FUEL

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MULTIPOINT INJECTION (MPI)

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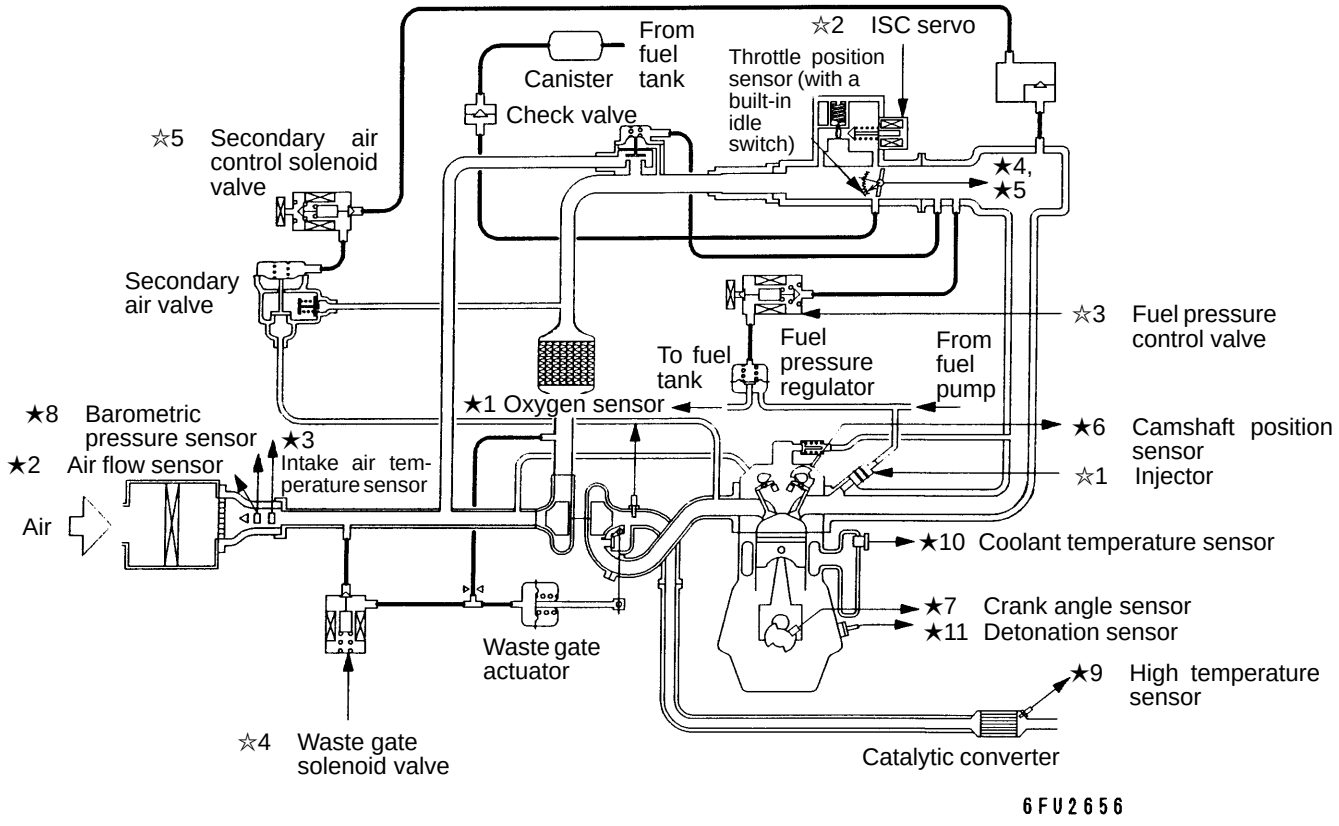


Given above is the MPI system diagram for EVOLUTION-IV. The MPI system for EVOLUTION-V is different from this in the following point;

- Oxygen sensor with a heater is adopted.
- The diagnosis connector power supply circuit is different.
- The high temperature sensor is no longer used.

SERVICE SPECIFICATIONS

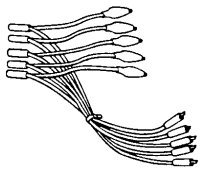
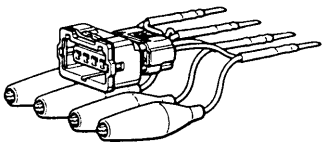
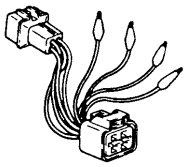
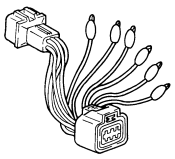
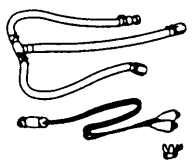
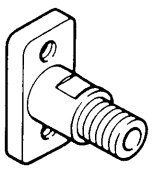
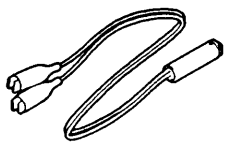
Items			Specifications
Basic ignition timing °BTDC			5 ± 3
Basic idle speed rpm			850 ± 50
Throttle position sensor adjusting voltage mV			400 – 1,000
Throttle position sensor resistance kΩ			3.5 – 6.5
ISC servo coil resistance (at 20°C) Ω			28 – 33
Intake air temperature sensor resistance kΩ		At 20°C	2.3 – 3.0
		At 80°C	0.30 – 0.42
Coolant temperature sensor resistance kΩ		At 20°C	2.1 – 2.7
		At 80°C	0.26 – 0.36
Fuel pressure kPa {kgf/cm^2}	When vacuum hose is connected		230 {2.35}
	When vacuum hose is disconnected		289 – 309 {2.95 – 3.15}
Injector coil resistance Ω			2 – 3
Amount of injector fuel leak drop/min			1 or less
Oxygen sensor output voltage			0.6 – 1.0
Fuel pressure control valve coil resistance (at 20°C) Ω			28 – 36

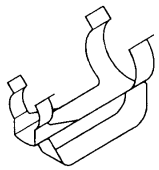
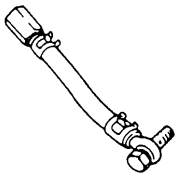
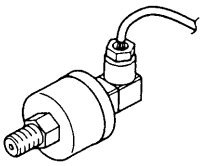
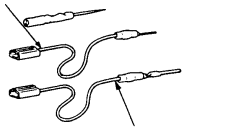
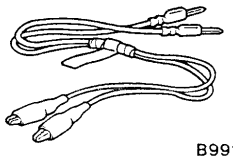
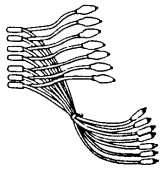
SEALANT

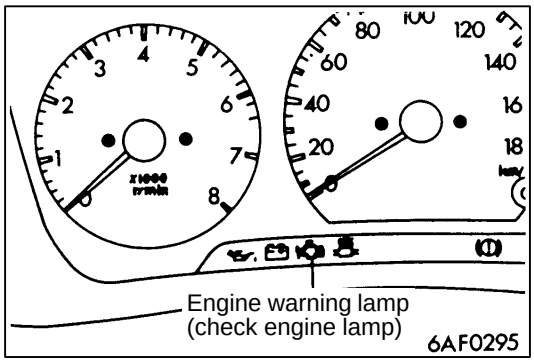
Item	Specified sealant
Coolant temperature sensor	Drying sealant: HELMESEAL H-1M [0110513]

NOTE:
Given in [ ] are MITSUBISHI GENUINE PART numbers.

SPECIAL TOOLS

Tool	Number	Name	Use
	MB991348	Test harness set	• Measurement of voltage during trouble-shooting • Inspection using an oscilloscope
	MB991519	Alternator harness connector	Measurement of voltage during troubleshooting
	MB991536	TPS check harness	Adjustment of idle switch and throttle position sensor (TPS)
	MD998464	Test harness (4-pin, square)	Inspection of oxygen sensor
	MD998463	Test harness (6-pin, square)	• Inspection of idle speed control servo • Inspection using an oscilloscope
	MD998478	Test harness (3-pin, triangle)	• Measurement of voltage during trouble-shooting • Inspection using an oscilloscope
	MD998706	Injector test set	Checking the spray condition of injectors
	MD998741	Injector test adaptor	
	MB991607	Injector test harness	

Tool	Number	Name	Use
	MD998746	Clip	Checking the spray condition of injectors
	MD998709	Adaptor hose	Measurement of fuel pressure
	MD998742	Hose adaptor	
	MB991637	Fuel pressure gauge set	
	MB991223	Inspection test herness set ● Pin contact pressure inspection harness ● Market tester contact probe (for general connectors)	Measurement of terminal voltage
	MB991529	Diagnostic trouble code check harness	Reading of diagnosis codes
	MB991709	Test harness	● Measurement of voltage during trouble-shooting ● Inspection using an oscilloscope



TROUBLESHOOTING

1. DIAGNOSIS FUNCTION

1-1 ENGINE WARNING LAMP (CHECK ENGINE LAMP)

If an abnormality occurs in any of the following items related to the Multipoint Fuel Injection (MPI) system, the engine warning lamp will illuminate.
If the lamp remains illuminated or if the lamp illuminates while the engine is running, check the diagnosis code output.

Engine warning lamp inspection items

Engine-ECU
Air flow sensor (AFS)
Intake air temperature sensor
Throttle position sensor (TPS)
Engine coolant temperature sensor
Crank angle sensor
Camshaft position sensor
Barometric pressure sensor
Detonation sensor
Injector
Ignition coil, power transister
Misfire <Evolution-V only>

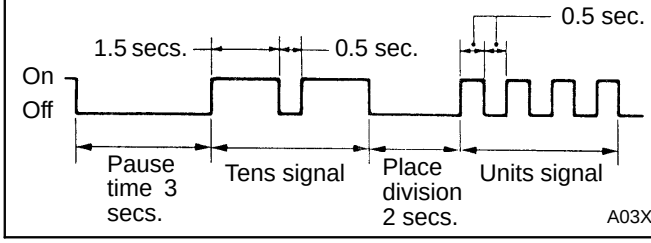
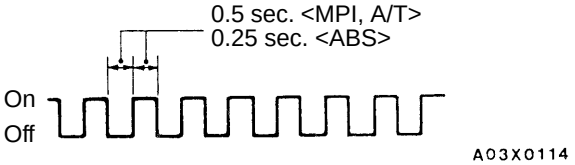
1-2 METHOD OF READING AND ERASING DIAGNOSIS CODES

(1) Use the special tool to earth No.1 terminal (diagnosis control terminal) of the diagnosis connector.
(2) To check ABS system, remove the valve relay.

NOTE
That is because the valve relay is off and the warning lamp remains illuminated if there is a fault in the ABS system.

(3) Turn off the ignition switch.
(4) Read out a diagnosis code by observing how the warning lamp flashes.

Indication of diagnosis code by warning lamp

When the diagnosis code No.24 is output	When no diagnosis code is output*
	

NOTE
*: Even if the ABS system is normal, removing the valve relay causes the diagnosis code No.52 to be output.

1-3 ERASING DIAGNOSIS CODES

(1) Turn the ignition switch to OFF.
(2) After disconnecting the battery cable from the battery (–) terminal for 10 seconds or more, reconnect the cable.
(3) After the engine has warmed up, run it at idle for about 15 minutes.

1-4 FAIL-SAFE FUNCTION REFERENCE TABLE

When the main sensor malfunctions are detected by the diagnosis function, the vehicle is controlled by means of the pre-set control logic to maintain safe conditions for driving.

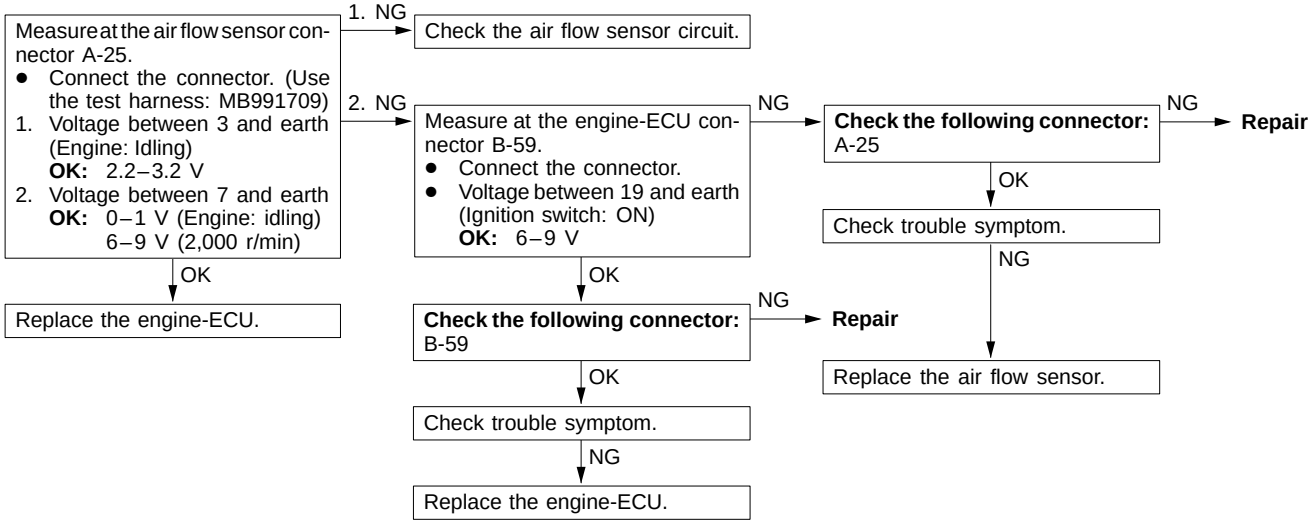
Malfunctioning item	Control contents during malfunction
Air flow sensor (AFS)	(1) Uses the throttle position sensor signal and engine speed signal (crank angle sensor signal) to take reading of the basic injector drive time and basic ignition timing from the pre-set mapping. (2) Fixes the ISC servo in the appointed position so idle control is not performed.
Intake air temperature sensor	Controls as if the intake air temperature is 25°C.
Throttle position sensor (TPS)	No increase in fuel injection amount during acceleration due to the throttle position sensor signal.
Engine coolant temperature sensor	Controls as if the engine coolant temperature is 80°C. (This condition is maintained until the ignition switch is turned off even when the sensor signal returns normal.)
Camshaft position sensor	(1) Injects fuel to all cylinders simultaneously for 4 seconds. (However, after the ignition switch is turned to ON, the No. 1 cylinder top dead centre is not detected at all.) (2) Lets the fan motor (radiator and condensor) run at high speed.
Barometric pressure sensor	Controls as if the barometric pressure is 101 kPa {760 mmHg}.
Detonation sensor	Switches the ignition timing from ignition timing for super petrol to ignition timing for standard petrol.
Ignition coil, power transistor	Cuts off the fuel supply to cylinders with an abnormal ignition.
Alternator FR terminal	Does not control the output of the alternator according to an electrical load. (works as a normal alternator)
Misfire (Evolution-V only)	Cuts off the fuel to the misfiring cylinder if a misfire that could damage the catalyst is detected.

2. INSPECTION CHART FOR DIAGNOSIS CODES

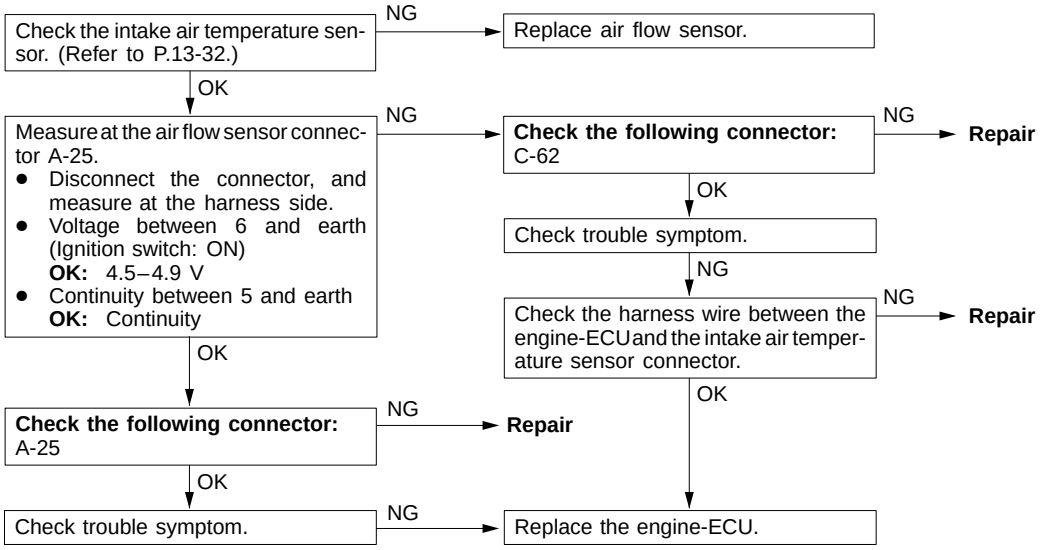
Code No.	Diagnosis item	Reference page
12	Air flow sensor (AFS) system	13-8
13	Intake air temperature sensor system	13-9
14	Throttle position sensor (TPS) system	13-9
21	Engine coolant temperature sensor system	13-10
22	Crank angle sensor system	13-11
23	Camshaft position sensor system	13-11
24	Vehicle speed sensor system	13-12
25	Barometric pressure sensor system	13-13
31	Detonation sensor system	13-14
41	Injector system	13-14
44	Ignition coil and power transistor unit system	13-15
64	Alternator FR terminal system	13-16

3. INSPECTION PROCEDURE FOR DIAGNOSIS CODES

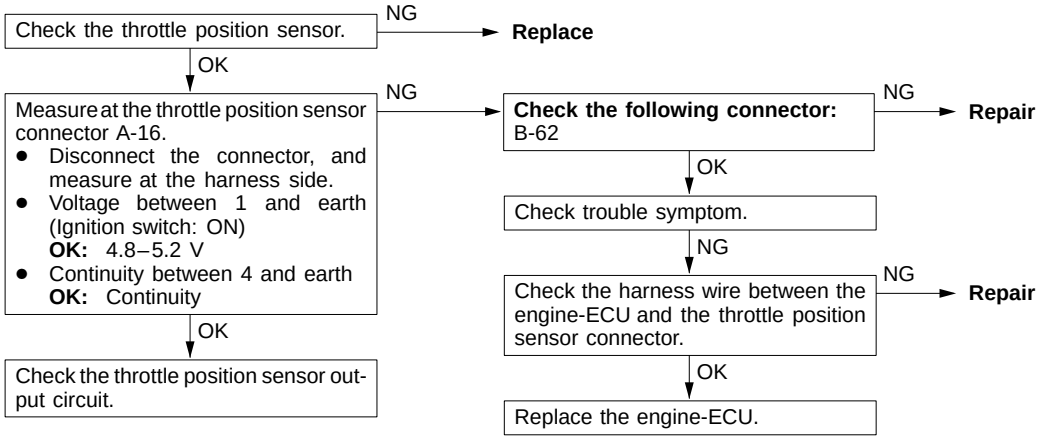
Code No. 12 Air flow sensor (AFS) system	Probable cause
Range of Check ● Engine speed is 500 r/min or more. Set conditions ● Sensor output frequency is 3 Hz or less for 4 seconds.	● Malfunction of the air flow sensor ● Improper connector contact, open circuit or short-circuited harness wire of the air flow sensor ● Malfunction of the engine-ECU



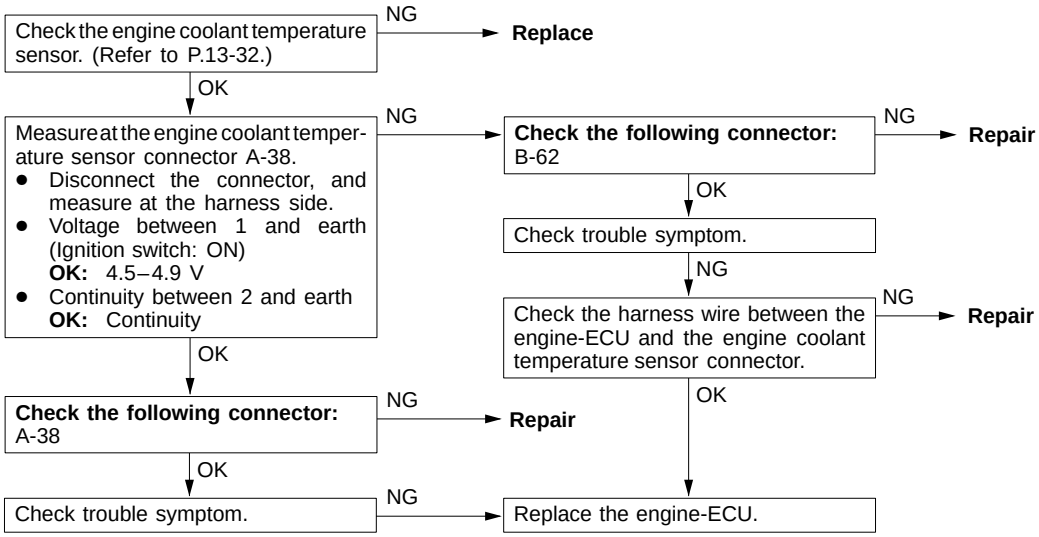
Code No. 13 Intake air temperature sensor system	Probable cause
Range of Check ● Ignition switch: ON ● Excluding 60 seconds after the ignition switch is turned to ON or immediately after the engine starts. Set conditions ● Sensor output voltage is 4.6 V or more (corresponding to an intake air temperature of –45°C or less) for 4 seconds. or ● Sensor output voltage is 0.2V or less (corresponding to an intake air temperature of 125°C or more) for 4 seconds.	● Malfunction of the intake air temperature sensor ● Improper connector contact, open circuit or short-circuited harness wire of the intake air temperature sensor circuit ● Malfunction of the engine-ECU



Code No. 14 Throttle position sensor (TPS) system	Probable cause
Range of Check ● Ignition switch: ON ● Excluding 60 seconds after the ignition switch is turned to ON or immediately after the engine starts. Set conditions ● The sensor output voltage is 0.2 V or less for 4 seconds.	● Malfunction of the throttle position sensor ● Improper connector contact, open circuit or short-circuited harness wire of the throttle position sensor circuit ● Improper “ON” state of idle position switch ● Short circuit of the idle position switch signal line ● Malfunction of the engine-ECU



Code No. 21 Engine coolant temperature sensor system	Probable cause
Range of Check ● Ignition switch: ON ● Excluding 60 seconds after the ignition switch is turned to ON or immediately after the engine starts. Set conditions ● Sensor output voltage is 4.6 V or more (corresponding to an engine coolant temperature of –45°C or less) for 4 seconds. or ● Sensor output voltage is 0.1 V or less (corresponding to an engine coolant temperature of 140°C or more) for 4 seconds.	● Malfunction of the engine coolant temperature sensor ● Improper connector contact, open circuit or short-circuited harness wire of the engine coolant temperature sensor circuit ● Malfunction of the engine-ECU
Range of Check ● Ignition switch: ON ● Engine speed is approx. 50 r/min or more Set conditions ● The sensor output voltage increases from 1.6 V or less (corresponding to an engine coolant temperature of 40°C or more) to 1.6 V or more (corresponding to an engine coolant temperature of 40°C or less). ● After this, the sensor output voltage is 1.6 V or more for 5 minutes.	



Code No. 22 Crank angle sensor system	Probable cause
Range of Check ● Engine is cranking. Set conditions ● Sensor output voltage does not change for 4 seconds (no pulse signal input.)	● Malfunction of the crank angle sensor ● Improper connector contact, open circuit or short-circuited harness wire of the crank angle sensor ● Malfunction of the engine-ECU

Measure at the crank angle sensor connector A-51.
- Connect the connector. (Use the test harness: MD998478.)
- Voltage between 2 (black clip) and earth (Engine: cranking)
  OK: 0.4–4.0 V
- Voltage between 2 (black clip) and earth (Engine: idling)
  OK: 1.5–2.5 V

OK → Replace the engine-ECU.

NG ↓

Measure at the crank angle sensor connector A-51.
- Disconnect the connector, and measure at the harness side.

1. Voltage between 3 and earth (Ignition switch: ON)
   OK: System voltage
2. Voltage between 2 and earth (Ignition switch: ON)
   OK: 4.8–5.2 V
3. Continuity between 1 and earth
   OK: Continuity

1. NG → Check the harness wire between the crank angle sensor and the control relay connector, and repair if necessary.

2. NG → **Check the following connector:** B-62 → NG → **Repair**

OK ↓

Check the following connector: A-51 → NG → **Repair**

OK ↓

Check trouble symptom.

NG ↓

Replace the crank angle sensor.

OK ↓

Check trouble symptom.

NG ↓

Check the harness wire between the engine-ECU and the crank angle sensor connector. → NG → **Repair**

OK ↓

Replace the engine-ECU.

3. NG → Check the harness wire between the crank angle sensor and the earth, and repair if necessary.

Code No. 23 Camshaft position sensor system	Probable cause
Range of Check ● Ignition switch: ON ● Engine speed is approx. 50 r/min or more. Set conditions ● Sensor output voltage does not change for 4 seconds (no pulse signal input.)	● Malfunction of the camshaft position sensor ● Improper connector contact, open circuit or short-circuited harness wire of the camshaft position sensor circuit ● Malfunction of the engine-ECU

Measure at the camshaft position sensor connector A-97.
- Connect the connector.
- Voltage between 2 and earth (Engine: cranking)
  OK: 0.4–3.0 V
- Voltage between 2 and earth (Engine: idling)
  OK: 0.5–2.0 V

OK → Replace the engine-ECU.

NG ↓

Measure at the camshaft position sensor connector A-97.
- Disconnect the connector, and measure at the harness side.

1. Voltage between 3 and earth (Ignition switch: ON)
   OK: System voltage
2. Voltage between 2 and earth (Ignition switch: ON)
   OK: 4.8–5.2 V
3. Continuity between 1 and earth
   OK: Continuity

1. NG → Check the harness wire between the camshaft position sensor and the control relay connector, and repair if necessary.

2. NG → **Check the following connector:** B-62 → NG → **Repair**

OK ↓

Check the following connector: A-97 → NG → **Repair**

OK ↓

Check trouble symptom.

NG ↓

Replace the camshaft position sensor.

OK ↓

Check trouble symptom.

NG ↓

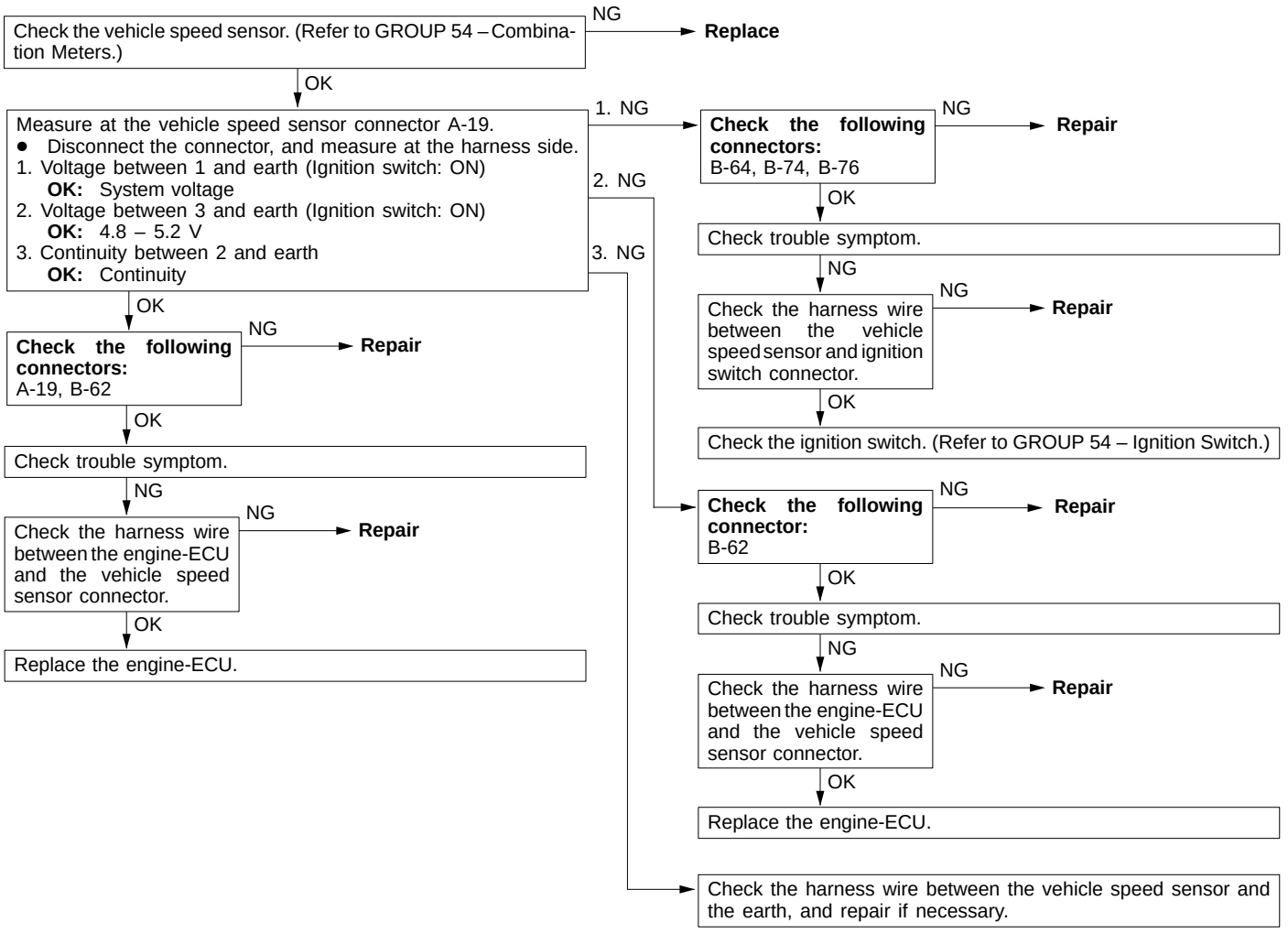
Check the harness wire between the engine-ECU and the camshaft position sensor connector. → NG → **Repair**

OK ↓

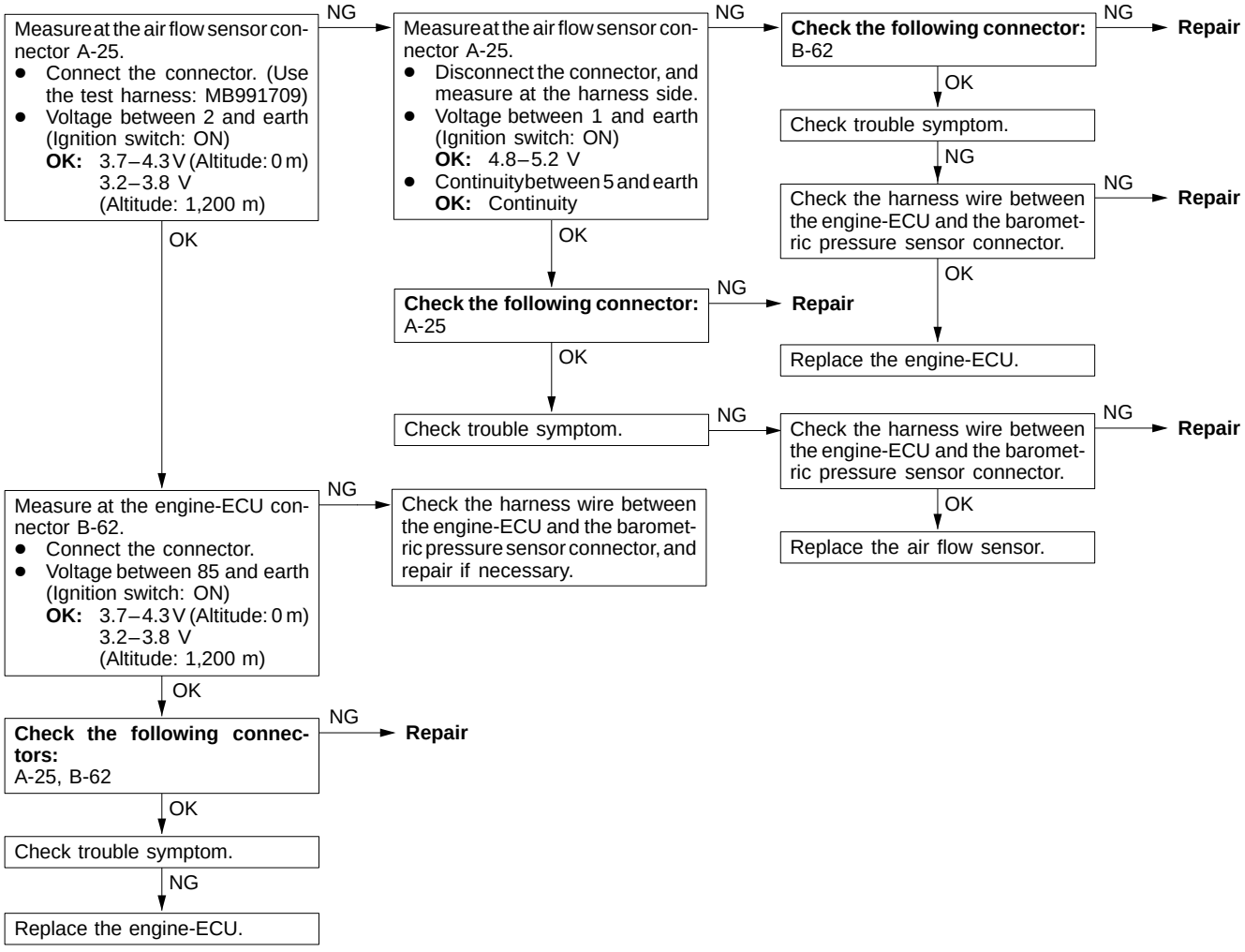
Replace the engine-ECU.

3. NG → Check the harness wire between the camshaft position sensor and the earth, and repair if necessary.

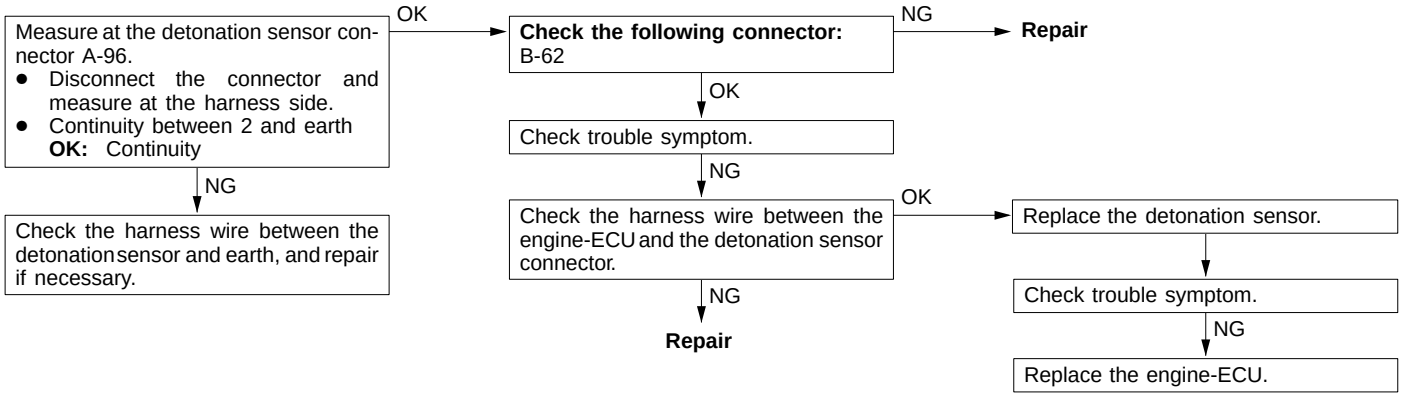
Code No. 24 Vehicles speed sensor system	Probable cause
Range of check ● Ignition switch: ON ● Excluding 60 seconds after the ignition switch is turned to ON or immediately after the engine starts. ● Idle position switch: OFF ● Engine speed is 3,000 r/min or more. ● Driving under high engine load conditions. Set conditions ● Sensor output voltage does not change for 4 seconds (no pulse signal input).	● Malfunction of the vehicle speed sensor ● Improper connector contact, open circuit or short-circuited harness wire of the vehicle speed sensor circuit ● Malfunction of the engine-ECU



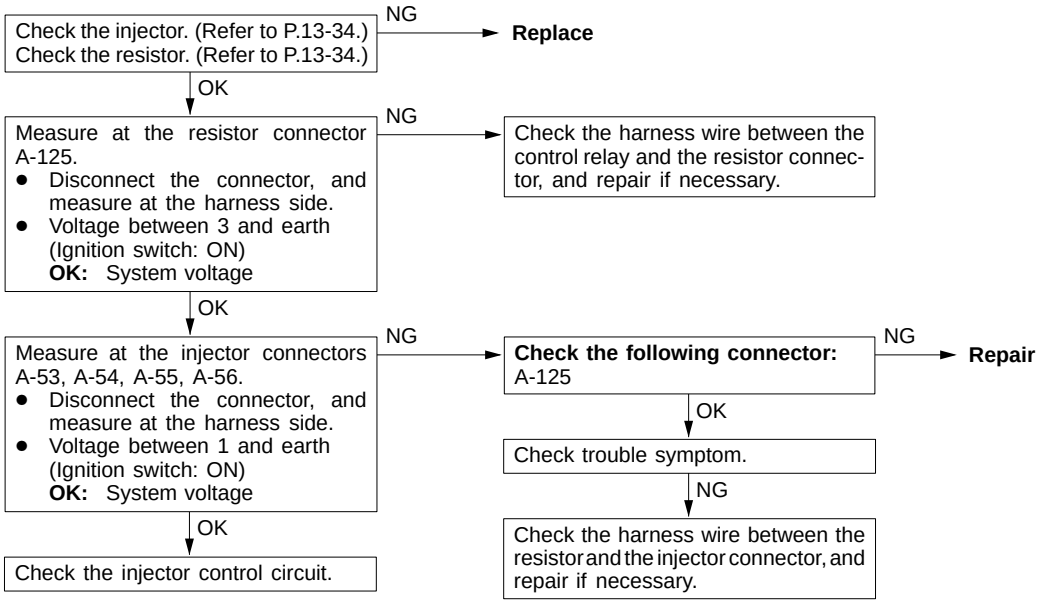
Code No. 25 Barometric pressure sensor system	Probable cause
Range of Check ● Ignition switch: ON ● Excluding 60 seconds after the ignition switch is turned to ON or immediately after the engine starts. Set conditions ● Sensor output voltage is 4.5 V or more (corresponding to a barometric pressure of 114 kPa {855 mmHg} or more) for 4 seconds. or ● Sensor output voltage is 0.2 V or less (corresponding to a barometric pressure of 53 kPa {40 mmHg} or less) for 4 seconds.	● Malfunction of the barometric pressure sensor ● Improper connector contact, open circuit or short-circuited harness wire of the barometric pressure sensor circuit ● Malfunction of the engine-ECU



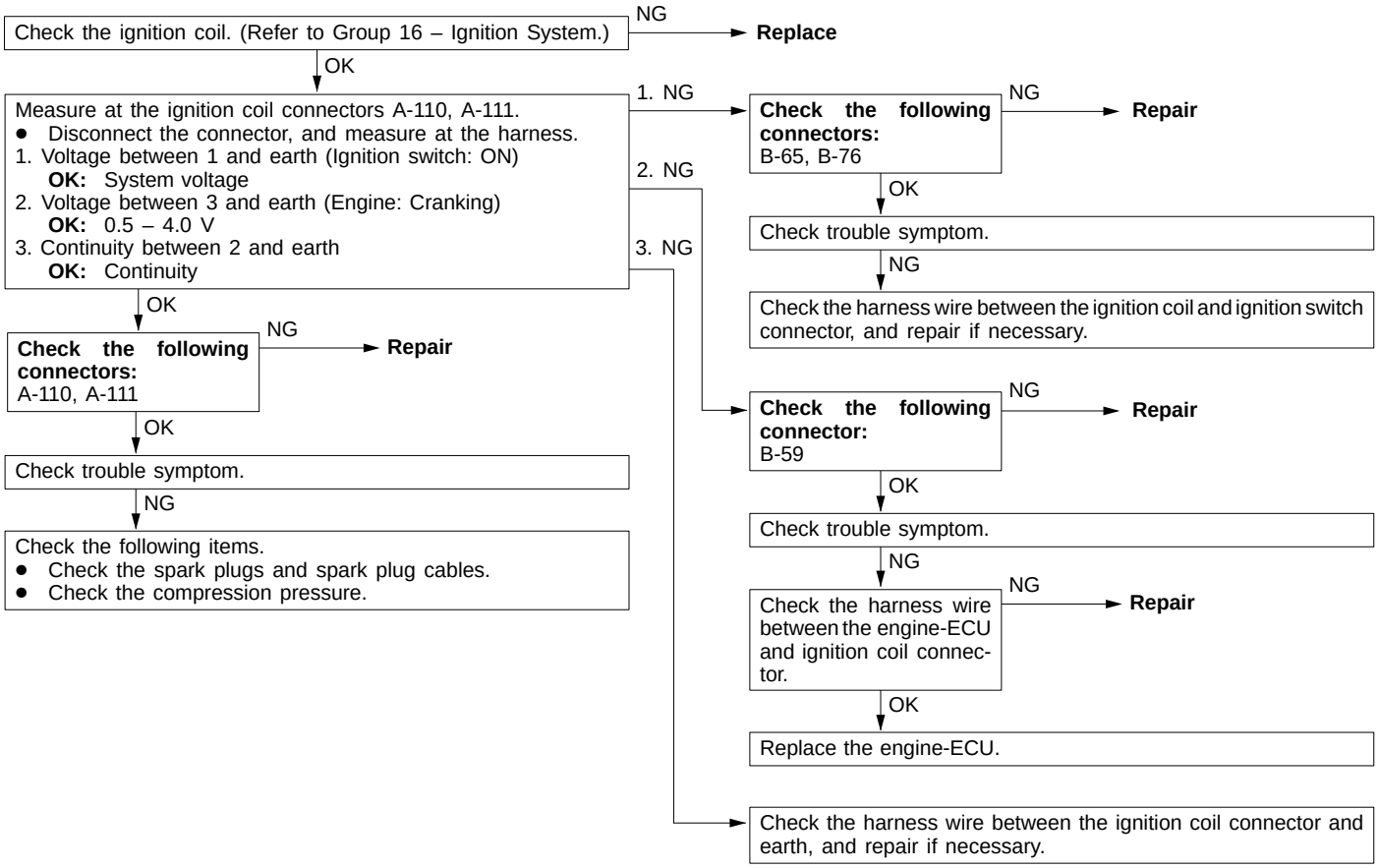
Code No.31 Detonation sensor system	Probable cause
Range of Check ● Ignition switch: ON ● Excluding 60 seconds after the ignition switch is turned to ON or immediately after the engine starts. ● Engine speed is approx. 5,000 r/min or more Set conditions The change in the detonation sensor output voltage (detonation sensor peak voltage at each 1/2 revolution of the crankshaft) is less than 0.06 V for 200 times in succession.	● Malfunction of the detonation sensor ● Improper connector contact, open circuit or short-circuited harness wire of the detonation sensor circuit ● Malfunction of the engine-ECU



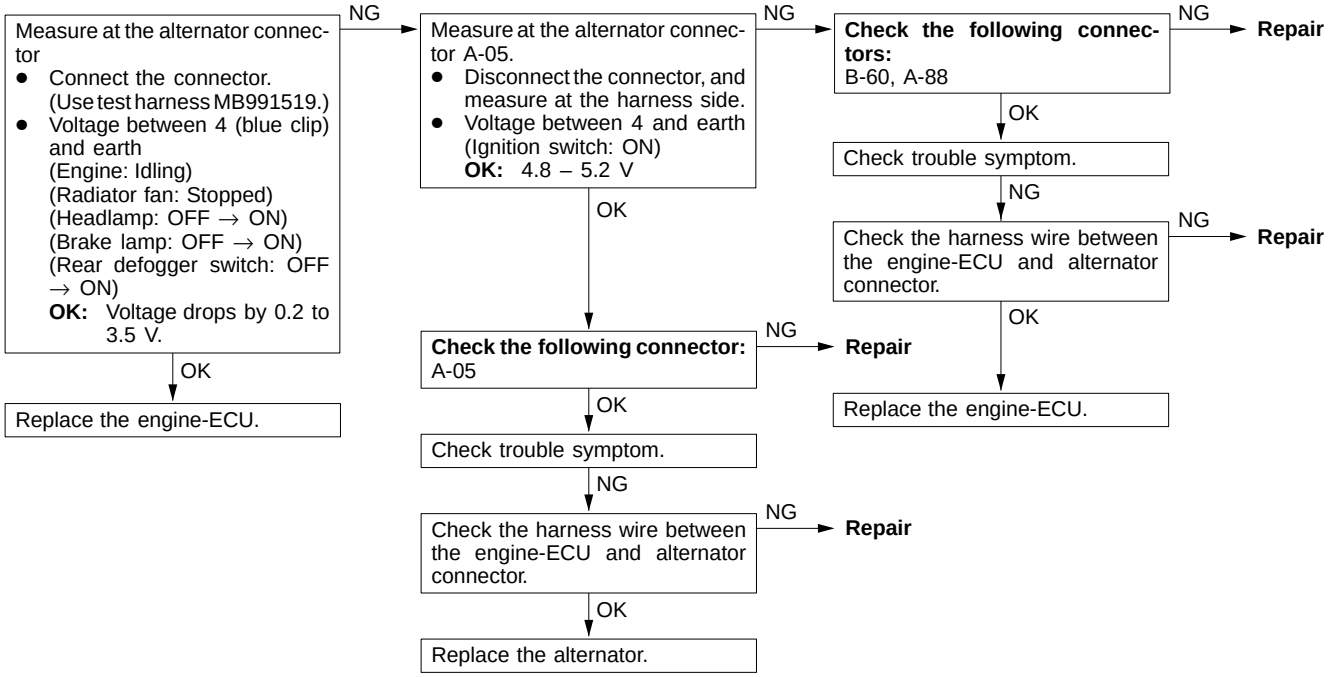
Code No. 41 Injector system	Probable cause
Range of Check ● Engine speed is approx. 50 – 1,000 r/min ● The throttle position sensor output voltage is 1.15 V or less. Set conditions ● Surge voltage of injector coil is not detected for 4 seconds.	● Malfunction of the injector ● Improper connector contact, open circuit or short-circuited harness wire of the injector circuit ● Malfunction of the engine-ECU



Code No. 44 Ignition coil and power transistor unit system	Probable cause
Range of Check ● Engine speed is approx. 50 – 4,000 r/min. ● Engine is not being cranked. Set conditions ● Abnormal engine speed is detected due to misfiring by crank angle sensor. (One of two coils fails.)	● Malfunction of the ignition coil ● Improper connector contact, open circuit or short-circuited harness wire of the ignition primary circuit ● Malfunction of the engine-ECU.



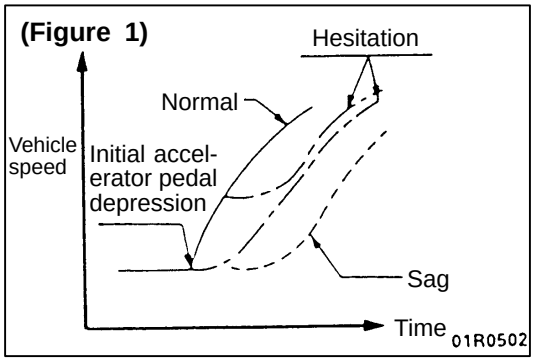
Code No. 64 Alternator FR Terminal System	Probable cause
Range of Check ● Engine speed is approximately 50 r/min or more. Set conditions ● Input voltage at the alternator FR terminal is 4.5 V or more for 20 seconds.	● Open circuit in alternator FR terminal circuit ● Malfunction of the engine-ECU.



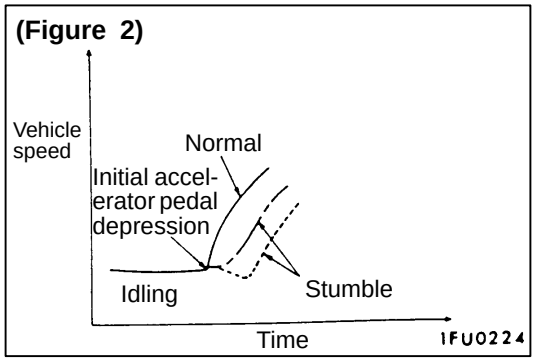
4. PROBLEM SYMPTOMS TABLE

Items		Symptom
Starting	Won't start	The starter is used to crank the engine, but there is no combustion within the cylinders, and the engine won't start.
	Fires up and dies	There is combustion within the cylinders, but then the engine soon stalls.
	Hard starting	Engine starts after cranking a while.
Idling stability	Rough idle Hunting	Engine speed doesn't remain constant and changes at idle. Usually, a judgement can be based upon the movement of the tachometer pointer, and the vibration transmitted to the steering wheel, shift lever, body, etc. This is called rough idle or hunting.
	Incorrect idle speed	The engine doesn't idle at the usual correct speed.
	Engine stall (Die out)	The engine stalls when the accelerator pedal is released, regardless of whether the vehicles is moving or not.
	Engine stall (Pass out)	The engine stalls when the accelerator pedal is depressed or while it is being used.
Driving	Hesitation, Sag	"Hesitation" is the delay in response of the vehicle speed (engine speed) that occurs when the accelerator is depressed in order to accelerate from the speed at which the vehicle is now traveling, or a temporary drop in vehicle speed (engine speed) during such acceleration. Serious hesitation is called "sag". (Refer to Figure 1.)
	Poor acceleration	Poor acceleration is inability to obtain an acceleration corresponding to the degree of throttle opening, even though acceleration is smooth, or the inability to reach maximum speed.
	Stumble	Engine speed increase is delayed when the accelerator pedal is initially depressed for acceleration. (Refer to Figure 2.)
	Shock	The feeling of a comparatively large impact or vibration when the engine is accelerated or decelerated.
	Surge	This is repeated forward or rearward surging during constant speed travel or during variable speed travel.
	Knocking	A sharp sound like a hammer striking the cylinder walls during driving and which adversely affects driving.
Stopping	Run on ("Dieseling")	The condition in which the engine continues to run after the ignition switch is turned to OFF. Also called "Dieseling".

(Figure 1)



(Figure 2)



5. SERVICE DATA LIST

<EVOLUTION-IV>

Item No.	Inspection item	Inspection contents		Normal condition
11	Oxygen sensor	Engine: After having been warmed up Air/fuel mixture is made leaner when decelerating, and is made richer when racing.	When at 4,000 r/min, engine is suddenly decelerated	200 mV or less
			When engine is suddenly raced	600 – 1,000 mV
		Engine: After having been warmed up The oxygen sensor signal is used to check the air/fuel mixture ratio, and control condition is also checked by the ECU.	Engine is idling	400 mV or less (Changes) 600 – 1,000 mV
			2,500 r/min	
12	Air flow sensor*	● Engine coolant temperature: 80 – 95°C ● Lamps, electric cooling fan and all accessories: OFF ● Transmission: Neutral	Engine is idling	17 – 43 Hz
			2,500 r/min	46 – 86 Hz
			Engine is raced	Frequency increases in response to racing
13	Intake air temperature sensor	Ignition switch: ON or with engine running	When intake air temperature is –20°C	–20°C
			When intake air temperature is 0°C	0°C
			When intake air temperature is 20°C	20°C
			When intake air temperature is 40°C	40°C
			When intake air temperature is 80°C	80°C
14	Throttle position sensor	Ignition switch: ON	Set to idle position	300 – 1,000 mV
			Gradually open	Increases in proportion to throttle opening angle
			Open fully	4,500 – 5,500 mV
16	Power supply voltage	Ignition switch: ON		System voltage
18	Cranking signal (ignition switch-ST)	Ignition switch: ON	Engine: Stopped	OFF
			Engine: Cranking	ON

NOTE
*: When the car is new (distance it travelled is less than 500 km), output frequency of the air flow sensor may become about 10% higher.

Item No.	Inspection item	Inspection contents		Normal condition
21	Engine coolant temperature sensor	Ignition switch: ON or with engine running	When engine coolant temperature is –20°C	–20°C
			When engine coolant temperature is 0°C	0°C
			When engine coolant temperature is 20°C	20°C
			When engine coolant temperature is 40°C	40°C
			When engine coolant temperature is 80°C	80°C
22	Crank angle sensor	• Engine: Idling • Idle position switch: ON	When engine coolant temperature is –20°C	1,300 – 1,500 rpm
			When engine coolant temperature is 0°C	1,300 – 1,500 rpm
			When engine coolant temperature is 20°C	1,300 – 1,500 rpm
			When engine coolant temperature is 40°C	1,150 – 1,350 rpm
			When engine coolant temperature is 80°C	750 – 950 rpm
25	Barometric pressure sensor	Ignition switch: ON	At altitude of 0 m	101 kPa
			At altitude of 600 m	95 kPa
			At altitude of 1,200 m	88 kPa
			At altitude of 1,800 m	81 kPa
26	Idle position switch	Ignition switch: ON (Check by operating accelerator pedal repeatedly.)	Throttle valve: Set to idle position	ON
			Throttle valve: Slightly open	OFF*1
27	Power steering fluid pressure switch	Engine: Idling	Steering wheel stationary	OFF
			Steering wheel turning	ON
28	A/C switch	Engine: Idling (when A/C switch is ON, A/C compressor should be operating.)	A/C switch: OFF	OFF
			A/C switch: ON	ON

Item No.	Inspection item	Inspection contents		Normal condition
41	Injector drive time*2	Engine: Cranking	When engine coolant temperature is 0°C (injection is carried out for all cylinders simultaneously)	27 – 41 ms
			When engine coolant temperature is 20°C	14 – 22 ms
			When engine coolant temperature is 80°C	3.9 – 5.9 ms
	Injector drive time*3	• Engine coolant temperature: 80 – 95°C • Lamps, electric cooling fan and all accessories: OFF • Transmission: Neutral	Engine is idling	1.2 – 2.4 ms
			2,500 r/min	1.0 – 2.2 ms
			When engine is suddenly raced	Increases
44	Ignition advance	• Engine: After having been warmed up • Timing lamp is set. (The timing lamp is set in order to check actual ignition timing.)	Engine is idling	3 – 13°BTDC
			2,500 r/min	24 – 44°BTDC
45	ISC (stepper) motor position *4	• Engine coolant temperature: 80 – 90°C • Lamps, electric cooling fan and all accessories: OFF • Transmission: Neutral • Idle position switch: ON • Engine: Idling (When A/C switch is ON, A/C compressor should be operating.)	A/C switch: OFF	2 – 25 steps
			A/C switch: OFF → ON	Increases by 10 – 70 steps
			A/C switch: OFF	Increases by 5 – 50 steps
49	A/C relay	Engine: After having been warmed up/Engine is idling	A/C switch: OFF	OFF (Compressor clutch is not operating)
			A/C switch: ON	ON (Compressor clutch is operating)

NOTE
*1: The idle position switch normally turns off when the voltage of the throttle position sensor is 50 – 100 mV higher than the voltage at the idle position. If the idle position switch turns back on after the throttle valve is opened, the idle position switch and the throttle position sensor need to be adjusted.
*2: The injector drive time represents the time when the cranking speed is at 250 r/min or below when the power supply voltage is 11 V.
*3: In a new vehicle [driven approximately 500 km or less], the injector drive time is sometimes 10% longer than the standard time.
*4: In a new vehicle [driven approximately 500 km or less], the step of the stepper motor is sometimes 30 steps greater than the standard value.

<EVOLUTION-V>

Descriptions other than those given below are the same as for the EVOLUTION-IV.

Item No.	Inspection item	Inspection contents		Normal condition
12	Air flow sensor*1	● Engine coolant temperature: 80 – 95°C ● Lamps, electric cooling fan and all accessories: OFF ● Transmission: Neutral	Engine is idling	12 – 38 Hz
			2,500 r/min	36 – 76 Hz
			Engine is raced	Frequency increases in response to racing
41	Injector drive time*2	Engine: Cranking*2	When engine coolant temperature is 0°C	27 – 40 ms
			When engine coolant temperature is 20°C	14.5 – 21.7 ms
			When engine coolant temperature is 80°C	3.8 – 5.6 ms
	Injector drive time *3	● Engine coolant temperature: 80 – 95°C ● Lamps, electric cooling fan and all accessories: OFF ● Transmission: Neutral	Engine is idling	0.9 – 2.1 ms
			2,500 r/min	0.7 – 1.9 ms
			When engine is suddenly raced	Increases
44	Ignition advance	● Engine: After having been warmed up ● Timing lamp is set.	Engine is idling	0 – 13°BTDC
			2,500 r/min	24 – 44°BTDC

NOTE

*1: In a new vehicle (driven approximately 500 km or less), the air flow sensor output frequency is sometimes 10 % higher than the standard frequency.

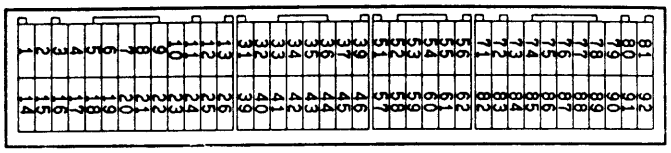
*2: The injector drive time represents the time when the cranking speed is at 250 r/min or below when the power supply voltage is 11 V.

*3: In a new vehicle (driven approximately 500 km or less), the injector drive time is sometimes 10 % longer than the standard time.

6. ENGINE-ECU INSPECTION

6-1 TERMINAL VOLTAGES

Engine ECU connector



9FU0393

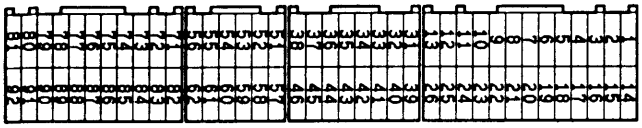
Terminal No.	Check item	Check condition (Engine condition)	Normal condition
1	No.1 injector	While engine is idling after having been warmed up, suddenly depress the accelerator pedal.	Momentarily drops slightly from 11 – 14 V.
14	No.2 injector		
2	No.3 injector		
15	No.4 injector		
3	Fuel pressure control valve	Ignition switch: ON	Battery voltage
		Engine: Cranking to idling (within about two minutes)	0 – 3 V to battery voltage
4	Stepper motor coil (A1)	Engine: Immediately after engine has been started for warming up	Changes repeatedly from battery voltage to 0 – 6 V and from 0 – 6 V to battery voltage.
17	Stepper motor coil (A2)		
5	Stepper motor coil (B1)		
18	Stepper motor coil (B2)		
6	Secondary air control solenoid valve	Ignition switch: ON	Battery voltage
8	Fuel pump relay	Ignition switch: ON	Battery voltage
		Engine: Idling	0 – 3 V
10	Power transistor unit (A)	Engine speed: 3,000 r/min	0.3 – 3.0 V
23	Power transistor unit (B)		
11	Wastegate solenoid valve	Ignition switch: ON	Battery voltage
		Engine: At idle after having been warmed up (when premium gasoline is used)	0 – 3 V
12	Power supply	Ignition switch: ON	Battery voltage
25			
19	Air flow sensor reset signal	Engine: Idling	0 – 1 V
		Engine speed: 3,000 r/min	6 – 9 V
20	Fan motor relay (HI)	Fan not operating (coolant temperature: 90°C or below)	Battery voltage
		Fan at high speed (coolant temperature: 105°C or above)	0 – 3 V

Terminal No.	Check item	Check condition (Engine condition)		Normal condition
21	Fan motor relay (LOW)	Fan not operating (coolant temperature: 90°C or below)		Battery voltage
		Fan at low speed (coolant temperature: 90 – 100°C)		0 – 3 V
22	A/C relay	• Engine: Idling • A/C switch: OFF to ON (Compressor is being driven.)		Battery voltage, or 6 V or more instantaneously to 0 – 3 V
33	Alternator G terminal	• Engine: Warm, idle (radiator fan: OFF) • Headlamp: OFF to ON • Brake lamp: OFF to ON • Rear defogger switch: OFF to ON		Voltage rises by 0.2 – 3.5 V.
36	Engine warning lamp	Ignition switch: OFF → ON		0 – 3 V → Battery voltage (After several seconds have elapsed)
37	Power steering fluid pressure switch	Engine: Idling after warming up	When steering wheel is stationary	Battery voltage
			When steering wheel is turned	0 – 3 V
38	Control relay	Ignition switch: OFF		Battery voltage
		Ignition switch: ON		0 – 3 V
39	Fuel pump relay No.2	While engine is idling, suddenly depress the accelerator pedal.		Momentarily rises slightly from 0 to 3 V.
40	Exhaust temperature warning lamp	Ignition switch: OFF to ON		0 – 3 V to battery voltage (After several seconds have elapsed)
41	Alternator FR terminal	• Engine: Warm, idle (radiator fan: OFF) • Headlamp: OFF to ON • Brake lamp: OFF to ON • Rear defogger switch: OFF to ON		Voltage drops by 0.2 – 3.5 V.
45	A/C switch	Engine: Idle speed	Turn the A/C switch OFF	0 – 3 V
			Turn the A/C switch ON (A/C compressor is operating)	Battery voltage
60	Oxygen sensor heater (Evolution-V only)	Engine: Idling		0 – 3 V
		Engine speed: 5,000 r/min		Battery voltage
71	Ignition switch-ST	Engine: Cranking		8 V or more

Terminal No.	Check item	Check condition (Engine condition)		Normal condition
72	Intake air temperature sensor	Ignition switch: ON	When intake air temperature is 0°C	3.2 – 3.8 V
			When intake air temperature is 20°C	2.3 – 2.9 V
			When intake air temperature is 40°C	1.5 – 2.1 V
			When intake air temperature is 80°C	0.4 – 1.0 V
76	Oxygen sensor	Engine: Running at 2,000 r/min after having been warmed up (Check using a digital type voltmeter)		0 ↔ 0.8 V (Changes repeatedly)
80	Backup power supply	Ignition switch: OFF		Battery voltage
81	Sensor impressed voltage	Ignition switch: ON		4.5 – 5.5 V
82	Ignition switch-IG	Ignition switch: ON		Battery voltage
83	Engine coolant temperature sensor	Ignition switch: ON	When engine coolant temperature is 0°C	3.2 – 3.8 V
			When engine coolant temperature is 20°C	2.3 – 2.9 V
			When engine coolant temperature is 40°C	1.3 – 1.9 V
			When engine coolant temperature is 80°C	0.3 – 0.9 V
84	Throttle position sensor	Ignition switch: ON	Set throttle valve to idle position	0.3 – 1.0 V
			Fully open throttle valve	4.5 – 5.5 V
85	Barometric pressure sensor	Ignition switch: ON	When altitude is 0 m	3.7 – 4.3 V
			When altitude is 1,200 m	3.2 – 3.8 V
86	Vehicle speed sensor	• Ignition switch: ON • Move the vehicle slowly forward		0 ↔ 5 V (Changes repeatedly)
87	Idle position switch	Ignition switch: ON	Set throttle valve to idle position	0 – 1 V
			Slightly open throttle valve	4 V or more
88	Camshaft position sensor	Engine: Cranking		0.4 – 3.0 V
		Engine: Idle speed		0.5 – 2.0 V
89	Crank angle sensor	Engine: Cranking		0.4 – 4.0 V
		Engine: Idle speed		1.5 – 2.5 V
90	Air flow sensor	Engine: Idle speed		2.2 – 3.2 V
		Engine speed: 2,500 r/min		

6-2 RESISTANCE AND CONTINUITY BETWEEN HARNESS SIDE CONNECTORS AND TERMINALS

Engine-ECU Harness Side Connector Terminal Arrangement



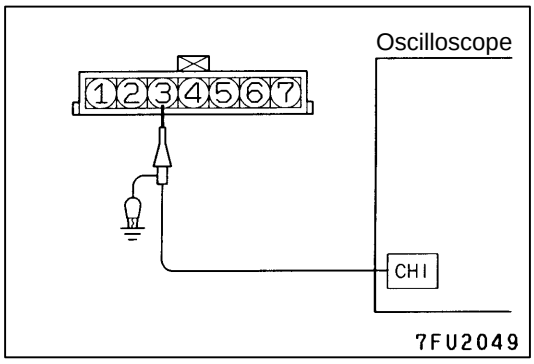
9FU0392

Terminal No.	Inspection item	Normal condition (Check condition)
1 – 12	No.1 injector	2 – 3 Ω (At 20°C)
14 – 12	No.2 injector	
2 – 12	No.3 injector	
15 – 12	No.4 injector	
3 – 12	Fuel pressure control valve	28 – 36 Ω (At 20°C)
4 – 12	Stepper motor coil (A1)	28 – 33 Ω (At 20°C)
17 – 12	Stepper motor coil (A2)	
5 – 12	Stepper motor coil (B1)	
18 – 12	Stepper motor coil (B2)	
6 – 12	Secondary air control solenoid valve	28 – 36 Ω (At 20°C)
11 – 12	Wastegate solenoid valve	62 – 74 Ω (At 20°C)
13 – Body earth	Engine-ECU earth	Continuity established (0 Ω)
26 – Body earth		
60 – 12	Oxygen sensor heater (EVOLUTION-V only)	11 – 18 Ω (at 20°C)
72 – 92	Intake air temperature sensor	5.3 – 6.7 kΩ (When intake air temperature is 0°C)
		2.3 – 3.0 kΩ (When intake air temperature is 20°C)
		1.0 – 1.5 kΩ (When intake air temperature is 40°C)
		0.30 – 0.42 kΩ (When intake air temperature is 80°C)
74 – 77	High temperature sensor	3 Ω or less
83 – 92	Engine coolant temperature sensor	5.1 – 6.5 kΩ (When coolant temperature is 0°C)
		2.1 – 2.7 kΩ (When coolant temperature is 20°C)
		0.9 – 1.3 kΩ (When coolant temperature is 40°C)
		0.26 – 0.36 kΩ (When coolant temperature is 80°C)
87 – 92	Idle position switch	Continuity established (when throttle valve is at idle position)
		No continuity (when throttle valve is slightly open)
91 – Body earth	–	Continuity established

7. INSPECTION PROCEDURE USING OSCILLOSCOPE

7-1 AIR FLOW SENSOR (AFS)

Observing waveforms displayed on the oscilloscope allows you to visually identify possible unusual disturbances in waveform that could temporarily occur in the air flow sensor output.



<Measurement procedure>

(1) Disconnect the air flow sensor connector and connect the special tool (Test Harness: MB991709) to it. (Ensure that all terminals are connected.)
(2) Connect the oscilloscope probe to terminal no. 3 of air flow sensor connector.

NOTE
If the engine ECU connector is used, connect the oscilloscope probe to terminal no. 90.

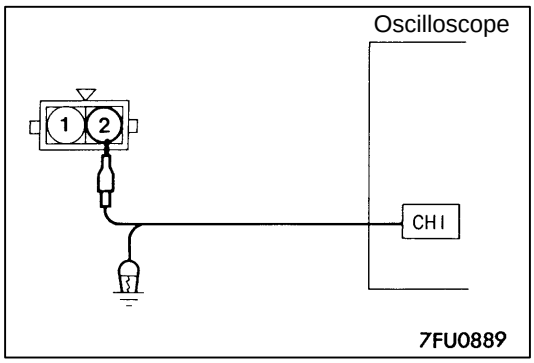
(3) Perform the same steps from here on as with the 4G9 engine.

7-2 CAMSHAFT POSITION SENSOR AND CRANK ANGLE SENSOR

Perform the same steps as with the conventional 4G9 engine for the inspection.

7-3 INJECTOR

Observing waveforms displayed on the oscilloscope allows you to visually check the conditions of injector drive signals actually output from the engine ECU.

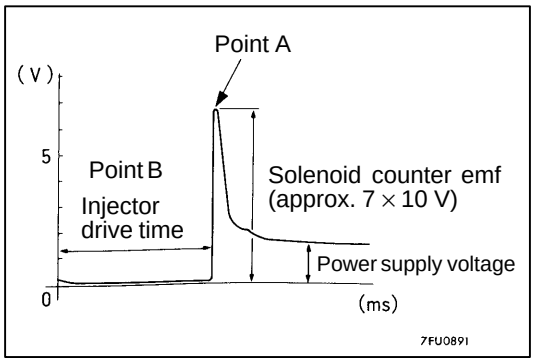


Injector Control Signal (Oscilloscope 1)

<Measurement procedure>

(1) Disconnect the injector connector and connect the special tool (Test Harness: MB991348) to the circuit. (Ensure that the terminals on both the power supply and engine ECU sides are connected.)
(2) Connect the oscilloscope probe to terminal no. 2 of injector connector.

NOTE
If the engine ECU connector is used for the measurement, take measurements at each of the following terminals. Connect the oscilloscope probe to terminal no. 1 when the waveform is observed with no. 1 cylinder, to terminal no. 14 when the waveform is observed with no. 2 cylinder, to terminal no. 2 when the waveform is observed with no. 3 cylinder, and to terminal no. 15 when the waveform is observed with no. 4 cylinder.



<Standard waveform>

Observation conditions

Probe selector switch	× 10
AC-GND-DC	DC
VOLTS/DIV.	1 V
TIME/DIV.	0.5 ms
Misc.	–
Engine speed	Idle

<Explanation on waveform>

The power supply voltage is being normally applied and, when a signal is received from the engine ECU, the voltage drops to around 0 V for the period of time equivalent to its drive signal.
When the signal from the engine ECU turns OFF, the counter emf of the coil causes a voltage peak to develop, thus resuming the power supply voltage.

Injector drive time:
The fuel injection time as determined by the engine ECU according to the output values of sensors including AFS. Injector drive time = effective injection time + invalid injection time (Invalid injection time: corrects operation time lag caused by a power supply voltage drop)

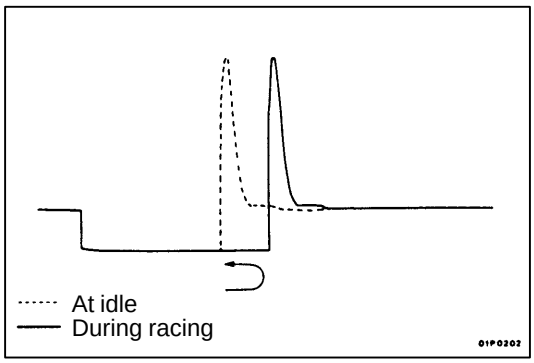
Solenoid coil counter emf:
When the signal from the engine ECU turns OFF, counter emf occurs in the injector coil (approx. 65 to 75 V).

Power supply voltage:
The power supply voltage is being applied in the absence of a signal from the engine ECU. If this voltage is low, it extends the invalid injection time and, thus, the drive time.

<Waveform observation points>

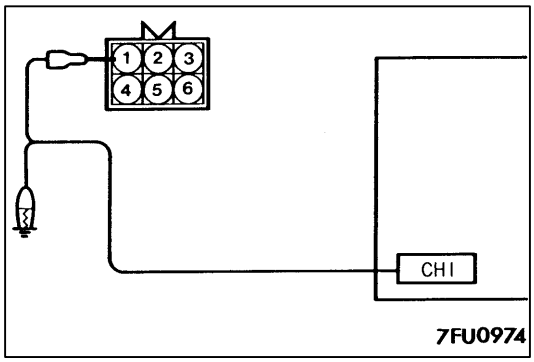
Point A: Strength of solenoid coil counter emf

Solenoid coil counter emf is low or zero.	Injector solenoid shorting



Point B: Injector drive time

When the engine is suddenly raced, the drive time temporarily extends by a wide margin and soon returns to the normal drive time corresponding to the engine speed.



Injector Power Supply Voltage (Oscilloscope 2)

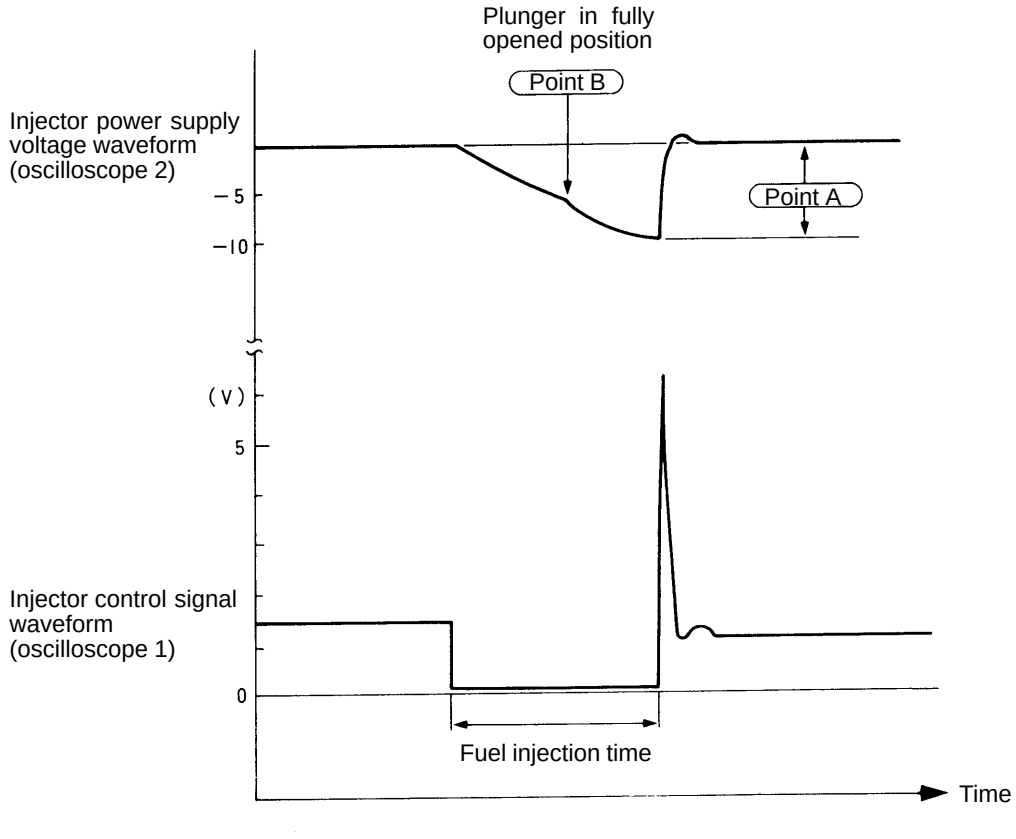
<Measurement procedure>

(1) Disconnect the resistor connector and connect the special tool (Harness Connector: MD998463) to the circuit.
(2) Connect the oscilloscope probe to resistor connector terminal (1) (special tool red clip) when the waveform is observed with no. 1 cylinder, to terminal (4) (black clip) when the waveform is observed with no. 2 cylinder, to terminal (5) (green clip) when the waveform is observed with no. 3 cylinder, and to terminal (6) (yellow clip) when the waveform is observed with no. 4 cylinder.
(3) For the power supply voltage, observe the waveform of the injector control signal at the same time. (Refer to P.13-26 for the injector control signal measurement procedure.)

<Standard waveform>

Observation conditions

	Injector power supply voltage waveform	Injector control signal
Probe selector switch	× 1	× 10
AC-GND-DC	AC	DC
VOLTS/DIV.	5 V	1 V
TIME/DIV.	0.5 ms	
Misc.	To be timed with injector control signal	
Engine speed	Idle (850 rpm)	



<Explanation of waveform>

The injector power supply voltage waveform shows a voltage drop caused by resistance of the resistor. As the amount of current increases, voltage gradually decreases and a spike occurs at the plunger fully opened position due to counter emf.

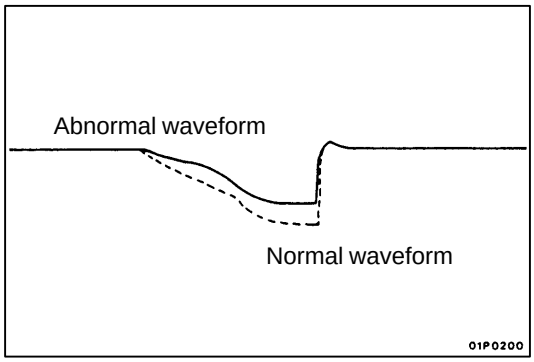
<Waveform observation points>

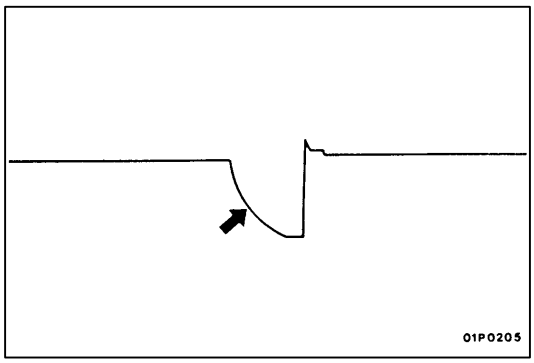
Point A: Voltage drop during fuel injection time (Refer to abnormal waveform example 1.)

Difference from standard waveform	Possible cause
Voltage drop during fuel injection time is small (there should normally be a voltage drop of about 10 V).	Resistance of resistor is too small. Resistance of injector is too large.

Point B: Spike when plunger is fully open (Refer to abnormal waveform example 2.)

Difference from standard waveform	Possible cause
No spike when plunger is fully open	Plunger inoperative





<Abnormal waveform examples>

- Example 1

  [Cause of problem]

  Resistance of the resistor is too small.

  [Waveform characteristics]

  Small voltage drop

- Example 2

  [Cause of problem]

  Plunger is inoperative.

  [Waveform characteristics]

  No spike when plunger is fully open.

7-4 IGNITION COIL

Perform the same steps as with the conventional 4G9 engine for the inspection.

ON-VEHICLE SERVICE

1. IDLE POSITION SWITCH AND THROTTLE POSITION SENSOR (TPS) ADJUSTMENT

The thickness of the feeler gauge inserted between the fixed SAS and throttle lever should be 0.45 mm.

2. FIXED SAS ADJUSTMENT

<EVOLUTION-IV>

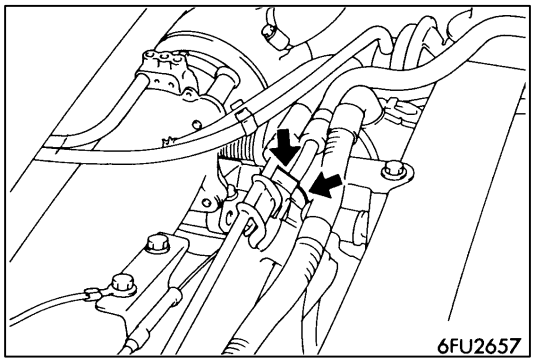
Turn down one turn after the fixed SAS has touched the throttle lever.

<EVOLUTION-V>

Turn down 1-1/4 turns after the fixed SAS has touched the throttle lever.

3. BASIC IDLE SPEED ADJUSTMENT

The basic idle speed should be 850 ± 50 rpm.

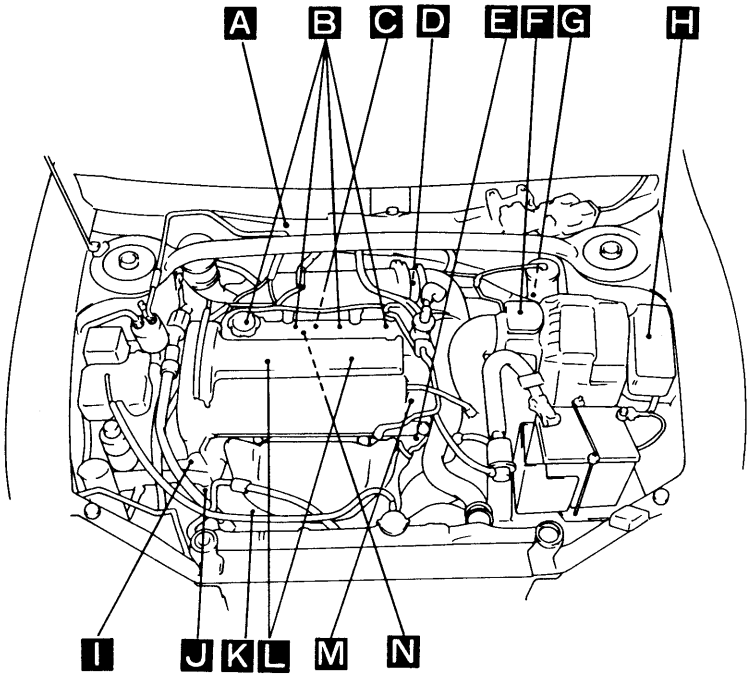


4. FUEL PRESSURE MEASUREMENT

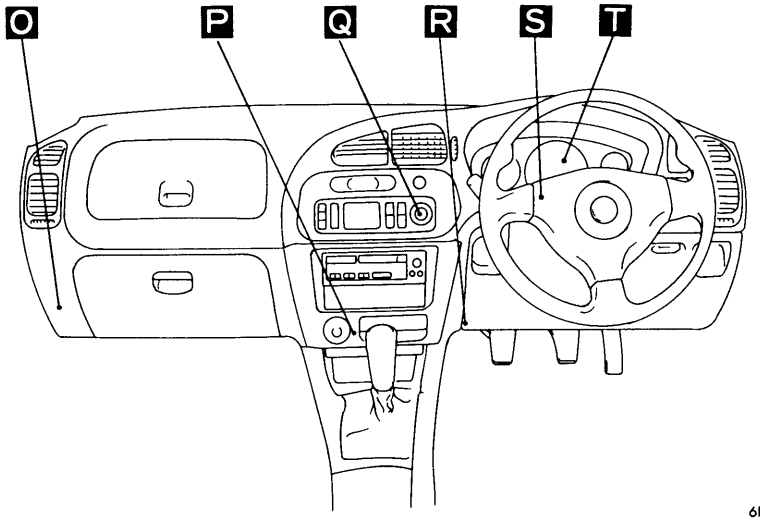
The fuel pressure gauge should be installed at the location shown on the left.

5. MPI SYSTEM COMPONENTS LAYOUT

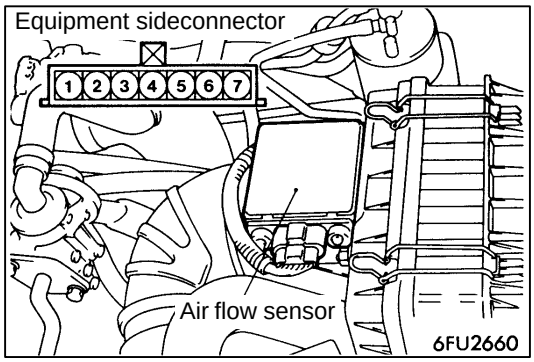
Name	Symbol	Name	Symbol
A/C switch	Q	Exhaust temperature warning lamp	S
A/C relay	H	Fuel pressure control valve	A
Air flow sensor (with a built-in intake air temperature sensor and barometric pressure sensor)	F	Ignition coil and power transistor unit	L
		Injector	B
Camshaft position sensor	M	ISC servo	D
Control relay and fuel pump relay	P	Oxygen sensor	K
Coolant temperature sensor	E	Power steering fluid pressure switch	I
Crank angle sensor	J	Secondary air control solenoid valve	N
Detonation sensor	C	Throttle position sensor (with a built-in idle switch)	D
Diagnosis connector	R		
Engine ECU	O	Vehicle speed sensor	T
Engine warning lamp	S	Wastegate solenoid valve	G



6FU2658



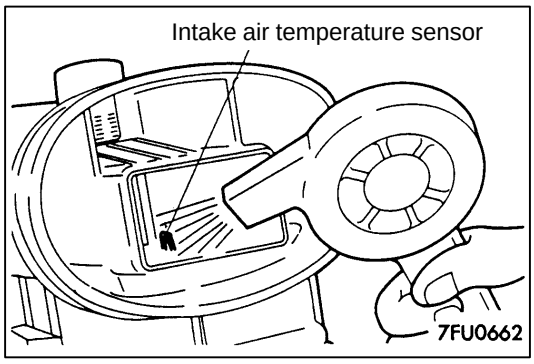
6FU2659



6. INTAKE AIR TEMPERATURE SENSOR CHECK

1. Disconnect the air flow sensor connector.
2. Measure resistance between terminals 5 and 6.

Standard value:
2.3 – 3.0 kΩ (at 20°C)
0.30 – 0.42 kΩ (at 80°C)

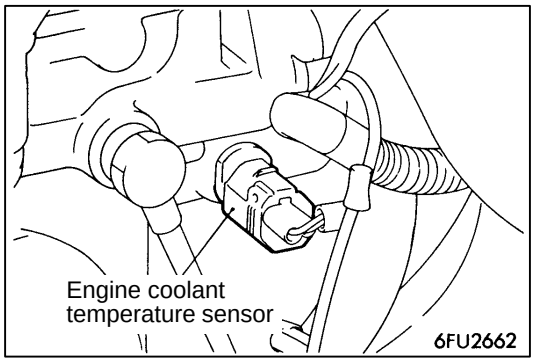


3. Measure resistance while heating the sensor using a hair drier.

Normal condition:

Temperature (°C)	Resistance (kΩ)
Higher	Smaller

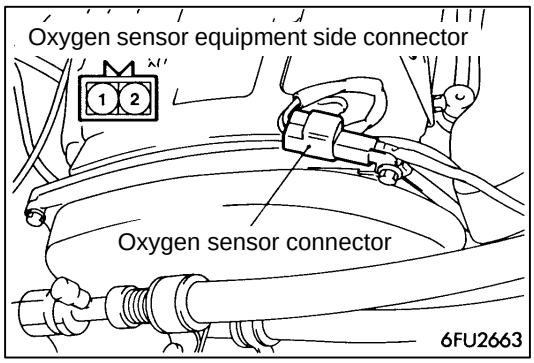
4. If the value deviates from the standard value or the resistance remains unchanged, replace the air flow sensor assembly.



7. ENGINE COOLANT TEMPERATURE SENSOR CHECK

The engine coolant temperature sensor is located as shown on the left.

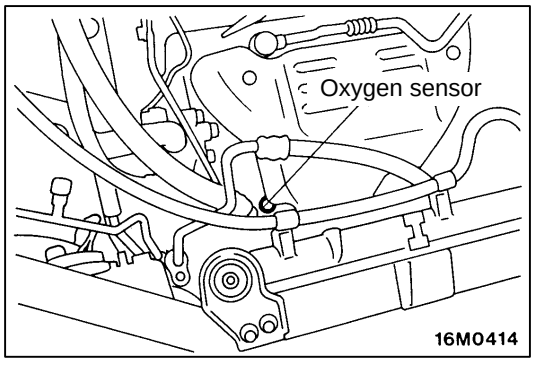
Standard value:
2.1 – 2.7 kΩ (at 20°C)
0.26 – 0.36 kΩ (at 80°C)



8. OXYGEN SENSOR CHECK

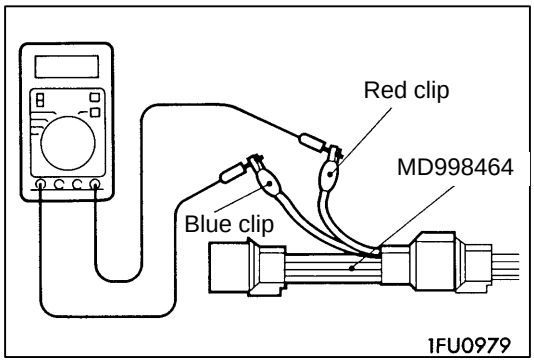
<EVOLUTION-IV>

The sensor connector is located as shown on the left.

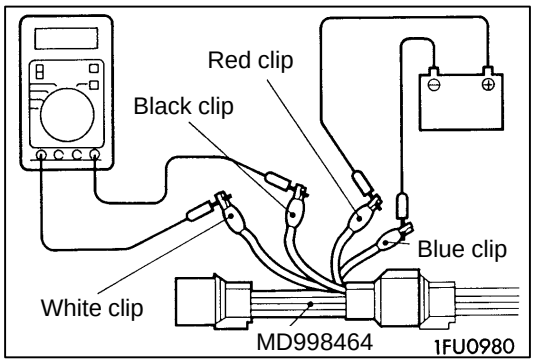


<EVOLUTION-V>

(1) Disconnect the oxygen sensor connector and connect the special tool (Test Harness: MD998464) to the oxygen sensor connector.



(2) Check that there is continuity (11 to 18 Ω at 20°C) across terminal no. 1 (special tool red clip) and terminal no. 3 (special tool blue clip) of the oxygen sensor connector.
(3) If there is no continuity, replace the oxygen sensor.



(4) Run the engine until the engine coolant temperature exceeds 80°C.
(5) Using jumper wires, connect oxygen sensor terminal no. 1 (special tool red clip) and terminal no. 3 (special tool blue clip) to battery (+) and (–) terminal, respectively.

Caution
Make sure of the correct connections: if a wrong connection is made, a broken oxygen sensor results.

(6) Connect a digital voltmeter between terminal no. 2 (special tool black clip) and terminal no. 4 (special tool white clip).
(7) Race the engine repeatedly to measure the oxygen sensor output voltage.

Standard value:

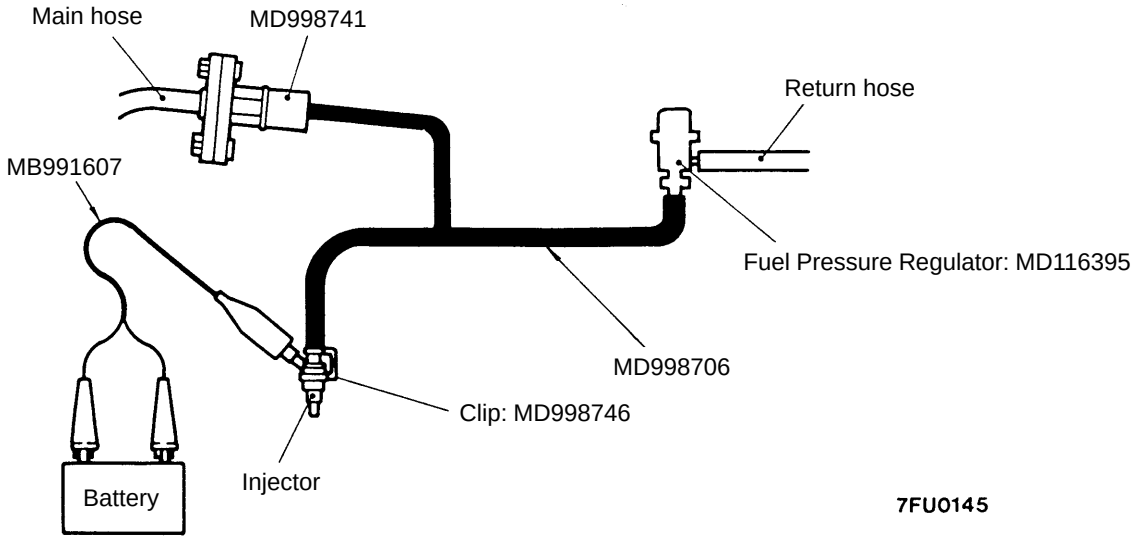
Engine	Oxygen sensor output voltage	NOTE
When engine is raced	0.6 – 1.0 V	When engine racing is repeated to enrich air-fuel ratio, an operational oxygen sensor should output a voltage of 0.6 to 1.0 V.

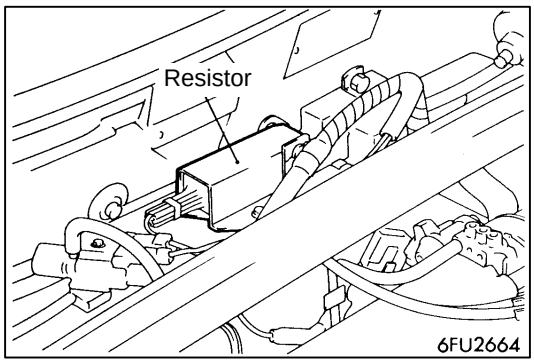
NOTE
Use the same procedures to remove and install the oxygen sensor.

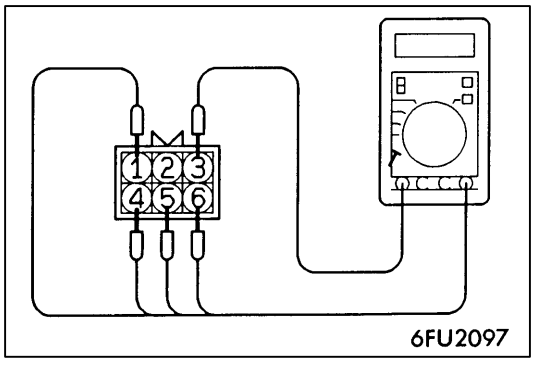
9. INJECTOR CHECK

Injection Condition Check

(1) Release the residual pressure from the fuel pipe line to prevent fuel from flowing out.
(2) Remove the injector.
(3) Set up the special tools (Injector Test Set, Adapter, Fuel Pressure Regulator, and Clip) as illustrated below.
(4) From here on, use the same procedure as with the conventional 4G9 engine for the check.





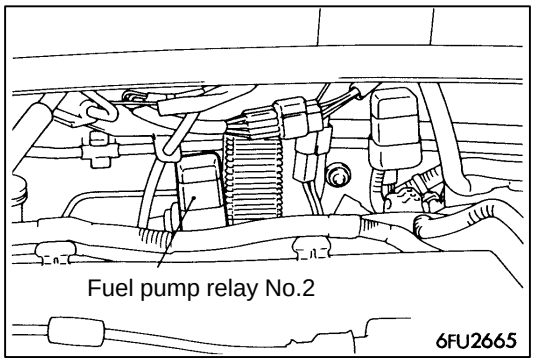


10. RESISTOR CHECK

(1) Disconnect the resistor connector.
(2) Measure resistance across terminals as detailed below.

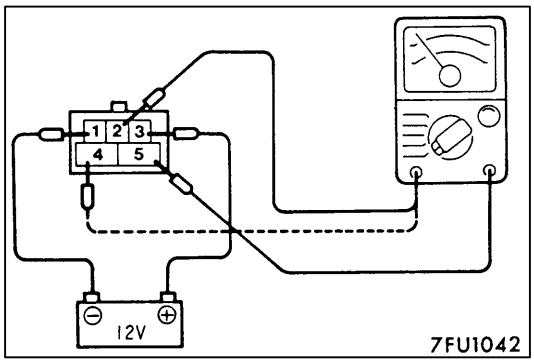
Standard value

Measurement terminals	Resistance (Ω)
1 – 3	5.5 to 6.5 (at 20°C)
4 – 3	
5 – 3	
6 – 3	



11. FUEL PUMP RELAY NO.2 CHECK

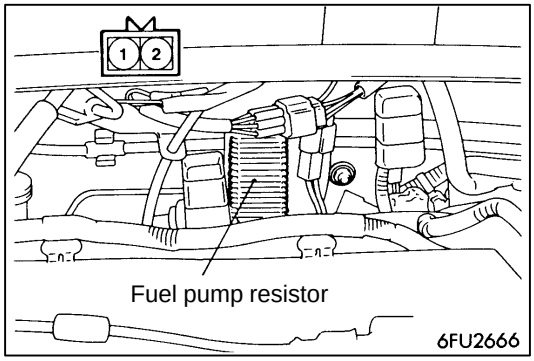
(1) Remove fuel pump relay No.2.



(2) Using jumper wires, connect fuel pump relay No.2 terminal (3) to battery (+) terminal, and terminal (1) to battery (–) terminal, respectively.
(3) Connecting and disconnecting the jumper wire on the battery (–) terminal end, check for continuity across terminal (2) and terminal (5), and across terminal (4) and terminal (5), of fuel pump relay No.2.

Jumper wire	Continuity across terminals (2) and (5)	Continuity across terminals (4) and (5)
Connected	No	Yes
Disconnected	Yes	No

(4) If the continuity is checked abnormally, replace fuel pump relay No.2.



12. FUEL PUMP RESISTOR CHECK

(1) Disconnect the fuel pump resistor connector.

(2) Measure resistance across the terminals.

Standard value: 0.6 – 0.9 Ω

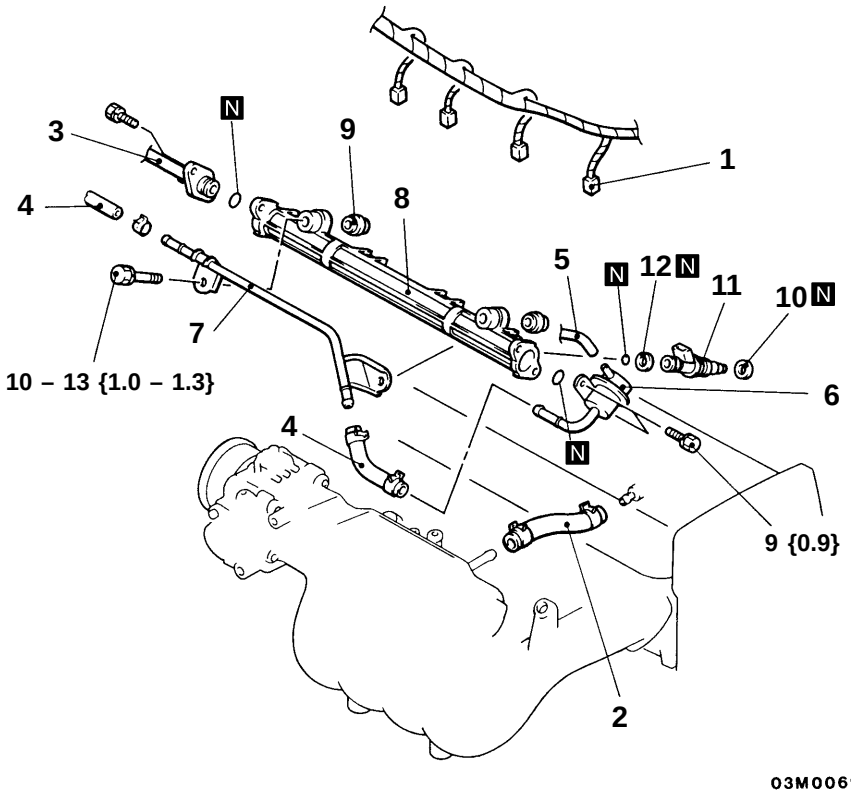
(3) If the measurement falls outside the specified range, replace the fuel pump resistor.

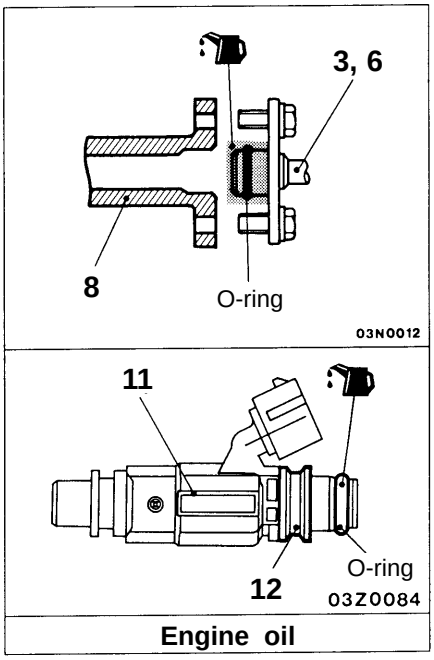
INJECTOR

REMOVAL AND INSTALLATION

Pre-removal Operation
(1) Fuel Discharge Prevention
(2) Air Hose D Removal
(Refer to GROUP15 – Intercooler.)

Post-installation Operation
(1) Air Hose D Installation
(Refer to GROUP15 – Intercooler.)
(2) Fuel Leakage Check





Unit: Nm {kgf·m}

Removal steps

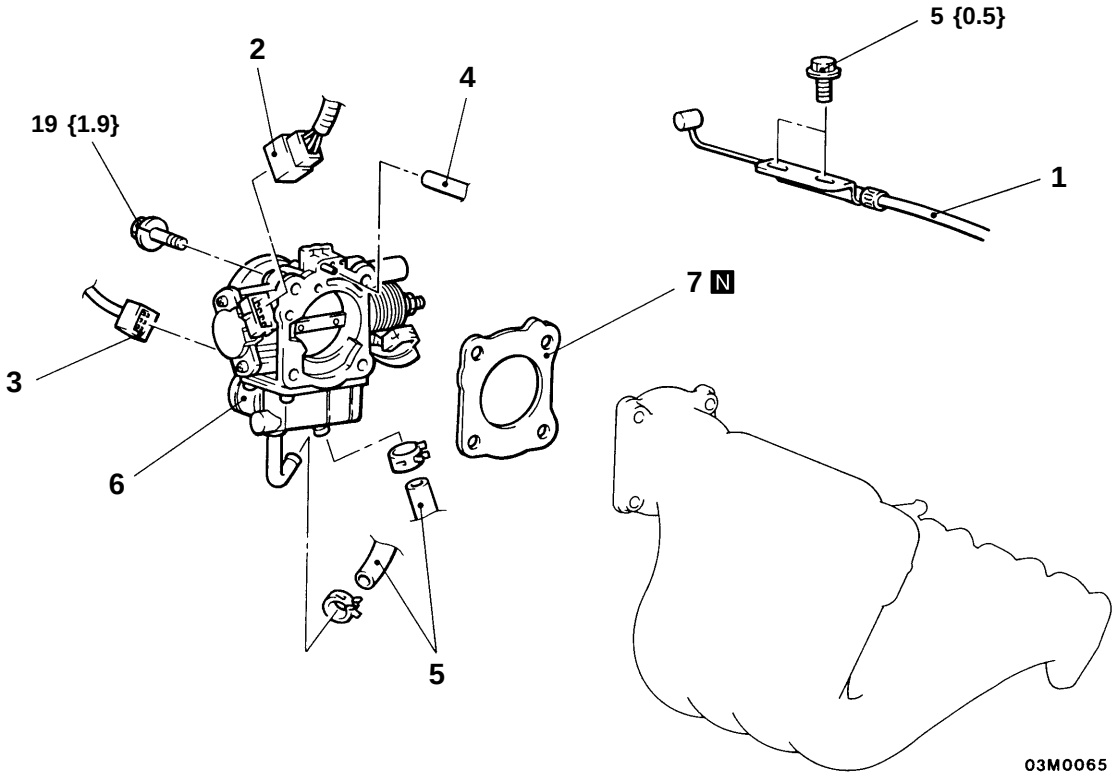
1. Injector connector
2. PCV hose connection
◀A▶ 3. High-pressure fuel hose connection
4. Fuel return hose connection
5. Vacuum hose connector
◀A▶ 6. Fuel pressure regulator
7. Fuel return pipe
◀A▶ 8. Delivery pipe
9. Insulator
10. Insulator
◀A▶ ▶A◀ 11. Injector
12. Grommet

THROTTLE BODY

REMOVAL AND INSTALLATION

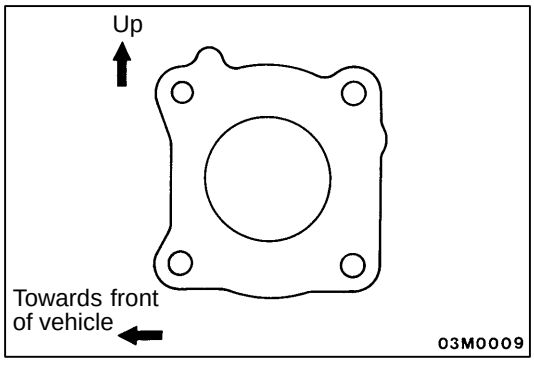
Pre-removal Operation
(1) Engine Coolant Draining
(2) Air Hose D Removal
(Refer to GROUP 15 – Intercooler.)
(3) Strut Tower Bar Removal

Post-installation Operation
(1) Strut Tower Bar Installation
(2) Air Hose D Installation
(Refer to GROUP 15 – Intercooler.)
(3) Engine Coolant Supplying
(4) Accelerator Cable Adjustment



Unit: Nm {kgf·m}

Removal steps
1. Accelerator cable connection
2. Throttle position sensor connector
3. Idle speed control servo connector
4. Vacuum hose connection
5. Water hose connection
6. Throttle body
▶A◀ 7. Throttle body gasket



INSTALLATION SERVICE POINT

▶A◀ THROTTLE BODY GASKET INSTALLATION

Place the gasket so that the projecting part is positioned as shown in the illustration, and then install it between the intake manifold and the throttle body.