HOW TO TROUBLESHOOT ECU CONTROLLED SYSTEMS

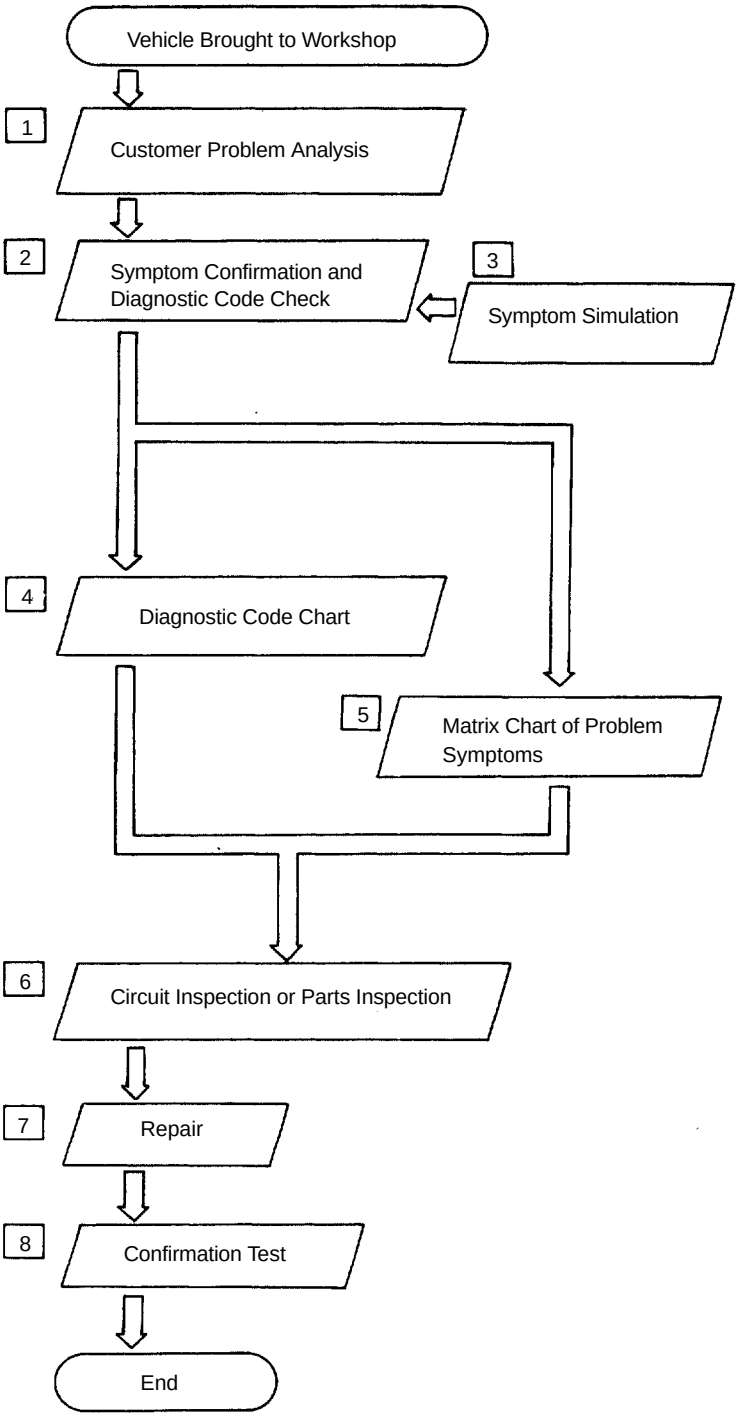
A large number of ECU controlled systems are used in the LEXUS LS400. In general, the ECU controlled system is considered to be a very intricate system requiring a high level of technical knowledge and expert skill to troubleshoot. However, the fact is that if you proceed to inspect the circuits one by one, troubleshooting of these systems is not complex. If you have adequate understanding of the system and a basic knowledge of electricity, accurate diagnosis and necessary repair can be performed to locate and fix the problem. This manual is designed through emphasis of the above standpoint to help service technicians perform accurate and effective troubleshooting, and is compiled for the following major ECU controlled systems:

Repair Manual	System	Page
Vol. 1	1. Engine	TR-1
	2. Automatic Transmission	AT-126
	3. Electronic Modulated Air Suspension	SA-244
	4. Anti-Lock Brake	BR-59
	5. Traction Control	BR-122
Vol. 2	6. Steering Column Electronic Control	SR-34
	7. SRS Airbag	AB-25
	8. Power Seat Control	BE-261
	9. Door Lock Control	BE-305
	10. Theft Deterrent	BE-344
	11. Wireless Door Lock Control	BE-394
	12. Cruise Control	BE-426
	13. Air Conditioner	AC-68

The troubleshooting procedure and how to make use of it are described on the following pages.

HOW TO PROCEED WITH TROUBLESHOOTING

Carry out troubleshooting in accordance with the procedure on the following page. Here, only the basic procedure is shown. Details are provided in each section, showing the most effective methods for each circuit. Confirm the troubleshooting procedures first for the relevant circuit before beginning troubleshooting of that circuit.



[1]
Ask the customer about the conditions and the environment when the problem occurred.

[2] [3]
Confirm the symptoms and the problem conditions, and check the diagnostic codes.
(When the problem symptoms do not appear during confirmation, use the symptom simulation method described later on.)

[4] [5] [6]
Check the results obtained in Step [2], then confirm the inspection procedure for the system or the part which should be checked using the diagnostic code chart or the matrix chart of problem symptoms.

[7]
Check and repair the affected system or part in accordance with the instructions in Step [6].

[8]
After completing repairs, confirm that the problem has been eliminated.
(If the problem is not reproduced, perform the confirmation test under the same conditions and in the same environment as when it occurred for the first time.)

(1) CUSTOMER PROBLEM ANALYSIS

In troubleshooting, the problem symptoms must be confirmed accurately and all preconceptions must be cleared away in order to give an accurate judgment. To ascertain just what the problem symptoms are, it is extremely important to ask the customer about the problem and the conditions at the time it occurred.

Important Points in the Problem Analysis

The following 5 items are important points in the problem analysis. Past problems which are thought to be unrelated and the repair history, etc. may also help in some cases, so as much information as possible should be gathered and its relationship with the problem symptoms should be correctly ascertained for reference in troubleshooting. A customer problem analysis table is provided in the troubleshooting section for each system for your use.

Important Points in the Customer Problem Analysis

- What_____Vehicle model, system name
- When_____Date, time, occurrence frequency
- Where_____Road conditions
- Under what conditions?_____Running conditions, driving conditions, weather conditions
- How did it happen?_____Problem symptoms

(Sample) Engine control system check sheet.

CUSTOMER PROBLEM ANALYSIS CHECK SHEET

ENGINE CONTROL System Check Sheet

Inspector's Name

Customer's Name		Registration No.	
		Registration Year	/ /
		Frame No.	
Date Vehicle Brought In		Odometer Reading	km Miles

Date of Problem Occurrence		
Frequency of Problem Occurrence		☐ Constant ☐ Sometimes (times/per day/month) ☐ Once only ☐ Other ( )
Conditions at Time of Problem Occurrence	Weather	☐ Fine ☐ Cloudy ☐ Rainy ☐ Snowy ☐ Various/Other
	Outdoor Temperature	☐ Hot ☐ Warm ☐ Cool ☐ Cold (Approx. °F (°C))
	Place	☐ High way ☐ Suburbs ☐ Inner City ☐ Hill (☐ Up, ☐ Down) ☐ Rough boad ☐ Other ( )
	Engine Temp.	☐ Cold ☐ Warming up ☐ After warming up ☐ Normal ☐ Other
	Engine Operation	☐ Starting ☐ Just after starting ☐ Idling ☐ Racing without load ☐ Driving (☐ Constant speed ☐ Acceleration ☐ Deceleration ☐ Other ( ))

Symptoms	☐ Engine does not Start	☐ Engine does not crank ☐ No initial combustion ☐ No complete combustion
	☐ Difficult to Start	☐ Engine cranks slowly ☐ Other ( )
	☐ Poor Idling	☐ [illegible] ☐ Idling rpm is abnormal [☐ High ☐ Low (rpm)])
	[illegible]	[illegible] (after fire) ☐ [illegible]

[2] SYMPTOM CONFIRMATION AND DIAGNOSTIC CODE CHECK

The diagnostic system in the LEXUS LS400 fulfills various functions. The first function is the Diagnostic Code Check in which a malfunction in the signal circuits to the ECU is stored in code in the ECU memory at the time of occurrence, to be output by the technician during troubleshooting. Another function is the Input Signal Check which checks if the signals from various switches are sent to the ECU correctly.
The air conditioner system has an Actuator Check function whereby the ECU automatically operates the actuators of the damper and blowermotor, etc. to check the operation. The cruise control system has a Cancel Signal Check function which memorizes and displays what sort of signal it was that last cancelled the cruise control. By using these check functions, the problem areas can be narrowed down quickly and troubleshooting can be performed effectively. Diagnostic functions are incorporated in the following systems in the LEXUS LS400.

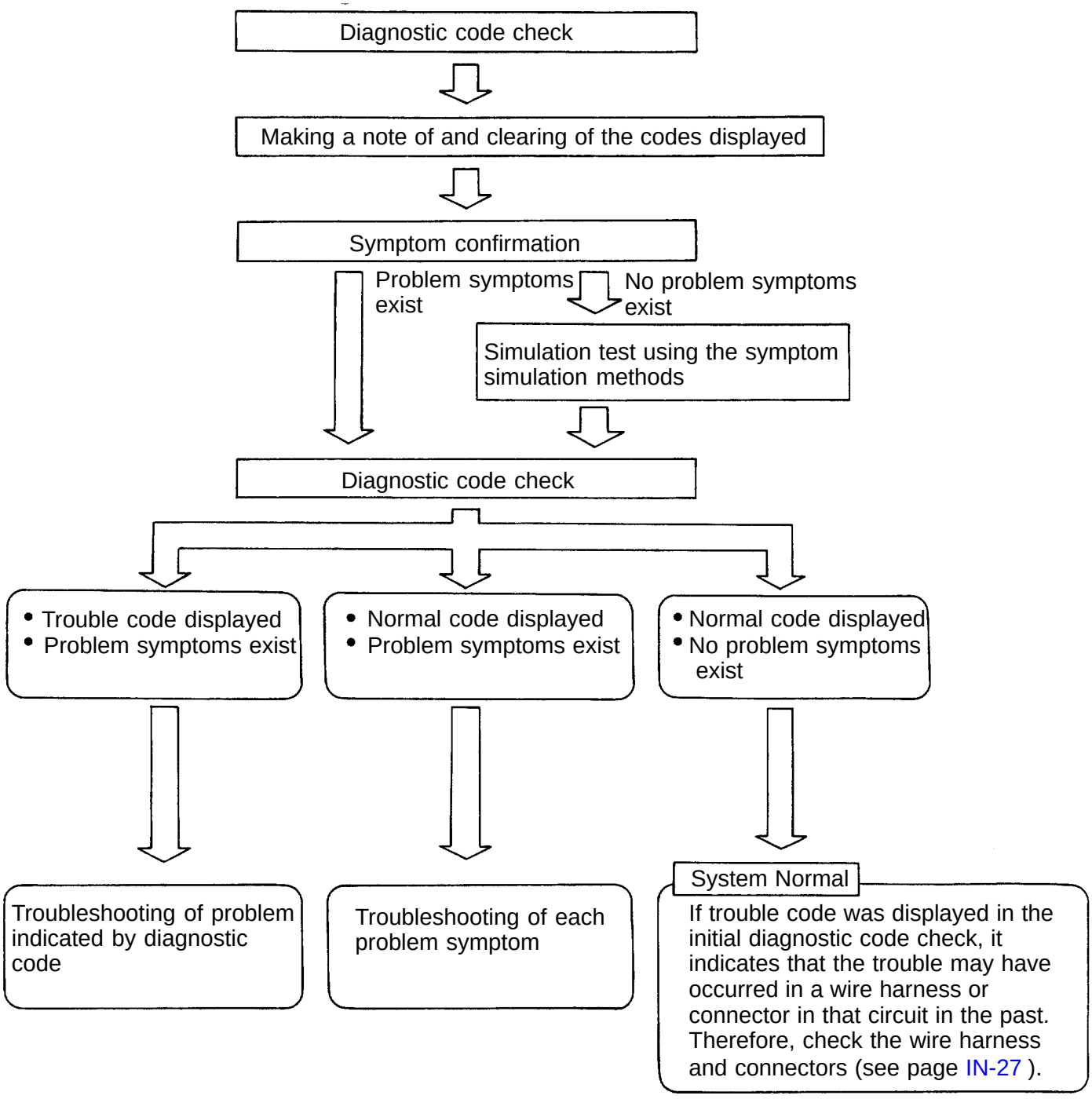
System	Diagnostic Code Check	Input Signal Check (Sensor Check)	Other Diagnosis Function
Engine	O (with Test Mode)	O	
Automatic Transmission	O (with Test Mode)	O	
Electronic Modulated Air Suspension (Option)	O		
Anti-Lock Brake	O	O	
Traction Control (Option)	O	O	
SRS Airbag	O		
Power Seat (only vehicles with memory function)		O	
Wireless Door Lock Control		O	
Cruise Control	O	O	Cancel Signal Check
Air Conditioner	O	O	Actuator Check

In diagnostic code check, it is very important to determine whether the problem indicated by the diagnostic code is still occurring or occurred in the past but returned to normal at present. In addition, it must be checked in the problem symptom check whether the malfunction indicated by the diagnostic code is directly related to the problem symptom or not. For this reason, the diagnostic codes should be checked before and after the symptom confirmation to determine the current conditions, as shown in the table below. If this is not done, it may, depending on the case, result in unnecessary troubleshooting for normally operating systems, thus making it more difficult to locate the problem, or in repairs not pertinent to the problem. Therefore, always follow the procedure in correct order and perform the diagnostic code check.

DIAGNOSTIC CODE CHECK PROCEDURE

Diagnostic Code Check (Make a note of and then clear)	Confirmation of Symptoms	Diagnostic Code Check	Problem Condition
Trouble Code Display	Problem Symptoms exist ⇨	Same trouble code is displayed	Problem is still occurring in the diagnostic circuit.
		Normal code is displayed	The problem is still occurring in a place other than in the diagnostic circuit. (The trouble code displayed first is either for a past problem or it is a secondary problem.)
	⇨ No problem symptoms exist		The problem occurred in the diagnostic circuit in the past.
Normal Code Display	⇨ Problem symptoms exist	Normal code is displayed	The problem is still occurring in a place other than in the diagnostic circuit.
	⇨ No problem symptoms exist	Normal code is displayed	The problem occurred in a place other than in the diagnostic circuit in the past.

Taking into account the above points, a flow chart showing how to proceed with troubleshooting using the diagnostic code check is shown below. This flow chart shows how to utilize the diagnostic code check effectively, then by carefully checking the results, indicates how to proceed either to diagnostic code troubleshooting or to troubleshooting of problem symptoms.



3 SYMPTOM SIMULATION

The most difficult case in troubleshooting is when there are no problem symptoms occurring. In such cases, a thorough customer problem analysis must be carried out, then simulate the same or similar conditions and environment in which the problem occurred in the customer's vehicle. No matter now much experience a technician has, or how skilled he may be, if he proceeds to troubleshoot without confirming the problem symptoms he will tend to overlook something important in the repair operation and make a wrong guess somewhere, which will only lead to a standstill. For example, for a problem which only occurs when the engine is cold, or for a problem which occurs due to vibration caused by the road during driving, etc., the problem can never be determined so long as the symptoms are confirmed with the engine hot condition or the vehicle at a standstill. Since vibration, heat or water penetration (moisture) are likely causes for problems which are difficult to reproduce, the symptom simulation tests introduced here are effective measures in that the external causes are applied to the vehicle in a stopped condition.

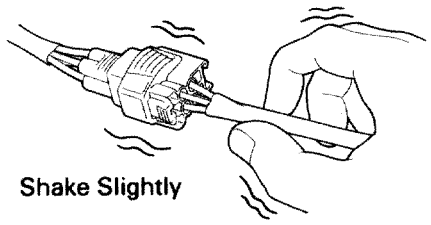
Important Points in the Symptom Simulation Test

In the symptom simulation test, the problem symptoms should of course be confirmed, but the problem area or parts must also be found out. To do this, narrow down the possible problem circuits according to the symptoms before starting this test and connect a tester beforehand. After that, carry out the symptom simulation test, judging whether the circuit being tested is defective or normal and also confirming the problem symptoms at the same time. Refer to the matrix chart of problem symptoms for each system to narrow down the possible causes of the symptom.

1 VIBRATION METHOD: When vibration seems to be the major cause.

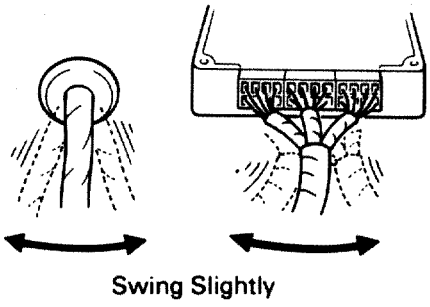
CONNECTORS

Slightly shake the connector vertically and horizontally.



WIRE HARNESS

Slightly shake the wire harness vertically and horizontally. The connector joint, fulcrum of the vibration, and body through portion are the major areas to be checked thoroughly.



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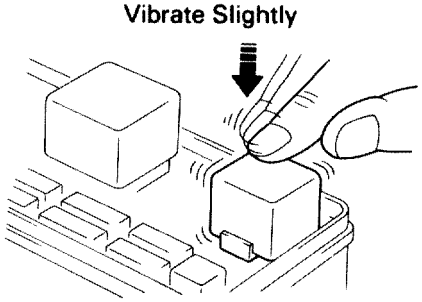
PARTS AND SENSORS

Apply slight vibration with a finger to the part of the sensor considered to be the problem cause and check if the malfunction occurs.

HINT: Applying strong vibration to relays may result in open relays.



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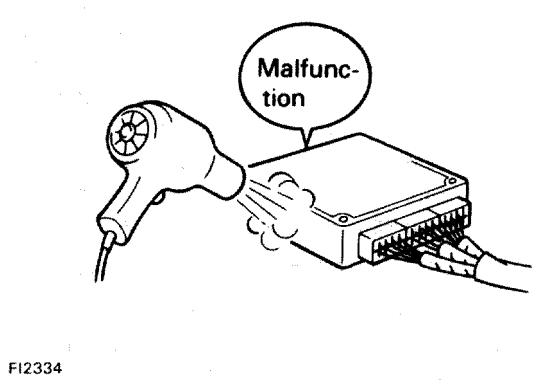
2	**HEAT METHOD: When the problem seems to occur when the suspect area is heated.**

Heat the component that is the likely cause of the malfunction with a hair dryer or similar object. Check to see if the malfunction occurs.

NOTICE:

(1) Do not heat to more than 60°C (140°F). (Temperature limit that no damage is done to the component.

(2) Do not apply heat directly to parts in the ECU.



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3	**WATER SPRINKLING METHOD: When the malfunction seems to occur on a rainy day or in a high-humidity condition.**

Sprinkle water onto the vehicle and check to see if the malfunction occurs.

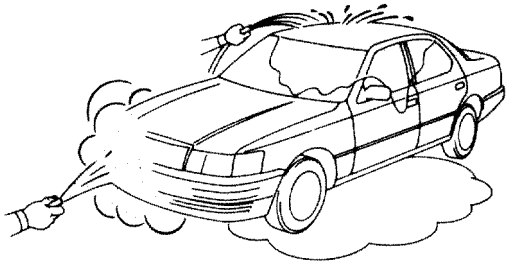
NOTICE:

(1) Never sprinkle water directly into the engine compartment, but indirectly change the temperature and humidity by applying water spray onto the radiator front surface.

(2) Never apply water directly onto the electronic components.

(Service hint)

If a vehicle is subject to water leakage, the leaked water may contaminate the ECU. When testing a vehicle with a water leakage problem, special caution must be used.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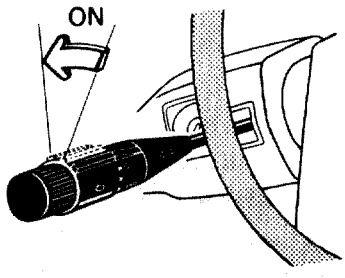
4	**OTHER: When a malfunction seems to occur when electrical load is excessive.**

Turn on all electrical loads including the heater blower, head lights, rear window defogger, etc. and check to see if the malfunction occurs.



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4 DIAGNOSTIC CODE CHART

The inspection procedure is shown in the table below. This table permits efficient and accurate troubleshooting using the trouble codes displayed in the diagnostic code check. Proceed with troubleshooting in accordance with the inspection procedure given in the diagnostic chart corresponding to the trouble codes displayed. The engine diagnostic code chart is shown below as an example.

- Code
  Indicates the trouble code.

- Circuit to be Checked
  Indicates the circuit or part which needs to be checked.

DIAGNOSTIC CODE CHART

If a malfunction code is displayed during the diagnostic code check in test mode, check the circuit for that code listed in the table below (Proceed to the page given for that circuit).

Code	Inspecting Circuit	See Page
12	RPM Signal Circuit (No. 1)	TR-21
13	RPM Signal Circuit (No. 2)	TR-25
14	Ignition Signal Circuit	TR-26
15		
16	ECT Control Signal Malfunction	TR-37
17	RPM Signal Circuit (No. 1)	TR-21
18		
21	Main Oxygen Sensor Circuit on Left Bank	TR-38
22	Water Temp. Sensor Circuit	TR-44
24	Intake Air Temp. Sensor Circuit	TR-48
25	Air-Fuel Ratio Lean Malfunction	TR-51
26	Air-Fuel Ratio Rich Malfunction	TR-51
27	Sub-Oxygen Sensor Circuit on Left Bank	TR-56
28	Main Oxygen Sensor Circuit on Right Bank	TR-38
29	Sub-Oxygen Sensor Circuit on Right Bank	TR-56
31	Air Flow Meter Circuit	TR-60
35	High Altitude Compensator Sensor (HAC Sensor) Circuit	TR-65
41	Throttle Position Sensor Circuit	TR-66
43		TR-71
		TR-66

- Page or Instructions
  Indicates the page where the inspection procedure for each circuit is to be found, or gives instructions for checking and repairs.

5 MATRIX CHART OF PROBLEM SYMPTOMS

The suspect circuits or parts for each problem symptom are shown in the table below. Use this table to troubleshoot the problem when a “Normal” code is displayed in the diagnostic code check but the problem is still occurring. Numbers in the table indicate the inspection order in which the circuits or parts should be checked.

HINT: When the problem is not detected by the diagnostic system even though the problem symptom is present, it is considered that the problem is occurring outside the detection range of the diagnostic system, or that the problem is occurring in a system other than the diagnostic system.

• Page

Indicates the page where the flow chart for each circuit is located.

• Problem Symptom

• Circuit or Part Name

Indicates the circuit or part which needs to be checked.

MATRIX CHART OF PROBLEM SYMPTOMS

When the malfunction code is not confirmed in the diagnostic code check and the problem still can not be confirmed in the basic inspection, then proceed to this step and perform troubleshooting according to the numbered order given in the table below. For ''Engine Mechanical and Others'' items in the suspect area column, details of each check item are provided on the next page.

The circuits indicated by ※ on the matrix chart can be inspected using the TCCS checker.

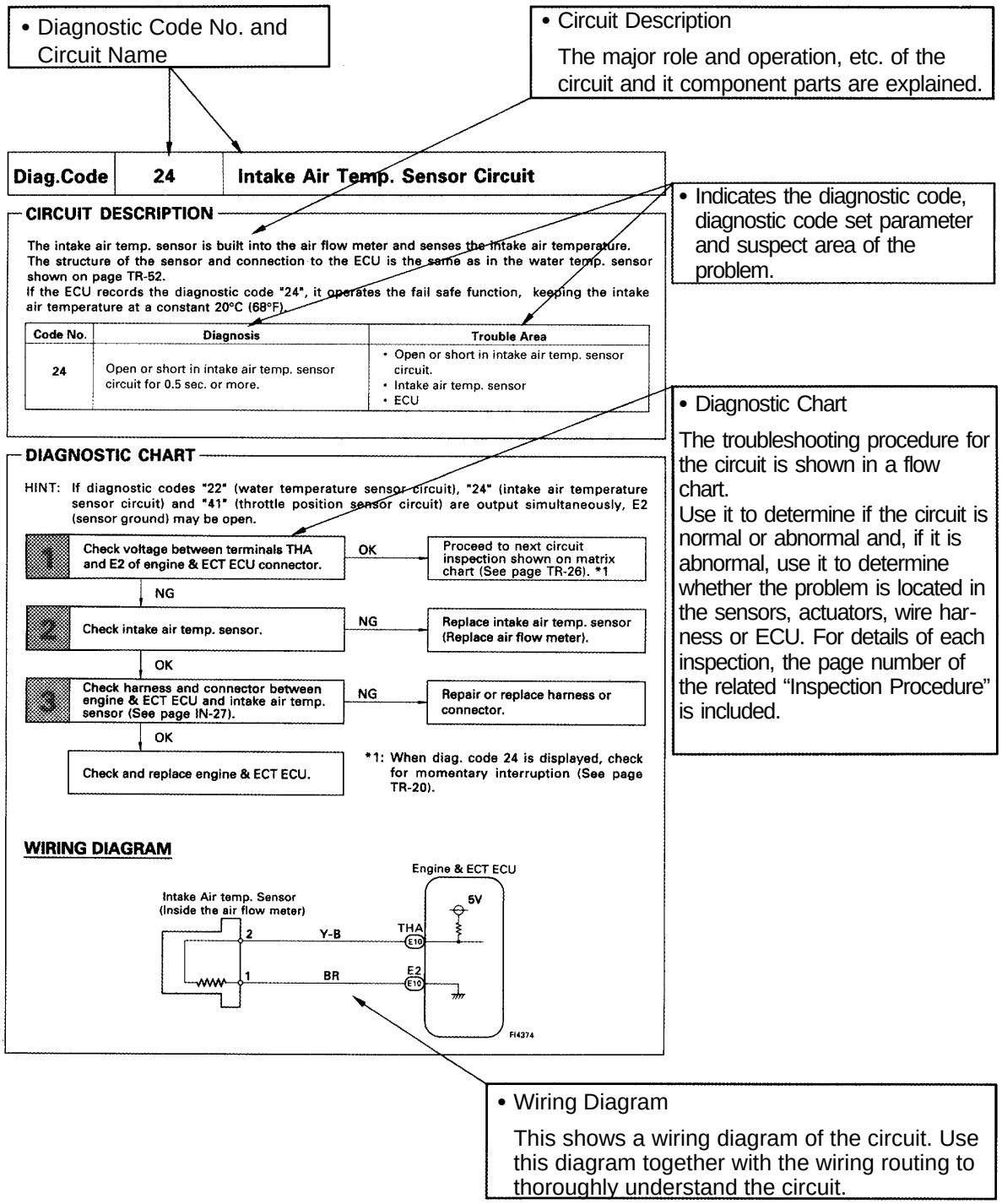
	See page	TR-29	IG-6	TR-59	TR-52	TR-56	TR-66	TR-72	TR-78	TR-83	TR-86	TR-92	TR-106	TR-110	TR-118	TR-121	TR-127	TR-132	TR-135
	Suspect area	※ RPM signal circuit (No.1)	Ignition signal circuit (Spark test)	※ Main oxygen sensor circuit	※ Water temp. sensor circuit	Intake air temp. sensor circuit	Sub-oxygen sensor circuit	※ Air flow meter circuit	※ Throttle position sensor circuit	※ Starter signal circuit	Knock sensor circuit	EGR System	※ Neutral start switch circuit	ECU power source circuit	Back up power source circuit	※ Injector circuit	Cold start injector circuit	※ ISC valve circuit	※ Fuel system circuit
	Symptom																		
Does not start	Engine does not crank													3					
	Starter runs-engine does not crank																		
	No initial combustion	9	2											1		6	8		3
	No complete combustion		8		10			7								11	12	3	2
Difficult to start	Engine cranks slowly																		
	Difficult to start normally		11		3	14						5				12	13	4	6
	Difficult to start cold				1	8				2		6				10	7	5	9
	Difficult to start hot				1	8						6				10	7	4	9
Poor idling	Incorrect first idle				4	5												6	
	High engine idle speed				4	5			10				9	8				6	
	Low engine idle speed				1							4	3			6		2	5
	Rough idling		5	9	3			14				4			13	15	16	7	8
	Misfire		4		8			11				3				13	14	9	10
Poor Driveability	Hesitation/Poor acceleration		12	10	8	9		7	6			5				16	17		11
	Back fire				3	4		6	5			2				8			7
	Muffler explosion (after fire)		7		2	3		5	4							11	12	6	1
	Surging			9	3	4			6			5				14	16		
											2	5							

• Circuit Inspection, Inspection Order

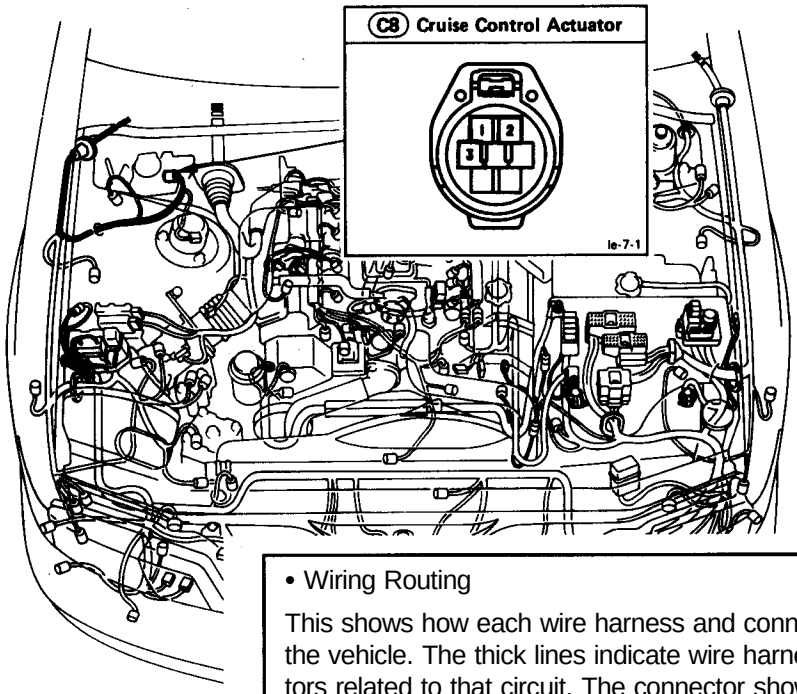
Indicates the circuit which needs to be checked for each problem symptom. Check in the order indicated by the numbers.

6 CIRCUIT INSPECTION

How to read and use each page is shown below.

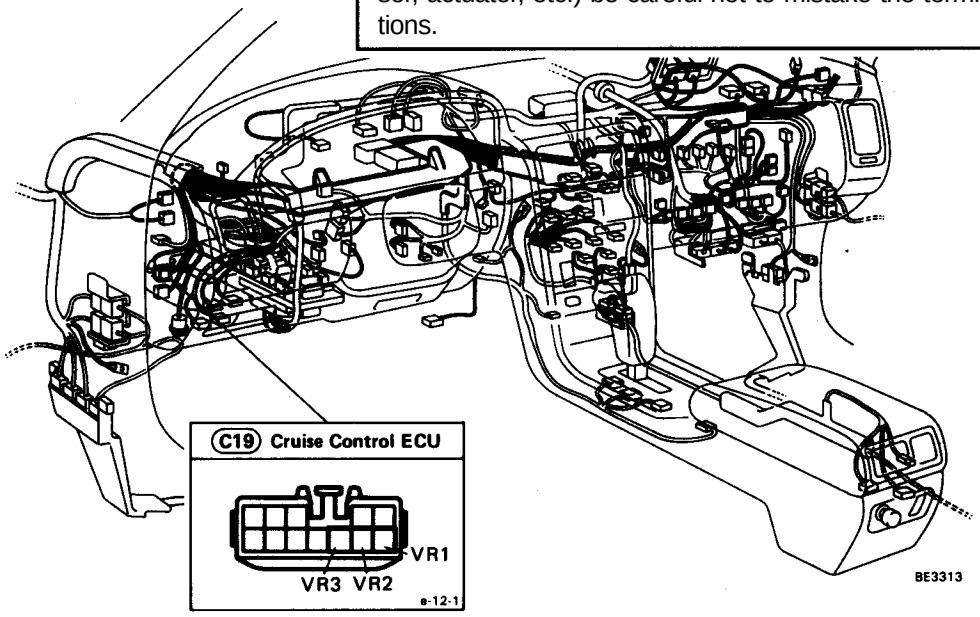


WIRING ROUTING



- Wiring Routing

This shows how each wire harness and connector is routed in the vehicle. The thick lines indicate wire harnesses and connectors related to that circuit. The connector shows the harness side connector, so when checking the part side connector (sensor, actuator, etc.) be careful not to mistake the terminal positions.



• Indicates the position of the ignition switch during the check.

OFF — Ignition Switch OFF
ON
STA — Ignition Switch STA
ACC — Ignition Switch ACC

• Indicates the condition of the connector during the check.

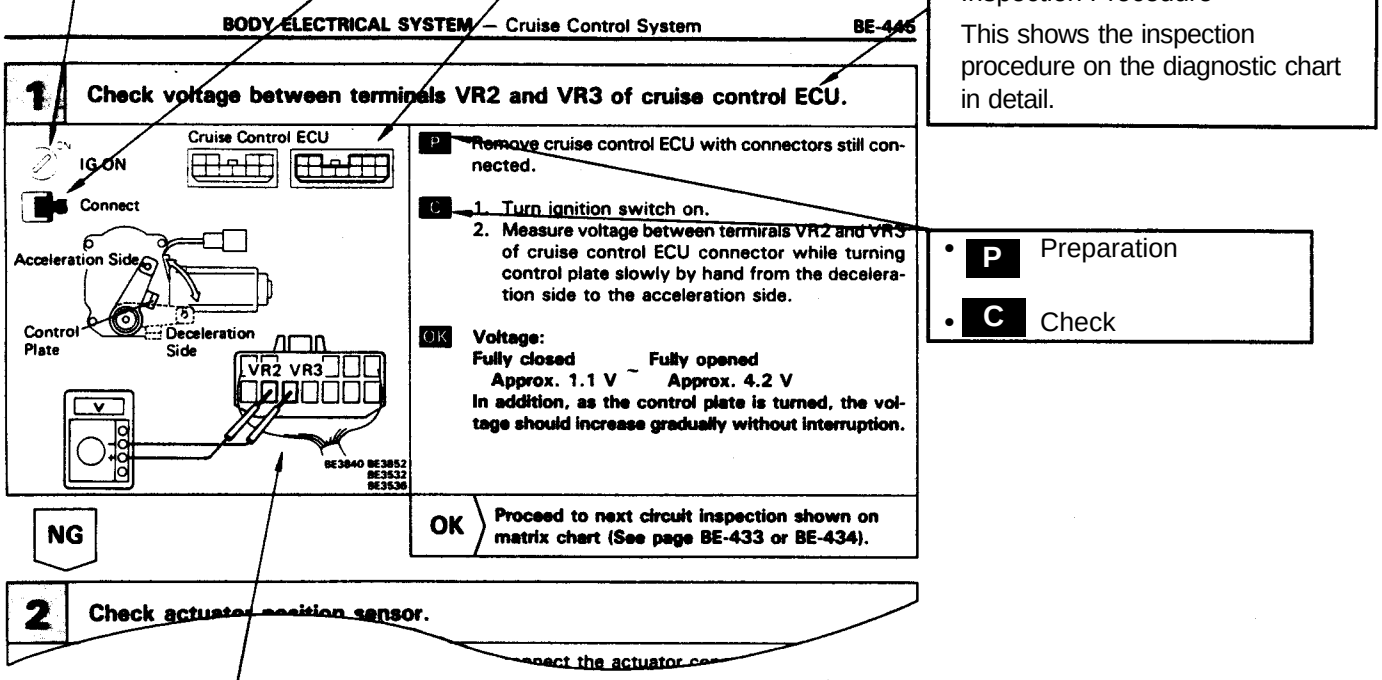
Connector being checked is connected

Connector being checked is disconnected

• Indicates which connector to the ECU is checked. The connector heavily outlined is the one to be checked

• Inspection Procedure

This shows the inspection procedure on the diagnostic chart in detail.

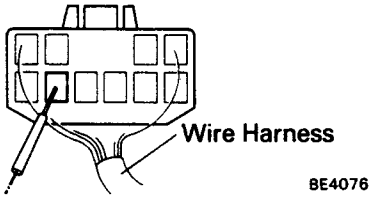


• P Preparation

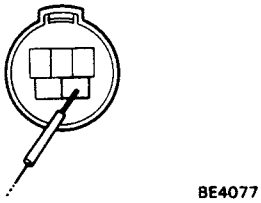
• C Check

• Indicates the place to check the voltage or resistance.

• Indicates the connector position to be checked, from the front or back side



Check from the connector back side. (with harness)



Check from the connector front side (without harness) In this case, care must be taken not to bend the terminals.

HOW TO USE THE DIAGNOSTIC CHART AND INSPECTION PROCEDURE

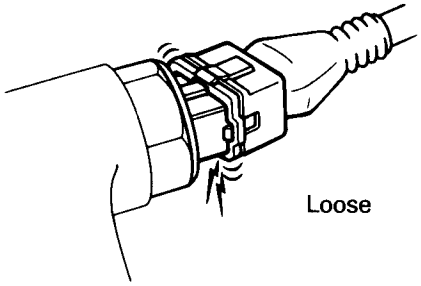
1. For troubleshooting, diagnostic code charts or problem symptom charts are provided for each circuit with detailed inspection procedures on the following pages.
2. When all the component parts, wire harnesses and connectors of each circuit except the ECU are found to be normal in troubleshooting, then it is determined that the problem is in the ECU. Accordingly, if diagnosis is performed without the problem symptoms occurring, the instruction will be to check and replace the ECU, even if the problem is not in the ECU. So, always confirm that the problem symptoms are occurring, or proceed with inspection while using the symptom simulation method.
3. The instructions ”Check wire harness and connector” and ”Check and replace ECU” which appear in the inspection procedure, are common and applicable to all diagnostic codes. Follow the procedure outlined below whenever these instructions appear.

Check Wire Harness and Connector

The problem in the wire harness or connector is an open circuit or a short circuit.

OPEN CIRCUIT:

This could be due to a disconnected wire harness, faulty contact in the connector, a connector terminal pulled out, etc.



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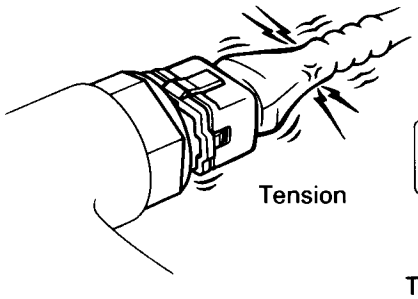

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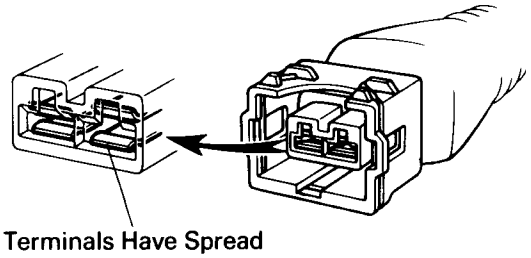

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HINT:

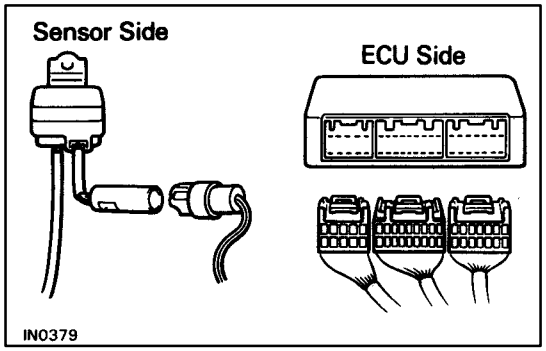
1. It is rarely the case that a wire is broken in the middle of it. Most cases occur at the connector. In particular, carefully check the connectors of sensors and actuators.
2. Faulty contact could be due to rusting of the connector terminals, to foreign materials entering terminals or a drop in the contact pressure between the male and female terminals of the connector. Simply disconnecting and reconnecting the connectors once changes the condition of the connection and may result in a return to normal operation.
   Therefore, in troubleshooting, if no abnormality is found in the wire harness and connector check, but the problem disappears after the check, then the cause is considered to be in the wire harness or connectors.

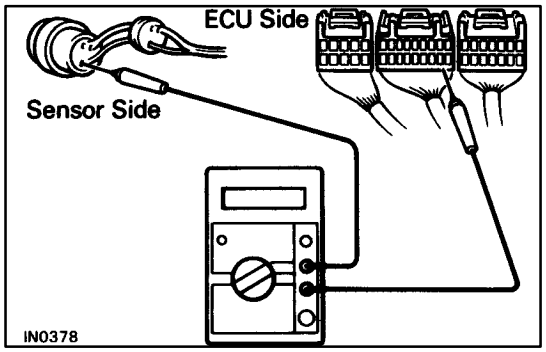
SHORT CIRCUIT:

This could be due to a short circuit between the wire harness and the body ground or to a short inside the switch, etc.

HINT:

- When there is a short between the wire harness and body ground, check thoroughly whether the wire harness is caught in the body or is clamped properly.





1. CONTINUITY CHECK (OPEN CIRCUIT CHECK)

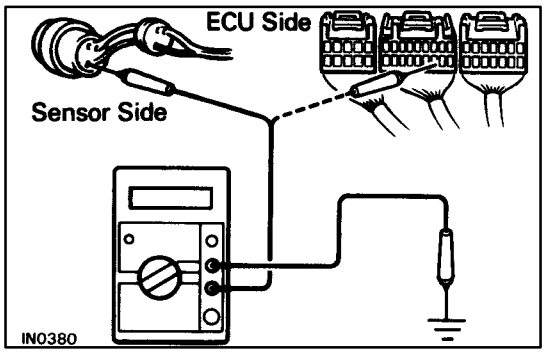
(1) Disconnect the connectors at both ECU and sensor sides.

(2) Measure the resistance between the applicable terminals of the connectors.

Resistance: 1 Ω or less

HINT:

- Measure the resistance while lightly shaking the wire harness vertically and horizontally.
- When tester probes are inserted into a connector, insert the probes from the back. For waterproof connectors in which the probes cannot be inserted from the back, be careful not to bend the terminals when inserting the tester probes.



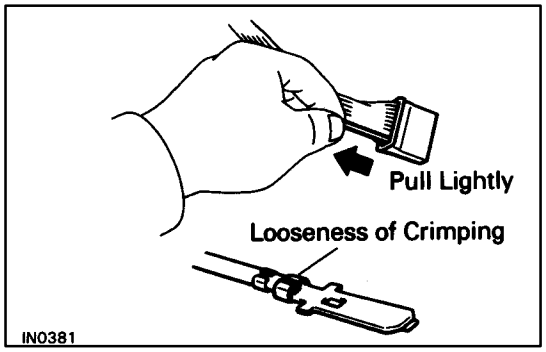
2. RESISTANCE CHECK (SHORT CIRCUIT CHECK)

(1) Disconnect the connectors at both ends.

(2) Measure the resistance between the applicable terminals of the connectors and body ground. Be sure to carry out this check on the connectors on both ends.

Resistance: 1 MΩ or higher

HINT: Measure the resistance while lightly shaking the wire harness vertically and horizontally.



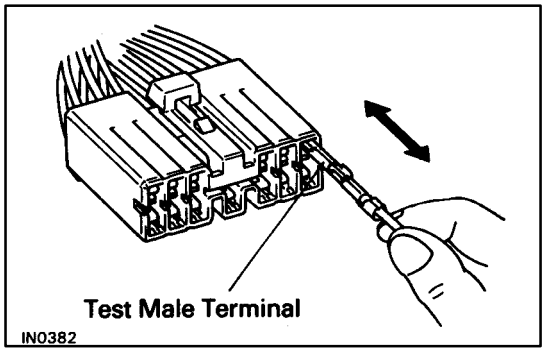
3. VISUAL CHECK AND CONTACT PRESSURE CHECK

(a) Disconnect the connectors at both ends.

(b) Check for rust or foreign material, etc. on the terminals of the connectors.

(c) Check crimped portions for looseness or damage and check if the terminals are secured in the lock position.

HINT: The terminals should not come out when pulled lightly.



(d) Prepare a test male terminal and insert it in the female terminal, then pull it out.

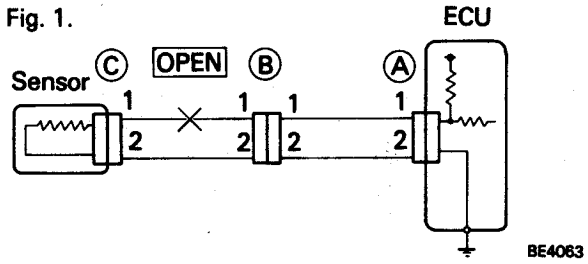
HINT: When the test terminal is pulled out more easily than others, there may be poor contact in that section.

Actual examples of the inspection method for open circuit and short circuit are explained below.

1. OPEN CIRCUIT CHECK

For the open circuit in the wire harness in Fig. 1, perform "(a) Continuity Check" or "(b) Voltage Check" to locate the section.

Fig. 1.

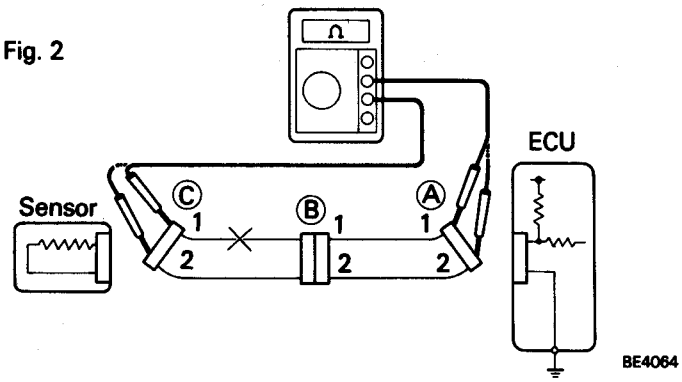


(a) Continuity Check

(1) Disconnect connectors (A) and (C) and measure the resistance between them.

In the case of Fig. 2,
Between terminal 1 of connector (A) and terminal 1 of connector (C) No continuity (open)
Between terminal 2 of connector (A) and terminal 2 of connector (C) Continuity
Therefore, it is found out that there is an open circuit between terminal 1 of connector (A) and terminal 1 of connector (C).

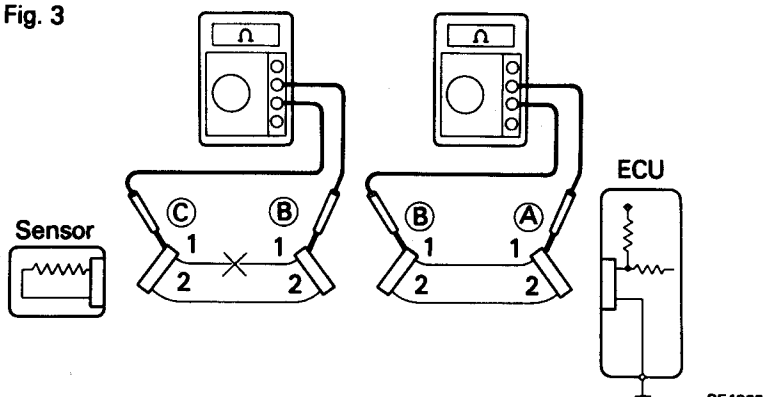
Fig. 2



(2) Disconnect connector (B) and measure the resistance between connectors (A) and (B), (B) and (C).

In the case of Fig. 3,
Between terminal 1 of connector (A) and terminal 1 of connector (B) Continuity
Between terminal 1 of connector (B) and terminal 1 of connector (C) No Continuity (open)
Therefore, it is found out that there is an open circuit between terminal 1 of connector (B) and terminal 1 of connector (C).

Fig. 3



(b) Voltage Check

In a circuit in which voltage is applied (to the ECU connector terminal), an open circuit can be checked for by conducting a voltage check.

(1) As shown in Fig. 4, with each connector still connected, measure the voltage between body ground and terminal 1 of connector (A) at the ECU 5V output terminal, terminal 1 of connector (B), and terminal 1 of connector (C), in that order.

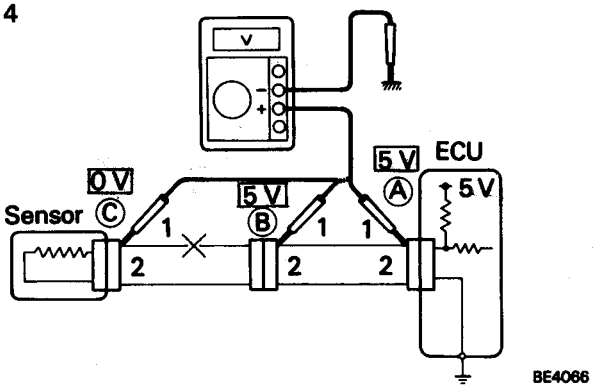
If the results are:

5 V: Between Terminal 1 of connector (A) and Body Ground

5 V: Between Terminal 1 of connector (B) and Body Ground

0 V: Between Terminal 1 of connector (C) and Body Ground then it is found out that there is an open circuit in the wire harness between terminal 1 of (B) and terminal 1 of (C).

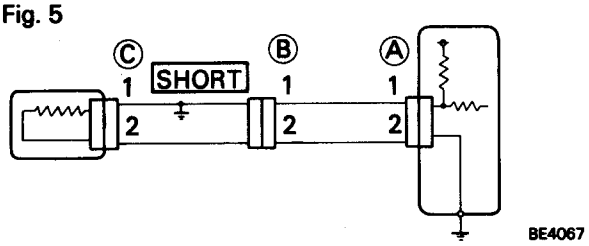
Fig. 4



2. SHORT CIRCUIT CHECK

If the wire harness is ground shorted as in Fig. 5, locate the section by conducting a “continuity check with ground”.

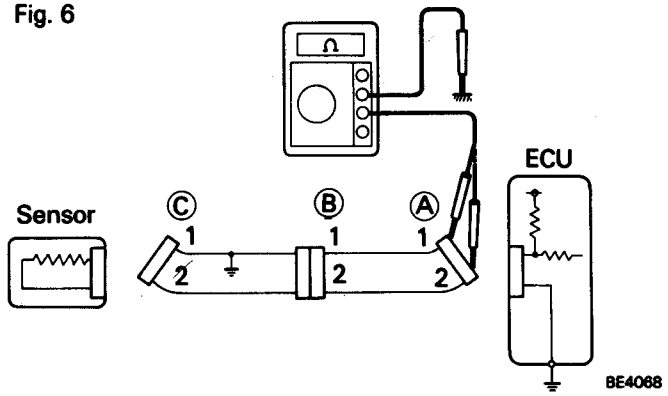
Fig. 5



(a) Continuity Check with Ground

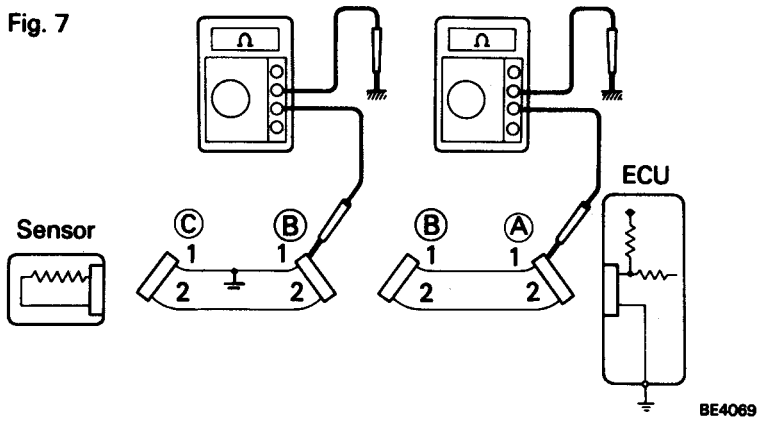
(1) Disconnect connectors (A) and (C) and measure the resistance between terminals 1 and 2 of connector (A) and body ground.
In the case of Fig. 6,
Between terminal 1 of connector (A) and body ground Continuity
Between terminal 2 of connector (A) and body ground No continuity (open)
Therefore, it is found out that there is a short circuit between terminal 1 of connector (A) and terminal 1 of connector (C).

Fig. 6



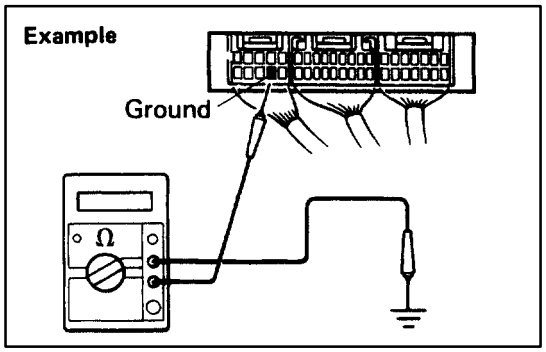
(2) Disconnect connector (B) and measure the resistance between terminal 1 of connector (A) and body ground, and terminal 1 of connector (B) and body ground.
Between terminal 1 of connector (A) and body ground No continuity (open)
Between terminal 1 of connector (B) and body ground Continuity
Therefore, it is found out that there is a short circuit between terminal 1 of connector (B) and terminal 1 of connector (C).

Fig. 7

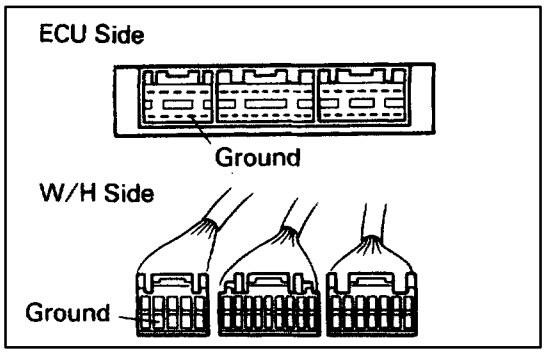


Check and Replace ECU

First check the ECU ground circuit. If it is faulty, repair it. If it is normal, the ECU could be faulty, so replace the ECU with a known good one and check if the symptoms appear.



(1) Measure the resistance between the ECU ground terminal and the body ground.
Resistance: 1 Ω or less



(2) Disconnect the ECU connector, check the ground terminals on the ECU side and the wire harness side for bend and check the contact pressure.