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| Model Year Start: 2023 | Model: Prius Prime | Prod Date Range: [03/2023 -] |
| Title: M20A-FXS (ENGINE CONTROL): SFI SYSTEM: P003612,P003613,P102A9E; HO2S Heater Control Circuit Bank 1 Sensor 2 Circuit Short to Battery; 2023 - 2024 MY Prius Prius Prime [03/2023 -] | | |

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|------------|----------------|-----------------------------------------------------------------------------|
| DTC | P003612 | HO2S Heater Control Circuit Bank 1 Sensor 2 Circuit Short to Battery |
|------------|----------------|-----------------------------------------------------------------------------|

| | | |
|------------|----------------|---------------------------------------------------------------------|
| DTC | P003613 | A/F (O2) Heater Control Circuit Bank 1 Sensor 2 Circuit Open |
|------------|----------------|---------------------------------------------------------------------|

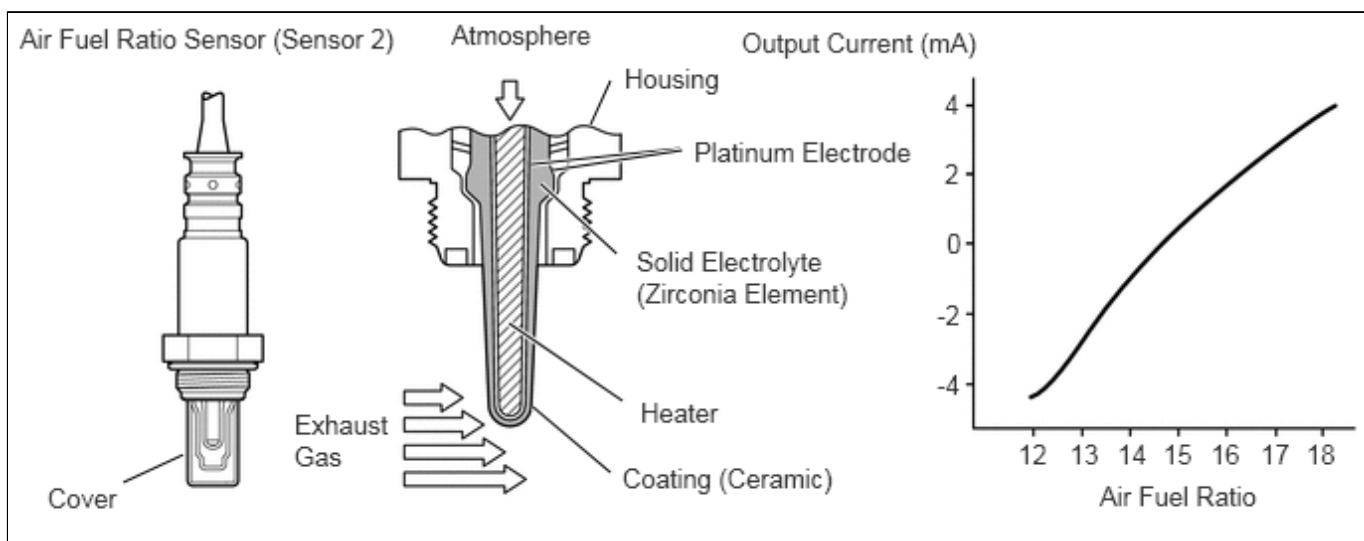
| | | |
|------------|----------------|--------------------------------------------------------------|
| DTC | P102A9E | O2 Sensor Heater Performance Bank 1 Sensor 2 Stuck On |
|------------|----------------|--------------------------------------------------------------|

DESCRIPTION

The air fuel ratio sensor (sensor 2) generates current that corresponds to the actual air fuel ratio. This sensor current is used to provide the ECM with feedback so that it can control the air fuel ratio. The ECM determines the deviation from the stoichiometric air fuel ratio level, and regulates the fuel injection duration. If the air fuel ratio sensor (sensor 2) malfunctions, the ECM is unable to control the air fuel ratio accurately.

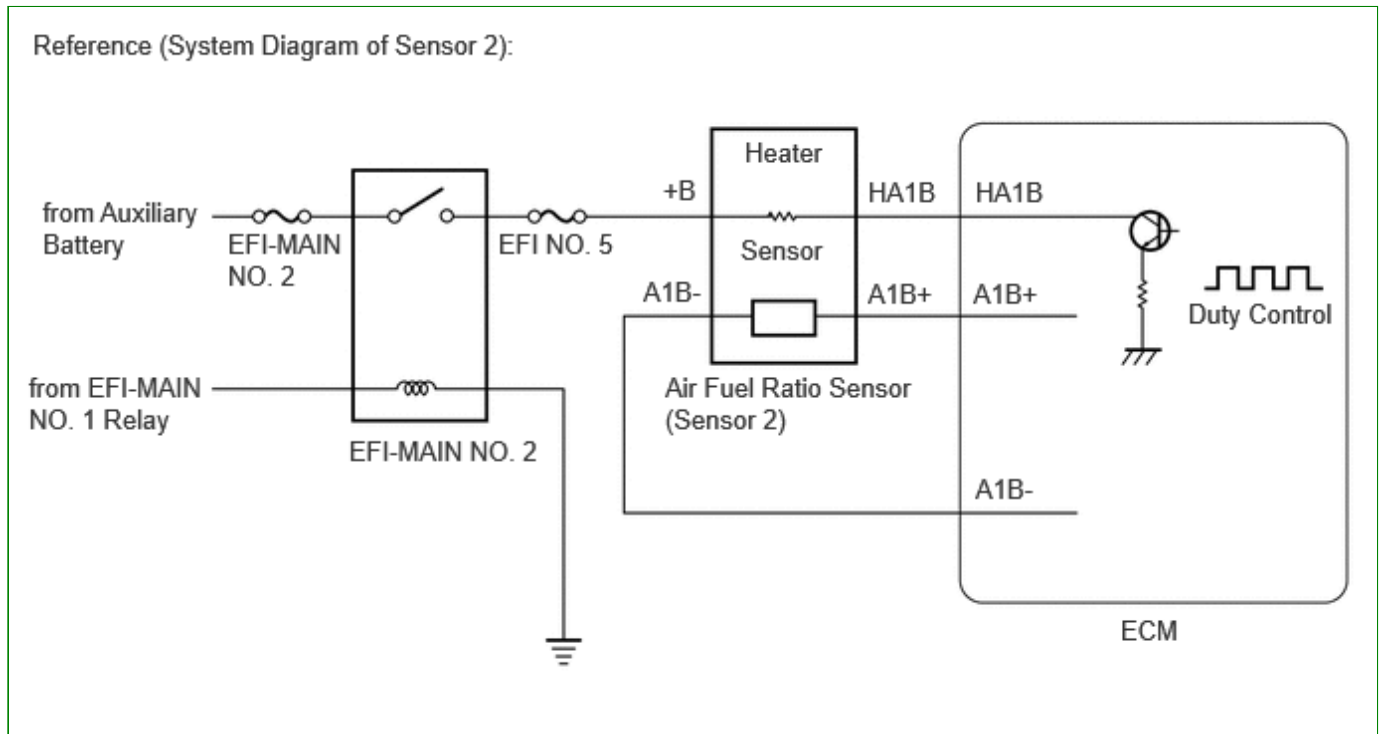
The air fuel ratio sensor (sensor 2) is a cup type sensor and uses a zirconia element for the sensor element. The zirconium element is made of platinum coated zirconium and includes an integrated heating element. The inner surface of the zirconia element is exposed to the outside air and the outer surface of it is exposed to the exhaust gas. The zirconia element generates a voltage according to the oxygen concentration of the exhaust gas and outside air. The air fuel ratio sensor (sensor 2) becomes very efficient when heated. When the exhaust gas temperature is low, the sensor does not generate useful voltage signals without supplementary heating. Therefore, the air fuel ratio sensor (sensor 2) includes a heater to heat the zirconia element.

In order to obtain a high purification rate of the carbon monoxide (CO), hydrocarbon (HC) and nitrogen oxide (NOx) components in the exhaust gas, a three-way catalytic converter is used. For the most efficient use of the three-way catalytic converter, the air fuel ratio must be precisely controlled so that it is always close to the stoichiometric air fuel ratio.



HINT:

- When any of these DTCs are stored, the ECM enters fail-safe mode. The ECM turns off the air fuel ratio sensor (sensor 2) heater in fail-safe mode. Fail-safe mode continues until the ignition switch is turned off.
- Although the DTC titles say oxygen sensor, these DTCs relate to the air fuel ratio sensor (sensor 2).
- The ECM has a pulse width modulated control circuit to adjust the current through the heater. The air fuel ratio sensor (sensor 2) heater circuit uses a relay on the +B side of the circuit.



| DTC NO. | DETECTION ITEM | DTC DETECTION CONDITION | TROUBLE AREA | MIL | DTC OUTPUT FROM | PRIORITY | NOTE |
|---------|----------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|-----------------|----------|-----------------|
| P003612 | HO2S Heater Control Circuit Bank 1 Sensor 2 Circuit Short to Battery | The air fuel ratio sensor (sensor 2) heater current is more than the specified value while the heater is operating (1 trip detection logic). | <ul style="list-style-type: none"> • Short in air fuel ratio sensor (sensor 2) heater circuit • Air fuel ratio sensor (sensor 2) • ECM | Comes on | Engine | A | SAE Code: P0038 |
| P003613 | A/F (O2) Heater Control Circuit Bank 1 Sensor 2 Circuit Open | The air fuel ratio sensor (sensor 2) heater current is less than the specified value while the heater is operating (1 trip detection logic). | <ul style="list-style-type: none"> • Open or short in air fuel ratio sensor (sensor 2) heater circuit • Air fuel ratio sensor (sensor 2) • EFI-MAIN NO. 2 relay • ECM | Comes on | Engine | A | SAE Code: P0037 |

| DTC NO. | DETECTION ITEM | DTC DETECTION CONDITION | TROUBLE AREA | MIL | DTC OUTPUT FROM | PRIORITY | NOTE |
|---------|-------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|-----------------|----------|-----------------|
| P102A9E | O2 Sensor Heater Performance Bank 1 Sensor 2 Stuck On | The air fuel ratio sensor (sensor 2) heater voltage is the specified value or less while the heater is not operating (1 trip detection logic). | <ul style="list-style-type: none"> Short in air fuel ratio sensor (sensor 2) heater circuit Air fuel ratio sensor (sensor 2) ECM | Comes on | Engine | A | SAE Code: P102D |

MONITOR DESCRIPTION

The air fuel ratio sensor (sensor 2) detects oxygen levels in the exhaust gas and transmits the information to the ECM. The inner surface of the sensor element is exposed to the outside air. The outer surface of the sensor element is exposed to the exhaust gas. The sensor element is made of platinum-coated zirconia and includes an integrated heating element.

The zirconia element generates a small voltage when there is a large difference in the oxygen concentrations between the exhaust gas and outside air. The platinum coating amplifies this voltage generation.

The air fuel ratio sensor (sensor 2) is more efficient when heated. When the exhaust gas temperature is low, the sensor cannot generate useful current signals without supplementary heating. The ECM regulates the supplementary heating using a duty-cycle approach to adjust the average current in the sensor heater element. If the heater current is outside the normal range, the signal transmitted by the air fuel ratio sensor (sensor 2) becomes inaccurate. As a result, the ECM is unable to regulate the air fuel ratio properly.

Air Fuel Ratio Sensor (Sensor 2) Heater Range Check (P003612 and P003613):

The ECM monitors the current applied to the air fuel ratio sensor (sensor 2) heater to check the heater for malfunctions.

If the heater current is outside the normal range, the signal transmitted by the air fuel ratio sensor (sensor 2) becomes inaccurate. When the current in the air fuel ratio sensor (sensor 2) heater is outside the normal operating range, the ECM interprets this as a malfunction in the sensor heater and stores a DTC.

Air Fuel Ratio Sensor (Sensor 2) Heater Performance (P102A9E):

When the air fuel ratio sensor (sensor 2) heater terminal voltage is the specified value or less while the heater is not operating, the ECM determines that there is a malfunction in the sensor heater and stores a DTC.

MONITOR STRATEGY

| | |
|---------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Related DTCs | P0037: Air fuel ratio sensor (sensor 2) heater range check (low current) P0038: Air fuel ratio sensor (sensor 2) heater range check (high current) P102D: Air fuel ratio sensor (sensor 2) heater performance |
| Required Sensors/Components (Main) | Air fuel ratio sensor (sensor 2) heater |
| Required Sensors/Components (Related) | - |
| Frequency of Operation | Continuous |

| | |
|-----------------------|-------------------------------------------------|
| Duration | 10 seconds: P0037 and P0038 5 seconds: P102D |
| MIL Operation | Immediate |
| Sequence of Operation | None |

TYPICAL ENABLING CONDITIONS

P0037

| | |
|------------------------------------------------------------------|-------------------|
| All of the following conditions are met | - |
| Auxiliary battery voltage | 10.5 V or higher |
| Time after heater on | 5 seconds or more |
| Air fuel ratio sensor (sensor 2) heater performance fail (P102D) | Not detected |
| Output duty cycle | 30% or higher |
| Heater high current cutout | Off |

P0038

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|---------------------------------------------------------|-------------------|
| Monitor runs whenever the following DTCs are not stored | None |
| All of the following conditions are met | - |
| Auxiliary battery voltage | 10.5 V or higher |
| Time after heater on | 5 seconds or more |
| CPU commanded duty cycle | Higher than 5% |
| Output duty cycle | Higher than 5% |

P102D

| | |
|---------------------------------------------------------|------------------|
| Monitor runs whenever the following DTCs are not stored | None |
| Both of the following conditions are met | - |
| Auxiliary battery voltage | 10.5 V or higher |
| Output duty cycle | Less than 95% |

TYPICAL MALFUNCTION THRESHOLDS

P0037

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|-------------------|-----------------|
| Heater on current | Less than 0.8 A |
|-------------------|-----------------|

P0038

| | |
|-------------------------------------------------|-----------------------------------------------|
| Either of the following conditions is met | - |
| Heater on current detected by heater monitor IC | More than 13 A |
| Heater on voltage detected by heater monitor IC | [Auxiliary battery voltage x 0.1] V or higher |

P102D

Heater off voltage detected by heater monitor IC

[Auxiliary battery voltage x 0.33] V or less

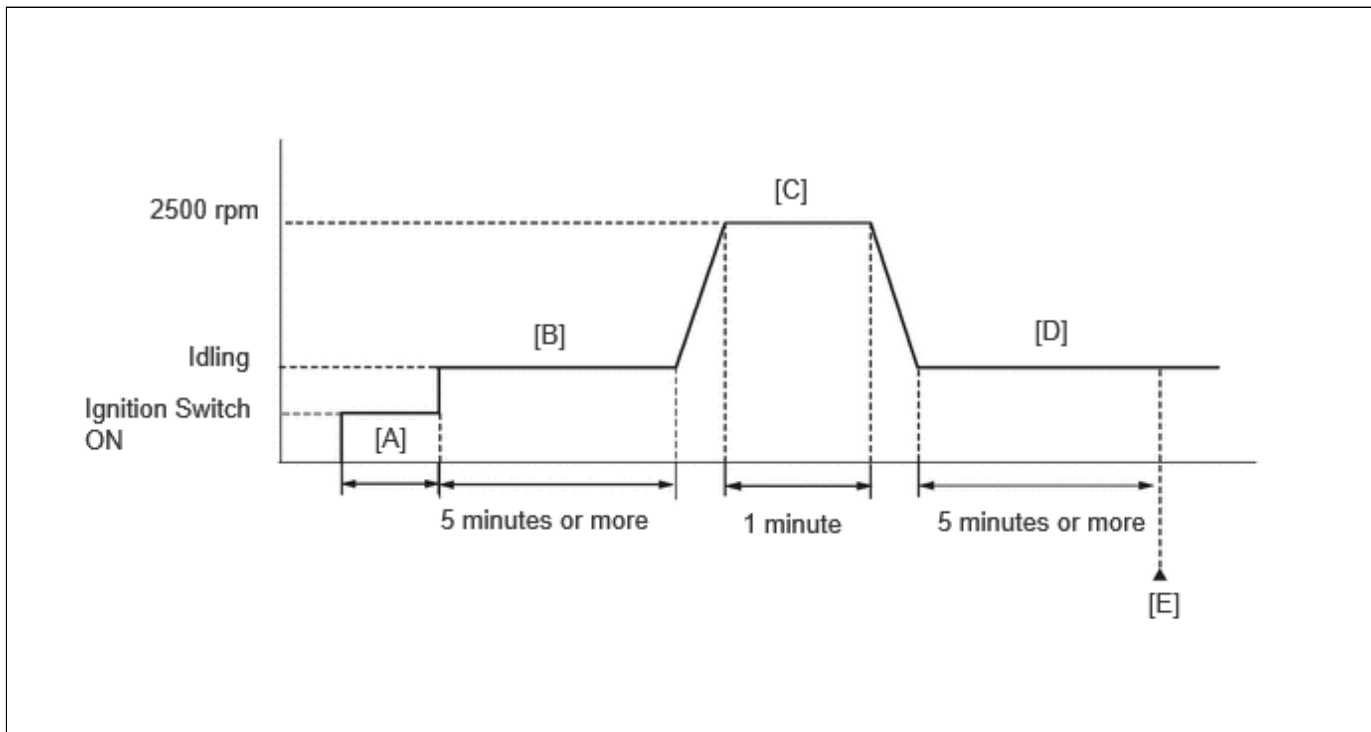
CONFIRMATION DRIVING PATTERN**HINT:**

- After repair has been completed, clear the DTC and then check that the vehicle has returned to normal by performing the following All Readiness check procedure.

Click here [INFO](#)

- When clearing the permanent DTCs, refer to the "CLEAR PERMANENT DTC" procedure.

Click here [INFO](#)



- Clear the DTCs (even if no DTCs are stored, perform the clear DTC procedure).
- Turn the ignition switch off and wait for at least 30 seconds.
- Turn the ignition switch to ON [A].
- Put the engine in Inspection Mode (Maintenance Mode).

Click here [INFO](#)

- Start the engine and idle it for 5 minutes or more [B].
- With the vehicle stationary, depress the accelerator pedal and maintain an engine speed of 2500 rpm for 1 minute [C].

HINT:

During charge control, the engine speed is set at idle. Therefore, the engine speed does not increase when depressing the accelerator pedal. In this case, perform steps [C] and [D] after charge control has completed.

- Idle the engine for 5 minutes or more [D].
- Enter the following menus: Powertrain / Engine / Trouble Codes [E].
- Read the pending DTCs.

HINT:

- If a pending DTC is output, the system is malfunctioning.
 - If a pending DTC is not output, perform the following procedure.
10. Enter the following menus: Powertrain / Engine / Utility / All Readiness.
 11. Input the DTC: P003612, P003613 or P102A9E.
 12. Check the DTC judgment result.

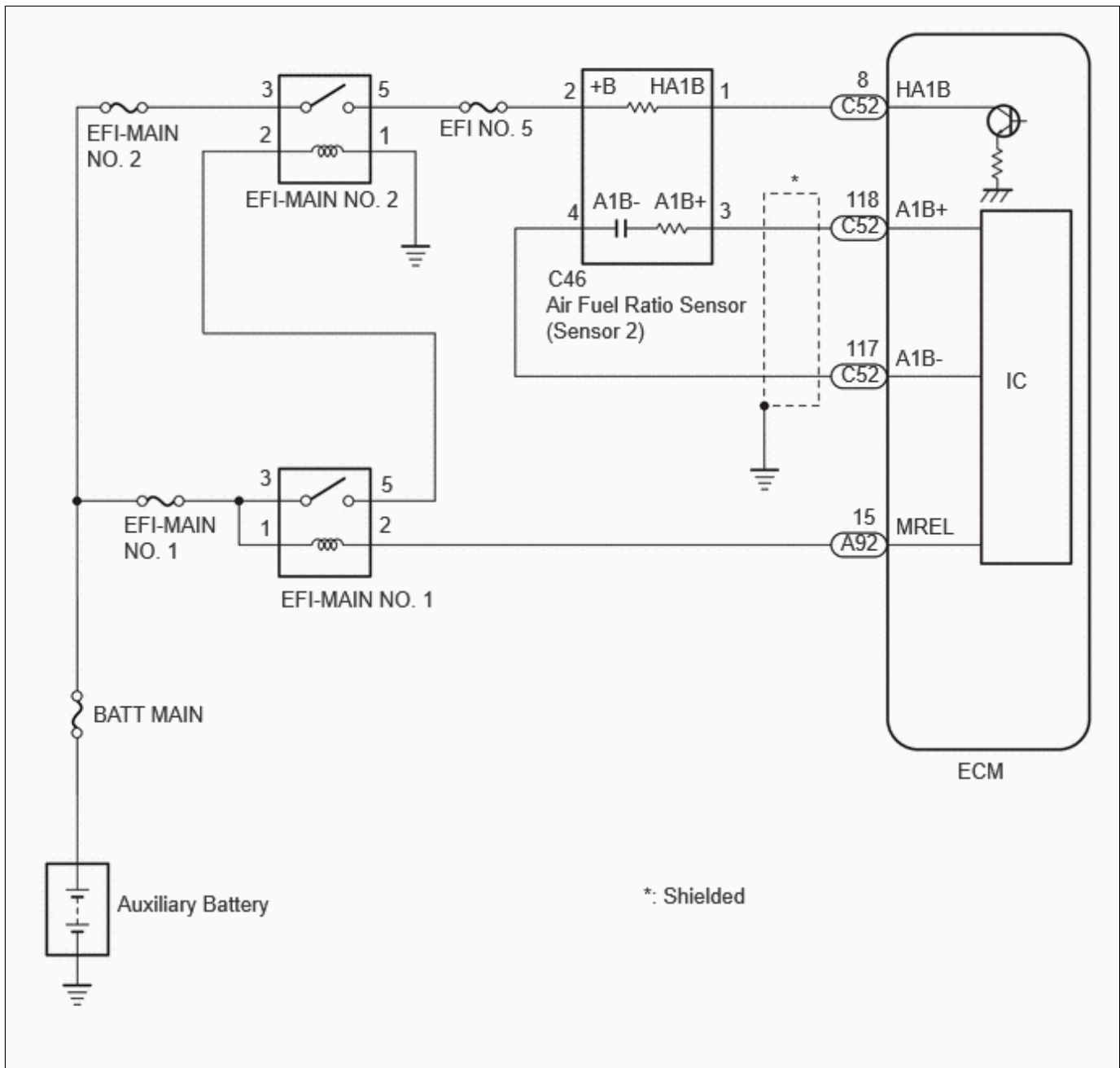
HINT:

- If the judgment result is NORMAL, the system is normal.
- If the judgment result is ABNORMAL, the system has a malfunction.
- If the judgment result is INCOMPLETE, perform steps [B] through [E] again.
- [A] to [E]: Normal judgment procedure.

The normal judgment procedure is used to complete DTC judgment and also used when clearing permanent DTCs.

- When clearing the permanent DTCs, do not disconnect the cable from the auxiliary battery terminal or attempt to clear the DTCs during this procedure, as doing so will clear the universal trip and normal judgment histories.

WIRING DIAGRAM



CAUTION / NOTICE / HINT

NOTICE:

- Inspect the fuses for circuits related to this system before performing the following procedure.
- Vehicle Control History may be stored in the hybrid vehicle control ECU if the engine is malfunctioning. Certain vehicle condition information is recorded when Vehicle Control History is stored. Reading the vehicle conditions recorded in both the freeze frame data and Vehicle Control History can be useful for troubleshooting.

for HEV Model: Click here [INFO](#)

for PHEV Model: Click here [INFO](#)

(Select Powertrain in Health Check and then check the time stamp data.)

- If any "Engine Malfunction" Vehicle Control History item has been stored in the hybrid vehicle control ECU, make sure to clear it. However, as all Vehicle Control History items are cleared simultaneously, if any Vehicle Control History items other than "Engine Malfunction" are stored, make sure to perform any troubleshooting for them before clearing Vehicle Control History.

for HEV Model: [Click here](#) INFO

for PHEV Model: [Click here](#) INFO

HINT:

- Refer to "Data List / Active Test" [A/F Sensor Heater Duty B1S2].

[Click here](#) INFO

- Sensor 1 refers to the sensor closest to the engine assembly.
- Sensor 2 refers to the sensor farthest away from the engine assembly.
- Change the fuel injection volume using the Control the Injection Volume for A/F Sensor function provided in the Active Test and monitor the air fuel ratio sensor (sensor 2) output current ([Click here](#) INFO). If the sensor output current does not change (almost no reaction) while performing the Active Test, the sensor may be malfunctioning.

PROCEDURE

| | |
|-----------|---------------------------------------------------------------------|
| 1. | INSPECT AIR FUEL RATIO SENSOR (SENSOR 2) (HEATER RESISTANCE) |
|-----------|---------------------------------------------------------------------|

[Click here](#) INFO

NG ▶ **REPLACE AIR FUEL RATIO SENSOR (SENSOR 2)**

OK



| | |
|-----------|----------------------------------------------------------------------------------|
| 2. | CHECK TERMINAL VOLTAGE (POWER SOURCE OF AIR FUEL RATIO SENSOR (SENSOR 2)) |
|-----------|----------------------------------------------------------------------------------|

Pre-procedure1

- (a) Disconnect the air fuel ratio sensor (sensor 2) connector.
- (b) Turn the ignition switch to ON.

Procedure1

- (c) Measure the voltage according to the value(s) in the table below.

Standard Voltage:



[Click Location & Routing\(C46\)](#)

[Click Connector\(C46\)](#)

| TESTER CONNECTION | CONDITION | SPECIFIED CONDITION | RESULT |
|--------------------------|--------------------|---------------------|--------|
| C46-2 (+B) - Body ground | Ignition switch ON | 11 to 14 V | V |

Post-procedure1

- (d) None

NG  **GO TO STEP 6**

OK



| | |
|-----------|-----------------------------------------------------------------------------|
| 3. | CHECK HARNESS AND CONNECTOR (AIR FUEL RATIO SENSOR (SENSOR 2) - ECM) |
|-----------|-----------------------------------------------------------------------------|

Pre-procedure1

- (a) Disconnect the air fuel ratio sensor (sensor 2) connector.
- (b) Disconnect the ECM connector.

Procedure1

- (c) Measure the resistance according to the value(s) in the table below.

Standard Resistance:



[Click Location & Routing\(C46,C52\).](#)

[Click Connector\(C46\).](#)

[Click Connector\(C52\).](#)

| TESTER CONNECTION | CONDITION | SPECIFIED CONDITION | RESULT |
|----------------------------------------------------------------|-----------|---------------------|--------|
| C46-1 (HA1B) - C52-8 (HA1B) | Always | Below 1 Ω | Ω |
| C46-1 (HA1B) or C52-8 (HA1B) - Body ground and other terminals | Always | 10 kΩ or higher | kΩ |

Post-procedure1

- (d) None

NG  **REPAIR OR REPLACE HARNESS OR CONNECTOR**

OK



| | |
|-----------|------------------|
| 4. | CLEAR DTC |
|-----------|------------------|

Pre-procedure1

- (a) None

Procedure1

- (b) Clear the DTCs.

Powertrain > Engine > Clear DTCs

Post-procedure1

(c) Turn the ignition switch off and wait for at least 30 seconds.

NEXT**5. CHECK WHETHER DTC OUTPUT RECURS (DTC P003612, P003613 AND/OR P102A9E)**

Pre-procedure1

(a) Drive the vehicle in accordance with the driving pattern described in Confirmation Driving Pattern.

Procedure1

(b) Read the DTCs.

Powertrain > Engine > Trouble Codes

| RESULT | PROCEED TO |
|---------------------------------------|------------|
| DTCs are not output | A |
| P003612, P003613 or P102A9E is output | B |

Post-procedure1

(c) None

A **CHECK FOR INTERMITTENT PROBLEMS****B** **REPLACE ECM****6. INSPECT EFI-MAIN NO. 2 RELAY**

Click here

NG **REPLACE EFI-MAIN NO. 2 RELAY****OK****7. CHECK TERMINAL VOLTAGE (POWER SOURCE OF EFI-MAIN NO. 2 RELAY)**

Pre-procedure1

- (a) Remove the EFI-MAIN NO. 2 relay from the No. 1 engine room relay block and No. 1 junction block assembly.

Procedure1

- (b) Measure the voltage according to the value(s) in the table below.

Standard Voltage:

| TESTER CONNECTION | CONDITION | SPECIFIED CONDITION | RESULT |
|----------------------------------------|-----------|---------------------|--------|
| 3 (EFI-MAIN NO. 2 relay) - Body ground | Always | 11 to 14 V | V |

Post-procedure1

- (c) None

NG  **REPAIR OR REPLACE HARNESS OR CONNECTOR
(AUXILIARY BATTERY - EFI-MAIN NO. 2 RELAY)**

OK

| | |
|-----------|-------------------------------------------------------------------------|
| 8. | CHECK HARNESS AND CONNECTOR (EFI-MAIN NO. 2 RELAY - BODY GROUND) |
|-----------|-------------------------------------------------------------------------|

Pre-procedure1

- (a) Remove the EFI-MAIN NO. 2 relay from the No. 1 engine room relay block and No. 1 junction block assembly.

Procedure1

- (b) Measure the resistance according to the value(s) in the table below.

Standard Resistance:

| TESTER CONNECTION | CONDITION | SPECIFIED CONDITION | RESULT |
|----------------------------------------|-----------|---------------------|----------|
| 1 (EFI-MAIN NO. 2 relay) - Body ground | Always | Below 1 Ω | Ω |

Post-procedure1

- (c) None

NG  **REPAIR OR REPLACE HARNESS OR CONNECTOR**

OK

9. CHECK HARNESS AND CONNECTOR (EFI-MAIN NO. 2 RELAY - AIR FUEL RATIO SENSOR (SENSOR 2))

Pre-procedure1

- (a) Remove the EFI-MAIN NO. 2 relay from the No. 1 engine room relay block and No. 1 junction block assembly.
- (b) Disconnect the air fuel ratio sensor (sensor 2) connector.

Procedure1

- (c) Measure the resistance according to the value(s) in the table below.

Standard Resistance:



[Click Location & Routing\(C46\)](#)

[Click Connector\(C46\)](#)

| TESTER CONNECTION | CONDITION | SPECIFIED CONDITION | RESULT |
|--------------------------------------------------------------------------|-----------|---------------------|--------|
| 5 (EFI-MAIN NO. 2 relay) - C46-2 (+B) | Always | Below 1 Ω | Ω |
| 5 (EFI-MAIN NO. 2 relay) or C46-2 (+B) - Body ground and other terminals | Always | 10 kΩ or higher | kΩ |

Post-procedure1

- (d) None

OK ► REPAIR OR REPLACE HARNESS OR CONNECTOR (EFI-MAIN NO. 1 RELAY - EFI-MAIN NO. 2 RELAY)

NG ► REPAIR OR REPLACE HARNESS OR CONNECTOR

