BLACK SMOKE

HINT:
Specified values in the following troubleshooting flowchart are the reference information.
Because of resultant values in DATA LIST vary depending on measuring conditions or vehicle's model years. Do not judge the vehicle normal even if the DATA LIST values indicate a standard level. There is a possibility that factors of the malfunction are hiding.

INSPECTION PROCEDURE

1	READ OUTPUT DTCS (RELATED TO ENGINE)

(a) Connect the hand–held tester (with 24 V VIM) to the DLC3.
(b) Turn the ignition switch ON and turn the hand–held tester ON.
(c) Enter the following menus: DIAGNOSIS / OBD/MOBD / DTC INFO / CURRENT CODES.
(d) Read DTCs.
Result:

Display (DTC Output)	Proceed to
Other than engine–related DTCs (see page 05–4)	A
DTCs related to the engine (see page 05–38)	B

B → **REPAIR OR REPLACE ENGINE CONTROL SYSTEM ACCORDING TO DTC OUTPUT (See page 05–38)**

A

2	CHECK INJECTOR COMPENSATION CODE (See page 05–1)

NG → **SET INJECTOR COMPENSATION CODE (See page 05–1)**

OK

3 READ VALUE OF DATA LIST

(a) Start the engine and turn the hand–held tester ON.
(b) On the hand–held tester, enter the following menus: DIAGNOSIS / OBD/MOBD / DATA LIST / ALL / INJ VOLUME and INJ VOL FB #1 to #4. Read the values.
Standard:

Item	Engine Speed *	Reference Value
INJ VOLUME	Idling (No engine load)	5 to 15 mm^3
INJ VOL FB #1	Idling (No engine load)	–2 to 2 mm^3
INJ VOL FB #2	Idling (No engine load)	–2 to 2 mm^3
INJ VOL FB #3	Idling (No engine load)	–2 to 2 mm^3
INJ VOL FB #4	Idling (No engine load)	–2 to 2 mm^3

HINT:
*: If no conditions are specifically stated for ”Idling”, the A/C switch is OFF and all accessory switches are OFF.

NG → **Go to step 12**

OK

4 PERFORM ENGINE RPM ACCELERATION

HINT:
If exhaust gas contains excessive black smoke, perform the following steps.
(a) Accelerate the engine speed up to the maximum RPM with no load 20 times.
(b) Check the volume of the black smoke in the exhaust gas.
Result:

Result	Proceed to
Black smoke is faded	OK
Black smoke remains in exhaust gas	NG

HINT:
Deposited soot in the exhaust system is a source of the excessive black smoke.

OK → **SYSTEM IS OK**

NG

5 CHECK AIR INTAKE SYSTEM AND EXHAUST SYSTEM

(a) Remove the air cleaner filter.
(b) Inspect the throttle valve (intake shutter) operation.
(1) Start the engine.
(2) Check if the throttle valve (intake shutter) fully opens when accelerating the engine speed.

OK → **CHECK AND REPAIR LOCATION WHERE MALFUNCTION EXIST**

NG

6	READ VALUE OF DATA LIST (MASS AIR FLOW RATE)

(a) Start the engine and turn the hand–held tester ON.
(b) On the hand–held tester, enter the following menus: DIAGNOSIS / OBD/MOBD / DATA LIST / ALL / MAF. Read the values.

Standard:

Engine Speed Condition	Air Flow Rate (gm/s)
650 rpm	10 to 30

NG → **REPLACE MASS AIR FLOW METER**

OK

7	CHECK TURBOCHARGING PRESSURE (See page 13–3)

NG → **REPLACE TURBOCHARGER SUB–ASSY (See page 13–6)**

OK

8	READ VALUE OF DATA LIST

(a) Start the engine and turn the hand–held tester ON.
(b) Enter the following menus: DIAGNOSIS / OBD/MOBD / DATA LIST / ALL.
(c) Select the following items in order and read values displayed on the hand–held tester respectively.
  (1) COMN RAIL PRESS
  (2) INJ VOLUME
  (3) M–INJ/PILOT ON
  (4) M–INJ/PILOT OFF
  (5) PILOT–INJ
  (6) INJ TIMING
  (7) INJ VOL FB #1 to #4

Standard:

Item	Engine Speed *	Standard Value
COMN RAIL PRESS	Idling	25 to 35 MPa
COMN RAIL PRESS	2,000 rpm (No engine load)	95 to 105 MPa
COMN RAIL PRESS	3,000 rpm (No engine load)	80 to 90 MPa
INJ VOLUME	Idling	5 to 15 mm^3
INJ VOLUME	2,000 rpm (No engine load)	10 to 20 mm^3
INJ VOLUME	3,000 rpm (No engine load)	30 to 40 mm^3
M–INJ/PILOT ON	Idling	650 to 800 μs
M–INJ/PILOT OFF	Idling	650 to 750 μs
PILOT–INJ	Idling	500 to 600 μs
INJ TIMING	Idling	0°CA
INJ TIMING	2,000 rpm (No engine load)	–5 to –3°CA
INJ TIMING	3,000 rpm (No engine load)	–8 to –6°CA
INJ VOL FB #1	Idling	–2 to 2 mm^3
INJ VOL FB #2	Idling	–2 to 2 mm^3
INJ VOL FB #3	Idling	–2 to 2 mm^3
INJ VOL FB #4	Idling	–2 to 2 mm^3

HINT:
*: If no conditions are specifically stated for ”Idling”, the A/C switch is OFF and all accessory switches are OFF.

NG → **Go to step 12**

OK

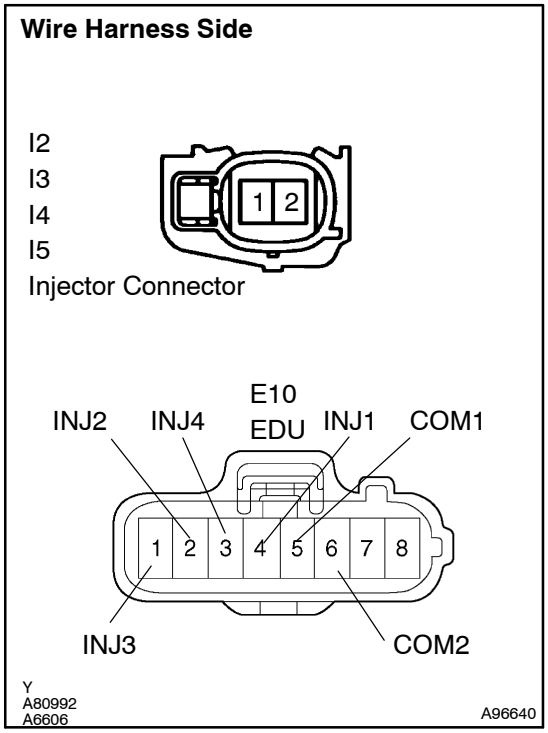
9	INSPECT CYLINDER COMPRESSION PRESSURE (See page 14–1)

NG → **CHECK AND REPAIR ENGINE**

OK

10 CHECK HARNESS AND CONNECTOR (INJECTOR – EDU)

HINT:
DTC P0200/97 (1 trip detection logic) will be present if there is an open or short in the EDU circuit.



(a) Disconnect the I2, I3, I4 or I5 injector connector.
(b) Disconnect the E10 EDU connector.
(c) Measure the resistance of the wire harness side connectors.

Standard:

Tester Connection	Specified Condition
Injector No. 1 (I2–1) – INJ#1 (E10–4) Injector No. 2 (I3–1) – INJ#2 (E10–2) Injector No. 3 (I4–1) – INJ#3 (E10–1) Injector No. 4 (I5–1) – INJ#4 (E10–3) Injector No. 1 (I2–2) – COM1 (E10–5) Injector No. 2 (I3–2) – COM2 (E10–6) Injector No. 3 (I4–2) – COM2 (E10–6) Injector No. 4 (I5–2) – COM1 (E10–5)	Below 1 Ω
Injector No. 1 (I2–1) or INJ#1 (E10–4) – Body ground Injector No. 2 (I3–1) or INJ#2 (E10–2) – Body ground Injector No. 3 (I4–1) or INJ#3 (E10–1) – Body ground Injector No. 4 (I5–1) or INJ#4 (E10–3) – Body ground Injector No. 1 (I2–2) or COM1 (E10–5) – Body ground Injector No. 2 (I3–2) or COM2 (E10–6) – Body ground Injector No. 3 (I4–2) or COM2 (E10–6) – Body ground Injector No. 4 (I5–2) or COM1 (E10–5) – Body ground	10 kΩ or higher

NG → **REPAIR OR REPLACE HARNESS AND CONNECTOR**

OK

11 PERFORM ACTIVE TEST (INJECTOR CUT #1 TO #4)

(a) Start the engine and turn the hand–held tester ON.
(b) Enter the following menus: DIAGNOSIS / OBD/MOBD / ACTIVE TEST / INJECTOR CUT #1 to #4.
(c) Check the engine idling condition while the fuel injection of each cylinder is cut by the hand–held tester.

Result:

Engine Idle Condition	Proceed to
Becomes unstable	A
Does not change	B

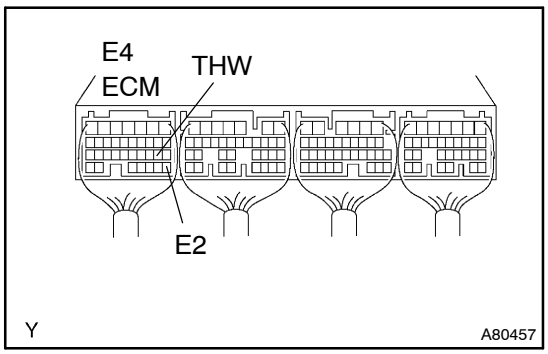
HINT:
Replace the injector mounted on the cylinder that causes rough idling.

B → **REPLACE INJECTOR ASSY (See page 11–20)**

A

REPLACE EDU

12 CHECK ECM (THW VOLTAGE)



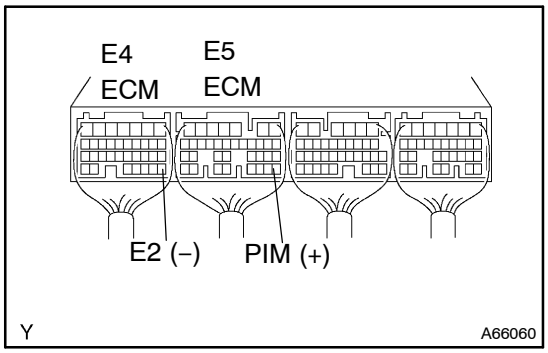
(a) Turn the ignition switch ON.
(b) Measure the voltage of the ECM connector.
Standard:

Tester Connection	Condition	Specified Condition
E4 – 19 (THW) – E4 – 28 (E2)	Idling, engine coolant temperature is 80 to 120°C (176 to 248°F)	0.4 to 1.0 V

NG → **Go to step 18**

OK

13 CHECK ECM (PIM VOLTAGE)



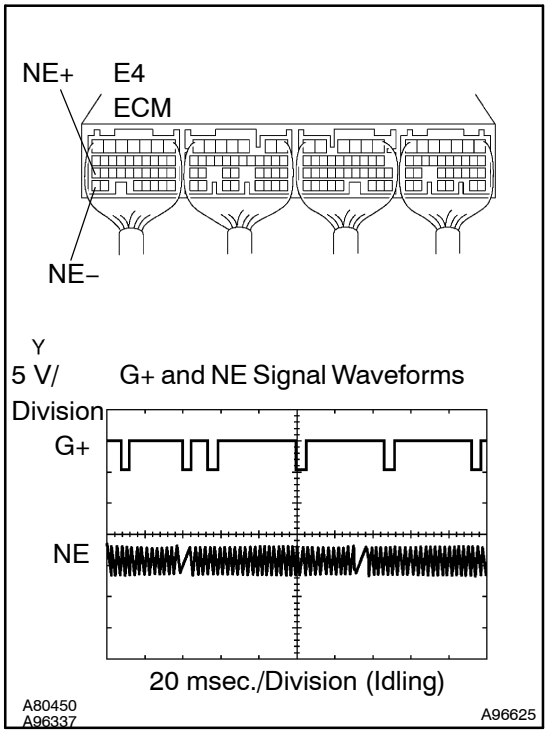
(a) Turn the ignition switch ON.
(b) Measure the voltage of the ECM connectors.
Standard:

Tester Connection	Condition	Specified Condition
E5–28 (PIM) – E4–28 (E2)	Negative pressure of 93 kPa (675 mmHg, 27.5 in.Hg) applied	0.25 to 0.4 V
E5–28 (PIM) – E4–28 (E2)	Positive pressure of 150 kPa (1,125 mmHg, 44 in.Hg) applied	1.0 to 1.4 V

NG → **Go to step 19**

OK

14 CHECK ECM (NE+ SIGNAL)



(a) Inspect using an oscilloscope.
(1) While the engine is idling, check the waveform of the ECM connector.

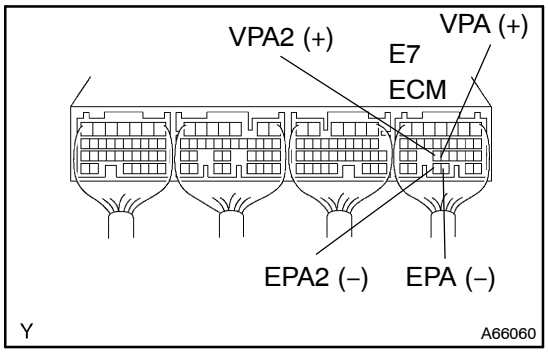
Standard:

Tester Connection	Specified Condition
E4–27 (NE+) – E4–34 (NE–)	Correct waveform is as shown

NG → **Go to step 20**

OK

15 CHECK ECM (VPA, VPA2 VOLTAGE)



(a) Turn the ignition switch ON.
(b) Measure the voltage of the ECM connector.

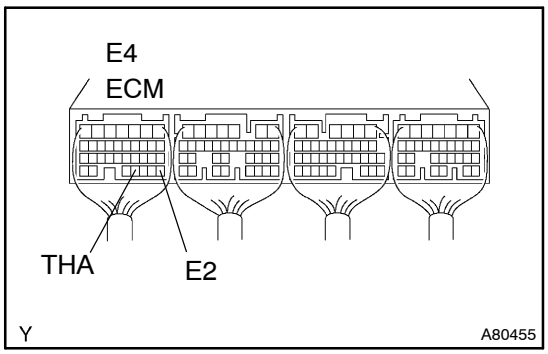
Standard:

Tester Connection	Accelerator Pedal Condition	Specified Condition
E7–22 (VPA) – E7–28 (EPA)	Released	0.5 to 1.1 V
E7–22 (VPA) – E7–28 (VPA)	Depressed	3.0 to 4.6 V
E7–23 (VPA2) – E7–29 (EPA2)	Released	0.9 to 2.3 V
E7–23 (VPA2) – E7–29 (EPA2)	Depressed	3.4 to 5.0 V

NG → **Go to step 21**

OK

16 CHECK ECM (THA VOLTAGE)



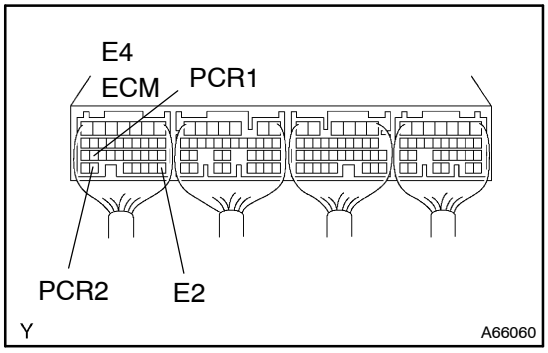
(a) Turn the ignition switch ON.
(b) Measure the voltage of the ECM connector.
Standard:

Tester Connection	Condition	Specified Condition
E4 – 31 (THA) – E4 – 28 (E2)	Idling, intake air temperature at 20°C (68°F)	0.5 to 3.4 V

NG → **Go to step 22**

OK

17 CHECK ECM (PCR1, PCR2 VOLTAGE)



(a) Start the engine.
(b) Measure the voltage of the ECM connector.
Standard:

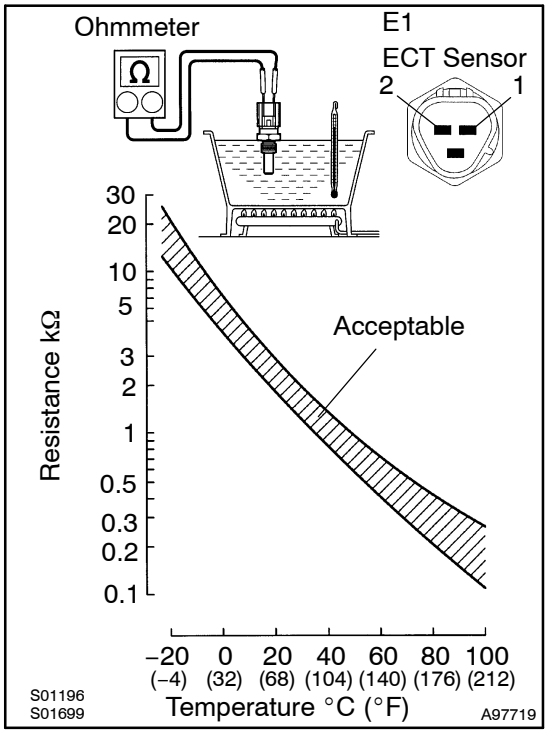
Tester Connection	Condition	Specified Condition
E4 – 26 (PCR1) – E4 – 28 (E2)	Engine is idling	1.7 to 2.2 V
E4 – 33 (PCR2) – E4 – 28 (E2)	Engine is idling	1.2 to 1.6 V

NG → **Go to step 23**

OK

REPLACE ECM (See page 10–10)

18 INSPECT ENGINE COOLANT TEMPERATURE SENSOR



(a) Remove the ECT sensor.
(b) Measure the resistance between the terminals.
Standard:

Tester Connection	Condition	Specified Condition
1 – 2	20°C (68°F)	2.21 to 2.69 kΩ
1 – 2	80°C (176°F)	0.29 to 0.354 kΩ

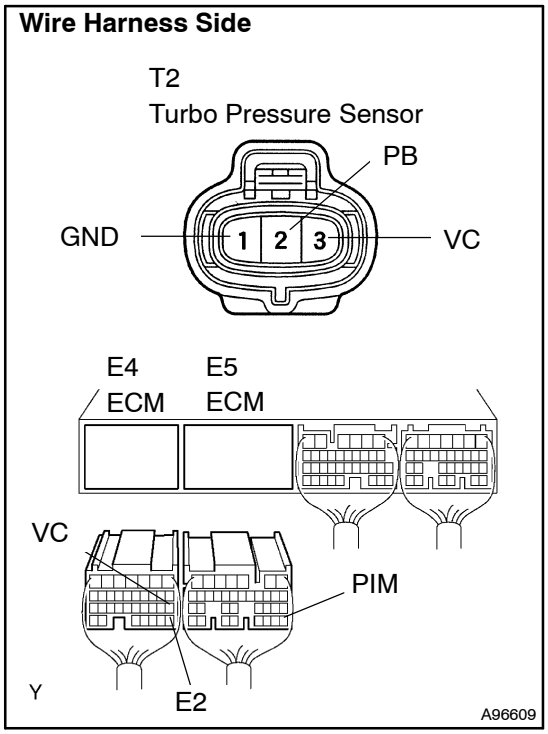
NOTICE:
If checking the ECT sensor in water, be careful not to allow water to contact the terminals. After checking, dry the sensor.
HINT:
Alternate procedure: Connect an ohmmeter to the installed ECT sensor and read the resistance. Use an infrared thermometer to measure the engine coolant temperature in the immediate vicinity of the sensor. Compare these values to the resistance/temperature graph. Change the ECT (warm up or allow to cool down) and repeat the test.

NG → **REPLACE ENGINE COOLANT TEMPERATURE SENSOR**

OK

REPAIR OR REPLACE HARNESS AND CONNECTOR

19 CHECK WIRE HARNESS (TURBO PRESSURE SENSOR – ECM)



(a) Disconnect the T2 sensor connector.
(b) Disconnect the E4 and E5 ECM connectors.
(c) Measure the resistance of the wire harness side connectors.
Standard:

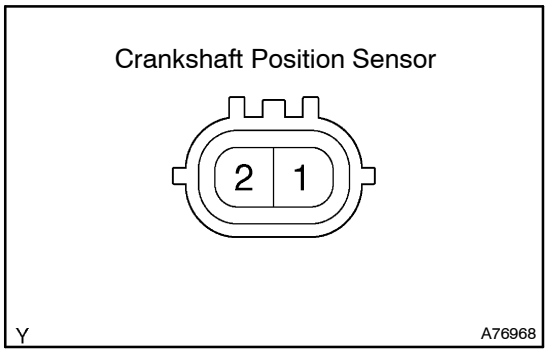
Tester Connection	Specified Condition
T2–2 (PB) – E5–28 (PIM) T2–3 (VC) – E4–18 (VC) T2–1 (GND) – E4–28 (E2)	Below 1 Ω
T2–2 (PB) or E5–28 (PIM) – Body ground T2–3 (VC) or E4–18 (VC) – Body ground T2–1 (GND) or E4–28 (E2) – Body ground	10 kΩ or higher

NG → **REPAIR OR REPLACE HARNESS AND CONNECTOR**

OK

REPLACE TURBO PRESSURE SENSOR

20 INSPECT CRANKSHAFT POSITION SENSOR



(a) Disconnect the C4 sensor connector.
(b) Measure the resistance of the sensor.
Standard:

Tester Connection	Condition	Specified Condition
1 – 2	Cold	1,630 to 2,740 Ω
1 – 2	Hot	2,065 to 3,225 Ω

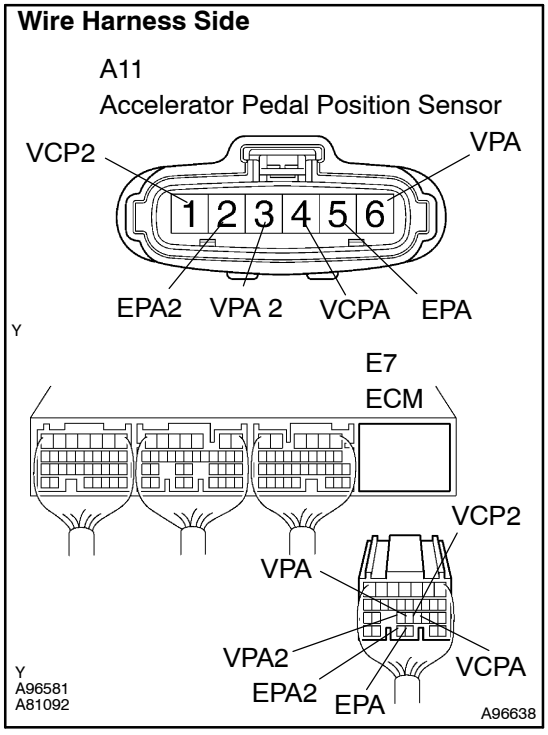
NOTICE:
In the above section, the terms ”Cold” and ” Hot” refer to the temperature of the coils. ”Cold” means approximately –10 to 50°C (14 to 122°F). ”Hot” means approximately 50 to 100°C (122 to 212°F).

NG → **REPLACE CRANKSHAFT POSITION SENSOR**

OK

REPAIR OR REPLACE HARNESS AND CONNECTOR

21 CHECK WIRE HARNESS (ACCELERATOR PEDAL POSITION SENSOR – ECM)



(a) Disconnect the A11 sensor connector.
(b) Disconnect the E7 ECM connector.
(c) Measure the resistance of the wire harness side connectors.
Standard:

Tester Connection	Specified Condition
A11–1 (VCP2) – E7–21 (VCP2) A11–2 (EPA2) – E7–29 (EPA2) A11–3 (VPA2) – E7–23 (VPA2) A11–4 (VCPA) – E7–20 (VCPA) A11–5 (EPA) – E7–28 (EPA) A11–6 (VPA) – E7–22 (VPA)	Below 1 Ω
A11–1 (VCP2) or E7–21 (VCP2) – Body ground A11–2 (EPA2) or E7–29 (EPA2) – Body ground A11–3 (VPA2) or E7–23 (VPA2) – Body ground A11–4 (VCPA) or E7–20 (VCPA) – Body ground A11–5 (EPA) or E7–28 (EPA) – Body ground A11–6 (VPA) or E7–22 (VPA) – Body ground	10 kΩ or higher

NG → **REPAIR OR REPLACE HARNESS AND CONNECTOR**

OK

REPLACE ACCELERATOR PEDAL ASSY (ACCELERATOR PEDAL POSITION SENSOR)

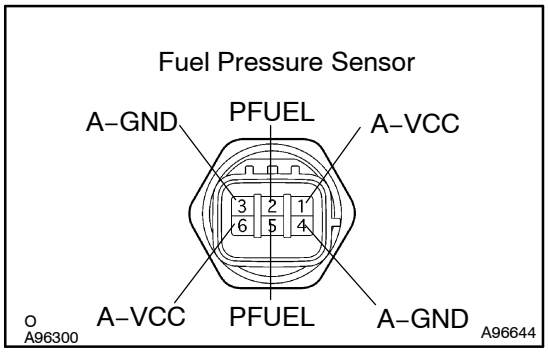
22	INSPECT MASS AIR FLOW METER (See page 10–3)

NG → REPLACE MASS AIR FLOW METER

OK

REPAIR OR REPLACE HARNESS AND CONNECTOR

23	INSPECT COMMON RAIL ASSY (FUEL PRESSURE SENSOR)



(a) Disconnect the F8 fuel pressure sensor connector.
(b) Measure the resistance of the sensor connector.

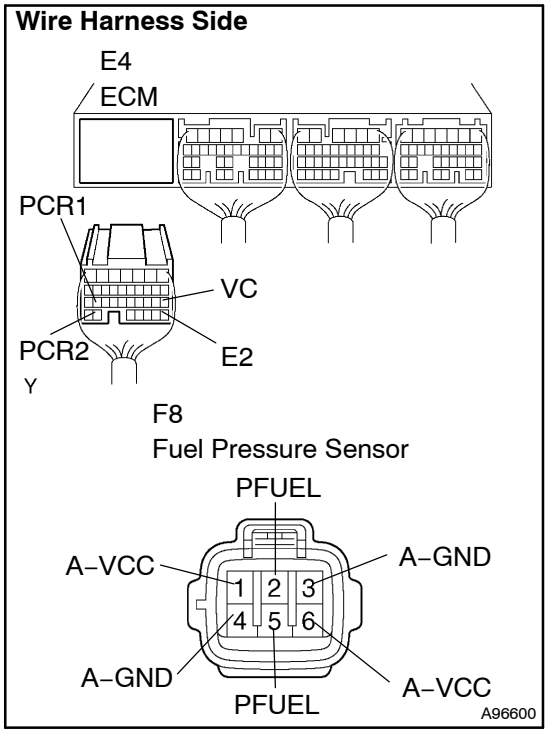
Standard:

Tester Connection	Specified Condition
F8–2 (PFUEL) – F8–3 (A–GND)	16.4 kΩ or less
F8–5 (PFUEL) – F8–4 (A–GND)	16.4 kΩ or less
F8–1 (A–VCC) – F8–2 (PFUEL)	3 kΩ or less
F8–6 (A–VCC) – F8–5 (PFUEL)	3 kΩ or less

NG → REPLACE COMMON RAIL ASSY (FUEL PRESSURE SENSOR) (See page 11–15)

OK

24	CHECK HARNESS AND CONNECTOR (FUEL PRESSURE SENSOR – ECM)



(a) Disconnect the E4 ECM connectors.
(b) Disconnect the F8 fuel pressure sensor connector.
(c) Measure the resistance of the wire harness side connectors.

Standard:

Tester Connection	Specified Condition
E4–26 (PCR1) – F8–5 (PFUEL) E4–33 (PCR2) – F8–2 (PFUEL) E4–18 (VC) – F8–6 (A–VCC) E4–18 (VC) – F8–1 (A–VCC) E4–28 (E2) – F8–4 (A–GND) E4–28 (E2) – F8–3 (A–GND)	Below 1 Ω
E4–26 (PCR1) or F8–5 (PFUEL) – Body ground E4–33 (PCR2) or F8–2 (PFUEL) – Body ground E4–18 (VC) or F8–6 (A–VCC) – Body ground E4–18 (VC) or F8–1 (A–VCC) – Body ground E4–28 (E2) or F8–4 (A–GND) – Body ground E4–28 (E2) or F8–3 (A–GND) – Body ground	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS AND CONNECTOR

OK

25	REPLACE ECM (See page 10–10)

NG → REPLACE INJECTION OR SUPPLY PUMP ASSY (See page 11–10)

OK

END