HOW TO TROUBLESHOOT ECU CONTROLLED SYSTEMS

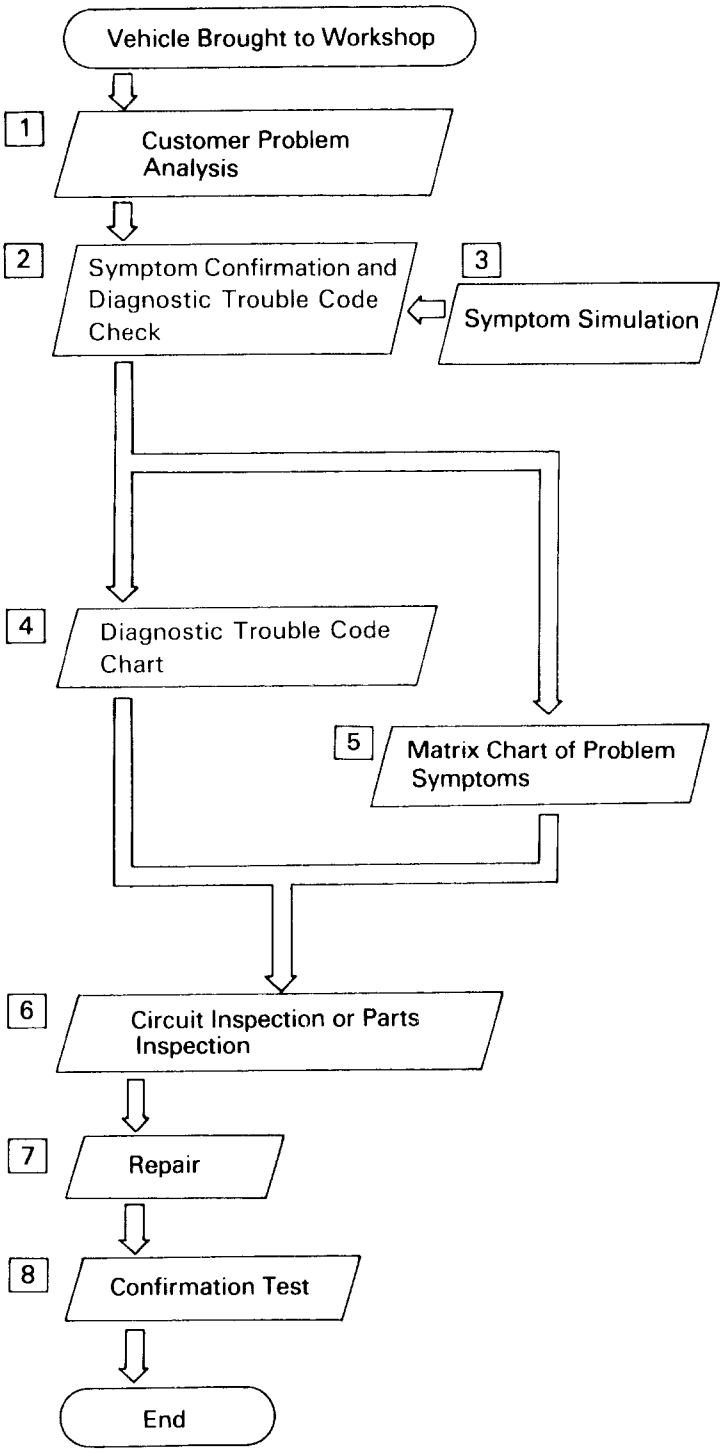
A large number of ECU controlled systems are used in the LEXUS LS400. In general, the ECU controlled system is considered to be a very intricate system requiring a high level of technical knowledge and expert skill to troubleshoot. However, the fact is that if you proceed to inspect the circuits one 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	EG–253
	2. Automatic Transmission	AT–27
	3. Electronic Modulated Air Suspension	SA–90
	4. Anti–Lock Brake	BR–47
	5. Traction Control	BR–91
Vol. 2	6. Steering Column Electronic Control	SR–27
	7. Supplemental Restraint System	RS–43
	8. Power Seat Control	BE–281
	9. Cruise Control	BE–363
	10. Multiplex Communication System	BE–396
	11. Air Conditioning	AC–13

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 trouble 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 trouble 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

- 3 What _____ Vehicle model, system name
- 3 When _____ Date, time, occurrence frequency
- 3 Where _____ Road conditions
- 3 Under what conditions? _____ Running conditions, driving conditions, weather conditions
- 3 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		Model and Model Year	
Driver's Name		Frame No.	
Date Vehicle Brought In		Engine Model	
License No.		Odometer Reading	km miles

Problem Symptoms	Engine does not Start	Engine does not crank No initial combustion No complete combustion
	Difficult to Start	Engine cranks slowly Other _____
	Poor Idling	Incorrect first idle Idling rpm is abnormal (High Low (rpm)) Rough idling Other _____
	Poor Driveability	Hesitation Back fire Muffler explosion (after-fire) Surging Knocking Other _____
	Engine Stall	Soon after starting After accelerator pedal depressed After accelerator pedal released During A/C operation Shifting from N to D Other _____
	Others	
		Constant Sometimes (times per day/month) er _____
		Cloudy Rainy Snow
		Cool

2 SYMPTOM CONFIRMATION AND DIAGNOSTIC TROUBLE CODE CHECK

The diagnostic system in the LEXUS LS400 fulfills various functions. The first function is the Diagnostic Trouble 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 conditioning system has an Actuator Check function whereby the ECU automatically operates the actuators of the damper and blowermotor, etc. to check the operation. 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.

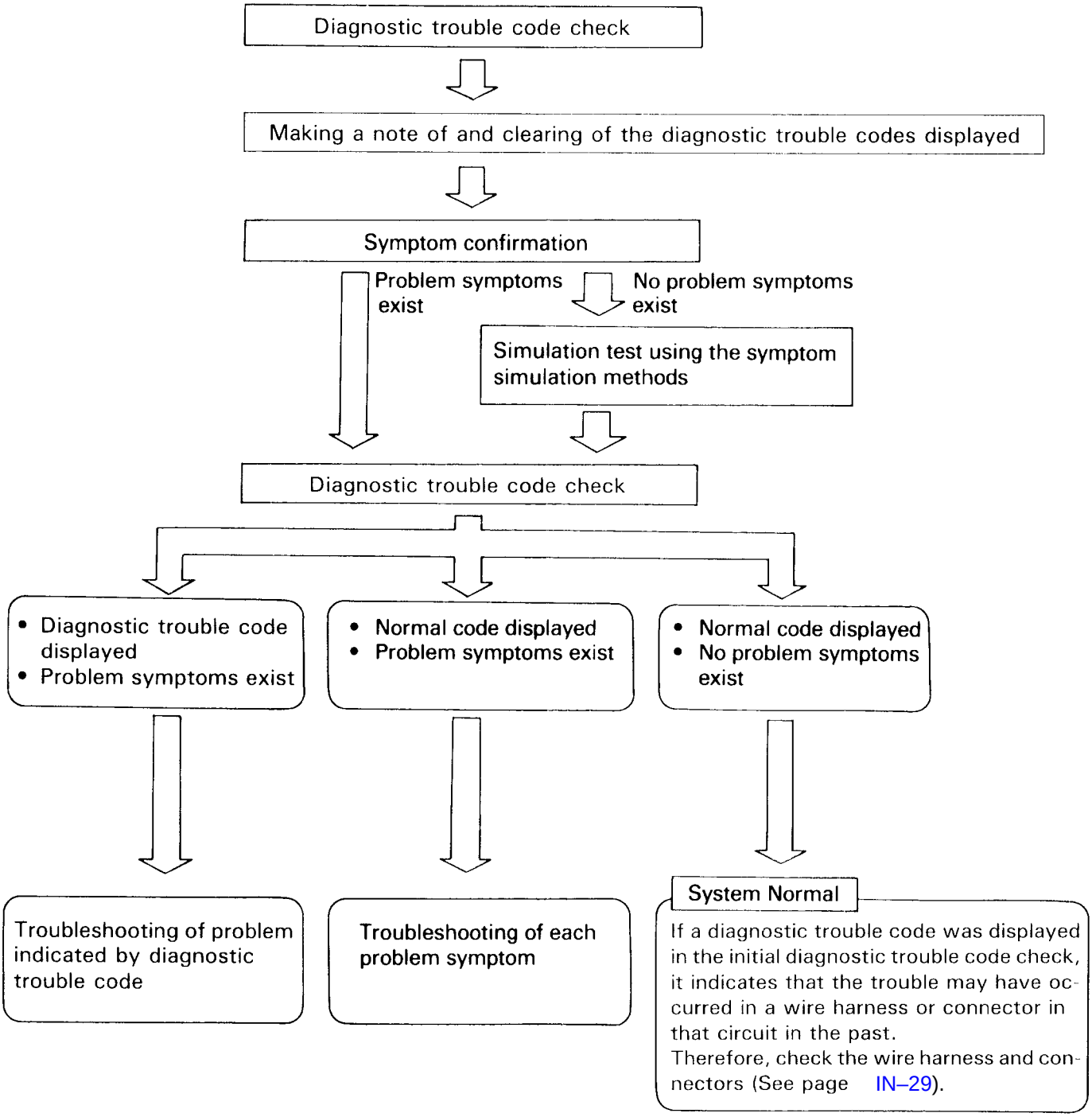
System	Diagnostic Trouble Code Check	Input Signal Check (Sensor Check)	Other Diagnosis Function
Engine	○(with Check Mode)	○	Diagnostic Test Mode
Automatic Transmission	○(with Check Mode)	○	Diagnostic Test Mode
Electronic Modulated Air Suspension	○		
Anti–Lock Brake	○	○	
Traction Control	○	○	
Supplemental Restraint System	○		
Multiplex Communication System	○		
Cruise Control	○	○	
Air Conditioning	○	○	Actuator Check

In diagnostic trouble code check, it is very important to determine whether the problem indicated by the diagnostic trouble 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 trouble code is directly related to the problem symptom or not. For this reason, the diagnostic trouble 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 trouble code check.

DIAGNOSTIC TROUBLE CODE CHECK PROCEDURE

Diagnostic Trouble Code Check (Make a note of and then clear)	Confirmation of Symptoms	Diagnostic Trouble Code Check	Problem Condition
Diagnostic Trouble Code Display	Problem symptoms Exist	Same Diagnostic 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 diagnostic 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 trouble code check is shown below. This flow chart shows how to utilize the diagnostic trouble code check effectively, then by carefully checking the results, indicates how to proceed either to diagnostic trouble code troubleshooting or to troubleshooting of problem symptoms.

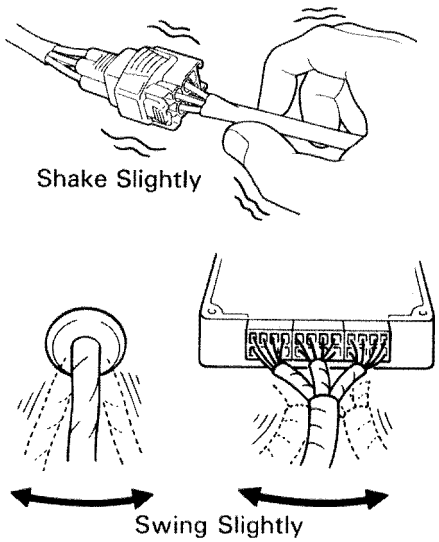
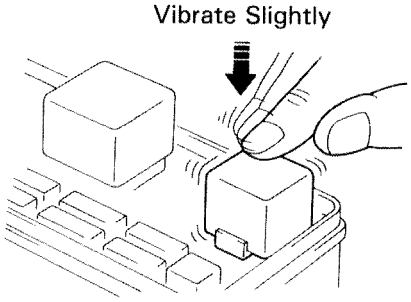


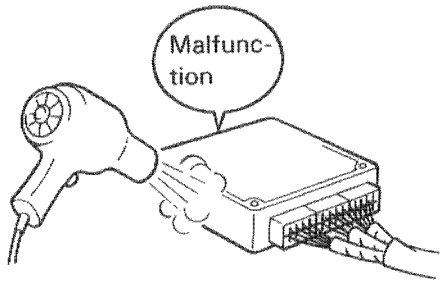
3 SYMPTOM SIMULATION

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.

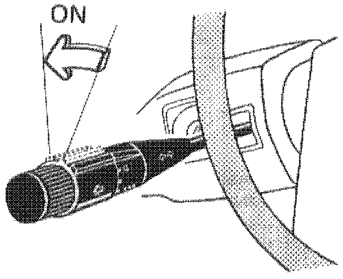
Important Points in the Symptom Simulation Test

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.	 PI9981 FI2332
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.	 P20001

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.**	 FI2334

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.	 BE4059

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.	 FI2336

4 DIAGNOSTIC TROUBLE CODE CHART

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

- DTC No.
  Indicates the diagnostic trouble code.

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

DIAGNOSTIC TROUBLE CODE CHART (SAE Controlled)

HINT: Parameters listed in the chart may not be exactly the same as your reading due to the type of instrument or other factors.

- Diagnostic Trouble Code Detecting Condition
  Indicates the diagnostic trouble code set parameter.

DTC No.	Detection Item	DTC Detecting Condition
P0100	Mass Air Flow Circuit Malfunction	Open or short in mass air flow meter circuit with engine speed 4,000 rpm or less
P0101	Mass Air Flow Circuit Range/Performance Problem	Conditions a) and b) continue with engine speed 900 rpm or less (2 trip detection logic) a) Closed throttle position switch: ON b) Mass air flow meter output > 2.2 V
	ke Air Temp. Circuit tion	Open or short in intake air temp. sensor circuit
	Circuit	Open or short in engine coo

- Trouble Area
  Indicates the suspect area of the problem.

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

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

Trouble Area	MIL	Memory	See Page
• Open or short in mass air flow meter circuit • Mass air flow meter • ECM			EG-289
or circuit			

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 trouble 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 DTC check and the problem still can not be confirmed in the basic inspection, proceed to this matrix chart and perform troubleshooting according to the numbered order given in the table below.

	See page	EG-377	EG-384	EG-389	EG-394	AC-86	ST-26, 42	EG-35	AX-81	IN-36
	Suspect area	Starter signal circuit	ECM power source circuit	Fuel pump control circuit	Fuel pressure control circuit	A/C signal circuit (Compressor circuit)	Starter and starter relay	Compression	A/T faulty	Engine control module (ECM)
	Symptom									
Does not start	Engine does not crank						1			
	No initial combustion		1	2						
	No complete combustion			1						
	Poor normal condition	1		2				3		
		1		2						
		1		3						
			2							

- **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.

• Diagnostic Trouble Code No. and Detection Item

• Circuit Description
The major role and operation, etc. of the circuit and its component parts are explained.

DTC	P0325	Knock Sensor 1 Circuit Malfunction
DTC	P0330	Knock Sensor 2 Circuit Malfunction

• Indicates the diagnostic trouble code, diagnostic trouble code set parameter and suspect area of the problem.

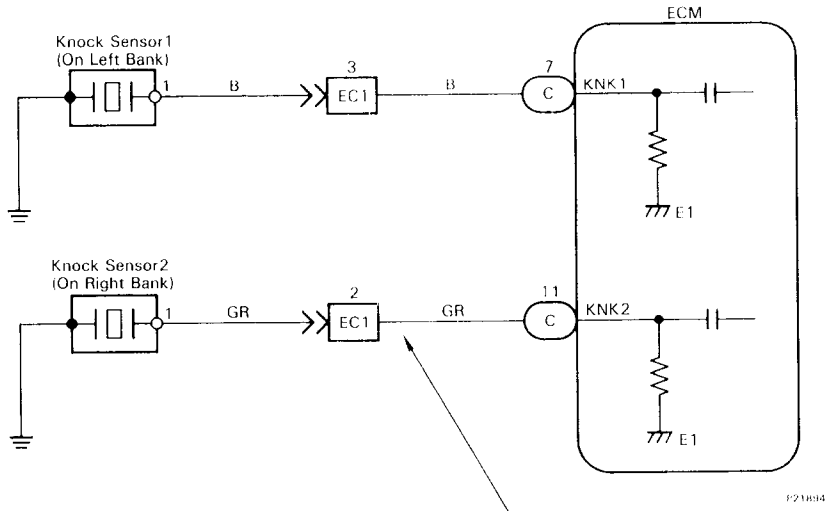
CIRCUIT DESCRIPTION

Knock sensors are fitted one each to the right bank and left bank of the cylinder block to detect engine knocking. This sensor contains a piezoelectric element which generates a voltage when it becomes deformed, which occurs when the cylinder block vibrates due to knocking. If engine knocking occurs, ignition timing is retarded to suppress it.

DTC No.	DTC Detecting Condition	Trouble Area
P0325	No knock sensor 1 signal to ECM with engine speed 1,700 ~ 5,600 rpm	• Open or short in knock sensor 1 circuit • Knock sensor 1 (looseness) • ECM
P0330	No knock sensor 2 signal to ECM with engine speed 1,700 ~ 5,600 rpm	• Open or short in knock sensor 2 circuit • Knock sensor 2 (looseness) • ECM

If the ECM detects the above diagnosis conditions, it operates the fail safe function in which the corrective retard angle value is set to the maximum value.

WIRING DIAGRAM



• Wiring Diagram
This shows a wiring diagram of the circuit. Use this diagram together with ELECTRICAL WIRING DIAGRAM to thoroughly understand the circuit.

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

LOCK Ignition Switch LOCK(OFF)

ON Ignition Switch ON

START Ignition Switch START

ACC Ignition Switch ACC

EG-306 ENGINE TROUBLESHOOTING – CIRCUIT INSPECTION

4 **Check voltage between terminals VTA and E2 of ECM.**

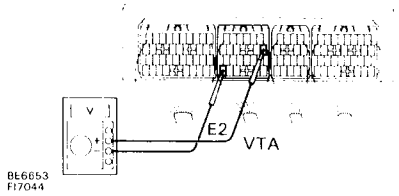
ON

P (1) Remove the instrument panel under cover.
(2) Turn ignition switch ON.

C Measure voltage between terminals VTA and E2 of ECM.

OK

Throttle valve	Voltage
Fully closed	0.3 ~ 0.8 V
Fully open	3.2 ~ 4.9 V



BE6653
FI7044

OK

NG **Check for open and short in harness and connector between ECM and throttle position sensor (VTA or E2 line) (See page IN-35).**

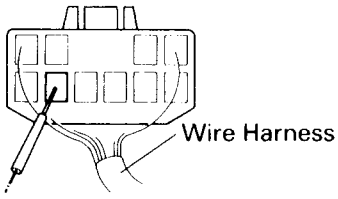
page IN-40).

- Inspection Procedure

Use the inspection procedure to determine if the circuit is normal or abnormal, and, if it is abnormal, use it to determine whether the problem is located in the sensors, actuators, wire harness or ECU.

- **P** Preparation
- **C** Check

- Indicates the place to check the voltage or resistance.
- Indicates the connector position to checked, from the front or back side.



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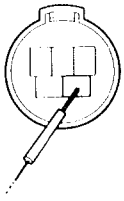
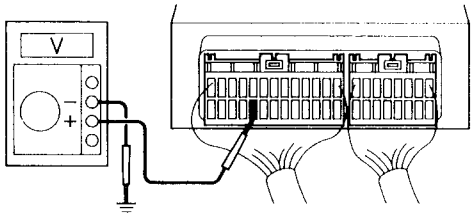
Check from the connector back side. (with harness)



BE4077

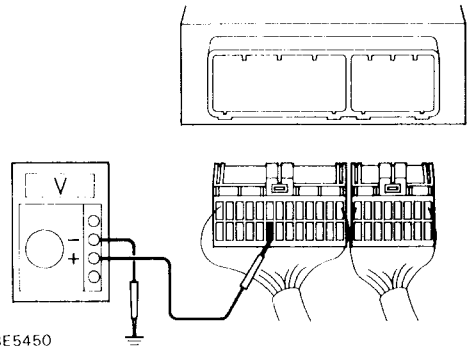
Check from the connector front side (without harness) In this case, care must be taken not to bend the terminals.

- Indicates the condition of the connector of ECU during the check.



Connector being checked is connected.

BR5459



Connector being checked is disconnected.

BE5450

HOW TO USE THE DIAGNOSTIC CHART AND INSPECTION PROCEDURE

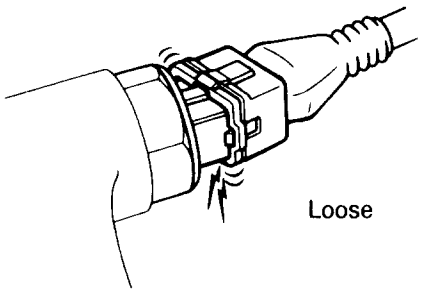
1. For troubleshooting, diagnostic trouble code charts or problem symptom charts are provided for each circuit with detailed inspection procedures on the following pages.
2. When all the component parts, wire harnesses and connectors of each circuit except the ECU are found to be normal in troubleshooting, 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 trouble 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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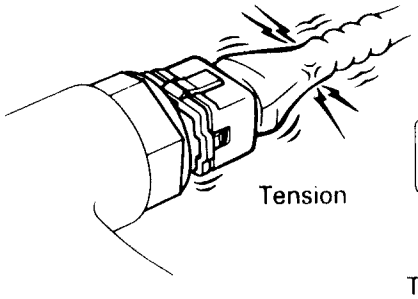

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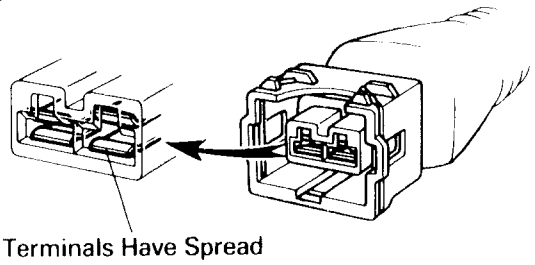

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HINT:

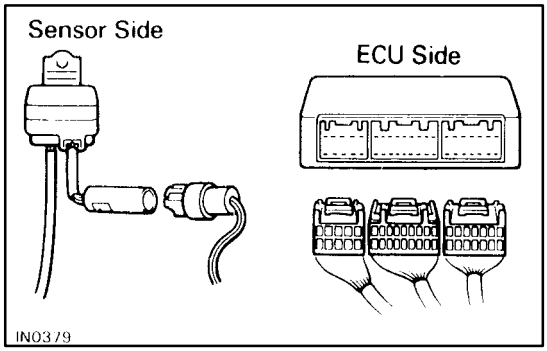
1. It is rarely the case that a wire is broken in the middle of it. Most cases occur at the connector. In particular, carefully check the connectors of sensors and actuators.
2. Faulty contact could be due to rusting of the connector terminals, to foreign materials entering terminals or a drop in the 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.

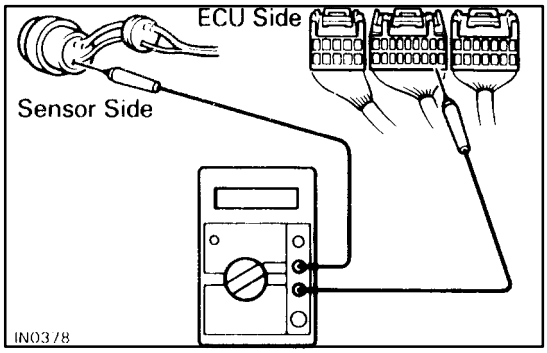
SHORT CIRCUIT:

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)

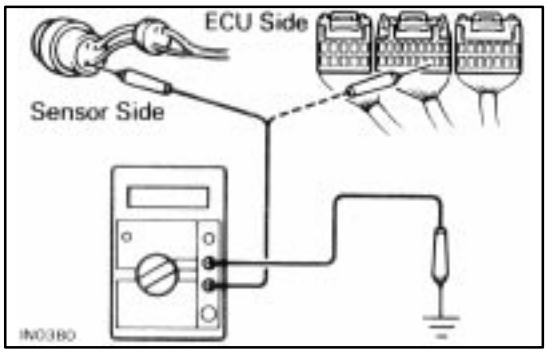
(1) Disconnect the connectors at both ECU and sensor sides.

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

Resistance: 1Ω 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.



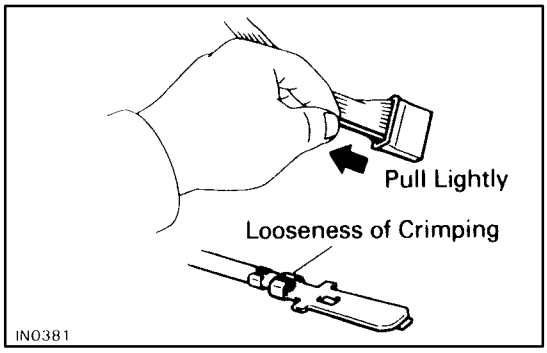
2. RESISTANCE CHECK (SHORT CIRCUIT CHECK)

(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.



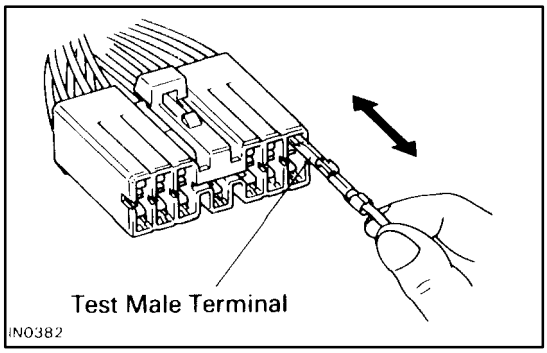
3. VISUAL CHECK AND CONTACT PRESSURE CHECK

(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.

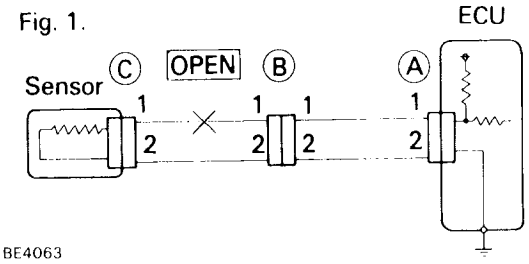
HINT: When the test terminal is pulled out more easily than others, there may be poor contact in that section.

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 connector A and C and measure the resistance between them.

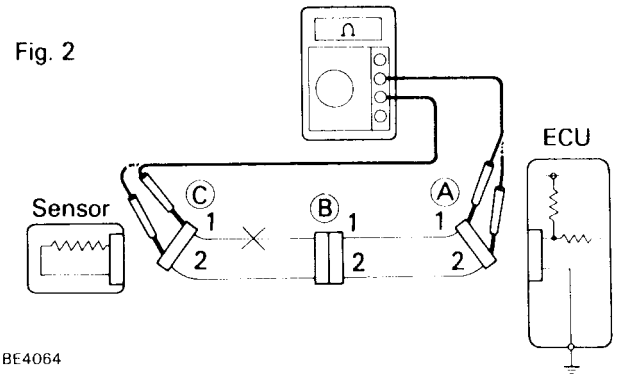
In the case of Fig. 2,

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.

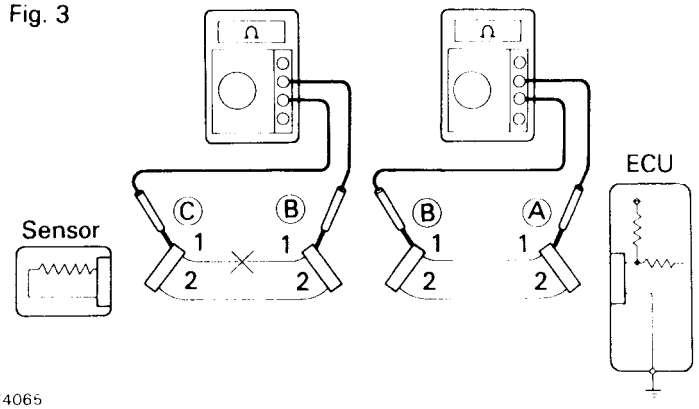
In the case of Fig. 3,

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:

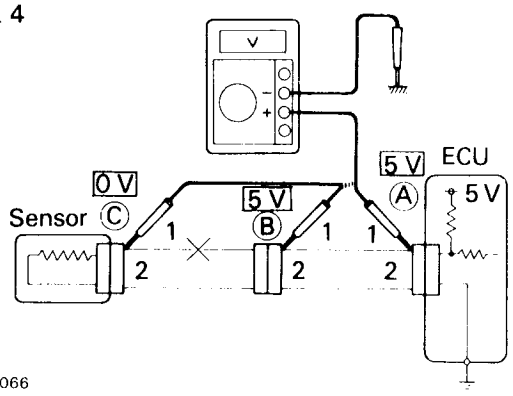
5 V: Between Terminal 1 of connector A and Body Ground

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.

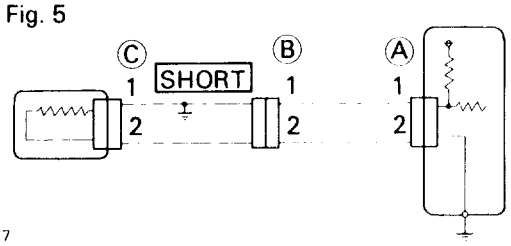
Fig. 4



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”.

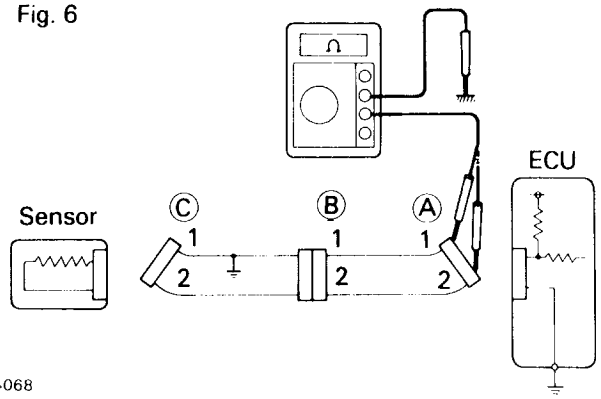
Fig. 5



(a) Continuity Check with Ground

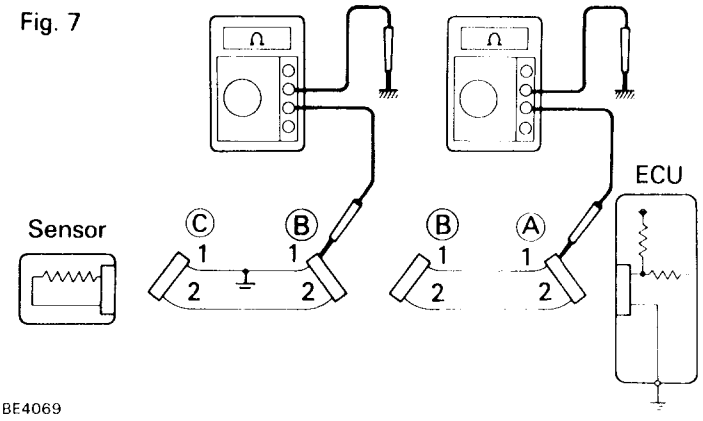
(1) Disconnect connectors A and C and measure the resistance between terminals 1 and 2 of connector A and body ground.
In the case of Fig. 6,
Between terminal 1 of connector A and body ground → Continuity
Between terminal 2 of connector A and body ground → No continuity (open)
Therefore, it is found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

Fig. 6



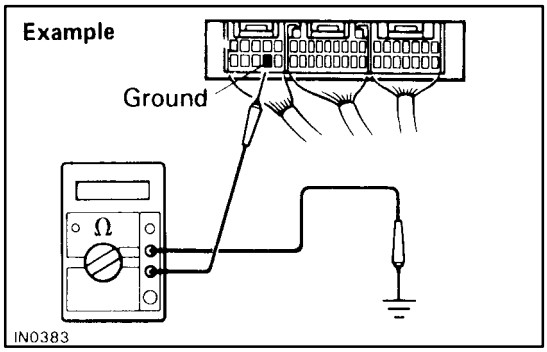
(2) Disconnect connector B and measure the resistance between terminal 1 of connector A and body ground, and terminal 1 of connector B and body ground.
Between terminal 1 of connector A and body ground → No continuity (open)
Between terminal 1 of connector B and body ground → Continuity
Therefore, it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

Fig. 7

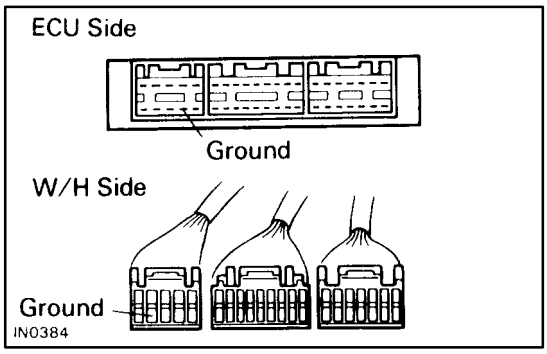


Check and Replace ECU

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: 1Ω or less



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