Learning Objectives:

1. Perform a general diagnostic process regardless of the type of customer concern on ECU controlled systems.
2. Utilize advanced diagnostic tools for greater accuracy and speed.
3. Lay out the troubleshooting steps and resources you will need to follow when diagnosing customer concerns.
Section 1

Introduction to Engine Control System Processes and Diagnostic Tools

Overview

The purpose of this section is to:

- help you understand the general diagnostic process that you will follow regardless of the type of customer concern you are troubleshooting.

- features of diagnostic tools that will help you with greater accuracy and speed.

- lay out the troubleshooting steps and resources you will need to follow when diagnosing customer concerns.

Diagnostic Tools and Resources

There are many troubleshooting “tools” that can be used to accurately identify and troubleshoot driveability problems. These include:

- Previous Troubleshooting Experience

- Use of the OBD self-diagnostic system

- Service Literature – Technical Information System (TIS), Repair Manuals, Electrical Wiring Diagrams, and Technical Service Bulletins

- Diagnostic Toolset

- TechView

There are also other resources at your disposal for those extraordinary situations where your best attempts fail to resolve the customer concerns:

- Technical Assistance hotline

- Area office assistance; STSs, FTSs, and FPEs

With these resources available to you, even the most difficult customer concerns can be resolved while maintaining high standards for customer satisfaction.

Previous Troubleshooting Experience

Your experience is one of the best resources you have. Depending on the symptom or customer description of the driveability concern, you can often eliminate many sub-systems from your diagnostic investigations. It is important to note, however, this does not mean that troubleshooting is performed in a random manner. In fact, you will always fix the car faster and with more accuracy when you follow a systematic diagnostic approach.
Use of the On-Board (Self) Diagnostic System

All ECMs are equipped with an on-board self-diagnostic system (OBD). This system is capable of detecting shorts and opens in most sensor electrical circuits and in some actuator circuits. Later models equipped with the OBD II system can also detect component and system performance.

These OBD systems are an integral part of your troubleshooting process and will weigh heavily in your diagnostic outcome.

Diagnostic Toolset

The Diagnostic Toolset consists of the Diagnostic Tester and the Vehicle Break-out Box (V-BoB). Depending on the vehicle you are working on and the nature of the customer concern, both of these tools are extremely valuable for gathering large quantities of diagnostic data in a relatively short period of time. For troubleshooting engine control system concerns, the Diagnostic Toolset allows you to quickly perform the following functions:

- Read and define Diagnostic Trouble Codes (DTCs)
- Display serial data stream containing sensor, actuator, and diagnostic information
- Display signal voltages on a fully adjustable laboratory oscilloscope
- Store and playback snapshot data.
- Test sensors and actuators dynamically using Active Tests
- All CARB OBD II functions
Diagnostic Toolset with TIS

Fig. 1-1
TL84101
TechView

TechView is a computer-based program that works hand in hand with the Diagnostic Tester. This tool aids in collecting live data from the vehicle where the technician can view the data in a variety of formats (graphs, charts, lists) and store files for later viewing. Some of the TechView features include:

- Real Time Data List
- Tester Snapshot Data
- DTC Information
- OBD System Monitors
- Freeze Frame Data
- File Information

Each technician creates a user name where all of the vehicle information is stored and can be used again for future reference.

Before using the Diagnostic Tester, the Diagnostic Toolset Manual should be read thoroughly.
If the Diagnostic Tester cannot communicate with ECU controlled systems when connected to DLC3, the ignition switch is ON, and the Diagnostic Tester is on, there is a problem on the vehicle side or tool side.

1) If communication is normal when the Diagnostic Tester is connected to another vehicle, inspect the diagnosis data link line (Bus=line) or ECM (ECU) power circuit of the vehicle.

2) If communication is still not possible when the Diagnostic Tester is connected to another vehicle, the problem is probably in the Diagnostic Tester itself, so perform the Self Test procedures outline in the Diagnostic Toolset Operator’s Manual.
Customer Problem Analysis

1. Customer Problem Analysis
   - Ask the customer about the conditions and the environment when the problem occurred.

2. Symptom Confirmation and Diagnostic Trouble Code Check
   - Confirm the symptoms and the problem condition and check the diagnostic trouble codes. (When the problem symptoms do not appear during confirmation, use the symptom simulation method described later on.)

3. Symptom Simulation

4. Diagnostic Trouble Code Chart
   - 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 problem symptoms table.

5. Problem Symptoms Table

6. Circuit Inspection or Parts Inspection

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

8. Confirmation Test
   - 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.)

End
In troubleshooting, the problem symptoms must be confirmed accurately and all preconceptions must be cleared away 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.

The following five 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 Diagnostics section for each system for your use.

### The Five Major Questions

#### 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

![Fig. 1-3](TL874f103)

### Customer Problem Analysis Check Sheet

![Fig. 1-4](TL874f104)
Section 1

The diagnostic system fulfills various functions. The first function is the Diagnostic Trouble Code Check. A malfunction in the signal circuits to the ECM is stored in code in the ECM’s memory at the time of occurrence. This DTC is retrieved by the technician during troubleshooting.

Another function is the Input Signal Check, which checks if the signals from various switches are sent to the ECM correctly. By using these check functions, the problem areas can be narrowed down quickly and troubleshooting can be performed effectively.

In diagnostic trouble code check, it is very important to determine if the problem indicated by the diagnostic trouble code is present or occurred in the past and returned to normal.

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 these reasons, the diagnostic trouble codes should be checked before and after the symptom confirmation to determine the current conditions, as shown in the following figure.

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.

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### DTC Check Procedure

#### DIAGNOSTIC TROUBLE CODE CHECK PROCEDURE

<table>
<thead>
<tr>
<th>Diagnostic Trouble Code Check (Make a note of and then clear)</th>
<th>Confirmation of Symptoms</th>
<th>Diagnostic Trouble Code Check</th>
<th>Problem Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diagnostic Trouble Code Display</td>
<td>Problem symptoms exist</td>
<td>Same diagnostic trouble code is displayed</td>
<td>Problem is still occurring in the diagnostic circuit</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Normal code is displayed</td>
<td>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)</td>
</tr>
<tr>
<td></td>
<td>No problem symptoms exist</td>
<td></td>
<td>The problem occurred in the diagnostic circuit in the past</td>
</tr>
<tr>
<td>Normal Code Display</td>
<td>Problem symptoms exist</td>
<td>Normal code is displayed</td>
<td>The problem is still occurring in a place other than in the diagnostic circuit</td>
</tr>
<tr>
<td></td>
<td>No problem symptoms exist</td>
<td>Normal code is displayed</td>
<td>The problem occurred in a place other than in the diagnostic circuit in the past</td>
</tr>
</tbody>
</table>

Fig. 1-5
**DTC Check Procedure**

Taking into account the points on the previous page, a flow chart showing how to proceed with troubleshooting using the diagnostic trouble code check is shown here. 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 table.

Fig. 1-6

TLA04106
The most difficult cases to diagnose is when no problem symptoms are 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 how much experience or how skilled the technician is, to proceed to troubleshoot without confirming the problem symptoms will often result in wasted time and failure to resolve the customer concerns. For example, for a problem which only occurs when the engine is cold, the problem can never be determined so long as the symptoms are confirmed when the engine is hot.

Since vibration, heat or water penetration (moisture) are likely causes for problems that are difficult to reproduce, the symptom simulation tests introduced here are effective measures to apply to the vehicle.

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 problem symptoms table for each system to narrow down the possible causes of the symptom.
### Other Methods for Simulating Conditions

<table>
<thead>
<tr>
<th></th>
<th>HEAT METHOD: When the problem seems to occur when the suspect area is heated.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>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.</td>
</tr>
<tr>
<td></td>
<td>NOTICE: (1) Do not heat to more than 60 °C (140 °F). (Temperature is limited not to damage the components.) (2) Do not apply heat directly to parts in the ECU.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>WATER SPRINKLING METHOD: When the malfunction seems to occur on a rainy day or in a high-humidity condition.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sprinkle water onto the vehicle and check to see if the malfunction occurs.</td>
</tr>
<tr>
<td></td>
<td>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.</td>
</tr>
<tr>
<td></td>
<td>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 taken.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>OTHER: When a malfunction seems to occur when electrical load is excessive.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Turn on all electrical loads including the heater blower, headlights, rear window defogger, etc. and check to see if the malfunction occurs.</td>
</tr>
</tbody>
</table>

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Fig. 1-8

TL84108
The inspection procedure is shown in the following figure. 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.

**DTC Chart**

Fig. 1-9
The suspected 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.

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.
How to read and use each page is shown in the following figures. This chart provides the procedure to diagnose a circuit or system. Often, you will use the Diagnostic Tester, DVOM, or oscilloscope to diagnose faults in a circuit.

**Circuit Inspection**

- **Diagnostic Trouble Code No. and Detection Item**
- **Circuit Description**
  The major role and operation, etc. of the circuit and its component parts are explained.

**CIRCUIT DESCRIPTION**
Knock sensor is fitted to 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.

- **Trouble Area**
  - No knock sensor 1 signal to ECM with engine speed 1,200 rpm or more.
  - Knock sensor 1 function failure.
  - Knock sensor 1 (transistor).
  - ECM.

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

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

**Wiring Diagram**

- **Knock Sensor 1**
- **ECM**
- **GR**
- **E5**
- **KNK**
- **E1**

The first letter indicates the basic wire color and the second letter indicates the color of the stripe.

**Fig. 1-11**

TL841111
**Inspection Procedure**

1. Check continuity between terminal KNK of ECM connector and body ground.
   - **PREPARATION:**
     - (a) Remove the glove compartment (See page SF–68).
     - (b) Disconnect the E6 connector of ECM.
   - **CHECK:**
     - Measure resistance between terminal KNK of ECM connector and body ground.
     - **OK:**
       - Resistance: 1 MΩ or higher
     - **NG:**
       - OK: Go to step 3.
     - **NG:**
       - OK: Go to step 4.

2. Check knock sensor (See page SF–61).
   - **OK:** Replace knock sensor.

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

- 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.

- Indicates the condition of the connector of ECU during the check.
  - Connector being checked is connected.
  - Connector being checked is disconnected.
In electrical/electronic diagnostics, you will frequently encounter situations where diagnosis consumes 90% of the actual repair time. By using this procedure to narrow down the number of tests you perform, you can reduce diagnostic time.

After successfully locating the faulty circuit and pinpointing the fault, repair is a relatively simple matter. It is important, however, to ensure customer satisfaction after the repair by performing one last step before releasing the vehicle.

On occasion, you will have to diagnose and repair vehicles with compound problems. To ensure that the vehicle is operating normally, and that the original symptom has been remedied, a quick quality control check of the vehicle is performed. This is accomplished during the Repair Confirmation step.

This is always the final step in diagnosis. Regardless of how you arrived at this step, there are always several items you want to confirm before releasing the vehicle to your customer. The items you will be looking for during this quality control quick check are:

- Satisfactory driveability under the problem conditions stated by the customer

- Repair Confirmation (Readiness Tests) where indicated completed

- All DTC(s) eliminated from ECM keep alive memory

These last two items can be confirmed using the Diagnostic Tester. Once confirmed, the vehicle can be returned to the customer. You can be confident that by following these procedures, in the order given, that you will repair the vehicle with a high rate of success in the shortest possible time.

You cannot attempt to fix a problem that does not exist. Therefore, in cases where the problem cannot be duplicated, better communication with the owner, or outside assistance, may offer a solution.

Owner Perception: Sometimes an owner perceives a "normal" operating condition to be a problem. The best way to identify these cases is to accompany the owner on a "road test." Let the customer drive and point out the problem condition during the road test.
Worksheet Objectives
When troubleshooting using the Diagnostic Tester, there are general procedures that will aid in troubleshooting the vehicle. This worksheet will familiarize you with those procedures.

Section 1:
1. The primary purpose of the Customer Problem Analysis Check sheet is:

2. The DTC Check procedure is used to confirm if the problem is present or can be duplicated. What are three possible outcomes from this procedure?

3. What are the four methods for simulating conditions?

4. When is the Problem Symptoms Table used?
5. Name four items of information found in the Circuit Inspection.


6. Name three items that are checked during the Repair Confirmation.


Worksheet Objectives
Display data using a variety of Diagnostic Tester modes that will aid in troubleshooting and interpreting the results.

Tools and Equipment
- Vehicle
- Repair Manual, EWD, & NCF
- Diagnostic Tester & Manual
- Diagnostic Tester Printer
- Hand Tools, Fender Covers, Floor Mats, and Shop Towels

Section 1: Setup
1. On a vehicle selected by the instructor, warm up the vehicle and connect the Diagnostic Tester to the vehicle. Refer to the Diagnostic Tester Manual for specific setup instructions if needed.

Section 2: Data List
1. Select DATA LIST mode under ENHANCED OBD II.

2. Compare All DATA List to the EXTENDED DATA List. What is the major difference between these lists?

Section 3: LED/LIST Mode
1. Select LED/LIST mode

2. Observe DATA LIST. When would you use this mode?

3. Reorder LED/LIST parameters according to instructor’s directions.
Section 4: Bar Graph Mode
1. Select BAR GRAPH mode

2. Observe Data List. When would you use this mode?

3. Reorder LED/LIST parameters according to instructor’s directions.

Section 5: STRIP CHART Mode
1. Select STRIP CHART mode. Select and list 5 parameters as identified by the instructor.

2. Observe Data List. When would you use this mode?

Section 6: CUSTOM DATA Mode
1. Select CUSTOM DATA mode. Select and list below the 6 parameters as identified by the instructor.

2. Observe Data List. When would you use this mode?
Section 7: SNAPSHOT Mode

1. Select SNAPSHOT mode. Select and list below the 6 parameters as identified by the instructor.

__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________

2. Prepare to create a fault as identified by your instructor. You will create the fault during a snapshot capture. Write below the type of fault, any terminal pin numbers used, and the intended DTC.

__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________

3. Create a snapshot with the fault recorded. Replay the captured snapshot and repeat if the fault was not recorded. Remove the fault when done and return vehicle to original condition.

4. What DTC(s) were recorded?

__________________________________________________________________________

5. Clear DTC(s)

6. When would you use SNAPSHOT mode?

__________________________________________________________________________

7. Switch to another team’s SNAPSHOT file and diagnose the cause. What was the fault?

Vehicle: ___________________________          Fault: ___________________________

Vehicle: ___________________________          Fault: ___________________________

Vehicle: ___________________________          Fault: ___________________________
Notes
Review this sheet as you are doing the worksheet. Check each category after completing the worksheet and instructor presentation. Ask the instructor if you have questions. The comments section is for you to write where to find the information, questions, etc.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open Data List in CARB and ENHANCED OBD</td>
<td></td>
</tr>
<tr>
<td>View data in LIST/LED format and describe the advantage of this mode</td>
<td></td>
</tr>
<tr>
<td>View data in Strip Chart mode and describe the advantage of this mode</td>
<td></td>
</tr>
<tr>
<td>Save and view a SnapShot and describe the advantage of this mode</td>
<td></td>
</tr>
<tr>
<td>Interpret vehicle condition based on Data Lists</td>
<td></td>
</tr>
<tr>
<td>Retrieve DTC(s), Freeze Frame and CARB Readiness data</td>
<td></td>
</tr>
</tbody>
</table>
Worksheet Objectives
In this worksheet, you will diagnose a vehicle by viewing the vehicle’s Real Time Data. You will then practice saving and opening files.

Tools and Equipment

- Diagnostic Tester
- TIS with Tech View
- Hand Tool Set

NOTE: Follow the instructions and steps in the TechView Guide before proceeding.

Section 1: Problem Solving using TechView

1. Under the direction of the instructor, create a problem with the vehicle.

2. Save the DATA LIST only. Make sure the problem can be seen from the DATA LIST. Clear DTC(s) from the vehicle.

3. You will rotate through the other workstations. Write down the vehicle and the cause of the problem.

<table>
<thead>
<tr>
<th>Vehicle</th>
<th>Year/Prod. Date</th>
<th>Engine</th>
<th>Transmission</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tbody>
</table>
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<table>
<thead>
<tr>
<th>Topic</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open a new file</td>
<td></td>
</tr>
<tr>
<td>Save a file</td>
<td></td>
</tr>
<tr>
<td>Open and resave an existing file</td>
<td></td>
</tr>
<tr>
<td>Display data in all TechView formats and describe the advantage of each mode</td>
<td></td>
</tr>
<tr>
<td>Save Data Lists in TechView</td>
<td></td>
</tr>
<tr>
<td>Retrieve DTC(s), Freeze Frame and CARB Readiness data</td>
<td></td>
</tr>
<tr>
<td>Retrieve Snapshot data</td>
<td></td>
</tr>
<tr>
<td>Interpret data from TechView to diagnose the root cause of a problem</td>
<td></td>
</tr>
</tbody>
</table>