## ENGINE CONTROL SYSTEM

### 1. General

The engine control system for the new 4A–FE and 7A–FE engines have the same basic construction and operation as the engine control system in the previous 4A–FE engine. In the new engines, a rotary solenoid type IAC [ISC] valve is used in the IAC [ISC] system and a test mode function has been added to the diagnosis system to achieve an engine control system which matches the new engines. In the 7A–FE engine, a knocking correction function using a knock sensor is also added.

Comparison of the engine control system between the new engines and previous 4A-FE engine is as follows:

| Sustan                         | Outline  | Ne    | Previous |       |  |
|--------------------------------|--|-------|----------|-------|--|
| System                         | Outline  | 4A–FE | 7A–FE    | 4A–FE |  |
|                                | A D–Type MFI [EFI] system is used, which<br>indirectly detects intake air volume by the<br>manifold absolute pressure sensor signal.           | 0     | 0        | 0     |  |
| MFI* <sup>1</sup> [EFI]        | The fuel injection system is a 2–group type,<br>each of which injects two cylinders simulta-<br>neously.                                       | 0     | 0        | _     |  |
| I Page 43                      | The fuel injection system is a simultaneous all–cylinders injection system.  | _     | _        | 0     |  |
| Cold Start<br>Injector Control | The injection duration of the cold start in-<br>jector is controlled by the start injector time<br>switch.                                     | _     | _        | 0     |  |
|                                | Ignition timing is determined by the ECM <sup>*4</sup><br>[ECU] based on signals from various sen-<br>sors.                                    | 0     | 0        | 0     |  |
| EI* <sup>2</sup> [ESA]         | It retards ignition timing to suppress knock-<br>ing when it occurs.   | _     | 0        | —     |  |
| ☞ Page 43                      | In vehicle equipped with automatic trans-<br>axle, torque control compensation during<br>gear shifting is used to minimize the shift<br>shock. | _     | 0        | _     |  |
| IAC* <sup>3</sup> [ISC]        | A rotary solenoid type IAC [ISC] valve is<br>used, which controls the fast idle and idle<br>speeds.  | 0     | 0        | —     |  |
| Page 44                        | A duty control VSV type IAC valve [ACV] regulates air volume bypassing the throttle valve and controls idling speed.                           | _     | _        | 0     |  |
| Fuel Pump Control              | Fuel pump operation is controlled by signals<br>from the ECM [ECU] based on the engine<br>speed signal (NE).                                   | 0     | 0        | 0     |  |

\*1: MFI (Multiport Fuel Injection)

\*<sup>2</sup>: EI (Electronic Ignition)

\*<sup>3</sup>: IAC (Idle Air Control)

\*<sup>4</sup>: ECM (Engine Control Module)

| Sustam  | Outline  | Ne    | Previous         |                         |
|---|--|-------|------------------|-------------------------|
| System  | Outime   | 4A–FE | 7A–FE            | 4A-FE                   |
| EGR Cut–Off Control                               | The EGR is cut off under light engine loads<br>or low temperature conditions to maintain<br>drivability.   | ○*1   | ○*1              | <b>○</b> * <sup>2</sup> |
| Air Conditioning<br>Cut–Off Control* <sup>3</sup> | By controlling the air conditioning compressor in accordance with the throttle valve opening angle and the vehicle speed, drivability is maintained. | 0     | 0                | 0                       |
| Diagnosis   | When a malfunction occurs, the ECM <sup>*4</sup><br>[ECU] diagnoses and memorizes the failed<br>section.   | 0     | 0                | 0                       |
| i ugo i i   | A test mode function has been added.   | 0     | 0<br>0<br>0<br>0 | —                       |
| Fail–Safe<br>☞ Page 46                            | When a malfunction occurs, the ECM <sup>*4</sup><br>[ECU] stops or controls the engine accord-<br>ing to the data already stored in memory.          | 0     | 0                | 0                       |

\*1: California specification vehicle only.

\*2: 2WD for California specification and 4WD vehicles.

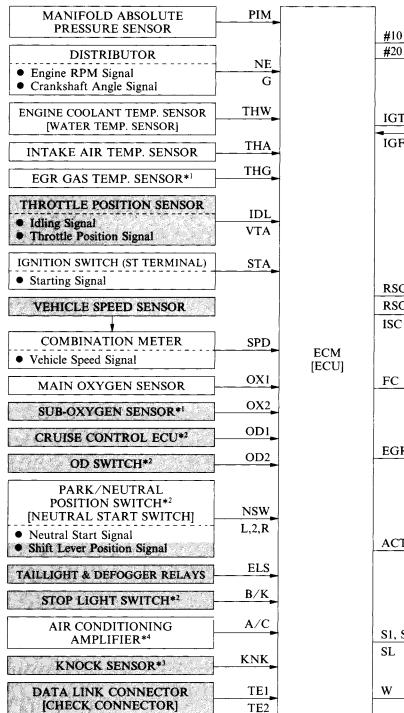
\*<sup>3</sup>: Models with air conditioning.

\*<sup>4</sup>: ECM (Engine Control Module)

#### 2. Construction

The configuration of the engine control system in the new 4A–FE and 7A–FE engine is as shown in the following chart. Shaded portions differ from the previous 4A–FE engine.

#### SENSORS



ACTUATORS MFI [EFI] **NO. 1 AND 3 INJECTORS NO. 2 AND 4 INJECTORS** EI [ESA] IGT IGNITER IGF **IGNITION COIL** DISTRIBUTOR SPARK PLUGS IAC [ISC] RSC CONTROL VALVE RSO VSV FUEL PUMP CONTROL CIRCUIT OPENING RELAY EGR CUT-OFF CONTROL\*1 EGR VSV AIR CONDITIONING **CUT-OFF CONTROL** ACT AIR CONDITIONING AMPLIFIER ELECTRONIC CONTROLLED TRANSMISSION CONTROL\*5 S1, S2 SOLENOID VALVES

MALFUNCTION INDICATOR

 TE2
 LAMP [CHECK ENGINE LAMP]

 BATT
 + B

EFI MAIN RELAY

\*1: Applicable only to California specification vehicles.

\*<sup>2</sup>: Applicable only to automatic transaxle vehicles.

\*<sup>3</sup>: Applicable only to vehicles with 7A-FE engine.

\*4: Applicable only to vehicles with air conditioning.

\*5: Applicable only 7A-FE engine vehicles with automatic transaxle.

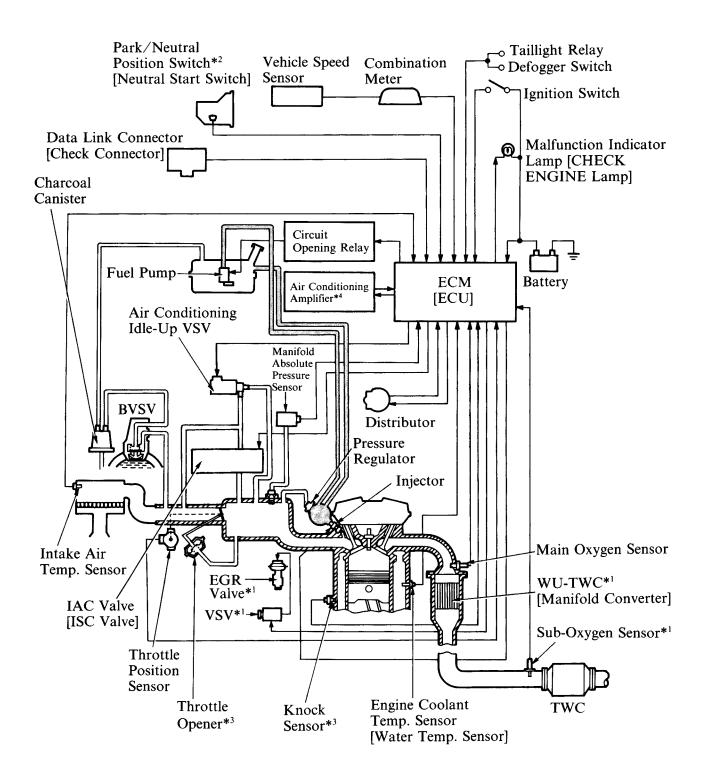
BATTERY

# 3. Summary of Engine Control System

The table summarizes the engine control system for the new 4A–FE and 7A–FE engines. Items highlighted by are changes from the previous 4A–FE engine.

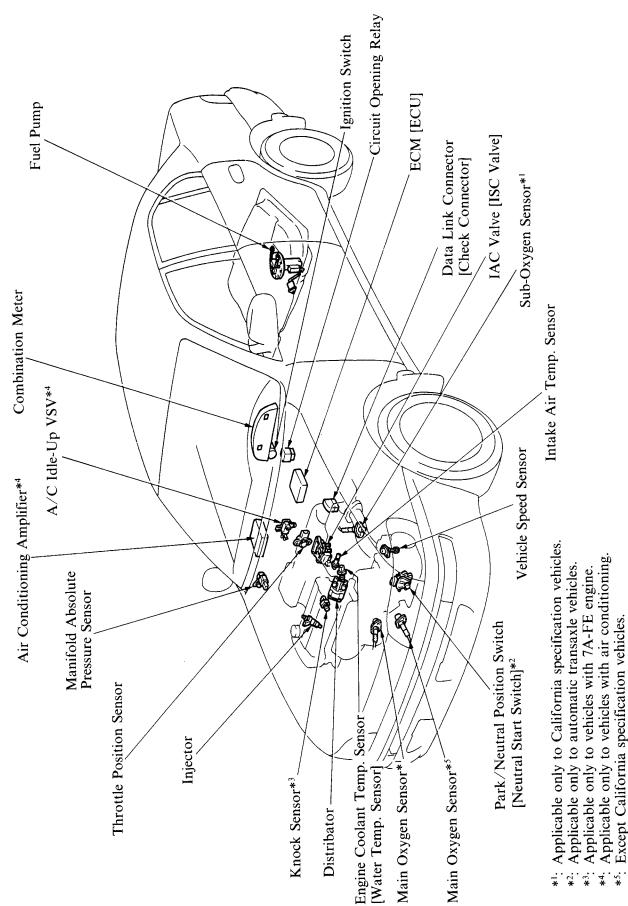
|   | *1:                     |                               |                       | cable only to California specifica-<br>ehicles.             |                                   | —-<br>T— |   |  | 1                       | 1 1000<br>1 1000 |     | S               | SEN:                 | SOR                | 2                    |                         |  | -                           |                            | 1.446.9         |                                       | 1   | Τ        |                |
|---|-------------------------|-------------------------------|-----------------------|---|-----------------------------------|----------|---|--|-------------------------|------------------|-----|-----------------|----------------------|--------------------|----------------------|-------------------------|--|-----------------------------|----------------------------|-----------------|---------------------------------------|-----|----------|----------------|
|   |                         | Ap                            |                       | cable only to automatic transaxle                           |                                   |          |   | Sensor]                                  |                         |                  |     |                 |                      |                    |                      |                         | trt Switch]  |                             |                            |                 |                                       |     |          |                |
| * <sup>3</sup> : Applicable only to vehicles with 7A–FE engine. |                         |                               |                       |   | nsor                              |          |   | ter Temp.                                |                         |                  |     |                 |                      |                    |                      |                         | Veutral Sta  |                             |                            |                 | Connecto                              |     |          |                |
|   | *4:                     |                               | opli<br>onin          | cable only to vehicles with air condi-<br>g.                | sure Se                           | -        |   | tsor [Wa                                 | or                      |                  |     |                 |                      |                    |                      | _                       | itch *2 []   | elays                       | ifier *4                   |                 | Check                                 | L L |          |                |
|   | *5:                     |                               |                       | cable only to 7A–FE engine vehicles<br>automatic transaxle. | Manifold Absolute Pressure Sensor |          |   | Engine Coolant Temp. Sensor [Water Temp. | Intake Air Temp. Sensor |                  |     | Ignition Switch | Vehicle Speed Sensor | Main Oxygen Sensor | Sub-Oxygen Sensor *1 | EGR Gas Temp. Sensor *1 | Park/Neutral Position Switch *2 [Neutral Start Switch] | Taillight & Defogger Relays | Air Conditioning Amplifier | Knock Sensor *3 | Data Link Connector [Check Connector] |     |          | EFI Main Relay |
|   |                         |                               |                       | CONTROL ITEMS   | PIM                               | NE       | U | THW                                      | THA                     | IDL              | VTA | STA             | SPD                  | OXI                | 0X2                  | THG                     | NSW  | ELS                         | A/C                        | KNK             | TEI                                   | TES |          | +B             |
|   | F                       | Puel                          | Inje                  | ction Timing Control  |                                   | •        | • |  |                         |                  |     |                 |                      | -                  | duri, and            |                         |  |                             |                            |                 |                                       |     |          |                |
|   | 5                       | S                             | tart                  | ing Injection Control                                       |                                   | •        |   | ٠  |                         |                  |     |                 |                      |                    |                      |                         |  |                             |                            |                 |                                       |     | •        | •              |
|   | Control                 | Irol                          | B                     | asic Injection Control                                      | •                                 | •        |   |  |                         |                  | •   |                 |                      |                    |                      |                         |  |                             |                            |                 |                                       |     |          |                |
| E   | n C                     | Cont                          | su                    | Intake Air Temp. Correction                                 |                                   |          |   |  | •                       |                  |     |                 |                      | _                  |                      |                         |  |                             |                            |                 |                                       | •   |          |                |
| MFI [EFI]   | Fuel Injection Duration | After-Start Injection Control | Injection Corrections | After-Start Enrichment                                      |                                   | ullet    |   | •  |                         |                  | •   |                 |                      |                    |                      |                         |  |                             |                            |                 |                                       | •   |          |                |
| MFI   | D                       | Injec                         | Corre                 | Warm-Up Enrichment  |                                   | ullet    |   | •  |                         |                  |     |                 |                      |                    |                      |                         |  |                             |                            |                 |                                       | •   |          |                |
|   | tion                    | tart                          | ion                   | Power Enrichment  | •                                 | ullet    |   | •  |                         |                  | •   |                 |                      |                    |                      |                         |  |                             |                            |                 |                                       | •   |          |                |
|   | njec                    | ter-S                         | njeci                 | Air-Fuel Ratio Feedback Correction                          | •                                 | •        |   | •  |                         | •                | •   |                 | •                    | •                  | •                    |                         |  |                             |                            |                 |                                       | •   |          | _              |
|   | l lət                   | Af                            |                       | Voltage Correction  |                                   |          |   |  |                         |                  |     |                 |                      |                    |                      |                         |  |                             |                            |                 |                                       | •   |          | •              |
|   |                         | Sec.e.s.                      |                       | Cut-Off   | •                                 | •        |   | •  |                         | •                | •   |                 | •                    | _                  |                      |                         | •  |                             | •                          |                 |                                       | •   |          |                |
|   | I                       | 1000                          | 1971.11 ELegence      | Timing Signal Control                                       |                                   | •        |   |  |                         |                  |     |                 |                      |                    |                      |                         |  |                             |                            |                 |                                       | •   |          | •              |
|   |                         | L                             | tart                  | ng Ignition Control   |                                   | •        |   |  |                         |                  |     | •               |                      |                    |                      |                         |  |                             |                            |                 |                                       | •   |          |                |
|   | otro                    | trol                          | r                     | asic Ignition Advance Angle                                 | •                                 | •        |   | •  |                         | •                | •   |                 | •                    |                    |                      |                         | •  |                             | •                          |                 |                                       |     |          |                |
| EI [ESA]  | <b>Fiming Control</b>   | After-Start Ignition Control  | Advance Angle         | Warm-Up Correction  | ●                                 |          |   | •  |                         | •                |     |                 |                      |                    |                      |                         |  |                             |                            |                 |                                       | •   |          |                |
| EI  | ning                    | tion                          | vance                 | Knocking Correction*3                                       | •                                 | •        | ٠ | •  |                         | •                |     |                 |                      |                    |                      |                         |  |                             |                            | •               |                                       | •   |          |                |
| [   | ·                       | Igni                          |                       | Stable Idling Correction                                    |                                   | •        |   | ٠  |                         | •                |     |                 | •                    |                    |                      |                         | •  |                             |                            |                 |                                       | •   |          |                |
|   | Ignition                | Start                         | Igniti                | EGR Correction  | •                                 | ٠        |   |  |                         |                  |     |                 |                      |                    |                      |                         |  |                             |                            | $ \rightarrow $ |                                       |     | 単        |                |
|   | Igni                    | fter-                         | Corrective Ignition   | Torque Control Compensation During Shifting*5               |                                   | •        |   | •  |                         |                  |     |                 | _                    | _                  | $ \rightarrow$       |                         |  |                             |                            |                 |                                       |     |          |                |
| 21  |                         |                               | -                     | Maximum and Minimum Advance Angle Control                   |                                   |          |   |  |                         |                  |     |                 |                      |                    |                      |                         |  |                             | $\square$                  | $ \rightarrow$  | $\square$                             | _   | 4        |                |
|   |                         |                               |                       | Control   |                                   | •        |   | •  | •                       |                  |     | •               | _                    | _                  |                      |                         |  |                             | _                          | $\dashv$        |                                       |     |          |                |
| SCI   |                         |                               |                       | d Check Control   |                                   |          |   | •  |                         |                  |     |                 |                      |                    | _                    |                         |  |                             | •                          | $\downarrow$    | •                                     | _   | -        |                |
| IAC [ISC]   | and the second          | -                             |                       | p Control   | $ \rightarrow$                    |          |   | •  |                         |                  |     |                 |                      |                    |                      | _                       |  |                             |                            |                 | $\perp$                               | •   | <u> </u> |                |
| IA  | 12.08                   | 38. 8. 1.                     | 111791013131          | c Control   |                                   | •        |   | •  |                         | •                |     | •               | •                    |                    | _                    |                         | •  | •                           | •                          | $ \rightarrow$  |                                       |     |          | <b>)</b>       |
|   |                         | -                             |                       | peed Change Estimate Control                                |                                   | •        |   | •  |                         | •                |     | •               | •                    |                    | $\parallel$          |                         | •  | •                           | •                          | $\downarrow$    | $\rightarrow$                         |     | ₽        |                |
| -   |                         |                               |                       | Control   |                                   | •        |   |  |                         |                  |     | •               | -                    |                    | $\rightarrow$        |                         |  |                             | $\dashv$                   |                 |                                       | •   | ▶        |                |
|   |                         |                               |                       | ff Control*i  | •                                 | •        | - | •  |                         | •                |     |                 | •                    |                    |                      |                         |  |                             |                            |                 | •                                     |     | 4        |                |
|   | 1000.11Sp               | LEN SKID.                     | 1407040000            | oning Cut-Off Control* <sup>4</sup>                         |                                   | •        |   |  |                         | •                | •   | •               | •                    |                    | $\rightarrow$        | $\downarrow$            |  |                             | •                          |                 | •                                     |     | 4        |                |
| a second second   | 10.000/940202           | nos                           | toto Spring           |   |                                   |          |   |  |                         |                  |     |                 | $\rightarrow$        |                    |                      | •                       | _  |                             | $\downarrow$               | •               | <u> </u>                              | ₽_  | +        |                |
| LF  | ail-                    | Safe                          | e                     |   |                                   |          |   |  |                         |                  |     |                 |                      | [                  |                      |                         |  |                             |                            |                 |                                       |     |          |                |

#### 4. Engine Control System Diagram



- \*1: Applicable only to California specification vehicles.
- \*<sup>2</sup>: Applicable only to automatic transaxle vehicles.
- \*<sup>3</sup>: Applicable only to vehicles with 7A–FE engine.
- \*<sup>4</sup>: Applicable only to vehicles with air conditioning.

# 5. Layout of Components



## 6. Modification of Main Components

Major modification in main components of the 4A-FE and 7A-FE engines are shown below.

| Model                    |                         |             |                            | New                                    | Previous                   |   |  |
|--------------------------|-------------------------|-------------|----------------------------|--|----------------------------|---|--|
| Engine                   |                         |             | 4A–FE                      | 7A–FE                                  | 4A–FE                      | Reference manuals                                 |  |
| Component                |                         |             |                            | ,                                      |                            |   |  |
| Throttle Position Sensor |                         |             | Linear Type                | <i>~</i>                               | Point Type                 | '87 CAMRY<br>(NCF014U),<br>TD–17                  |  |
|                          | Main                    |             | without Heater, 1          | $\leftarrow$                           | without Heater, 1          |   |  |
| Oxygen Sensor            |                         | Sub*        | without Heater, 1          | it Heater, 1 $\leftarrow$ N.A.         |                            | '87 CAMRY<br>(NCF014U),<br>TD–18                  |  |
| Knock Sensor             |                         |             | N.A.                       | Built–In Piezoelectric<br>Element Type | N.A.                       | '88 CELICA<br>All-Trac/4WD<br>(NCF033U),<br>TD-31 |  |
|                          | Engin<br>RPM            | e<br>Sensor | 2 Pick–Up Coils<br>4 Teeth | <i>~</i>                               | 1 Pick–Up Coil<br>24 Teeth | '92 PASEO   |  |
| Distributor              | Cams<br>Positi<br>Senso | on          | 1 Pick–Up Coil<br>1 Tooth  | <del>~</del>                           | 1 Pick–Up Coil<br>4 Teeth  | (NCF074U),<br>page 38                             |  |

\*: California specification vehicles only.

# 7. MFI [EFI] System

#### General

The MFI [EFI] system in the new 4A–FE and 7A–FE engines are basically the same as that of the previous 4A–FE engine. However, the fuel injection pattern has changed from the simultaneous injection type to the 2–group injection type, as in the 5S–FE engine for the '92 Camry. Refer to page 50 of '92 Camry New Car Features (Pub. No. NCF077U) for details.

# 8. EI [ESA] System

#### General

The following changes were made in the electronic ignition system [ESA] of the new 4A-FE and 7A-FE engines.

| Item                              | Outline of change   | Applicable engine                    | Reference manuals                              |
|-----------------------------------|---|--------------------------------------|--|
| Roles of ECM<br>[ECU] and igniter | Terms of the roles of the ECM [ECU] and igni-<br>ter are changed. | 4A–FE<br>and<br>7A–FE                | <sup>'91</sup> TERCEL<br>(NCF071U), page 51    |
| Knocking<br>correction            | A knocking correction using a knock sensor is added.              | 7A–FE                                | '88 CELICA<br>All–Trac 4WD<br>(NCF033U), TD–35 |
| Torque control compension         | A torque control compensation during shifting is added.           | 7A–FE<br>with automatic<br>transaxle | '90 CELICA<br>(NCF056U), page 86               |

# 9. IAC [ISC] System

#### General

44

A duty control VSV type IAC [ISC] valve in the previous 4A–FE engine was replaced by a rotary solenoid type valve in the new 4A–FE and 7A–FE engines. The new type offers improved response and reliability. This valve is basically the same in construction and operation as that of the '90 Celica. Refer to Page 87 of '90 Celica New Car Features (Pub. No. NCF056U) for details.

In the previous 4A–FE engine, the idle speed was controlled only by the IAC [ISA] valve. In the new engines, a VSV is used to increase the idle while the air conditioning is in operation. In addition, the IAC [ISC] system was changed to a new one that varies the target idling speed in accordance with the condition of the air conditioning. These systems are basically the same as those in the 5S–FE engine for the '92 Camry.

The difference from the '92 Camry is that this system has an electrical load signal (ELS) added to the relevant signals. The target idle speed thus varies according to electrical loads such as the taillights or defogger. Refer to page 51 of '92 Camry New Car Features (Pub. No. NCF077U) for details.

### 10.Diagnosis

As in the '89 Cressida, a test mode function has been added to the diagnosis system. For details of this function, see page TD-20 of '89 Cressida New Car Features (Pub. No. NCF044U).

#### **Diagnostic Items**

Diagnostic items for the new 4A–FE and 7A–FE engines are shown below. Information in the shaded area applies only to the 7A–FE engine.

| Code<br>No.      | Item   | Diagr<br>Moc |      | Diagnosis   | Malfunction<br>Stored in |
|------------------|--|--------------|------|---|--------------------------|
| 110.             |  | Normal       | Test |   | Memory                   |
|                  |  |              |      | • No "NE" signal to ECM [ECU] within 2 sec-<br>onds after engine is cranked.  |                          |
| 12               | RPM Signal   | 0            |      | • No "G" signal to ECM [ECU] for 3 seconds when the engine speed is between 600 rpm and 4000 rpm.   | Yes                      |
|                  |  | 0            | _    | No "NE" signal to ECM [ECU] when the engine speed is above 1500 rpm.  | Yes                      |
| 13               | RPM Signal   | _            | 0    | No "G" signal to ECM [ECU] while "NE" signal<br>is input 4 times to ECM [ECU] when engine speed<br>is between 500 rpm and 4000 rpm.                     | Yes                      |
| 14               | Ignition Signal  | 0            |      | No "IGF" signal to ECM [ECU] 4 times in succession.   | Yes                      |
| 16* <sup>2</sup> | Electronic<br>Controlled<br>Transmission<br>Control Signal | 0            |      | Electronic Controlled Transmission control pro-<br>gram faulty.   | No                       |
| 21               | Main Oxygen<br>Sensor Signal                               | 0            | 0    | During air-fuel ratio feedback correction, output<br>voltage of main oxygen sensor remains between<br>0.35V and 0.7V continuously for a certain period. | Yes                      |

| Code<br>No. | Item   | Diagnostic<br>Mode <sup>*1</sup> |             | Diagnosis   | Malfunction<br>Stored in |
|-------------|--|----------------------------------|-------------|---|--------------------------|
| 110.        |  | Normal                           | Normal Test |   | Memory                   |
| 22          | Engine Coolant<br>Temp. Sensor<br>Signal<br>[Water Temp.<br>Sensor Signal] | 0                                | 0           | Open or short circuit in engine coolant temp.<br>sensor signal [water temp. sensor signal] (THW).   | Yes                      |
| 24          | Intake Air<br>Temp. Sensor<br>Signal                                       | 0                                | 0           | Open or short circuit in intake air temp. sensor signal (THA).  | Yes                      |
| 25          | Air–Fuel<br>Ratio Lean<br>Malfunction                                      | ○*3                              | ⊜*3         | Open or short circuit in main oxygen sensor sig-<br>nal (OX1).  | Yes                      |
| 26          | Air–Fuel<br>Ratio Rich<br>Malfunction                                      | _*4                              | ○*4         | When marked variation is detected in engine<br>revolutions during idle switch on and feedback<br>condition.                                     | Yes                      |
| 27          | Sub–Oxygen<br>Sensor Signal  | ○*4                              | ○*4         | Open or short circuit in sub-oxygen sensor sig-<br>nal (OX2).   | Yes                      |
| 31          | Manifold<br>Absolute<br>Pressure<br>Sensor Signal                          | 0                                | 0           | Open or short circuit in manifold absolute pres-<br>sure sensor signal (PIM).   | Yes                      |
| 41          | Throttle<br>Position<br>Sensor Signal                                      | _* <sup>5</sup>                  | 0           | Open or short circuit in throttle position sensor signal (VTA).   | Yes                      |
| 42          | Vehicle Speed  | 0                                |             | No "SPD" signal to ECM [ECU] for 8 seconds when vehicle is running.   | Yes                      |
| 42          | Sensor Signal  |                                  | х           | No "SPD" signal input to ECM [ECU] after igni-<br>tion switch is turned on.   | No                       |
| 43          | Starter Signal   |                                  | х           | No "STA" signal input to ECM [ECU] after igni-<br>tion switch is turned on.   | No                       |
| 52          | Knock<br>Sensor Signal   | 0                                | —           | Open or short circuit in knock sensor signal (KNK).   | Yes                      |
| 71          | EGR System<br>Malfunction  | <u></u> *4                       | ⊖*4         | <ul> <li>EGR gas temp. below a predetermined level during EGR operation.</li> <li>Open circuit in EGR gas temp. sensor signal (THG).</li> </ul> | Yes                      |
| 51          | Switch<br>Condition<br>Signal  |                                  | Х           | No "IDL" signal or no "NSW" signal or "A/C" signal to ECM [ECU] during diagnosis code check for test mode.                                      | No                       |

<sup>\*1:</sup> O mark in the diagnostic mode column indicates that the malfunction indicator lamp [CHECK ENGINE lamp] will light up when a diagnosis is conducted and a malfunction is detected. X mark indicates that the lamp will not light up even if a malfunction is detected during a diagnosis. — mark indicates that diagnosis is not performed for that item.

- \*<sup>2</sup>: Models with automatic transaxle only.
- \*<sup>3</sup>: When a malfunction occurs, only code No. 25 is stored.
- \*<sup>4</sup>: This diagnosis occurs only for California specification vehicles. If a malfunction occurs involving a lean or rich air–fuel ratio, code Nos. 25 and 26 are stored simultaneously in the ECM [ECU].
- \*<sup>5</sup>: In the normal mode, when a malfunction occurs in code No. 41, the malfunction indicator lamp [CHECK ENGINE lamp] lights up only in California specification vehicles.

### 11.Fail-Safe

The fail–safe functions of the new 4A–FE engine are the same as those of the previous model. Note, however, that fail–safe functions related to the knock sensor and the electronic controlled transmission are added in the 7A–FE engine. These functions are the same as those in the 5S–FE engine for the '92 Camry. Refer to page 53 of '92 Camry New Car Features (Pub. No. NCF077U) for details.