Service Bulletin

FUEL INJECTION PUMP
New Product

TOYOTA i-ART Common Rail System (CRS)

1. Outline

- This manual describes the i-ART* CRS newly equipped in TOYOTA International Multipurpose Vehicles (HILUX) released for Brazil in April 2012.
  * : intelligent Accuracy Refinement Technology
- New items and items that have changed in relation to the conventional HILUX (KD engine) are listed below.
  - Newly designed G3Pi piezo injectors with built-in i-ART pressure sensor (and fuel temperature measurement function)
  - System pressure: Maximum pressure increased from 180 MPa to 200 MPa
  - Redundant dual-layer efficient moisture separation filters

<Items that Have Changed as a Result of the Additions Above>
- Discontinuation of the supply pump fuel temperature sensor
- Discontinuation of the rail pressure sensor

2. Applicable Vehicles

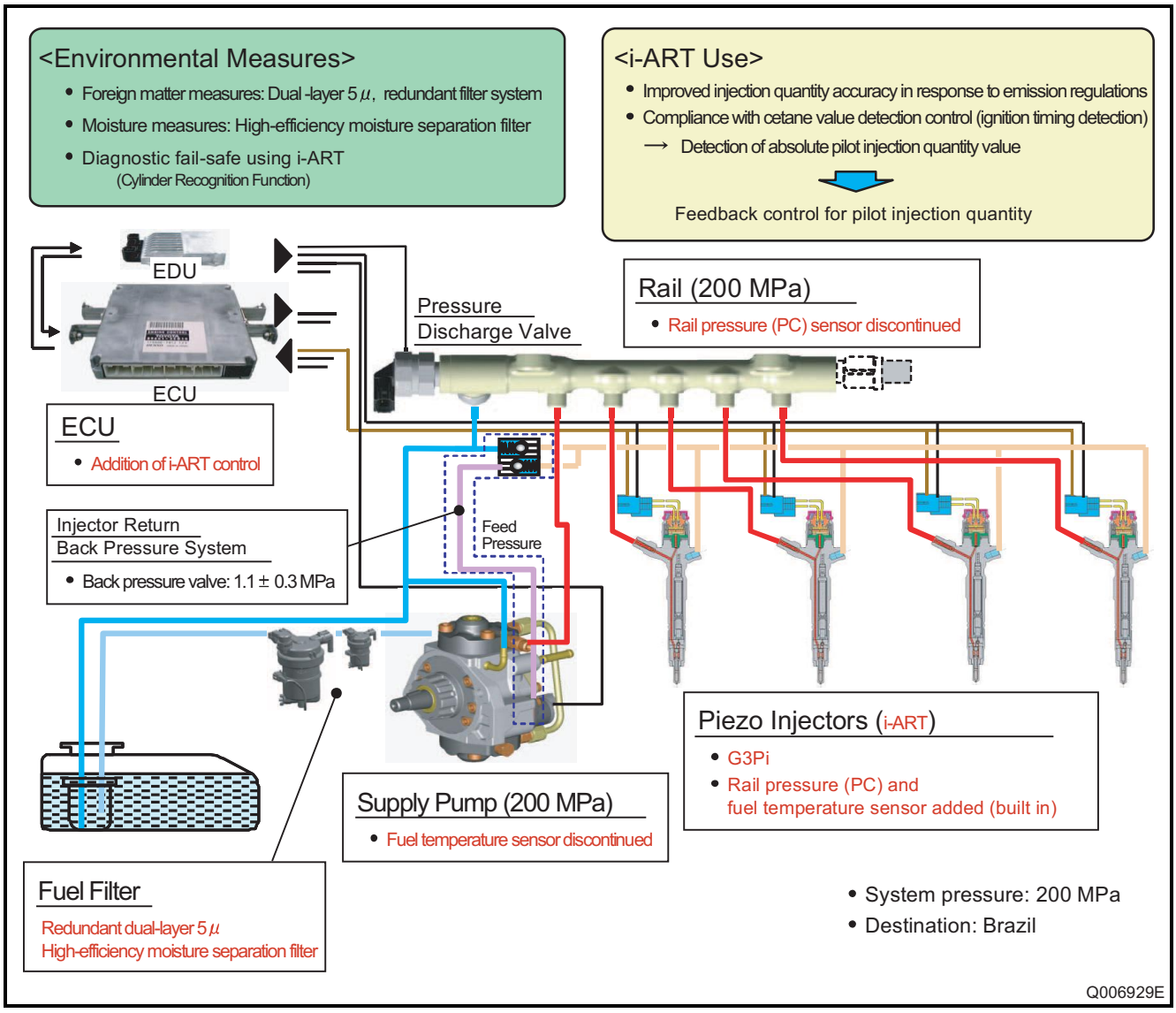
Destination	Vehicle Model	Engine Type	Exhaust Volume	Sale Start Date
Brazil	HILUX	1KD-FTV	3.0 L	April 2012

3. DENSO Product List

Product Name	DENSO Part Number	Customer Part Number	Remarks
Supply Pump	SM294000-171#	221000-0L0100	HP3
Rail	SM096000-514#	23810-0L040	
Injector	295900-027#	23670-30270	G3Pi built-in i-ART sensor
Engine ECU	MA275900-532#	896660K430	MT vehicles, two-door pickup
	MA275900-533#	896660K440	MT vehicles, four-door pickup
	MA275900-534#	896660K450	AT vehicles, four-door pickup
	MA275900-535#	896660K450	AT vehicles, SUV
EDU	101310-604#	89870-71090	
Glow Plug	142000-191#	19850-30030	
Glow Plug Controller	101327-004#	28550-30030	
Exhaust Gas Recirculation (EGR) Valve	(VN) 1510100-023#	25800-30210	

4. CRS Configuration

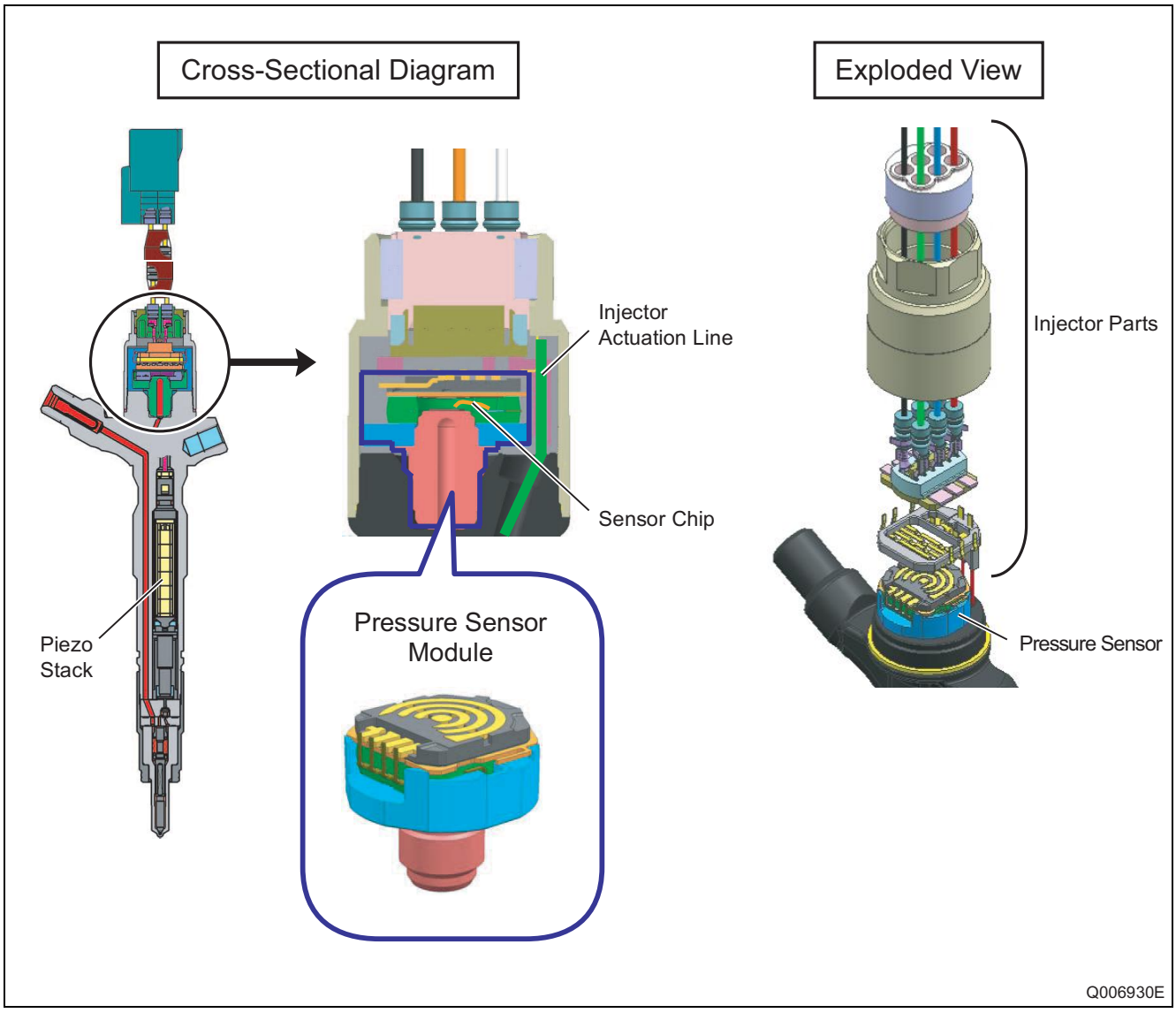
- The i-ART CRS is configured as shown in the figure below.



5. i-ART System

- The i-ART system has pressure sensors built into the piezo injector assemblies. i-ART detects pressure fluctuations and the fuel temperature for each cylinder while providing feedback to the ECU to control the injection rate to the optimal value.

(1) i-ART Piezo Injector Construction



(2) Operation

Non-Injection

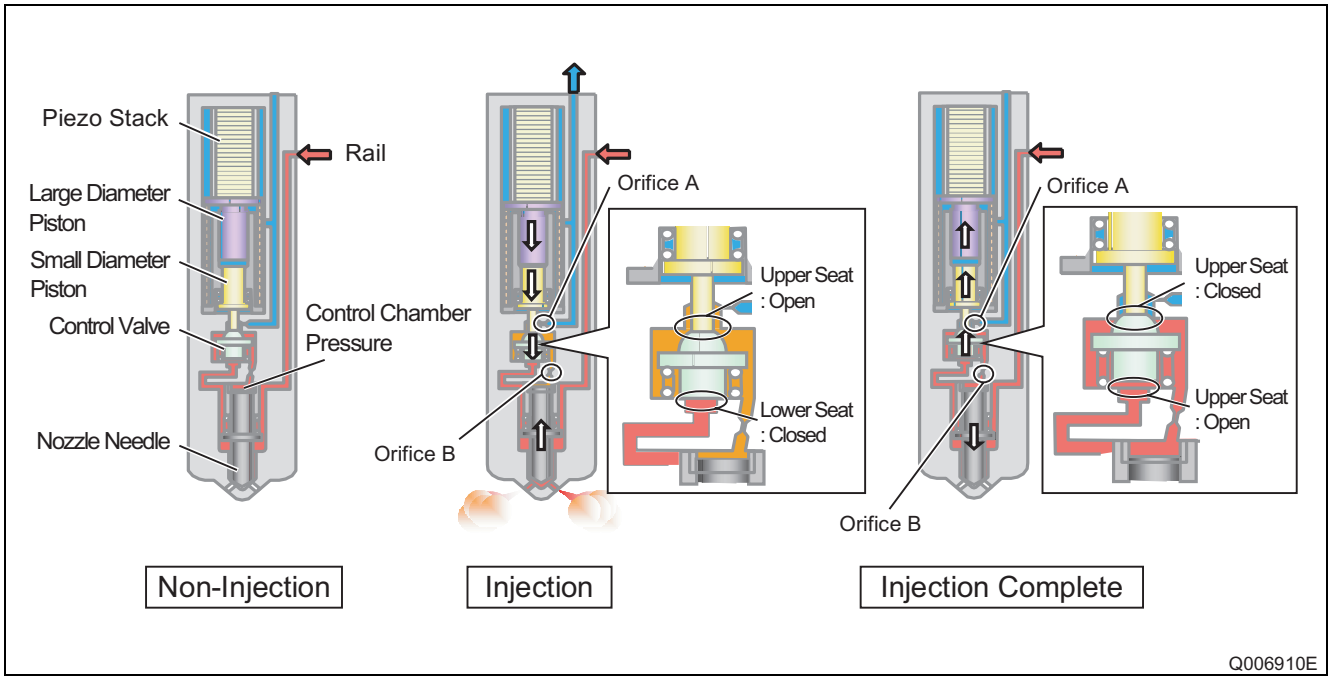
• When voltage is not applied to the piezo stack, the pressure in the control chamber and at the bottom of the nozzle needle is at the same value as fuel in the rail. The nozzle needle remains closed due to the difference in surface area exposed to pressure between the control chamber and bottom of the nozzle needle. Therefore, injection is not performed.

Injection

• When voltage is applied to the piezo stack, the stack expands. The transmission of actuation power from the large diameter piston to the small diameter piston expands the displacement of the piezo stack and pushes the control valve down, thereby opening the upper seat and closing the lower seat. As a result, fuel is discharged from the control chamber to the leak path via orifice A, and control chamber pressure decreases. Since pressure on the bottom of the nozzle needle becomes greater than that of the control chamber, the nozzle needle is pushed up and injection begins.

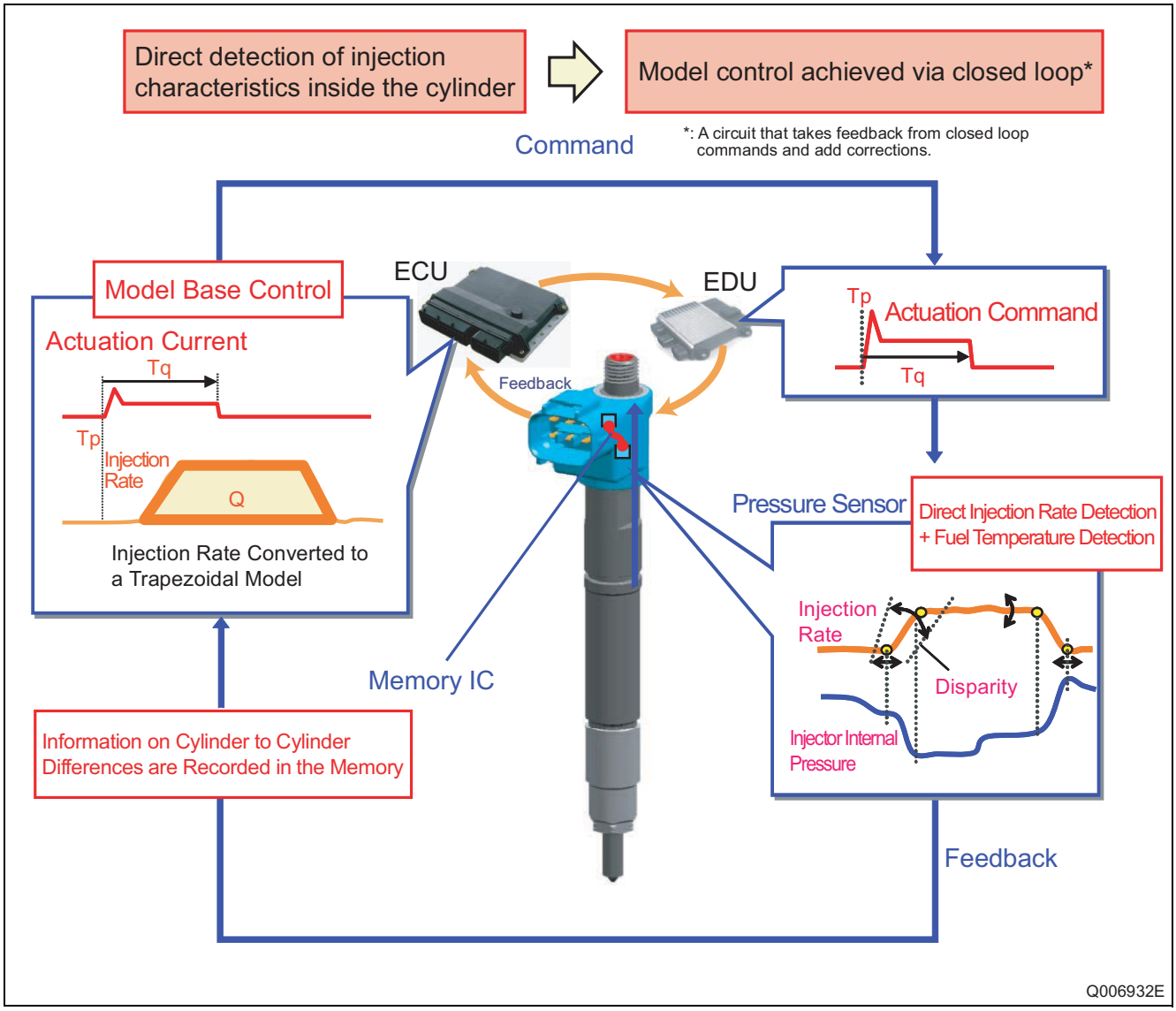
Injection Complete

• When the voltage applied to the piezo stack is removed, the stack shrinks, and both the large and small diameter pistons, as well as the control valve rise. Additionally, the lower seat opens, and the upper seat closes. As a result, a fuel path to the control chamber opens, and fuel pressure in the control chamber quickly returns to the same pressure as the rail. Therefore, the nozzle needle is pushed downward, and fuel injection stops.



(3) i-ART System Configuration

- i-ART system configuration is shown below.

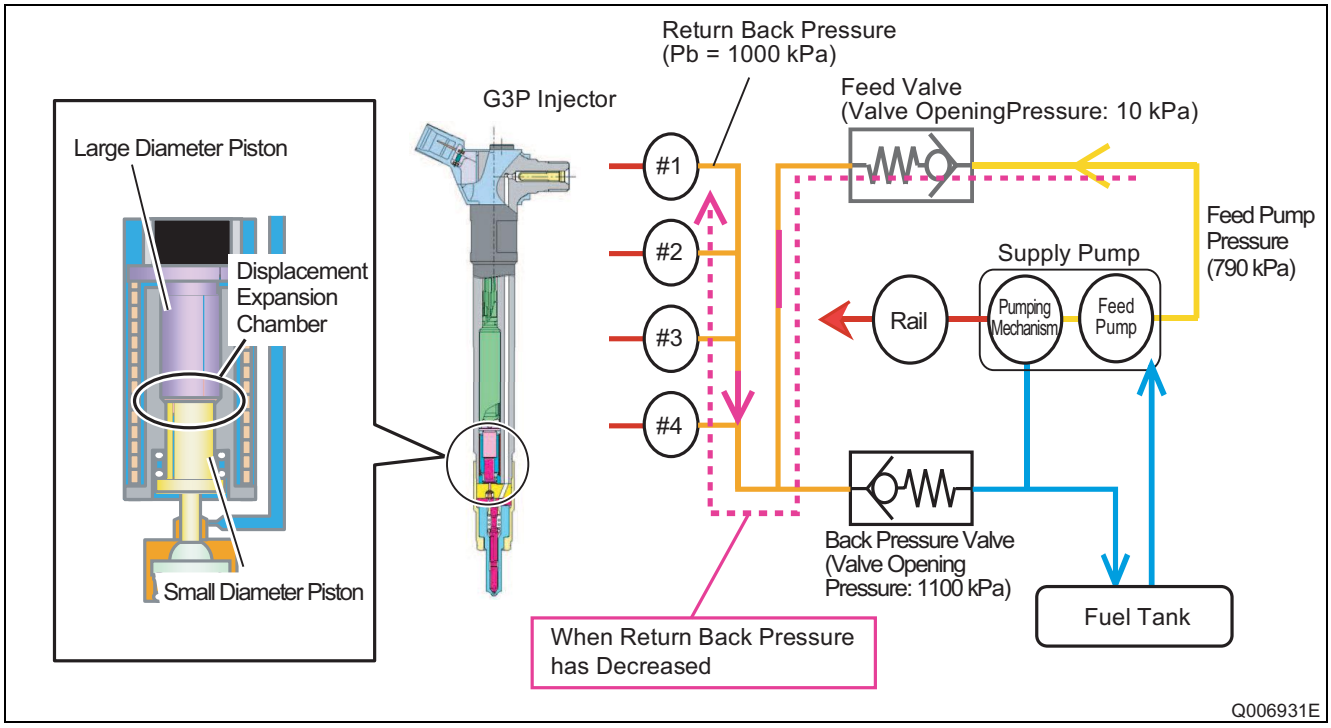


Model Base Control

- In model base control, a pressure sensor built into each injector detects the injector internal fuel pressure and provides the value as feedback to the ECU.
  The ECU calculates and corrects the injection rate to the most accurate value by converting the injection rate into a trapezoidal model. The ECU then transmits injector actuation command signals to the EDU.

6. Injector Return Back Pressure System

- When the injector return side is dry (no fuel) and air enters the displacement expansion chamber inside the injector, the ability to transmit piezo stack displacement is lost, and injection is no longer possible. To prevent the aforementioned circumstances, fuel is sent to the injector return side from the supply pump via the feed valve to apply back pressure. The air is therefore compressed and eliminated to improve startability.



7. Diagnostic Trouble Codes (DTC)

DTC	Warning Light		Memory	Diagnosis Item
	CE	PI		
P0046	○	-	○	Turbocharger/supercharger boost control "A" circuit range/ performance
P0047	○	-	○	Turbocharger/supercharger boost control "A" circuit low
P0048	○	-	○	Turbocharger/supercharger boost control "A" circuit high
P007C	×	-	○	Charge air cooler temperature sensor circuit low bank 1
P007D	×	-	○	Charge air cooler temperature sensor circuit high bank 1
P0088	○	-	○	Fuel rail /system pressure too high
P0093	○	-	○	Fuel pump circuit malfunction (fuel leakage)
P0100	○	-	○	Mass Air Flow (MAF) meter malfunction (low)
P0107	○	-	○	Turbo pressure sensor circuit malfunction low
P0108	○	-	○	Turbo pressure sensor circuit malfunction high
P0112	×	-	○	Atmospheric temperature sensor circuit malfunction low
P0113	×	-	○	Atmospheric temperature sensor circuit malfunction high
P0115	○	-	○	Water temperature sensor circuit malfunction
P0117	○	-	○	Water temperature sensor circuit malfunction low
P0118	○	-	○	Water temperature sensor circuit malfunction low
P0122	○	-	○	Throttle sensor circuit malfunction low
P0123	○	-	○	Throttle sensor circuit malfunction high
P0168	○	-	○	Fuel temperature too high
P0201	○	-	○	Injector circuit/open-cylinder 1
P0202	○	-	○	Injector circuit/open-cylinder 2
P0203	○	-	○	Injector circuit/open-cylinder 3
P0204	○	-	○	Injector circuit/open-cylinder 4
P0299	○	-	○	VN turbo circuit malfunction (open)
P029D	○	-	○	Cylinder 1 - injector leaking
P02A1	○	-	○	Cylinder 2 - injector leaking
P02A5	○	-	○	Cylinder 3 - injector leaking
P02A9	○	-	○	Cylinder 4 - injector leaking
P0335	○	-	○	Crankshaft position sensor circuit malfunction (NE circuit)
P0339	×	-	○	Crankshaft position sensor circuit malfunction (NE circuit)

DTC	Warning Light		Memory	Diagnosis Item
	CE	PI		
P0340	○	-	○	Cylinder recognition sensor circuit malfunction (GI circuit)
P0405	○	-	○	Exhaust Gas Recirculation (EGR) sensor "A" circuit low
P0406	○	-	○	EGR sensor "A" circuit high
P042E	○	-	○	EGR "A" control stuck open
P0488	○	-	○	Throttle motor system abnormality
P0489	○	-	○	EGR motor control "A" circuit low
P0490	○	-	○	EGR motor control "A" circuit high
P0500	○	-	○	Vehicle speed sensor malfunction
P0503	-	○	○	Vehicle speed sensor circuit malfunction
P0504	×	-	○	Stop light switch signal circuit
P052F	×	-	○	Glow plug control module system voltage
P0560	○	-	○	Engine ECU battery malfunction
P0571	-	○	○	Stop light switch circuit malfunction
P0575	-	○	○	Cruise control input circuit
P0606	○	-	○	ECU processor
P060A	○	-	○	Internal control module monitoring processor performance
P060B	○	-	○	Internal control module A/D processor performance
P0617	○	-	○	Starter relay circuit high
P0627	○	-	○	Fuel pump circuit malfunction (open circuit)
P062D	○	-	○	Fuel injector driver circuit performance bank 1
P064C	×	-	○	Glow plug control module
P066B	×	-	○	Cylinder 1 glow plug control circuit high
P066D	×	-	○	Cylinder 2 glow plug control circuit high
P066F	×	-	○	Cylinder 3 glow plug control circuit high
P0671	×	-	○	Cylinder 1 glow plug circuit/open
P0672	×	-	○	Cylinder 2 glow plug circuit/open
P0673	×	-	○	Cylinder 3 glow plug circuit/open
P0674	×	-	○	Cylinder 4 glow plug circuit/open
P067B	×	-	○	Cylinder 4 glow plug control circuit high
P0683	×	-	○	Glow plug control module to ECU communication circuit

DTC	Warning Light		Memory	Diagnosis Item
	CE	PI		
P0724	○	-	○	Brake switch "B" circuit high
P115D	○	-	○	Intake manifold runner control "B"circuit/low
P115E	○	-	○	Intake manifold runner control "B" circuit/high
P1229	○	-	○	Fuel pump circuit malfunction (over force feed)
P1251	○	-	○	VN turbo circuit malfunction (open)
P1271	○	-	○	Fuel regulator circuit malfunction
P1272	○	-	○	Fuel regulator circuit malfunction
P13A1	○	-	○	Injector internal pressure sensor circuit low (cylinder 1)
P13A2	○	-	○	Injector internal pressure sensor circuit high (cylinder 1)
P13A3	○	-	○	Injector internal pressure sensor circuit range/performance (cylinder 1)
P13A6	○	-	○	Injector internal pressure sensor circuit low (cylinder 2)
P13A7	○	-	○	Injector internal pressure sensor circuit high (cylinder 2)
P13A8	○	-	○	Injector internal pressure sensor circuit range/performance (cylinder 2)
P13AB	○	-	○	Injector internal pressure sensor circuit low (cylinder 3)
P13AC	○	-	○	Injector internal pressure sensor circuit high (cylinder 3)
P13AD	○	-	○	Injector internal pressure sensor circuit range/performance (cylinder 3)
P13B1	○	-	○	Injector internal pressure sensor circuit low (cylinder 4)
P13B2	○	-	○	Injector internal pressure sensor circuit high (cylinder 4)
P13B3	○	-	○	Injector internal pressure sensor circuit range/performance (cylinder 4)
P13C1	○	-	○	Injector internal fuel temperature sensor circuit low (cylinder 1)
P13C2	○	-	○	Injector internal fuel temperature sensor circuit high (cylinder 1)
P13C3	×	-	○	Injector internal temperature sensor circuit range/performance (cylinder 1)
P13C6	○	-	○	Injector internal fuel temperature sensor circuit low (cylinder 2)
P13C7	○	-	○	Injector internal fuel temperature sensor circuit high (cylinder 2)
P13C8	×	-	○	Injector internal temperature sensor circuit range/performance (cylinder 2)
P13CB	○	-	○	Injector internal fuel temperature sensor circuit low (cylinder 3)
P13CC	○	-	○	Injector internal fuel temperature sensor circuit high (cylinder 3)
P13CD	×	-	○	Injector internal temperature sensor circuit range/performance (cylinder 3)
P13D1	○	-	○	Injector internal fuel temperature sensor circuit low (cylinder 4)

DTC	Warning Light		Memory	Diagnosis Item
	CE	PI		
P13D2	○	-	○	Injector internal fuel temperature sensor circuit high (cylinder 4)
P13D3	×	-	○	Injector internal temperature sensor circuit range/performance (cylinder 4)
P13E1	○	-	○	Injector internal pressure sensor (fuel pressure control) circuit low (cylinder 1)
P13E2	○	-	○	Injector internal pressure sensor (fuel pressure control) circuit high (cylinder 1)
P13E6	○	-	○	Injector internal pressure sensor (fuel pressure control) circuit low (cylinder 4)
P13E7	○	-	○	Injector internal pressure sensor (fuel pressure control) circuit high (cylinder 4)
P1603	×	-	○	Engine stall history
P1604	×	-	○	Engine difficult to start
P1605	×	-	○	Poor idling
P1607	○	-	○	Cruise control input processor
P1608	×	-	○	Poor engine power
P1626	○	-	○	X manufacturer control P16 computer and auxiliary outputs range check (low input)
P1627	○	-	○	X manufacturer control P16 computer and auxiliary outputs range check (high input)
P166F	×	-	○	Glow plug control module
P167A	○	-	○	Lost communication with injector (cylinder 1)
P167B	○	-	○	Lost communication with injector (cylinder 2)
P167C	○	-	○	Lost communication with injector (cylinder 3)
P167D	○	-	○	Lost communication with injector (cylinder 4)
P168A	×	-	○	Injector EEPROM error (cylinder 1)
P168B	×	-	○	Injector EEPROM error (cylinder 2)
P168C	×	-	○	Injector EEPROM error (cylinder 3)
P168D	×	-	○	Injector EEPROM error (cylinder 4)
P2006	○	-	○	Intake manifold runner control circuit/open
P2009	○	-	○	Intake manifold runner control circuit/low bank 1
P2010	○	-	○	Intake manifold runner control circuit/high bank 1
P2120	○	-	○	Accelerator pedal position sensor 1 circuit malfunction (open/short)
P2121	○	-	○	Accelerator pedal position sensor circuit malfunction (range)

DTC	Warning Light		Memory	Diagnosis Item
	CE	PI		
P2122	○	-	○	Accelerator pedal position sensor 1 circuit malfunction (open/short)
P2123	○	-	○	Accelerator pedal position sensor 1 circuit malfunction (open/short)
P2125	○	-	○	Accelerator pedal position sensor 2 circuit malfunction (open/short)
P2127	○	-	○	Accelerator pedal position sensor 2 circuit malfunction (open/short)
P2128	○	-	○	Accelerator pedal position sensor 2 circuit malfunction (open/short)
P2138	○	-	○	Accelerator pedal position sensor 1 and 2 circuit malfunction (open/short)
P2226	○	-	○	Atmospheric pressure sensor circuit malfunction
P2228	○	-	○	Atmospheric pressure sensor circuit malfunction low
P2229	○	-	○	Atmospheric pressure sensor circuit malfunction high
P245C	○	-	○	EGR cooler bypass control circuit low
P245D	○	-	○	EGR cooler bypass control circuit high
P2564	○	-	○	Turbocharger/supercharger boost control position sensor "A" circuit low
P2565	○	-	○	Turbocharger/supercharger boost control position sensor "A" circuit high
B2799	×	-	○	Immobilizer
B279A	×	-	○	Immobilizer communication line stuck high
B279C	×	-	○	Immobilizer presence detection
U0101	○	-	○	Lost communication with ECU