ENGINE

2GR-FE TRD Supercharged Engine

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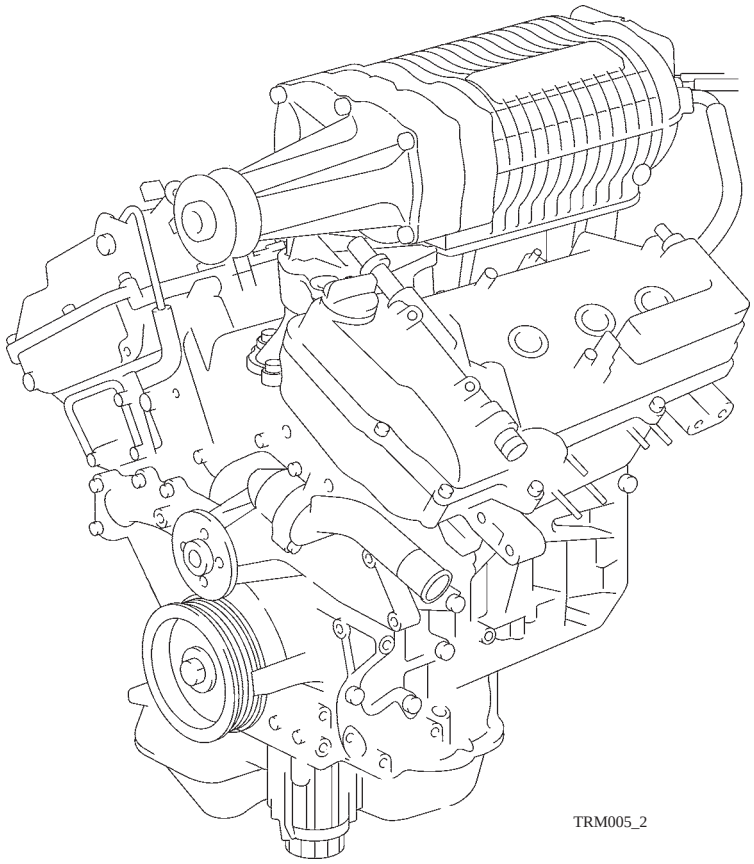
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ENGINE

2GR-FE TRD SUPERCHARGED ENGINE

✹ DESCRIPTION

The 2GR-FE V6, 3.5-litre, 24-valve DOHC engine is fitted with a Supercharger. This engine uses the Dual VVT-i (Dual Variable Valve Timing-intelligent) system, DIS (Direct Ignition System) and ETCS-i (Electronic Throttle Control System-intelligent). These control functions achieve improved engine performance, fuel economy, and reduced exhaust emissions. The ACIS (Acoustic Control Induction System) is removed to make way for a new Intake Manifold and Supercharger.



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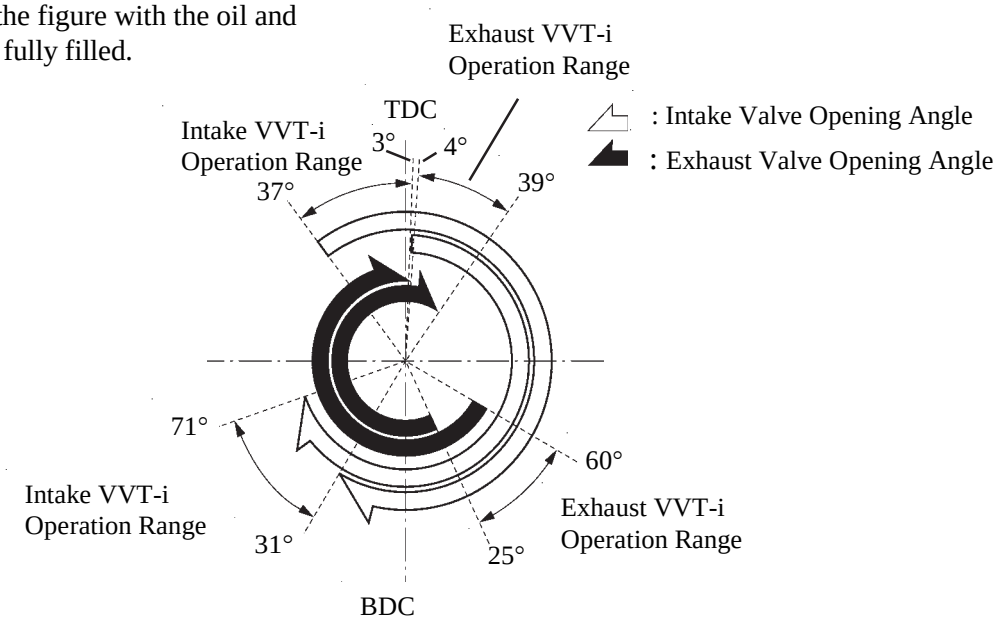
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Engine Specifications

Item			2GR-FE	2GR-FE Supercharged
No. of Cyls. & Arrangement			6-Cylinder, V Type	←
Valve Mechanism			24-Valve DOHC, Chain Drive (with Dual VVT-i)	←
Combustion Chamber			Pentroof Type	←
Manifolds			Parallel-Flow	←
Fuel System			EFI	←
Ignition System			DIS	←
Displacement cm^3			3456	←
Bore X Stroke mm			94.0 X 83.0	←
Compression Ratio			10.8 : 1	←
Max. Output		EEC	200 kW @ 6200 rpm	241 kW @ 6400 rpm
Max. Torque		EEC	336 N·m @ 4700 rpm	400 N·m @ 4000 rpm
Valve Timing	Intake	Open	37° BTDC to 3° ATDC	←
		Close	31° to 71° ABDC	←
	Exhaust	Open	60° to 25° BBDC	←
		Close	4° to 39° ATDC	←
Firing Order			1 – 2 – 3 – 4 – 5 – 6	←
Oil Grade			API grade SL "Energy-Conserving", SM "Energy-Conserving" or ILSAC	←
Research Octane Number			91	98 or higher
Emission Regulation			EURO IV	←
Engine Service Mass*1 (Reference) Kg			163	175 incl. Supercharger

*1: Weight shows the figure with the oil and engine coolant fully filled.

Valve Timing



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PERFORMANCE

✹ 2GR-FE SUPERCHARGED VS NORMALLY ASPIRATED ENGINE



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✹ FEATURES OF 2GR-FE ENGINE

The 2GR-FE engine has achieved the following performance through the use of the items listed below.

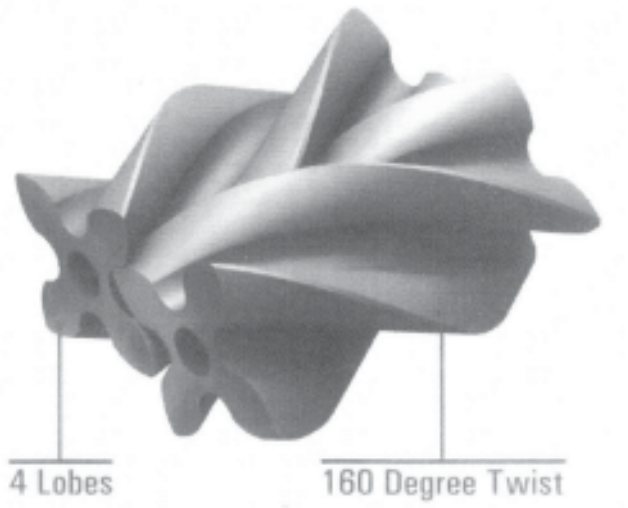
(1) High performance and reliability
(2) Low noise and vibration
(3) Lightweight and compact design
(4) Good serviceability
(5) Clean emission and fuel economy

Item		(1)	(2)	(3)	(4)	(5)
Engine Proper	A steel laminate type cylinder head gasket is used.	○				
	An upright intake port is used.	○		○		
	A taper squish shape is used for combustion chamber.	○				○
	A cylinder block made of aluminium alloy is used.			○		
	The skirt portion of the piston is applied with resin plating to reduce friction.	○	○			○
	An oil pan No.1 made of aluminium alloy is used.		○	○		
Valve Mechanism	The Dual VVT-i system is used.	○				○
	A hydraulic lash adjuster is used.	○	○		○	
	A timing chain and chain tensioner are used.		○	○	○	
	Roller rocker arms are used.	○				○
Lubrication System	An oil filter with a replaceable element is used.				○	
Cooling System	The engine coolant is used the TOYOTA Genuine SLLC (Super Long Life Coolant).				○	
Intake and Exhaust System	The link-less type throttle body is used.			○	○	
	A stainless steel exhaust manifold is used.			○		○
	A ceramic type TWC (Three-Way Catalytic Converter) is used.					○
Fuel System	The fuel delivery pipe made of plastic is used.			○		
	A compact 12-hole type injector is used.	○				○
	Quick connectors are used to connect the fuel hose with the fuel pipe.				○	
Ignition System	The DIS makes ignition timing adjustment unnecessary.	○			○	○
	The long-reach type spark plugs are used.	○				
Charging System	A segment conductor type alternator is used.	○		○		
	An alternator pulley with a clutch is used.					○
Starting System	The PS (Planetary reduction-Segment conductor motor) type starter is used.			○		

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Item		(1)	(2)	(3)	(4)	(5)
Engine Mount	An active control engine mount is used.		○			
Serpentine Belt Drive System	A serpentine belt drive system is used.			○	○	
Engine Control System	The MRE (Magnetic Resistance Element) type VVT sensors are used.	○				
	The ETCS-i is used.	○				○
	The cranking holding function is used. (Only for models with smart entry and start system)	○				
	Evaporative emission control system is used.					○
Supercharger system (TVS Type)	2 x 4 lobe rotors with 160 degree twist are used to optimise performance and improve reliability. A Light weight and Compact Supercharger is used to make use of available space.	○		○		

TVS



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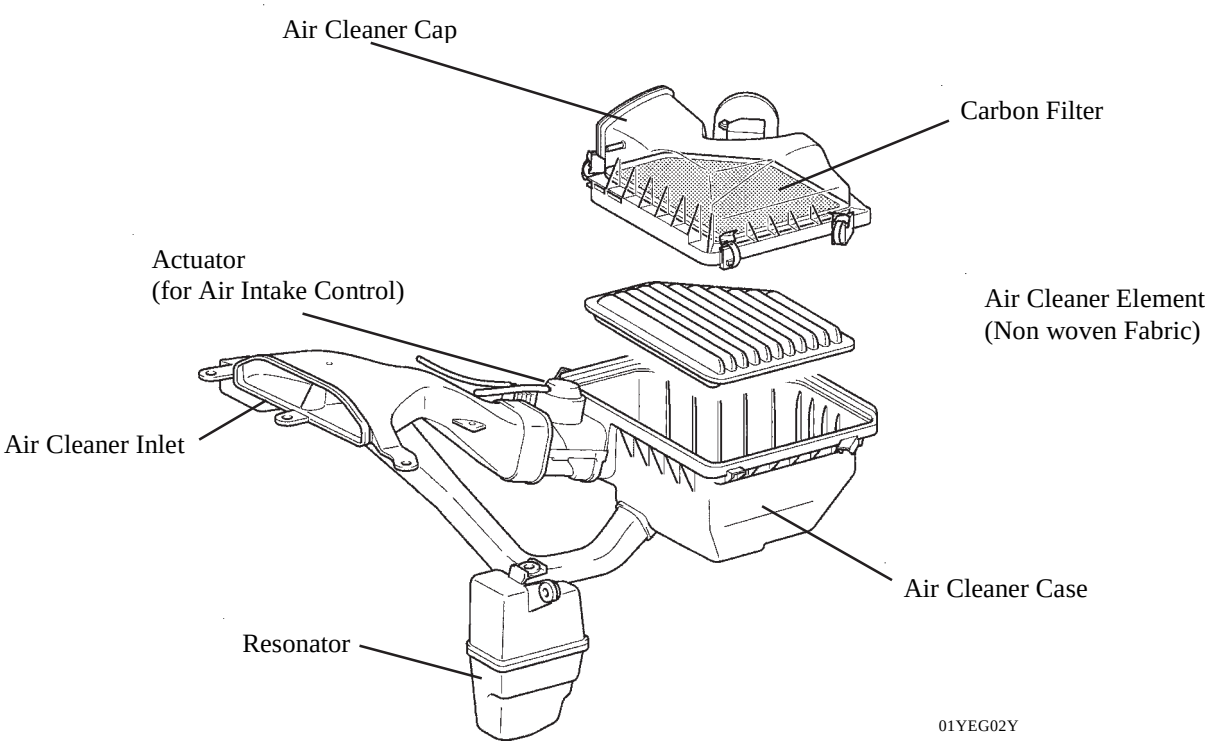
✹ INTAKE AND EXHAUST SYSTEM

1. General

- The link-less type throttle body is used and with excellent throttle control.
- The adoption of the ETCS-i has realised excellent throttle control.
- A stainless steel exhaust manifold and exhaust pipe are used.
- Intake System has been optimised for maximum performance.
- Re-designed internals of the Main Muffler for a lower back pressure and more sporty exhaust note.

2. Air Cleaner

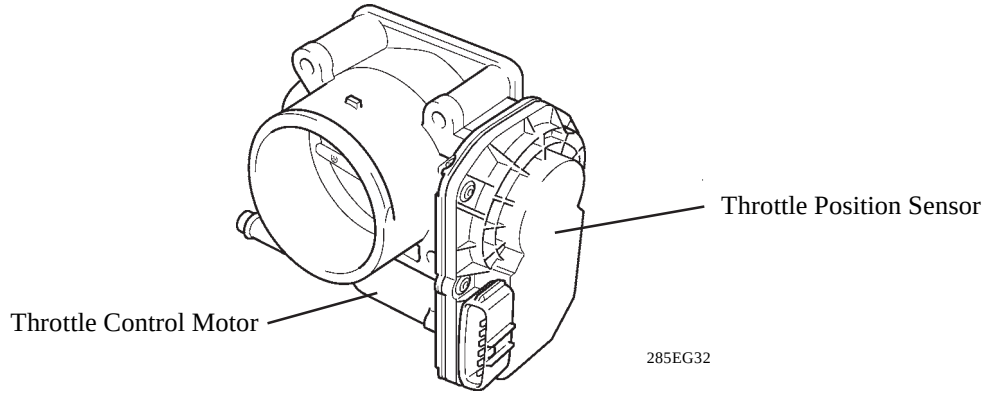
- A non-woven, full-fabric type air cleaner element is used.
- A carbon filter, which adsorbs the HC that accumulates in the intake system when the engine is stopped, is used in the air cleaner case in order to reduce evaporative emissions. This filter is maintenance-free.
- The air intake control system is programmed to open whenever the engine is running on vehicles fitted with the TRD Supercharger.
- A Resonator is used to reduce the amount of intake air sound.



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3. Throttle Body

- A link-less type throttle body in which the throttle position sensor and the throttle control motor are integrated is used. It has excellent throttle valve control.
- In the throttle control motor, a DC motor with excellent response and minimal power consumption is used. The engine ECU performs the duty ratio control of the direction and the amperage of the current that flows to the throttle control motor in order to regulate the throttle valve angle.



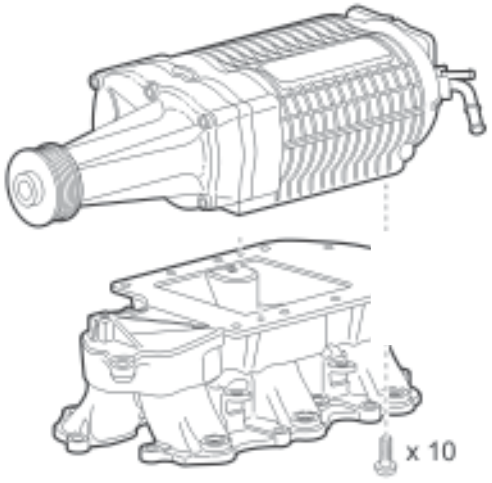
4. TRD Supercharger

General

· The supercharger is essentially an air pump driven by the engines' crankshaft. It forces air into the combustion chamber through all engine rpm ranges depending on operatiing conditions.
· The supercharger rotates while ever the engine is operating, for this reason boost is obtained through a wide operating range (rpm).

Operation

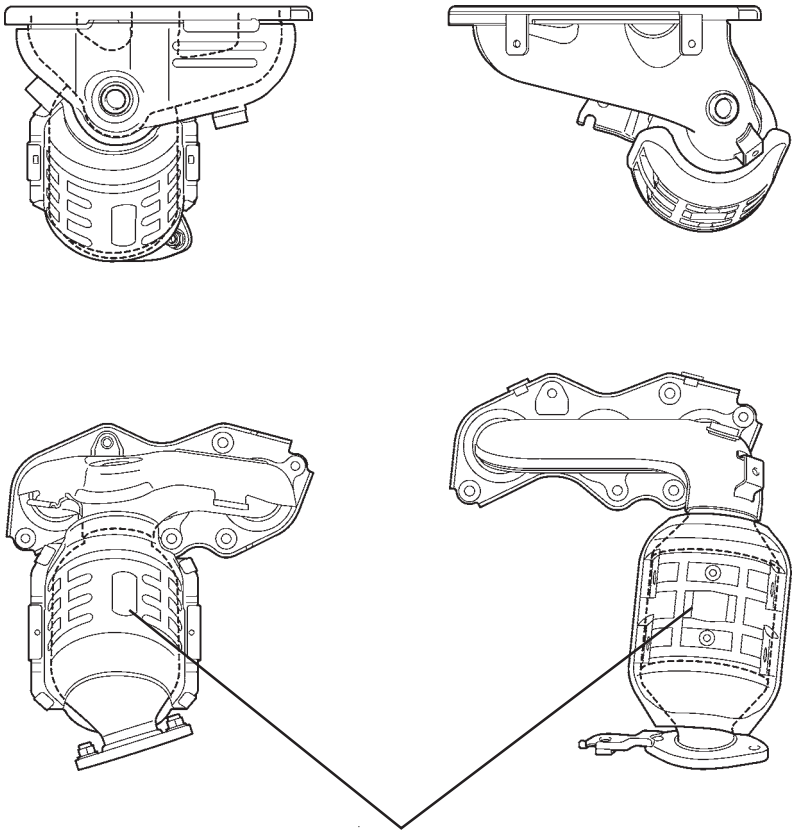
At engine idle or deceleration - a low pressure (negative pressure) exists after the throttle butterfly. This low pressure opens the by-pass valve in the Supercharger (via the vaccum actuator) which equalises the pressure both before and after the supercharger. Effectively no boost is achieved whenever the bypass valve is wide open.
Acceleration heavy load - Throttle butterfly is opened, the pressure both before and after the throttle butterfly equalises, this causes the by-pass valve to close effectively supplying boost pressure to the combustion chamber.



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5. Exhaust Manifold

- A stainless steel exhaust manifold with an integrated TWC is used for warm-up of the TWC and for weight reduction.
- A ceramic type TWC is used. This TWC is incorporated on each of the right and left banks.
- This TWC enables to improve exhaust emissions by optimising the cells density and the wall thickness.



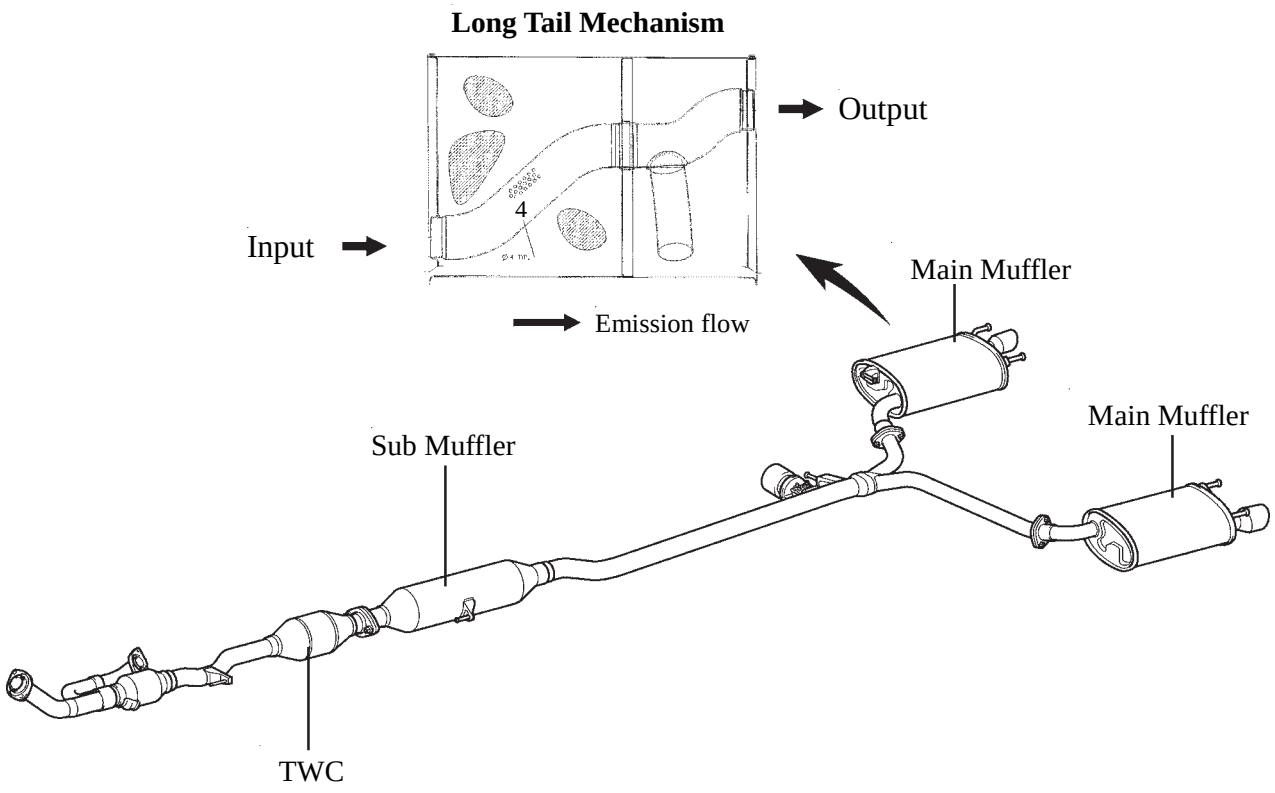
Right Bank Exhaust Manifold

Left Bank Exhaust Manifold

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6. Exhaust Pipe

- The exhaust pipe is made of stainless steel for improved rust resistance.
- A ceramic type TWC is used.
- The shape of the muffler outlet pipe, the size and density of the perfurations in the passage tube the bag contents within the muffler were all developed to achieve a target exhaust note.
- The muffler casing is common to a standard Aurion however most of the internals and tail pipe are unique for TRD.



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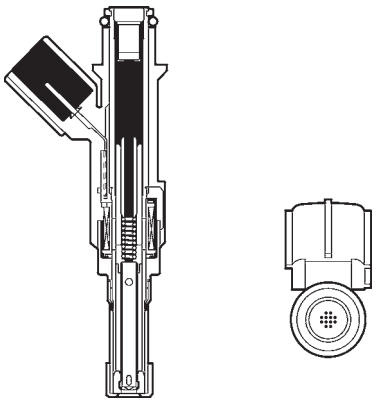
✹ FUEL SYSTEM

1. General

- The fuel return less system is used to reduce evaporative emissions.
- A fuel cut control is used to stop the fuel pump when the SRS airbag is deployed in a frontal or side collision.
- The fuel delivery pipe made of plastic is used.
- A quick connector is used to connect the fuel pipe with the fuel hose for excellent serviceability.
- A new high flow compact 12-hole type injector is used to increase fuel quantity required for the increased air mass.
- A compact fuel pump in which a fuel filter, pressure regulator, and fuel sender gauge is integrated in the fuel pump assembly is used.

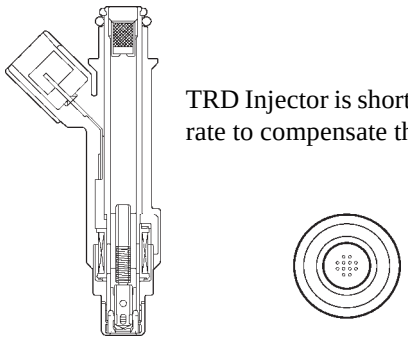
Injector

Standard Aurion



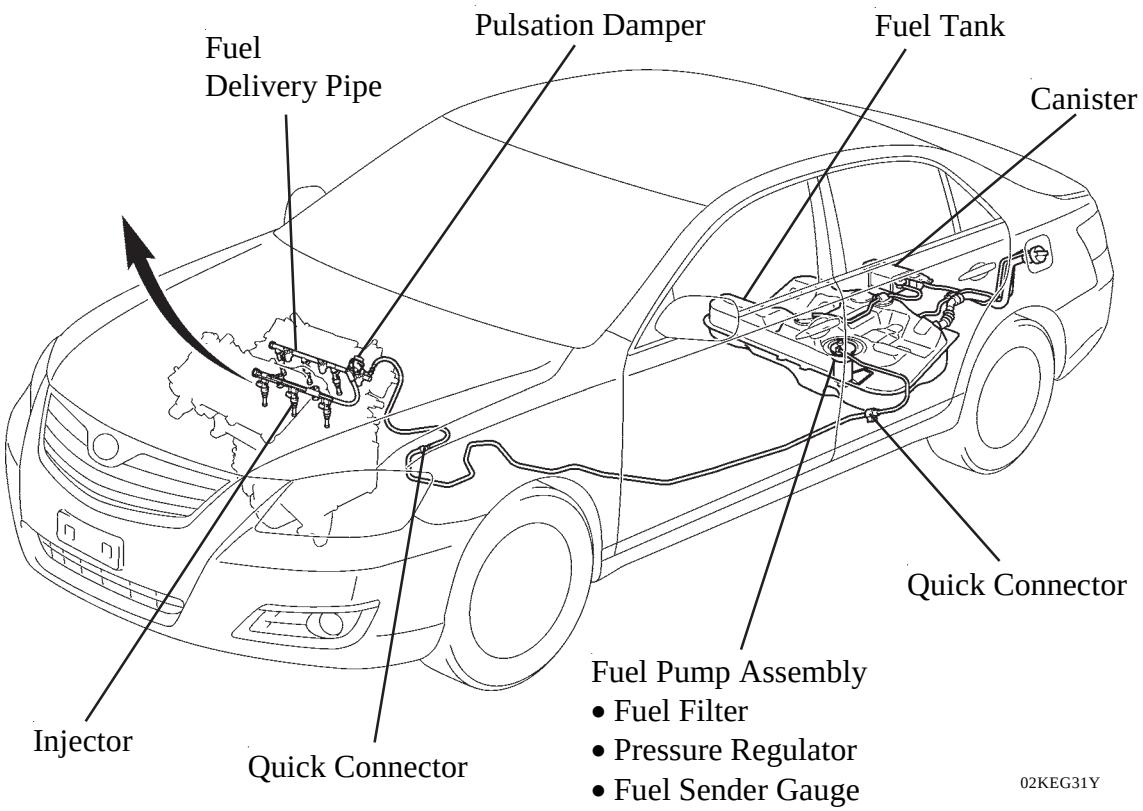
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TRD Aurion



TRD Injector is shorter with a higher flow rate to compensate the increased air volume

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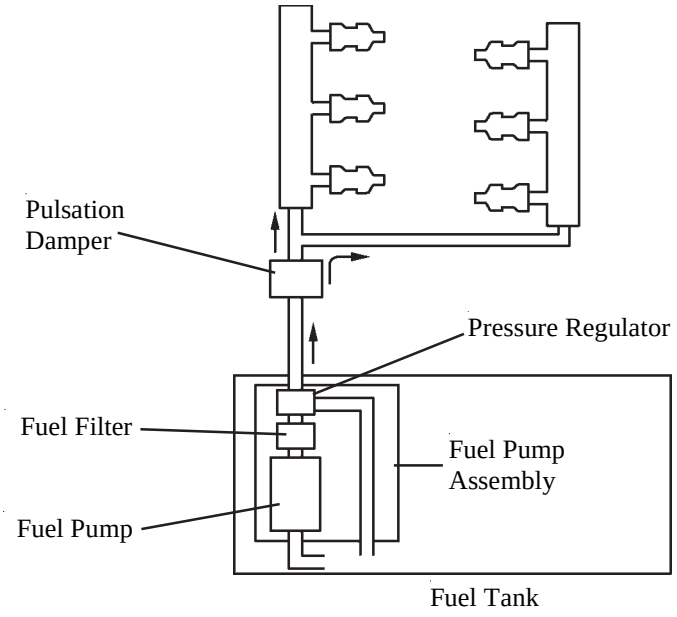


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2. Fuel Return less System

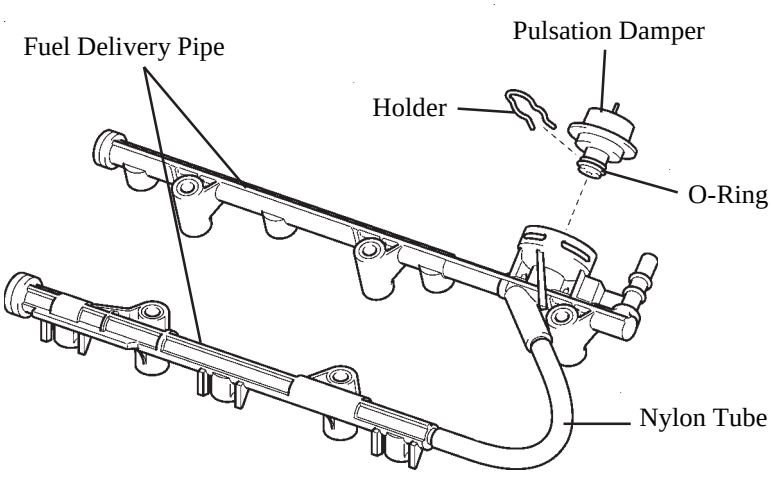
This system is used to reduce the evaporative emission. As shown below, integrating the fuel filter, pressure regulator, and fuel sender gauge with fuel pump assembly, it possible to discontinue the return of fuel from the engine area and prevent temperature rise inside the fuel tank.



208EG117

3. Fuel Delivery Pipe

- The fuel delivery pipe made of plastic is used to realise lightweight.
- The right and left fuel delivery pipes are connected by a nylon tube.
- The pulsation damper is sealed with an O-ring and secured with a holder.



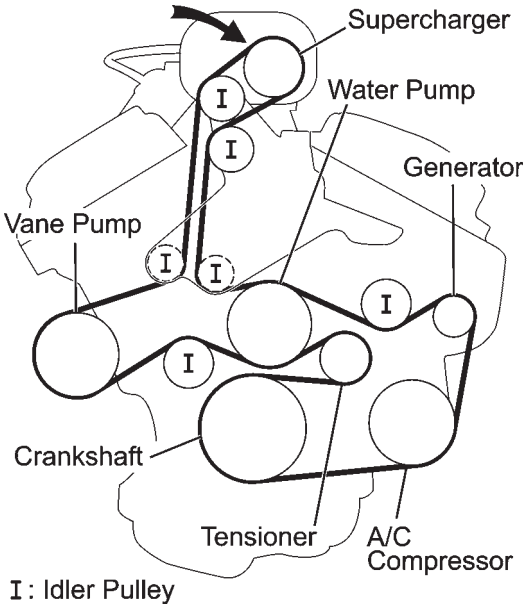
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✹ SERPENTINE BELT DRIVE SYSTEM

1. General

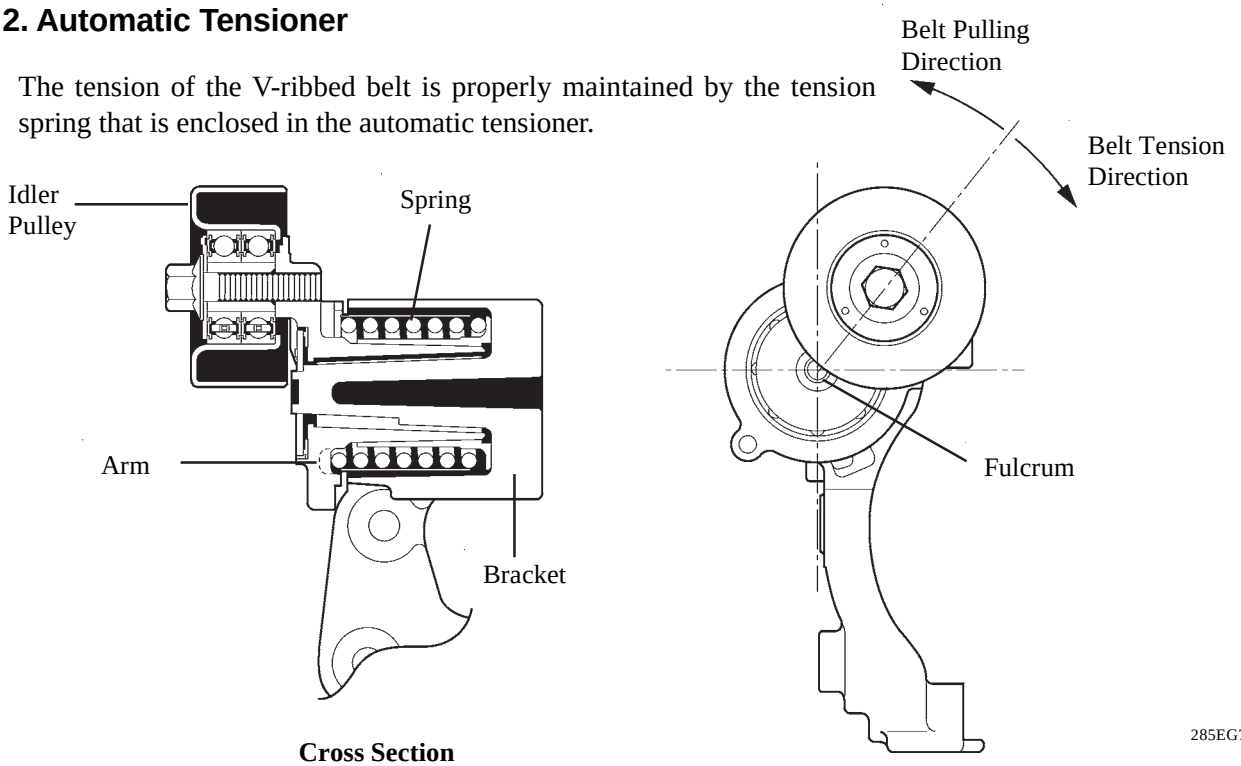
- Accessory components are driven by a serpentine belt consisting of a single V-ribbed belt. It reduces the overall engine length, weight and number of engine parts.
- An automatic tensioner eliminates the need for tension adjustment.



V-BELT

2. Automatic Tensioner

The tension of the V-ribbed belt is properly maintained by the tension spring that is enclosed in the automatic tensioner.



Cross Section

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✹ ENGINE CONTROL SYSTEM

1. General

The engine control system of the 2GR-FE engine has the following features.

System	Outline
EFI (Electronic Fuel Injection)	• An L-type EFI system directly detects the intake air mass with a hot wire type air flow meter. • The fuel injection system is a sequential multi-port fuel injection system. • Fuel injection takes two forms: Synchronous injection, which always takes place with the same timing in accordance with the basic injection duration and an additional correction based on the signals provided by the sensors. Non-synchronous injection, which takes place at the time an injection request based on the signals provided by the sensors, is detected, regardless of the crankshaft position. • Synchronous injection is further divided into group injection during a cold start, and independent injection after the engine is started.
ESA (Electronic Spark Advance)	• Ignition timing is determined by the engine ECU based on signals from various sensors. The engine ECU corrects ignition timing in response to engine knocking. • This system selects the optimal ignition timing in accordance with the signals received from the sensors and sends the (IGT) ignition signal to the igniter.
ETCS-i (Electronic Throttle Control System-intelligent)	Optimally controls the throttle valve opening in accordance with the amount of accelerator pedal effort and the condition of the engine and the vehicle.
Dual VVT-i (Dual Variable Valve Timing-intelligent)	Controls the intake and exhaust camshafts to optimal valve timing in accordance with the engine condition.
ACIS (Acoustic Control Induction System)	Not used with Supercharger
Air Intake Control System	The intake air duct is divided into two areas. With the Supercharger, the engine ECU controls the air intake control valve (via the VSV and actuator) to permanently remain open whenever the engine is running.
Fuel Pump Control	• Fuel pump operation is controlled by signals from the engine ECU. • The fuel pump is stopped, when the SRS airbag is deployed in a frontal, side, and rear of side collision.

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System	Outline
Air Conditioner Cut-off Control	By turning the air conditioner compressor ON or OFF in accordance with the engine condition, drivability is maintained.
Cooling Fan Control	The Cooling Fan ECU linearly controls the speed of the fans in accordance with the engine coolant temperature, vehicle speed, engine speed, and air conditioner operating conditions. As a result, the cooling performance is improved.
Starter Control* (Cranking Hold Function)	• Once the engine switch is pushed, while the brake pedal is depressed, this control continues to operate the starter until the engine started.
Air Fuel Ratio Sensor and Oxygen Sensor Heater Control	Maintains the temperature of the air fuel ratio sensor or oxygen sensor at an appropriate level to increase accuracy of detection of the oxygen concentration in the exhaust gas.
Evaporative Emission Control	The engine ECU controls the purge flow of evaporative emission (HC) in the canister in accordance with engine conditions.
Active Control Engine Mount [See page EG-34]	The damping characteristic of the front engine mount is controlled variably to reduce idling vibration.
Engine Immobiliser	Prohibits fuel delivery and ignition if an attempt is made to start the engine with an invalid key.
Diagnosis	When the engine ECU detects a malfunction, the engine ECU diagnoses and memorises the failed section.
Fail-Safe	When the engine ECU detects a malfunction, the engine ECU stops or controls the engine according to the data already stored in the memory.

*: Only for models with smart entry and start system

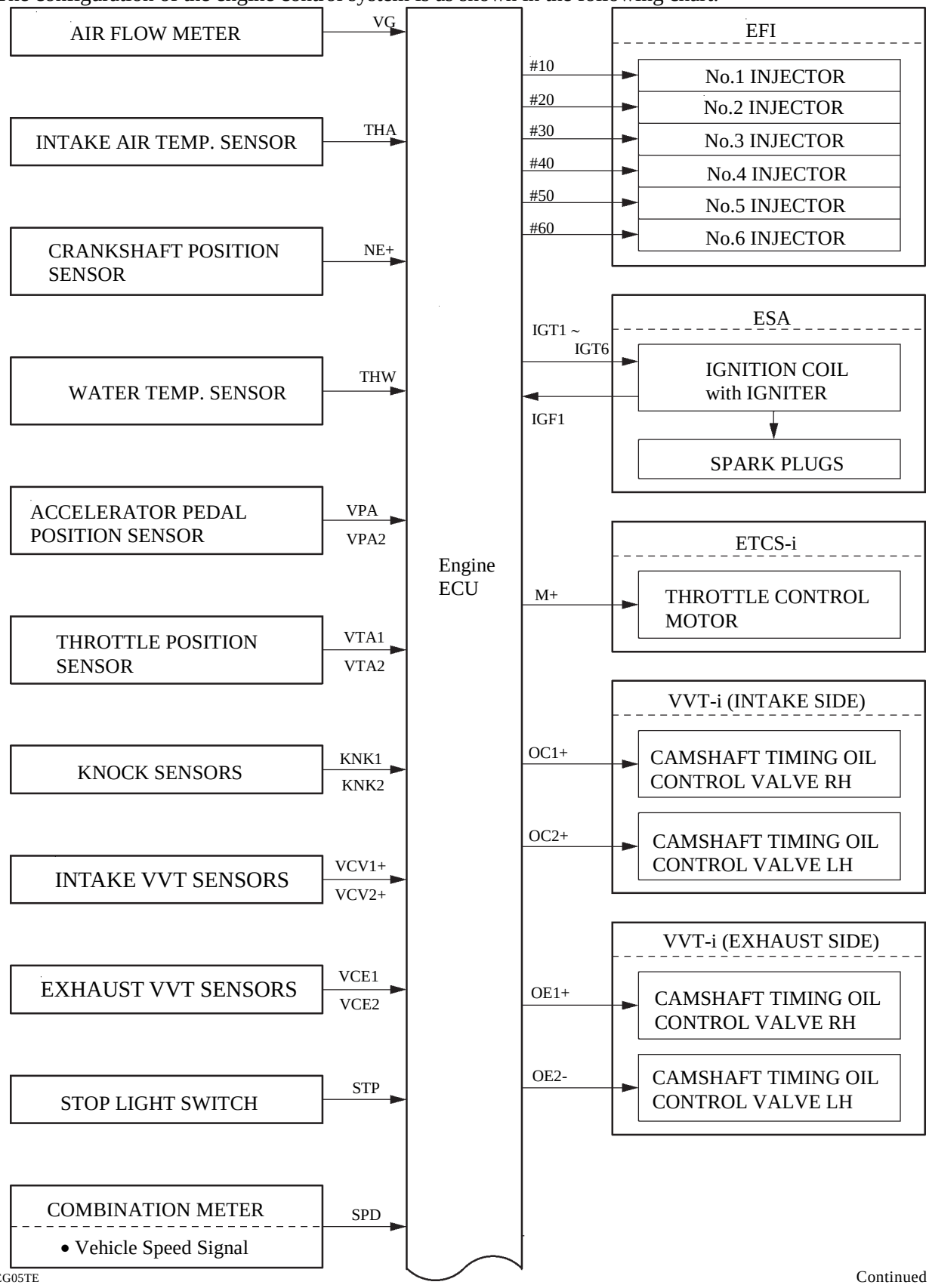
Engine Calibration

- Optimised to deliver maximum torque
- Fast throttle response, achieved by power enrichment and TRD pedal mapping
- Fast throttle response
- Euro 4 emissions compliant
- Standard Aurion fuelling strategy adopted at cruising speeds
- Software has been modified for higher intake pressures
- Full engine calibration carried out to optimise power and torque, but maintain Standard Aurion driveability, fuel economy and durability

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2. Construction

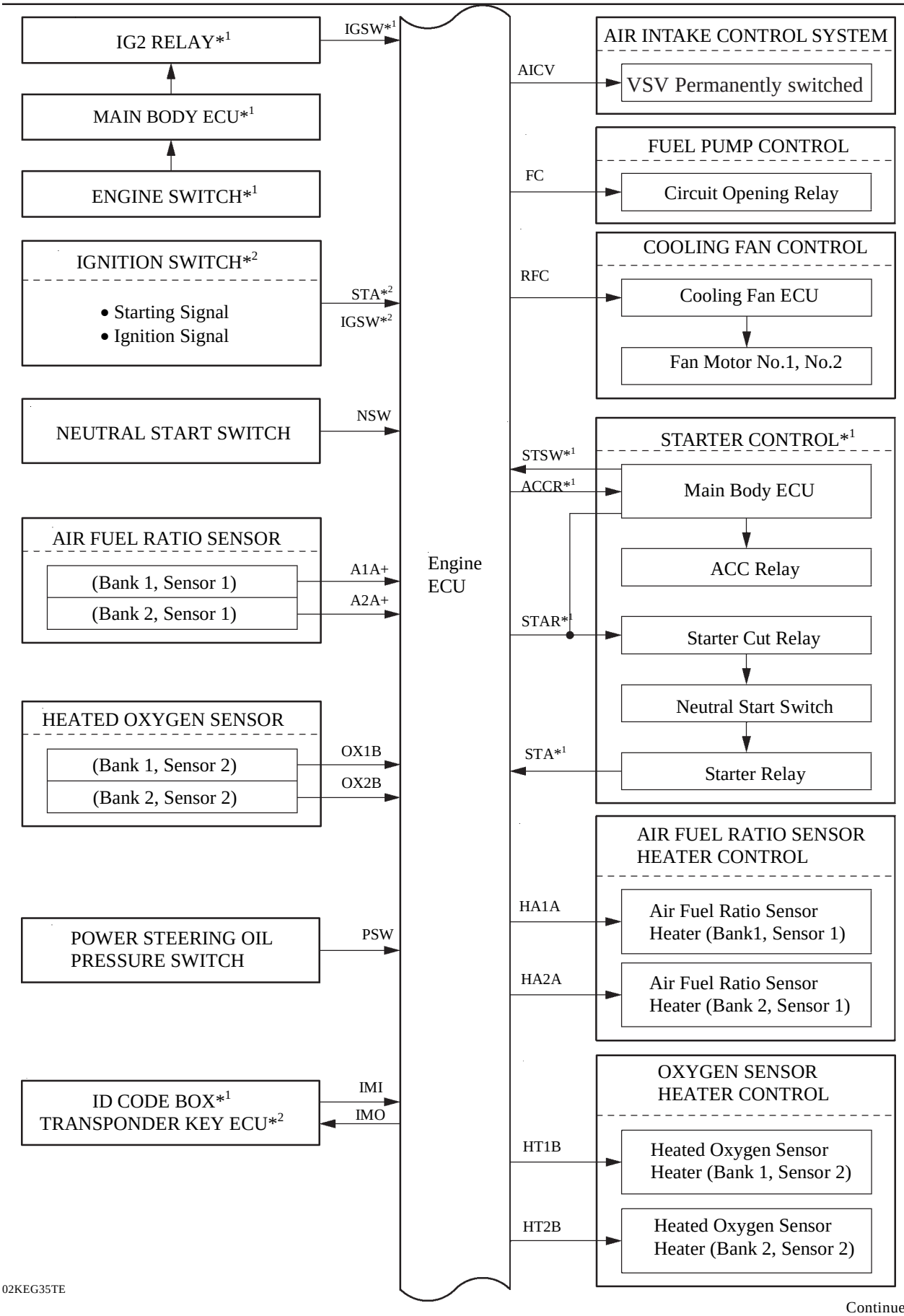
The configuration of the engine control system is as shown in the following chart.



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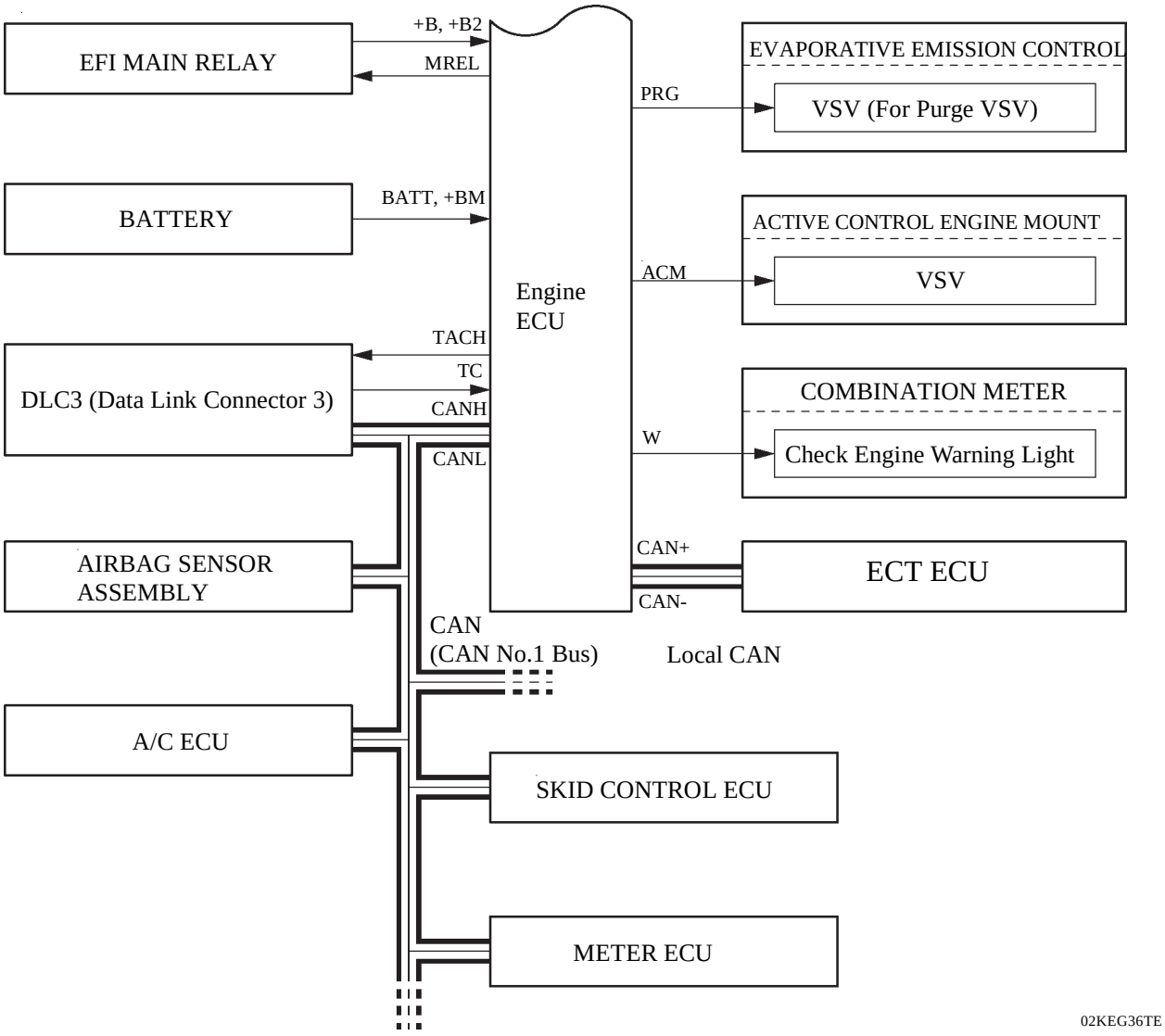
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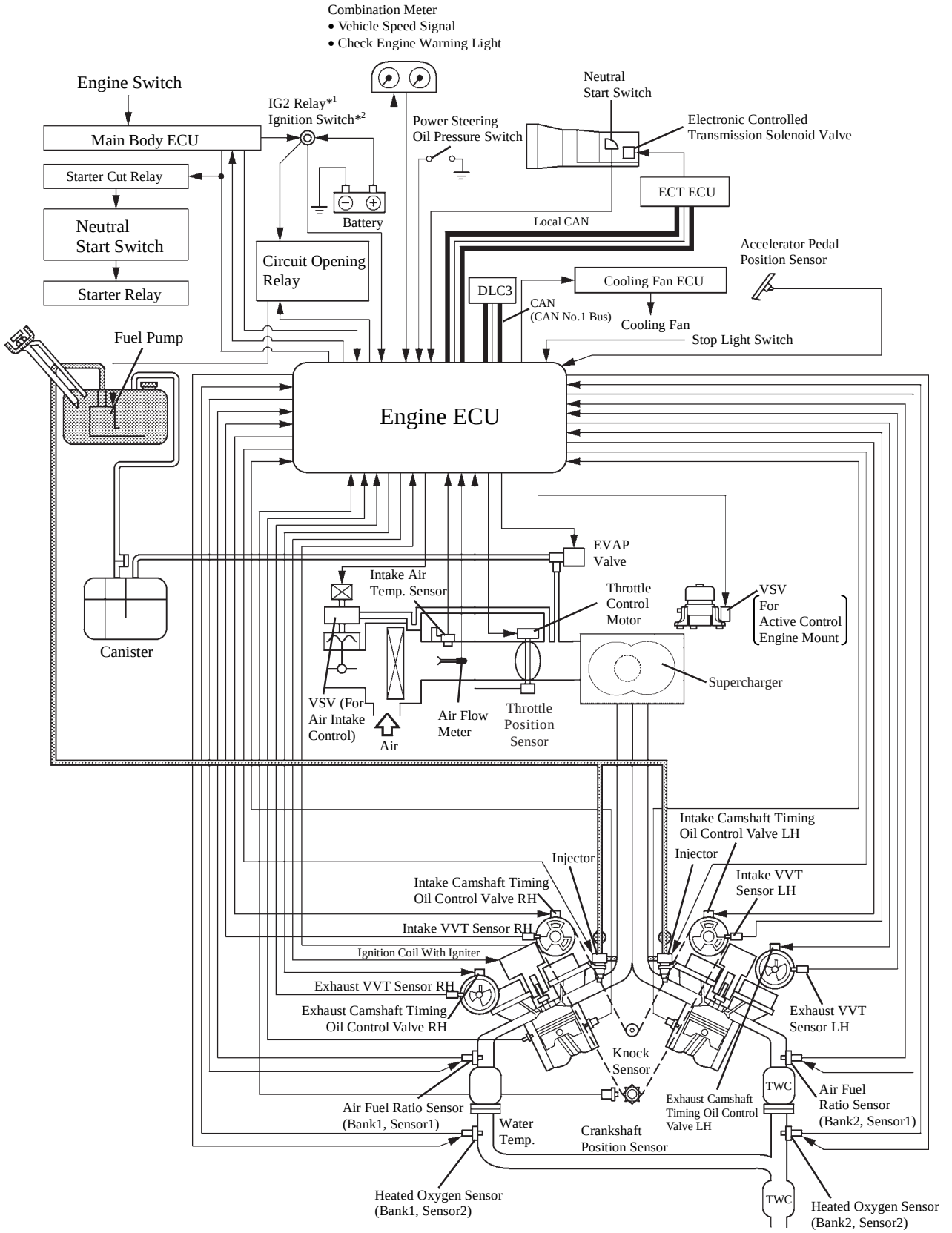
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*1: Only for models with smart entry and start system
*2: Only for models without smart entry and start system

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3. Engine Control System Diagram



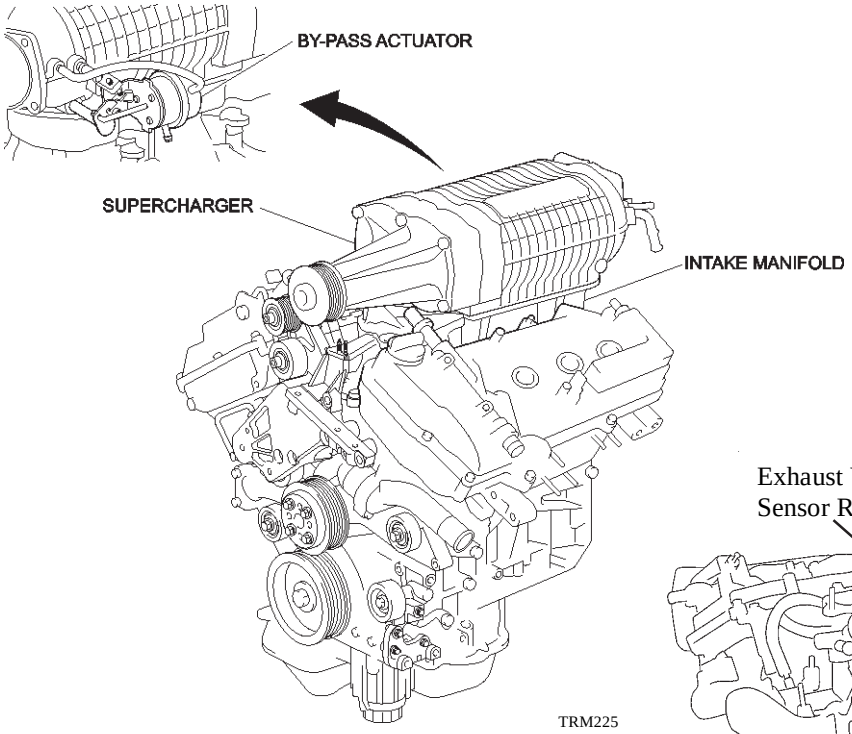
*1: Only for models with smart entry and start system

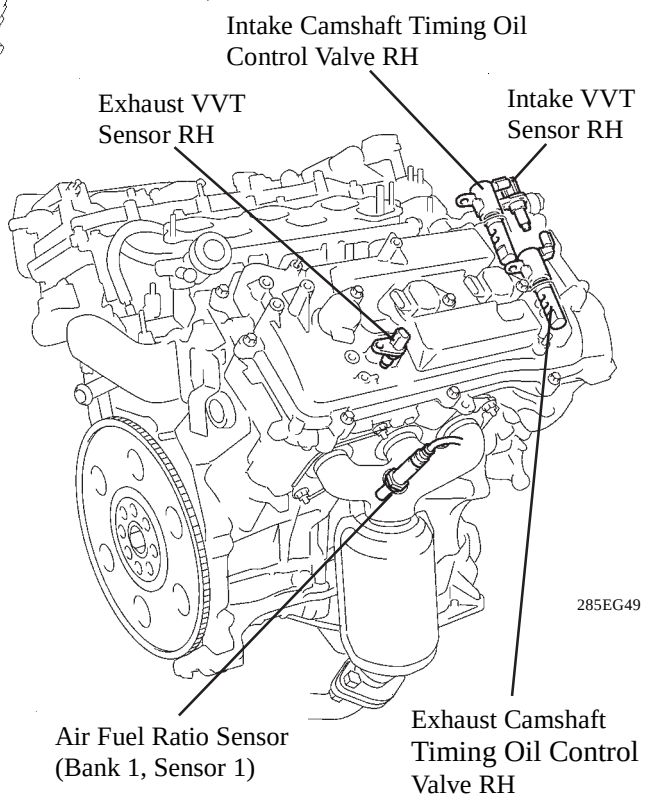
*2: Only for models without smart entry and start system

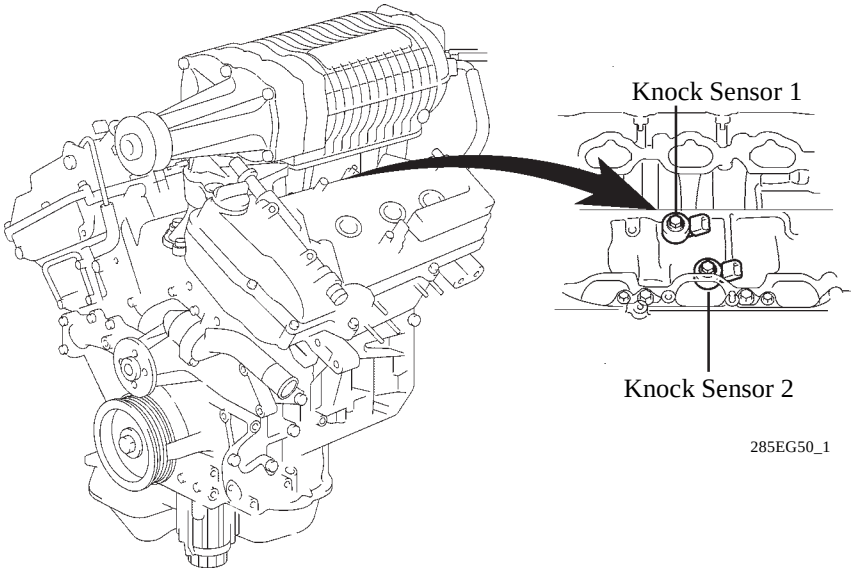
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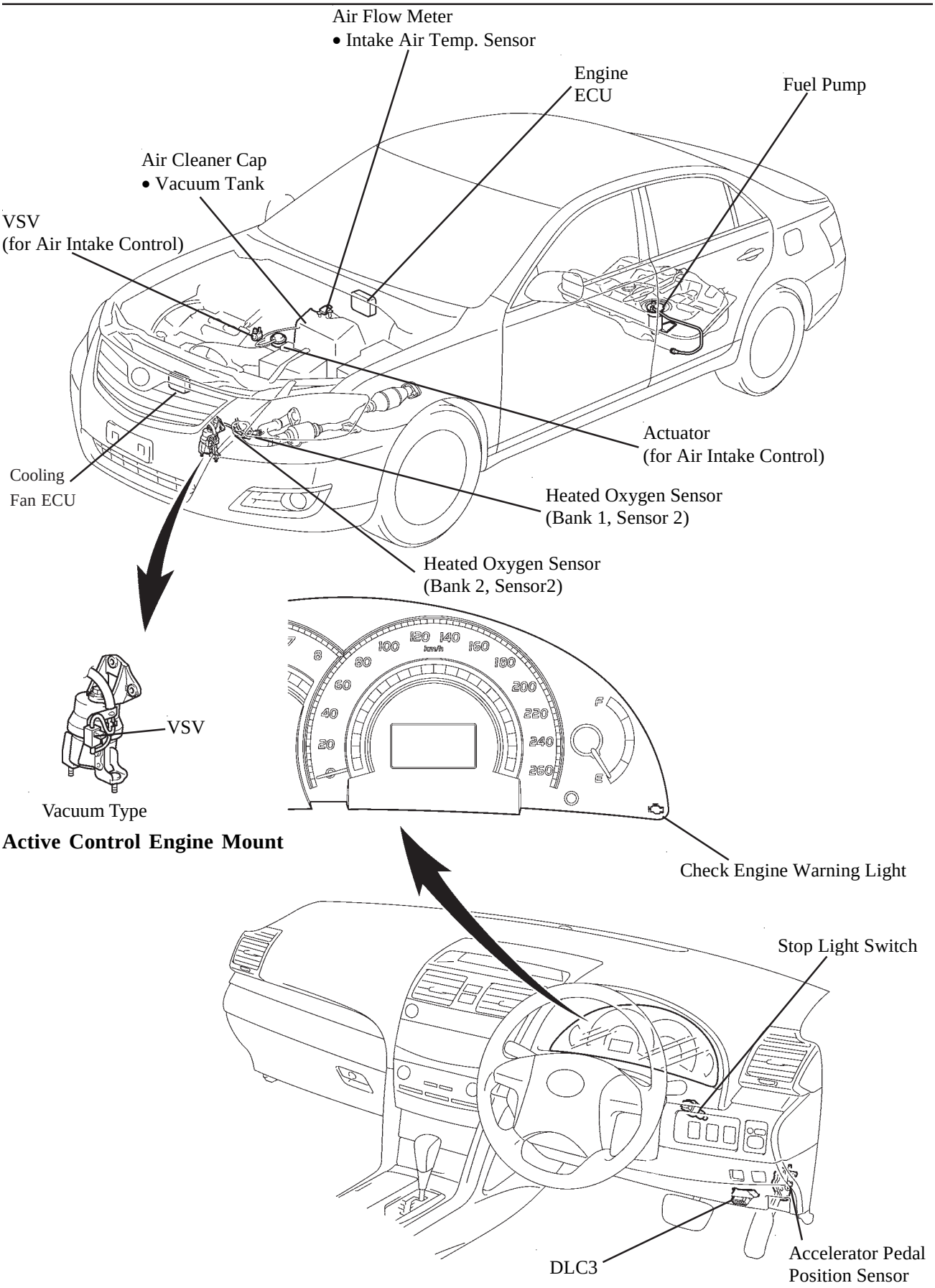
4. Layout of Main Components







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5. Main Component of Engine Control System

General

The main components of the 2GR-FE engine control system are as follows:

Components	Outline	Qty	Function
Engine ECU	32-bit CPU	1	The engine ECU optimally controls the EFI ESA and ISC to suit the operating conditions of the engine in accordance with the signals provided by the sensors.
Oxygen Sensor (Bank 1, Sensor 2) (Bank 2, Sensor 2)	Cup Type with Heater	2	• This sensor detects the oxygen concentration in the exhaust emission by measuring the electromotive force which is generated in the sensor itself.
Air Fuel Ratio Sensor (Bank 1, Sensor 1) (Bank 2, Sensor 1)	Planar Type with Heater	2	• As with the oxygen sensor, this sensor detects the oxygen concentration in the exhaust emission. However, it detects the oxygen concentration in the exhaust emission linearly.
Air Flow Meter	Hot-wire Type	1	• This sensor has a built-in hot-wire to directly detect the intake air mass.
Crankshaft Position Sensor (Rotor Teeth)	Pick-up Coil Type (36-2)	1	This sensor detects the engine speed and performs the cylinder identification.
Intake VVT Sensor LH, RH (Rotor Teeth)	MRE Type (3)	2	This sensor performs the cylinder identification.
Exhaust VVT Sensor LH, RH (Rotor Teeth)	MRE Type (3)	2	This sensor performs the cylinder identification.
Water Temperature Sensor	Thermistor Type	1	This sensor detects the engine coolant temperature by means of an internal thermistor.
Intake Air Temperature Sensor	Thermistor Type	1	This sensor detects the intake air temperature by means of an internal thermistor.
Knock Sensor 1,2	Built-in Piezoelectric Type (Flat Type)	2	This sensor detects an occurrence of the engine knocking indirectly from the vibration of the cylinder block caused by the occurrence of engine knocking.
Throttle Position Sensor	No-contact Type	1	• This sensor detects the throttle valve opening angle.
Accelerator Pedal Position Sensor	No-contact Type	1	• This sensor detects the amount of pedal effort applied to the accelerator pedal.
Injector	12-Hole Type	6	The injector is an electromagnetically-operated nozzle which injects fuel in accordance with signals from the engine ECU.

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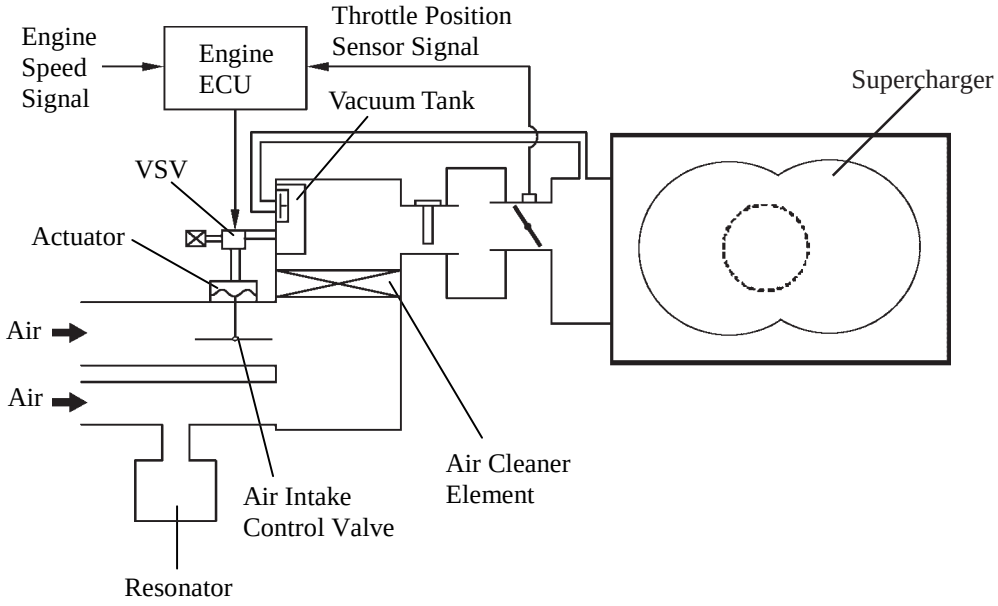
6. Air Intake Control System

General

The system has a dual path design for air intake. An air intake control valve and actuator control the air flow path.
With the fitment of the supercharger the Air Intake Control System is not needed, therefore the valve is constantly open whenever the engine is running.

Operation

- Whenever the engine is operating, the engine ECU operates the VSV to open the air intake control valve. As a result, the intake area has been maximised and the intake efficiency is improved even at low speeds.



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