

FUEL

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		CRANKSHAFT POSITION SENSOR
		ACCELERATOR PEDAL

FUEL SYSTEM <4D5-step III>

GENERAL

OUTLINE OF CHANGES

Some service procedures have been established as the following changes have been made due to the compliance with the Emission Regulation Step III.

- An electronic-controlled fuel injection pump has been used.
- A crankshaft position sensor has been used as the electronic-controlled fuel injection pump has been used.
- An engine-ECU has been used as the electronic-controlled fuel injection pump has been used. Removal and installation procedure of the engine-ECU is the same as for vehicles with 4G6 engine or 6G7 engine.
- Due to the introduction of the electronic-controlled injection pump, the accelerator cable has been abolished, and the accelerator pedal position sensor has been added.

GENERAL INFORMATION

The electronically-controlled fuel injection system consists of sensors which detect the condition of the diesel engine, an engine-ECU which controls the system based on signals from these sensors, and actuators which operate according to control commands from the engine-ECU.

The engine-ECU carries out operations such as fuel injection rate control, fuel injection timing control and idle up control. In addition, the engine-ECU is equipped with several self-diagnosis functions which make troubleshooting easier in the event that a problem develops.

FUEL INJECTION RATE CONTROL

The fuel injection completion timing is controlled by means of a solenoid-type spill valve to ensure that the optimum amount of fuel is supplied to the engine in accordance with gradual changes in the engine running condition.

Before fuel injection starts, the solenoid-type spill valve is on (energized), so that the valve is closed. As the plunger turns and rises, fuel is sent out under pressure, and when the fuel flow rate reaches the target value for fuel injection, the solenoid-type spill valve turns off. When the solenoid-type spill valve turns off, the fuel under high pressure inside the plunger is leaked out into the pump chamber and fuel injection is completed.

FUEL INJECTION TIMING CONTROL

The position of the injection pump timer piston is controlled so that fuel injection is carried out at the optimum timing in accordance with the engine running condition.

The timer piston position is determined by duty control of the timing control solenoid valve which is located in the line between the high-pressure chamber and the low-pressure chamber of the timer piston.

The fuel injection timing is advanced by increasing the control duty of the timing control solenoid valve.

IDLE SPEED CONTROL

Controlling the fuel injection rate in accordance with the engine running condition maintains the idle speed at the optimum condition.

SELF-DIAGNOSIS FUNCTION

- When an abnormality is detected in any of the sensors or actuators, the engine warning lamp illuminates to warn the driver.
- When an abnormality is detected in any of the sensors or actuators, a diagnosis code number corresponding to the problem which occurred is output.
- The RAM data relating to the sensors and actuators which is stored in the engine-ECU can be read using the MUT-II. In addition, the actuators can be force-driven under certain conditions.

OTHER CONTROL FUNCTIONS

1. Power Supply Control

When the ignition switch is turned to ON, the relay turns on and power is supplied to components such as the timing control solenoid valve.

2. Intake Air Throttle Control

When the engine-ECU detects an abnormality in any of the sensors or actuators, the throttle valve is half opened to restrict the amount of intake air in order to prevent the vehicle from running away.

3. A/C Relay Control

Turns the compressor clutch of the A/C ON and OFF

4. Condenser Fan Motor Relay Control

Controls the condenser fan motor relay based on the A/C switch, engine coolant temperature and vehicle speed input signals.

5. Intercooler Fan Motor Relay Control

Controls the intercooler fan motor relay based on the boost air temperature and vehicle speed input signals.

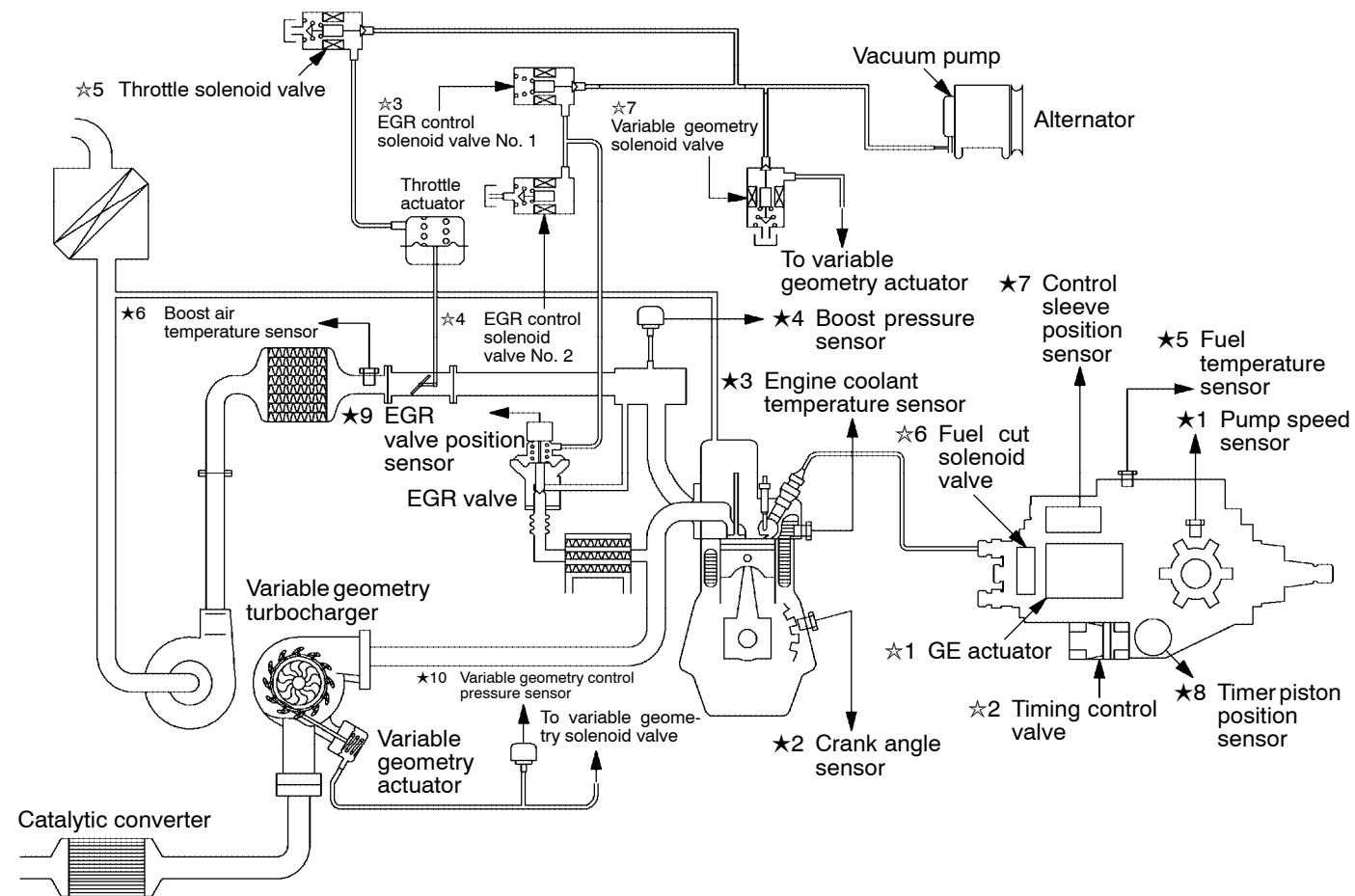
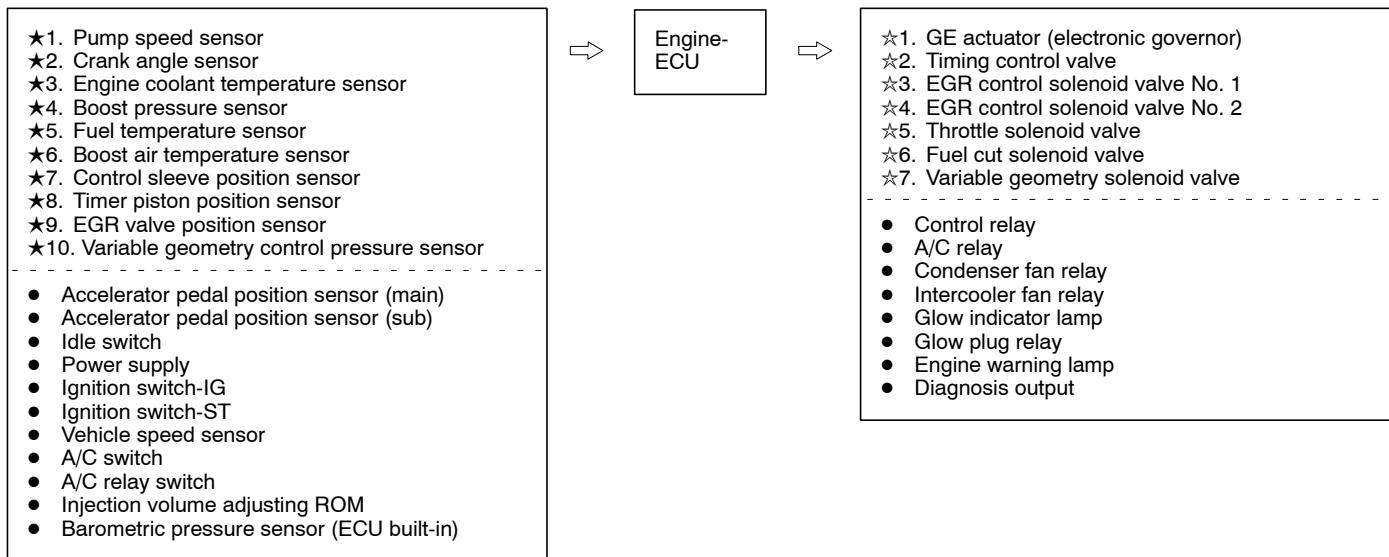
6. Glow Control

Refer to GROUP 16.

7. EGR Control

Refer to GROUP 17.

CONTROL SYSTEM DIAGRAM



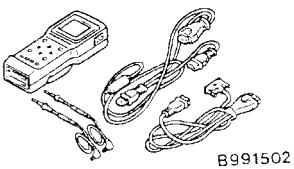
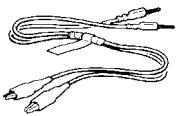
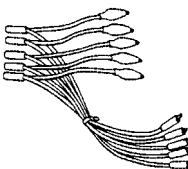
SERVICE SPECIFICATIONS

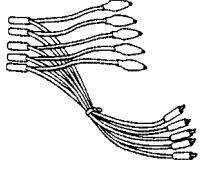
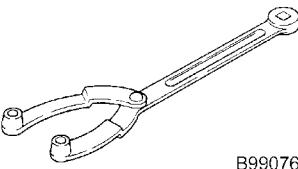
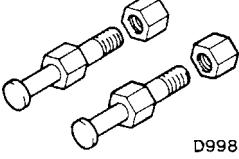
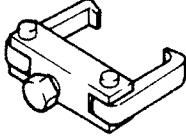
Item		Standard value
Fuel injection initial pressure kPa		14,710 - 15,490
Accelerator pedal position sensor reference voltage V		0.985 - 1.085
Accelerator pedal position sensor resistance kΩ		3.5 - 6.5
Boost air temperature sensor (Intake air temperature sensor) resistance kΩ	When the temperature is 20°C	2.3 - 3.0
	When the temperature is 80°C	0.30 - 0.42
Engine coolant temperature sensor resistance kΩ	When the temperature is 20°C	2.1 - 2.7
	When the temperature is 80°C	0.26 - 0.36
Fuel cut solenoid valve resistance Ω		6.8 - 9.2
Timing control valve resistance Ω		10.8 - 11.2
Timer piston position sensor resistance Ω	Connector terminals No. 1 - No. 2	160 - 168
	Connector terminals No. 1 - No. 3	80 - 84
	Connector terminals No. 2 - No. 3	80 - 84
Control sleeve position sensor resistance Ω	Connector terminals No. 4 - No. 12	11.2 - 12.4
	Connector terminals No. 4 - No. 8	5.6 - 6.2
	Connector terminals No. 8 - No. 12	5.6 - 6.2
GE actuator (electronic governor) resistance Ω	Connector terminals No. 6 - No. 10	0.64 - 0.72
Fuel temperature sensor resistance kΩ	Connector terminals No. 7 - No. 11	1.4 - 2.6
Pump speed sensor resistance kΩ		1.36 - 1.84
Throttle solenoid valve resistance Ω		36 - 44

SEALANT

Item	Specified sealant
Engine coolant temperature sensor	3M Nut Locking Part No. 4177 or equivalent

SPECIAL TOOL

Tool	Number	Name	Use
	MB991502	MUT-II sub assembly	Electronically controlled fuel injection system check
	MB991529	Diagnosis code check harness	Diagnosis code reading
	MB991348	Test harness set	<ul style="list-style-type: none"> ● Boost pressure sensor check ● Variable geometry control pressure sensor check

Tool	Number	Name	Use
	MB991658	Test harness set	<ul style="list-style-type: none"> ● APS adjustment ● Inspection using an analyzer
	MD998478	Test harness (3-pin, square)	<ul style="list-style-type: none"> ● Crank angle sensor check ● Inspection using an analyzer
	MB990767 B990767	End yoke holder	Holding the fuel injection pump sprocket
	MD998719 D998719	Crankshaft pulley holder pin	
	MD998388	Injection pump sprocket puller	Fuel injection pump sprocket removal

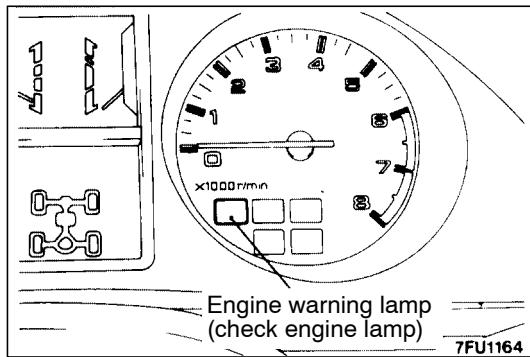
TROUBLESHOOTING

STANDARD FLOW OF DIAGNOSTIC TROUBLESHOOTING

Refer to GROUP 00 - How to Use Troubleshooting/Inspection Service Points.

NOTE

When replacing the engine-ECU, replace immobilizer-ECU and ignition key as well at the same time.



DIAGNOSIS FUNCTION

ENGINE WARNING LAMP (CHECK ENGINE LAMP)

Engine warning lamp is lit when any abnormality takes place in the item related to electronically controlled fuel injection system shown in the following table.

If the malfunction indicator lamp has been on and/or is lit when the engine is in operation, check the diagnosis output.

Engine warning lamp check items

Accelerator pedal position sensor (main)
Accelerator pedal position sensor (sub)
Boost pressure sensor (Boost sensor)
Crank angle sensor
Control sleeve position sensor
Timer piston position sensor
Throttle solenoid valve
GE actuator
Variable geometry control pressure sensor
Barometric pressure sensor
Timing control valve
Idle switch
Engine-ECU

METHOD OF ERASING AND ERASING DIAGNOSIS CODES

Refer to GROUP 00 - How to Use Troubleshooting/Inspection Service Points.

INSPECTION USING MUT-II DATA LIST AND ACTUATOR TESTING

1. Carry out inspection by means of the data list and the actuator test function.
If there is an abnormality, check and repair the chassis harnesses and components.
2. After repairing, re-check using MUT-II and check that the abnormal input and output have returned to normal as a result of the repairs.
3. Erase the diagnosis code memory.
4. Remove the MUT-II.
5. Start the engine again and carry out a road test to confirm that the problem has disappeared.

FAIL-SAFE, BACKUP FUNCTIONS

When abnormalities in the major sensors are detected by diagnosis functions, pre-set control logic operates to maintain a safe driving condition for the vehicle.

Diagnosis item	Control features in malfunction
Accelerator pedal position sensor	<ul style="list-style-type: none"> Accelerator pedal released (idle switch ON) Acceleration opening degree = 0 % Accelerator pedal applied (idle switch OFF) Engine controlled at low speed Acceleration opening degree = 30 % fixed Void EGR control
Idle switch	Void idling speed control.
Engine speed sensor	<ul style="list-style-type: none"> Engine controlled at low speed Void EGR control Void variable geometry turbocharger control
Boost air temperature sensor	<ul style="list-style-type: none"> Maintain the intake air temperature at 50°C. Void EGR control
Vehicle speed sensor	<ul style="list-style-type: none"> Void idling speed control. Void EGR control
Engine coolant temperature sensor	<ul style="list-style-type: none"> Maintain the engine coolant temperature at 80°C (However, the system assumes the coolant temperature as 0°C when engine is started.). Void EGR control
Control sleeve position sensor	<ul style="list-style-type: none"> Engine controlled at low speed Void EGR control Void variable geometry turbocharger control
Timer piston position sensor	<ul style="list-style-type: none"> Injection timing stabilizing control Void EGR control
Barometric pressure sensor (ECU built-in)	<ul style="list-style-type: none"> Keep the barometric pressure at 101 kPa. Void EGR control Void variable geometry turbocharger control
Fuel temperature sensor	Maintain the fuel temperature at 40°C.
Boost pressure sensor	<ul style="list-style-type: none"> Keep the boost pressure as barometric pressure (101 kPa). Void EGR control Void variable geometry turbocharger control
Injection volume adjusting ROM	Void correction.
GE actuator	<ul style="list-style-type: none"> Engine controlled at low speed Void EGR control Void variable geometry turbocharger control
Over boost	<ul style="list-style-type: none"> Void variable geometry turbocharger control Engine controlled at low fuel injection
Timing control valve	<ul style="list-style-type: none"> Injection timing stabilizing control Void EGR control
EGR valve position sensor	Void EGR control
Variable geometry control pressure sensor	<ul style="list-style-type: none"> Void EGR control Void variable geometry turbocharger control

INSPECTION CHART FOR DIAGNOSIS CODES

Code No.	Diagnosis item	Reference page
11	Accelerator pedal position sensor (main) system	13-10
12*	Boost pressure sensor system	13-11
13	Barometric pressure sensor (ECU built-in) system	13-12
14	Fuel temperature sensor system	13-12
15	Engine coolant temperature sensor system	13-13
16	Boost air temperature sensor system	13-13
17	Vehicle speed sensor system	13-14
18	Pump speed sensor system	13-15
21	Crank angle sensor system	13-16
23	Idle switch (accelerator pedal position sensor built-in) system	13-17
25*	Timer piston position sensor system	13-18
26*	Control sleeve position sensor system	13-19
27	Accelerator pedal position sensor (sub) system	13-20
41*	Throttle solenoid valve system	13-21
43	Timing control valve system	13-22
46	Injection volume adjusting ROM system	13-23
48*	GE actuator (in the middle of control sleeve position sensor inoperative) system	13-24
49*	Over boost (variable geometry control pressure sensor system malfunction)	13-25
51	EGR valve position sensor system	13-26
52	Variable geometry control pressure sensor system	13-27
54	Immobilizer system	13-28

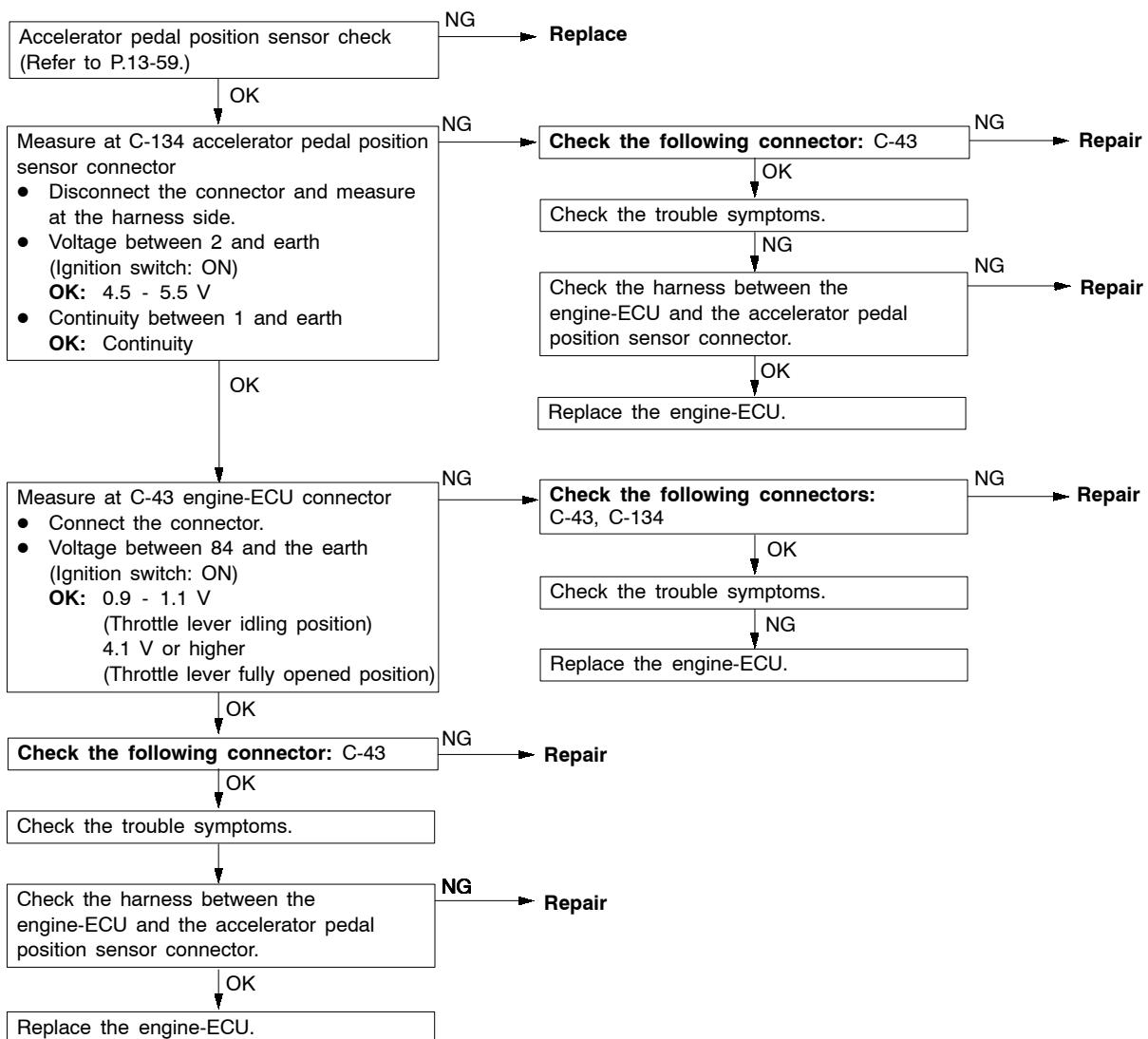
Caution

If the above-mentioned diagnosis code number with the asterisks can be displayed along with another code number in parentheses simultaneously, check the other code number before replacing the engine-ECU.

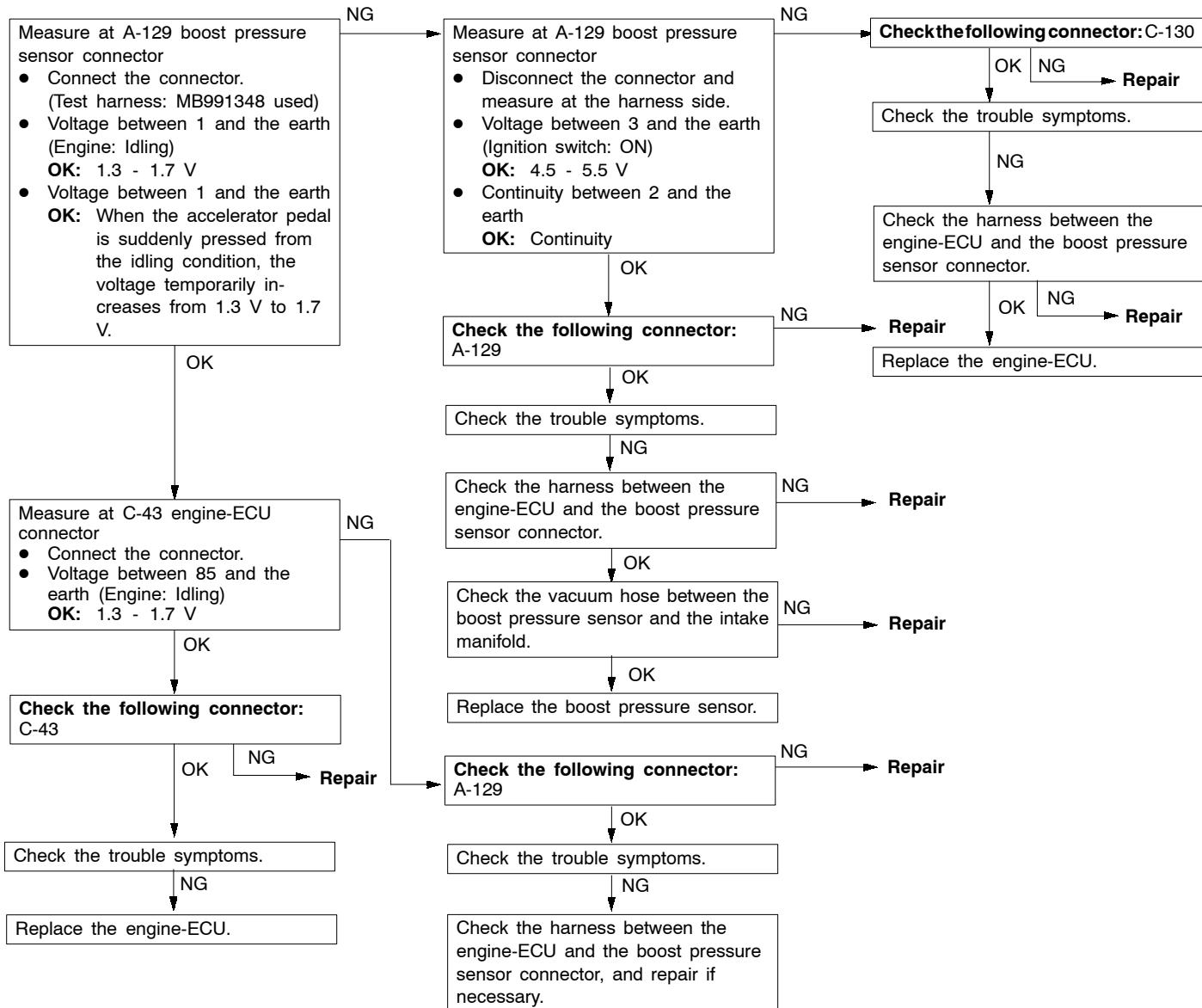
12 (41, 49), 26 (48), 25 (43), 41 (12, 49), 48 (26), 49 (12, 41)

INSPECTION PROCEDURE FOR DIAGNOSIS CODE

Code No. 11 Accelerator pedal position sensor (main) system	Probable cause
<p>Range of Check</p> <ul style="list-style-type: none"> Ignition switch: ON, accelerator pedal position sensor (sub) operative, except for during engine cranking <p>Set Conditions</p> <ul style="list-style-type: none"> Accelerator pedal position sensor output voltage is as below for 1 second: Sub side: 0.2 V or more, less than 2.5 V Main side: 4.5 V or more or Sub or main side: less than 0.2 V <p>Range of Check</p> <ul style="list-style-type: none"> Ignition switch: ON, except for during engine cranking <p>Set Conditions</p> <ul style="list-style-type: none"> The output voltage of accelerator pedal position sensor (main and sub) for 0.2 second is 0.2 V or higher, or lower than 4.5 V and the difference in sensor output voltage between the main and sub is 1 V or higher, or idle switch: ON, and sensor main output voltage is 1.875 V or higher. 	<ul style="list-style-type: none"> Accelerator pedal position sensor inoperative Accelerator pedal position sensor open circuit, short circuit, or connector contact inoperative Engine-ECU inoperative



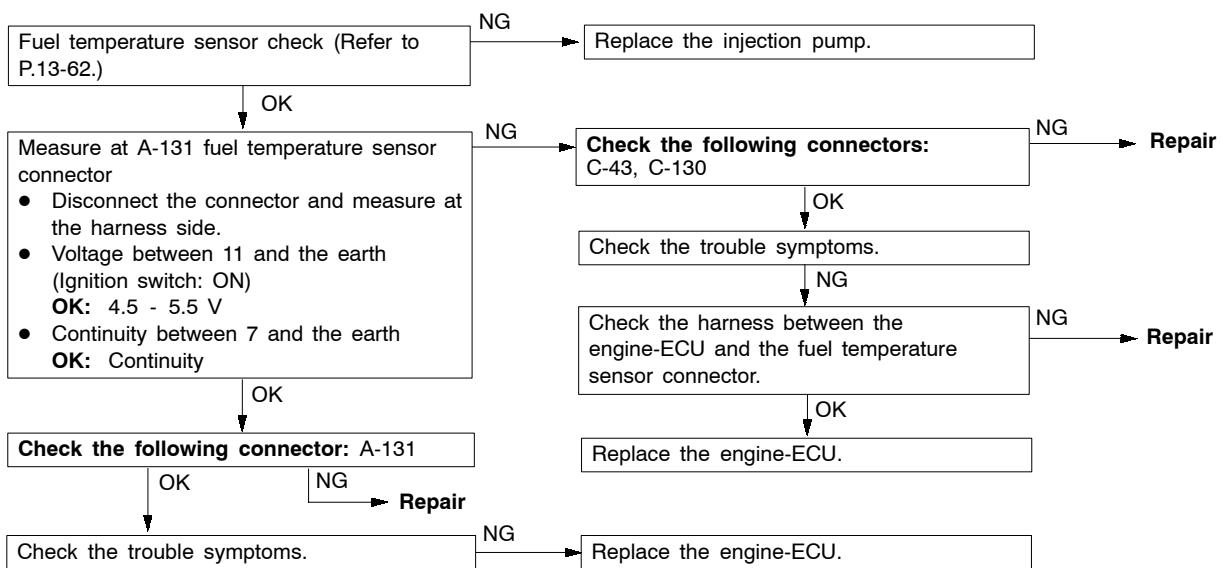
Code No. 12 Boost pressure sensor (boost sensor) system	Probable cause
<p>Range of Check</p> <ul style="list-style-type: none"> Ignition switch: ON, except for during engine cranking <p>Set Conditions</p> <ul style="list-style-type: none"> Sensor output voltage for 1 second is 4.5 V or higher (boost pressure is approximately 267 kPa). or Sensor output voltage for 1 second is 0.2 V or lower (boost pressure is approximately 51.7 kPa or lower) <p>Range of Check</p> <ul style="list-style-type: none"> Engine speed is 2,000 r/min or higher, barometric pressure is 69.7 kPa or less (equivalent to an altitude of 300 m) and under high load. <p>Set Conditions</p> <ul style="list-style-type: none"> Boost pressure is lower than the barometric pressure + 13 kPa for 3 seconds. 	<ul style="list-style-type: none"> Boost pressure sensor inoperative Boost pressure sensor open circuit, short circuit, or connector contact inoperative Boost pressure sensor hose disconnected Engine-ECU inoperative



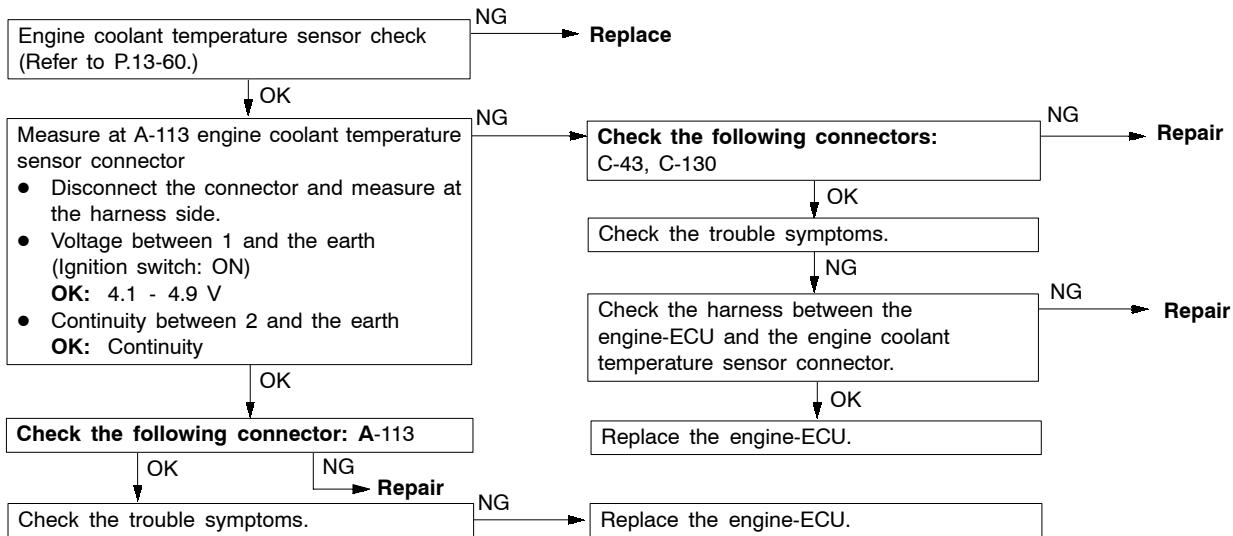
Code No. 13 Barometric pressure sensor system	Probable cause
<p>Range of Check</p> <ul style="list-style-type: none"> Ignition switch: ON, except for during engine cranking <p>Set Conditions</p> <ul style="list-style-type: none"> The sensor output voltage is for 3 seconds is 4.5 V or higher (the barometric pressure is approximately 114 kPa or over). <p>or</p> <ul style="list-style-type: none"> The sensor output voltage is for 3 seconds is 1.5 V or lower (the barometric pressure is approximately 40 kPa or under). <p>Range of Check</p> <ul style="list-style-type: none"> Ignition switch: ON The coolant temperature is 40°C or lower <p>Set conditions</p> <ul style="list-style-type: none"> Difference between the barometric pressure and boost pressure sensors is 13.3 kPa or more 	Engine-ECU inoperative



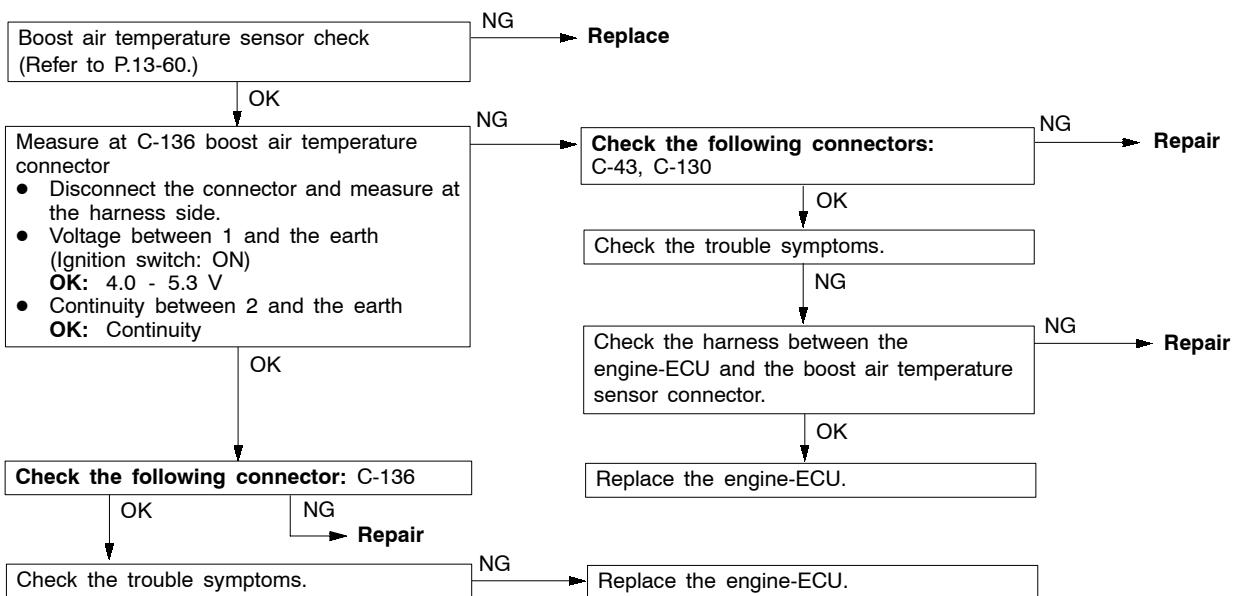
Code No. 14 Fuel temperature sensor system	Probable cause
<p>Range of Check</p> <ul style="list-style-type: none"> Ignition switch: ON, except for during engine cranking <p>Set Conditions</p> <ul style="list-style-type: none"> The sensor output voltage for 3 seconds is 0.2 V or lower (the fuel temperature is approximately 125°C or higher). <p>or</p> <ul style="list-style-type: none"> The sensor output voltage for 3 seconds is 4.6 V or higher (the fuel temperature is approximately -47°C or lower). 	<ul style="list-style-type: none"> Fuel temperature sensor inoperative Fuel temperature sensor open circuit, short circuit, or connector contact inoperative Engine-ECU inoperative



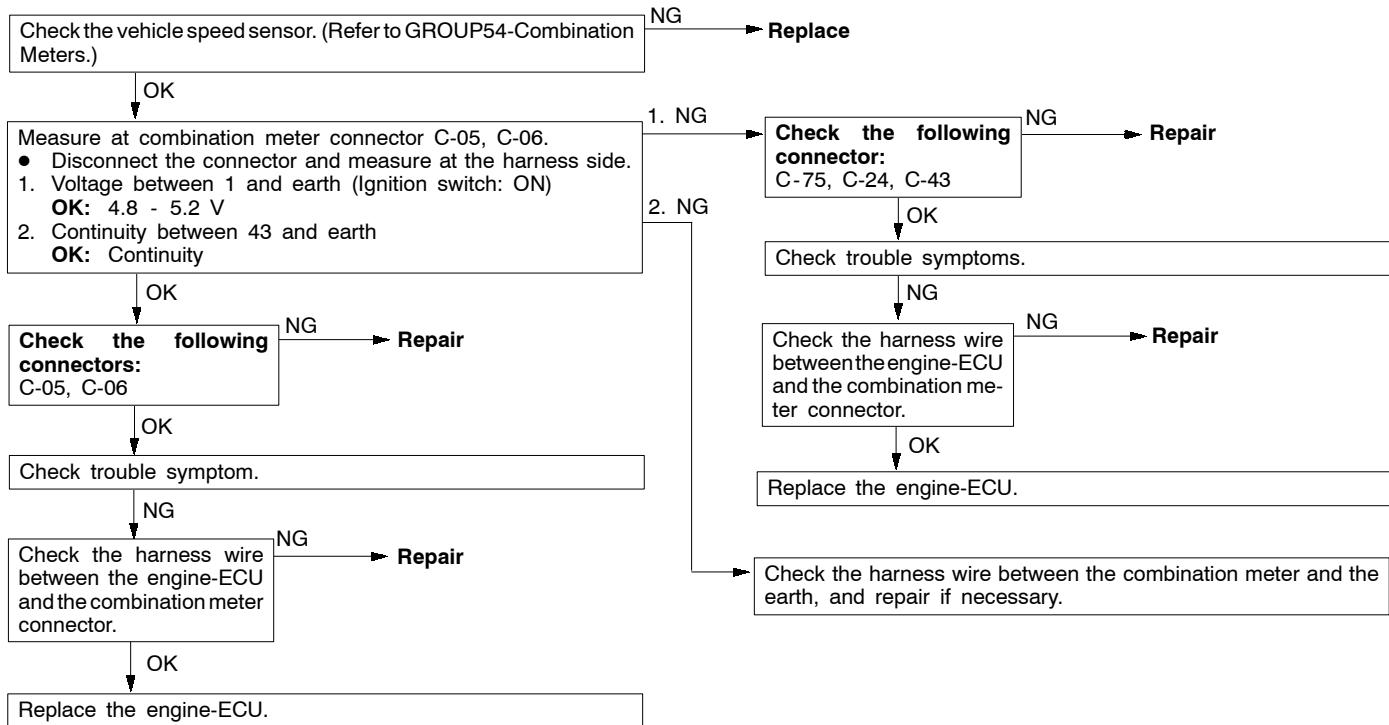
Code No. 15 Engine coolant temperature sensor system	Probable cause
<p>Range of Check</p> <ul style="list-style-type: none"> Ignition switch: ON, except for during engine cranking <p>Set Conditions</p> <ul style="list-style-type: none"> The sensor output voltage for 3 seconds is 4.9 V or higher (the coolant temperature is approximately -45°C or lower). <p>or</p> <ul style="list-style-type: none"> The sensor output voltage for 3 seconds is 0.2 V or lower (the coolant temperature is approximately 140°C or higher). 	<ul style="list-style-type: none"> Engine coolant temperature sensor inoperative Engine coolant temperature sensor open circuit, short circuit, or connector contact inoperative Engine-ECU inoperative



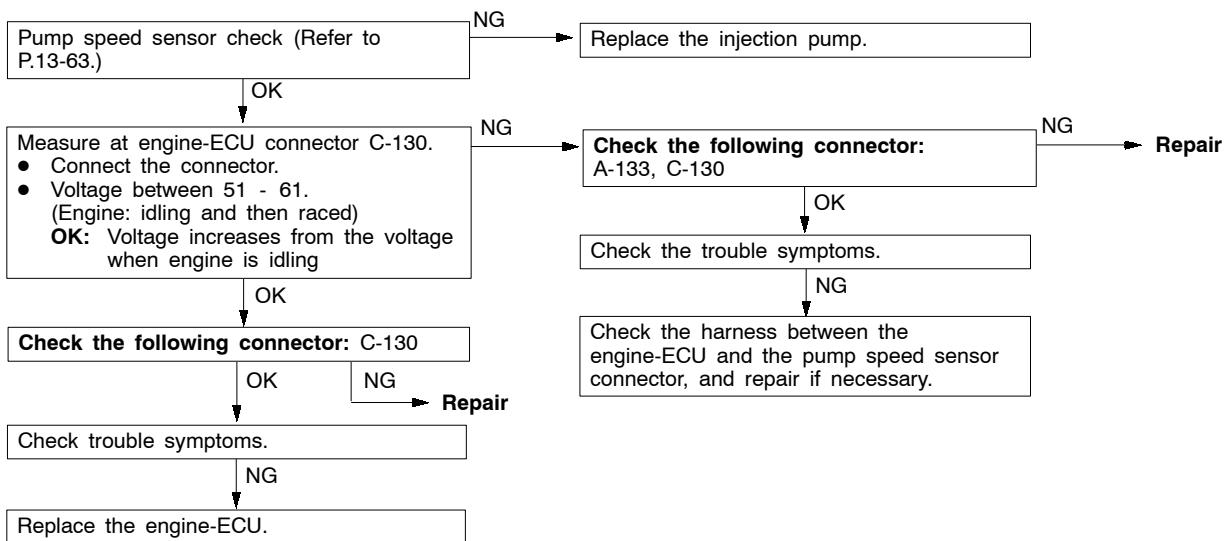
Code No. 16 Boost air temperature sensor (intake air sensor) system	Probable cause
<p>Range of Check</p> <ul style="list-style-type: none"> Ignition switch: ON, except for during engine cranking <p>Set Conditions</p> <ul style="list-style-type: none"> The sensor output voltage for 3 seconds is 4.6 V or higher (the intake air temperature is approximately -45°C or lower). <p>or</p> <ul style="list-style-type: none"> The sensor output voltage for 3 seconds is 0.3 V or lower (the intake air temperature is approximately 110°C or higher). 	<ul style="list-style-type: none"> Boost air temperature sensor inoperative Boost air temperature sensor open circuit, short circuit, or connector contact inoperative Engine-ECU inoperative



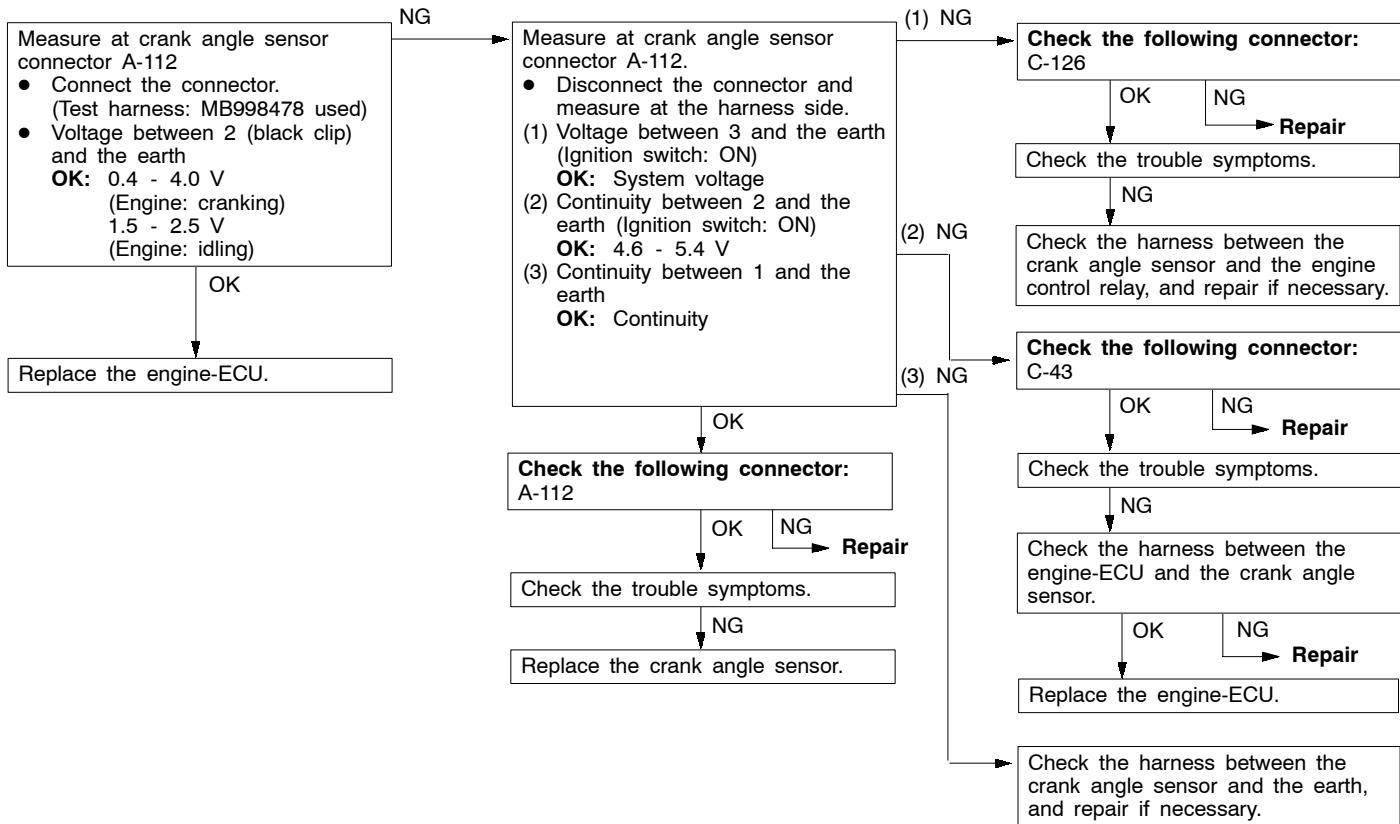
Code No. 17 Vehicle speed sensor system	Probable cause
<p>Range of Check</p> <ul style="list-style-type: none"> • Ignition switch: ON • Engine speed: 2,800 r/min or higher • Driving with heavy load <p>Set Conditions</p> <ul style="list-style-type: none"> • Slower than vehicle speed of 3 km/h 	<ul style="list-style-type: none"> • Vehicle speed sensor inoperative • Vehicle speed sensor open circuit, short circuit, or connector contact inoperative • Engine-ECU inoperative



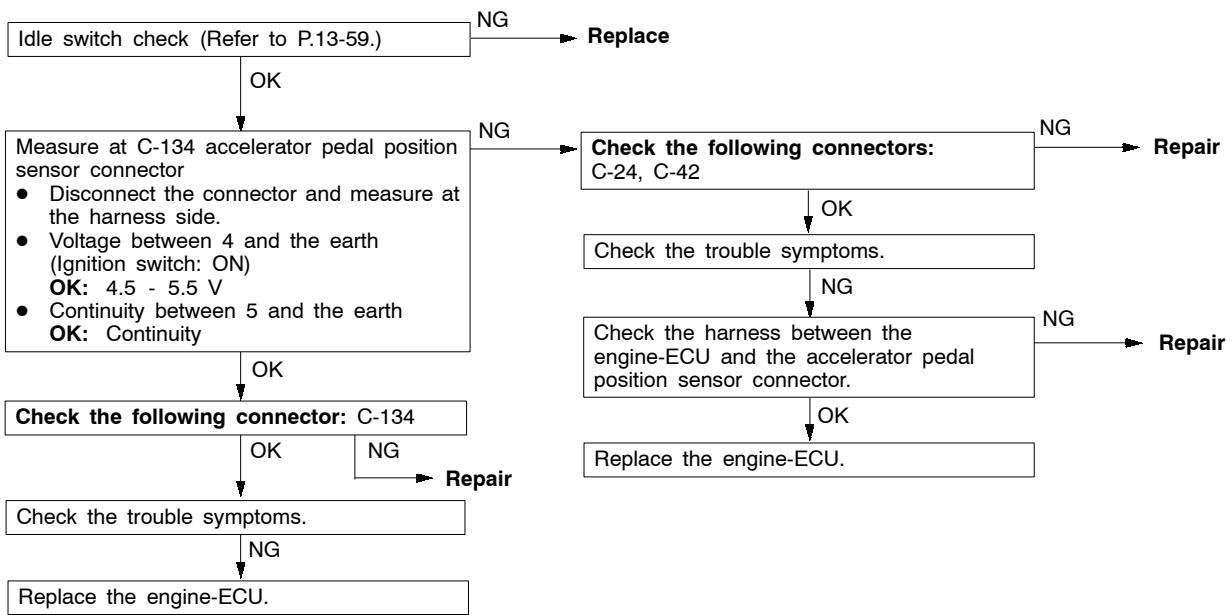
Code No. 18 Pump speed sensor system	Probable cause
<p>Range of Check</p> <ul style="list-style-type: none"> • Ignition switch: ON • Not during the engine cranking <p>Set Conditions</p> <ul style="list-style-type: none"> • The difference between the pump speed sensor and the crank angle sensor output value is 500 r/min or higher for 4 seconds 	<ul style="list-style-type: none"> • Malfunction of pump speed sensor • Open circuit or short-circuit in pump speed sensor circuit, or poor sensor contact • Engine-ECU inoperative



Code No. 21 Crank angle sensor system	Probable cause
Range of Check • Engine cranking Set Conditions • Sensor output voltage does not change for 2 seconds (no pulse signal input)	• Malfunction of crank angle sensor • Open circuit or short-circuit in crank angle sensor circuit, or poor connector contact • Engine-ECU inoperative
Range of Check • Ignition switch: ON • Not during the engine cranking • Pump speed sensor circuit: Normal Set Conditions • When crank angle sensor signal is being input normally, suddenly no sensor signal is input for 0.3 seconds or more	



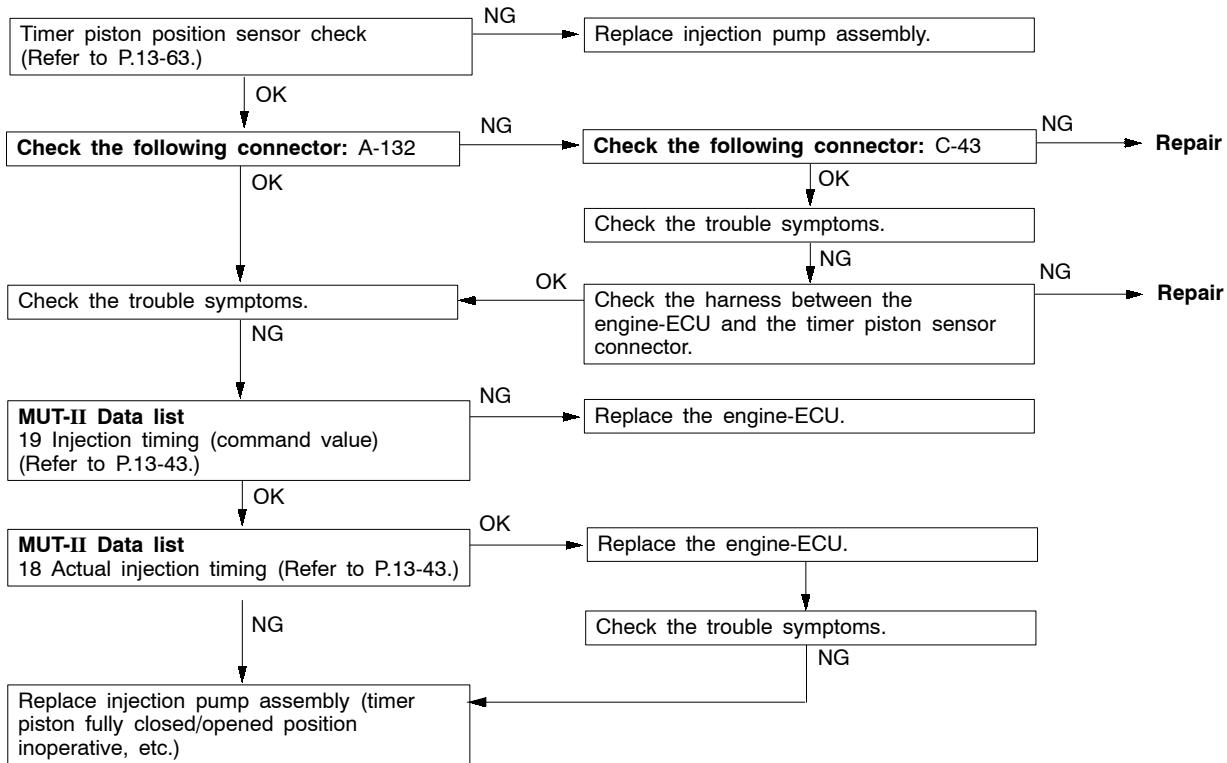
Code No. 23 Idle switch (accelerator pedal position sensor built-in) system	Probable cause
<p>Range of Check Ignition switch: ON, accelerator pedal position sensor (main, sub) operative, except for during engine cranking Set Conditions</p> <ul style="list-style-type: none"> Idle switch (built-in): ON for 0.8 second, accelerator pedal position sensor (main, sub) output voltage 1.875 V or higher Idle switch (built-in): OFF for 10 minutes, accelerator pedal position sensor (main, sub) opening degrees less than 1.17 % 	<ul style="list-style-type: none"> Accelerator pedal position sensor inoperative Accelerator pedal position sensor open circuit, short circuit, or connector contact inoperative Idle switch "ON" inoperative Idle switch signal line short circuit Engine-ECU inoperative



Code No. 25 Timer piston position sensor system	Probable cause
Range of Check • Ignition switch: OK • Not during the engine cranking Set Conditions • The sensor output voltage for 1 second is 4.9 V* or more or • The sensor output voltage for 1 second is 0.25 V* or less	<ul style="list-style-type: none"> • Timer piston position sensor inoperative • Timer piston position sensor open circuit, short circuit, or connector contact inoperative • Engine-ECU inoperative

NOTE:

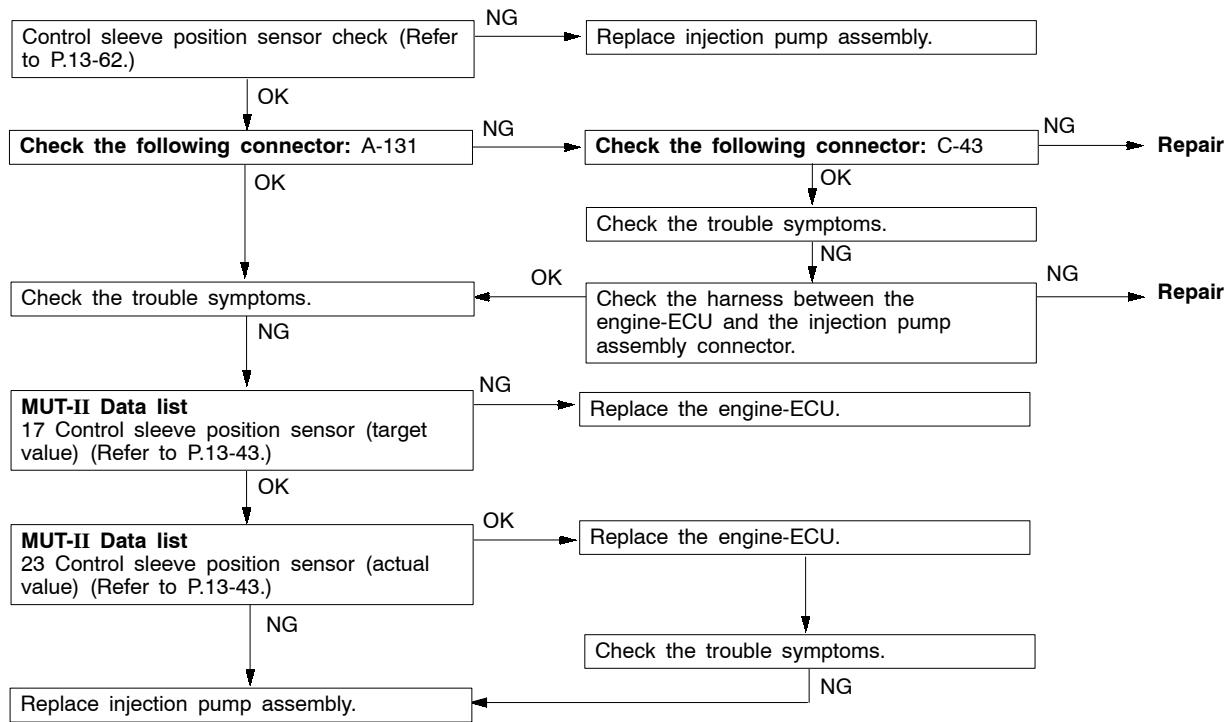
*: This voltage is derived from the input pulse signal converted in the engine-ECU and cannot be measured.



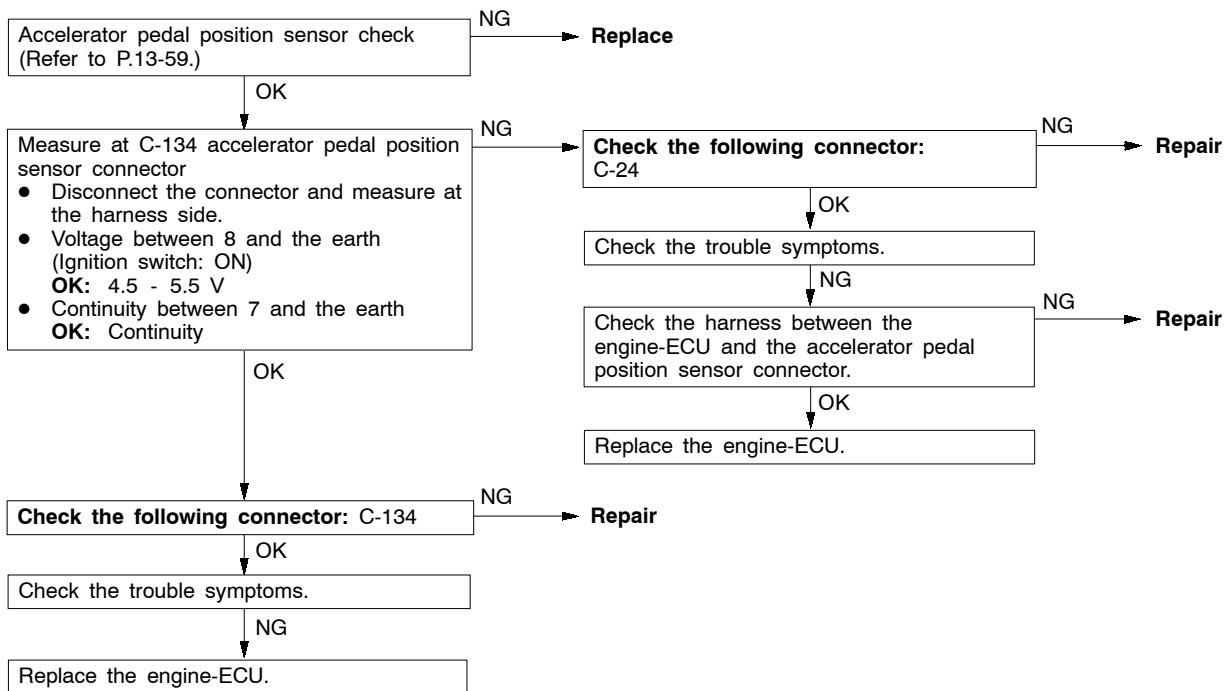
Code No. 26 Control sleeve position sensor system	Probable cause
Range of Check • Ignition switch: ON Set Conditions • The sensor output voltage for 0.3 second is 4.5 V* or more or • The sensor output voltage for 0.3 second is 0.25 V* or less	<ul style="list-style-type: none"> Control sleeve position sensor inoperative Control sleeve position sensor open circuit, short circuit, or connector contact inoperative Engine-ECU inoperative

NOTE:

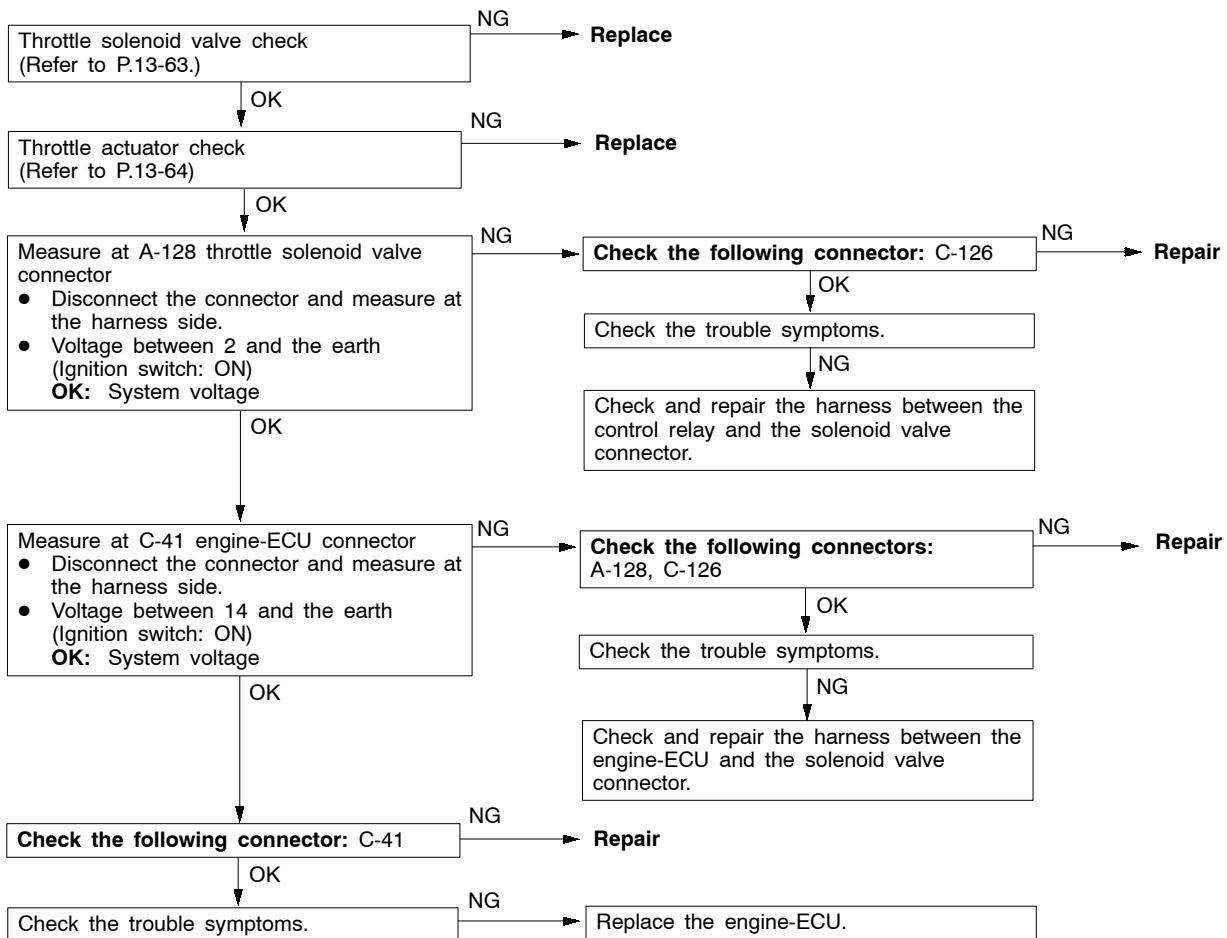
*: This voltage is derived from the input pulse signal converted in the engine-ECU and cannot be measured.



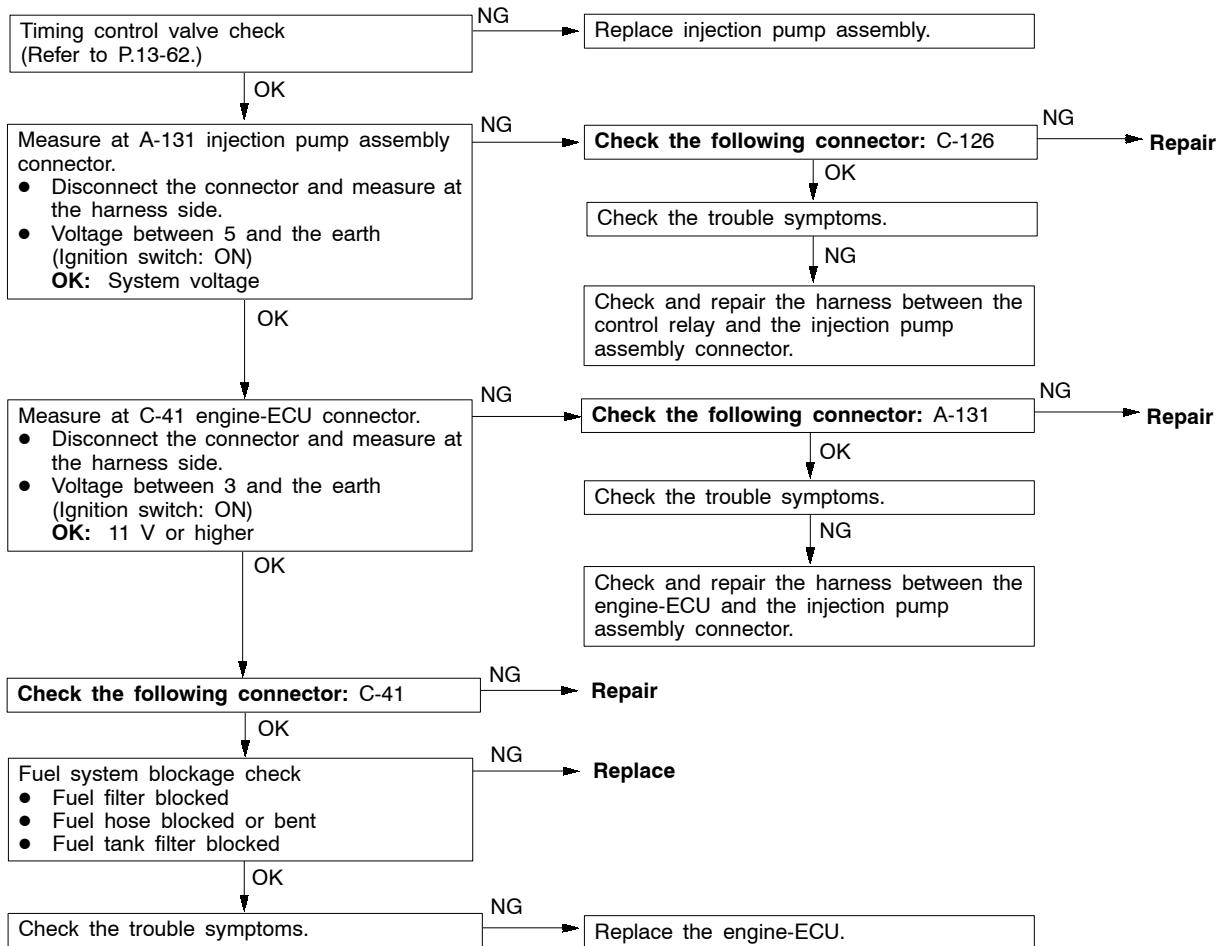
Code No. 27 Accelerator pedal position sensor (sub) system	Probable cause
<p>Range of Check</p> <ul style="list-style-type: none"> Ignition switch: ON, accelerator pedal position sensor (main) operative, except for during engine cranking <p>Set Conditions</p> <ul style="list-style-type: none"> Accelerator pedal position sensor output voltage for 1 second Sub side: 0.2 V or higher, lower than 2.5 V Main side: 4.5 V or higher or Sub or main: Lower than 0.2 V <p>Range of Check</p> <ul style="list-style-type: none"> Ignition switch: ON, except for during engine cranking <p>Set Conditions</p> <ul style="list-style-type: none"> The difference in the output sensor voltage between the main and the sub sensor is 1 V or higher, or the idle switch ON, and sensor main output voltage is 1.875 V or higher. 	<ul style="list-style-type: none"> Accelerator pedal position sensor inoperative Accelerator pedal position sensor open circuit, short circuit, or connector contact inoperative Engine-ECU inoperative



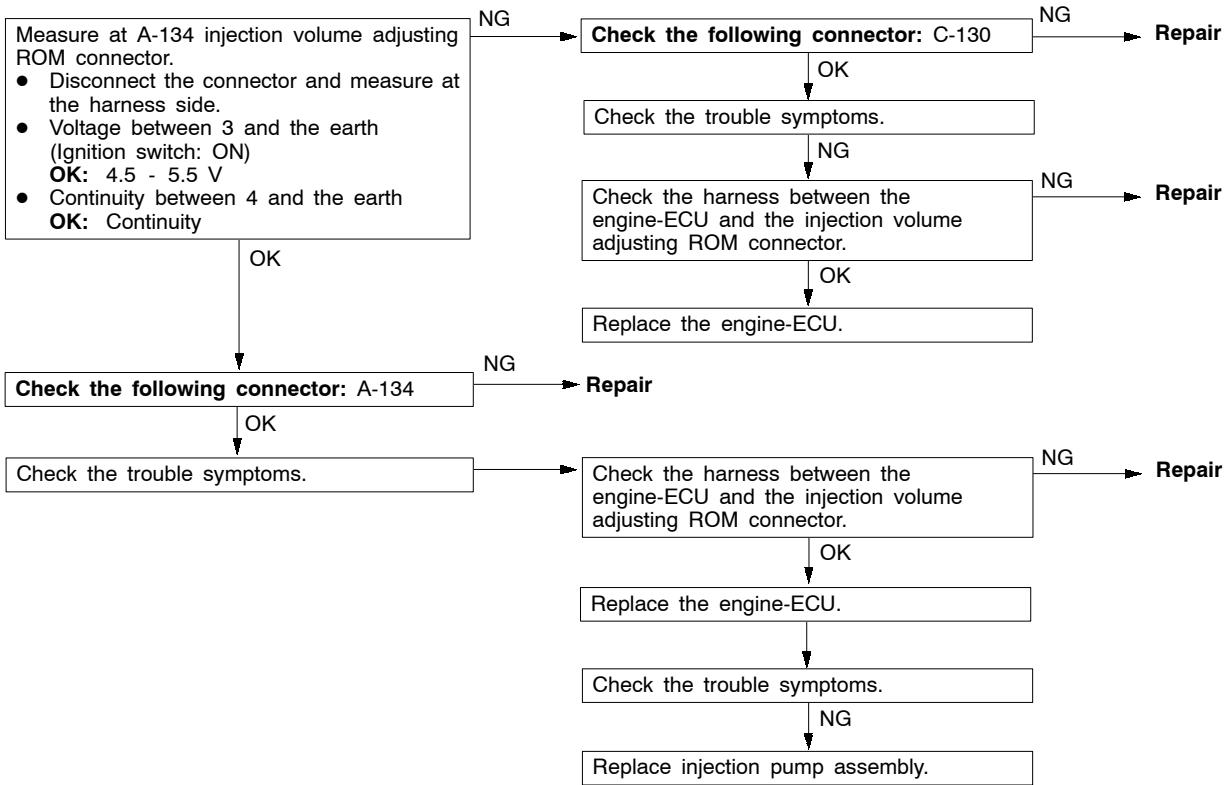
Code No. 41 Throttle solenoid valve system	Probable cause
<p>Range of Check</p> <ul style="list-style-type: none"> • Ignition switch: OFF • Barometric pressure is 95.4 kPa or over (equivalent to an altitude of 500 m). <p>Set Conditions</p> <ul style="list-style-type: none"> • Boost pressure sensor output does not change. 	<ul style="list-style-type: none"> • Throttle solenoid valve inoperative • Throttle solenoid valve open circuit, short circuit, or connector contact inoperative • Engine-ECU inoperative • Malfunction of throttle actuator



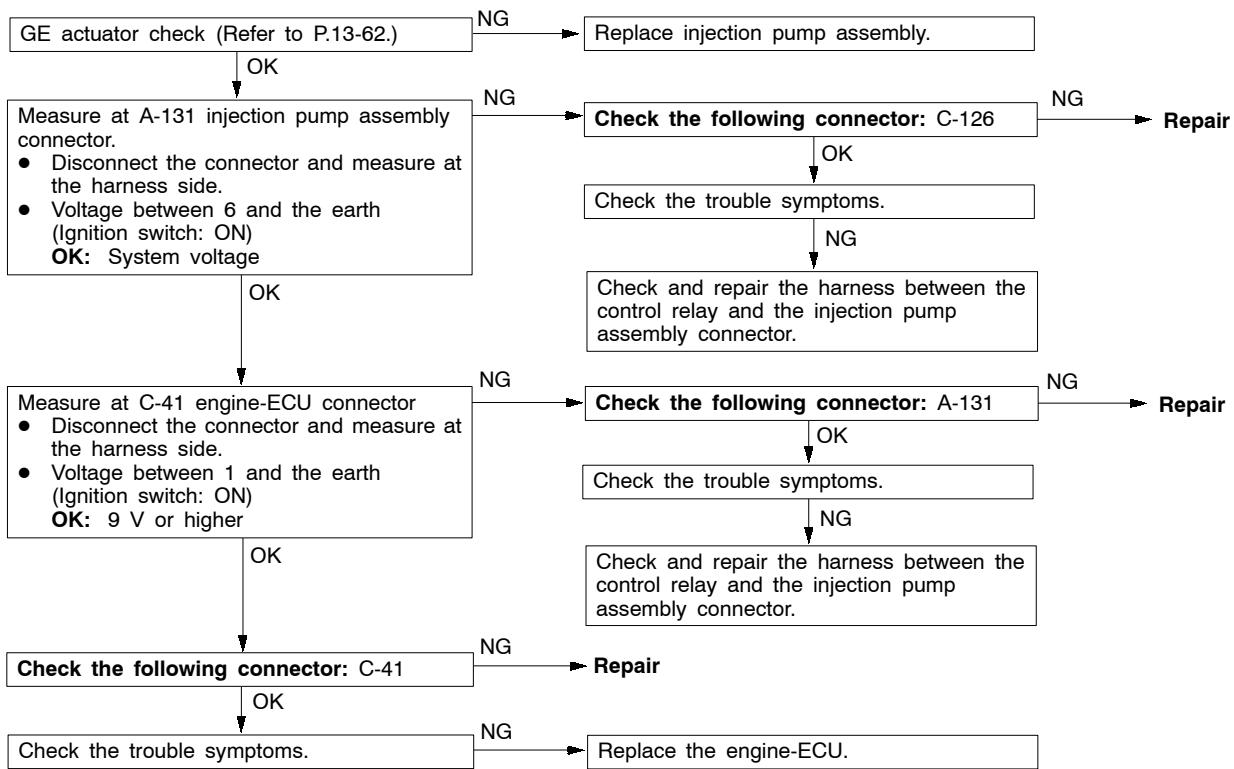
Code No. 43 Timing control valve system	Probable cause
<p>Range of Check</p> <ul style="list-style-type: none"> • Engine coolant temperature 80°C or higher and the engine running <p>Set Conditions</p> <ul style="list-style-type: none"> • Target value minus actual value is 0.64 V or more for 5 seconds 	<ul style="list-style-type: none"> • Timing control valve inoperative • Timing control valve open circuit, short circuit, or connector contact inoperative • Engine-ECU inoperative • Blockage in fuel system



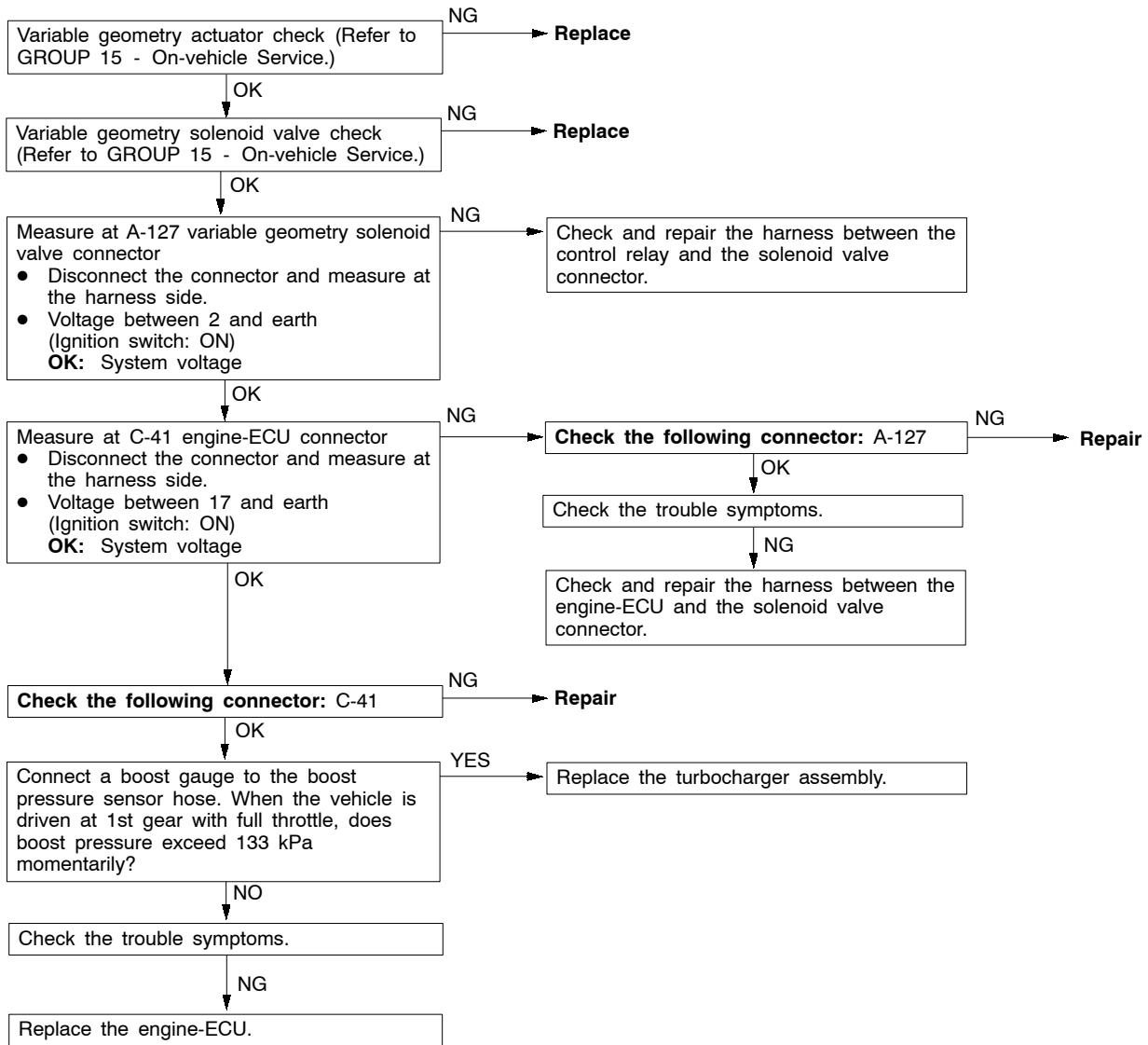
Code No. 46 Injection volume adjusting ROM system	Probable cause
Range of Check • Ignition switch: ON Set Conditions • When communication fails	• Injection volume adjusting ROM inoperative • Engine-ECU inoperative



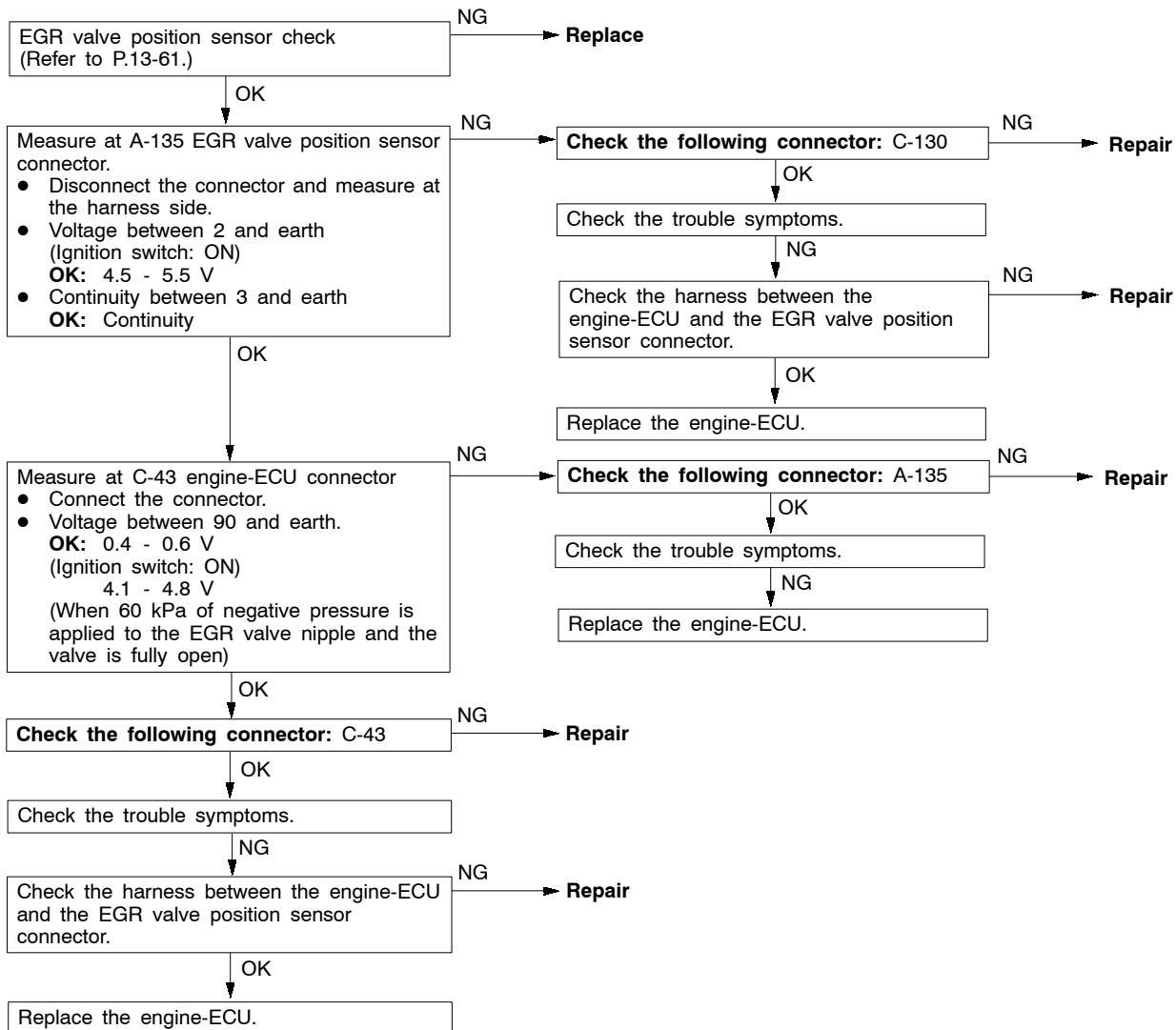
Code No. 48 GE actuator (in the middle of control sleeve position sensor inoperative) system	Probable cause
<p>Range of Check</p> <ul style="list-style-type: none"> • Ignition switch: ON <p>Set Conditions</p> <ul style="list-style-type: none"> • Target value minus actual value is 1 V or more for 1 second 	<ul style="list-style-type: none"> • Control sleeve position sensor inoperative • GE actuator inoperative • Control sleeve position sensor open circuit, short circuit, or connector contact inoperative • Engine-ECU inoperative



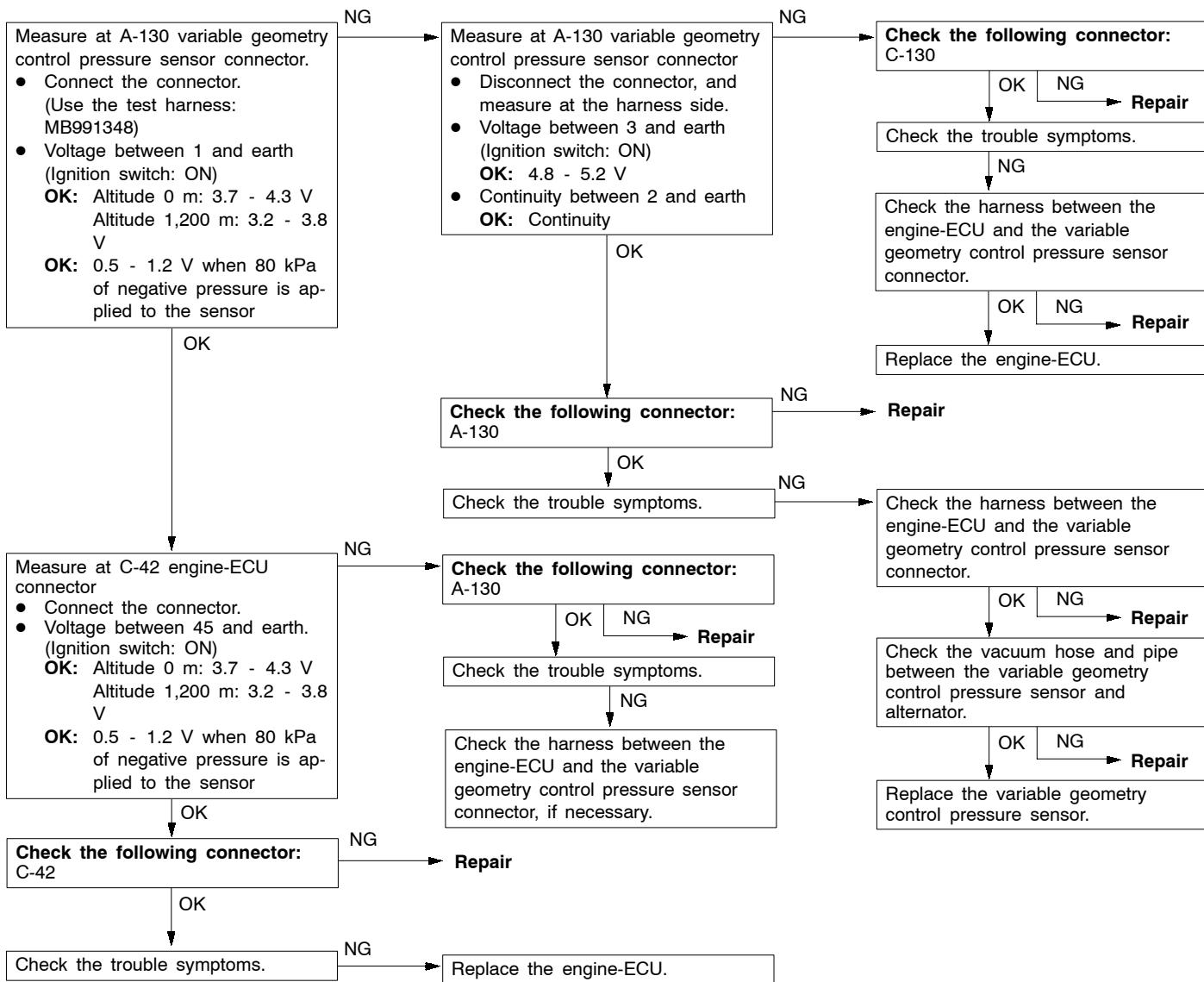
Code No. 49 Over boost	Probable cause
Range of Check • Ignition switch: ON Set Conditions • Boost pressure is higher than the barometric pressure + 133 kPa	<ul style="list-style-type: none"> Malfunction of the variable geometry actuator Malfunction of variable geometry solenoid valve Variable geometry solenoid valve open circuit, short circuit, or connector contact inoperative Engine-ECU inoperative



Code No. 51 EGR valve position sensor system	Probable cause
<p>Range of Check • Ignition switch: ON, except during engine cranking Set Condition • Output voltage of EGR valve position sensor for 3 seconds is 4.85 V or higher, or lower than 0.15 V</p>	<ul style="list-style-type: none"> • EGR valve position sensor inoperative • EGR valve position sensor open circuit, short circuit or connector circuit inoperative • Engine-ECU inoperative



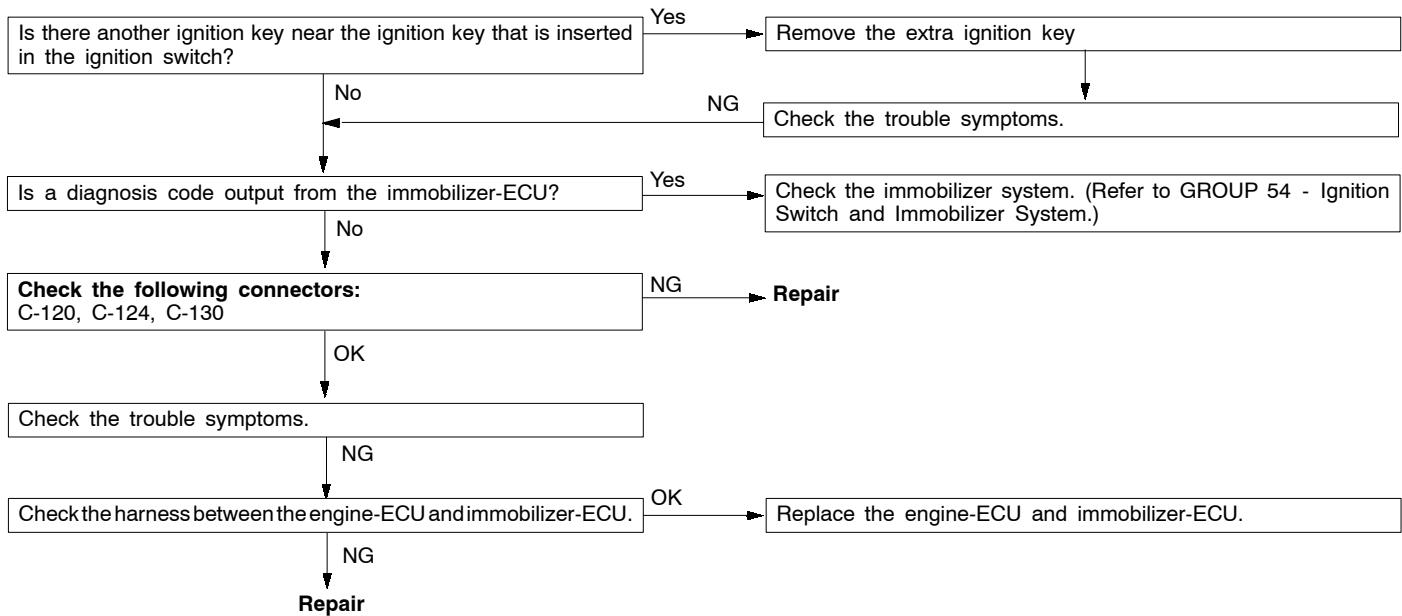
Code No. 52 Variable geometry control pressure sensor system	Probable cause
<p>Range of Check</p> <ul style="list-style-type: none"> Ignition switch: ON, except during engine cranking <p>Set Condition</p> <ul style="list-style-type: none"> 4.5 V or higher, or 0.2 V or lower <p>Range of Check</p> <ul style="list-style-type: none"> Engine idling <p>Set Conditions</p> <ul style="list-style-type: none"> The difference between target and actual negative pressures remains 10.6 kPa or more for 10 seconds. 	<ul style="list-style-type: none"> Variable geometry control pressure sensor inoperative Variable geometry control pressure sensor open circuit, short circuit or connector contact inoperative Vacuum hose disconnected or ruptured Engine-ECU inoperative



Code No. 54 Immobilizer system	Probable cause
Range of Check • Ignition switch: ON Set Conditions • Improper communication between the engine-ECU and immobilizer-ECU	<ul style="list-style-type: none"> Radio interference of encrypted codes Incorrect encrypted code Malfunction of harness or connector Malfunction of immobilizer-ECU Engine-ECU inoperative

NOTE

- If the ignition switches are close each other when starting the engine, radio interference may cause this code to be displayed.
- This code may be displayed when registering the key encrypted code.



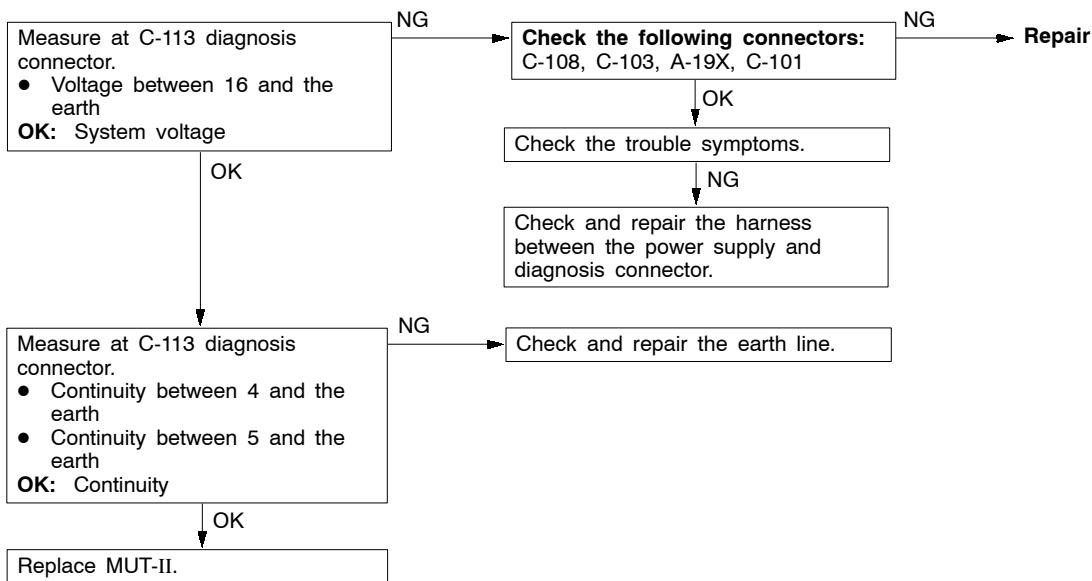
INSPECTION CHART FOR TROUBLE SYMPTOMS

Trouble Symptom		Inspection procedure No.	Reference page
No communication can be established between MIUT-II and the engine-ECU.	No communication can be established with all systems.	1	13-30
	No communication can be established only with the engine-ECU	2	13-30
Engine warning lamp related	Immediately after the ignition switch is "ON", the engine warning lamp does not turn on.	3	13-31
	The engine warning lamp keeps on and does not turn off.	4	13-31
Starting performance	No initial combustion (unable to start)	5	13-32
	Starting performance is bad when the engine is cold (difficult to start)	6	13-32
	Starting performance is bad regardless of when the engine is hot or cold (difficult to start)	7	13-33
Idling stability (idling inoperative)	Low idling speed when the engine is cold (improper idling speed)	8	13-33
	High idling speed (improper idling speed)	9	13-33
	Low idling speed (improper idling speed)	10	13-34
	Idling unstable (rough idling, hunting)	11	13-34
Idling stability (idling sustainment inoperative)	The engine halts after running for a while.	12	13-34
	The engine halts during idling.	13	13-35
Driveability	Lack of output power	14	13-35
	Occurrence of abnormal knocking	15	13-35
	Abnormal black smoke	16	13-36
	Abnormal white smoke	17	13-36
	Hunting during driving	18	13-36
A/C condenser fan malfunction		19	13-37
Intercooler fan malfunction		20	13-38

INSPECTION PROCEDURES FOR TROUBLE SYMPTOMS

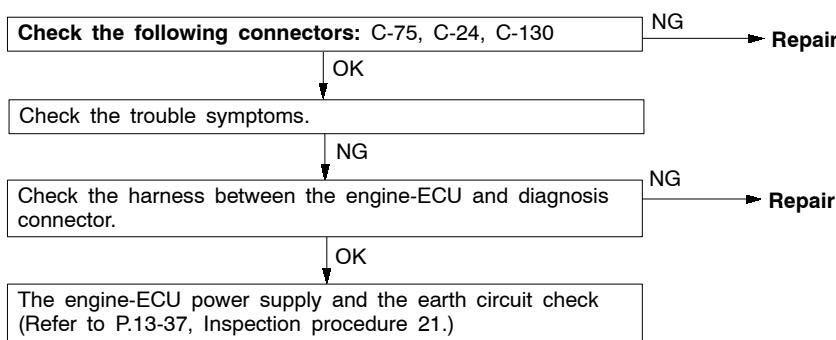
INSPECTION PROCEDURE 1

No communication can be established between MUT-II and all systems.	Probable cause
Probable cause can be found in troubles with the power supply circuit and the earth circuit to the diagnosis connector. ● Voltage between 16 and the earth OK: System voltage	<ul style="list-style-type: none"> Diagnosis connector inoperative Harness inoperative



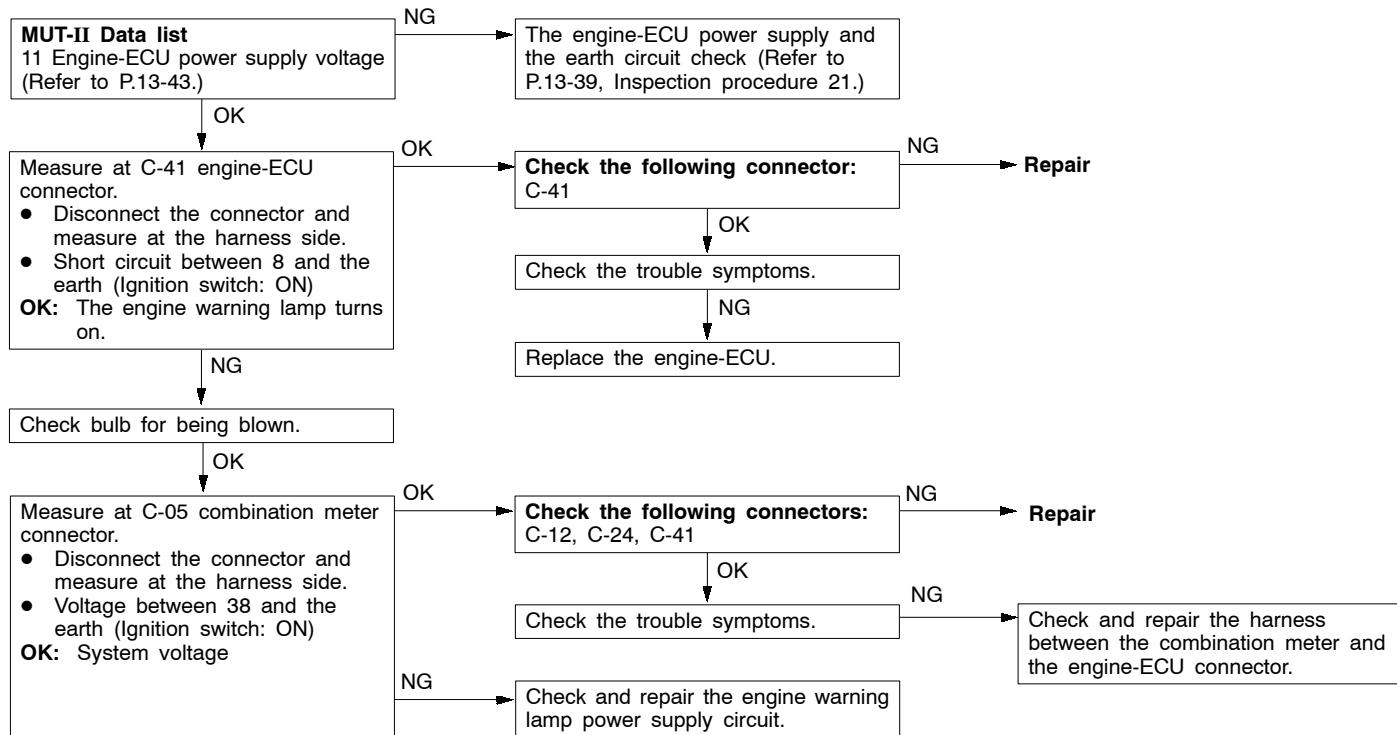
INSPECTION PROCEDURE 2

No communication can be established between MUT-II and the engine-ECU.	Probable cause
Probable causes are shown in the following: ● The power is not supplied to the engine-ECU. ● The earth circuit of the engine-ECU inoperative ● The engine-ECU inoperative ● Communication between the engine-ECU and MUT-II inoperative	<ul style="list-style-type: none"> The power supply circuit of the engine-ECU inoperative Engine-ECU inoperative Open circuit at the harness between the engine-ECU and the diagnosis connector



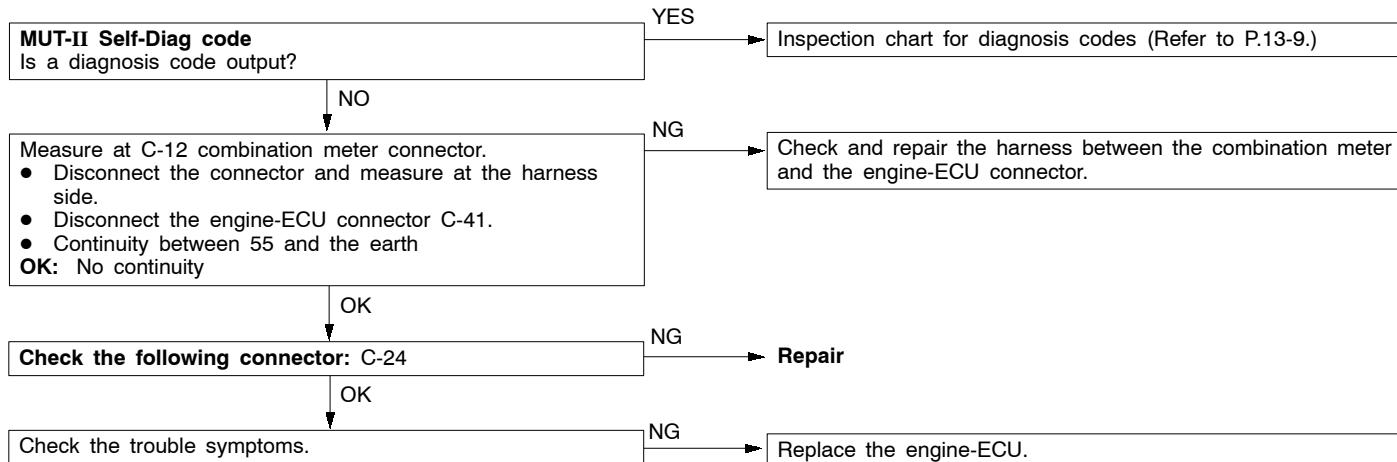
INSPECTION PROCEDURE 3

Immediately after the ignition switch is "ON", the engine warning lamp does not turn on.	Probable cause
<p>The engine-ECU turns on the engine warning lamp for 5 seconds immediately after turning on the ignition switch to check the bulb for being blown. If the engine warning lamp does not turn on immediately after turning the ignition switch ON, problems shown in the right could exist.</p>	<ul style="list-style-type: none"> • The engine warning lamp blown • The engine warning lamp circuit inoperative • Engine-ECU inoperative



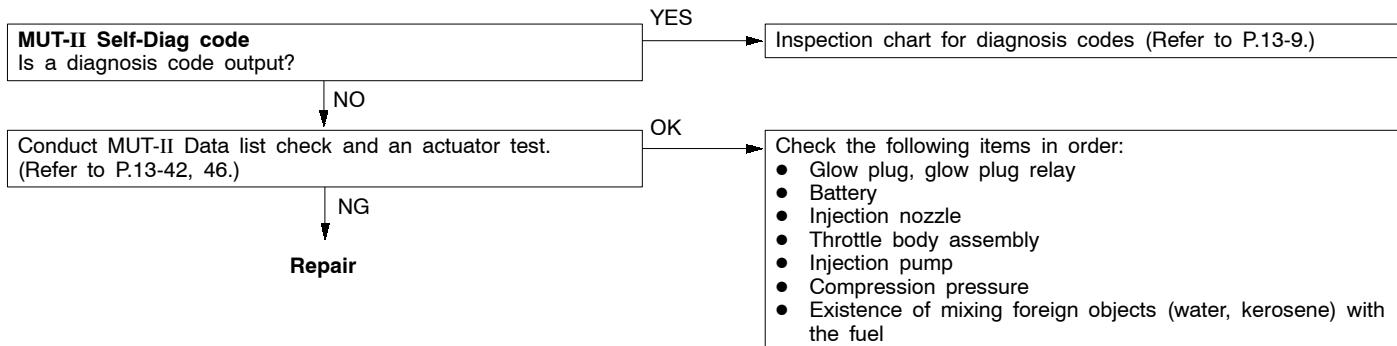
INSPECTION PROCEDURE 4

The engine warning lamp keeps on and does not turn off.	Probable cause
<p>The probable causes can be found in either the engine-ECU detecting the malfunction in the sensor and/or the actuator, or the problem shown in the right takes place.</p>	<ul style="list-style-type: none"> • Short circuit at the harness between the engine warning lamp and the engine-ECU • Engine-ECU inoperative



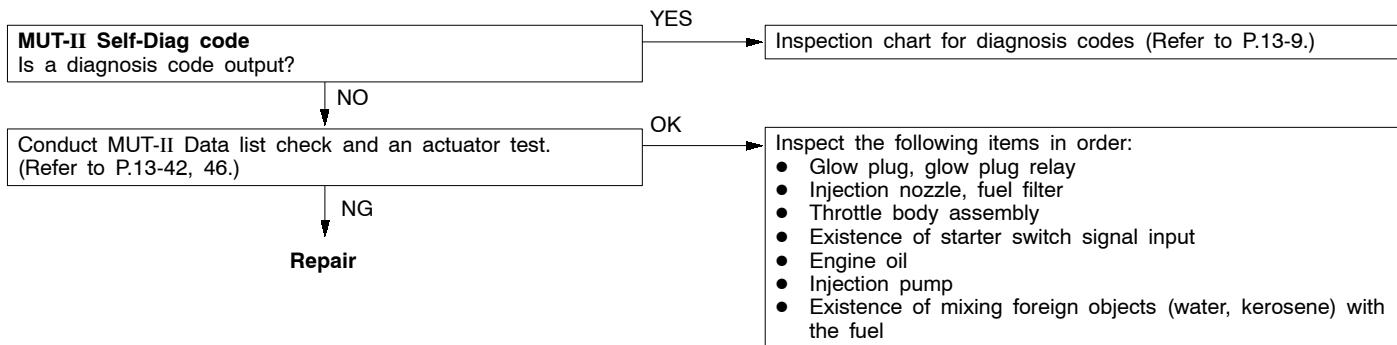
INSPECTION PROCEDURE 5

No initial combustion (unable to start)	Probable cause
Probable causes can be found in troubles with control system, injection pump, glow system, and power supply system.	<ul style="list-style-type: none"> ● Control system inoperative ● Injection pump inoperative ● Intake system inoperative ● Glow system inoperative ● Engine-ECU inoperative



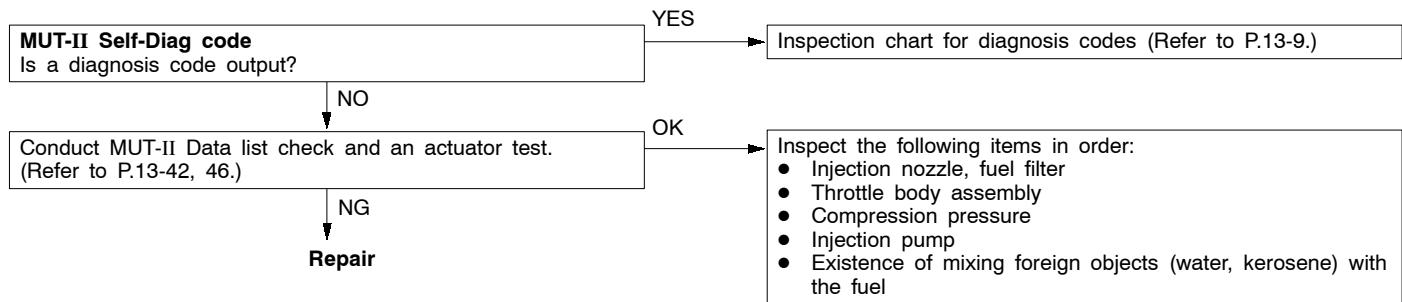
INSPECTION PROCEDURE 6

Starting performance is bad when the engine is cold (unable to start)	Probable cause
Probable causes can be found in troubles with control system, injection pump, fuel system, intake system, and glow system.	<ul style="list-style-type: none"> ● Control system inoperative ● Injection pump inoperative ● Fuel system inoperative ● Intake system inoperative ● Glow system inoperative ● Engine-ECU inoperative



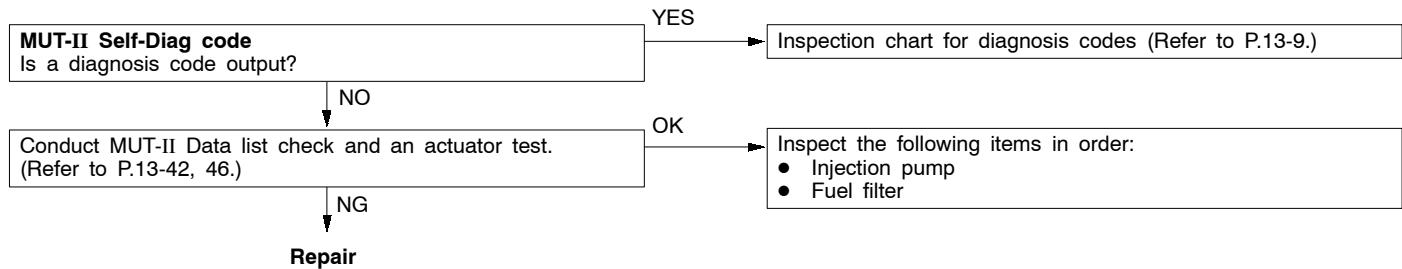
INSPECTION PROCEDURE 7

Starting performance is bad regardless of whether the engine is hot or cold (unable to start)	Probable cause
Probable causes can be found in troubles with control system, injection pump, fuel system, and intake system.	<ul style="list-style-type: none"> Control system inoperative Injection pump inoperative Fuel system inoperative Intake system inoperative Engine-ECU inoperative



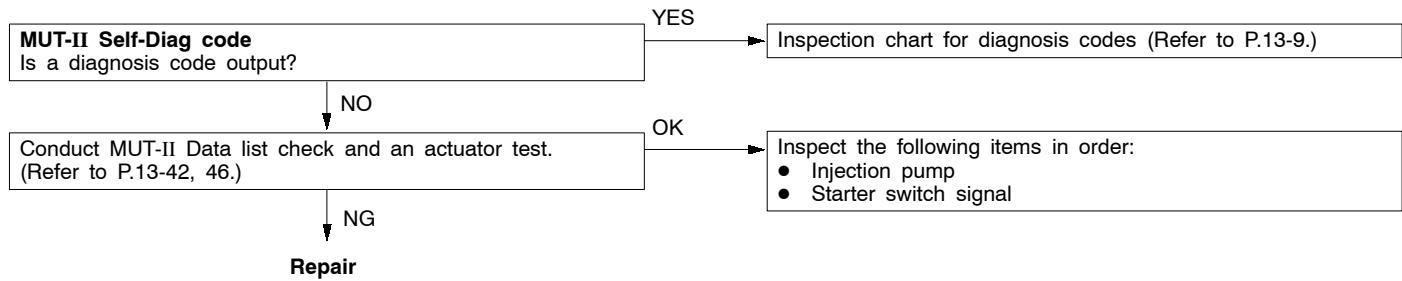
INSPECTION PROCEDURE 8

Low idling speed when the engine is cold (improper idling speed)	Probable cause
Probable causes can be found in troubles with control system, injection pump, and fuel system.	<ul style="list-style-type: none"> Control system inoperative Injection pump inoperative Fuel system inoperative Engine-ECU inoperative



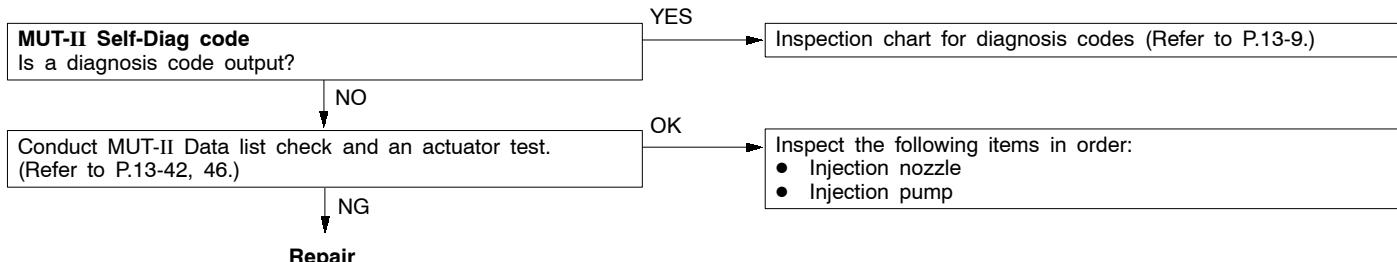
INSPECTION PROCEDURE 9

High idling speed (improper idling speed)	Probable cause
Probable causes can be found in troubles with control system and injection pump.	<ul style="list-style-type: none"> Control system inoperative Injection pump inoperative Engine-ECU inoperative



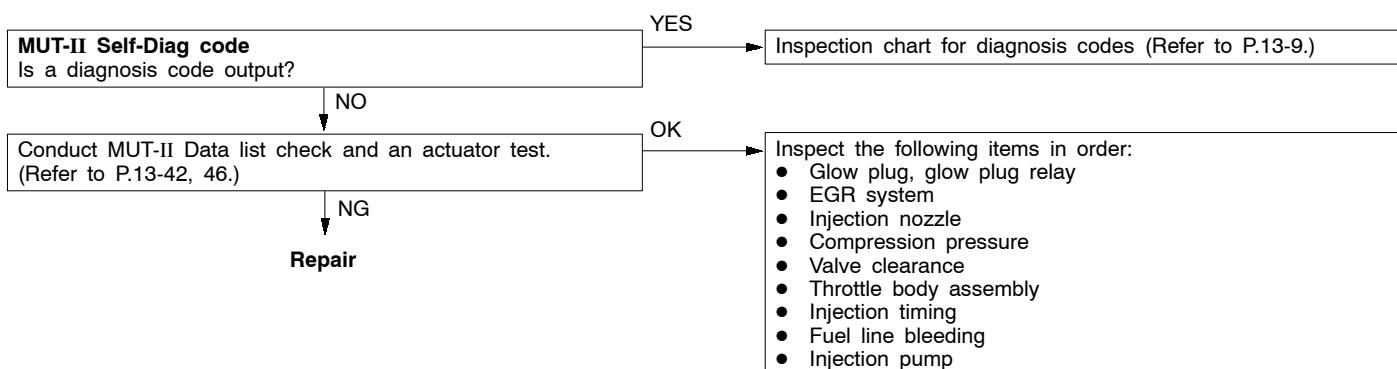
INSPECTION PROCEDURE 10

Low idling speed (improper idling speed)	Probable cause
Probable causes can be found in troubles with control system, injection pump, and fuel.	<ul style="list-style-type: none"> ● Control system inoperative ● Injection pump inoperative ● Fuel system inoperative ● Engine-ECU inoperative



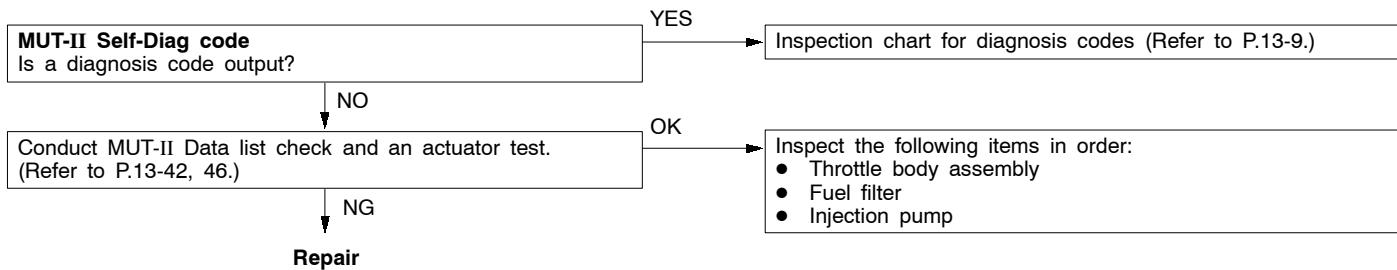
INSPECTION PROCEDURE 11

Idling instable (rough idling, hunting)	Probable cause
Probable causes can be found in troubles with control system, injection pump, fuel system, glow system, intake system, and EGR system.	<ul style="list-style-type: none"> ● Control system inoperative ● Injection pump inoperative ● Fuel system inoperative ● Intake system inoperative ● Glow system inoperative ● EGR system inoperative ● Engine-ECU inoperative



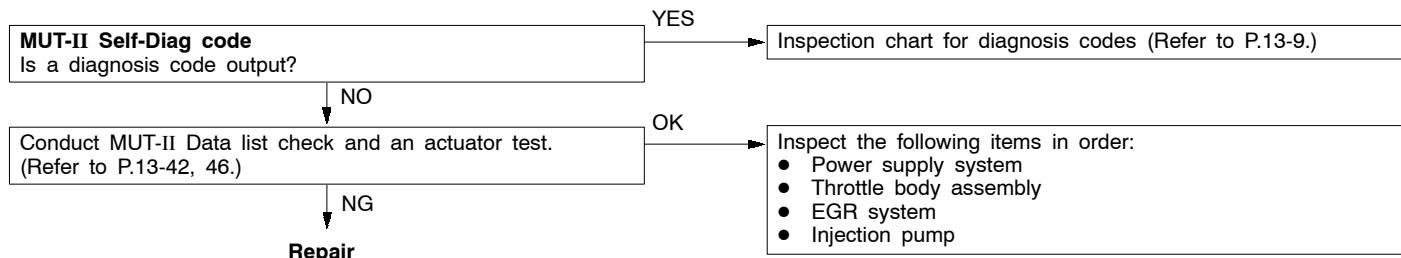
INSPECTION PROCEDURE 12

The engine stalls after running for a while.	Probable cause
Probable causes can be found in troubles with control system, injection pump, fuel system, and intake system.	<ul style="list-style-type: none"> ● Control system inoperative ● Injection pump inoperative ● Fuel system inoperative ● Intake system inoperative ● Engine-ECU inoperative



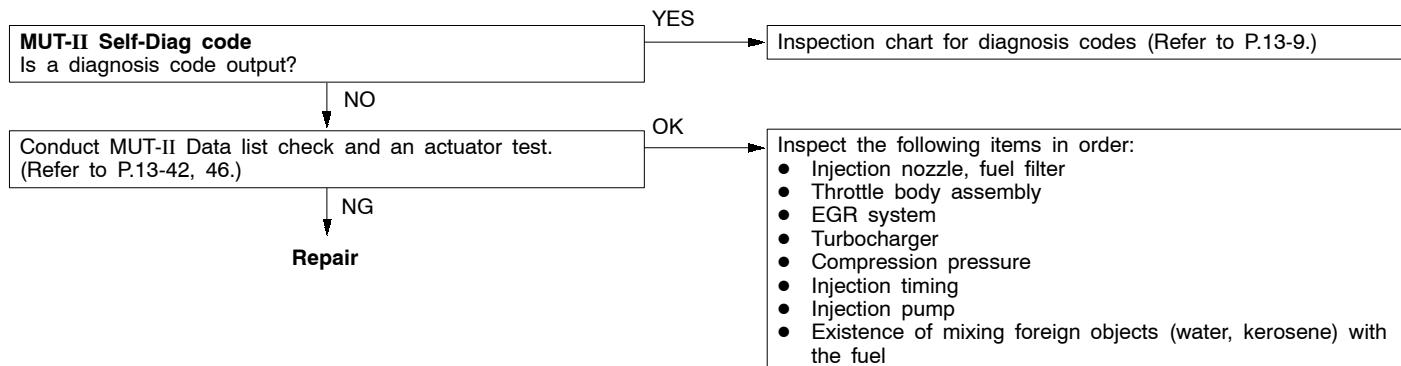
INSPECTION PROCEDURE 13

The engine stalls during idling.	Probable cause
Probable causes can be found in troubles with control system, injection pump, intake system, EGR system, and power supply.	<ul style="list-style-type: none"> Control system inoperative Injection pump inoperative Fuel system inoperative Intake system inoperative EGR system inoperative Engine-ECU inoperative



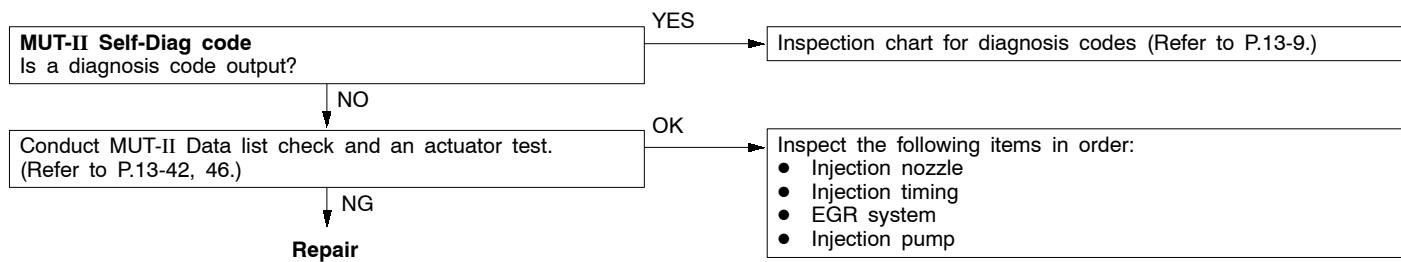
INSPECTION PROCEDURE 14

Lack of output power	Probable cause
Probable causes can be found in troubles with control system, injection pump, fuel system, intake system, and EGR system.	<ul style="list-style-type: none"> Control system inoperative Injection pump inoperative Fuel system inoperative Intake system inoperative EGR system inoperative Engine-ECU inoperative



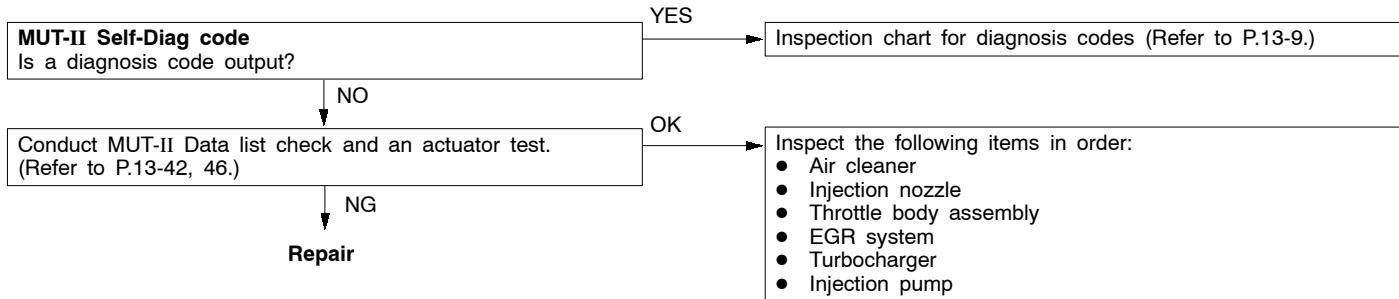
INSPECTION PROCEDURE 15

Occurrence of abnormal knocking	Probable cause
Probable causes can be found in troubles with control system, injection pump, fuel system, and EGR system.	<ul style="list-style-type: none"> Control system inoperative Injection pump inoperative Fuel system inoperative EGR system inoperative Engine-ECU inoperative



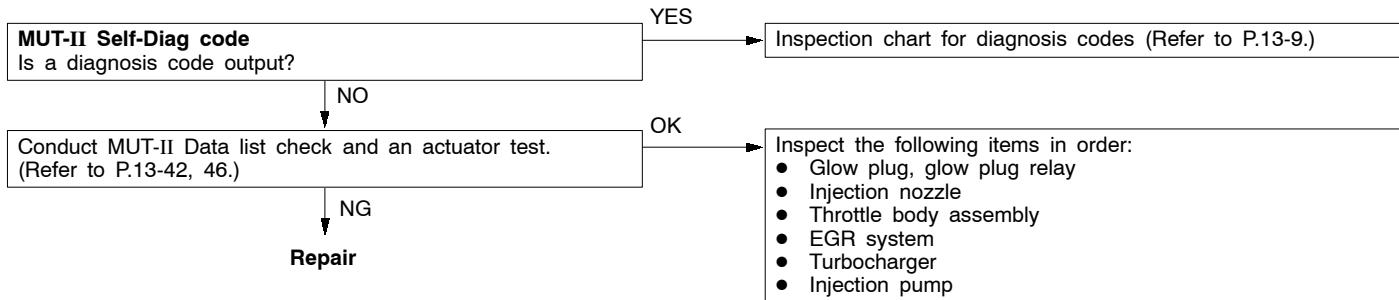
INSPECTION PROCEDURE 16

Abnormal black smoke	Probable cause
Probable causes can be found in troubles with control system, injection pump, fuel system, intake system, and EGR system.	<ul style="list-style-type: none"> ● Control system inoperative ● Injection pump inoperative ● Fuel system inoperative ● Intake system inoperative ● EGR system inoperative ● Engine-ECU inoperative



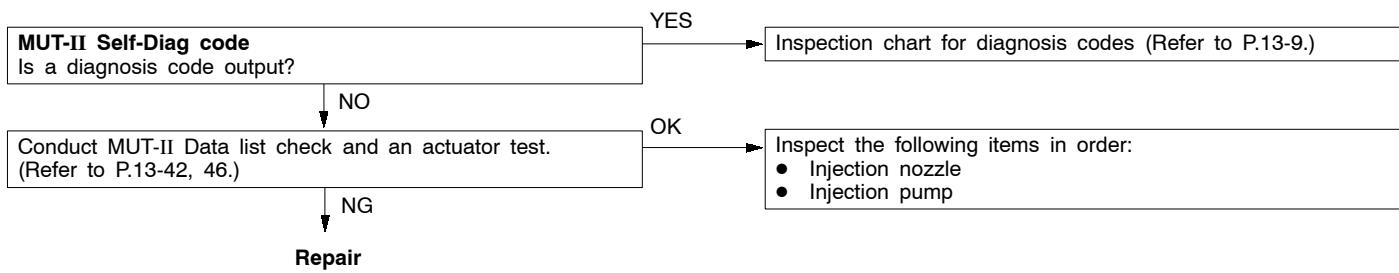
INSPECTION PROCEDURE 17

Abnormal white smoke	Probable cause
Probable causes can be found in troubles with control system, injection pump, fuel system, intake system, EGR system, and glow system.	<ul style="list-style-type: none"> ● Control system inoperative ● Injection pump inoperative ● Fuel system inoperative ● Intake system inoperative ● EGR system inoperative ● Glow system inoperative ● Engine-ECU inoperative



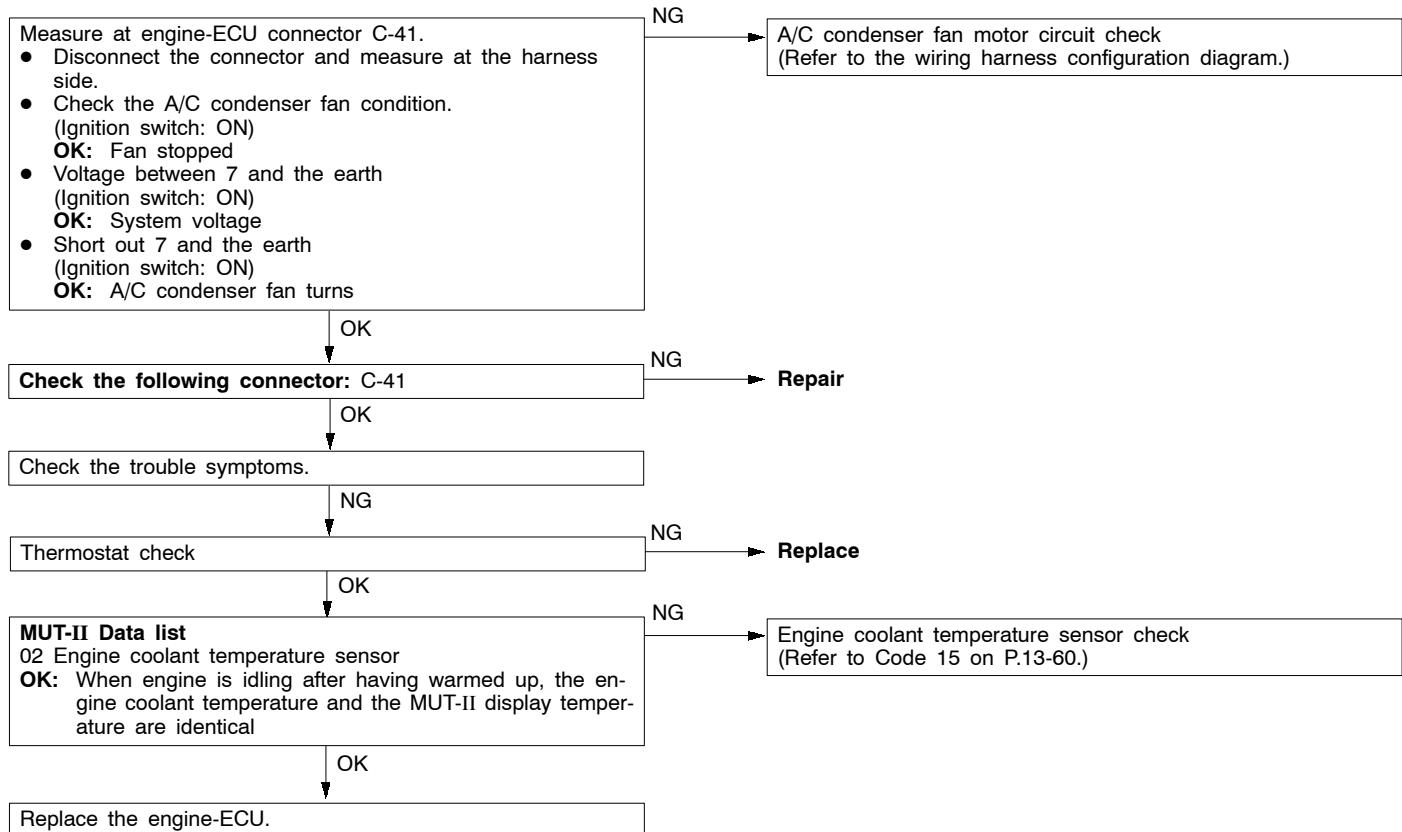
INSPECTION PROCEDURE 18

Hunting during driving	Probable cause
Probable causes can be found in troubles with control system, injection pump, and fuel system.	<ul style="list-style-type: none"> ● Control system inoperative ● Injection pump inoperative ● Fuel system inoperative ● Engine-ECU inoperative



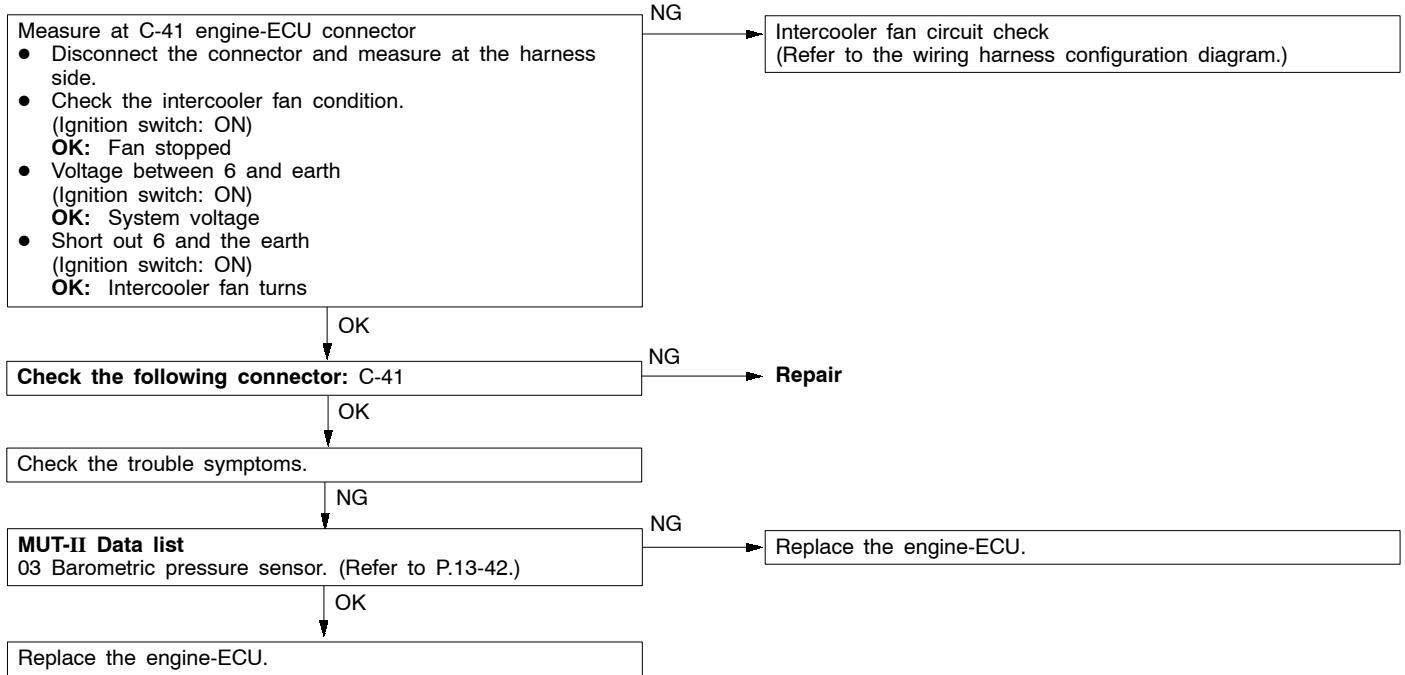
INSPECTION PROCEDURE 19

A/C condenser fan operating problem	Probable cause
The power transistor inside the engine-ECU turns on and off to control the A/C condenser fan motor relay.	<ul style="list-style-type: none"> Malfunction of A/C condenser fan motor relay Malfunction of A/C condenser fan motor Malfunction of thermostat Open circuit or short-circuit in circuit, or poor connector contact Malfunction of engine-ECU



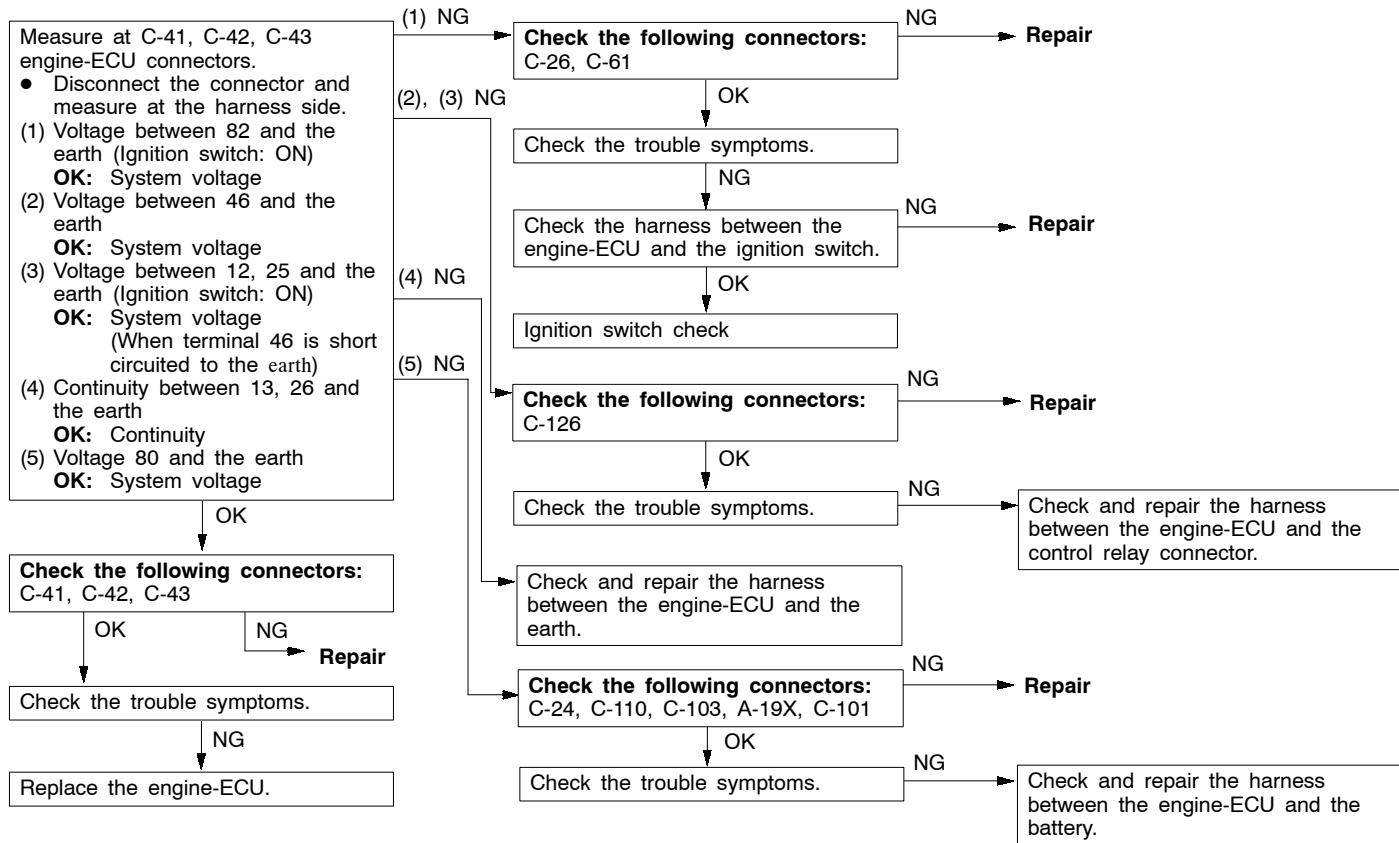
INSPECTION PROCEDURE 20

Intercooler fan malfunction	Probable cause
<p>The power transistor inside the engine-ECU turns on and off to control the intercooler fan motor relay.</p>	<ul style="list-style-type: none"> Malfunction of intercooler fan motor relay Malfunction of intercooler fan motor Open circuit or short-circuit in circuit, or poor connector contact Engine-ECU inoperative



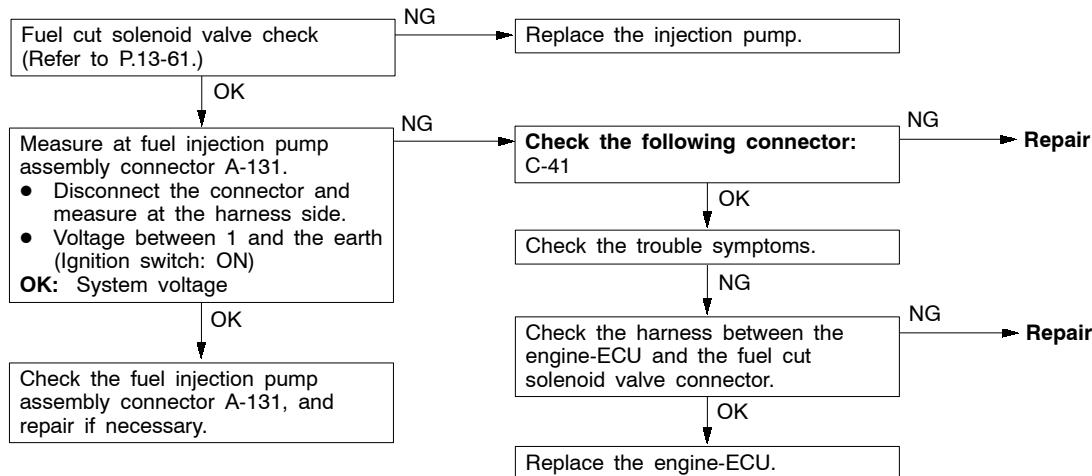
INSPECTION PROCEDURE 21

Engine-ECU power supply and earth circuit check



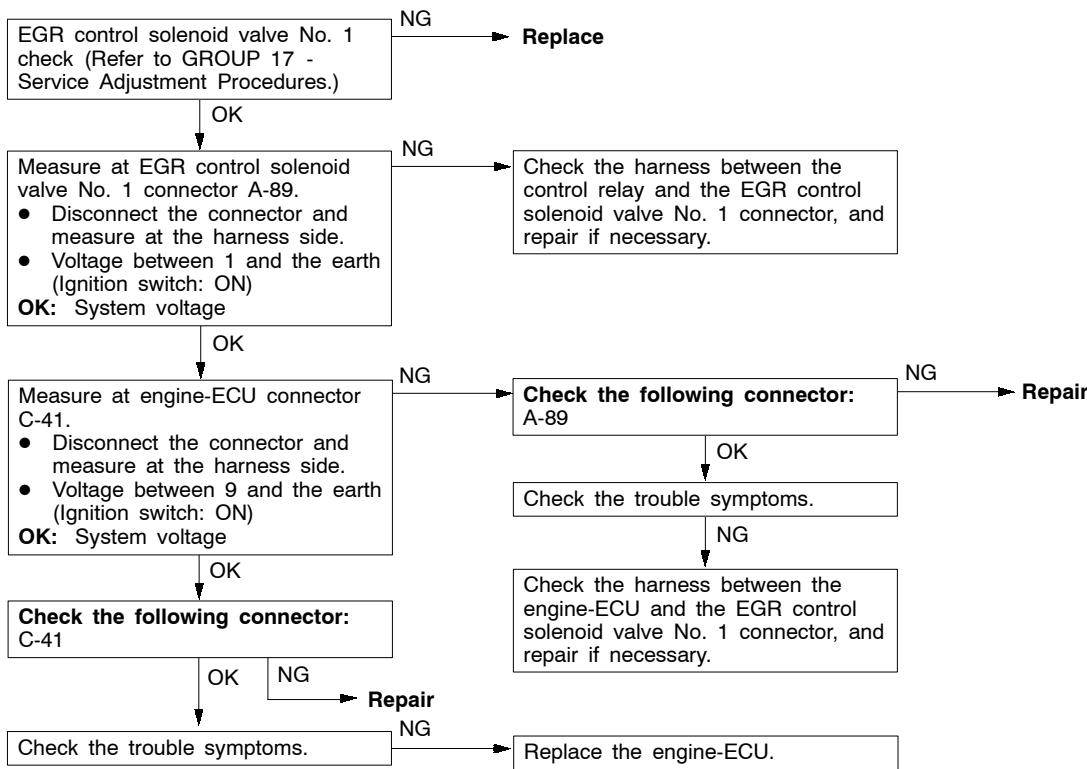
INSPECTION PROCEDURE 22

Fuel cut solenoid valve circuit inspection



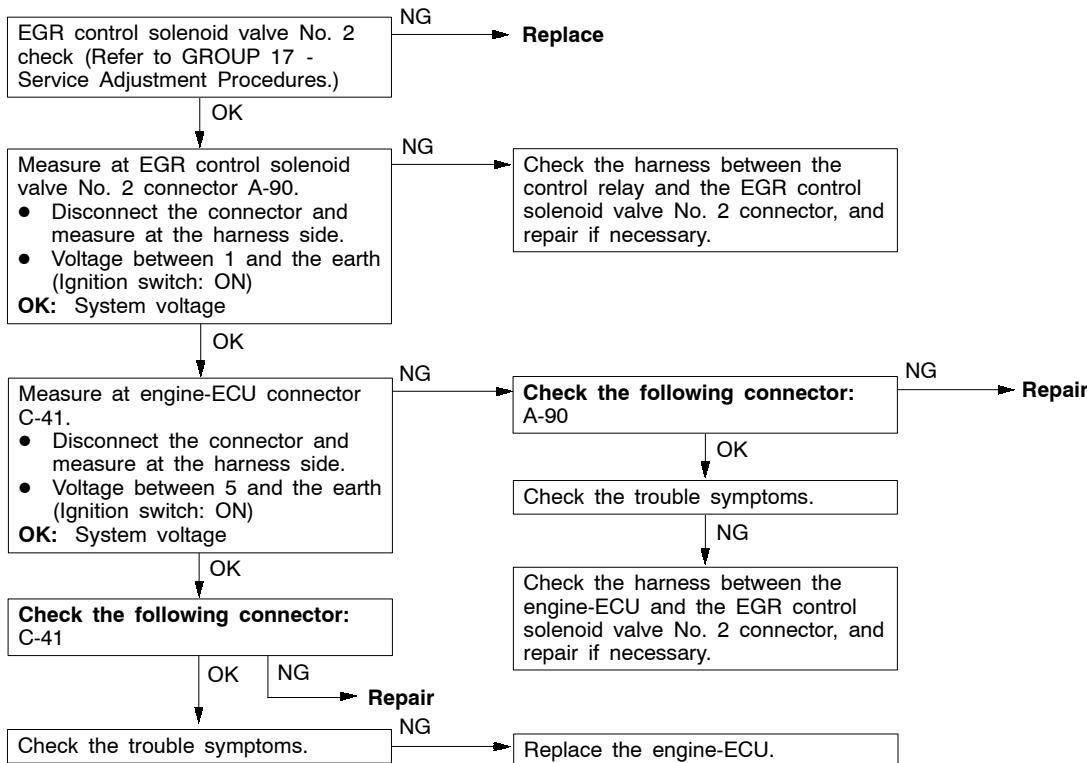
INSPECTION PROCEDURE 23

EGR control solenoid valve No. 1 circuit inspection



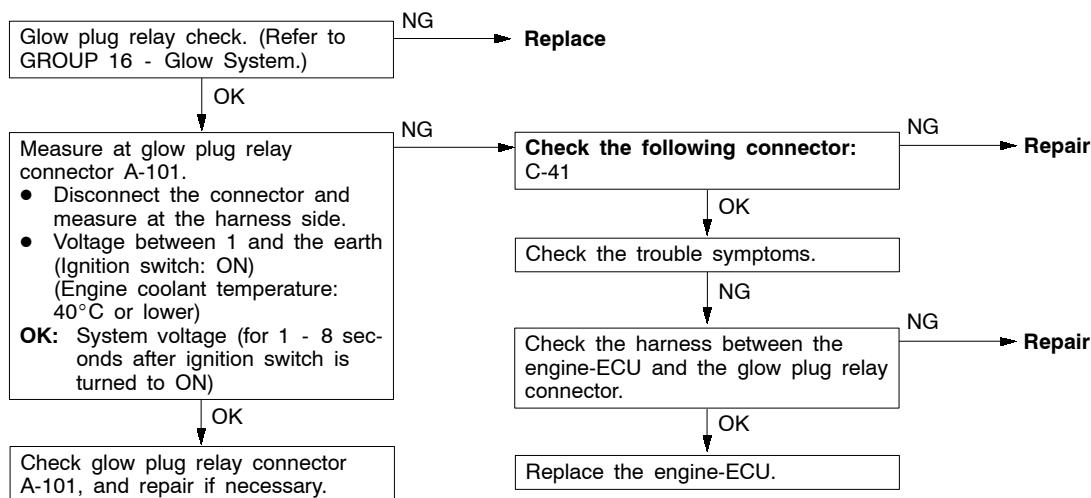
INSPECTION PROCEDURE 24

EGR control solenoid valve No. 2 circuit inspection



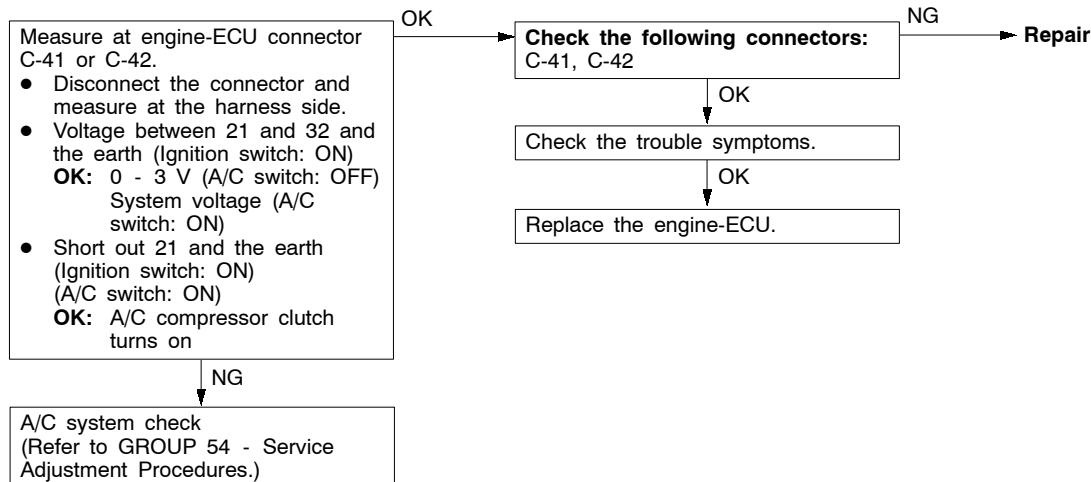
INSPECTION PROCEDURE 25

Glow plug relay inspection



INSPECTION PROCEDURE 26

A/C switch and A/C relay inspection



DATA LIST REFERENCE TABLE

Item No.	Check item	Inspection conditions	Value to be determined as normal	Code No. or inspection procedure No.	Reference page
01	Boost air temperature sensor	Ignition switch: ON or the engine running	When the intake air temperature is -20°C	-20°C	Code No. 16
			When the intake air temperature is 0°C	0°C	
			When the intake air temperature is 20°C	20°C	
			When the intake air temperature is 40°C	40°C	
			When the intake air temperature is 80°C	80°C	
02	Engine coolant temperature sensor	Ignition switch: ON or the engine running	When the engine coolant temperature is -20°C	-20°C	Code No. 15
			When the engine coolant temperature is 0°C	0°C	
			When the engine coolant temperature is 20°C	20°C	
			When the engine coolant temperature is 40°C	40°C	
			When the engine coolant temperature is 80°C	80°C	
03	Barometric pressure sensor	Ignition switch: ON	Altitude 0 m	101 kPa	Code No. 13
			Altitude 600 m	95 kPa	
			Altitude 1,200 m	88 kPa	
			Altitude 1,800 m	81 kPa	
04	Boost pressure sensor	<ul style="list-style-type: none"> ● Engine coolant temperature: 80 - 95°C ● Lamps, electrical cooling fan, and accessories: OFF ● Transmission: Neutral ● Ignition switch: ON 	Altitude 0 m	101 kPa	Code No. 12
			Altitude 600 m	95 kPa	
			Altitude 1,200 m	88 kPa	
			Altitude 1,800 m	81 kPa	
			Idling	81 - 109 kPa	
			When sudden racing is done	Increased	
05	Fuel temperature sensor	Ignition switch: ON or the engine running	When the fuel temperature is -20°C	-20°C	Code No. 14
			When the fuel temperature is 0°C	0°C	
			When the fuel temperature is 20°C	20°C	
			When the fuel temperature is 40°C	40°C	
			When the fuel temperature is 80°C	80°C	

Item No.	Check item	Inspection conditions		Value to be determined as normal	Code No. or inspection procedure No.	Reference page
06	Vehicle speed sensor	When driving	Compare the engine speed displayed in the speed meter with that in MUT-II	Matched	Code No. 17	13-14
07	Pump speed sensor	Engine: Cranking	Compare the engine speed displayed in the tachometer with that in MUT-II	Matched	Code No. 18	13-15
		Engine: Idling	Compare the engine speed displayed in the tachometer with that in MUT-II			
08	Crank angle sensor	Engine: Cranking	Compare the engine speed displayed in the tachometer with that in MUT-II	Matched	Code No. 21	13-16
		Engine: Idling				
09	Accelerator pedal position sensor (main)	Ignition switch: ON	Accelerator pedal: Idling position	1,015 - 1,055 mV	Code No. 11	13-10
			Accelerator pedal: Fully opened position	4,035 - 4,500 mV or higher		
10	Accelerator pedal position sensor (main)	Ignition switch: ON	Accelerator pedal: Idling position	0 %	Code No. 11	13-10
			Accelerator pedal: Fully opened position	99 - 100 %		
11	System voltage	Ignition switch: ON		System voltage	Procedure No. 21	13-39
13	Timing control valve* ¹	Engine: After warming up the engine	Idling	70 - 90 %	Code No. 25 or No. 43	13-18 13-22
			When engine is suddenly raced	Changes		
17	Control sleeve position (target value)	Engine: After warming up the engine	Idling	2.1 - 2.5 V	Code No. 26	13-19
			2,500 r/min (no load)	1.8 - 2.2 V		
18	Actual injection timing	Engine: After warming up the engine	Idling	0.7 - 1.2 V	-	-
			When engine is suddenly raced	Increases		
19	Injection timing command value	Engine: After warming up the engine	Idling	0.7 - 1.2 V	-	-
			When engine is suddenly raced	Increases		
21	GE actuator	Engine: After warming up the engine	Idling	0 %	Code No. 26 or No. 48	13-19 13-24
			2,500 r/min	18 - 38 %		
23	Control sleeve position (actual value)	Engine: After warming up the engine	Idling	2.1 - 2.5 V	Code No. 26	13-19
			2,500 r/min (no load)	1.8 - 2.2 V		
24	Accelerator pedal position sensor (sub)	Ignition switch: ON	Accelerator pedal: Idling position	1,015 - 1,055 mV	Code No. 27	13-20
			Accelerator pedal: Fully opened position	4,035 - 4,500 mV or higher		

Item No.	Check item	Inspection conditions		Value to be determined as normal	Code No. or inspection procedure No.	Reference page
25	Accelerator pedal position sensor (sub)	Ignition switch: ON	Accelerator pedal: Idling position	0 %	Code No. 27	13-20
			Accelerator pedal: Fully opened position	99 - 100 %		
31	EGR valve position sensor (target value)	Engine: After warming up the engine	Idling under no load	2.3 - 3.3 V	Code No. 51	13-26
			Engine is suddenly raced	Momentarily decreases (0.3 - 0.7 V)		
32	EGR valve position sensor (actual value)	Engine: After warming up the engine	Idling under no load	2.3 - 3.3 V	Code No. 51	13-26
			Engine is suddenly raced	Momentarily decreases (0.3 - 0.7 V)		
33	Variable geometry control pressure sensor	Engine: After warming up the engine	Idling	53 - 59 kPa	Code No. 52	13-27
			Engine is suddenly raced	Momentarily increases		

NOTE

*1: The opening degree of the timing control valve is converted into percentage. (0 %: timer non-advanced angle, 100 %: timer maximum advanced angle)

*2: The opening degree of the EGR solenoid valve is converted into percentage.

Item No.	Check item	Inspection conditions		Value to be determined as normal	Code No. or inspection procedure No.	Reference page
41	Idle switch	Ignition switch: ON (check by repeated accelerator operation)	Release the foot from the accelerator pedal.	ON	Code No. 23	13-17
			Step on the accelerator pedal slightly.	OFF		
43	A/C switch	Engine: Idling (The A/C compressor should be in operation when the A/C switch is "ON")	A/C switch: ON	ON	Procedure No. 26	13-41
			A/C switch: OFF	OFF		
44	Ignition switch-ST	Ignition switch: ON	Engine: Stop	OFF	—	—
			Engine: Cranking	ON		
45	Ignition switch-IG	Ignition switch: ON		ON	—	—
46	Control relay	Ignition switch: ON		ON	—	—
47	A/C relay	Engine: Idling after warming up the engine	A/C switch: OFF	OFF (A/C compressor clutch not in operation)	Procedure No. 26	13-41
			A/C switch: ON	ON (A/C compressor clutch in operation)		

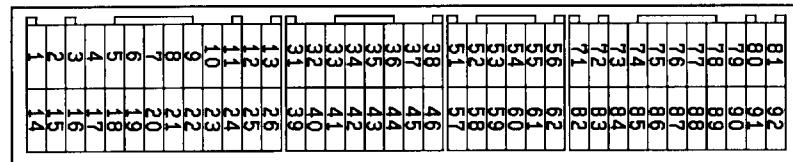
Item No.	Check item	Inspection conditions		Value to be determined as normal	Code No. or inspection procedure No.	Reference page
50	Condenser fan relay	Ignition switch: ON	A/C switch: OFF (engine coolant temperature at 102°C or higher) A/C switch: ON (engine coolant temperature at 102°C or higher, or outside temperature at 15°C or higher)	ON	Procedure No. 19	13-37
	Condenser fan relay	Ignition switch: ON	A/C switch: OFF (engine coolant temperature at 95°C or lower) A/C switch: ON (engine coolant temperature at 95°C or lower, or outside temperature at 15°C or lower)	OFF		
52	Glow plug relay	● Ignition switch: ON ● Select actuator test item No. 02.	Relay not driven Relay is forcibly driven	OFF ON	Procedure No. 25	13-41
53	Throttle solenoid valve	Ignition switch: ON (Engine stops)		OFF	Code No. 41	13-21
		Engine: main sensor or actuator is failed		ON		
55	Engine warning lamp	● Ignition switch: ON ● Select actuator test item No. 16.	Engine warning lamp off Engine warning lamp is forced on	OFF ON	Procedure No. 3	13-31
56	Glow lamp	● Ignition switch: ON ● Select actuator test item No. 15.	Glow lamp off Glow lamp is forced on	OFF ON		
60	Fuel cut relay	● Ignition switch: ON ● Select actuator test item No. 27.	Relay not driven Relay is forcibly driven	OFF ON	Procedure No. 22	13-39
62	AT/MT switch	Ignition switch: ON	Vehicles with M/T	M/T		
72	Intercooler fan relay	Ignition switch: ON	Boost air temperature at 45°C or lower Boost air temperature at 60°C or higher	OFF ON	Procedure No. 20	13-38
73	EGR control solenoid valve No. 1	Engine: After warming up the engine	Idling under no load (stable condition) Engine is suddenly raced (EGR amount decreasing) Engine is suddenly raced (EGR amount increasing)	OFF OFF ON (momentarily)		

Item No.	Check item	Inspection conditions			Value to be determined as normal	Code No. or inspection procedure No.	Reference page
74	EGR control solenoid valve No. 2	Engine: After warming up the engine	Idling (stable condition)	ON	OFF (momentarily)	Procedure No. 24	13-40
			When engine is suddenly raced (EGR amount decreasing)	OFF (momentarily)			
			When engine is suddenly raced (EGR amount increasing)	ON			

ACTUATOR TEST TABLE

Item No.	Check item	Drive Contents	Inspection conditions	Value to be determined as normal	Code No. or inspection procedure No.	Reference page
02	Glow plug relay	Turning the relay from OFF to ON or from ON to OFF	Ignition switch: ON	Battery charge is energized to the glow plug when the glow plug relay is ON.	Procedure No. 25	13-41
03	A/C compressor relay	Turning the relay from OFF to ON or from ON to OFF	Ignition switch: ON	The A/C compressor clutch makes an audible sound.	Procedure No. 26	13-41
11	Timing control valve	Turn the timing control valve to ON	<ul style="list-style-type: none"> Ignition switch: ON Engine: Idling Timer piston position sensor: Normal 	Makes an audible sound	Code No. 43	13-22
12		Turn the timing control valve to OFF				
15	Glow lamp	Turn the glow lamp on or off	Ignition switch: ON	The glow lamp turns on.	–	–
16	Warning lamp	Turn the warning lamp on or off	Ignition switch: ON	The warning lamp turns on.	Procedure No. 3, 4	13-31
22	Condenser fan relay	Turning the relay from OFF to ON or from ON to OFF	Ignition switch: ON	The condenser fan rotates.	Procedure No. 19	13-37
23	Throttle solenoid valve	Turn the solenoid valve from OFF to ON or from ON to OFF	<ul style="list-style-type: none"> Ignition switch: ON Vehicle speed: 0 km/h Engine speed: 1,000 r/min or lower 	Makes an audible sound	Code No. 41	13-21

Item No.	Check item	Drive Contents	Inspection conditions	Value to be determined as normal	Code No. or inspection procedure No.	Reference page
25	GE actuator	Turn the GE actuator to ON	<ul style="list-style-type: none"> ● Ignition switch: ON ● Engine speed: 0 r/min or lower ● Control sleeve position sensor: Normal 	Measure the wave pattern between engine-ECU connector terminals No. 1 and No. 15 using an analyzer and check the change in the duty ratio.	Code No. 48	13-24
26		Turn the GE actuator to OFF				
27	Fuel cut solenoid valve	Turn the solenoid valve from OFF to ON or from ON to OFF.	<ul style="list-style-type: none"> ● Ignition switch: ON ● Vehicle speed: 0 km/h 	Makes an audible sound	—	—
34	Middle position of GE actuator	Hold the injection governor in its middle position.	<ul style="list-style-type: none"> ● Ignition switch: ON 	When the crankshaft is turned clockwise during the adjustment of the injection timing, the injection pipes spray out fuel.	Code No. 48	13-24
35	Variable geometry solenoid valve	Turn the solenoid valve to ON	Ignition switch: ON	Makes an audible sound	Code No. 49	13-25
36		Turn the solenoid valve to OFF	Engine: Idling	Operating sound and vibration, which accompany with the duty activation, cease.		
37	EGR control solenoid valve No. 1	Turn the solenoid valve from OFF to ON from ON to OFF	Ignition switch: ON	Makes an audible sound	Procedure No. 23	13-40
38	EGR control solenoid valve No. 2	Turn the solenoid valve from OFF to ON from ON to OFF	Ignition switch: ON	Makes an audible sound	Procedure No. 24	13-40
39	Intercooler fan relay	Turn the solenoid valve from OFF to ON from ON to OFF	Ignition switch: ON	Makes an audible sound	Procedure No. 20	13-38

CHECK AT THE ENGINE-ECU TERMINALS**TERMINAL VOLTAGE CHECK CHART****Engine-ECU Connector Terminal Arrangement**

W6106AQ

Terminal No.	Check item	Inspection conditions (engine status)		Normal condition:
1	GE actuator	Ignition switch: ON (Engine stops)		9 V or higher
2	Fuel cut solenoid valve	Other than below		0 - 1 V
		Engine: Idling → Stop (in about 1 - 3 second)		System voltage (for 3 - 5 seconds)
3	Timing control valve	Ignition switch: ON (Engine stops)		11 V or higher
4	Glow lamp	Ignition switch: OFF → ON		0 - 1 V (In few seconds) → System voltage
5	EGR control solenoid valve No. 2	Engine: Idling after warming up the engine (stable condition)		System voltage
		When any one of the following conditions is satisfied: <ul style="list-style-type: none"> • Engine speed: 3,700 r/min or higher • Engine speed: 450 r/min or lower • Vehicle speed: 176 km/h or higher • The accelerator pedal is fully depressed • The accelerator pedal is released when engine speed is 2,700 r/min or higher and vehicle speed is 140 km/h or higher • Engine coolant temperature: 112°C or higher 		System voltage
6	Intercooler fan relay	Ignition switch: ON	Boost air temperature at 45°C or lower	System voltage
			Boost air temperature at 60°C or higher	0 - 1 V
7	Condenser fan relay	Condenser fan in operation		0 - 1 V
8	Engine warning lamp	Ignition switch: OFF → ON		0 - 1 V (In few seconds) → System voltage
9	EGR control solenoid valve No. 1	Ignition switch: ON		System voltage
		Engine: After warming up the engine, conduct sudden racing from idling.		Very briefly rises from voltage during idling
12	Power supply	Ignition switch: ON		System voltage
25				
14	Throttle solenoid valve	Ignition switch: ON (Engine stops)		System voltage
		Engine: Idling after warming up the engine.		0 - 1 V
15	GE actuator power supply	Ignition switch: ON		System voltage

Terminal No.	Check item	Inspection conditions (engine status)		Normal condition:
16	Glow plug relay	<ul style="list-style-type: none"> • Engine coolant temperature: 40°C or lower • Ignition switch: OFF → ON 		System voltage (In about 8 seconds: at 20°C) → 0 - 1 V
17	Variable geometry solenoid valve	Engine: After warming up the engine	Engine is idling	4.4 - 10.1 V
			Engine is suddenly raced	Voltage rises
21	A/C relay	A/C switch: OFF → ON		System voltage → 0 - 1 V
31	Idle switch	Ignition switch: ON	Release the foot from the accelerator pedal.	0 - 1 V
			Step on the accelerator pedal slightly	3 V or higher
32	A/C switch	A/C in operation (compressor in operation)		System voltage
36	Selector switch between A/T and M/T	Ignition switch: ON		System voltage (M/T)
46	Control relay	Ignition switch: ON		0 - 1 V
		Ignition switch: ON → OFF (in about 8 seconds)		System voltage
51	Pump speed sensor	Engine: Idling (Use a digital voltage meter to check.)		0 V ↔ 5 V (repeat the change)
55	Accelerator pedal position sensor (sub)	Ignition switch: ON	Accelerator pedal: Idling position	0.9 - 1.1 V
			Accelerator pedal: Fully opened position	3.7 V or higher
60	Sensor power supply	Ignition switch: ON		4.6 - 5.4 V
71	Ignition switch-ST	Engine: Cranking		8 V or higher
80	Back-up power supply	Ignition switch: OFF		System voltage
81	Power supply to accelerator pedal position sensor (main)	Ignition switch: ON		4.6 - 5.4 V
82	Ignition switch-IG	Ignition switch: ON		System voltage
83	Engine coolant temperature sensor	Ignition switch: ON	Engine coolant temperature: 0°C	3.7 - 4.3 V
			Engine coolant temperature: 20°C	2.8 - 3.4 V
			Engine coolant temperature: 40°C	1.9 - 2.5 V
			Engine coolant temperature: 80°C	0.6 - 1.2 V
84	Accelerator pedal position sensor (main)	Ignition switch: ON	Accelerator pedal: Idling position	0.9 - 1.1 V
			Accelerator pedal: Fully opened position	3.7 V or higher
85	Boost pressure sensor	Ignition switch: ON (101 kPa)		1.0 - 1.4 V
86	Vehicle speed sensor	<ul style="list-style-type: none"> • Ignition switch: ON • Move the vehicle forward slowly 		0 V ↔ 8 - 12 V (repeat the change)

Terminal No.	Check item	Inspection conditions (engine status)		Normal condition:
87	Fuel temperature sensor	Ignition switch: ON	Fuel temperature: 0°C	3.2 - 3.6 V
			Fuel temperature: 20°C	2.3 - 2.7 V
			Fuel temperature: 40°C	1.5 - 1.9 V
			Fuel temperature: 80°C	0.4 - 0.8 V
88	Boost air temperature sensor	Ignition switch: ON	Intake air temperature: 0°C	3.2 - 3.8 V
			Intake air temperature: 20°C	2.3 - 2.9 V
			Intake air temperature: 40°C	1.4 - 2.0 V
			Intake air temperature: 80°C	0.4 - 1.0 V
89	Crank angle sensor	Engine: Idling (Use a digital voltage meter to check.)		0 V ↔ 5 V (repeat the change)
90	EGR valve position sensor	Engine: After warming up the engine	Idling under no load	2.3 - 3.3 V
			Engine is suddenly raced	Momentarily drops from voltage during idling
91	Parking switch	Ignition switch: ON (Engine stops)	Parking brake: ON	0 - 1 V
			Parking brake: OFF	System voltage

CHECK CHART FOR RESISTANCE AND CONTINUITY BETWEEN TERMINALS

1. Turn the ignition switch to LOCK (OFF) position.
2. Disconnect the engine-ECU connector.
3. Measure the resistance and check for continuity between the terminals of the engine-ECU harness-side connector while referring to the check chart.

NOTE

- (1) When measuring resistance and checking continuity, a harness for checking contact pin pressure should be used instead of inserting a test probe.
- (2) Checking need not be carried out in the order given in the chart.

Caution

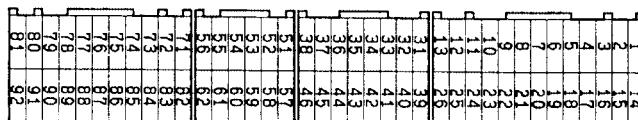
If the terminals that should be checked are mistaken, or if connector terminals are not correctly shorted to earth, damage may be caused to the vehicle wiring, sensors, engine-ECU and/or ohmmeter.

Be careful to prevent this!

4. If the ohmmeter shows any deviation from the standard value, check the corresponding sensor, actuator and related electrical wiring, and then repair or replace.

5. After repair or replacement, recheck with the ohmmeter to confirm that the repair or replacement has corrected the problem.

Engine-ECU Harness Side Connector Terminal Arrangement



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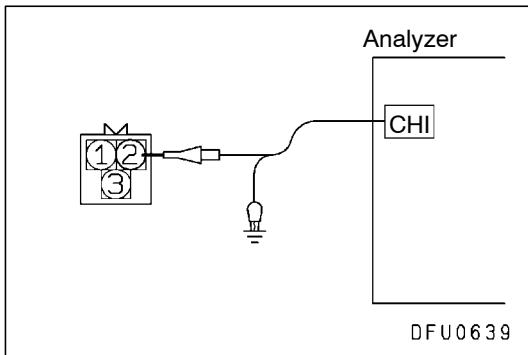
Terminal No.	Inspection item	Normal condition (Check condition)
1 - 15	GE actuator	0.64 - 0.72 Ω
2 - Body earth	Fuel cut solenoid valve	6.8 - 9.2 Ω
3 - 12	Timing control valve	10.8 - 11.2 Ω
5 - 12	EGR control solenoid valve No. 2	36 - 44 Ω (at 20°C)
9 - 12	EGR control solenoid valve No. 1	36 - 44 Ω (at 20°C)
13 - Body earth	Engine-ECU earth	Continuity (0 Ω)
26 - Body earth		
14 - 12	Throttle solenoid valve	29 - 35 Ω (at 20°C)
31 - 61	Idle switch	Continuity (Replace the foot from the accelerator pedal)
		No continuity (when accelerator pedal is fully depressed)
51 - 61	Pump speed sensor	1.36 - 1.84 kΩ
73 - 74	Control sleeve position sensor	5.6 - 6.2 Ω
73 - 75		5.6 - 6.2 Ω
74 - 75		11.2 - 12.4 Ω
77 - 78	Timer piston position sensor	160 - 168 Ω
76 - 77		80 - 84 Ω
76 - 78		80 - 84 Ω

Terminal No.	Inspection item	Normal condition (Check condition)
83 - 61	Engine coolant temperature sensor	5.1 - 6.5 kΩ (when the engine coolant temperature is 0°C)
		2.1 - 2.7 kΩ (when the engine coolant temperature is 20°C)
		0.9 - 1.3 kΩ (when the engine coolant temperature is 40°C)
		0.26 - 0.36 kΩ (when the engine coolant temperature is 80°C)
87 - 61	Fuel temperature sensor	5.1 - 6.5 kΩ (when the fuel temperature is 0°C)
		2.1 - 2.7 kΩ (when the fuel temperature is 20°C)
		0.9 - 1.3 kΩ (when the fuel temperature is 40°C)
		0.26 - 0.36 kΩ (when the fuel temperature is 80°C)
88 - 61	Boost air temperature sensor	5.3 - 6.7 kΩ (when the intake air temperature is 0°C)
		2.3 - 3.0 kΩ (when the intake air temperature is 20°C)
		1.0 - 1.5 kΩ (when the intake air temperature is 40°C)
		0.30 - 0.42 kΩ (when the intake air temperature is 80°C)

INSPECTION PROCEDURE USING AN ANALYZER

CRANK ANGLE SENSOR

An analyzer can be used to observe the wave pattern in order to visually check the crankshaft rotation and abnormalities in the sensor output.



Measurement Method

1. Disconnect the crank angle sensor connector and connect the special tool (test harness: MD998478) in between.
2. Connect the analyzer probe to terminal No. 2 of the crank angle sensor connector (black clip of special tool).

NOTE

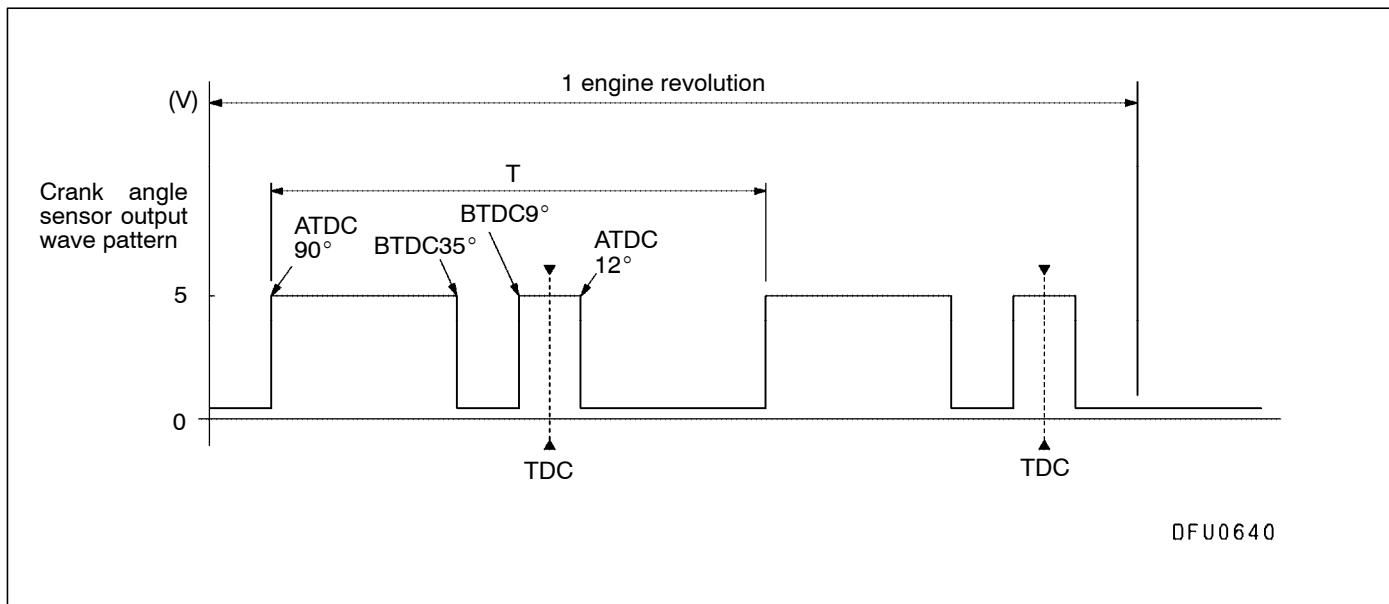
When measuring at the engine-ECU connector, connect the analyzer probe to terminal No. 89.

Standard Wave Pattern

Observation conditions

	Crank angle sensor
Probe select switch	× 1
TIME/DIV.	10 ms
VOLTS/DIV.	2 V
AC - GND - DC	DC
Other	-
Engine r/min	Idle speed

Standard wave pattern



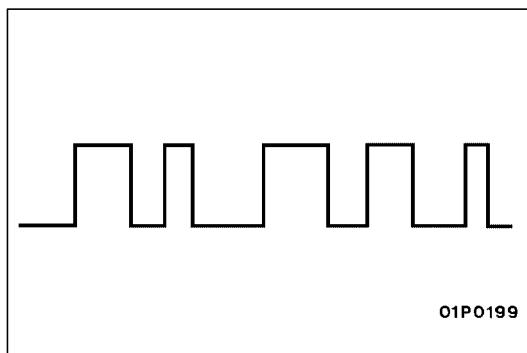
Explanation of Wave Pattern

The crank angle sensor detects the rotation of a sensing plate. Accordingly, the period T (seconds) can be measured and the engine speed can be calculated from the following formula.

$$\text{Engine speed (r/min)} = \frac{2}{4T \text{ (sec)}} \times 60 = \frac{30}{T \text{ (sec)}}$$

Wave Pattern Observation Points

Check that cycle time T becomes shorter and the frequency increases when the engine speed is increased.



Examples of Abnormal Wave Patterns

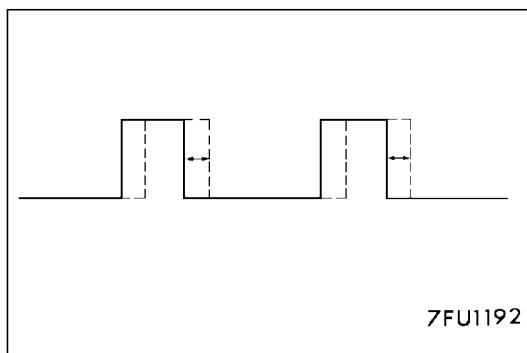
- Example 1

Cause of problem

Sensor interface malfunction

Wave pattern characteristics

Rectangular wave pattern is output even when the engine is not started.



- Example 2

Cause of problem

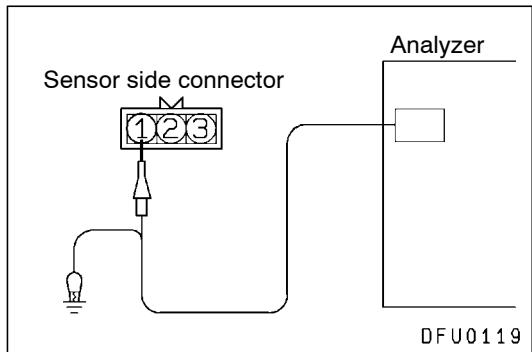
Abnormality in sensor disk

Wave pattern characteristics

Wave pattern is displaced to the left or right.

PUMP SPEED SENSOR

An analyzer can be used to observe the wave pattern in order to visually check the pump shaft rotation and abnormalities in the sensor output.



Measurement Method

1. Disconnect the pump speed sensor connector and connect the special tool (test harness: MD991658) in between. (All terminals should be connected.)
2. Connect the analyzer probe to terminal No. 1 of the pump speed sensor connector (black clip of special tool).

NOTE

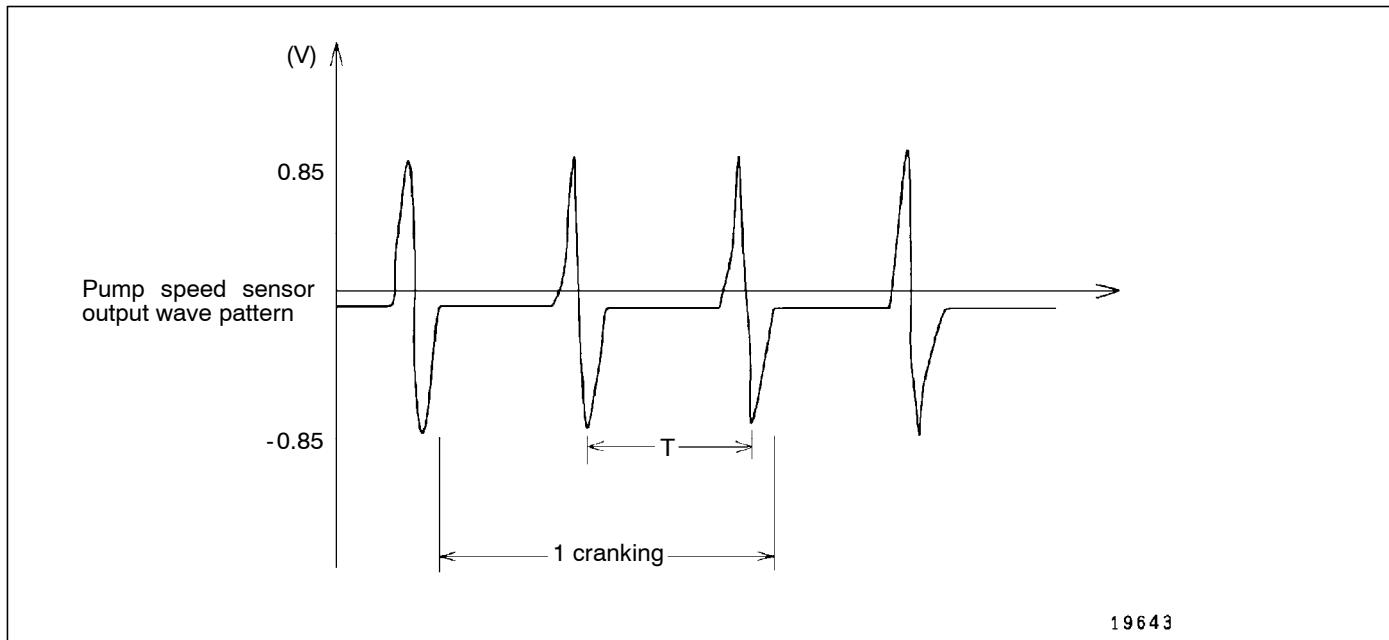
When measuring at the engine-ECU connector, connect the analyzer probe to terminal No. 51.

Standard Wave Pattern

Observation conditions

	Pump speed sensor
Probe select switch	Set according to the probe.
TIME/DIV.	About 10 msec
VOLTS/DIV.	About 0.5 V
AC - GND - DC	DC
Engine r/min	Idle speed

Standard wave pattern



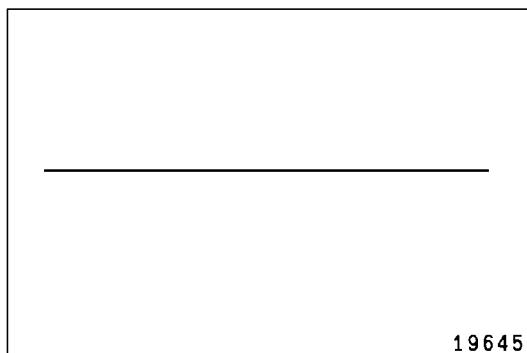
Explanation of Wave Pattern

The pump speed sensor detects the rotation of the pump shaft. Accordingly, the period T (seconds) can be measured and the engine speed can be calculated from the following formula.

$$\text{Engine speed} = \frac{2}{4 \times T \text{ (sec)}} \times 60$$

Wave Pattern Observation Points

Check that cycle time T becomes shorter and the frequency increases when the engine speed is increased.



Examples of Abnormal Wave Patterns

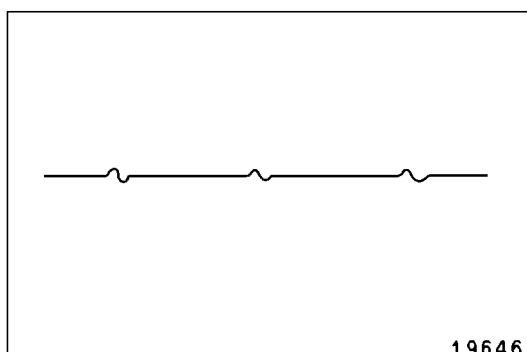
- Example 1

Cause of problem

Malfunction or open circuit in sensor

Wave pattern characteristics

No signal is output even when engine is started.



- Example 2

Cause of problem

Incorrect gap between sensor and sensing gear plate

Wave pattern characteristics

No signal is output even when engine is started, or signal amplitude is small.

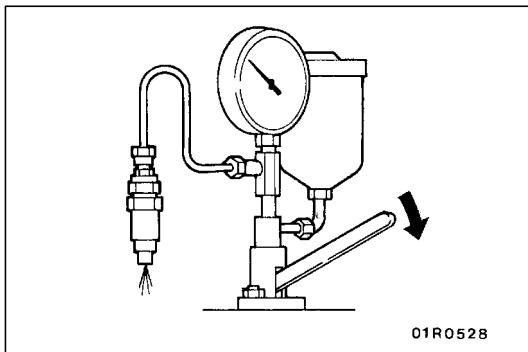
ON-VEHICLE SERVICE

INJECTION TIMING CHECK AND ADJUSTMENT

Refer to GROUP 11 - Engine Adjustment.

IDLE SPEED CHECK AND ADJUSTMENT

Refer to GROUP 11 - Engine Adjustment.



INJECTION NOZZLE CHECK AND ADJUSTMENT

Caution

Never touch the injection spray that is injected from the nozzle.

FUEL INJECTION INITIAL PRESSURE CHECK

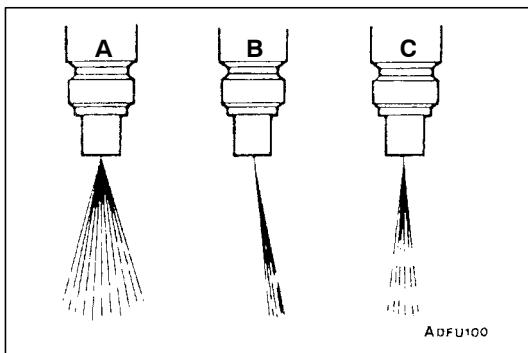
1. Install the injection nozzle to a nozzle tester.
2. Move the lever of the nozzle tester 2 - 3 times to inject fuel and to bleed the air.
3. Gently press down the lever of the nozzle tester, and take a reading of the indication value on the pressure gauge at the point where the needle slowly rises and then suddenly drops.

**Standard value (Fuel injection initial pressure):
14,710 - 15,490 kPa**

4. If the fuel injection initial pressure is outside the standard value, disassembly the nozzle holder to clean it, and then change the thickness of the shim to adjust the fuel injection initial pressure.

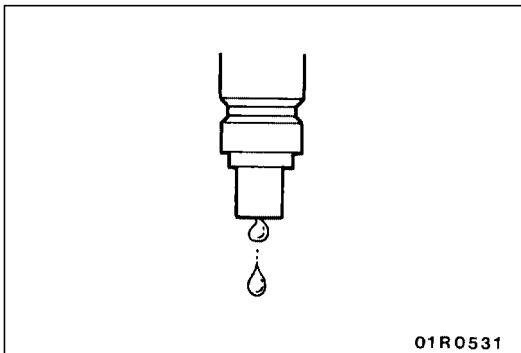
NOTE

- (1) For disassembly, reassembly and adjustment of the nozzle holder, refer to '91 PAJERO Workshop Manual (Pub. No. PWJE9085) P.13B-8.
- (2) There are 10 shims for adjustment, with thicknesses in the range of 0.10 - 0.80 mm.
- (3) When the shim thickness is increased by 0.1 mm, the fuel injection initial pressure increases by 2,350 kPa.

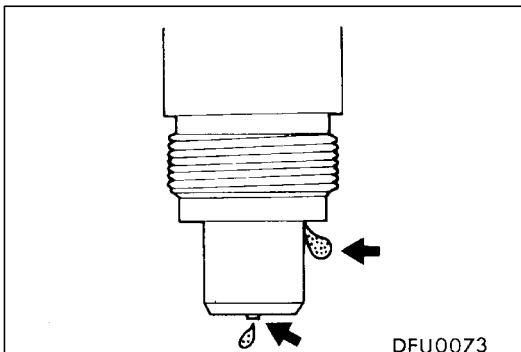


INJECTION SPRAY CONDITION CHECK

1. Move the lever of the nozzle tester rapidly (4 - 6 times per second) to eject the fuel continuously. Check to be sure that the injection spray comes out evenly in a cone shape (injection spray angle is 0°). The injection spray patterns shown in the illustration at left are wrong.
 - A. Injection angle is too large
 - B. Bias
 - C. Intermittent fuel injection

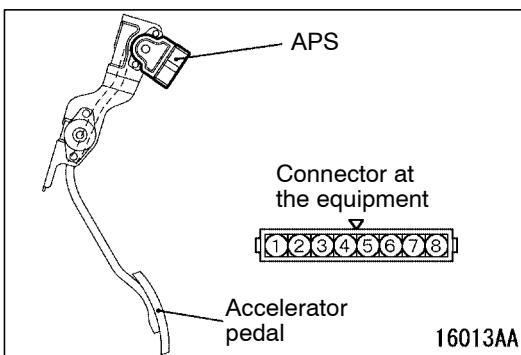


2. Check to be sure that no fuel drips after injection is completed.
3. If there are any drips, disassemble the nozzle, clean it and reinspect, or replace the nozzle.



NOZZLE FUEL-TIGHT CHECK

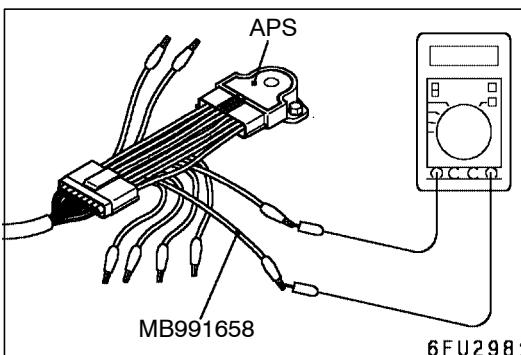
1. Gently raise the lever of the nozzle tester until the pressure inside the nozzle (value displayed on pressure gauge) becomes 12,750 - 13,730 kPa, and after holding this pressure for approximately 10 seconds, check to be sure that there are no fuel leaks from the nozzle.
2. If there are any leaks, disassemble the injection nozzle, clean it and re-inspect, or replace the nozzle.



ACCELERATOR PEDAL POSITION SENSOR (APS) ADJUSTMENT

Caution

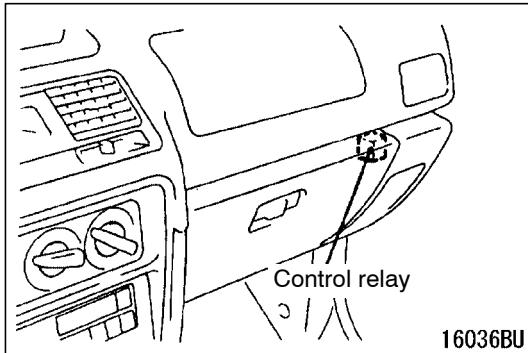
- (1) APS is properly adjusted in the factory. Therefore, APS should not be moved carelessly.
- (2) If the adjustment is not done correctly, carry out a new adjustment in the following procedure:



1. Connect MUT-II to the diagnosis connector. If MUT-II is not used, the following operation should be done:
 - (1) Disconnect APS connector and connect the special tool (test harness: MB991658) between two connectors.
(Be careful not to take a wrong terminal No.)
 - (2) Connect a digital voltmeter between APS connector terminal No. 3 (APS1 output) and terminal No. 1 (APS1 earth).
2. Loosen the APS mounting bolt to make it temporarily tightened.
3. Ensure that the accelerator pedal arm contacts the closing stopper.
4. Turn on the ignition switch. (Engine does not start.)
5. Turn APS to make APS1 output the standard value.

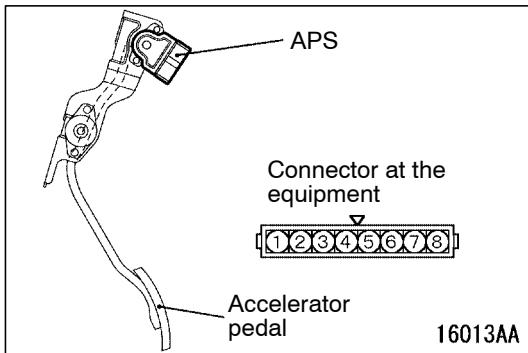
Standard value: 0.985 - 1.085 V

6. Tighten the APS mounting bolt securely.



CONTROL RELAY CONTINUITY CHECK

Connect a tester to:	Battery voltage	Normal condition
2 - 4	Not applied	Continuity
1 - 3	Not applied	No continuity
	Applied: Connect the positive battery cable to No. 2 terminal, and the negative battery cable to No. 4 terminal.	Continuity



ACCELERATOR PEDAL POSITION SENSOR (APS) CHECK

1. Disconnect the APS connector.
2. Measure the resistance between APS connector terminal No. 2 [APS (main) power supply] and the terminal No. 1 [APS (main) earth] as well as the resistance between terminal No. 8 [APS (sub) power supply] and terminal No. 7 [APS (sub) earth].

Standard value: 3.5 - 6.5 kΩ

3. Measure the resistance between APS connector terminal No. 2 [APS (main) power supply] and the terminal No. 3 [APS (main) output] as well as the resistance between terminal No. 8 [APS (sub) power supply] and terminal No. 6 [APS (sub) output].

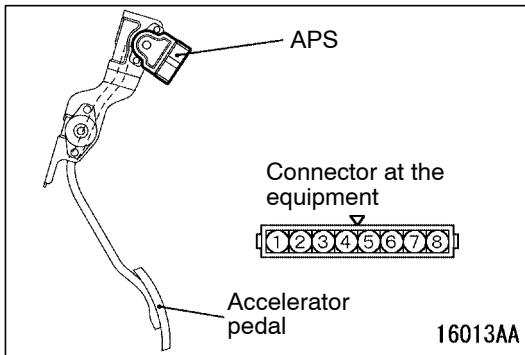
Normal condition:

Step on the accelerator pedal slowly.	Resistance smoothly changes in proportion to the travel of the accelerator pedal.
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4. If the APS is out of the range of the standard value or the resistance does not change smoothly, replace APS.

NOTE

Make an adjustment on APS after replacement. (Refer to P.13-58.)



IDLE SWITCH CHECK

1. Disconnect the accelerator pedal position sensor (APS) connector.
2. Check the continuity between the idle switch connector terminal No. 4 (idle switch) and terminal No. 5 (earth).

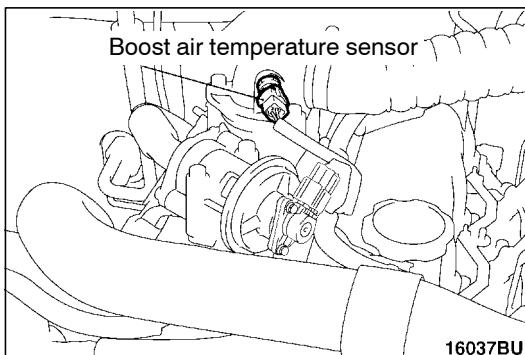
Normal condition:

Accelerator pedal	Continuity
Step on	None
Release	Yes

3. Replace APS if it is inoperative.

NOTE

Make an adjustment on APS after replacement.(Refer to P.13-58.)



BOOST AIR TEMPERATURE SENSOR (INTAKE AIR TEMPERATURE SENSOR) CHECK

1. Remove the boost air temperature sensor.
2. Measure the resistance at the boost air temperature sensor connector terminal.

Standard value:

2.3 - 3.0 kΩ (at 20°C)
0.30 - 0.42 kΩ (at 80°C)

3. Measure the resistance at the sensor part being warmed up by a hair dryer.

Normal condition:

Temperature (°C)	Resistance value (kΩ)
Rising	Become smaller

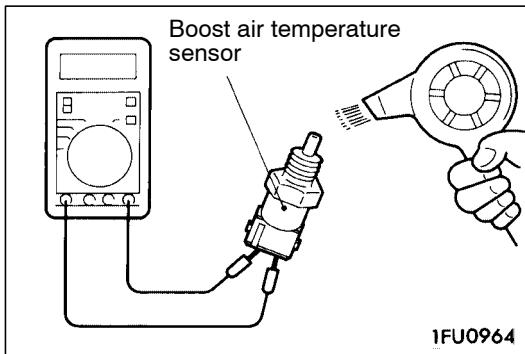
4. If the resistance is not within the range of the standard value or does not change at all, replace the boost air temperature sensor.

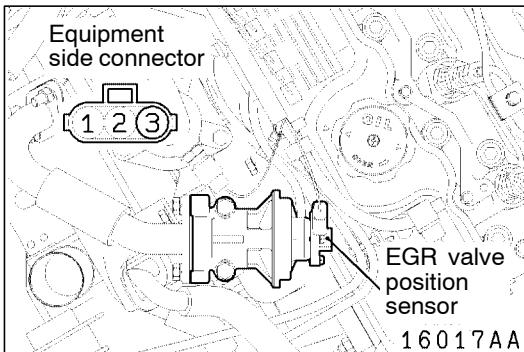
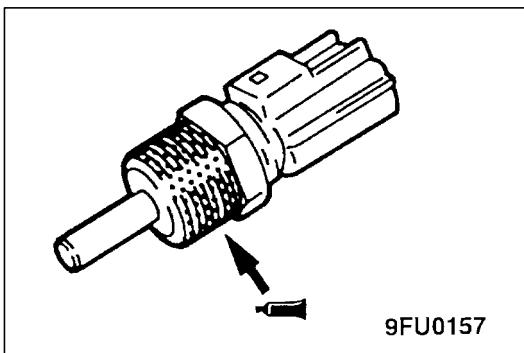
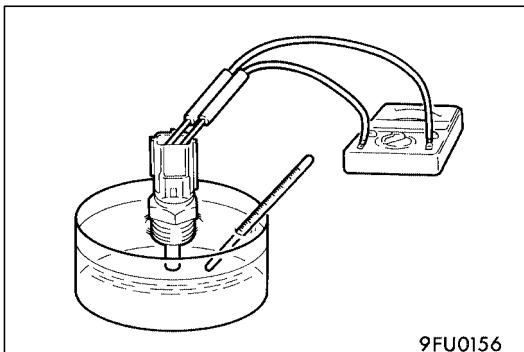
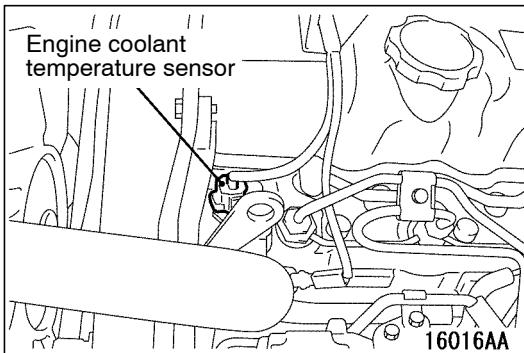
NOTE

Replace the gasket as well.

5. Tighten the boost air temperature sensor to the specified torque.

Tightening torque: 14 ± 1 N·m





ENGINE COOLANT TEMPERATURE SENSOR CHECK

1. Remove the engine coolant temperature sensor.

2. Measure the resistance between the terminals of the connectors while immersing the sensor part of the engine coolant temperature sensor in the hot water.

Standard value:

2.1 - 2.7 k Ω (at 20°C)
0.26 - 0.36 k Ω (at 80°C)

3. If the resistance is not within the range of the standard value, replace the engine coolant temperature sensor.

4. Apply the sealant to the thread of the engine coolant temperature sensor and tighten it to the specified torque.

Sealant:

3M Nut Locking Part No. 4171 or equivalent

Tightening torque: 36 ± 6 N·m

EGR VALVE POSITION SENSOR CHECK

1. Disconnect the EGR valve position sensor connector.
2. Measure the resistance between the EGR valve position sensor side connector terminal No. 2 and terminal No. 3.

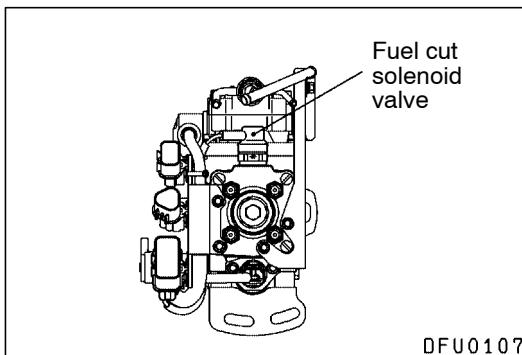
Standard value: 3.5 - 6.5 k Ω

3. Install a hand vacuum pump to the EGR valve nipple.
4. Measure the resistance between the EGR valve position sensor-side connector terminal No. 1 and terminal No. 3 when a negative pressure is applied.

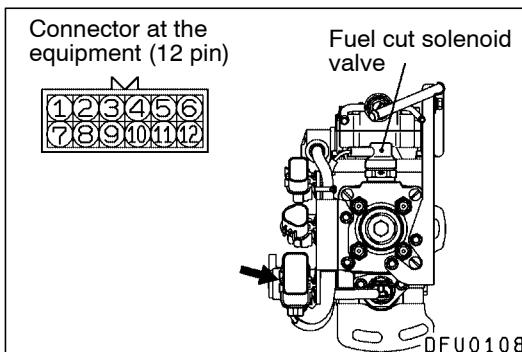
Normal condition:

Slowly increase the negative pressure to 60 kPa.	Changes smoothly in proportion to the negative pressure
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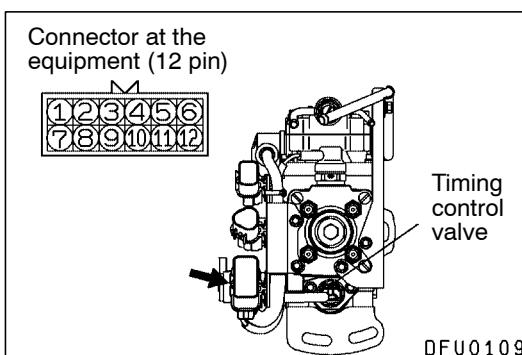
5. If the resistance is outside the standard value, or if it doesn't change smoothly, replace the EGR valve position sensor.



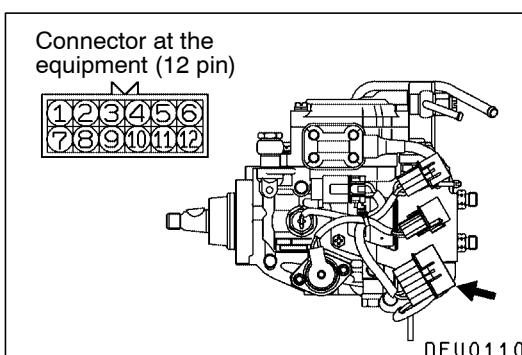
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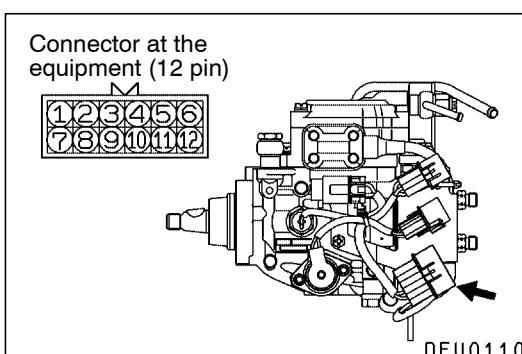
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DFU0109



DFU0110



DFU0110

FUEL INJECTION PUMP CHECK

FUEL CUT SOLENOID VALVE CHECK

Operation noise check

1. Attach the sound scope to the fuel cut solenoid valve to check for running noise when the ignition switch is "ON" position.

Coil resistance check

1. Disconnect the injection pump connector (12 pin).
2. Measure the resistance between terminal No. 1 (fuel cut solenoid valve) and the injection pump body.

Standard value: 6.8 - 9.2 Ω

TIMING CONTROL VALVE CHECK

1. Disconnect the injection pump connector (12 pin).
2. Measure the resistance between terminal No. 5 and terminal No. 9.

Standard value: 10.8 - 11.2 Ω

GE ACTUATOR (ELECTRONIC GOVERNOR) CHECK

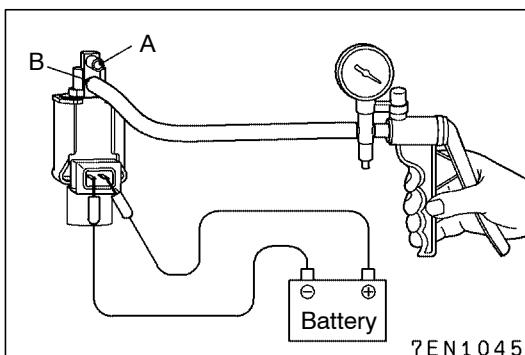
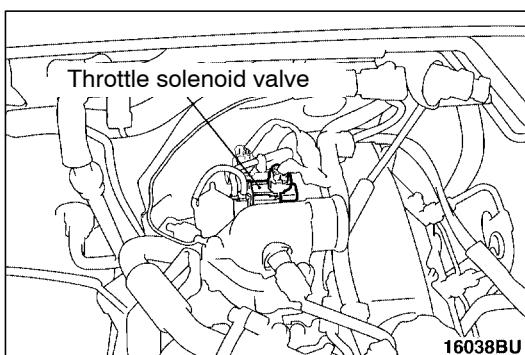
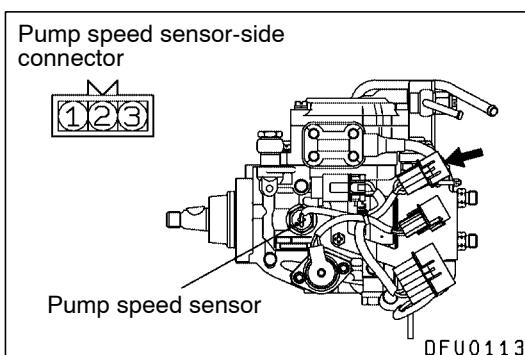
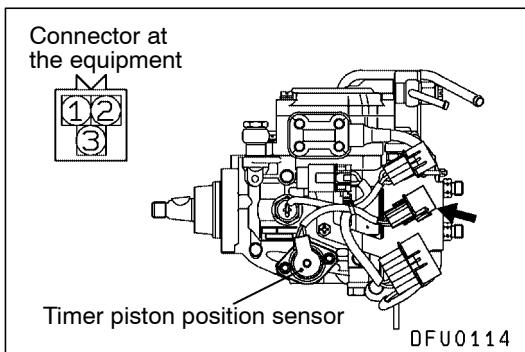
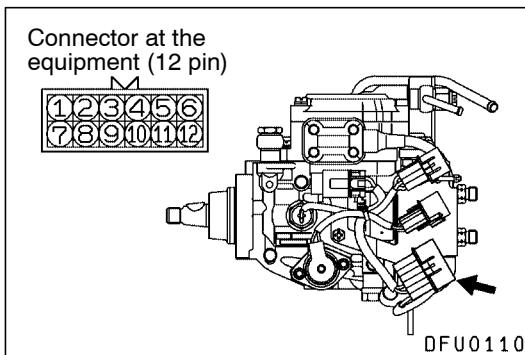
1. Disconnect the injection pump connector (12 pin).
2. Measure the resistance between terminal No. 6 and terminal No. 10.

Standard value: 0.64 - 0.72 Ω

FUEL TEMPERATURE SENSOR CHECK

1. Disconnect the injection pump connector (12 pin).
2. Measure the resistance between terminal No. 7 and terminal No. 11.

Standard value: 1.4 - 2.6 $k\Omega$



CONTROL SLEEVE POSITION SENSOR CHECK

1. Disconnect the injection pump connector (12 pin).
2. Measure the resistance between the following terminals.

Standard value:

Terminal No. 4 - Terminal No. 12	11.2 - 12.4 Ω
Terminal No. 4 - Terminal No. 8	5.6 - 6.2 Ω
Terminal No. 8 - Terminal No. 12	5.6 - 6.2 Ω

TIMER PISTON POSITION SENSOR CHECK

1. Disconnect the timer piston position sensor connector.
2. Measure the resistance between the following terminals.

Standard value:

Terminal No. 1 - Terminal No. 2	160 - 168 Ω
Terminal No. 1 - Terminal No. 3	80 - 84 Ω
Terminal No. 2 - Terminal No. 3	80 - 84 Ω

PUMP SPEED SENSOR CHECK

1. Disconnect the pump speed sensor connector.
2. Measure the resistance between terminals No. 1 and No. 2.

Standard value: 1.36 - 1.84 k Ω

THROTTLE SOLENOID VALVE CHECK

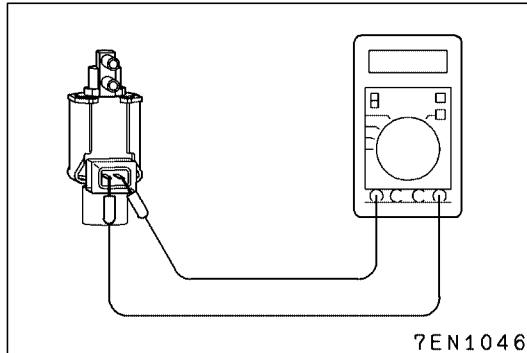
INSPECTION PROCEDURE

1. Disconnect the vacuum hose (black and yellow stripe) from the solenoid valve.
2. Disconnect the harness connector.

3. Install a hand vacuum pump to solenoid valve nipple B.
4. Use jumper leads to connect the solenoid valve terminals and the battery terminals.
5. Disconnect the jumper lead from the battery (-) terminal, and then apply negative pressure to check the air-tightness.

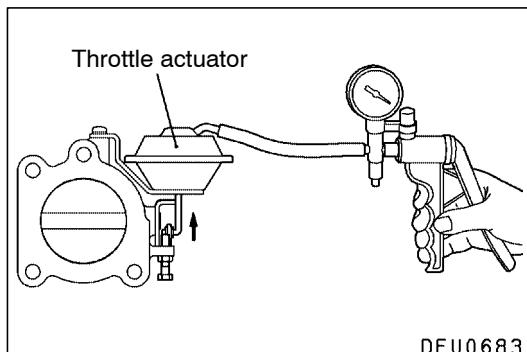
Standard value:

Jumper lead	Nipple A	Normal condition
Connected	Open	Negative pressure leaks
	Closed	Negative pressure maintained
Disconnected	Open	Negative pressure maintained

**COIL RESISTANCE CHECK**

1. Measure the resistance between the solenoid valve terminals.

Standard value: 29 - 35 Ω (at 20°C)

**THROTTLE ACTUATOR CHECK**

1. Remove the vacuum hose (yellow stripe) from the throttle actuator and connect a hand vacuum pump to the throttle actuator nipple.
2. Check that the actuator rod moves smoothly when applying vacuum gradually.
Also, check that the vacuum is maintained when applying 53 kPa of vacuum.

VARIABLE GEOMETRY SOLENOID VALVE CHECK

Refer to GROUP 15 - On-vehicle Service.

EGR CONTROL SOLENOID VALVE CHECK

Refer to GROUP 17 - Emission Control System <4D5-step III>.

FUEL INJECTION PUMP

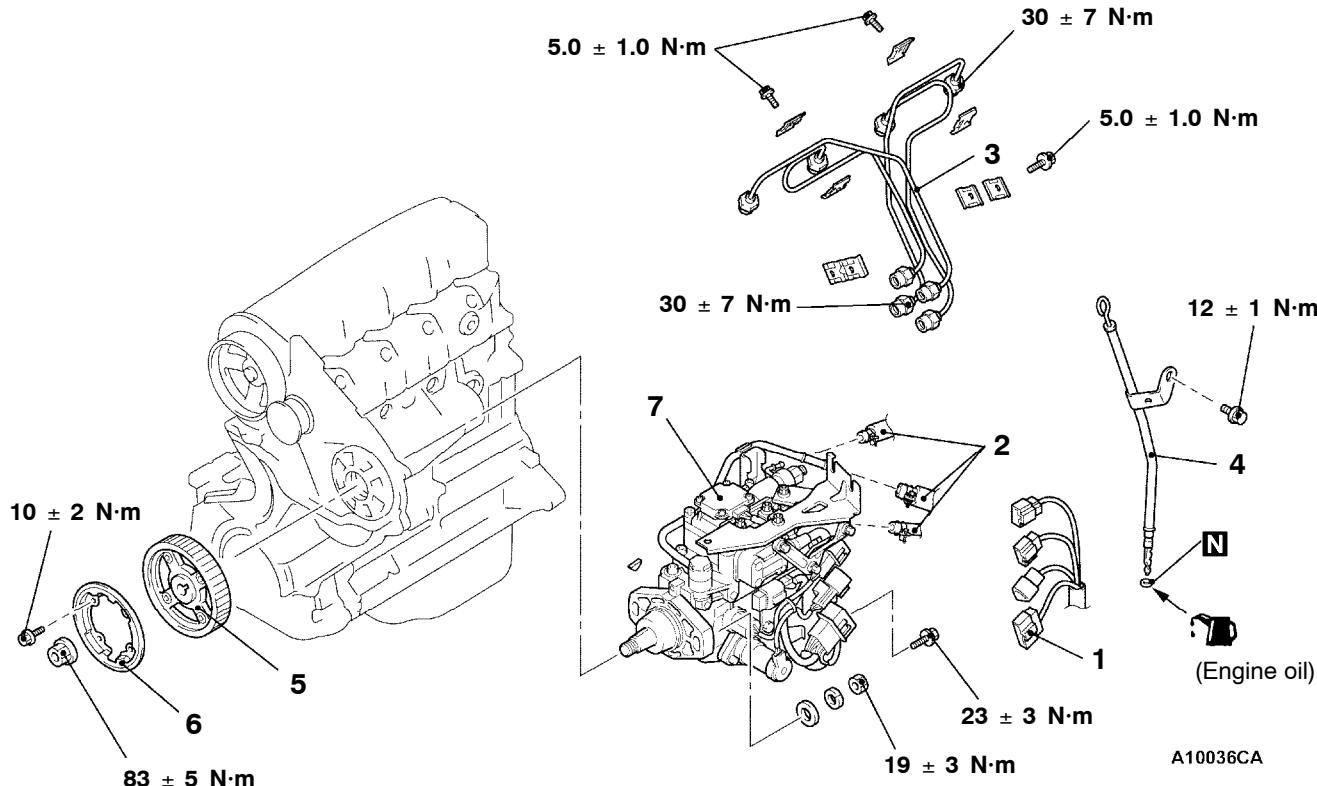
REMOVAL AND INSTALLATION

Pre-removal Operation

- Engine Coolant Draining.
- Battery and Battery Tray Removal
- Intercooler Removal (Refer to GROUP 15.)
- Timing Belt Removal (Refer to GROUP 11.)

Post-installation Operation

- Timing Belt Installation (Refer to GROUP 11.)
- Intercooler Installation (Refer to GROUP 15.)
- Battery and Battery Tray Installation
- Engine Coolant Supplying.



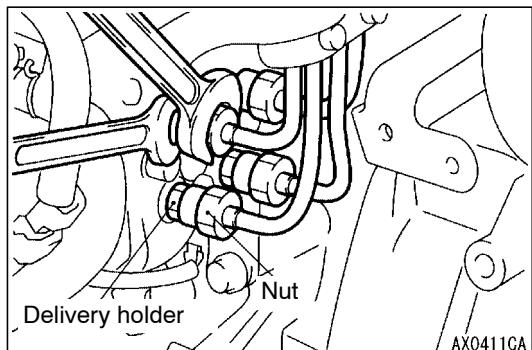
Removal steps

◀A▶

1. Fuel injection pump connector
2. Fuel hoses connection
3. Fuel injection pipe
4. Engine oil level gauge guide and oil level gauge assembly



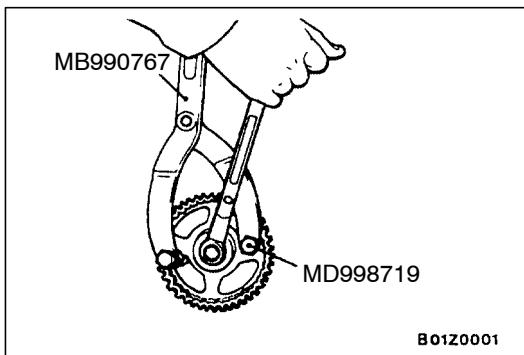
5. Fuel injection pump sprocket
6. Flange
7. Fuel injection pump



REMOVAL SERVICE POINTS

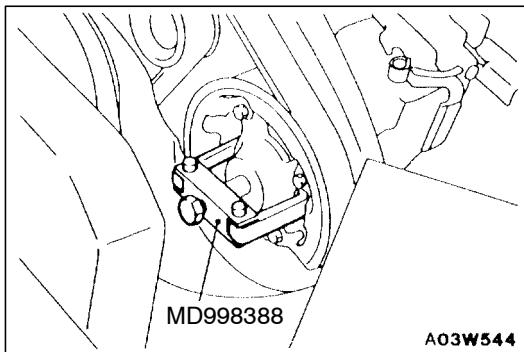
◀A▶ FUEL INJECTION PIPE REMOVAL

Loosen the nuts at the end of the injection pipe with the delivery holder (for pump side) and injection nozzle assembly (for nozzle side) retained by a spanner, etc.



◀B▶ FUEL INJECTION PUMP SPROCKET REMOVAL

1. Use the special tool to stop the fuel injection pump sprocket from turning, and remove the fuel injection pump sprocket mounting bolt.



2. Use the special tool to remove the fuel injection pump sprocket.

Caution

- (1) Do not hit pump drive shaft with hammer, etc.
- (2) When holding injection pump, do not allow to dangle by holding accelerator lever or fast idle lever.

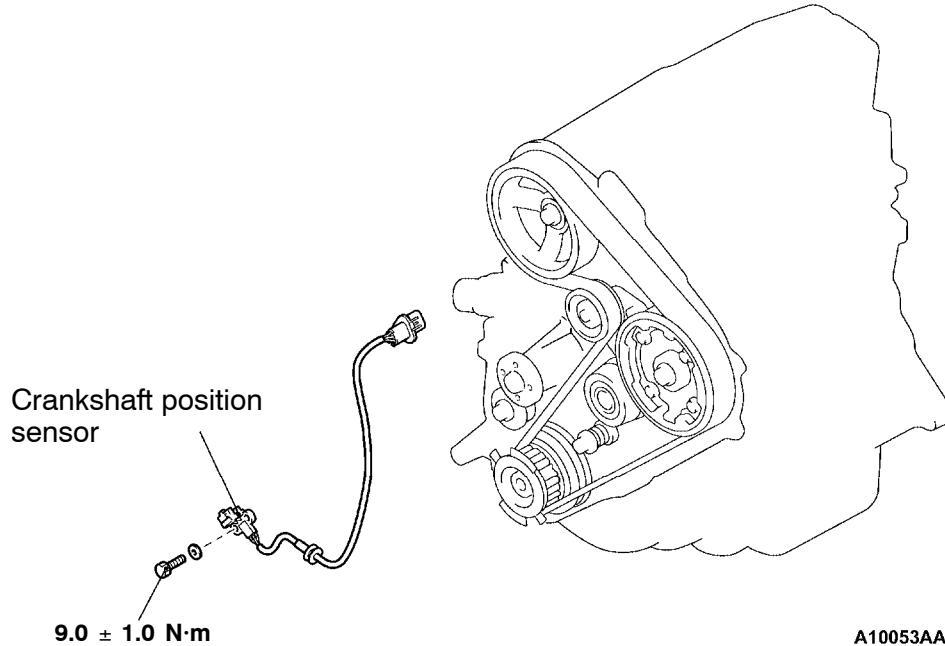
Do not remove these levers. Removal will cause injection pump malfunction.

CRANKSHAFT POSITION SENSOR

REMOVAL AND INSTALLATION

Pre-removal and Post-installation Operation

- Timing Belt Cover Removal and Installation
(Refer to GROUP 11.)

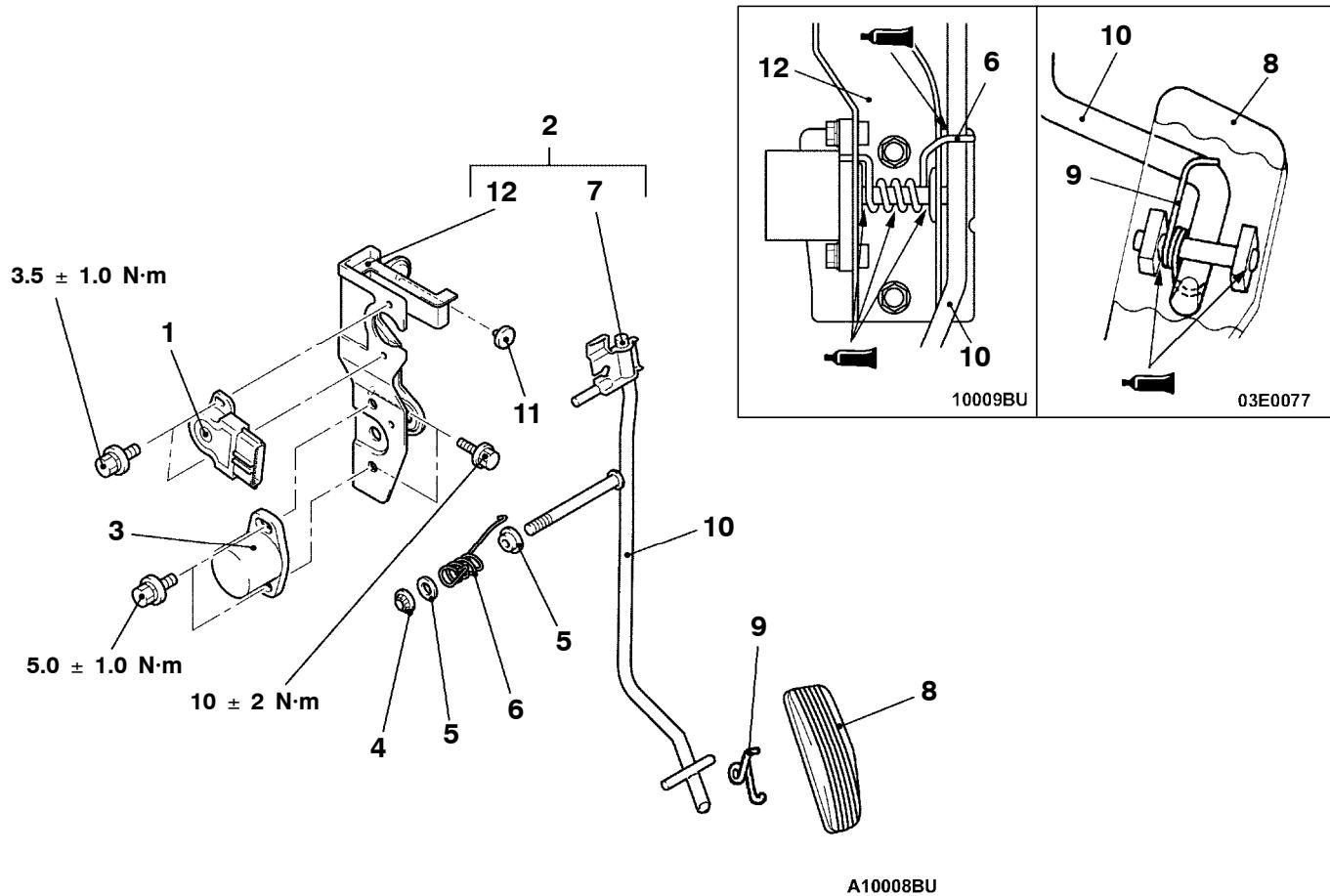


ACCELERATOR PEDAL

REMOVAL AND INSTALLATION

Post-installation Operation

- Accelerator Pedal Position Sensor Check and Adjustment (Refer to P.13-58.)



Removal steps

1. Accelerator pedal position sensor
2. Accelerator pedal assembly
3. Hysteresis assembly
4. Push-on spring nut
5. Bushing
6. Spring
7. Accelerator arm and pedal assembly
8. Accelerator pedal
9. Spring
10. Accelerator arm
11. Pedal stopper
12. Accelerator pedal bracket

NOTES