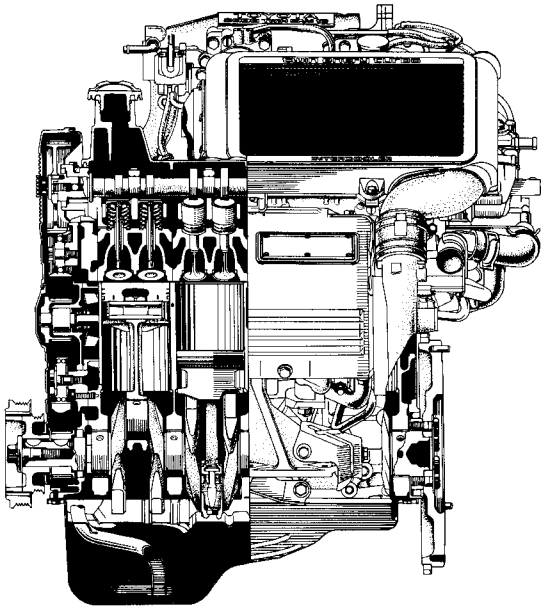
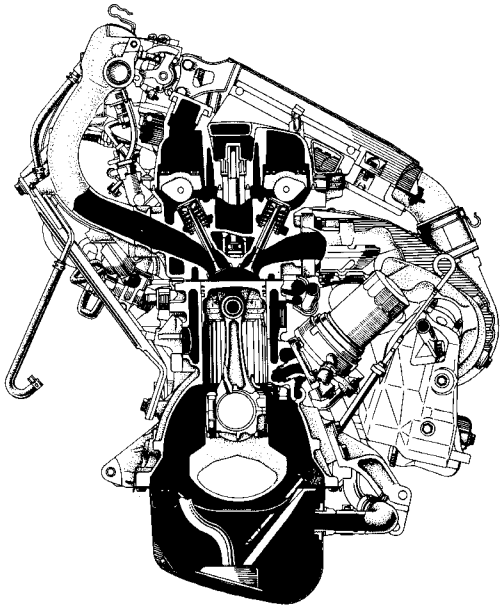
ENGINE

3S–GTE ENGINE

■ DESCRIPTION

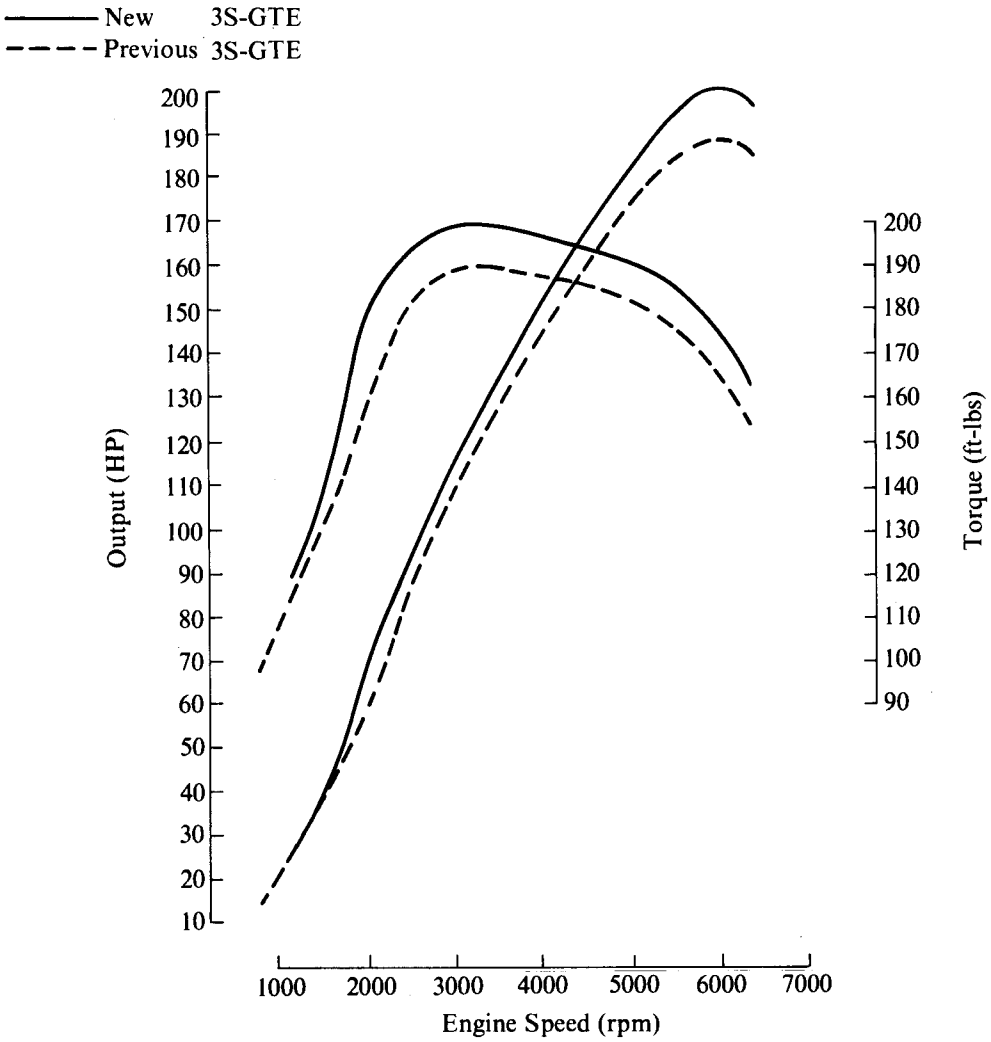
To coincide with the full remodeling of the car itself, the respectable 3S–GTE engine was also modified for higher performance appropriate for the All–Trac/4WD vehicles.





■ ENGINE SPECIFICATIONS AND PERFORMANCE CURVE

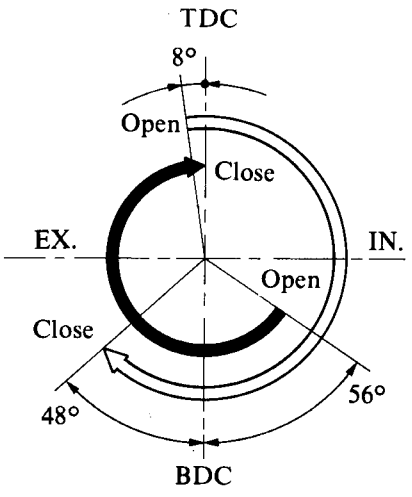
Item	Engine	New 3S–GTE	Previous 3S–GTE
No. of Cyls. & Arrangement		4–cylinder, In–line	←
Valve Mechanism		4–valve, DOHC, Belt Drive	←
Combustion Chamber		Pentroof Type	←
Manifolds		Cross–flow	←
Displacement	cu. in. (cc)	121.9 (1998)	←
Bore x Stroke	in. (mm)	3.39 x 3.39 (86.0 x 86.0)	←
Compression Ratio		8.8 : 1	8.5 : 1
Max. Output	(SAE–NET)	200 HP @ 6000 rpm	190 HP @ 6000 rpm
Max. Torque	(SAE–NET)	200 ft·lbs @ 3200 rpm	190 ft·lbs @ 3200 rpm
Fuel Octane Number	(RON)	96	←
Oil Grade		API SG	API SF or SG



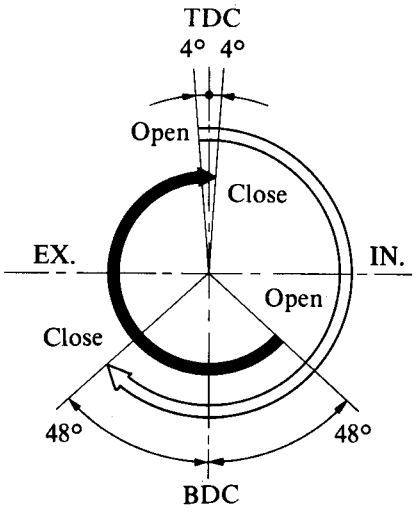
■ VALVE MECHANISM

1. Valve Timing

The valve timing was modified, as shown below, as part of the engine improvement.



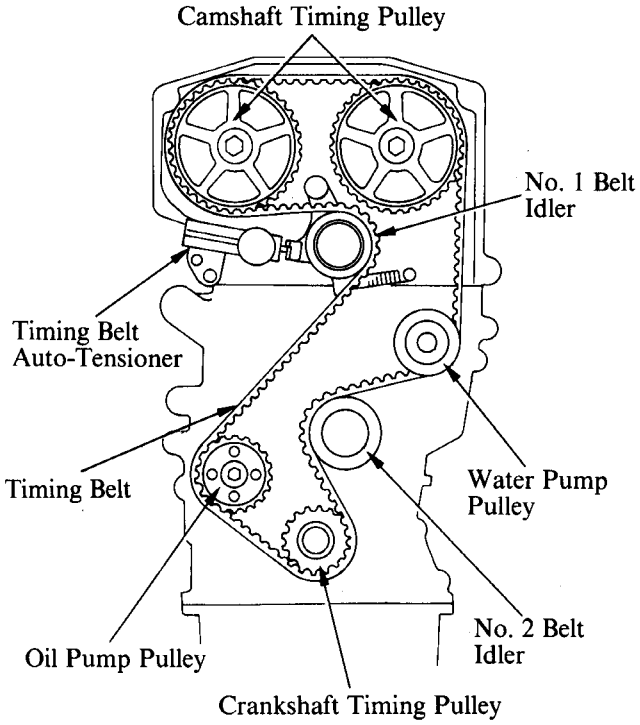
New 3S-GTE

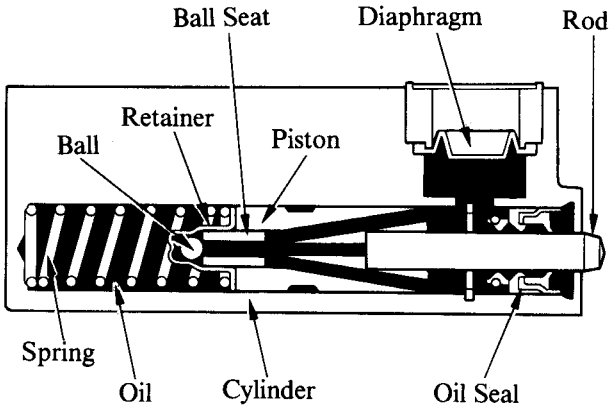


Previous 3S-GTE

2. Timing Belt Auto–Tensioner

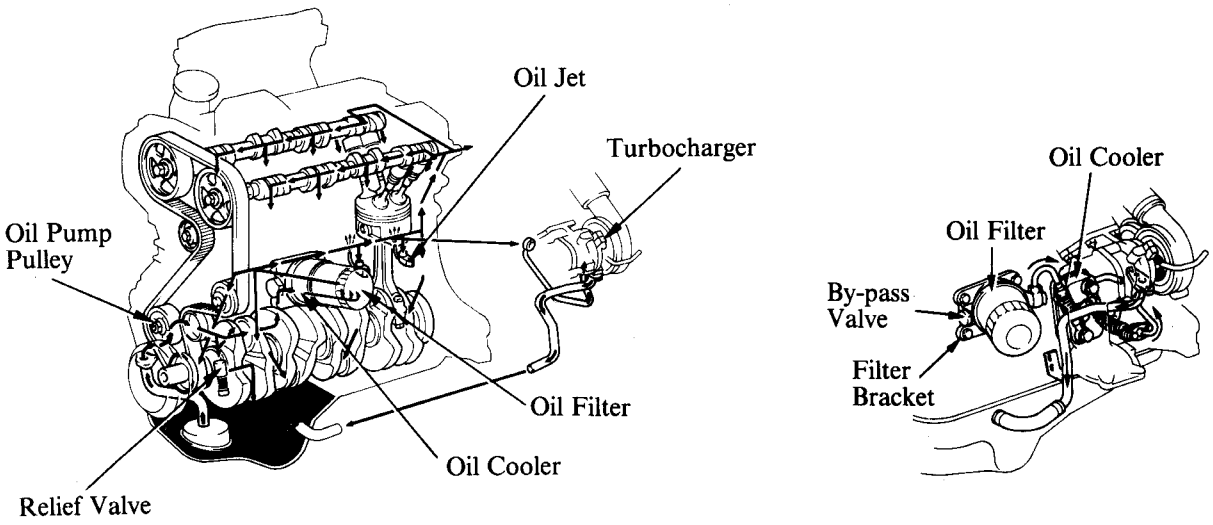
A hydraulically–regulated belt tensioner, combining a spring and an oil pressure damper, has been used. It maintains the timing belt tension at an appropriate level at all times and thus minimizes belt noise.



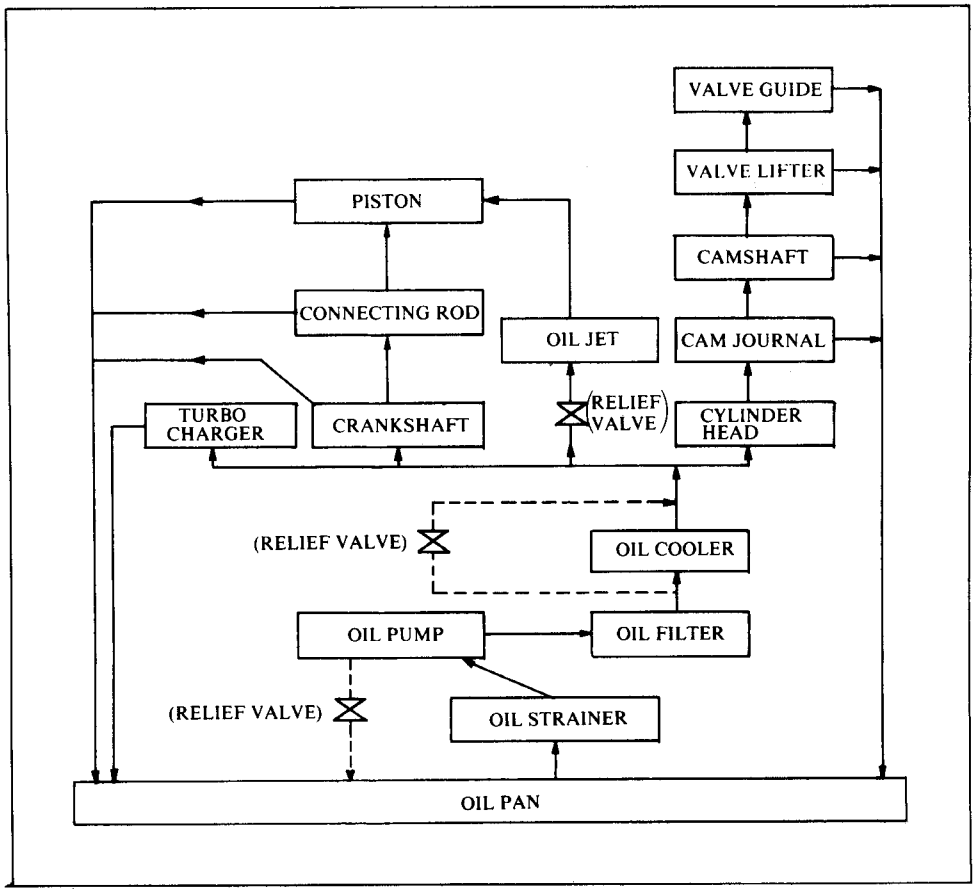


■ LUBRICATION SYSTEM

The conventional square type oil cooler was replaced with a round type oil cooler having greater cooling efficiency to improve the engine cooling performance. The oil passage was modified partially as a result of the change.

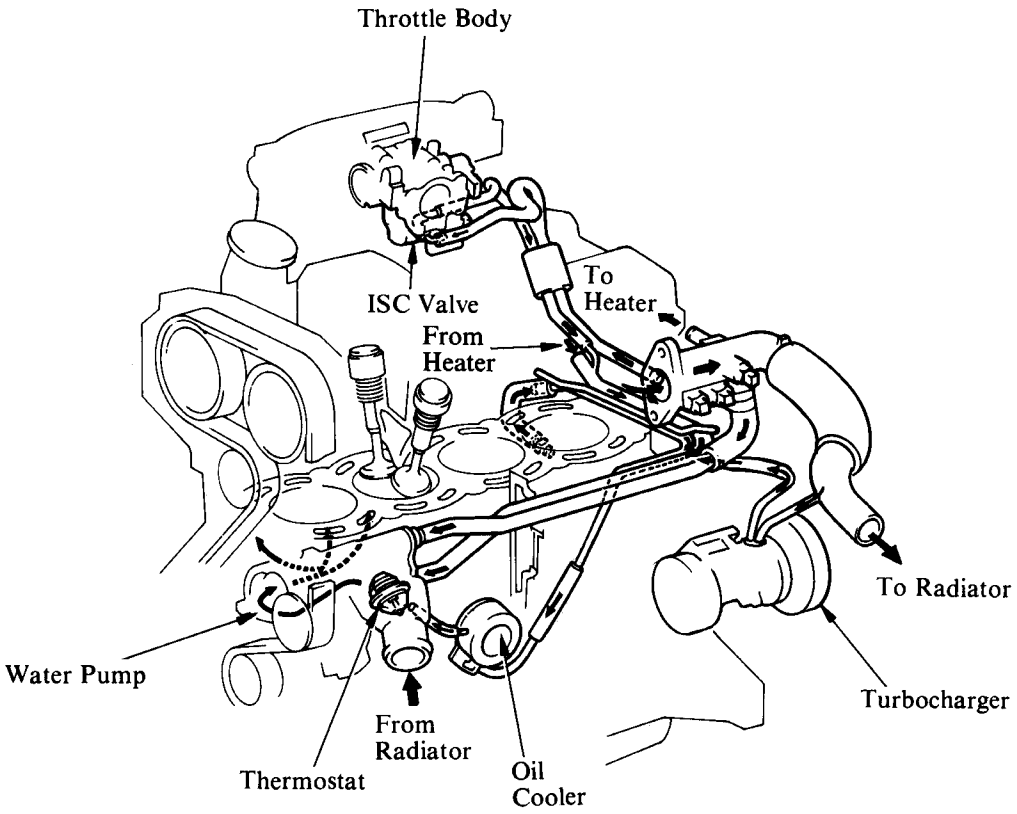


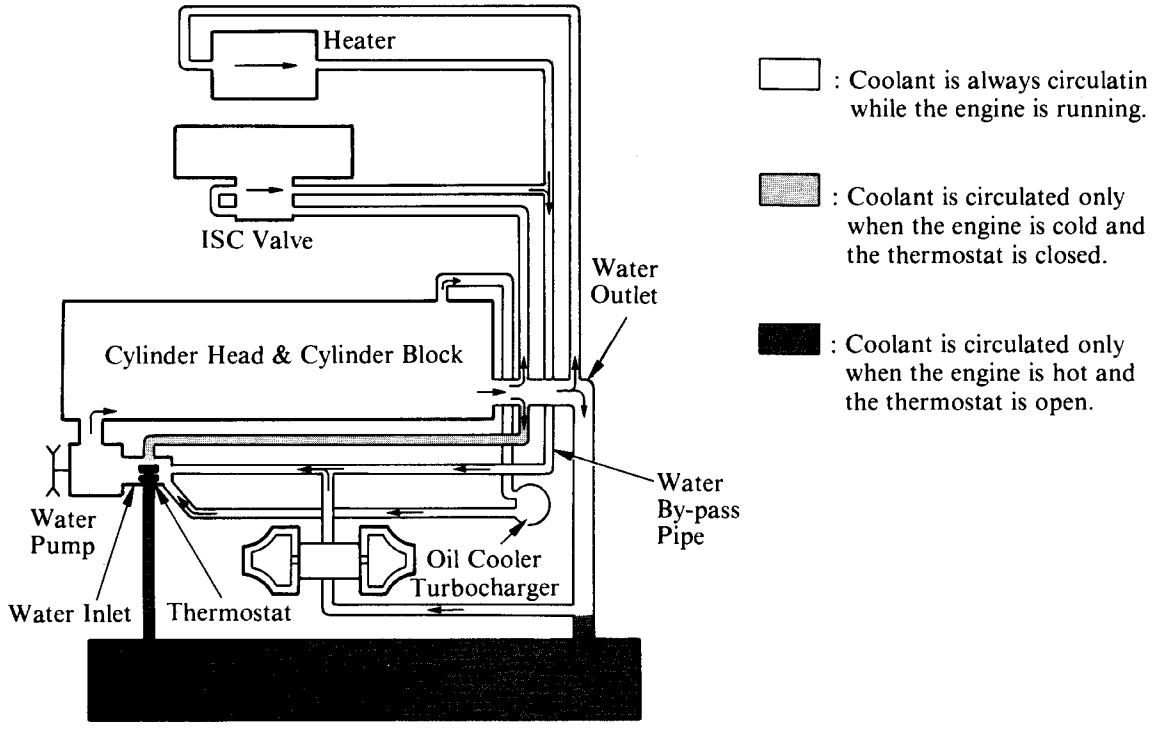
New **Previous**



■ COOLING SYSTEM

The turbocharger cooling passage was modified, in addition to modification of the oil cooler cooling passage.



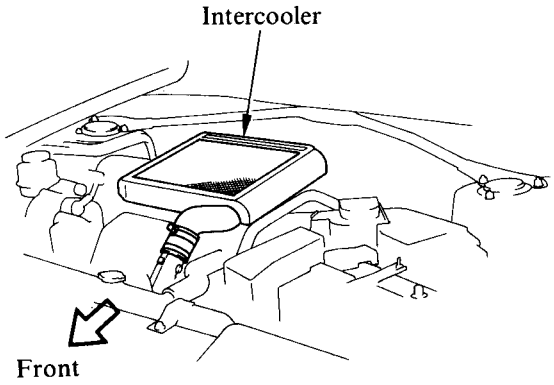


■ INTAKE SYSTEM

1. Air to Air Intercooler

General

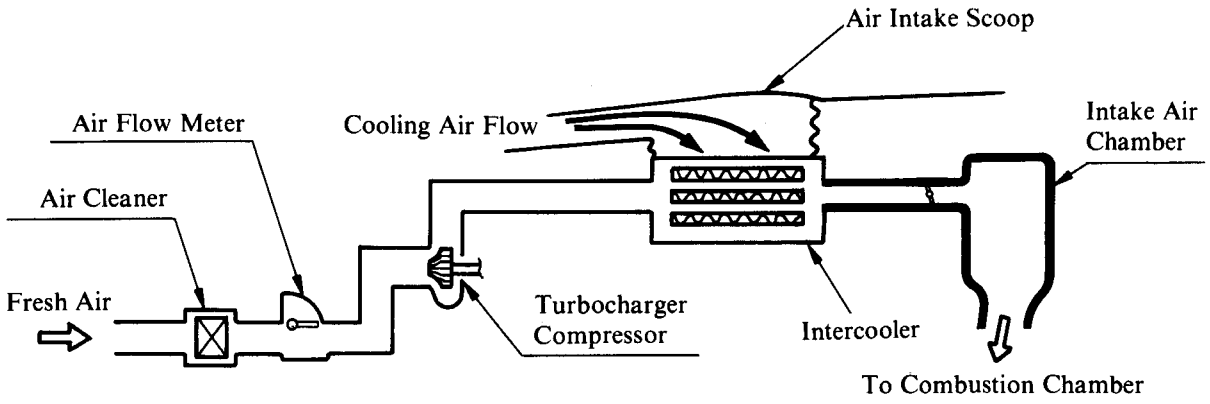
- The conventional water–cooler intercooler was replaced with an air to air intercooler in the new 3S–GTE engine. The system was simplified in design as a result of the change, and ease of maintenance and servicing was improved.
- The larger intercooler ensures increased cooling performance. Since it is located directly above the engine, it requires a shorter air passage resulting in better response.



▶Core Size◀

	New 3S–GTE air to air type	Previous 3S–GTE water–cooled type
W	8.9 in. (225 mm)	9.8 in. (250 mm)
H	9.4 in. (238 mm)	2.4 in. (60 mm)
D	2.5 in. (64 mm)	3.2 in. (81 mm)

System Diagram



In this system, the turbocharger air is cooled by the flow of air from the air intake scoop through the intercooler.

■ TURBOCHARGER SYSTEM

1. General

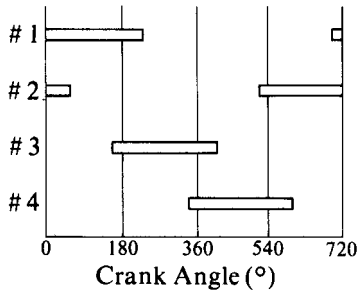
The conventional turbocharger system of the previous 3S–GTE engine was further improved in the new 3S–GTE engine to enhance performance.

2. Twin Entry Turbocharger System

The engine has ranges in which there is some overlap in the exhaust valve opening timing of some cylinders. This can cause interference to the exhaust gas flow where the exhaust gases from the two cylinders join and result in exhaust energy loss in the turbocharged engine. Also, cylinders which have just finished the EXHAUST process are affected by the high back pressure of the exhaust initial process, so that high pressure gas remains behind more easily. This hinders smooth intake flow to the engine.

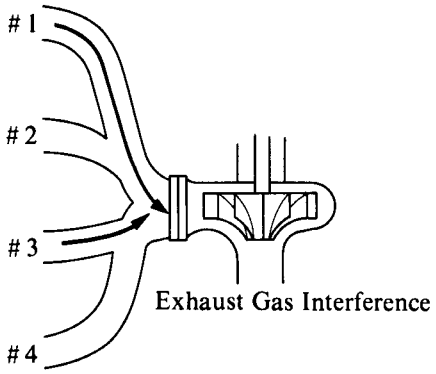
This exhaust gas interference is eliminated in the new 3S–GTE engine by providing two exhaust ports, for cylinders NO. 1 and NO. 4, and for cylinders NO. 2 and NO. 3, together with two scrolls inside the turbine housing. This new design increases the engine's low–speed performance and acceleration response.

▶Exhasut Valve Opening Timing◀

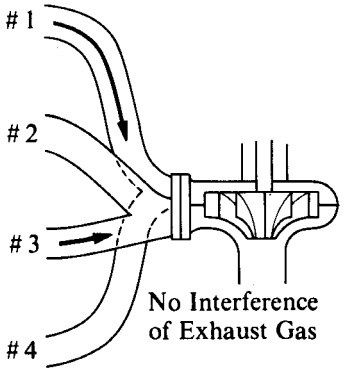


(Firing Order 1 → 3 → 4 → 2)

▶Previous System◀

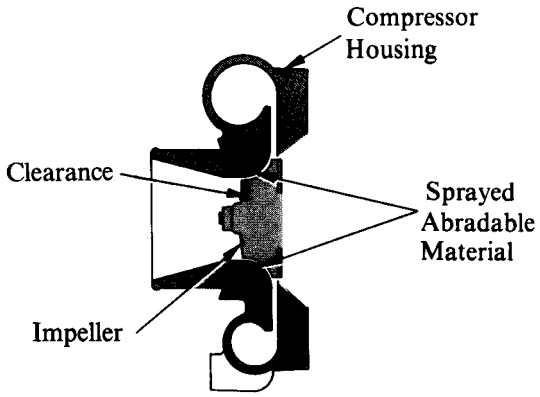


▶Twin Entry System◀



3. Abradable–Sprayed Turbocharger Compressor Housing

The turbocharger has a smaller clearance between the compressor housing shroud and the impeller to further improve the compressor efficiency. Abradable spraying (spraying of material which is easily abradable) is performed on the shroud section of the compressor housing and the abradable material is scraped off by the impeller. This provides minimum clearance while maintaining reliability.



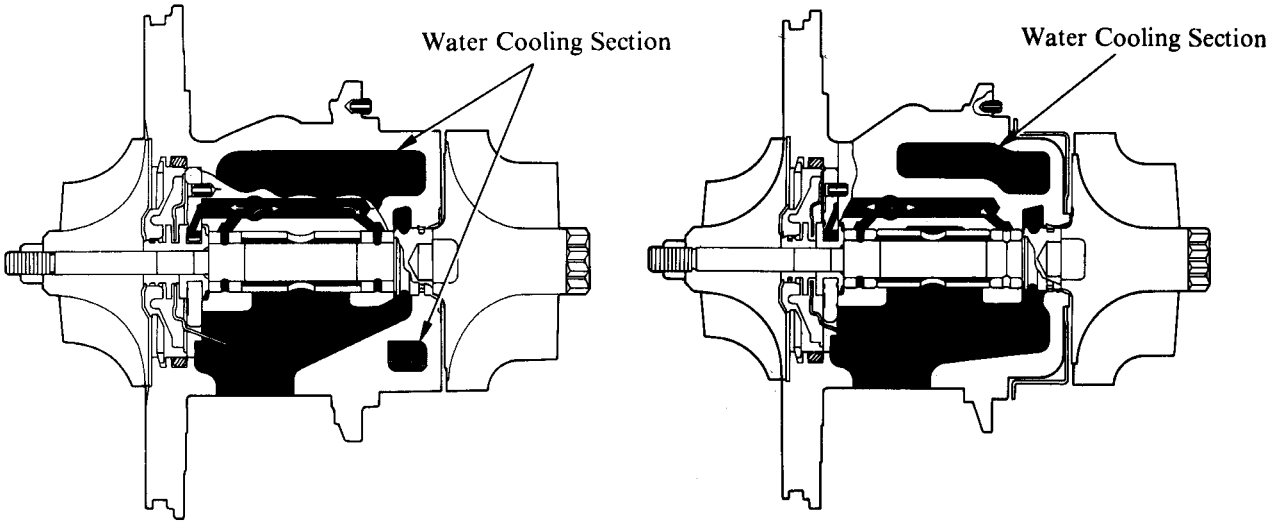
–REFERENCE–

Plasma Spraying

Spraying is a method commonly used as a means to improve resistance against extreme heat, corrosion, wear, etc. Metal, ceramic, resin and the like are heated and the semi–molten material is sprayed over the base material to form an abradable coat.

4. Full–Circumference Water–Cooled Bearing Housing

The oil drain walls of the bearing housing are designed in such a way that coolant is supplied to the entire bearing circumference. This reduces the temperature of the bearing parts and oil drain walls so that oil deterioration is suppressed and reliability is increased.



New **Previous**

■ ENGINE CONTROL SYSTEM

1. General

The engine control system for the new 3S–GTE is basically the same as the previous model. Fuel pump control and air conditioner cut–off control have been added while the fuel pressure control was eliminated.

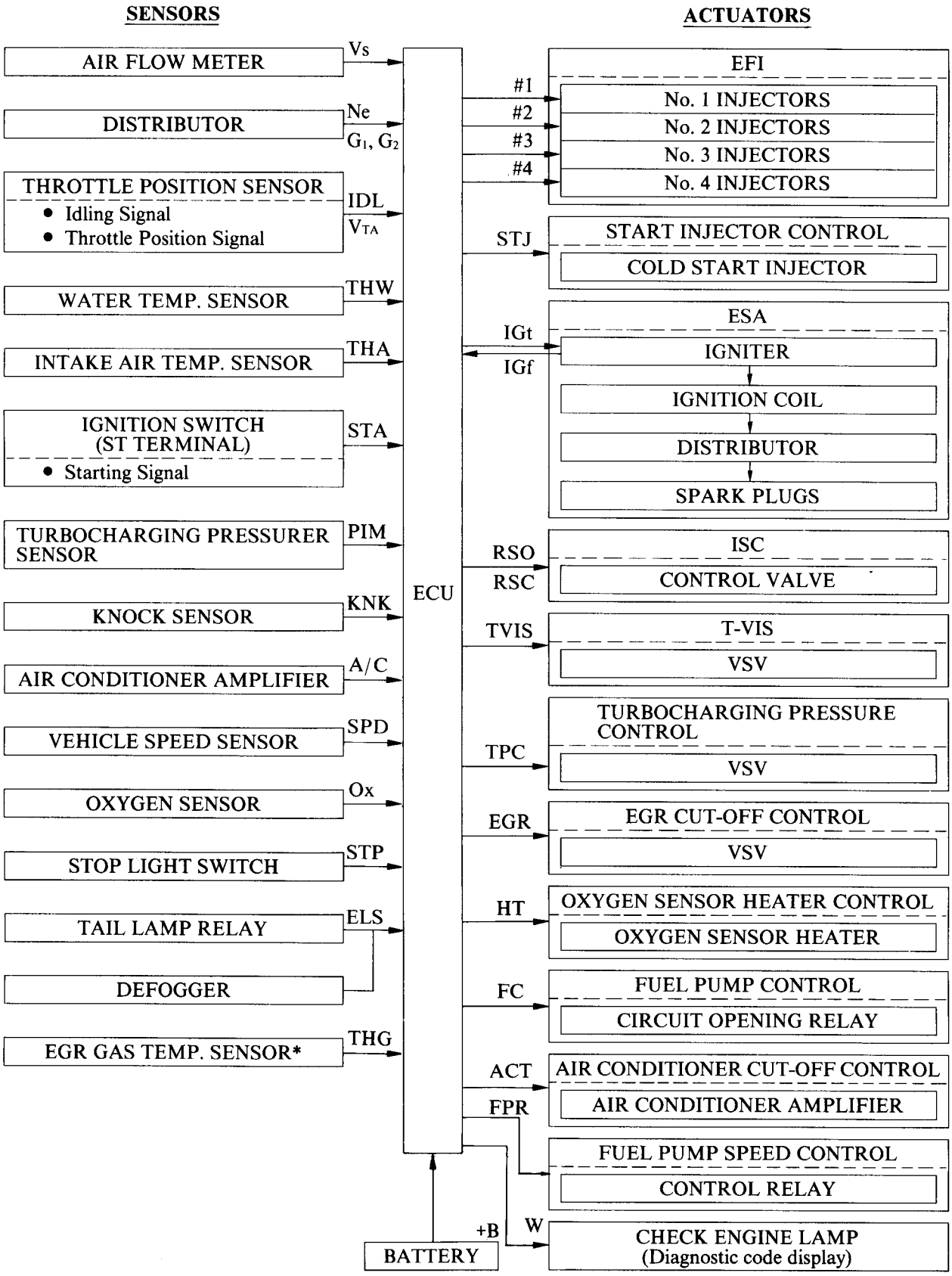
The following compares the new and old control systems:

Engine / System	New 3S–GTE	Previous 3S–GTE
EFI (Electronic Fuel Injection)	An L–type EFI system is used which directly detects the intake air volume with a vane type air flow meter. The fuel injection system is an independent injection system.	←
Cold Start Injector Control	When coolant temperature is between 50°F and 95°F (10°C and 35°C), the injection duration of the cold start injector is controlled by the ECU. At 62.6°F (17°C) or lower, it is controlled by the start injector time switch.	←
ESA (Electronic Spark Advance)	The ECU controls ignition timing in accordance with signals from various sensors. ECU stores two basic advance angle data according to the fuel octane rating.	←
Fuel Judgment	The ECU judges by the signal from the knock sensor whether the fuel octane rating is premium or regular.	←
ISC (Idle Speed Control)	A rotary solenoid type ISC system is used, which controls the fast idle and idle speeds.	←
T–VIS (Toyota–Variable Induction System)	The intake air passages are switched according to the engine speed and fuel octane rating to increase performance in low and medium speed ranges.	←
Turbocharging Pressure Control	Suppresses turbocharging pressure to reduce knocking when regular gasoline is used.	←
EGR Cut–Off Control	Cut off EGR according to the engine condition to maintain drivability of the vehicle and durability of the EGR components.	←
Oxygen Sensor Heater Control	Maintains the temperature of the oxygen sensor at an appropriate level to increase accuracy of detection of the oxygen concentration in the exhaust gas.	←
Fuel Pump Control	Fuel pump operation is controlled by signals from ECU.	Fuel pump operation is controlled by signals from air flow meter.
Air Conditioner Cut–Off Control	By controlling the air conditioner compressor in accordance with the throttle valve opening angle and the vehicle speed, drivability is maintained.	N.A.

Fuel Pressure Control	N.A.	In hot engine condition, the fuel pressure is increased to improve restartability.
Fuel Pump Speed Control	Under light engine loads pump speed is reduced, maintaining durability of the pump.	←
Diagnosis	When a malfunction occurs, the ECU diagnoses and memorizes the failed section. The engine control system checks 19 items for California models and 18 items for other models.	← The engine control system checks 21 items for California models and 20 items for other models.
Fail–Safe	When a malfunction occurs, the ECU stops or controls the engine according to the data already stored in memory.	←

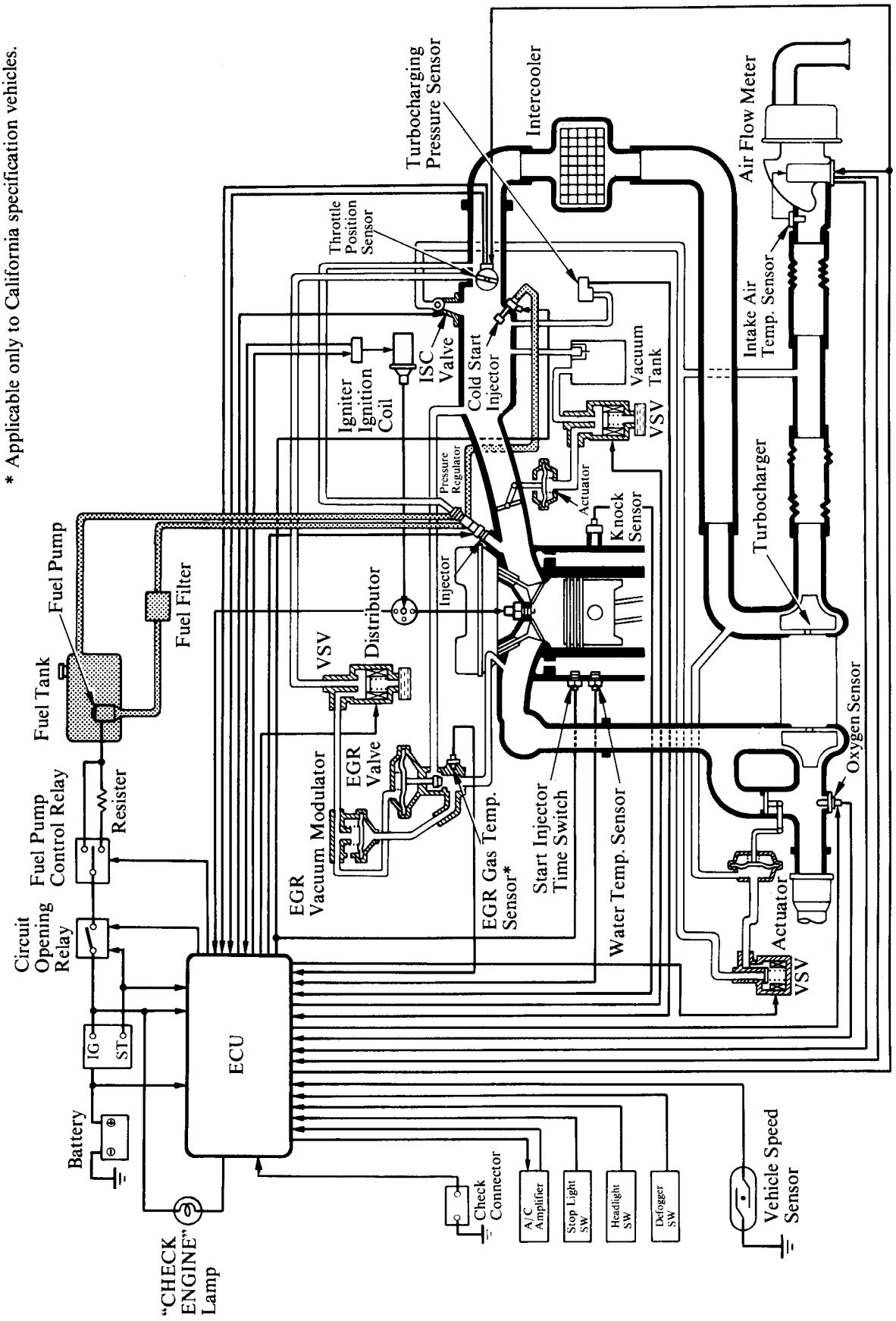
2. Construction

The engine control system can be broadly divided into three groups; the sensors, ECU and actuators.



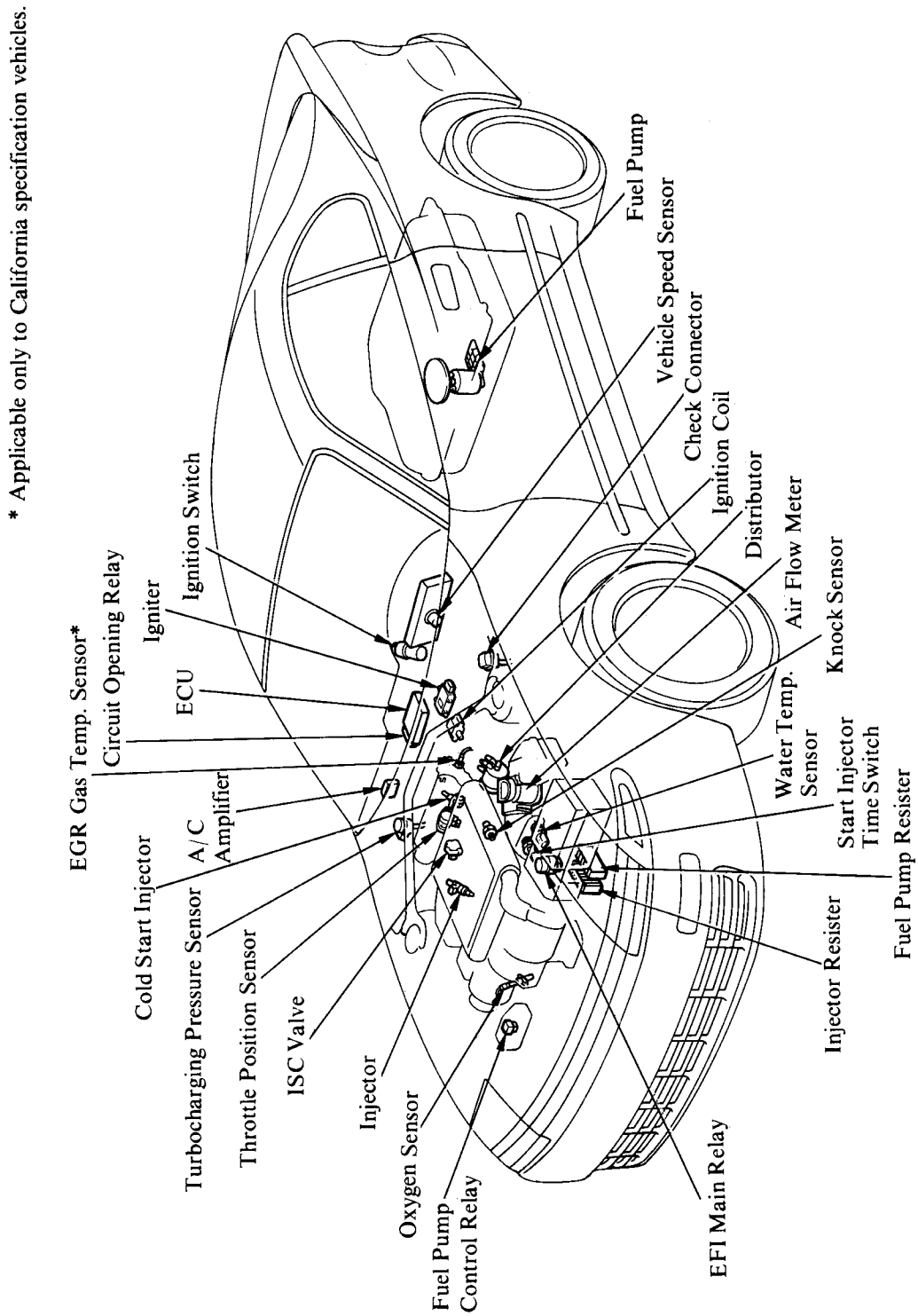
*: Applicable only to California specification vehicles.

3. Engine Control System Diagram



*: Applicable only to California specification vehicles.

4. Arrangement of Engine Control System Components



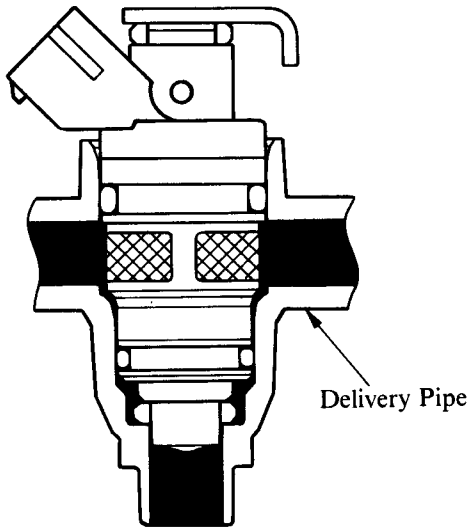
*: Applicable only to California specification vehicles.

5. Main Components of Engine Control System

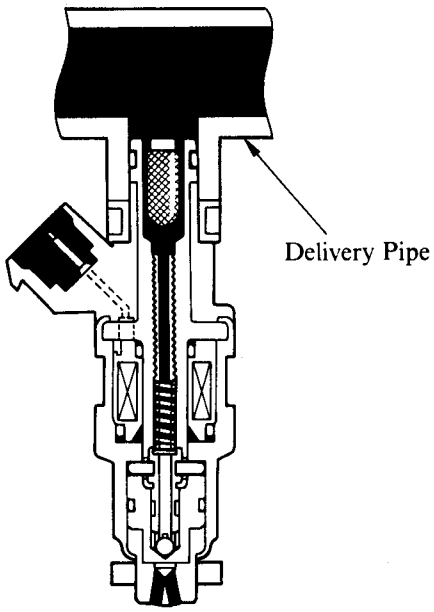
Main components of the engine control system in the new 3S–GTE engine are basically the same as the previous model. The injectors, however, were changed as explained below.

Fuel Injectors

The conventional top–feed type injectors were replaced with side–feel type injectors in the new 3S–GTE engine. Each injector is cooled by the fuel flow to prevent vapor lock that tends to occur under high temperature.



Side-Feed Type (New)



Top-Feed Type (Previous)

The delivery pipe was also modified with the change in the injector type. The pulsation damper is no longer used.

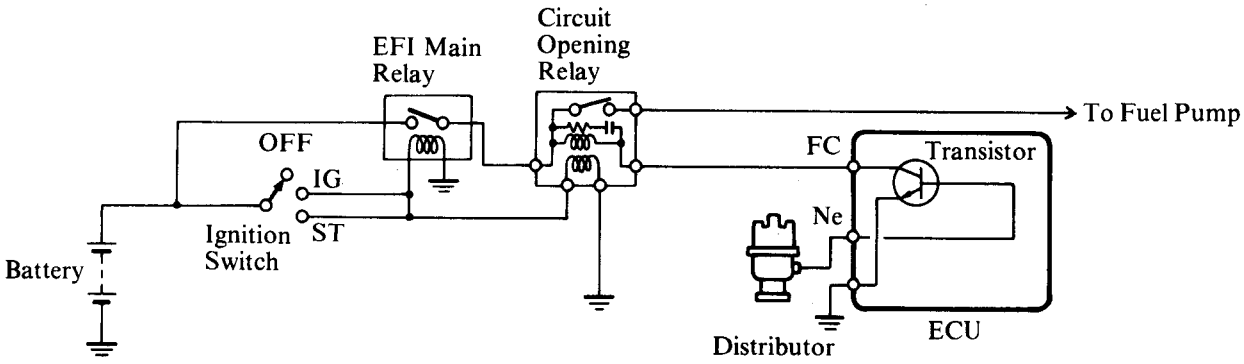
6. Fuel Pump Control

The fuel pump in the previous 3S–GTE engine was operated by a fuel pump switch in the air flow meter. In the new 3S–GTE engine, the fuel pump is operated by a circuit opening relay controlled by the ECU.

General

The fuel pump is designed to operate only when the engine is running. During cranking of the engine, current from the ST terminal of the ignition switch turns the circuit opening relay on and operates the fuel pump. After the engine is started, the ECU controls fuel pump operation based on the engine speed signal (Ne) from the distributor.

Operation



1) During Engine Starting

During engine starting, current flows from the IG terminal of the ignition switch to the L_1 coil of the EFI main relay, turning the relay on. At the same time, current flows from the ST terminal of the ignition switch to the L_3 coil of the circuit opening relay as well, turning it on to operate the fuel pump. The starter operates next and the engine begins to turn, at which point the ECU receives the Ne signal from the distributor. This signal causes the transistor inside the ECU to activate, and thus current flows to the L_2 coil of the circuit opening relay. When this occurs, the circuit opening relay stays on.

2) After Engine Starting

After the engine starts and the ignition switch is returned from the ST position to the IG position, current flowing to the L_3 coil of the circuit opening relay cuts off. Current continues to flow continuously to the L_2 coil, even after starting, from the transistor inside the ECU. As a result, the circuit opening relay stays on, allowing the fuel pump to continue operating.

3) When Engine Stops

When the engine stops, the Ne signal to the ECU stops. This halts operation of the transistor, thereby cutting off the flow of current to the L_2 coil of the circuit opening relay. Due to this, the circuit opening relay turns off and stops the fuel pump operation.

7. Air Conditioner Cut–Off Control

This system is to maintain drivability by switching the air conditioner compressor off temporarily when the vehicle is accelerated suddenly, or when the engine is running under a heavy load condition at a speed of 16 mph (25 km/h) or less.

CONDITIONS

The system operates when all of the conditions below are satisfied at the same time.

- Air conditioner switch on
- Throttle valve opening angle above a predetermined level
- Vehicle speed below 16 mph (25 km/h)

RELEVANT SIGNALS

- Air conditioner switch (A/C)
- Throttle position (V_{TA})
- Vehicle speed (SPD)

8. Diagnosis

The diagnostic system in the new 3S–GTE engine monitors 18 conditions (19 in California models). Although the new and the previous 3S–GTE engines function basically the same, codes 11 and 54 have been deleted in the new engine.

Diagnostic Items

Code No.	Item	Diagnosis	Trouble Area	"CHECK ENGINE" Lamp
12	RPM Signal	No "Ne" or "G" signal to ECU within 2 seconds after the engine has been cranked.	• Distributor circuit • Distributor • Starter signal circuit • ECU	ON
13	RPM Signal	No "Ne" signal to ECU when the engine speed is above 1000 rpm.	• Distributor circuit • Distributor • ECU	ON
14	Ignition Signal	No "IGf" signal to ECU 8∼11 times in succession.	• Igniter and ignition coil circuit • Igniter and ignition coil • ECU	ON
21	Oxygen Sensor Signal	During air–fuel ratio feedback correction, voltage output from the oxygen sensor does not exceed a set value on the lean side and the rich side continuously for a certain period.	• Oxygen sensor circuit • Oxygen sensor	ON
	Oxygen Sensor Heater Signal	Open or short circuit in water temp. sensor signal (HT).	• Oxygen sensor heater circuit • Oxygen sensor heater • ECU	
22	Water Temp. Sensor Signal	Open or short circuit in water temp. sensor signal (THW).	• Water temp. sensor circuit • Water temp. sensor • ECU	ON
24	Intake Air Temp. Sensor Signal	Open or short circuit in intake air temp. sensor signal (THA).	• Intake air temp. sensor circuit • Intake air temp. sensor • ECU	ON*
25	Air–fuel Ratio Lean Malfunction	1)* When air–fuel ratio feedback correction value or adaptive control value continues at the upper (lean) or lower (rich) limit renewed for a certain period of time. 2)* When air–fuel ratio feedback correction value or adaptive control value feedback frequency is abnormally high during feedback condition. 3) Open or short circuit in oxygen sensor signal.	• Injector circuit • Injector • Fuel line pressure • Ignition system • Oxygen sensor circuit • Oxygen sensor • Air flow meter • Water temp. sensor • ECU	ON / ON*
26	Air–fuel Ratio Rich Malfunction		• Injector circuit • Injector • Fuel line pressure • Cold start injector • Air flow meter • Water temp. sensor • ECU	ON / ON*
31	Air Flow Meter Signal	Open circuit in V_C signal or short circuit between V_C and E_2 when idle contacts are closed.	• Air flow meter circuit • Air flow meter • ECU	ON
32	Air Flow Meter Signal	Open circuit in E_2 or short circuit between V_C and V_S.	• Air flow meter circuit • Air flow meter • ECU	ON

*: Applicable only to California specification vehicles.

Code No.	Item	Diagnosis	Trouble Area	"CHECK ENGINE" Lamp
41	Throttle Position Sensor Signal	Open or short circuit in throttle position sensor signal (V_{TA}).	• Throttle position sensor signal • Throttle position sensor • ECU	ON
42	Vehicle Speed Sensor Signal	No "SPD" signal to ECU for 8 seconds when engine speed is between 2500 rpm and 6000 rpm and coolant temp. is above 176°F (80°C) except when racing the engine.	• Vehicle speed sensor circuit • Vehicle speed sensor • ECU	OFF
43	Starter Signal	No "STA" signal to ECU until engine speed reaches 800 rpm with vehicle not moving.	• Ignition switch circuit • Ignition switch • ECU	OFF
52	Knock Sensor Signal	Open circuit in knock sensor signal (KNK).	• Knock sensor circuit • Knock sensor • ECU	ON
53	Knock Control Signal in ECU	Knock control in ECU faulty.	• ECU	ON
71*	EGR System Malfunction	• EGR gas temp. below a predetermined level during EGR operation. • Open circuit in EGR gas temp. sensor signal (THG).	• EGR system • EGR gas temp. sensor circuit • EGR gas temp. sensor • ECU	ON
51	Switch Condition Signal	No "IDL" signal or "A/C" signal to ECU, with the check terminals T and E_1 connected.	• A/C amplifier • A/C switch circuit • Throttle position sensor circuit • Throttle position sensor • Accelerator pedal and cable • ECU	OFF

*: Applicable only to California specification vehicles.

NOTE:
- All detected diagnostic codes, except 51 and 53, will be retained in the ECU memory until cancelled out.
- Once the malfunction is corrected, the "CHECK ENGINE" lamp will go out, but the diagnostic code(s) will remain stored in the ECU memory (except for codes 51 and 53).
- If two or more malfunctions are present at the same time, the lowest–numbered diagnostic code will be displayed first.
- After the malfunction is corrected, the diagnostic system is cleared by removing the EFI fuse for more than 10 seconds with the ignition switch off.

■ EMISSION CONTROL SYSTEM

1. System Purpose

System	Abbreviation	Purpose
Positive crankcase ventilation	PCV	Reduces blow–by gas (HC)
Evaporative emission control	EVAP	Reduces evaporative HC
Exhaust gas recirculation	EGR	Reduces NOx
Three–way catalyst	TWC	Reduces HC, CO and NOx
Electronic fuel injection	EFI	Regulates all engine conditions for reduction of exhaust emissions.

2. Component Layout and Schematic Drawing