass. Turbocharger has water cooling.



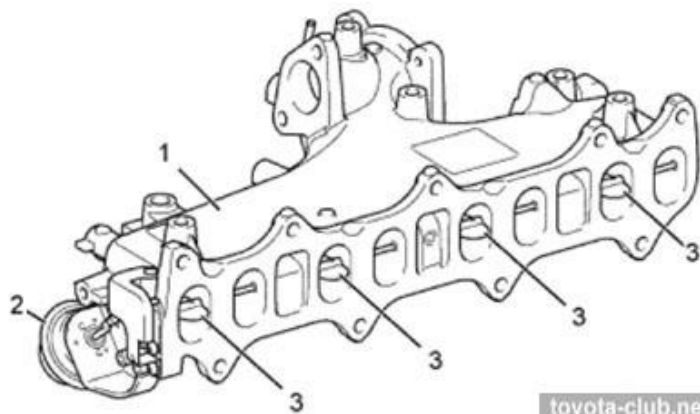
1 - turbocharger, 2 - actuator, 3 - linkage, 4 - compressor wheel, 5 - unison ring, 6 - nozzle vane, 7 - turbine wheel, 8 - drive arm, 9 - driven arm.

- At low load and low engine speed actuator moves the control ring and turns pivotally connected vanes to partially closed position. This increases the speed of gas entering the turbine, increases the boost pressure and increases engine torque.
- At high load and high speed vanes are moved to the open position, allowing maintain the desired boost pressure and reduce resistance at exhaust.



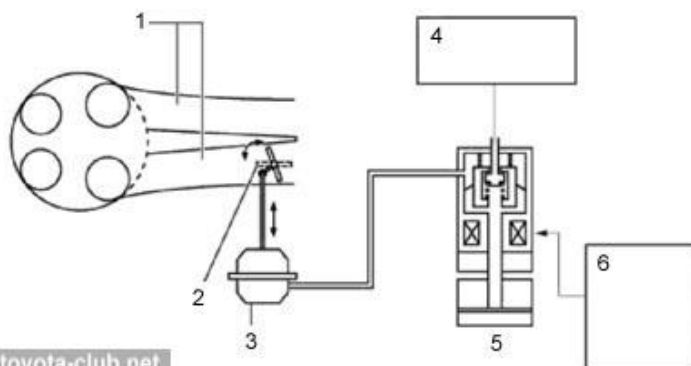
- To cool the charge air car is equipped with front-mount intercooler.
- There is the electronic controlled throttle in the intake channel. It is used to reduce the noise at idling or deceleration, and for smoother engine stop.
- The pneumatically driving flaps with are installed in the intake manifold to close one of the inlet ports, what forming intensive vortex in the

cylinder and improve the combustion process.



1 - intake manifold, 2 - actuator, 3 - flaps.

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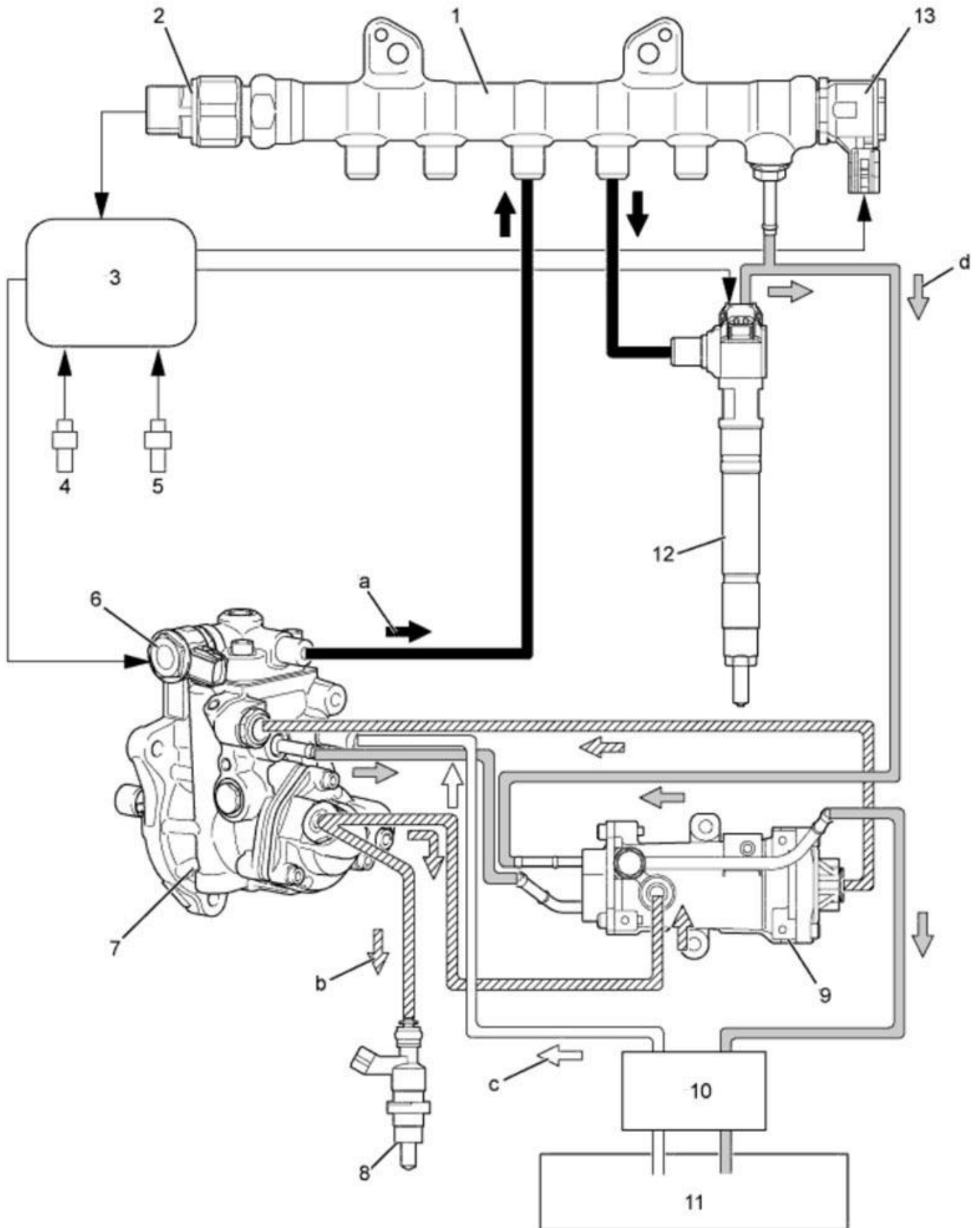


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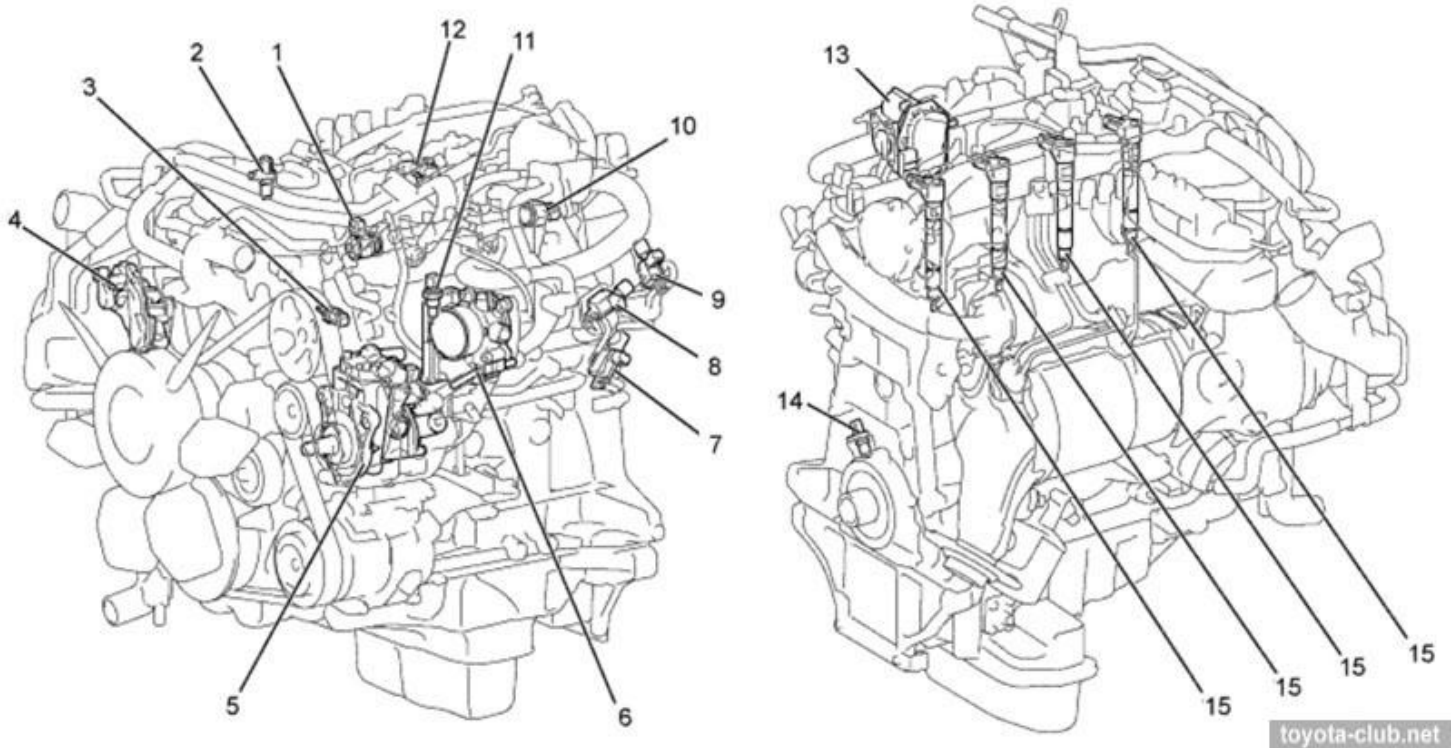
1 - intake port, 2 - flap, 3 - actuator, 4 - vacuum pump, 5 - vacuum-switch valve, 6 - engine control module.

#### Fuel system / Engine control

Common Rail type fuel system - the fuel is supplied by high pressure pump in a common rail and then is injected into the cylinders via the electronically controlled injectors. The injection pressure - 35-220 MPa (record for Toyota diesel). The components made by Denso.



Fuel system. 1 - common rail, 2 - fuel pressure sensor, 3 - ECM, 4 - crankshaft position sensor, 5 - camshaft position sensor, 6 - control valve (IMV/SCV), 7 - supply pump, 8 - exhaust fuel injector, 9 - pressurized fuel filter, 10 - fuel filter, 11 - fuel tank, 12 - injector, 13 - pressure discharge valve. a - high pressure, b - feed pressure, c - suction, d - return.



1 - pressure discharge valve, 2 - camshaft position sensor, 3 - coolant temperature sensor, 4 - turbocharger (VGT), 5 - supply pump, 6 - throttle body, 7 - vacuum switching valve (active mounts), 8 - EGR VSV, 9 - swirl control VSV, 10 - fuel pressure sensor, 11 - air temperature sensor, 12 - turbo pressure sensor, 13 - EGR control valve, 14 - crankshaft position sensor, 15 - injector.

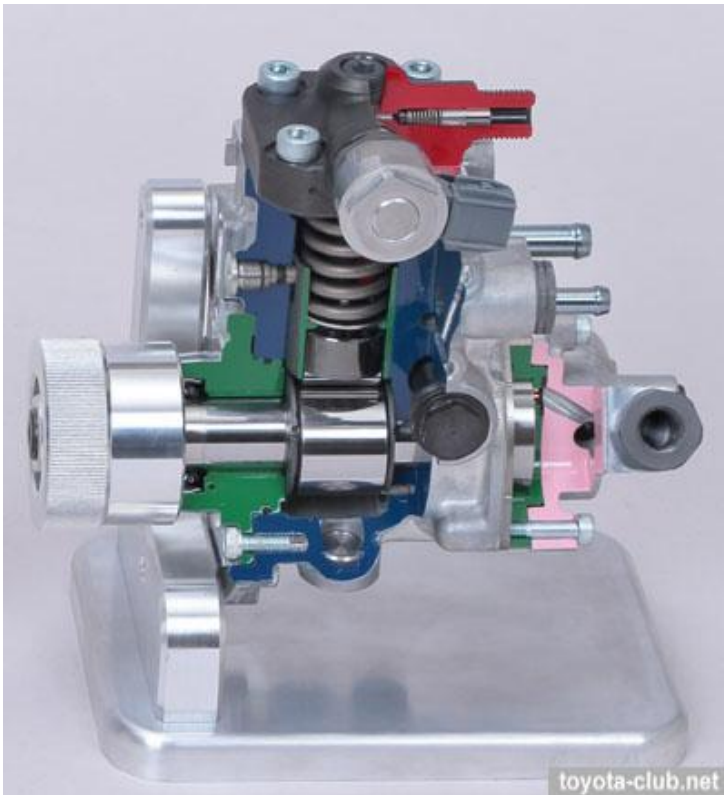
Injection can be carried out several times at the cycle: two short pilot (before TDC of the compression stroke), main (TDC of the compression stroke and the beginning of the expansion stroke), after-injection (on the expansion stroke).

Fuel pressure control carried out by supply pump control valve and by pressure discharge valve.

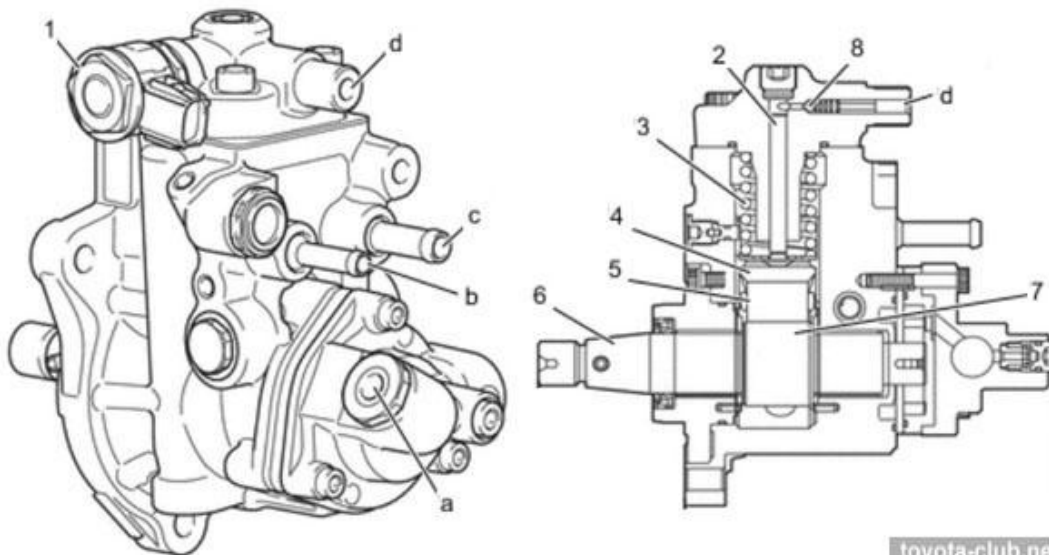
There are following sensors in the system:

- boost pressure
- fuel pressure
- crankshaft position (MRE)
- camshaft position (MRE)
- air flow sensor (MAF) / air temperature sensor
- throttle position (Hall effect)
- accelerator position (Hall effect)
- DPF differential pressure
- exhaust gas temperature - thermistor type, located before DOC, before DPF, after DPF, after SCR catalyst
- air-fuel ratio, after DPF
- NOx, in central exhaust pipe

Fuel system / Supply pump

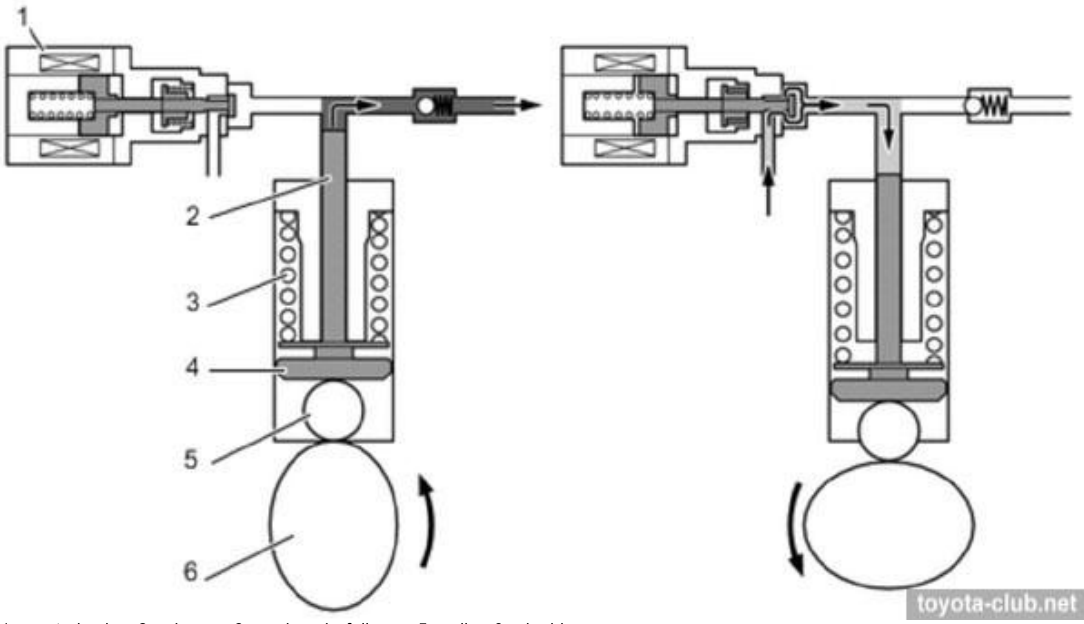


High pressure supply pump - HP5S type, consists of cam shaft, plunger, check valve, feed pump and control valve. The simpler versions without DPF have not additional low-pressure section.



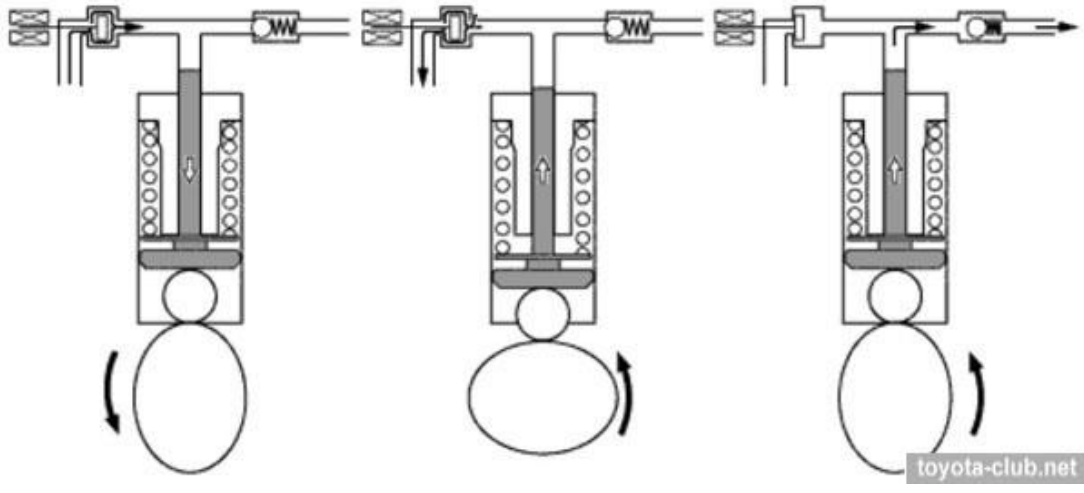
1 - control valve, 2 - plunger, 3 - spring, 4 - follower, 5 - roller, 6 - camshaft, 7 - double cam, 8 - check ball. a - to exhaust fuel addition injector and pressurized fuel filter, b - fuel return port (to pressurized fuel filter), c - fuel inlet port (from fuel tank), d - to common-rail assembly.

Rotating cam via follower moves the plunger upwards. If the control valve is closed, the pressure increases and the fuel from the pump flows into the rail. ECM controls the timing of control valve closing and thus provides a target level of pressure in the fuel rail. If the plunger is not pushed by cam, it is returned downward by the spring force.

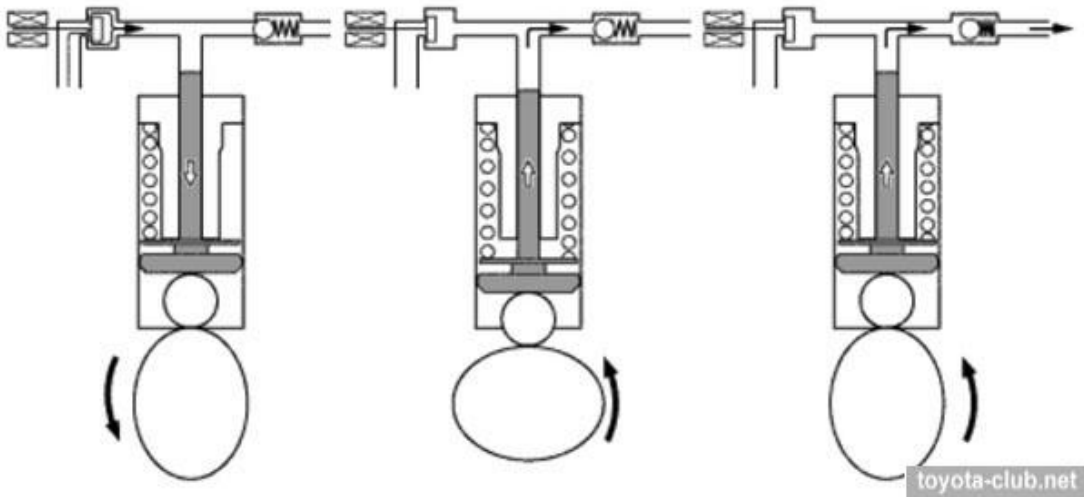


1 - control valve, 2 - plunger, 3 - spring, 4 - follower, 5 - roller, 6 - double cam.

Late closing of the control valve increases fuel discharge to inlet and reduces supply volume.



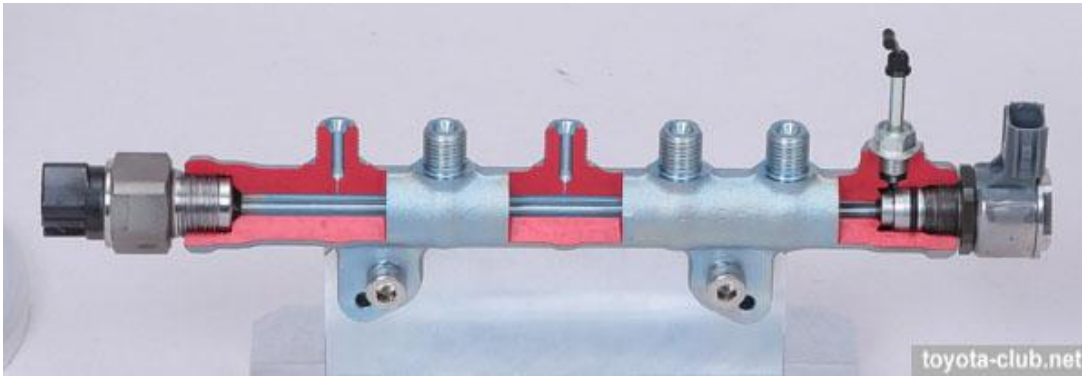
Early closing of the control valve increases supply volume.



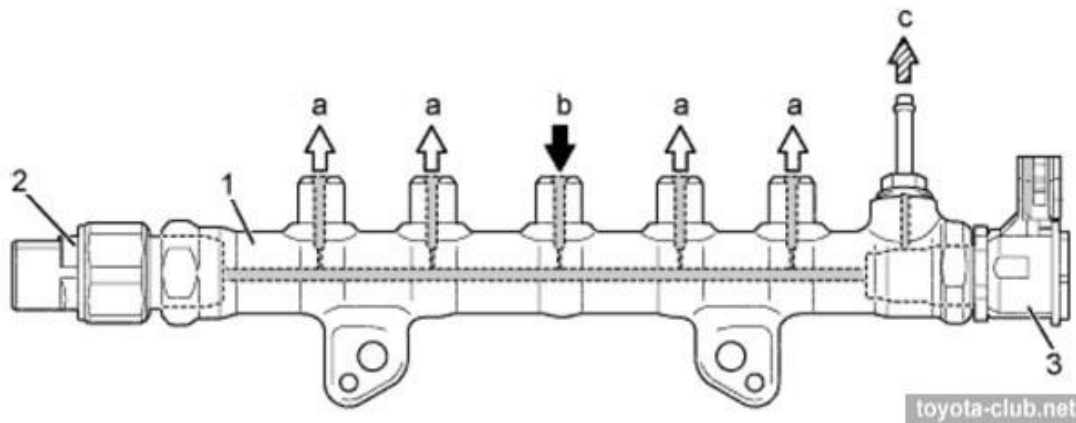
The pressurized fuel filter can be installed to provide additional protection of pump, rail and injectors.



## Fuel system / Rail



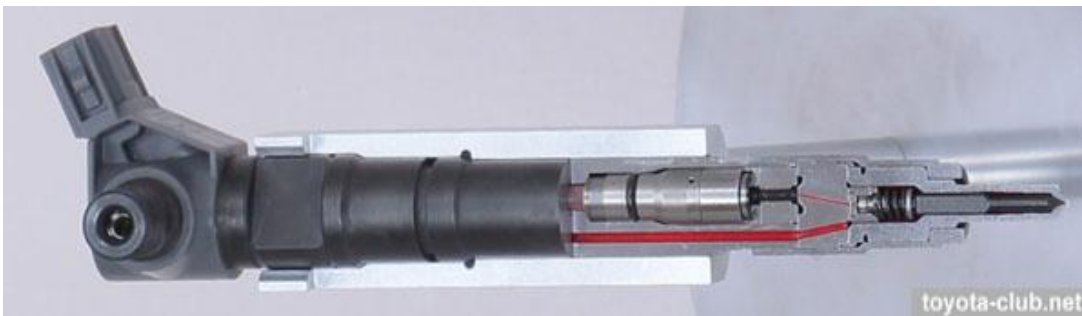
There are fuel pressure sensor and pressure discharge valve in the fuel rail. Electronically controlled valve opens and closes by a signal from the control unit, moreover, it can function of emergency pressure relief.



1 - common-rail, 2 - fuel pressure sensor, 3 - pressure discharge valve. a - to injector, b - from supply pump, c - to fuel tank.

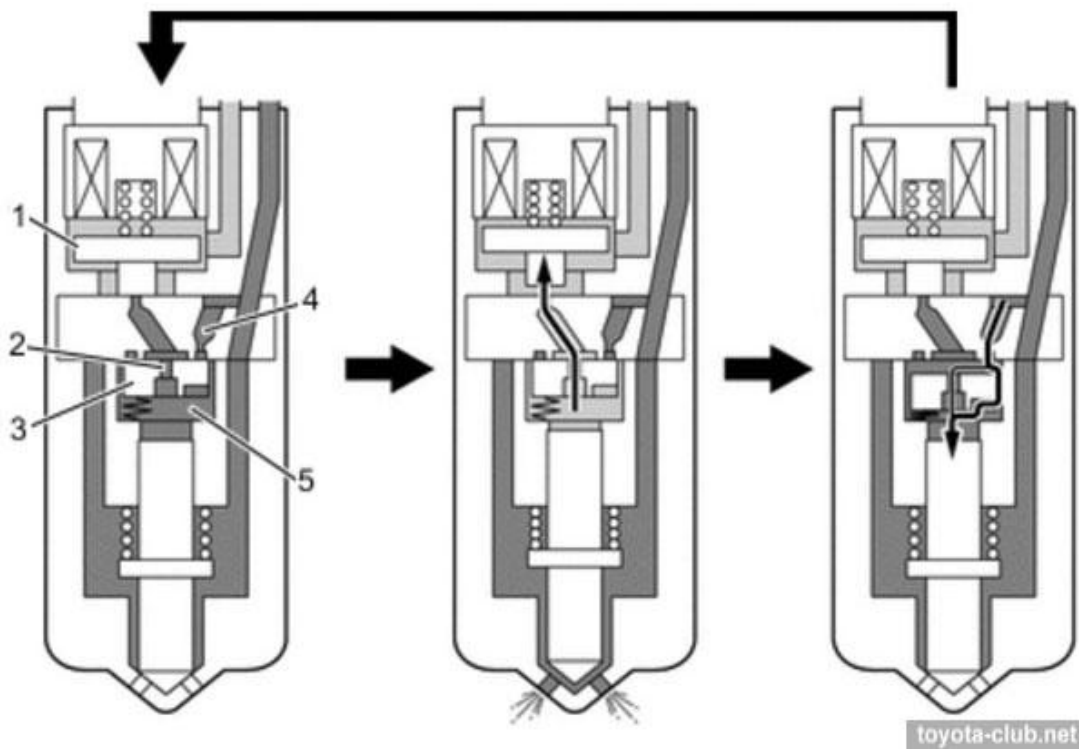
## Fuel system / Injectors

• In accordance with the latest trends, GD series obtain solenoid injectors (not piezo). Specific injector data (model code, the individual feed correction) printed as QR code and be sure to be programmed in the control unit.



Injector operation has some difference from the previous Toyota's common rail diesels:

- When closed, the valve is held by a spring. The pressure in the control chamber is high. The fuel pressure acting on the bottom of the needle is not enough to open it.
- When the current supply to the coil, the valve opens the channel through which the fuel discharged from the control chamber. Due to pressure difference arises, the injector needle opens and fuel is injected.
- After current cut-off valve is closed. The control plate moves downward and fuel under high pressure fills control chamber and acts on top of the needle. The needle is closed and fuel injection stops. After pressure equalization in control chamber, the control plate is moved up by a spring.



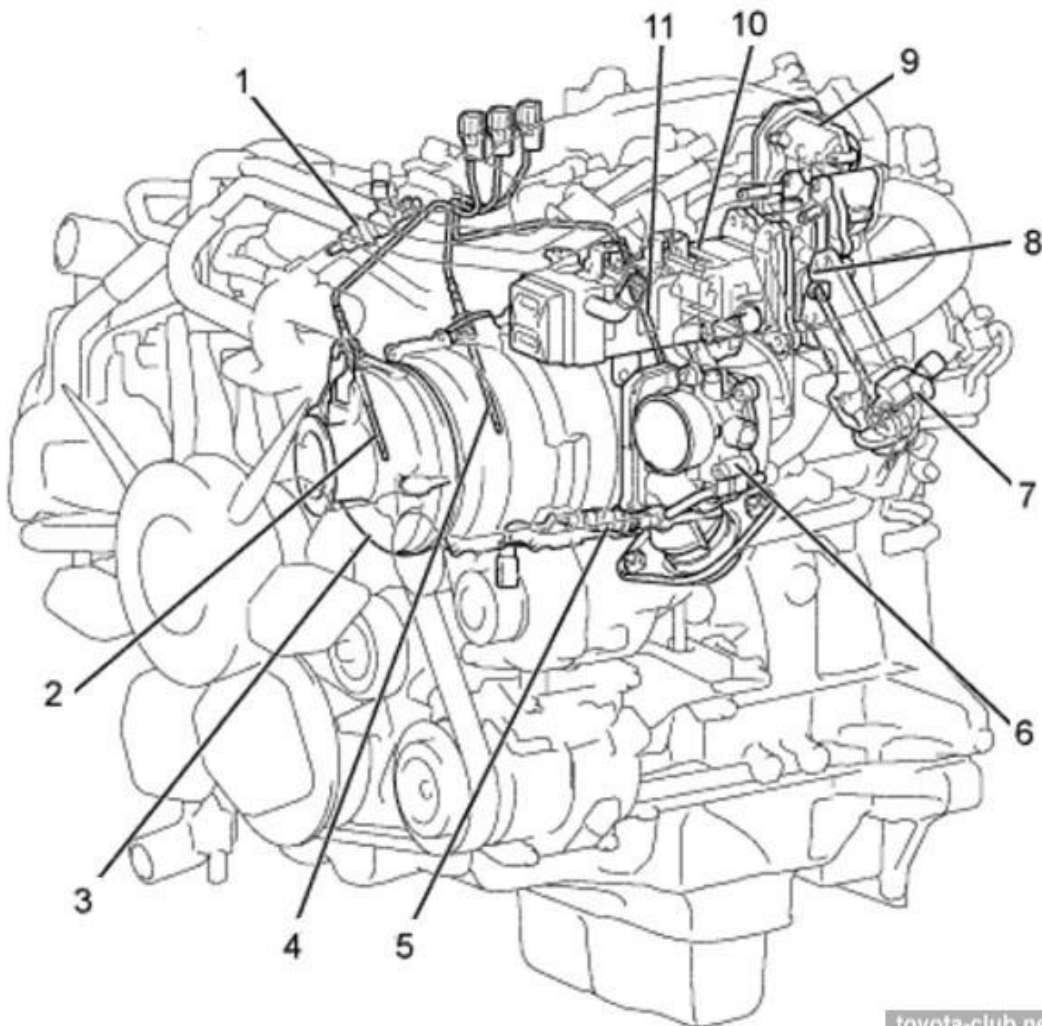
1 - control valve, 2 - out-orifice, 3 - control plate, 4 - in-orifice, 5 - control chamber.

- The exhaust manifold has built-in low-pressure fuel injector supplied directly from the pump to raise the temperature of DPF for accumulated soot combustion.

#### Emission control system

Depending on the market, there are several levels:

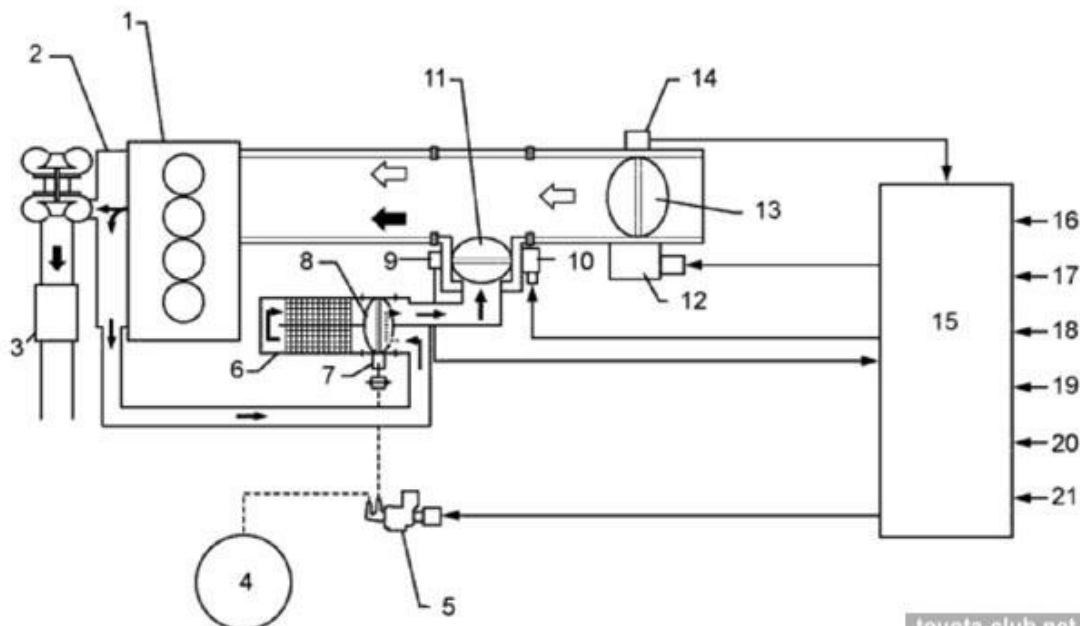
- EGR - Euro 2, for the third world
- EGR+DOC - Euro 4, for the third world
- EGR+DOC+DPF - Euro 5, for Australia and Russia
- EGR+DOC+DPF+SCR - Euro 6, for Europe and Japan



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1 - exhaust fuel addition injector, 2 - exhaust gas temperature sensor 3, 3 - exhaust manifold converter (DOC - oxidation catalyst + DPF), 4 - exhaust gas temperature sensor 2, 5 - air fuel ratio sensor, 6 - throttle body, 7 - vacuum switching valve, 8 - EGR cooler bypass valve, 10 - EGR cooler, 11 - exhaust gas temperature sensor 1.

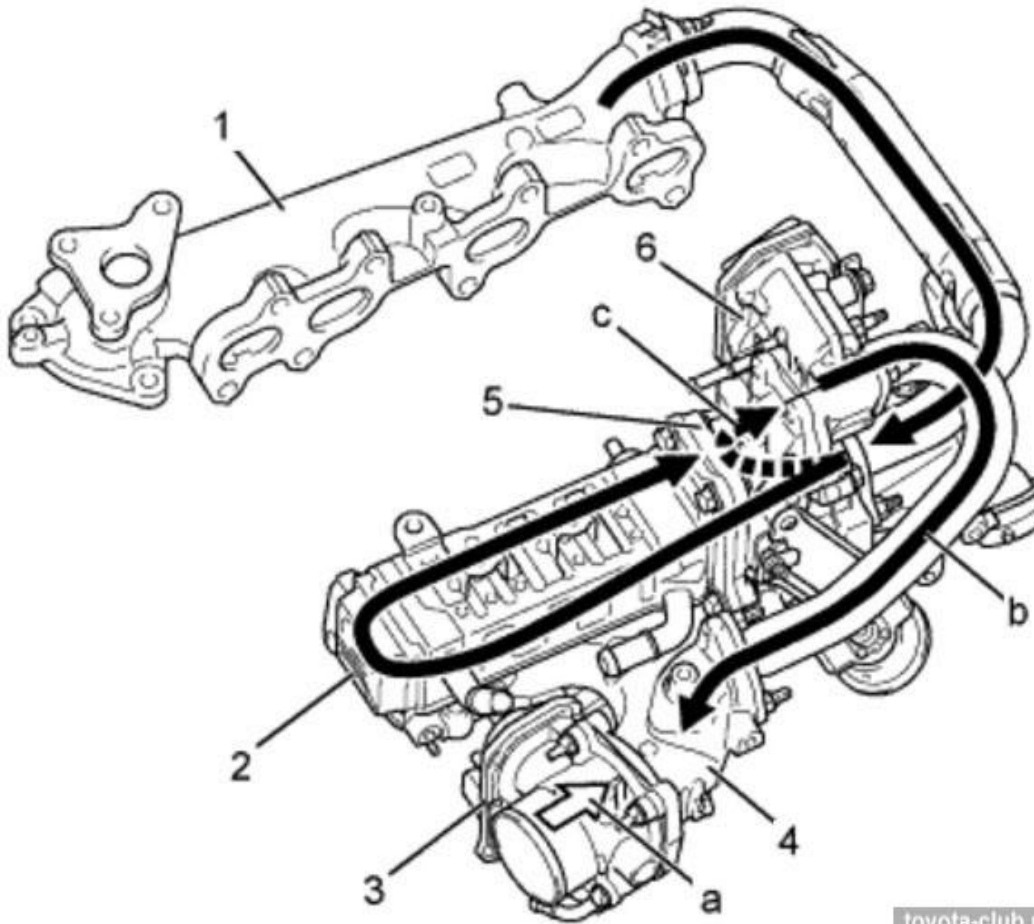
• EGR (exhaust gas recirculation) - bypass a part of exhaust gases to the intake to reduce the maximum temperature in the cylinder and reduce the nitrogen oxides emissions. EGR valve - electronically controlled, with DC motor and non-contact position sensor (Hall effect).



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1 - cylinder block, 2 - exhaust manifold, 3 - DOC, 4 - vacuum pump, 5 - vacuum switching valve, 6 - EGR cooler, 7 - EGR cooler bypass valve actuator, 8 - EGR cooler bypass valve, 9 - EGR valve position sensor, 10 - EGR valve motor, 11 - EGR control valve, 12 - throttle motor, 13 - throttle valve, 14 - throttle position sensor, 15 - ECM, 16 - crankshaft position sensor, 17 - accelerator pedal sensor, 18 - coolant temperature sensor, 19 - turbo pressure sensor, 20 - air temperature sensor, 21 - air flow meter.

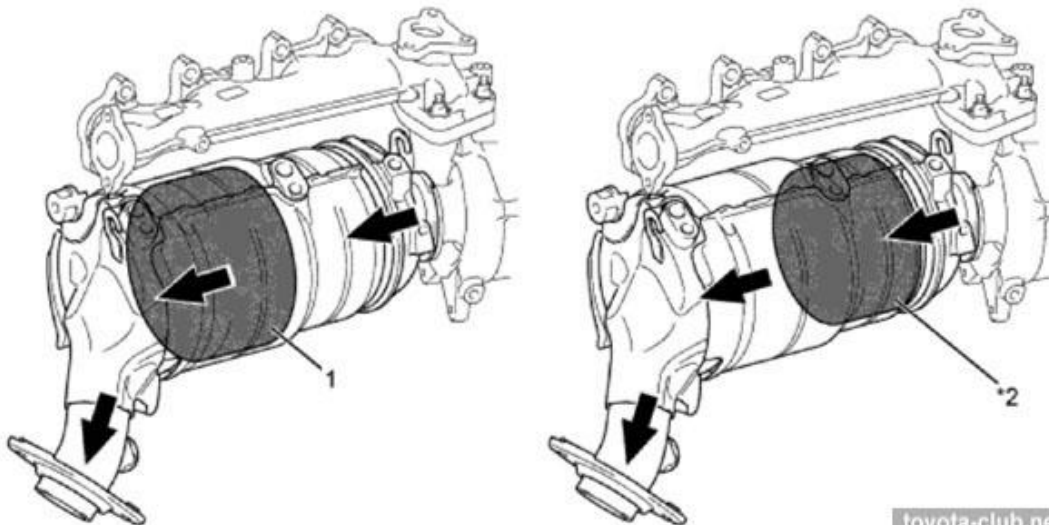
To avoid excessive cooling of exhaust gases at low load, EGR cooler valve send gas flow bypass the radiator.



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1 - exhaust manifold, 2 - EGR cooler, 3 - throttle body, 4 - intake manifold, 5 - EGR cooler bypass valve, 6 - EGR control valve. a - intake air, b - EGR gas, c - EGR gas (through bypass).

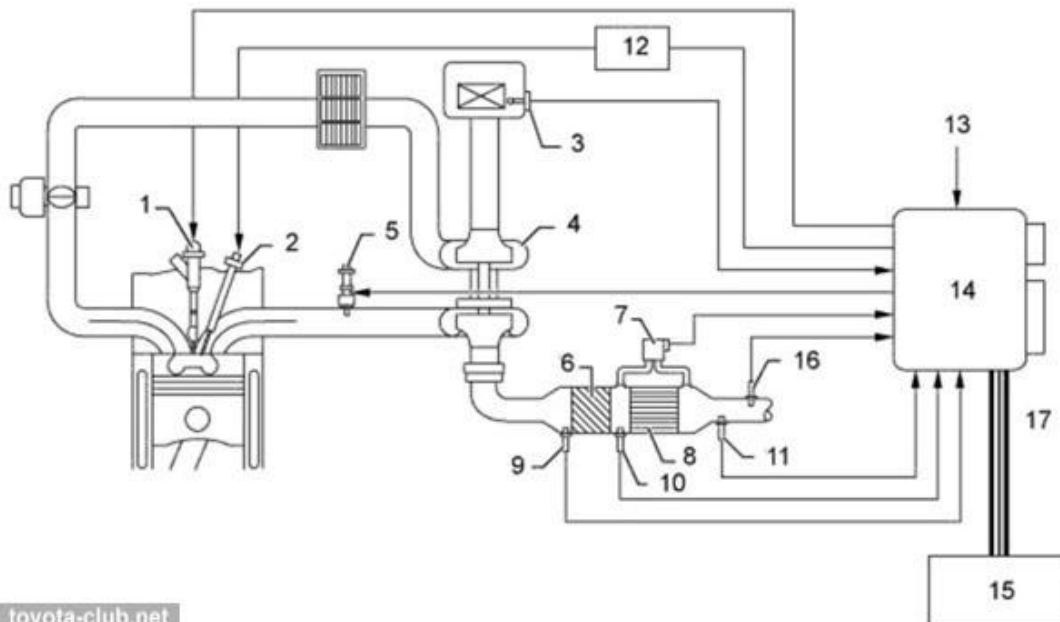
- DOC (oxidation catalyst) - primary stage of exhaust gas cleaning - oxidizes hydrocarbons (HC) and carbon monoxide (CO) to water (H<sub>2</sub>O) and carbon dioxide (CO<sub>2</sub>).



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1 - DPF catalyst, 2 - oxidation catalyst

- DPF (diesel particulate filter) - used to accumulation and combustion of soot particles.



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1 - injector, 2 - glow plug, 3 - air flow meter, 4 - turbocharger, 5 - exhaust fuel addition injector, 6 - oxidation catalyst (DOC), 7 - differential pressure sensor, 8 - diesel particulate filter (DPF), 9 - exhaust gas temperature sensor 1, 10 - exhaust gas temperature sensor 2, 11 - exhaust gas temperature sensor 3, 12 - glow plug controller, 13 - coolant temperature sensor, 14 - ECM, 15 - combination meter, 16 - air fuel ratio sensor, 17 - CAN bus (V) .

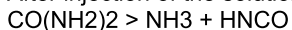
DPF passive regeneration can be performed by itself under the condition of exhaust gases high temperature. However, over time the amount of soot in the filter is increased and its capacity is reduced which requires active regeneration. The control unit determines clogging of the filter by analysis of driving conditions, and activates injectors, the exhaust injector, glow plugs and controls the engine speed. The DPF material temperature increases and soot particles burn out.

But if driving conditions do not allow to perform active regeneration automatically for a long time, soot accumulation may exceed the specified limits, so then the ECU illuminates DPF warning lamp, offering the driver to move at a constant speed above 60 km/h to perform active regeneration. When the maximum level of soot accumulation exceeded the warning lamp flashes, offering the driver to go to the workshop to perform regeneration in the manual mode. Finally, in order to avoid damage to the DPF, ECU activates fail-safe mode with limited engine power output.

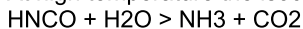
HiLux has optional switch of manual mode regeneration.

- SCR (selective catalytic reduction) - used to reduce of NOx contents in the exhaust gas for Euro 6 emission standards by the injection of urea solution.

After injection of the solution the water vaporizes, then urea dissociates into isocyanic acid and ammonia by hydrolysis.

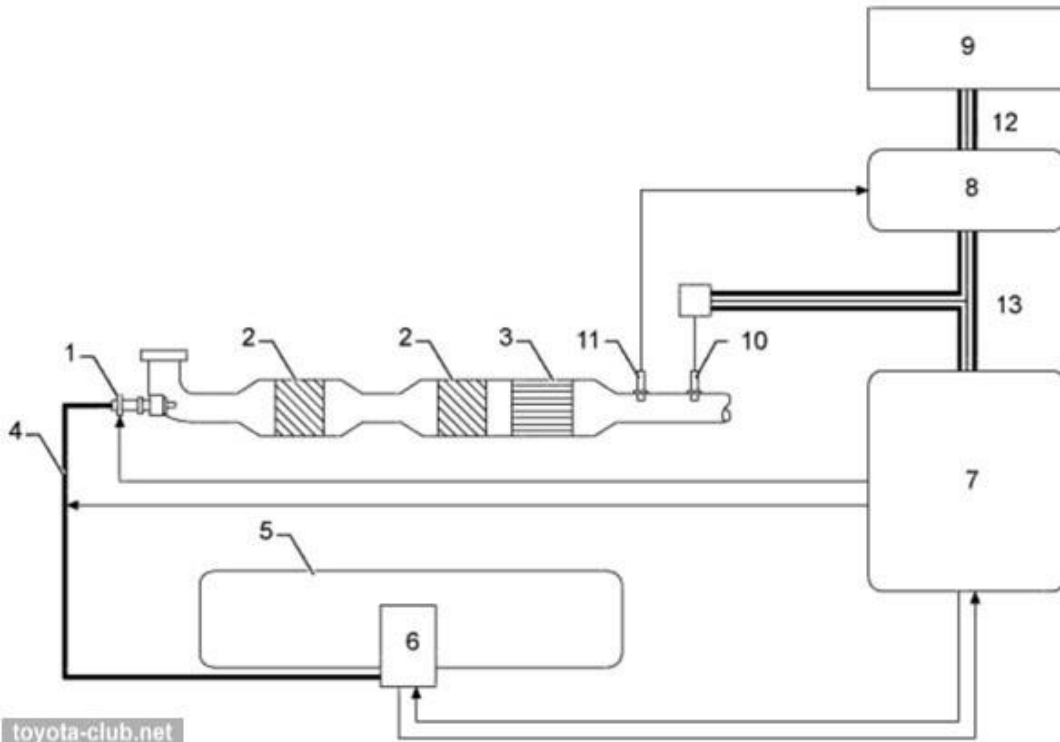


At high temperature the isocyanic acid in its turn dissociates to carbon dioxide and ammonia by hydrolysis.



Ammonia accumulates in the catalyst and reacts with nitrogen oxides of exhaust gases, resulting in a pure nitrogen and water.





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1 - urea injector, 2 - SCR catalyst, 3 - ASC catalyst, 4 - urea tube with heater, 5 - urea tank, 6 - urea pump, 7 - urea pump control unit, 8 - ECM, 9 - combination meter, 10 - NOx sensor, 11 - exhaust gas temperature sensor, 12 - CAN bus (V), 13 - CAN bus (L).

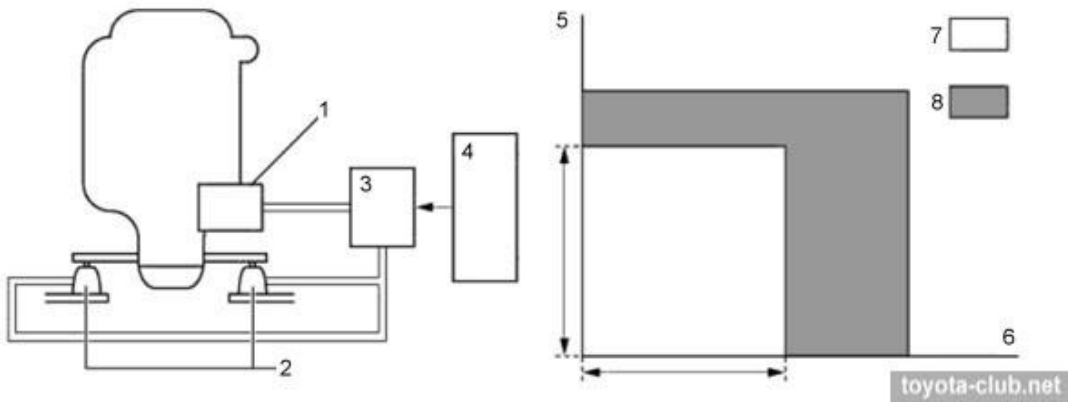
The urea pump functions are proper supply of urea into the exhaust system (pressure of about 0.5 MPa), urea heating (temperature of solution freezing is about  $-11^{\circ}\text{C}$ ), filtration and reagent level monitoring



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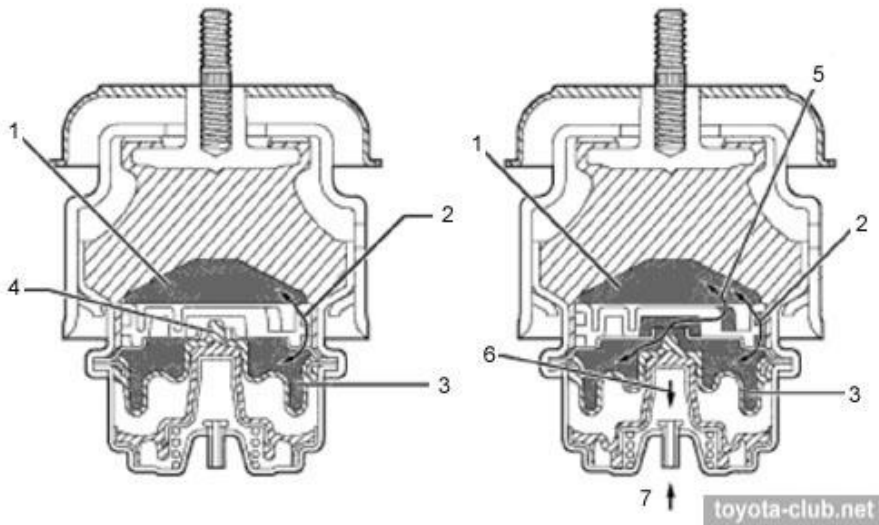
Engine mounts

Engines for Prado equipped with active mounts to adjust damping force.



1 - vacuum pump, 2 - active mounts, 3 - VSV, 4 - ECM, 5 - vehicle speed, 6 - engine speed, 7 - valve ON, 8 - valve OFF.

- With the engine running at idle and vehicle low-speed, vacuum from the pump supplied by VSV to the diaphragm, which moves and opens additional channels for the fluid inside the mount. This allows more efficient damping of engine vibrations.
- Except idling, ECM switches VSV removing the vacuum from diaphragm. So the fluid circulates only through one channel with a relatively large resistance.



1 - chamber 1, 2 - channel 1, chamber 2, 4 - diaphragm, 5 - channel 2, 6 - diaphragm (pulled), 7 - vacuum.