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Model Year Start: 2023	Model: Prius Prime	Prod Date Range: [12/2022 -]
Title: HYBRID / BATTERY CONTROL: HYBRID CONTROL SYSTEM (for M20A-FXS): Cooling System; 2023 - 2024 MY Prius Prius Prime [12/2022 -]		

Cooling System

DESCRIPTION

The cause of the malfunction may be the cooling system.

Check whether the grille is blocked, whether coolant is leaking, the radiator fan operating condition and whether coolant has frozen.

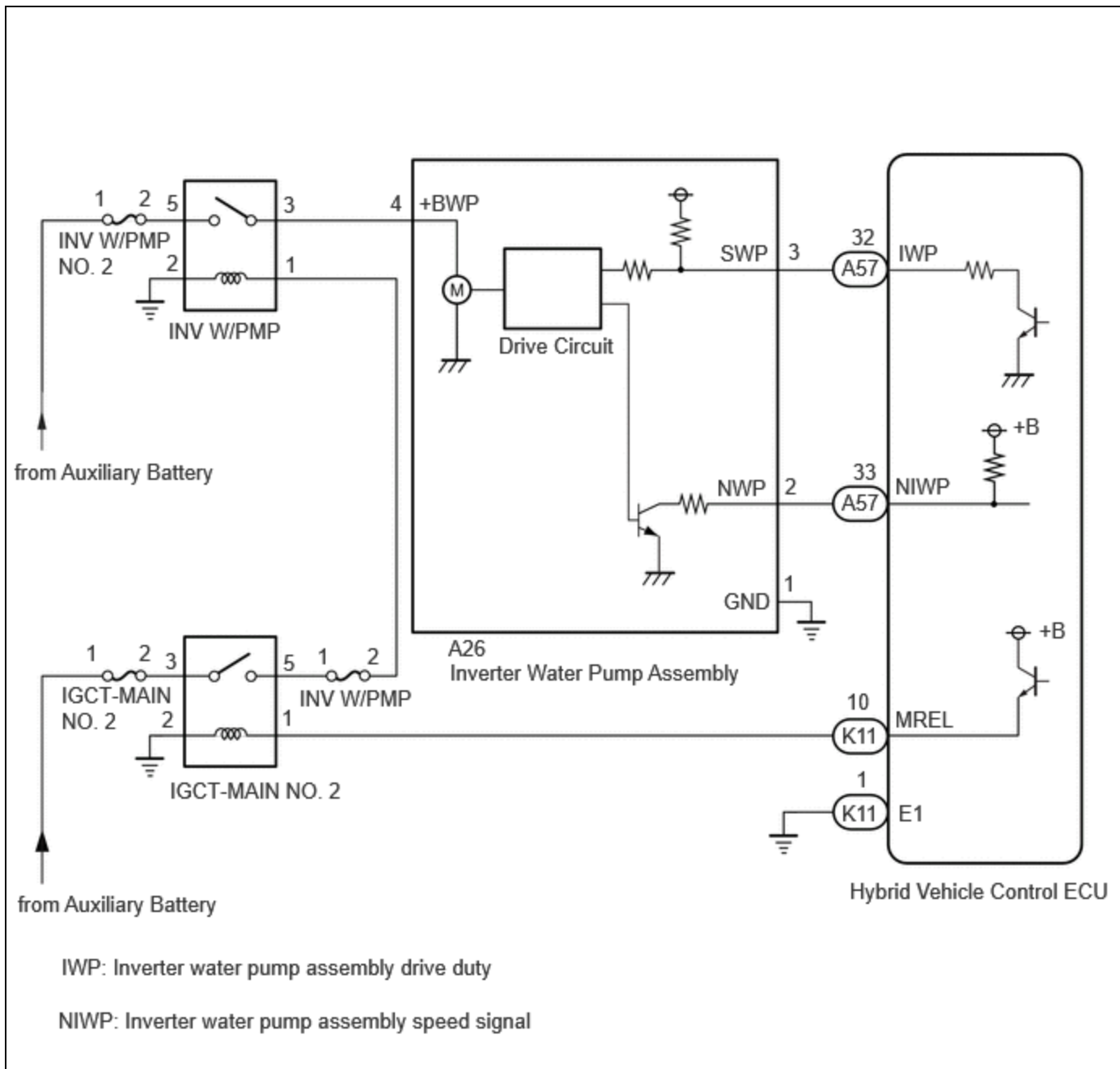
Related Parts Check

AREA	INSPECTION
Grille blockage, coolant amount, coolant hoses, radiator fan	Check for overheating due to hybrid cooling system malfunction.
Inverter coolant temperature sensor (built-in inverter)	Check for temperature sensor malfunction.
Coolant freezing check	Check freeze frame values to determine whether the hybrid coolant was frozen when the DTC was stored.

SYSTEM DESCRIPTION

The inverter converts the high-voltage direct current of the HV battery into alternating current for the generator (MG1) and motor (MG2). The inverter generates heat during the conversion process. Therefore, the inverter is cooled by a special cooling system consisting of the inverter water pump assembly, the cooling fan, and a radiator. This cooling system is independent of the engine cooling system. The hybrid vehicle control ECU monitors the inverter water pump assembly, cooling fan and cooling system, and detects malfunctions.

WIRING DIAGRAM



CAUTION / NOTICE / HINT

This diagnostic procedure is referenced to in the diagnostic procedure of several DTCs.

If the result of this diagnostic procedure is normal, proceed as directed in the procedure for the DTC.

CAUTION:

Refer to the precautions before inspecting high voltage circuit.

Click here [INFO](#)

NOTICE:

- After the ignition switch is turned off, there may be a waiting time before disconnecting the negative (-) auxiliary battery terminal.

Click here [INFO](#)

- When disconnecting and reconnecting the auxiliary battery

HINT:

When disconnecting and reconnecting the auxiliary battery, there is an automatic learning function that completes learning when the respective system is used.

[Click here](#) 

PROCEDURE

1.	CHECK VEHICLE CONDITION
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Pre-procedure1

(a) None.

Procedure1

(b) Make sure that the front side of the radiator grille is not blocked with anything.

(c) Ask the customer if the front side of the radiator grille was blocked with anything.

RESULT	PROCEED TO
Not blocked.	A
Is/was blocked.	B

HINT:

If the radiator grille is blocked, the inverter coolant temperature will increase and this DTC may be stored.

Post-procedure1

(d) None.

B  **IF EQUIPPED, EXPLAIN TO CUSTOMER THAT OPTIONAL COMPONENTS WILL BE REMOVED**

A


2.	CHECK QUANTITY OF HV COOLANT
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Pre-procedure1

(a) None.

Procedure1

(b) Check the HV coolant level in the inverter reserve tank.

(c) Check for HV coolant leaks.

RESULT	PROCEED TO
No leaks are found and the HV coolant level in the inverter reserve tank assembly is above the low line.	A
No leaks are found and the HV coolant level in the inverter reserve tank assembly is below the low line.	B
HV coolant leaks are evident.	C

HINT:

- After repairing the HV coolant leaks and adding coolant, perform the Active Tests "Activate the Inverter Water Pump" (Hybrid Control System) and "Control the Cooling Fan Duty Ratio" (Engine Control System) and make sure that there are no malfunctions.
- If there are signs of coolant leakage around the connecting parts of a hose and the inverter with converter assembly, replace the hose with a new one.

Post-procedure1

(d) None.

B ► **ADD HV COOLANT**

C ► **INSPECT FOR COOLANT LEAK AND ADD COOLANT**

A



3.	CHECK COOLANT HOSE
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(a) Check that the cooling system hoses are not kinked or clogged.

OK:

The cooling system hoses are not kinked or clogged.

NG ► **REPAIR OR REPLACE COOLANT HOSE**

OK



4.	CHECK GRILLE SHUTTER SYSTEM
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(a) Check the Grill Shutter System.

HINT:

Click here [INFO](#)

OK:

The Grill Shutter System is normal.

NG  **CHECK GRILLE SHUTTER SYSTEM**

Click here 

OK



5.	PERFORM ACTIVE TEST USING GTS (CONTROL THE ENGINE COOLING FAN)
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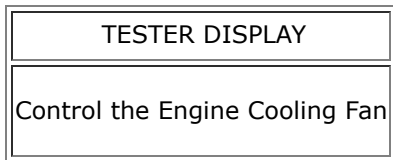
Pre-procedure1

(a) None.

Procedure1

(b) Perform the "Control the Engine Cooling Fan" Active Test.

Powertrain > Engine > Active Test



OK:

GTS OPERATION	FAN OPERATION
30 - 100%	Cooling fan operates
0%	Cooling fan stops

RESULT	PROCEED TO
Cooling fan operate	A
Cooling fan does not operate	B
Cooling fan do not stop	

Post-procedure1

(c) Turn the ignition switch off.

B  **CHECK COOLING FAN SYSTEM**



6. PERFORM ACTIVE TEST USING GTS (ACTIVATE THE INVERTER WATER PUMP)

NOTICE:

- Make sure that the HV coolant level is above the low line of the inverter reserve tank.
- Be sure to perform the inspection with the auxiliary battery voltage at 11 V or more.

HINT:

When the auxiliary battery voltage is low, the inverter water pump assembly may not operate.

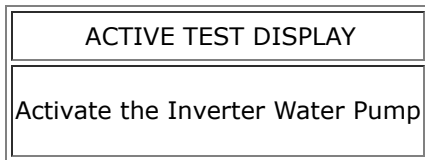
Pre-procedure1

(a) None.

Procedure1

(b) According to the display on the GTS, perform the Active Test "Activate the Inverter Water Pump" and check the value of the Data List item "Inverter Water Pump Revolution".

Powertrain > Hybrid Control > Active Test



OK:

TESTER DISPLAY	CONDITION	SPECIFIED CONDITION
Inverter Water Pump Revolution	Ignition switch ON During Active Test	3000 to 9500 rpm

HINT:

- Perform the Active Test with the inverter coolant temperature between -15 and 65°C (5 to 149°F).
- When the inverter water pump assembly is not operating, the Data List item "Inverter Water Pump Revolution" displays a value 200 rpm or less.

Post-procedure1

(c) Turn the ignition switch off.

NG **GO TO STEP 9**

OK



7.	READ VALUE USING GTS (DATA LIST)
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Pre-procedure1

(a) Turn the ignition switch to ON (READY) and wait for 1 minute with the engine stopped.

Procedure1

(b) Read the Data List with the engine stopped.

Powertrain > Hybrid Control > Data List

TESTER DISPLAY
Generator Inverter Temperature
Motor Inverter Temperature
Rear Motor Inverter Temperature
Boosting Converter Temperature (Upper)
Boosting Converter Temperature (Lower)
Inverter Coolant Water Temperature

RESULT	PROCEED TO
Other than below.	A
"Inverter Coolant Water Temperature" value is higher than the displayed temperature of any other Data List item by 20°C (68°F) or more.	B

HINT:

The lower limit temperature that can be displayed for "Generator Inverter Temperature", "Motor Inverter Temperature", "Rear Motor Inverter Temperature", "Boosting Converter Temperature (Upper)" and "Boosting Converter Temperature (Lower)" is 0°C (32°F). The lower limit temperature for "Inverter Coolant Water Temperature" is -40°C (-40°F). The "Inverter Coolant Water Temperature" value displayed on the GTS may be lower than the others, but this is not a malfunction.

Post-procedure1

(c) Turn the ignition switch off.

B **REPLACE INVERTER WITH CONVERTER ASSEMBLY**



8.	CHECK HV COOLANT (CHECK FOR CONDITIONS THAT MAY HAVE CAUSED FREEZING)
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Pre-procedure1

(a) Read the Freeze Frame Data item "Ambient Temperature" using the GTS.

Powertrain > Hybrid Control > Trouble Codes

Procedure1

(b) Check if the Freeze Frame Data item "Ambient Temperature" is below the freezing temperature of the HV coolant.

RESULT	PROCEED TO
Ambient Temperature value is above freezing temperature of the HV coolant.	A
Ambient Temperature value is below freezing temperature of the HV coolant.	B

HINT:

- HV coolant (SLLC) with a 30% concentration freezes at -15°C (5°F) and HV coolant (SLLC) with a 50% concentration freezes at -35°C (-31°F).
- If the HV coolant freezes in the HV radiator or inverter water pump, the coolant temperature in the inverter with converter assembly rises because the HV coolant cannot circulate. As a result, a DTC may be stored.
- A DTC is stored when the inverter water pump impeller cannot rotate due to freezing of the HV coolant.
- If DTCs are output due to freezing of the LLC, the problem symptom cannot be reproduced. Check the LLC replacement history and whether the LLC was frozen based on the ambient temperature when the DTCs were stored.

Post-procedure1

(c) Turn the ignition switch off.

A ► **COOLING SYSTEM NORMAL (PERFORM NEXT STEP FOR REFERENCED DTC)**

B ► **REPLACE HV COOLANT**

9.	CHECK CONNECTOR CONNECTION CONDITION (HYBRID VEHICLE CONTROL ECU CONNECTOR)
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Click here [INFO](#)

NG ► **CONNECT SECURELY**

OK**10.**
CHECK CONNECTOR CONNECTION CONDITION (INVERTER WATER PUMP ASSEMBLY CONNECTOR)

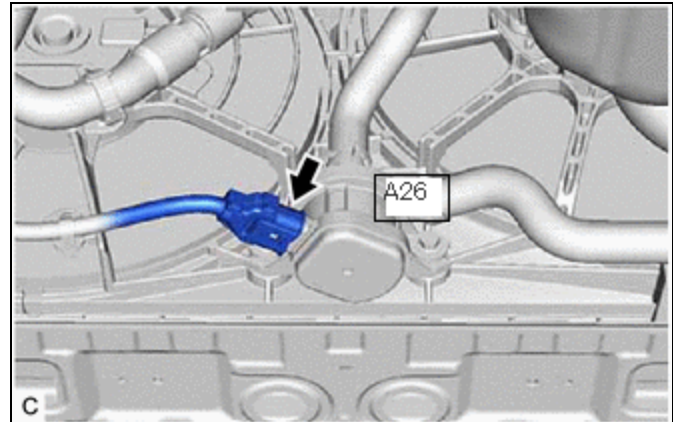
- (a) Check the connector connections and contact pressure of the relevant terminals for the inverter water pump assembly connector.

HINT:

Click here 

OK:

The connector is connected securely, the terminals are not deformed or corroded and there are no contact problems.


NG  **CONNECT SECURELY**
OK**11.**
CHECK HARNESS AND CONNECTOR (HYBRID VEHICLE CONTROL ECU - INVERTER WATER PUMP ASSEMBLY)

Pre-procedure1

- (a) Disconnect the hybrid vehicle control ECU connector.
 (b) Disconnect the inverter water pump assembly connector.

Procedure1

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

Standard Resistance (Check for Open):



[Click Location & Routing\(A57,A26\).](#)

[Click Connector\(A57\).](#)

[Click Connector\(A26\).](#)

TESTER CONNECTION	CONDITION	SPECIFIED CONDITION	RESULT
A57-32 (IWP) - A26-3 (SWP)	Ignition switch off	Below 1 Ω	Ω

Standard Resistance (Check for Short):



[Click Location & Routing\(A57,A26\).](#)

[Click Connector\(A57\).](#)

[Click Connector\(A26\).](#)

TESTER CONNECTION	CONDITION	SPECIFIED CONDITION	RESULT
A57-32 (IWP) or A26-3 (SWP) - Body ground and other terminals	Ignition switch off	10 kΩ or higher	kΩ

Post-procedure1

(d) Reconnect the inverter water pump assembly connector.

(e) Reconnect the hybrid vehicle control ECU connector.

NG **REPAIR OR REPLACE HARNESS OR CONNECTOR**

OK



12.	READ VALUE USING GTS (INVERTER WATER PUMP REVOLUTION)
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NOTICE:

Be sure to perform the inspection with the auxiliary battery voltage at 11 V or more.

HINT:

When the auxiliary battery voltage is low, the inverter water pump assembly may not operate.

Pre-procedure1

(a) Remove the INV W/PMP NO. 2 fuse from No. 1 engine room relay block and No. 1 junction block assembly.

Procedure1

(b) According to the display on the GTS, read the Data List.

Powertrain > Hybrid Control > Data List

TESTER DISPLAY
Inverter Water Pump Revolution

OK:

TESTER DISPLAY	CONDITION	SPECIFIED CONDITION
Inverter Water Pump Revolution	Ignition switch ON	200 rpm or less

RESULT	PROCEED TO
The value of Inverter Water Pump Revolution is 200 rpm or less	A
None of the above conditions are met	B

Post-procedure1

- (c) Turn the ignition switch off.
- (d) Install the INV W/PMP NO. 2 fuse.

B REPLACE HYBRID VEHICLE CONTROL ECU

Click here [INFO](#)

A

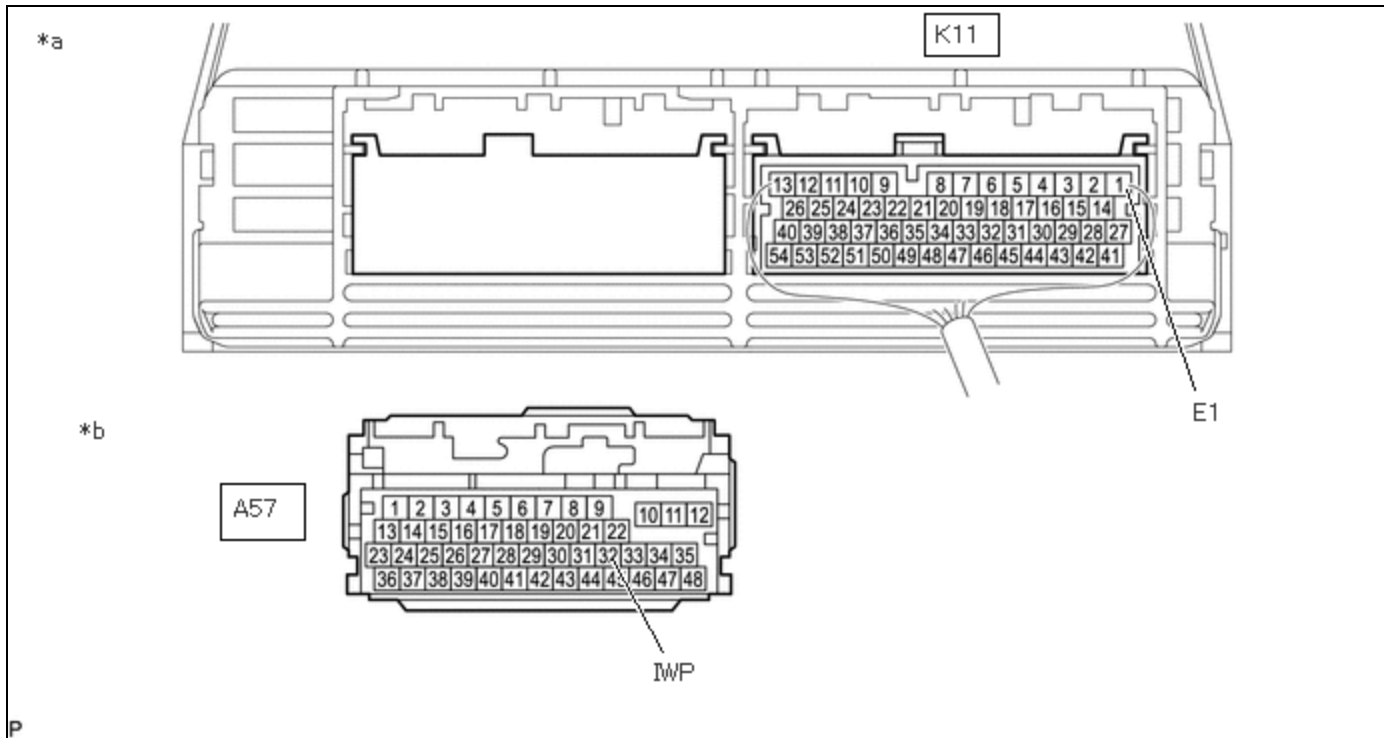

13.	CHECK HARNESS AND CONNECTOR (HYBRID VEHICLE CONTROL ECU - INVERTER WATER PUMP ASSEMBLY)
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Pre-procedure1

- (a) Disconnect the hybrid vehicle control ECU connector.
- (b) Turn the ignition switch to ON.

Procedure1

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



*a	Component with harness connected (Hybrid Vehicle Control ECU)	*b	Front view of wire harness connector (to Hybrid Vehicle Control ECU)
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Standard Voltage:



[Click Location & Routing\(A57,K11\).](#)

[Click Connector\(A57\).](#)

[Click Connector\(K11\).](#)

TESTER CONNECTION	CONDITION	SPECIFIED CONDITION	RESULT
A57-32 (IWP) - K11-1 (E1)	Ignition switch ON	11 to 14 V	V

NOTICE:

Make sure to check for and clear DTCs after performing this inspection.

Post-procedure1

(d) Turn the ignition switch off.

(e) Reconnect the hybrid vehicle control ECU connector.

NG **GO TO STEP 15**

OK



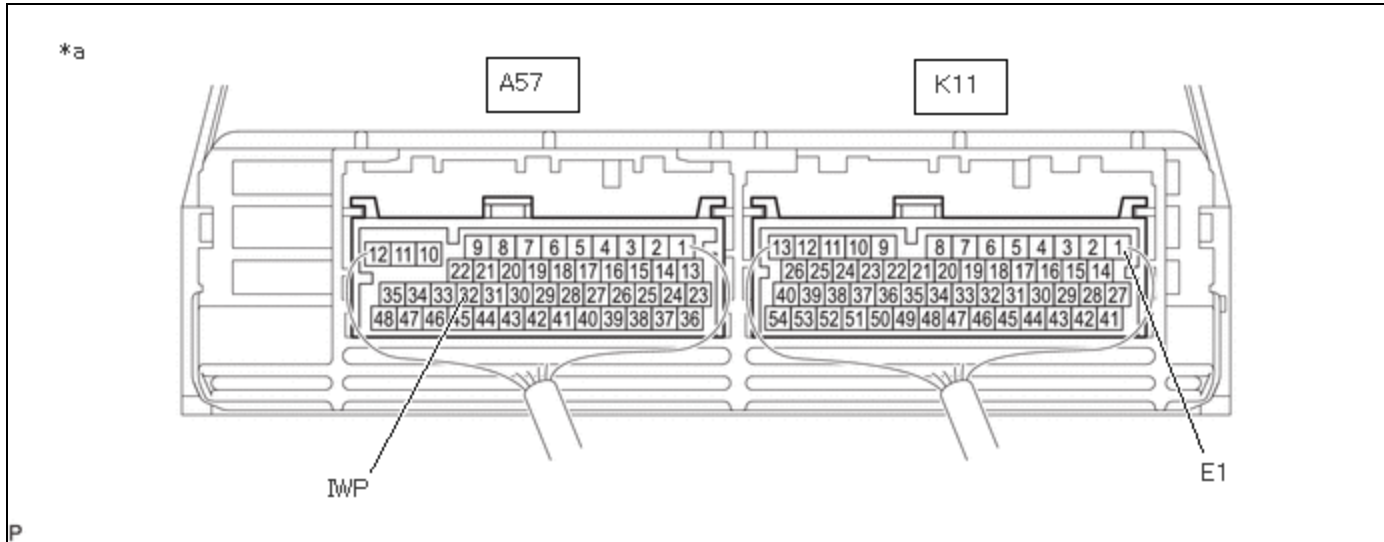
14. CHECK HYBRID VEHICLE CONTROL ECU (CHECK WAVEFORM)

Pre-procedure1

- (a) Connect an oscilloscope between the hybrid vehicle control ECU terminals specified in the table below.
- (b) Turn the ignition switch to ON.

Procedure1

- (c) Check the waveform while turning the ignition switch to ON.



*a	Component with harness connected (Hybrid Vehicle Control ECU)	-	-
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ITEM	CONTENT
Terminal	A57-32 (IWP) - K11-1 (E1)
Equipment Setting	5 V/DIV., 50 ms./DIV.
Condition	Ignition switch ON

OK:

Waveform duty ratio is between 3% and 9%.

Post-procedure1

- (d) Turn the ignition switch off.

NG **REPLACE HYBRID VEHICLE CONTROL ECU**

Click here [INFO](#)

OK



15.	REPLACE INVERTER WATER PUMP ASSEMBLY
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HINT:

[Click here](#) 

NEXT



16.	ADD HV COOLANT AND PERFORM AIR BLEEDING
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(a) After replacing the inverter water pump assembly, add HV coolant and perform air bleeding.

HINT:

[Click here](#) 

NEXT  **END**

