HOW TO USE THIS MANUAL

GENERAL INFORMATION

IN02D-01

1. INDEX

An INDEX is provided on the first page of each section to guide you to the item to be repaired. To assist you in finding your way through the manual, the Section Title and major heading are given at the top of every page.

2. GENERAL DESCRIPTION

At the beginning of each section, a General Description is given that pertains to all repair operations contained in that section.

Read these precautions before starting any repair task.

3. TROUBLESHOOTING

TROUBLESHOOTING tables are included for each system to help you diagnose the problem and find the cause. The fundamentals of how to proceed with troubleshooting are described on page IN-8.

Be sure to read this before performing troubleshooting.

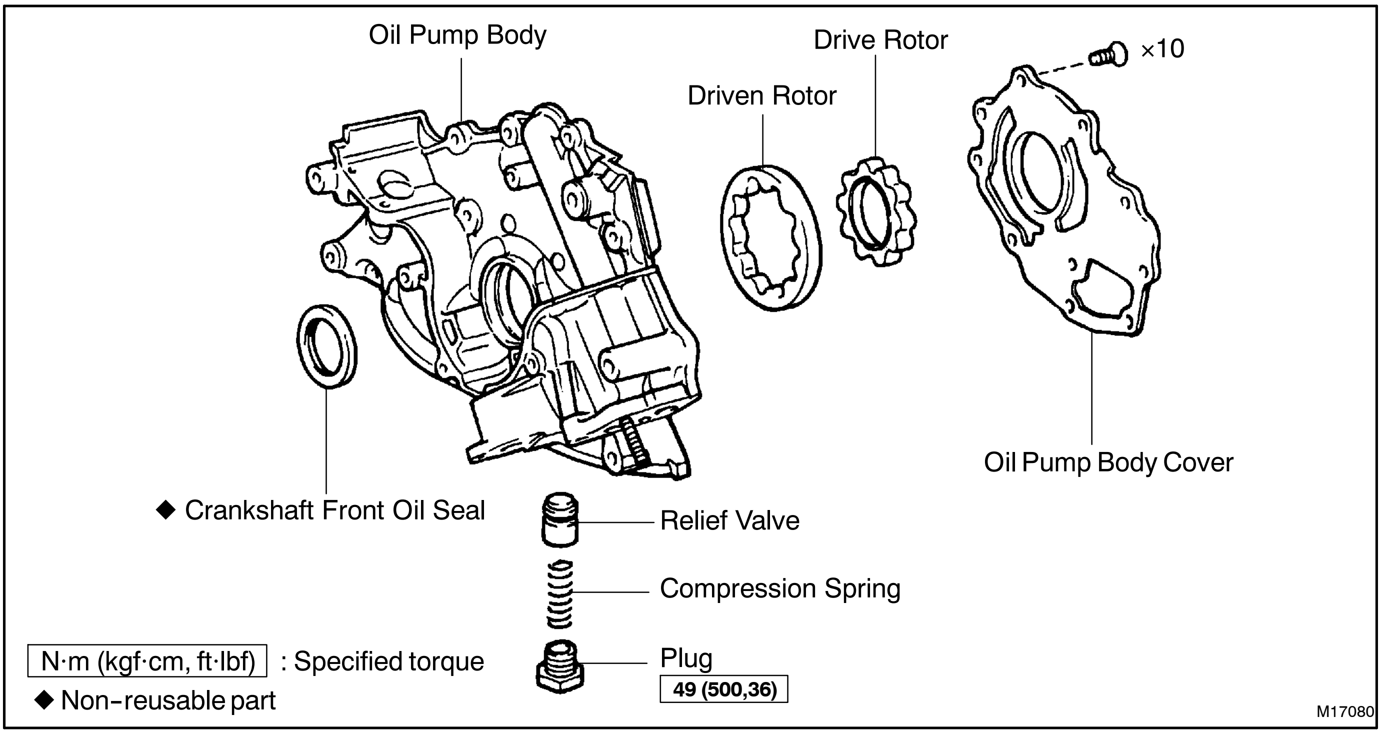
4. PREPARATION

Preparation lists the SST (Special Service Tools), recommended tools, equipment, lubricant and SSM (Special Service Materials) which should be prepared before beginning the operation and explains the purpose of each one.

5. REPAIR PROCEDURES

Most repair operations begin with an overview illustration. It identifies the components and shows how the parts fit together.

Example:



The procedures are presented in a step-by-step format:

- The illustration shows what to do and where to do it.
- The task heading tells what to do.
- The detailed text tells how to perform the task and gives other information such as specifications and warnings.

Example:

Task heading : what to do

Illustration:
what to do and where

21. CHECK PISTON STROKE OF OVERDRIVE BRAKE

(a) Place SST and a dial indicator onto the overdrive brake piston as shown in the illustration.

SST 09350-30020 (09350-06120)

Set part No. *Component part No.*

Detailed text : how to do task

(b) Measure the stroke applying and releasing the compressed air (392 - 785 kPa, 4 - 8 kgf.cm^2 or 57 - 114 psi) as shown in the illustration.

Piston stroke: 1.40 — 1.70 mm (0.0551 — 0.0669 in.)

Specification

This format provides the experienced technician with a FAST TRACK to the information needed. The upper case task heading can be read at a glance when necessary, and the text below it provides detailed information. Important specifications and warnings always stand out in bold type.

6. REFERENCES

References have been kept to a minimum. However, when they are required you are given the page to refer to.

7. SPECIFICATIONS

Specifications are presented in bold type throughout the text where needed. You never have to leave the procedure to look up your specifications. They are also found in Service Specifications section, for quick reference.

8. CAUTIONS, NOTICES, HINTS:

- CAUTIONS are presented in bold type, and indicate there is a possibility of injury to you or other people.
- NOTICES are also presented in bold type, and indicate the possibility of damage to the components being repaired.
- HINTS are separated from the text but do not appear in bold. They provide additional information to help you perform the repair efficiently.

9. SI UNIT

The UNITS given in this manual are primarily expressed according to the SI UNIT (International System of Unit), and alternately expressed in the metric system and in the English System.

Example:

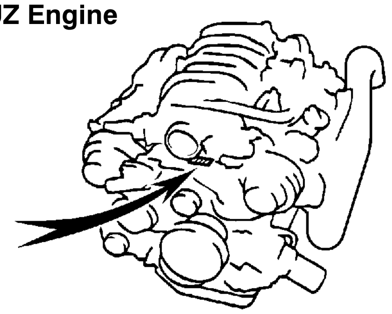
Torque: 30 N·m (310 kgf·cm, 22 ft·lbf)

IDENTIFICATION INFORMATION

IN05L-01

ENGINE SERIAL NUMBER

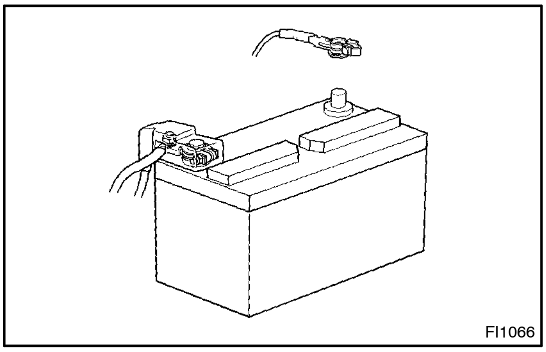
M1UZ Engine



M01548

1. ENGINE SERIAL NUMBER

The engine serial number is stamped on the engine block, as shown in the illustration.



REPAIR INSTRUCTIONS

IN05M-01

GENERAL INFORMATION

1. BASIC REPAIR HINT

(a) Use the protection covers to keep the boat clean and prevent damage.

(b) During disassembly, keep parts in the appropriate order to facilitate reassembly.

(c) Observe the following:

(1) Before performing electrical work, disconnect the negative (-) terminal cable from the battery.

(2) If it is necessary to disconnect the battery for inspection or repair, always disconnect the negative (-) terminal cable which is grounded to the engine block.

(3) To prevent damage to the battery terminal, loosen the cable nut and raise the cable straight up without twisting or prying it.

(4) Clean the battery terminals and cable ends with a clean shop rag. Do not scrape them with a file or other abrasive objects.

(5) Install the cable ends to the battery terminals with the nut loose, and tighten the nut after installation. Do not use a hammer to tap the cable ends onto the terminals.

(6) Be sure the cover for the positive (+) terminal is properly in place.

(d) Check hose and wiring connectors to make sure that they are secure and correct.

(e) Non-reusable parts

(1) Always replace cotter pins, gaskets, O-rings and oil seals etc. with new ones.

(2) Non-reusable parts are indicated in the component illustrations by the ”◆” symbol.

(f) Precoated parts

Precoated parts are bolts and nuts, etc. that are coated with a seal lock adhesive at the factory.

(1) If a precoated part is retightened, loosened or caused to move in any way, it must be recoated with the specified adhesive.

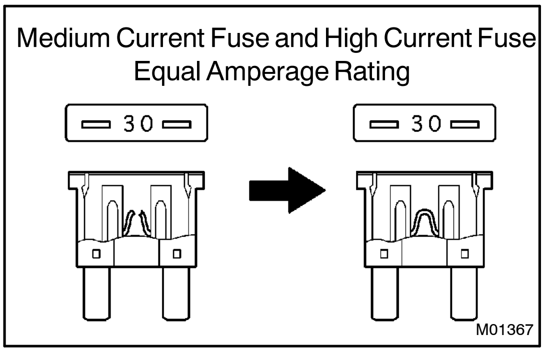
(2) When reusing precoated parts, clean off the old adhesive and dry with compressed air. Then apply the specified seal lock adhesive to the bolt, nut or threads.

(3) Precoated parts are indicated in the component illustrations by the ”★” symbol.

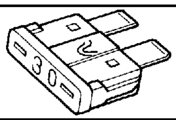
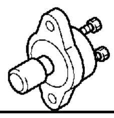
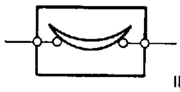
(g) When necessary, use a sealer on gaskets to prevent leaks.

(h) Carefully observe all specifications for bolt tightening torques. Always use a torque wrench.

(i) Use of special service tools (SST) and special service materials (SSM) may be required, depending on the nature of the repair. Be sure to use SST and SSM where specified and follow the proper work procedure. A list of SST and SSM can be found in preparation section in this manual.

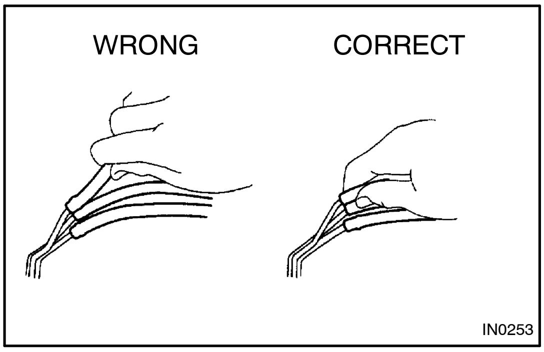


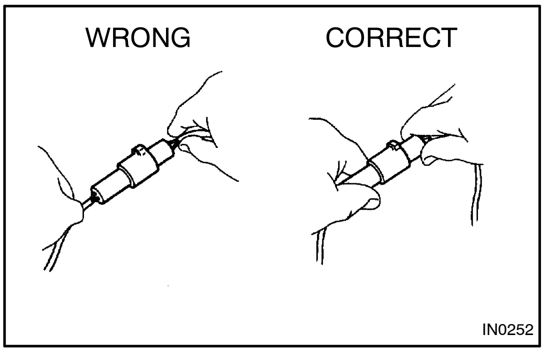
(j) When replacing fuses, be sure the new fuse has the correct amperage rating. DO NOT exceed the rating or use one with a lower rating.

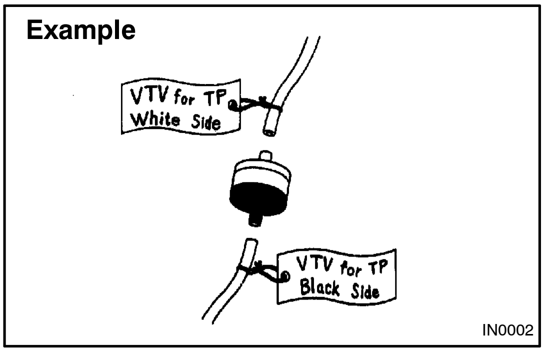
Illustration	Symbol	Part Name	Abbreviation
 BE5594	 IN0365	FUSE	FUSE
 M05598	 IN0368	CIRCUIT BREAKER	CB

(k) Care must be taken when sling up and supporting the engine. Be sure to support the engine at the proper positions (See page IN-7).
(1) After the engine is slung up, be sure to support it on stands. It is extremely dangerous to do any work on engine suspended at the sling hook, even for a small job that can be finished quickly.

(l) Observe the following precautions to avoid damage to the following parts:
(1) Do not open the cover or case of the ECU, ECM unless absolutely necessary. (If the IC terminals are touched, the IC may be destroyed by static electricity.)







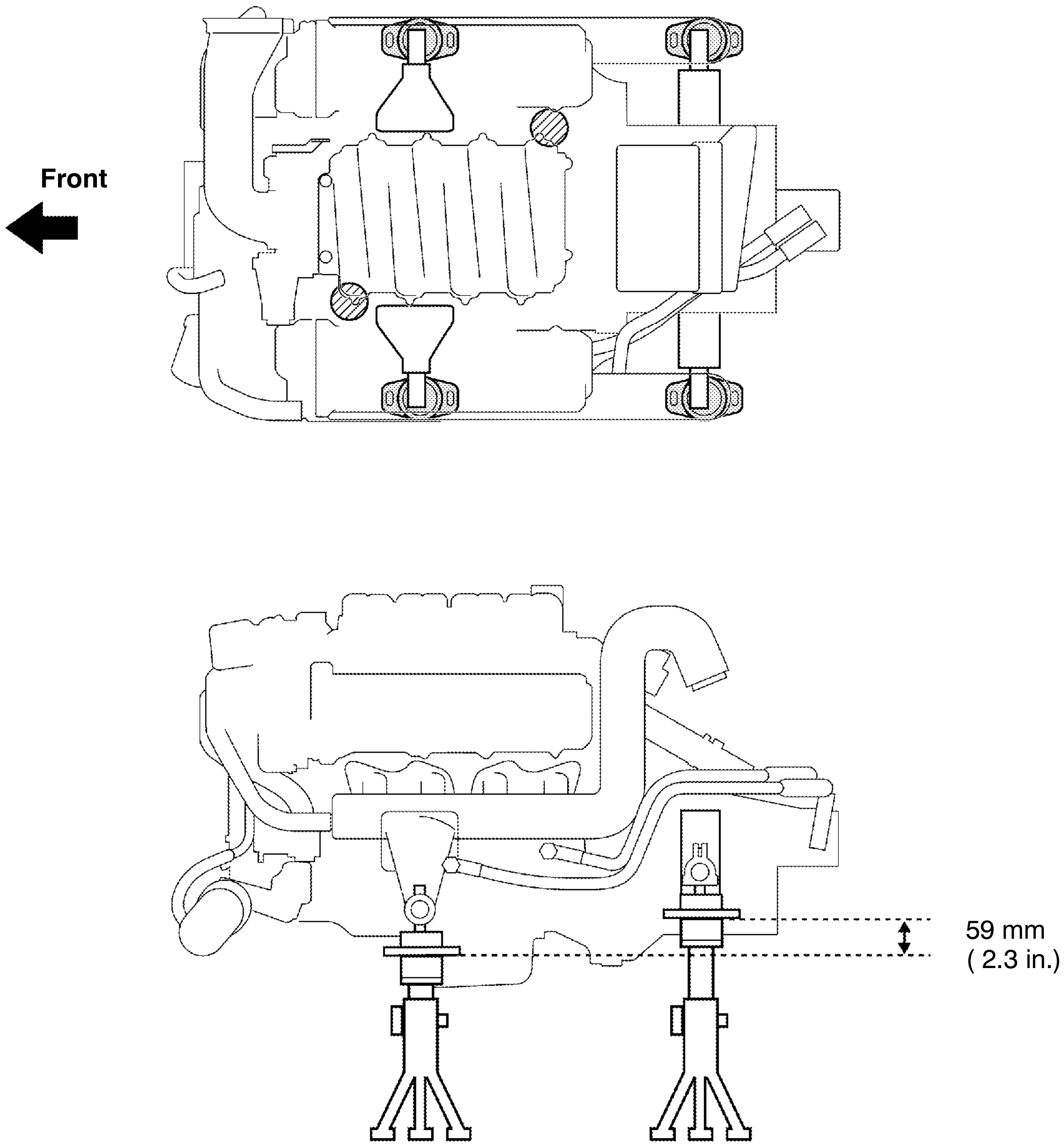
(2) To disconnect vacuum hoses, pull on the end, not the middle of the hose.
(3) To pull apart electrical connectors, pull on the connector itself, not the wires.
(4) Be careful not to drop electrical components, such as sensors or relays. If they are dropped on a hard floor, they should be replaced and not reused.
(5) When steam cleaning an engine, protect the electronic components, air filter and emissions-related components from water.
(6) Never use an impact wrench to remove or install temperature switches or temperature sensors.
(7) When checking continuity at the wire connector, insert the tester probe carefully to prevent terminals from bending.
(8) When using a vacuum gauge, never force the hose onto a connector that is too large. Use a step-down adapter for adjustment. Once the hose has been stretched, it may leak.

(m) Tag hoses before disconnecting them:
(1) When disconnecting vacuum hoses, use tags to identify how they should be reconnected.
(2) After completing a job, double check that the vacuum hoses are properly connected. A label under the hood shows the proper layout.

(n) Unless otherwise stated, all resistance is measured at an ambient temperature of 20°C (68°F). Because the resistance may be outside specification if measured at high temperatures immediately after the engine has been running measurements should be made when the engine has cooled down.

IN05N-01

ENGINE SLING AND SUPPORT POSITIONS



HINT: To level the engine, move up the rear stands 59 mm (2.3 in.) as shown above figure.

SLING POSITION

Front ——————— Front Engine Hanger
Rear ——————— Rear Engine Hanger

SUPPORT POSITION

Front ——————— Front Engine mounting Insulator
Rear ——————— Rear Engine mounting Insulator

M01930

HOW TO TROUBLESHOOT ECU CONTROLLED SYSTEMS

IN05Q-01

GENERAL INFORMATION

A large number of ECU controlled systems are used in the M1UZ Engine. 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.

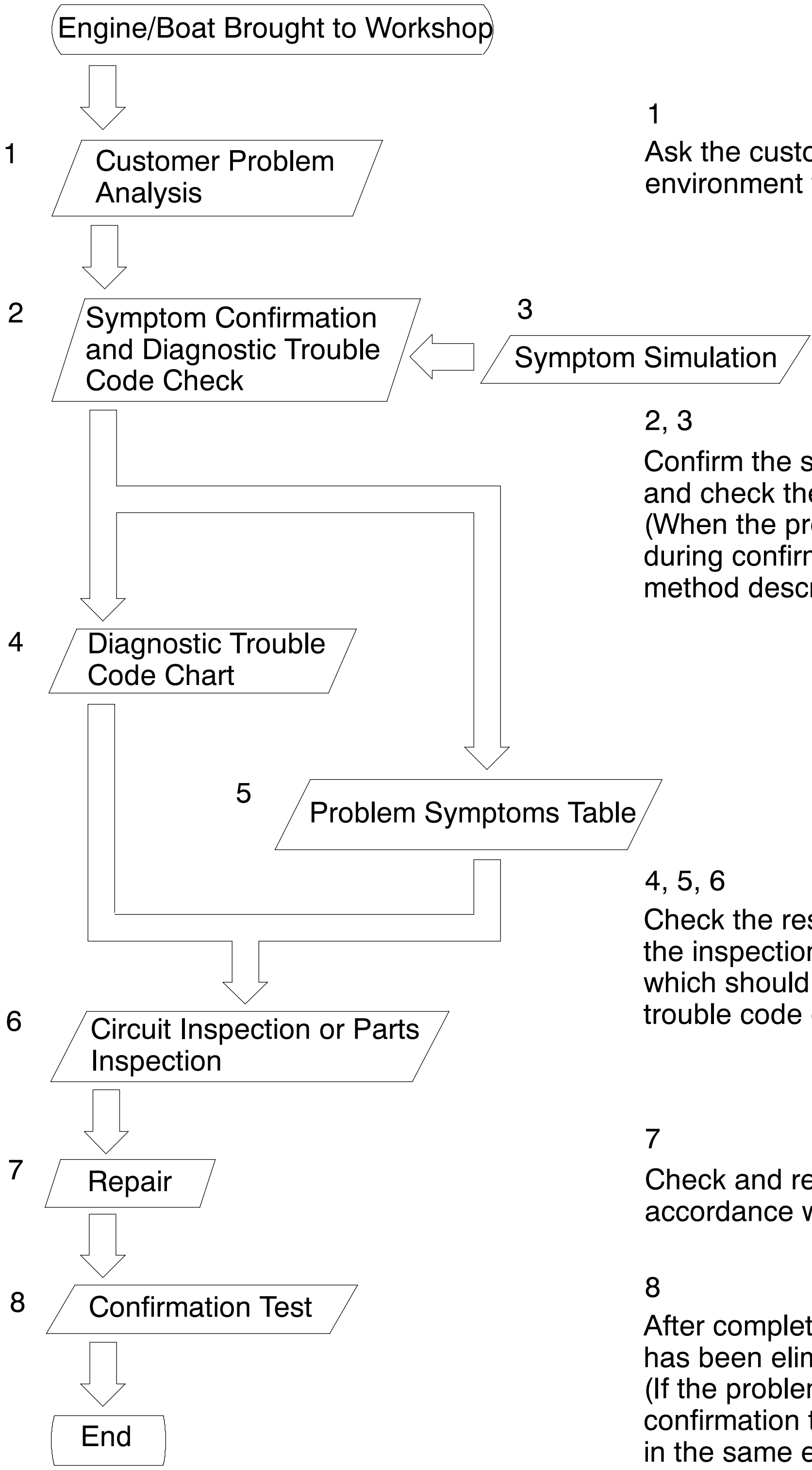
FOR USING OBDII SCAN TOOL OR TOYOTA HAND-HELD TESTER

- Before using the OBDII scan tool or TOYOTA hand-held tester, the OBDII scan tool's instruction book or TOYOTA hand-held tester's operator manual should be read thoroughly.
- If the OBDII scan tool or TOYOTA hand-held tester cannot communicate with ECU controlled systems when you have connected the cable of the OBDII scan tool or TOYOTA hand-held tester to DLC3, Turned the ignition switch ON and operated the scan tool, there is a problem on the engine side or tool side.
  (1) If communication is normal when the tool is connected to another engine, inspect the diagnosis data link line (Bus⊕line) or ECU power circuit of the engine.
  (2) If communication is still not possible when the tool is connected to another engine, the problem is probably in the tool itself, so perform the Self Test procedures outlined in the Tester Operator's Manual.

IN05P–01

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 the DI 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 problem symptoms table.

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 Point 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 ----- Engine model, system name
- When ----- Date, time, occurrence frequency
- Where -----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

ENGINE CONTROL SYSTEM Check Sheet

Inspector's Name ____________________

Customer's Name		**Model and Model Year**	
Driver's Name		**Hull No.**	
Data Boat Brought in		**Engine Model**	
License No.		**Hourmeter Reading**	hour

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 (rpm)** ☐ **Low (rpm)** ☐ **Rough idling** ☐ **Other** ____________________
	☐ **Poor Drive ability**	☐ **Hesitation** ☐ **Back fire** ☐ **Muffler explosion (after-fire)** ☐ **Surging** ☐ **Knocking** ☐ **Other** ____________________
	☐ **Engine Stall**	☐ **Soon after starting** ☐ **After accelerator pedal depressed** ☐ **After accelerator pedal released** ☐ **Shifting from N to F or N to R** ☐ **Other** ____________________
	☐ **Others**	

...onstant ☐ **Sometimes (times per day/month)**

2. SYMPTOM CONFIRMATION AND DIAGNOSTIC TROUBLE CODE CHECK

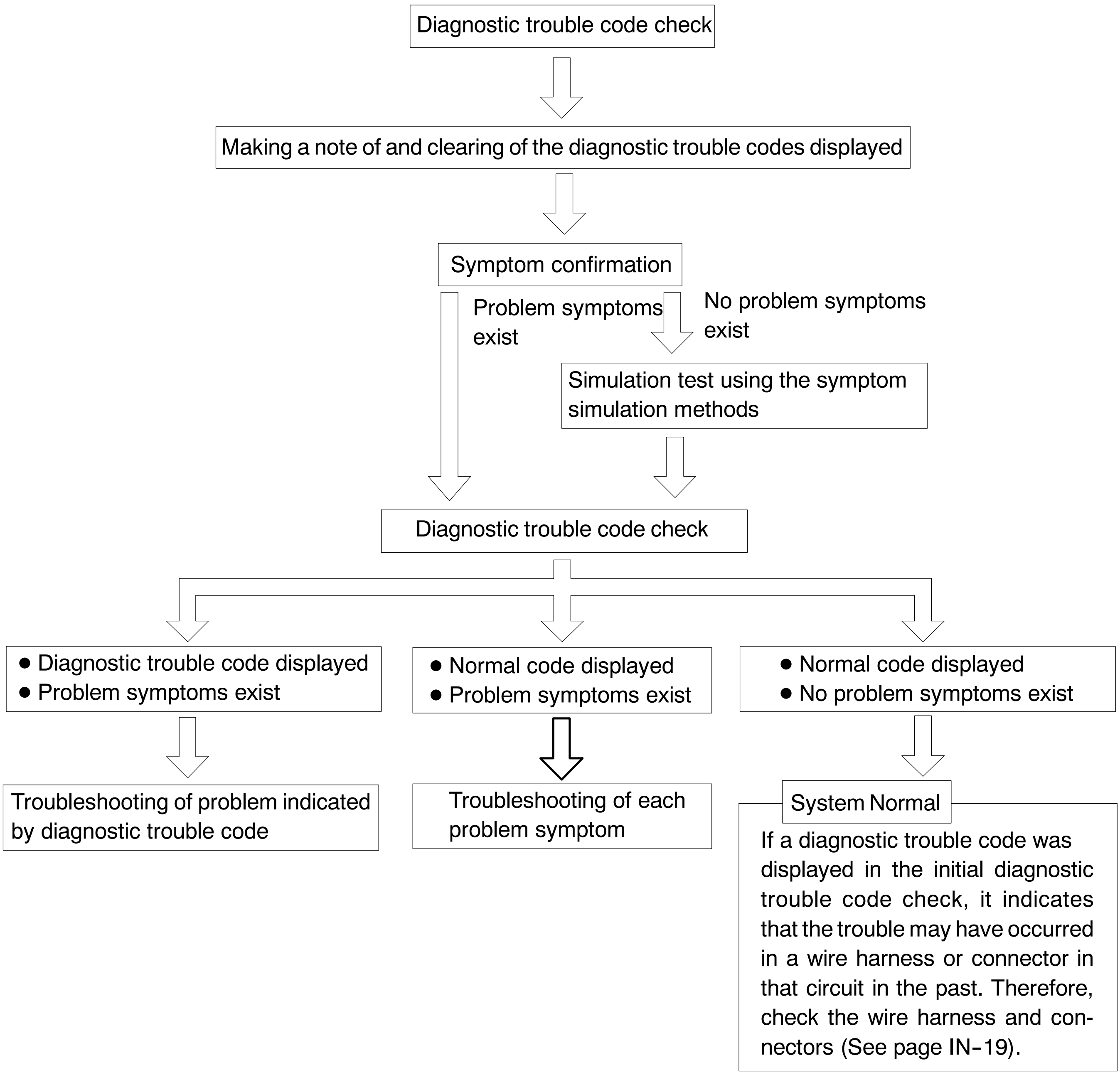
The diagnostic system in the M1UZ engine fulfills various functions. The first function is the Diagnostic Trouble Code Check in which a malfunction in the signal circuits to the ECU is stored in code in the ECU memory at the time of occurrence, to be output by the technician during troubleshooting. Another function is the Input Signal Check which checks if the signals from various switches are sent to the ECU correctly. 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 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.

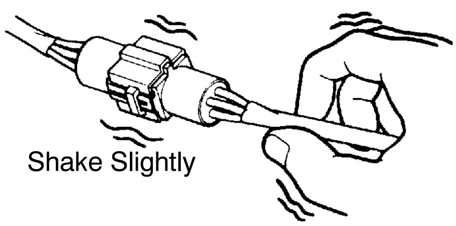
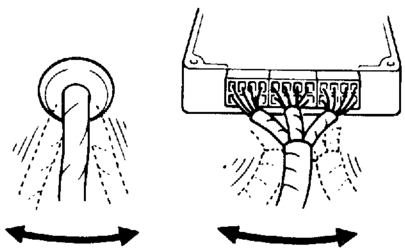
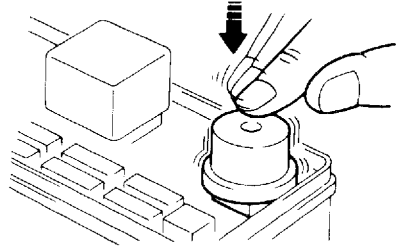


3. SYMPTOM SIMULATION

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 engine. No matter how 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 certain rpm, etc., the problem can never be determined so long as the symptoms are confirmed with the engine hot condition or the engine 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 engine 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 problem symptoms table 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 opening through portion are the major areas to be checked thoroughly.	FI2331 FI2332
PARTS AND SENSOR 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.	FI2330

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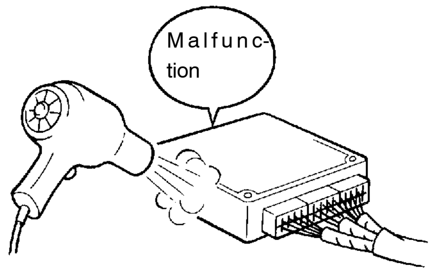
2	**HEAT METHOD: When the problem seems to occur when the suspect area is heated.**
Heat the component that is the likely cause of the malfunction with a hair dryer or similar object. Check to see if the malfunction occurs. **NOTICE:** **(1) Do not heat to more than 60 °C (140 °F). (Temperature is limited not to damage the components.)** **(2) Do not apply heat directly to parts in the ECU.**	 FI2334

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

- Trouble Area
  Indicates the suspect area of the problem.

- Detection Item
  Indicates the system of the problem or contents of the problem.

DTC 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.

If a malfunction code is displayed during the DTC check mode, check the circuit for that code listed in the table below. For details of each code, turn to the page referred to under the "See page" for the respective "DTC No." in the DTC chart.

DTC No. (See page)	Detection Item	Trouble Area	MIL*	Memory
P0100 (DI-24)	Mass Air Flow Circuit Malfunction	• Open or short in mass air flow meter circuit • Mass air flow meter • ECM	○	○
P0101 (DI-28)	Mass Air Flow Circuit Range/Performance Problem	• Mass air flow meter	○	○
P0110 (DI-29)	Intake Air Temp. Circuit Malfunction	• Open or short in intake air temp. sensor circuit • Intake air temp. sensor • ECM	○	○
P0115 (DI-34)	Engine Coolant Temp. Circuit Malfunction	• Open or short in engine coolant temp. sensor circuit • Engine coolant temp. sensor • ECM	○	○
P0116 (DI-38)	Engine Coolant Temp. Circuit Range/Performance Problem	• Engine coolant temp. sensor • Cooling system	○	○
P0120 (DI-39)	Throttle/Pedal Position Sensor/Switch "A" Circuit Malfunction	• Open or short in throttle position sensor circuit • Throttle position sensor • ECM	○	○
	...ttle/ Pedal Position Sensor/Switch ...ge/Performance	• Throttle position sensor		

5. PROBLEM SYMPTOMS TABLE

The suspect circuits or parts for each problem symptom are shown in the table below. Use this table to troubleshooting 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.
- Circuit Inspection, Inspection Order
  Indicates the circuit which needs to be checked for each problem symptom. Check in the order indicated by the numbers.
- Problem Symptom
- Circuit or Part Name
  Indicates the circuit or part which needs to be checked.

PROBLEM SYMPTOMS TABLE

Symptom	Suspect Area	See page
Engine does not crank (Does not start)	1. Starter and starter relay	ST-14 ST-15
No initial combustion (Does not start)	1. ECM power source circuit 2. Fuel pump control circuit 3. Engine control module (ECM)	DI-147 DI-151 DI-147
No complete combustion (Does not start)	1. Fuel pump control circuit	DI-151
Engine cranks normally (Difficult to start)	1. Starter signal circuit 2. Fuel pump control circuit 3. Compression	DI-144 DI-151 EM-3
Cold engine (Difficult to start)	1. Starter signal circuit 2. Fuel pump control circuit	DI-144 DI-151
Hot engine	1. Starter signal circuit 2. Fuel pump control circuit	DI-144 DI-151
idle speed (Poor idling)	1. ECM power source circuit	DI-834
idling)	1. Fuel pump control circuit	
	1. Compression 2. Fuel pump control circuit	

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

CIRCUIT DESCRIPTION

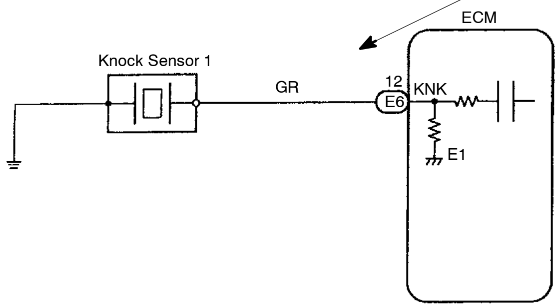
Knock sensor is fitted to the cylinder block to detect engine knocking. This sensor contains a piezoelectric element which generates a voltage when it becomes deformed, which occurs when the cylinder block vibrates due to knocking. If engine knocking occurs, ignition timing is retarded to suppress it.

DTC No.	DTC Detecting Condition	Trouble Area
P0325	No knock sensor 1 signal to ECM with engine speed, 1,200 rpm or more.	● Open or short in knock sensor1 circuit ● Knock sensor 1 (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.

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

WIRING DIAGRAM



- Wiring Diagram
  This shows a wring diagram of the circuit.
  Use the diagram together with ELECTRICAL WIRING DIAGRAM to thoroughly understand the cicuit.
  Wiring colors are indicated by an alphabetical code.
  B = Black, L = Blue, R = Red, BR = Brown,
  LG = Light Green, V = Violet, G = Green,
  O = Orange, W = White, GR = Gray, P = Pink,
  Y = Yellow
  The first letter indicates the basic wire color and the second letter indicates the color of the stripe.

V08423

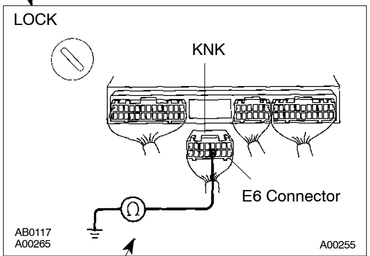
- Indicates the position of the ignition switch during the check.

LOCK Ignition Switch LOCK (OFF)
ON Ignition Switch ON
START Ignition Switch START

- 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.

INSPECTION PROCEDURE

1	**Check continuity between terminal KNK of ECM connector and body ground.**



PREPARATION:
(a) Remove the glove compartment (See page SF-67).
(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

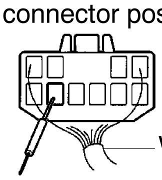
OK	**Go to step 3.**

NG

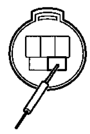
2	**Check knock sensor (See page SF-59).**

OK	**Replace knock sensor.**

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

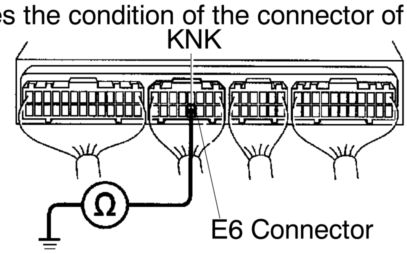


Check from the connector back side.
(with harness)

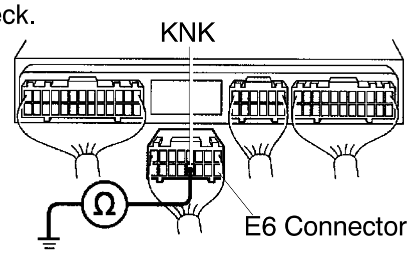


Check from the connector front side. (without harness)
In this case, care must be taken not to bend the terminals.

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



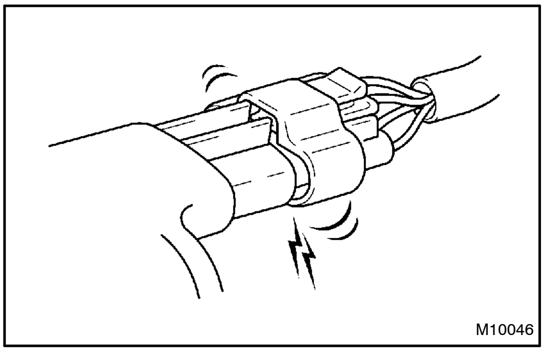
Connector being checked is connected.

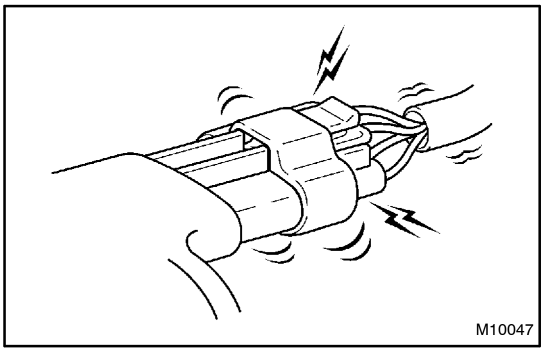


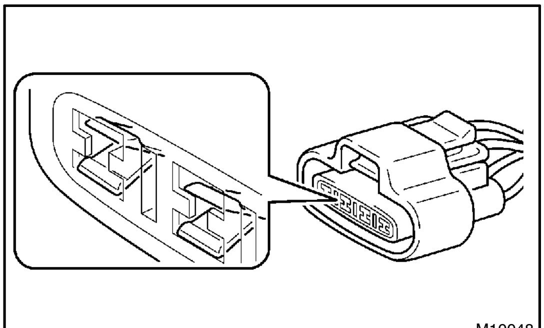
Connector being checked is disconnected.

V08425

IN02K–02


M10046


M10047


M10048

HOW TO USE THE DIAGNOSTIC CHART AND INSPECTION PROCEDURE

1. CONNECTOR CONNECTION AND TERMINAL INSPECTION

- For troubleshooting, diagnostic trouble code charts or problem symptom charts are provided for each circuit with detailed inspection procedures on the following pages.
- 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,refer to step 8 to 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.
- 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.

OPEN CIRCUIT:

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

HINT:

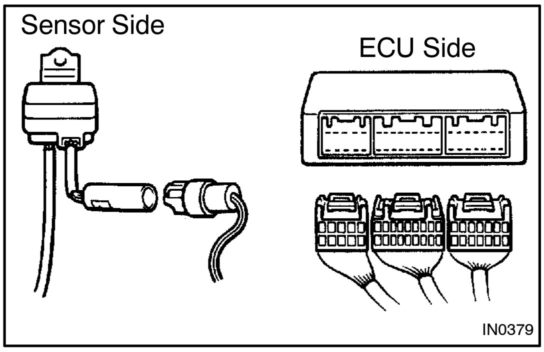
- It is rarely the case that a wire is broken in the middle of it. Most cases occur at the connector. In particular, carefully check the connectors of sensors and actuators.
- Faulty contact could be due to rusting of the connector terminals, to foreign materials entering terminals or a deformation of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

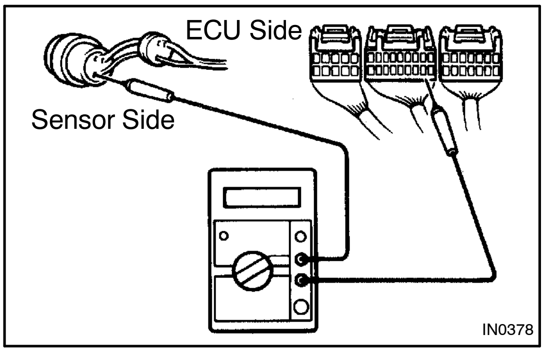
This could be due to a connect between the wire harness and the body ground or to a short occurred inside the switch etc.

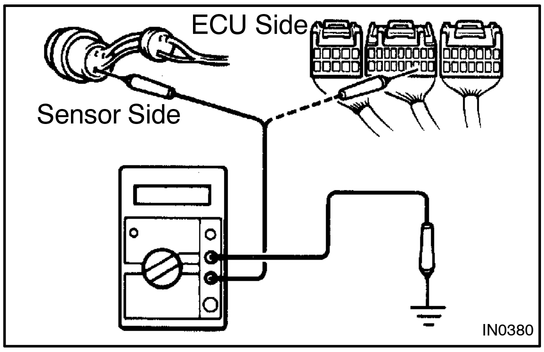
HINT:

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.

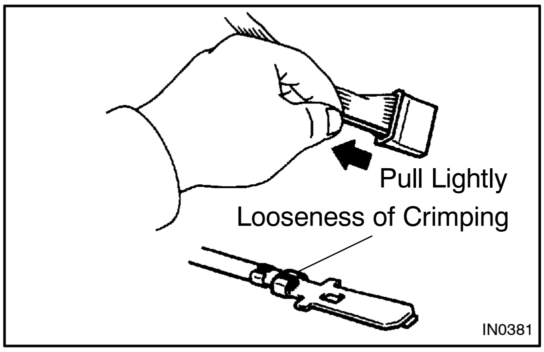


2. **CONTINUITY CHECK (OPEN CIRCUIT CHECK)**
(a) Disconnect the connectors at both ECU and sensor sides.
(b) Measure the resistance between the applicable terminals of the connectors.
HINT:
- Measure the resistance while lightly shaking the wire harness vertically and horizontally.
- When tester probes 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.

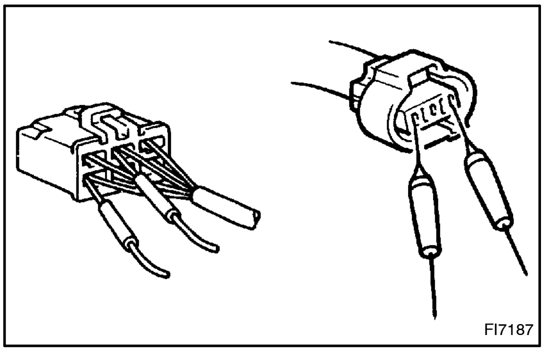




3. **RESISTANCE CHECK (SHORT CIRCUIT CHECK)**
(a) Disconnect the connectors on both ends.
(b) Measure the resistance between the applicable terminals of the connectors and body ground. Be sure to carry out this check on the connectors on both ends.
Resistance: 1 MΩ or higher
HINT:
Measure the resistance while lightly shaking the wire harness vertically and horizontally.

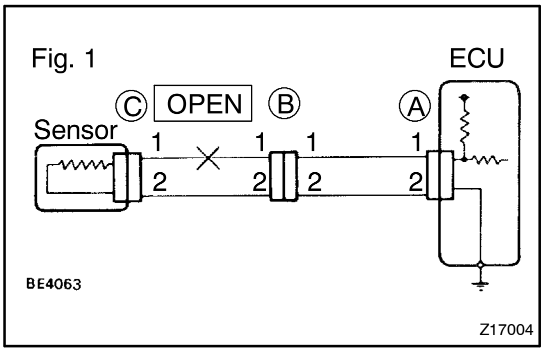


4. **VISUAL CHECK AND CONTACT PRESSURE CHECK**
(a) Disconnect the connectors at both ends.
(b) Check for rust or foreign material, etc. in the terminals of the connectors.
(c) Check crimped portions for looseness or damage and check if the terminals are secured in lock portion.
HINT:
The terminals should not come out when pulled lightly.
(d) Prepare a test male terminal and insert it in the female terminal, then pull it out.
NOTICE:
When testing a gold-plated female terminal, always use a gold-plated male terminal.
HINT:
When the test terminal is pulled out more easily than others, there may be poor contact in that section.



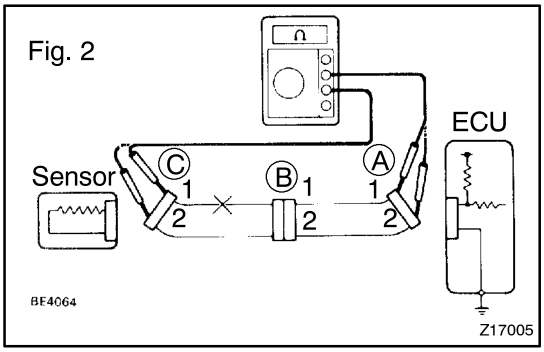
5. CONNECTOR HANDLING

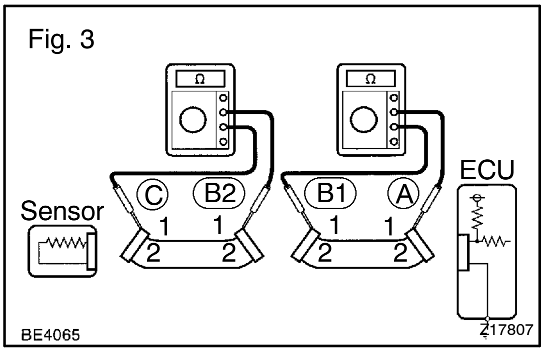
When inserting tester probes into a connector, insert them from the rear of the connector. When necessary, use mini test leads. For water resistant connectors which cannot be accessed from behind, take good care not to deform the connector terminals.



6. CHECK OPEN CIRCUIT

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

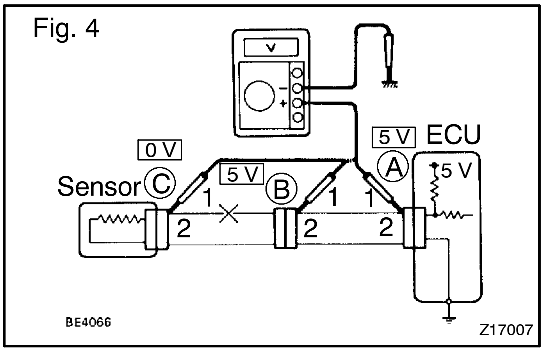




(a) Check the continuity.

(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".

(2) Disconnect connector "B" and measure the resistance between them.
In the case of Fig.3,
Between terminal 1 of connector "A" and terminal 1 of connector "B1" → Continuity
Between terminal 1 of connector "B2" 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 "B2" and terminal 1 of connector "C".



(b) Check the voltage.

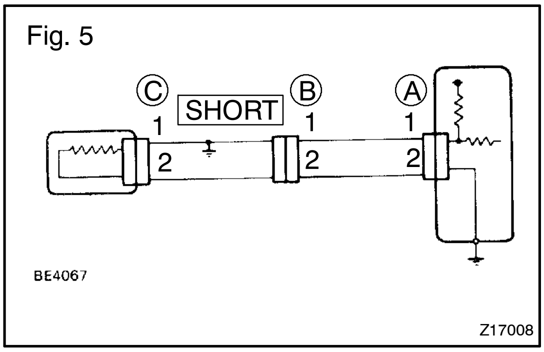
In a circuit in which voltage is applied (to the ECU connector terminal), an open circuit can be checked for by conducting a voltage check.

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:

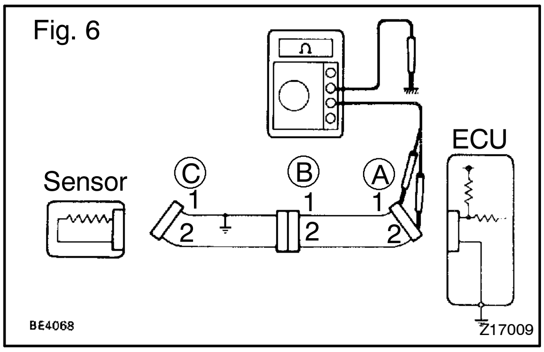
5V: Between Terminal 1 of connector ”A” and Body Ground
5V: Between Terminal 1 of connector ”B” and Body Ground
0V: Between Terminal 1 of connector ”C” and Body Ground

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”.



7. CHECK SHORT CIRCUIT

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



Check the continuity with ground.

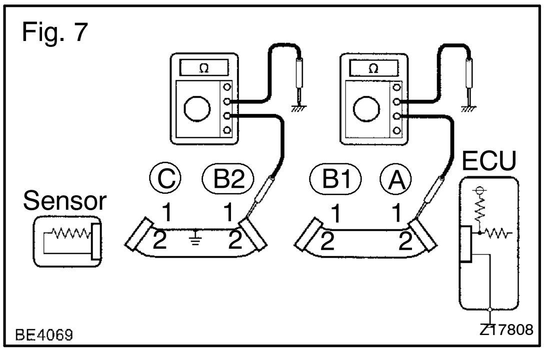
(1) Disconnect connectors ”A” and ”C” and measure the resistance between terminal 1 and 2 of connector ”A” and body ground.

In the case of Fig.6

Between terminal 1 of connector ”A” and body ground → Continuity (short)

Between terminal 2 of connector ”A” and body ground → No continuity

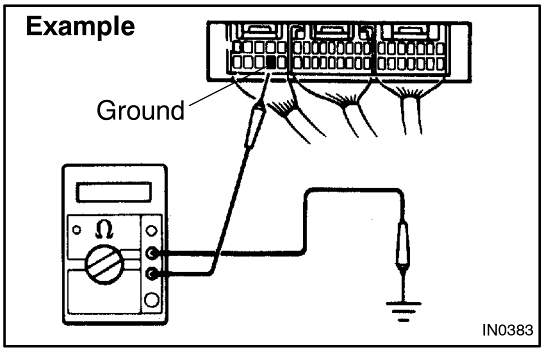
Therefore, it is found out that there is a short circuit between terminal 1 of connector ”A” and terminal 1 of connector ”C”.



(2) Disconnect connector "B" and measure the resistance between terminal 1 of connector "A" and body ground, and terminal 1 of connector "B2" and body ground.
Between terminal 1 of connector "A" and body ground → No continuity
Between terminal 1 of connector "B2" and body ground → Continuity (short)
Therefore, it is found out that there is a short circuit between terminal 1 of connector "B2" and terminal 1 of connector "C".

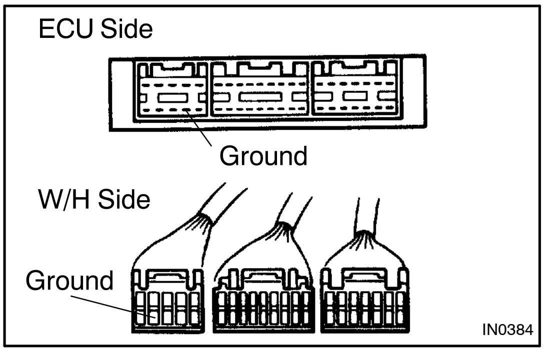
8. CHECK AND REPLACE ECU

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 normal functioning one and check that 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.

TERMS

IN03P-02

ABBREVIATIONS USED IN THIS MANUAL

Abbreviations	Meaning
ATF	Automatic Transmission Fluid
BTDC	Before Top Dead Center
CB	Circuit Breaker
DOHC	Double Over Head Cam
DP	Dash Pot
ECU	Electronic Control Unit
ELR	Emergency Locking Retractor
ESA	Electronic Spark Advance
EX	Exhaust (Manifold, Valve)
FIPG	Formed in Place Gasket
FL	Fusible Link
FPU	Fuel Pressure Up
Fr	Front
HAC	High Altitude Compensation
IG	Ignition
IIA	Integrated Ignition Assembly
IN	Intake (Manifold, Valve)
J/B	Junction Block
LED	Light Emitting Diode
LH	Left-Hand
LSPV	Load Sensing Proportioning valve
Max.	Maximum
Min.	Minimum
MP	Multipurpose
O/S	Oversize
P&BV	Proportioning and Bypass Valve
PCV	Positive Crankcase Ventilation
RH	Right-Hand
Rr	Rear
SSM	Special Service Materials
SST	Special Service Tools
STD	Standard
SW	Switch
TDC	Top Dead center
TEMP.	Temperature
T/M	Transmission
U/S	Undersize
VCV	Vacuum Control Valve
VSV	Vacuum Switching Valve
VTV	Vacuum Transmitting Valve
w/	With
w/o	Without

IN03Q-01

GLOSSARY OF SAE AND TOYOTA TERMS

This glossary lists all SAE-J1930 terms and abbreviations used in this manual in compliance with SAE recommendations, as well as their TOYOTA equivalents.

SAE ABBREVIATIONS	SAE TERMS	TOYOTA TERMS ( )--ABBREVIATIONS
AIR	Secondary Air Injection	Air Injection (AI)
B+	Battery Positive Voltage	+B, Battery Voltage
BARO	Barometric Pressure	-
CFI	Continuous Fuel Injection	-
CKP	Crankshaft Position	Crank Angle
CL	Closed Loop	Closed Loop
CMP	Camshaft Position	Cam Angle
CTOX	Continuous Trap Oxidizer	-
CTP	Closed Throttle Position	-
DFI	Direct Fuel Injection (Diesel)	Direct Injection (DI)
DI	Distributor Ignition	-
DLC1 DLC2 DLC3	Data Link Connector 1 Data Link Connector 2 Data Link Connector 3	1: Check Connector 2: Total Diagnosis Comunication Link (TDCL) 3: OBD II Diagnostic Connector
DTC	Diagnostic Trouble Code	Diagnostic Code
DTM	Diagnostic Test Mode	-
ECL	Engine Control Level	-
ECM	Engine Control Module	Engine ECU (Electronic Control Unit)
ECT	Engine Coolant Temperature	Coolant Temperature, Water Temperature (THW)
EEPROM	Electrically Erasable Programmable Read Only Memory	Electrically Erasable Programmable Read Only Memory (EEPROM), Erasable Programmable Read Only Memory (EPROM)
EFE	Early Fuel Evaporation	Cold Mixture Heater (CMH), Heat Control Valve (HCV)
EI	Electronic Ignition	Distributorless Ignition (DI)
EM	Engine Modification	Engine Modification (EM)
EPROM	Erasable Programmable Read Only Memory	Programmable Read Only Memory (PROM)
FEEPROM	Flash Electrically Erasable Programmable Read Only Memory	-
FEPROM	Flash Erasable Programmable Read Only Memory	-
FF	Flexible Fuel	-
FP	Fuel Pump	Fuel Pump
GEN	Generator	Alternator
GND	Ground	Ground (GND)
IAC	Idle Air Control	Idle Speed Control (ISC)
IAT	Intake Air Temperature	Intake or Inlet Air Temperature
ICM	Ignition Control Module	-
IFI	Indirect Fuel Injection	Indirect Injection
IFS	Inertia Fuel-Shutoff	-
ISC	Idle Speed Control	-
KS	Knock Sensor	Knock Sensor
MAF	Mass Air Flow	Air Flow Meter

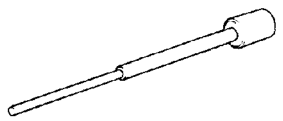
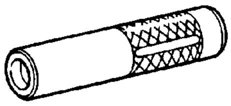
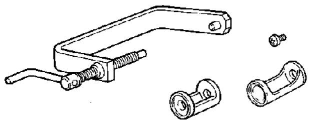
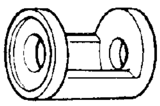
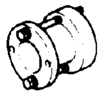
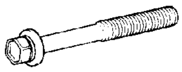
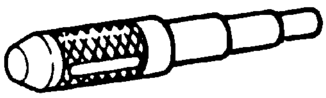
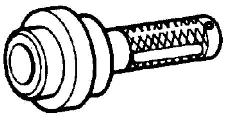
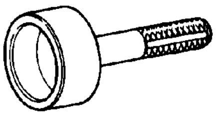
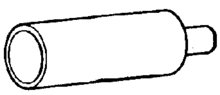
MAP	Manifold Absolute Pressure	Manifold Pressure Intake Vacuum
MC	Mixture Control	Electric Bleed Air Control Valve (EBCV) Mixture Control Valve (MCV) Electric Air Control Valve (EACV)
MDP	Manifold Differential Pressure	-
MFI	Multiport Fuel Injection	Electronic Fuel Injection (EFI)
MIL	Malfunction Indicator Lamp	Check Engine Light
MST	Manifold Surface Temperature	-
MVZ	Manifold Vacuum Zone	-
NVRAM	Non-Volatile Random Access Memory	-
OBD	On-Board Diagnostic	On-Board Diagnostic (OBD)
OP	Open Loop	Open Loop
PAIR	Pulsed Secondary Air Injection	Air Suction (AS)
PCM	Powertrain Control Module	-
PROM	Programmable Read Only Memory	-
RAM	Random Access Memory	Random Access Memory (RAM)
RM	Relay Module	-
ROM	Read Only Memory	Read Only Memory (ROM)
RPM	Engine Speed	Engine Speed
SFI	Sequential Multiport Fuel Injection	Electronic Fuel Injection (EFI), Sequential Injection
SRI	Service Reminder Indicator	-
SRT	System Readiness Test	-
ST	Scan Tool	-
TB	Throttle Body	Throttle Body
TBI	Throttle Body Fuel Injection	Single Point Injection Central Fuel Injection (Ci)
TCM	Transmission Control Module	Transmission ECU (Electronic Control Unit)
TP	Throttle Position	Throttle Position
TR	Transmission Range	-
TVV	Thermal Vacuum Valve	Bimetallic Vacuum Switching Valve (BVSV) Thermostatic Vacuum Switching Valve (TVSV)
VAF	Volume Air Flow	Air Flow Meter
VR	Voltage Regulator	Voltage Regulator
WOT	Wide Open Throttle	Full Throttle

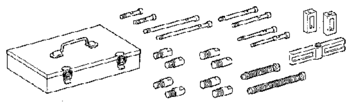
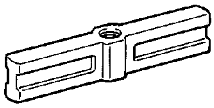
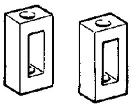
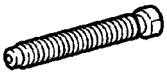
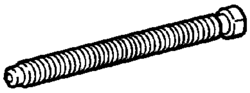
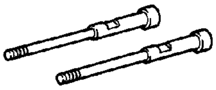
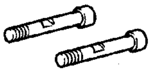
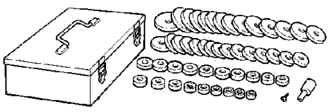
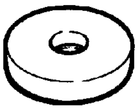
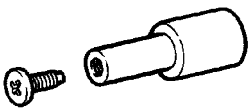
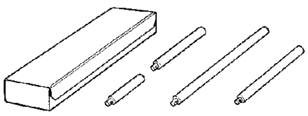
INTRODUCTION

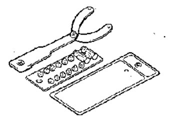
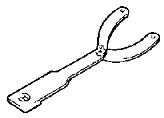
ENGINE MECHANICAL

SST (Special Service Tools)

PP0YR-01

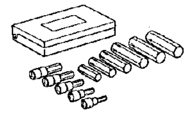
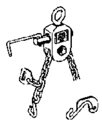
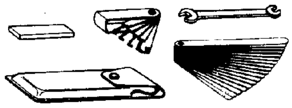
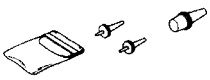
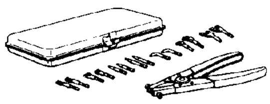
	09201-01055	Valve Guide Bushing Remover & Re placer 5.5	
	09201-41020	Valve Stem Oil Seal Replacer	
	09202-70020	Valve Spring Compressor	
	(09202-00010)	Attachment	
	09213-70010	Crankshaft Pulley Holding Tool	
	(90105-08076)	Bolt	
	09222-30010	Connecting Rod Bushing Remover & Replacer	
	09223-46011	Crankshaft Front Oil Seal Replacer	Camshaft oil seal Crankshaft pulley Crankshaft timing pulley
	09223-56010	Crankshaft Rear Oil Seal Replacer	
	(09316-00011)	Replacer Pipe	Crankshaft front oil seal
	09330-00021	Companion Flange Holding Tool	Crankshaft pulley
	09843-18040	Diagnosis Check Wire No.2	

	09950-50010	Puller C Set	
	(09951-05010)	Hanger 150	Crankshaft pulley Crankshaft timing pulley
	(09952-05010)	Slide Arm	Crankshaft pulley Crankshaft timing pulley
	(09953-05010)	Center Bolt 100	Crankshaft pulley Crankshaft timing pulley
	(09953-05020)	Center Bolt 150	Crankshaft pulley Crankshaft timing pulley
	(09954-05010)	Claw No.1	Crankshaft timing pulley
	(09954-05020)	Claw No.2	Crankshaft pulley
	09950-60010	Replacer Set	
	(09951-00240)	Replacer 24	Spark plug tube
	(09951-00440)	Replacer 44	Spark plug tube
	(09952-06010)	Adapter	Spark plug tube
	09950-70010	Handle Set	
	(09951-07100)	Handle 100	Spark plug tube Valve guide bushing

	09960-10010	Variable Pin Wrench Set	
	(09962-01000)	Variable Pin Wrench Arm Assy	Camshaft timing pulley Camshaft sub-gear
	(09963-00350)	Pin 3.5	Camshaft timing pulley
	(09963-00500)	Pin 5	Camshaft sub-gear

PP0YS-01

RECOMMENDED TOOLS

	09040-00010	Hexagon Wrench Set .	
	09090-04010	Engine Sling Device .	For suspension engine
	09200-00010	Engine Adjust Kit .	
	09258-00030	Hose Plug Set .	Plug for vacuum hose, fuel hose etc.
	09904-00010	Expander Set .	

PP0YT-01

EQUIPMENT

Caliper gauge	
Compression gauge	
Connecting rod aligner	
Cylinder gauge	
Dial indicator	
Dye penetrant	
Engine tune-up tester	
Heater	
Magnetic finger	
Micrometer	
OBD II scan tool	
Piston ring compressor	
Piston ring expander	
Plastigage	
Precision straight edge	
Soft brush	
Spring tester	Valve spring
Steel square	Valve spring
Thermometer	
Torque wrench	
Valve seat cutter	
Vernier calipers	

PP0YU-01

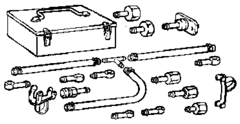
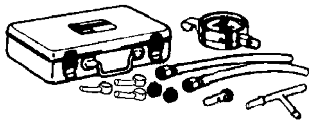
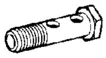
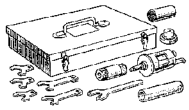
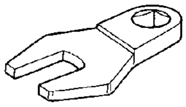
SSM (Service Special Materials)

08826-00080	Seal Packing Black or equivalent (FIPG)	Camshaft bearing cap Cylinder head semi-circular plug Cylinder head cover Rear oil sear retainer
08826-00100	Seal Packing 1282B, THREE BOND 1282B or equivalent (FIPG)	Coolant drain union
08833-00070	Adhesive 1324, THREE BOND 1324 or equivalent	Drive plate bolt Spark plug tube
08833-00080	Adhesive 1344 THREE BOND 1344 LOCTITE 242 or equivalent	No.1 idler pulley bolt

SFI

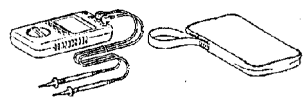
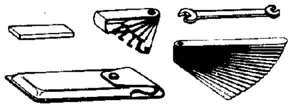
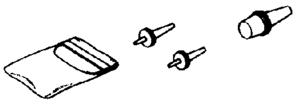
SST (Special Service Tools)

PP0YV-01

	09268-41047	Injection Measuring Tool Set	
	09268-45014	EFI Fuel Pressure Gauge	
	(09268-41190)	Adaptor	
	(90405-06167)	I Union	
	09612-24014	Steering Gear Housing Overhaul Tool Set	
	(09617-24011)	Steering Rack Wrench	Fuel pressure pulsation damper
	09816-30010	Oil Pressure Switch Socket	Knock sensor
	09842-30070	Wiring "F" EFI Inspection	
	09843-18020	Diagnosis Check Wire	

PP0YW-01

RECOMMENDED TOOLS

	09082-00040	TOYOTA Electrical Tester.	
	09200-00010	Engine Adjust Kit .	
	09258-00030	Hose Plug Set .	Plug for vacuum hose, fuel hose etc.

COOLING

PP0Y9-01

EQUIPMENT

Gasket scraper	
Heater	Thermostat
Thermometer	Thermostat
Torque wrench	

PP0YB-01

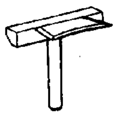
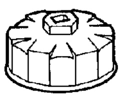
SSM (Service Special Materials)

	08826-00100	Seal Packing 1282B, THREE BOND 1282B or equivalent (FIPG)	Water pump Water inlet housing

LUBRICATION

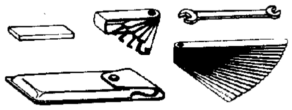
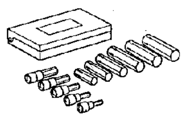
SST (Special Service Tools)

PP0Y2-01

	09032-00100	Oil Pan Seal Cutter	
	09228-07501	Oil Filter Wrench	

PP0Y3-01

RECOMMENDED TOOLS

	09200-00010	Engine Adjust Kit .	
	09040-00010	Hexagon Wrench Set .	

PP0Y4-01

EQUIPMENT

Oil pressure gauge	
Precision straight edge	
Torque wrench	

PP0Y6-01

LUBRICANT

Item	Capacity	Classification
Engine oil Dry fill Drain and refill w/ Oil filter change w/o Oil filter change	 7.0 liters (7.4 US qts, 6.2 Imp. qts) 5.3 liters (5.6 US qts, 4.9 Imp. qts) 5.0 liters (5.3 US qts, 4.4 Imp. qts)	API grade SH, Energy-Conserving II or SJ, Energy-Conserving or ILSAC multigrade engine oil. SAE 5W-30 is the best choice for your vehicle, for good fuel economy, and good starting in cold weather.

PP0Y5-01

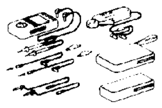
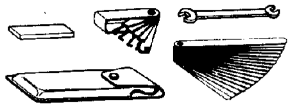
SSM (Service Special Materials)

08826-00080	Seal Packing Black or equivalent (FIPG)	Oil pump No.1 oil pan No.2 oil pan
08833-00080	Adhesive 1344 THREE BOND 1344 LOCTITE 242 or equivalent	Oil pressure switch No.1 idler pulley bolt

IGNITION

RECOMMENDED TOOLS

PP0YK-01

	09082-00050	TOYOTA Electrical Tester Set.	
	09200-00010	Engine Adjust Kit .	

PP0YL-01

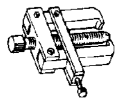
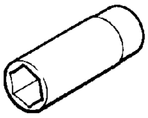
EQUIPMENT

Megger (Insulation resistance meter)	Spark plug
Spark plug cleaner	
Torque wrench	
Ohmmeter	

STARTING

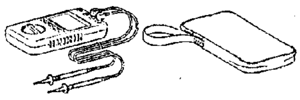
SST (Special Service Tools)

PP0YH-01

	09286-46011	Injection Pump Spline Shaft Puller	Armature front bearing
	09810-38140	Starter Magnet Switch Nut Wrench 14	
	09820-00030	Alternator Rear Bearing Replacer	Armature bearing

PP0YI-01

RECOMMENDED TOOLS

	09082-00040	TOYOTA Electrical Tester.	

PP0YJ-01

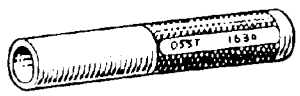
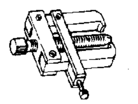
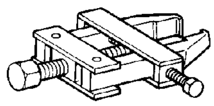
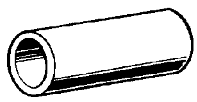
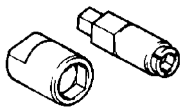
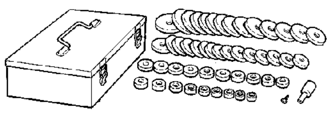
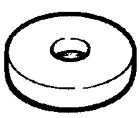
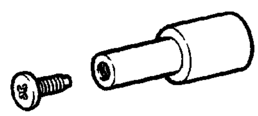
EQUIPMENT

Dial indicator	Commutator
Magnetic finger	Steel ball
Pull scale	Brush spring
Sandpaper	Commutator
Torque wrench	
V-block	Commutator
Vernier calipers	Commutator, Brush

CHARGING

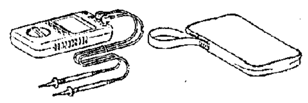
SST (Special Service Tools)

PP0YE-01

	09285-76010	Injection Pump Camshaft Bearing Cone Replacer	Rotor rear bearing cover
	09286-46011	Injection Pump Spline Shaft Puller	Rectifier end frame
	09820-00021	Alternator Rear Bearing Puller	
	09820-00030	Alternator Rear Bearing Replacer	
	09820-63010	Alternator Pulley Set Nut Wrench Set	
	09950-60010	Replacer Set	Rotor front bearing
	(09951-00260)	Replacer 26	
	(09951-00500)	Replacer 50	
	(09952-06010)	Adapter	

PP0YF-01

RECOMMENDED TOOLS

	09082-00040	TOYOTA Electrical Tester.	

PP0YG-01

EQUIPMENT

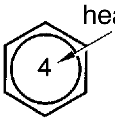
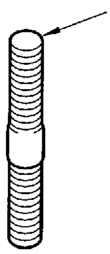
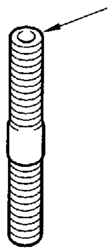
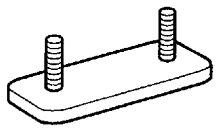
Ammeter(A)	
Torque wrench	
Vernier calipers	Rotor (Slip ring)

PREPARATION

STANDARD BOLT

HOW TO DETERMINE BOLT STRENGTH

SS00F-01

	Mark	Class
Hexagon head bolt	 Bolt head No. 4- 5- 6- 7- 8- 9- 10- 11-	4T 5T 6T 7T 8T 9T 10T 11T
	 No mark	4T
Hexagon flange bolt w/ washer hexagon bolt	 No mark	4T
Hexagon head bolt	 2 Protruding lines	5T
Hexagon flange bolt w/ washer hexagon bolt	 2 Protruding lines	6T
Hexagon head bolt	 3 Protruding lines	7T
Hexagon head bolt	 4 Protruding lines	8T
Hexagon flange bolt w/ washer hexagon bolt	 4 Protruding lines	9T
Hexagon flange bolt w/ washer hexagon bolt	 5 Protruding lines	10T
Hexagon flange bolt w/ washer hexagon bolt	 6 Protruding lines	11T
Stud bolt	No mark 	4T
	Grooved 	6T
Welded bolt		4T

V06821

SS00G-01

SPECIFIED TORQUE FOR STANDARD BOLTS

Class	Diameter mm	Pitch mm	Specified torque					
			Hexagon head bolt			Hexagon flange bolt		
			N·m	kgf·cm	ft·lbf	N·m	kgf·cm	ft·lbf
4T	6	1	5	55	48 in.·lbf	6	60	52 in.·lbf
	8	1.25	12.5	130	9	14	145	10
	10	1.25	26	260	19	29	290	21
	12	1.25	47	480	35	53	540	39
	14	1.5	74	760	55	84	850	61
	16	1.5	115	1,150	83	—	—	—
5T	6	1	6.5	65	56 in.·lbf	7.5	75	65 in.·lbf
	8	1.25	15.5	160	12	17.5	175	13
	10	1.25	32	330	24	36	360	26
	12	1.25	59	600	43	65	670	48
	14	1.5	91	930	67	100	1,050	76
	16	1.5	140	1,400	101	—	—	—
6T	6	1	8	80	69 in.·lbf	9	90	78 in.·lbf
	8	1.25	19	195	14	21	210	15
	10	1.25	39	400	29	44	440	32
	12	1.25	71	730	53	80	810	59
	14	1.5	110	1,100	80	125	1,250	90
	16	1.5	170	1,750	127	—	—	—
7T	6	1	10.5	110	8	12	120	9
	8	1.25	25	260	19	28	290	21
	10	1.25	52	530	38	58	590	43
	12	1.25	95	970	70	105	1,050	76
	14	1.5	145	1,500	108	165	1,700	123
	16	1.5	230	2,300	166	—	—	—
8T	8	1.25	29	300	22	33	330	24
	10	1.25	61	620	45	68	690	50
	12	1.25	110	1,100	80	120	1,250	90
9T	8	1.25	34	340	25	37	380	27
	10	1.25	70	710	51	78	790	57
	12	1.25	125	1,300	94	140	1,450	105
10T	8	1.25	38	390	28	42	430	31
	10	1.25	78	800	58	88	890	64
	12	1.25	140	1,450	105	155	1,600	116
11T	8	1.25	42	430	31	47	480	35
	10	1.25	87	890	64	97	990	72
	12	1.25	155	1,600	116	175	1,800	130

V00079

ENGINE MECHANICAL

SS0HU-01

SERVICE DATA

Compression pressure	at 250 rpm STD	1,226 kPa (12.5 kgf/cm^2, 178 psi) or more
	Minimum	981 kPa (10.0 kgf/cm^2, 142 psi)
	Difference of pressure between each cylinder	98 kPa (1.0 kgf/cm^2, 14 psi) or less
Valve clearance	at cold Intake	0.15 – 0.25 mm (0.006 – 0.010 in.)
	Exhaust	0.25 – 0.35 mm (0.010 – 0.014 in.)
	Valve clearance adjusting shim No.00	2.000 mm (0.0787 in.)
	No.02	2.020 mm (0.0795 in.)
	No.04	2.040 mm (0.0803 in.)
	No.06	2.060 mm (0.0811 in.)
	No.08	2.080 mm (0.0819 in.)
	No.10	2.100 mm (0.0827 in.)
	No.12	2.120 mm (0.0835 in.)
	No.14	2.140 mm (0.0843 in.)
	No.16	2.160 mm (0.0850 in.)
	No.18	2.180 mm (0.0858 in.)
	No.20	2.200 mm (0.0866 in.)
	No.22	2.220 mm (0.0874 in.)
	No.24	2.240 mm (0.0882 in.)
	No.26	2.260 mm (0.0890 in.)
	No.28	2.280 mm (0.0898 in.)
	No.30	2.300 mm (0.0906 in.)
	No.32	2.320 mm (0.0913 in.)
	No.34	2.340 mm (0.0921 in.)
	No.36	2.360 mm (0.0929 in.)
	No.38	2.380 mm (0.0937 in.)
	No.40	2.400 mm (0.0945 in.)
	No.42	2.420 mm (0.0953 in.)
	No.44	2.440 mm (0.0961 in.)
	No.46	2.460 mm (0.0969 in.)
	No.48	2.480 mm (0.0976 in.)
	No.50	2.500 mm (0.0984 in.)
	No.52	2.520 mm (0.0992 in.)
	No.54	2.540 mm (0.1000 in)
	No.56	2.560 mm (0.1008 in.)
	No.58	2.580 mm (0.1016 in.)
	No.60	2.600 mm (0.1024 in.)
	No.62	2.620 mm (0.1031 in.)
	No.64	2.640 mm (0.1039 in.)
	No.66	2.660 mm (0.1047 in.)
	No.68	2.680 mm (0.1055 in.)
	No.70	2.700 mm (0.1063 in.)
	No.72	2.720 mm (0.1071 in.)
	No.74	2.740 mm (0.1079 in.)
	No.76	2.760 mm (0.1087 in.)
	No.78	2.780 mm (0.1094 in.)
	No.80	2.800 mm (0.1102 in.)
Ignition timing	w/ Terminals TC and E1 connected of DLC1	8 –12° BTDC @ idle
Idle speed	–	700 ± 50 rpm
Timing belt tensioner	Protrusion from housing end	10.5 – 11.5 mm (0.413 – 0.453 in.)

Cylinder head	Warpage	Maximum	0.10 mm (0.039 in.)
	Valve seat		
	Refacing angle		30°, 45°, 60°
	Contacting angle		45°
	Contacting width		1.0 - 1.4 mm (0.039 - 0.055 in.)
	Valve guide bushing bore diameter	STD	10.285 - 10.306 mm (0.4049 - 0.4057 in.)
		O/S 0.05	10.335 - 10.356 mm (0.4069 - 0.4077 in.)
	Cylinder head bolt thread inside diameter	STD	9.770 - 9.960 mm (0.3846 - 0.3921 in.)
		Minimum	9.60 mm (0.3780 in.)
Valve guide bushing	Inside diameter		5.510 - 5.530 mm (0.2169 - 0.2177 in.)
	Outside diameter (for repair part)	STD	10.333 - 10.344 mm (0.4068 - 0.4072 in.)
		O/S 0.05	10.383 - 10.394 mm (0.4088 - 0.4092 in.)
Valve	Valve overall length	STD Intake	94.80 - 95.30 mm (3.7323 - 3.7520 in.)
		Exhaust	94.85 - 95.35 mm (3.7342 - 3.7539 in.)
		Minimum Intake	94.55 mm (3.7224 in.)
		Exhaust	94.60 mm (3.7244 in.)
	Valve face angle		44.5°
	Stem diameter	Intake	5.470 - 5.485 mm (0.2154 - 0.2159 in.)
		Exhaust	5.465 - 5.480 mm (0.2152 - 0.2157 in.)
	Stem oil clearance	STD Intake	0.025 - 0.060 mm (0.0010 - 0.0024 in.)
		Exhaust	0.030 - 0.065 mm (0.0012 - 0.0026 in.)
		Maximum Intake	0.08 mm (0.0031 in.)
		Exhaust	0.10 mm (0.0039 in.)
	Margin thickness	STD	1.0 mm (0.039 in.)
		Minimum	0.5 mm (0.020 in.)
Valve spring	Deviation	Maximum	2.0 mm (0.079 in.)
	Free length		54.05 - 54.15 mm (2.1279 - 2.1319 in.)
	Installed tension	at 35.0 mm (1.378 in.)	204 - 226 N (20.8 - 23.0 kgf·cm, 45.9 - 50.7 lbf)
Valve lifter	Lifter diameter		30.966 - 30.976 mm (1.2191 - 2.2195 in.)
	Lifter bore diameter		31.000 - 31.016 mm (1.2205 - 1.2211 in.)
	Oil clearance	STD	0.024 - 0.050 mm (0.0009 - 0.0020 in.)
		Maximum	0.07 mm (0.0028 in.)
Camshaft	Thrust clearance	STD Intake	0.060 - 0.100 mm (0.0024 - 0.0039 in.)
		Exhaust	0.040 - 0.090 mm (0.0016 - 0.0035 in.)
		Maximum Intake	0.13 mm (0.0051 in.)
		Exhaust	0.12 mm (0.0047 in.)
	Journal oil clearance	STD	0.030 - 0.067 mm (0.0012 - 0.0026 in.)
		Maximum	0.10 mm (0.0039 in.)
	Journal diameter	Intake (A)	30.984 - 31.000 mm (1.2198 - 1.2205 in.)
		Others	26.954 - 26.970 mm (1.0612 - 1.0618 in.)
	Circle runout		0.08 mm (0.0031 in.)
	Cam lobe height	STD Intake	42.610 - 42.710 mm (1.6776 - 1.6815 in.)
		Exhaust	42.630 - 42.730 mm (1.6783 - 1.6823 in.)
		Minimum Intake	42.46 mm (1.6717 in.)
		Exhaust	42.48 mm (1.6724 in.)
	Camshaft gear backlash	STD	0.020 - 0.200 mm (0.0008 - 0.0079 in.)
		Maximum	0.30 mm (0.0188 in.)
	Camshaft gear spring end free distance		18.2 - 18.8 mm (0.712 - 0.740 in.)
Camshaft timing tube	Journal diameter	Green peinted mark	39.958 - 39.964 mm (1.5731 - 1.5734 in.)
		Red peinted mark	39.964 - 39.970 mm (1.5734 - 1.5736 in.)
	Journal oil clearance	Sylinder head mark A	0.036 - 0.050 mm (0.0014 - 0.0020 in.)
		Sylinder head mark B	0.038 - 0.052 mm (0.0015 - 0.0021 in)
		Maximum	0.085 mm (0.0033 in.)
Manifold	Warpage	Maximum Intake	0.15 mm (0.0059 in.)
		Exhaust	0.50 mm (0.0197 in.)

Cylinder block	Cylinder head surface warpage	Maximum	0.07 mm (0.0028 in.)
	Cylinder bore diameter	STD Mark 1	87.500 – 87.510 mm (3.4449 – 3.4453 in.)
		Mark 2	87.510 – 87.520 mm (3.4453 – 3.4457 in.)
		Mark 3	87.520 – 87.530 mm (3.4457 – 3.4461 in.)
		Maximum	87.73 mm (3.4539 in.)
	Main bearing cap bolt tension portion diameter		
		STD	7.500 – 7.600 mm (0.2953 – 0.2992 in.)
		Minimum	7.20 mm (0.2835 in.)
Piston and piston ring	Piston diameter	STD Mark 1	87.406 – 87.416 mm (3.4411 – 3.4416 in.)
		Mark 2	87.416 – 87.426 mm (3.4416 – 3.4420 in.)
		Mark 3	87.426 – 87.436 mm (3.4420 – 3.4424 in.)
	Piston oil clearance	STD	0.084 – 0.104 mm (0.0033 – 0.0041 in.)
		Maximum	0.124 mm (0.0049 in.)
	Piston ring groove clearance	No.1	0.020 – 0.070 mm (0.0008 – 0.0028 in.)
		No.2	0.010 – 0.050 mm (0.0004 – 0.0020 in.)
	Piston ring end gap	STD No.1	0.250 – 0.450 mm (0.0098 – 0.0177 in.)
		No.2	0.500 – 0.700 mm (0.0197 – 0.0276 in.)
		Oil	0.150 – 0.500 mm (0.0059 – 0.0197 in.)
		Maximum No.1	1.05 mm (0.0413 in.)
		No.2	1.30 mm (0.0512 in.)
		Oil	1.10 mm (0.0433 in.)
Connecting rod	Thrust clearance	STD	0.160 – 0.290 mm (0.0063 – 0.0138 in.)
		Maximum	0.35 mm (0.0138 in.)
	Connecting rod thickness		22.880 – 22.920 mm (0.9008 – 0.9024 in.)
	Connecting rod oil clearance	STD	0.027 – 0.053 mm (0.0011 – 0.0021 in.)
		Maximum	0.065 mm (0.0026 in.)
	Connecting rod bearing center wall thickness		
	(Reference)	Mark 2	1.484 – 1.487 mm (0.0584 – 0.0585 in.)
		Mark 3	1.487 – 1.490 mm (0.0585 – 0.0587 in.)
		Mark 4	1.490 – 1.493 mm (0.0587 – 0.0588 in.)
		Mark 5	1.493 – 1.496 mm (0.0588 – 0.0589 in.)
		Mark 6	1.496 – 1.499 mm (0.0589 – 0.0590 in.)
		Mark 7	1.499 – 1.502 mm (0.0590 – 0.0591 in.)
	Rod bend	Maximum per 100 mm (3.94 in.)	0.05 mm (0.0020 in.)
	Rod twist	Maximum per 100 mm (3.94 in.)	0.15 mm (0.0059 in.)
	Bushing inside diameter		22.005 – 22.014 mm (0.8663 – 0.8667 in.)
	Piston pin diameter		21.997 – 22.006 mm (0.8660 – 0.8664 in.)
	Bushing oil clearance	STD	0.005 – 0.011 mm (0.0002 – 0.0004 in)
		Maximum	0.05 mm (0.0020 in.)
	Connecting rod bolt tension portion diameter	STD	7.200 – 7.300 mm (0.2835 – 0.2874 in.)
		Minimum	7.00 mm (0.2756 in.)
Crankshaft	Thrust clearance	STD	0.020 – 0.220 mm (0.0008 – 0.0087 in.)
		Maximum	0.30 mm (0.0118 in.)
	Thrust washer thickness		2.440 – 2.490 mm (0.0961 – 0.0980 in.)
	Main journal bore diameter on cylinder block (with main bearing)		66.986 – 67.000 mm (2.6372 – 2.6378 in.)
	Main journal oil clearance	STD No.1 and No.5	0.017 – 0.033 mm (0.0007 – 0.0013 in.)
		Others	0.029 – 0.045 mm (0.0011 – 0.0018 in.)
		Maximum No.1 and No.5	0.043 mm (0.0017 in.)
		Others	0.055 mm (0.0022 in.)
	Main journal diameter		66.988 – 67.000 mm (2.6373 – 2.6378 in.)

Crankshaft (cont'd)	Main bearing center wall thickness (Reference)		
		No.1 and No.5 Mark 3	2.492 - 2.495 mm (0.0981 - 0.0982 in.)
		Mark 4	2.495 - 2.498 mm (0.0982 - 0.0983 in.)
		Mark 5	2.498 - 2.501 mm (0.0983 - 0.0985 in.)
		Mark 6	2.501 - 2.504 mm (0.0985 - 0.0986 in.)
		Mark 7	2.504 - 2.507 mm (0.0986 - 0.0987 in.)
		Others Mark 1	2.486 - 2.489 mm (0.0979 - 0.0980 in.)
		Mark 2	2.489 - 2.492 mm (0.0980 - 0.0981 in.)
		Mark 3	2.492 - 2.495 mm (0.0981 - 0.0982 in.)
		Mark 4	2.495 - 2.498 mm (0.0982 - 0.0983 in.)
		Mark 5	2.498 - 2.501 mm (0.0983 - 0.0985 in.)
	Crank pin diameter		51.982 - 52.000 mm (2.0465 - 2.0472 in.)
	Circle runout	Maximum	0.08 mm (0.0031 in.)
	Main journal taper and out-of-round	Maximum	0.02 mm (0.0008 in.)
	Crank pin taper and out-of-round	Maximum	0.02 mm (0.0008 in.)

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TORQUE SPECIFICATION

Part tightened		N·m	kgf·cm	ft·lbf
No.1 idler pulley, No.2 idler pulley x Cylinder Block		34.5	350	25
Drive belt tensioner x Cylinder block		16	160	12
Camshaft timing pulley x Camshaft timing tube		7.5	80	66
Timing belt tensioner x Oil pump		26	270	19
Crankshaft pulley x Crankshaft		245	2,500	181
Fan bracket x Cylinder block	12 mm head	16	160	12
	14 mm head	32	330	24
No.2 timing belt cover x Cylinder block		16	160	12
No.3 timing belt cover x Cylinder block, cylinder head		7.5	80	66 in.·lbf
Oil cooler pipe x No.3 timing belt cover, Fan bracket		7.5	80	66 in.·lbf
Drive belt idler pulley x Fan bracket		39	400	29
Exhaust manifold x Cylinder head		44	450	32
Cylinder head x Cylinder block	1st	39	400	29
	2nd	Turn 90°	Turn 90°	Turn 90°
Camshaft drive gear x Camshaft timing tube		7.5	80	66 in.·lbf
Camshaft timing tube x Camshaft		78	790	58
Straight screw plug x Camshaft timing tube		15	150	11
Camshaft bearing cap x Cylinder head	Bolt C	7.5	80	66 in.·lbf
	Others	16	160	12
Cylinder head cover x Cylinder head		6.0	60	53 in.·lbf
Engine hanger x Cylinder head		37	380	27
Front water bypass joint, Rear water bypass joint x Cylinder head		18	185	13
Intake manifold x Cylinder head		18	185	13
V-bank cover bracket x Engine hanger, Intake manifold		7.5	80	66 in.·lbf
Throttle control cable bracket x Intake manifold		18	185	13
Timing belt rear plate x Cylinder head		7.5	80	66 in.·lbf
Main bearing cap x Cylinder block	2 progressive type 1st	27	275	20
	2nd	Turn 90°	Turn 90°	Turn 90°
	Others	49	500	36
Connecting rod cap x Connecting rod	1st	25	250	18
	2nd	Turn 90°	Turn 90°	Turn 90°
Rear oil seal retainer x Cylinder block		8.0	80	71 in.·lbf
Engine coolant drain union x Cylinder block		49	500	36
Water seal plate x Cylinder block		14	145	10
Water bypass pipe x Cylinder Block		18	185	13
Front engine mounting bracket x Cylinder block		39	400	29
Rear engine mounting bracket x Transmission		61	620	45
Engine mounting pin x Engine mounting bracket		68	690	50
Engine mounting insulator x Engine mounting pin		110	1,100	80
Engine mounting insulator x Boat		47	480	35
Flywheel x Crankshaft	1st	29.5	300	22
	2nd	Turn 90°	Turn 90°	Turn 90°
Engine drive coupling x Flywheel		30	300	22
Flywheel housing x Cylinder block	14mm head	39	400	29
	17mm head	57	580	42

Flywheel housing x Transmission	44	450	32
Transmission oil cooler bracket x Exhaust manifold	8.0	80	71in.·lbf
Transmission oil cooler hose x Transmission, Oil cooler	44	450	32
Idler pully bracket x Cylinder head	39	400	29
Idler pully x Idler pully bracket	39	400	29
Engine control computer bracket x Flywheel housing	18	185	13
Engine control computer x Engine control computer case	3.0	30	27in.·lbf
Engine control computer bracket x Engine control computer case	8.0	80	71in.·lbf

SFI

SERVICE DATA

SS0HW-01

Fuel pressure regulator	Fuel pressure		304 - 343 kPa (3.1 - 3.5 kgf/cm^2, 44 - 50 psi)
Fuel pump	Resistance	at 20°C (68°F)	0.5 - 30 Ω
Injector	Resistance Injection volume Difference between each cylinder Fuel leakage	at 20°C (68°F)	13.4 - 14.2 Ω 60 - 73 cm^3 (3.7 - 4.5 cu in.) per 15 sec. 13 cm^3 (0.6 cu in.) or less One drop or less per 12 minutes
MAF meter	Resistance (THA - E2)	at -20°C (-4°F) at 20°C (68°F) at 60°C (140°F)	13.6 - 18.4 kΩ 2.21 - 2.69 kΩ 0.493 - 0.667 kΩ
Throttle body	Throttle body fully closed angle		4°
Throttle position sensor	Resistance (VC - E2)	at 20 °C (68 °F)	1.25 - 2.35 kΩ
Accelerator pedal position sensor	Resistance (VC - E2) Standard throttle valve opening percentage	at 20 °C (68 °F) Sensor lever full-open position	1.64 - 3.28 kΩ 60 % or more
Throttle control motor w/ clutch	Motor resistance Clutch resistance	at 20 °C (68 °F) at 20 °C (68 °F)	0.3 - 100 Ω 4.2 - 5.2 Ω
Camshaft timing oil control valve	Resistance	at 20°C (68°F)	6.9 - 7.9 Ω
VSV for acoustic control induction system (ACIS)	Resistance	at 20°C (68°F)	33 - 39 Ω
ECT sensor	Resistance	at -20°C (-4°F) 0°C (32°F) 20°C (68°F) 40°C (104°F) 60°C (140°F) 80°C (176°F)	10 - 20 kΩ 4 - 7 kΩ 2 - 3 kΩ 0.9 - 1.3 kΩ 0.4 - 0.7 kΩ 0.2 - 0.4 kΩ
VVT sensor	Resistance	Cold Hot	835 - 1,400 Ω 1,060 - 1,645 Ω
Fuel cut rpm		Fuel return rpm	1,400 rpm
Water temperature sender	Resistance	at 55°C (130°F) at 82°C (180°F)	158 - 202 Ω 63 - 79 Ω
Oil pressure sender	Resistance	at 0 kgf/cm^2 (0 psi) at 1.8 kgf/cm^2 (25 psi) at 7.0kgf/cm^2 (100 psi)	240 Ω 153 Ω 33.5 Ω

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TORQUE SPECIFICATION

Part tightened	N·m	kgf·cm	ft·lbf
Fuel pump bracket x Clinder block	29	300	21
Fuel pump assembly x Fuel pump bracket	7.0	70	60 in.·lbf
Fuel inlet pipe x Fuel pump	27.5	280	20
No.2 Fuel hose x Fuel pump	1.5	15	13 in.·lbf
Delivery pipe x Intake manifold	18	185	13
Thottle control cable bracket x Intake manifold	18	185	13
V-bank cover bracket x Engine hanger, Intake Manifold	7.5	80	69 in.·lbf
Fuel pressure pulsation damper x delivery pipe	39	400	29
for SST	33	340	24
Fuel pressure regulator x delivery pipe	29	300	21
FR Fuel pipe x delivery pipe	39	400	29
Throttle control motor x Throttle control motor cover	3.4	35	30 in.·lbf
Throttle control motor cover x Throttle body	3.4	35	30 in.·lbf
Accelerator pedal position sensor x Thrattle body	5.5	55	47 in.·lbf
Water bypass hose and pipe x Throttlebody	5.4	55	47 in.·lbf
Throttle body x Intake manifold	18	185	13
Camshaft oil control valve x Front bearing cap	7.5	80	66 in.·lbf
Intake air control valve x Upper intake manifold	8.5	85	75 in.·lbf
Actuator x Upper intake manifold	8.5	85	75 in.·lbf
Upper intake manifold x Lower intake manifold	18	185	13
ECT sensor x Front water bypass joint	20	200	14
Knock sensor x Cylinder block	44	450	33

COOLING

SS0HJ-01

SERVICE DATA

Thermostat	Valve opening temperature		69 - 73°C (156 - 163°F)
	Valve lift	at 85°C (185°F)	10 mm (0.39 in.) or more

SS0HK–01

TORQUE SPECIFICATION

Part tightened		N·m	kgf·cm	ft·lbf
Engine drain plug x Cylinder block		24.5	250	18
Water pump x Cylinder block	Stud Bolt and Nut	18	185	13
	Bolt	21	215	15
Water inlet housing x Water pump		18	185	13
Water outlet x Water inlet housing		19	195	14
Sea water hose x Water inlet housing		2.5	25	22 in.·lbf
Sea water pump bracket x Fan bracket,Cylinder block		38	390	28
Sea water pump x Sea water pump bracket		18	185	13
Sea water pump pully x Sea water pump		98	1,000	72
Sea water pump x No.1 Sea water hose		2.5	25	22 in.·lbf

LUBRICATION

SERVICE DATA

SS0HH-01

Oil pressure		at idle speed	29 kPa (0.3 kgf/cm^2, 4.2 psi) or more
		at 3,000 rpm	294 - 588 kPa (3.0 - 6.0 kgf/cm^2, 43 - 85 psi)
Oil pump	Tip clearance	STD	0.110 - 0.240 mm (0.0043 - 0.0094 in.)
		Maximum	0.35 mm (0.0138 in.)
	Side clearance	STD	0.030 - 0.090 mm (0.0012 - 0.0035 in.)
		Maximum	0.15 mm (0.0059 in.)
	Body clearance	STD	0.100 - 0.175 mm (0.0039 - 0.0069 in.)
		Maximum	0.30 mm (0.0118 in.)

SS0HI-01

TORQUE SPECIFICATION

Part tightened		N·m	kgf·cm	ft·lbf
No.2 oil pan x Oil drain hose		39	400	29
Oil pump body cover x Oil pump body		10	105	7
Oil pump body x Plug		49	500	36
Oil pump x Cylinder block	12 mm and 6 mm hexagon socket head	15.5	160	11
	14 mm head	30.5	310	22
Crankshaft position sensor x Oil pump		6.5	65	58 in.·lbf
Oil cooler w/ bracket x Oil pump		18	185	13
Oil strainer x Cylinder block		7.5	80	66 in.·lbf
No.1 oil pan x Cylinder block	10 mm head	7.5	80	66 in.·lbf
	12 mm head	28	290	21
	Nut	28	290	21
Oil pan baffle plate x No.1 oil pan		7.5	80	66 in.·lbf
No.2 oil pan x No.1 oil pan	Bolt	7.5	80	66 in.·lbf
	Nut	28	290	21

IGNITION

SS0HQ–01

SERVICE DATA

Firing order	–		1 – 8 – 4 – 3 – 6 – 5 – 7 – 2
Spark plug	Recommended spark plug	DENSO	SK20R11
		NGK	IFR6A11
	Correct insulation resistance		10 MΩ or more
	Correct electrode gap for new spark plug		1.1 mm (0.043 in.)
	Maximum electrode gap for used spark plug		1.2 mm (0.047 in.)
Camshaft position sensor	Resistance	Cold	835 – 1,400 Ω
		Hot	1,060 – 1,645 Ω
Crankshaft position sensor	Resistance	Cold	1,630 – 2,740 Ω
		Hot	2,065 – 3,225 Ω

SS0HR-01

TORQUE SPECIFICATION

Part tightened	N·m	kgf·cm	ft·lbf
Spark plug x Cylinder head	17.5	180	13
Ignition coil x Cylinder head cover	7.5	80	66 in.·lbf
Camshaft position sensor x LH cylinder head	7.5	80	66 in.·lbf
Crankshaft position sensor x Oil pump	6.5	65	58 in.·lbf

STARTING

SS0HO-01

SERVICE DATA

Starter	Rated voltage and output power		12 V 2.0 kW
	No-load characteristics	Current	100 A or less at 11.5 V
		rpm	2,500 rpm or more
	Brush length	STD	15.0 mm (0.591 in.)
		Minimum	9.0 mm (0.354 in.)
	Spring installed load	STD	21.5 - 27.5 N (2.2 - 2.8 kgf, 4.8 - 6.2 lbf)
		Minimum	12.7 N (1.3 kgf, 2.9 lbf)
	Commutator		
	Diameter	STD	35.0 mm (1.378 in.)
		Minimum	34.0 mm (1.339 in.)
	Undercut depth	STD	0.7 mm (0.028 in.)
		Minimum	0.2 mm (0.008 in.)
	Circle runout	Maximum	0.05 mm (0.0020 in.)
	Field frame		
	Shunt coil resistance	at 20°C (68°F)	1.5 - 1.9 Ω
	Magnetic switch		
	Contact plate for wear	Maximum	0.9 mm (0.035 in.)

SS0HP-01

TORQUE SPECIFICATION

Part tightened	N·m	kgf·cm	ft·lbf
Terminal 30 nut, Terminal C nut x Terminal bolt	17	170	13
End cover x Magnetic switch housing	3.6	37	32 in.·lbf
End cover x Brush holder	3.8	39	34 in.·lbf
Starter housing x Magnetic switch	9.3	95	82 in.·lbf
End cover with field frame x Magnetic switch	9.3	95	82 in.·lbf
Lead wire of field coil x Terminal C	5.9	60	52 in.·lbf
Wire clamp, Starter wire x Starter	9.81	98	87 in.·lbf
Starter x Cylinder block	39	400	29
Water bypass pipe x Cylinder block	18	185	13

CHARGING

SS0HM–01

SERVICE DATA

Battery	Voltage	at 20°C (68°F)	12.5 – 12.9 V
Generator	Rated output		12 V – 80 A
	Rotor coil resistance	at 20°C (68°F)	2.1 – 2.5 Ω
	Slip ring diameter	STD	14.2 mm – 14.4 mm (0.559 – 0.567 in.)
		Minimum	12.8 mm (0.504 in.)
	Brush exposed length	STD	10.5 mm (0.413 in.)
		Minimum	1.5 mm (0.059 in.)
Voltage regulator	Regulating voltage	at 25°C (77°F)	13.7 – 14.8 V
		at 115°C (239°F)	13.2 – 14.0 V

SS0HN-01

TORQUE SPECIFICATION

Part tightened	N·m	kgf·cm	ft·lbf
Bearing cover x Drive end frame	3.0	31	27 in.·lbf
Rectifier end frame without wire clip x Drive end frame	4.5	46	40 in.·lbf
Rectifier end frame with cord clip x Drive end frame	5.4	55	48 in.·lbf
Generator pulley x Rotor	110.5	1,128	81
Rectifier holder x Lead wire on rectifier end frame	2.94	30	26 in.·lbf
Voltage regulator x Rectifier end frame	2.0	20	18 in.·lbf
Voltage regulator x Rectifier holder	2.0	20	18 in.·lbf
Brush holder x Rectifier holder	2.0	20	18 in.·lbf
Brush holder x Voltage regulator	2.0	20	18 in.·lbf
Rear end cover x Rectifier holder	4.4	45	39 in.·lbf
Plate terminal x Rectifier holder	3.8	39	34 in.·lbf
Terminal insulator x Rectifier holder	6.5	66	58 in.·lbf
Generator x Cylinder block	39	400	29

SERVICE SPECIFICATIONS

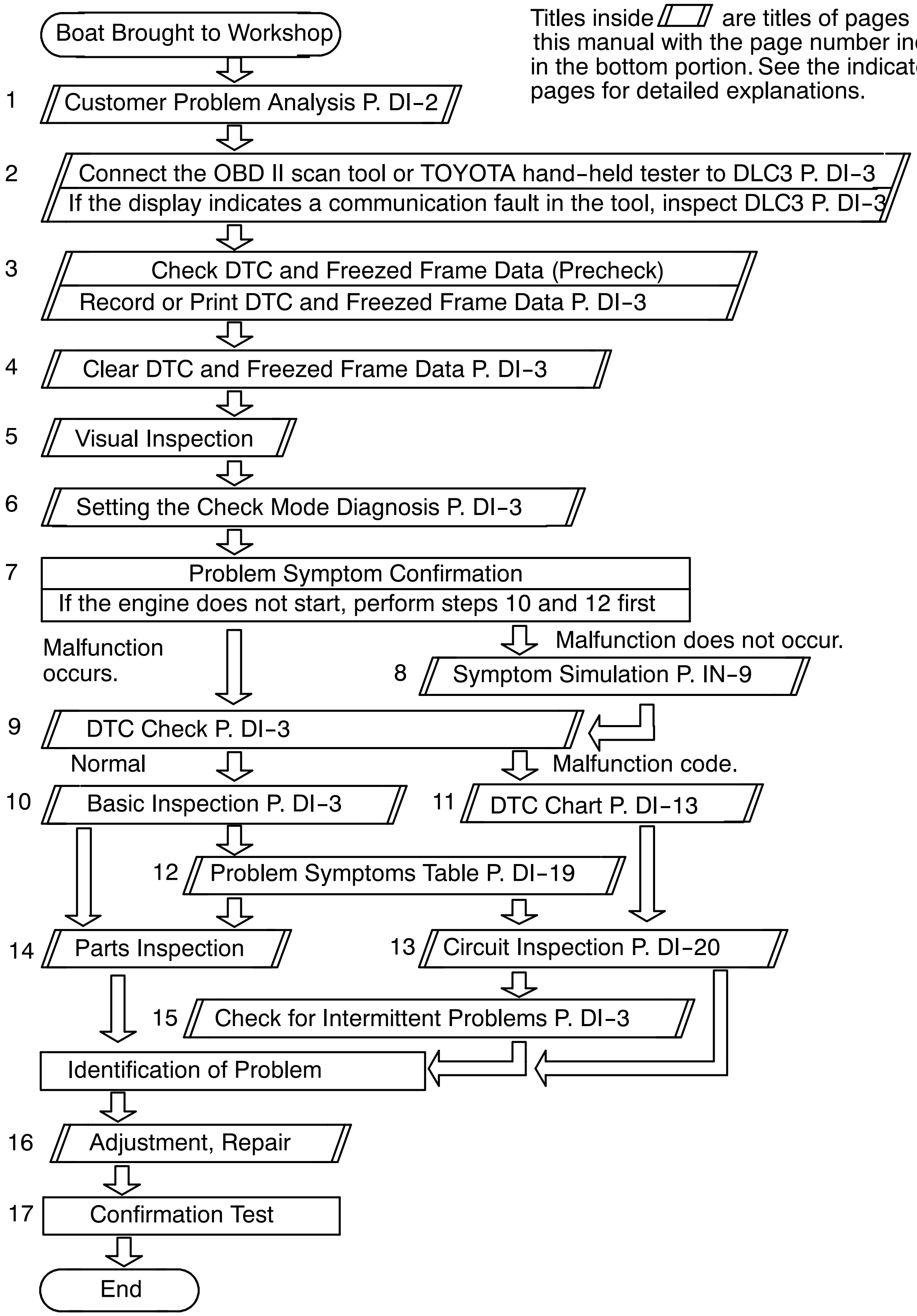
ENGINE

DI2OC-01

HOW TO PROCEED WITH TROUBLESHOOTING

Troubleshoot in accordance with the procedure on the following page.

Titles inside ▱ are titles of pages in this manual with the page number indicated in the bottom portion. See the indicated pages for detailed explanations.



DI2OD-01

CUSTOMER PROBLEM ANALYSIS CHECK

ENGINE CONTROL SYSTEM Check Sheet

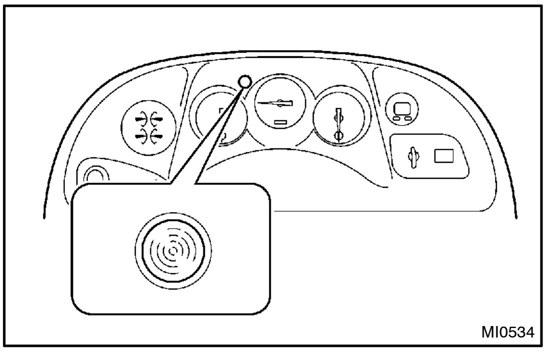
Inspector's Name ______

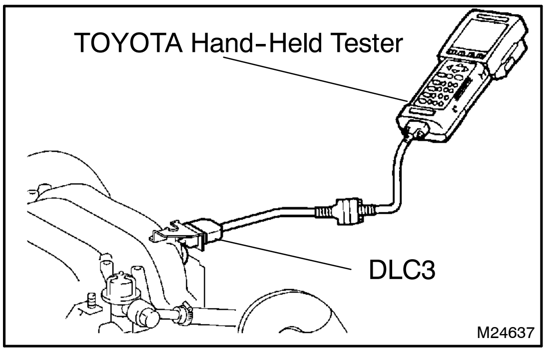
Customer's Name		Model and Model Year	
Driver's Name		Hull No.	
Date Boat Brought in		Engine Model	
License No.		Hourmeter Reading	hour

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 (rpm) ☐ Low (rpm) ☐ Rough idling ☐ Other ______
	☐ Poor Driveability	☐ Hesitation ☐ Back fire ☐ Muffler explosion (after-fire) ☐ Surging ☐ Knocking ☐ Other ______
	☐ Engine Stall	☐ Soon after starting ☐ After throttle lever depressed ☐ After throttle lever released ☐ Shifting from N to F or N to R ☐ Other ______
	☐ Others	

Dates Problem Occurred		
Problem Frequency		☐ Constant ☐ Sometimes (times per day/month) ☐ Once only ☐ Other ______
Condition When Problem Occurs	Weather	☐ Fine ☐ Cloudy ☐ Rainy ☐ Snowy ☐ Various/Other ______
	Outdoor Temperature	☐ Hot ☐ Warm ☐ Cool ☐ Cold (approx. ____°F/____°C)
	Engine Temp.	☐ Cold ☐ Warming up ☐ After warming up ☐ Any temp. ☐ Other ______
	Engine Operation	☐ Starting ☐ Just after starting (min.) ☐ Idling ☐ Racing ☐ Driving ☐ Constant speed ☐ Acceleration ☐ Deceleration ☐ Other ______
	Battery Switch	☐ On ☐ Off

Condition of MIL		☐ Remains on ☐ Sometimes light up ☐ Does not light up
DTC Inspection	Normal Mode (Precheck)	☐ Normal ☐ Malfunction code(s) (code) ☐ Freezed frame data ( )
	Check Mode	☐ Normal ☐ Malfunction code(s) (code) ☐ Freezed frame data ( )





PRE-CHECK

1. DIAGNOSIS SYSTEM

(a) Description

When troubleshooting M1UZ engine, the only difference from the usual troubleshooting procedure is that you connect to the engine the OBD II scan tool complying with SAE J1978 or TOYOTA hand-held tester, and read off various data output from the engine's ECM.

The Malfunction Indicator Lamp (MIL) lighting up when a malfunction is detected, the applicable Diagnostic Trouble Codes (DTC) prescribed by SAE J2012 are recorded in the ECM memory (See page DI-13). If the malfunction dose not reoccur in 3 trips, the MIL goes off automatically but the DTCs remain recorded in the ECM memory.

To check the DTCs, connect the OBD II scan tool or TOYOTA hand-held tester to Data Link Connector 3 (DLC3) on the engine. The OBD II scan tool or TOYOTA hand-held tester also enables you to erase the DTCs and check freezed frame data and various forms of engine data. (For operating instructions, see the OBD II scan tool's instruction book.)

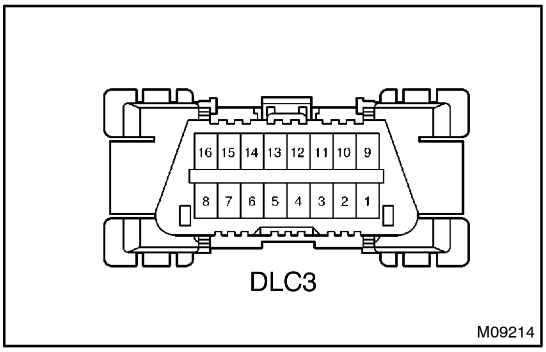
DTCs include SAE controlled codes and manufacturer controlled codes. SAE controlled codes must be set as prescribed by the SAE, while manufacturer controlled codes can be set freely by the manufacturer within the prescribed limits. (See DTC chart on page DI-13)

The diagnosis system operates in normal mode during normal boat use. It also has a check mode for technicians to simulate malfunction symptoms and troubleshoot. Most DTCs use 2 trip detection logic* to prevent erroneous detection, and ensure thorough malfunction detection. By switching the ECM to check mode when troubleshooting, the technician can cause the MIL to light up for a malfunction that is only detected once or momentarily. (TOYOTA hand-held tester only) (See step 2)

*2 trip detection logic: When a logic malfunction is first detected, the malfunction is temporarily stored in the ECM memory. If the same malfunction is detected again during the second drive test, this second detection causes the MIL to light up.

The 2 trip repeats the same mode a 2nd time. (However, the IG switch must be turned OFF between the 1st trip and 2nd trip.)

Freeze frame data:
Freeze frame data records the engine conditions (fuel system, calculator load, engine coolant temperature, fuel trim etc.) when the malfunction is detected, when trouble-shooting it is useful for determining whether the engine was running or stopped, the engine warmed up or not, the air-fuel ratio lean or rich, etc. at the time of the malfunction.

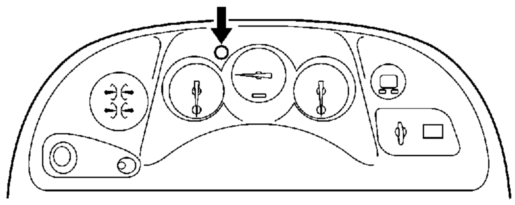


(b) Check the DLC3.
The engine's ECM uses the ISO 9141-2 communication protocol. The terminal arrangement of DLC3 complies with SAE J1962 and matches the ISO 9141-2 format.

Terminal No.	Connection / Voltage or Resistance	Condition
7	Bus ⊕ Line / Pulse generation	During transmission
4	Chassis Ground ↔ Body Ground / 1 Ω or less	Always
16	Battery Positive ↔ Body Ground / 9 ~ 14 V	Always

HINT:
If your display shows "UNABLE TO CONNECT TO ENGINE" when you have connected the cable of the OBD II scan tool or TOYOTA hand-held tester to DLC3, turned the ignition switch ON and operated the scan tool, there is a problem on the engine side or tool side.

- If communication is normal when the tool is connected to another engine, inspect DLC3 on the original engine.
- If communication is still not possible when the tool is connected to another engine, the problem is probably in the tool itself, so consult the Service Department listed in the tool's instruction manual.


M16433

2. INSPECT DIAGNOSIS (Normal Mode)

(a) Check the MIL.

(1) The MIL comes on when the ignition switch is turned ON and the engine is not running.

HINT:
If the MIL does not light up, troubleshoot the combination meter.

(2) When the engine started, the MIL should go off. If the lamp remains on, the diagnosis system has detected a malfunction or abnormality in the system.

(b) Check the DTC.

NOTICE:
TOYOTA hand-held tester only: When the diagnosis system is switched from normal mode to check mode, it erases all DTCs and freezed frame data recorded in normal mode. So before switching modes, always check the DTCs and freezed frame data, and note them down.

(1) Prepare the OBD II scan tool (complying with SAE J1978) or TOYOTA hand-held tester.

(2) Connect the OBD II scan tool or TOYOTA hand-held tester to DLC3 at the lower left of the instrument panel.

(3) Turn the ignition switch ON and push the OBD II scan tool or TOYOTA hand-held tester switch ON.

(4) Use the OBD II scan tool or TOYOTA hand-held tester to check the DTCs and freezed frame data, note them down. (For operating instructions, see the OBD II scan tool's instruction book.)

(5) See DI-13 to confirm the details of the DTCs.

NOTICE:
When simulating symptoms with an OBD II scan tool (excluding TOYOTA hand-held tester) to check the DTCs, use normal mode. For code on the DTC chart subject to "2 trip detection logic", turn the ignition switch OFF after the symptom is simulated the first time. Then repeat the simulation process again. When the problem has been simulated twice, the MIL lights up and the DTCs are recorded in the ECM.

(c) Clear the DTC.

The DTCs and freezed frame data will be erased by either action.

(1) Operating the OBD II scan tool (complying with SAE J1978) or TOYOTA hand-held tester to erase the codes. (See the OBD II scan tool's instruction book for operating instructions.)

(2) Disconnecting the battery terminals or EFI fuse.

NOTICE:

If the TOYOTA hand-held tester switches the ECM from normal mode to check mode or vice-versa, or if the ignition switch is turned from ON to ACC or OFF during check mode, the DTCs and freezed frame data will be erased.

3. INSPECT DIAGNOSIS (Check Mode)

TOYOTA hand-held tester only:

Compared to the normal mode, the check mode has an increased sensitivity to detect malfunctions.

Furthermore, the same diagnostic items which are detected in the normal mode can also be detected in the check mode.

(a) Check the DTC.

(1) Initial conditions
- Battery positive voltage 11V or more.
- Throttle valve fully closed.
- Transmission in "N" position.

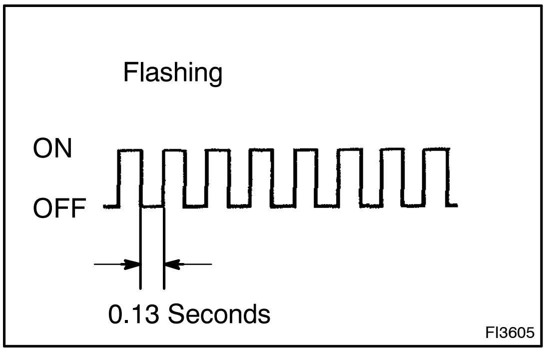
(2) Turn the ignition switch OFF.

(3) Prepare the TOYOTA hand-held tester.

(4) Connect the TOYOTA hand-held tester to the DLC3 in the fuse box at the lower left of the instrument panel.

(5) Turn the ignition switch ON and push the TOYOTA hand-held tester switch ON.

(6) Switch the TOYOTA hand-held tester normal mode to check mode. (Check that the MIL flashes.)



NOTICE:

If the TOYOTA hand-held tester switches the ECM from normal mode to check mode or vice-versa, or if the ignition switch is turned from ON to ACC or OFF during check mode, the DTCs and freezed frame data will be erased.

(7) Start the engine. (The MIL goes out after the engine start.)

(8) Simulate the conditions of the malfunction described by the customer.

NOTICE:

Leave the ignition switch ON until you have checked the DTCs, etc.

(9) After simulating the malfunction conditions, use the TOYOTA hand-held tester diagnosis selector to check the DTCs and freezed frame data, etc.

HINT:

Take care not to turn the ignition switch OFF. Turning the ignition switch OFF switches the diagnosis system from check mode to normal mode. so all DTCs, etc. are erased.

(10) After checking the DTC, inspect the applicable circuit.

4. FAIL-SAFE CHART

If any of the following codes is recorded, the ECM enters fail-safe mode.

DTC No.	Fail-Safe Operation	Fail-Safe Deactivation Conditions
P0100	Ignition timing fixed at 5° BTDC	Returned to normal condition
P0110	Intake air temperature is fixed at 20°C (68°F)	Returned to normal condition
P0115	Engine coolant temperature is fixed at 80°C (176°F)	Returned to normal condition
P0325 P0330	Max. timing retardation	Ignition switch OFF
P1300 P1305 P1310 P1315 P1320 P1325 P1330 P1340	Fuel cut	Returned to normal condition

5. CHECK FOR INTERMITTENT PROBLEMS

TOYOTA HAND-HELD TESTER only:

By putting the engine's ECM in check mode, 1 trip detection logic is possible instead of 2 trip detection logic and sensitivity to detect open circuits is increased. This makes it easier to detect intermittent problems.

(1) Clear the DTCs.
(2) Set the check mode.
(3) Perform a simulation test (See page IN-9).
(4) Check the connector and terminal (See page IN-19).
(5) Handle the connector (See page IN-19).

6. BASIC INSPECTION

When the malfunction code is not confirmed in the DTC check, troubleshooting should be performed in the order for all possible circuits to be considered as the causes of the problems. In many cases, by carrying out the basic engine check shown in the following flow chart, the location causing the problem can be found quickly and efficiently. Therefore, use of this check is essential in engine troubleshooting.

1	**Is battery positive voltage 11 V or more when engine is stopped?**

NO → **Charge or replace battery.**

YES

2	**Is engine cranked?**

NO → **Proceed to page ST-16, ST-18 and continue to troubleshoot.**

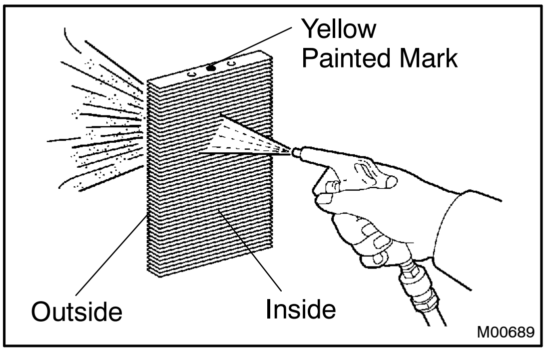
YES

3	**Does engine start?**

NO → **Go to step 7.**

YES

4	**Check air filter.**



PREPARATION:
Remove the air filter.
CHECK:
Visual check that the air filter is not dirty or excessive oily.
HINT:
If necessary, clean the filter using water or kerosene. After cleaning the filter, blow it dry using compressed air.

NG → **Repair or replace**

NOTICE:
Install the air filter into the intake air connector while facing the yellow painted mark upward.

OK

5	**Check idle speed.**

PREPARATION:
(a) Warm up the engine to normal operating temperature.
(b) Switch off all accessories.
(c) Switch off air conditioning.
(d) Shift transmission into "N" position.
(e) Connect the OBD II scan tool or TOYOTA hand-held tester to the DLC3 on the vehicle.

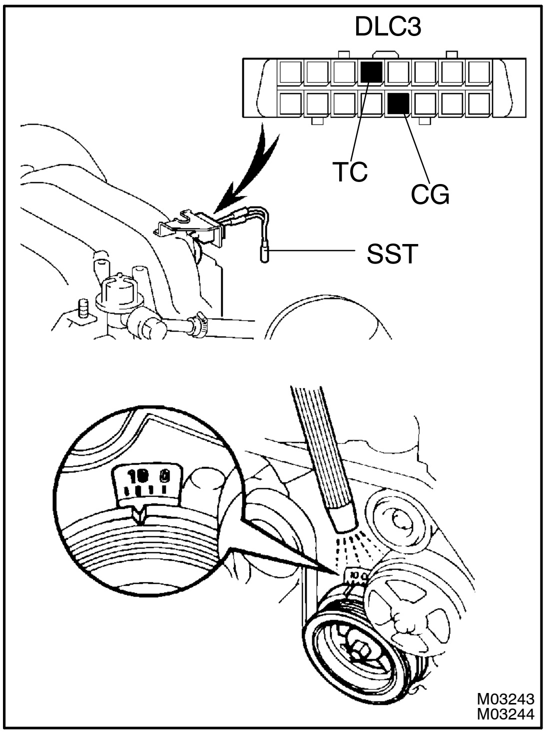
CHECK:
Use CURRENT DATA to check the idle speed.

OK:
Idle speed: 650 ~ 750 rpm

NG → **Proceed to problem symptoms table on page DI-19.**

OK

6	**Check ignition timing.**



PREPARATION:
(a) Warm up the engine to normal operating temperature.
(b) Shift transmission into "N" position.
(c) Keep the engine speed at idle.
(d) Using SST, connect terminals TC and CG of the DLC3.
SST 09843 - 18040
(e) Using a timing light, connect the tester to the ignition coil connector wire (See page EM-7).

CHECK:
Check ignition timing.

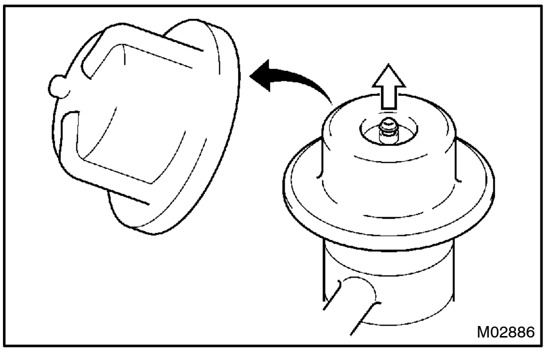
OK:
Ignition timing: 10° BTDC at idle

NG → **Proceed to page IG-1 and continue to troubleshoot.**

OK

Proceed to problem symptoms table on page DI-19.

7	**Check fuel pressure.**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PREPARATION:

(a) Be sure that enough fuel is in the tank.
(b) Connect the TOYOTA hand-held tester to the DLC3.
(c) Turn the ignition switch ON and push TOYOTA hand-held tester main switch ON.
(d) Use ACTIVE TEST mode to operate the fuel pump.
(e) Please refer to the TOYOTA hand-held tester operator's manual for further details.
(f) If you have no TOYOTA hand-held tester, connect the positive (+) and negative (-) leads from the battery to the fuel pump connector (See page SF-1).

CHECK:

Check that there is pressure in the fuel inlet hose from the fuel filter.

HINT:

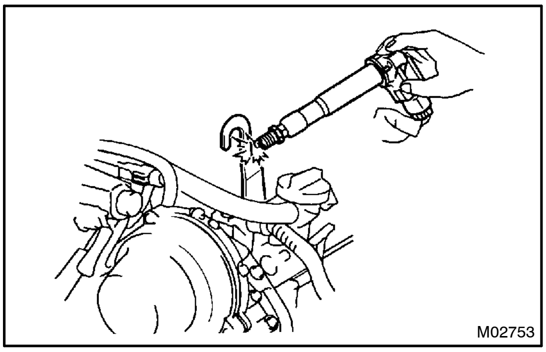
When checking the fuel pressure pulsation damper, remove the cover on it.

When pressure is applied, the button on the fuel pressure pulsation damper rises.

NG	**Proceed to page SF-5 and continue to troubleshoot.**

OK

8	**Check for spark.**



PREPARATION:

(a) Remove the ignition coil from the spark plug.
(b) Remove the spark plug.
(c) Install the spark plug to the ignition coil.
(d) Disconnect the injector connector.
(e) Ground the spark plug.

CHECK:

Check if spark occurs while engine is being cranked.

NOTICE:

To prevent excess fuel being injected from the injectors during this test, don't crank the engine for more than 5 ~ 10 seconds at a time.

NG — **Proceed to page IG-1 and continue to troubleshoot.**

OK

Proceed to problem symptoms table on page DI-19.

7. ENGINE OPERATING CONDITION

NOTICE:

The values given below for "Normal Condition" are representative values, so a boat may still be normal even if its value varies from those listed here. So do not decide whether a part is faulty or not solely according to the "Normal Condition" here.

(a) CARB mandated signals.

TOYOTA hand-held tester display	Measurement Item	Normal Condition*
CALC LOAD	Calculator Load: Current intake air volume as a proportion of max. intake air volume	Idling: 13.9 ~ 19.7% Racing without load (2,500rpm): 13.9 ~ 19.7%
COOLANT TEMP	Engine Coolant Temp. Sensor Value	After warming up: 65 ~ 80°C(149~176°F)
ENGINE SPD	Engine Speed	Idling: 650 ~ 750 rpm
IGN ADVANCE	Ignition Advance: Ignition Timing of Cylinder No. 1	Idling: BTDC 5 ~ 15°
INTAKE AIR	Intake Air Temp. Sensor Value	Equivalent to ambient temp.
MAF	Air Flow Rate Through Mass Air Flow Meter	Idling: 4.0 ~ 5.6 gm/sec. Racing without load (2,500 rpm): 13.2 ~ 18.7 gm/sec.
THROTTLE POS	Voltage Output of Throttle Position Sensor Calculated as a percentage: 0 V → 0 %, 5 V → 100 %	Throttle fully closed: 8 ~ 20 % Throttle fully open: 64 ~ 96 %

*: If no conditions are specifically stated for "Idling", it means the shift lever is at N position and all accessory switches are OFF.

(b) TOYOTA Enhanced Signals.

TOYOTA hand-held tester display	Measurement Item	Normal Condition*
MISFIRE RPM	Engine RPM for first misfire range	Misfire 0: 0 rpm
MISFIRE LOAD	Engine load for first misfire range	Misfire 0: 0 g/r
INJECTOR	Fuel injection time for cylinder No.1	Idling: 1.8 ~ 3.2 ms
STARTER SIG	Starter Signal	Cranking: ON
CTP	Closed Throttle Position	Throttle fully closed: ON
FC IDL	Fuel Cut Idle: Fuel cut when throttle valve fully closed, during deceleration	Fuel cut operating: ON
FC TAU	Fuel Cut TAU: Fuel cut during very light load	Fuel cut operating: ON
CYL#1 ~ CYL#8	Abnormal revolution variation for each cylinder	0 %
IGNITION	Total number of ignition for every 1,000 revolutions	0 ~ 4,000
FUEL PUMP	Fuel Pump Signal	Idling: ON
THROTTLE POS #2	Throttle position sensor No.2 output voltage	Throttle fully closed: 2.0 ~ 2.9 V Throttle fully open: 4.6 ~ 5.0 V
ACCEL POS	Accelerator pedal position sensor No.1 output voltage	Accelerator released: 0.25 ~ 0.9 V Accelerator depressed: 3.2 ~ 4.8 V
ACCEL POS #2	Accelerator pedal position sensor No.2 output voltage	Accelerator released: 1.8 ~ 2.7 V Accelerator depressed: 4.7 ~ 5.0 V
THROTTLE TARGET POS	Target position of throttle valve	Idling: 0.4 ~ 1.1 V
THROTTLE OPEN DUTY	Throttle motor opening duty ratio	Throttle fully closed: 0 % When accelerator pedal is depressed, duty ratio is increased
THROTTLE CLOSE DUTY	Throttle motor closed duty ratio	Throttle fully closed: 0 % When accelerator pedal is quick released, duty ratio is increased
THROTTLE MOTOR CTL	Whether or not throttle motor control is permitted	Idling: ON
THROTTLE CLUTCH CTL	Whether or not magnetic clutch control is permitted	Idling: ON
+BM	Whether or not electric throttle control system power is inputted	Idling: ON
ACCEL IDL	Whether or not accelerator pedal position sensor is detecting idle	Idling: ON
THROTTLE IDL	Whether or not throttle position sensor is detecting idle	Idling: ON
FAIL #1	Whether or not fail safe function is executed	ETCS is failed: ON
FAIL #2	Whether or not fail safe function is executed	ETCS is failed: ON
THROTTLE LEAN VALUE	Throttle fully closed learning value	0.4 ~ 0.8 V
ACCEL LEAN VALUE	Accelerator fully closed learning value	0.4 ~ 0.8 V
THROTTLE MOTOR	Throttle motor control current	Idling: 0 ~ 3.0 A
ETCS MAG CLUTCH	Magnetic clutch control current	0.8 ~ 1.0 A

*: If no conditions are specifically stated for "Idling", it means the shift lever is at N position and all accessory switches are OFF.

DI2PO–01

DIAGNOSTIC TROUBLE CODE CHART

1. 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.

If a malfunction code is displayed during the DTC check in check mode, check the circuit for that code listed in the table below. For details of each code, turn to the page referred to under the ”See Page” for the respective ”DTC No.” in the DTC chart.

DTC No. (See Page)	Detection Item	Trouble Area	MIL*1 (flashing*2)	Memory
P0100 (DI–20)	Mass Air Flow Circuit Malfunction	• Open or short in mass air flow meter circuit • Mass air flow meter • ECM	○ (31)	○
P0110 (DI–24)	Intake Air Temp. Circuit Malfunction	• Open or short in intake air temp. sensor circuit • Intake air temp. sensor (inside mass air flow meter) • ECM	○ *3	○
P0115 (DI–29)	Engine Coolant Temp. Circuit Malfunction	• Open or short in engine coolant temp. sensor circuit • Engine coolant temp. sensor • ECM	○ (24)	○
P0120 (DI–33)	Throttle/Pedal Position Sensor/Switch ”A” Circuit Malfunction	• Open or short in throttle position sensor circuit • Throttle position sensor • ECM	○ (41)	○
P0121 (DI–39)	Throttle/Pedal Position Sensor/Switch ”A” Circuit Range/Performance Problem	• Throttle position sensor • ECM	○ (41)	○
P0325 (DI–40)	Knock Sensor 1 Circuit Malfunction	• Open or short in knock sensor 1 circuit • Knock sensor 1 (looseness) • ECM	○ (52)	○
P0330 (DI–40)	Knock Sensor 2 Circuit Malfunction	• Open or short in knock sensor 2 circuit • Knock sensor 2 (looseness) • ECM	○ (55)	○
P0335 (DI–44)	Crankshaft Position Sensor ”A” Circuit Malfunction	• Open or short in crankshaft position sensor circuit • Crankshaft position sensor • Starter • ECM	○ (12.13)	○
P0340 (DI–47)	Camshaft Position Sensor Circuit Malfunction	• Open or short in camshaft position sensor circuit • Camshaft position sensor • Starter • ECM	○ (12)	○

*1: MIL lights up while engine running,
*2: MIL flashing by switching the ECM to check mode
*3: MIL lights up only (check engine lamp lights up)

2. Manufacturer Controlled

DTC No. (See Page)	Detection Item	Trouble Area	MIL*1 (flashing*2)	Memory
P1120 (DI-49)	Accelerator Pedal Position Sensor Circuit Malfunction	• Open or short in accelerator pedal position sensor circuit • Accelerator pedal position sensor • ECM	○ (19)	○
P1121 (DI-54)	Accelerator Pedal Position Sensor Range/Performance Problem	• Accelerator pedal position sensor • ECM	○ (19)	○
P1125 (DI-55)	Throttle Control Motor Circuit Malfunction	• Open or short in throttle control motor circuit • Throttle control motor • ECM	○ (89)	○
P1126 (DI-58)	Magnetic Clutch Circuit Malfunction	• Open or short in magnetic clutch circuit • Magnetic clutch • ECM	○ (89)	○
P1127 (DI-61)	ETCS Actuator Power Source Circuit Malfunction	• Open in ETCS (electric throttle control system) power source circuit • ECM	○ (89)	○
P1128 (DI-63)	Throttle Control Motor Lock Malfunction	• Throttle control motor • Throttle body • ECM	○ (89)	○
P1129 (DI-65)	Electric Throttle Control System Malfunction	• Electric throttle control system • ECM	○ (89)	○
P1300 (DI-66)	Igniter Circuit Malfunction (No.1)	• Open or short in IGF1 or IGT1 circuit from No.1 ignition coil with igniter to ECM • No.1 ignition coil with igniter • ECM	○ (14)	○
P1305 (DI-66)	Igniter Circuit Malfunction (No.2)	• Open or short in IGF2 or IGT2 circuit from No.2 ignition coil with igniter to ECM • No.2 ignition coil with igniter • ECM	○ (15)	○
P1310 (DI-66)	Igniter Circuit Malfunction (No.3)	• Open or short in IGF2 or IGT3 circuit from No.3 ignition coil with igniter to ECM • No.3 ignition coil with igniter • ECM	○ (14)	○
P1315 (DI-66)	Igniter Circuit Malfunction (No.4)	• Open or short in IGF1 or IGT4 circuit from No.4 ignition coil with igniter to ECM • No.4 ignition coil with igniter • ECM	○ (14)	○
P1320 (DI-66)	Igniter Circuit Malfunction (No.5)	• Open or short in IGF2 or IGT5 circuit from No.5 ignition coil with igniter to ECM • No.5 ignition coil with igniter • ECM	○ (14)	○
P1325 (DI-66)	Igniter Circuit Malfunction (No.6)	• Open or short in IGF1 or IGT6 circuit from No.6 ignition coil with igniter to ECM • No.6 ignition coil with igniter • ECM	○ (14)	○

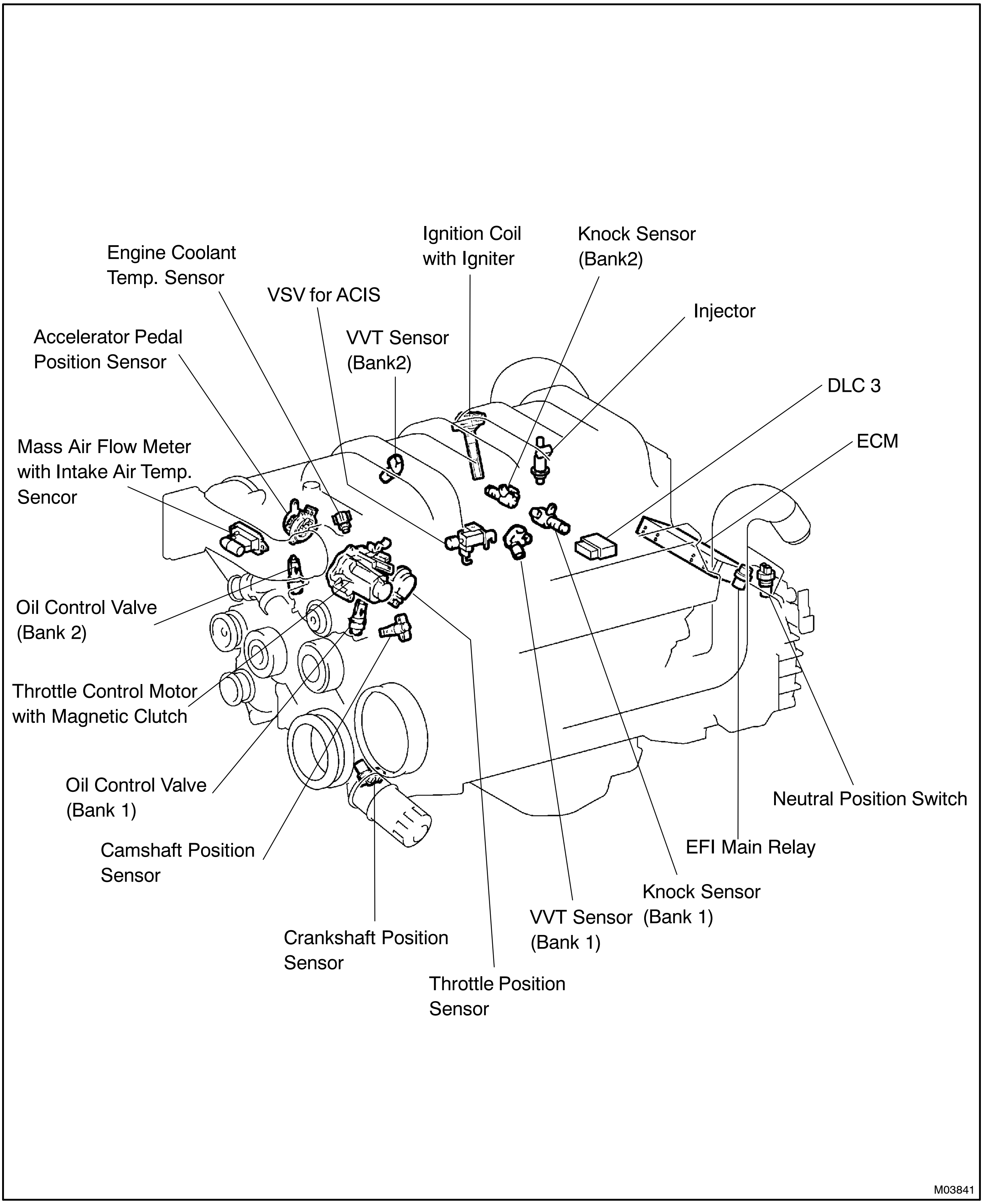
*1: MIL lights up while engine running,
*2: MIL flashing by switching the ECM to check mode

DTC No. (See Page)	Detection Item	Trouble Area	MIL*1 (flashing*2)	Memory
P1330 (DI-66)	Igniter Circuit Malfunction (No.7)	• Open or short in IGF1 or IGT7 circuit from No.7 ignition coil with igniter to ECM • No.7 ignition coil with igniter • ECM	○ (14)	○
P1335 (DI-73)	Crankshaft Position Sensor Circuit Malfunction (during engine running)	• Open or short in crankshaft position sensor circuit • Crankshaft position sensor • Starter • ECM	- (13)	○
P1340 (DI-66)	Igniter Circuit Malfunction (No.8)	• Open or short in IGF2 or IGT8 circuit from No.8 ignition coil with igniter to ECM • No.8 ignition coil with igniter • ECM	○ (14)	○
P1345 (DI-74)	VVT Sensor Circuit Malfunction (Bank 1)	• Open or short in VVT sensor circuit • VVT sensor • ECM	○ (18)	○
P1346 (DI-76)	VVT Sensor Circuit Range/Performance Problem (Bank 1)	• Mechanical system malfunction (Skipping teeth of timing belt, belt stretched) • ECM	○ (18)	○
P1349 (DI-77)	VVT System Malfunction (Bank 1)	• Valve timing • Oil control valve • VVT controller assembly • ECM	○ (59)	○
P1350 (DI-74)	VVT Sensor Circuit Malfunction (Bank 2)	• Same as DTC No. P1345	○ (18)	○
P1351 (DI-76)	VVT Sensor Circuit Range/Performance Problem (Bank 2)	• Same as DTC No. P1346	○ (18)	○
P1354 (DI-77)	VVT System Malfunction (Bank 2)	• Same as DTC No. P1349	○ (59)	○
P1633 (DI-84)	ECM Malfunction (ETCS Circuit)	• ECM	○ (89)	○
P1656 (DI-85)	OCV Circuit Malfunction (Bank1)	• Open or short in oil control valve circuit (bank 1) • Oil control valve (bank 1) • ECM	○ (39)	○
P1663 (DI-85)	OCV Circuit Malfunction (Bank2)	• Open or short in oil control valve cirucit (bank 2) • Oil control valve (bank 2) • ECM	○ (39)	○

*1: – • • • MIL does not light up, ○ • • • MIL lights up while engine renning.
*2: MIL flashing by switching the ECM to check mode

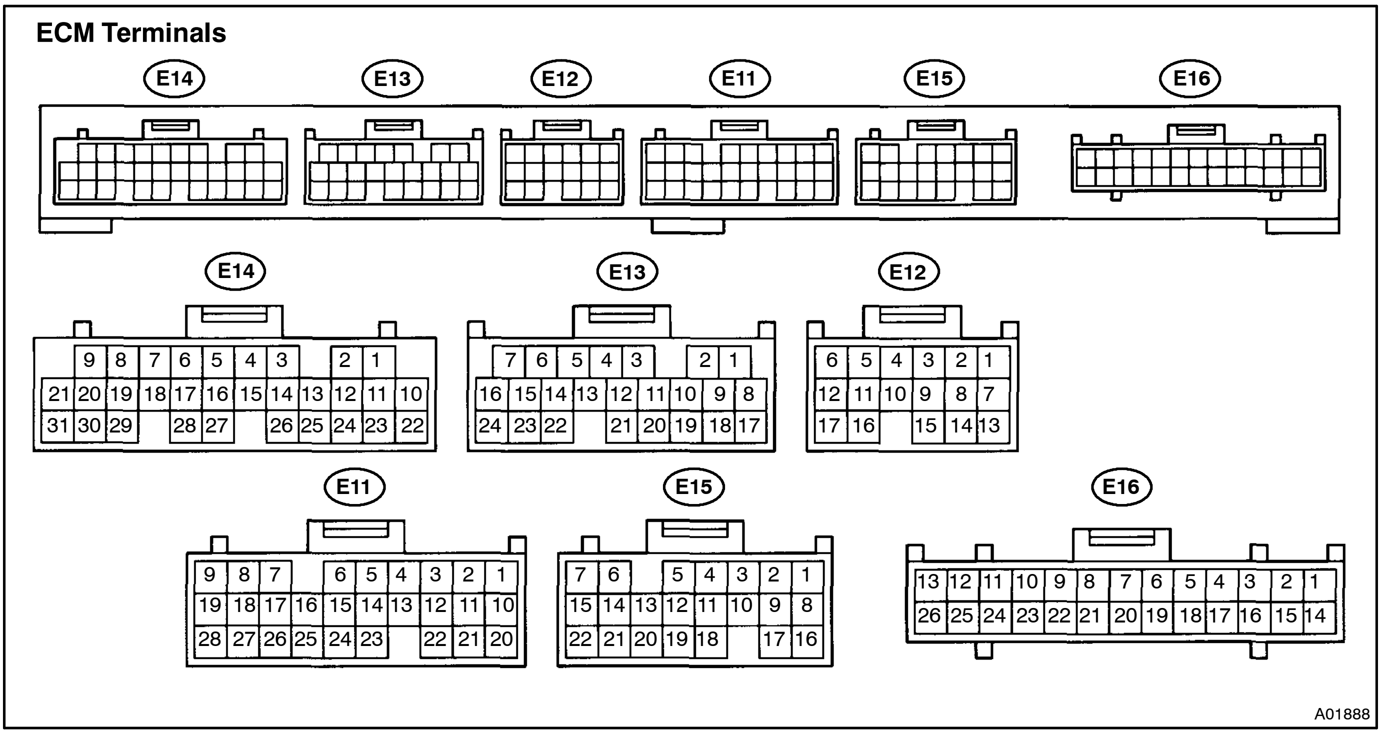
PARTS LOCATION

DI2OF-01



DI1L7-01

TERMINALS OF ECM



Symbols (Terminals No.)	Wiring Color	Condition	STD Voltage (V)
BATT (E15-1) - E1 (E13-17)	B ↔ W-B	Always	9 ~ 14
+BM (E15-7) - E1 (E13-17)	L ↔ W-B		
IGSW (E15-9) - E1 (E13-17)	B ↔ W-B	IG switch ON	9 ~ 14
+B (E15-16) - E1 (E13-17)	W ↔ W-B		
+B1 (E15-8) - E1 (E13-17)	W ↔ W-B		
VC (E13-2) - E2 (E13-18)	L ↔ BR	IG switch ON	4.5 ~ 5.5
VTA (E13-13) - E2 (E13-18)	Y ↔ BR	IG switch ON Throttle lever fully closed	0.4 ~ 1.0
		IG switch ON Throttle lever fully closed	3.2 ~ 4.8
VTA2 (E13-20) - E2 (E13-18)	Y-B ↔ BR	IG switch ON Throttle lever fully closed	2.0 ~ 2.9
		IG switch ON Throttle lever fully closed	4.6 ~ 5.1
VPA (E13-21) - E2 (E13-18)	R ↔ BR	IG switch ON Throttle lever fully closed	0.3 ~ 0.9
		IG switch ON Throttle lever fully closed	3.2 ~ 4.8
VPA2 (E13-9) - E2 (E13-18)	R-B ↔ BR	IG switch ON Throttle lever fully closed	1.8 ~ 2.7
		IG switch ON Throttle lever fully closed	4.7 ~ 5.1
VG (E13-10) - EVG (E13-19)	L-Y ↔ G-W	Idling, N position	0.5 ~ 3.0
THA (E13-22) - E2 (E13-18)	Y-B ↔ BR	Idling, Intake air temp. 20°C (68°F)	0.5 ~ 3.4
THW (E13-14) - E2 (E13-18)	R-L ↔ BR	Idling, Engine coolant temp. 80°C (176°F)	0.2 ~ 1.0
STA (E11-17) - E1 (E13-17)	Y-R ↔ W-B	Shift lever position N position, ignition switch START	6.0 or more

Symbols (Terminals No.)	Wiring Color	Condition	STD Voltage (V)
#1 (E13–5) – E01 (E14–21) #2 (E13–6) – E01 (E14–21) #3 (E14–1) – E01 (E14–21) #4 (E14–2) – E01 (E14–21) #5 (E14–3) – E01 (E14–21) #6 (E14–4) – E01 (E14–21) #7 (E14–5) – E01 (E14–21) #8 (E14–6) – E01 (E14–21)	Y ⇔ W–B B ⇔ W–B L ⇔ W–B R ⇔ W–B G ⇔ W–B R–L ⇔ W–B W ⇔ W–B B–W ⇔ W–B	IG switch ON	9 ~ 14
		Idling	Pulse generation
IGT1 (E14–11) – E1 (E13–17) IGT2 (E14–12) – E1 (E13–17) IGT3 (E14–13) – E1 (E13–17) IGT4 (E14–14) – E1 (E13–17) IGT5 (E14–15) – E1 (E13–17) IGT6 (E14–16) – E1 (E13–17) IGT7 (E14–25) – E1 (E13–17) IGT8 (E14–26) – E1 (E13–17)	Y ⇔ W–B B ⇔ W–B L ⇔ W–B R ⇔ W–B G ⇔ W–B R–L ⇔ W–B W ⇔ W–B B–W ⇔ W–B	Idling	Pulse generation (See page DI–66)
IGF1 (E14–27) – E1 (E13–17) IGF2 (E14–28) – E1 (E13–17)	Y ⇔ W–B Y ⇔ W–B	IG switch ON	4.5 ~ 5.5
		Idling	Pulse generation (See page DI–66)
G2 (E14–10) – NE– (E14–22)	B ⇔ W	Idling	Pulse generation (See page DI–44)
NE+ (E14–23) – NE– (E14–22)	B ⇔ W		
MREL (E15–10) – E1 (E13–17)	B ⇔ W–B	IG switch ON	9 ~ 14
FC (E15–5) – E1 (E13–17)	G ⇔ W–B	IG switch ON	9 ~ 14
KNKL (E14–18) – E1 (E13–17)	B ⇔ W–B	Maintain engine speed at 4,000 rpm after warming up	Pulse generation (See page DI–40)
KNKR (E14–17) – E1 (E13–17)	GR ⇔ W–B		
TC (E11–5) – E1 (E13–17)	LG ⇔ W–B	IG switch ON	9 ~ 14
W (E15–6) – E1 (E13–17)	P ⇔ W–B	Idling	9 ~ 14
		IG switch ON	Below 3.0
VVL+ (E13–16) – VVL– (E13–24)	P ⇔ V	Idling	Pulse generation (See page DI–74)
VVR+ (E13–15) – VVR– (E13–23)	Y ⇔ L		
OCV+ (E14–20) – OCV– (E14–19)	L–W ⇔ L–B	IG switch ON	Pulse generation (See page DI–77)
OCR+ (E11–19) – OCR– (E11–28)	G–W ⇔ G–B		
ACIS (E14–29) – E01 (E14–21)	L–W ⇔ W–B	IG switch ON	9 ~ 14
		Engine speed between 2,500 rpm and 4,000 rpm	Below 3.0
CL+ (E12–12) – CL– (E13–8)	G–W ⇔ B–R	Idling	Pulse generation (See page DI–58)
M+ (E14–8) – E1 (E13–17) M– (E14–7) – E1 (E13–17)	G ⇔ W–B R ⇔ W–B	Idling	Pulse generation (See page DI–55)
SIL (E15–11) – E1 (E13–17)	L ⇔ W–B	During transmission	Pulse generation

DI2OH-01

PROBLEM SYMPTOMS TABLE

Symptom	Suspect Area	See page
Engine does not crank (Does not start)	1. Starter 2. Starter relay	ST-16 ST-18
No initial combustion (Does not start)	1. ECM power source circuit 2. Circuit opning relay 3. Fuel pump	DI-91 SF-59 SF-5
No complete combustion (Does not start)	1. Circuit opning relay 2. Fuel pump	SF-59 SF-5
Under normal condition (Difficult to start)	1. Starter signal circuit 2. Circuit opning relay 3. Fuel pump 4. Compression	DI-88 SF-59 SF-5 EM-1
Cold engine (Difficult to start)	1. Starter signal circuit 2. Circuit opning relay 3. Fuel pump	DI-88 SF-59 SF-5
Hot engine (Difficult to start)	1. Starter signal circuit 2. Circuit opning relay 3. Fuel pump	DI-88 SF-59 SF-5
High engine idle speed (Poor idling)	1. ECM power source circuit	DI-91
Low engine idle speed (Poor idling)	1. Circuit opning relay 2. Fuel pump	SF-59 SF-5
Rough idling (Poor idling)	1. Compression 2. Circuit opning relay 3. Fuel pump	EM-1 SF-59 SF-5
Hunting (Poor idling)	1. ECM power source circuit 2. Circuit opning relay 3. Fuel pump	DI-91 SF-59 SF-5
Hesitation/Poor acceleration (Poor driveability)	1. Circuit opning relay 2. Fuel pump	SF-59 SF-5
Surging (Poor driveability)	1. Circuit opning relay 2. Fuel pump	SF-59 SF-5
Soon after starting (Engine stall)	1. Circuit opning relay 2. Fuel pump	SF-59 SF-5

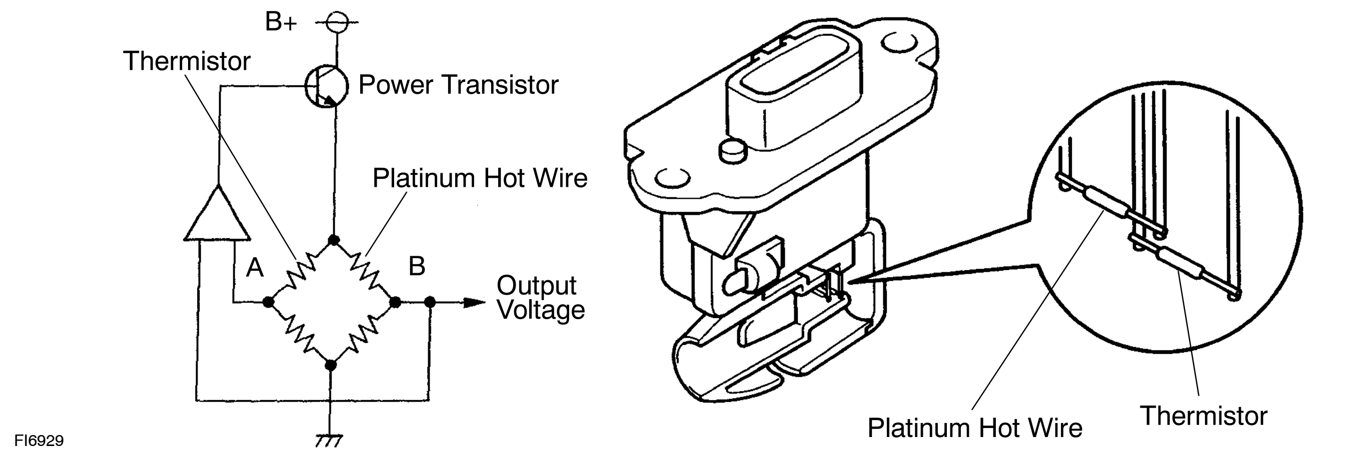
DI2OI-01

CIRCUIT INSPECTION

DTC	P0100	Mass Air Flow Circuit Malfunction

CIRCUIT DESCRIPTION

The mass air flow meter uses a platinum hot wire. The hot wire air flow meter consists of a platinum hot wire, thermistor and a control circuit installed in a plastic housing. The hot wire air flow meter works on the principle that the hot wire and thermistor located in the intake air bypass of the housing detect any changes in the intake air temperature.
The hot wire is maintained at the set temperature by controlling the current flow through the hot wire. This current flow is ten measured as the output voltage of the mass air flow meter.
The circuit is constructed so that the platinum hot wire and thermistor provide a bridge circuit, with the power transistor controlled so that the potential of A and B remains equal to maintain the set temperature.



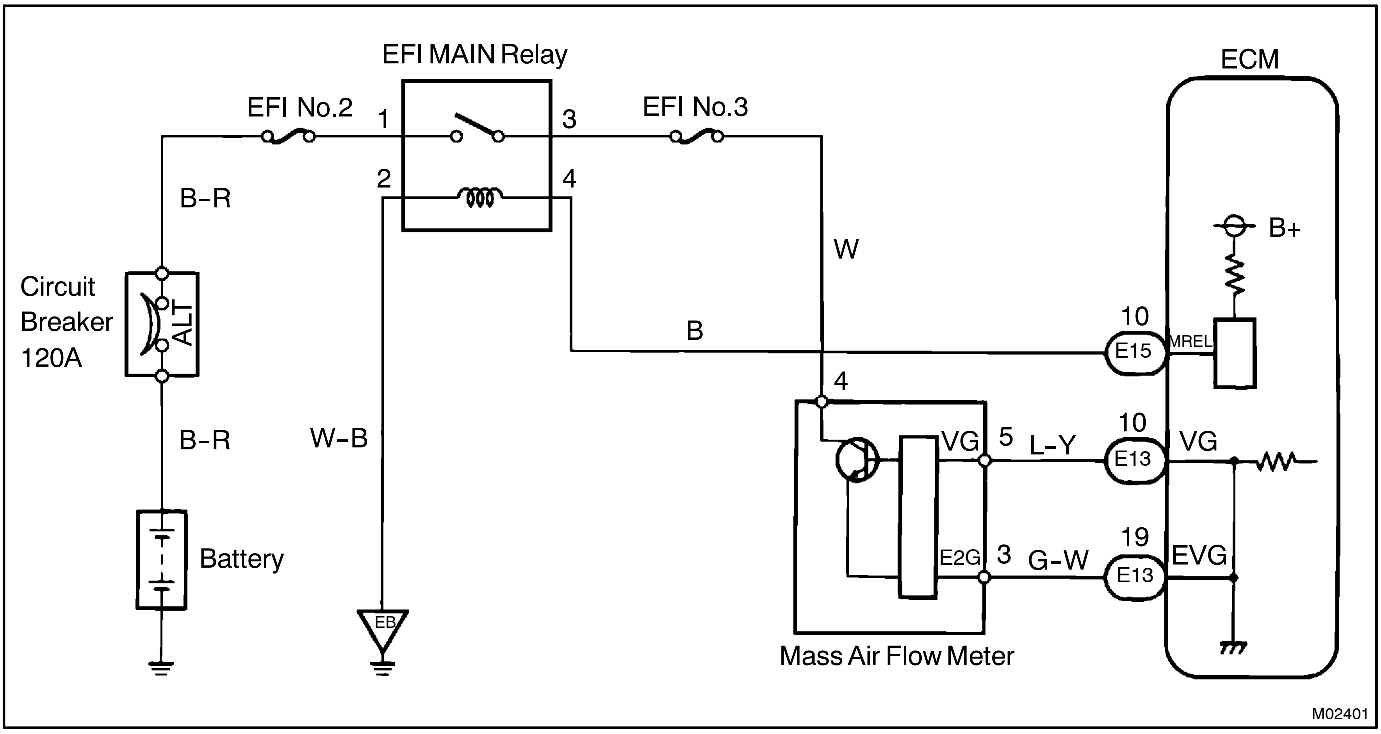
FI6929
S05741
A00435

DTC No.	DTC Detecting Condition	Trouble Area
P0100	Open or short in mass air flow meter circuit with more than 3 sec. engine speed 4,000 rpm or less	• Open or short in mass air flow meter circuit • Mass air flow meter • ECM
	Open or short in mass air flow meter circuit with more than 3 sec. engine speed 4,000 rpm or more (2 trip detection logic)	

HINT:
After confirming DTC P0100 use the OBD II scan tool or TOYOTA hand-held tester to confirm the mass air flow ratio from CURRENT DATA.

Mass Air Flow Value (gm/sec.)	Malfunction
Approx. 0.0	• Mass air flow meter power source circuit open • VG circuit open or short
271.0 or more	• EVG circuit open

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:
Read freeze frame data using TOYOTA hand-held tester or OBD II scan tool. Because freeze frame records the engine conditions when the malfunction is detected, when troubleshooting it is useful for determining whether the engine was running or stopped, the engine warmed up or not, the air-fuel ratio lean or rich, etc. at the time of the malfunction.

1	**Connect OBD II scan tool or TOYOTA hand-held tester, and read value of mass air flow rate.**

PREPARATION:
(a) Connect the OBD II scan tool or TOYOTA hand-held tester to the DLC3.
(b) Turn the ignition switch ON and push the OBD II scan tool or TOYOTA hand-held tester main switch ON.
(c) Start the engine.

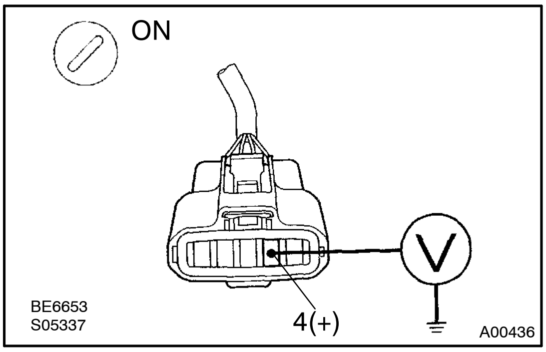
CHECK:
Read mass air flow rate on the OBD II scan tool or TOYOTA hand-held tester.

RESULT:

	Type I	Type II
Mass air flow rata (gm/sec.)	0.0	271.0 or more

Type I	**Go to step 2.**
Type II	**Go to step 5.**

2	**Check voltage of mass air flow meter power source.**



PREPARATION:
(a) Disconnect the mass air flow meter connector.
(b) Turn the ignition switch ON.

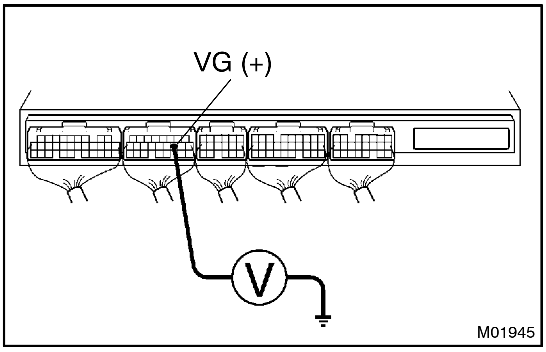
CHECK:
Measure voltage between terminal 4 of the mass air flow meter connector and body ground.

OK:
Voltage: 9 ~ 14 V

NG → **Check for open in harness and connector between EFI main relay (Marking: EFI) and mass air flow meter (See page IN-19).**

OK

3	**Check voltage between terminals VG of ECM connector and body ground.**



PREPARATION:
(a) Remove the wire harness boot.
(b) Start the engine.

CHECK:
Measure voltage between terminal VG of the ECM connector and body ground while engine is idling.

OK:
Voltage:
0.5 ~ 3.0 V (N position)

OK → **Check and replace ECM (See page IN-19).**

NG

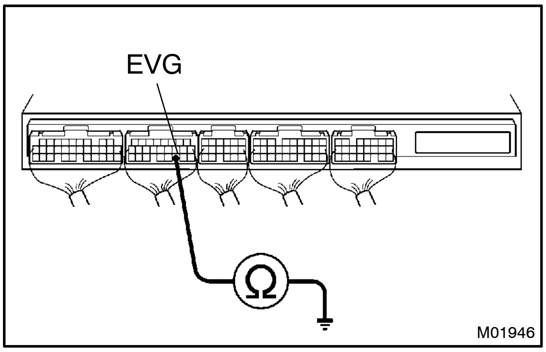
4	Check for open and short in harness and connector between mass air flow meter and ECM (See page IN-19).

NG → **Repair or replace harness or connector.**

OK ↓

Replace mass air flow meter.

5	Check continuity between terminal EVG of ECM connector and body ground.



PREPARATION:

Remove the wire harness boot.

CHECK:

Check continuity between terminal EVG of the ECM connector and body ground.

OK:

Continuity (1 Ω or less)

NG → **Check and replace ECM (See page IN-19).**

OK ↓

6	Check for open in harness and connector between mass air flow meter and ECM (See page IN-19).

NG → **Repair or replace harness or connector.**

OK ↓

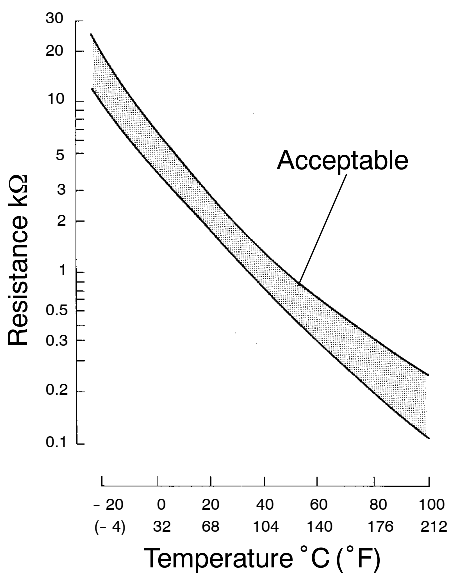
Replace mass air flow meter.

DI2OK-01

DTC	P0110	Intake Air Temp. Circuit Malfunction

CIRCUIT DESCRIPTION

(fig. 1)



FI4741

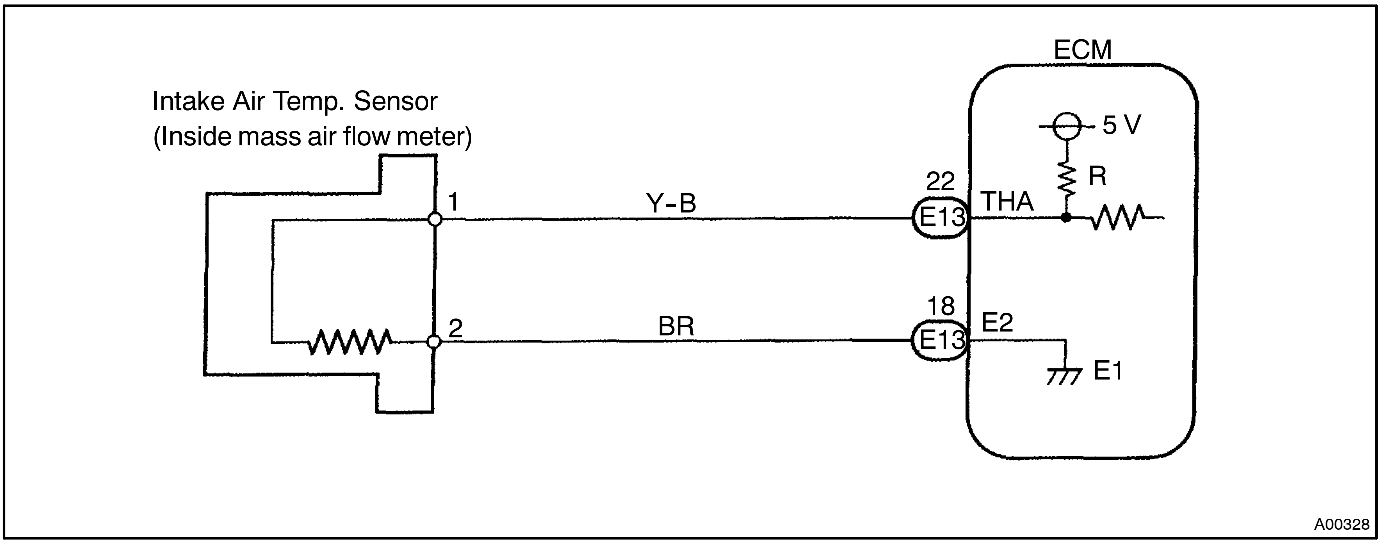
The intake air temp. sensor is built into the mass air flow meter and senses the intake air temperature.
A thermistor built in the sensor changes the resistance value according to the intake air temperature.
The lower the intake air temperature, the greater the thermistor resistance value, and the higher the intake air temperature, the lower the thermistor resistance value (See fig. 1).
The intake air temp. sensor is connected to the ECM (See below). The 5 V power source voltage in the ECM is applied to the intake air temp. sensor from the terminal THA via resistor R.
That is, the resistor R and the intake air temp. sensor are connected in series. When the resistance value of the intake air temp. sensor changes in accordance with changes in the intake air temperature, the potential at terminal THA also changes. Based on this signal, the ECM increases the fuel injection volume to improve driveability during cold engine operation.

DTC No.	DTC Detecting Condition	Trouble Area
P0110	Open or short in intake air temp. sensor circuit	• Open or short in intake air temp. sensor circuit • Intake air temp. sensor (inside mass air flow meter) • ECM

HINT:
After confirming DTC P0110 use the OBD II scan tool or TOYOTA hand-held tester to confirm the intake air temperature from CURRENT DATA.

Temperature Displayed	Malfunction
-40°C (-40°F)	Open circuit
140°C (284°F) or more	Short circuit

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

- If DTC P0110 (Intake Air Temp. Circuit Malfunction), P0115 (Engine Coolant Temp. Circuit Malfunction), P0120 (Throttle Position Sensor Circuit Malfunction) and P1120 (Accelerator Pedal Position Sensor Circuit Malfunction) are output simultaneously, E2 (Sensor Ground) may be open.
- Read freeze frame data using TOYOTA hand-held tester or OBD II scan tool. Because freeze frame records the engine conditions when the malfunction is detected, when troubleshooting it is useful for determining whether the engine was running or stopped, the engine warmed up or not, the air-fuel ratio lean or rich, etc. at the time of the malfunction.

1	**Connect OBD II scan tool or TOYOTA hand-held tester, and read value of intake air temperature.**

PREPARATION:
(a) Connect the OBD II scan tool or TOYOTA hand-held tester to the DLC3.
(b) Turn the ignition switch ON and push the OBD II scan tool or TOYOTA hand-held tester main switch ON.

CHECK:
Read temperature value on the OBD II scan tool or TOYOTA hand-held tester.

OK:
Same as actual intake air temperature

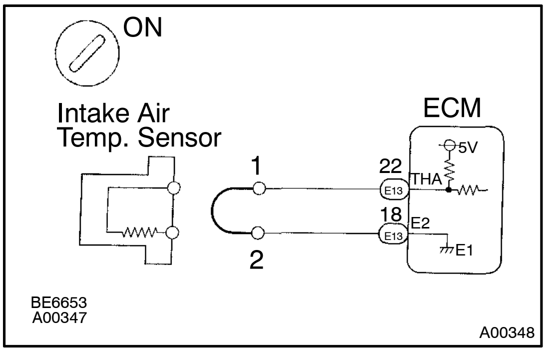
HINT:
- If there is open circuit, OBD II scan tool or TOYOTA hand-held tester indicates -40°C (-40°F).
- If there is short circuit, OBD II scan tool or TOYOTA hand-held tester indicates 140°C (284°F) or more.

NG → **-40°C (-40°F)...Go to step 2.**
140°C (284°F) or more...Go to step 4.

OK

Check for intermittent problems (See page DI-3).

2	**Check for open in harness or ECM.**



PREPARATION:
(a) Disconnect the mass air flow meter connector.
(b) Connect the sensor wire harness terminals together.
(c) Turn the ignition switch ON.

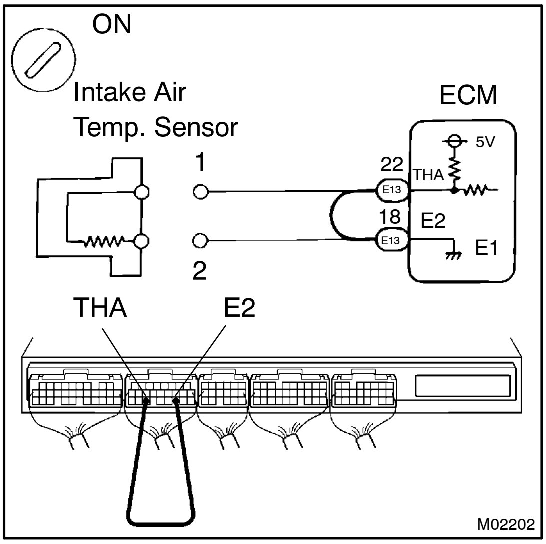
CHECK:
Read temperature value on the OBD II scan tool or TOYOTA hand-held tester.

OK:
Temperature value: 140°C (284°F) or more

OK → **Confirm good connection at sensor. If OK, replace mass air flow meter.**

NG

3	Check for open in harness or ECM.



PREPARATION:
(a) Remove the wire harness boot.
(b) Connect between terminals THA and E2 of the ECM connector.

HINT:
Mass air flow meter connector is disconnected.
Before checking, do a visual and contact pressure check for the ECM connector (See page IN-19).

CHECK:
Read temperature value on the OBD II scan tool or TOYOTA hand-held tester.

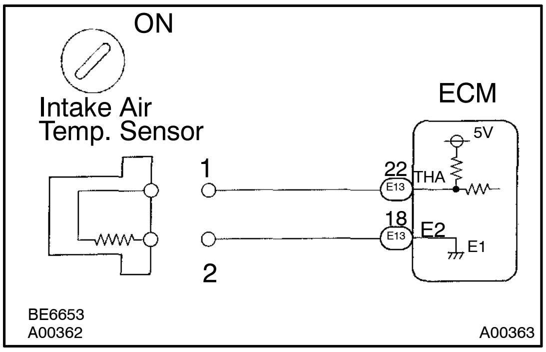
OK:
Temperature value: 140°C (284°F) or more

OK	Open in harness between terminals E2 or THA, repair or replace harness.

NG

Confirm good connection at ECM.
If OK, check and replace ECM.
(See page IN-19)

4	Check for short in harness and ECM.



PREPARATION:
(a) Disconnect the mass air flow meter connector.
(b) Turn the ignition switch ON.

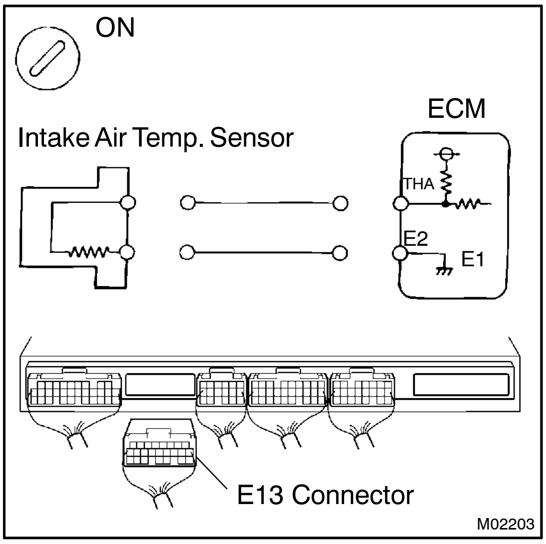
CHECK:
Read temperature value on the OBD II scan tool or TOYOTA hand-held tester.

OK:
Temperature value: -40°C (-40°F)

OK	Replace mass air flow meter.

NG

5	**Check for short in harness or ECM.**



PREPARATION:

(a) Remove the wire harness boot.

(b) Disconnect the E13 connector of the ECM.

HINT:

Mass air flow meter connector is disconnected.

(c) Turn the ignition switch ON.

CHECK:

Read temperature value on the OBD II scan tool or TOYOTA hand-held tester.

OK:

Temperature value: -40°C (-40°F)

OK → **Repair or replace harness or connector.**

NG

Check and replace ECM (See page IN-19).

DI2OL-01

DTC	P0115	Engine Coolant Temp. Circuit Malfunction

CIRCUIT DESCRIPTION

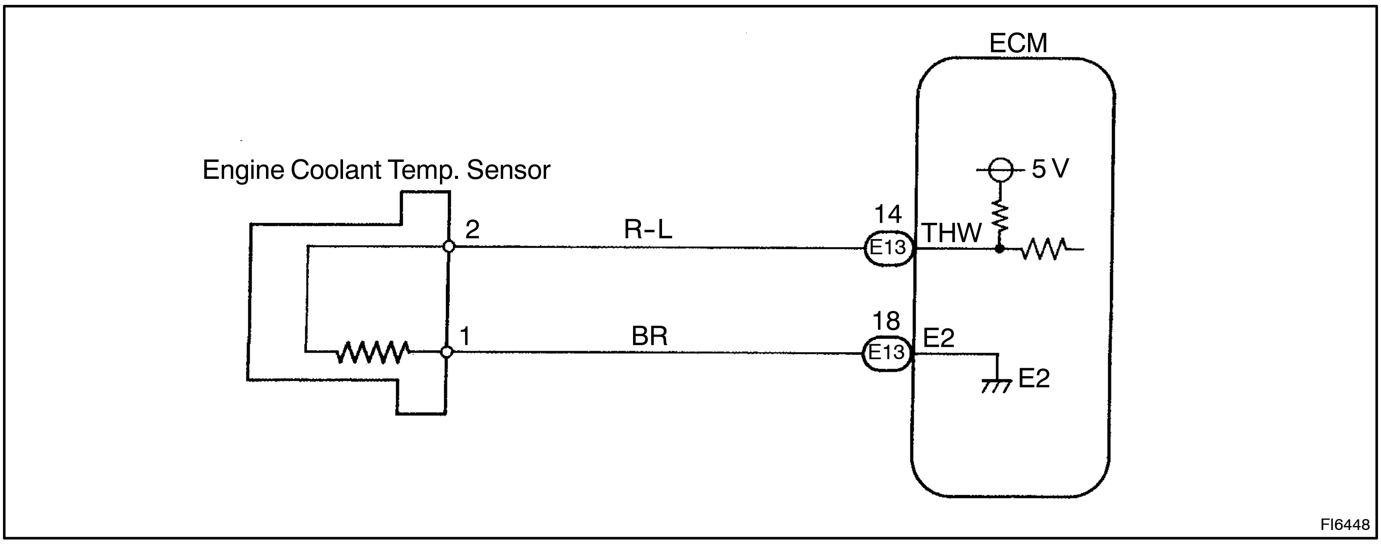
A thermistor built into the engine coolant temp. sensor changes the resistance value according to the engine coolant temperature.
The structure of the sensor and connection to the ECM is the same as in the DTC P0110 (Intake Air Temp. Circuit Malfunction) shown on page DI-24.

DTC No.	DTC Detecting Condition	Trouble Area
P0115	Open or short in engine coolant temp. sensor circuit	• Open or short in engine coolant temp. sensor circuit • Engine coolant temp. sensor • ECM

HINT:
After confirming DTC P0115 use the OBD II scan tool or TOYOTA hand-held tester to confirm the engine coolant temperature from CURRENT DATA.

Temperature Displayed	Malfunction
-40°C (-40°F)	Open circuit
140C° (284°F) or more	Short circuit

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:
- If DTC P0110 (Intake Air Temp. Circuit Malfunction), P0115 (Engine Coolant Temp. Circuit Malfunction), P0120 (Throttle Position Sensor Circuit Malfunction) and P1120 (Accelerator Position Sensor Circuit Malfunction) are output simultaneously, E2 (sensor ground) may be open.
- Read freeze frame data using TOYOTA hand-held tester or OBD II scan tool. Because freeze frame records the engine conditions when the malfunction is detected, when troubleshooting it is useful for determining whether the vehicle was running or stopped, the engine warmed up or not, the air-fuel ratio lean or rich, etc. at the time of the malfunction.

1	**Connect OBD II scan tool or TOYOTA hand-held tester, and read value of engine coolant temperature.**

PREPARATION:
(a) Connect the OBD II scan tool or TOYOTA hand-held tester to the DLC3.
(b) Turn the ignition switch ON and switch the OBD II scan tool or TOYOTA hand-held tester main switch ON.

CHECK:
Read temperature value on the OBD II scan tool or TOYOTA hand-held tester.

OK:
Same as actual engine coolant temperature

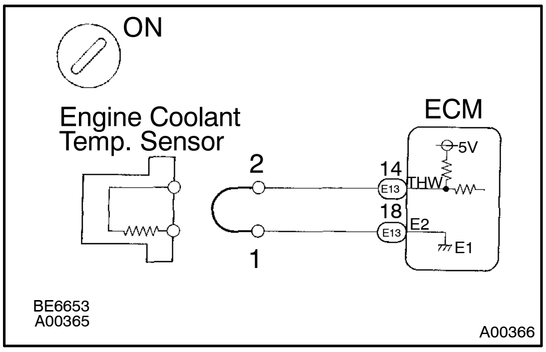
HINT:
- If there is open circuit, OBD II scan tool or TOYOTA hand-held tester indicates -40°C (-40°F).
- If there is short circuit, OBD II scan tool or TOYOTA hand-held tester indicates 140°C (284°F) or more.

NG → **-40°C (-40°F)...Go to step 2.**
140°C (284°F) or more...Go to step 4.

OK

Check for intermittent problems (See page DI-3).

2	Check for open in harness or ECM.



PREPARATION:

(a) Disconnect the engine coolant temp. sensor connector.
(b) Connect sensor wire harness terminals together.
(c) Turn the ignition switch ON.

CHECK:

Read temperature value on the OBD II scan tool or TOYOTA hand-held tester.

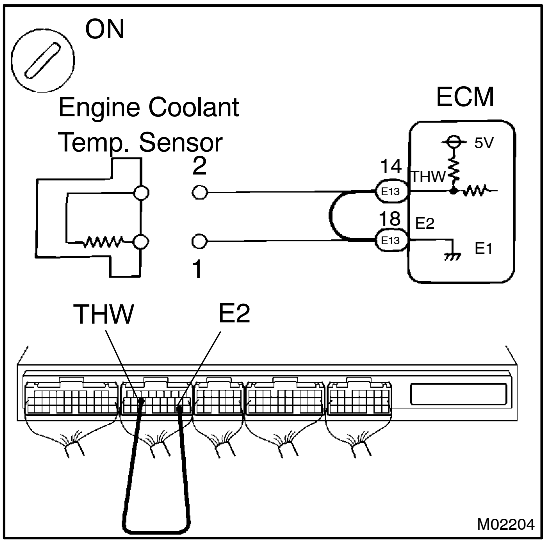
OK:

Temperature value: 140°C (284°F) or more

OK → **Confirm good connection at sensor. If OK, replace engine coolant temp. sensor.**

NG

3	Check for open in harness or ECM.



PREPARATION:

(a) Remove the wire harness boot.
(b) Connect between terminals THW and E2 of the ECM connector.

HINT:
Engine coolant temp. sensor connector is disconnected.
Before checking, do a visual and contact pressure check for the ECM connector (See page IN-19).

(c) Turn the ignition switch ON.

CHECK:

Read temperature value on the OBD II scan tool or TOYOTA hand-held tester.

OK:

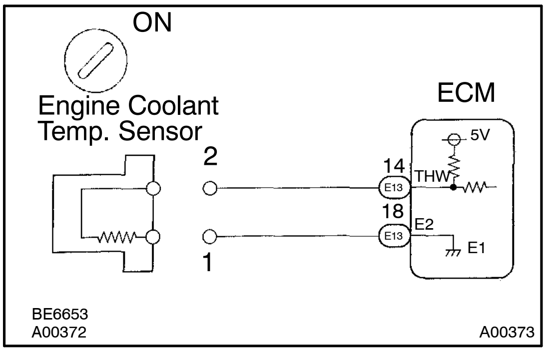
Temperature value: 140°C (284°F) or more

OK → **Open in harness between terminals E2 or THW, repair or replace harness.**

NG

Confirm good connection at ECM.
If OK, check and replace ECM.
(See page IN-19)

4	**Check for short in harness and ECM.**

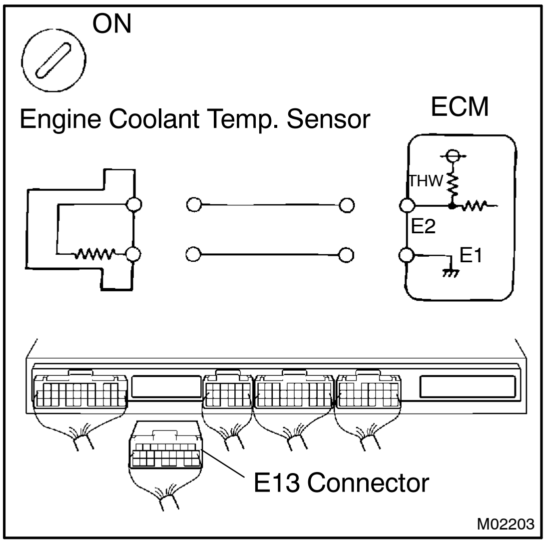


PREPARATION:
(a) Disconnect the engine coolant temp. sensor connector.
(b) Turn the ignition switch ON.
CHECK:
Read temperature value on the OBD II scan tool or TOYOTA hand-held tester.
OK:
Temperature value: -40°C (-40°F)

OK → **Replace engine coolant temp. sensor.**

NG

5	**Check for short in harness or ECM.**



PREPARATION:
(a) Remove the wire harness boot.
(b) Disconnect the E16 connector of the ECM.
HINT:
Engine coolant temp. sensor connector is disconnected.
(c) Turn the ignition switch ON.
CHECK:
Read temperature value on the OBD II scan tool or TOYOTA hand-held tester.
OK:
Temperature value: -40°C (-40°F)

OK → **Repair or replace harness or connector.**

NG

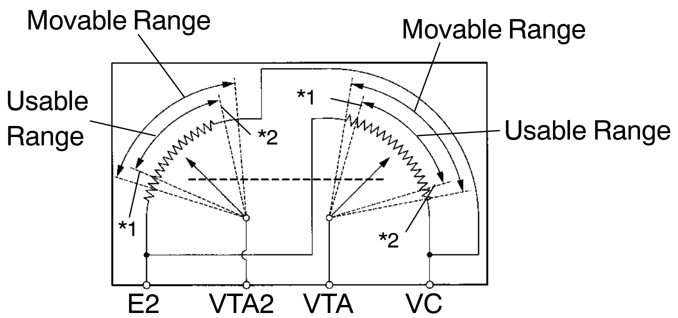
Check and replace ECM (See page IN-19).

DI2OM-01

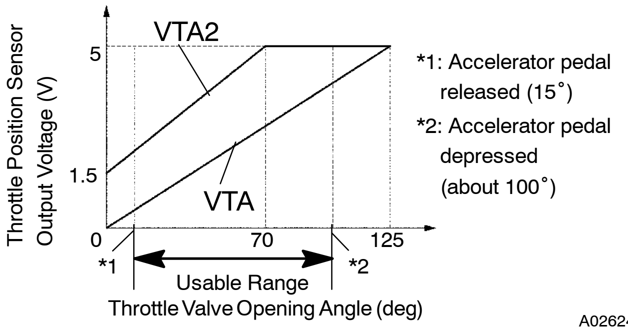
DTC	P0120	Throttle Position Sensor Circuit Malfunction

CIRCUIT DESCRIPTION

Throttle position sensor is mounted on the throttle body and it have the 2 sensors to detect the throttle opening angle and the malfunction of the throttle position sensor's own.
The voltage applied to the terminals VTA and VTA2 of the ECM changes between 0 V and 5 V in proportion to the opening angle of the throttle valve.
The ECM judges the current opening angle of the throttle valve from these signals input from terminals VTA and VTA2, and the ECM controls the throttle motor to make the throttle valve angle properly in response to driving condition.
If this DTC is stored, the ECM shuts down the power for the throttle motor and the electromagnetic clutch, and the throttle valve is fully closed by the return spring.
However, the opening angle of the throttle valve can be controlled by the throttle lever through the throttle cable.



A02395 A02396



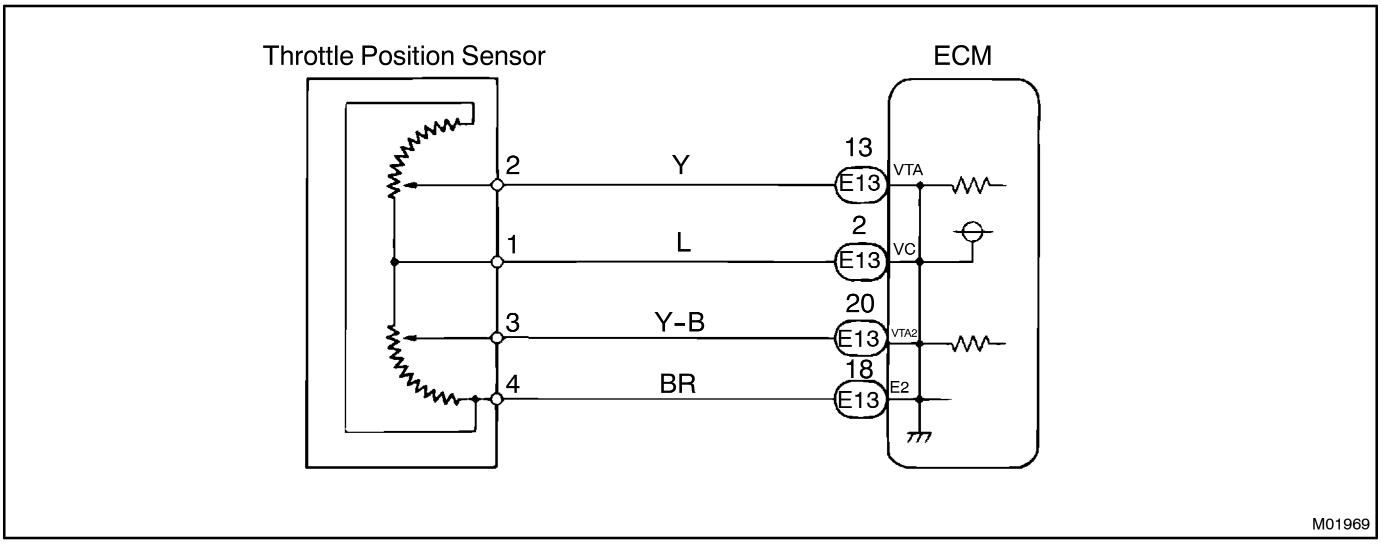
A02624

DTC No.	DTC Detecting Condition	Trouble Area
P0120	Condition (a), (b), (c), (d) or (e) continues for 2.0 seconds: (a) VTA ≦ 0.2 V (b) VTA2 ≦ 0.5 V (c) VTA ≧ 4.8 V (d) When VTA ≧ 0.2 V and ≦ 2.0 V, and VTA2 ≧ 4.97 V (b) VTA-VTA2 ≦ 0.02 V	• Open or short in throttle position sensor circuit • Throttle position sensor • ECM
	Condition (a) continues for 0.4 seconds: (a) VTA ≦ 0.2 V and VTA2 ≦ 0.5 V	

HINT:
After confirming DTC P0120 use the OBD II scan tool or TOYOTA hand-held tester to confirm the throttle valve opening percentage.

Throttle valve opening position expressed as percentage and voltage				Trouble area
Accelerator pedal released		Accelerator pedal depressed		
THROTTLE POS	THROTTLE POS #2	THROTTLE POS	THROTTLE POS #2	
0 %	0 V	0 %	0 V	VC line open
0 %	2.0~2.9 V	0 %	4.6~5.1 V	VTA line open or grand short
8~20 %	0 V	64~96 %	0 V	VTA2 line open or grand short
100 %	5 V	100 %	5 V	E2 line open

WIRING DIAGRAM



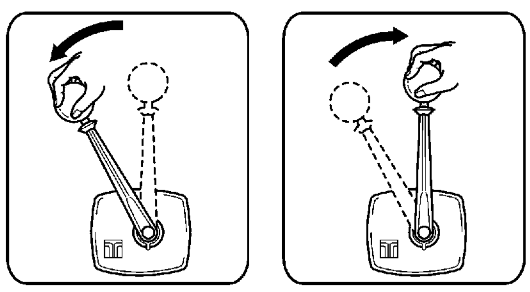
INSPECTION PROCEDURE

HINT:

- If DTC P0110 (Intake Air Temp. Circuit Malfunction), P0115 (Engine Coolant Temp. Circuit Malfunction), P0120 (Throttle Position Sensor Circuit Malfunction) and P1120 (Accelerator Pedal Position Sensor Circuit Malfunction) are output simultaneously, E2 (Sensor Ground) may be open.
- Read freeze frame data using TOYOTA hand-held tester or OBD II scan tool. Because freeze frame records the engine conditions when the malfunction is detected, when troubleshooting it is useful for determining whether the vehicle was running or stopped, the engine warmed up or not, the air-fuel ratio lean or rich, etc. at the time of the malfunction.

TOYOTA hand-held tester

1	**Connect TOYOTA hand-held tester, read throttle valve opening percentage.**


M17052

PREPARATION:

(a) Connect the TOYOTA hand-held tester to DLC3.

(b) Turn the ignition switch ON and switch the TOYOTA hand-held tester main switch ON.

CHECK:

Read the throttle valve opening percentage for VTA circuit and read the voltage for VTA2 circuit.

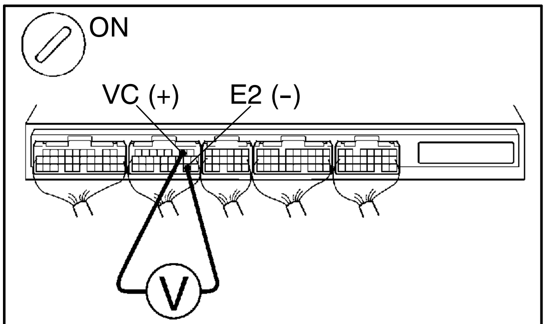
OK:

Throttle lever	Throttle valve opening position expressed as percentage (VTA)	Voltage (VTA2)
Released	64 ~ 96 %	4.6 ~ 5.1 V
Depressed	8 ~ 20 %	2.0 ~ 2.9 V

OK → **Check and replace ECM (See page IN-19).**

NG

2	**Check voltage between terminals VC and E2 of ECM connector.**



M02286

PREPARATION:

(a) Remove the wire harness boot.

(b) Turn the ignition switch ON.

CHECK:

Measure voltage between terminals VC and E2 of the ECM connector.

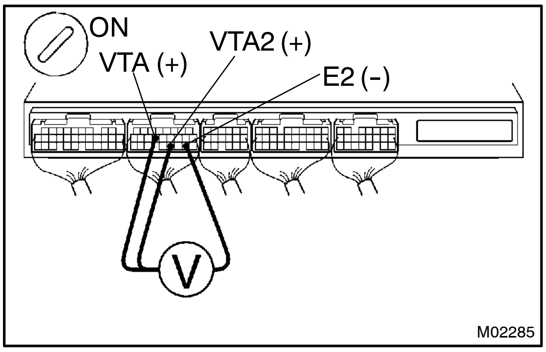
OK:

Voltage: 4.5 ~ 5.5 V

NG → **Check and replace ECM (See page IN-19).**

OK

3	**Check voltage between terminals VTA, VTA2 and E2 of ECM connector.**



PREPARATION:

(a) Remove the wire harness boot.

(b) Turn the ignition switch ON.

CHECK:

Measure voltage between terminals VTA, VTA2 and E2 of the ECM connector.

OK:

Accelerator pedal	Voltage	
	VTA	VTA2
Released	0.4 ~ 1.0 V	2.0 ~ 2.9 V
Depressed	3.2 ~ 4.8 V	4.6 ~ 5.1 V

OK → **Check and replace ECM (See page IN-19).**

NG

4	**Check throttle position sensor (See page SF-31).**

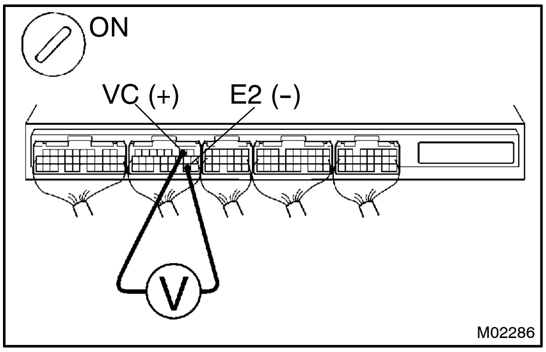
NG → **Replace throttle position sensor (See page SF-37).**

OK

Check for open and short in harness and connector between ECM and throttle position sensor (VC, VTA, VTA2, E2 line) (See page IN-19).

OBD II scan tool (excluding TOYOTA hand-held tester)

1	Check voltage between terminals VC and E2 of ECM connector.



PREPARATION:
(a) Remove the wire harness boot.
(b) Turn the ignition switch ON.

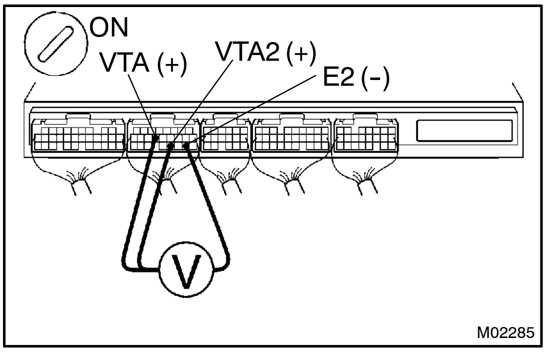
CHECK:
Measure voltage between terminals VC and E2 of the ECM connector.

OK:
Voltage: 4.5 ~ 5.5 V

NG → **Check and replace ECM (See page IN-19).**

OK

2	Check voltage between terminals VTA, VTA2 and E2 of ECM connector.



PREPARATION:
(a) Remove the wire harness boot.
(b) Turn the ignition switch ON.

CHECK:
Measure voltage between terminals VTA, VTA2 and E2 of the ECM connector.

OK:

Accelerator pedal	Voltage	
	VTA	VTA2
Released	0.4 ~ 1.0 V	2.0 ~ 2.9 V
Depressed	3.2 ~ 4.8 V	4.6 ~ 5.1 V

OK → **Check and replace ECM (See page IN-19).**

NG

3	Check throttle position sensor (See page SF-31).

NG → **Replace throttle position sensor (See page SF-37).**

OK

Check for open and short in harness and connector between ECM and throttle position sensor (VC, VTA, VTA2, E2 line) (See page IN-19).

DI2ON-01

DTC	P0121	Throttle Position Sensor Circuit Range/Performance Problem

CIRCUIT DESCRIPTION

Refer to DTC P0120 (Throttle Position Sensor CIrcuit Malfunction) on page DI–33.

DTC No.	DTC Detecting Condition	Trouble Area
P0121	Condition (a) continue for 2.0 seconds: (a) Difference between VTA and VTA2 is out of threshold	• Throttle position sensor • ECM

INSPECTION PROCEDURE

HINT:
Read freeze frame data using TOYOTA hand-held tester or OBD II scan tool. Because freeze frame records the engine conditions when the malfunction is detected, when troubleshooting it is useful for determining whether the engine was running or stopped, the engine warmed up or not, the air-fuel ratio lean or rich, etc. at the time of the malfunction.

Replace throttle position sensor (See page SF-37).

DI2OU-01

DTC	P0325	Knock Sensor 1 Circuit Malfunction

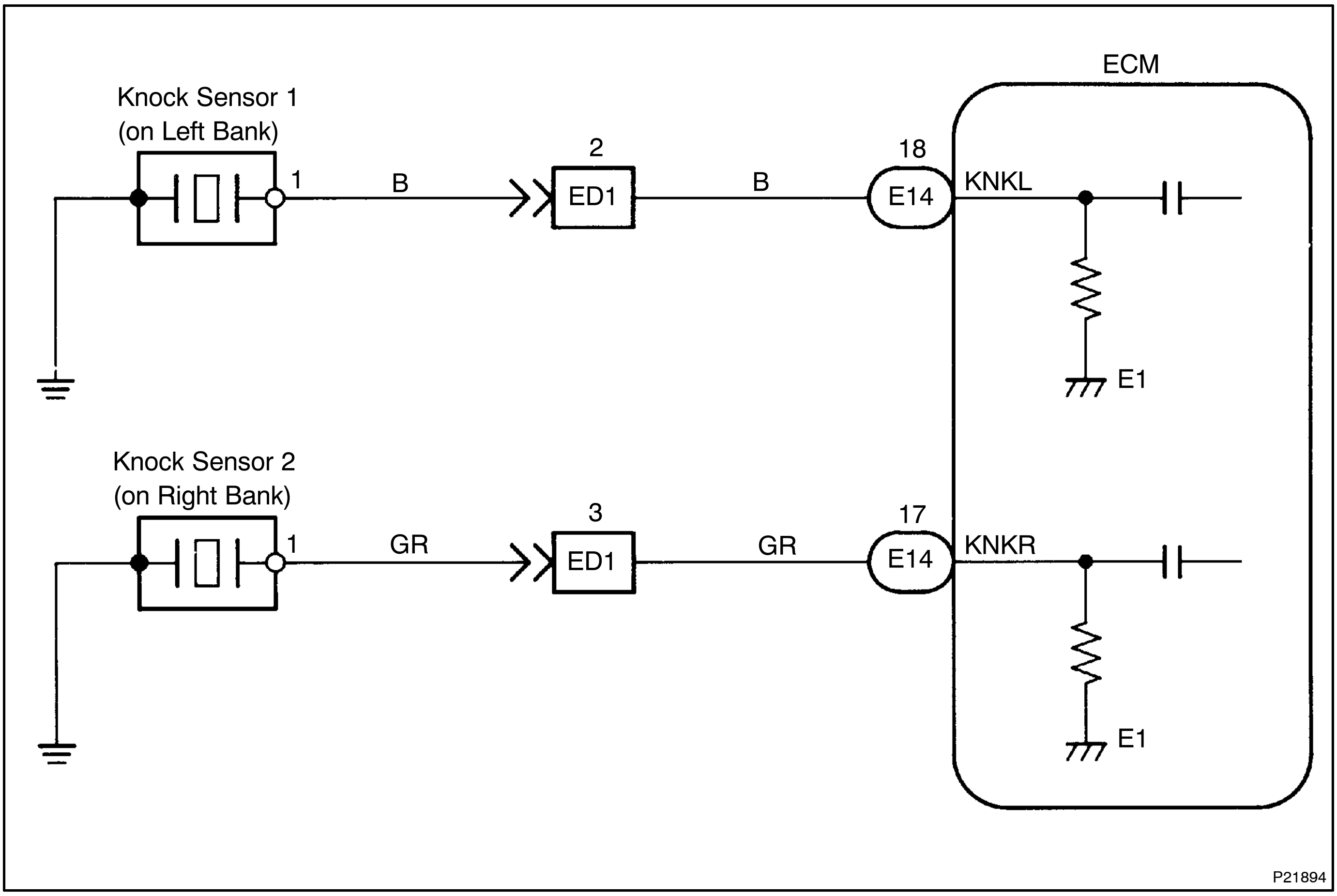
DTC	P0330	Knock Sensor 2 Circuit Malfunction

CIRCUIT DESCRIPTION

Knock sensors are fitted one 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 between 1,700 rpm and 5,400 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 between 1,700 rpm and 5,400 rpm	• Open or short in knock sensor 2 circuit • Knock sensor 2 (looseness) • ECM

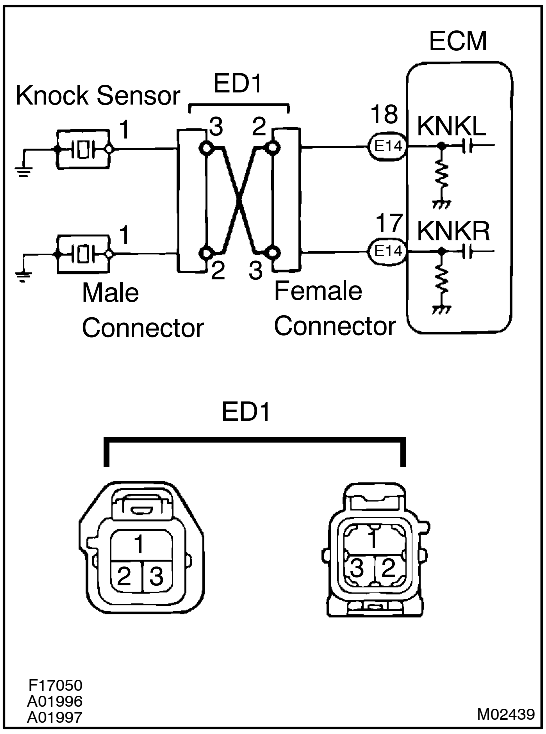
WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:
- DTC P0325 is for the left bank knock sensor circuit.
- DTC P0330 is for the right bank knock sensor circuit.
- Read freeze frame data using TOYOTA hand-held tester or OBD II scan tool. Because freeze frame records the engine conditions when the malfunction is detected, when troubleshooting it is useful for determining whether the vehicle was running or stopped, the engine warmed up or not, the air-fuel ratio lean or rich, etc. at the time of the malfunction.

1	**Connect OBD II scan tool or TOYOTA hand-held tester and check knock sensor circuit.**



PREPARATION:
(a) Connect the OBD II scan tool or TOYOTA hand-held tester to the DLC3.
(b) Disconnect the wire to wire connector ED1.
(c) Connect the terminals of the disconnected ED1 male connector and ED1 female as follows.

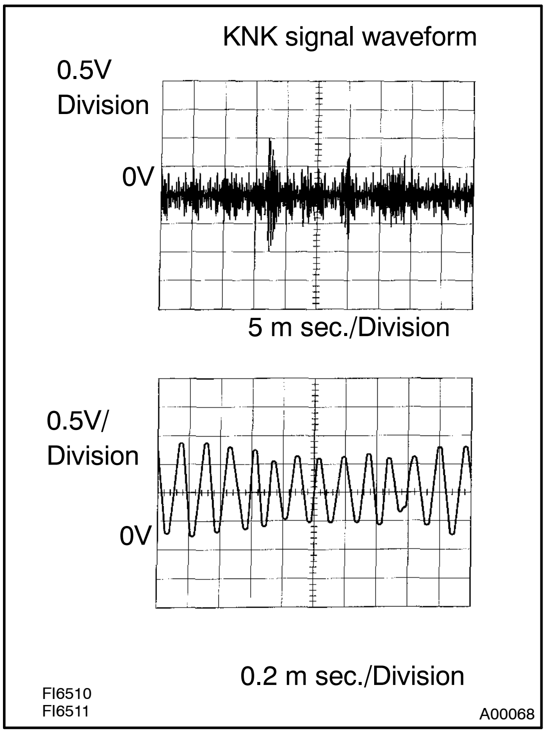
Male connector ↔ Female connector
Terminal 1 ↔ Terminal 2
Terminal 2 ↔ Terminal 1

(d) Turn ignition switch ON and switch the OBDII scan tool or TOYOTA hand-held tester main switch ON.
(e) After the engine is warmed up, perform quick racing to 4,000 rpm three times.

CHECK:
Check the DTC.

RESULT:

Type I	DTC same as when vehicle brought in. P0325 → P0325 or P0330 → P0330
Type II	DTC different to when vehicle brought in. P0325 → P0330 or P0330 → P0325



Reference: INSPECTION USING OSCILLOSCOPE

- With the engine racing (4,000 rpm) measure between terminal KNK1, KNK2 of the ECM connector and body ground.

HINT:
The correct waveforms are as shown.

- Spread the time on the horizontal axis, and confirm that period of the wave is 0.13 m sec.
  (Normal mode vibration frequency of knock sensor: 7.7 kHz)

HINT:
If normal mode vibration frequency is not 7.7 kHz, the sensor is malfunctioning.

Type II	**Go to step 3.**

Type I

2	**Check for open and short in harness and connector between ED1 connector and ECM (See page IN-19).**

NG	**Repair or replace harness or connector.**

OK

Check and replace ECM (See page IN-19).

3	**Check for open and short in harness and connector between ED1 connector and knock sensor (See page IN-19).**

HINT:
- If DTC P0325 has changed to P0330, check the knock sensor circuit on the left bank side.
- If DTC P0330 has changed to P0325, check the knock sensor circuit on the right bank side.

NG → **Repair or replace harness or connector.**

OK

Replace knock sensor.

DI2OV-01

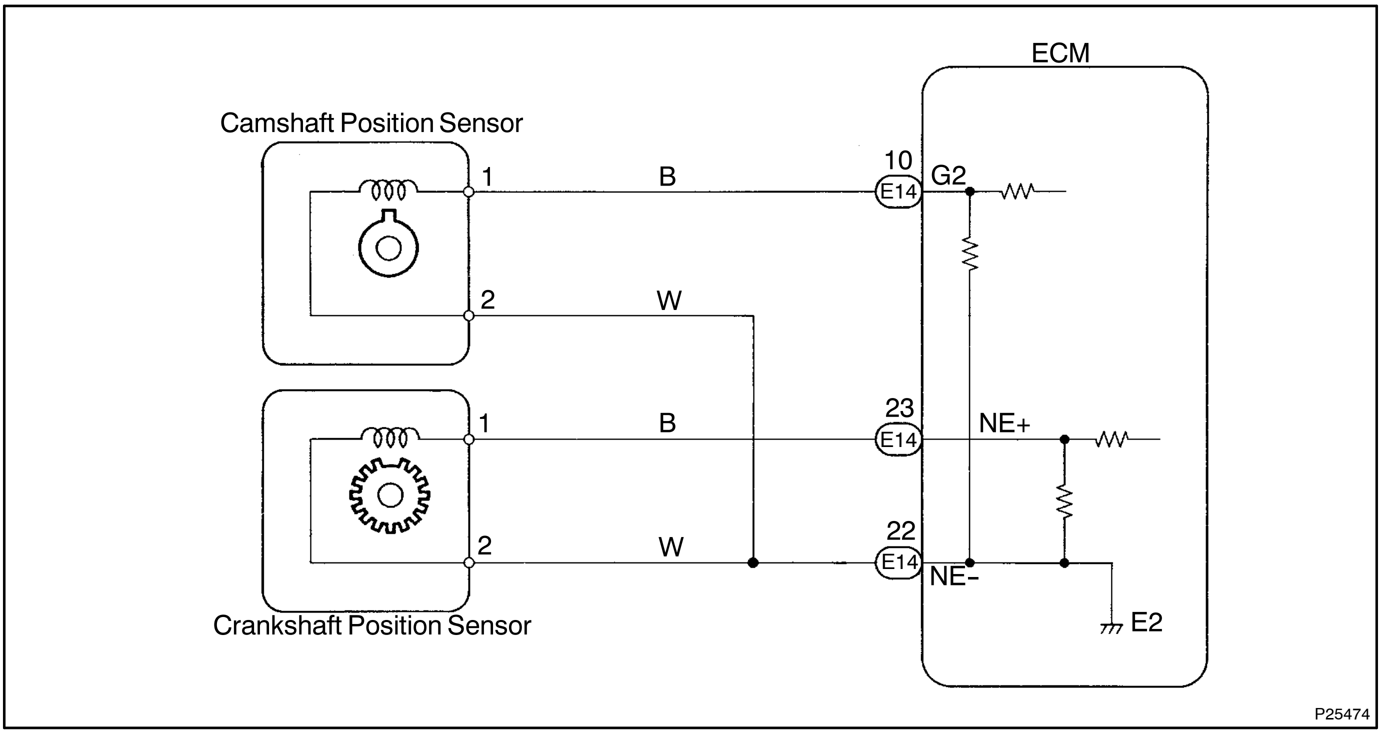
DTC	P0335	Crankshaft Position Sensor Circuit Malfunction

CIRCUIT DESCRIPTION

The crankshaft position sensor, which detects the engine speed and crankshaft angle signal (NE signal), has been installed on the oil pump body.
The NE signal plate has 34 teeth. The NE signal sensor generates 34 signals of every engine revolution. The ECM detects the standard crankshaft angle based on the G2 signals, and the actual crankshaft angle and the engine speed by the NE signals.

DTC No.	DTC Detecting Condition	Trouble Area
P0335	No crankshaft position sensor signal to ECM during cranking (2 trip detection logic)	• Open or short in crankshaft position sensor circuit • Crankshaft position sensor • Starter • ECM
	No crankshaft position sensor signal to ECM with engine speed 450 rpm or more (2 trip detection logic)	

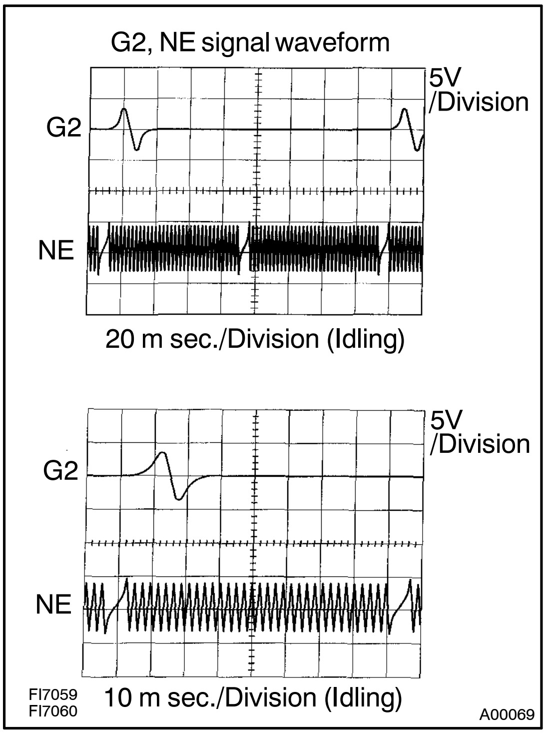
WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:
- Perform troubleshooting of DTC P0335 first. If no trouble is found, troubleshoot the following mechanical systems.
- Read freeze frame data using TOYOTA hand-held tester or OBD II scan tool. Because freeze frame records the engine conditions when the malfunction is detected, when troubleshooting it is useful for determining whether the vehicle was running or stopped, the engine warmed up or not, the air-fuel ratio lean or rich, etc. at the time of the malfunction.

1	**Check resistance of crankshaft position sensor (See page IG-1).**



Reference: INSPECTION USING OSCILLOSCOPE

During cranking or idling, check between terminals G2 and NE-, NE and NE- of the ECM connector.

HINT:

The correct waveforms are as shown.

NG → **Replace crankshaft position sensor.**

OK

2	**Check for open and short in harness and connector between ECM and crankshaft position sensor (See page IN-19).**

NG → **Repair or replace harness or connector.**

OK

3	Inspect sensor installation and teeth of signal plate.

NG → Tighten sensor. Replace signal plate.

OK

Check and replace ECM (See page IN-19).

DI2OW-01

DTC	P0340	Camshaft Position Sensor Circuit Malfunction

CIRCUIT DESCRIPTION

Camshaft position sensor (G2 signal) consist of a signal plate and pickup coil.
The G2 signal plate has 1 tooth, on its outer circumference and is mounted on the left bank camshafts.
When the camshafts rotate, the protrusion on the signal plate and the air gap on the pickup coil change, causing fluctuations in the magnetic field and generating an electromotive force in the pickup coil.
The NE signal plate has 34 teeth and is mounted on the crankshaft. The NE signal sensor generates 34 signals for every engine revolution. The ECM detects the standard crankshaft angle based on the G2 signal and the actual crankshaft angle and the engine speed by the NE signals.

DTC No.	DTC Detecting Condition	Trouble Area
P0340	No camshaft position sensor signal to ECM during cranking (2 trip detection logic)	• Open or short in camshaft position sensor circuit • Camshaft position sensor • Starter • ECM
	No camshaft position sensor signal to ECM with engine speed 600 rpm or more	

WIRING DIAGRAM

Refer to DTC P0335 (Crankshaft Positio Sensor Circuit Malfunction) on page DI-44 for the WIRING DIAGRAM.

INSPECTION PROCEDURE

HINT:
Read freeze frame data using TOYOTA hand-held tester or OBD II scan tool. Because freeze frame records the engine conditions when the malfunction is detected, when troubleshooting it is useful for determining whether the engine was running or stopped, the engine warmed up or not, the air-fuel ratio lean or rich, etc. at the time of the malfunction.

1	Check resistance of camshaft position sensor (See page IG-1).

Reference: INSPECTION USING OSCILLOSCOPE
Refer to DTC P0335 (Crankshaft Position Sensor ”A” Circuit Malfunction) on page DI-44 for the Reference: INSPECTION USING OSCILLOSCOPE.

NG → **Replace camshaft position sensor.**

OK

2	Check for open and short in harness and connector between ECM and camshaft position sensor (See page IN-19).

NG → Repair or replace harness or connector.

OK

3	Inspect sensor installation.

NG → Tighten sensor.

OK

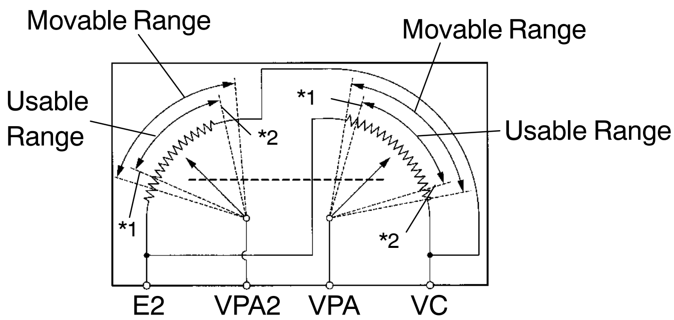
Check and replace ECM (See page IN-19).

DI2P3-01

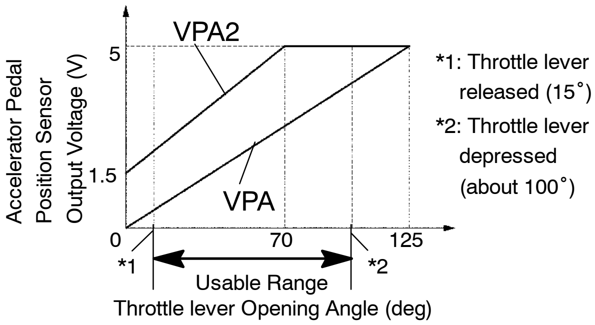
DTC	P1120	Accelerator Position Sensor Circuit Malfunction

CIRCUIT DESCRIPTION

Accelerator pedal position sensor is mounted on the throttle body and it have the 2 sensors to detects the accelerator position and a malfunction of the accelerator position's own.
The accelerator pedal position sensor is connected with the throttle lever by the throttle wire and the voltage applied to the terminals VPA and VPA2 of the ECM changes between 0 V and 5 V in proportion to the opening angle of the throttle lever.
The ECM judges the current opening angle of the throttle lever from these signals input from terminals VPA and VPA2 and the ECM controls the throttle motor based on these signals.
If this DTC is stored, the ECM shuts down the power for the throttle motor and the magnetic clutch, and the throttle valve is fully closed by the return spring.
However, the opening angle of the throttle valve can be controlled by the throttle lever through the throttle cable.



A02395 A02396



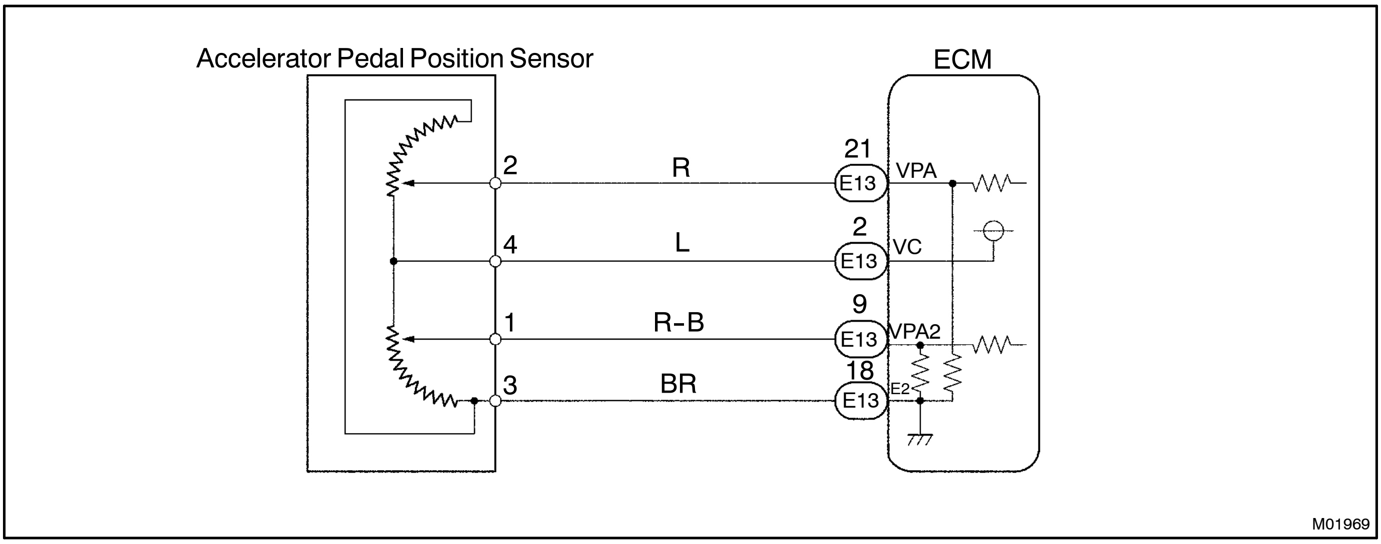
A02624

DTC No.	DTC Detecting Condition	Trouble Area
P1120	Condition (a), (b), (c) or (d) continues for 2.0 seconds: (a) VPA ≦ 0.2 V (b) VPA2 ≦ 0.5 V (c) VPA ≧ 4.8 V (d) When VPA ≧ 0.2 V and ≦ 1.8 V, and VPA2 ≧ 4.97 V	• Open or short in accelerator pedal position sensor circuit • Accelerator pedal position sensor • ECM
	Condition (a) or (b) continues for 0.4 seconds: (a) VPA ≦ 0.2 V and VPA2 ≦ 1.5 V (b) VPA-VPA2 ≦ 0.02 V	

HINT:
After confirming DTC P1120 use the OBD II scan tool or TOYOTA hand-held tester to confirm the accelerator pedal opening percentage.

Accelerator pedal opening position expressed as voltage				Trouble area
Throttle lever released		Throttle lever depressed		
ACCEL POS #1	ACCEL POS #2	ACCEL POS #1	ACCEL POS #2	
0 V	0 V	0 V	0 V	VC line open
0 V	1.8~2.7 V	0 V	4.7~5.1 V	VPA line open or grand short
0.3~0.9 V	0 V	3.2~4.8 V	0 V	VPA2 line open or grand short
5 V	5 V	5 V	5 V	E2 line open

WIRING DIAGRAM

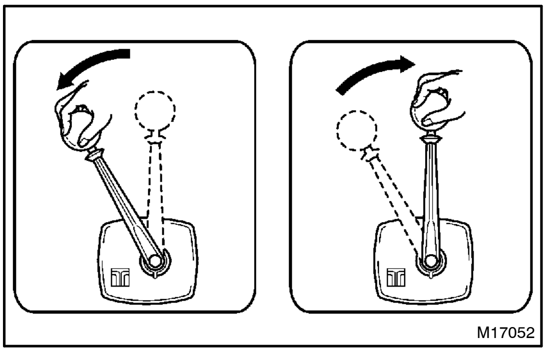


INSPECTION PROCEDURE

HINT:
- If DTC P0110 (Intake Air Temp. Circuit Malfunction), P0115 (Engine Coolant Temp. Circuit Malfunction), P0120 (Throttle Position Sensor Circuit Malfunction) and P1120 (Accelerator Pedal Position Sensor Circuit Malfunction) are output simultaneously, E2 (Sensor Ground) may be open.
- Read freeze frame data using TOYOTA hand-held tester or OBD II scan tool. Because freeze frame records the engine conditions when the malfunction is detected, when troubleshooting it is useful for determining whether the engine was running or stopped, the engine warmed up or not, the air-fuel ratio lean or rich, etc. at the time of the malfunction.

TOYOTA hand-held tester

1	**Connect TOYOTA hand-held tester, read the voltage for accelerator pedal position sensor data.**



PREPARATION:
(a) Connect the TOYOTA hand-held tester to DLC3.
(b) Turn the ignition switch ON and switch the TOYOTA hand-held tester main switch ON.

CHECK:
Read the voltage for the throttle lever position sensor data.

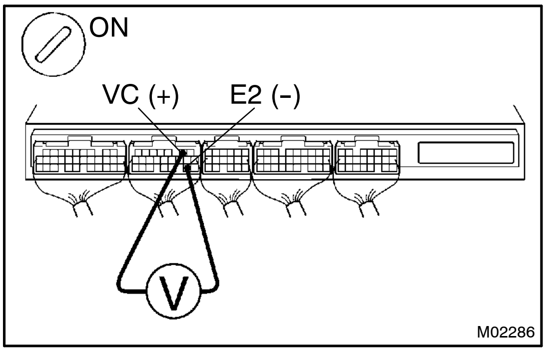
OK:

Throttle lever	VPA	VPA2
Releaded	0.3 ~ 0.9 V	1.8 ~ 2.7 V
Depressed	3.2 ~ 4.8 V	4.7 ~ 5.1 V

OK	**Check and replace ECM (See page IN-19).**

NG

2 Check voltage between terminals VC and E2 of ECM connector.



PREPARATION:

(a) Remove the wire harness boot.

(b) Turn the ignition switch ON.

CHECK:

Measure voltage between terminals VC and E2 of the ECM connector.

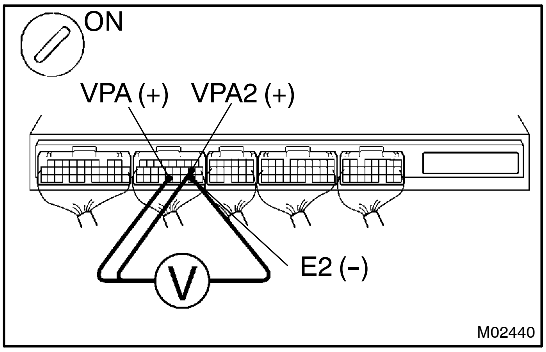
OK:

Voltage: 4.5 ~ 5.5 V

NG → **Check and replace ECM (See page IN–19).**

OK

3 Check voltage between terminals VPA, VPA2 and E2 of ECM connector.



PREPARATION:

(a) Remove the wire harness boot.

(b) Turn the ignition switch ON.

CHECK:

Measure voltage between terminals VPA, VPA2 and E2 of the ECM connector.

OK:

Throttle lever	Voltage	
	VPA	VPA2
Released	0.3 ~ 0.9 V	1.8 ~ 2.7 V
Depressed	3.2 ~ 4.8 V	4.7 ~ 5.1 V

OK → **Check and replace ECM (See page IN–19).**

NG

4	**Check accelerator pedal position sensor (See page SF-31).**

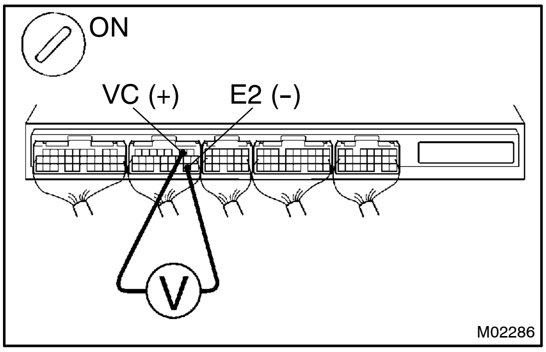
NG	**Replace accelerator pedal position sensor (See page SF-42).**

OK

Check for open and short in harness and connector between ECM and accelerator pedal position sensor (VC, VPA,VPA2, E2 line) (See page IN-19).

OBD II scan tool (excluding TOYOTA hand-held tester)

1	**Check voltage between terminals VC and E2 of ECM connector.**



PREPARATION:
(a) Remove the wire harness boot.
(b) Turn the ignition switch ON.

CHECK:
Measure voltage between terminals VC and E2 of the ECM connector.

OK:
Voltage: 4.5 ~ 5.5 V

NG	**Check and replace ECM (See page IN-19).**

OK

2	**Check voltage between terminals VPA, VPA2 and E2 of ECM connector.**

PREPARATION:
(a) Remove the wire harness boot.
(b) Turn the ignition switch ON.

CHECK:
Measure voltage between terminals VPA, VPA2 and E2 of the ECM connector.

OK:

Throttle lever	Voltage	
	VPA	VPA2
Relesed	0.3 ~ 0.9 V	1.8 ~ 2.7 V
Depressed	3.2 ~ 4.8 V	4.7 ~ 5.1 V

OK → **Check and replace ECM (See page IN-19).**

NG

3	**Check accelerator pedal position sensor (See page SF-31).**

NG → **Replace accelerator pedal position sensor (See page SF-37).**

OK

Check for open and short in harness and connector between ECM and accelerator pedal position sensor (VC, VPA,VPA2, E2 line) (See page IN-19).

DI2P4-01

DTC	P1121	Accelerator Pedal Position Sensor Range/ Performance Problem

CIRCUIT DESCRIPTION

Refer to DTC P1120 (Accelerator Pedal Position Sensor Circuit Malfunction) on page DI-49.

DTC No.	DTC Detecting Condition	Trouble Area
P1121	Condition (a) continue for 2.0 seconds: (a) Difference between VPA and VPA2 is out of threshold	• Accelerator Pedal position sensor • ECM

WIRING DIAGRAM

Refer to DTC P1120 (Accelerator Pedal Position Sensor Circuit Malfunction) on page DI-49.

INSPECTION PROCEDURE

HINT:
Read freeze frame data using TOYOTA hand-held tester or OBD II scan tool. Because freeze frame records the engine conditions when the malfunction is detected, when troubleshooting it is useful for determining whether the engine was running or stopped, the engine warmed up or not, the air-fuel ratio lean or rich, etc. at the time of the malfunction.

Replace accelerator pedal position sensor (See page SF-37).

DI2P5-01

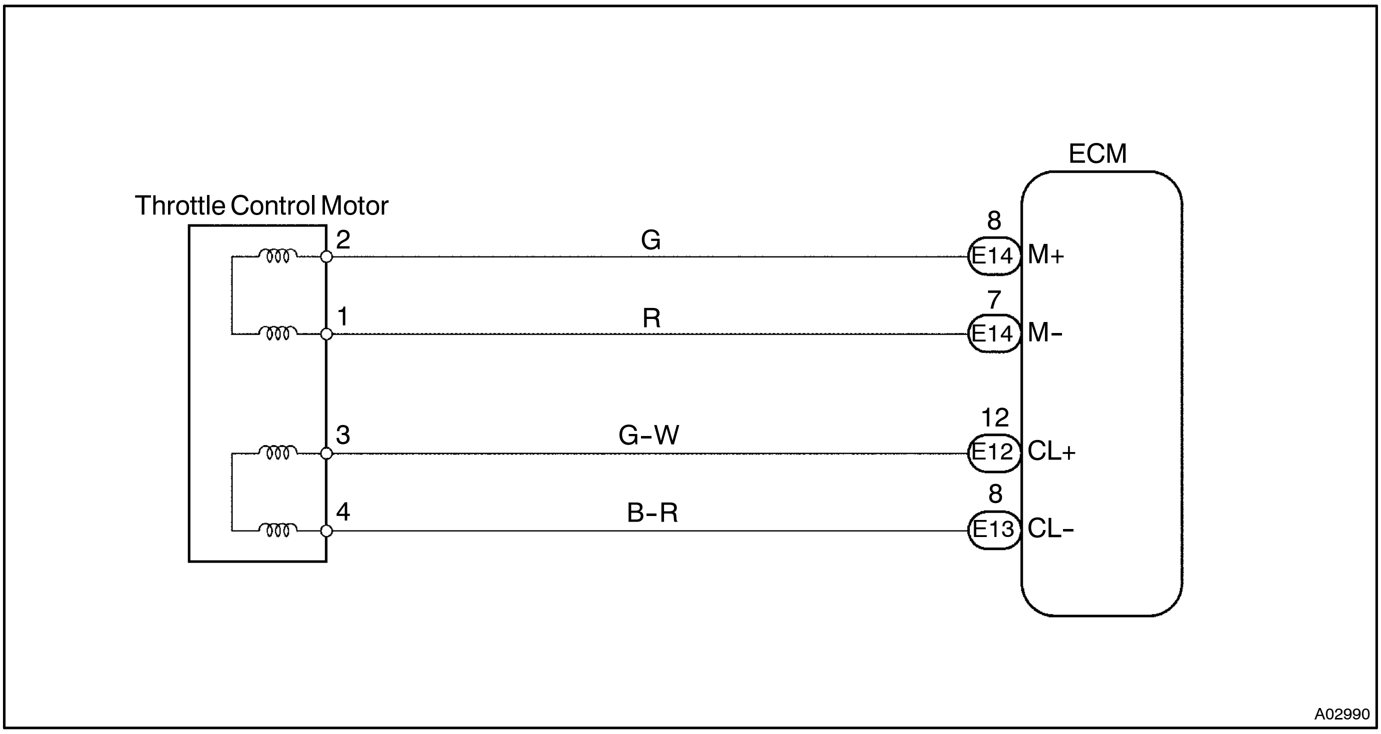
DTC	P1125	Throttle Control Motor Circuit Malfunction

CIRCUIT DESCRIPTION

Throttle motor is operated by the ECM and it opens and closes the throttle valve.
The opening angle of the throttle valve is detected by the throttle position sensor which is mounted on the throttle body and it provides feedback to the ECM to control the throttle motor in order to the throttle valve opening angle properly in response to driving condition.
If this DTC is stored, the ECM shuts down the power for the throttle motor and the magnetic clutch, and the throttle valve is fully closed by the return spring.
However, the opening angle of the throttle valve can be controlled by the throttle lever through the throttle cable.

DTC No.	DTC Detecting Condition	Trouble Area
P1125	Condition (a) and (b) continues for 0.8 seconds: (a) Throttle control motor output duty ≧ 80 % (b) Throttle control motor current < 0.3 A	• Open or short in throttle control motor circuit • Throttle control motor • ECM
	Throttle control motor current ≧ 16 A	
	Under condition continue for 0.6 seconds: Throttle control motor current ≧ 7 A	

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:
Read freeze frame data using TOYOTA hand-held tester or OBD II scan tool. Because freeze frame records the engine conditions when the malfunction is detected, when troubleshooting it is useful for determining whether the engine was running or stopped, the engine warmed up or not, the air-fuel ratio lean or rich, etc. at the time of the malfunction.

1	**Check throttle control motor circuit.**

When using TOYOTA hand-held tester:

PREPARATION:

(a) Connect the TOYOTA hand-held tester to the DLC3.

(b) Turn the ignition switch ON and TOYOTA hand-held tester main switch ON.

CHECK:

Read the throttle motor current value on the TOYOTA hand-held tester.

OK:

Blow 7 A at idle

When not using TOYOTA hand-held tester:

PREPARATION:

(a) Connect the oscilloscope between terminals M+ or M- and E1 of the ECM.

(b) Start the engine.

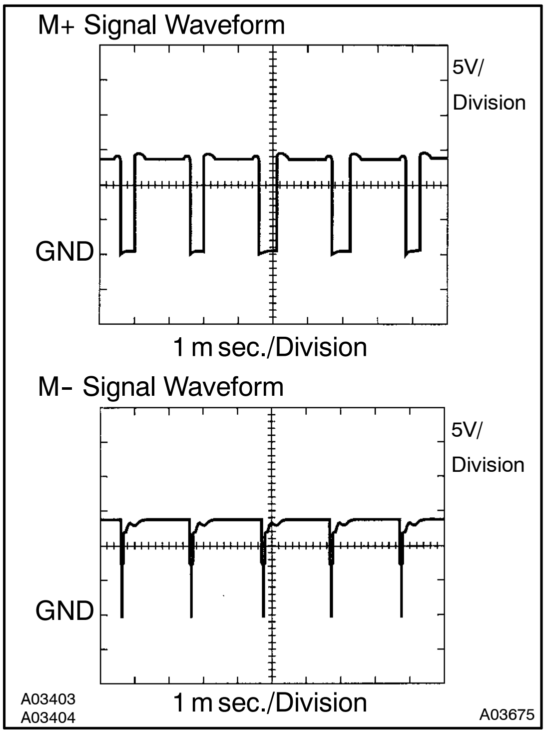
CHECK:

Check the waveform between terminals M+ or M- and E1 of the ECM when engine is idling.

OK:

The correct waveforms are as shown.

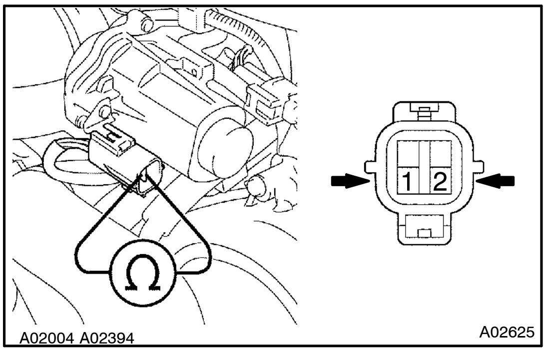
HINT:
The waveform frequency varies depending on the throttle opening.



OK	**Check and replace ECM (See page IN-19).**

NG

2	Check throttle control motor.



PREPARATION:
Disconnect the throttle control motor and magnetic clutch connector.
CHECK:
Measure resistance between terminals 1 and 2 of the throttle control motor and magnetic clutch.
OK:
Resistance: 0.3 ~ 100 Ω at 20°C (68°F)

NG → **Replace throttle control motor (See page SF–37).**

OK

3	Check for open and short in harness and connector between throttle control motor and ECM (See page IN–19).

NG → **Repair or replace.**

OK

Check and replace ECM (See page IN–19).

DI2P6-01

DTC	P1126	Magnetic Clutch Circuit Malfunction

CIRCUIT DESCRIPTION

Magnetic clutch is mounted between the throttle motor and the valve, and it connects the throttle motor with the throttle valve.
Therefore, the throttle motor opens and closes the throttle valve through the magnetic clutch.
If the electric throttle control system has a malfunction, the magnetic clutch separates the throttle motor from the throttle valve in order not to operate the throttle valve by the throttle motor.
If this DTC is stored, the ECM shuts down the power for the throttle motor and the magnetic clutch, and the throttle valve is fully closed by the return spring.
However, the opening angle of the throttle valve can be controlled by the throttle lever through the throttle cable.

DTC No.	DTC Detecting Condition	Trouble Area
P1126	Condition (a) continue for 0.8 seconds: (a) Magnetic clutch current ≧ 1.4 A or ≦ 0.4 A	• Open or short in magnetic clutch cirucit • Magnetic clutch • ECM
	Condition (a) continues for 1.5 seconds: (a) Magnetic clutch current ≧ 1.0 A or ≦ 0.8 A	

WIRING DIAGRAM

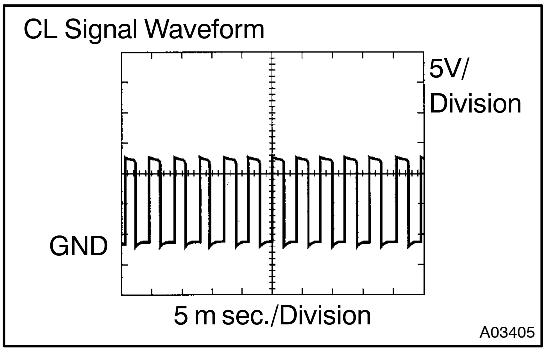
Refer to DTC P1125 (Throttle Control Motor Circuit Malfunction) on page DI-55 for the WIRING DIAGRAM.

INSPECTION PROCEDURE

HINT:
Read freeze frame data using TOYOTA hand-held tester or OBD II scan tool. Because freeze frame records the engine conditions when the malfunction is detected, when troubleshooting it is useful for determining whether the engine was running or stopped, the engine warmed up or not, the air-fuel ratio lean or rich, etc. at the time of the malfunction.

1	Check magnetic clutch circuit.

When using TOYOTA hand-held tester:
PREPARATION:
(a) Connect the TOYOTA hand-held tester to the DLC3.
(b) Turn the ignition switch ON and TOYOTA hand-held tester main switch ON.
CHECK:
Resd the magnetic clutch current value on the TOYOTA hand-held tester.
OK:
Current: 0.8 ~ 1.0 A



When not using TOYOTA hand-held tester:

PREPARATION:

(a) Connect the oscilloscope between terminals CL+ and CL– of the ECM.

(b) Start the engine.

CHECK:

Check the waveform between terminals CL+ and CL– of the ECM when engine is idling.

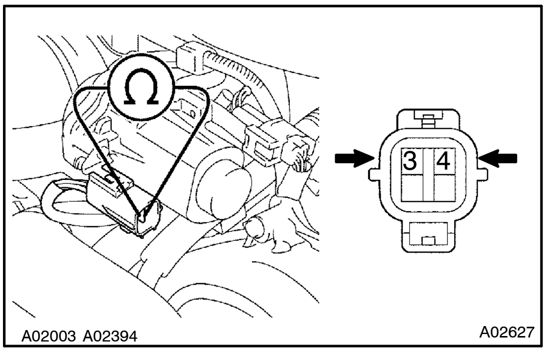
OK:

The correct waveform is as shown.

NG	Go to step 4.

OK

2	Check magnetic clutch.



PREPARATION:

Disconnect the throttle control motor and magnetic clutch connector.

CHECK:

Measure resistance between terminals 3 and 4 of the throttle control motor and magnetic clutch.

OK:

Resistance: 4.2 ~ 5.2 Ω at 20°C (68°F)

NG	Replace throttle control motor (with magnetic clutch) (See page SF-37).

OK

3	Check for open and short in harness and connector between magnetic clutch and ECM (See page IN-19).

NG	Repair or replace.

OK

4	Check operation of magnetic clutch.

CHECK:

(a) Clear the DTC.
(b) Perform the following steps and check the DTC.
 (1) Turn the ignition switch ON.
 (2) Start the engine.
 (3) Turn the ignition switch OFF and wait 3 seconds.
 (4) Turn the ignition switch ON.

OK:

DTC P1126 is not stored

NG → **Replace throttle control motor (with magnetic clutch) (See page SF-37).**

OK

Check and replace ECM (See page IN-19).

DI2P7-01

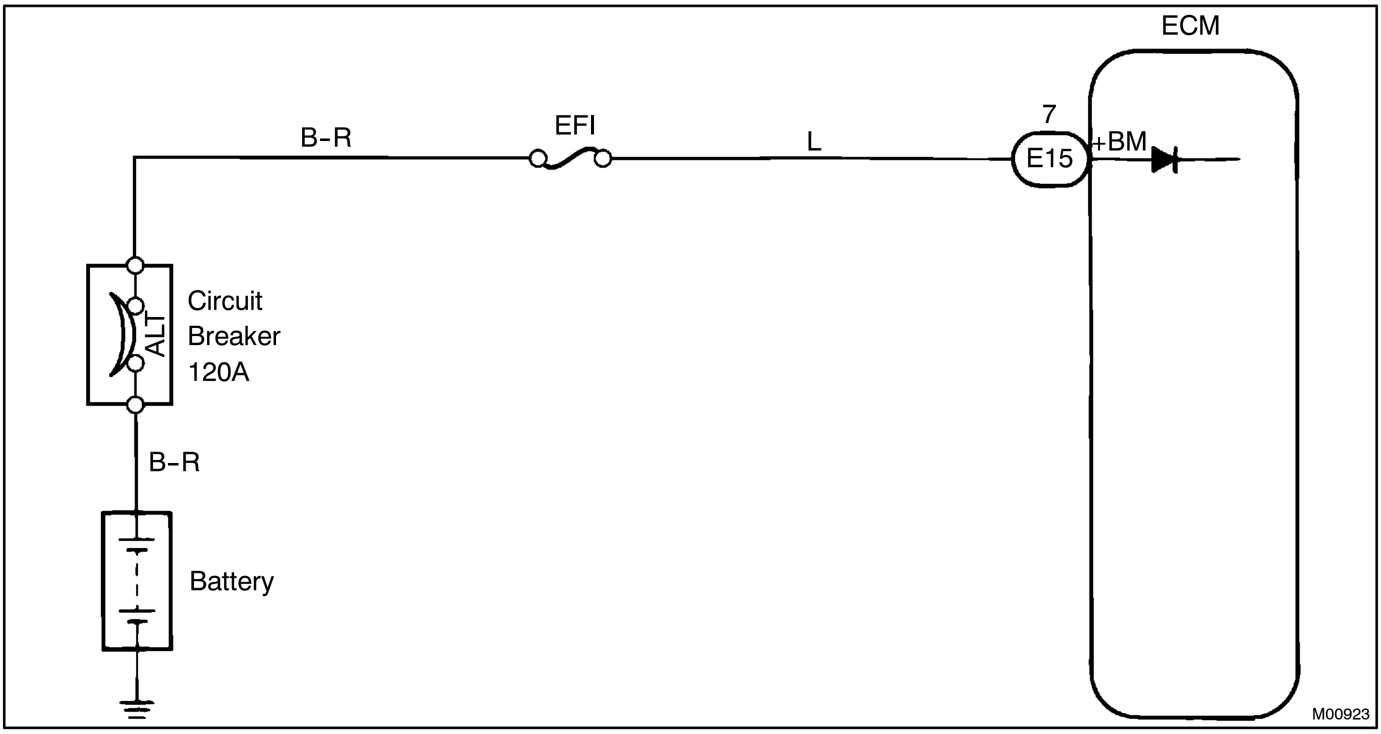
DTC	P1127	EFI Actuator Power Source Circuit Malfunction

CIRCUIT DESCRIPTION

Battery positive voltage is supplied to terminal +BM of the ECM even once when the ignition switch is OFF for the electric throttle control system.
If this DTC is stored, the ECM shuts down the power for the throttle motor and the magnetic clutch, and the throttle valve is fully closed by the return spring.
However, the opening angle of the throttle valve can be controlled by the throttle lever through the throttle cable.

DTC No.	DTC Detecting Condition	Trouble Area
P1127	Open in EFI power source circuit	• Open in EFI power source circuit • ECM

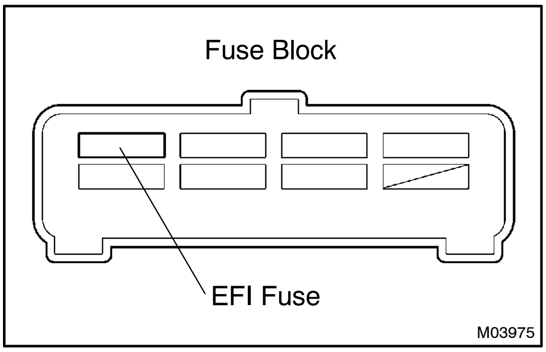
WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:
Read freeze frame data using TOYOTA hand-held tester or OBD II scan tool. Because freeze frame records the engine conditions when the malfunction is detected, when troubleshooting it is useful for determining whether the engine was running or stopped, the engine warmed up or not, the air-fuel ratio lean or rich, etc. at the time of the malfunction.

1	**Check EFI fuse.**

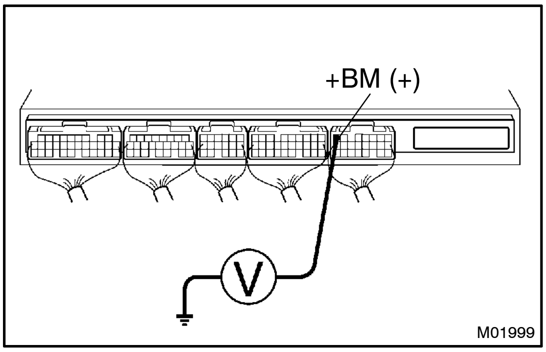


PREPARATION:
Remove the EFI fuse from fuse block.
CHECK:
Check countinuity of the EFI fuse.
OK:
Continuity

NG → **Check for short in all harness and components connected to EFI fuse.**

OK

2	**Check voltage between terminal +BM of ECM connector and body ground.**



PREPARATION:
Remove the wire harness boot.
CHECK:
Measure voltage between terminal +BM of the ECM connector and body ground.
OK:
Voltage: 9 ~ 14 V

OK → **Check and replace ECM (See page IN-19).**

NG

Check and repair harness or connector between battery and EFI fuse and ECM (See page IN-19).

DI2P8-01

DTC	P1128	Throttle Control Motor Lock Malfunction

CIRCUIT DESCRIPTION

Throttle motor is operated by the ECM and it opens and closes the throttle valve.
The opening angle of the throttle valve is detected by the throttle position sensor which is mounted on the throttle body and it provides feedback to the ECM to control the throttle motor in order the throttle valve opening angle properly in response to driving condition.
If this DTC is stored, the ECM shuts down the power for the throttle motor and the magnetic clutch, and the throttle valve is fully closed by the return spring.
However, the opening angle of the throttle valve can be controlled by the throttle lever through the throttle cable.

DTC No.	DTC Detecting Condition	Trouble Area
P1128	Lock throttle control motor during control throttle control motor	• Throttle control motor • Throttle body assembly • ECM

WIRING DIAGRAM

Refer to DTC P1125 (Throttle Control Motor Circuit Malfunction) on page DI-55 for the WIRING DIAGRAM.

INSPECTION PROCEDURE

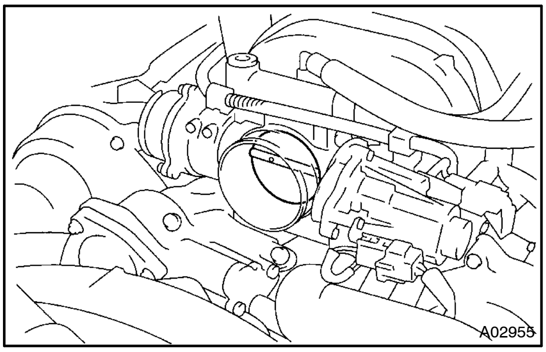
HINT:
Read freeze frame data using TOYOTA hand-held tester or OBD II scan tool. Because freeze frame records the engine conditions when the malfunction is detected, when troubleshooting it is useful for determining whether the engine was running or stopped, the engine warmed up or not, the air-fuel ratio lean or rich, etc. at the time of the malfunction.

1	**Check throttle control motor (See page DI-55, step 2).**

NG → **Replace throttle control motor (See page SF-37).**

OK

2	**Visualy check throttle valve.**



PREPARATION:
Remove the intake air connector.
CHECK:
Check whether or not a foreign body is caught between the throttle valve and the housing.

NG → **Remove a foreign body and clean throttle body.**

OK

Replace throttle body.

DI2P9–01

DTC	P1129	Electric Throttle Control System Malfunction

CIRCUIT DESCRIPTION

Electric Throttle Control System (ETCS) is composed of the throttle motor to operate the throttle valve, the electromagnetic clutch to connect the throttle motor with the throttle valve, the throttle position sensor to detect the opening angle of the throttle valve, the accelerator position sensor to detect the throttle lever position, the ECM to control the ETCS and the one valve type throttle body.
The ECM controls the throttle motor to make the throttle valve opening angle properly in response driving condition.
The throttle position sensor which is mounted on the throttle body detects the opening angle of the throttle valve, and it provides feedback to the ECM to control the throttle motor.
If the ETCS has a malfunction, the ECM shuts down the power for the throttle motor and the magnetic clutch, and the throttle valve is fully closed by the return spring.
However, the opening angle of the throttle valve can be controlled by the throttle lever through the throttle cable.

DTC No.	DTC Detecting Condition	Trouble Area
P1129	Throttle opening angle continues to vary great from target throttle opening angle	• Electric throttle control system • ECM

WIRING DIAGRAM

Refer to DTC P1125 (Throttle Control Motor Circuit Malfunction) on page DI–55 for the WIRING DIAGRAM.

INSPECTION PROCEDURE

HINT:
Read freeze frame data using TOYOTA hand–held tester or OBD II scan tool. Because freeze frame records the engine conditions when the malfunction is detected, when troubleshooting it is useful for determining whether the engine was running or stopped, the engine warmed up or not, the air–fuel ratio lean or rich, etc. at the time of the malfunction.

1	Are there any other codes (beside DTC P1129) being output?

YES → **Go to relevant DTC chart (See page DI–13).**

NO

Replace ECM, and clear DTC. If DTC P1129 is memorized again, and then replace throttle body.

DI2PB-01

DTC	P1300	Igniter Circuit Malfunction (No.1)

DTC	P1305	Igniter Circuit Malfunction (No.2)

DTC	P1310	Igniter Circuit Malfunction (No.3)

DTC	P1315	Igniter Circuit Malfunction (No.4)

DTC	P1320	Igniter Circuit Malfunction (No.5)

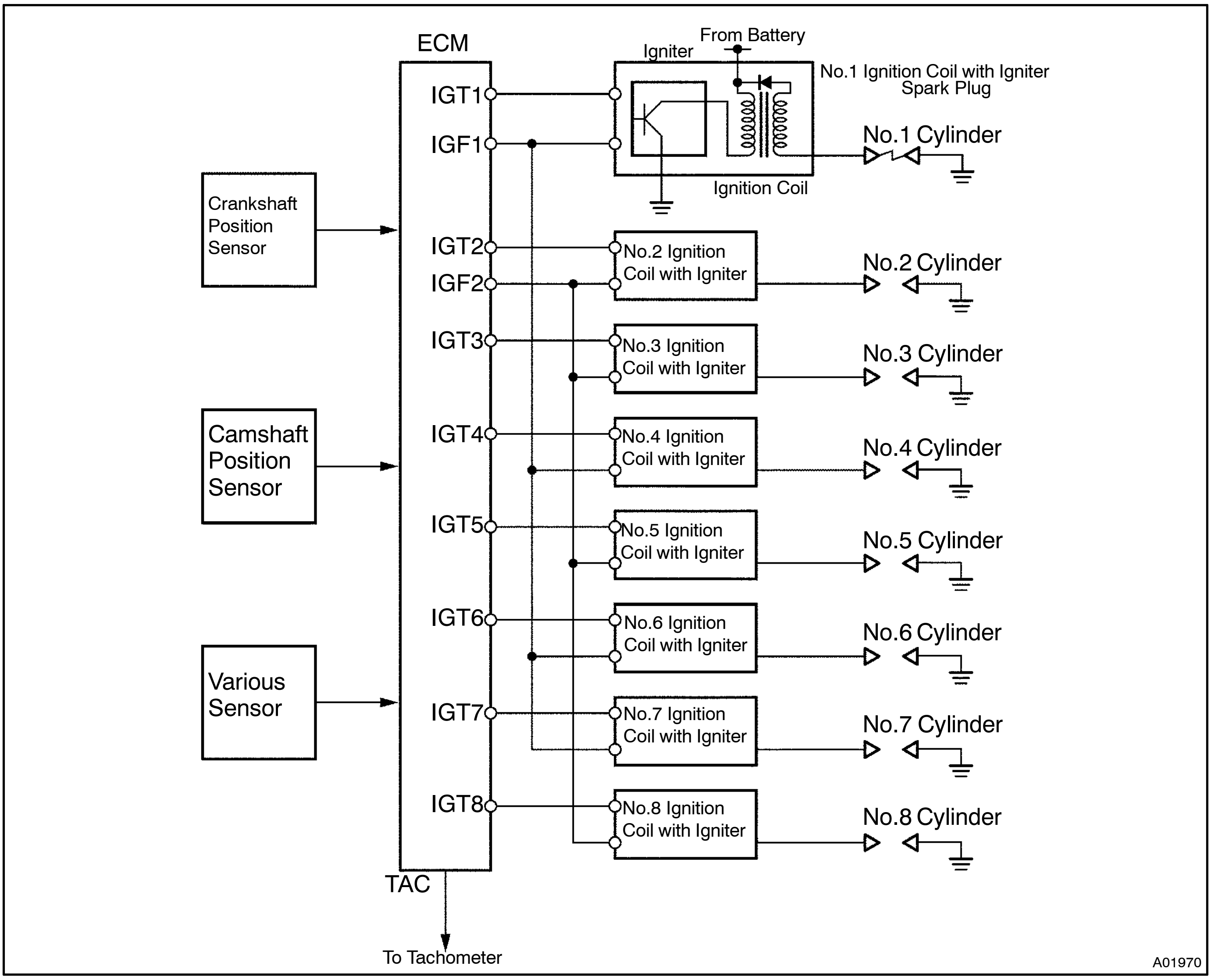
DTC	P1325	Igniter Circuit Malfunction (No.6)

DTC	P1330	Igniter Circuit Malfunction (No.7)

DTC	P1340	Igniter Circuit Malfunction (No.8)

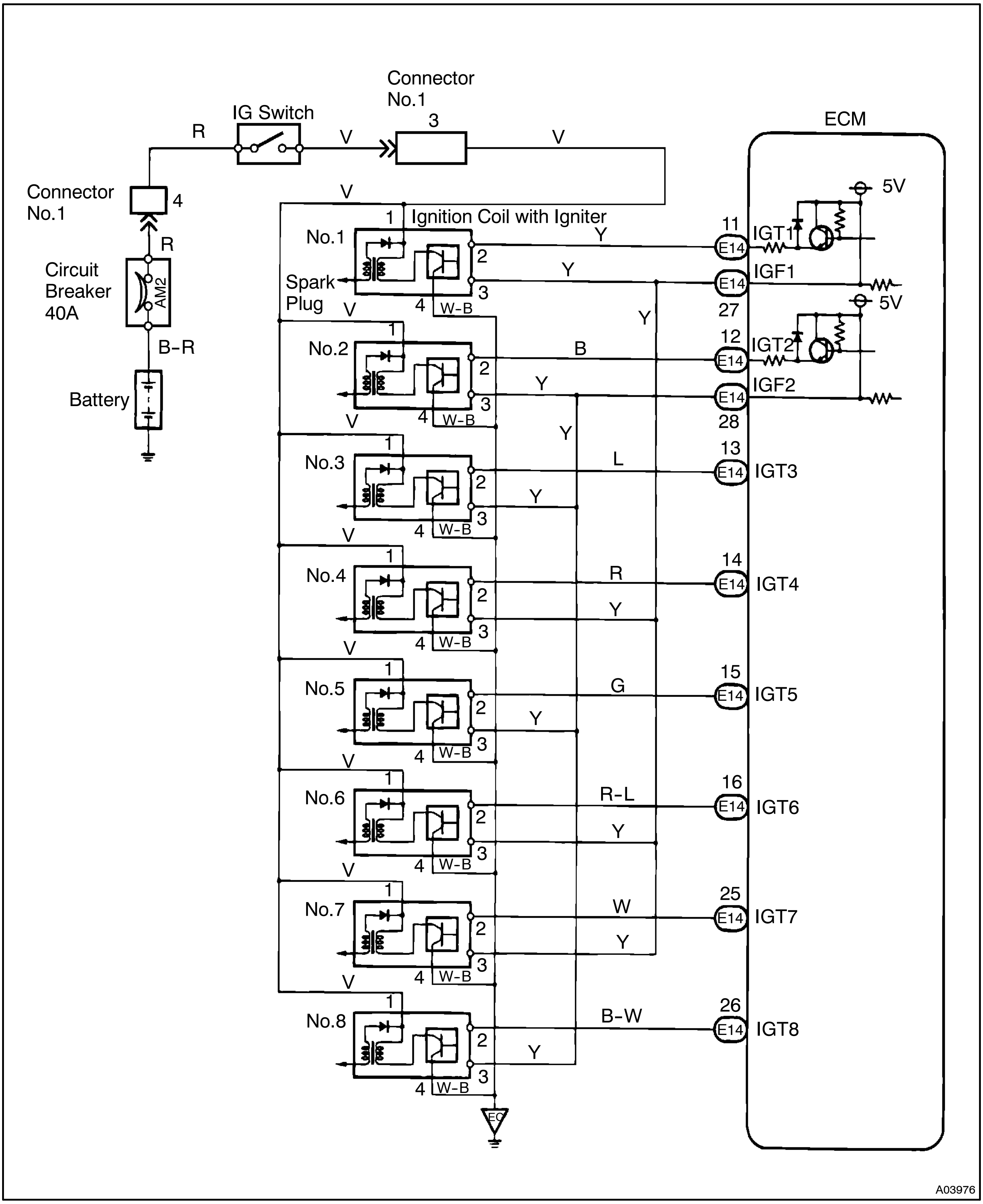
CIRCUIT DESCRIPTION

A DIS (Direct Ignition System) has been adopted. The DIS improves the ignition timing accuracy, reduces high-voltage loss, and enhances the the overall reliability of the ignition system by eliminating the distributor. The DIS is a 1-cylinder ignition system which ignites one cylinder with one ignition coil. In the 1-cylinder ignition system, the one spark plug is connected to the end of the secondary winding. High voltage generated in the secondary winding is applied directly to the spark plug. The spark of the spark plug pass from the center elecrtode to the ground electrode.
The ECM determines ignition timing and outputs the ignition signals (IGT) for each cylinder. Based on IGT signals, the power transistors in the igniter cuts off the current to the primary coil in the ignition coil is supplied to the spark plug that are connected to the end of the secondary coil. At the same time, the igniter also sends an ignition confirmation signal (IGF) as a fail-safe measure to the ECM.



DTC No.	DTC Detecting Condition	Trouble Area
P1300 P1305 P1310 P1315 P1320 P1325 P1330 P1340	No IGF signal to ECM while engine is running	• Open or short in IGF1 or IGF2 and IGT1 ~ 8 circuit from ignition coil with igniter • No.1 ~ No.8 ignition coil with igniter • ECM

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

- If DTC P1300 is displayed, check No.1 ignition coil with igniter circuit.
- If DTC P1305 is displayed, check No.2 ignition coil with igniter circuit.
- If DTC P1310 is displayed, check No.3 ignition coil with igniter circuit.
- If DTC P1315 is displayed, check No.4 ignition coil with igniter circuit.
- If DTC P1320 is displayed, check No.5 ignition coil with igniter circuit.
- If DTC P1325 is displayed, check No.6 ignition coil with igniter circuit.
- If DTC P1330 is displayed, check No.7 ignition coil with igniter circuit.
- If DTC P1340 is displayed, check No.8 ignition coil with igniter circuit.
- If DTC P1300, P1315, P1325, P1330 are output simultaneously, IGF1 circuit may be open or short.
- If DTC P1305, P1310, P1320, P1340 are output simultaneously, IGF2 circuit may be open or short.
- Read freeze frame data using TOYOTA hand-held tester or OBD II scan tool. Because freeze frame records the engine conditions when the malfunction is detected, when troubleshooting it is useful for determining whether the engine was running or stopped, the engine warmed up or not, the air-fuel ratio lean or rich, etc. at the time of the malfunction.

1	**Check spark plug and spark.**

NG → **Go to step 4.**

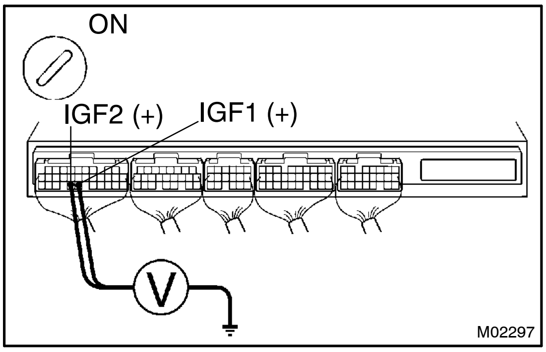
OK

2	**Check for open and short in harness and connector in IGF and IGT signal circuit between ECM and ignition coil with igniter (See page IN-19).**

NG → **Repair or replace harness or connector.**

OK

3	**Disconnect ignition coil with igniter connector and check voltage between terminals IGF1, 2 of ECM connector and body ground.**



PREPARATION:

(a) Remove the wire harness boot.
(b) Disconnect the ignition coil with igniter connector.
(c) Turn the ignition switch ON.

CHECK:

Measure voltage between terminals IGF1, 2 of the ECM connector and body ground.

OK:

Voltage: 4.5 ~ 5.5 V

OK → **Replace ignition coil with igniter.**

NG

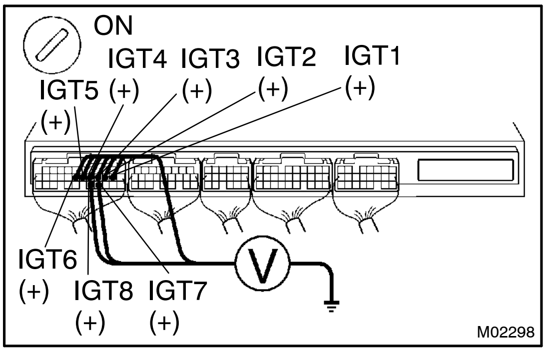
Check and replace ECM (See page IN-19).

4	**Check for open and short in harness and connector in IGT signal circuit between ECM and ignition coil with igniter (See page IN-19).**

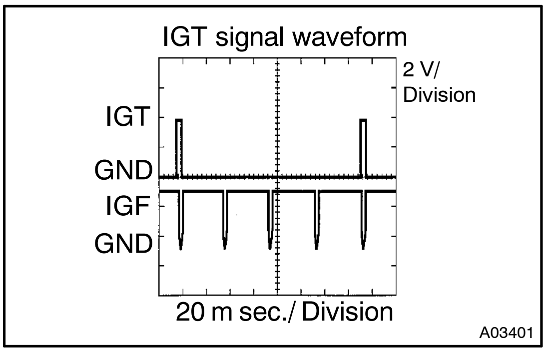
NG → **Repair or replace harness or connector.**

OK

5	Check voltage between terminals IGT1 ~ 8 of ECM connector and body ground.



PREPARATION:
Remove the wire harness boot.
CHECK:
Measure voltage between terminals IGT1 ~ 8 of the ECM connector and body ground when engine is cranked.
OK:
Voltage: More than 0.1 V and less than 4.5 V

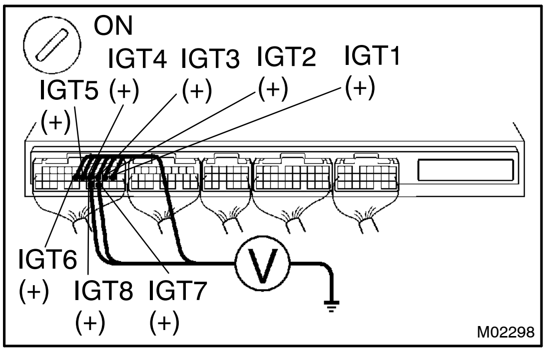


Reference: INSPECTION USING OSCILLOSCOPE
During cranking or idling, check waveform between terminals IGT1 ~ 8 and E1 of the ECM connector.
HINT:
Correct waveform appears as sohwn, with rectangle waves.

NG	Check and replace ECM (See page IN-19).

OK

6	Disconnect ignition coil with igniter connector and check voltage between terminals IGT1 ~ 8 of ECM connector and body ground.

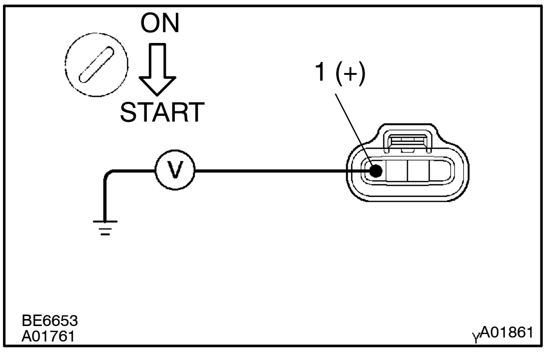


PREPARATION:
(a) Remove the wire harness boot.
(b) Disconnect the ignition coil with igniter connector.
CHECK:
Measure voltage between terminals IGT1 ~ 8 of the ECM connector and body ground when engine is cranked.
OK:
Voltage: More than 0.1 V and less than 4.5 V

NG	Check and replace ECM (See page IN-19).

OK

7	Check ignition coil with igniter power source circuit.



PREPARATION:
Disconnect the ignition coil with igniter connector.

CHECK:
Measure voltage between terminal 1 of ignition coil with igniter connector and body ground, when ignition switch is turned to "ON" and "START" position.

OK:
Voltage: 9 ~ 14 V

NG	Repair ignition coil with igniter power source circuit.

OK

8	Check for open and short in harness and connector between ignition switch and ignition coil with igniter (See page IN-19).

NG	Repair or replace harness or connector.

OK

9	Check EFI main relay (Marking: EFI) (See page SF-58).

NG	Replace EFI main relay (marking: EFI).

OK

Replace ignition coil with igniter.

DI2PC–01

DTC	P1335	Crankshaft Position Sensor Circuit Malfunction (during engine running)

CIRCUIT DESCRIPTION

Refer to DTC P0335 (Crankshaft Position Sensor Circuit Malfunction) on page DI–44.

DTC No.	DTC Detecting Condition	Trouble Area
P1335	No crankshaft position sensor signal to ECM with engine speed 1,000 rpm or more	• Open or short in crankshaft position sensor circuit • Crankshaft position sensor • Starter • ECM

WIRING DIAGRAM

Refer to DTC P0335 (Crankshaft Position Sensor Circuit Malfunction) on page DI–44 for the WIRING DIAGRAM.

INSPECTION PROCEDURE

HINT:
Read freeze frame data using TOYOTA hand–held tester or OBD II scan tool. Because freeze frame records the engine conditions when the malfunction is detected, when troubleshooting it is useful for determining whether the engine was running or stopped, the engine warmed up or not, the air–fuel ratio lean or rich, etc. at the time of the malfunction.
Refer to DTC P0335 (Crankshaft Position Sensor Circuit Malfunction) on page DI–44.

DI2PD-01

DTC	P1345	VVT Sensor Circuit Malfunction (Bank 1)

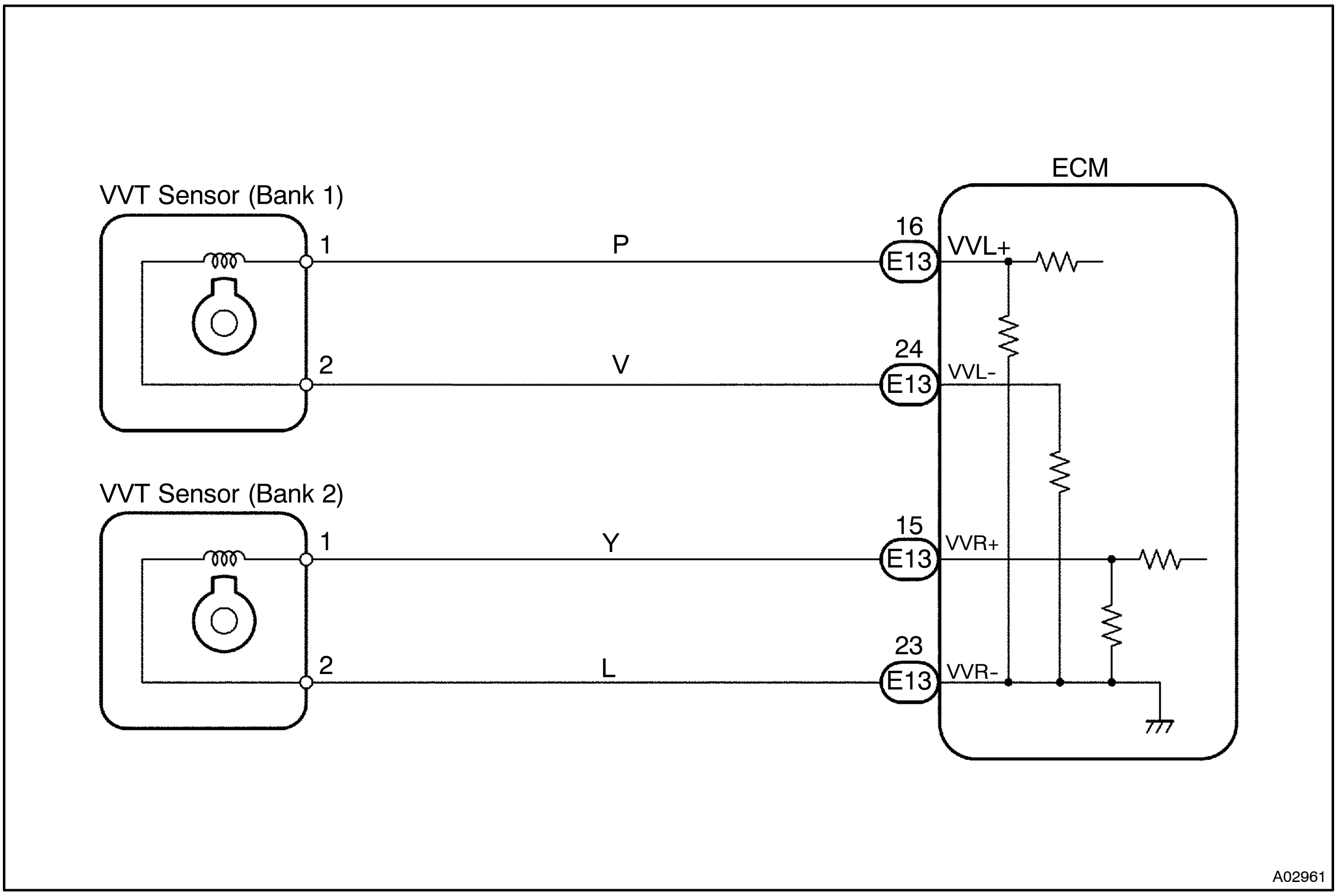
DTC	P1350	VVT Sensor Circuit Malfunction (Bank 2)

CIRCUIT DESCRIPTION

VVT sensor (VVL or VVR signal) consist of a signal plate and pickup coil.
The VVL or VVR signal plate has 1 tooth on its outer circumference and is mounted on the intake camshafts.
When the camshafts rotate, the protrusion on the signal plate and the air gap on the pickup coil change, causing fluctuations in the magnetic field and generating an electromotive force in the pickup coil.
The actual camshaft angle is detected by the VVT sensor and it provides feedback to the ECM to control the intake valve timing in response to during condition.

DTC No.	DTC Detecting Condition	Trouble Area
P1345 P1350	No VVT sensor signal to ECM during cranking at 4 sec. or more	• Open or short in VVT sensor circuit • VVT sensor • ECM
	No VVT sensor signal to ECM with 5 sec. or more engine speed 600 rpm or more	
	While the crankshaft rotates twice, VVT sensor signal will be input to ECM 5 times or more	

WIRING DIAGRAM

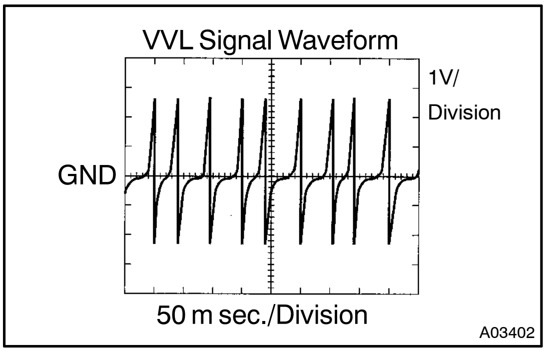


INSPECTION PROCEDURE

HINT:

- If DTC P1345 is dysplayed, check left bank VVT sensor.
- If DTC P1350 is dysplayed, check right bank VVT sensor.
- Read freeze frame data using TOYOTA hand-held tester or OBD II scan tool. Because freeze frame records the engine conditions when the malfunction is detected, when troubleshooting it is useful for determining whether the engine was running or stopped, the engine warmed up or not, the air-fuel ratio lean or rich, etc. at the time of the malfunction.

1	**Check resistance of VVT sensor (See page SF-73).**



Reference: INSPECTION USING OSCILLOSCOPE
During idling, check between terminals VVL+ and VVL-, VVR+ and VVR- of the ECM connector.
HINT:

- The correct waveform is as shown.
- The waveform frequency is shortened as the engine speed becomes higher.

NG → **Replace VVT sensor.**

OK

2	**Check for open and short in harness and connector between ECM and VVT sensor (See page IN-19).**

NG → **Repair or replace harness or connector.**

OK

3	**Inspect sensor installation.**

NG → **Tighten sensor.**

OK

Check and replace ECM (See page IN-19).

DI2PE-01

DTC	P1346	VVT Sensor Circuit Range/Performance Problem (Bank 1)

DTC	P1351	VVT Sensor Circuit Range/Performance Problem (Bank 2)

CIRCUIT DESCRIPTION

Refer to DTC P1345, P1350 (VVT Sensor Circuit Malfunction (Bank 1, 2)) on page DI-74.

DTC No.	Detection Item	Trouble Area
P1346	Deviation in crankshaft position sensor signal and VVT sensor (bank 1) signal (2 trip detection logic)	• Mechanical system malfunction (Skipping teeth of timing belt, belt stretched) • ECM
P1351	Deviation in crankshaft position sensor signal and VVT sensor (bank 2) signal (2 trip detection logic)	

WIRING DIAGRAM

Refer to DTC P1345, P1350 (VVT Sensor Circuit Malfunction (Bank 1, 2)) on page DI-74 for the WIRING DIAGRAM.

INSPECTION PROCEDURE

HINT:
Read freeze frame data using TOYOTA hand-held tester or OBD II scan tool. Because freeze frame records the engine conditions when the malfunction is detected, when troubleshooting it is useful for determining whether the engine was running or stopped, the engine warmed up or not, the air-fuel ratio lean or rich, etc. at the time of the malfunction.

1	**Check valve timing (Check for loose and jumping teeth of timing belt) (See page EM-12).**

NG → **Adjust valve timing (Repair or replace timing belt).**

OK

Check and replace ECM (See page IN-19).

DI2PF-01

DTC	P1349	VVT System Malfunction (Bank 1)

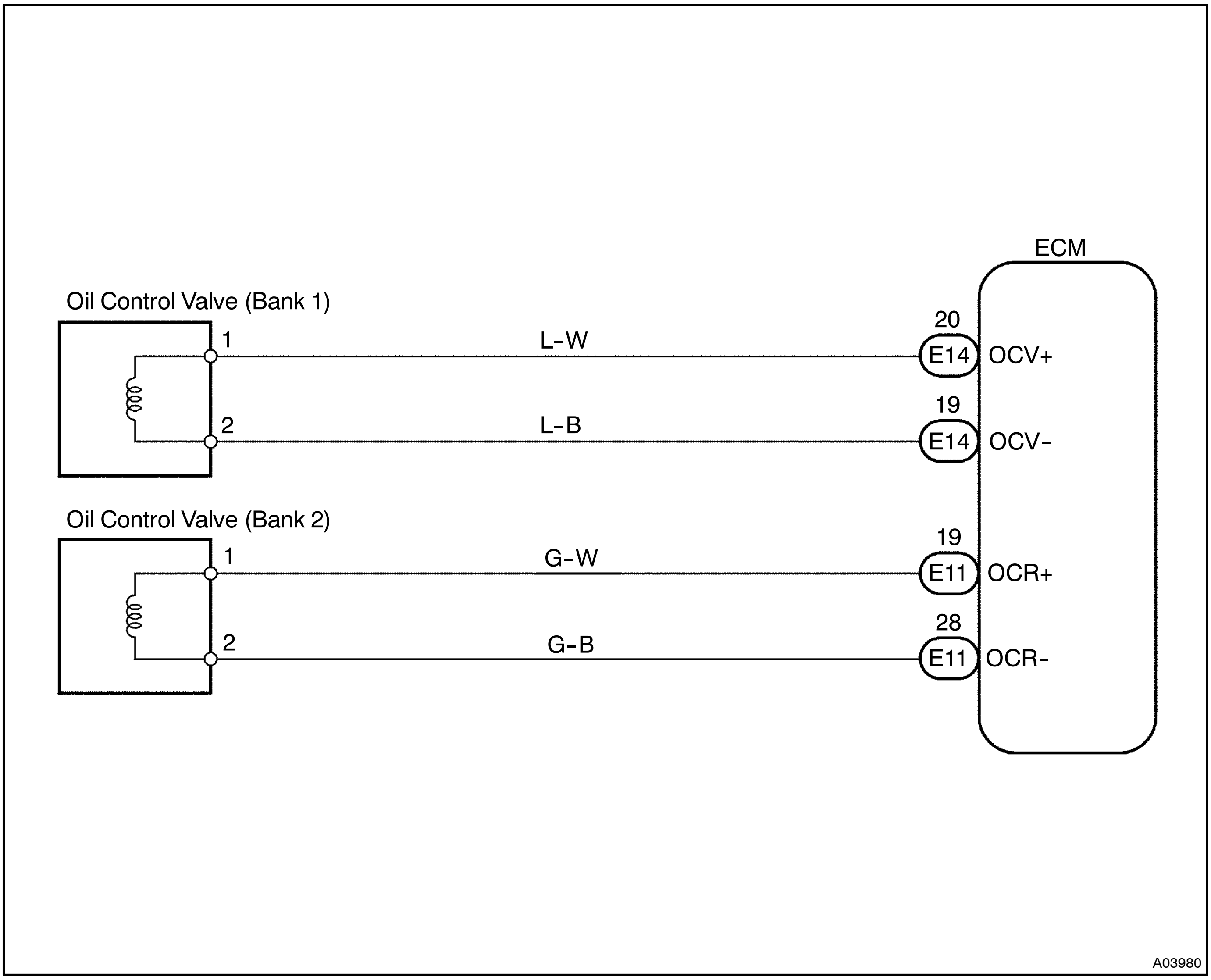
DTC	P1354	VVT System Malfunction (Bank 2)

CIRCUIT DESCRIPTION

VVT system controls the intake valve timing to proper timing in response to driving condition.
ECM controls OCV (Oil Control Valve) to make the intake valve timing properly, and, oil pressure controlled with OCV is supplied to the VVT controller, and then, VVT controller changes relative position between the camshaft and the crankshaft.

DTC No.	DTC Detecting Condition	Trouble Area
P1349 P1354	Condition (a) or (b) continues for after the engine is warmed up and engine speed at 400 ~ 4,000 rpm : (a) Valve timing does not change from of current valve timing (b) Current valve timing is fixed	• Valve timing • Oil control valve • VVT controller assembly • ECM

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

- If DTC P1349 is displayed, check left bank VVT system circuit.
- If DTC P1354 is displayed, check right bank VVT system circuit.
- Read freeze frame data using TOYOTA hand-held tester or OBD II scan tool. Because freeze frame records the engine conditions when the malfunction is detected, when troubleshooting it is useful for determining whether the engine was running or stopped, the engine warmed up or not, the air-fuel ratio lean or rich, etc. at the time of the malfunction.

TOYOTA hand-held tester

1	**Check valve timing (See page EM-12).**

NG → **Repair valve timing.**

OK ↓

2	**Check operation of OCV.**

PREPARATION:

(a) Start the engine and warmed it up.

(b) Connect the TOYOTA hand-held tester and select VVT from ACTIVE TEST menu.

CHECK:

Check the engine speed when operate the OCV by the TOYOTA hand-held tester.

OK:

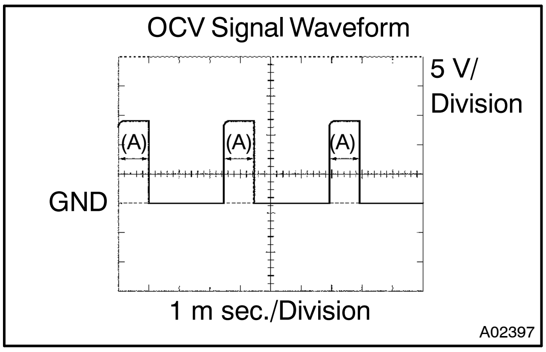
OCV is OFF:
Normal engine speed
OCV is ON:
Rough idle or engine stall

OK → **VVT system is OK.***

*: DTC P1349 and P1354 are also output after the foreign object is caught in some part of the system in the engine oil and the system returns to normal in a short time. As ECM controls so that foreign objects are ejected, there is no problem about VVT. There is also no problem since the oil filter should get the foreign object in the engine oil.

NG ↓

3	**Check voltage between terminals OCV+ and OCV- of ECM connector.**

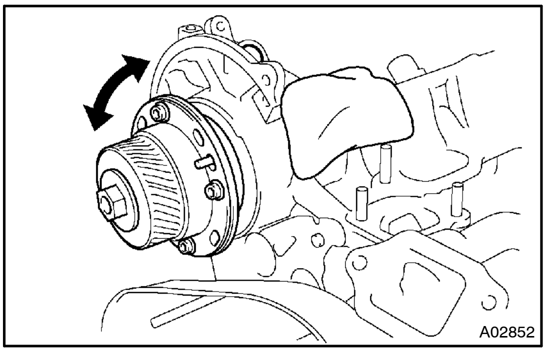


Reference: INSPECTION USING OSCILLOSCOPE
Turn the ignition switch ON, check waveform between terminals OCV+ and OCV- of the ECM connector.
HINT:
- The correct waveform is as shown.
- The waveform frequency (A) is lengthened as the engine speed becomes higher.

NG → **Check and replace ECM (See page IN-19).**

OK

4	**Check VVT controller assembly.**



PREPARATION:
(a) Remove the timing belt (See page EM-12).
(b) Remove the cylinder head cover.
(c) Remove the oil control valve (See page EM-29).
(d) Drain oil into the VVT controller assembly (See page EM-29).

CHECK:
Check whether the oil into VVT controller assembly is drained or not.

OK:
The oil into VVT controller assembly is drained.

NG → **Replace VVT controller assembly, and then go to step 5.**

OK

5	**Check oil control valve (See page SF-46).**

NG → **Replace oil control valve, and then go to step 6.**

OK

6	Check blockage of oil control valve, oil check valve and oil pipe No.1.

NG → **Repair or replace.**

OK ↓

7	Check whether or not DTC P1349/P1354 is stored.

PREPARATION:
(a) Clear the DTC (See page DI-3).
(b) Perform simulation test.
CHECK:
Check whether or not DTC P1349/P1354 is stored (See page DI-3).
OK:
DTC P1349/P1354 is not stored

OK → **VVT system is OK.***

*: DTC P1349 and P1354 are also output after the foreign object is caught in some part of the system in the engine oil and the system returns to normal in a short time. As ECM controls so that foreign objects are ejected, there is no problem about VVT. There is also no problem since the oil filter should get the foreign object in the engine oil.

NG ↓

Replace ECM.

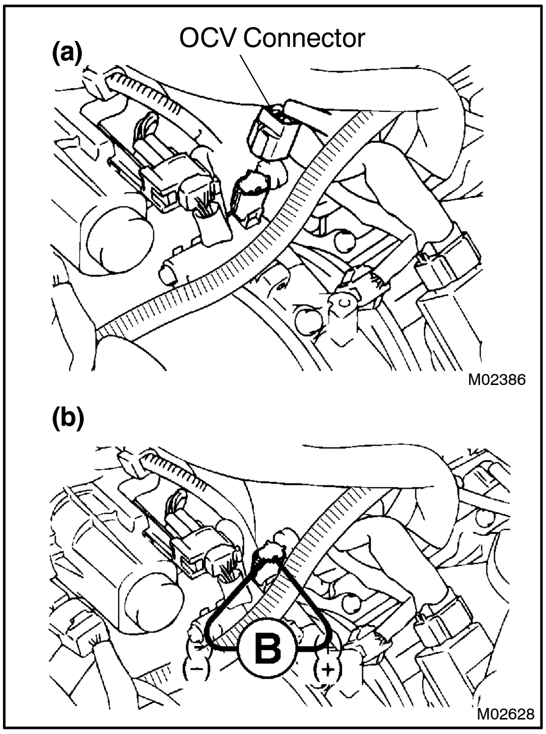
OBD II scan tool (excluding TOYOTA hand-held tester)

1	Check valve timing (See page EM-12).

NG → **Repair valve timing.**

OK ↓

2	Check operation of OCV.



PREPARATION:
Start the engine.

CHECK:

(a) Check the engine speed when disconnect the OCV connector.

(b) Check the engine speed when apply battery positive voltage between terminals of OCV.

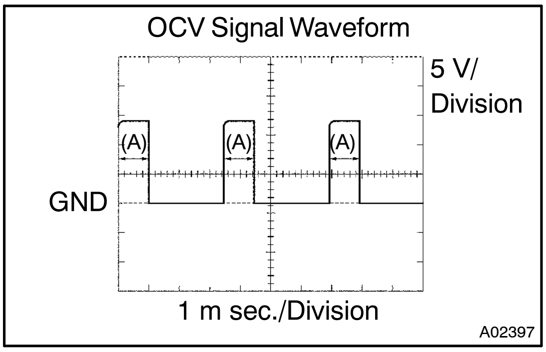
RESULT:

Result	Check (a)	Check (b)
1	Normal engine speed	Rough idle or engine stall
2	Except 1	

2	Go to step 4.

1

3	**Check voltage between terminals OCV+ and OCV- of ECM connector.**



Reference: INSPECTION USING OSCILLOSCOPE
Turn the ignition switch ON, check waveform between terminals OCV+ and OCV- of the ECM connector.
HINT:
- The correct waveform is as shown.
- The waveform frequency (A) is lengthened as the engine speed becomes higher.

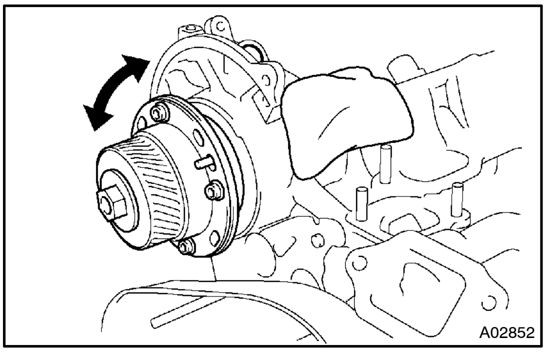
OK	**VVT system is OK.***

*: DTC P1349 and P1354 are also output after the foreign object is caught in some part of the system in the engine oil and the system returns to normal in a short time. As ECM controls so that foreign objects are ejected, there is no problem about VVT. There is also no problem since the oil filter should get the foreign object in the engine oil.

NG

Check and replace ECM (See page IN-19).

4	**Check VVT controller assembly.**



PREPARATION:
(a) Remove the timing belt (See page EM-12).
(b) Remove the cylinder head cover.
(c) Remove the oil control valve (See page EM-29).
(d) Drain oil into the VVT controller assembly (See page EM-29).

CHECK:
Check whether the oil into VVT controller assembly is drained or not.

OK:
The oil into VVT controller assembly is drained.

NG	**Replace VVT controller assembly, and then go to step 5.**

OK

5	Check oil control valve (See page SF-46).

NG → **Replace oil control valve, and then go to step 6.**

OK

6	Check blockage of oil control valve, oil check valve and oil pipe No.1.

NG → **Repair or replace.**

OK

7	Check whether or not DTC P1349/P1354 is stored.

PREPARATION:
(a) Clear the DTC (See page DI-3).
(b) Perform simulation test.
CHECK:
Check whether or not DTC P1349/P1354 is stored (See page DI-3).
OK:
DTC P1349/P1354 is not stored

OK → **VVT system is OK.***

*: DTC P1349 and P1354 are also output after the foreign object is caught in some part of the system in the engine oil and the system returns to normal in a short time. As ECM controls so that foreign objects are ejected, there is no problem about VVT. There is also no problem since the oil filter should get the foreign object in the engine oil.

NG

Replace ECM.

DI2PI-01

DTC	P1633	ECM Malfunction (ETCS Circuit)

CIRCUIT DESCRIPTION

Refer to DTC P1129 (Electric Throttle Control System Malfunction) on page DI-65.

DTC No.	DTC Detecting Condition	Trouble Area
P1633	ECM malfunction	• ECM

INSPECTION PROCEDURE

HINT:
Read freeze frame data using TOYOTA hand-held tester or OBD II scan tool. Because freeze frame records the engine conditions when the malfunction is detected, when troubleshooting it is useful for determining whether the engine was running or stopped, the engine warmed up or not, the air-fuel ratio lean or rich, etc. at the time of the malfunction.

Replace ECM.

DI2PJ-01

DTC	P1656	OCV Circuit Malfunction (bank 1)

DTC	P1663	OCV Circuit Malfunction (bank 2)

CIRCUIT DESCRIPTION

Refer to DTC P1349, P1354 (VVT System Malfunction (Bank 1, 2)) on page DI-77.

DTC No.	DTC Detecting Condition	Trouble Area
P1656 P1663	Open or short in oil control valve circuit	• Open or short in oil control valve circuit • Oil control valve • ECM

WIRING DIAGRAM

Refer to DTC P1349, P1354 (VVT System Malfunction (Bank 1, 2)) on page DI-77 for the WIRING DIAGRAM.

INSPECTION PROCEDURE

HINT:

- If DTC P1656 dysplayed, check left bank OCV circuit.
- If DTC P1663 dysplayed, check right bank OCV circuit.
- Read freeze frame data using TOYOTA hand-held tester or OBD II scan tool. Because freeze frame records the engine conditions when the malfunction is detected, when troubleshooting it is useful for determining whether the engine was running or stopped, the engine warmed up or not, the air-fuel ratio lean or rich, etc. at the time of the malfunction.

TOYOTA hand-held tester

1	Check OCV circuit.

PREPARATION:

(a) Start the engine and warmed it up.

(b) Connect the TOYOTA hand-held tester and select VVT from ACTIVE TEST menu.

CHECK:

Check the engine speed when operate the OCV by the TOYOTA hand-held tester.

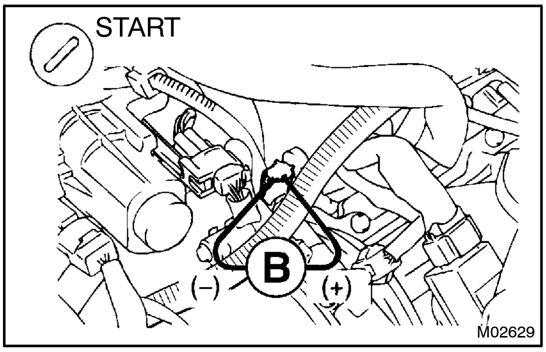
OK:

VVT system is OFF (OCV is OFF):
Normal engine speed
VVT system is ON (OCV is ON):
Rough idle or engine stalled

OK → **Check for intermittent problems (See page DI-3).**

NG

2	Check operation of OCV.



PREPARATION:
(a) Start the engine and warmed it up.
(b) Disconnect the OCV connector.
(c) Apply battery positive voltage between terminals of the OCV.

CHECK:
Check the engine speed.

OK:
Rough idle or engine stalled.

NG → **Replace OCV.**

OK

3	Check voltage between terminals OCV+ and OCV- of ECM connector (See page DI-77, step 3).

NG → **Check and replace ECM (See page IN-19).**

OK

4	Check for open and short in harness and connector between OCV and ECM (See page IN-19).

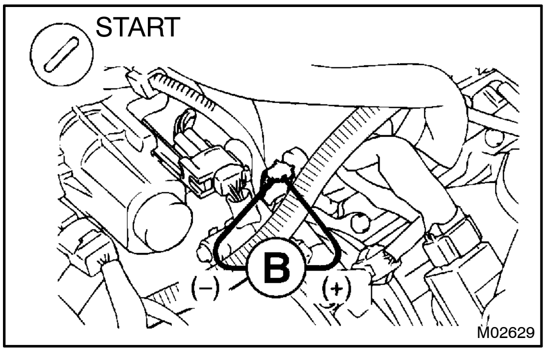
NG → **Repair or replace.**

OK

Check for intermitent problems (See page DI-3).

OBD II scan tool (excluding TOYOTA hand-held tester)

1	**Check operation of OCV.**



PREPARATION:
(a) Start the engine and warmed it up.
(b) Disconnect the OCV connector.
(c) Apply battery positive voltage between terminals of the OCV.

CHECK:
Check the engine speed.

OK:
Rough idle or engine stalled

NG → **Replace OCV.**

OK

2	**Check voltage between terminals OCV+ and OCV– of ECM connector (See page DI-77, step 3).**

NG → **Check and replace ECM (See page IN-19).**

OK

3	**Check for open and short in harness and connector between OCV and ECM (See page IN-19).**

NG → **Repair or replace.**

OK

Check for intermitent problems (See page DI-3).

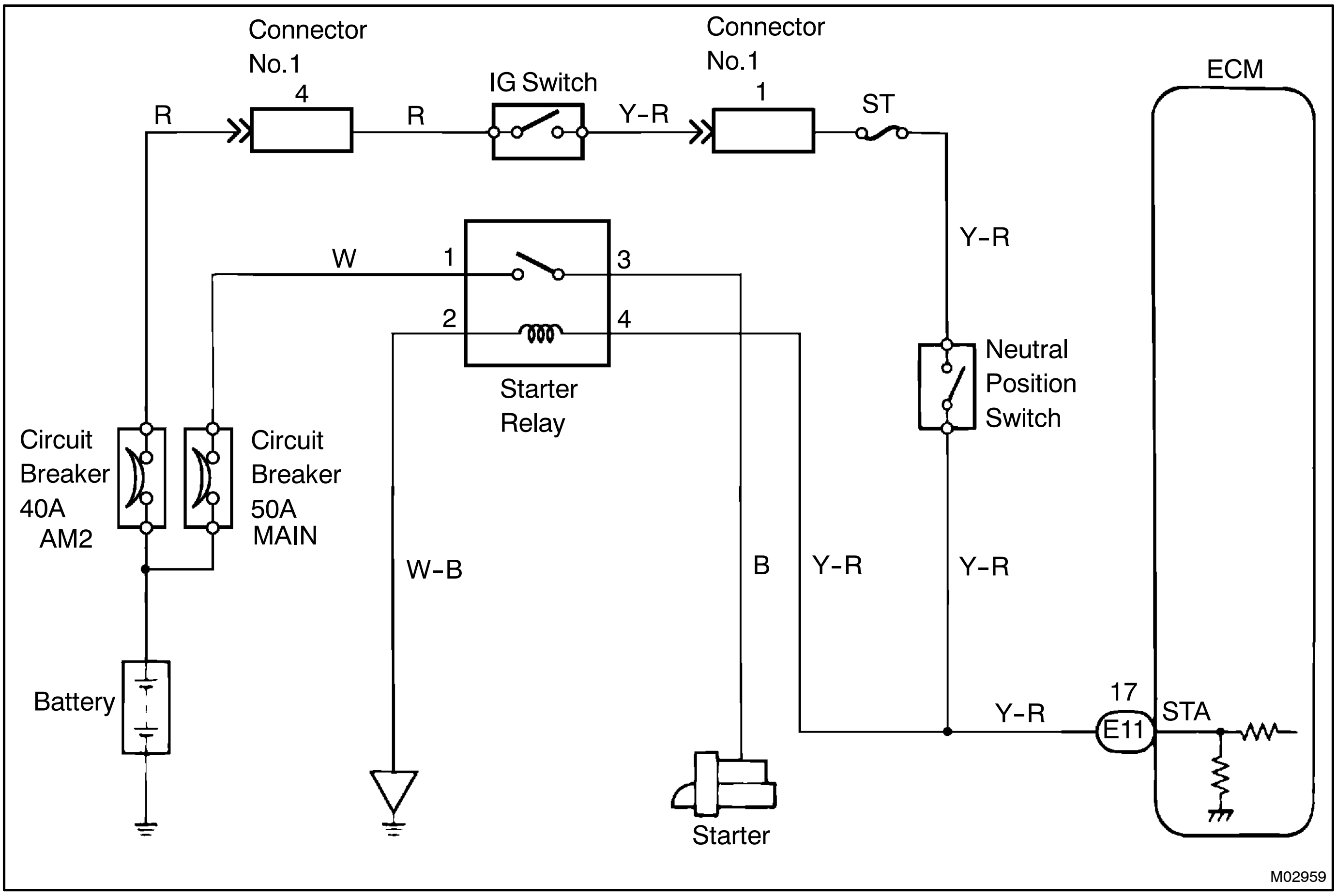
DI2PL-01

Starter Signal Circuit

CIRCUIT DESCRIPTION

When the engine is cranked, the intake air flow is slow, so fuel vaporization is poor. A rich mixture is therefore necessary in order to achieve good startability. While the engine is being cranked, the battery positive voltage is applied to terminal STA of the ECM. The starter signal id mainly used to increase the fuel injection volume for the starting injection control and after-start injection control.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:
This diagnostic chart is based on the premise that the engine is cranked normally. If the engine is not cranked, proceed to the problem symptoms table on page DI-3.

TOYOTA hand-held tester

1	**Connect TOYOTA hand-held tester and check STA signal.**

PREPARATION:
(a) Connect the TOYOTA hand-held tester to the DLC3.
(b) Turn the ignition switch ON and push the TOYOTA hand-held tester main switch ON.

CHECK:
Read STA signal on the TOYOTA hand-held tester while starter operates.

OK:

Ignition Switch Position	ON	START
STA signal	OFF	ON

OK → **Proceed to next circuit inspection shown on problem symptoms table (See page DI-3).**

NG

2	**Check for open in harness and connector between ECM and starter relay (Marking: ST) (See page IN-19).**

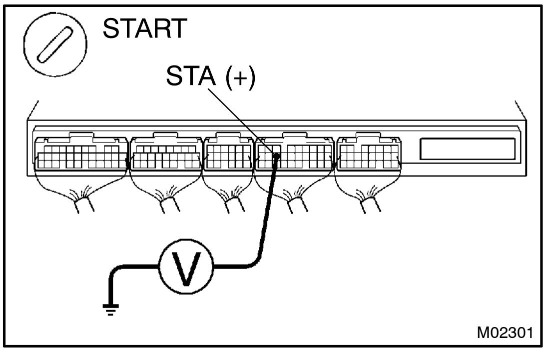
NG → **Repair or replace harness or connector.**

OK

Check and replace ECM (See page IN-19).

OBD II scan tool (excluding TOYOTA hand-held tester)

1	Check voltage between terminal STA of ECM connector and body ground.



PREPARATION:

(a) Remove the wire harness boot.

(b) Turn the ignition switch ON.

CHECK:

Measure voltage between terminal STA of the ECM connector and body ground, during engine cranking.

OK:

Voltage: 6 V or more

OK	Proceed to next circuit inspection shown on problem symptoms table (See page DI-3).

NG

2	Check for open in harness and connector between ECM and starter relay (Marking: ST) (See page IN-19).

NG	Repair or replace harness or connector.

OK

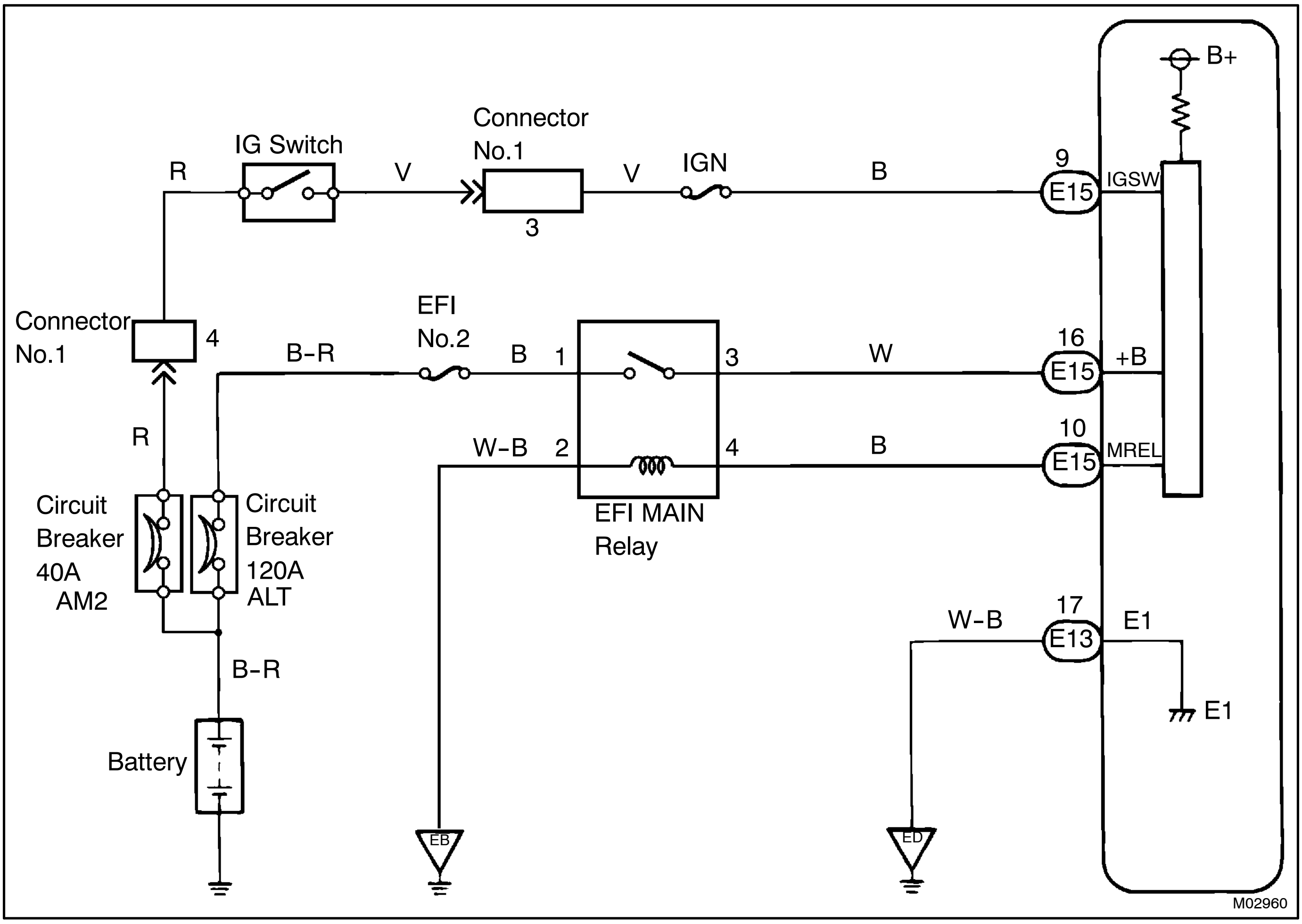
Check and replace ECM (See page IN-19).

ECM Power Source Circuit

CIRCUIT DESCRIPTION

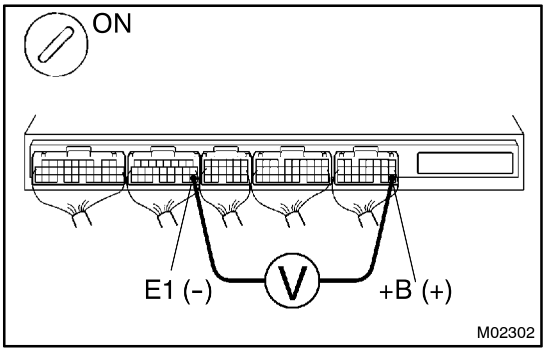
When the ignition switch is turned ON, battery positive voltage is applied to the terminal IGSW of the ECM and the EFI main relay (Making: EFI) control circuit in the ECM sends a signal to the terminal MREL of the ECM switching on the EFI main relay.
This signal causes current to flow to the coil, closing the contacts of the EFI main relay and supplying power to the terminals +B of the ECM.
If the ignition switch is turned off, the ECM continues to switch on the EFI main relay for a maximum of 2 seconds for the initial setting of the IAC valve.

WIRING DIAGRAM



INSPECTION PROCEDURE

1	**Check voltage between terminals + B and E1 of ECM connector.**



PREPARATION:

(a) Remove the wire harness boot.

(b) Turn the ignition switch ON.

CHECK:

Measure voltage between terminals +B and E1 of the ECM connector.

OK:

Voltage: 9 ~ 14 V

OK → **Proceed to next circuit inspection shown on Problem symptoms table (See page DI-3).**

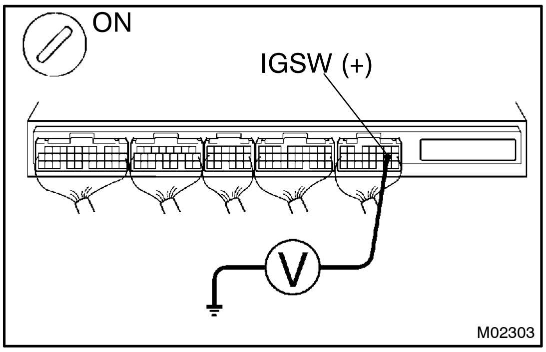
NG

2	**Check for open in harness and connector between terminal E1 of ECM and body ground (See page IN-19).**

NG → **Repair or replace harness or connector.**

OK

3	**Check voltage between terminal IGSW of ECM connector and body ground.**



PREPARATION:

Turn the ignition switch ON.

CHECK:

Measure voltage between terminal IGSW of the ECM and body ground.

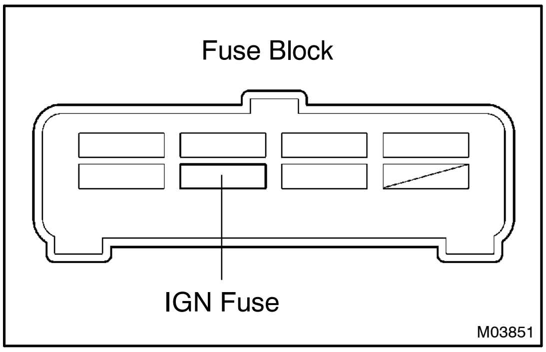
OK:

Voltage: 9 ~ 14 V

OK → **Go to step 6.**

NG

4	**Check IGN fuse.**



PREPARATION:
Remove the IGN fuse from the fuse block.
CHECK:
Check continuity of the IGN fuse.
OK:
Continuity

NG → **Check for short in all harness and components connected to IGN fuse.**

OK

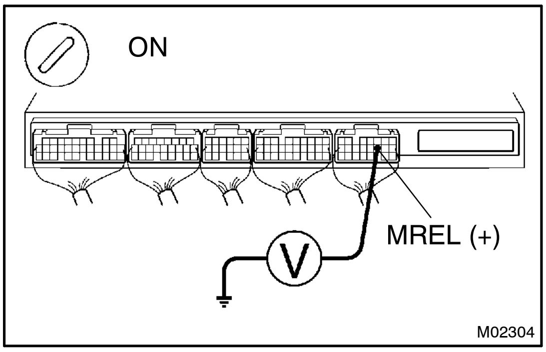
5	**Check ignition switch.**

NG → **Replace ignition switch.**

OK

Check and repair harness and connector between battery and ignition switch, ignition switch and ECM (See page IN–19).

6	Check voltage between terminal MREL of ECM connector and body ground.



PREPARATION:
Turn the ignition switch ON.
CHECK:
Measure voltage between terminal MREL of the ECM connector and body ground.
OK:
Voltage: 9 ~ 14 V

NG → **Check and replace ECM (See page IN-19).**

OK

7	Check EFI fuse of fuse block.

NG → **Check for short in all harness and components connected to EFI fuse.**

OK

8	Check EFI main relay (Marking: EFI) (See page SF-58).

NG → **Replace EFI main relay (Marking: EFI).**

OK

9	Check for open and short in harness and connector between terminal MREL of ECM and body ground (See page IN-19).

NG → **Repair and replace harness or connector.**

OK

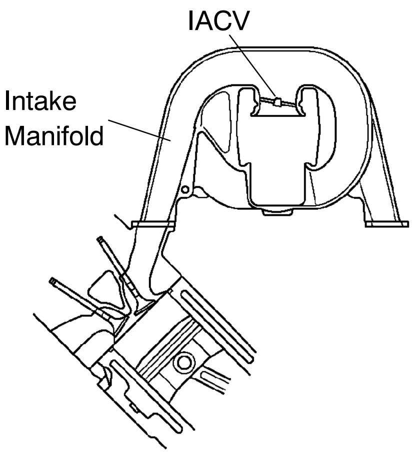
Check and repair harness or connector between EFI fuse and battery.

DI2PN-01

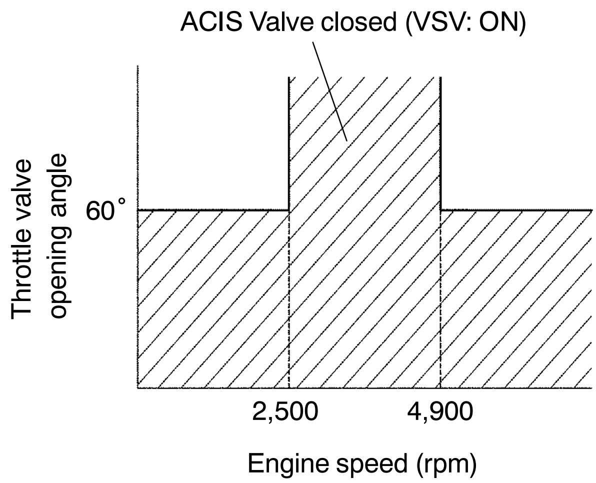
ACIS Control VSV Circuit

CIRCUIT DESCRIPTION

This circuit opens and closes the ACIS (Acoustic Control Induction System) Valve in response to the engine load in order to increase the intake efficiency.
When the engine speed is 2,500 rpm or less or 4,900 rpm or more and the throttle valve opening angle is 60° or more, the VSV is OFF, so the ACIS valve is open. All the other times, the ECM turns the VSV ON and closes the ACIS valve.



A01995 A02995



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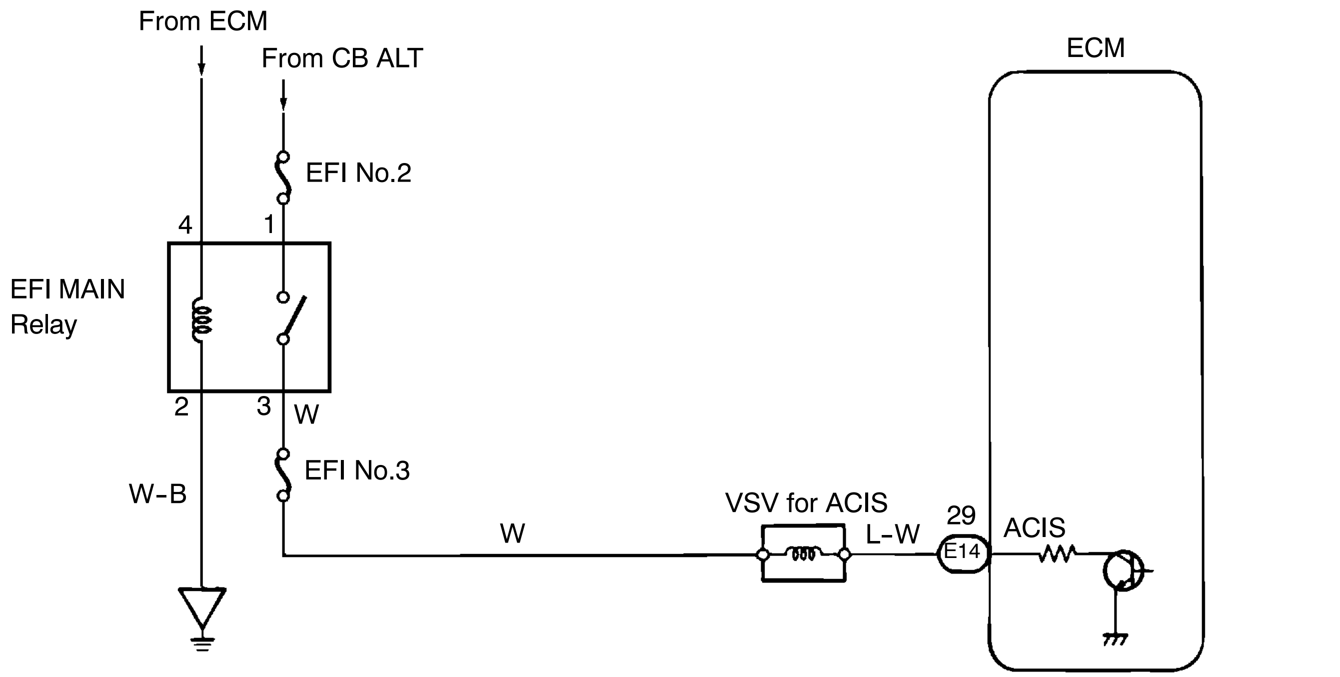
WIRING DIAGRAM



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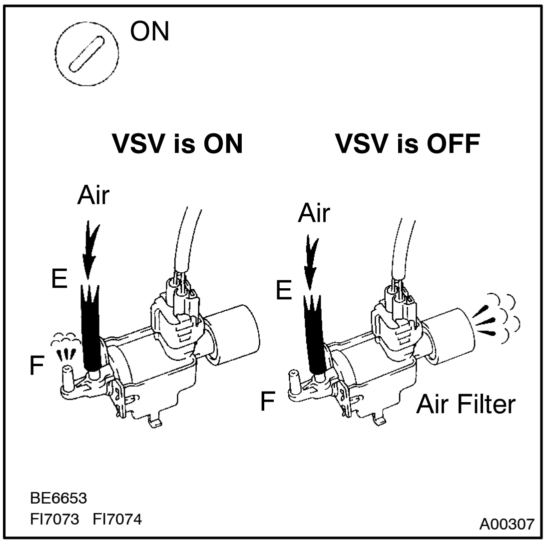
INSPECTION PROCEDURE

TOYOTA hand-held tester

1	Connect TOYOTA hand-held tester and check operation of VSV for ACIS.



PREPARATION:

(a) Connect the TOYOTA hand-held tester to the DLC3.
(b) Turn the ignition switch ON and TOYOTA hand-held tester main switch ON.
(c) Select ACTIVE TEST mode on the TOYOTA hand-held tester.

CHECK:

Check operation of the VSV when VSV is operated by the TOYOTA hand-held tester.

OK:

VSV is ON:
Air from pipe E is flowing out through pipe F.
VSV is OFF:
Air from pipe E is flowing out through the air filter.

OK → **Check for vacuum tank (See page SF-55).**

NG

2	Check VSV for ACIS (See page SF-63).

NG → **Replace VSV for ACIS.**

OK

3	**Check for open and short in harness and connector between EFI main relay (Marking: EFI) and ECM (See page IN-19).**

NG → **Repair or replace harness or connector.**

OK

Check and replace ECM (See page IN-19).

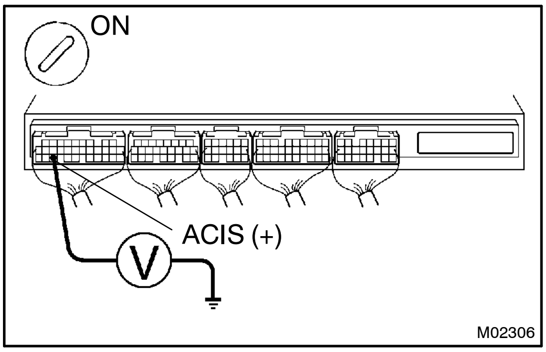
OBD II scan tool (excluding TOYOTA hand-held tester)

1	**Check VSV for ACIS (See page SF-63).**

NG → **Replace VSV for ACIS.**

OK

2	**Check voltage between terminal ACIS of ECM connector and body ground.**



PREPARATION:

(a) Remove the wire harness boot.

(b) Turn the ignition switch ON.

CHECK:

Measure voltage between terminal ACIS of the ECM connector and body ground.

OK:

Voltage: 9 ~ 14 V

NG → **Check for open and short in harness and connector between EFI main relay (Marking: EFI) and ECM (See page IN-19).**

OK

3	Check for vacuum tank (See page SF-55).

NG → **Repair or replace.**

OK ↓

Check and replace ECM (See page IN-19).

DIAGNOSTICS

COMPRESSION

EM0FR-01

INSPECTION

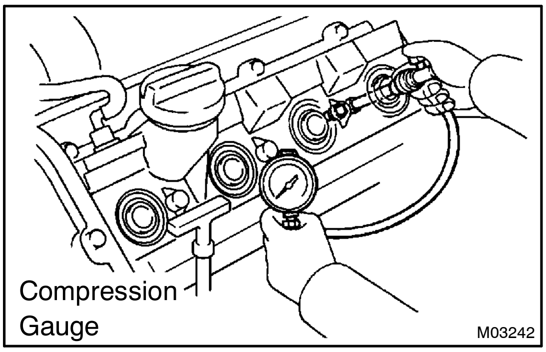
HINT:

If there is lack of power, excessive oil consumption or poor fuel economy, measure the compression pressure.

1. WARM UP AND STOP ENGINE

Allow the engine to warm up to normal operating temperature.

2. REMOVE SPARK PLUGS
(See page IG-1)



3. CHECK CYLINDER COMPRESSION PRESSURE

(a) Insert a compression gauge into the spark plug hole.

(b) Fully open the throttle.

(c) While cranking the engine, measure the compression pressure.

HINT:

Always use a fully charged battery to obtain engine speed of 250 rpm or more.

(d) Repeat steps (a) through (c) for each cylinder.

NOTICE:

This measurement must be done in as short a time as possible.

Compression pressure:
1,226 kPa (12.5 kgf/cm^2, 178 psi) or more
Minimum pressure:
981 kPa (10.0 kgf/cm^2, 142 psi)
Difference between each cylinder:
98 kPa (1.0 kgf/cm^2, 14 psi) or less

(e) If the cylinder compression in one or more cylinders is low, pour a small amount of engine oil into the cylinder through the spark plug hole and repeat steps (a) through (c) for cylinders with low compression.

- If adding oil helps the compression, chances are that the piston rings and/or cylinder bore are worn or damage.
- If pressure stays low, a valve may be sticking or seating is improper, or there may be leakage past the gasket.

4. REINSTALL SPARK PLUGS
(See page IG-1)

VALVE CLEARANCE

EM0FS-01

INSPECTION

HINT:

Inspect and adjust the valve clearance when the engine is cold.

1. **REMOVE V-BANK COVER**
2. **REMOVE INTAKE AIR CONNECTOR ASSEMBLY**
3. **REMOVE NO.3 TIMING BELT COVERS**
   (See page EM-12)
4. **REMOVE IGNITION COILS**
   (See page IG-6)
5. **REMOVE RH CYLINDER HEAD COVER**

(a) Disconnect the engine wire clamp from the wire bracket on the cylinder head cover.

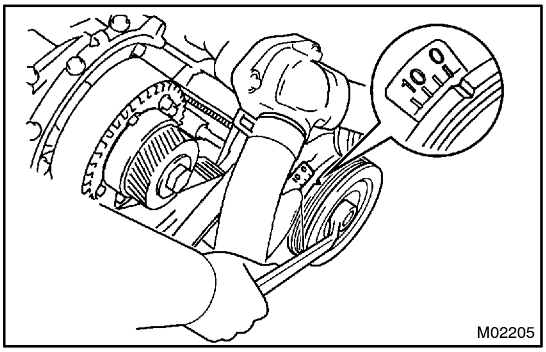
(b) Remove the 9 bolts, 9 seal washers and cylinder head cover.

6. **REMOVE LH CYLINDER HEAD COVER**

(a) Disconnect the PCV hose.

(b) Disconnect the engine wire clamp from the wire bracket on the cylinder head cover.

(c) Remove the 9 bolts, 9 seal washers and cylinder head cover.



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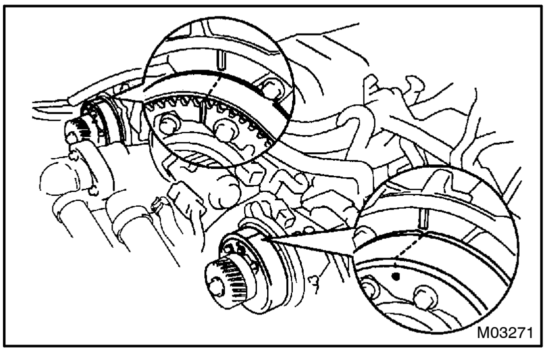
7. **SET NO.1 CYLINDER TO TDC/COMPRESSION**

(a) Turn the crankshaft pulley, and align its groove with timing mark "0" of the No.1 timing belt cover.



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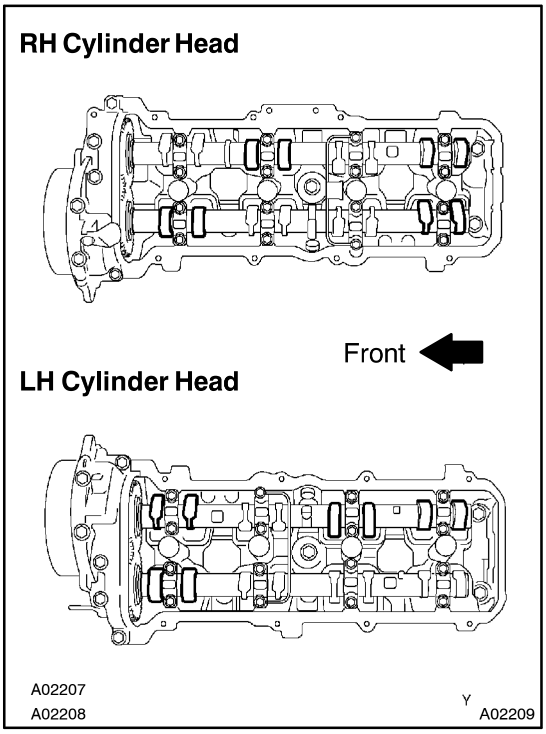
(b) Check that the timing marks of the camshaft timing pulleys and timing belt rear plates are aligned.

If not, turn the crankshaft 1 revolution (360°) and align the mark as above.

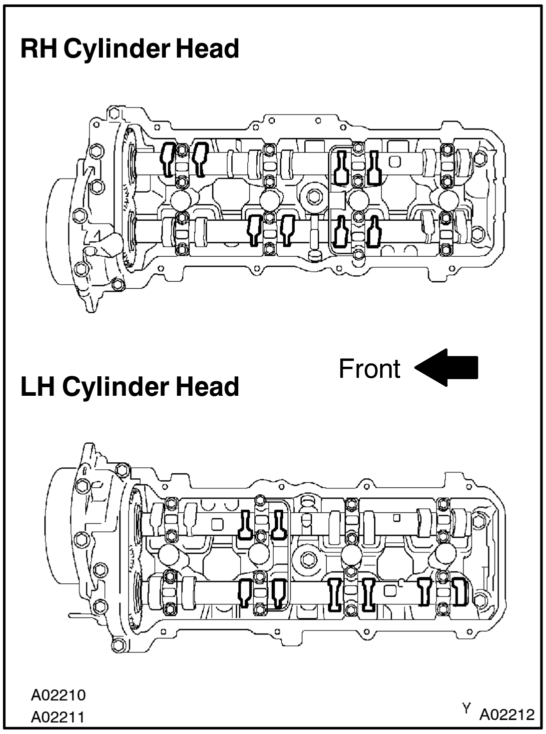


8. INSPECT VALVE CLEARANCE

(a) Check only the valves indicated.

- Using a feeler gauge, measure the clearance between the valve lifter and camshaft.
- Record the out-of-specification valve clearance measurements. They will be used later to determine the required replacement adjusting shim.

Valve clearance (Cold):
Intake
0.15 - 0.25 mm (0.006 - 0.010 in.)
Exhaust
0.25 - 0.35 mm (0.010 - 0.014 in.)



(b) Turn the crankshaft 1 revolution (360°) and align the mark as above. (See procedure in step 10)

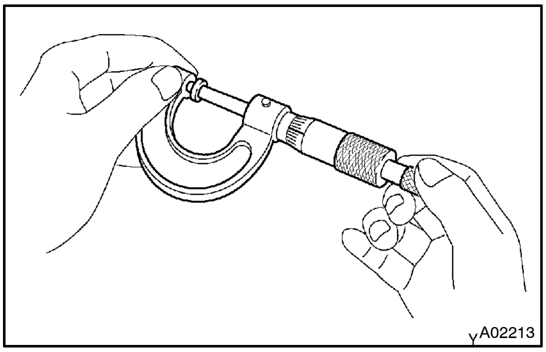
(c) Check only the valves indicated as shown. Measure the valve clearance. (See procedure in step (a))

9. ADJUST VALVE CLEARANCE

(a) Remove the timing belt.
(See page EM-12)

(b) Remove the camshafts.
(See page EM-29)

(c) Remove the valve lifter and adjusting shim.



(d) Determine the replacement adjusting shim size according to these Formula or Charts:

- Using a micrometer, measure the thickness of the removed shim.
- Calculate the thickness of a new shim so that the valve clearance comes within the specified value.

T .... Thickness of removed shim
A .... Measured valve clearance
N .... Thickness of new shim

Intake:
N = T + (A – 0.20 mm (0.008 in.))
Exhaust:
N = T + (A – 0.30 mm (0.012 in.))

- Select a new shim with a thickness as close as possible to the calculated value.

HINT:
Shims are available in 41 increments of 0.020 mm (0.0008 in.), from 2.00 mm (0.0787 in.) to 2.80 mm (0.1102 in.).

(e) Place a new adjusting shim on the valve.
(f) Place the valve lifter.
(g) Reinstall the camshafts.
(See page EM–52)
(h) Reinstall the timing belt.
(See page EM–19)
(i) Recheck the valve clearance.

10. REINSTALL CYLINDER HEAD COVERS
11. REINSTALL IGNITION COILS
12. REINSTALL NO.3 TIMING BELT COVERS
(See page EM–19)
13. REINSTALL INTAKE AIR CONNECTOR ASSEMBLY
14. REINSTALL V–BANK COVER

Adjusting Shim Selection Chart (Intake)

Measured clearance mm (in.) \ Installed shim thickness mm (in.)	2.000 (0.0787)	2.020 (0.0795)	2.040 (0.0803)	2.060 (0.0811)	2.080 (0.0819)	2.100 (0.0827)	2.120 (0.0835)	2.140 (0.0843)	2.160 (0.0850)	2.180 (0.0858)	2.200 (0.0866)	2.210 (0.0870)	2.220 (0.0874)	2.230 (0.0878)	2.240 (0.0882)	2.250 (0.0886)	2.260 (0.0890)	2.270 (0.0894)	2.280 (0.0898)	2.290 (0.0902)	2.300 (0.0906)	2.310 (0.0909)	2.320 (0.0913)	2.330 (0.0917)	2.340 (0.0921)	2.350 (0.0925)	2.360 (0.0929)	2.370 (0.0933)	2.380 (0.0937)	2.390 (0.0941)	2.400 (0.0945)	2.410 (0.0949)	2.420 (0.0953)	2.430 (0.0957)	2.440 (0.0961)	2.450 (0.0965)	2.460 (0.0969)	2.470 (0.0972)	2.480 (0.0976)	2.490 (0.0980)	2.500 (0.0984)	2.510 (0.0988)	2.520 (0.0992)	2.530 (0.0996)	2.540 (0.1000)	2.550 (0.1004)	2.560 (0.1008)	2.570 (0.1012)	2.580 (0.1016)	2.590 (0.1020)	2.600 (0.1024)	2.620 (0.1031)	2.640 (0.1039)	2.660 (0.1047)	2.680 (0.1055)	2.700 (0.1063)	2.720 (0.1071)	2.740 (0.1079)	2.760 (0.1087)	2.780 (0.1094)	2.800 (0.1102)
0.000−0.030 (0.0000−0.0012)							00	00	00	00	02	02	04	04	06	06	08	08	10	10	12	12	14	14	16	16	18	18	20	20	22	22	24	24	26	26	28	28	30	30	32	32	34	34	36	36	38	38	40	40	42	44	46	48	50	52	54	56	58	60	62
0.031−0.050 (0.0012−0.0020)						00	00	00	00	02	04	06	06	08	08	10	10	12	12	14	14	16	16	18	18	20	20	22	22	24	24	26	26	28	28	30	30	32	32	34	34	36	36	38	38	40	40	42	42	44	44	46	48	50	52	54	56	58	60	62	64
0.051−0.070 (0.0020−0.0028)					00	00	00	00	02	04	06	08	08	10	10	12	12	14	14	16	16	18	18	20	20	22	22	24	24	26	26	28	28	30	30	32	32	34	34	36	36	38	38	40	40	42	42	44	44	46	46	48	50	52	54	56	58	60	62	64	66
0.071−0.090 (0.0028−0.0035)				00	00	00	00	02	04	06	08	10	10	12	12	14	14	16	16	18	18	20	20	22	22	24	24	26	26	28	28	30	30	32	32	34	34	36	36	38	38	40	40	42	42	44	44	46	46	48	48	50	52	54	56	58	60	62	64	66	68
0.091−0.110 (0.0036−0.0043)			00	00	00	00	02	04	06	08	10	12	12	14	14	16	16	18	18	20	20	22	22	24	24	26	26	28	28	30	30	32	32	34	34	36	36	38	38	40	40	42	42	44	44	46	46	48	48	50	50	52	54	56	58	60	62	64	66	68	70
0.111−0.130 (0.0044−0.0051)		00	00	00	00	02	04	06	08	10	12	14	14	16	16	18	18	20	20	22	22	24	24	26	26	28	28	30	30	32	32	34	34	36	36	38	38	40	40	42	42	44	44	46	46	48	48	50	50	52	52	54	56	58	60	62	64	66	68	70	72
0.131−0.149 (0.0052−0.0059)		00	00	00	02	04	06	08	10	12	14	16	16	18	18	20	20	22	22	24	24	26	26	28	28	30	30	32	32	34	34	36	36	38	38	40	40	42	42	44	44	46	46	48	48	50	50	52	52	54	54	56	58	60	62	64	66	68	70	72	74
0.150−0.250 (0.0059−0.0098)																																																													
0.251−0.270 (0.0099−0.0106)	06	08	10	12	14	16	18	20	22	24	26	28	28	30	30	32	32	34	34	36	36	38	38	40	40	42	42	44	44	46	46	48	48	50	50	52	52	54	54	56	56	58	58	60	60	62	62	64	64	66	66	68	70	72	74	76	78	80	80	80	
0.271−0.290 (0.0107−0.0114)	08	10	12	14	16	18	20	22	24	26	28	30	30	32	32	34	34	36	36	38	38	40	40	42	42	44	44	46	46	48	48	50	50	52	52	54	54	56	56	58	58	60	60	62	62	64	64	66	66	68	68	70	72	74	76	78	80	80	80		
0.291−0.310 (0.0115−0.0122)	10	12	14	16	18	20	22	24	26	28	30	32	32	34	34	36	36	38	38	40	40	42	42	44	44	46	46	48	48	50	50	52	52	54	54	56	56	58	58	60	60	62	62	64	64	66	66	68	68	70	70	72	74	76	78	80	80	80			
0.311−0.330 (0.0122−0.0130)	12	14	16	18	20	22	24	26	28	30	32	34	34	36	36	38	38	40	40	42	42	44	44	46	46	48	48	50	50	52	52	54	54	56	56	58	58	60	60	62	62	64	64	66	66	68	68	70	70	72	72	74	76	78	80	80	80				
0.331−0.350 (0.0130−0.0138)	14	16	18	20	22	24	26	28	30	32	34	36	36	38	38	40	40	42	42	44	44	46	46	48	48	50	50	52	52	54	54	56	56	58	58	60	60	62	62	64	64	66	66	68	68	70	70	72	72	74	74	76	78	80	80	80					
0.351−0.370 (0.0138−0.0146)	16	18	20	22	24	26	28	30	32	34	36	38	38	40	40	42	42	44	44	46	46	48	48	50	50	52	52	54	54	56	56	58	58	60	60	62	62	64	64	66	66	68	68	70	70	72	72	74	74	76	76	78	80	80	80						
0.371−0.390 (0.0146−0.0154)	18	20	22	24	26	28	30	32	34	36	38	40	40	42	42	44	44	46	46	48	48	50	50	52	52	54	54	56	56	58	58	60	60	62	62	64	64	66	66	68	68	70	70	72	72	74	74	76	76	78	78	80	80	80							
0.391−0.410 (0.0154−0.0161)	20	22	24	26	28	30	32	34	36	38	40	42	42	44	44	46	46	48	48	50	50	52	52	54	54	56	56	58	58	60	60	62	62	64	64	66	66	68	68	70	70	72	72	74	74	76	76	78	78	80	80	80	80								
0.411−0.430 (0.0162−0.0169)	22	24	26	28	30	32	34	36	38	40	42	44	44	46	46	48	48	50	50	52	52	54	54	56	56	58	58	60	60	62	62	64	64	66	66	68	68	70	70	72	72	74	74	76	76	78	78	80	80	80	80	80									
0.431−0.450 (0.0170−0.0177)	24	26	28	30	32	34	36	38	40	42	44	46	46	48	48	50	50	52	52	54	54	56	56	58	58	60	60	62	62	64	64	66	66	68	68	70	70	72	72	74	74	76	76	78	78	80	80	80	80	80	80										
0.451−0.470 (0.0178−0.0185)	26	28	30	32	34	36	38	40	42	44	46	48	48	50	50	52	52	54	54	56	56	58	58	60	60	62	62	64	64	66	66	68	68	70	70	72	72	74	74	76	76	78	78	80	80	80	80	80	80	80											
0.471−0.490 (0.0185−0.0193)	28	30	32	34	36	38	40	42	44	46	48	50	50	52	52	54	54	56	56	58	58	60	60	62	62	64	64	66	66	68	68	70	70	72	72	74	74	76	76	78	78	80	80	80	80	80	80	80													
0.491−0.510 (0.0193−0.0201)	30	32	34	36	38	40	42	44	46	48	50	52	52	54	54	56	56	58	58	60	60	62	62	64	64	66	66	68	68	70	70	72	72	74	74	76	76	78	78	80	80	80	80	80	80	80															
0.511−0.530 (0.0201−0.0209)	32	34	36	38	40	42	44	46	48	50	52	54	54	56	56	58	58	60	60	62	62	64	64	66	66	68	68	70	70	72	72	74	74	76	76	78	78	80	80	80	80	80	80	80																	
0.531−0.550 (0.0209−0.0217)	34	36	38	40	42	44	46	48	50	52	54	56	56	58	58	60	60	62	62	64	64	66	66	68	68	70	70	72	72	74	74	76	76	78	78	80	80	80	80	80	80	80																			
0.551−0.570 (0.0217−0.0224)	36	38	40	42	44	46	48	50	52	54	56	58	58	60	60	62	62	64	64	66	66	68	68	70	70	72	72	74	74	76	76	78	78	80	80	80	80	80	80	80																					
0.571−0.590 (0.0225−0.0232)	38	40	42	44	46	48	50	52	54	56	58	60	60	62	62	64	64	66	66	68	68	70	70	72	72	74	74	76	76	78	78	80	80	80	80	80	80	80																							
0.591−0.610 (0.0233−0.0240)	40	42	44	46	48	50	52	54	56	58	60	62	62	64	64	66	66	68	68	70	70	72	72	74	74	76	76	78	78	80	80	80	80	80	80	80																									
0.611−0.630 (0.0241−0.0248)	42	44	46	48	50	52	54	56	58	60	62	64	64	66	66	68	68	70	70	72	72	74	74	76	76	78	78	80	80	80	80	80	80	80																											
0.631−0.650 (0.0248−0.0256)	44	46	48	50	52	54	56	58	60	62	64	66	66	68	68	70	70	72	72	74	74	76	76	78	78	80	80	80	80	80	80	80																													
0.651−0.670 (0.0256−0.0264)	46	48	50	52	54	56	58	60	62	64	66	68	68	70	70	72	72	74	74	76	76	78	78	80	80	80	80	80	80	80																															
0.671−0.690 (0.0264−0.0272)	48	50	52	54	56	58	60	62	64	66	68	70	70	72	72	74	74	76	76	78	78	80	80	80	80	80	80	80																																	
0.691−0.710 (0.0272−0.0280)	50	52	54	56	58	60	62	64	66	68	70	72	72	74	74	76	76	78	78	80	80	80	80	80	80	80																																			
0.711−0.730 (0.0280−0.0287)	52	54	56	58	60	62	64	66	68	70	72	74	74	76	76	78	78	80	80	80	80	80	80	80																																					
0.731−0.750 (0.0288−0.0295)	54	56	58	60	62	64	66	68	70	72	74	76	76	78	78	80	80	80	80	80	80	80																																							
0.751−0.770 (0.0296−0.0303)	56	58	60	62	64	66	68	70	72	74	76	78	78	80	80	80	80	80	80	80																																									
0.771−0.790 (0.0304−0.0311)	58	60	62	64	66	68	70	72	74	76	78	80	80	80	80	80	80	80																																											
0.791−0.810 (0.0311−0.0319)	60	62	64	66	68	70	72	74	76	78	80	80	80	80	80	80																																													
0.811−0.830 (0.0319−0.0327)	62	64	66	68	70	72	74	76	78	80	80	80	80	80																																															
0.831−0.850 (0.0327−0.0335)	64	66	68	70	72	74	76	78	80	80	80	80																																																	
0.851−0.870 (0.0335−0.0343)	66	68	70	72	74	76	78	80	80	80																																																			
0.871−0.890 (0.0343−0.0350)	68	70	72	74	76	78	80	80	80																																																				
0.891−0.910 (0.0351−0.0358)	70	72	74	76	78	80	80	80																																																					
0.911−0.930 (0.0359−0.0366)	72	74	76	78	80	80	80																																																						
0.931−0.950 (0.0367−0.0374)	74	76	78	80	80	80																																																							
0.951−0.970 (0.0374−0.0382)	76	78	80	80	80																																																								
0.971−0.990 (0.0382−0.0390)	78	80	80	80																																																									
0.991−1.010 (0.0390−0.0398)	80	80	80																																																										
1.011−1.030 (0.0398−0.0406)	80	80																																																											
1.031−1.050 (0.0406−0.0413)	80																																																												

Intake valve clearance (Cold):
0.15 - 0.25 mm (0.006 - 0.010 in.)

EXAMPLE:
The 2.300 mm (0.0906 in.) shim is installed, and the measured clearance is 0.440 mm (0.0173 in.). Replace the 2.300 mm (0.0906 in.) shim with a No. 54 shim.

New shim thickness mm (in.)

Shim No.	Thickness	Shim No.	Thickness	Shim No.	Thickness
00	2.000 (0.0787)	28	2.280 (0.0898)	56	2.560 (0.1008)
02	2.020 (0.0795)	30	2.300 (0.0906)	58	2.580 (0.1016)
04	2.040 (0.0803)	32	2.320 (0.0913)	60	2.600 (0.1024)
06	2.060 (0.0811)	34	2.340 (0.0921)	62	2.620 (0.1031)
08	2.080 (0.0819)	36	2.360 (0.0929)	64	2.640 (0.1039)
10	2.100 (0.0827)	38	2.380 (0.0937)	66	2.660 (0.1047)
12	2.120 (0.0835)	40	2.400 (0.0945)	68	2.680 (0.1055)
14	2.140 (0.0843)	42	2.420 (0.0953)	70	2.700 (0.1063)
16	2.160 (0.0850)	44	2.440 (0.0961)	72	2.720 (0.1071)
18	2.180 (0.0858)	46	2.460 (0.0969)	74	2.740 (0.1079)
20	2.200 (0.0866)	48	2.480 (0.0976)	76	2.760 (0.1087)
22	2.220 (0.0874)	50	2.500 (0.0984)	78	2.780 (0.1094)
24	2.240 (0.0882)	52	2.520 (0.0992)	80	2.800 (0.1102)
26	2.260 (0.0890)	54	2.540 (0.1000)		

A03111

Adjusting Shim Selection Chart (Exhaust)

Installed shim thickness mm (in.) / Measured clearance mm (in.)	2.000 (0.0787)	2.020 (0.0795)	2.040 (0.0803)	2.060 (0.0811)	2.080 (0.0819)	2.100 (0.0827)	2.120 (0.0835)	2.140 (0.0843)	2.160 (0.0850)	2.180 (0.0858)	2.200 (0.0866)	2.210 (0.0870)	2.220 (0.0874)	2.230 (0.0878)	2.240 (0.0882)	2.250 (0.0886)	2.260 (0.0890)	2.270 (0.0894)	2.280 (0.0898)	2.290 (0.0902)	2.300 (0.0906)	2.310 (0.0909)	2.320 (0.0913)	2.330 (0.0917)	2.340 (0.0921)	2.350 (0.0925)	2.360 (0.0929)	2.370 (0.0933)
0.000–0.030 (0.0000–0.0012)												00	00	00	00	00	00	00	00	00	02	02	04	04	06	06	08	08
0.031–0.050 (0.0012–0.0020)											00	00	00	00	00	00	00	02	02	04	04	06	06	08	08	10	10	12
0.051–0.070 (0.0020–0.0028)										00	00	00	00	00	00	02	02	04	04	06	06	08	08	10	10	12	12	14
0.071–0.090 (0.0028–0.0035)									00	00	00	00	00	02	02	04	04	06	06	08	08	10	10	12	12	14	14	16
0.091–0.110 (0.0036–0.0043)								00	00	00	00	02	02	04	04	06	06	08	08	10	10	12	12	14	14	16	16	18
0.111–0.130 (0.0044–0.0051)							00	00	00	00	02	04	04	06	06	08	08	10	10	12	12	14	14	16	16	18	18	20
0.131–0.150 (0.0052–0.0059)						00	00	00	00	02	04	06	06	08	08	10	10	12	12	14	14	16	16	18	18	20	20	22
0.151–0.170 (0.0059–0.0067)					00	00	00	00	02	04	06	08	08	10	10	12	12	14	14	16	16	18	18	20	20	22	22	24
0.171–0.190 (0.0067–0.0075)				00	00	00	00	02	04	06	08	10	10	12	12	14	14	16	16	18	18	20	20	22	22	24	24	26
0.191–0.210 (0.0075–0.0083)			00	00	00	00	02	04	06	08	10	12	12	14	14	16	16	18	18	20	20	22	22	24	24	26	26	28
0.211–0.230 (0.0083–0.0091)		00	00	00	00	02	04	06	08	10	12	14	14	16	16	18	18	20	20	22	22	24	24	26	26	28	28	30
0.231–0.249 (0.0091–0.0098)		00	00	00	02	04	06	08	10	12	14	16	16	18	18	20	20	22	22	24	24	26	26	28	28	30	30	32
0.250–0.350 (0.0098–0.0138)																												
0.351–0.370 (0.0138–0.0146)	06	08	10	12	14	16	18	20	22	24	26	28	28	30	30	32	32	34	34	36	36	38	38	40	40	42	42	44
0.371–0.390 (0.0146–0.0154)	08	10	12	14	16	18	20	22	24	26	28	30	30	32	32	34	34	36	36	38	38	40	40	42	42	44	44	46
0.391–0.410 (0.0154–0.0161)	10	12	14	16	18	20	22	24	26	28	30	32	32	34	34	36	36	38	38	40	40	42	42	44	44	46	46	48
0.411–0.430 (0.0162–0.0169)	12	14	16	18	20	22	24	26	28	30	32	34	34	36	36	38	38	40	40	42	42	44	44	46	46	48	48	50
0.431–0.450 (0.0170–0.0177)	14	16	18	20	22	24	26	28	30	32	34	36	36	38	38	40	40	42	42	44	44	46	46	48	48	50	50	52
0.451–0.470 (0.0178–0.0185)	16	18	20	22	24	26	28	30	32	34	36	38	38	40	40	42	42	44	44	46	46	48	48	50	50	52	52	54
0.471–0.490 (0.0185–0.0193)	18	20	22	24	26	28	30	32	34	36	38	40	40	42	42	44	44	46	46	48	48	50	50	52	52	54	54	56
0.491–0.510 (0.0193–0.0201)	20	22	24	26	28	30	32	34	36	38	40	42	42	44	44	46	46	48	48	50	50	52	52	54	54	56	56	58
0.511–0.530 (0.0201–0.0209)	22	24	26	28	30	32	34	36	38	40	42	44	44	46	46	48	48	50	50	52	52	54	54	56	56	58	58	60
0.531–0.550 (0.0209–0.0217)	24	26	28	30	32	34	36	38	40	42	44	46	46	48	48	50	50	52	52	54	54	56	56	58	58	60	60	62
0.551–0.570 (0.0217–0.0224)	26	28	30	32	34	36	38	40	42	44	46	48	48	50	50	52	52	54	54	56	56	58	58	60	60	62	62	64
0.571–0.590 (0.0225–0.0232)	28	30	32	34	36	38	40	42	44	46	48	50	50	52	52	54	54	56	56	58	58	60	60	62	62	64	64	66
0.591–0.610 (0.0233–0.0240)	30	32	34	36	38	40	42	44	46	48	50	52	52	54	54	56	56	58	58	60	60	62	62	64	64	66	66	68
0.611–0.630 (0.0241–0.0248)	32	34	36	38	40	42	44	46	48	50	52	54	54	56	56	58	58	60	60	62	62	64	64	66	66	68	68	70
0.631–0.650 (0.0248–0.0256)	34	36	38	40	42	44	46	48	50	52	54	56	56	58	58	60	60	62	62	64	64	66	66	68	68	70	70	72
0.651–0.670 (0.0256–0.0264)	36	38	40	42	44	46	48	50	52	54	56	58	58	60	60	62	62	64	64	66	66	68	68	70	70	72	72	74
0.671–0.690 (0.0264–0.0272)	38	40	42	44	46	48	50	52	54	56	58	60	60	62	62	64	64	66	66	68	68	70	70	72	72	74	74	76
0.691–0.710 (0.0272–0.0280)	40	42	44	46	48	50	52	54	56	58	60	62	62	64	64	66	66	68	68	70	70	72	72	74	74	76	76	78
0.711–0.730 (0.0280–0.0287)	42	44	46	48	50	52	54	56	58	60	62	64	64	66	66	68	68	70	70	72	72	74	74	76	76	78	78	80
0.731–0.750 (0.0288–0.0295)	44	46	48	50	52	54	56	58	60	62	64	66	66	68	68	70	70	72	72	74	74	76	76	78	78	80	80	80
0.751–0.770 (0.0296–0.0303)	46	48	50	52	54	56	58	60	62	64	66	68	68	70	70	72	72	74	74	76	76	78	78	80	80	80	80	80
0.771–0.790 (0.0304–0.0311)	48	50	52	54	56	58	60	62	64	66	68	70	70	72	72	74	74	76	76	78	78	80	80	80	80	80	80	80
0.791–0.810 (0.0311–0.0319)	50	52	54	56	58	60	62	64	66	68	70	72	72	74	74	76	76	78	78	80	80	80	80	80	80	80		
0.811–0.830 (0.0319–0.0327)	52	54	56	58	60	62	64	66	68	70	72	74	74	76	76	78	78	80	80	80	80	80	80	80				
0.831–0.850 (0.0327–0.0335)	54	56	58	60	62	64	66	68	70	72	74	76	76	78	78	80	80	80	80	80	80	80						
0.851–0.870 (0.0335–0.0343)	56	58	60	62	64	66	68	70	72	74	76	78	78	80	80	80	80	80	80	80								
0.871–0.890 (0.0343–0.0350)	58	60	62	64	66	68	70	72	74	76	78	80	80	80	80	80	80	80										
0.891–0.910 (0.0351–0.0358)	60	62	64	66	68	70	72	74	76	78	80	80	80	80	80	80												
0.911–0.930 (0.0359–0.0366)	62	64	66	68	70	72	74	76	78	80	80	80	80	80														
0.931–0.950 (0.0367–0.0374)	64	66	68	70	72	74	76	78	80	80	80	80																
0.951–0.970 (0.0374–0.0382)	66	68	70	72	74	76	78	80	80	80																		
0.971–0.990 (0.0382–0.0390)	68	70	72	74	76	78	80	80	80																			
0.991–1.010 (0.0390–0.0398)	70	72	74	76	78	80	80	80																				
1.011–1.030 (0.0398–0.0406)	72	74	76	78	80	80	80																					
1.031–1.050 (0.0406–0.0413)	74	76	78	80	80	80																						
1.051–1.070 (0.0414–0.0421)	76	78	80	80	80																							
1.071–1.090 (0.0422–0.0429)	78	80	80	80																								
1.091–1.110 (0.0430–0.0437)	80	80	80																									
1.111–1.130 (0.0437–0.0445)	80	80																										
1.131–1.150 (0.0445–0.0453)	80																											

Installed shim thickness mm (in.) / Measured clearance mm (in.)	2.380 (0.0937)	2.390 (0.0941)	2.400 (0.0945)	2.410 (0.0949)	2.420 (0.0953)	2.430 (0.0957)	2.440 (0.0961)	2.450 (0.0965)	2.460 (0.0969)	2.470 (0.0972)	2.480 (0.0976)	2.490 (0.0980)	2.500 (0.0984)	2.510 (0.0988)	2.520 (0.0992)	2.530 (0.0996)	2.540 (0.1000)	2.550 (0.1004)	2.560 (0.1008)	2.570 (0.1012)	2.580 (0.1016)	2.590 (0.1020)	2.600 (0.1024)	2.620 (0.1031)	2.640 (0.1039)	2.660 (0.1047)	2.680 (0.1055)	2.700 (0.1063)	2.720 (0.1071)	2.740 (0.1079)	2.760 (0.1087)	2.780 (0.1094)	2.800 (0.1102)
0.000–0.030 (0.0000–0.0012)	10	10	12	12	14	14	16	16	18	18	20	20	22	22	24	24	26	26	28	28	30	30	32	34	36	38	40	42	44	46	48	50	52
0.031–0.050 (0.0012–0.0020)	12	14	14	16	16	18	18	20	20	22	22	24	24	26	26	28	28	30	30	32	32	34	34	36	38	40	42	44	46	48	50	52	54
0.051–0.070 (0.0020–0.0028)	14	16	16	18	18	20	20	22	22	24	24	26	26	28	28	30	30	32	32	34	34	36	36	38	40	42	44	46	48	50	52	54	56
0.071–0.090 (0.0028–0.0035)	16	18	18	20	20	22	22	24	24	26	26	28	28	30	30	32	32	34	34	36	36	38	38	40	42	44	46	48	50	52	54	56	58
0.091–0.110 (0.0036–0.0043)	18	20	20	22	22	24	24	26	26	28	28	30	30	32	32	34	34	36	36	38	38	40	40	42	44	46	48	50	52	54	56	58	60
0.111–0.130 (0.0044–0.0051)	20	22	22	24	24	26	26	28	28	30	30	32	32	34	34	36	36	38	38	40	40	42	42	44	46	48	50	52	54	56	58	60	62
0.131–0.150 (0.0052–0.0059)	22	24	24	26	26	28	28	30	30	32	32	34	34	36	36	38	38	40	40	42	42	44	44	46	48	50	52	54	56	58	60	62	64
0.151–0.170 (0.0059–0.0067)	24	26	26	28	28	30	30	32	32	34	34	36	36	38	38	40	40	42	42	44	44	46	46	48	50	52	54	56	58	60	62	64	66
0.171–0.190 (0.0067–0.0075)	26	28	28	30	30	32	32	34	34	36	36	38	38	40	40	42	42	44	44	46	46	48	48	50	52	54	56	58	60	62	64	66	68
0.191–0.210 (0.0075–0.0083)	28	30	30	32	32	34	34	36	36	38	38	40	40	42	42	44	44	46	46	48	48	50	50	52	54	56	58	60	62	64	66	68	70
0.211–0.230 (0.0083–0.0091)	30	32	32	34	34	36	36	38	38	40	40	42	42	44	44	46	46	48	48	50	50	52	52	54	56	58	60	62	64	66	68	70	72
0.231–0.249 (0.0091–0.0098)	32	34	34	36	36	38	38	40	40	42	42	44	44	46	46	48	48	50	50	52	52	54	54	56	58	60	62	64	66	68	70	72	74
0.250–0.350 (0.0098–0.0138)																																	
0.351–0.370 (0.0138–0.0146)	44	46	46	48	48	50	50	52	52	54	54	56	56	58	58	60	60	62	62	64	64	66	66	68	70	72	74	76	78	80	80	80	
0.371–0.390 (0.0146–0.0154)	46	48	48	50	50	52	52	54	54	56	56	58	58	60	60	62	62	64	64	66	66	68	68	70	72	74	76	78	80	80	80		
0.391–0.410 (0.0154–0.0161)	48	50	50	52	52	54	54	56	56	58	58	60	60	62	62	64	64	66	66	68	68	70	70	72	74	76	78	80	80	80			
0.411–0.430 (0.0162–0.0169)	50	52	52	54	54	56	56	58	58	60	60	62	62	64	64	66	66	68	68	70	70	72	72	74	76	78	80	80	80				
0.431–0.450 (0.0170–0.0177)	52	54	54	56	56	58	58	60	60	62	62	64	64	66	66	68	68	70	70	72	72	74	74	76	78	80	80	80					
0.451–0.470 (0.0178–0.0185)	54	56	56	58	58	60	60	62	62	64	64	66	66	68	68	70	70	72	72	74	74	76	76	78	80	80	80						
0.471–0.490 (0.0185–0.0193)	56	58	58	60	60	62	62	64	64	66	66	68	68	70	70	72	72	74	74	76	76	78	78	80	80	80							
0.491–0.510 (0.0193–0.0201)	58	60	60	62	62	64	64	66	66	68	68	70	70	72	72	74	74	76	76	78	78	80	80	80	80								
0.511–0.530 (0.0201–0.0209)	60	62	62	64	64	66	66	68	68	70	70	72	72	74	74	76	76	78	78	80	80	80	80	80									
0.531–0.550 (0.0209–0.0217)	62	64	64	66	66	68	68	70	70	72	72	74	74	76	76	78	78	80	80	80	80	80	80										
0.551–0.570 (0.0217–0.0224)	64	66	66	68	68	70	70	72	72	74	74	76	76	78	78	80	80	80	80	80	80	80											
0.571–0.590 (0.0225–0.0232)	66	68	68	70	70	72	72	74	74	76	76	78	78	80	80	80	80	80	80	80													
0.591–0.610 (0.0233–0.0240)	68	70	70	72	72	74	74	76	76	78	78	80	80	80	80	80	80	80															
0.611–0.630 (0.0241–0.0248)	70	72	72	74	74	76	76	78	78	80	80	80	80	80	80	80																	
0.631–0.650 (0.0248–0.0256)	72	74	74	76	76	78	78	80	80	80	80	80	80	80																			
0.651–0.670 (0.0256–0.0264)	74	76	76	78	78	80	80	80	80	80	80	80																					
0.671–0.690 (0.0264–0.0272)	76	78	78	80	80	80	80	80	80	80																							
0.691–0.710 (0.0272–0.0280)	78	80	80	80	80	80	80	80																									
0.711–0.730 (0.0280–0.0287)	80	80	80	80	80	80																											
0.731–0.750 (0.0288–0.0295)	80	80	80	80																													
0.751–0.770 (0.0296–0.0303)	80	80																															

Exhaust valve clearance (Cold):
0.25 - 0.35 mm (0.010 - 0.014 in.)

EXAMPLE:
The 2.300 mm (0.0906 in.) shim is installed, and the measured clearance is 0.440 mm (0.0173 in.). Replace the 2.300 mm (0.0906 in.) shim with a No. 44 shim.

New shim thickness mm (in.)

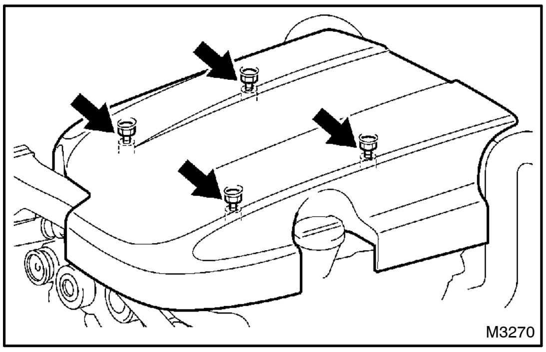
Shim No.	Thickness	Shim No.	Thickness	Shim No.	Thickness
00	2.000 (0.0787)	28	2.280 (0.0898)	56	2.560 (0.1008)
02	2.020 (0.0795)	30	2.300 (0.0906)	58	2.580 (0.1016)
04	2.040 (0.0803)	32	2.320 (0.0913)	60	2.600 (0.1024)
06	2.060 (0.0811)	34	2.340 (0.0921)	62	2.620 (0.1031)
08	2.080 (0.0819)	36	2.360 (0.0929)	64	2.640 (0.1039)
10	2.100 (0.0827)	38	2.380 (0.0937)	66	2.660 (0.1047)
12	2.120 (0.0835)	40	2.400 (0.0945)	68	2.680 (0.1055)
14	2.140 (0.0843)	42	2.420 (0.0953)	70	2.700 (0.1063)
16	2.160 (0.0850)	44	2.440 (0.0961)	72	2.720 (0.1071)
18	2.180 (0.0858)	46	2.460 (0.0969)	74	2.740 (0.1079)
20	2.200 (0.0866)	48	2.480 (0.0976)	76	2.760 (0.1087)
22	2.220 (0.0874)	50	2.500 (0.0984)	78	2.780 (0.1094)
24	2.240 (0.0882)	52	2.520 (0.0992)	80	2.800 (0.1102)
26	2.260 (0.0890)	54	2.540 (0.1000)		

A03112

IGNITION TIMING

EM0FT-01

INSPECTION

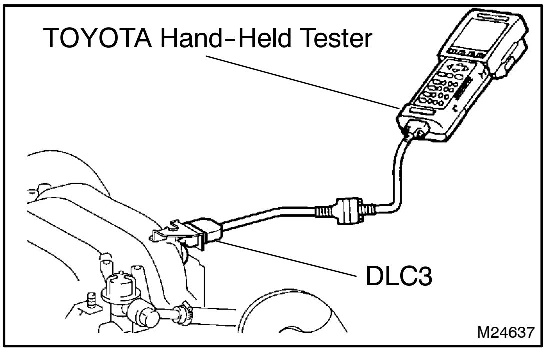

M3270

1. WARM UP ENGINE

Allow the engine to warm up to normal operating temperature.

2. REMOVE V-BANK COVER

Remove the 4 bolts and V-bank cover.

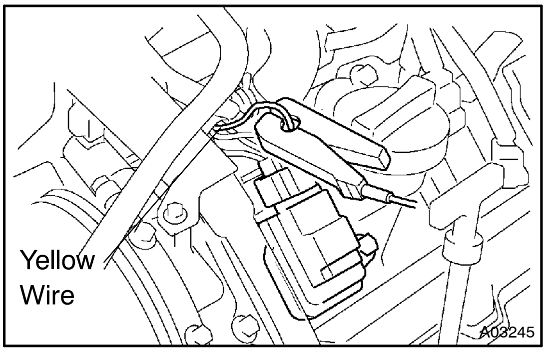


M24637

3. CONNECT TOYOTA HAND-HELD TESTER OR OBD II SCAN TOOL

(a) Connect the hand-held tester or OBD II scan tool to the DLC3.

(b) Please refer to the hand-held tester or OBD II scan tool operator's manual for further details.



A03245

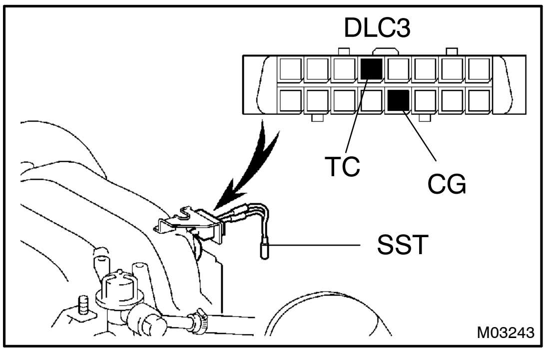
4. CONNECT TIMING LIGHT TO ENGINE

Connect the tester probe of a timing light to the yellow lead wire of the ignition coil connector for No.1 cylinder.

5. CHECK IDLE SPEED

(a) Race the engine speed at 2,500 rpm for approx. 90 seconds.

(b) Check the idle speed.
Idle speed:
700 ± 50 rpm

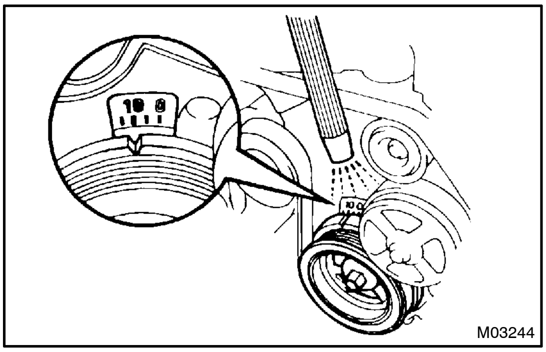


M03243

6. DISCONNECT TOYOTA HAND-HELD TESTER OR OBD II SCAN TOOL

7. INSPECT IGNITION TIMING

(a) Using SST, connect terminals TC and CG of the DLC3.
SST 09843-18040


M03244

(b) Using a timing light, check the ignition timing.
Ignition timing:
8 - 12° BTDC @ idle
(Transmission in neutral position)

(c) Remove the SST from the DLC3.
SST 09843-18040

8. DISCONNECT TIMING LIGHT FROM ENGINE

9. REINSTALL V-BANK COVER

IDLE SPEED

EM0FU-01

INSPECTION

1. INITIAL CONDITIONS

(a) Engine at normal operating temperature
(b) Air cleaner installed
(c) All pipes and hoses of air induction system connected
(d) All accessories switched OFF
(e) All vacuum lines properly connected

HINT:
All vacuum hoses should be properly connected.

(f) SFI system wiring connectors fully plugged
(g) Ignition timing set correctly
(h) Transmission in neutral position

2. CONNECT TOYOTA HAND-HELD TESTER OR OBD II SCAN TOOL (See page EM-7)

3. INSPECT IDLE SPEED

(a) Race the engine speed at 2,500 rpm for approx. 90 seconds.
(b) Check the idle speed.
Idle speed:
700 ± 50 rpm

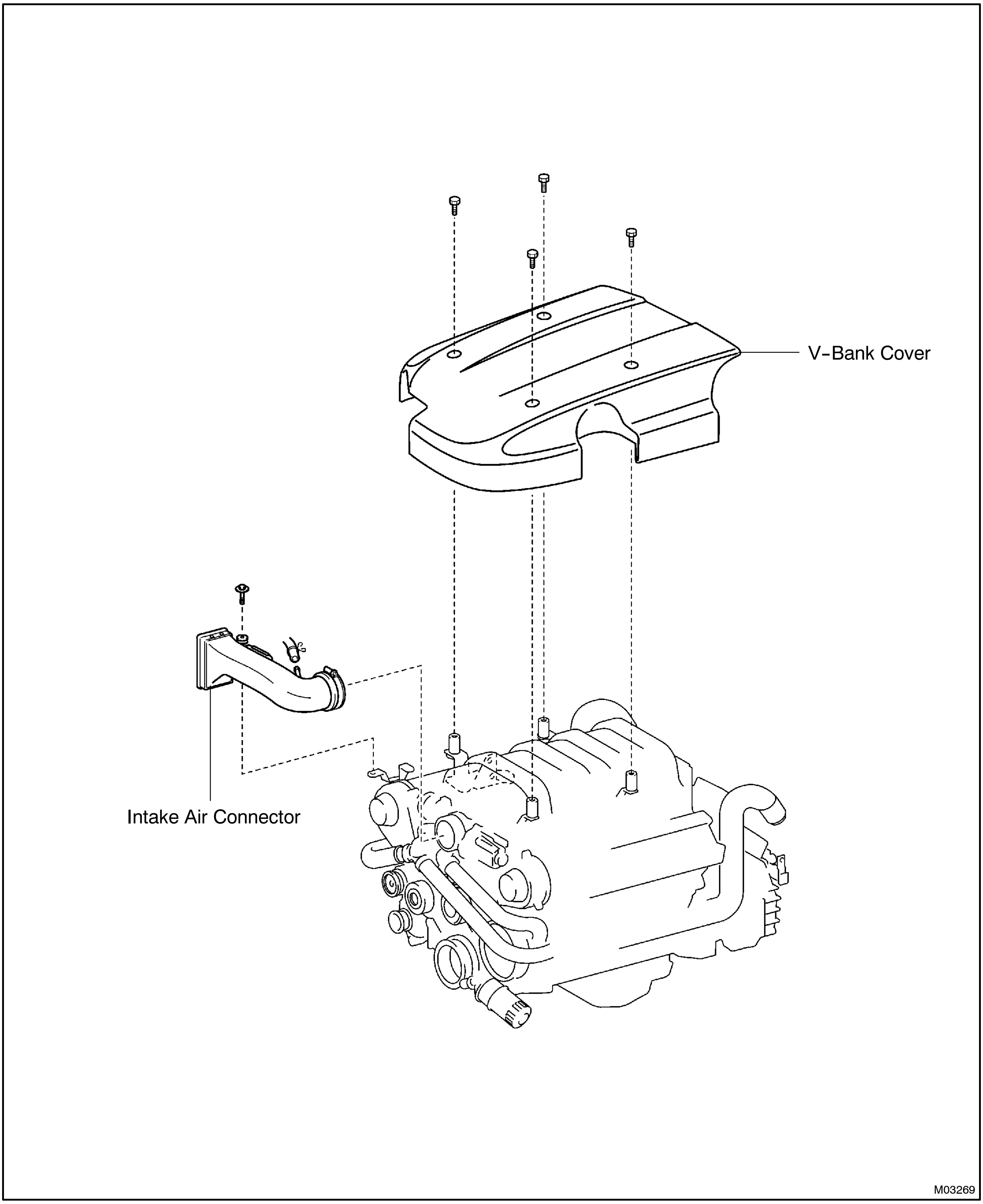
If the idle speed is not as specified, check the air intake system.

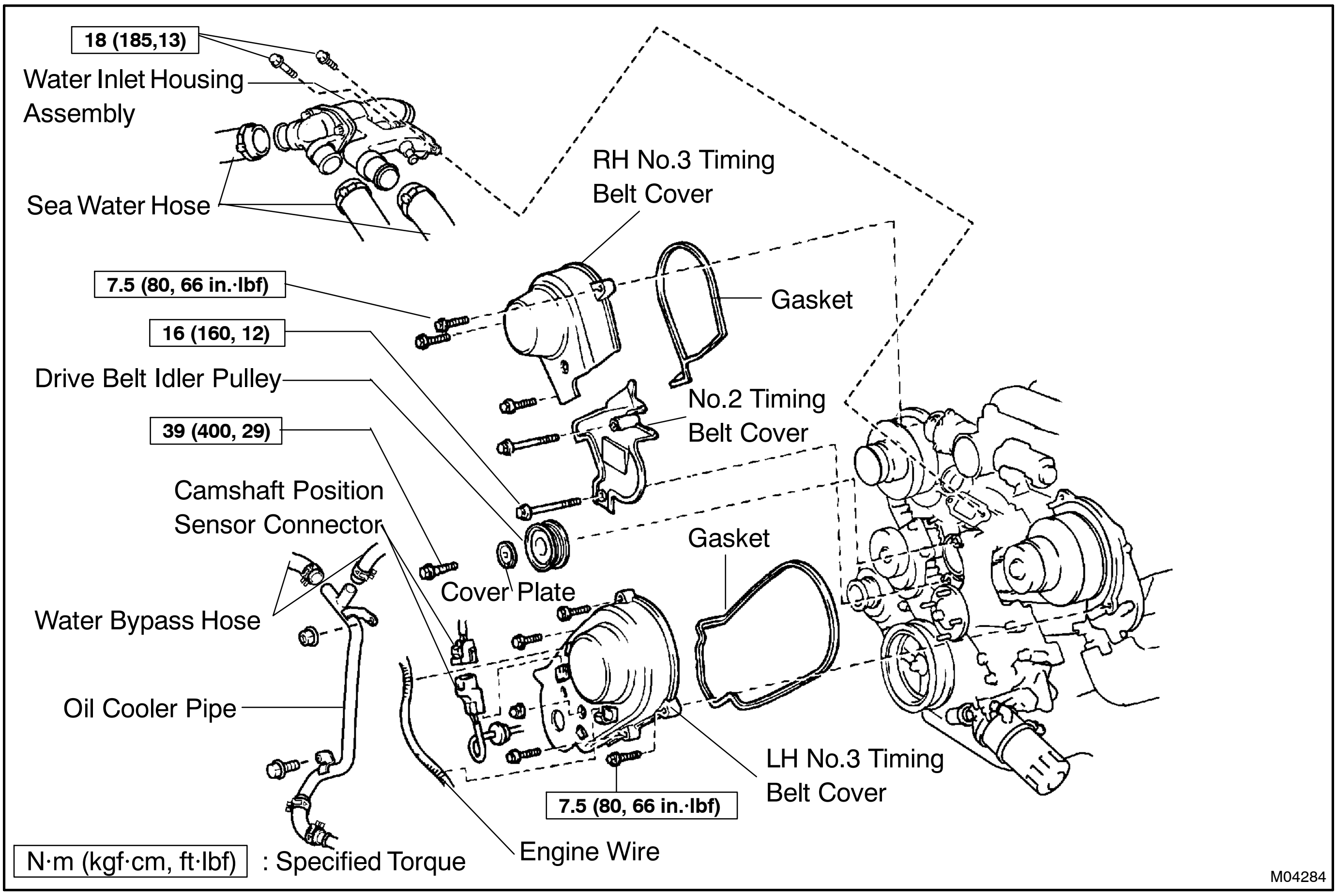
4. DISCONNECT TOYOTA HAND-HELD TESTER OR OBD II SCAN TOOL

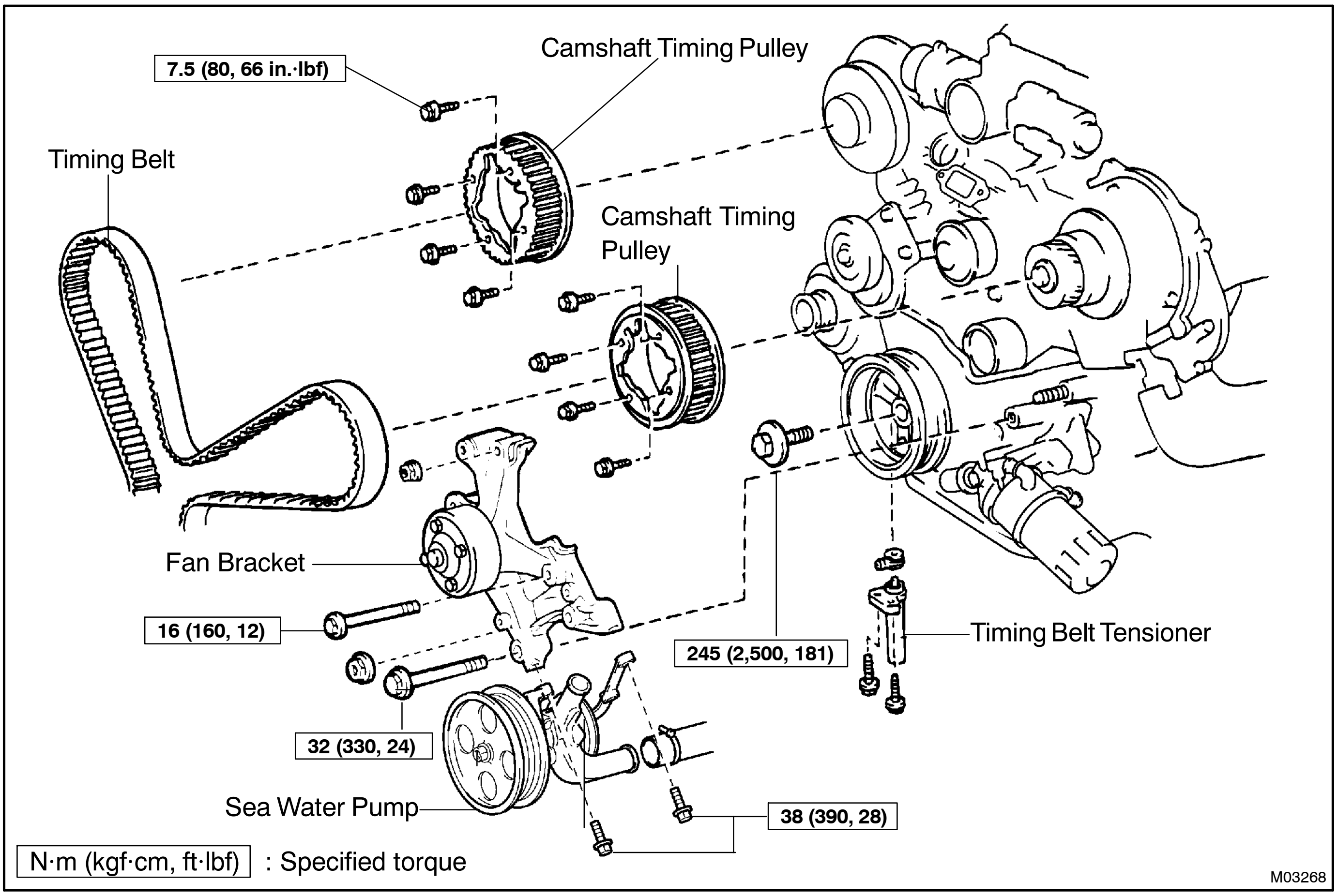
TIMING BELT

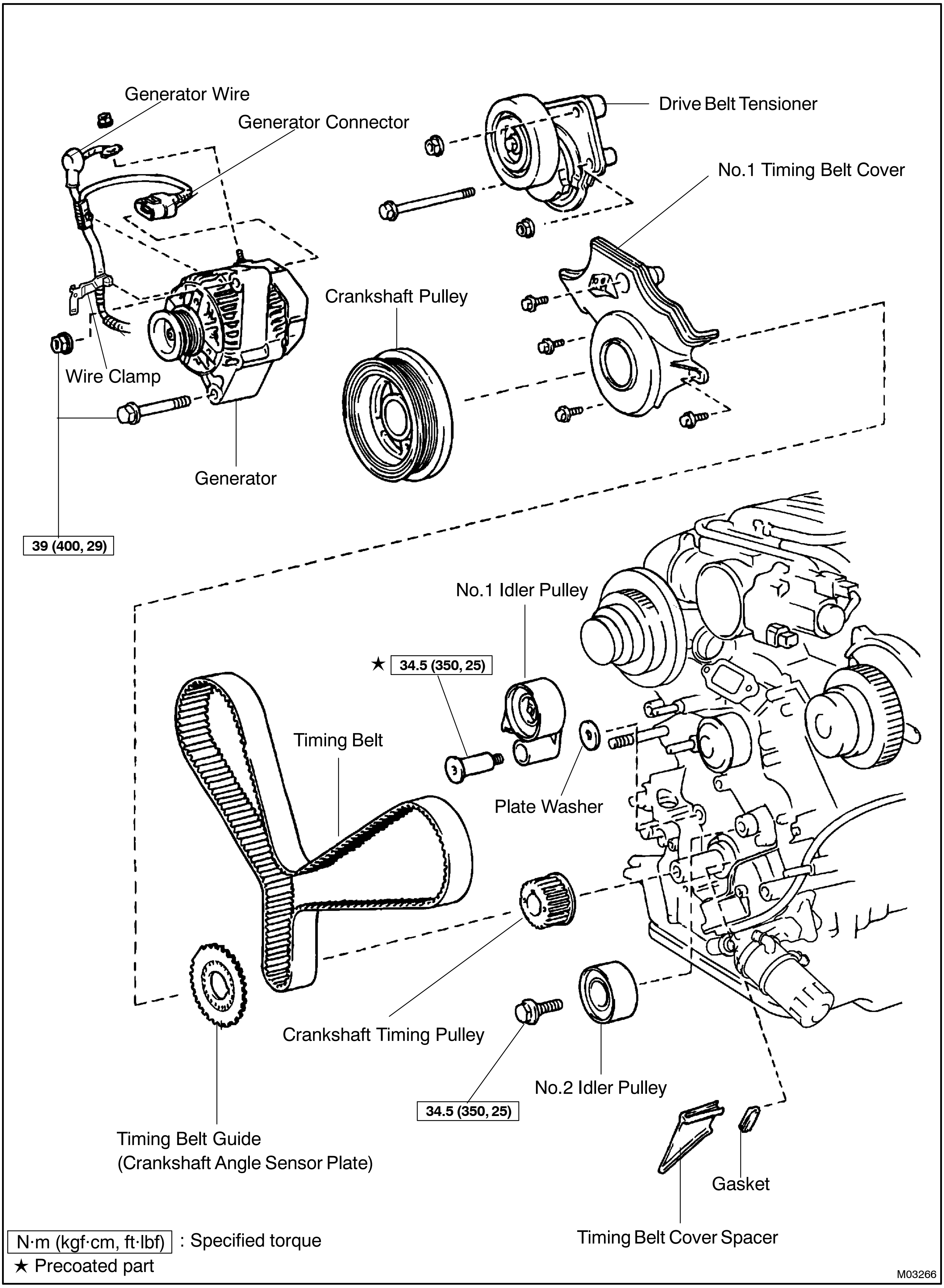
COMPONENTS

EM0FV-01



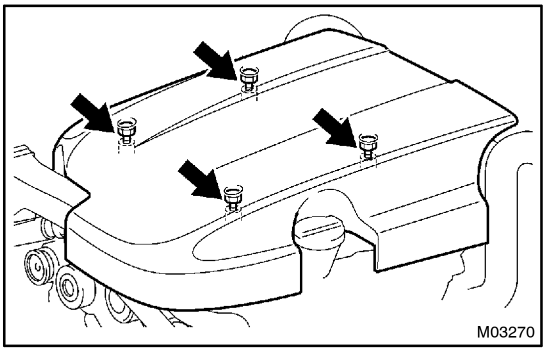

18 (185,13)
Water Inlet Housing Assembly
Sea Water Hose
RH No.3 Timing Belt Cover
7.5 (80, 66 in.·lbf)
Gasket
16 (160, 12)
Drive Belt Idler Pulley
No.2 Timing Belt Cover
39 (400, 29)
Camshaft Position Sensor Connector
Gasket
Cover Plate
Water Bypass Hose
Oil Cooler Pipe
LH No.3 Timing Belt Cover
7.5 (80, 66 in.·lbf)
N·m (kgf·cm, ft·lbf) : Specified Torque
Engine Wire
M04284


7.5 (80, 66 in.·lbf)
Camshaft Timing Pulley
Timing Belt
Camshaft Timing Pulley
Fan Bracket
16 (160, 12)
245 (2,500, 181)
Timing Belt Tensioner
32 (330, 24)
Sea Water Pump
38 (390, 28)
N·m (kgf·cm, ft·lbf) : Specified torque
M03268


Generator Wire
Generator Connector
Drive Belt Tensioner
No.1 Timing Belt Cover
Crankshaft Pulley
Wire Clamp
Generator
39 (400, 29)
No.1 Idler Pulley
★ 34.5 (350, 25)
Timing Belt
Plate Washer
Crankshaft Timing Pulley
34.5 (350, 25)
No.2 Idler Pulley
Timing Belt Guide
(Crankshaft Angle Sensor Plate)
Gasket
Timing Belt Cover Spacer
N·m (kgf·cm, ft·lbf) : Specified torque
★ Precoated part
M03266

EM0FW-01

REMOVAL



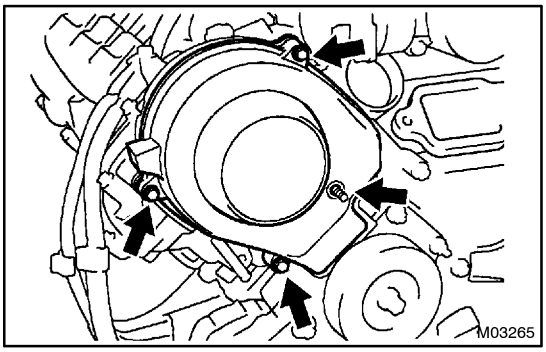
1. REMOVE V-BANK COVER

Remove the 4 bolts and V-bank cover.

2. REMOVE INTAKE AIR CONNECTOR

3. REMOVE DRIVE BELT
(See page CH-7)

4. REMOVE WATER INLET, INLET HOUSING, No.2 SEA WATER HOSE, No.3 SEA WATER HOSE AND No.4 SEA WATER HOSE ASSEMBLIES
(See page CO-5)

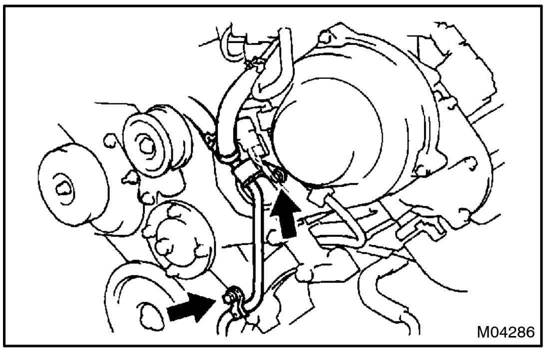


5. REMOVE DRIVE BELT IDLER PULLEY

Remove the pulley bolt, cover plate and idler pulley.

6. REMOVE RH NO.3 TIMING BELT COVER

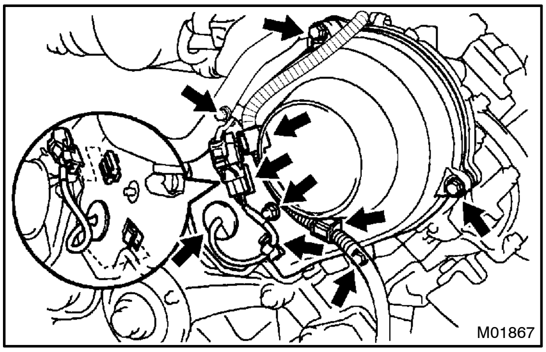
Remove the 3 bolts, cap nut, timing belt cover and gasket.



7. REMOVE LH NO.3 TIMING BELT COVER

(a) Remove the bolt and nut, and disconnect the oil cooler pipe from the timing belt cover and fan bracket.

(b) Disconnect the 2 water bypass hoses from the oil cooler pipe.



(c) Disconnect the engine wire from the 2 wire clamps.

(d) Remove the 4 bolts.

(e) Disconnect the camshaft position sensor wire from the wire clamp on the timing belt cover.

(f) Disconnect the sensor connector from the connector bracket.

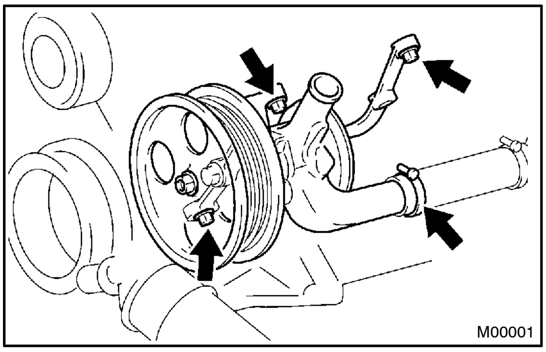
(g) Disconnect the sensor connector.

(h) Remove the wire grommet from the timing belt cover.

(i) Remove the timing belt cover and gasket.

8. REMOVE NO.2 TIMING BELT COVER

Remove the 2 bolts and No.2 timing belt cover.



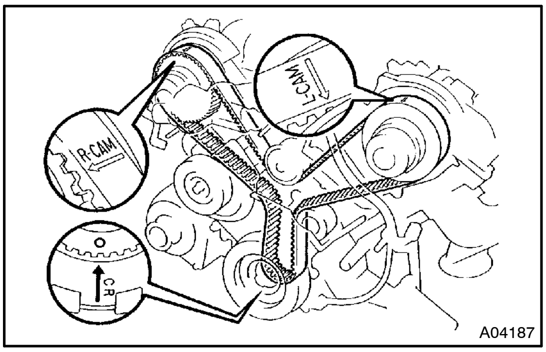
9. REMOVE SEA WATER PUMP

(a) Loosen the hose clamps on sea water hose No. 1

(b) Remove the 3 bolts, and remove the sea water pump with the sea water pump bracket.

10. REMOVE FAN BRACKET

Remove the 2 bolts, 2 nuts and fan bracket.

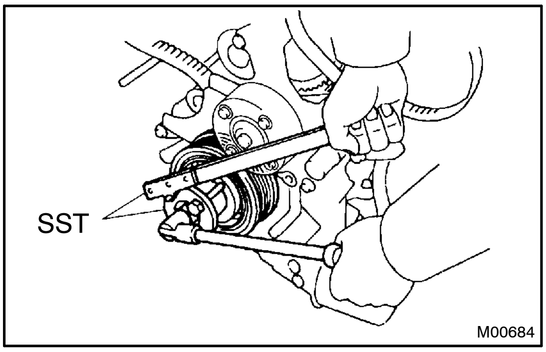


11. IF RE–USING TIMING BELT, CHECK INSTALLATION MARKS ON TIMING BELT

Check that there are 3 installation marks on the timing belt by turning the crankshaft pulley as shown in the illustration.

HINT:

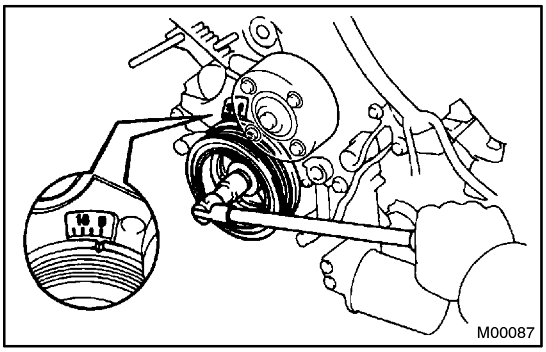
If the installation marks have disappeared, place a new installation mark on the timing belt before removing each part.



12. LOOSEN CRANKSHAFT PULLEY BOLT

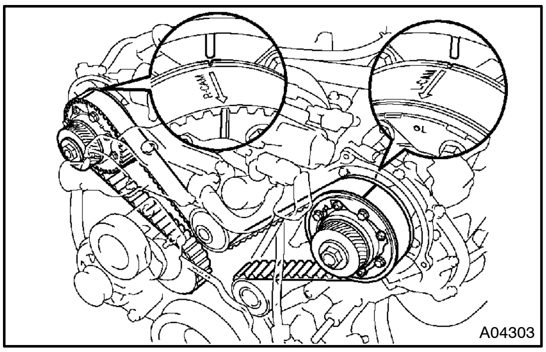
Using SST, loosen the pulley bolt.

SST 09213–70010 (90105–08076),
09330–00021



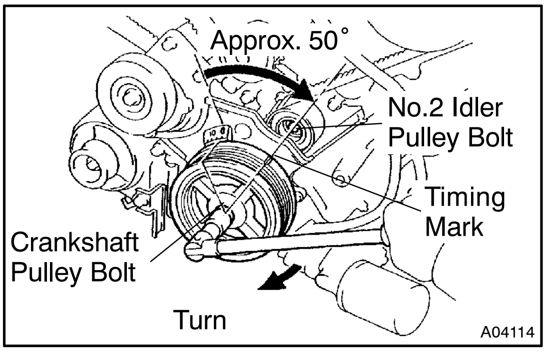
13. SET NO.1 CYLINDER TO APPROX. 50° ATDC/COMPRESSION

(a) Turn the crankshaft pulley and align its groove with timing mark "0" of the No.1 timing belt cover.



(b) Check that the timing marks of the camshaft timing pulleys and timing belt rear plates aligned.

If not, turn the crankshaft 1 revolution (360°).



(c) Turn the crankshaft pulley approx. 50° clockwise, and put the timing mark of the crankshaft pulley in line with the centers of the crankshaft pulley bolt and the idler pulley bolt.

NOTICE:
If the timing belt is disengaged, having the crankshaft pulley at the wrong angle can cause the piston head and valve head to come into contact with each other when you remove the camshaft timing pulley (step 19), causing damage. So always set the crankshaft pulley at the correct angle.

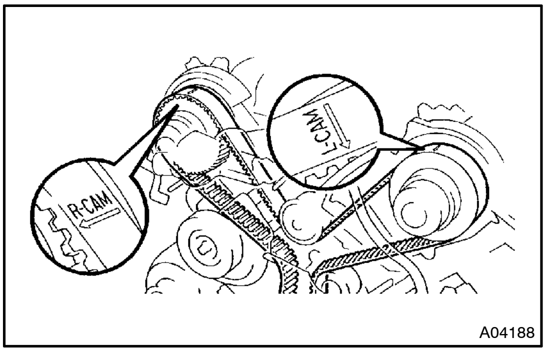
(d) Remove the crankshaft pulley bolt.

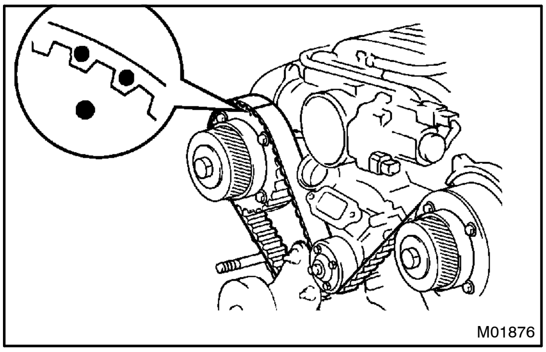
NOTICE:
Do not turn the crankshaft pulley.

14. REMOVE TIMING BELT TENSIONER

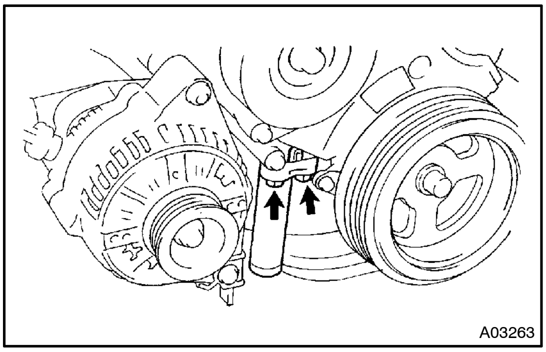
HINT:

- When re–using timing belt:
  If the installation marks have disappeared, before remove the timing belt, place 2 new installation marks on the timing belt to match the timing marks of the camshaft timing pulleys.

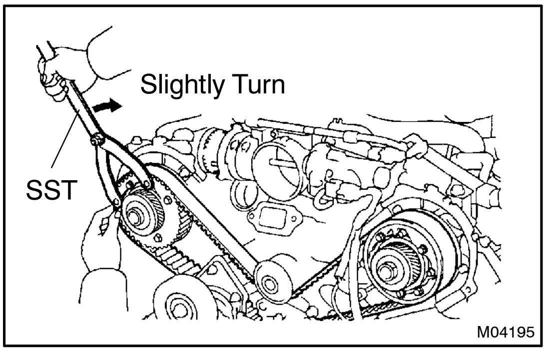




- When replacing timing belt tensioner only:
  To avoid meshing of the timing pulley and timing belt, secure one of them with string. And place matchmarks on the timing belt and RH camshaft timing pulley.



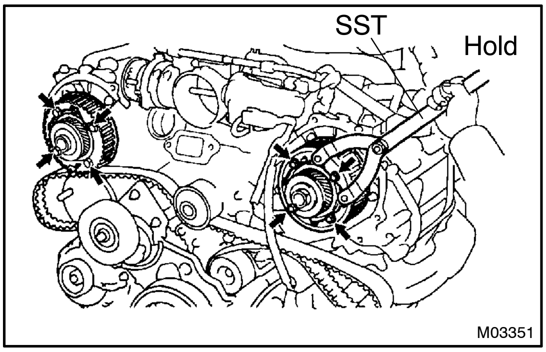
Alternately loosen the 2 bolts, and remove them, the belt tensioner and dust boot.



15. DISCONNECT TIMING BELT FROM CAMSHAFT TIMING PULLEYS

(a) Using SST, loosen the tension spring between the LH and RH camshaft timing pulleys by slightly turning the RH camshaft timing pulley clockwise.
SST 09960-10010 (09962-01000, 09963-00350)

(b) Disconnect the timing belt from the camshaft timing pulleys.



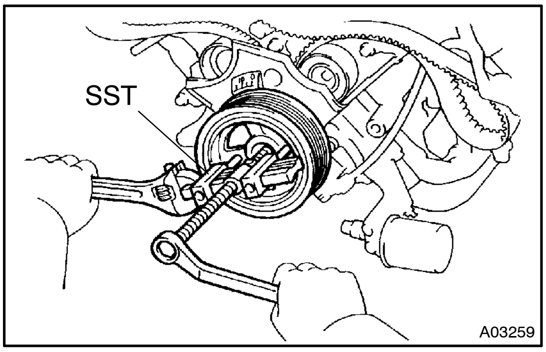
16. REMOVE CAMSHAFT TIMING PULLEYS

Using SST, remove the 4 bolts and timing pulley. Remove the 2 timing pulleys.
SST 09960-10010 (09962-01000, 09963-00350)

17. REMOVE GENERATOR
(See page CH-7)

18. REMOVE DRIVE BELT TENSIONER

Remove the bolt, 2 nuts and belt tensioner.



19. REMOVE CRANKSHAFT PULLEY

Using SST, remove the crankshaft pulley.
SST 09950-50010 (09951-05010, 09952-05010, 09953-05010, 09953-05020, 09954-05020)

NOTICE:
Do not turn the crankshaft pulley.

20. REMOVE NO.1 TIMING BELT COVER

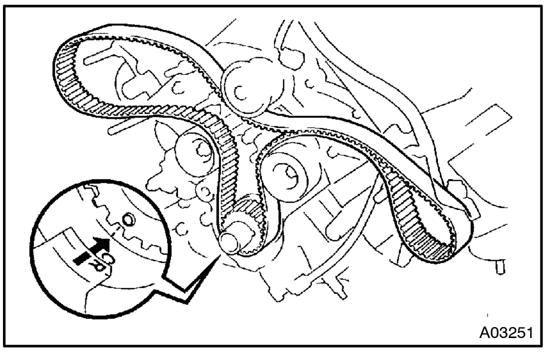
Remove the 4 bolts, timing belt cover.

21. REMOVE TIMING BELT GUIDE

22. REMOVE TIMING BELT COVER SPACER

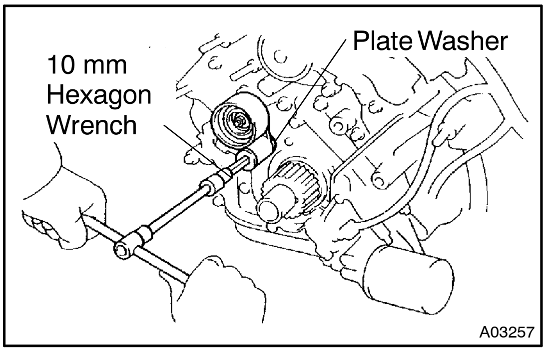
23. REMOVE TIMING BELT

HINT:
If re-using the belt and the installation mark has disappeared from it, place a new installation mark on the timing belt to the match the dot mark of the crankshaft timing pulley.



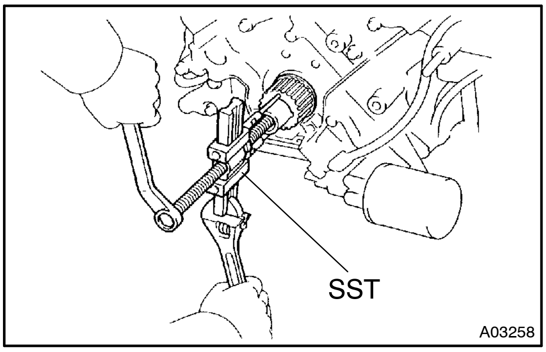
24. REMOVE NO.2 IDLER PULLEY

Remove the bolt and idler pulley.



25. REMOVE NO.1 IDLER PULLEY

Using a 10 mm hexagon wrench, remove the bolt, idler pulley and plate washer.



26. REMOVE CRANKSHAFT TIMING PULLEY

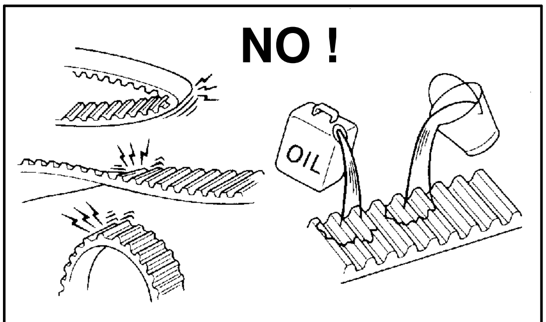
Using SST, remove the timing pulley.

SST 09950-50010 (09951-05010, 09952-05010, 09953-05010, 09953-05020, 09954-05010)

NOTICE:

Do not turn the timing pulley.

EM0FX-01



EM3336

INSPECTION

1. INSPECT TIMING BELT

NOTICE:

- **Do not bend, twist or turn the timing belt inside out.**
- **Do not allow the timing belt to come into contact with oil, water or steam.**
- **Do not utilize timing belt tension when installing or removing the mount bolt of the camshaft timing pulley.**

If there are any defects, as shown in the illustrations, check these points:

(a) Premature parting
- Check for proper installation.
- Check the timing cover gasket for damage and proper installation.

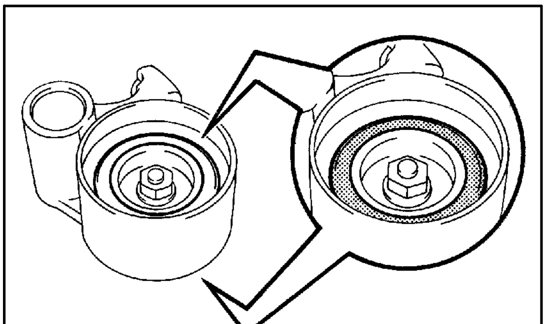
(b) If the belt teeth are cracked or damaged, check to see if either camshaft is locked.

(c) If there is noticeable wear or cracks on the belt face, check to see if there are nicks on the side of the idler pulley lock and water pump.

(d) If there is wear or damage on only one side of the belt, check the belt guide and the alignment of each pulley.

(e) If there is noticeable wear on the belt teeth, check timing cover for damage and check gasket has been installed correctly and for foreign material on the pulley teeth.

If necessary, replace the timing belt.


P20079

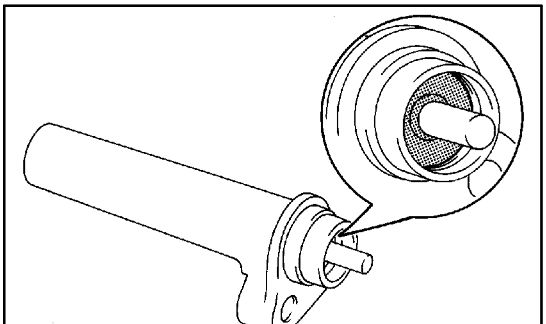
2. INSPECT IDLER PULLEYS

(a) Visually check the seal portion of the idler pulley for oil leakage.

If leakage is found, replace the idler pulley.

(b) Check that the idler pulley turns smoothly.

If necessary, replace the idler pulley.


P20633

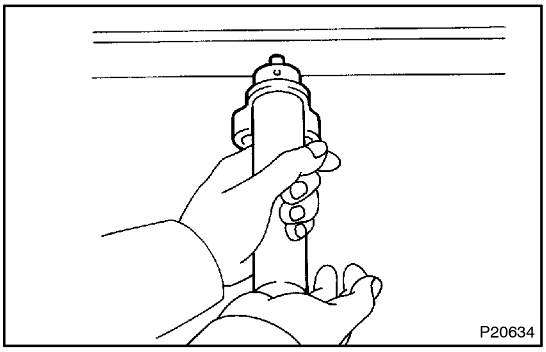
3. INSPECT TIMING BELT TENSIONER

(a) Visually check the seal portion of the tensioner for oil leakage.

HINT:

If there is only the faintest trace of oil on the seal on the push rod side, the tensioner is all right.

If leakage is found, replace the tensioner.

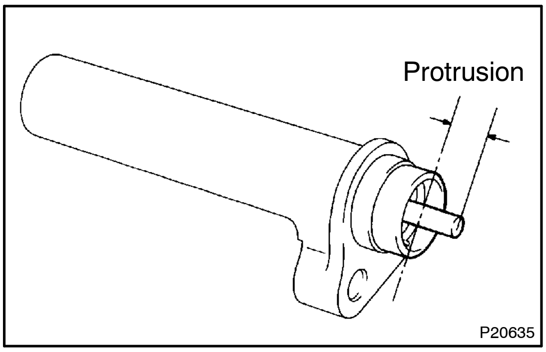


(b) Hold the tensioner with both hands and push the push rod strongly as shown to check that it doesn't move.

If the push rod moves, replace the tensioner.

NOTICE:

Never hold the tensioner push rod facing downward.



(c) Measure the protrusion of the push rod from the housing end.

Protrusion:

10.5 - 11.5 mm (0.413 - 0.453 in.)

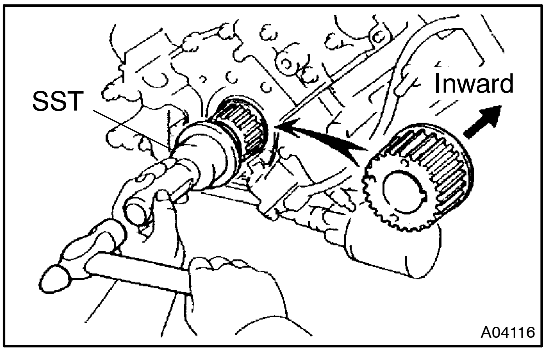
If the protrusion is not as specified, replace the tensioner.

4. INSPECT WATER PUMP

(See page CO-6)

EM0FY-01

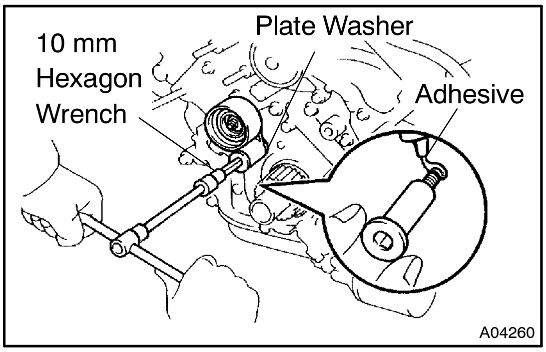
INSTALLATION



1. INSTALL CRANKSHAFT TIMING PULLEY

(a) Align the timing pulley set key with the key groove of the pulley.

(b) Using SST and a hammer, tap in the timing pulley, facing the flange side inward.
SST 09223-46011

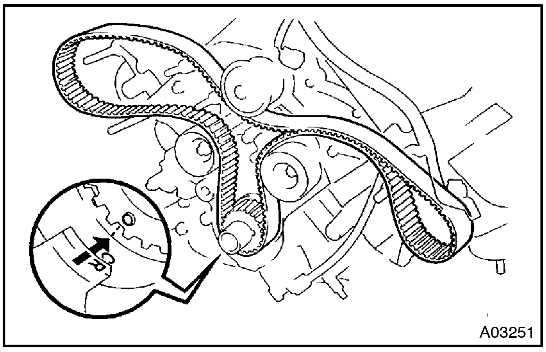


2. INSTALL NO.1 IDLER PULLEY

(a) Apply adhesive 2 or 3 threads of the pivot bolt.
Adhesive:
Part No. 08833-00080, THREE BOND 1344, LOCTITE 242 or equivalent

(b) Using a 10 mm hexagon wrench, install the plate washer and idler pulley with the pivot bolt.
Torque: 34.5 N·m (350 kgf·cm, 25 ft·lbf)

(c) Check that the pulley bracket moves smoothly.



3. INSTALL NO.2 IDLER PULLEY

(a) Install the idler pulley with the bolt.
Torque: 34.5 N·m (350 kgf·cm, 25 ft·lbf)

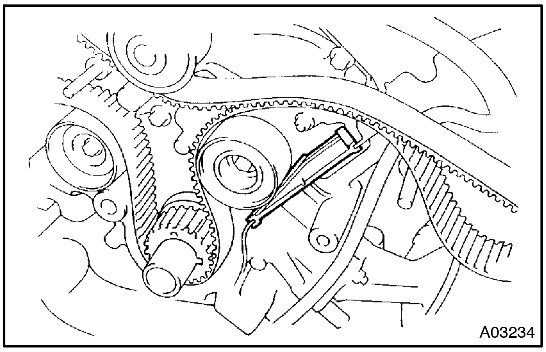
(b) Check that the idler pulley moves smoothly.

4. TEMPORARILY INSTALL TIMING BELT

NOTICE:
The engine should be cold.

(a) Remove any oil or water on the crankshaft pulley, oil pump pulley, water pump pulley, No.1 idler pulley and No.2 idler pulley, and keep them clean.

NOTICE:
Only wipe the pulleys; do not use any cleansing agent.



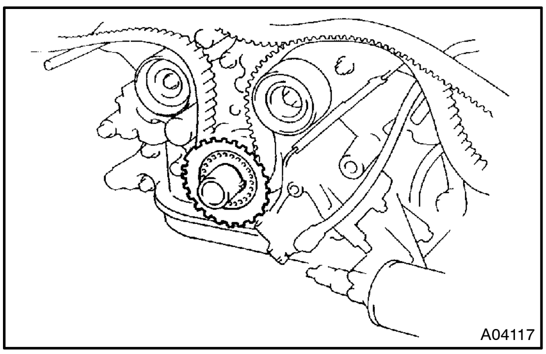
(b) Align the installation mark on the timing belt with the timing mark of the crankshaft timing pulley.

(c) Install the timing belt on the crankshaft timing pulley, No.1 idler pulley and No.2 idler pulley.

5. INSTALL TIMING BELT COVER SPACER

(a) Install the gasket to the cover spacer.

(b) Install the cover spacer.

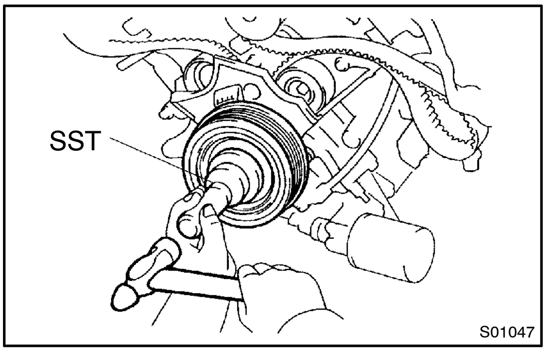


6. INSTALL TIMING BELT GUIDE

Install the belt guide, facing the cup side outward.

7. INSTALL NO.1 TIMING BELT COVER

Install the timing belt cover with the 4 bolts.



8. INSTALL CRANKSHAFT PULLEY

(a) Align the pulley set key with the key groove of the crankshaft pulley.

(b) Using SST and a hammer, tap in the crankshaft pulley.
SST 09223–46011

9. INSTALL DRIVE BELT TENSIONER

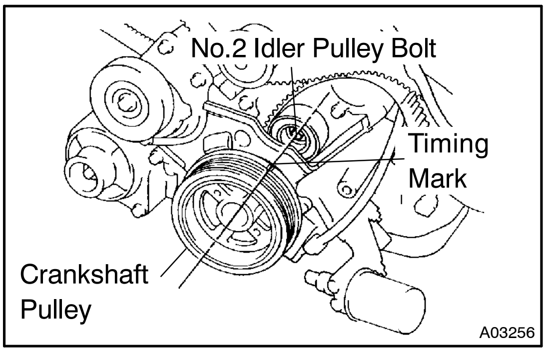
Install the belt tensioner with the bolt and 2 nuts.

Torque: 16 N·m (160 kgf·cm, 12 ft·lbf)

HINT:

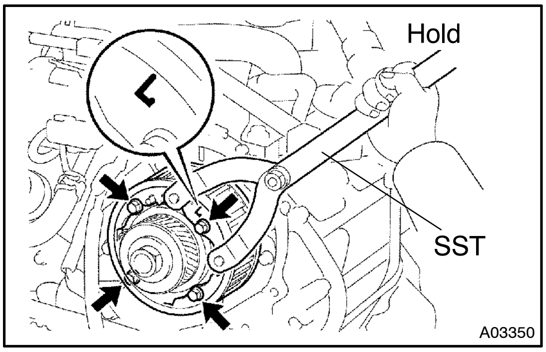
Use a bolt 106 mm (4.18 in.) in length.

10. INSTALL GENERATOR
(See page CH–17)



11. CHECK CRANKSHAFT PULLEY POSITION

Check that the timing mark of the crankshaft pulley is aligned with the centers of the crankshaft pulley and the idler pulley bolt.

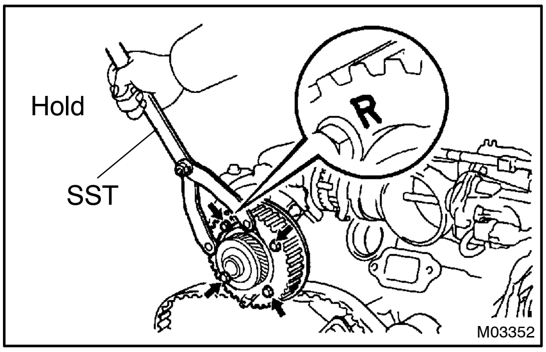


12. INSTALL LH CAMSHAFT TIMING PULLEY

(a) Align the camshaft timing tube knock pin with the knock pin groove of the timing pulley.

(b) Attach the timing pulley to the camshaft timing tube, facing the "L" mark forward.

(c) Using SST, install the 4 pulley bolts.
SST 09960–10010 (09962–01000, 09963–00350)
Torque: 7.5 N·m (80 kgf·cm, 66 ft·lbf)

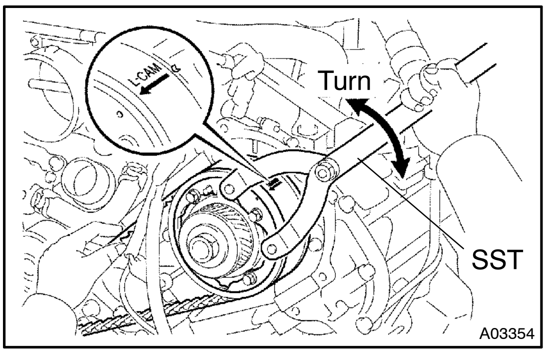


13. INSTALL RH CAMSHAFT TIMING PULLEY

(a) Align the camshaft timing tube knock pin with the knock pin groove of the timing pulley.

(b) Attach the timing pulley to the camshaft timing tube, facing the "R" mark forward.

(c) Using SST, install the 4 pulley bolts.
SST 09960–10010 (09962–01000, 09963–00350)
Torque: 7.5 N·m (80 kgf·cm, 66 ft·lbf)



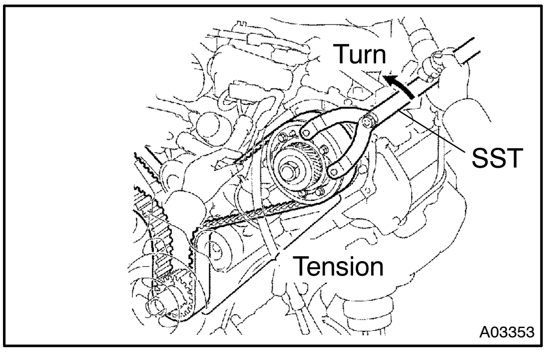
14. CONNECT TIMING BELT TO LH CAMSHAFT TIMING PULLEY

(a) Remove any oil or water on the LH camshaft timing pulley, and keep it clean.

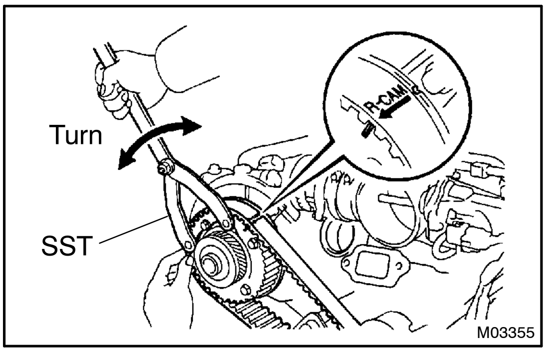
NOTICE:

Only wipe the pulleys; do not use any cleansing agent.

(b) Using SST, turn the timing pulley. Align the installation mark on the timing belt with the timing mark of the timing pulley, and hang the timing belt on the timing pulley.
SST 09960–10010 (09962–01000, 09963–00350)



(c) Using SST, turn the LH camshaft timing pulley counterclockwise until there is tension between the crankshaft timing pulley and LH camshaft timing pulley.
SST 09960–10010 (09962–01000, 09963–00350)

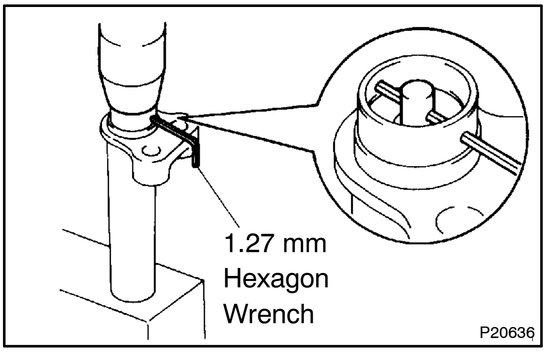


15. CONNECT TIMING BELT TO RH CAMSHAFT TIMING PULLEY

(a) Remove any oil or water on the RH camshaft timing pulley and water pump pulley, and keep them clean.

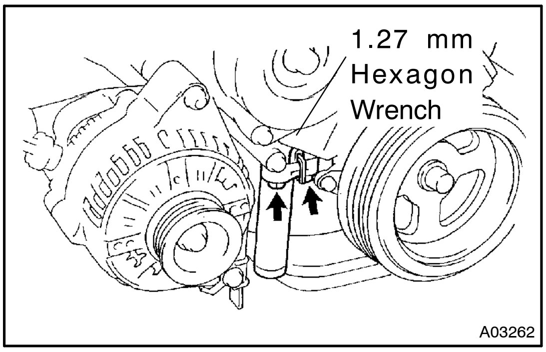
NOTICE:
Only wipe the pulleys; do not use any cleansing agent.

(b) Using SST, turn the timing pulley. Align the installation mark on the timing belt with the timing mark of the timing pulley, and hang the timing belt on the timing pulley.
SST 09960–10010 (09962–01000, 09963–00350)



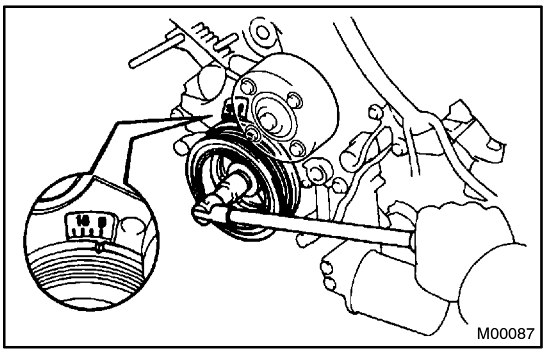
16. SET TIMING BELT TENSIONER

(a) Using a press, slowly press in the push rod using 981 – 9,807 N (100 – 1,000 kgf, 220 – 2,205 lbf) of pressure.
(b) Align the holes of the push rod and housing, pass a 1.27 mm hexagon wrench through the holes to keep the setting position of the push rod.
(c) Release the press.
(d) Install the dust boot to the belt tensioner.



17. INSTALL TIMING BELT TENSIONER

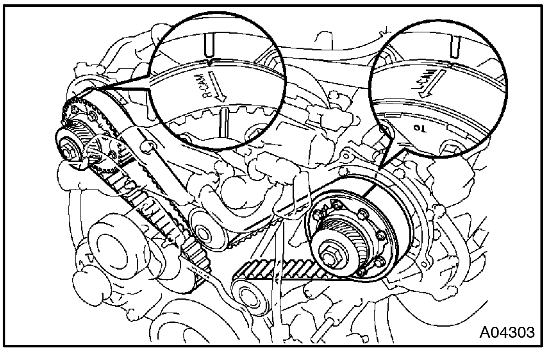
(a) Temporarily install the belt tensioner with the 2 bolts.
(b) Alternately tighten the 2 bolts.
Torque: 26 N·m (270 kgf·cm, 19 ft·lbf)
(c) Using pliers, remove the 1.27 mm hexagon wrench from the belt tensioner.



18. CHECK VALVE TIMING

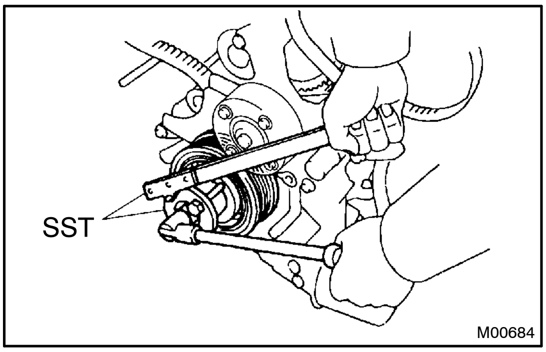
(a) Temporarily install the crankshaft pulley bolt.
(b) Slowly turn the crankshaft pulley 2 revolutions from TDC to TDC.

NOTICE:
Always turn the crankshaft pulley clockwise.



(c) Check that each pulley aligns with the timing marks as shown in the illustration.

If the timing marks do not align, remove the timing belt and reinstall it.

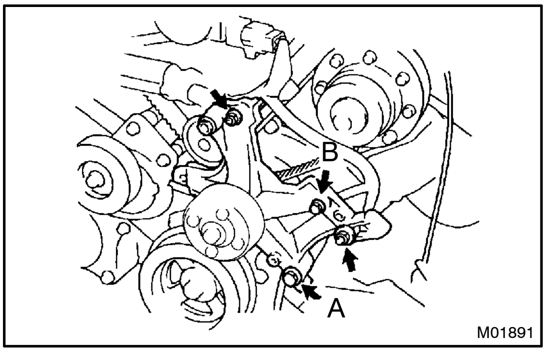


19. TIGHTEN CRANKSHAFT PULLEY BOLT

Using SST, install the pulley bolt.

SST 09213-70010 (90105-08076),
09330-00021

Torque: 245 N·m (2,500 kgf·cm, 181 ft·lbf)



20. INSTALL FAN BRACKET

(a) Install the fan bracket with the 2 bolts and 2 nuts.

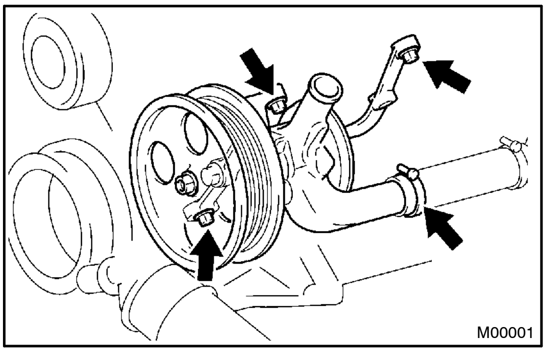
Torque:
12 mm head
16 N·m (160 kgf·cm, 12 ft·lbf)
14 mm head
32 N·m (330 kgf·cm, 24 ft·lbf)

HINT:

Each bolt length is indicated in the illustration.

Bolt Length:

106 mm (4.17 in.) for 12 mm head (A)
114 mm (4.49 in.) for 14 mm head (B)



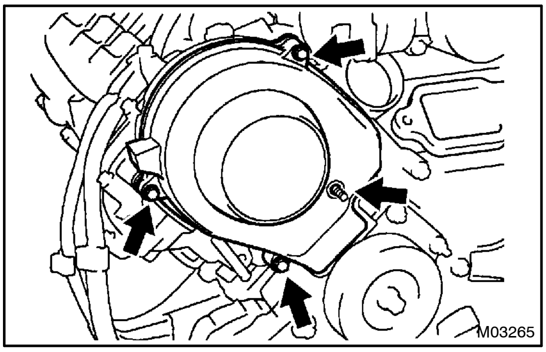
21. INSTALL SEA WATER PUMP

(a) Install the sea water pump bracket and sea water pump with the 3 bolts.

Torque: 38 N.m (390 kgf.cm, 28 ft.lbf)

(b) Secure sea water hose No. 1 with the hose clamp.

Torque: 2.5 N.m (25 kgf.cm, 22 ft.lbf)



22. INSTALL NO.2 TIMING BELT COVER

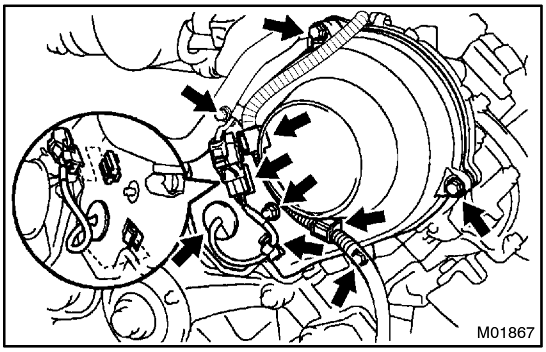
Install the No.2 timing belt cover with the 2 bolts.

Torque: 16 N·m (160 kgf·cm, 12 ft·lbf)

23. INSTALL RH NO.3 TIMING BELT COVER

(a) Install the gasket to the timing belt cover.
(b) Fit the timing belt cover, matching it with the fan bracket.
(c) Install the timing belt cover with the 3 bolts and cap nut.

Torque: 7.5 N·m (80 kgf·cm, 66 in.·lbf)

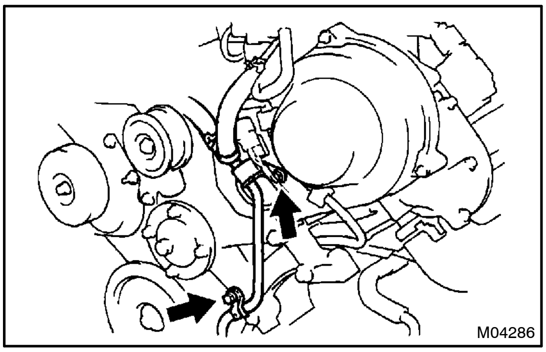


24. INSTALL LH NO.3 TIMING BELT COVER

(a) Install the gasket to the timing belt cover.
(b) Run the camshaft position sensor wire through the timing belt cover hole.
(c) Fit the timing belt cover, matching it with the fan bracket.
(d) Install the 4 bolts.

Torque: 7.5 N·m (80 kgf·cm, 66 in.·lbf)

(e) Install the wire grommet to the timing belt cover.
(f) Install the sensor connector to the connector bracket.
(g) Connect the sensor connector.
(h) Install the sensor wire to the wire clamp on the timing belt cover.
(i) Install the engine wire to the 2 wire clamps on the timing belt cover.



(j) Connect the 2 water bypass hoses to the oil cooler pipe.
(k) Install the oil cooler pipe with the bolt and nut to the timing belt cover and fan bracket.

Torque: 7.5 N·m (80 kgf·cm, 66 in.·lbf)

25. INSTALL DRIVE BELT IDLER PULLEY

Install the idler pulley and cover plate with the bolt.

Torque: 37 N·m (380 kgf·cm, 27 ft·lbf)

26. INSTALL WATER INLET, INLET HOSING, No.2 SEA WATER HOSE, No.3 SEA WATER HOSE, AND No.4 SEA WATER HOSE ASSEMBLIES

(See page CO-7)

27. INSTALL DRIVE BELT

(See page CH-17)

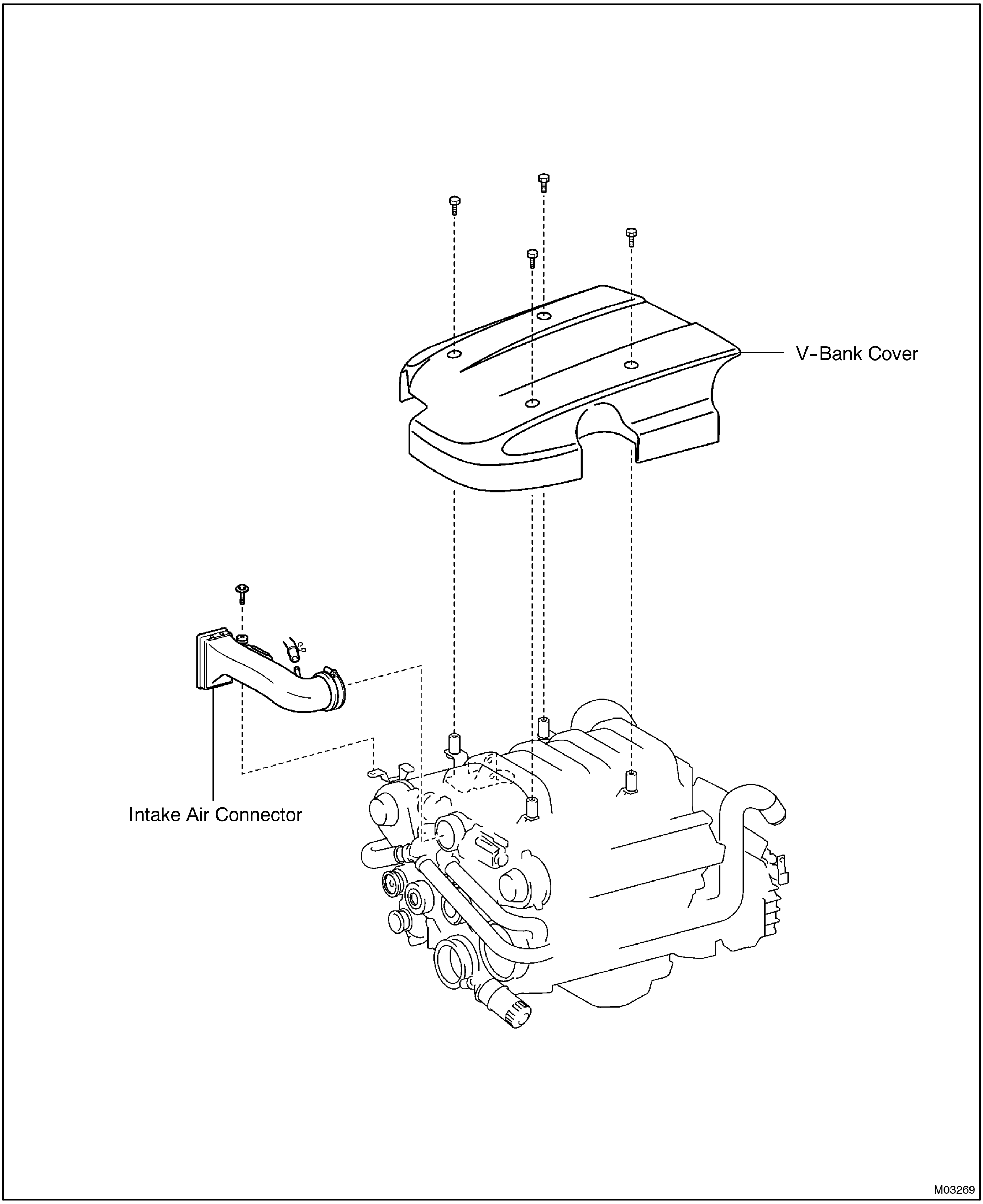
28. INSTALL INTAKE AIR CONNECTOR

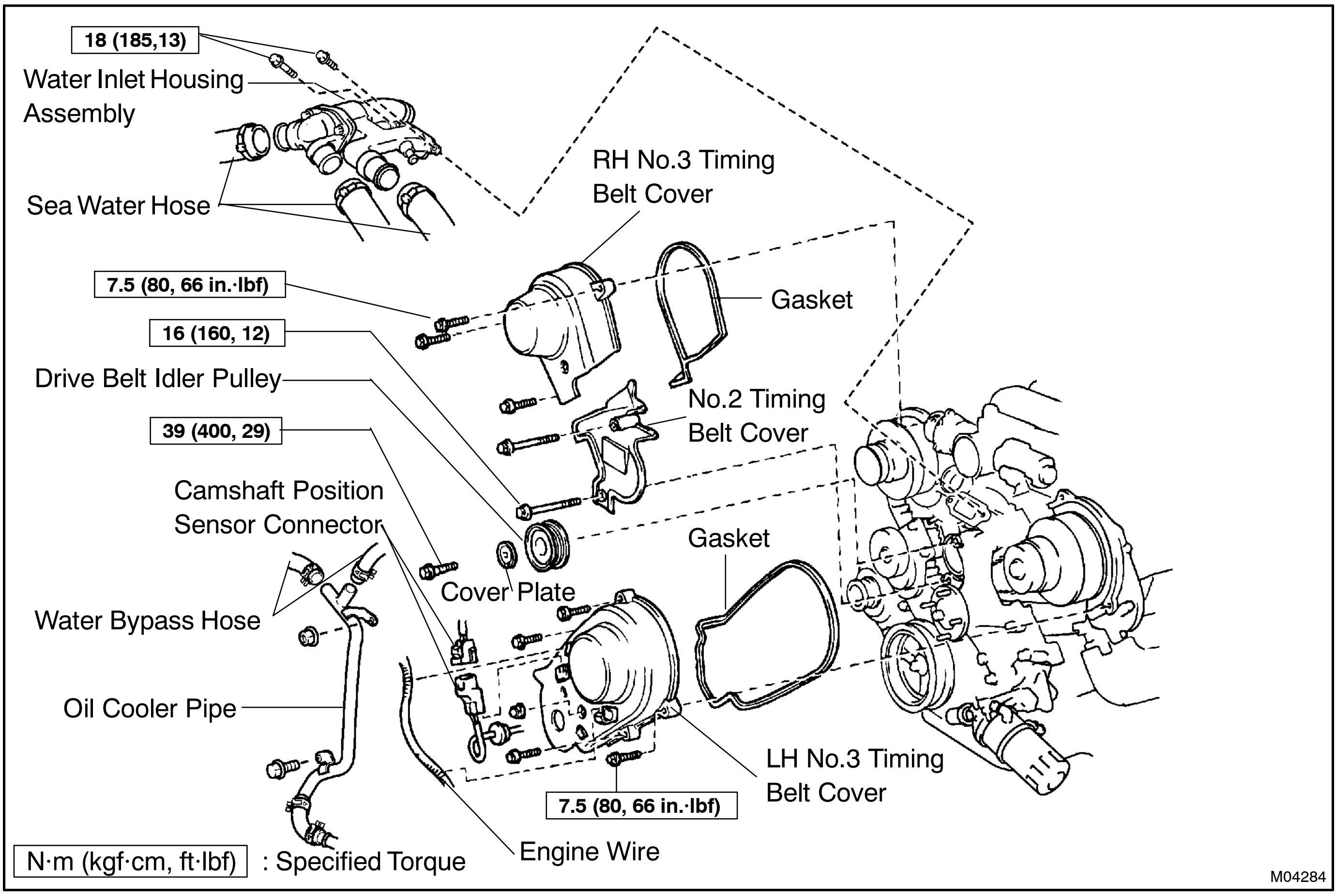
29. INSTALL V-BANK COVER

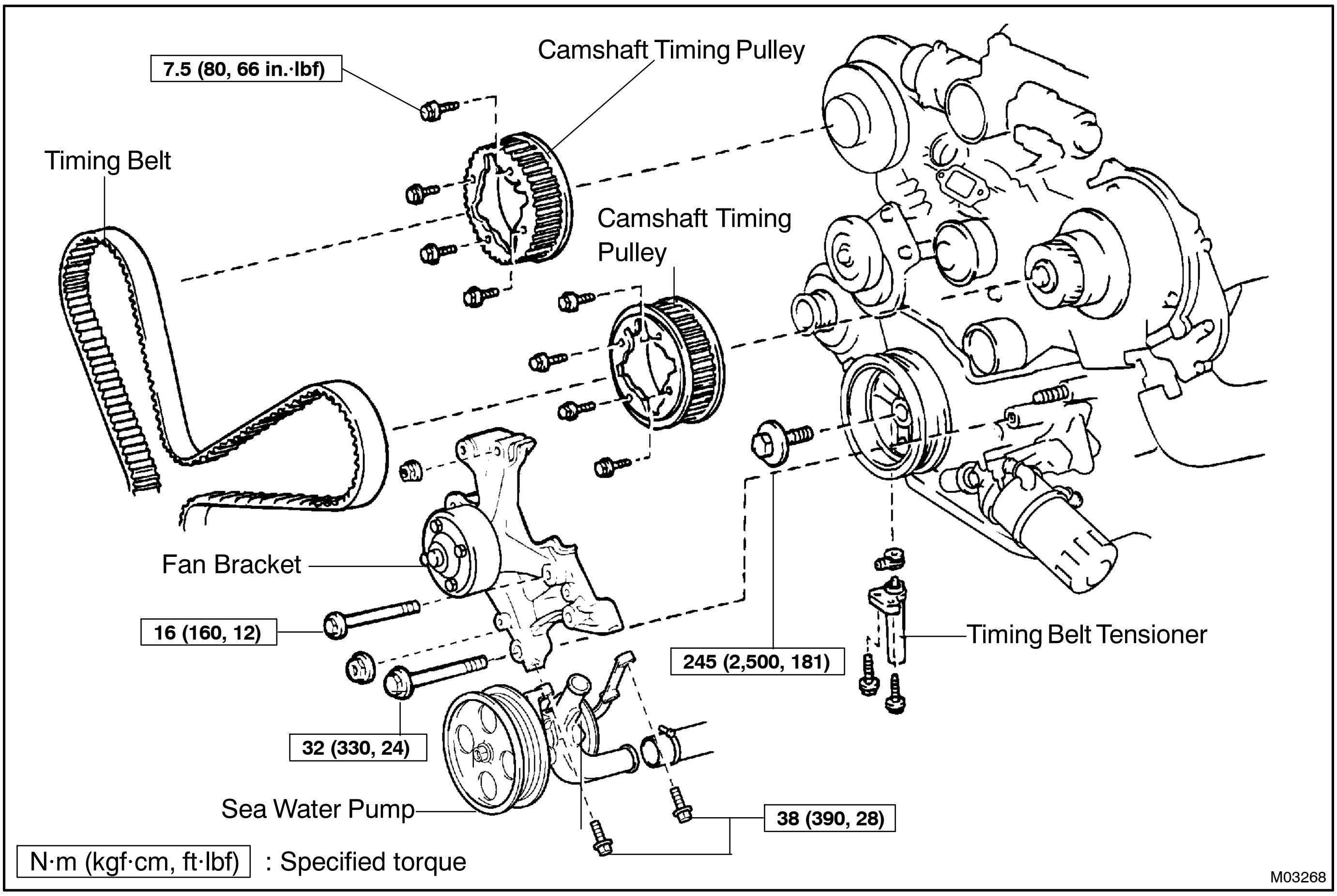
CYLINDER HEAD

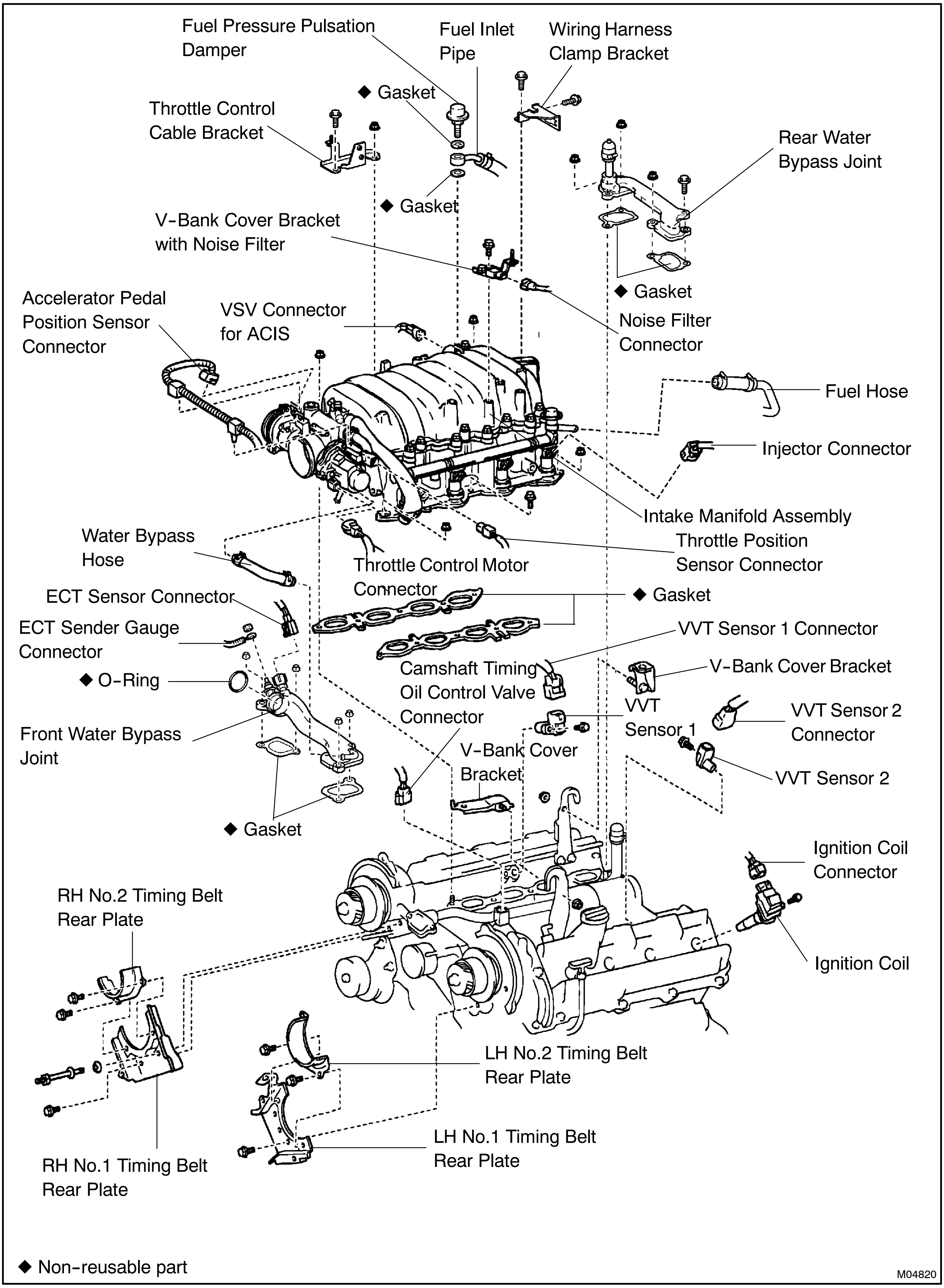
COMPONENTS

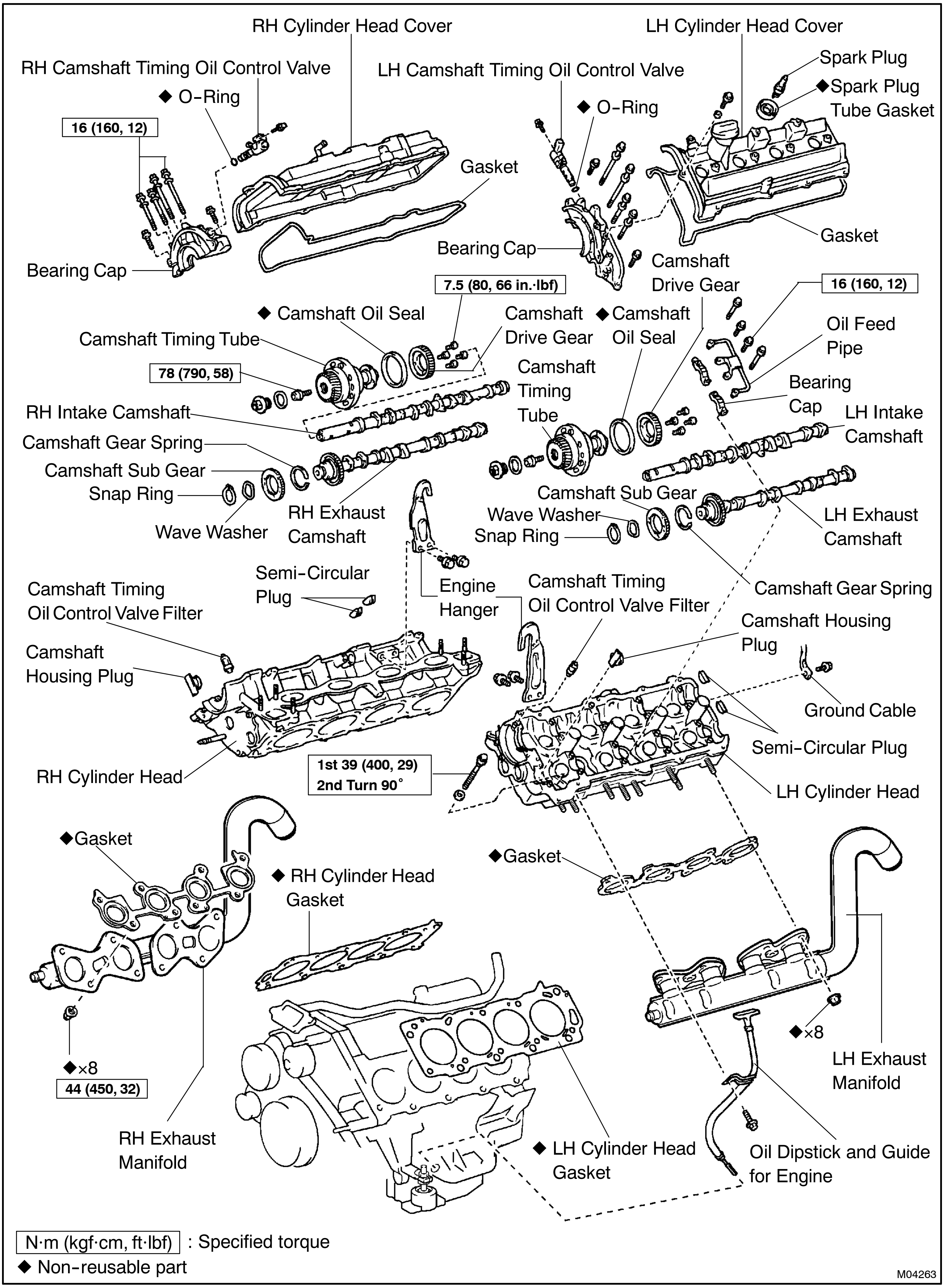
EM0FZ-01

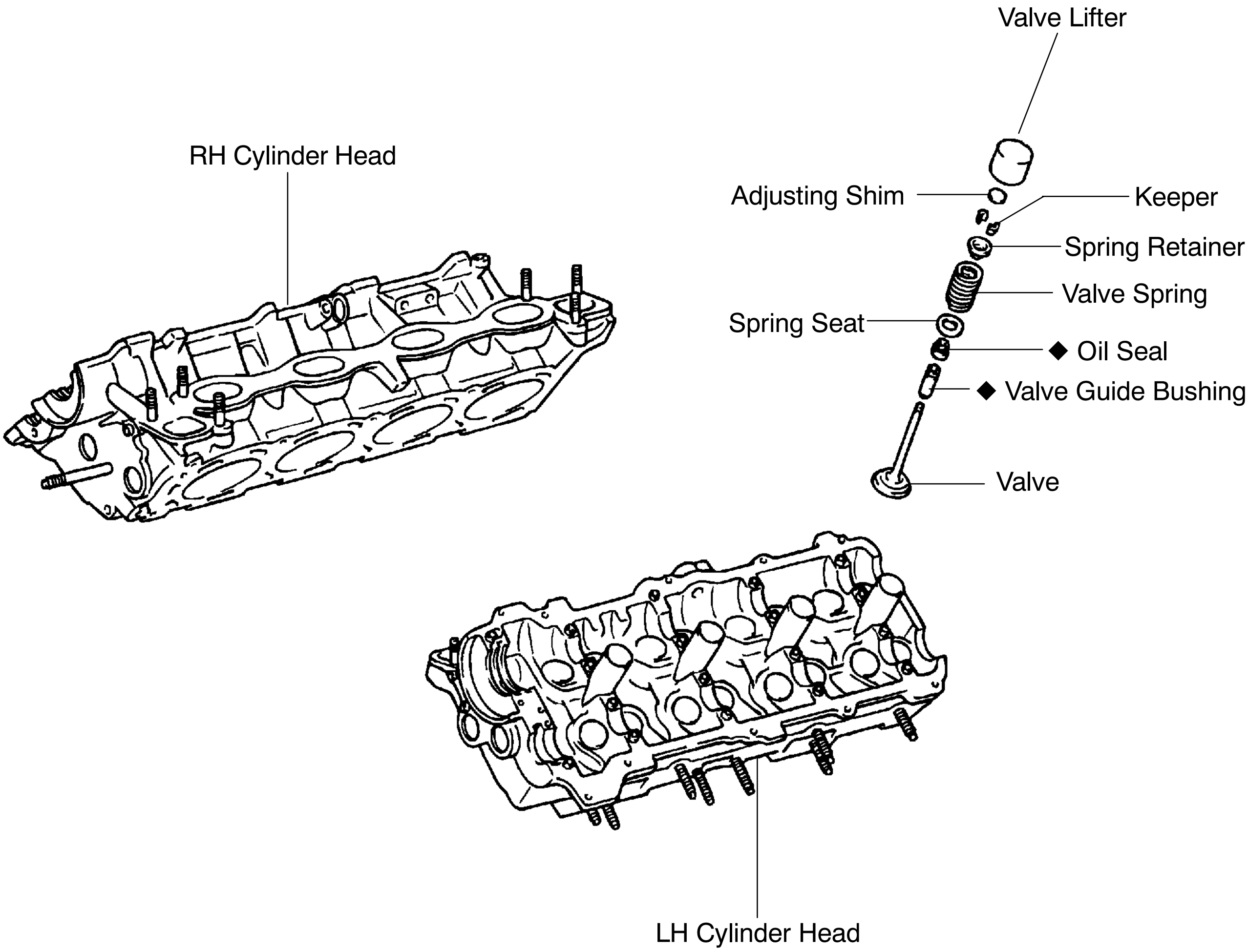



18 (185,13)
Water Inlet Housing Assembly
Sea Water Hose
RH No.3 Timing Belt Cover
7.5 (80, 66 in.·lbf)
Gasket
16 (160, 12)
Drive Belt Idler Pulley
No.2 Timing Belt Cover
39 (400, 29)
Camshaft Position Sensor Connector
Gasket
Cover Plate
Water Bypass Hose
Oil Cooler Pipe
LH No.3 Timing Belt Cover
7.5 (80, 66 in.·lbf)
N·m (kgf·cm, ft·lbf) : Specified Torque
Engine Wire
M04284


Camshaft Timing Pulley
7.5 (80, 66 in.·lbf)
Timing Belt
Camshaft Timing Pulley
Fan Bracket
16 (160, 12)
Timing Belt Tensioner
245 (2,500, 181)
32 (330, 24)
Sea Water Pump
38 (390, 28)
N·m (kgf·cm, ft·lbf) : Specified torque
M03268


Fuel Pressure Pulsation Damper
Fuel Inlet Pipe
Wiring Harness Clamp Bracket
◆ Gasket
Throttle Control Cable Bracket
Rear Water Bypass Joint
◆ Gasket
V-Bank Cover Bracket with Noise Filter
◆ Gasket
Accelerator Pedal Position Sensor Connector
VSV Connector for ACIS
Noise Filter Connector
Fuel Hose
Injector Connector
Intake Manifold Assembly
Water Bypass Hose
Throttle Position Sensor Connector
Throttle Control Motor Connector
ECT Sensor Connector
◆ Gasket
ECT Sender Gauge Connector
VVT Sensor 1 Connector
Camshaft Timing Oil Control Valve Connector
V-Bank Cover Bracket
◆ O-Ring
VVT Sensor 1
VVT Sensor 2 Connector
Front Water Bypass Joint
V-Bank Cover Bracket
VVT Sensor 2
◆ Gasket
Ignition Coil Connector
RH No.2 Timing Belt Rear Plate
Ignition Coil
LH No.2 Timing Belt Rear Plate
LH No.1 Timing Belt Rear Plate
RH No.1 Timing Belt Rear Plate
◆ Non-reusable part
M04820


RH Cylinder Head Cover
LH Cylinder Head Cover
RH Camshaft Timing Oil Control Valve
LH Camshaft Timing Oil Control Valve
Spark Plug
◆Spark Plug Tube Gasket
◆ O-Ring
◆ O-Ring
16 (160, 12)
Gasket
Bearing Cap
Bearing Cap
Gasket
Camshaft Drive Gear
7.5 (80, 66 in.·lbf)
16 (160, 12)
◆ Camshaft Oil Seal
Camshaft Drive Gear
◆Camshaft Oil Seal
Oil Feed Pipe
Camshaft Timing Tube
78 (790, 58)
Camshaft Timing Tube
Bearing Cap
RH Intake Camshaft
LH Intake Camshaft
Camshaft Gear Spring
Camshaft Sub Gear
Snap Ring
Camshaft Sub Gear
Wave Washer
Snap Ring
RH Exhaust Camshaft
LH Exhaust Camshaft
Wave Washer
Semi-Circular Plug
Camshaft Timing Oil Control Valve Filter
Engine Hanger
Camshaft Timing Oil Control Valve Filter
Camshaft Gear Spring
Camshaft Housing Plug
Camshaft Housing Plug
Ground Cable
Semi-Circular Plug
RH Cylinder Head
1st 39 (400, 29)
2nd Turn 90°
LH Cylinder Head
◆Gasket
◆Gasket
◆ RH Cylinder Head Gasket
◆×8
◆×8
44 (450, 32)
LH Exhaust Manifold
RH Exhaust Manifold
◆ LH Cylinder Head Gasket
Oil Dipstick and Guide for Engine
N·m (kgf·cm, ft·lbf) : Specified torque
◆ Non-reusable part
M04263



N·m (kgf·cm, ft·lbf) : Specified Torque

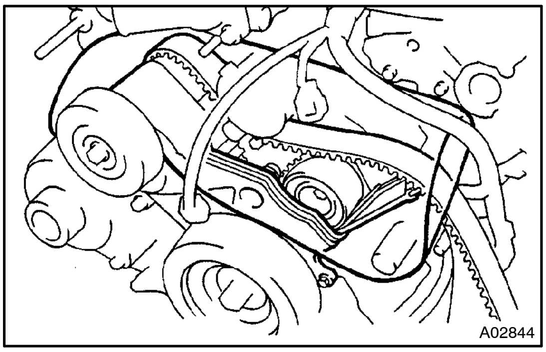
◆ Non-reusable part

M04264

EM0G0-01

REMOVAL

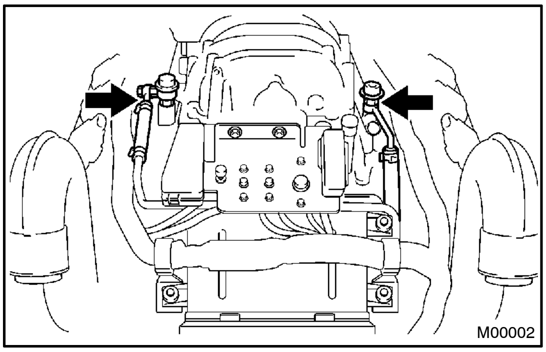
1. **DISCONNECT TIMING BELT FROM CAMSHAFT TIMING PULLEYS**
   (See page EM-12)
2. **REMOVE CAMSHAFT TIMING PULLEYS**
   (See page EM-12)
3. **REMOVE CAMSHAFT POSITION SENSOR**
   (See page IG-9)
4. **REMOVE IGNITION COILS**
   (See page IG-6)


A02844

5. **REMOVE TIMING BELT REAR PLATES**

(a) Remove the 3 bolts, stud bolt, and RH No.1 and No.2 timing belt rear plates.
(b) Disconnect the wire clamp from the LH timing belt rear plate.
(c) Remove the 3 bolts, LH No.1 and No.2 timing belt rear plates.

NOTICE:
- **Be careful not to drop anything inside the timing belt cover.**
- **Do not allow the belt to come into contact with oil, water or dust.**


M00002

6. **DISCONNECT FUEL INLET PIPE AND HOSE**

(a) Remove the fuel pressure pulsation damper, then remove the fuel inlet pipe.
(b) Disconnect the No. 4 fuel hose.

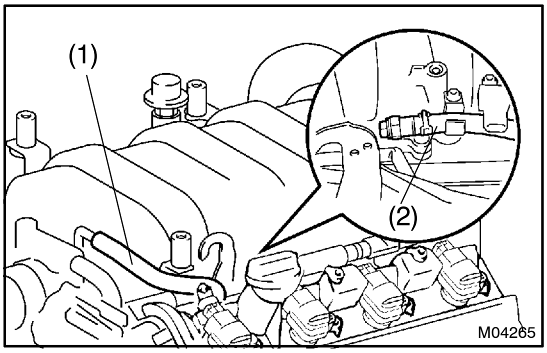
7. **DISCONNECT THROTTLE CABLE**
8. **REMOVE V-BANK COVER BRACKETS**

(a) Remove the nut and LH front V-bank cover bracket from the engine hanger.
(b) Remove the bolt, nut and throttle control cable bracket from the intake manifold.
(c) Remove the bolt and LH rear V-bank cover bracket from the intake manifold.
(d) Remove the nut and RH rear V-bank cover bracket from the engine hanger.

9. REMOVE INTAKE MANIFOLD ASSEMBLY

(a) Disconnect these connectors:

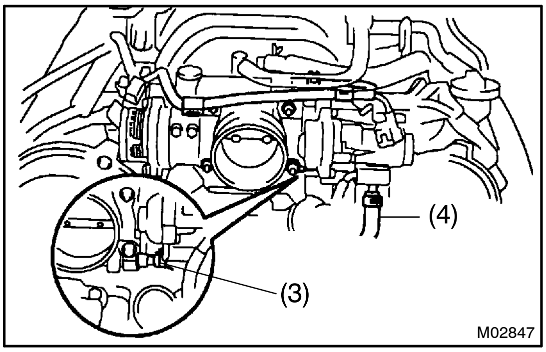
- Throttle position sensor connector
- Accelerator pedal position sensor connector
- Throttle control motor connector
- VSV connector for ACIS
- 8 injector connectors
- Noise filter connector
- Camshaft timing oil control valve connector



(b) Disconnect these hoses:

(1) PCV hose from PCV valve on LH cylinder head

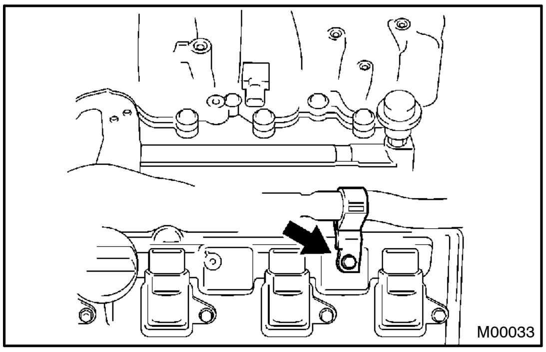
(2) Oil drain hose (from intake manifold)



(3) No.1 water bypass hose (from front water bypass joint) from throttle body

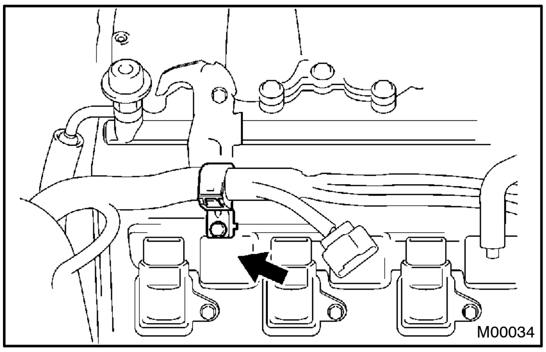
(4) No.7 water bypass hose (from water inlet housing) from throttle body

(c) Disconnect the 2 wire clamp from the throttle body.

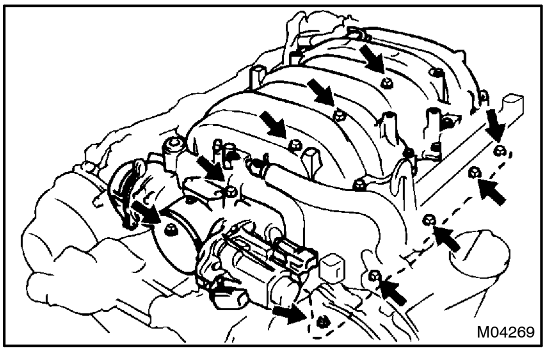


(d) Disconnect the engine wire.

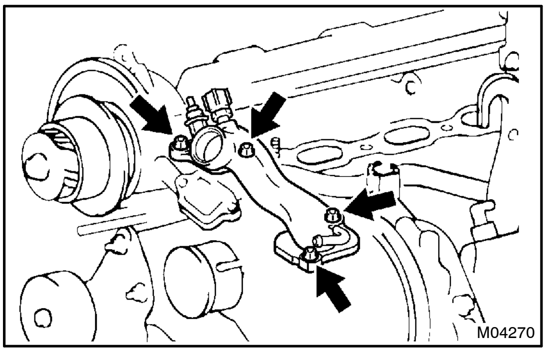
(1) Remove the bolt and wire clamp bracket from the LH cylinder head cover.



(2) Remove the bolt and wire clamp bracket from the RH cylinder head cover.



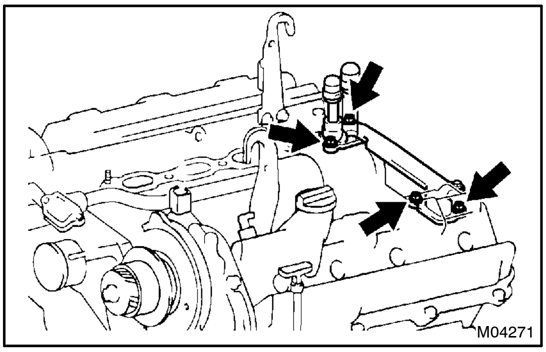
(e) Remove the 6 bolts, 4 nuts, intake manifold assembly and 2 gaskets.



10. REMOVE FRONT WATER BYPASS JOINT

(a) Disconnect these connectors:
- ECT sensor connector
- ECT sender gauge connector

(b) Remove the 4 nuts, water bypass joint and 2 gaskets.



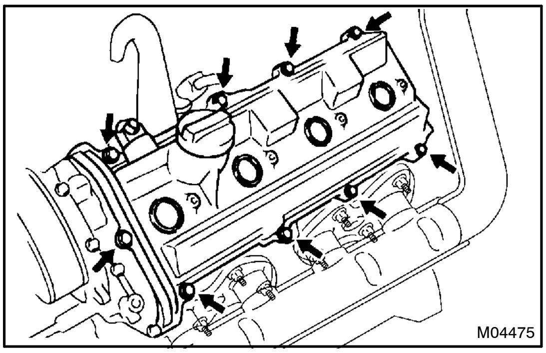
11. REMOVE REAR WATER BYPASS JOINT

Remove the 4 nuts, water bypass joint and 2 gaskets.

12. REMOVE VVT SENSORS

13. REMOVE ENGINE HANGERS

14. REMOVE OIL DIPSTICK AND GUIDE FOR ENGINE (See page LU-8)

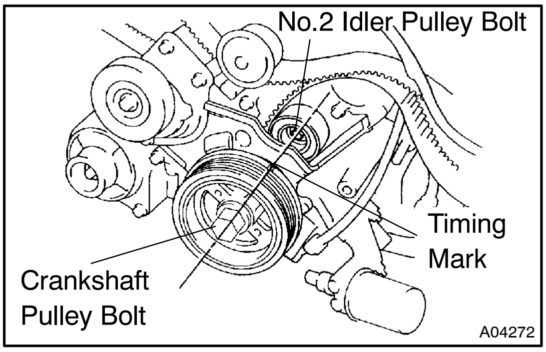


15. REMOVE CYLINDER HEAD COVERS

Remove the 9 bolts, 9 seal washers, cylinder head cover and gasket. Remove the 2 cylinder head covers.

16. IF NECESSARY, REMOVE SEMI-CIRCULAR PLUGS

17. REMOVE CAMSHAFT TIMING OIL CONTROL VALVE (See page SF-45)



18. REMOVE CAMSHAFTS

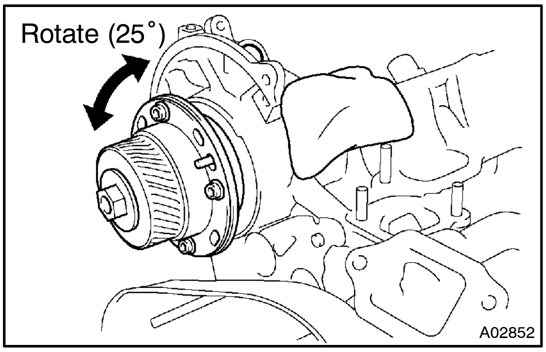
NOTICE:

Since the thrust clearance of the camshaft is small, the camshaft must be kept level while it is being removed. If the camshaft is not kept level, the portion of the cylinder head receiving the shaft thrust may crack or be damaged, causing the camshaft to seize or break. To avoid this, the following steps should be carried out.

(a) Check the crankshaft pulley position.
Check that the timing mark of the crankshaft pulley is in aligned with the centers of the crankshaft pulley bolt and idler pulley bolt.

NOTICE:

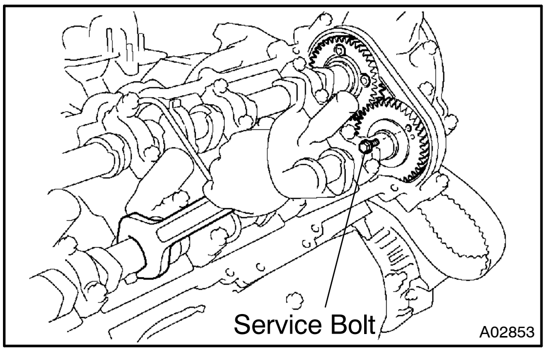
Having the crankshaft pulley at the wrong angle can cause the piston head and valve head to come into contact with each other when you remove the camshaft, causing damage. So always set the crankshaft pulley at the correct angle.



(b) Rotate the VVT–i pulley from left to right 2 to 3 times within its range of movement (25° <50° CA>) and use a waste cloth to collect the oil from the camshaft timing oil control valve installation hole.

NOTICE:

Approximately 20 cc (1.2 cu in.) of oil will be ejected, so take care not to spill it.



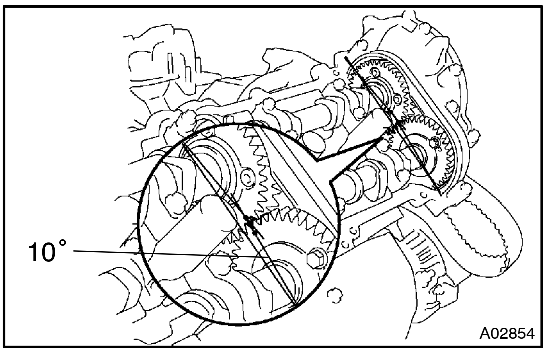
(c) Remove the RH camshafts.
(1) Boring the service bolt hole of the sub–gear upward by turning the hexagon wrench head portion of the exhaust camshaft with a wrench.
(2) Secure the sub–gear to the main gear with a service bolt.

Recommended service bolt:

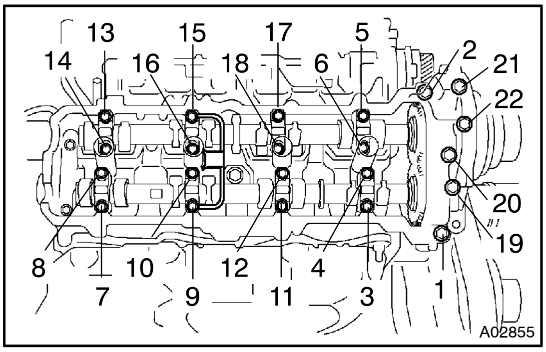
Thread diameter	6 mm
Thread pitch	1.0 mm
Bolt length	16 – 20 mm

HINT:

When removing the camshafts, make sure that the torsional spring force of the sub–gear has been eliminated by the above operation.

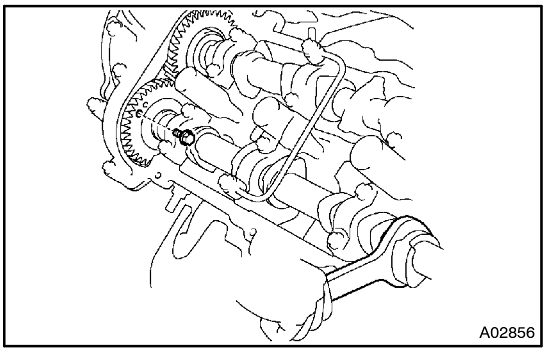


(3) Set the timing mark (1 dot mark) of the camshaft main gear at approx. 10° angle by turning the hexagon wrench head portion of the exhaust camshaft with a wrench.



(4) Uniformly loosen and remove the 22 bearing cap bolts in several passes, in the sequence shown.

(5) Remove the oil feed pipe, 9 bearing caps, cam shaft timing oil control valve filter and camshafts.



(d) Remove the LH camshafts.

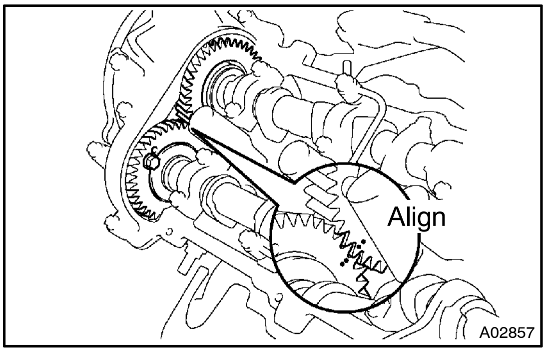
(1) Boring the service bolt hole of the sub–gear upward by turning the hexagon wrench head portion of the exhaust camshaft with a wrench.

(2) Secure the sub–gear to the main gear with a service bolt.

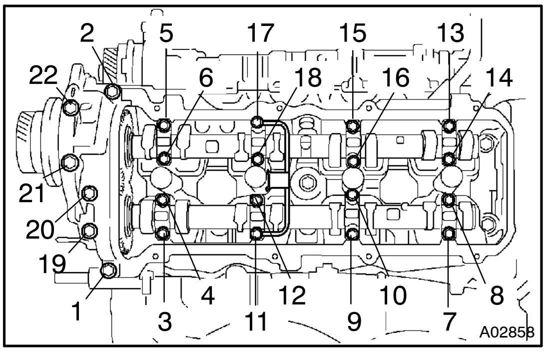
Recommended service bolt:

Thread diameter	6 mm
Thread pitch	1.0 mm
Bolt length	16 – 20 mm

HINT:
When removing the camshaft, make sure that the torsional spring force of the sub–gear has been eliminated by the above operation.



(3) Align the timing mark (2 dot marks) of the camshaft drive gear by turning the hexagon wrench head portion of the exhaust camshaft with a wrench.

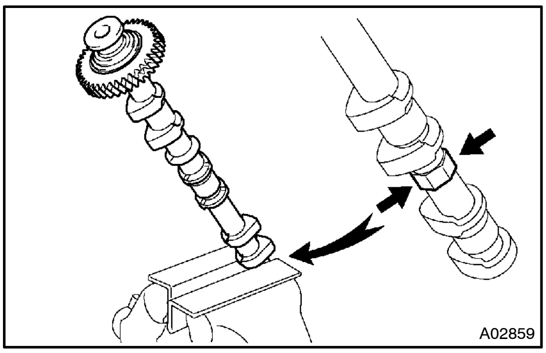


(4) Uniformly loosen and remove the 22 bearing cap bolts in several passes, in the sequence shown.

(5) Remove the oil feed pipe, 9 bearing caps, cam shaft timing oil control valve filter and camshafts.

HINT:
Arrange the bearing caps in correct order.

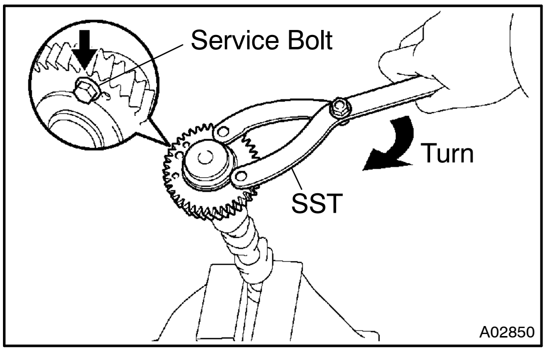
19. IF NECESSARY REMOVE CAMSHAFT HOUSING PLUGS



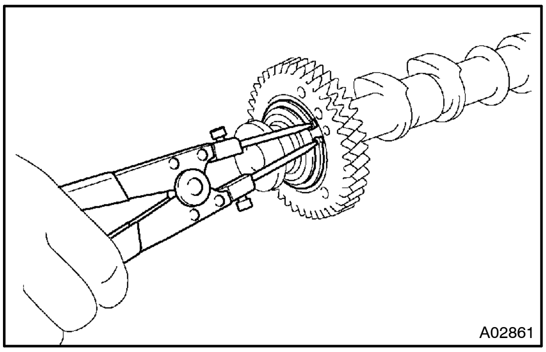
20. DISASSEMBLE EXHAUST CAMSHAFTS

(a) Mount the hexagon wrench head portion of the camshaft in a vise.

NOTICE:
Be careful not to damage the camshaft.

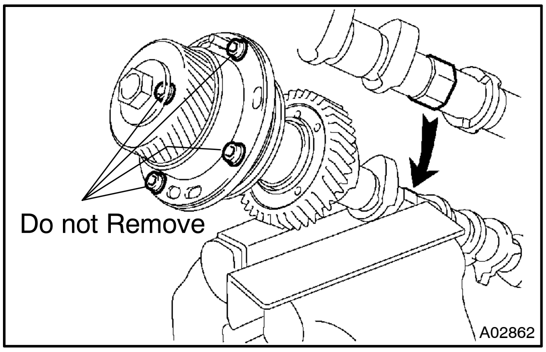


(b) Using SST, turn the sub-gear clockwise, and remove the service bolt.
SST 09960-10010 (09962-01000, 09963-00500)



(c) Using snap ring pliers, remove the snap ring.
(d) Remove these parts:
- Wave washer
- Camshaft sub-gear
- Camshaft gear spring

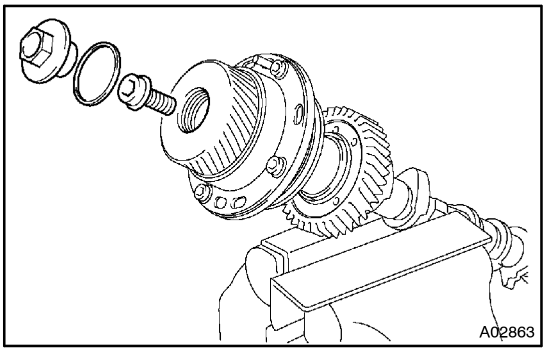
HINT:
Arrange the camshaft sub-gears and gear spring (RH and LH sides).



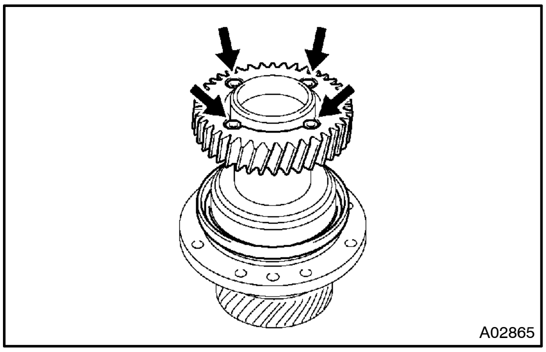
21. REMOVE CAM SHAFT TIMING TUBES

(a) Mount the hexagon wrench head portion of the intake camshaft in a vise.

NOTICE:
- **Be careful not to damage the camshaft.**
- **The 4 bolts shown in the illust ration determine the backlash of the gear in the timing tube, so do not remove them. If any of the 4 bolts are removed, install a new camshaft timing tube assembly.**

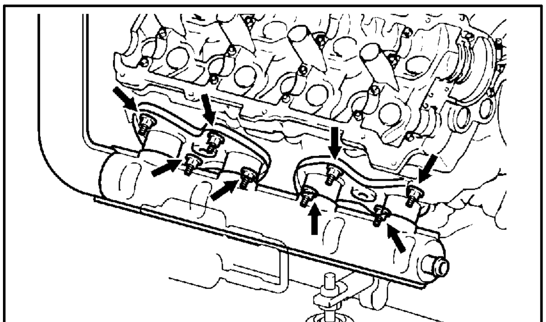


(b) Remove the straight screw plug and seal washer.
(c) Using a 10 mm hexagon wrench, and remove the set bolt and camshaft timing tube.



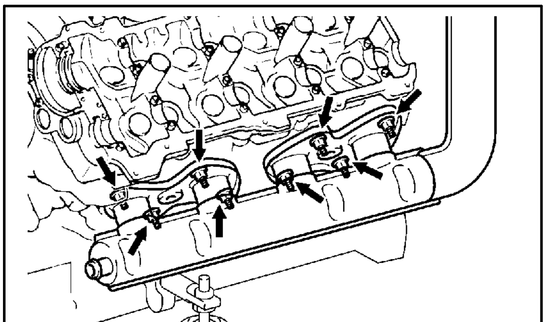
(d) Using a 5 mm hexagon wrench, and remove the 4 bolts, camshaft drive gear and oil seal.

NOTICE:
Be careful not to damage the camshaft timing tube.


M04275

22. REMOVE RH EXHAUST MANIFOLD FROM CYLINDER HEAD

Remove the 8 nuts, exhaust manifold and gasket.


M04276

23. REMOVE LH EXHAUST MANIFOLD FROM CYLINDER HEAD

Remove the 8 nuts, exhaust manifold and gasket.

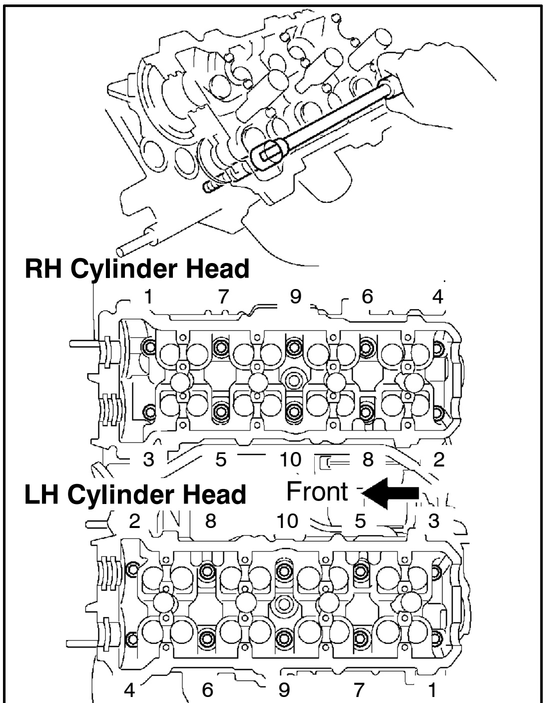
24. REMOVE OIL COOLER FOR TRANSMISSION
(See page EM–69)

25. REMOVE SPARK PLUGS


M02868

26. REMOVE CYLINDER HEAD

(a) Remove the bolt, and disconnect the ground cable from the LH cylinder head.

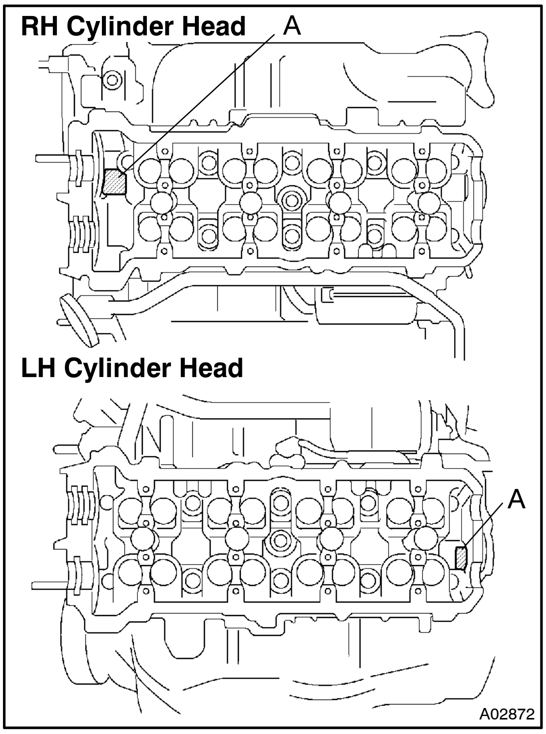


A02869

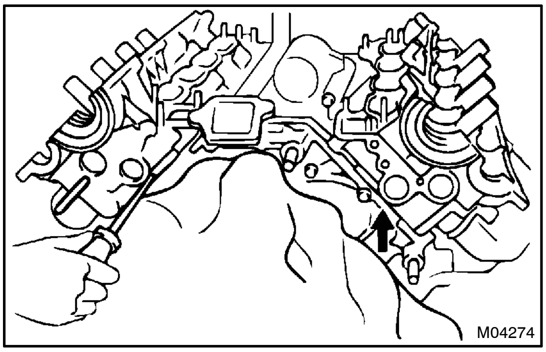
(b) Uniformly loosen the 10 cylinder head bolts on one side of each cylinder head in several passes, in the sequence shown, then do the other side as shown. Remove the 20 cylinder head bolts and plate washers.

NOTICE:

- **Cylinder head warpage or cracking could result from removing bolts in incorrect order.**



- **Do not drop the plate washer for cylinder head bolt into portion A of the cylinder head. If dropped into portion A, the plate washer will pass through the cylinder head and cylinder block into the oil pan.**



(c) Lift the cylinder head from the dowels on the cylinder block, and place the 2 cylinder heads on wooden blocks on a bench.

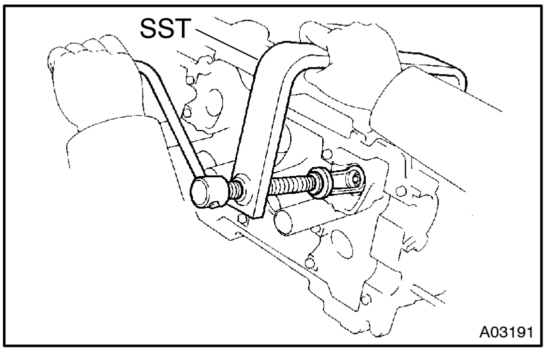
HINT:

If the cylinder head is lift off, pry between the cylinder head and cylinder block with a screwdriver.

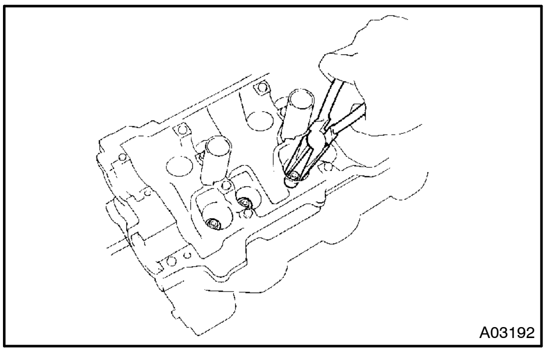
NOTICE:

- **Be careful not to damage the contact surfaces of the cylinder head and cylinder block.**
- **The cylinder head should not be tilted so as to secure the valve lifter. If the cylinder head is tilted, remove the valve lifter and check that the adjusting shim is set correctly.**

EM0G1-01



A03191


A03192

DISASSEMBLY

1. REMOVE VALVE LIFTERS AND SHIMS

HINT:

Arrange the valve lifters and shims in correct order.

2. REMOVE VALVES

(a) Using SST, compress the valve spring and remove the 2 keepers.
SST 09202-70020

(b) Remove these parts:
- Spring retainer
- Valve spring
- Valve
- Spring seat

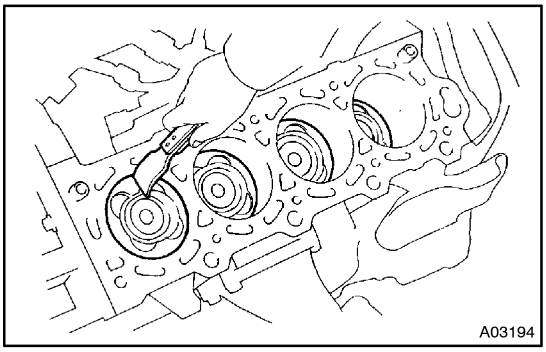
HINT:

Arrange the valves, valve springs, spring seats and spring retainers incorrect order.

(c) Using needle-nose pliers, remove the oil seal.

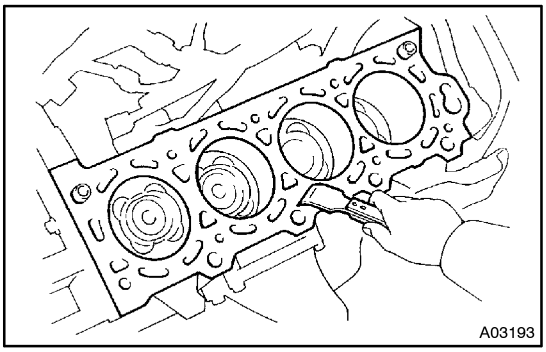
EM0G2–01

INSPECTION



1. CLEAN TOP SURFACES OF PISTONS AND CYLINDER BLOCK

(a) Turn the crankshaft, and bring each piston to top dead center (TDC). Using a gasket scraper, remove all the carbon from the piston top surface.

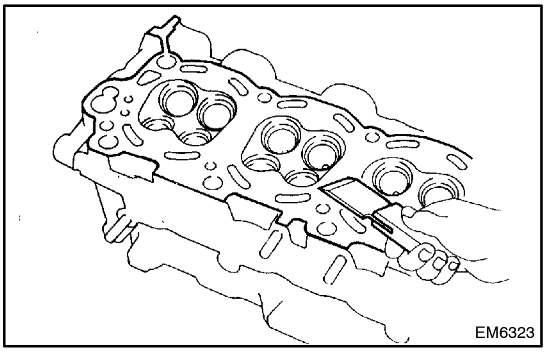


(b) Using a gasket scraper, remove all the gasket material from the cylinder block surface.

(c) Using compressed air, blow carbon and oil from the bolt holes.

CAUTION:

Protect your eyes when using high pressure compressed air.

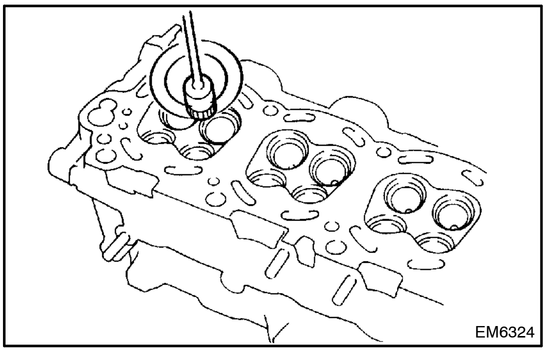


2. REMOVE GASKET MATERIAL

Using a gasket scraper, remove all the gasket material from the cylinder block contact surface.

NOTICE:

Be careful not to scratch the cylinder block contact surface.

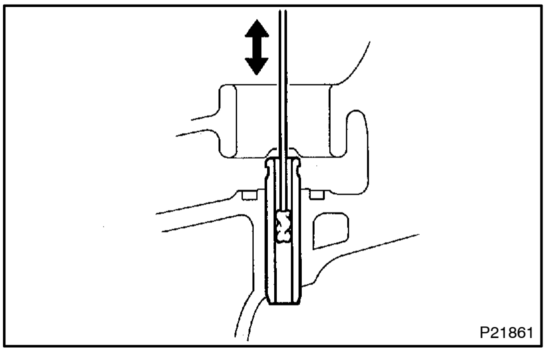


3. CLEAN COMBUSTION CHAMBERS

Using a wire brush, remove all the carbon from the combustion chambers.

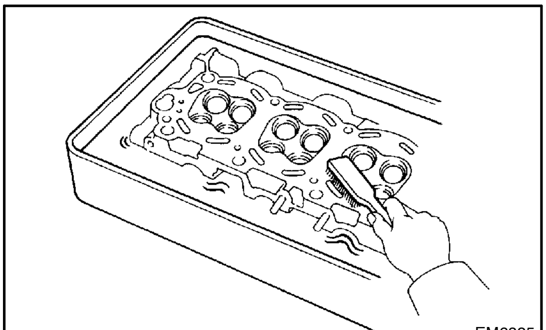
NOTICE:

Be careful not to scratch the cylinder block contact surface.



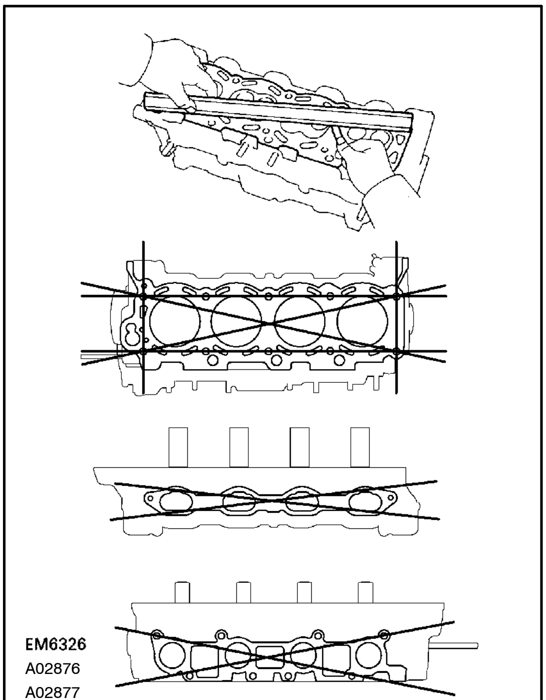
4. CLEAN VALVE GUIDE BUSHINGS

Using a valve guide bushing brush and solvent, clean all the guide bushings.


EM6325

5. CLEAN CYLINDER HEAD

Using a soft brush and solvent, thoroughly clean the cylinder head.

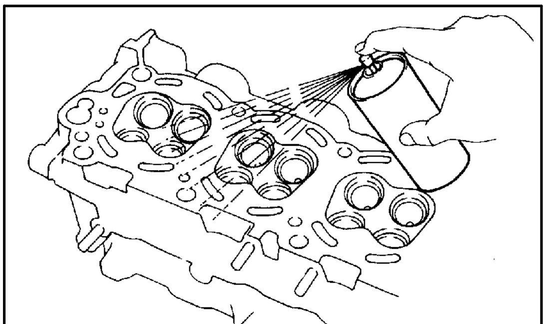

EM6326
A02876
A02877
A02878
A02879

6. INSPECT FOR FLATNESS

Using a precision straight edge and feeler gauge, measure the surfaces contacting the cylinder block and the manifolds for warpage.

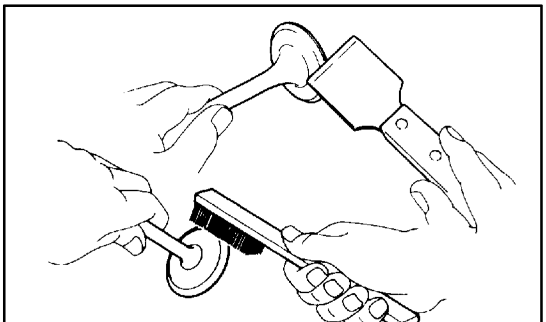
Maximum warpage:
0.10 mm (0.0039 in.)

If warpage is greater than maximum, replace the cylinder head.


EM6327

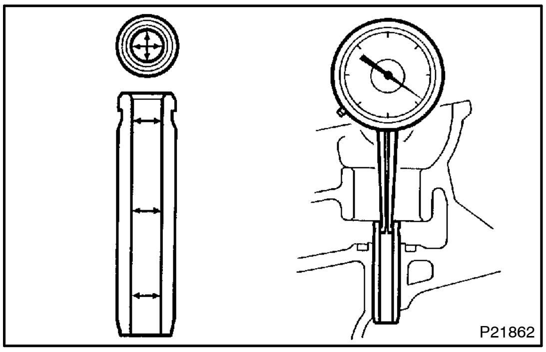
7. INSPECT FOR CRACKS

Using a dye penetrant, check the combustion chamber, intake ports, exhaust ports and cylinder block surface for cracks.
If cracked, replace the cylinder head.


EM0580

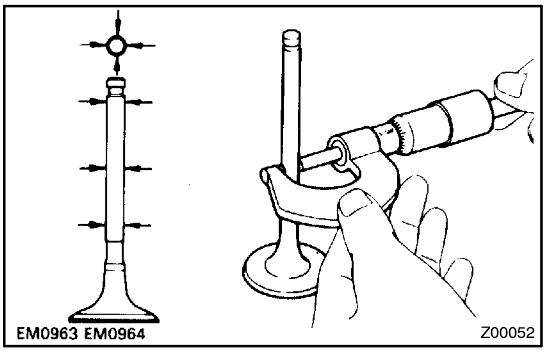
8. CLEAN VALVES

(a) Using a gasket scraper, chip off any carbon from the valve head.
(b) Using a wire brush, thoroughly clean the valve.



9. INSPECT VALVE STEMS AND GUIDE BUSHINGS

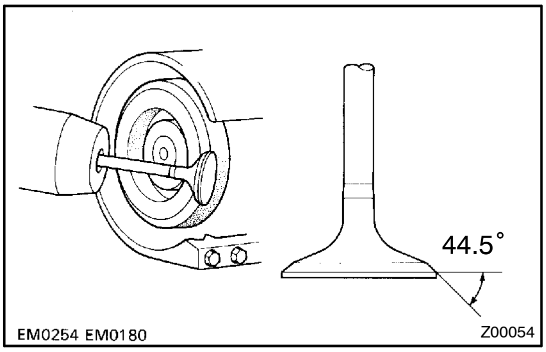
(a) Using a caliper gauge, measure the inside diameter of the guide bushing.
Bushing inside diameter:
5.510 - 5.530 mm (0.2169 - 0.2177 in.)



(b) Using a micrometer, measure the diameter of the valve stem.
Valve stem diameter:
Intake
5.470 - 5.485 mm (0.2154 - 0.2159 in.)
Exhaust
5.465 - 5.480 mm (0.2152 - 0.2157 in.)

(c) Subtract the valve stem diameter measurement from the guide bushing inside diameter measurement.
Standard oil clearance:
Intake
0.025 - 0.060 mm (0.0010 - 0.0024 in.)
Exhaust
0.030 - 0.065 mm (0.0012 - 0.0026 in.)
Maximum oil clearance:
Intake
0.08 mm (0.0031 in.)
Exhaust
0.10 mm (0.0039 in.)

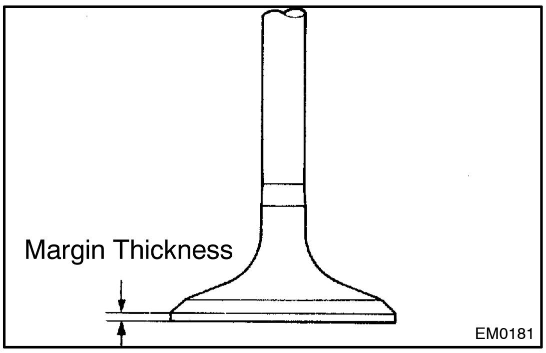
If the clearance is greater than maximum, replace the valve and guide bushing. (See Page EM-50)



10. INSPECT AND GRIND VALVES

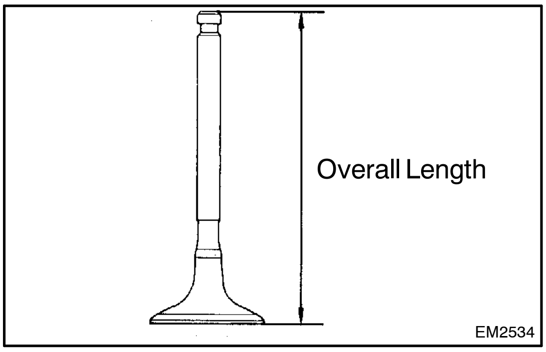
(a) Grind the valve enough to remove pits and carbon.

(b) Check that the valve is ground to the correct valve face angle.
Valve face angle:
44.5°

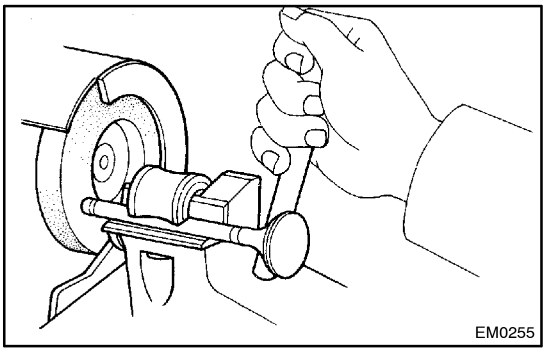


(c) Check the valve head margin thickness.
Standard margin thickness:
1.0 mm (0.039 in.)
Minimum margin thickness:
0.5 mm (0.020 in.)

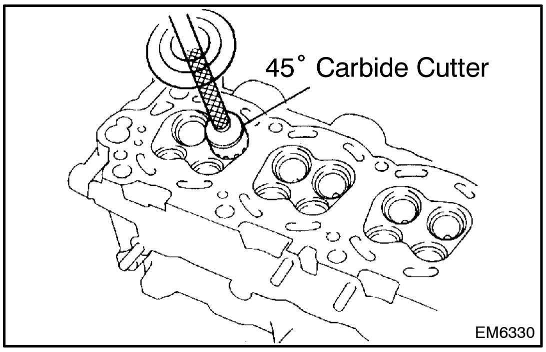
If the margin thickness is less than minimum, replace the valve.



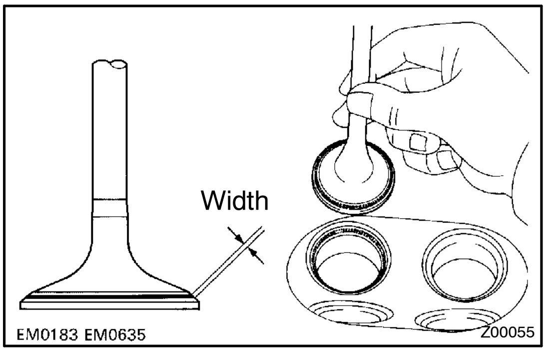
(d) Check the valve overall length.
Standard overall length:
Intake: 94.80 – 95.30 mm (3.7323 – 3.7520 in.)
Exhaust: 94.85 – 95.35 mm (3.7342 – 3.7539 in.)
Minimum overall length:
Intake: 94.55 mm (3.7224 in.)
Exhaust: 94.60 mm (3.7244 in.)
If the overall length is less than minimum, replace the valve.



(e) Check the surface of the valve stem tip for wear.
If the valve stem tip is worn, resurface the tip with a grinder or replace the valve.
NOTICE:
Do not grind off more than minimum.

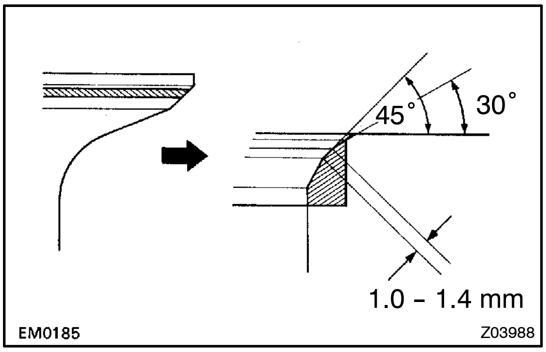


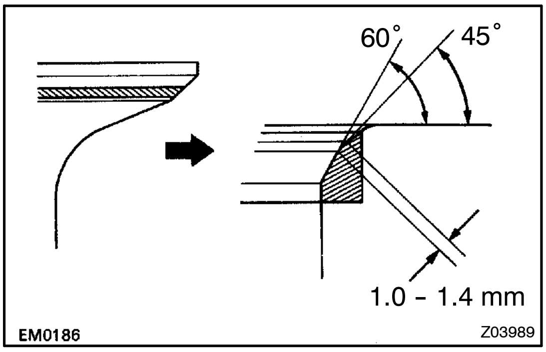
11. INSPECT AND CLEAN VALVE SEATS
(a) Using a 45° carbide cutter, resurface the valve seats. Remove only enough metal to clean the seats.



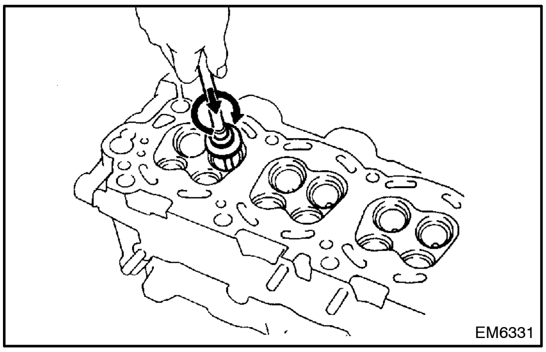
(b) Check the valve seating position.
Apply a light coat of prussian blue (or white lead) to the valve face. Lightly press the valve against the seat. Do not rotate valve.
(c) Check the valve face and seat for the following:
- If blue appears 360° around the face, the valve is concentric. If not, replace the valve.
- If blue appears 360° around the valve seat, the guide and face are concentric. If not, resurface the seat.
- Check that the seat contact is in the middle of the valve face with the following width:

1.0 – 1.4 mm (0.039 – 0.055 in.)
If not, correct the valve seats as follows:
- If the seating is too high on the valve face, use 30° and 45° cutters to correct the seat.

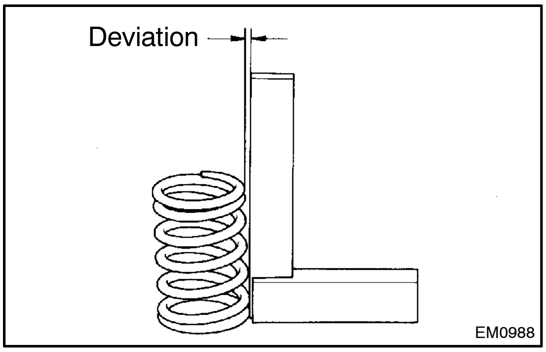




- If the seating is too low on the valve face, use 60° and 45° cutters to correct the seat.

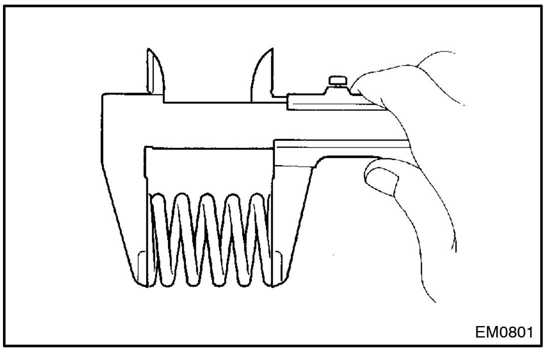


(d) Hand-lap the valve and valve seat with an abrasive compound.
(e) After hand-lapping, clean the valve and valve seat.

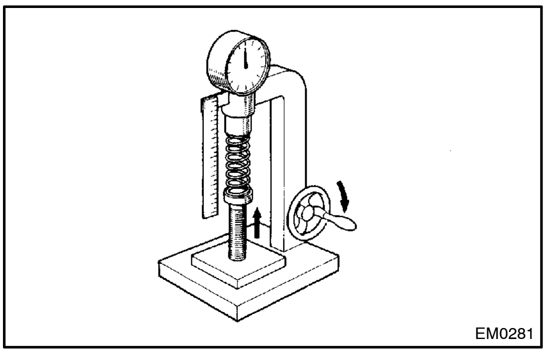


12. INSPECT VALVE SPRINGS

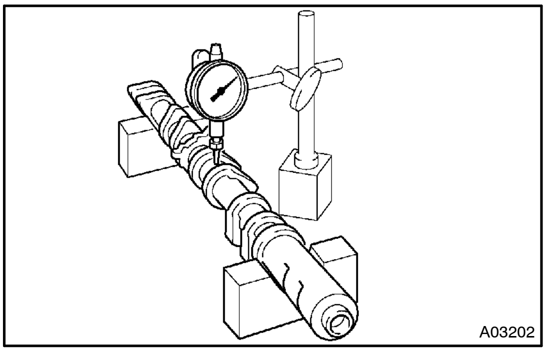
(a) Using a steel square, measure the deviation of the valve spring.
Maximum deviation:
2.0 mm (0.079 in.)
If the deviation is greater than maximum, replace the valve spring.



(b) Using vernier calipers, measure the free length of the valve spring.
Free length:
54.05 - 54.15 mm (2.1279 - 2.1319 in.)
If the free length is not as specified, replace the valve spring.



(c) Using a spring tester, measure the tension of the valve spring at the specified installed length.
Installed tension:
204 - 226 N (20.8 - 23.0 kgf, 45.9 - 50.7 lbf)
at 35.04 mm (1.3795 in.)
If the installed tension is not as specified, replace the valve spring.



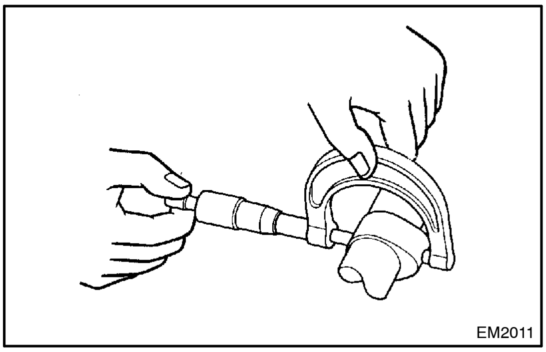
13. INSPECT CAMSHAFT FOR RUNOUT

(a) Place the camshaft on V–blocks.

(b) Using a dial indicator, measure the circle runout at the center journal.

Maximum circle runout:
0.08 mm (0.0031 in.)

If the circle runout is greater than maximum, replace the camshaft.

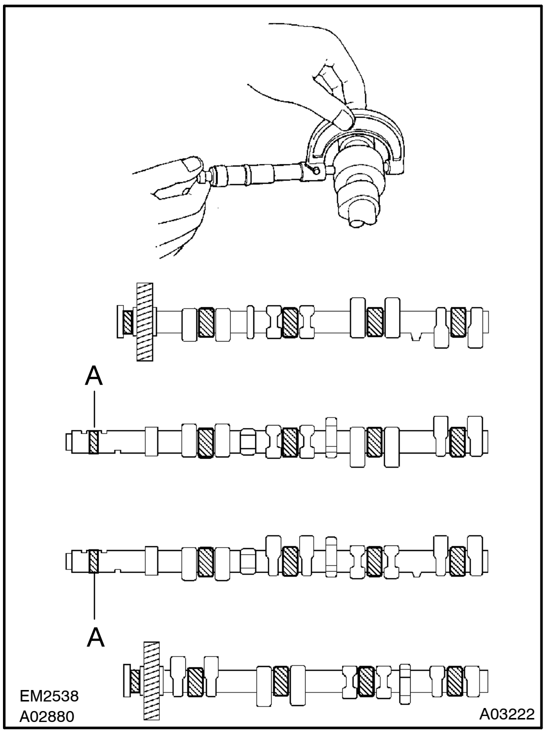


14. INSPECT CAM LOBES

Using a micrometer, measure the cam lobe height.

Standard cam lobe height:
Intake:
42.610 – 42.710 mm (1.6776 – 1.6815 in.)
Exhaust:
42.630 – 42.730 mm (1.6783 – 1.6823 in.)
Minimum cam lobe height:
Intake:
42.46 mm (1.6717 in.)
Exhaust:
42.48 mm (1.6724 in.)

If the cam lobe height is less than minimum, replace the camshaft.

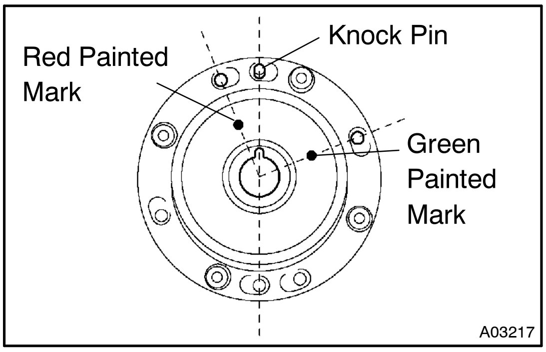


15. INSPECT CAMSHAFT JOURNALS

Using a micrometer, measure the journal diameter.

Journal diameter:
Intake camshaft (A)
30.984 – 31.000 mm (1.2198 – 1.2205 in.)
Others
26.954 – 26.970 mm (1.0612 – 1.0618 in.)

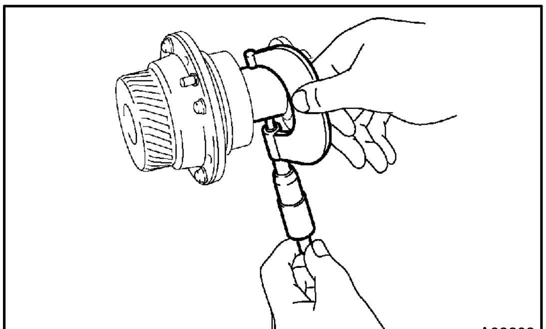
If the journal diameter is not as specified, check the oil clearance.



A03217

16. INSPECT CAMSHAFT TIMING TUBE JOURNALS

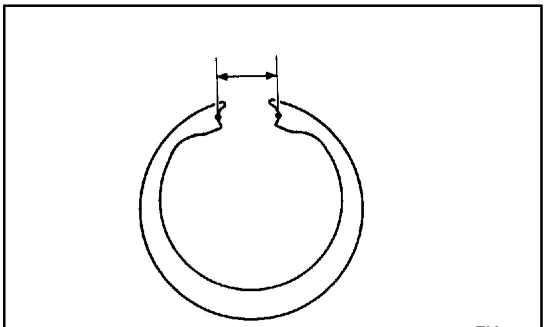
HINT:
There are 2 size of the camshaft timing tube journal diameter, green and red painted mark accordingly. The mark is painted on the face of the camshaft timing tube.


A03203

Using a micrometer, measure the journal diameter.

Journal diameter:
Green painted mark
39.958 – 39.964 mm (1.5731 – 1.5734 in.)
Red painted mark
39.964 – 39.970 mm (1.5734 – 1.5736 in.)

If the journal diameter is not as specified, check the oil clearance.


EM3322

17. INSPECT CAMSHAFT GEAR SPRING

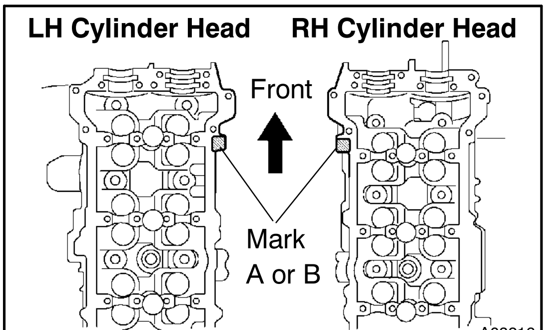
Using vernier calipers, measure the free distance between the spring ends.

Free distance:
18.2 – 18.8 mm (0.712 – 0.740 in.)

If the free distance is not as specified, replace the gear spring.

18. INSPECT CAMSHAFT BEARINGS

Check that bearings for flaking and scoring.
If the bearings are damaged, replace the bearing caps and cylinder head as a set.

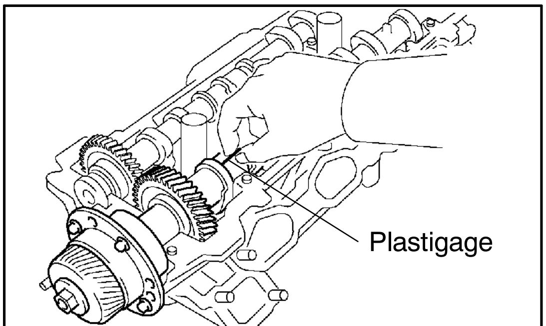


A03216

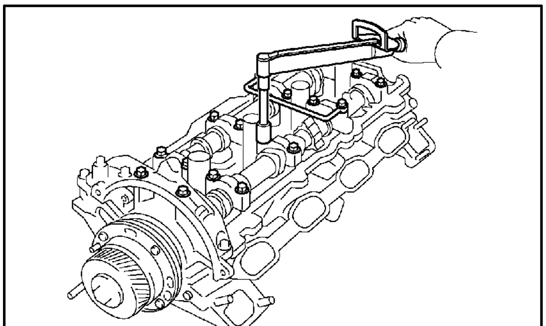
19. INSPECT CAMSHAFT TIMING TUBE AND CAMSHAFT JOURNAL OIL CLEARANCE

HINT:
There are 2 size of the camshaft timing tube journal oil clearance, Marked ”A” and ”B” accordingly. The mark is stamped on the top of the cylinder heads.

(a) Install the camshaft timing tube.
(See page EM–52)
(b) Clean the bearing caps and camshaft journals.
(c) Place the camshafts on the cylinder head.
(d) Lay a strip of Plastigage across each of the camshaft journals.



A03204

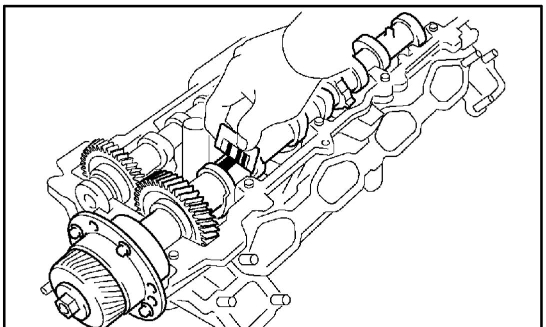


A03205

(e) Install the bearing caps.
(See page EM–52)
Torque: 16 N·m (160 kgf·cm, 12 ft·lbf)

NOTICE:
Do not turn the camshaft.

(f) Remove the bearing caps.



A03206

(g) Measure the Plastigage at its widest point.
Standard oil clearance:
Camshaft timing tube journal
Mark ”A”
0.036 – 0.050 mm (0.0014 – 0.0020 in.)
Mark ”B”
0.038 – 0.052 mm (0.0015 – 0.0021 in.)
Others
0.030 – 0.067 mm (0.0012 – 0.0026 in.)
Maximum oil clearance:
Camshaft timing tube journal
0.085 mm (0.0033 in.)
Others
0.10 mm (0.0039 in.)

If the oil clearance is greater than maximum, replace the camshaft. If necessary, replace the bearing caps and cylinder head as a set.

(h) Completely remove the Plastigage.
(i) Remove the camshafts.
(j) Remove the camshaft timing tube.

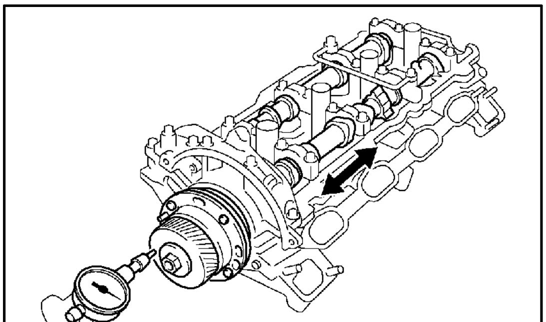
20. IF NECESSARY REPLACE CAMSHAFT TIMING TUBE

Select a camshaft timing tube according to mark on the cylinder head.

Cylinder Head	Camshaft timing tube
Mark ”A”	Green painted mark
Mark ”B”	Red painted mark

21. INSPECT CAMSHAFT THRUST CLEARANCE

(a) Install the camshaft timing tube.
(See page EM–52)
(b) Install the camshaft.
(See page EM–52)
(c) Using a dial indicator, measure the thrust clearance while moving the camshaft back and forth.
Standard thrust clearance:
Intake
0.060 – 0.100 mm (0.0024 – 0.0039 in.)
Exhaust
0.040 – 0.090 mm (0.0016 – 0.0035 in.)

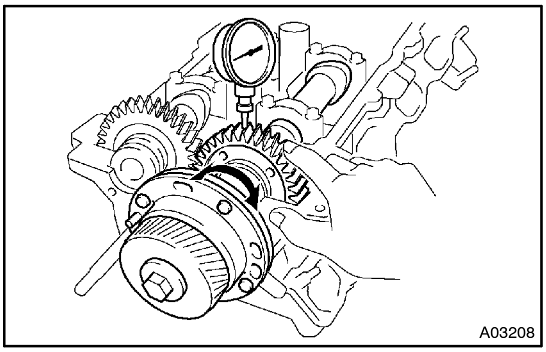


A03207

Maximum thrust clearance:
Intake: 0.13 mm (0.0051 in.)
Exhaust: 0.12 mm (0.0047 in.)

If the thrust clearance is greater than maximum, replace the camshaft. If necessary, replace the bearing caps and cylinder head as a set.

(d) Remove the camshafts.
(e) Remove the camshaft timing tube.

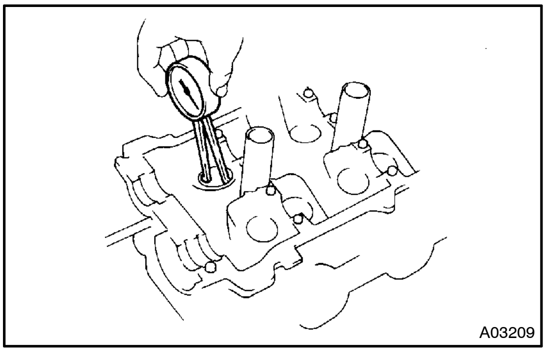


22. INSPECT CAMSHAFT GEAR BACKLASH

(a) Install the camshaft timing tube.
(See page EM–52)
(b) Install the camshafts without installing the exhaust cam sub–gear and front bearing cap.
(See page EM–52)
(c) Using a dial indicator, measure the backlash.
Standard backlash:
0.020 – 0.200 mm (0.0008 – 0.0079 in.)
Maximum backlash:
0.30 mm (0.0188 in.)

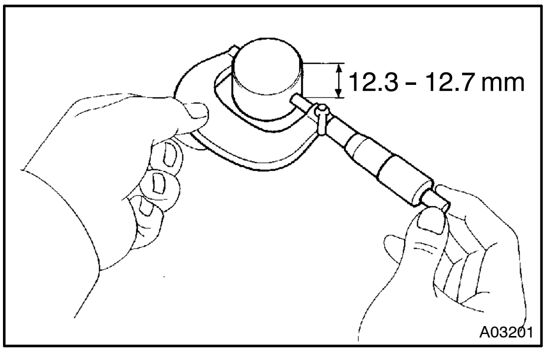
If the backlash is greater then maximum, replace the camshafts.

(d) Remove the camshafts.



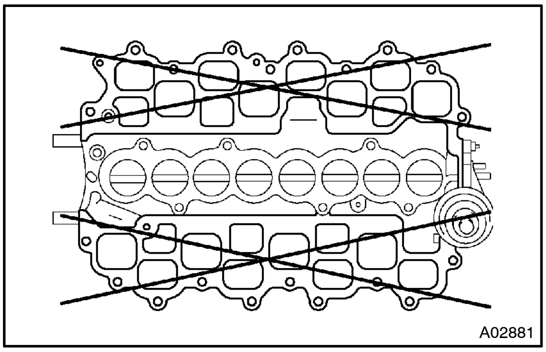
23. INSPECT VALVE LIFTERS AND LIFTER BORES

(a) Using a caliper gauge, measure the lifter bore diameter of the cylinder head.
Lifter bore diameter:
31.000 – 31.016 mm (1.2205 – 1.2211 in.)



(b) Using a micrometer, measure the lifter diameter at the valve lifter center line, 12.3 – 12.7 mm (0.484 – 0.500 in.) from the valve lifter head.
Lifter diameter:
30.966 – 30.976 mm (1.2191 – 1.2195 in.)
(c) Subtract the lifter diameter measurement from the lifter bore diameter measurement.
Standard oil clearance:
0.024 – 0.050 mm (0.0009 – 0.0020 in.)
Maximum oil clearance:
0.07 mm (0.0028 in.)

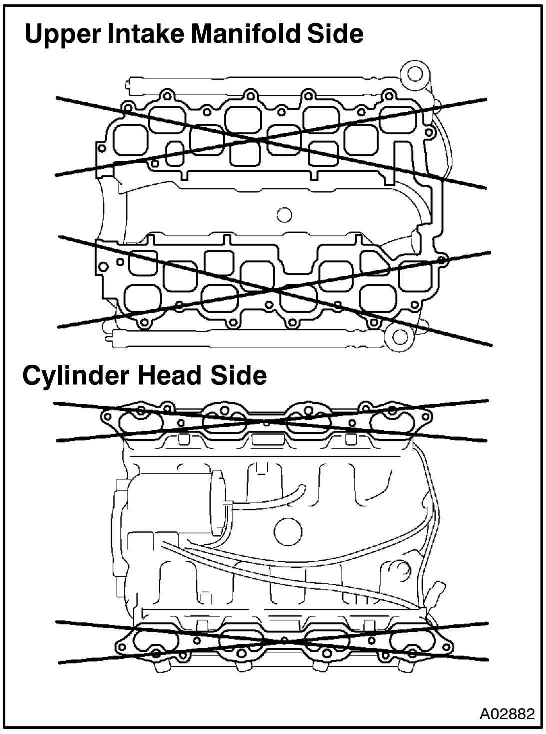
If the oil clearance is greater than maximum, replace the lifter. If necessary, replace the cylinder head.



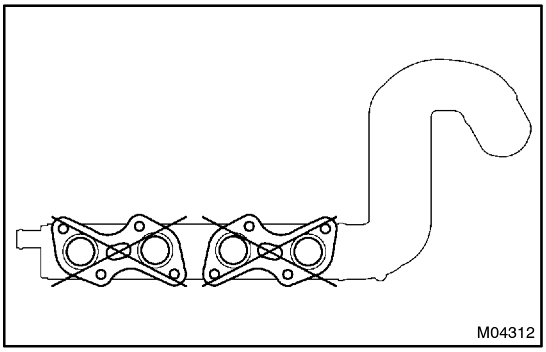
24. INSPECT INTAKE MANIFOLD

(a) Upper intake manifold:
Using a precision straight edge and feeler gauge, measure the surface contacting the lower intake manifold for warpage.
Maximum warpage: 0.15 mm (0.0059 in.)

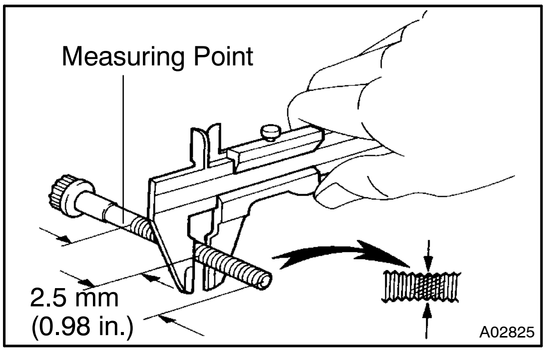
If warpage is greater than maximum, replace the upper intake manifold.



(b) Lower intake manifold:
Using a precision straight edge and feeler gauge, measure the surface contacting the cylinder head and upper intake manifold for warpage.
Maximum warpage:
0.15 mm (0.0059 in.)
If warpage is greater than maximum, replace the lower intake manifold.



25. INSPECT EXHAUST MANIFOLD
Using a precision straight edge and feeler gauge, measure the surface contacting the cylinder head for warpage.
Maximum warpage:
0.50 mm (0.0197 in.)
If warpage is greater than maximum, replace the manifold.

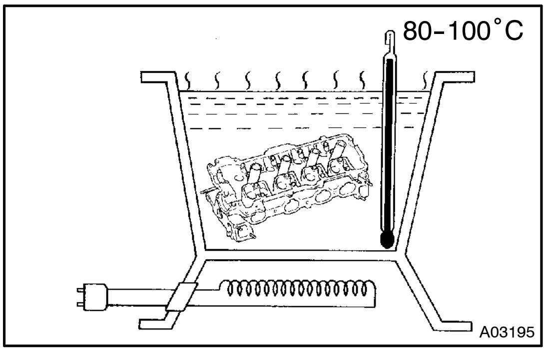


26. INSPECT CYLINDER HEAD BOLTS
Using vernier calipers, measure the thread outside diameter of the bolt.
Standard outside diameter:
9.770 – 9.960 mm (0.3846 – 0.3921 in.)
Minimum outside diameter:
9.60 mm (0.3780 in.)
If the diameter is less than minimum, replace the bolt.

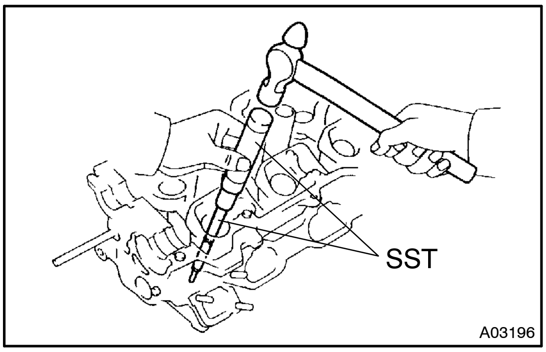
EM0G3-01

REPLACEMENT

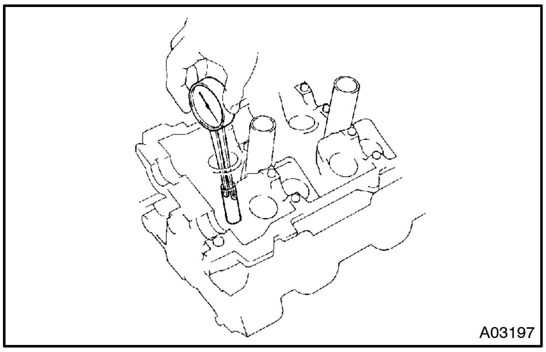
1. REPLACE VALVE GUIDE BUSHINGS



(a) Gradually heat the cylinder head to 80 - 100°C (176 - 212°F).



(b) Using SST and a hammer, tap out the guide bushing.
SST 09201-01055, 09950-70010 (09951-07100)



(c) Using a caliper gauge, measure the bushing bore diameter of the cylinder head.

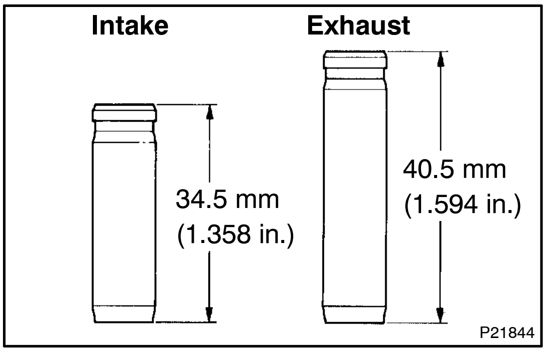
Both intake and exhaust

Bushing bore diameter mm (in.)	Bushing size
10.285 - 10.306 (0.4049 - 0.4057)	Use STD
10.335 - 10.356 (0.4069 - 0.4077)	Use O/S STD

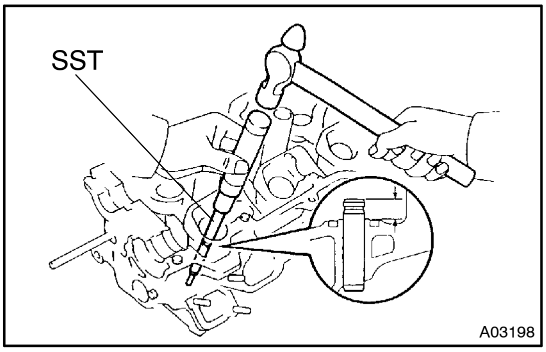
(d) Select a new guide bushing (STD or O/S 0.05).
If the bushing bore diameter of the cylinder head is greater than 10.306 mm (0.4057 in.), machine the bushing bore to the following dimension:

10.335 - 10.356 mm (0.4069 - 0.4077 in.)

If the bushing bore diameter of the cylinder head is greater than 10.356 mm (0.4077 in.), replace the cylinder head.



HINT:
Different the bushings are used for the intake and exhaust.



(e) Gradually heat the cylinder head to 80 – 100°C (176 – 212°F).

(f) Using SST and a hammer, tap in a new guide bushing to the specified protrusion height.

Protrusion height:

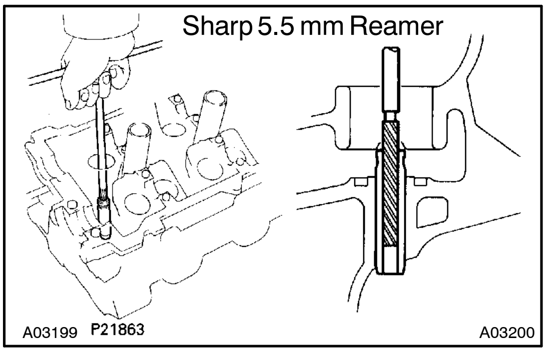
Intake

9.2 – 9.8 mm (0.362 – 0.386 in.)

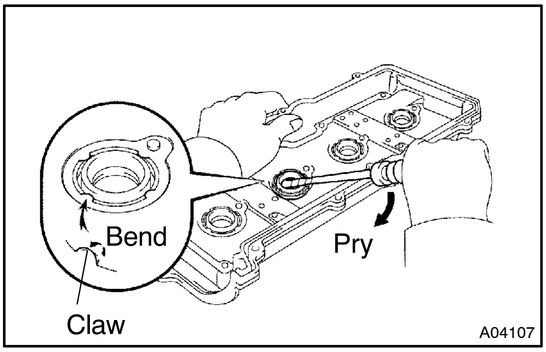
Exhaust

8.2 – 8.8 mm (0.323 – 0.346 in.)

SST 09201–01055, 09950–70010 (09951–07100)



(g) Using a sharp 5.5 mm reamer, ream the guide bushing to obtain the standard specified clearance (See page EM–40) between the guide bushing and valve stem.



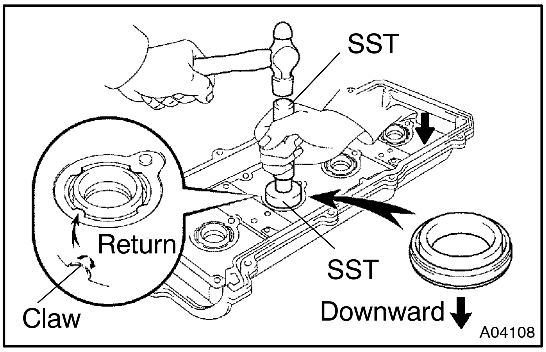
2. REPLACE SPARK PLUG TUBE GASKETS

(a) Bend the 4 ventilation case claws installed on the cylinder head cover to an angle of 90° or more.

(b) Using a screwdriver, pry out the gasket.

NOTICE:

Be careful not to damage the cylinder head cover. Tape the screwdriver tip.



(c) Using SST and a hammer, tap in a new gasket until its surface is flush with the upper edge of the cylinder head cover.

SST 09950–60010 (09551–00240, 09951–00440, 09952–06010), 09950–70010 (09951–07100)

NOTICE:

Be careful of the installation direction.

(d) Apply a light coat of MP grease to the gasket lip.

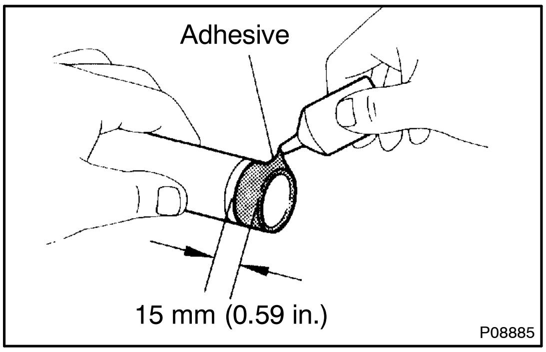
(e) Return the 4 ventilation case claws to its original position.

EM0G4-01

REASSEMBLY

HINT:

- Thoroughly clean all parts to be assembled.
- Before installing the parts, apply new engine oil to all sliding and rotating surfaces.
- Replace all gaskets and oil seals with new ones.

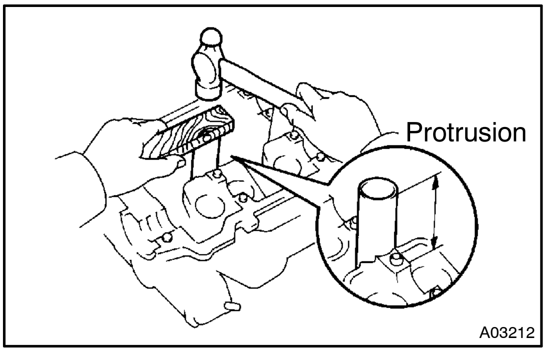


1. INSTALL SPARK PLUG TUBES

HINT:

When using a new cylinder head, spark plug tubes must be installed.

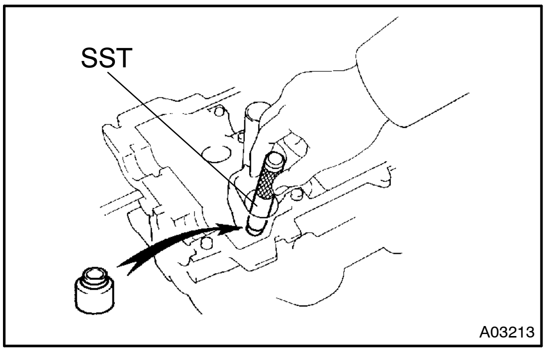
(a) Apply adhesive to the end of the spark plug tube.
Adhesive:
Part No. 08833-00070, THREE BOND 1324
or equivalent



(b) Using a wooden block and hammer, tap in a new spark tube until there is 48.4 - 49.6 mm (1.906 - 1.953 in.) protruding from the camshaft bearing cap installation surface of the cylinder head.

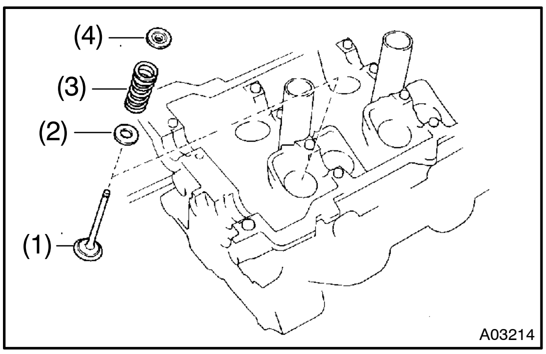
NOTICE:

Avoid tapping a new spark plug tube in too far by measuring the amount of the protrusion while tapping.

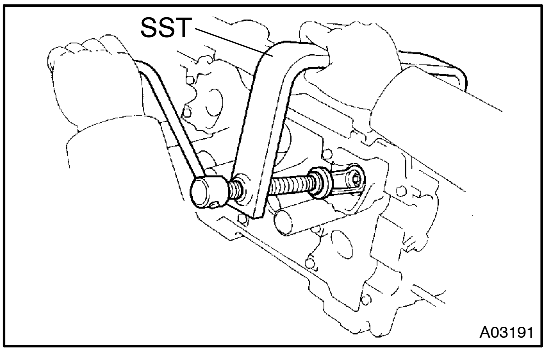


2. INSTALL VALVES

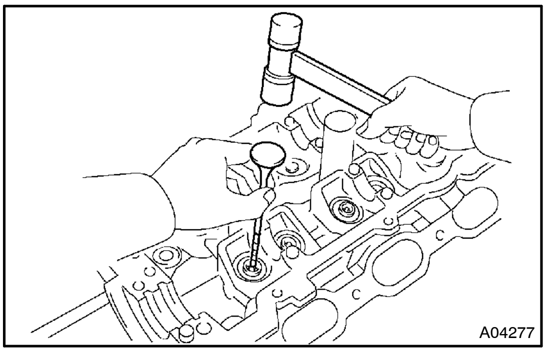
(a) Using SST, push in a new oil seal.
SST 09201-41020



(b) Install these parts:
(1) Valve
(2) Spring seat
(3) Valve spring
(4) Spring retainer



(c) Using SST, compress the valve spring and place the 2 keepers around the valve stem.
SST 09202-70020



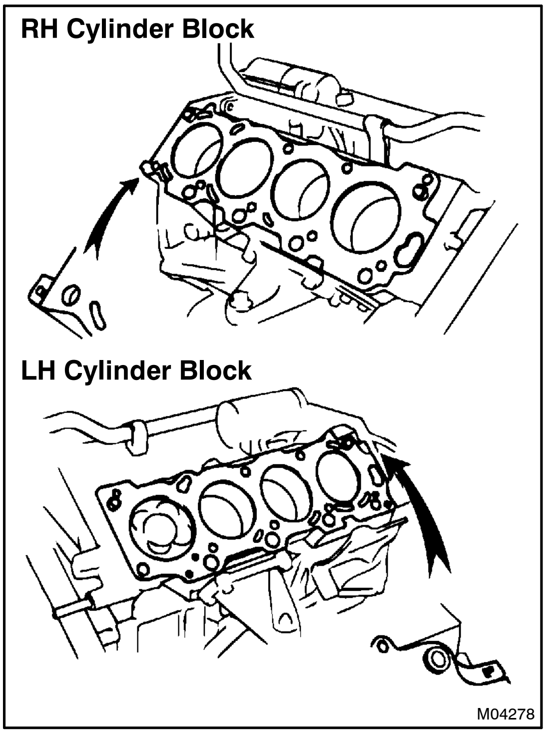
(d) Using a plastic-faced hammer and the valve stem (not in use) tip wound with vinyl tape, lightly tap the valve stem tip to assure proper fit.

NOTICE:
Be careful not to damage the valve stem tip.

3. INSTALL SHIMS AND VALVE LIFTERS

(a) Install the shim and valve lifter.
(b) Check that the valve lifter rotates smoothly by hand.

EM0G5–01



INSTALLATION

1. **PLACE CYLINDER HEAD ON CYLINDER BLOCK**

(a) Place 2 new cylinder head gaskets in position on the cylinder block.

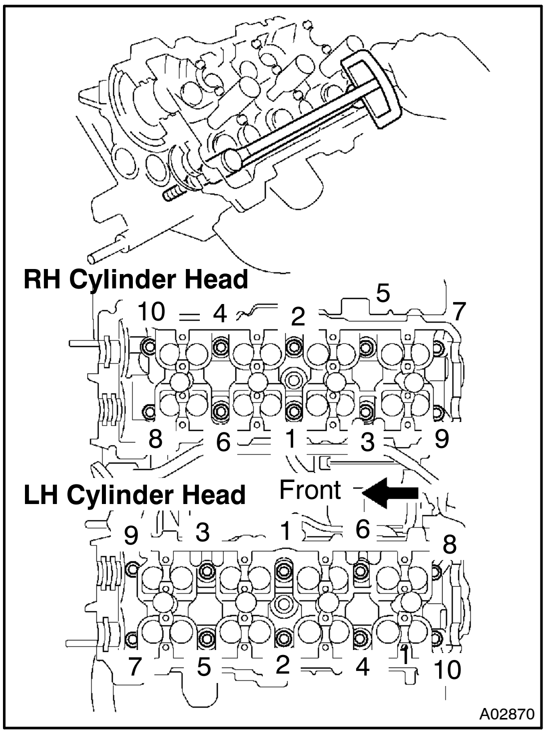
HINT:

On the rear side of the cylinder head gasket are marks to distinguish the LH and RH banks, a ”R” mark for the RH bank and a ”L” mark for the LH bank.

NOTICE:

Be careful of the installation direction.

(b) Place the 2 cylinder heads in position on the cylinder head gaskets.



2. **INSTALL CYLINDER HEAD BOLTS**

HINT:

- The cylinder head bolts are tightened in 2 progressive steps (steps (c) and (e)).
- If any cylinder head bolt is broken or deformed, replace it.

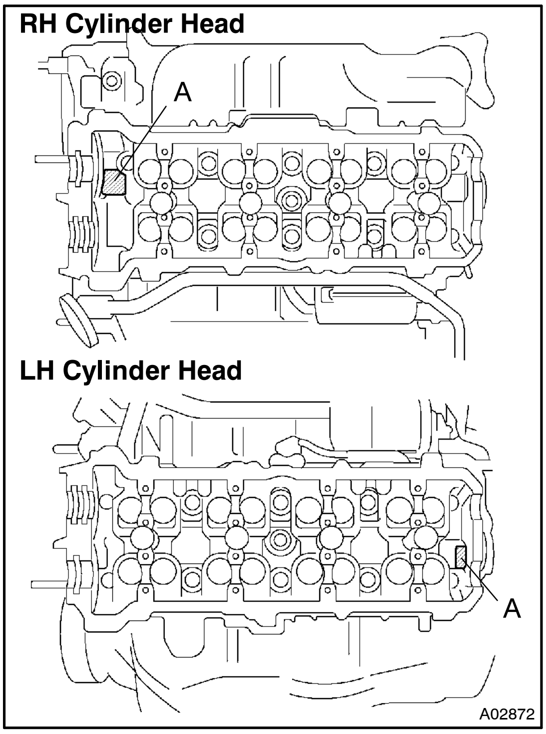
(a) Apply a light coat of engine oil on the threads and under the heads of the cylinder head bolts.

(b) Install the plate washer to the cylinder head bolt.

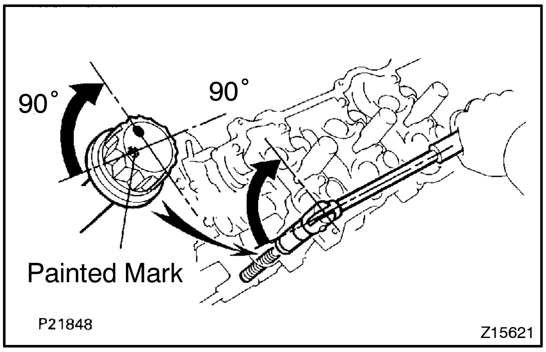
(c) Install and uniformly tighten the 10 cylinder head bolts on one side of the cylinder head in several passes in the sequence shown, then do the other side as shown.

Torque: 39 N·m (400 kgf·cm, 29 ft·lbf)

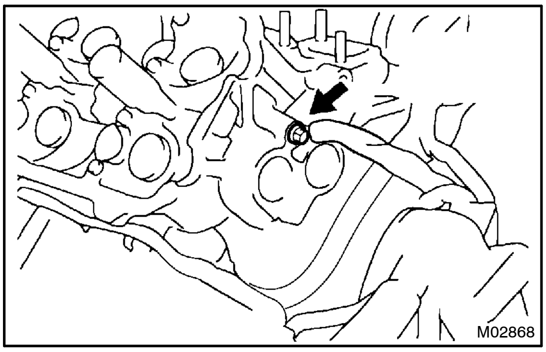
If any one of the cylinder head bolts does not meet the torque specification, replace the cylinder head bolt.



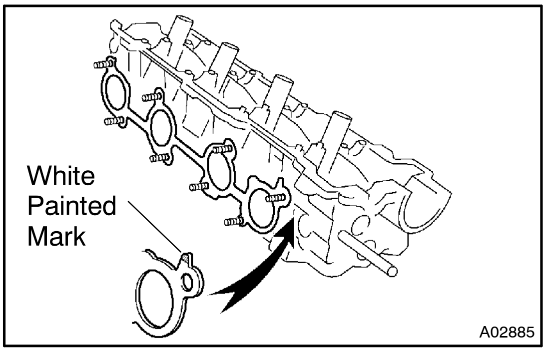
NOTICE:
Do not drop the plate washer for cylinder head bolt into portion A of the cylinder head. If dropped into portion A, the plate washer will pass through the cylinder head and cylinder block into the oil pan.



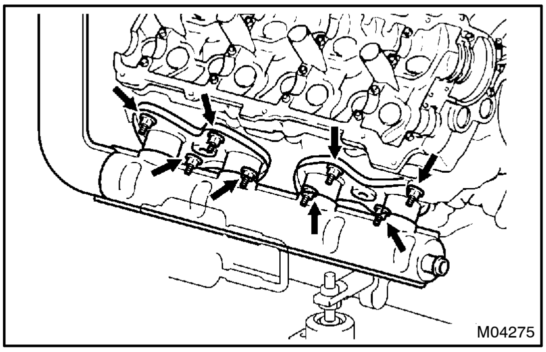
(d) Mark the front of the cylinder head bolt head with paint.
(e) Retighten the cylinder head bolts by 90° in the numerical order shown.
(f) Check that the painted mark is now at a 90° angle to front.



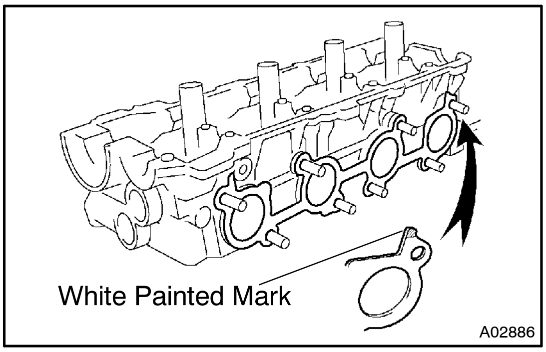
3. INSTALL ENGINE WIRE
Install the ground cable to the LH cylinder head with the bolt.
4. INSTALL SPARK PLUGS



5. INSTALL RH EXHAUST MANIFOLD TO CYLINDER HEAD
(a) Place a new gasket on the cylinder head with the white painted marks facing the manifold side.
NOTICE:
Be careful of the installation direction.



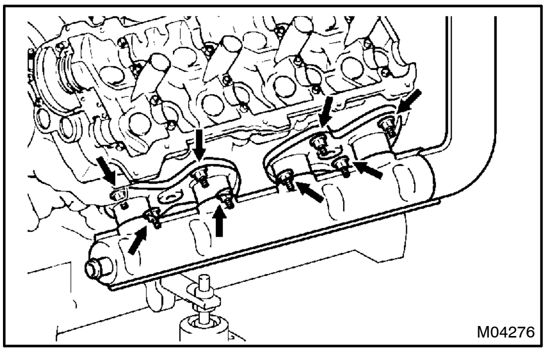
(b) Install the exhaust manifold with 8 new nuts. Uniformly tighten the nuts in several passes.
Torque: 44 N·m (450 kgf·cm, 32 ft·lbf)



6. INSTALL LH EXHAUST MANIFOLD TO CYLINDER HEAD

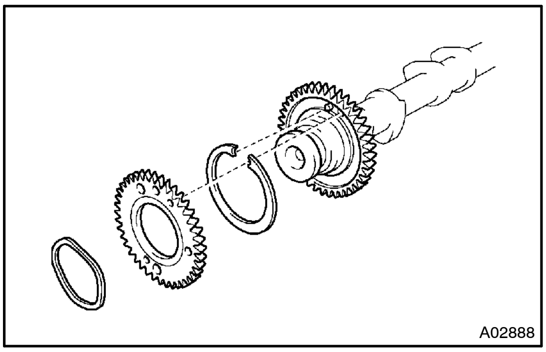
(a) Place a new gasket on the cylinder head with the white painted marks facing the manifold side.

NOTICE:
Be careful of the installation direction.



(b) Install the exhaust manifold with 8 new nuts. Uniformly tighten the nuts in several passes.
Torque: 44 N·m (450 kgf·cm, 32 ft·lbf)

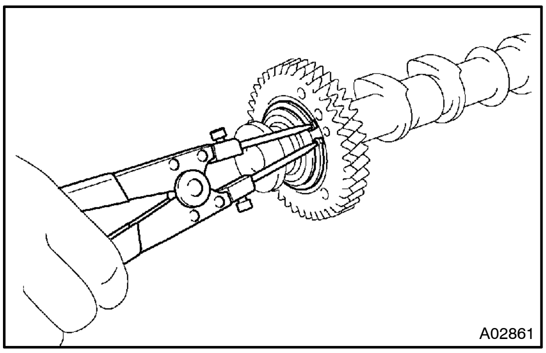
7. INSTALL OIL COOLER FOR TRANSMISSION
(See page EM–72)



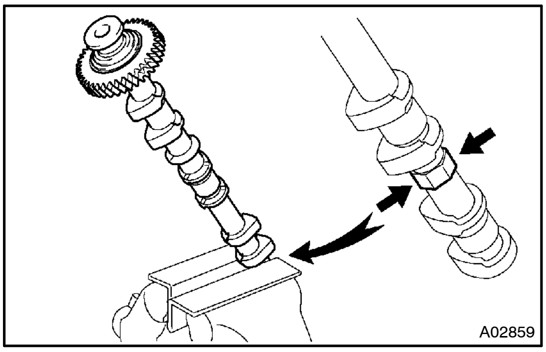
8. ASSEMBLE EXHAUST CAMSHAFT

(a) Install these parts:
(1) Camshaft gear spring
(2) Camshaft sub–gear

HINT:
Attach the pins on the gears to the gear spring ends.
(3) Wave washer

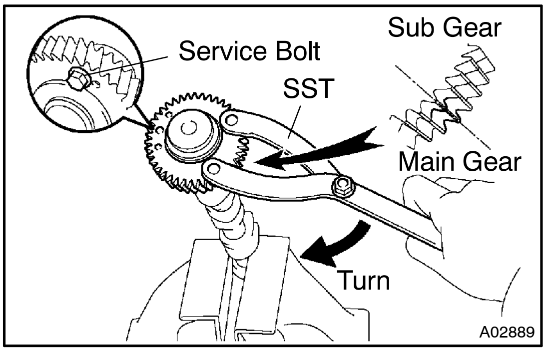


(b) Using snap ring plier, install the snap ring.



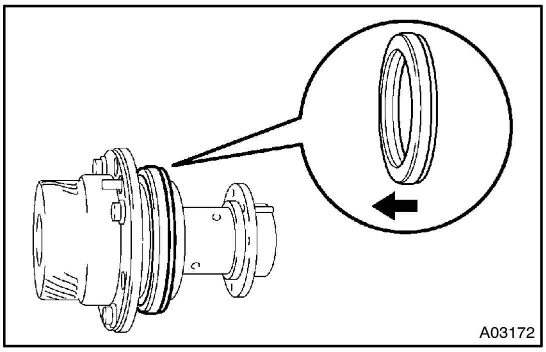
(c) Mount the hexagon wrench head portion of the camshaft in a vise.

NOTICE:
Be careful not to damage the camshaft.



(d) Using SST, align the holes of the camshaft main gear and sub–gear by turning camshaft sub–gear counterclockwise, and temporarily install a service bolt.
SST 09960–10010 (09962–01000, 09963–00500)

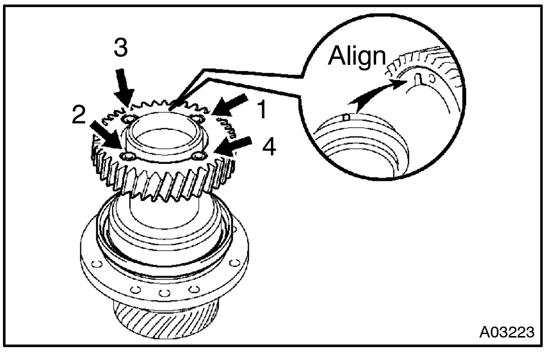
(e) Align the gear teeth of the main gear and sub–gear, and tighten the service bolt.



9. INSTALL CAMSHAFT TIMING TUBES

(a) Place a new oil seal to the timing tube.

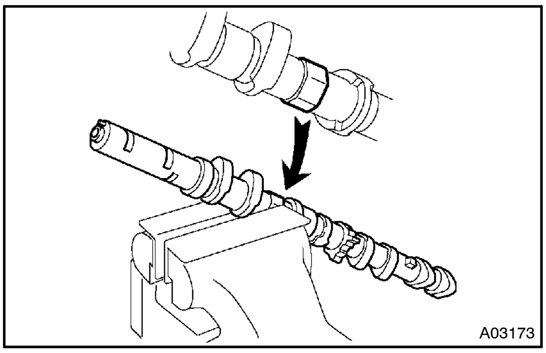
NOTICE:
Be careful installation direction.



(b) Align the timing tube knock pin with the knock pin groove of the camshaft drive gear, and temporarily install the camshaft drive gear with the 4 bolts.

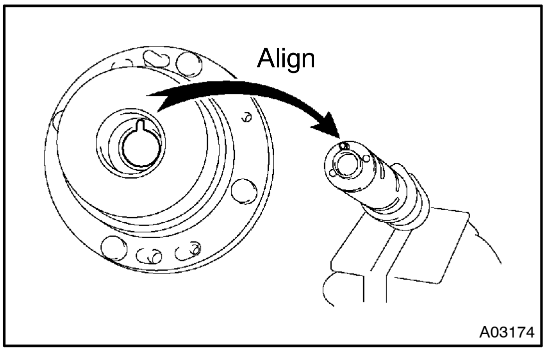
(c) Using a 5 mm hexagon wrench, uniformly tighten the 4 bolts.
Torque: 7.5 N·m (80 kgf·cm, 66 in.·lbf)

NOTICE:
Be careful not to damage the camshaft timing tube.

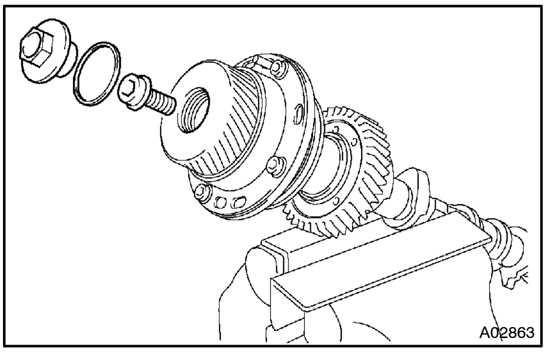


(d) Mount the hexagon wrench head portion of the intake camshaft in a vise.

NOTICE:
Be careful not to damage the camshaft.

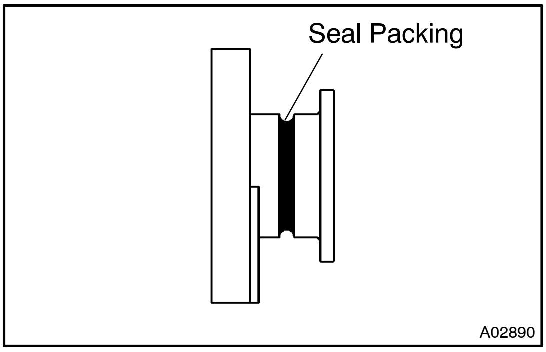


(e) Align the camshaft knock pin with the camshaft timing tube, and push the camshaft timing tube by hand until you feel it touch the bottom.



(f) Using a 10 mm hexagon wrench, install the set bolt.
Torque: 78 N·m (790 kgf·cm, 58 ft·lbf)

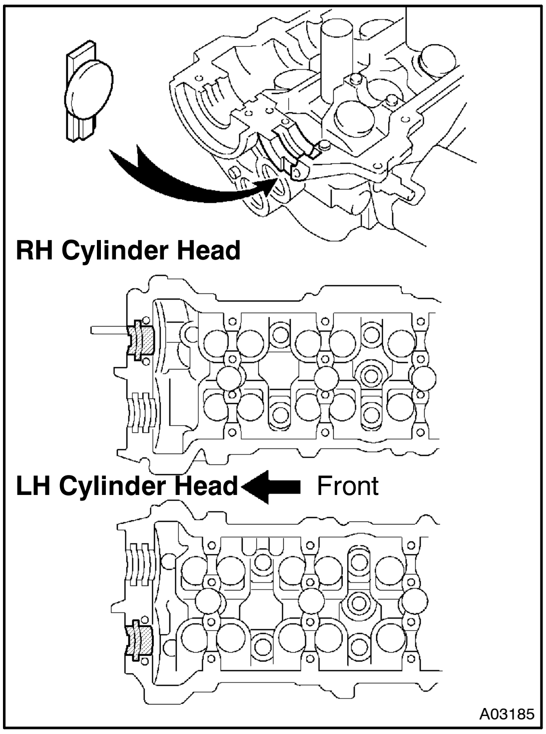
(g) Install the seal washer and straight screw plug.
Torque: 15 N·m (150 kgf·cm, 11 ft·lbf)



10. INSTALL CAMSHAFT HOUSING PLUGS

(a) Remove any old packing (FIPG) material.

(b) Apply seal packing to the camshaft housing plug grooves.
Seal packing:
Part No. 08826-00080 or equivalent

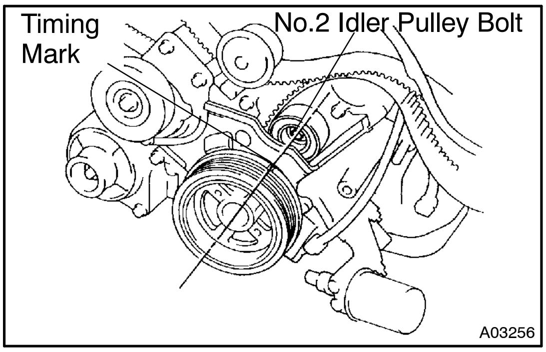


(c) Install the 2 camshaft housing plugs to the cylinder heads.

11. INSTALL CAMSHAFTS

NOTICE:

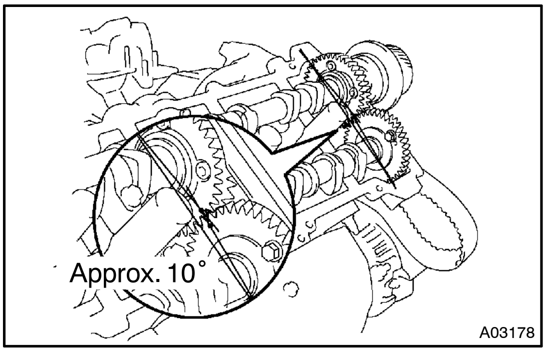
Since the thrust clearance of the camshaft is small, the camshaft must be kept level while it is being installed. If the camshaft is not kept level, the portion of the cylinder head receiving the shaft thrust may crack or be damaged, causing the camshaft to seize or break. To avoid this, the following steps should be carried out.



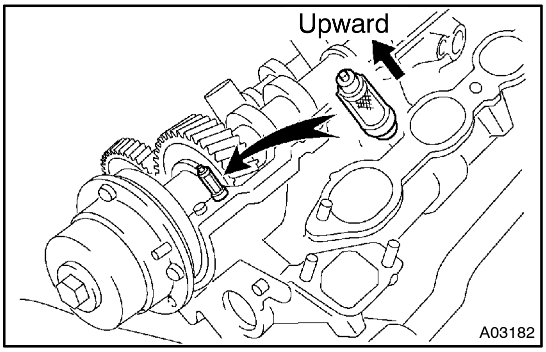
(a) Set the crankshaft pulley position.
Turn the crankshaft pulley clockwise or counterclockwise, and put the timing mark of the crankshaft pulley in line with the centers of the crankshaft pulley bolt and idler pulley bolt.

NOTICE:

Having the crankshaft pulley at the wrong angle can cause the piston head and valve head to come into contact with each other when you install the camshaft, causing damage. So always set the crankshaft pulley at the correct angle.



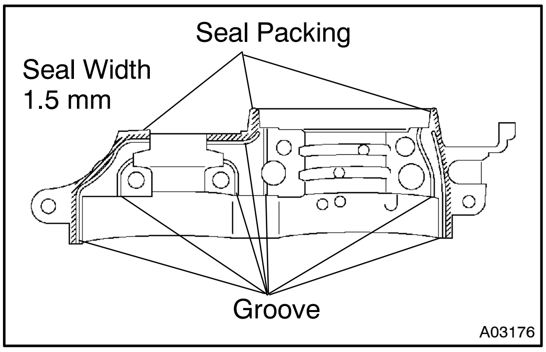
(b) Install the RH camshafts.
(1) Apply MP grease to the thrust portion of the intake and exhaust camshafts.
(2) Place the intake and exhaust camshafts.
(3) Set the timing mark (1 dot mark) of the camshaft main gear at approx. 10° angle.



(4) Place the camshaft oil control valve filter to the cylinder head.

NOTICE:

Be careful installation direction.



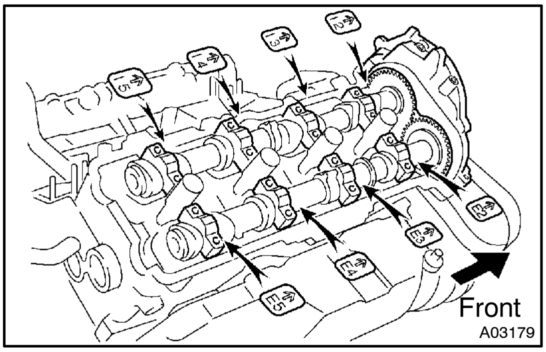
(5) Remove any old packing (FIPG) material from front bearing cap.

(6) Apply seal packing to the front bearing cap as shown in the illustration.

Seal packing:
Part No. 08826-00080 or equivalent

- Install a nozzle that has been cut to a 1.5 mm (0.06 in.) opening.
- Parts must be assembled within 5 minutes of application. Otherwise the material must be removed and reapplied.
- Immediately remove nozzle from the tube and reinstall cap.

NOTICE:
Do not apply seal packing to the front bearing cap grooves.

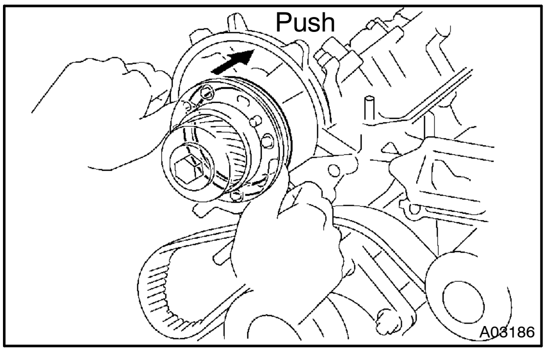


(7) Install the front bearing cap.

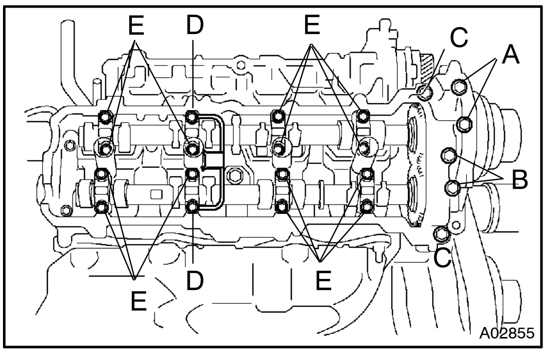
HINT:
Installing the front bearing cap will determine the thrust portion of the camshaft.

(8) Install the other bearing cap in the sequence shown with the arrow mark facing forward.

HINT:
Align the arrow marks at the front and rear of the cylinder head with the mark on the bearing cap.

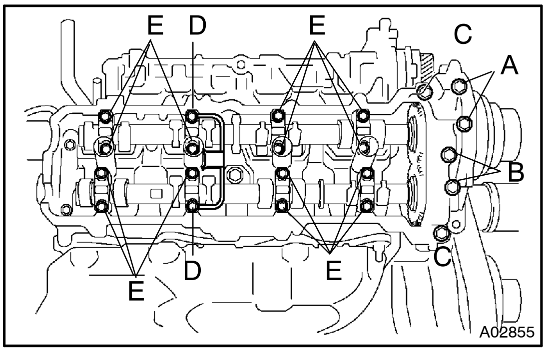


(9) Push in the camshaft oil seal.



(10) Apply a light coat of engine oil on the threads and under the heads (D and E) of the bearing cap bolts.

HINT:
Do not apply engine oil under the heads of the bearing cap bolt (A), (B) and (C).



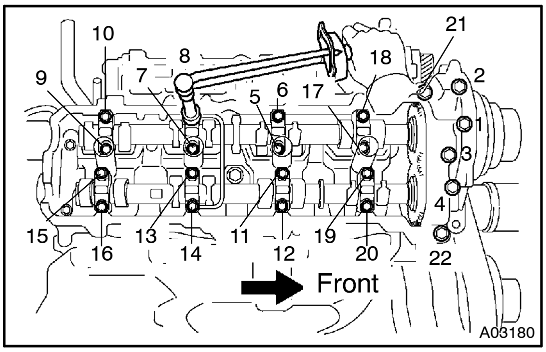
(11) Install the oil feed pipe and the 22 bearing cap bolts as shown.

HINT:

Each bolt length is indicated in the illustration.

Bolt length:

94 mm (3.70 in.) for A
72 mm (2.83 in.) for B
25 mm (0.98 in.) for C
52 mm (2.05 in.) for D
38 mm (1.50 in.) for E



(12) Uniformly tighten the 22 bearing cap bolts in several passes, in the sequence shown.

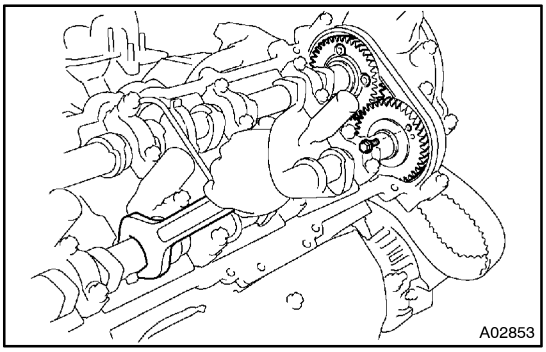
Torque:

Bolt C:

7.5 N·m (80 kgf·cm, 69 in.·lbf)

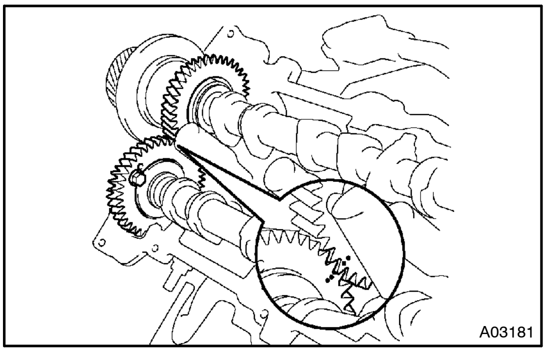
Others

16 N·m (160 kgf·cm, 12 ft·lbf)



(13) Boring the service bolt installed in the driven sub–gear upward by turning the hexagon wrench head portion of the camshaft with a wrench.

(14) Remove the service bolt.

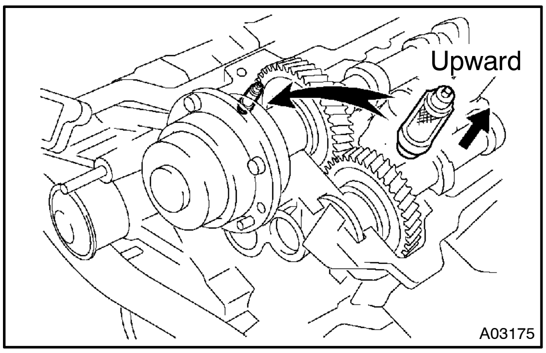


(c) Install the LH camshafts.

(1) Apply MP grease to the thrust portion of the intake and exhaust camshafts.

(2) Place the intake and exhaust camshafts.

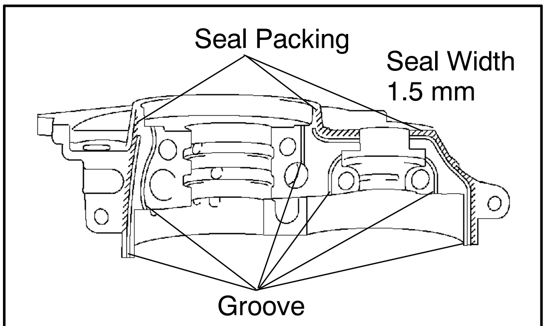
(3) Engage the intake to the exhaust gear by meeting the timing marks (2 dot marks) on each gear.



(4) Place the camshaft oil control valve filter to the cylinder head.

NOTICE:

Be careful installation direction.



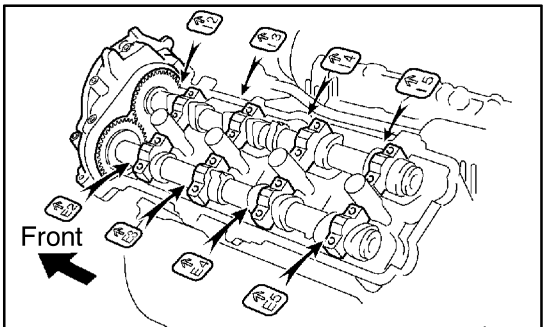
A03177

(5) Remove any old packing (FIPG) material.
(6) Apply seal packing to the front bearing cap.

Seal packing:
Part No. 08826-00080 or equivalent

- Install a nozzle that has been cut to a 1.5 mm (0.06 in.) opening.
- Parts must be assembled within 5 minutes of application. Otherwise the material must be removed and reapplied.
- Immediately remove nozzle from the tube and reinstall cap.

NOTICE:
Do not apply seal packing to the front bearing cap grooves.



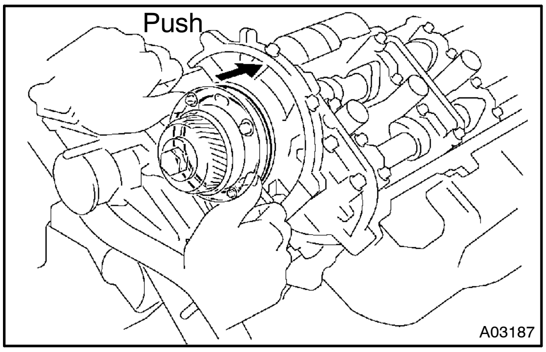
A03183

(7) Install the front bearing cap.

HINT:
Installing the front bearing cap will determine the thrust portion of the camshaft.

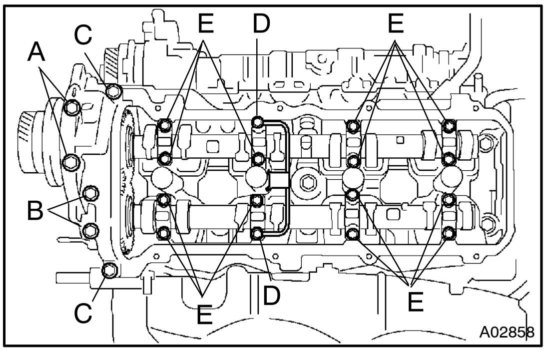
(8) Install the other bearing cap in the sequence shown with the arrow mark facing forward.

HINT:
Align the arrow marks at the front and rear of the cylinder head with the mark on the bearing cap.



A03187

(9) Push in the camshaft oil seal.



(10) Apply a light coat of engine oil on the threads and under the heads (D and E) of the bearing cap bolts.

HINT:

Do not apply engine oil under the heads of the bearing cap bolt (A), (B) and (C).

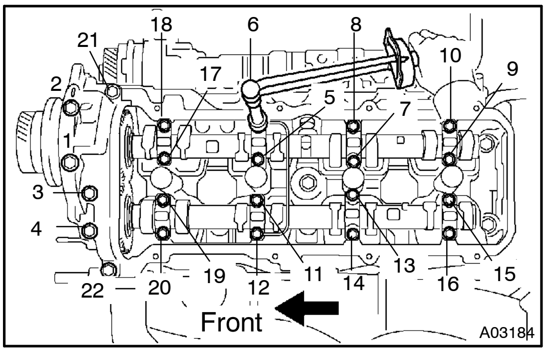
(11) Install the oil feed pipe and the 22 bearing cap bolts as shown.

HINT:

Each bolt length is indicated in the illustration.

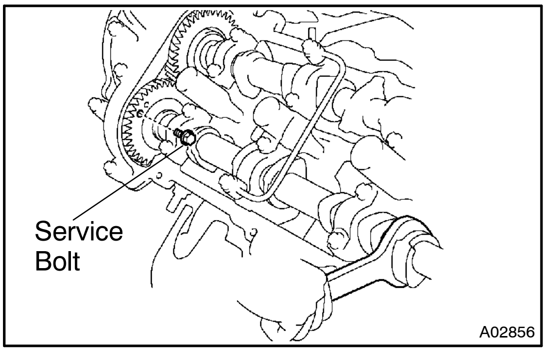
Bolt length:

94 mm (3.70 in.) for A
72 mm (2.83 in.) for B
25 mm (0.98 in.) for C
52 mm (2.05 in.) for D
38 mm (1.50 in.) for E



(12) Uniformly tighten the 22 bearing cap bolts in several passes, in the sequence shown.

Torque:
Bolt C:
7.5 N·m (80 kgf·cm, 69 in.·lbf)
Others
16 N·m (160 kgf·cm, 12 ft·lbf)

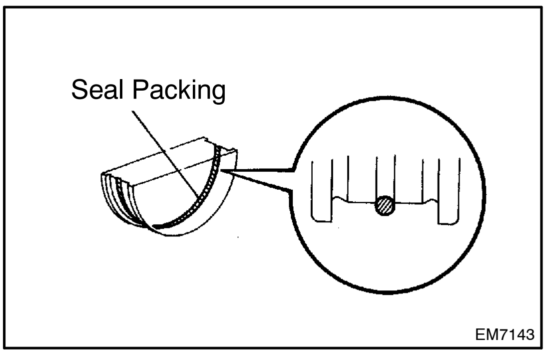


(13) Boring the service bolt installed in the driven sub-gear upward by turning the hexagon wrench head portion of the camshaft with a wrench.

(14) Remove the service bolt.

12. CHECK AND ADJUST VALVE CLEARANCE
(See page EM-2)

Turn the camshaft and position the cam lobe upward, and check and adjust the valve clearance.

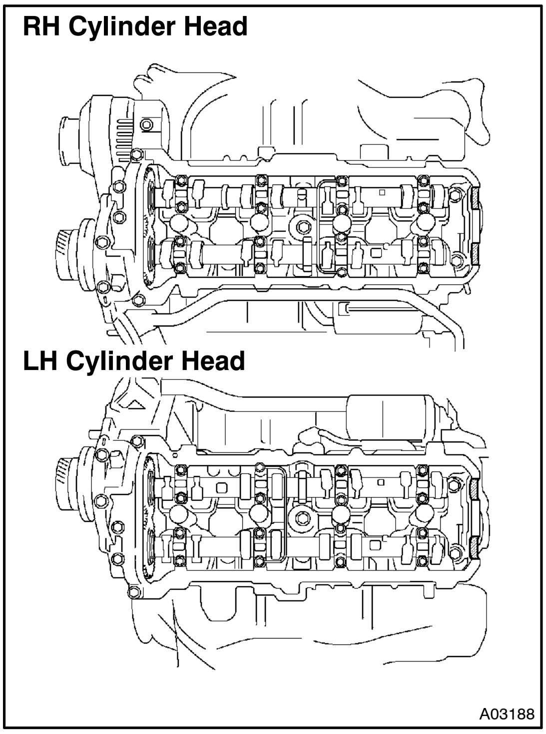


13. INSTALL SEMI-CIRCULAR PLUGS

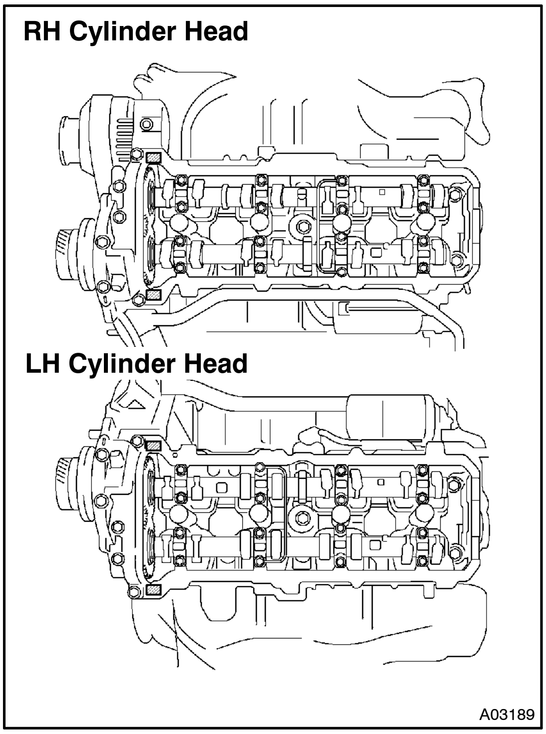
(a) Remove any old packing (FIPG) material.

(b) Apply seal packing to the semi-circular plug grooves.

Seal packing:
Part No. 08826-00080 or equivalent



(c) Install the 4 semi–circular plugs to the cylinder heads.



14. INSTALL CYLINDER HEAD COVER

(a) Remove any old packing (FIPG) material.

(b) Apply seal packing to the cylinder heads as shown in the illustration.

Seal packing:
Part No. 08826–00080 or equivalent

(c) Install the gasket to the cylinder head cover.

(d) Install the seal washer to the bolt.

(e) Install the cylinder head cover with the 9 bolts. Uniformly tighten the bolts in several passes. Install the 2 cylinder head covers.

Torque: 6.0 N·m (60 kgf·cm, 53 in.·lbf)

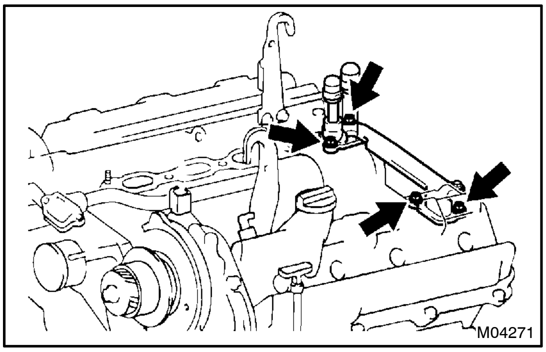
15. INSTALL ENGINE HANGERS

Torque: 37 N·m (380 kgf·cm, 27 ft·lbf)

16. INSTALL VVT SENSORS

17. INSTALL CAMSHAFT TIMING OIL CONTROL VALVE (See page SF–47)

18. INSTALL OIL DIPSTICK AND GUIDE FOR ENGINE (See page LU–15)

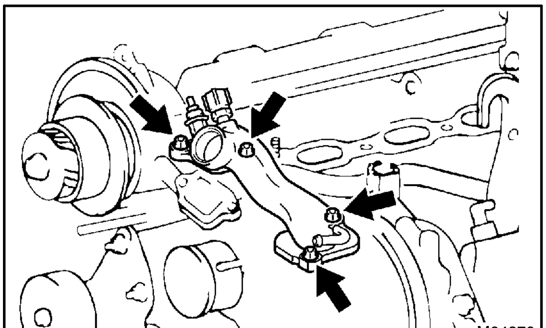


19. INSTALL REAR WATER BYPASS JOINT

(a) Install 2 new gaskets to the cylinder head.

(b) Install the 4 nuts holding the water bypass joint to the cylinder heads. Alternately tighten the nuts.

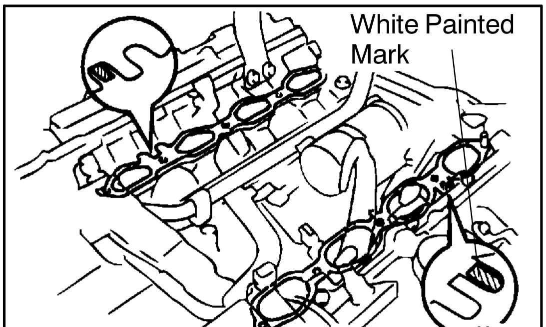
Torque: 18 N·m (185 kgf·cm, 13 ft·lbf)


M04270

20. INSTALL FRONT WATER BYPASS JOINT

(a) Install 2 new gaskets and the water bypass joint with the 4 nuts. Alternately tighten the nuts.
Torque: 18 N·m (185 kgf·cm, 13 ft·lbf)

(b) Connect these connectors:
- ECT sensor connector
- ECT sender gauge connector

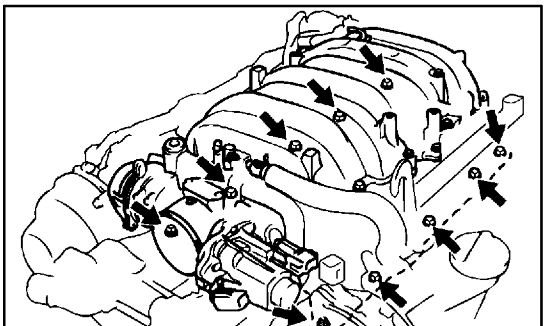


M04279

21. INSTALL INTAKE MANIFOLD ASSEMBLY

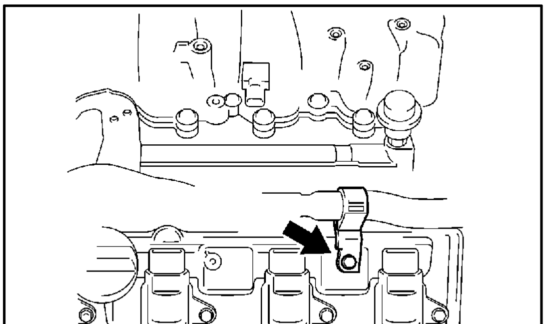
(a) Place 2 new gaskets on the cylinder heads with white painted mark facing upward.

NOTICE:
- **Align the port holes of the gasket and cylinder head.**
- **Be careful of the installation direction.**

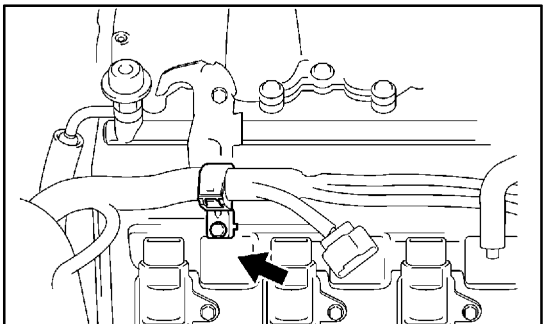

M04269

(b) Place the intake manifold assembly on the cylinder heads.

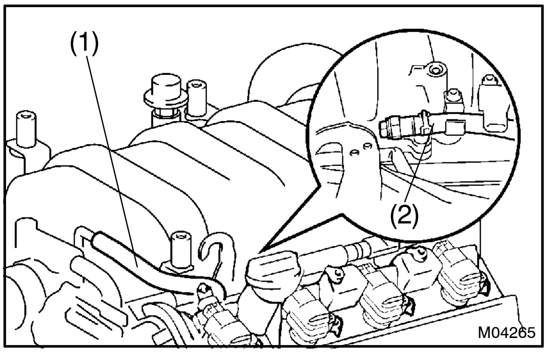
(c) Install and uniformly tighten the 6 bolts and 4 nuts in several passes.
Torque: 18 N·m (185 kgf·cm, 13 ft·lbf)


M00033

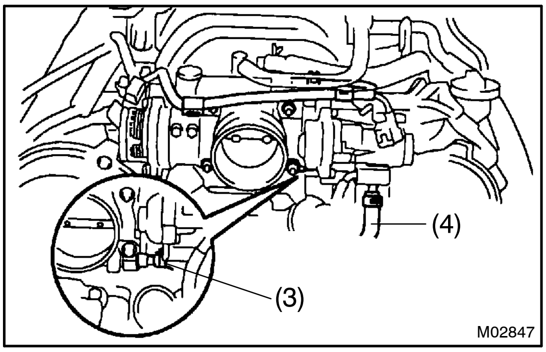
(d) Connect the engine wire.
(1) Connect the wire clamp bracket to the LH cylinder head cover with the bolt.


M00034

(2) Connect the wire clamp bracket to the RH cylinder head cover with the bolt.



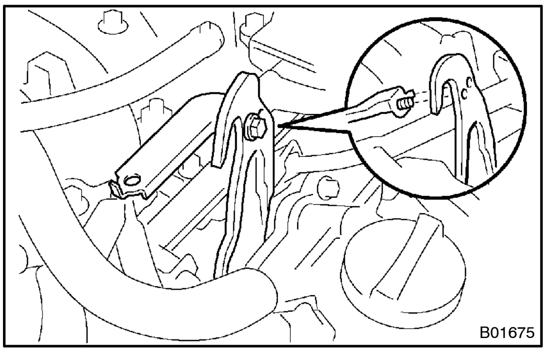
(e) Connect these hoses:
(1) PCV hose from PCV valve on LH cylinder head
(2) Oil drain hose (from intake manifold)



(3) No.1 water bypass hose (from front water bypass joint) from throttle body
(4) No.7 water bypass hose (from water inlet housing) from throttle body

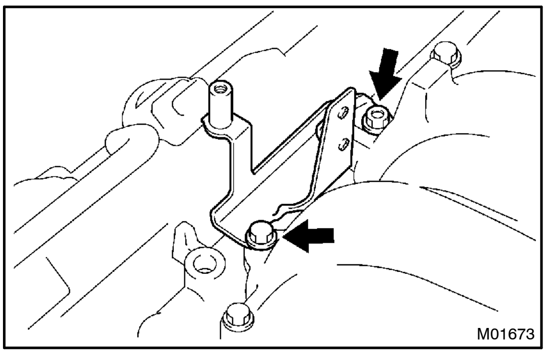
(f) Connect the 2 wire clamp to the throttle body.

(g) Connect these connectors:
- Throttle position sensor connector
- Accelerator pedal position sensor connector
- Throttle control motor connector
- VSV connector for ACIS
- 8 injector connectors
- Noise filter connector
- Camshaft timing oil control valve connector

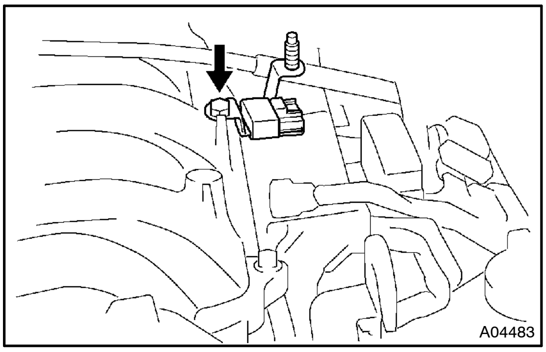


22. INSTALL V-BANK COVER BRACKETS

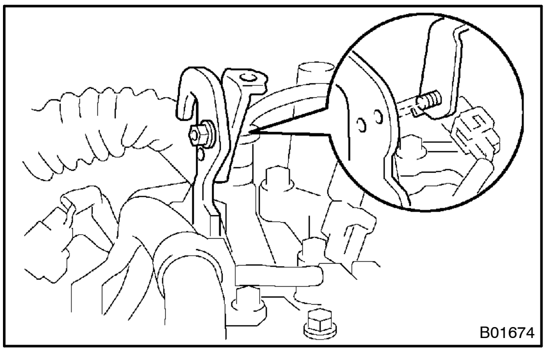
(a) Install the LH front V-bank cover bracket to the engine hanger with the nut.
Torque: 7.5 N·m (80 kgf·cm, 66 in.·lbf)



(b) Install the throttle cable bracket to the intake manifold with the bolt and nut.
Torque: 18 N·m (185 kgf·cm, 13ft·lbf)

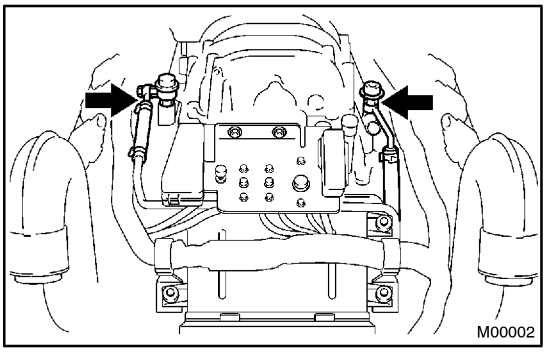


(c) Install the LH rear V–bank cover bracket with noise filter to the intake manifold with the bolt.
Torque: 7.5 N·m (80 kgf·cm, 66 in.·lbf)



(d) Install the RH rear V–bank cover bracket to the engine hanger with the nut.
Torque: 7.5 N·m (80 kgf·cm, 66 in.·lbf)

23. CONNECT THROTTLE CABLE



24. CONNECT FUEL INLET HOSE AND HOSE

(a) Install the fuel inlet pipe and fuel pressure pulsation damper to the RH delivery pipe.
Torque: 39 N·m (400 kgf·cm, 29 in.·lbf)

(b) Connect the No. 4 fuel hose.
Torque: 1.5 N·m (15 kgf·cm, 13 in.·lbf)

25. INSTALL TIMING BELT REAR PLATES

(a) Install the RH timing belt rear plates.
(1) Install the No.1 timing belt rear plate to the cylinder head with the bolt and stud bolt.
Torque: 7.5 N·m (80 kgf·cm, 66 in.·lbf)
(2) install the No.2 timing belt rear plate to the No.1 timing belt rear plate with the 2 bolts.
Torque: 7.5 N·m (80 kgf·cm, 66 in.·lbf)

(b) Install the LH timing belt rear plates.
(1) Connect the wire clamp to the No.1 timing belt rear plate.
(2) Install the No.1 timing belt rear plate to the cylinder head with the bolt.
Torque: 7.5 N·m (80 kgf·cm, 66 in.·lbf)
(3) install the No.2 timing belt rear plate to the No.1 timing belt rear plate with the 2 bolts.
Torque: 7.5 N·m (80 kgf·cm, 66 in.·lbf)

26. INSTALL IGNITION COILS
(See page IG–6)

27. INSTALL CAMSHAFT POSITION SENSOR
(See page IG–10)

28. INSTALL CAMSHAFT TIMING PULLEYS
(See page EM–19)

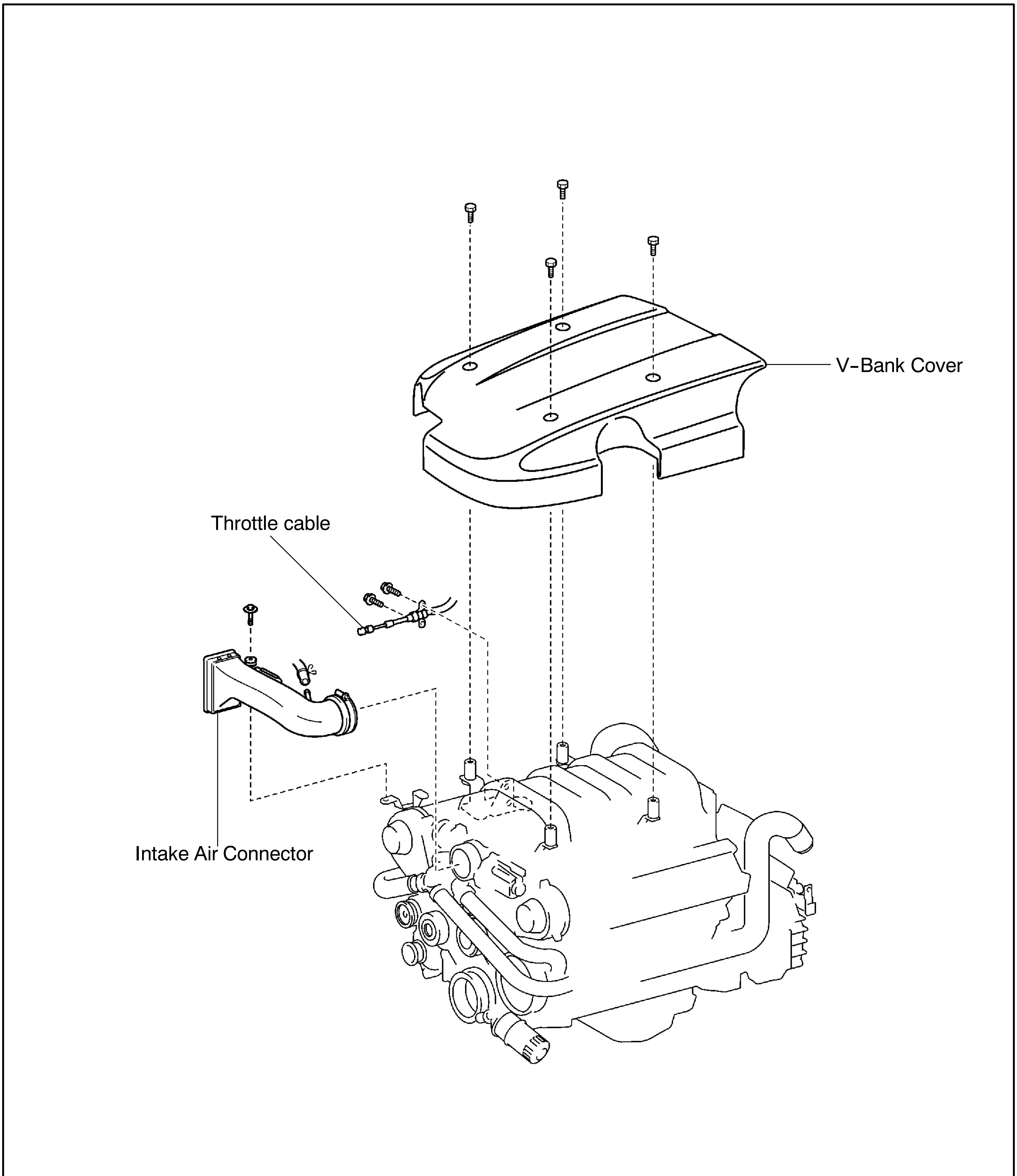
29. CONNECT TIMING BELT TO CAMSHAFT TIMING PULLEYS
(See page EM–19)

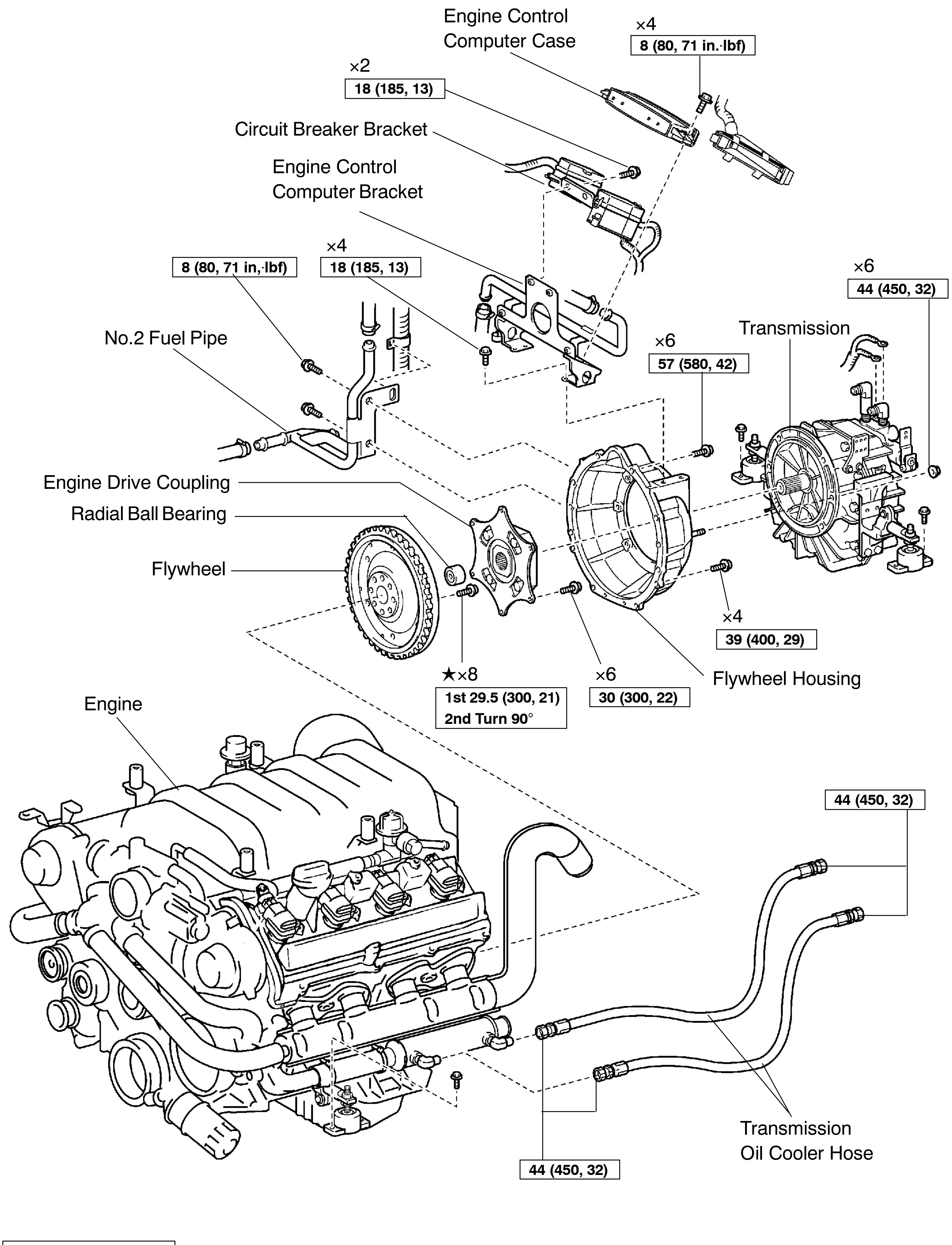
30. CHECK ENGINE OIL LEVEL

ENGINE UNIT

COMPONENTS

EM0G6-01





N·m (kgf·cm, ft·lbf) : Specified torque

★ Pre coted part

EM0G7–01

REMOVAL

1. REMOVE V–BANK COVER

2. DISCONNECT THROTTLE CABLE

3. DISCONNECT SHIFT CABLE

4. DISCONNECT ENGINE WIRE CONNECTORS

Disconnect the 2 engine wire connectors.

5. DISCONNECT GROUND CABLE FROM BODY

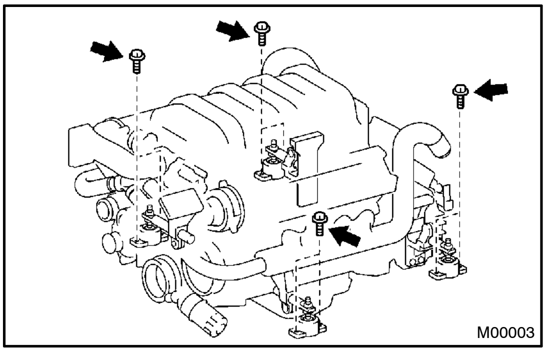
6. DISCONNECT NO.2 ENGINE WIRE FROM BATTERY

7. DISCONNECT HOSES

- Sea water hose from sea water filter
- Exhaust hoses
- Fuel inlet hose
- Fuel return hose

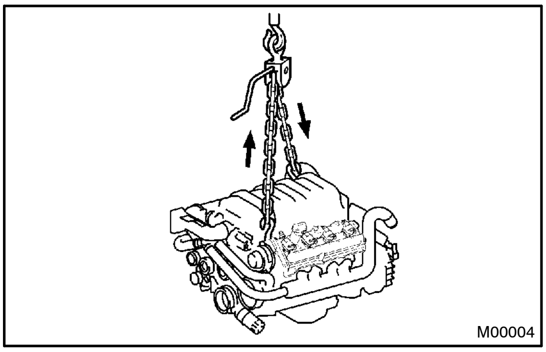
8. DISCONNECT DRIVESHAFT FROM TRANSMISSION

Remove the 4 bolts and 4 nuts, then disconnect drive shaft and transmission.


M00003

9. DISCONNECT ENGINE MOUNTING FROM BOAT BODY

Remove the 8 bolts and 8 nuts, then disconnect engine mounting from boat body.


M00004

10. REMOVE ENGINE AND TRANSMISSION ASSEMBLY FROM BOAT

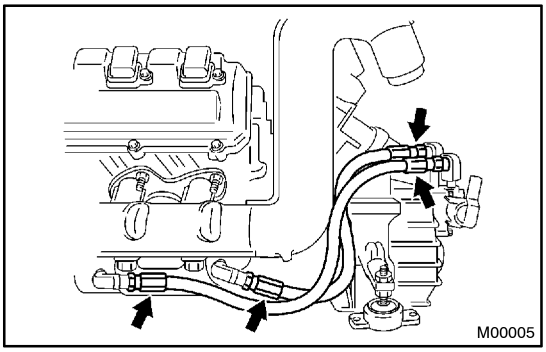
(a) Attach the engine chain hoist to the engine hangers.

(b) Lift the engine out of the boat slowly and carefully.

HINT:

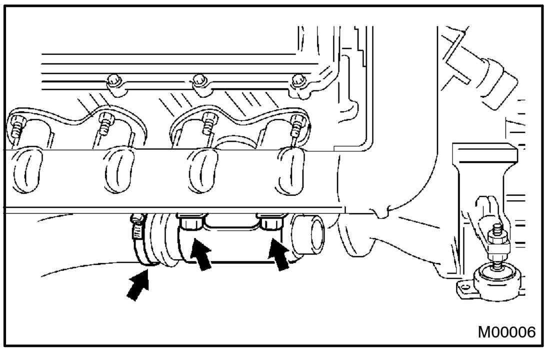
Make sure the engine is clear of all wires, hoses and cables.

(c) Place the engine and transmission assembly onto the stand.


M00005

11. REMOVE OIL COOLER HOSES FOR TRANSMISSION

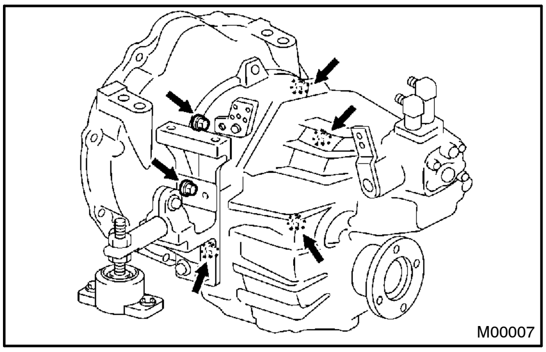
Loosen the 4 union nuts, and remove the 2 oil cooler hoses.



12. REMOVE OIL COOLER FOR TRANSMISSION

(a) Loosen the hose clamp on No. 1 sea water hose.

(b) Remove the 2 bolts, transmission oil cooler and transmission oil cooler bracket.



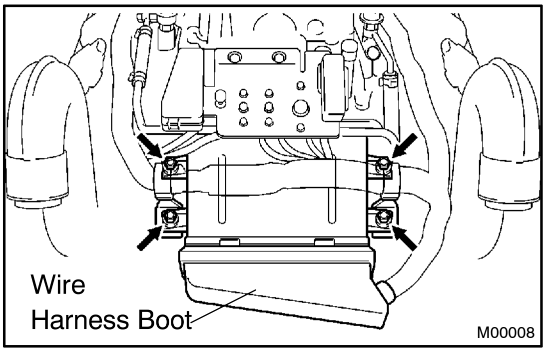
13. REMOVE TRANSMISSION

(a) Remove the neutral switch wiring.

(b) Remove the 6 nuts, then remove the transmission from the flywheel housing.

NOTICE:

Before you remove the transmission, put supports under the engine to prevent the engine falling from the stand.

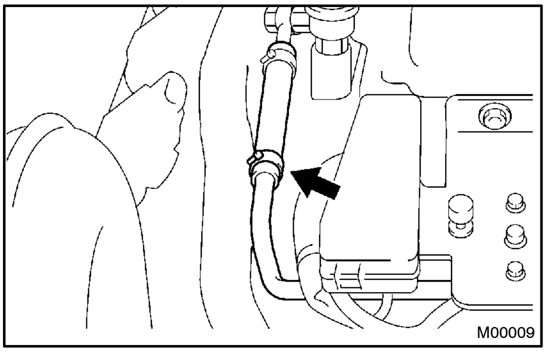


14. REMOVE ENGINE CONTROL COMPUTER CASE

(a) Remove the wire harness boot from the engine control computer case.

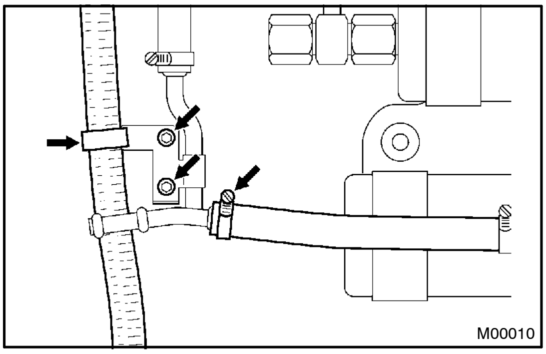
(b) Disconnect the 5 connectors from the engine control computer.

(c) Remove the 4 bolts, then remove the engine control computer case.



15. REMOVE ENGINE CONTROL COMPUTER BRACKET

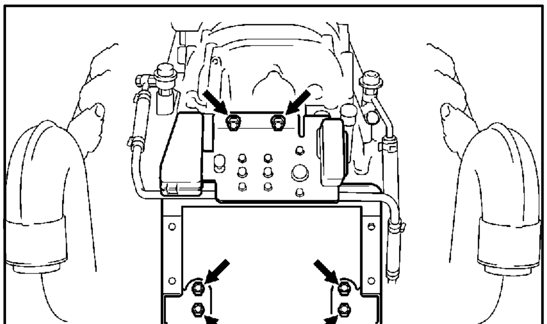
(a) Loosen the hose clamp, then disconnect the No. 4 fuel hose from the No. 4 fuel pipe.



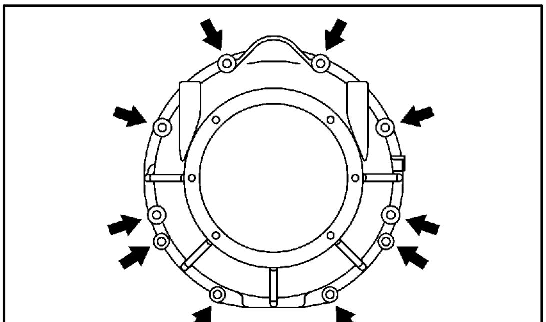
(b) Disconnect the engine wire harness from the No. 2 fuel pipe.

(c) Loosen the hose clamp, then disconnect the fuel hose from the No. 2 fuel pipe.

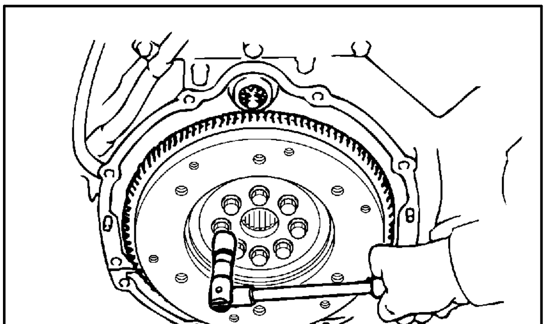
(d) Remove the 2 bolts and the No. 2 fuel pipe.


M00011

(e) Remove the 2 bolts, then remove the circuit breaker bracket from the engine control computer bracket.
(f) Remove the 4 bolts, then remove the engine control computer bracket from the flywheel housing.


M00012

16. REMOVE FLYWHEEL HOUSING
Remove the 10 bolts and flywheel housing.


M04140

17. REMOVE FLYWHEEL
(a) Remove the 6 bolts, engine drive coupling and radial ball bearing.
(b) Remove the 8 bolts, and flywheel.

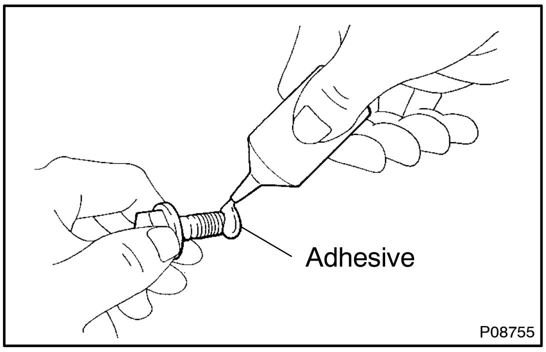
EM0G8–01

INSTALLATION

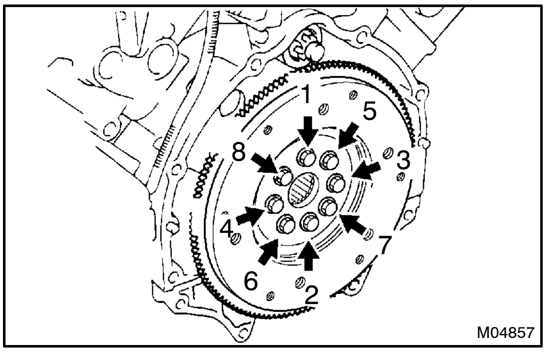
1. INSTALL FLYWHEEL

HINT:

- The mounting bolts are tightened in 2 progressive steps (steps (c) and (e)).
- If any one of the mounting bolts is broken or deformed, replace it.

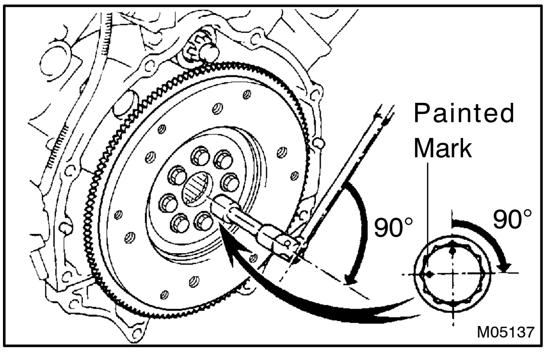


(a) Apply adhesive to 2 or 3 threads of the mounting bolt end.
Adhesive:
Part No. 08833–00070, THREE BOND 1324 or equivalent

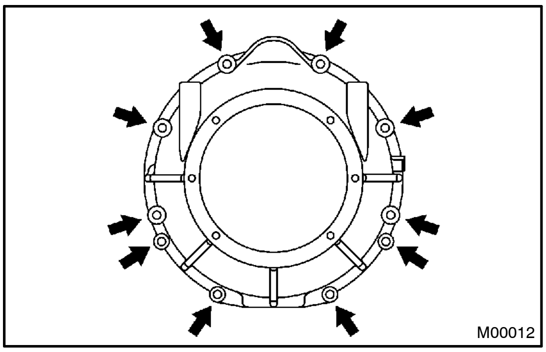


(b) Install the flywheel on the crankshaft.
(c) Install and uniformly tighten the 8 mounting bolts in several passes, in the sequence shown.
Torque: 29.5 N·m (300 kgf·cm, 21 ft·lbf)

If any one of the mounting bolts does not meet the torque specification, replace the mounting bolt.

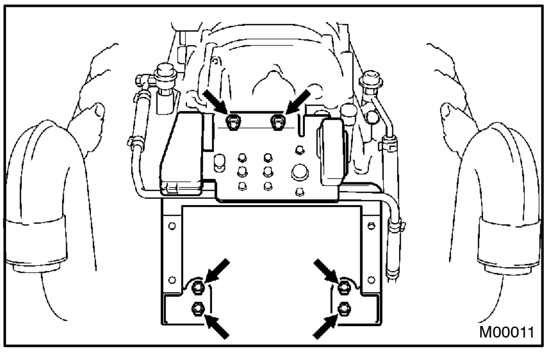


(d) Mark the mounting bolts with paint.
(e) Retighten the mounting bolts by 90° in the numerical order shown.
(f) Check that the painted mark is now at a 90° angle to (e).
(g) Install the radial ball bearing and engine drive coupling with the 6 bolts.
Torque: 30 N·m (300 kgf·cm, 22 ft·lbf)



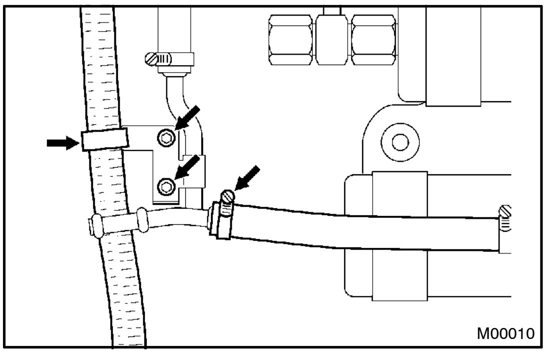
2. INSTALL FLYWHEEL HOUSING

(a) Install the flywheel housing with the 10 bolts.
Torque:
14 mm bolt: 39 N·m (400 kgf·cm, 29 ft·lbf)
17 mm bolt: 57 N·m (580 kgf·cm, 42 ft·lbf)



(b) Install the engine control computer bracket to the flywheel housing with the 4 bolts.
Torque: 18 N·m (185 kgf·cm, 13 ft·lbf)

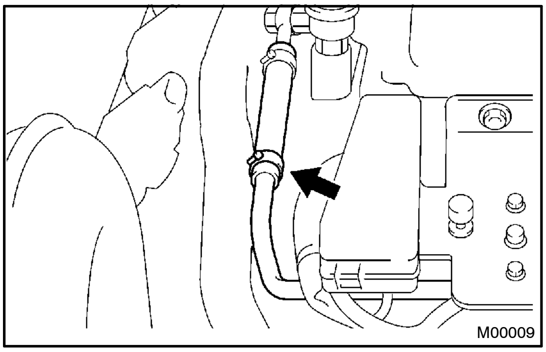
(c) Install the circuit breaker bracket to the engine control computer with the 2 bolts.
Torque: 18 N·m (185 kgf·cm, 13 ft·lbf)



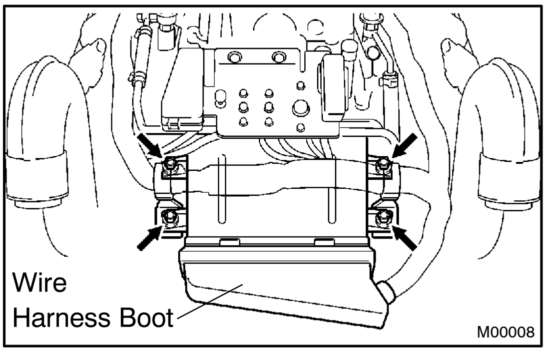
(d) Install the No. 2 fuel pipe to the flywheel housing with the 2 bolts.
Torque: 8 N·m (80 kgf·cm, 71 in.·lbf)

(e) Install the fuel hose to the No. 2 fuel pipe.
Torque: 1.5 N·m (15 kgf·cm, 13 in.·lbf)

(f) Secure the engine wire harness with clamps.



(g) Install the No.4 fuel pipe to the No.4 fuel hose.
Torque: 1.5 N·m (15 kgf·cm, 13 in.·lbf)

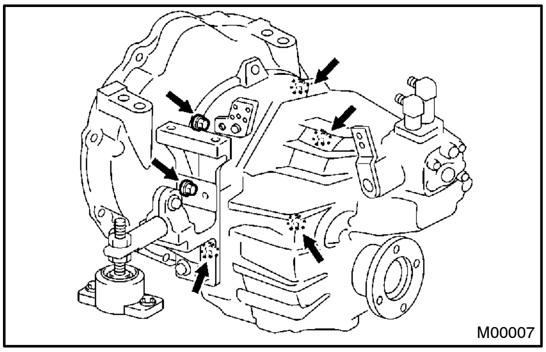


3. INSTALL ENGINE CONTROL COMPUTER CASE

(a) Install the engine control computer case to the engine control computer bracket with the 4 bolts.

(b) Connect the 5 connectors to the engine computer.
Torque: 8 N·m (80 kgf·cm, 71 in.·lbf)

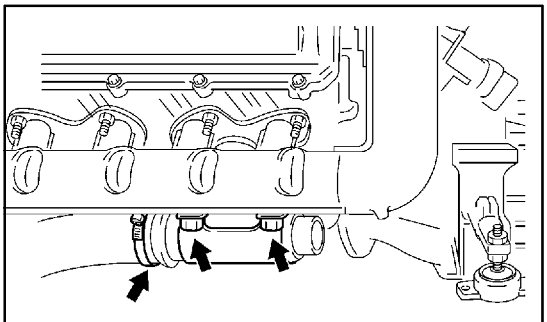
(c) Install the wire harness boot to the engine control computer case.



4. INSTALL TRANSMISSION

(a) Install the transmission with the 6 nuts.
Torque: 44 N·m (450 kgf·cm, 32 ft·lbf)

(b) Connect the neutral switch wiring.


M00006

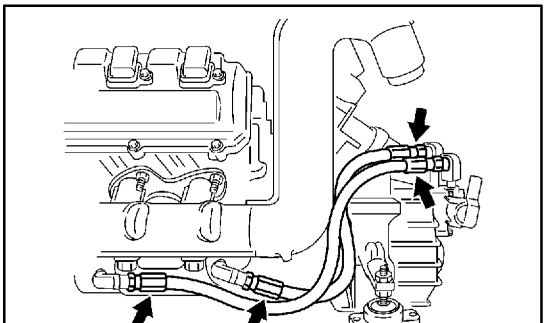
5. INSTALL OIL COOLER FOR TRANSMISSION

(a) Install the transmission oil cooler and transmission oil cooler bracket with the 2 bolts.

Torque: 8 N·m (80 kgf·cm, 71 in.·lbf)

(b) Secure the hose clamp on the No. 1 sea water hose.

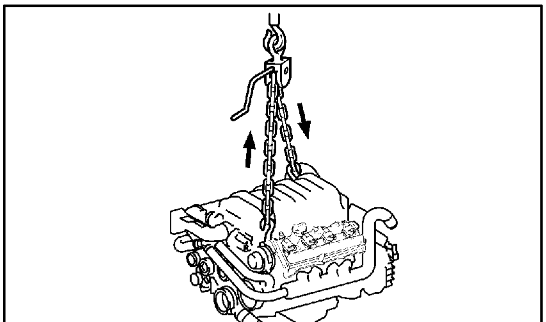
Torque: 2.5 N·m (25 kgf·cm, 22 in.·lbf)


M00005

6. INSTALL OIL COOLER HOSES FOR TRANSMISSION

Connect the 2 oil cooler hoses with the 4 union nuts.

Torque: 44 N·m (500 kgf·cm, 32 in.·lbf)


M00004

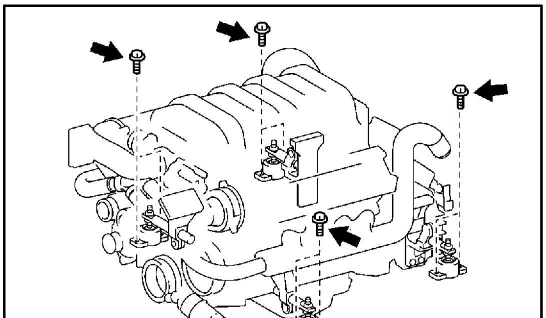
7. INSTALL ENGINE AND TRANSMISSION ASSEMBLY IN BOAT

(a) Attach the engine chain hoist to the engine hangers.

(b) Slowly lower the engine and transmission assembly into the engine compartment.

8. CONNECT DRIVE SHAFT AND TRANSMISSION

Connect the drive shaft and the transmission with the 4 bolts and nuts.


M00003

9. INSTALL ENGINE MOUNTINGS TO BOAT

Install the engine mountings at 4 locations with the 8 bolts and nuts.

Torque: 47 N·m (480 kgf·cm, 35 ft·lbf)

10. CONNECT HOSES

- Fuel inlet hose
- Sea water hose to sea water filter
- Exhaust hoses
- Fuel return hose

11. INSTALL NO.2 ENGINE WIRE TO BATTERY

12. INSTALL GROUND CABLE TO BODY

13. CONNECT ENGINE WIRE CONNECTORS

Connect the 2 engine wire connectors.

14. CONNECT SHIFT CABLE

15. CONNECT THROTTLE CABLE

16. INSTALL V–BANK COVER

17. START ENGINE AND CHECK FOR LEAKS

18. CHECK TRANSMISSION FLUID LEVEL

19. DO ENGINE ADJUSTMENT

20. DO ROAD TEST

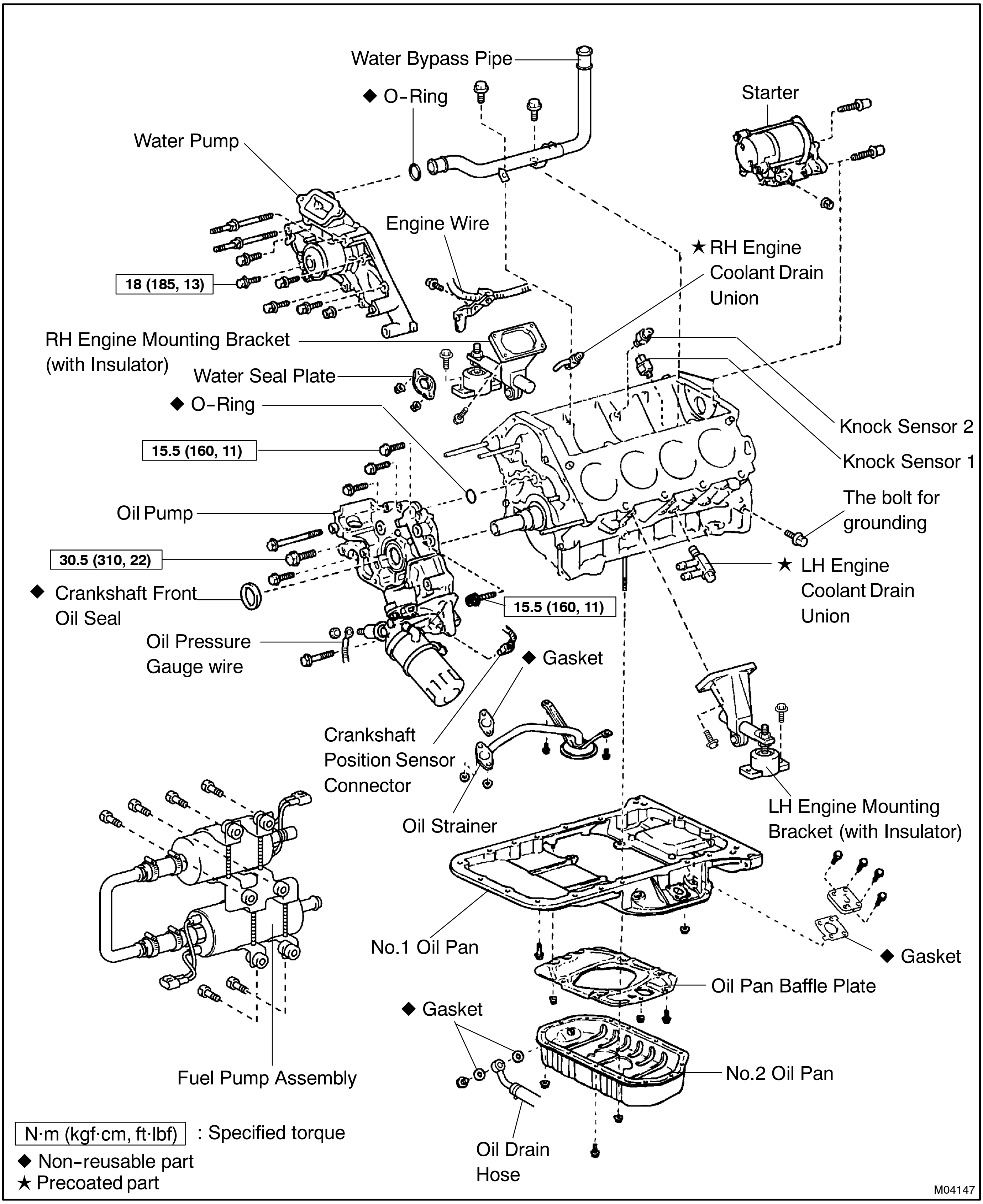
Check for abnormal noises, shock, slippage, correct shift points and smooth operation.

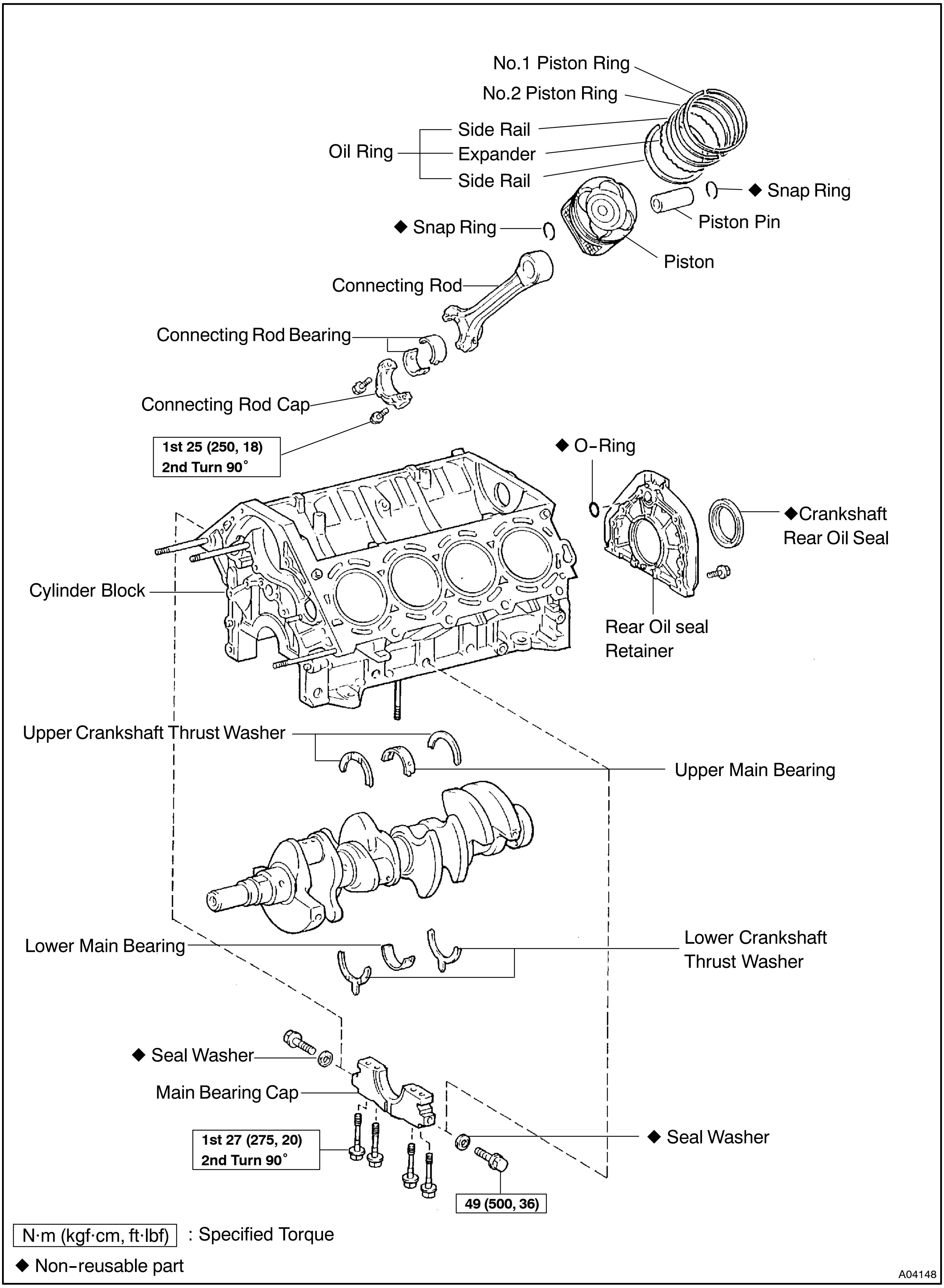
21. RECHECK AND OIL LEVELS

CYLINDER BLOCK

COMPONENTS

EM0G9-01

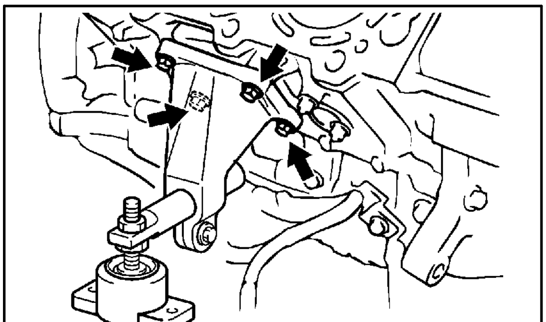



No.1 Piston Ring
No.2 Piston Ring
Oil Ring
Side Rail
Expander
Side Rail
◆ Snap Ring
Piston Pin
◆ Snap Ring
Piston
Connecting Rod
Connecting Rod Bearing
Connecting Rod Cap
1st 25 (250, 18)
2nd Turn 90°
◆ O-Ring
◆Crankshaft Rear Oil Seal
Cylinder Block
Rear Oil seal Retainer
Upper Crankshaft Thrust Washer
Upper Main Bearing
Lower Main Bearing
Lower Crankshaft Thrust Washer
◆ Seal Washer
Main Bearing Cap
1st 27 (275, 20)
2nd Turn 90°
◆ Seal Washer
49 (500, 36)
N·m (kgf·cm, ft·lbf) : Specified Torque
◆ Non-reusable part
A04148

EM0GA–01

DISASSEMBLY

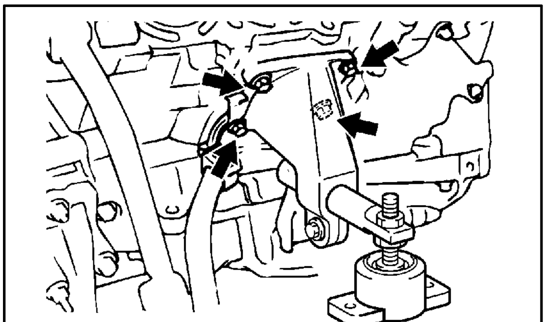
1. **INSTALL ENGINE TO ENGINE STAND FOR DISASSEMBLY**
2. **REMOVE TIMING BELT AND PULLEYS**
   (See page EM–12)
3. **REMOVE CYLINDER HEAD**
   (See page EM–29)
4. **REMOVE FUEL PUMP**
   (See page SF–8)



M04149

5. **REMOVE RH ENGINE MOUNTING BRACKET**

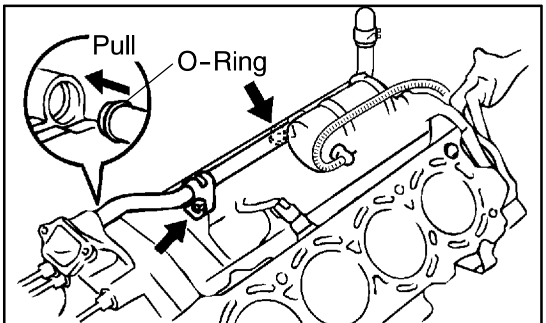
Remove the 4 bolts and mounting bracket.



M04150

6. **REMOVE LH ENGINE MOUNTING BRACKET**

Remove the 4 bolts and mounting bracket.

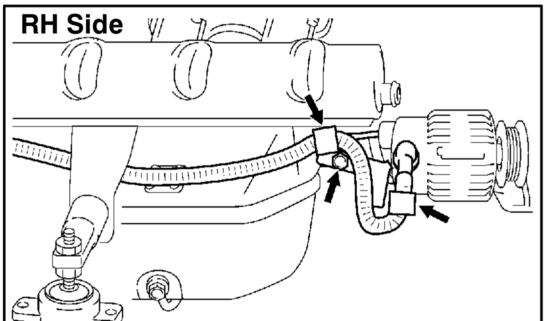


M04151

7. **REMOVE WATER BYPASS PIPE**

(a) Disconnect the engine wire clamp from the bracket on the water bypass pipe.
(b) Remove the 2 bolts.
(c) Pull out the water bypass pipe from the water pump.
(d) Remove the O–ring from the water bypass pipe.

8. **REMOVE STARTER**
   (See page ST–5)
9. **REMOVE KNOCK SENSORS**
   (See page SF–70)



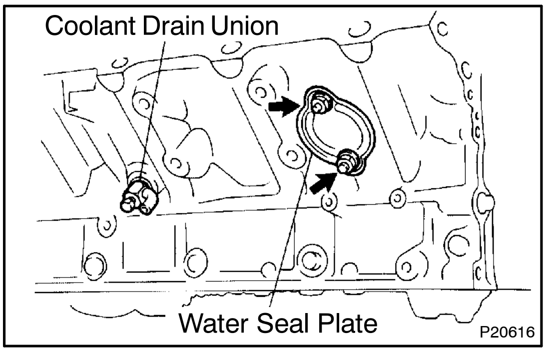
M00013

10. **REMOVE ENGINE WIRE**

(a) Disconnect the crankshaft position sensor.
(b) Remove the rubber cap and nut, and disconnect the oil pressure gauge wire.
(c) Remove the bolt and engine wire.

11. **REMOVE WATER PUMP**
    (See page CO–5)
12. **REMOVE NO.2 OIL PAN**
    (See page LU–8)

13. **REMOVE OIL PAN BAFFLE PLATE**
    (See page LU-8)
14. **REMOVE NO.1 OIL PAN**
    (See page LU-8)
15. **REMOVE OIL STRAINER**
    (See page LU-8)
16. **REMOVE OIL PUMP**
    (See page LU-8)

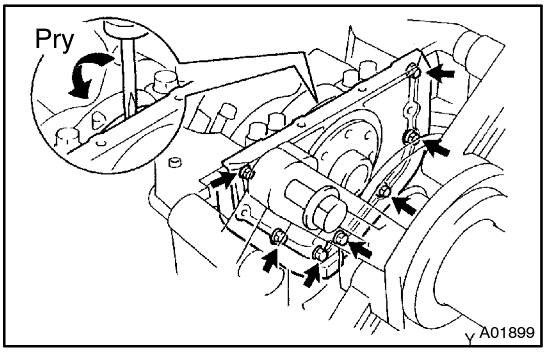


17. **REMOVE WATER SEAL PLATE**

Remove the 2 bolts and seal plate.

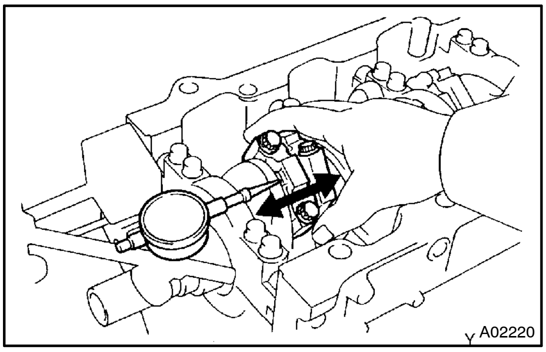
18. **REMOVE ENGINE COOLANT DRAIN UNIONS**

Remove the RH and LH drain unions.



19. **REMOVE REAR OIL SEAL RETAINER**

(a) Remove the 7 bolts.
(b) Using a screwdriver, remove the oil seal retainer by prying the portions between the oil seal retainer and main bearing cap.
(c) Remove the O-ring.



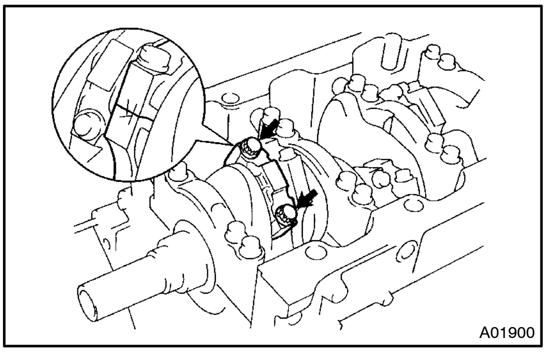
20. **CHECK CONNECTING ROD THRUST CLEARANCE**

Using a dial indicator, measure the thrust clearance while moving the connecting rod back an forth.

Standard thrust clearance:
0.160 - 0.290 mm (0.0063 - 0.0138 in.)
Maximum thrust clearance:
0.35 mm (0.0138 in.)

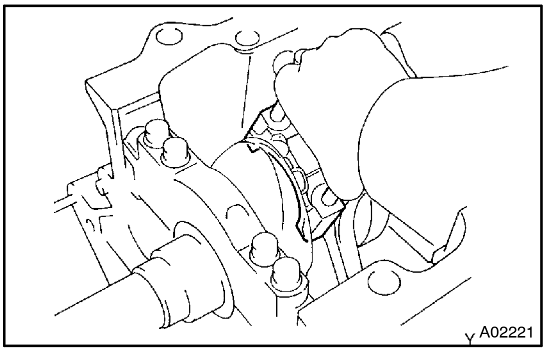
If the thrust clearance is greater than maximum, replace the connecting rod assembly(s). If necessary, replace the crankshaft.

Connecting rod thickness:
22.880 - 22.920 mm (0.9008 - 0.9024 in.)



21. **REMOVE CONNECTING ROD CAPS AND CHECK OIL CLEARANCE**

(a) Check the matchmarks on the connecting rod and cap to ensure correct reassembly.
(b) Remove the 2 connecting rod cap bolts.



(c) Using the 2 removed connecting rod cap bolts, remove the connecting rod cap and lower bearing by wiggling the connecting rod cap right and left.

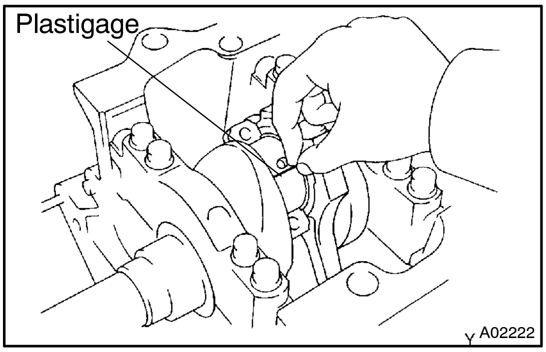
HINT:

Keep the lower bearing inserted with the connecting rod cap.

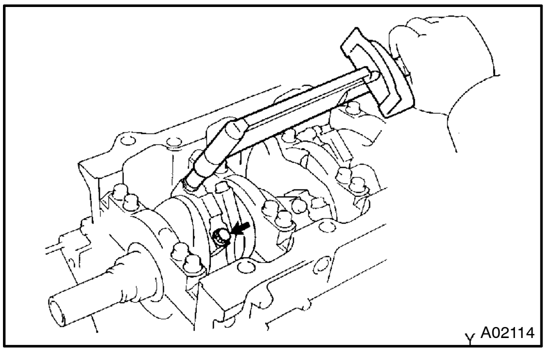
(d) Clean the crank pin and bearing.

(e) Check the crank pin and bearing for pitting and scratches.

If the crank pin or bearing is damaged, replace the bearings. If necessary, replace the crankshaft.



(f) Lay a strip of Plastigage across the crank pin.

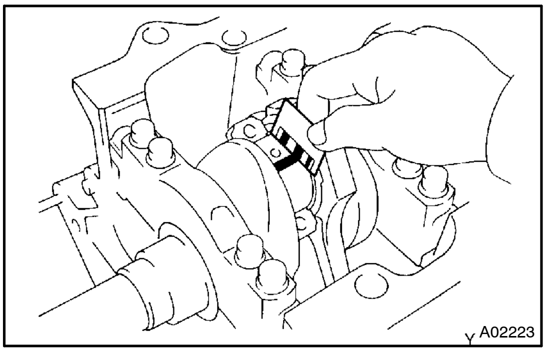


(g) Install the connecting rod cap with the 2 bolts.
(See page EM-96)

NOTICE:

Do not turn the crankshaft.

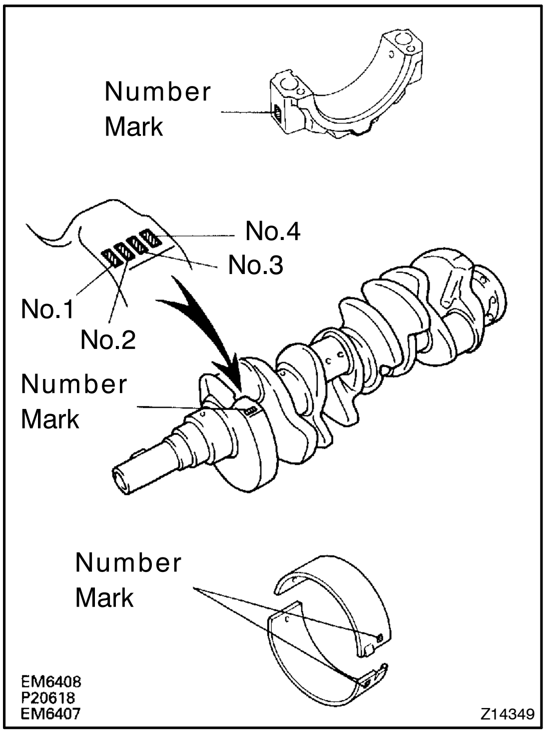
(h) Remove the 2 bolts, connecting rod cap and lower bearing. (See procedure (b) and (c) above)



(i) Measure the Plastigage at its widest point.

Standard oil clearance:
0.027 - 0.053 mm (0.0011 - 0.0021 in.)
Maximum oil clearance:
0.065 mm (0.0026 in.)

If the oil clearance is greater than maximum, replace the bearings. If necessary, replace the crankshaft.



HINT:
If using a standard bearing, replace it with one having the same number. If the number of the bearing cannot be determined, select the correct bearing by adding together the numbers imprinted on the connecting rod cap and crankshaft, then selecting the bearing with the same number as the total. There are 6 sizes of standard bearings, marked ”2”, ”3”, ”4”, ”5”, ”6” and ”7”.

	Number mark											
Connecting rod cap	1	1	2	1	2	3	2	3	4	3	4	4
Crankshaft	1	2	1	3	2	1	3	2	1	3	2	3
Use bearing	2	3		4			5			6		7

EXAMPLE:
Connecting rod cap ”3” + Crankshaft ”1”
= Total number 4 (Use bearing ”4”)

Reference
Connecting rod big end inside diameter:

Mark ”1”	55.000 – 55.006 mm (2.1654 – 2.1656 in.)
Mark ”2”	55.006 – 55.012 mm (2.1656 – 2.1658 in.)
Mark ”3”	55.012 – 55.018 mm (2.1658 – 2.1661 in.)
Mark ”4”	55.018 – 55.024 mm (2.1661 – 2.1663 in.)

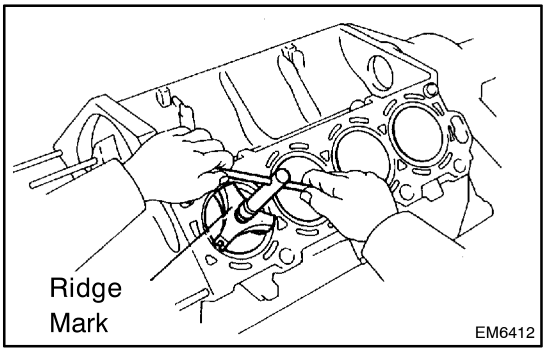
Crankshaft crank pin diameter:

Mark ”1”	51.994 – 52.000 mm (2.0470 – 2.0472 in.)
Mark ”2”	51.988 – 51.994 mm (2.0468 – 2.0470 in.)
Mark ”3”	51.982 – 51.988 mm (2.0465 – 2.0468 in.)

Standard sized bearing center wall thickness:

Mark ”2”	1.484 – 1.487 mm (0.0584 – 0.0585 in.)
Mark ”3”	1.487 – 1.490 mm (0.0585 – 0.0587 in.)
Mark ”4”	1.490 – 1.493 mm (0.0587 – 0.0588 in.)
Mark ”5”	1.493 – 1.496 mm (0.0588 – 0.0589 in.)
Mark ”6”	1.496 – 1.499 mm (0.0589 – 0.0590 in.)
Mark ”7”	1.499 – 1.502 mm (0.0590 – 0.0591 in.)

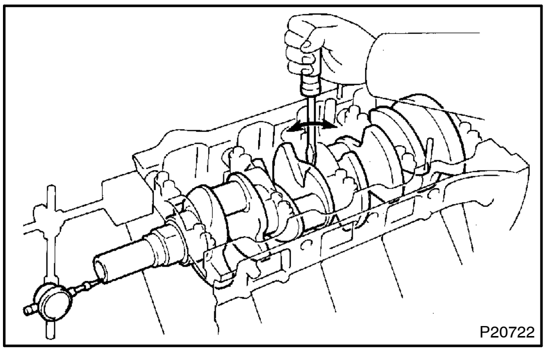
(a) Completely remove the Plastigage.



22. REMOVE PISTON AND CONNECTING ROD ASSEMBLIES

(a) Using a ridge reamer, remove all the carbon from the top of the cylinder.
(b) Push the piston, connecting rod assembly and upper bearing through the top of the cylinder block.

HINT:
- Keep the bearings, connecting rod and cap together.
- Arrange the piston and connecting rod assemblies in correct order.



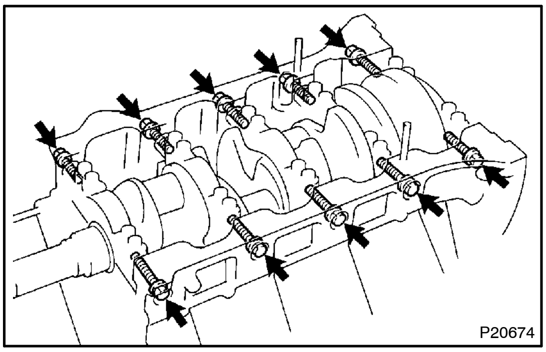
23. CHECK CRANKSHAFT THRUST CLEARANCE

Using a dial indicator, measure the thrust clearance while prying the crankshaft back and forth with a screwdriver.

Standard thrust clearance:
0.020 – 0.220 mm (0.0008 – 0.0087 in.)
Maximum thrust clearance:
0.30 mm (0.0118 in.)

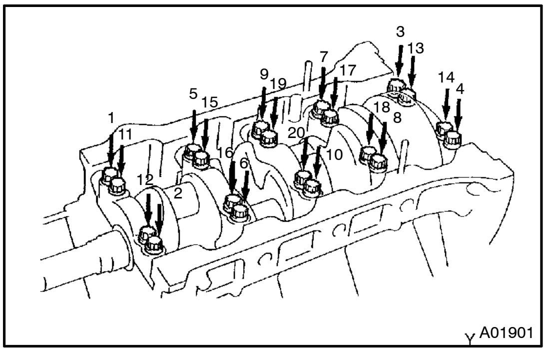
If the thrust clearance is greater than maximum, replace the thrust washers as a set.

Thrust washer thickness:
2.440 – 2.490 mm (0.0961 – 0.0980 in.)

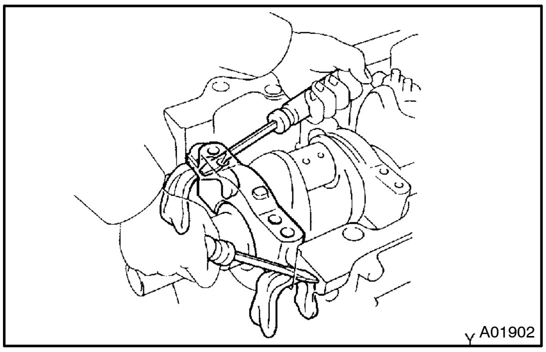


24. REMOVE MAIN BEARING CAPS AND CHECK OIL CLEARANCE

(a) Remove the 10 main bearing cap bolts.



(b) Uniformly loosen and remove the 20 main bearing cap bolts in several passes, in the sequence shown.



(c) Using 2 screwdrivers, pry out the main bearing cap, and remove the 5 main bearing caps, 5 lower bearings and 2 lower thrust washers (No.3 main bearing cap only).

NOTICE:
Be careful not to damage the cylinder block.

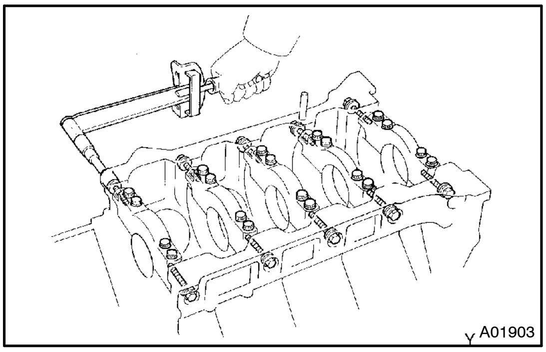
HINT:
- Keep the lower bearing and main bearing cap together.
- Arrange the main bearing caps and lower thrust washers in correct order.

(d) Lift out the crankshaft.
(e) Remove the 2 upper thrust washers.

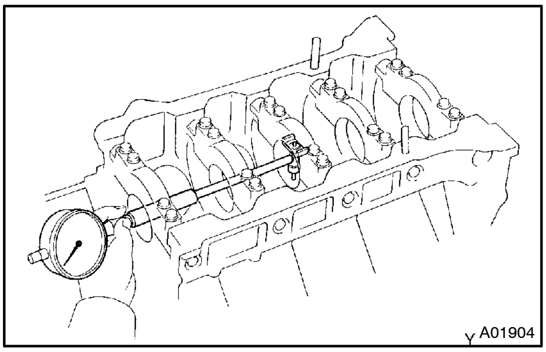
HINT:
- Arrange the upper thrust washers in correct order.
- Keep the upper bearings together with the cylinder block.

(f) Clean each main journal and bearing.
(g) Check each main journal and bearing for pitting and scratches.

If the journal or bearing is damaged, replace the bearings. If necessary, replace the crankshaft.



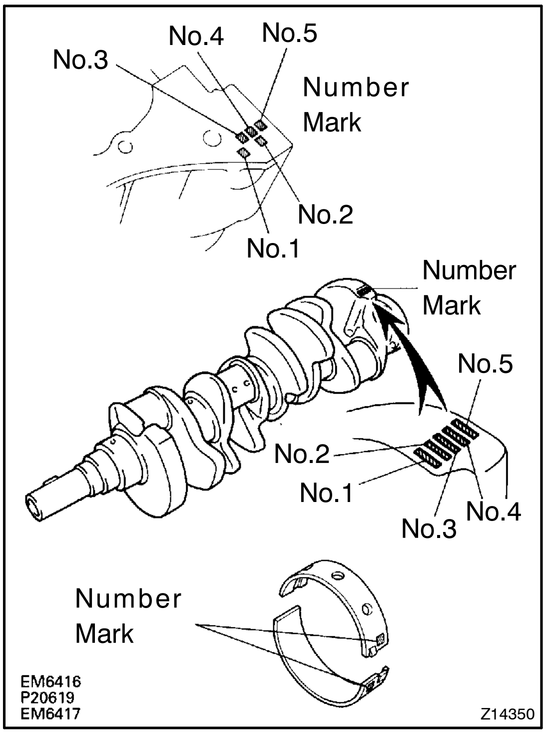
(h) Install the 10 main bearings and 5 main bearing caps with the 30 bolts. Do not install the crankshaft.
(See page EM–96)



(i) Using a cylinder gauge, measure the inside diameter of the main bearing.
Bearing inside diameter:
66.986 – 67.000 mm (2.6372 – 2.6378 in.)

(j) Measure the diameter of the main journal.
(See page EM–87)

(k) Subtract the main journal diameter measurement from the main bearing inside diameter measurement.
Standard clearance:
No.1 and No.5
0.017 – 0.033 mm (0.0007 – 0.0013 in.)
Others
0.029 – 0.045 mm (0.0011 – 0.0018 in.)
Maximum clearance:
No.1 and No.5
0.043 mm (0.0017 in.)
Others
0.055 mm (0.0022 in.)



If the oil clearance is greater than maximum, replace the bearings. If necessary, replace the crankshaft.
HINT:
If using a standard bearing, replace it with one having the same number. If the number of the bearing cannot be determined, select the correct bearing by adding together the numbers imprinted on the cylinder block and crankshaft, then refer to the table below for the appropriate bearing number. There are 5 sizes of the standard bearings. For No.1 and No.5 position bearings, use bearings marked ”3”, ”4”, ”5”, ”6” and ”7”. For others position bearings, use bearings marked ”1”, ”2”, ”3”, ”4” and ”5”.

No.1, No.5:

		Use bearing	
		Upper	Lower
Cylinder block (A) + Crankshaft (B)	0 – 5	3	3
	6 – 8	3	4
	9 – 11	4	4
	12 – 14	4	5
	15 – 17	5	5
	18 – 20	5	6
	21 – 23	6	6
	24 – 26	6	7
	27 – 28	7	7

EXAMPLE:
Cylinder block ”08” + Crankshaft ”06”
= Total number 14 (Use bearing ”4” (Upper), ”5” (Lower))

Others:

		Use bearing	
		Upper	Lower
Cylinder block (A) + Crankshaft (B)	0 – 5	1	1
	6 – 8	1	2
	9 – 11	2	2
	12 – 14	2	3
	15 – 17	3	3
	18 – 20	3	4
	21 – 23	4	4
	24 – 26	4	5
	27 – 28	5	5

EXAMPLE:
Cylinder block ”08” + Crankshaft ”06”
= Total number 14 (Use bearing ”2” (Upper), ”3” (Lower))

Reference

Cylinder block main journal bore diameter (A):

Mark ”00”	72.000 mm (2.8346 in.)
Mark ”01”	72.001 mm (2.8347 in.)
Mark ”02”	72.002 mm (2.8347 in.)
Mark ”03”	72.003 mm (2.8348 in.)
Mark ”04”	72.004 mm (2.8348 in.)
Mark ”05”	72.005 mm (2.8348 in.)
Mark ”06”	72.006 mm (2.8349 in.)
Mark ”07”	72.007 mm (2.8349 in.)
Mark ”08”	72.008 mm (2.8350 in.)
Mark ”09”	72.009 mm (2.8350 in.)
Mark ”10”	72.010 mm (2.8350 in.)
Mark ”11”	72.011 mm (2.8351 in.)
Mark ”12”	72.012 mm (2.8351 in.)
Mark ”13”	72.013 mm (2.8352 in.)
Mark ”14”	72.014 mm (2.8352 in.)
Mark ”15”	72.015 mm (2.8352 in.)
Mark ”16”	72.016 mm (2.8353 in.)

Crankshaft main journal diameter (B):

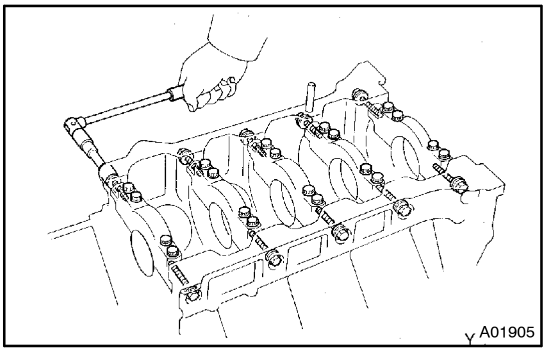
Mark ”00”	67.000 mm (2.6378 in.)
Mark ”01”	66.999 mm (2.6378 in.)
Mark ”02”	66.998 mm (2.6377 in.)
Mark ”03”	66.997 mm (2.6377 in.)
Mark ”04”	66.996 mm (2.6376 in.)
Mark ”05”	66.995 mm (2.6376 in.)
Mark ”06”	66.994 mm (2.6376 in.)
Mark ”07”	66.993 mm (2.6375 in.)
Mark ”08”	66.992 mm (2.6375 in.)
Mark ”09”	66.991 mm (2.6374 in.)
Mark ”10”	66.990 mm (2.6374 in.)
Mark ”11”	66.989 mm (2.6374 in.)
Mark ”12”	66.988 mm (2.6373 in.)

Standard bearing center wall thickness:
No.1 and No.5

Mark ”3”	2.492 – 2.495 mm (0.0981 – 0.0982 in.)
Mark ”4”	2.495 – 2.498 mm (0.0982 – 0.0983 in.)
Mark ”5”	2.498 – 2.501 mm (0.0983 – 0.0985 in.)
Mark ”6”	2.501 – 2.504 mm (0.0985 – 0.0986 in.)
Mark ”7”	2.504 – 2.507 mm (0.0986 – 0.0987 in.)

Others

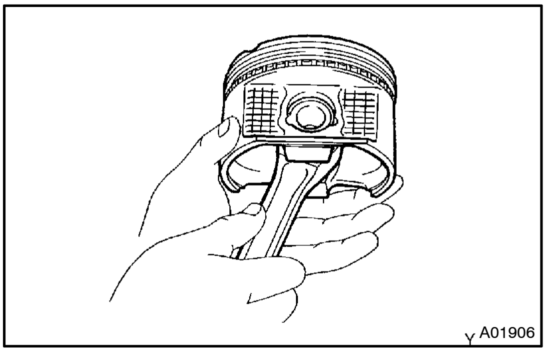
Mark ”1”	2.486 – 2.489 mm (0.0979 – 0.0980 in.)
Mark ”2”	2.489 – 2.492 mm (0.0980 – 0.0981 in.)
Mark ”3”	2.492 – 2.495 mm (0.0981 – 0.0982 in.)
Mark ”4”	2.495 – 2.498 mm (0.0982 – 0.0983 in.)
Mark ”5”	2.498 – 2.501 mm (0.0983 – 0.0985 in.)



(l) Remove the 10 bolts, 20 nuts, 5 main bearing caps and 5 lower main bearing.
(See procedure (a) to (c) above)

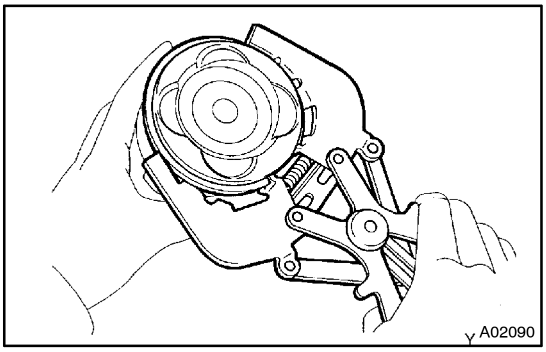
(m) Remove the 5 upper main bearings from the cylinder block.

HINT:
Arrange the main bearing caps, bearings and thrust washers in correct order.



25. CHECK FIT BETWEEN PISTON AND PISTON PIN

Try to move the piston back and forth on the piston pin.
If any movement is felt, replace the piston and pin as a set.


A02090

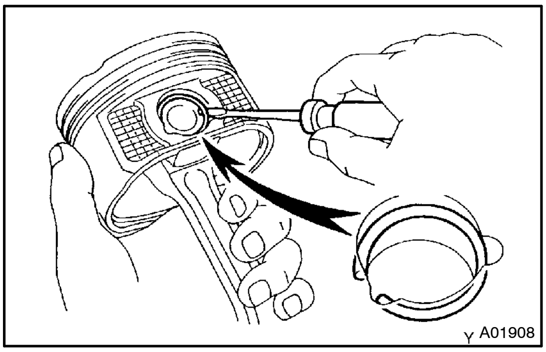
26. REMOVE PISTON RINGS

(a) Using a piston ring expander, remove the 2 compression rings.

(b) Remove the 2 side rails and oil ring by hand.

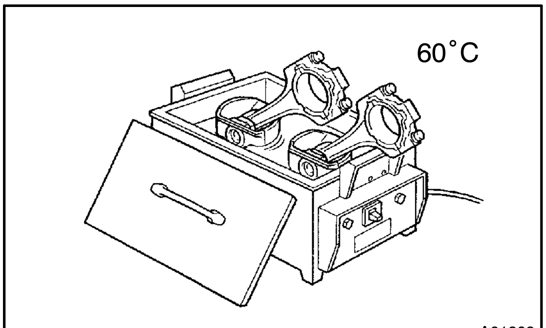
HINT:

Arrange the piston rings in correct order only.


A01908

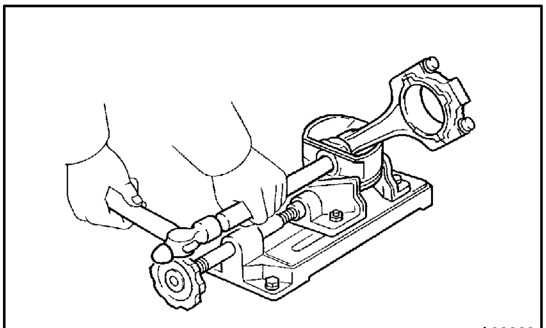
27. DISCONNECT CONNECTING ROD FROM PISTON

(a) Using a small screwdriver, pry out the 2 snap rings.



A01909

(b) Gradually heat the piston to approx. 60˚C (140˚F).


A02068

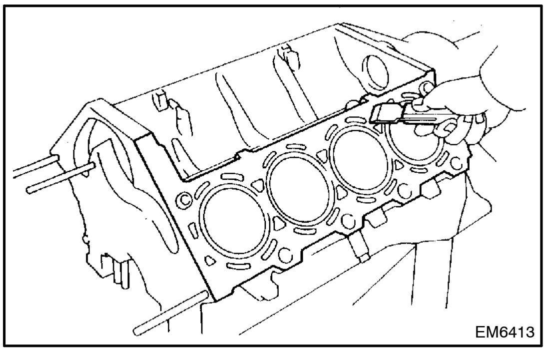
(c) Using a plastic-faced hammer and brass bar, lightly tap out the piston pin and pin and remove the connecting rod.

HINT:

- The piston and pin are a matched set.
- Arrange the pistons, pins, rings, connecting rods and bearings in correct order.

EM0GB–01

INSPECTION


EM6413

1. REMOVE GASKET MATERIAL

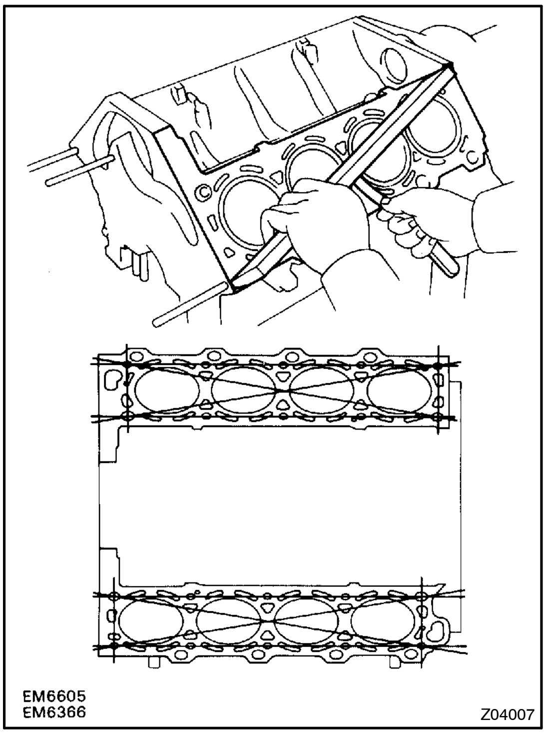
Using a gasket scraper, remove all the gasket material from the top surface of the cylinder block.

2. CLEAN CYLINDER BLOCK

Using a soft brush and solvent, thoroughly clean the cylinder block.

NOTICE:

If the cylinder is washed at high temperatures, the cylinder liner sticks out beyond the cylinder block, so always wash the cylinder block at a temperature of 45° or less.

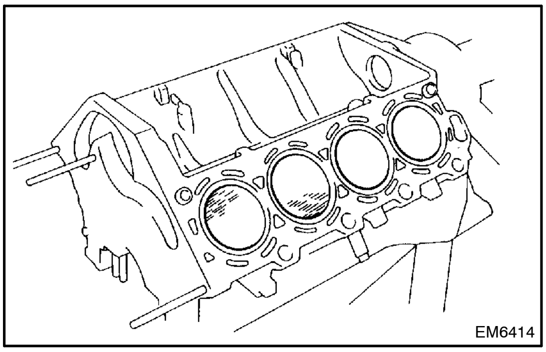

EM6605
EM6366
Z04007

3. INSPECT TOP SURFACE OF CYLINDER BLOCK FOR FLATNESS

Using a precision straight edge and feeler gauge, measure the surface contacting the cylinder head gasket for warpage.

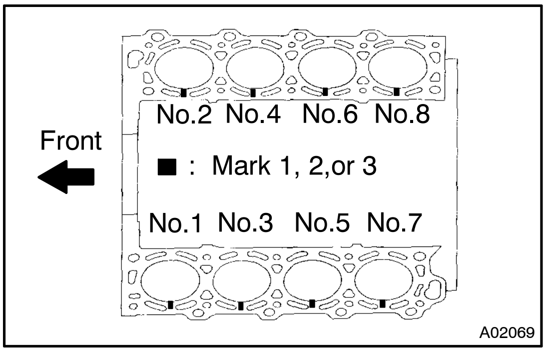
Maximum warpage:
0.07 mm (0.0028 in.)

If warpage is greater than maximum, replace the cylinder block.


EM6414

4. INSPECT CYLINDER FOR VERTICAL SCRATCHES

Visually check the cylinder for vertical scratches.
If deep scratches are present, replace the cylinder block.

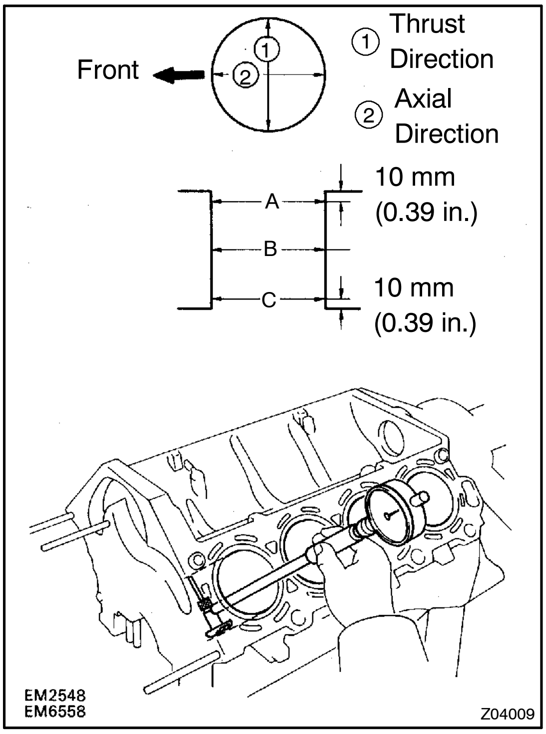


A02069

5. INSPECT CYLINDER BORE DIAMETER

HINT:

There are 3 sizes of the standard cylinder bore diameter, marked "1", "2" and "3" accordingly. The mark is stamped on the top of the cylinder block.



Using a cylinder gauge, measure the cylinder bore diameter at positions A, B and C in the thrust and axial directions.

Standard diameter:

Mark "1"

87.500 - 87.510 mm (3.4449 - 3.4453 in.)

Mark "2"

87.510 - 87.520 mm (3.4453 - 3.4457 in.)

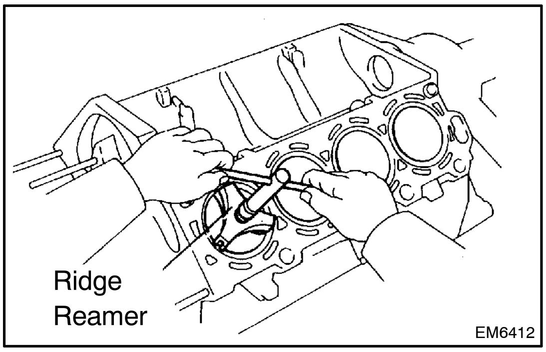
Mark "3"

87.520 - 87.530 mm (3.4457 - 3.4461 in.)

Maximum diameter:

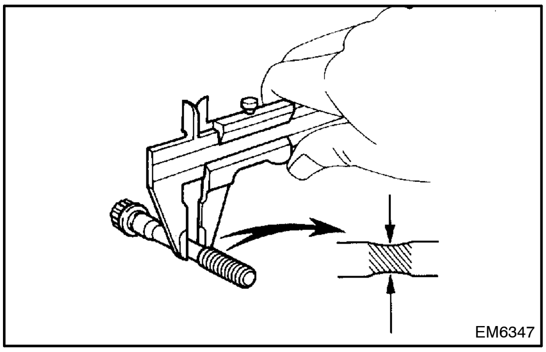
87.73 mm (3.4539 in.)

If the diameter is greater than maximum, replace the cylinder block.



6. REMOVE CYLINDER RIDGE

If the wear is less than 0.2 mm (0.008 in.), using a ridge reamer, grind the top of the cylinder.



7. INSPECT MAIN BEARING CAP BOLTS

Using vernier calipers, measure the tension portion diameter of the bolt.

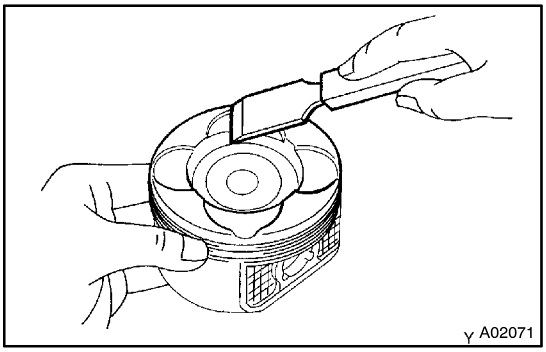
Standard diameter:

7.500 - 7.600 mm (0.2953 - 0.2992 in.)

Minimum diameter:

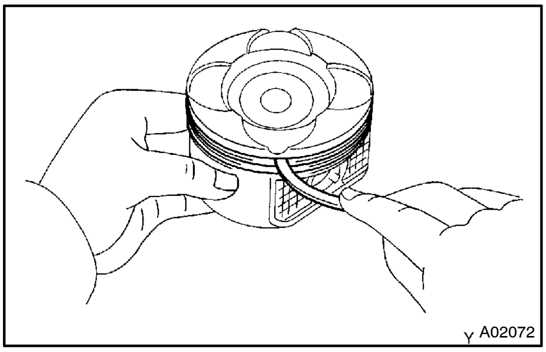
7.20 mm (0.2835 in.)

If the diameter is less than minimum, replace the stud bolt.

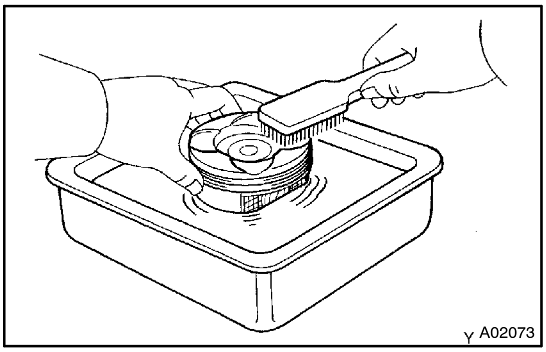


8. CLEAN PISTON

(a) Using a gasket scraper, remove the carbon from the piston top.



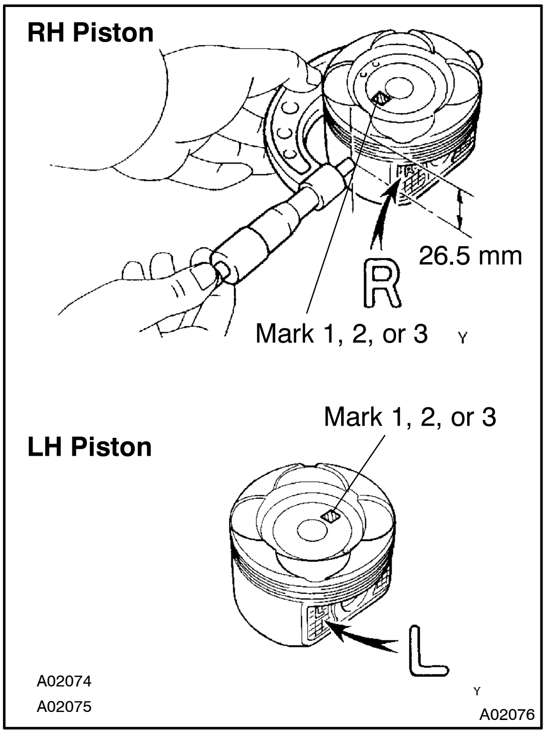
(b) Using a groove cleaning tool or broken ring, clean the piston ring grooves.



(c) Using solvent and a brush, thoroughly clean the piston.

NOTICE:

Do not use a wire brush.



9. INSPECT PISTON OIL CLEARANCE

HINT:

There are 3 sizes of the standard piston diameter, marked ”1”, ”2” and ”3” accordingly. The mark is stamped on the piston top.

(a) Using a micrometer, measure the piston diameter at right angles to the piston pin center line, 26.5 mm (1.04 in.) from the piston head.

Piston diameter:

Mark ”1”

87.406 - 87.416 mm (3.4411 - 3.4416 in.)

Mark ”2”

87.416 - 87.426 mm (3.4416 - 3.4420 in.)

Mark ”3”

87.426 - 87.436mm (3.4420 - 3.4424 in.)

(b) Measure the cylinder bore diameter in the thrust directions.

(See step 5 above)

(c) Subtract the piston diameter measurement from the cylinder bore diameter measurement.

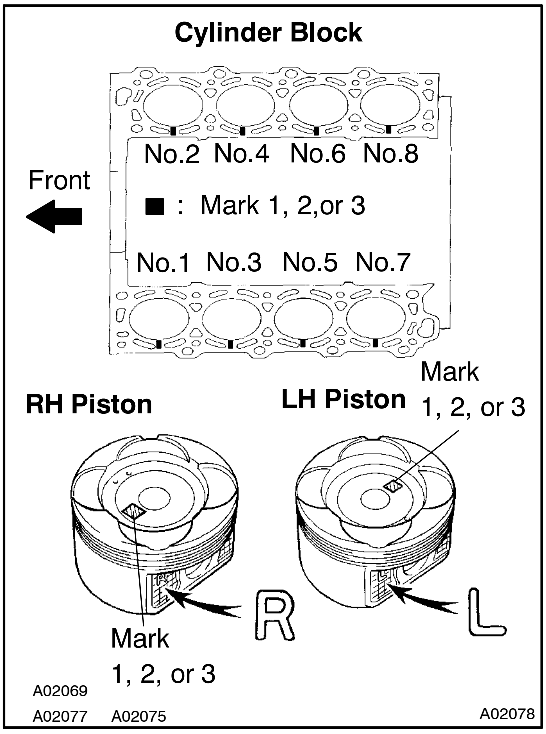
Standard oil clearance:

0.084 - 0.104 mm (0.0033 - 0.0041 in.)

Maximum oil clearance:

0.124 mm (0.0049 in.)

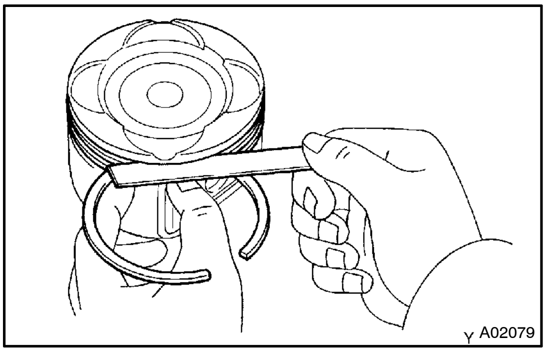
If the oil clearance is greater than maximum, replace all the 8 pistons. If necessary, replace the cylinder block.



HINT

Use new cylinder block:

- Use a piston with the same number mark as the cylinder diameter marked on the cylinder block.
- The shape of the piston varies for the RH and LH banks. The RH piston is marked with ”R”, the LH piston with ”L”.

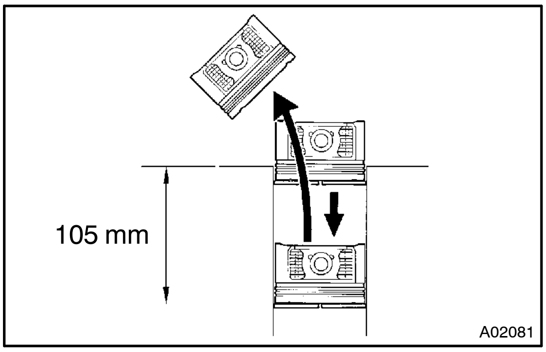


10. INSPECT PISTON RING GROOVE CLEARANCE

Using a feeler gauge, measure the clearance between new piston ring and the wall of the ring groove.

Ring groove clearance:
No.1
0.020 - 0.070 mm (0.0008 - 0.0028 in.)
No.2
0.010 - 0.050 mm (0.0004 - 0.0020 in.)

If the clearance is not as specified, replace the piston.



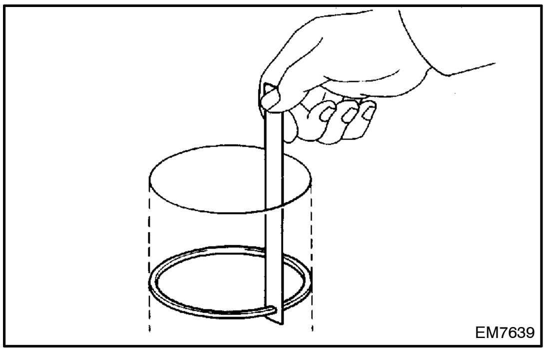
11. INSPECT PISTON RING END GAP

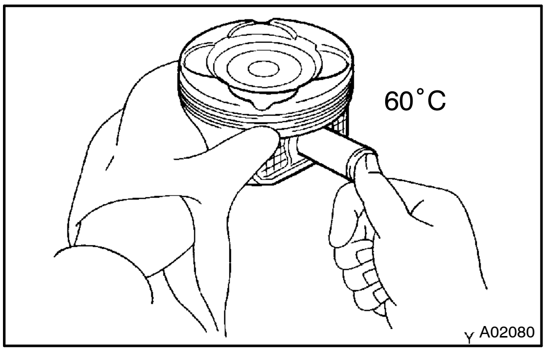
(a) Insert the piston ring into the cylinder bore.

(b) Using a piston, push the piston ring a little beyond the bottom of the ring travel, 105 mm (4.13 in.) from the top of the cylinder block.

(c) Using a feeler gauge, measure the end gap.

Standard end gap:
No.1
0.250 - 0.450 mm (0.0098 - 0.0177 in.)
No.2
0.500 - 0.700 mm (0.0197 - 0.0276 in.)
Oil (Side rail)
0.150 - 0.500 mm (0.0059 - 0.0197 in.)
Maximum end gap:
No.1
1.05 mm (0.0413 in.)
No.2
1.30 mm (0.0512 in.)
Oil (Side rail)
1.10 mm (0.0433 in.)

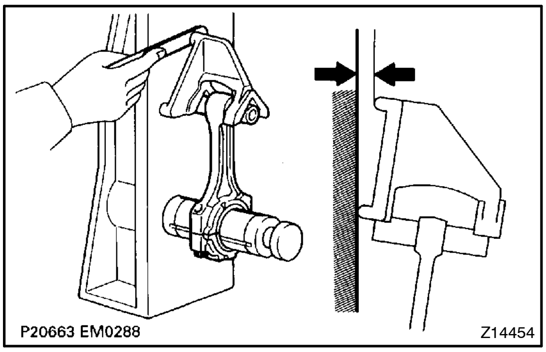




If the end gap is greater than maximum, replace the piston ring. If the end gap is greater than maximum, even with a new piston ring, replace the cylinder block.

12. INSPECT PISTON PIN FIT

At 60°C (140°F), you should be able to push the piston pin into the piston pin hole with your thumb.



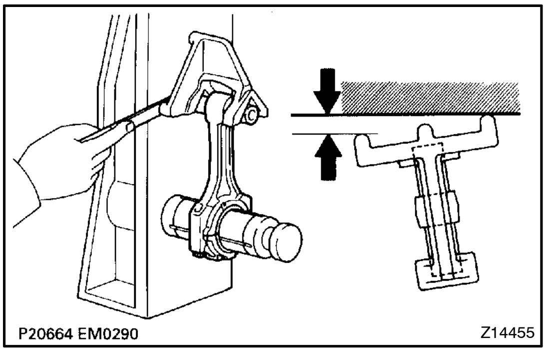
13. INSPECT CONNECTING ROD ALIGNMENT

Using a rod aligner and feeler gauge, check the connecting rod alignment.

- Check for bend.

Maximum bend:
0.05 mm (0.0020 in.) per 100 mm (3.94 in.)

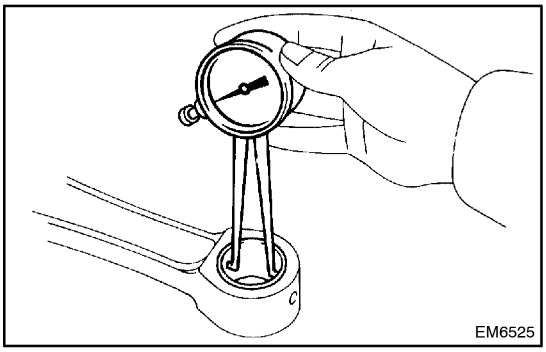
If bend is greater than maximum, replace the connecting rod assembly.



- Check for twist

Maximum twist:
0.15 mm (0.0059 in.) per 100 mm (3.94 in.)

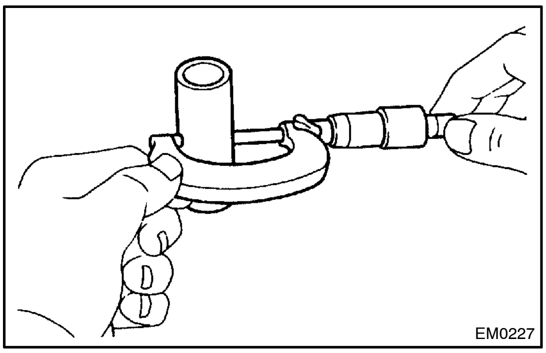
If twist is greater than maximum, replace the connecting rod assembly.



14. INSPECT PISTON PIN OIL CLEARANCE

(a) Using a caliper gauge, measure the inside diameter of the connecting rod bushing.

Bushing inside diameter:
22.005 – 22.014 mm (0.8663 – 0.8667 in.)

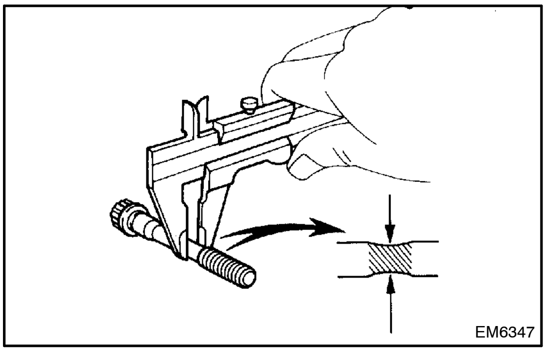


(b) Using a micrometer, measure the piston pin diameter.

Piston pin diameter:
21.997 – 22.006 mm (0.8660 – 0.8664 in.)

(c) Subtract the piston pin diameter measurement from the bushing inside diameter measurement.

Standard oil clearance:
0.005 – 0.011 mm (0.0002 – 0.0004 in.)
Maximum oil clearance:
0.05 mm (0.0020 in.)



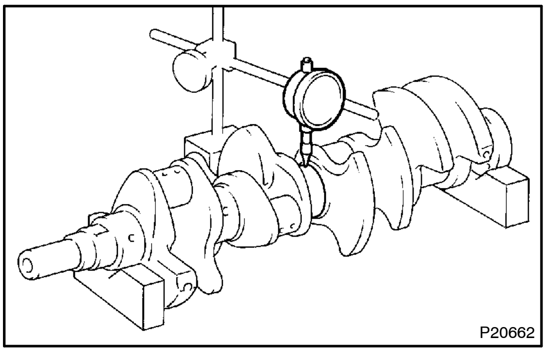
If the oil clearance is greater than maximum, replace the bushing. If necessary, replace the piston and piston pin as a set.

15. INSPECT CONNECTING ROD BOLTS

Using vernier calipers, measure the tension portion of the connecting rod bolt.

Standard diameter:
7.200 - 7.300 mm (0.2835 - 0.2874 in.)
Minimum diameter:
7.00 mm (0.2756 in.)

If the diameter is less than minimum, replace the bolt.

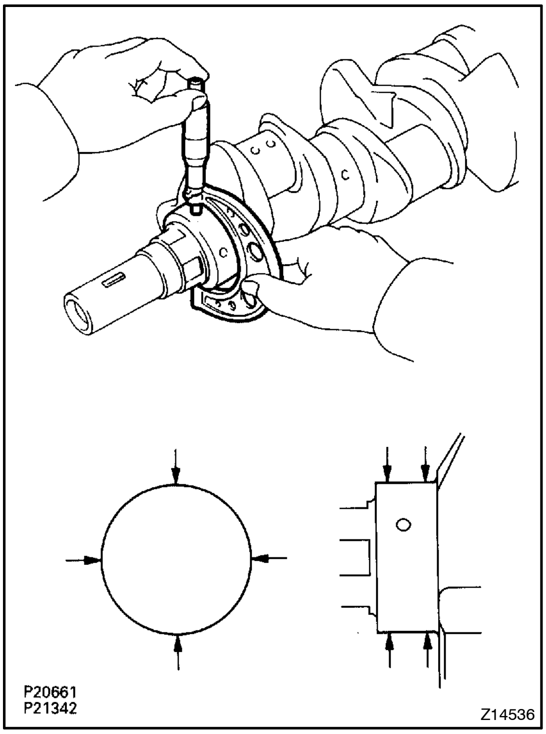


16. INSPECT CRANKSHAFT FOR CIRCLE RUNOUT

(a) Place the crankshaft on V-blocks.
(b) Using a dial indicator, measure the circle runout at the center journal.

Maximum circle runout:
0.08 mm (0.0031 in.)

If the circle runout is greater than maximum, replace the crankshaft.



17. INSPECT MAIN JOURNALS AND CRANK PINS

(a) Using a micrometer, measure the diameter of each main journal and crank pin.

Main journal diameter:
66.988 - 67.000 mm (2.6373 - 2.6378 in.)
Crank pin diameter:
51.982 - 52.000 mm (2.0465 - 2.0472 in.)

If the diameter is not as specified, check the oil clearance (See disassembly). If necessary, replace the crankshaft.

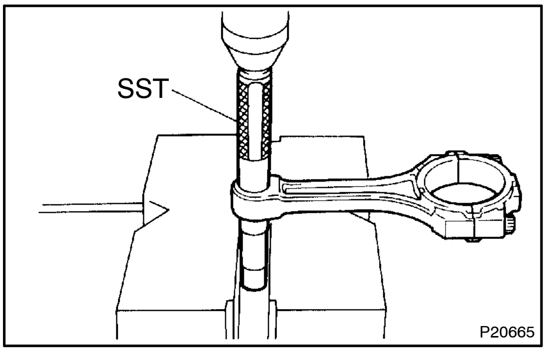
(b) Check each main journal and crank pin for taper and out-of-round as shown.

Maximum taper and out-of-round:
0.02 mm (0.0008 in.)

If the taper and out-of-round is greater than maximum, replace the crankshaft.

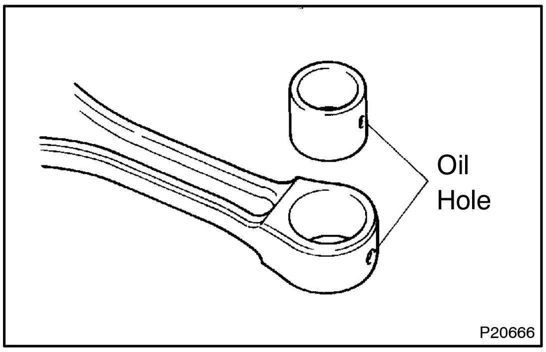
EM0GC–01

REPLACEMENT



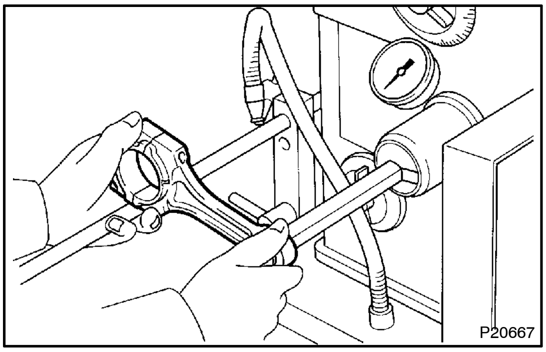
1. REPLACE CONNECTING ROD BUSHINGS

(a) Using SST and a press, press out the bushing.
SST 09222–30010

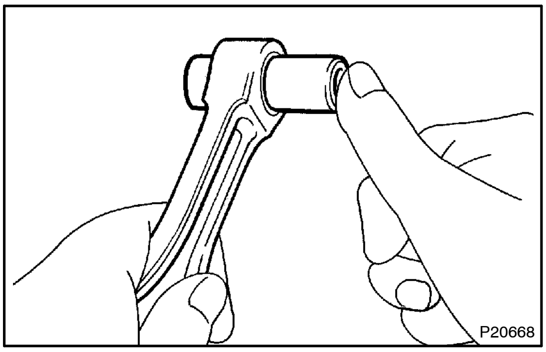


(b) Align the oil holes of a new bushing and the connecting rod.

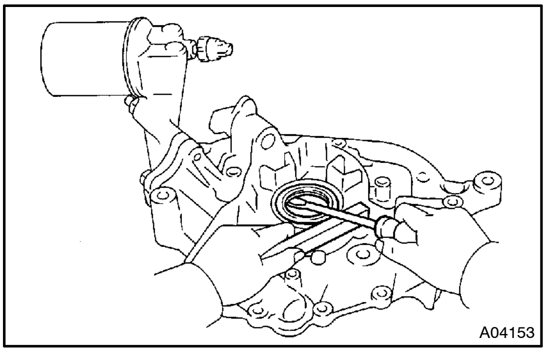
(c) Using SST and a press, press in the bushing.
SST 09222–30010



(d) Using a pin hole grinder, hone the bushing to obtain the standard specified clearance (See page EM–87) between the bushing and piston pin.



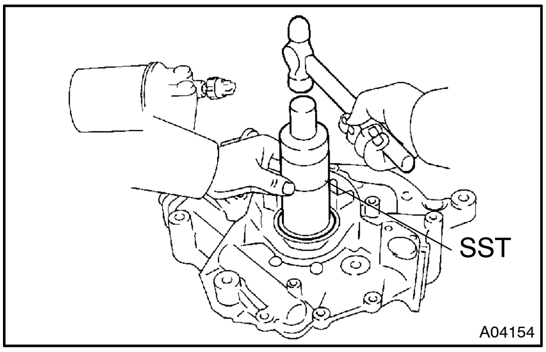
(e) Check the piston pin fit at normal room temperature. Coat the piston pin with engine oil, and push it into the connecting rod with your thumb.



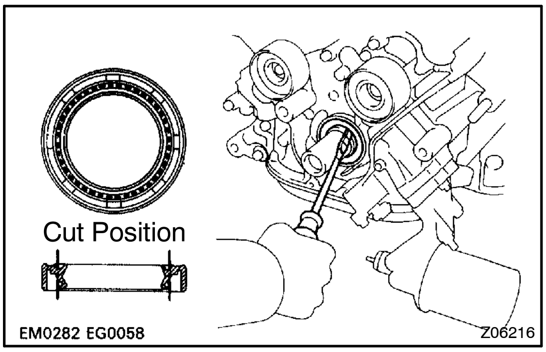
2. REPLACE CRANKSHAFT FRONT OIL SEAL

HINT:
There are 2 methods ((a) and (b)) to replace the oil seal.

(a) If oil pump is removed from cylinder block:
(1) Using a screwdriver, pry out the oil seal.

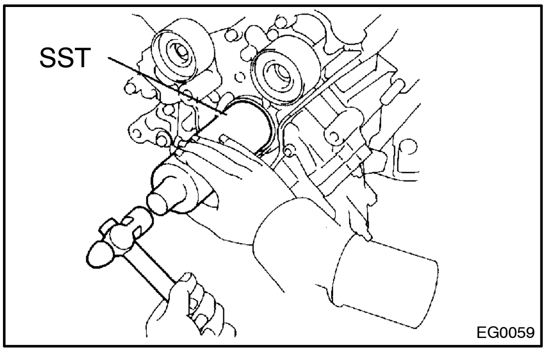


(2) Using SST and a hammer, tap in a new oil seal until its surface is flush with the oil pump body edge.
SST 09316-60011 (09316-00011)
(3) Apply MP grease to the oil seal lip.

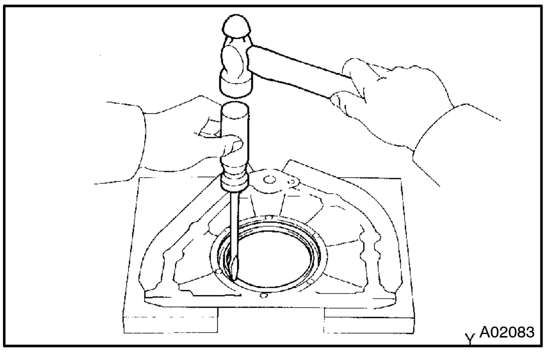


(b) If oil pump is installed to the cylinder block:
(1) Using a knife, cut off the oil seal lip.
(2) Using a screwdriver, pry out the oil seal.

NOTICE:
Be careful not to damage the crankshaft. Tape the screwdriver tip.

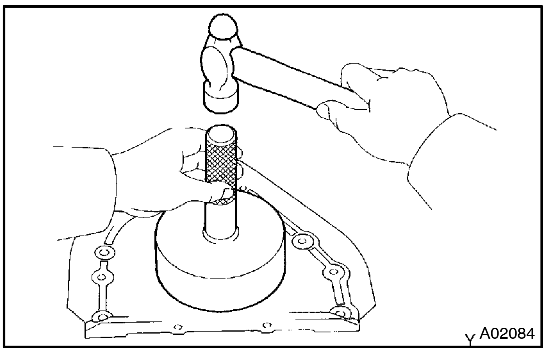


(3) Apply MP grease to a new oil seal lip.
(4) Using SST and a hammer, tap in the oil seal until its surface is flush with the oil pump body edge.
SST 09316-60011 (09316-00011)

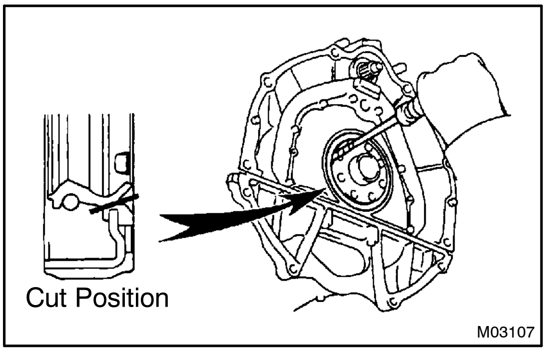


3. REPLACE CRANKSHAFT REAR OIL SEAL

HINT:
There are 2 methods ((a) and (b)) to replace the oil seal which.
(a) If rear oil seal retainer is removed from cylinder block:
(1) Using a screwdriver and hammer, tap out the oil seal.

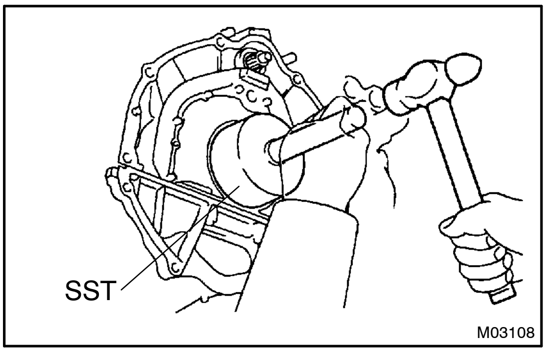


(2) Using SST and a hammer, tap in a new oil seal until its surface is flush with the rear oil seal retainer edge.
SST 09223-56010
(3) Apply MP grease to the oil seal lip.



(b) If rear oil seal retainer is installed to cylinder block:
  (1) Using a knife, cut off the oil seal lip.
  (2) Using a screwdriver, pry out the oil seal.

NOTICE:
Be careful not to damage the crankshaft. Tape the screwdriver tip.



  (3) Apply MP grease to a new oil seal lip.
  (4) Using SST and a hammer, tap in the oil seal until its surface is flush with the rear oil seal retainer edge.

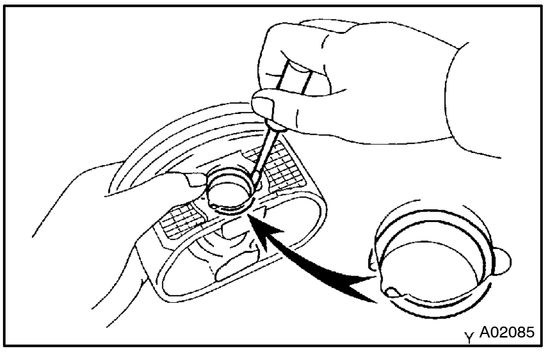
SST 09223-56010

EM0GD-01

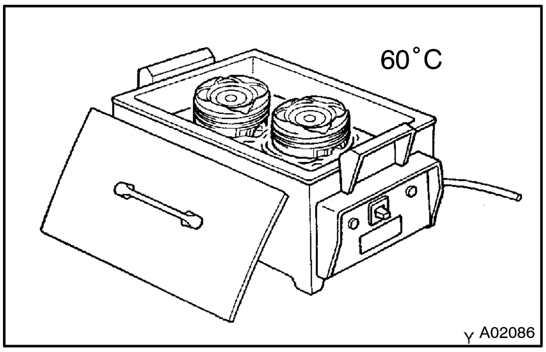
REASSEMBLY

HINT:
- Thoroughly clean all parts to be assembled.
- Before installing the parts, apply new engine oil to all sliding and rotating surfaces.
- Replace all gaskets, O-rings and oil seals with new parts.

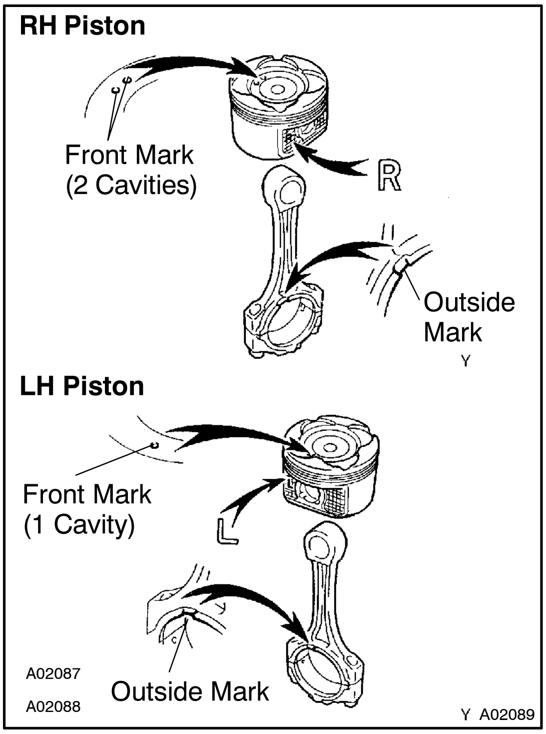
1. ASSEMBLE PISTON AND CONNECTING ROD



(a) Using a small screwdriver, install a new snap ring on one side of the piston pin hole.



(b) Gradually heat the piston to about 60°C (140°F).



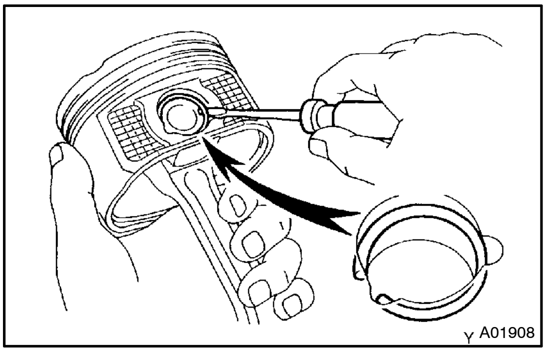
(c) Coat the piston pin with engine oil.

(d) Position the piston front mark with respect to the outside mark on the connecting rod as shown in the diagram.

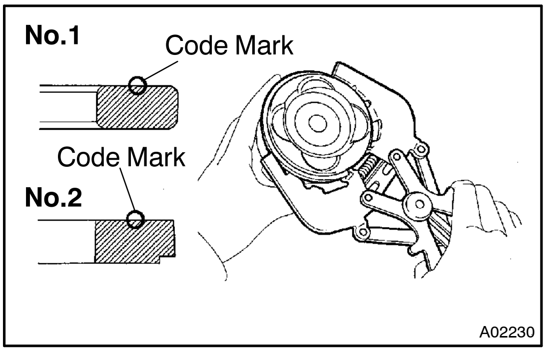
NOTICE:

The installation directions of the piston and connecting rod are different for the RH and LH banks. The RH piston is marked with "R", the LH piston with "L".

(e) Align the piston pin holes of the piston and connecting rod, and push in the piston pin with your thumb.



(f) Using a small screwdriver, install a new snap ring on the other side of the piston pin hole.



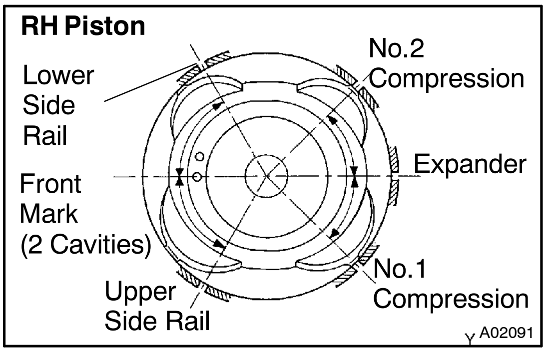
2. INSTALL PISTON RINGS

(a) Install the oil ring expander and 2 side rails by hand.

(b) Using a piston ring expander, install the 2 compression rings with the code mark facing upward.

Code mark:

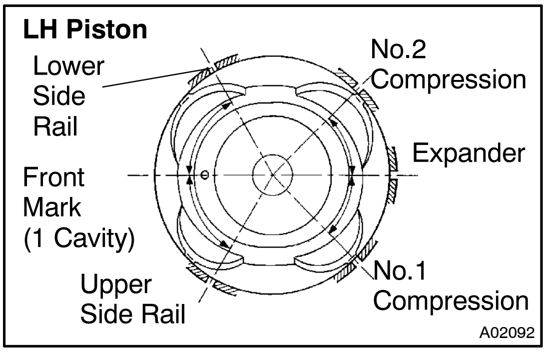
No.1	1R
No.2	2R

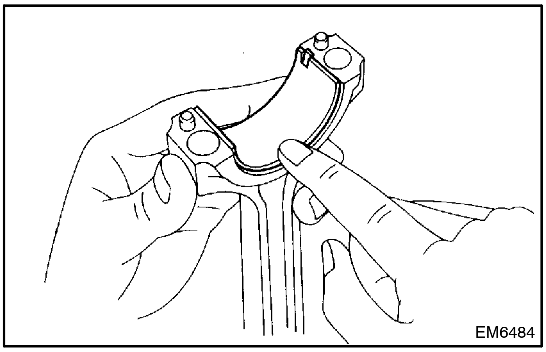


(c) Position the piston rings so that the ring ends are as shown.

NOTICE:

Do not align the ring ends.

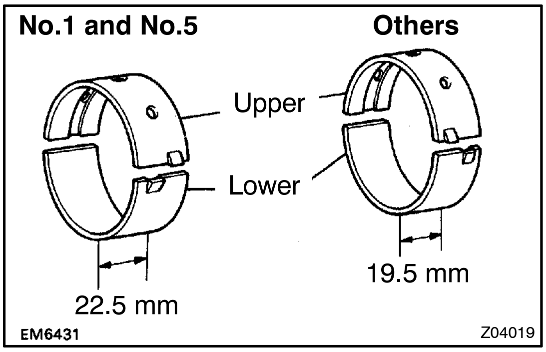




3. INSTALL BEARINGS

(a) Align the bearing claw with the groove of the connecting rod or connecting cap.

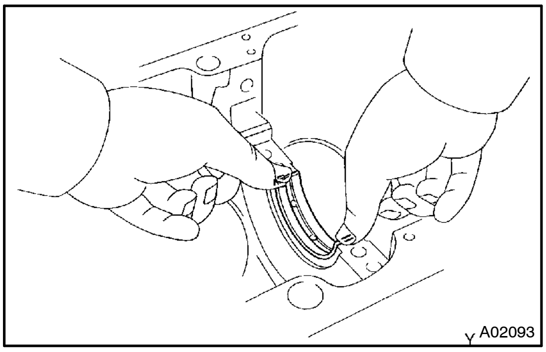
(b) Install the bearings in the connecting rod and connecting rod cap.



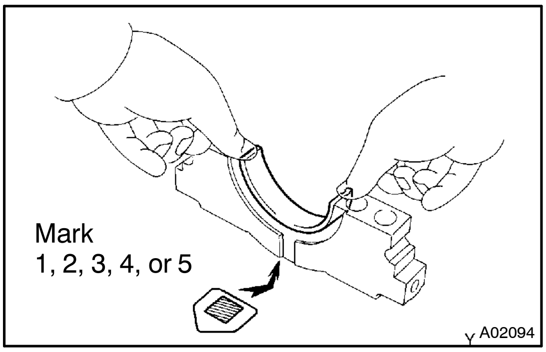
4. INSTALL MAIN BEARINGS

HINT:

- Main bearings come in widths of 19.5 mm (0.768 in.) and 22.5 mm (0.886 in.). Install the 22.5 mm (0.886 in.) bearings in the No.1 and No.5 cylinder block journal positions with the main bearing cap. Install the 19.5 mm (0.768 in.) bearings in the other positions.
- Upper bearings have an oil groove and oil holes; lower bearings do not.



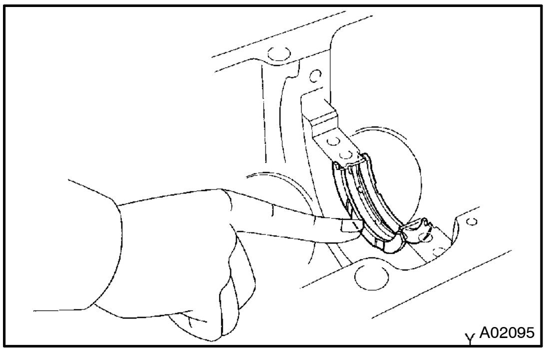
(a) Align the bearing claw with the claw groove of the cylinder block, and push in the 5 upper bearings.



(b) Align the bearing claw with the claw groove of the main bearing cap, and push in the 5 lower bearings.

HINT:

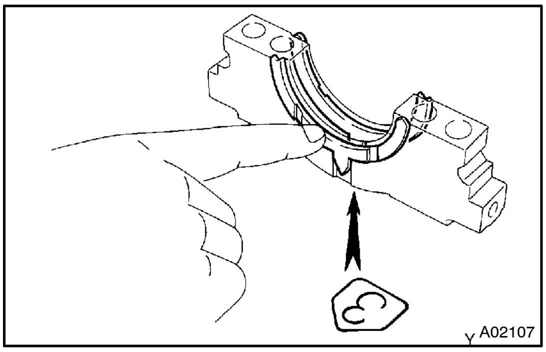
A number is marked on each main bearing cap to indicate the installation position.



5. INSTALL UPPER THRUST WASHERS

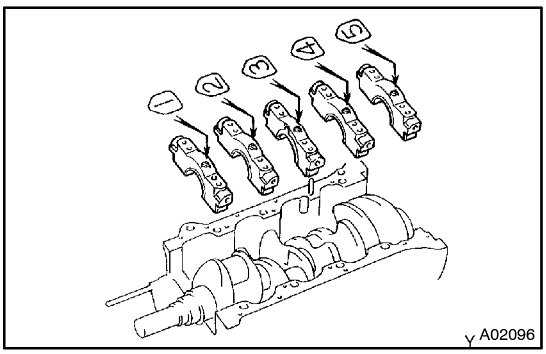
Install the 2 thrust washers under the No.3 journal position of the cylinder block with the oil grooves facing outward.

6. PLACE CRANKSHAFT ON CYLINDER BLOCK

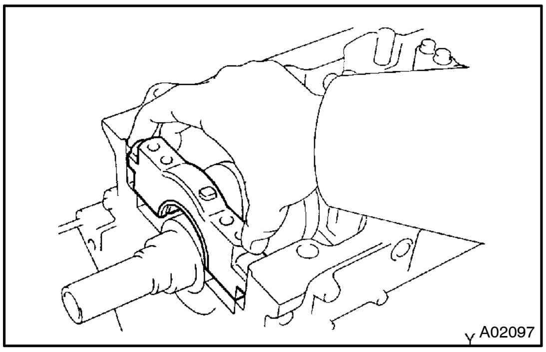


7. PLACE MAIN BEARING CAPS AND LOWER THRUST WASHERS ON CYLINDER BLOCK

(a) Install the 2 thrust washers on the No.3 bearing cap with the grooves facing outward.

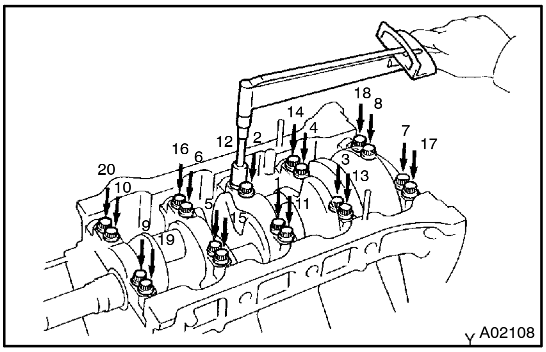


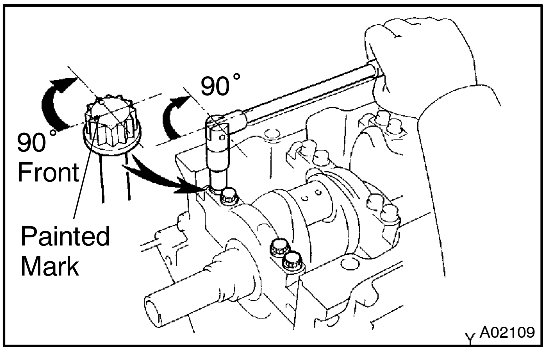
(b) Install the 5 main bearing caps in their proper locations.



HINT:
Place the bearing caps level and let them return to their original position by their own weight.

NOTICE:
Do not install the main bearing cap by tapping it.





8. INSTALL MAIN BEARING CAP BOLTS

HINT:

- The main bearing cap bolts are tightened in 2 progressive steps (steps (b) and (d)).
- If any one of the main bearing cap bolts is broken or deformed, replace it.

(a) Apply a light coat of engine oil on the threads and under the main bearing cap bolts.

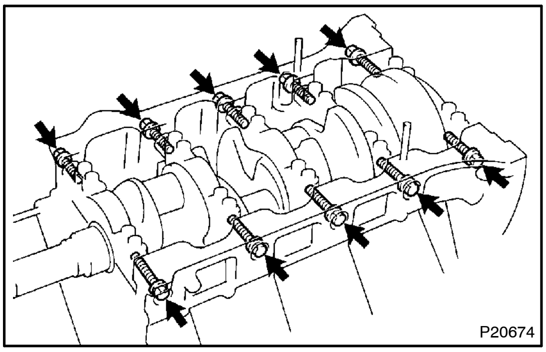
(b) Install and uniformly tighten the 20 main bearing cap bolts in several passes, in the sequence shown.
Torque: 27 N·m (275 kgf·cm, 20 ft·lbf)

If any one of the main bearing cap bolts does not meet the torque specification, replace the main bearing cap bolt.

(c) Mark the front of the main bearing cap bolt with paint.

(d) Retighten the main bearing cap bolts by 90° in the numerical order shown.

(e) Check that the painted mark is now at a 90° angle to the front.

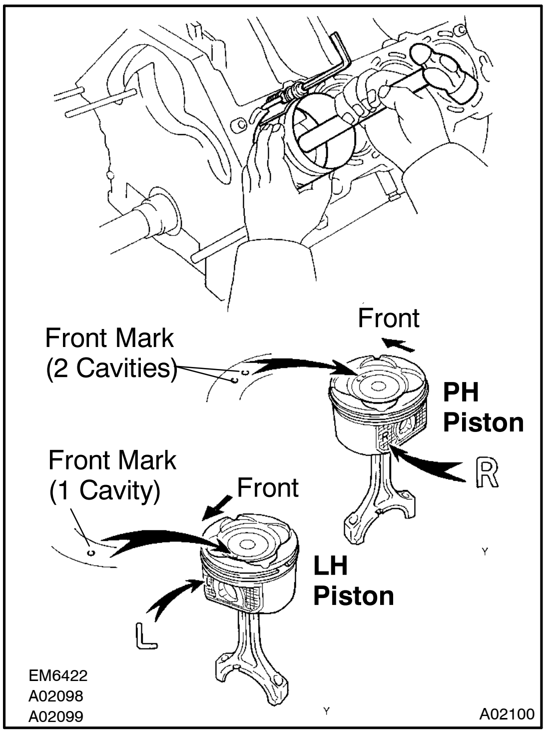


(f) Install a new seal washer to the main bearing cap bolt.

(g) Install and uniformly tighten the 10 main bearing cap bolts.
Torque: 49 N·m (500 kgf·cm, 36 ft·lbf)

(h) Check that the crankshaft turns smoothly.

9. CHECK CRANKSHAFT THRUST CLEARANCE (See page EM-78)

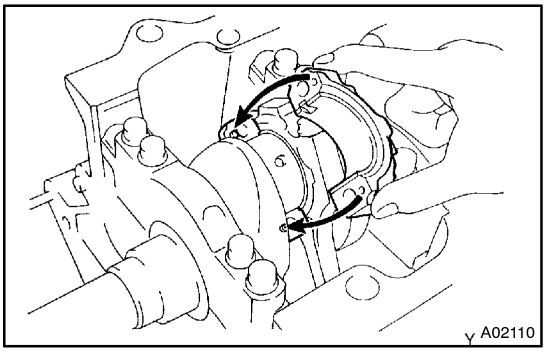


10. INSTALL PISTON AND CONNECTING ROD ASSEMBLES

Using a piston ring compressor, push the correctly numbered piston and connecting rod assemblies into each cylinder with the front mark of the piston facing forward.

NOTICE:

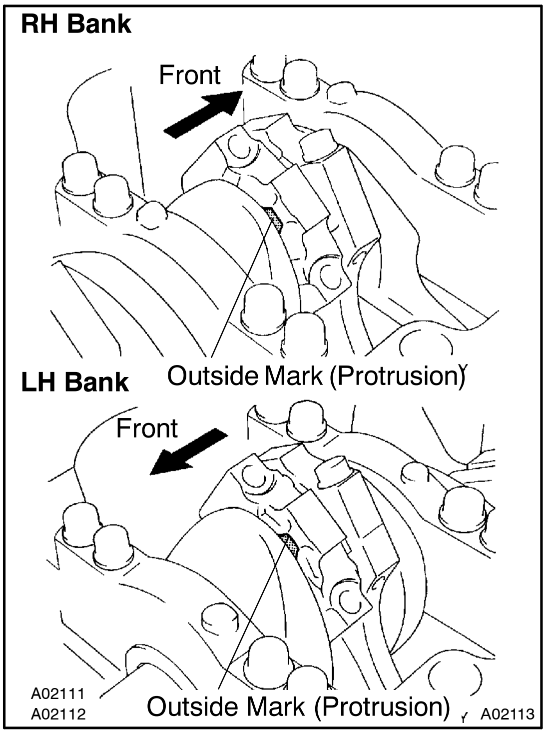
The shape of the piston varies for the RH and LH banks. The RH piston is marked with "R", the LH piston with "L".



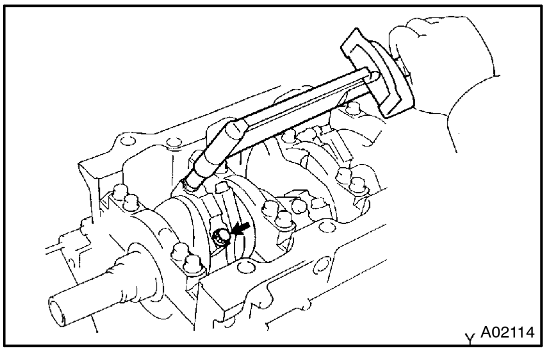
11. PLACE CONNECTING ROD CAP ON CONNECTING ROD

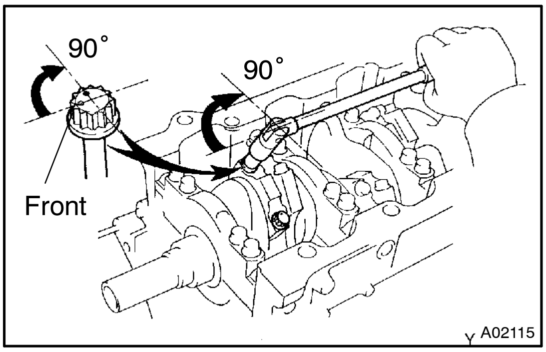
(a) Match the numbered connecting rod cap with the connecting rod.

(b) Align the pin groove of the connecting rod cap with the pins of the connecting rod, and install the connecting rod cap.



(c) Check that the outside mark of the connecting rod cap is facing in correct direction.





12. INSTALL CONNECTING ROD CAP BOLTS

HINT:

- The connecting rod cap bolts are tightened in 2 progressive steps (steps (b) and (d)).
- If any one of the connecting rod cap bolts is broken or deformed, replace it.

(a) Apply a light coat of engine oil on the threads and under the heads of the connecting rod cap bolts.

(b) Install and alternately tighten the 2 connecting rod cap bolts in several passes.

Torque: 25 N·m (250 kgf·cm, 18 ft·lbf)

If any one of the connecting rod cap bolts does not meet the torque specification, replace the connecting rod cap bolts.

(c) Mark the front of the connecting cap bolt with paint.

(d) Retighten the cap bolts 90° as shown.

(e) Check that the painted mark is now at a 90° angle to the front.

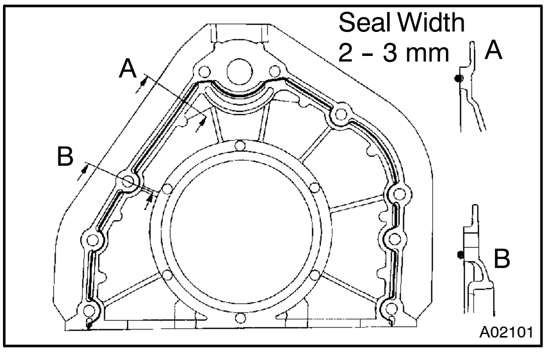
(f) Check that the crankshaft turns smoothly.

13. CHECK CONNECTING ROD THRUST CLEARANCE (See page EM-78)

14. INSTALL REAR OIL SEAL RETAINER

(a) Remove any old packing (FIPG) material and be careful not to drop any oil on the contact surfaces of the oil seal retainer and cylinder block.

- Using a razor blade and gasket scraper, remove all the oil packing (FIPG) material from the gasket surfaces and sealing grooves.
- Thoroughly clean all components to remove all the loose material.
- Using a non-residue solvent, clean both sealing surfaces.

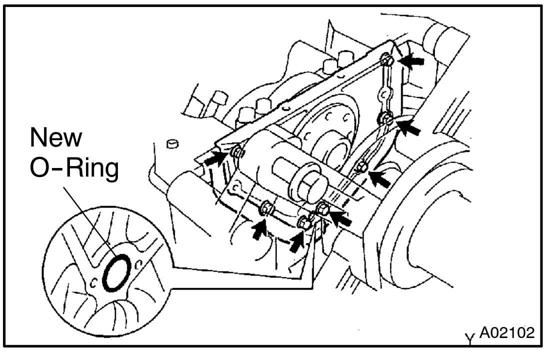


(b) Apply seal packing to the oil seal retainer as shown in the illustration.

Seal packing:

Part No. 08826-00080 or equivalent

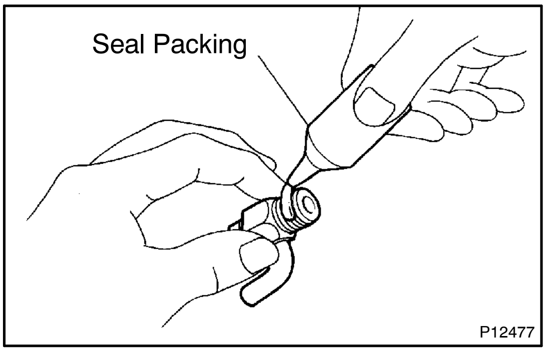
- Install a nozzle that has been cut to a 2 - 3 mm (0.08 - 0.12 in.) opening.
- Parts must be assembled within 5 minutes of application. Otherwise the material must be removed and reapplied.
- Immediately remove nozzle from the tube and reinstall cap.



(c) Install a new O-ring to the cylinder block.

(d) Install the oil seal retainer with the 7 bolts.

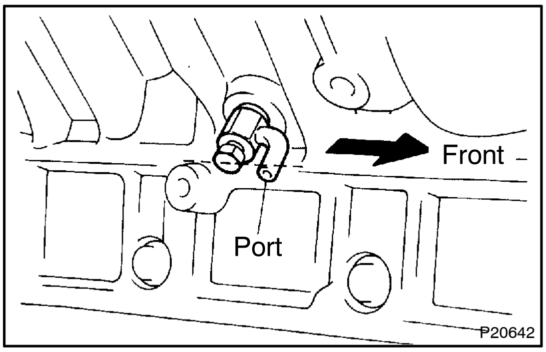
Torque: 8.0 N·m (80 kgf·cm, 71 in.·lbf)



15. INSTALL ENGINE COOLANT DRAIN UNIONS

(a) Apply seal packing to 2 or 3 threads.

Seal packing:
Part No. 08826–00100 or equivalent



(b) Install the RH and LH drain unions.

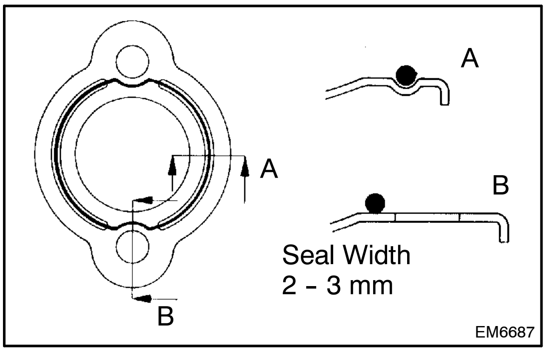
Torque: 49 N·m (500 kgf·cm, 36 ft·lbf)

HINT:
After applying the specified torque, rotate the drain union clockwise until its drain port is facing forward.

16. INSTALL WATER SEAL PLATE

(a) Remove any old packing (FIPG) material and be careful not to drop any oil on the contact surfaces of the seal plate and cylinder block.

- Using a razor blade and gasket scraper, remove all the old packing (FIPG) material from the gasket surfaces and sealing groove.
- Thoroughly clean all components to remove all the loose material.
- Using a non–residue solvent, clean both sealing surfaces.



(b) Apply seal packing to the seal plate as shown in the illustration.

Seal packing:
Part No. 08826–00080 or equivalent

- Install a nozzle that has been cut to a 2 – 3 mm (0.08 – 0.12 in.) opening.
- Parts must be assembled within 5 minutes of application. Otherwise the material must be removed and reapplied.
- Immediately remove nozzle from the tube and reinstall cap.

(c) Install the seal plate with the 2 nuts. Alternately tighten the nuts in several passes.

Torque: 14 N·m (145 kgf·cm, 10 ft·lbf)

17. INSTALL OIL PUMP
(See page LU–15)

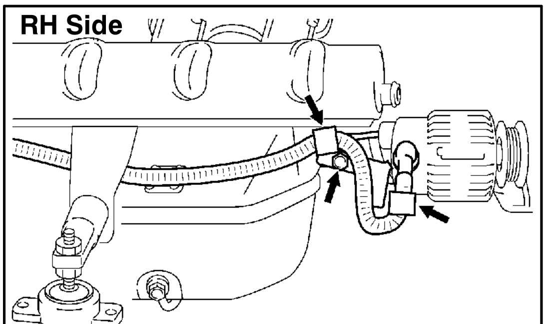
18. INSTALL OIL STRAINER
(See page LU–15)

19. INSTALL NO.1 OIL PAN
(See page LU-15)

20. INSTALL OIL PAN BAFFLE PLATE
(See page LU-15)

21. INSTALL NO.2 OIL PAN
(See page LU-15)

22. INSTALL WATER PUMP
(See page CO-7)



M00013

23. INSTALL ENGINE WIRE

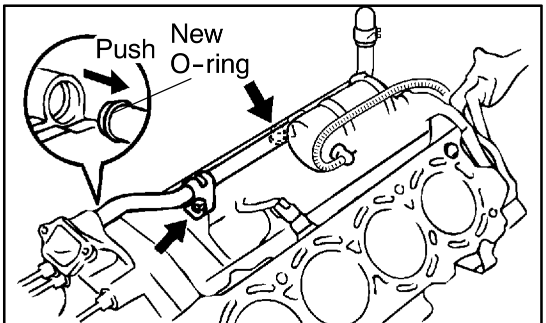
(a) Install the engine wire to the RH side of the cylinder block with the bolt.

(b) Connect the crankshaft position sensor connector.

(c) Connect the oil pressure gauge wire with the nut and rubber cap.

24. INSTALL KNOCK SENSORS
(See page SF-70)

25. INSTALL STARTER
(See page ST-17)



M04152

26. INSTALL WATER BYPASS PIPE

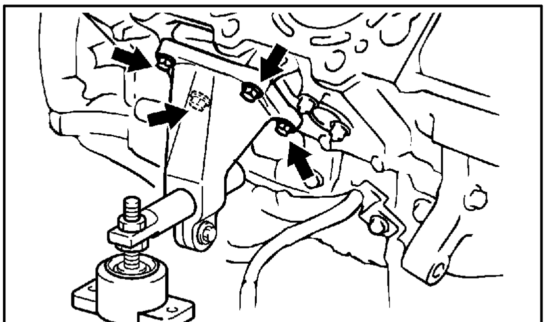
(a) Install a new O-ring to the water bypass pipe.

(b) Apply soapy water to the O-ring.

(c) Push the water bypass pipe end into the pipe hole of the water pump.

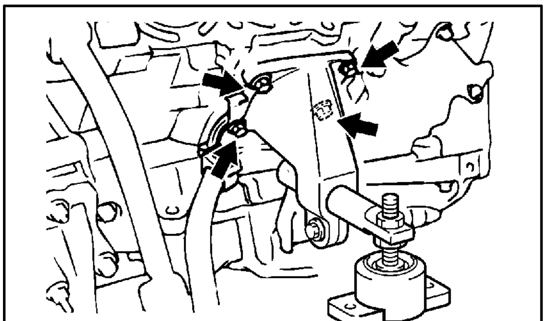
(d) Install the water bypass pipe with the 2 bolts.
Torque: 18 N·m (185 kgf·cm, 13 ft·lbf)

(e) Install the engine wire clamp to the bracket on the water bypass pipe.


M04149

27. INSTALL RH ENGINE MOUNTING BRACKET

Install the mounting bracket with the 4 bolts.
Torque: 39N·m (400 kgf·cm, 29 ft·lbf)


M04150

28. INSTALL LH ENGINE MOUNTING BRACKET

(a) Install the mounting bracket with the 4 bolts.
Torque: 39 N·m (400 kgf·cm, 29 ft·lbf)

(b) Install the engine wire to the mounting bracket with the bolt.

29. **INSTALL FUEL PUMP**
    (See page SF-9)
30. **INSTALL CYLINDER HEADS**
    (See page EM-52)
31. **INSTALL TIMING BELT AND PULLEYS**
    (See page EM-19)
32. **DISCONNECT ENGINE FROM ENGINE STAND**

ENGINE MECHANICAL

EMISSION CONTROL SYSTEM

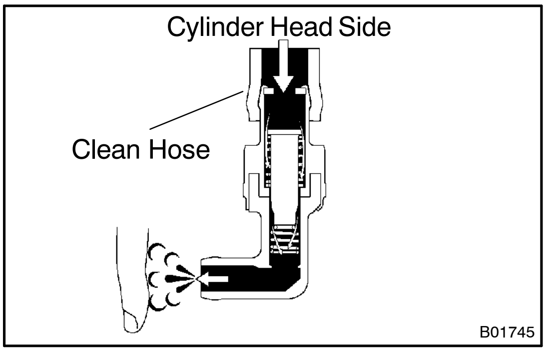
EC05X-01

PURPOSE

The emission control systems are installed to reduce the amount of HC exhausted from the engine (2), to prevent the atmospheric release of blow-by gas-containing HC (1).
The function of each system is shown in the following table:

System	Abbreviation	Function
(1) Positive Crankcase Ventilation	PCV	Reduces HC
(2) Sequential Multiport Fuel Injection*	SFI	Injects a precisely timed, optimum amount of fuel for reduced exhaust emissions

Remark: * For inspection and repair of the SFI system, refer to the SF section in this manual.



POSITIVE CRANKCASE VENTILATION (PCV) SYSTEM

EC060–01

INSPECTION

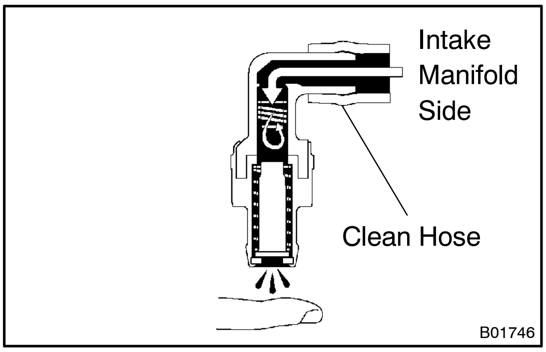
1. **REMOVE PCV VALVE**
2. **INSTALL CLEAN HOSE TO PCV VALVE**
3. **INSPECT PCV VALVE OPERATION**

(a) Blow air into the cylinder head side, and check that air passes through easily.

CAUTION:

Do not suck air through the valve.

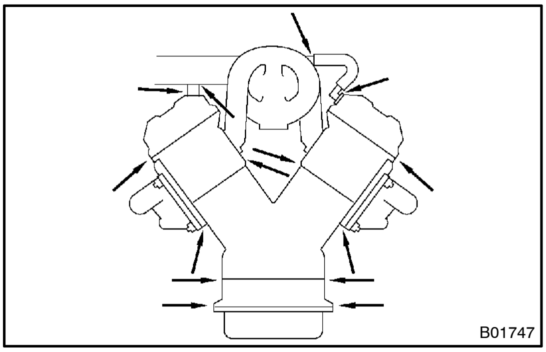
Petroleum substances inside the valve are harmful.



(b) Blow air into the air intake chamber side, and check that air passes through with difficulty.

If operation is not as specified, replace the PCV valve.

4. **REMOVE CLEAN HOSE FROM PCV VALVE**
5. **REINSTALL PCV VALVE**



6. **VISUALLY INSPECT HOSE, CONNECTIONS AND GASKETS**

Check for cracks, leaks or damage.

EMISSION CONTROL

SFI SYSTEM

SF0RO-01

PRECAUTION

1. BEFORE WORKING ON THE FUEL SYSTEM, DISCONNECT THE NEGATIVE (-) TERMINAL CABLE FROM THE BATTERY

NOTICE:

Any diagnostic trouble code retained by the computer will be erased when the negative (-) terminal cable is removed from the battery.

Therefore, if necessary, read the diagnosis before disconnecting the negative (-) terminal cable from the battery.

2. DO NOT SMOKE OR WORK NEAR AN OPEN FLAME WHEN WORKING ON THE FUEL SYSTEM

3. KEEP GASOLINE AWAY FROM RUBBER OR LEATHER PARTS

4. MAINTENANCE PRECAUTIONS

(a) In event of the engine misfire, following the precautions should be taken.
- (1) Check proper connection of battery terminals, etc.
- (2) After repair work, check that the ignition coil terminals and all other ignition system lines are reconnected securely.
- (3) When cleaning the engine compartment, be especially careful to protect the electrical system from water.

5. IF BOAT IS EQUIPPED WITH MOBILE RADIO SYSTEM (HAM, CB, ETC.)

If the boat is equipped with a mobile communication system, refer to the precaution in the IN section.

6. AIR INDUCTION SYSTEM

(a) Separation of the engine oil dipstick, oil filler cap, PCV hose, etc. may cause the engine to run out of tune.

(b) Disconnection, looseness or cracks in the parts of the air induction system between the throttle body and cylinder head will allow air suction and cause the engine to run out of tune.

7. ELECTRONIC CONTROL SYSTEM

(a) Before removing SFI wiring connectors, terminals, etc., first disconnect the power by either turning the ignition switch OFF or disconnecting the negative (-) terminal cable from the battery.

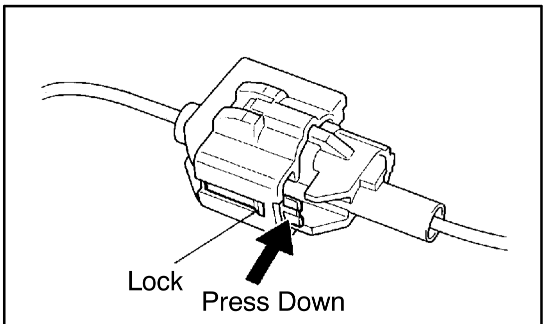
HINT:

Always check the diagnostic trouble code before disconnecting the negative (-) terminal cable from the battery.

(b) When installing the battery, be especially careful not to incorrectly connect the positive (+) and negative (-) cables.

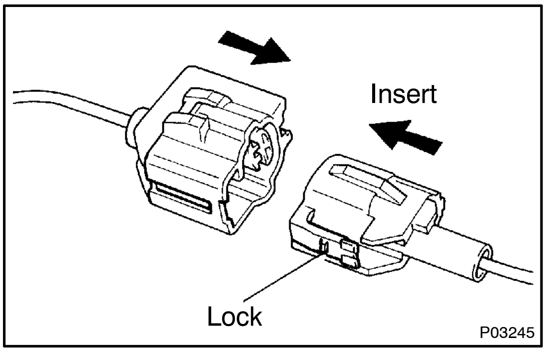
(c) Do not permit parts to receive a severe impact during removal or installation. Handle all SFI parts carefully, especially the ECM.

(d) Do not be careless during troubleshooting as there are numerous transistor circuits and even slight terminal contact can further troubles.
(e) Do not open the ECM cover.



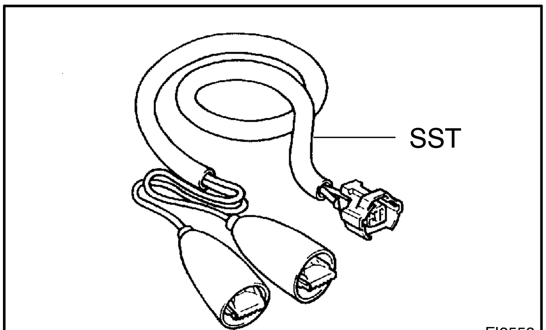
P03244

(f) When inspecting during rainy weather, take care to prevent entry of water. Also, when washing the engine compartment, prevent water from getting on the SFI parts and wiring connectors.
(g) Parts should be replaced as an assembly.
(h) Care is required when pulling out and inserting wiring connectors.
(i) Release the lock and pull out the connector, pulling on the connectors.



P03245

(j) Fully insert the connector and check that it is locked.
(k) When inspecting a connector with a volt/ohmmeter
(l) Carefully take out the water-proofing rubber if it is a water-proof type connector.
(m) Insert the test probe into the connector from the wiring side when checking the continuity, amperage or voltage.
(n) Do not apply unnecessary force to the terminal.
(o) After checking, install the water-proofing rubber on the connector securely.



FI2553

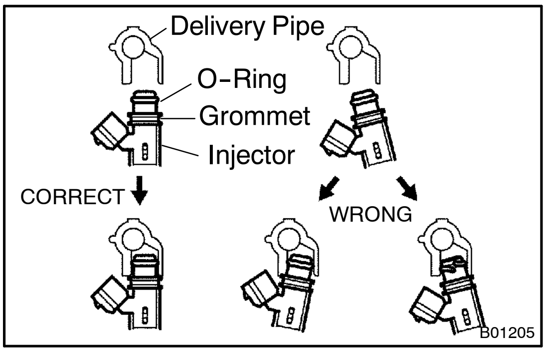
(p) Use SST for inspection or test of the injector or its wiring connector.
SST 09842-30070

8. FUEL SYSTEM

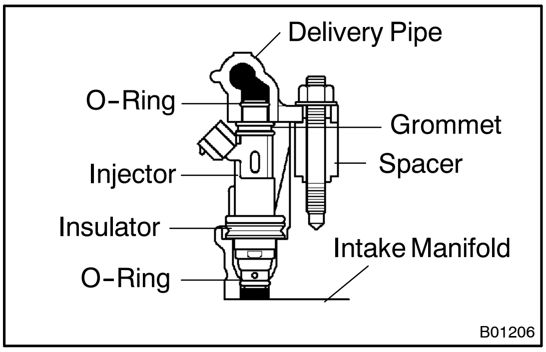
(a) When disconnecting the high fuel pressure line, a large amount of gasoline will spill out, so observe the following procedures:
  (1) Disconnect the fuel pump connector.
  (2) Start the engine. After the engine has stopped on its own, turn the ignition switch OFF.

(3) Put a container under the connection.
(4) Disconnect the connection.
(5) Plug the connection with a rubber plug.
(6) Reconnect the fuel pump connector.

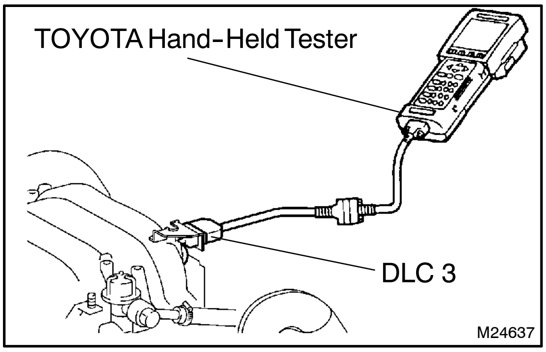
(b) Connect the high pressure line.



(c) Observe these precautions when removing and installing the injectors.
(1) Never reuse the O-ring.
(2) When placing a new O-ring on the injector, take care not to damage it in any way.
(3) Coat a new O-ring with spindle oil or gasoline before installing-never use engine, gear or brake oil.



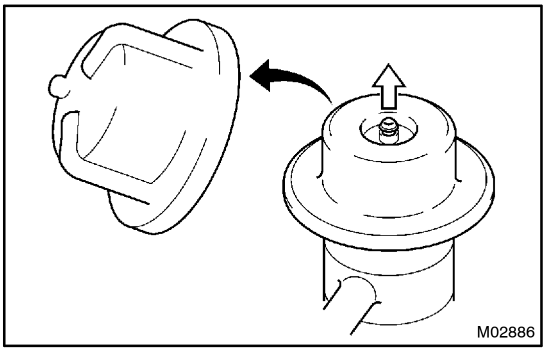
(d) Install the injector to the delivery pipe and intake manifold as shown in the illustration.
Before installing the injector must apply spindle oil or gasoline on the place where a delivery pipe or an intake manifold touches an O-ring of the injector.



(e) Check that there are no fuel leaks after doing maintenance anywhere on the fuel system.
(1) Connect a TOYOTA hand-held tester to the DLC3.
(2) Turn the ignition switch ON, and push the TOYOTA hand-held tester main switch ON.

NOTICE:
Do not start the engine.

(3) Select the active test mode on the TOYOTA hand-held tester.
(4) Please refer to the TOYOTA hand-held tester operator's manual for further details.
(5) If you have no TOYOTA hand-held tester, connect the positive (+) and negative (-) leads from the battery to the fuel pump connector.
(See page SF-5)

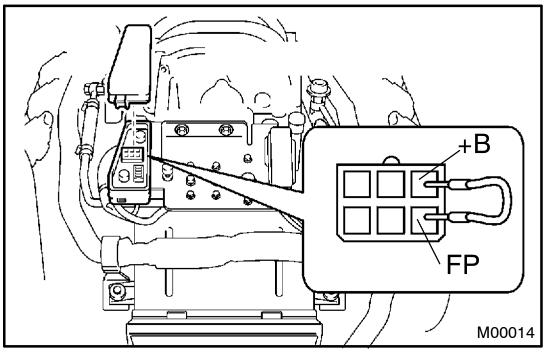


(6) Check the button on the fuel pressure pulsation damper rises.
The pressure in the high pressure line will rise to approx. 392 kPa (4 kgf/cm^2, 57 psi). In this state, check to see that there are no leaks from any part of the fuel system.

HINT:
When checking the fuel pressure pulsation damper, remove the cover on it.

(7) Turn the ignition switch OFF.

(8) Disconnect the TOYOTA hand-held tester from the DLC3.



FUEL PUMP

SF0RP-01

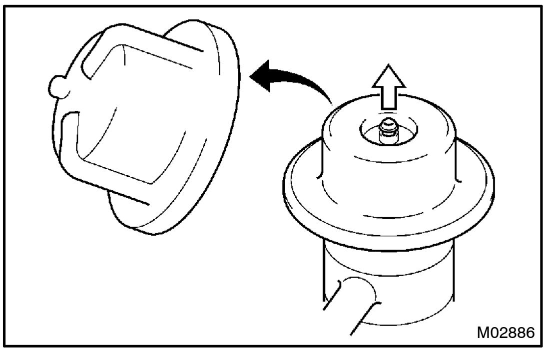
ON-BOAT INSPECTION

1. CHECK FUEL PUMP OPERATION

(a) Remove the circuit opening relay.
(b) Using the SST, connect terminal +B and terminal FP of the relay box.
SST 09843-18020
(c) Turn the ignition switch ON.

NOTICE:

- **Do not start the engine.**
- **These tests must be done quickly (within 10 seconds) to prevent the coil from burning out.**

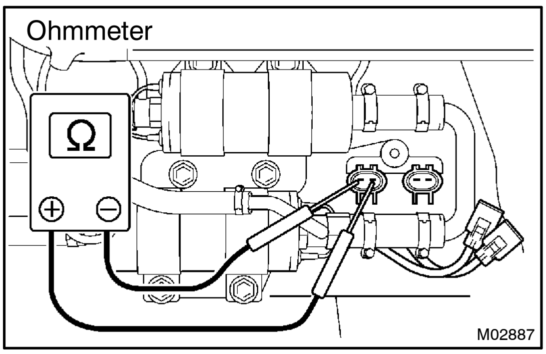


(d) Check that there is pressure in the fuel pressure pulsation damper.

HINT:
When checking the fuel pressure pulsation damper, remove the cover on it.
If there is fuel pressure, you will hear the sound of fuel flowing.
If there is no pressure, check these parts:

- Fusible link
- Fuses
- EFI main relay
- Fuel pump
- Circuit opening relay
- Fuel pump resistor
- ECM
- Wiring connections

(e) Turn the ignition switch OFF.
(f) Remove the SST from the relay box.
(g) Install the circuit opening relay.

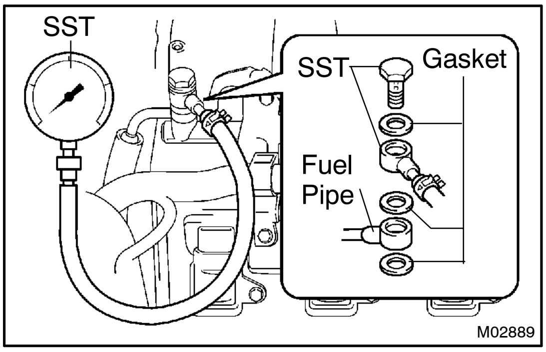


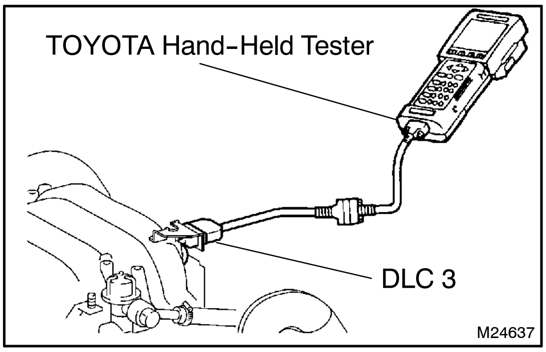
2. INSPECT FUEL PUMP RESISTANCE

Using an ohmmeter, measure the resistance between the terminals.

Resistance:
0.5 – 30 Ω at 20°C (68°F)

If the resistance is not as specified, replace the fuel pump and/or set plate.





3. CHECK FUEL PRESSURE

(a) Check the battery positive voltage is above 12 V.

(b) Disconnect the negative (-) terminal cable from the battery.

(c) Remove the RH fuel pressure pulsation damper (See page SF-25).

(d) Install the fuel inlet hose and SST (pressure gauge) to the delivery pipe with 3 lower gaskets and the SST (union bolt).

SST 09268-45014 (09268-41190, 90405-06167)

Torque: 39 N·m (400 kgf·cm, 29 ft·lbf)

(e) Wipe off any splattered gasoline.

(f) Using the SST, connect terminal +B and terminal FP of the relay box.

(See step 1. (a) to (b) above)

(g) Reconnect the negative (-) terminal cable to the battery.

(h) Turn the ignition switch ON.

(i) Measure the fuel pressure.

Fuel pressure:

304 - 343 kPa (3.1 - 3.5 kgf/cm^2, 44 - 50 psi)

If pressure is high, replace the fuel pressure regulator.

If pressure is low, check these parts:

- Fuel hoses and connections
- Fuel pump
- Fuel filter
- Fuel pressure regulator

(j) Remove the SST from the relay box.

(See Step 1. (f) to (g) above.)

(k) Start the engine.

(l) Measure the fuel pressure at idle.

Fuel pressure:

304 - 343 kPa (3.1 - 3.5 kgf/cm^2, 44 - 50 psi)

If pressure is not as specified, check the fuel pressure regulator.

(m) Stop the engine.

(n) Check that the fuel pressure remains as specified for 5 minutes after the engine has stopped.

Fuel pressure:

147 kPa (1.5 kgf/cm^2, 21 psi) or more

If pressure is not as specified, check the fuel pump, pressure regulator and/or injectors.

(o) After checking fuel pressure, disconnect the negative (-) terminal cable from the battery and carefully remove the SST to prevent gasoline from splashing.

SST 09268-45014

(p) Reinstall the fuel pressure pulsation damper (See page SF-26).

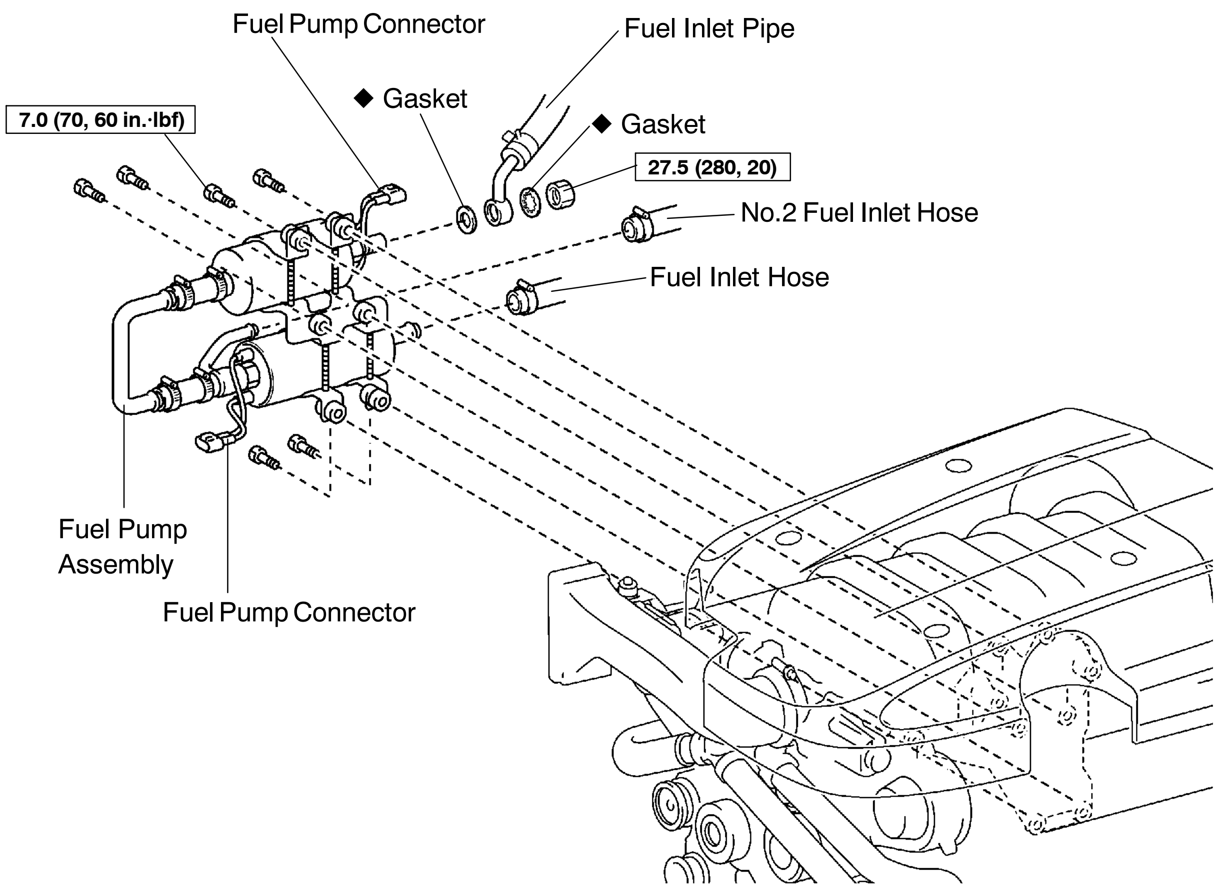
(q) Reconnect the negative (-) terminal cable to the battery.

(r) Check for fuel leaks.

(See page SF-1)

SF0RQ-01

COMPONENTS

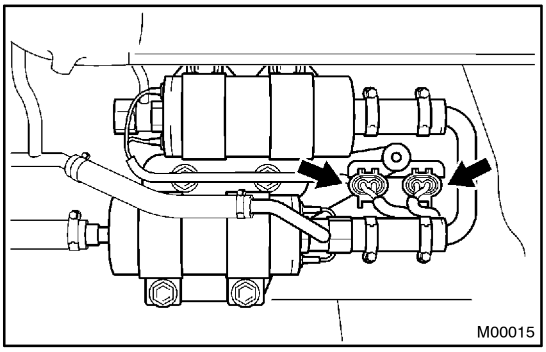


N·m (kgf·cm, ft·lbf) : Specified torque

◆ Non-reusable part

M02546

SF0RR-01

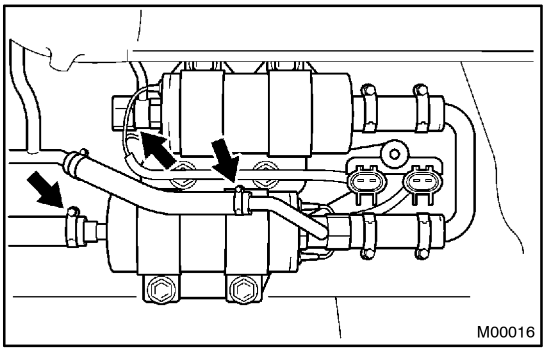

M00015

REMOVAL

CAUTION:

Do not smoke or work near an open flame when working on the fuel pump.

1. **DISCONNECT FUEL PUMP CONNECTORS**

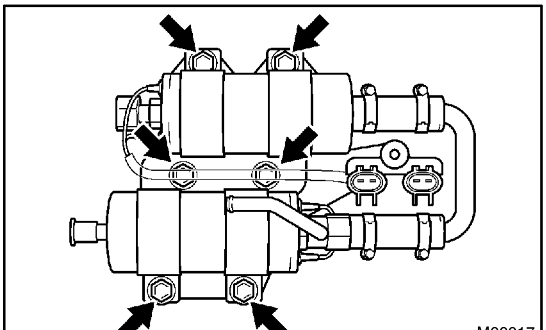

M00016

2. **DISCONNECT FUEL PIPE AND FUEL HOSE**

(a) Loosen the hose clamp and disconnect the fuel inlet hose.

(b) Remove the bolt and disconnect the fuel inlet pipe.

(c) Loosen the hose clamp and disconnect the No. 2 fuel hose.

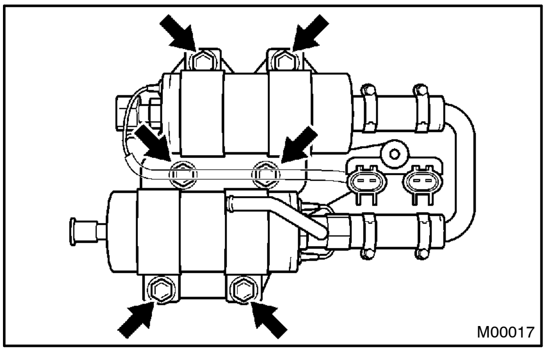

M00017

3. **REMOVE FUEL PUMP ASSY**

Rmove the 6 bolts and remove the fuel pump assembly.

SF0RS-01

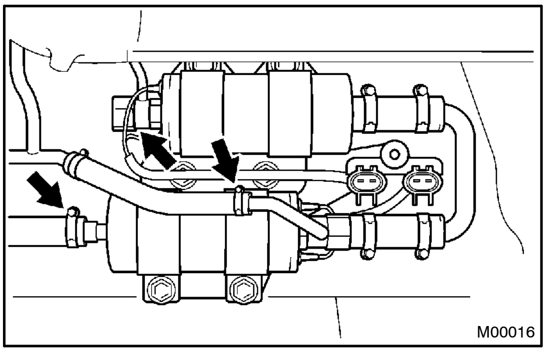
INSTALLATION



1. INSTALL FUEL PUMP ASSY

Install the fuel pump assembly to the fuel pump bracket with the 6 bolts.

Torque: 7.0 N·m (70 kgf·cm, 60 in.·lbf)



2. CONNECT FUEL PIPE AND FUEL HOSE

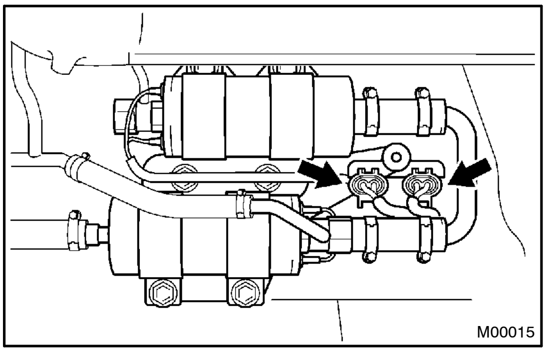
(a) Install the No. 2 fuel hose to the fuel pump and tighten the hose clamp.

Torque: 1.5 N.m (15 kgf.cm, 13 in.·lbf)

(b) Install the fuel inlet pipe to the fuel pump.

Torque: 27.5 N.m (280 kgf.cm, 20 ft.lbf)

(c) Install the fuel inlet hose to the fuel pump and tighten the hose clamp.



3. CONNECT FUEL PUMP CONNECTOR

FUEL PRESSURE REGULATOR

SF0RT-01

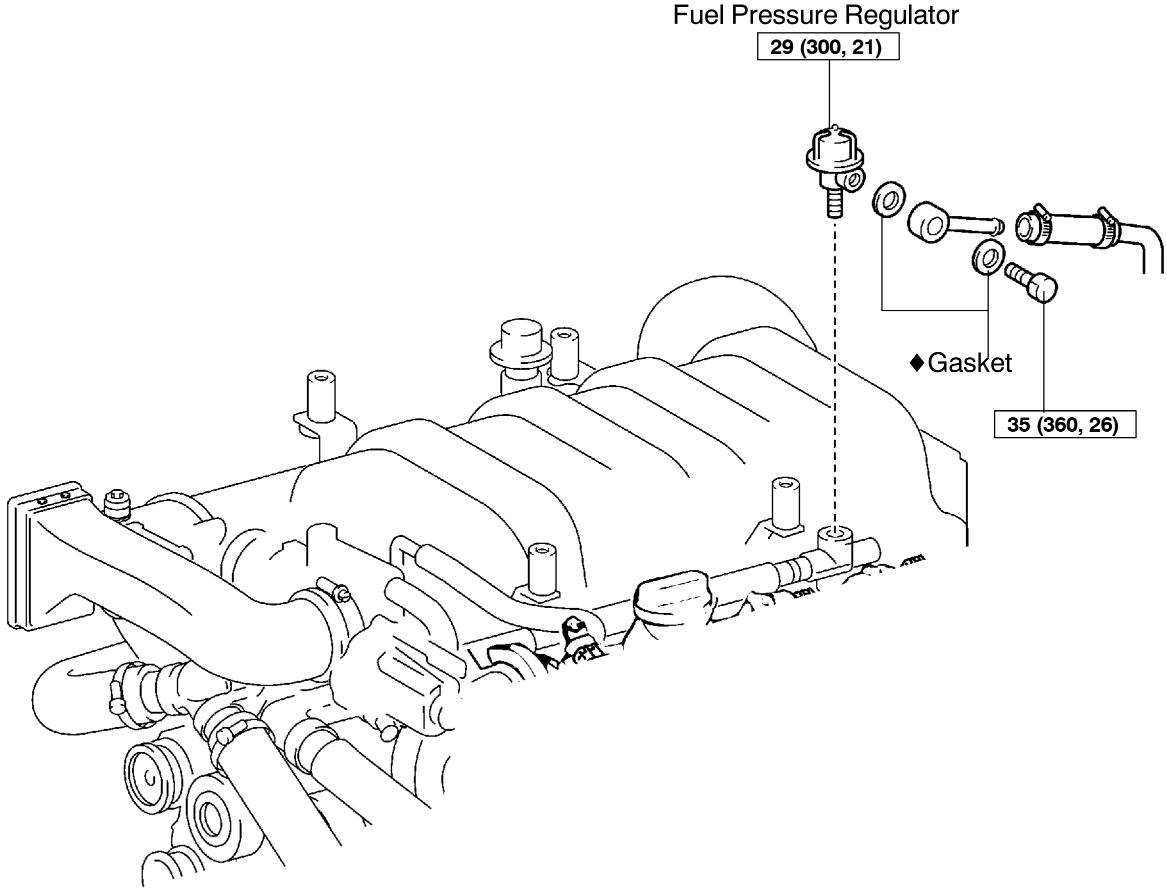
ON-BOAT INSPECTION

INSPECT FUEL PRESSURE

(See page SF-5)

SF0RV-01

COMPONENTS

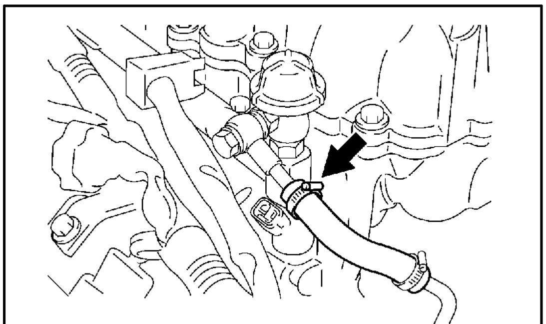


N·m (kgf·cm, ft·lbf) : Specified torque

◆ Non-reusable part

M02547

SF0RW-01

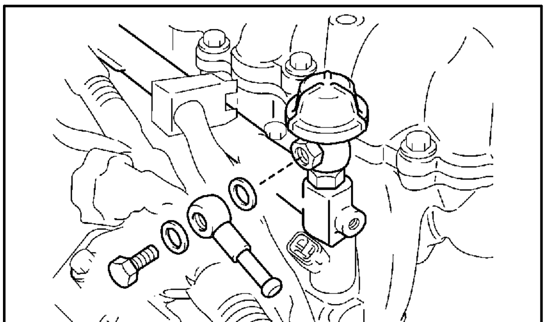

M00018

REMOVAL

1. REMOVE V-BANK COVER

2. REMOVE NO.4 FUEL HOSE

Loosen the hose clamp and disconnect the No. 4 fuel hose from the fuel pipe.


M00019

3. REMOVE PRESSURE REGULATOR

(a) Remove the union bolt, sub-pipe and 2 gaskets from the pressure regulator.

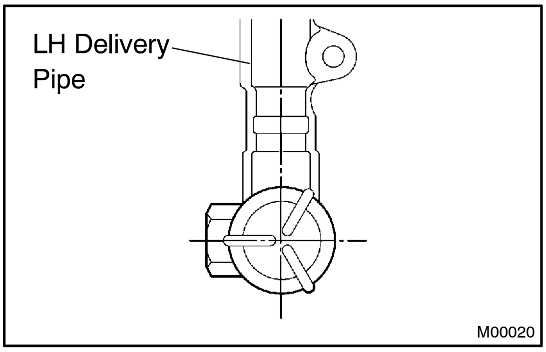
(b) Remove the LH delivery pipe from the pressure regulator.

CAUTION:

- **Put a shop towel under the delivery pipe.**
- **Slowly loosen the pressure regulator.**

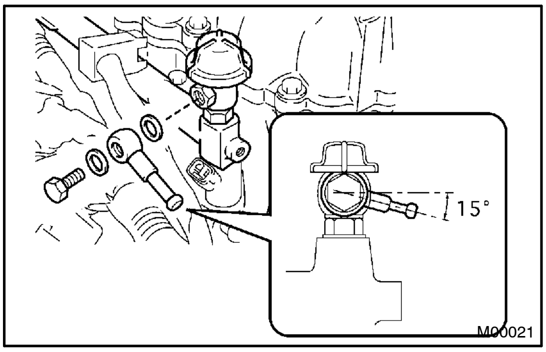
SF0RX-01

INSTALLATION

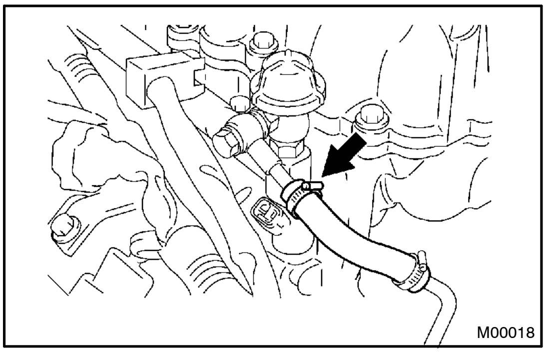


1. INSTALL PRESSURE REGULATOR

(a) Install the pressure regulator to the LH delivery pipe in the direction shown in the illustration at the left.
Torque: 29 N·m (300 kgf·cm, 21 ft·lbf)



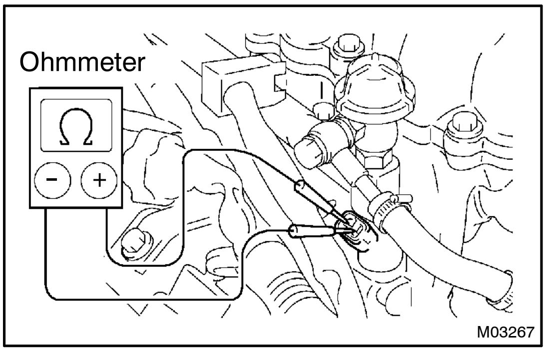
(b) Install the sub-pipe, 2 gaskets and the union bolt to the pressure regulator.
Torque: 35 N·m (360 kgf·cm, 26 ft·lbf)



2. INSTALL NO. 4 FUEL HOSE

Install the No. 4 fuel hose to the fuel pipe and tighten the hose clamp.
Torque: 1.5 N·m (15 kgf·cm, 13 in.·lbf)

3. INSTALL V-BANK COVER



INJECTOR

SF0RY-01

ON-BOAT INSPECTION

1. REMOVE V-BANK COVER

2. INSPECT INJECTOR RESISTANCE

(a) Disconnect the 8 injector connectors.

(b) Using a ohmmeter, measure the resistance between the terminals.

Resistance:

13.4 – 14.2 Ω at 20°C (68°F)

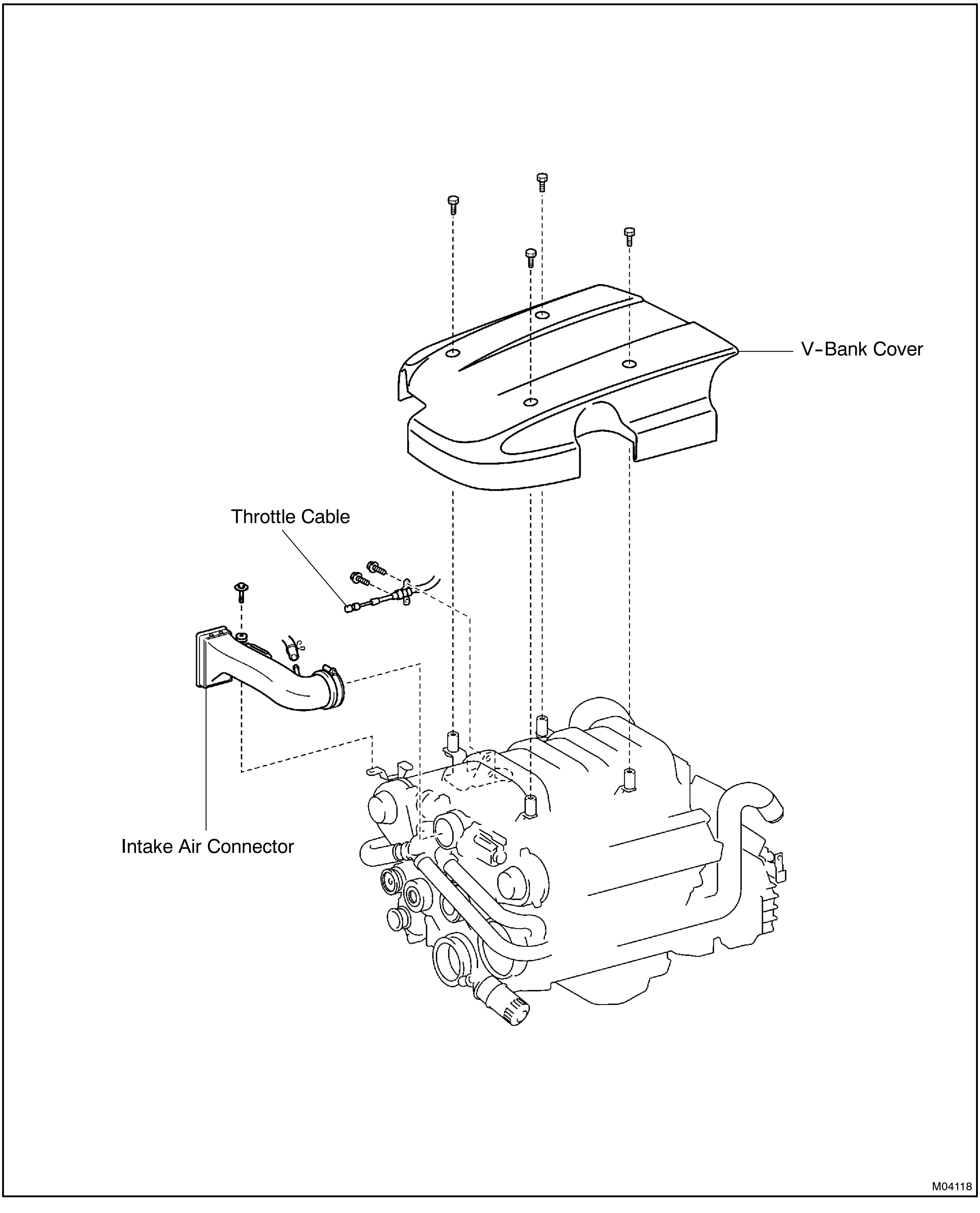
If the resistance is not as specified, replace the injector.

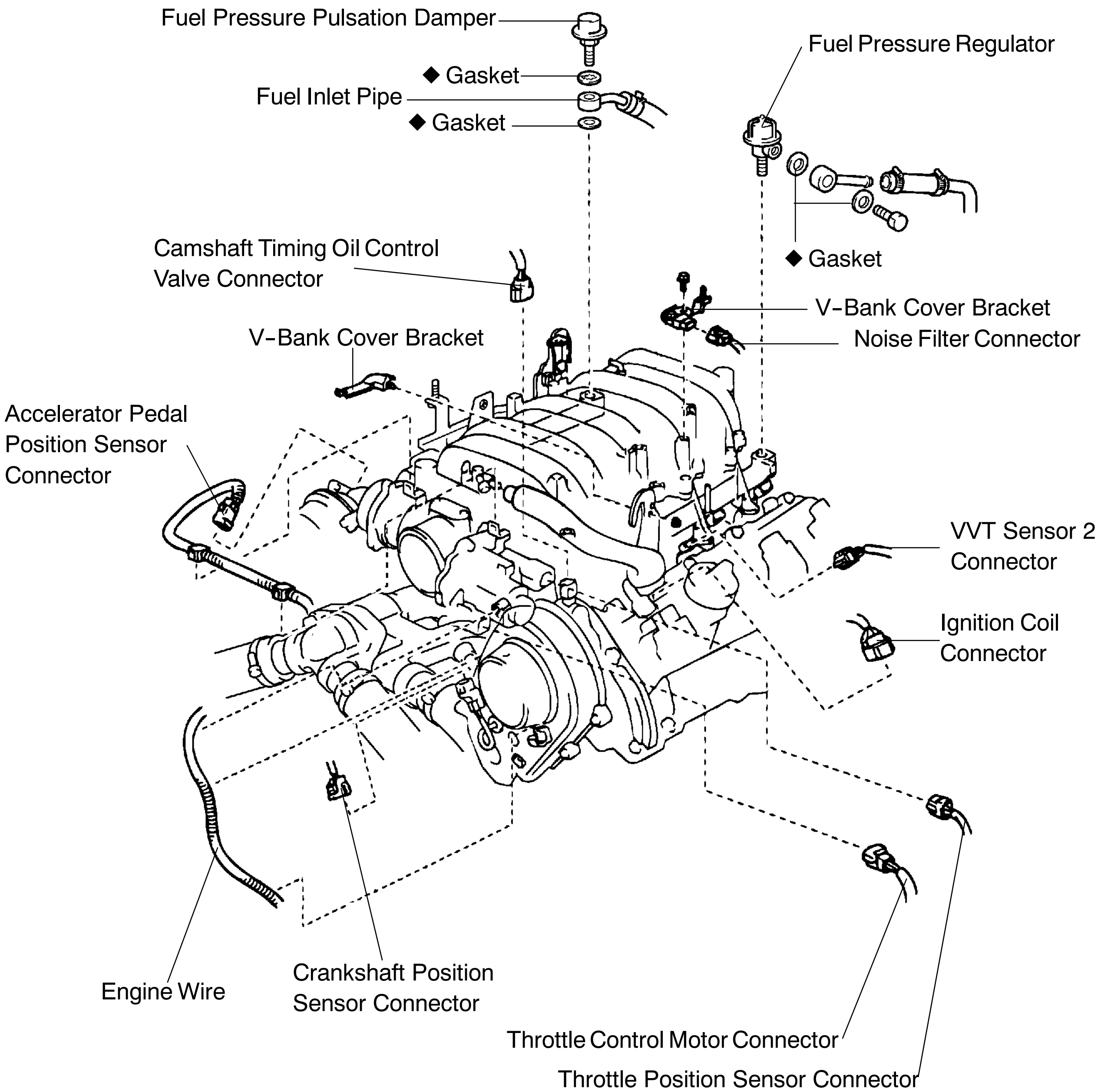
(c) Reconnect the 8 injector connectors.

3. REINSTALL V-BANK COVER

SF0RZ-01

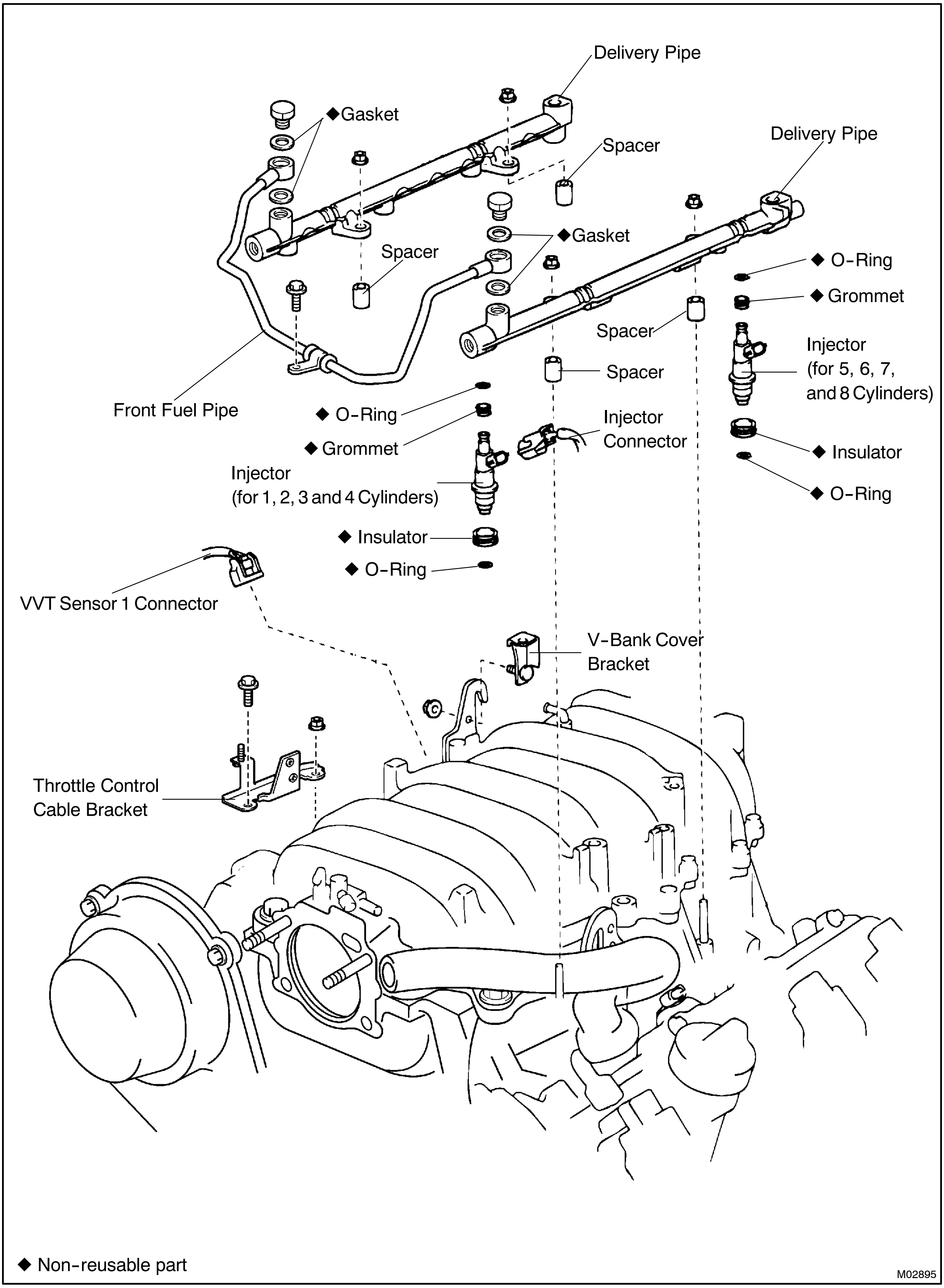
COMPONENTS





◆ Non-reusable part

M02894


Delivery Pipe
◆Gasket
Spacer
Delivery Pipe
◆Gasket
Spacer
◆ O-Ring
◆ Grommet
Spacer
Injector
(for 5, 6, 7, and 8 Cylinders)
Spacer
Front Fuel Pipe
◆ O-Ring
◆ Grommet
Injector
Connector
◆ Insulator
◆ O-Ring
Injector
(for 1, 2, 3 and 4 Cylinders)
◆ Insulator
◆ O-Ring
VVT Sensor 1 Connector
V-Bank Cover
Bracket
Throttle Control
Cable Bracket
◆ Non-reusable part
M02895

SF0S0-01

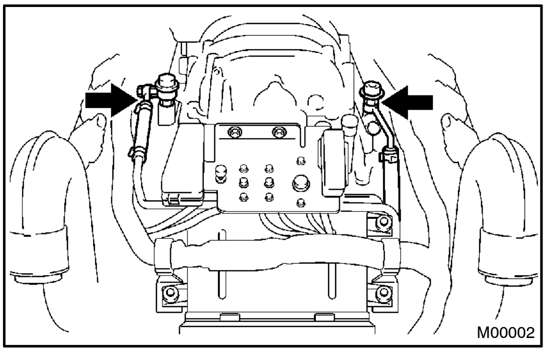
REMOVAL

1. **REMOVE V-BANK COVER**
2. **REMOVE INTAKE AIR CONNECTOR**
3. **DISCONNECT THROTTLE CABLE**
4. **REMOVE THROTTLE BODY**
   (See page SF-31)
5. **DISCONNECT ENGINE WIRE CONECTORS**

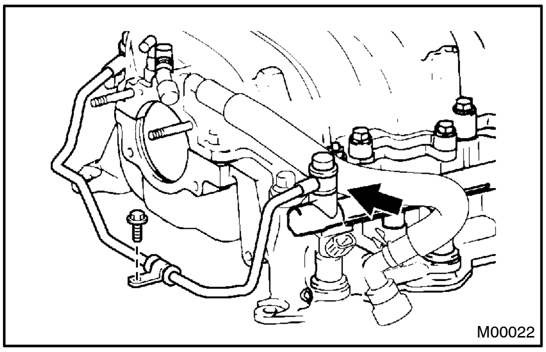
Disconnect these connectors:
- 8 injector connectors
- 2 VVT sensor connectors
- 2 camshaft position sensor connectors
- LH side noise filter connector
- LH side DLC-3 connector
- RH side ECT sensor connector
- RH side ECT sender gause connector

6. **REMOVE DELIVERY PIPES AND INJECTORS**

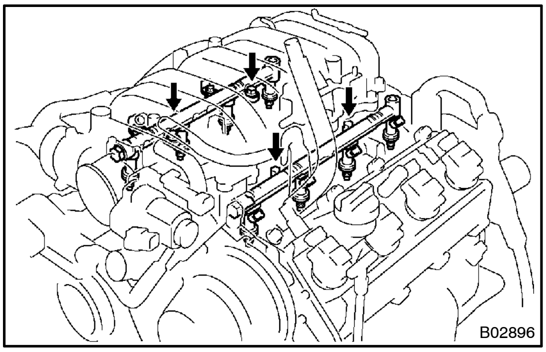
NOTICE:
- **Be careful not to drop the injectors when removing the delivery pipes.**
- **Pay attention to put any hung load on the injector to and from the side direction.**



(a) Remove these parts:
- Throttle control cable bracket
- Oil drain hose clamp and spacer
- Wiring harness clamp bracket
- V-bank cover bracket w/noise filter
- RH rear V-bank cover bracket
- LH front V-bank cover bracket
- Fuel pressure pulsation damper and fuel inlet pipe
- No.4 fuel hose

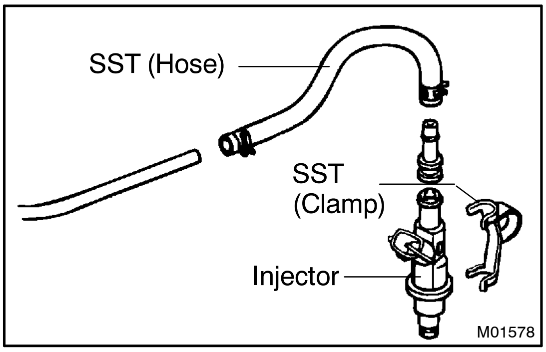


(b) Remove the 2 union bolts, 4 gaskets, bolt and FR fuel pipe.



(c) Remove the 4 nuts holding the delivery pipe to the intake manifold.
(d) Remove the 2 delivery pipes and 8 injectors assembly and 4 spacers.
(e) Pull out the 8 injectors from the delivery pipes.
(f) Remove the 2 O-rings, grommet and insulator from each injector.

SF0S1-01



INSPECTION

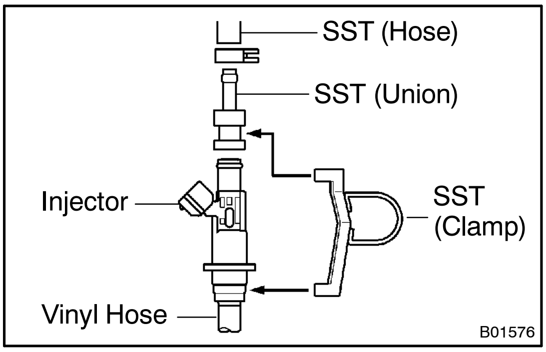
1. INSPECT INJECTOR INJECTION

CAUTION:

Keep injector clear of sparks during the test.

(a) Disconnect the fuel inlet hose from the fuel tube.

(b) Connect SST (hose) to the fuel inlet tube.
SST 09268-41047



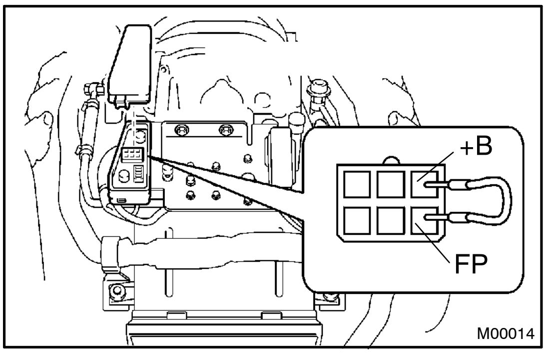
(c) Install the grommet and O-ring to the injector.

(d) Connect SST (hose) to the injector with SST (union), and hold the injector and union with SST (clamp).
SST 09268-41047

(e) Put the injector into the graduated cylinder.

HINT:

Install a suitable vinyl hose onto the injector to prevent gasoline from splashing out.



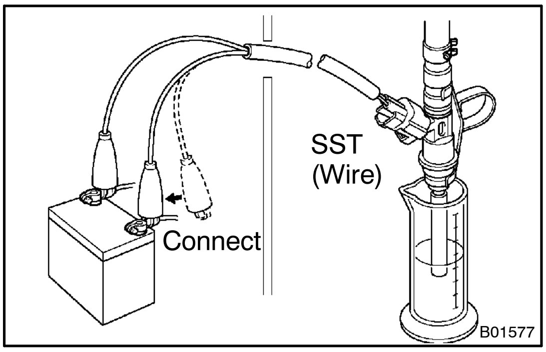
(f) Remove the circuit opening relay.

(g) Using the SST, connect terminal +B and terminal FP of the relay box.
SST 09843-18020

(h) Turn the ignition switch ON.

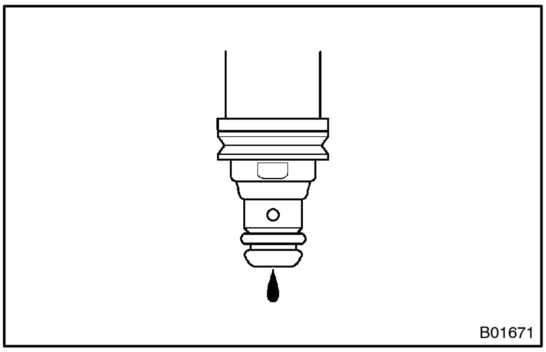
NOTICE:

DO not start the engine.



(i) Connect SST (wire) to the injector and battery for 15 seconds, and measure the injection volume with a graduated cylinder. Test each injector 2 or 3 times.
SST 09842-30070
Injection volume:
60 - 73 cm^3 (3.7 - 4.5 cu in.) per 15 sec.
Difference between each injector:
13 cm^3 (0.6 cu in.) or less

If the injection volume is not as specified, replace the injector.



2. INSPECT LEAKAGE

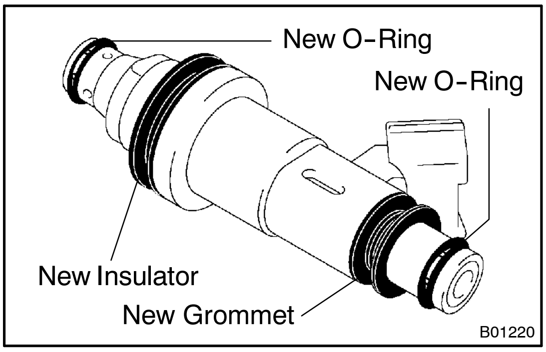
(a) In the condition above, disconnect the test probes of SST (wire) from the battery and check the fuel leakage from the injector.
SST 09842-30070
Fuel drop:
One drop or less per 12 minutes

(b) Turn the ignition switch OFF.

(c) Disconnect the negative (-) terminal cable from the battery.
(d) Remove SST
SST 09268-41047
(e) Reconnect the fuel inlet hose to the fuel tube.
(f) Remove the SST from the relay box.
SST 09843-18020
(g) Install the circuit opening relay.

SF0S2-01

INSTALLATION



1. INSTALL INJECTORS AND DELIVERY PIPES

NOTICE:

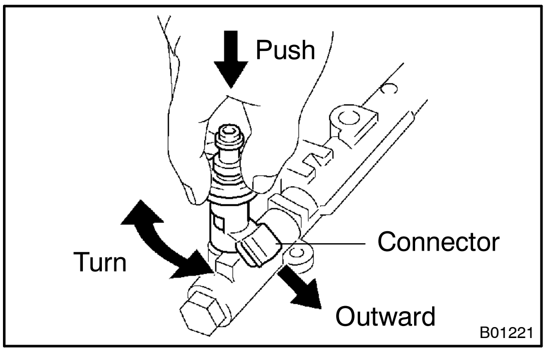
- **Be careful not to drop the injectors when installing the delivery pipes.**
- **Pay attention to put any hung load on the injector to and from the side direction.**

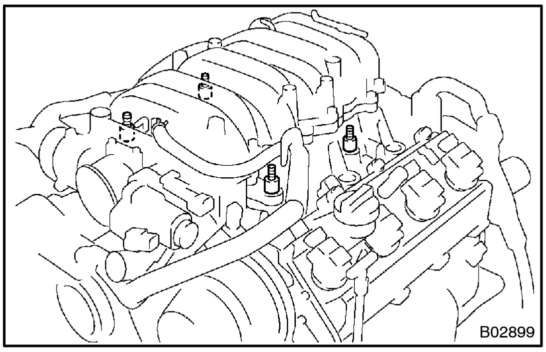
(a) Install a new grommet and new insulator to each injector.

(b) Apply a light coat of gasoline to 2 new O-rings and install them to each injector.

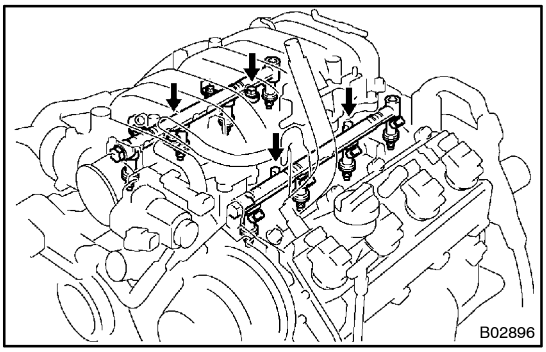
(c) While turning the injector clockwise and counterclockwise, push it to the delivery pipes. Install the 8 injectors.

(d) Position injector connector outward.



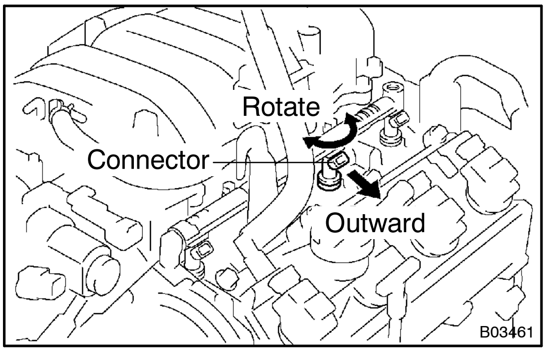


(e) Place the 4 spacers on the intake manifold.



(f) Place the 8 injectors and 2 delivery pipes assembly in position on the intake manifold.

(g) Temporarily install the 4 nuts.



(h) Check that the injectors rotate smoothly.

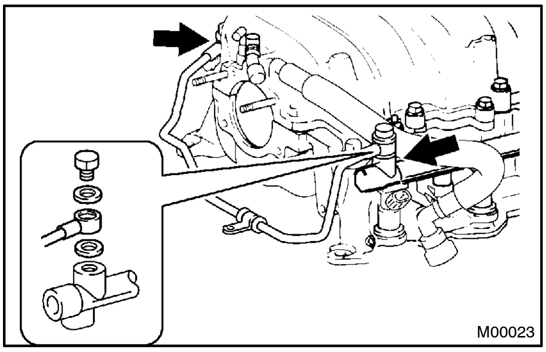
HINT:

If injectors do not rotate smoothly, the probable cause is incorrect installation of O-rings. Replace the O-rings.

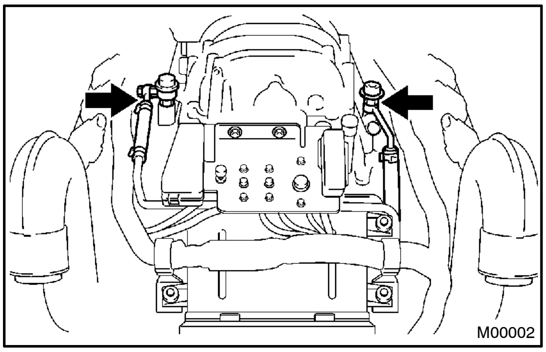
(i) Position injector connector outward.

(j) Tighten the 4 nuts holding the delivery pipes to the intake manifold.

Torque: 18 N·m (185 kgf·cm, 13 ft·lbf)


M00023

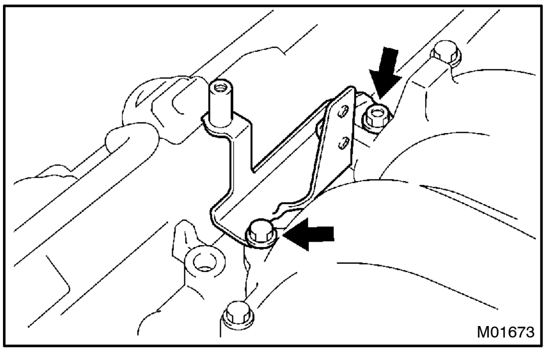
(k) Install the FR fuel pipe to the delivery pipe with the 2 union bolts and 4 gaskets.
Torque: 39 N·m (400 kgf·cm, 29 ft·lbf)


M00002

(l) Install the fuel pipe and hose
- Fuel pressure pulsation damper and fuel inlet hose

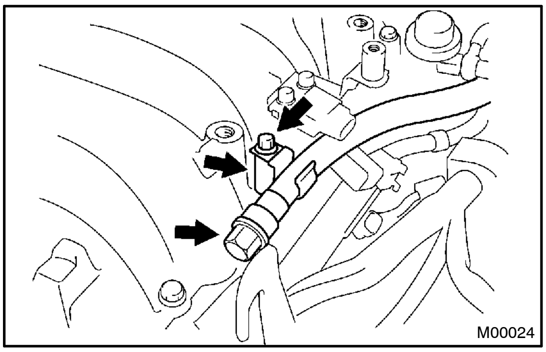
Torque: 39 N·m (400 kgf·cm, 29 ft.·lbf)
- No.4 fuel hose

Torque: 1.5 N·m (15 kgf·cm, 13 in.·lbf)


M01673

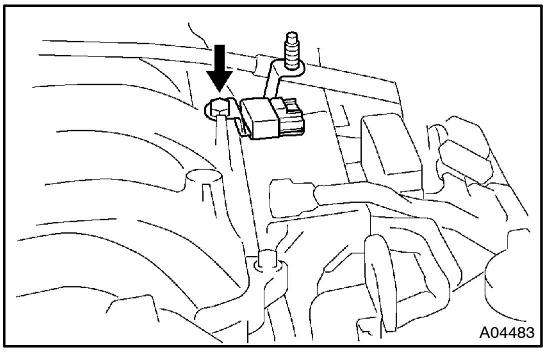
(m) Install these parts:
- Throttle control cable bracket

Torque: 18 N·m (185 kgf·cm, 13 ft.·lbf)


M00024

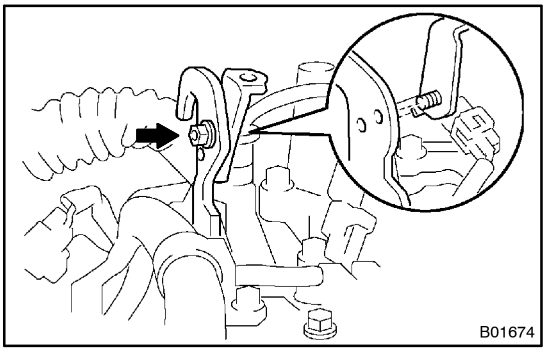
- Oil drain hose clamp and spacer

Torque: 12 N·m (120 kgf·cm, 9 ft.·lbf)


A04483

- V-bank cover bracket w/noise filter

Torque: 7.5 N·m (80 kgf·cm, 66 in.·lbf)



- RH rear V–bank cover bracket

Torque: 7.5 N·m (80 kgf·cm, 66 in.·lbf)

- LH front V–bank cover bracket

Torque: 7.5 N·m (80 kgf·cm, 66 in.·lbf)

2. CONNECT ENGINE WIRE CONNECTORS

Connect these connectors:

- 8 injector connectors
- 2 VVT sensor connectors
- 2 camshaft position sensor connectors
- LH side noise filter connector
- LH side DLC3 connector
- RH side ECT sensor connector
- RH side ECT sender gause connector

Torque: 2.5 N·m (25 kgf·cm, 22 in.·lbf)

3. INSTALL THROTTLE BODY
(See page SF–41)

4. CONNECT THROTTLE CABLE

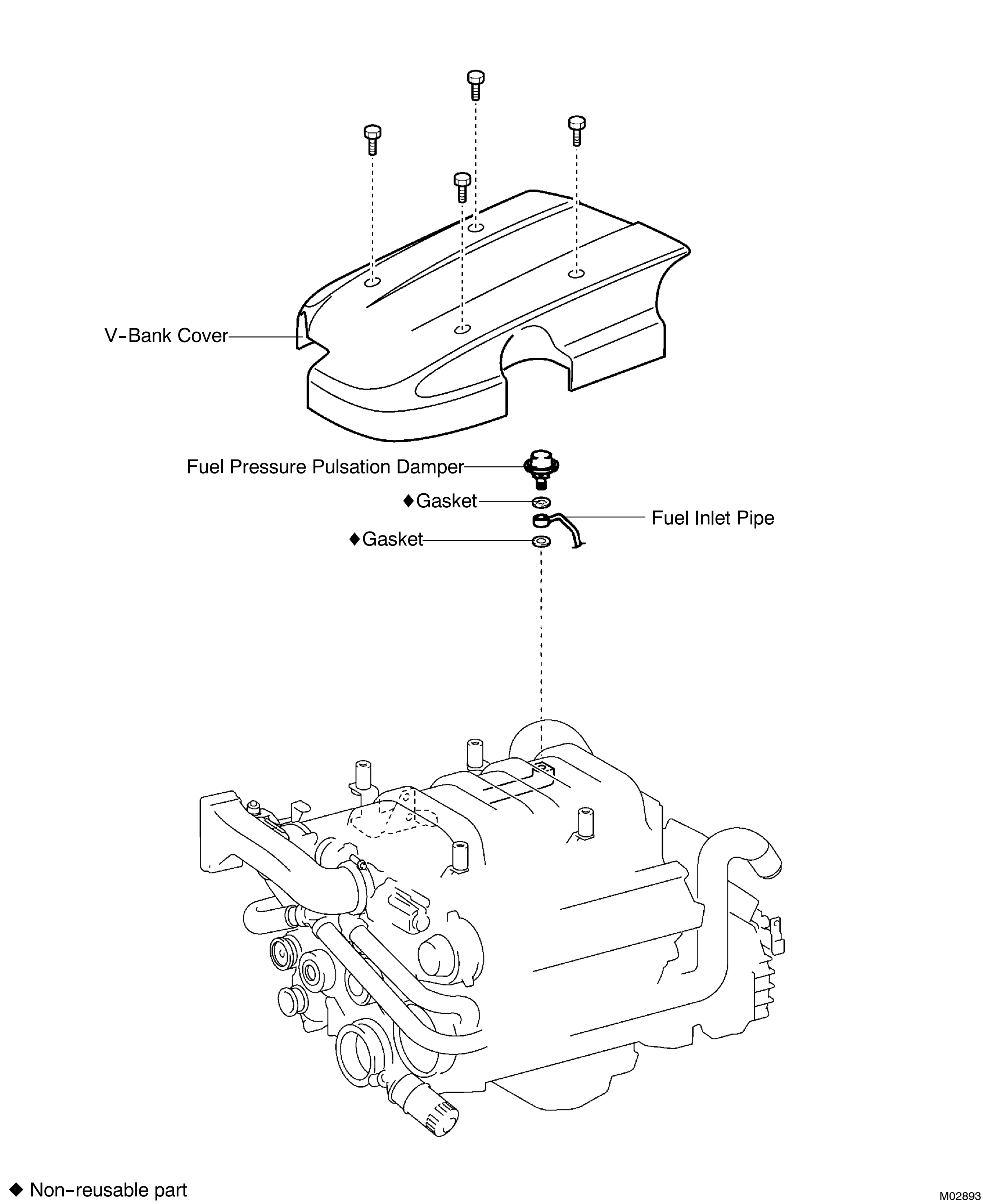
5. INSTALL INTAKE AIR CONNECTOR

6. INSTALL V–BANK COVER

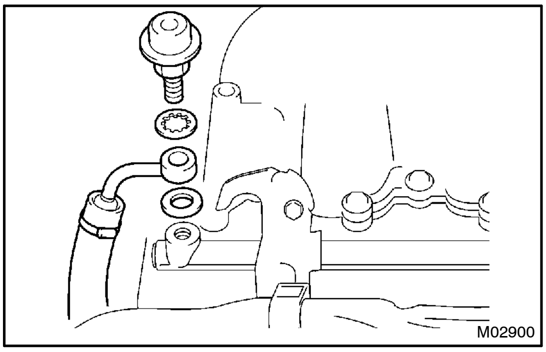
FUEL PRESSURE PULSATION DAMPER

SF0S3-01

COMPONENTS



SF0S4-01


M02900

REMOVAL

1. REMOVE V-BANK COVER

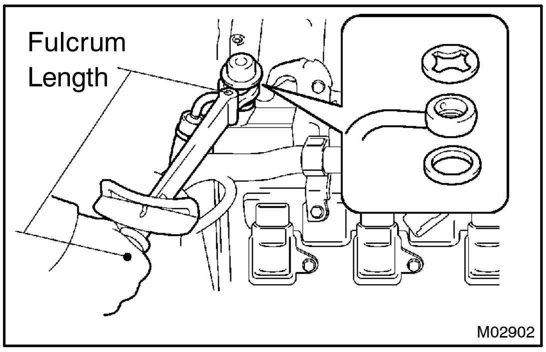
2. REMOVE FUEL PRESSURE PULSATION DAMPER

(a) Remove pulsation damper and upper gasket.

(b) Remove the fuel inlet pipe and lower gasket.

CAUTION:

- **Put a shop towel under the delivery pipe.**
- **Slowly loosen the pulsation damper.**



SF0S5-01

INSTALLATION

1. INSTALL FUEL PRESSURE PULSATION DAMPERS

Using SST, install 2 new gaskets, the fuel inlet pipe and pulsation damper. Install the 2 pulsation dampers.

SST 09612-24014 (09617-24011)

Torque:

39 N·m (400 kgf·cm, 29 ft·lbf)

33 N·m (340 kgf·cm, 24 ft·lbf) for SST

HINT:

Use a torque wrench with a fulcrum length of 30 cm (11.81 in.).

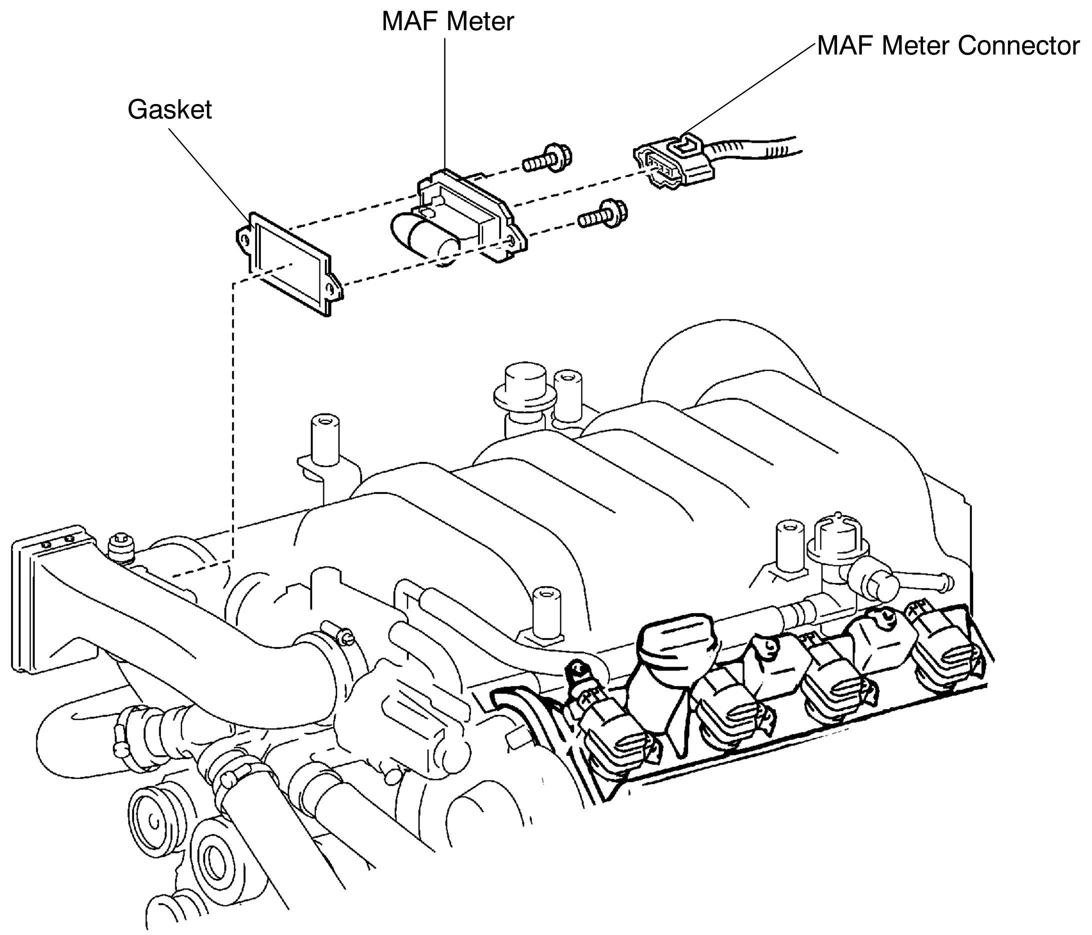
2. CHECK FOR FUEL LEAKS
(See page SF-1)

3. INSTALL V-BANK COVER

MASS AIR FLOW (MAF) METER

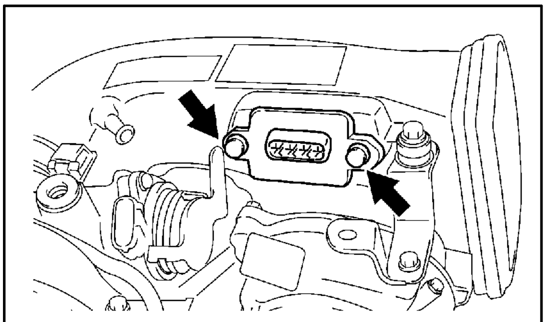
COMPONENTS

SF0SB-01



M2905

SF0SD-01

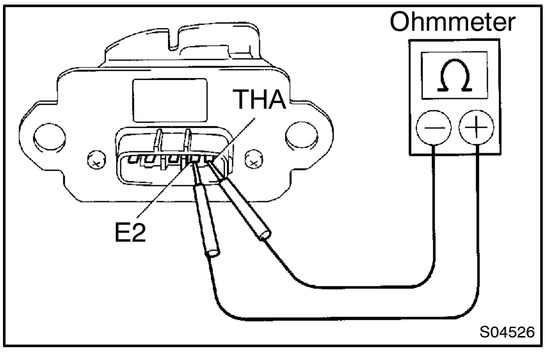

M02906

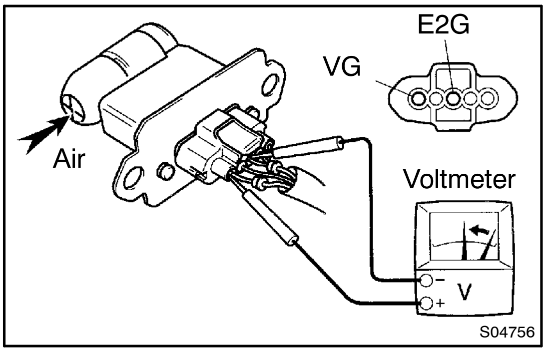
REMOVAL

REMOVE MAF METER

(a) Disconnect the MAF meter connector.

(b) Remove the 2 bolts, MAF meter and gasket.





SF0SE-01

INSPECTION

1. INSPECT MAF METER RESISTANCE

Using an ohmmeter, measure the resistance between terminals THA and E2.

Terminals	Resistance	Temperature
THA - E2	13.6 - 18.4 kΩ	-20°C (-4°F)
THA - E2	2.21 - 2.69 kΩ	20°C (68°F)
THA - E2	0.493 - 0.667 kΩ	60°C (140°F)

If the resistance is not as specified, replace the MAF meter.

2. INSPECT MAF METER OPERATION

(a) Connect the MAF meter connector.
(b) Turn the ignition switch ON.
(c) Using a voltmeter, connect the positive (+) tester probe to terminal VG, and negative (-) tester probe to terminal E2G.
(d) Blow air into the MAF meter, and check that the voltage fluctuates.

If operation is not as specified, replace the MAF meter.

(e) Turn the ignition switch LOCK.
(f) Disconnect the MAF meter connector.

SF0SF-01

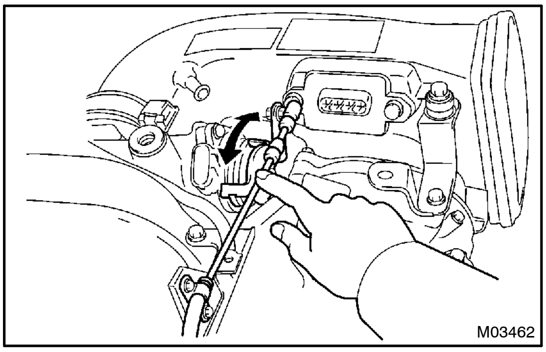
INSTALLATION

Installation is in the reverse order of removal.
(See page SF-28)

THROTTLE BODY

SF0SG-01

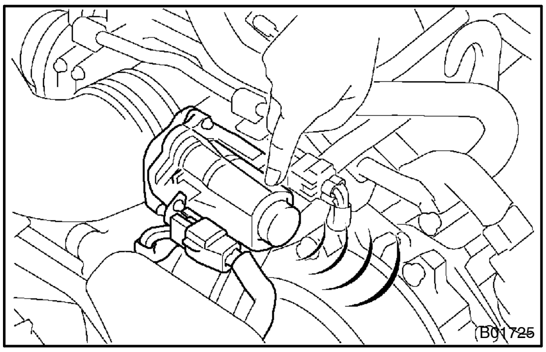
ON-BOAT INSPECTION


M03462

1. REMOVE V-BANK COVER

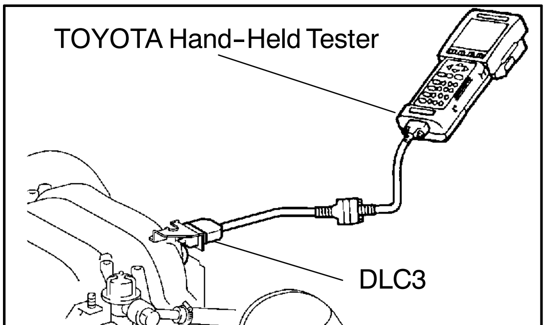
2. INSPECT SYSTEM OPERATION

(a) Check that the throttle linkage moves smoothly.


B01725

(b) Inspect the throttle control motor for operating sound.
   (1) Turn the ignition switch ON.
   (2) When turning the accelerator pedal position sensor lever, check the running sound of the motor. Also, check that there is no friction sound.

If operation is not as specified, check the throttle control motor (See step 4), wiring and ECM.



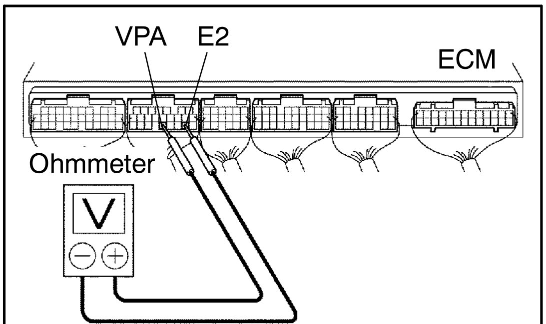
M24637

(c) Inspect the accelerator pedal position sensor.
   (1) Connect the TOYOTA hand-held tester to the DLC3.
   (2) Check that the MIL does not light up.
   (3) When turning the accelerator pedal position sensor lever to the full-open position, check that the throttle valve opening percentage (THROTTLE POS) of the CURRENT DATA showns the standard value.

Standard throttle valve opening percentage:
60 % or more

If operation is not as specified, check that the accelerator pedal position sensor (See step 5), wiring and ECM.

If you have no TOYOTA hand-held tester, measure voltage between terminals VPA and E2 of the ECM connector.



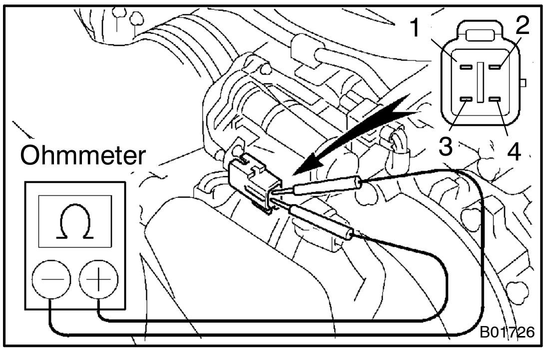
B01739

(d) Inspect the air assist system.
   (1) Start the engine and check that the MIL does not light up.
   (2) Allow the engine to warm up to normal operating temperature.
   (3) Turn the A/C conditioning ON to OFF, and check the idle speed.

Idle speed (Transmission in neutral):
700 ± 50 rpm

NOTICE:
Perform inspection under condition without electrical load.

(e) After checking the above (b) to (d), perform the driving test and check that there is no sense of incongruity.



3. INSPECT THROTTLE CONTROL MOTOR w/ CLUTCH

(a) Disconnect the throttle control motor w/ clutch connector.

(b) Using an ohmmeter, measure the motor resistance between terminal 1 (M+) and 2 (M-).

Motor resistance:

0.3 - 100 Ω at 20°C (68°F)

If the resistance is not as specified, replace the throttle control motor w/ clutch. (See page SF-37)

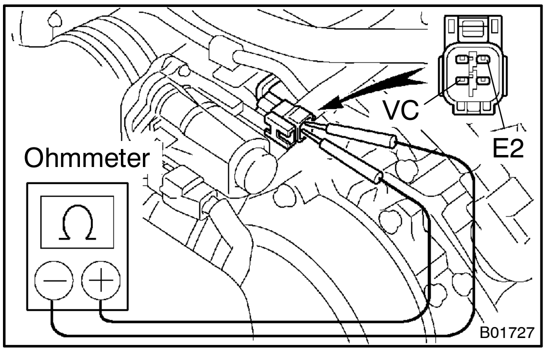
(c) Using an ohmmeter, measure the clutch resistance between terminal 3 (CL-) and 4 (CL+).

Clutch resistance:

4.2 - 5.2 Ω at 20°C (68°F)

If the resistance is not as specified, replace the throttle control motor w/ clutch. (See page SF-37)

(d) Reconnect the throttle control motor connector.



4. INSPECT THROTTLE POSITION SENSOR

(a) Disconnect the throttle position sensor connector.

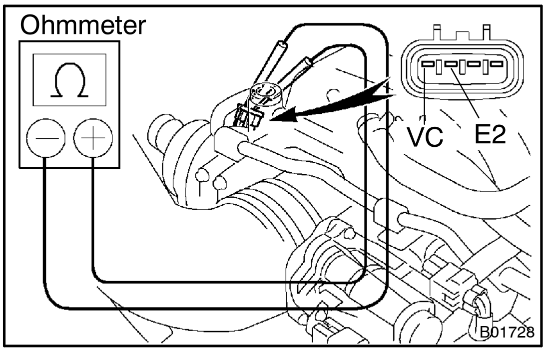
(b) Using an ohmmeter, measure the resistance between terminals VC and E2.

Resistance:

1.25 - 2.35 kΩ at 20°C (68°F)

If the resistance is not as specified, replace the throttle position sensor. (See page SF-37)

(c) Reconnect the throttle position sensor connector.



5. INSPECT ACCELERATOR PEDAL POSITION SENSOR

(a) Disconnect the accelerator position sensor connector.

(b) Using an ohmmeter, measure the resistance between terminals VC and E2.

Resistance:

1.64 - 3.28 kΩ at 20°C (68°F)

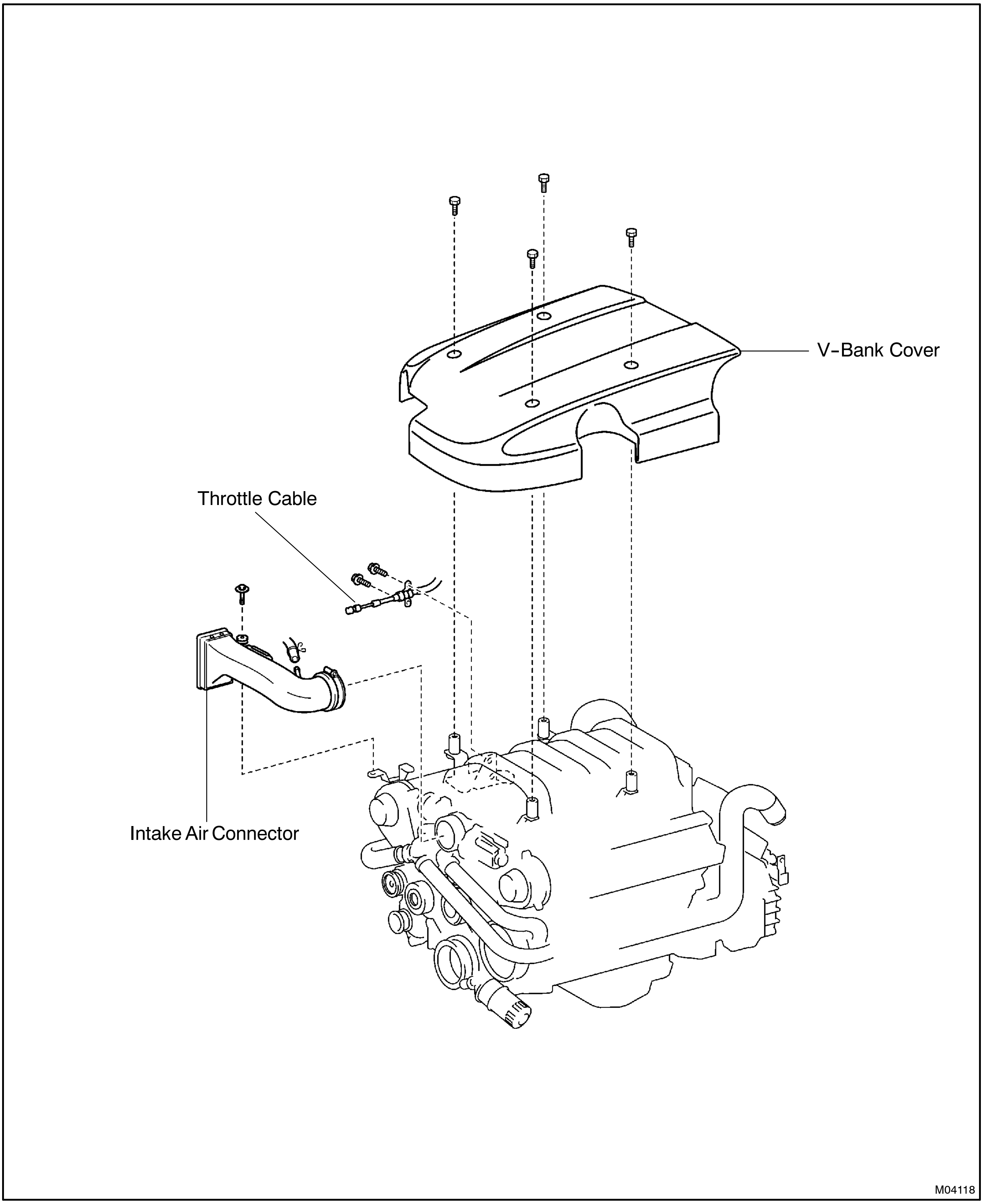
If the resistance is not as specified, replace the accelerator pedal position sensor. (See page SF-37)

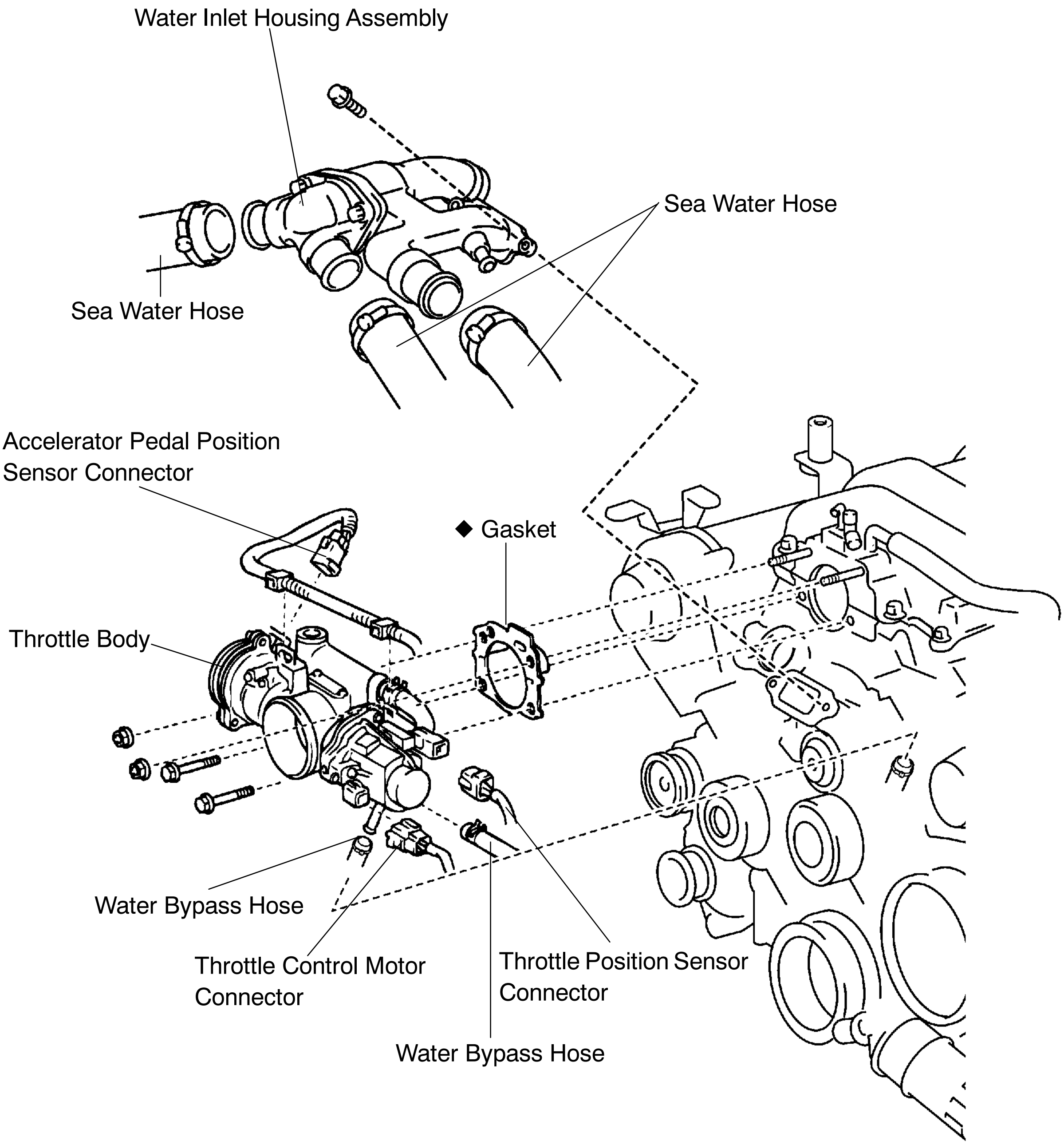
(c) Reconnect the accelerator pedal position sensor connector.

6. REINSTALL V-BANK COVER

SF0SH-01

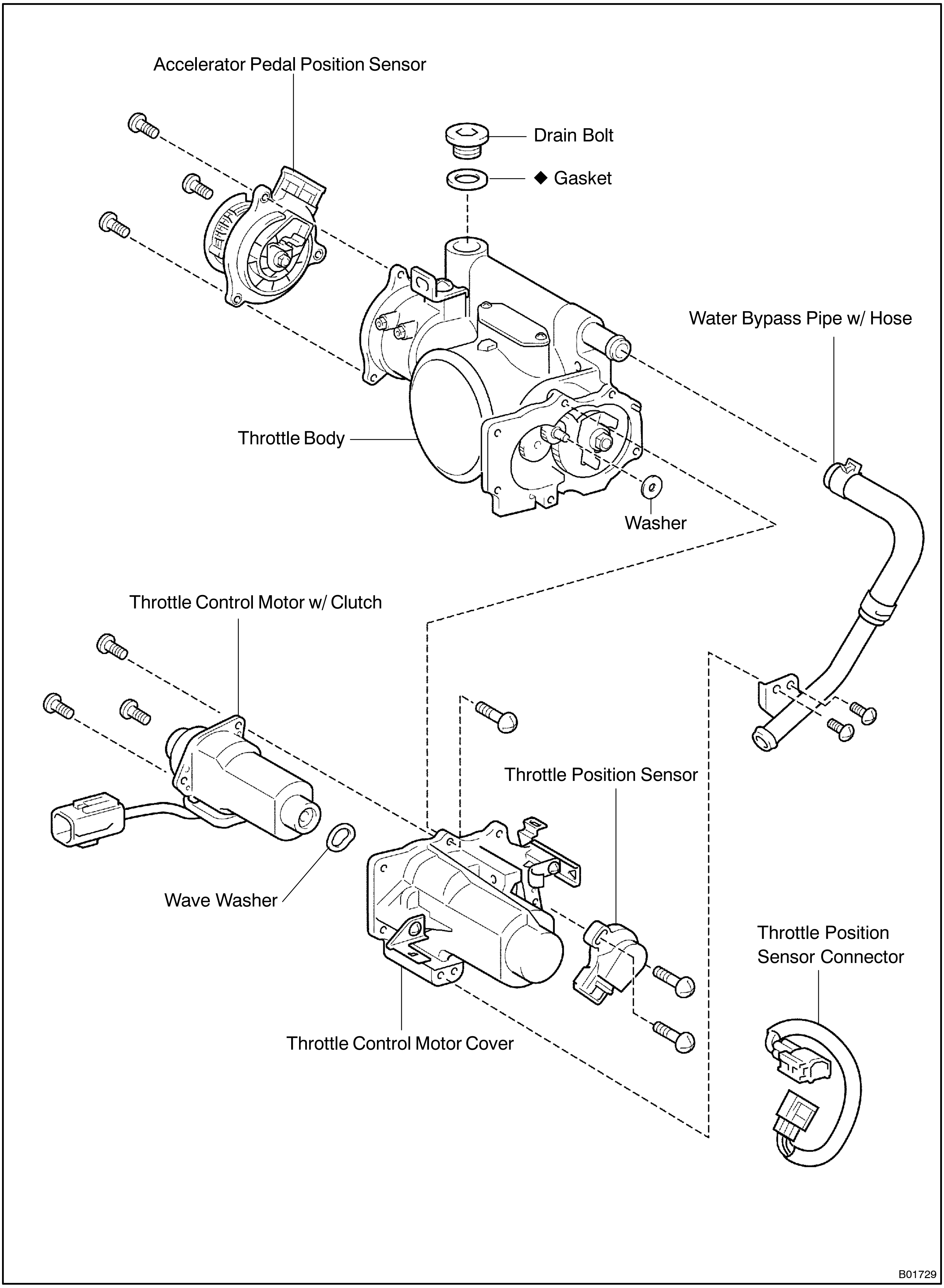
COMPONENTS





◆ Non-reusable part

M02907


Accelerator Pedal Position Sensor
Drain Bolt
◆ Gasket
Water Bypass Pipe w/ Hose
Throttle Body
Washer
Throttle Control Motor w/ Clutch
Throttle Position Sensor
Wave Washer
Throttle Position
Sensor Connector
Throttle Control Motor Cover
B01729

SF0SI-01

REMOVAL

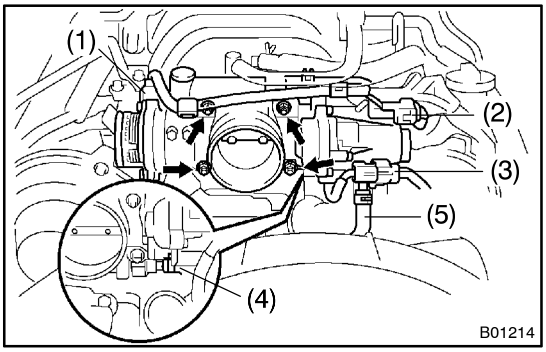
1. REMOVE V-BANK COVER

2. REMOVE INTAKE AIR CONNECTOR

3. DISCONNECT THROTTLE CABLE FROM THROTTLE BODY

4. REMOVE WATER INLET HOUSING ASSEMBLY
(See page CO-5)

5. REMOVE THROTTLE BODY



(a) Disconnect these hoses and connectors from the throttle body:
- (1) Accelerator pedal position sensor connector
- (2) Throttle position sensor connector
- (3) Throttle control motor connector
- (4) No.1 water bypass hose
- (5) No.7 water bypass hose

(b) Disconnect the 2 wire clamps from the throttle body.

(c) Remove the 2 bolts, 2 nuts, throttle body and gasket.
Torque: 18 N·m (185 kgf·cm, 13 ft·lbf)

HINT:
At the time of installation, please refer to the following items.
Use a new gasket.

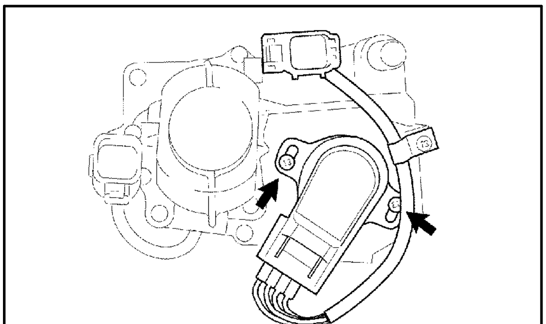
SF0SJ–01

REPLACEMENT

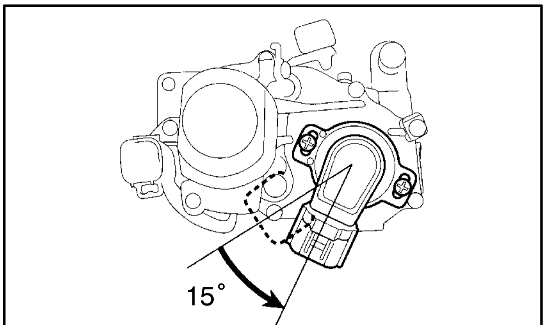
NOTICE:

- **To prevent deterioration, do not shock the throttle position sensor and accelerator pedal position sensor.**
- **Mixing of the foreign objects may cause the gear locking, so thoroughly check that there is no stuck of any foreign objects and clean up if any.**

1. REPLACE THROTTLE POSITION SENSOR


B01731

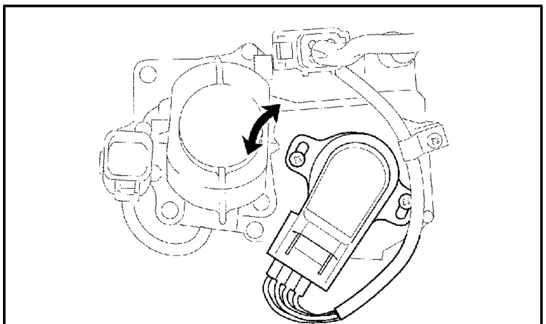
(a) Remove the 2 screws and water bypass hose and pipe.
(b) Disconnect the connector from the throttle position sensor and bracket, and remove the screw and connector.
(c) Remove the 2 set screws and throttle position sensor.
(d) Reinstall the throttle position sensor.
(1) Check that the throttle valve is under the condition of the opener opening angle (about 4°).



B01732

(2) Install the sensor to the place where is at 15° rotated to the right from the specified installation position.
(3) Gradually turn sensor counterclockwise until it touches the throttle valve shaft and temporarily torque the 2 set screws.
(e) Install the connector with the screw, and connect the connector to throttle position sensor and bracket.
(f) Adjust the throttle position sensor.
(1) Connect the throttle position sensor connector.

NOTICE:
Do not connect the accelerator pedal position sensor connector.


B01733

(2) Connect the TOYOTA hand–held tester or OBDII scan tool to the DLC3.
(3) Turn the ignition switch ON.
(4) While reading the valve of the throttle valve opening percentage (THROTTLE POS) of the CURRENT DATA, turn the throttle position sensor slowly to left and right and set the sensor at the center value of the standard value, and then torque the screws.

Standard throttle valve opening percentage:
14.4 – 16 %
Torque: 2 N·m (20 kgf·cm, 17in.·lbf)

NOTICE:
After turning the ignition switch ON, do not depress the throttle lever.

(5) Recheck throttle valve opening percentage.
If the throttle valve opening percentage is not as specified, repeat step (4).

(6) Perform fully closed throttle valve by hand and check that the valve of the throttle valve opening percentage (THROTTLE POS) of the CURRENT DATA stays with the standard value.

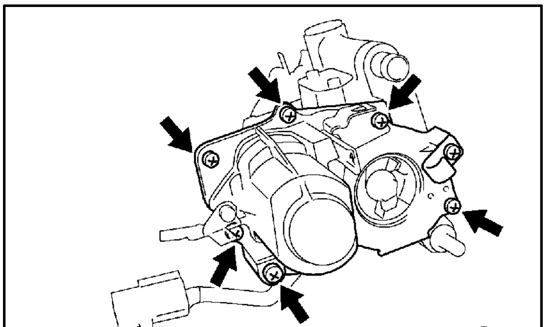
Standard throttle valve opening percentage:
10 - 14 %

If the throttle valve opening percentage is not as specified, repeat steps (4) to (6).

(7) Paint the sensor set screw.
(8) Turn the ignition switch OFF.
(9) Disconnect the TOYOTA hand-held tester or OBDII scan tool from the DLC3.
(10) Disconnect the throttle position sensor connector.

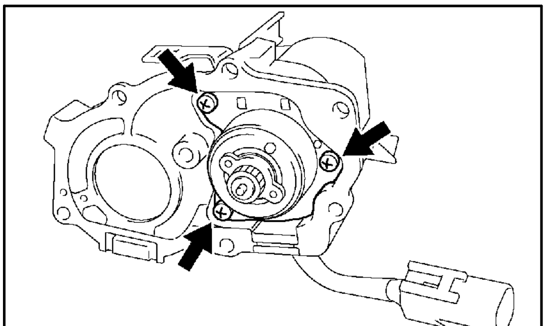
(g) Reinstall the water bypass hose and pipe with the 2 screws.

Torque: 5.4 N·m (55 kgf·cm, 47in.·lbf)

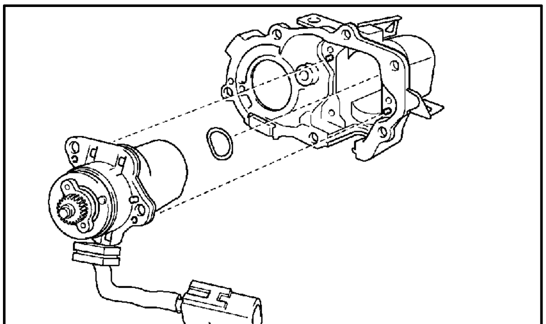

B01735

2. REPLACE THROTTLE CONTROL MOTOR w/ CLUTCH

(a) Remove the water bypass hose and pipe.
(b) Remove the throttle position sensor.
(c) Remove the throttle control motor w/ clutch.
(1) Disconnect the connector from the bracket.
(2) Remove the 6 screws cover and motor assembly, and washer.


B01736

(3) Remove the 3 screws, throttle control motor w/ clutch and wave washer from the cover.

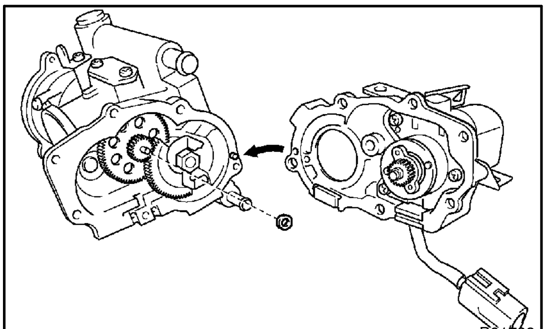

B01737

(d) Reinstall the throttle control motor w/ clutch.
(1) Place the wave washer to the cover.
(2) Match the holes of the positioning pin of the cover and the motor, and then install the throttle control motor w/ clutch with the 3 set screws.

Torque: 3.4 N·m (35 kgf·cm, 30 in.·lbf)

(3) Apply the grease thinly on the whole surface of the gear teeth.

NOTICE:
Do not apply the grease other than specified because grease has been already applied to the component to be replaced.

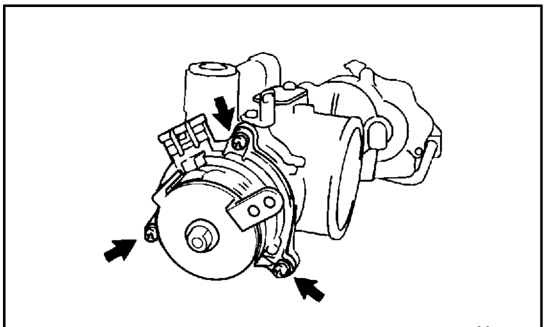

B01738

(4) Place the washer as shown in the illustration.
(5) Match the holes of the positioning pin of the throttle body and the motor cover, and then install the throttle control motor and cover assembly with the 6 set screws.

Torque: 3.4 N·m (35 kgf·cm, 30 in.·lbf)

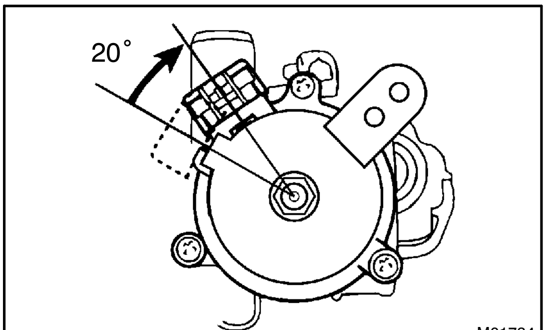
(6) Connect the connector to the bracket.

(e) Reinstall and adjust the throttle position sensor. (See step 1)


M01740

3. REPLACE ACCELERATOR PEDAL POSITION SENSOR

(a) Remove the 3 set screws and accelerator position sensor.



M01734

(b) Reinstall the accelerator pedal position sensor.
(1) Check that the throttle valve is under the condition of the opener opening angle (about 4°).
(2) Install the sensor to the place where is at 20° rotated to the left from the specified installation position.
(3) Gradually turn sensor clockwise until it touches the throttle valve shaft and temporarily torque the 3 set screws.

Torque: 5.4 N·m (55 kgf·cm, 47in.·lbf)

(c) Inspect the accelerator pedal position sensor.
(1) Connect the accelerator pedal position sensor connector.
(2) Connect the TOYOTA hand–held tester or OBDII scan tool to the DLC3.
(3) Turn the ignition switch ON.
(4) Check that the ACCEL POS #1 (VPA) voltage of the CURRENT DATA shows the standard value.

Standard accelerator pedal position voltage:
0.35 – 0.85 V

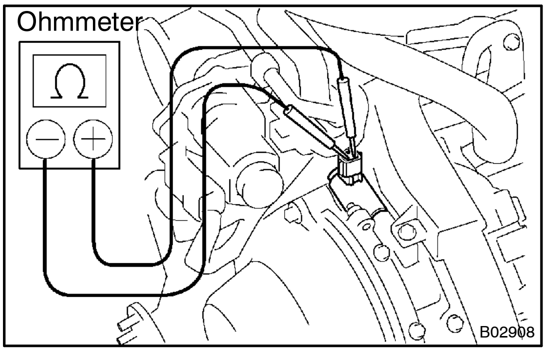
NOTICE:
After turning the ignition switch ON, do not depress the accelerator pedal.

4. CHECK SYSTEM OPERATION
(See page SF-31)

SF0SK–01

INSTALLATION

Installation is in the reverse order of removal.
(See page SF–36)



CAMSHAFT TIMING OIL CONTROL VALVE

SF0SL-01

ON-BOAT INSPECTION

INSPECT OIL CONTROL VALVE RESISTANCE

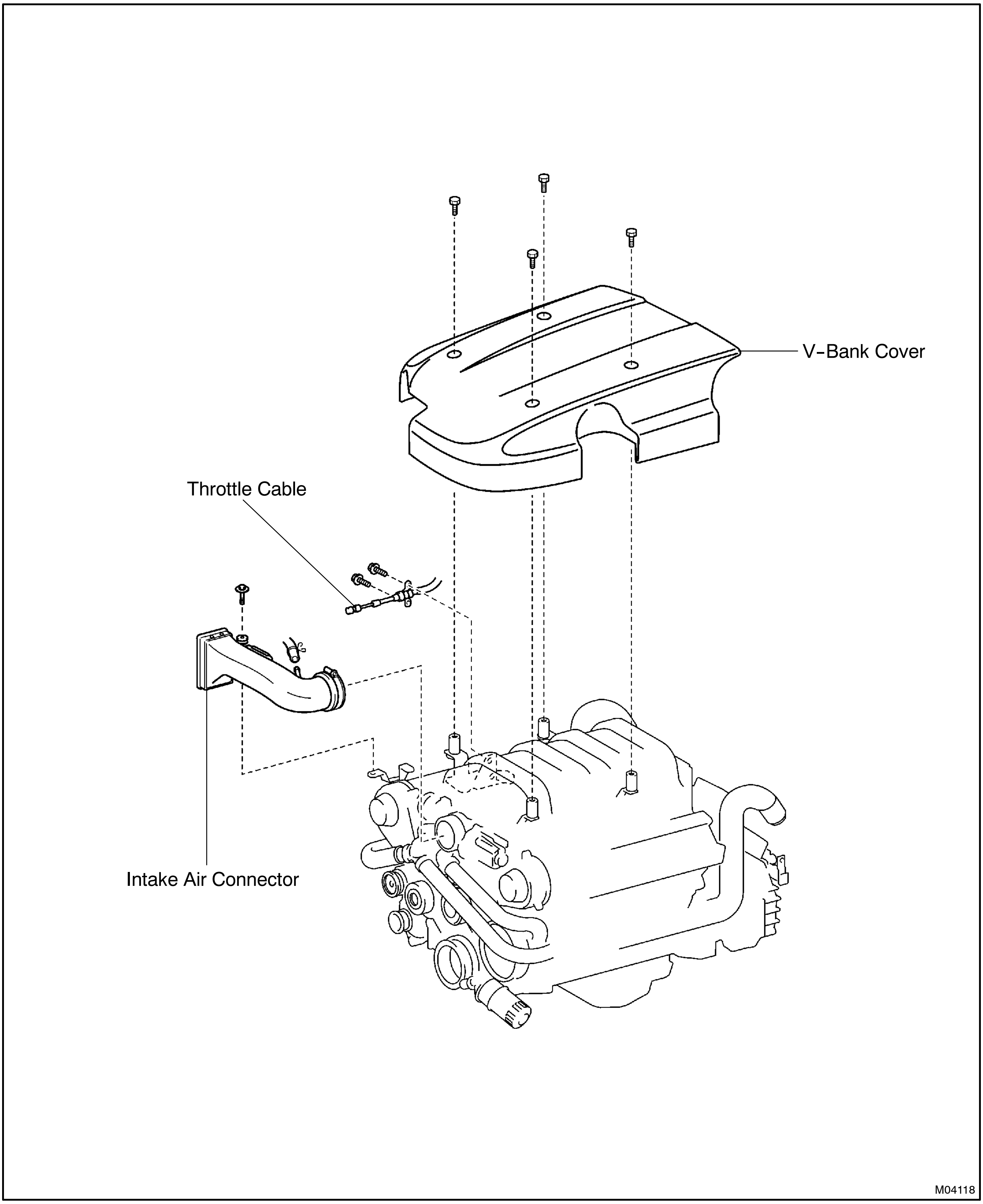
(a) Remove the V-bank cover.
(b) Remove the intake air connector.
(c) Disconnect the oil control valve connector.
(d) Using an Ohmmeter, measure the resistance between the terminals.
Resistance:
6.9 - 7.9 Ω at 20°C (68°F)

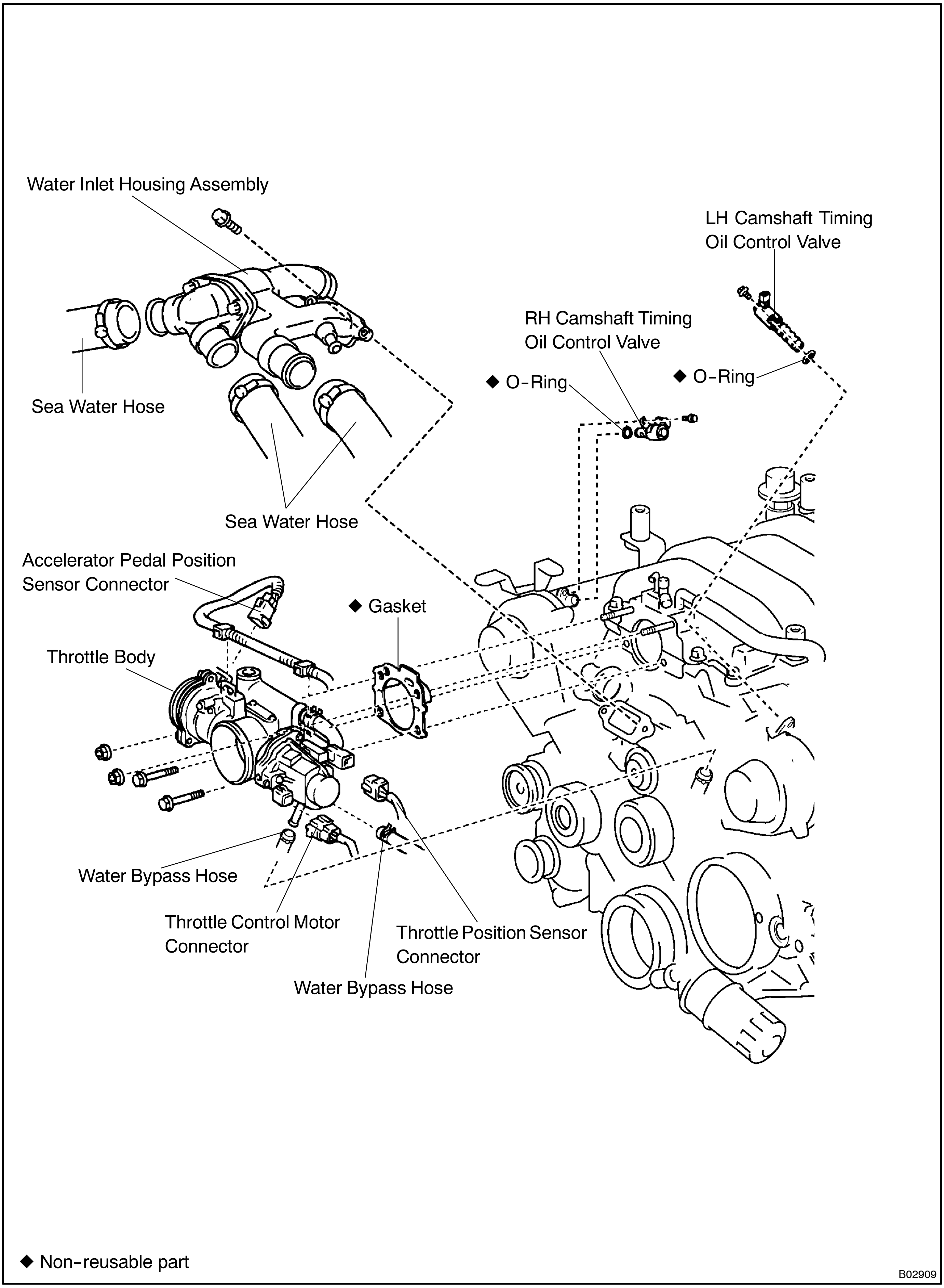
If the resistance is not as specified, replace the valve.

(e) Reconnect the oil control valve connector.
(f) Reinstall the intake air connector.
(g) Reinstall the V-bank cover.

SF0SM-01

COMPONENTS

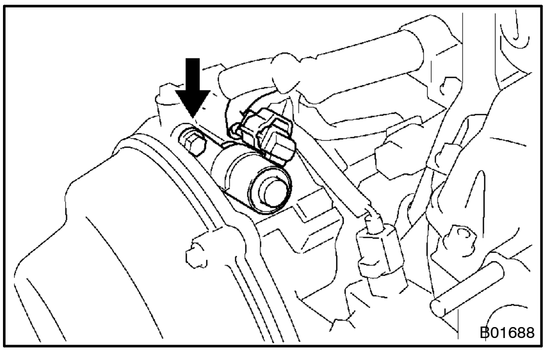



Water Inlet Housing Assembly
LH Camshaft Timing
Oil Control Valve
RH Camshaft Timing
Oil Control Valve
◆ O-Ring
◆ O-Ring
Sea Water Hose
Sea Water Hose
Accelerator Pedal Position
Sensor Connector
◆ Gasket
Throttle Body
Water Bypass Hose
Throttle Control Motor
Connector
Throttle Position Sensor
Connector
Water Bypass Hose
◆ Non-reusable part
B02909

SF0SN-01

REMOVAL

1. **REMOVE V-BANK COVER**
2. **REMOVE INTAKE AIR CONNECTOR**
3. **DISCONNECT THROTTLE BODY FROM INTAKE MANIFOLD**
   (See page SF-53)



4. **REMOVE CAMSHAFT TIMING OIL CONTROL VALVE**

(a) Disconnect the engine wire from the wire clamp on the LH timing belt rear plate.

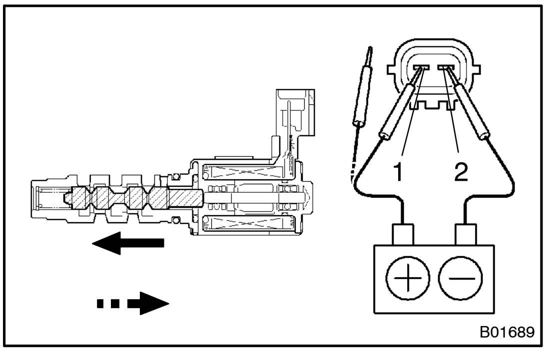
(b) Disconnect the 2 camshaft oil control valve connectors.

(c) Remove the bolt, camshaft oil control valve and O-ring. Remove the 2 camshaft oil control valves.
Torque: 7.5 N·m (80 kgf·cm, 66 in.·lbf)

(d) Remove the O-ring from the each camshaft oil control valve.

HINT:
At the time of installation, please refer to the following items.
Use a new O-rings.

SF0SO-01



INSPECTION

INSPECT OIL CONTROL VALVE OPERATION

Connect positive ⊕ lead to terminal 1 of connector and negative ⊖ lead to terminal 2, then check the movement of the valve.

When battery positive voltage is applied.	Valve moves in ← direction.
When battery positive voltage is cut off.	Valve moves in ⇢ direction.

If operation is not as specified, replace the oil control valve.

SF0SP–01

INSTALLATION

Installation is in the reverse order of removal.
(See page SF–45)

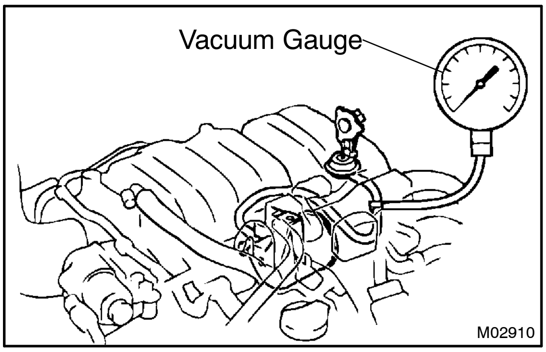
ACOUSTIC CONTROL INDUCTION SYSTEM (ACIS)

SF0SQ-01

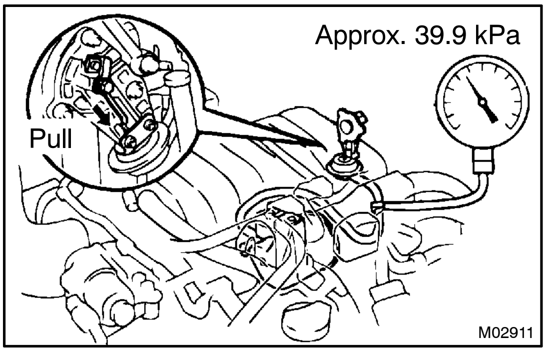
ON-BOAT INSPECTION

INSPECT INTAKE AIR CONTROL VALVE

(a) Remove V-bank cover.
(b) Remove the intake air connector.
(c) Disconnect the throttle body from the intake manifold. (See page SF-53)
(d) Remove the intake manifold. (See page EM-29)



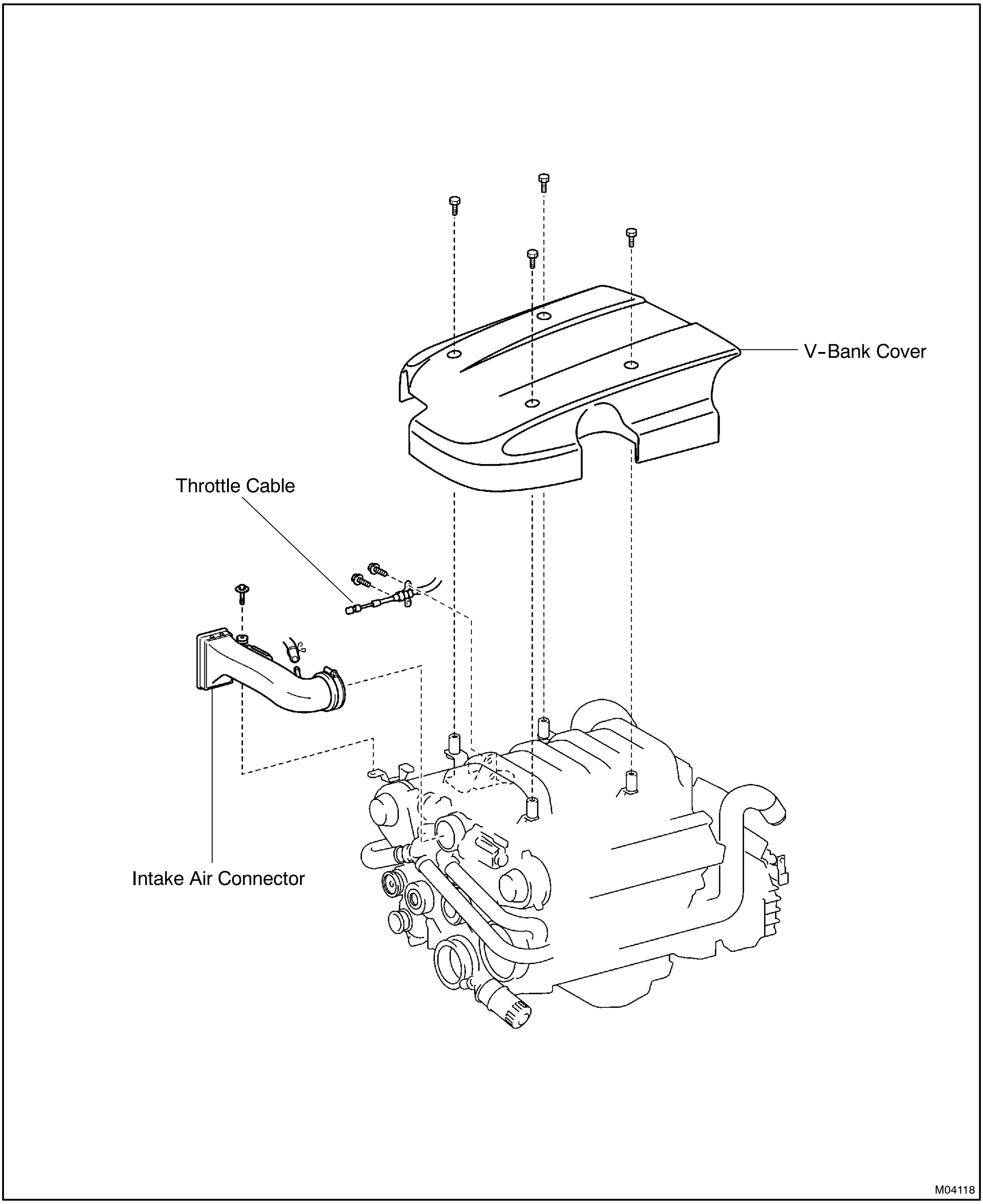
(e) Using a 3-way connector, connect vacuum gauge to the actuator hose.
(f) Reinstall the intake manifold.
(g) Reconnect the throttle body.
(h) Start the engine.

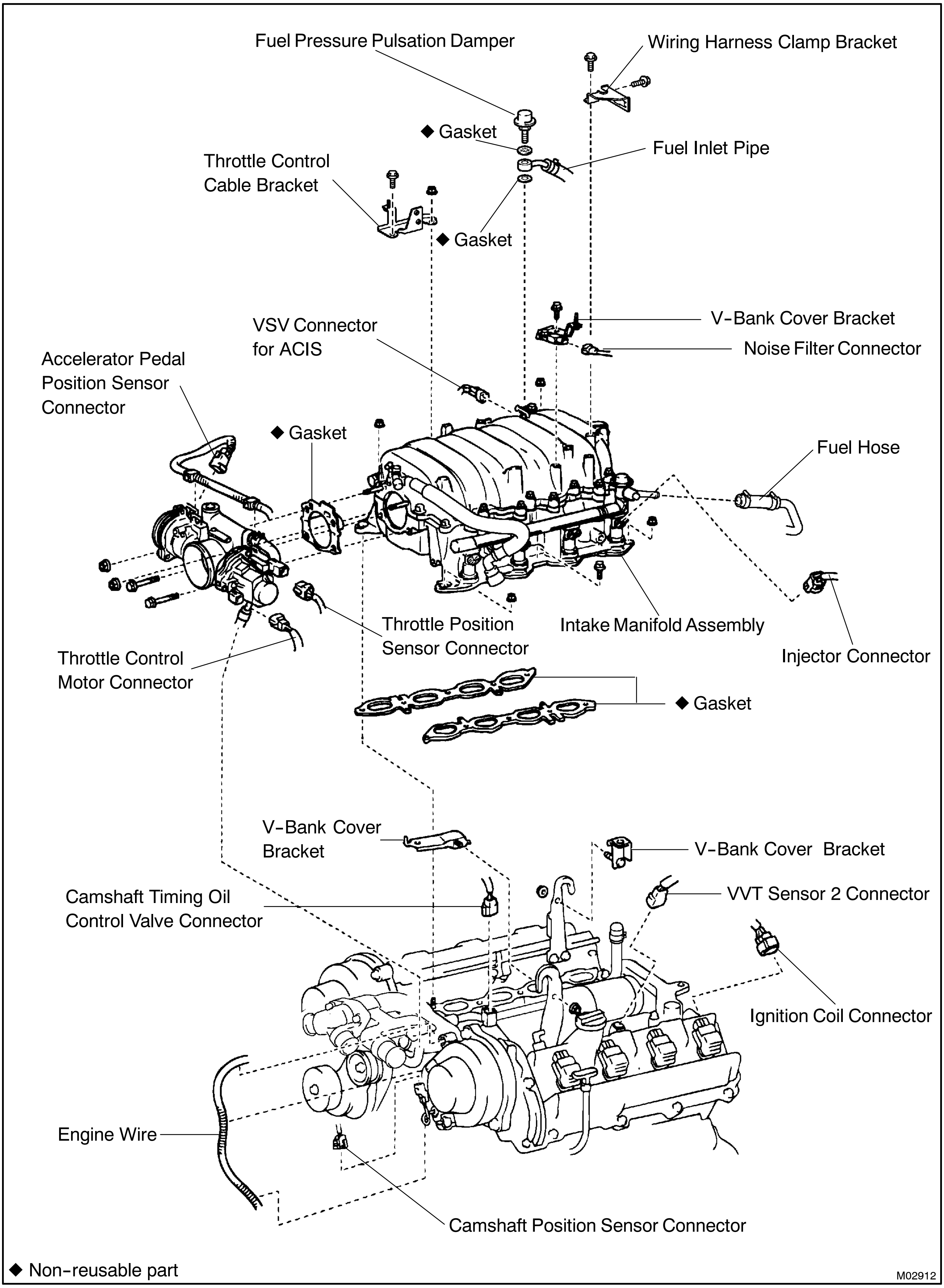


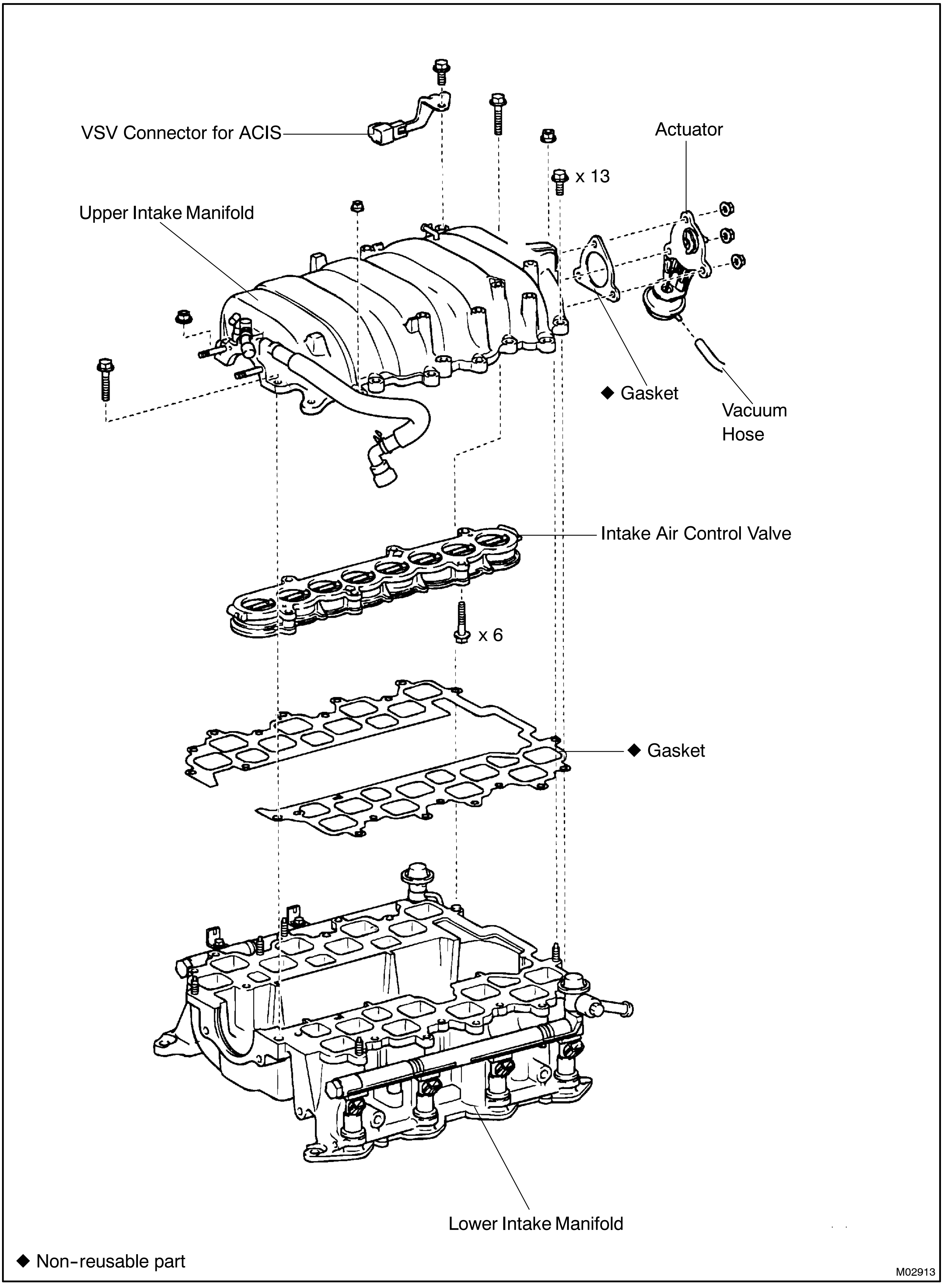
(i) While the engine is idling, check that the vacuum gauge needle momentarily fluctuates up to approx. 39.9 kPa (300 mmHg, 11.8 in.Hg). (The actuator rod is pulled out.)
(j) Rapidly depress the accelerator pedal to fully open position and check that the vacuum gauge needle points to 0 kPa (0 mmHg, 0 in.Hg). (The actuator rod is returned.)
(k) Disconnect the throttle body.
(l) Remove the intake manifold.
(m) Remove the vacuum gauge, and connect the vacuum hose to the actuator.
(n) Reinstall the intake manifold.
(o) Reconnect the throttle body.
(p) Reinstall the intake air connector.
(q) Reinstall the V-bank cover.

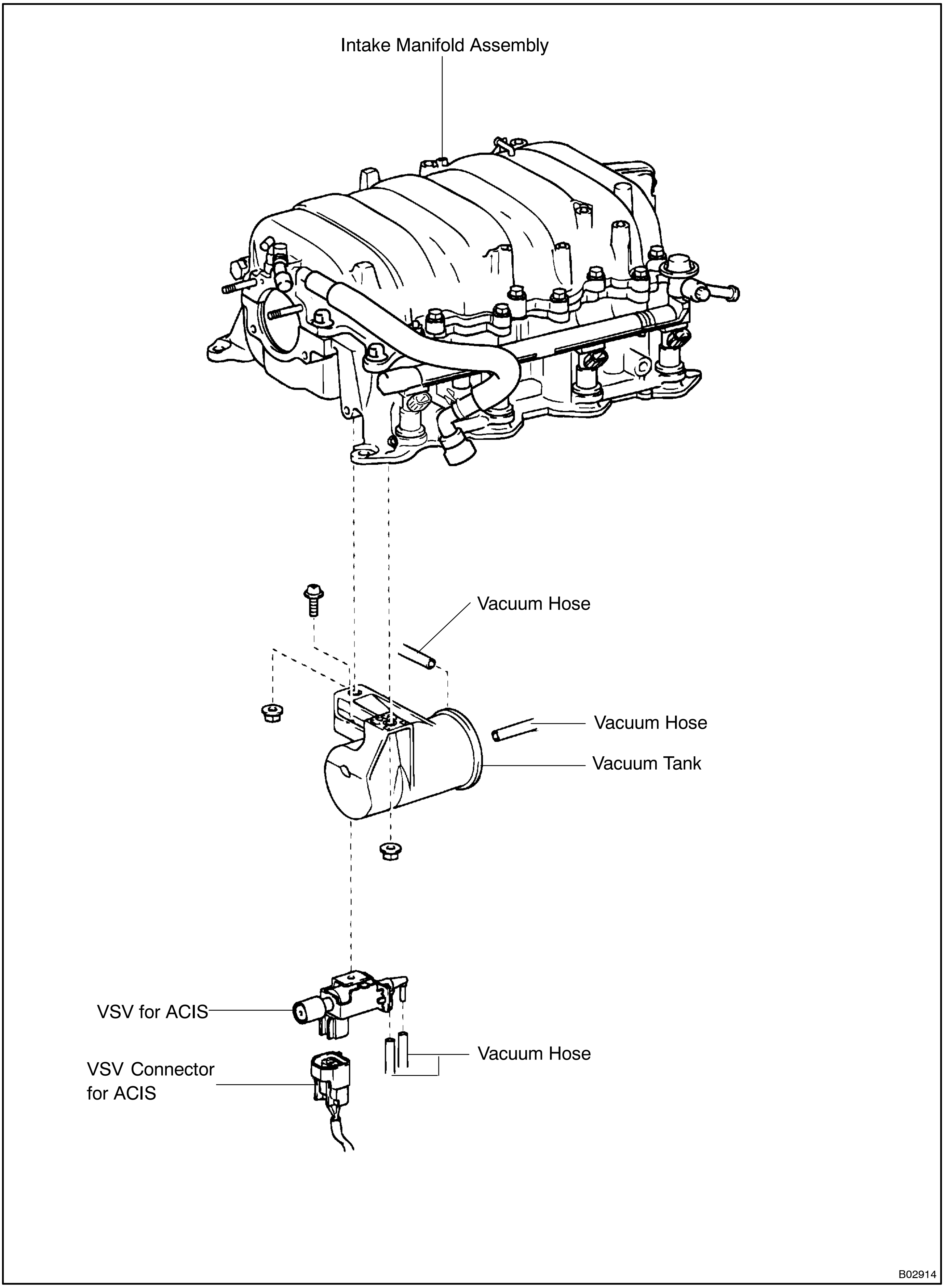
SF0SR-01

COMPONENTS




Fuel Pressure Pulsation Damper
Wiring Harness Clamp Bracket
◆ Gasket
Fuel Inlet Pipe
Throttle Control
Cable Bracket
◆ Gasket
V-Bank Cover Bracket
Noise Filter Connector
VSV Connector
for ACIS
Accelerator Pedal
Position Sensor
Connector
◆ Gasket
Fuel Hose
Throttle Position
Sensor Connector
Intake Manifold Assembly
Injector Connector
Throttle Control
Motor Connector
◆ Gasket
V-Bank Cover
Bracket
V-Bank Cover Bracket
Camshaft Timing Oil
Control Valve Connector
VVT Sensor 2 Connector
Ignition Coil Connector
Engine Wire
Camshaft Position Sensor Connector
◆ Non-reusable part
M02912


VSV Connector for ACIS
Actuator
x 13
Upper Intake Manifold
◆ Gasket
Vacuum
Hose
Intake Air Control Valve
x 6
◆ Gasket
Lower Intake Manifold
◆ Non-reusable part
M02913


Intake Manifold Assembly
Vacuum Hose
Vacuum Hose
Vacuum Tank
VSV for ACIS
VSV Connector for ACIS
Vacuum Hose
B02914

SF0SS–01

REMOVAL

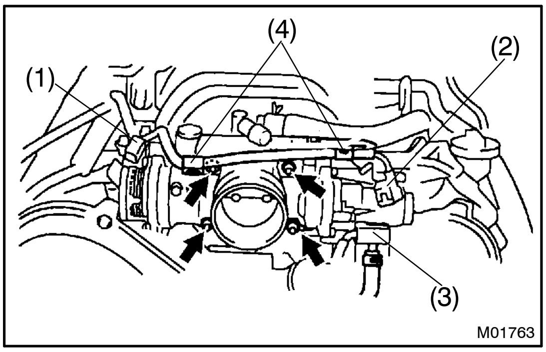
1. REMOVE V–BANK COVER

2. REMOVE INTAKE AIR CONNECTOR

3. REMOVE WATER INLET HOUSING ASSEMBLY (See page CO–5)

4. DISCONNECT THROTTLE BODY FROM INTAKE MANIFOLD

(a) Disconnect the throttle cable.



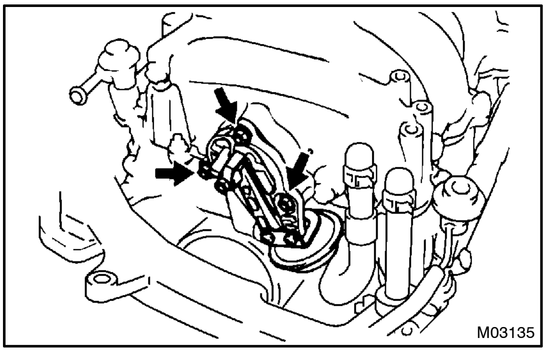
(b) Disconnect these connectors and wire clamps:
   (1) Accelerator pedal position sensor connector
   (2) Throttle position sensor connector
   (3) Throttle control motor connector
   (4) Wire clamps

(c) Remove the 2 bolts and 2 nuts, and disconnect the throttle body.

(d) Remove the gasket.

5. REMOVE V–BANK COVER BRACKETS

6. REMOVE INTAKE MANIFOLD ASSEMBLY (See page EM–29)

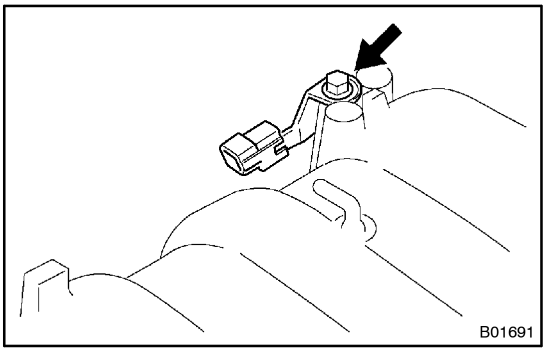


7. REMOVE ACTUATOR

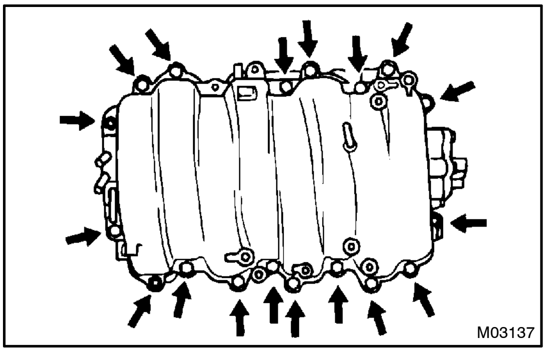
Remove the 3 nuts, actuator and gasket.

8. REMOVE UPPER INTAKE MANIFOLD

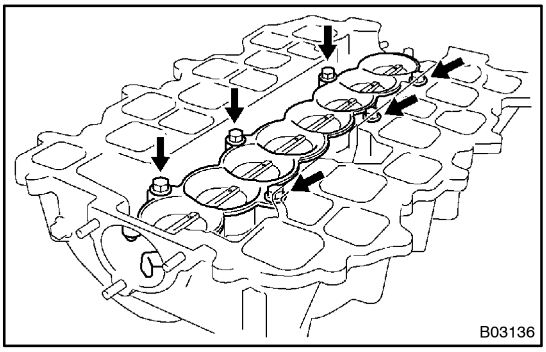
(a) Disconnect the vacuum hose from the actuator.



(b) Remove the bolt, and disconnect the VSV connector for ACIS from the upper intake manifold.



(c) Remove the 3 nuts,15 bolts, upper intake manifold and gasket.

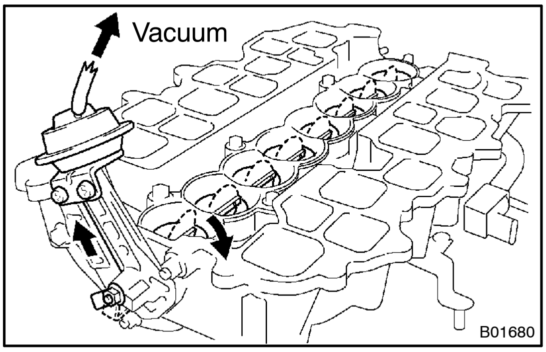


9. REMOVE INTAKE AIR CONTROL VALVE

Remove the 6 bolts and intake air control valve.

SF0ST–01

INSPECTION



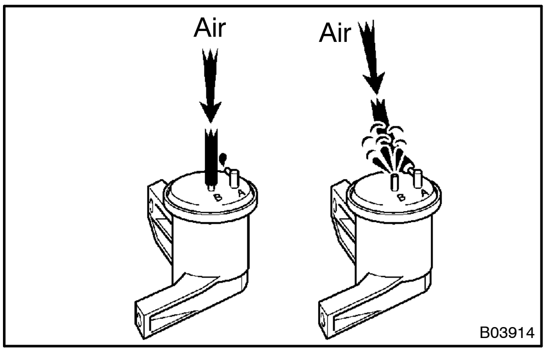
1. INSPECT INTAKE AIR CONTROL VALVE

(a) Install the air control valve and actuator to the upper intake manifold.
(See page SF–56)

(b) With 39.9 kPa (300 mmHg, 11.8 in.Hg) of vacuum applied to the actuator, check that the actuator rod moves.

(c) One minute after applying the vacuum in (a), check that the actuator rod does not return.

If the operation is not as specified, replace the intake air control valve actuator.

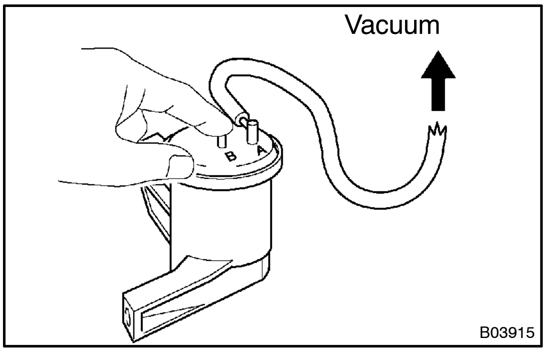


2. INSPECT VACUUM TANK

(a) Remove the vacuum tank.

(b) Check that air does not flow from port B to port A.

(c) Check that air flows from port A to port B.



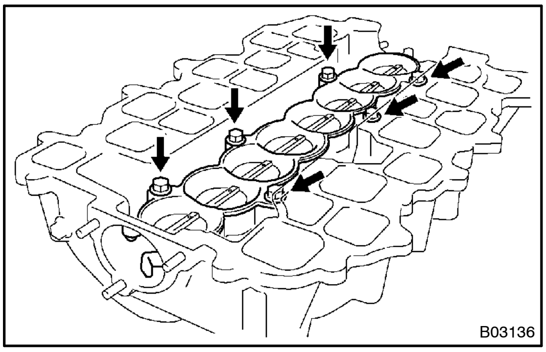
(d) Plug port B with your finger, and apply 39.9 kPa (300 mmHg, 11.8 in.Hg) of vacuum to port A, and check that there is no change is vacuum after one minute.

If the operation is not as specified, replace the vacuum tank.

(e) Reinstall the vacuum tank.

3. INSPECT VSV
(See page SF–63)

SF0SU-01

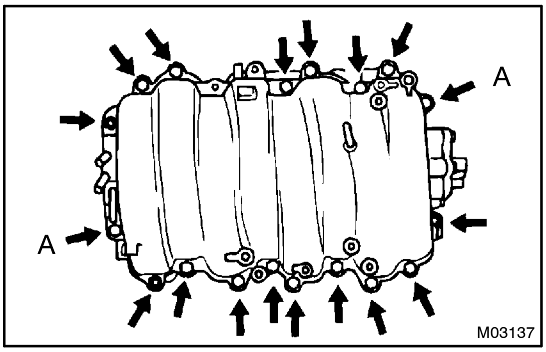


INSTALLATION

1. INSTALL INTAKE AIR CONTROL VALVE

Install the intake air control valve to the upper intake manifold with the 6 bolts.

Torque: 8.5 N·m (85 kgf·cm, 75 in.·lbf)



2. INSTALL UPPER INTAKE MANIFOLD

(a) Place a new gasket on the lower intake manifold.

(b) Install the upper intake manifold with the 3 nuts and 15 bolts.

Torque: 18 N·m (185 kgf·cm, 13 ft·lbf)

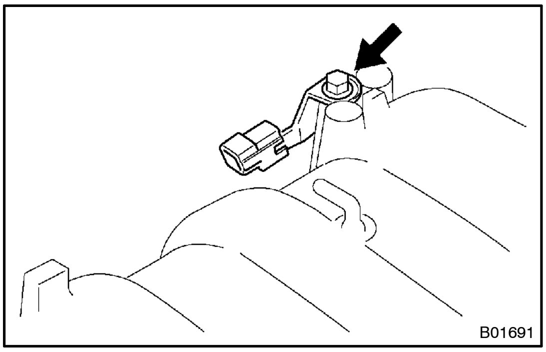
HINT:

Each bolt length is indicated in the illustration.

Bolt length:

30 mm (1.18 in.) for A

20 mm (0.79 in.) for others

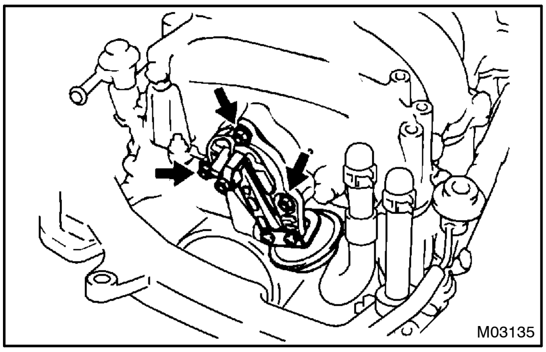


(c) Connect the vacuum hose to the actuator.

HINT:

Pass the vacuum hose under the fuel pipe.

(d) Connect the VSV connector for ACIS to the intake manifold with the bolt.



3. INSTALL ACTUATOR

(a) Place a new gasket to the upper intake manifold.

(b) Install the actuator to the upper intake manifold with the 3 nuts.

4. INSTALL INTAKE MANIFOLD ASSEMBLY
(See page EM-52)

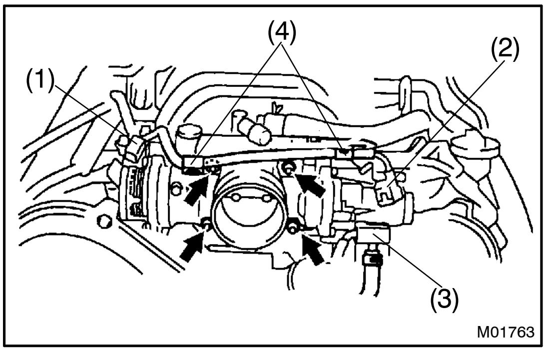
5. INSTALL V-BANK COVER BRACKETS
(See page EM-52)

6. CONNECT THROTTLE BODY

(a) Place the gasket to the intake manifold.

(b) Connect the throttle body with the 2 bolts and 2 nuts.

Torque: 18 N·m (185 kgf·cm, 13 ft·lbf)



(c) Connect these connectors and wire clamps:
  (1) Accelerator pedal position sensor connector
  (2) Throttle position sensor connector
  (3) Throttle control motor connector
  (4) Wire clamps

(d) Connect the accelerator cable.

7. INSTALL WATER INLET HOUSING ASSEMBLY
(See page CO-7)

8. CHECK FOR FUEL LEAKS
(See page SF-1)

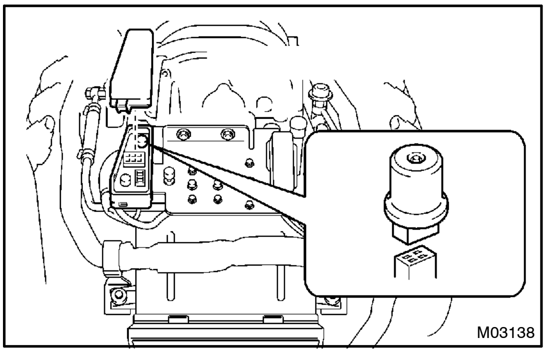
9. INSTALL INTAKE AIR CONNECTOR

10. INSTALL V-BANK COVER

EFI MAIN RELAY

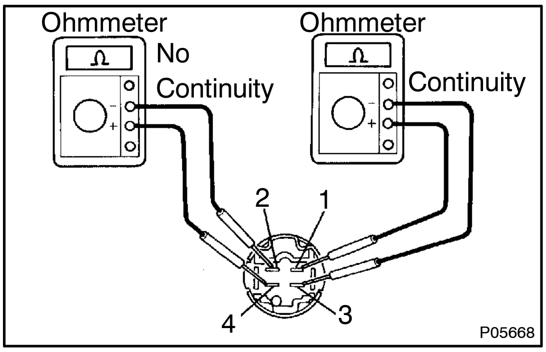
SF0SV-01

INSPECTION



1. REMOVE EFI MAIN RELAY (Marking: EFI MAIN)

LOCATION: Inside relay block at rear of engine.



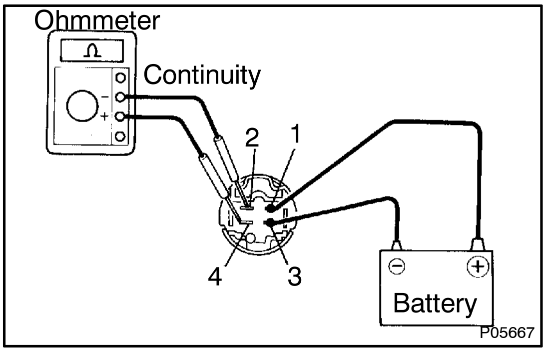
2. INSPECT EFI MAIN RELAY CONTINUITY

(a) Using an ohmmeter, check that there is continuity between terminals 1 and 3.

If there is no continuity, replace the relay.

(b) Check that there is no continuity between terminals 2 and 4.

If there is continuity, replace the relay.



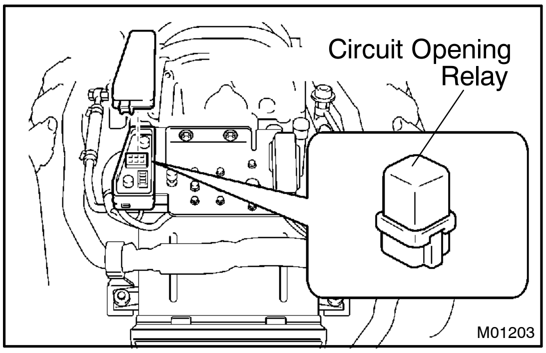
3. INSPECT EFI MAIN RELAY OPERATION

(a) Apply battery voltage across terminals 1 and 3.

(b) Using an ohmmeter, check that there is continuity between terminals 2 and 4.

If there is no continuity, replace the relay.

4. REINSTALL EFI MAIN RELAY



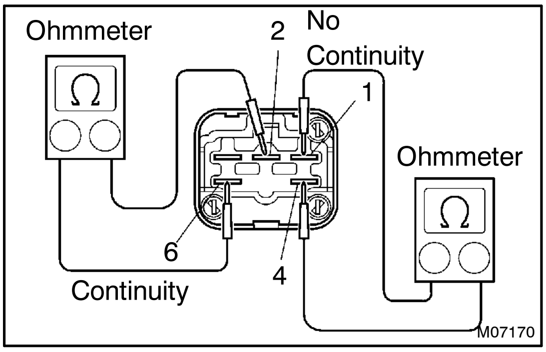
CIRCUIT OPENING RELAY

SF0SV–01

INSPECTION

1. REMOVE CIRCUIT OPENING RELAY (Marking: C/OPN)

LOCATION: Inside relay block at rear of engine.



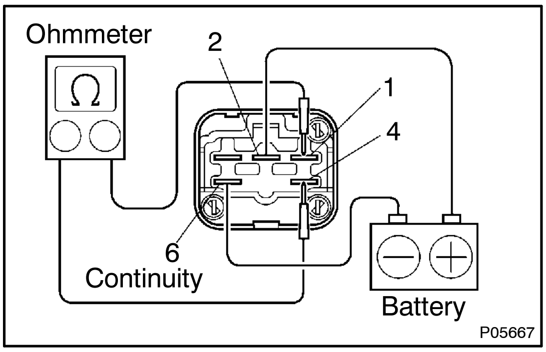
2. INSPECT CIRCUIT OPENING RELAY CONTINUITY

(a) Using an ohmmeter, check that there is continuity between terminals 2 and 6.

If there is no continuity, replace the relay.

(b) Check that there is no continuity between terminals 1 and 4.

If there is continuity, replace the relay.



3. INSPECT CIRCUIT OPENING RELAY OPERATION

(a) Apply battery voltage across terminals 2 and 6.

(b) Using an ohmmeter, check that there is continuity between terminals 1 and 4.

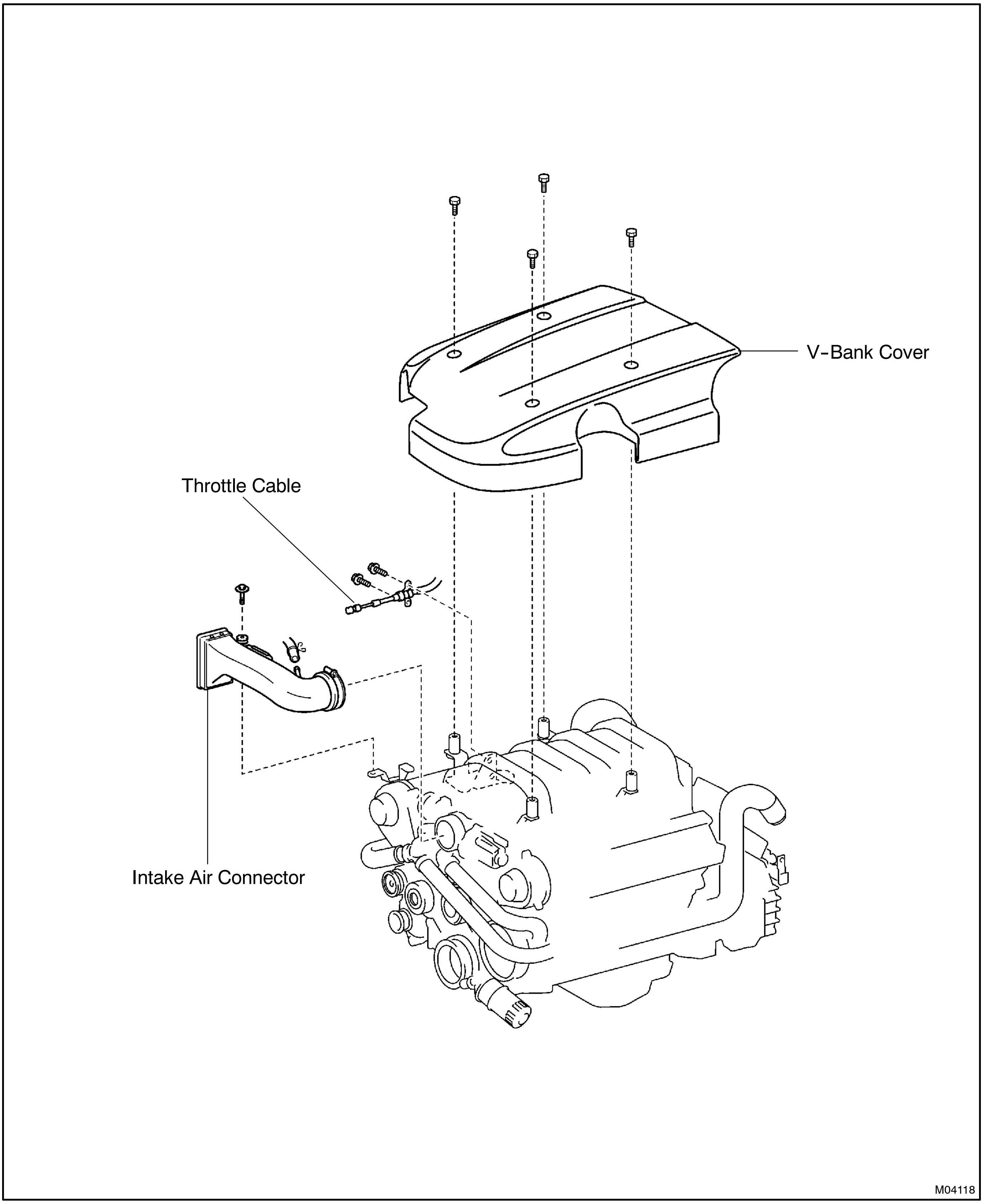
If there is no continuity, replace the relay.

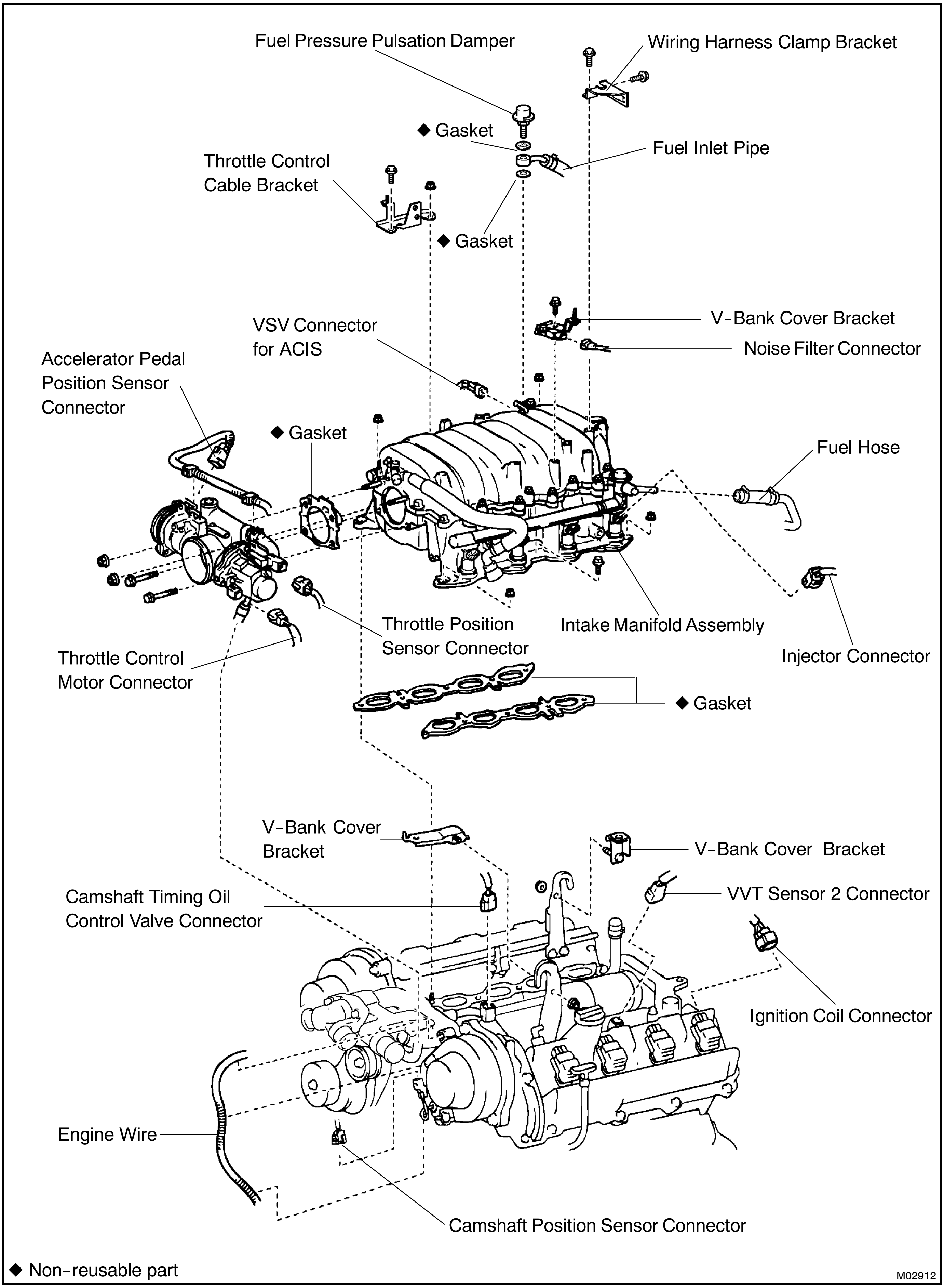
4. REINSTALL CIRCUIT OPENING RELAY

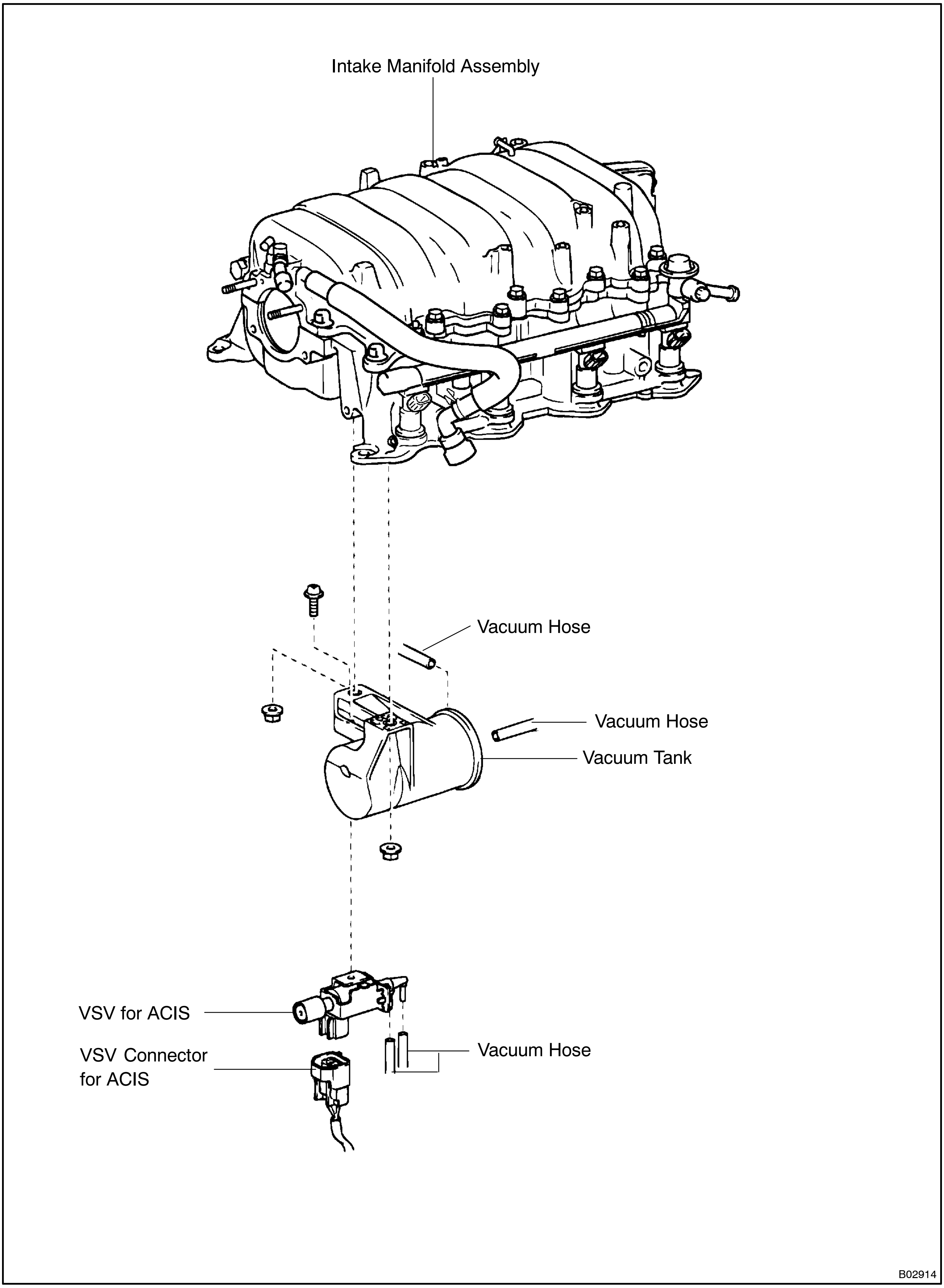
VSV FOR ACOUSTIC CONTROL INDUCTION SYSTEM (ACIS)

SF0T1-01

COMPONENTS




Fuel Pressure Pulsation Damper
Wiring Harness Clamp Bracket
◆ Gasket
Fuel Inlet Pipe
Throttle Control
Cable Bracket
◆ Gasket
V-Bank Cover Bracket
Noise Filter Connector
VSV Connector
for ACIS
Accelerator Pedal
Position Sensor
Connector
◆ Gasket
Fuel Hose
Throttle Position
Sensor Connector
Intake Manifold Assembly
Injector Connector
Throttle Control
Motor Connector
◆ Gasket
V-Bank Cover
Bracket
V-Bank Cover Bracket
VVT Sensor 2 Connector
Camshaft Timing Oil
Control Valve Connector
Ignition Coil Connector
Engine Wire
Camshaft Position Sensor Connector
◆ Non-reusable part
M02912


Intake Manifold Assembly
Vacuum Hose
Vacuum Hose
Vacuum Tank
VSV for ACIS
VSV Connector for ACIS
Vacuum Hose
B02914

SF0T2-01

INSPECTION

1. REMOVE V–BANK COVER

2. REMOVE INTAKE AIR CONNECTOR

3. REMOVE WATER INLET HOUSING ASSEMBLY (See page CO–5)

4. DISCONNECT THROTTLE BODY (See page SF–53)

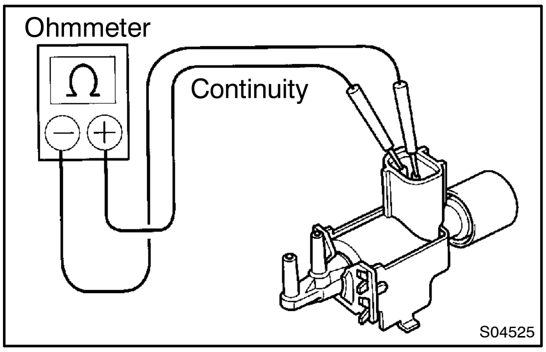
5. REMOVE INTAKE MANIFOLD ASSEMBLY (See page EM–29)

6. REMOVE VACUUM TANK

7. REMOVE VSV

(a) Disconnect the 2 vacuum hoses and connector from the VSV.

(b) Remove the screw and VSV.

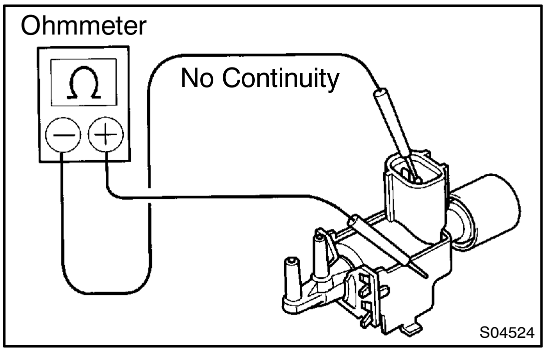


8. INSPECT VSV FOR OPEN CIRCUIT

Using an ohmmeter, check that there is continuity between each terminals.

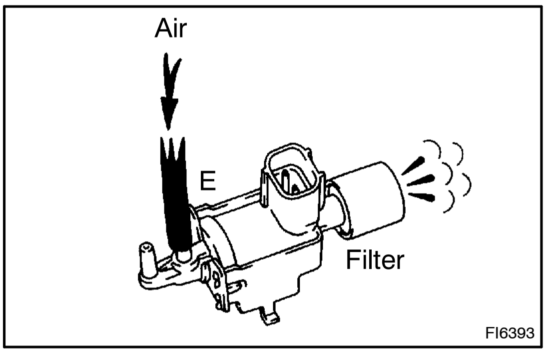
Resistance:
33 – 39 Ω at 20°C (68°F)

If there is no continuity, replace the VSV.



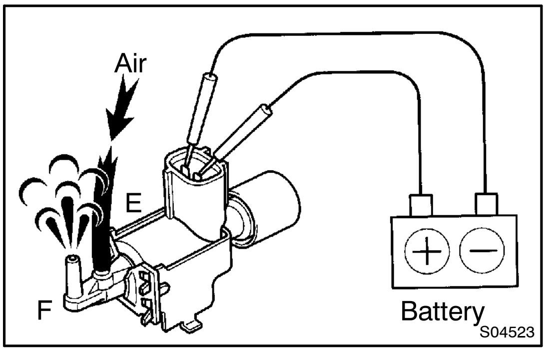
9. INSPECT VSV FOR GROUND

Using an ohmmeter, check that there is no continuity between each terminal and the body.
If there is continuity, replace the VSV.



10. INSPECT VSV OPERATION

(a) Check that air flows from port E to the filter



(b) Apply battery voltage across the terminals.
(c) Check that air flows from port E to port F.
If operation is not as specified, replace the VSV.

11. REINSTALL VSV

(a) Install the VSV with the screw.
(b) Connect the 2 vacuum to the VSV.

12. REINSTALL VACUUM TANK

13. REINSTALL INTAKE MANIFOLD ASSEMBLY
(See page EM-54)

14. RECONNECT THROTTLE BODY
(See page SF-60)

15. REINSTALL WATER INLET HOUSING ASSEMBLY
(See page CO-7)

16. CHECK FOR FUEL LEAKS
(See page SF-1)

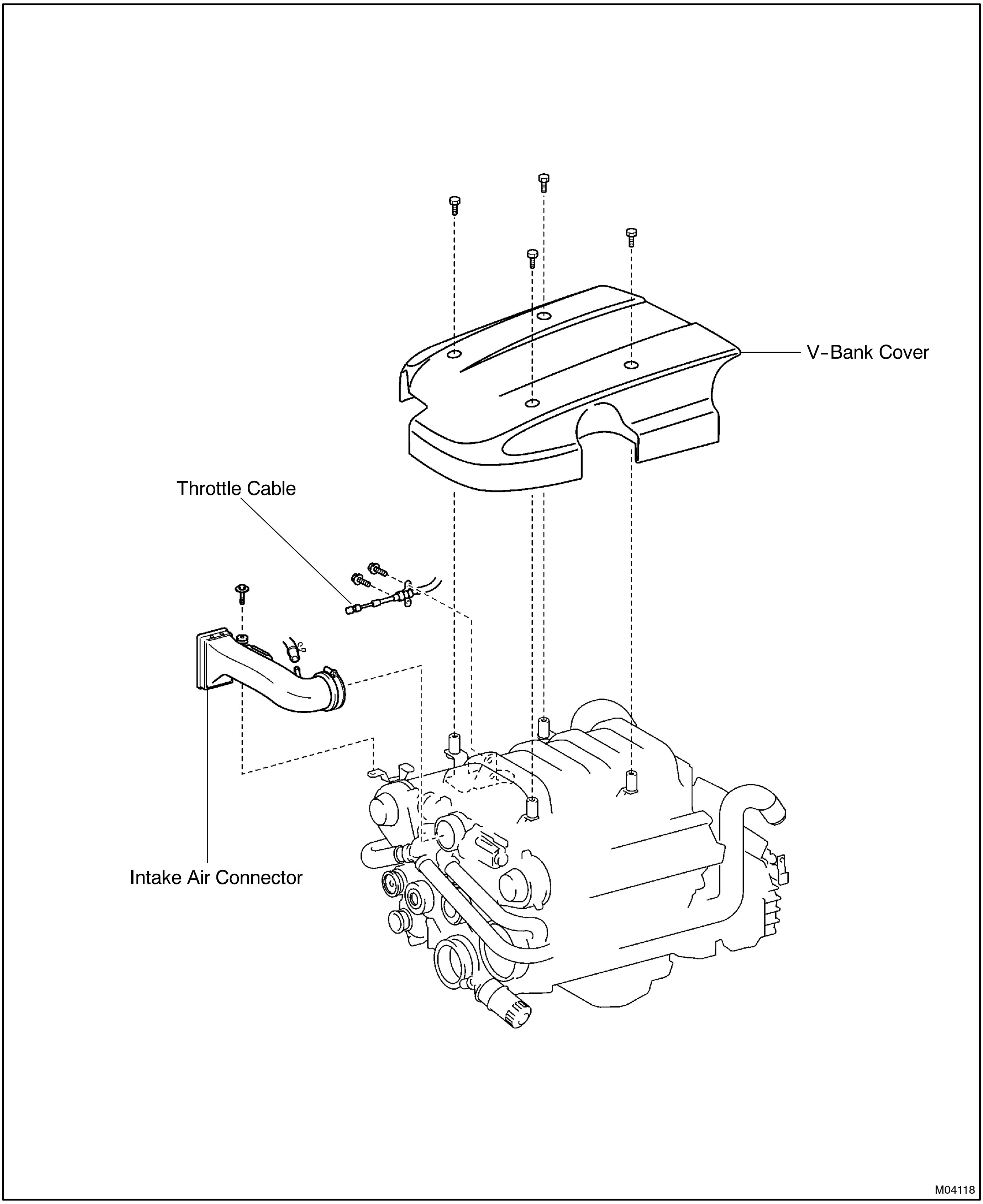
17. REINSTALL INTAKE AIR CONNECTOR

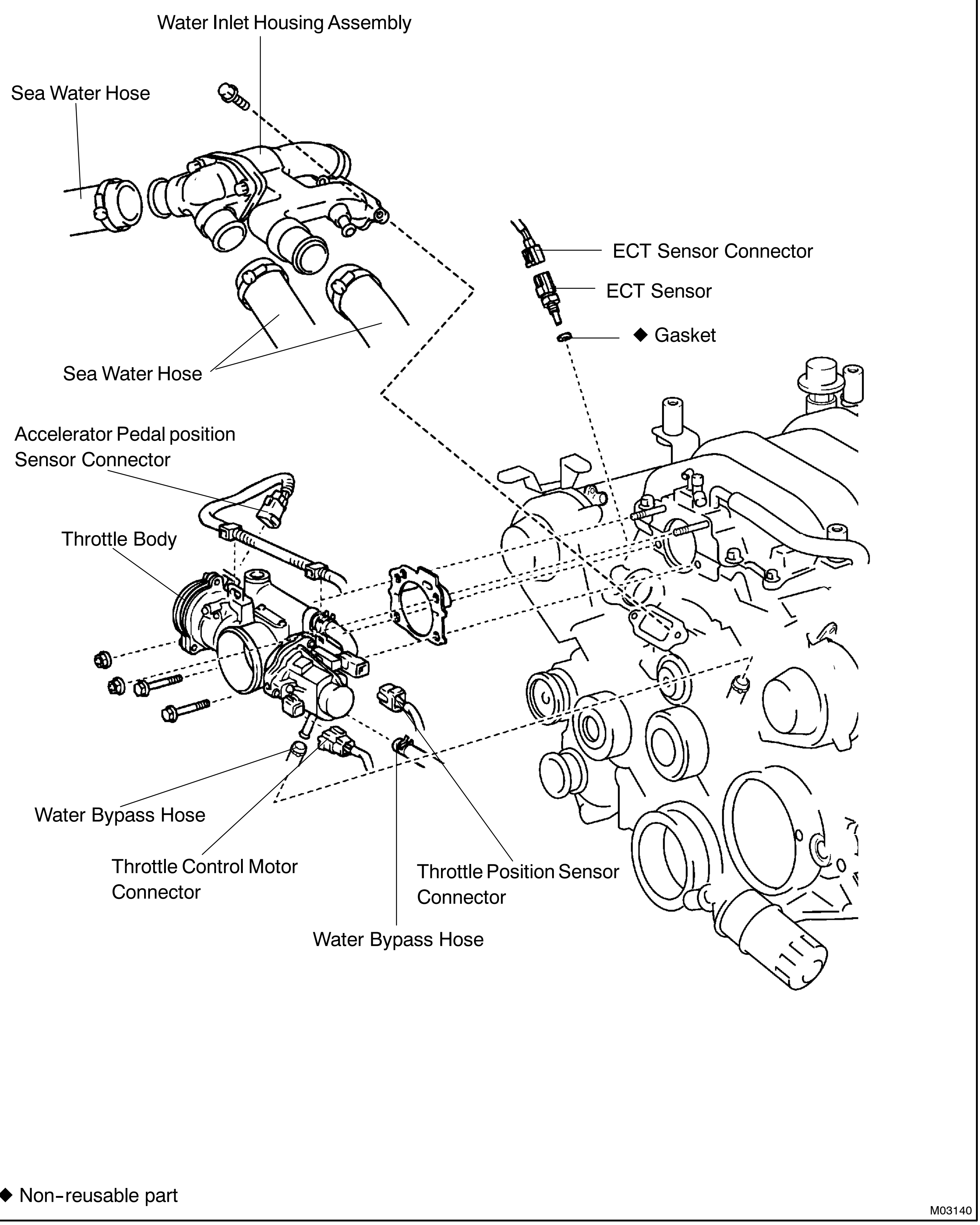
18. REINSTALL V-BANK COVER

ENGINE COOLANT TEMPERATURE (ECT) SENSOR

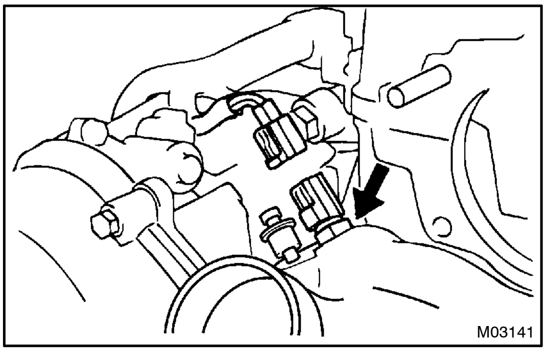
SF0T6-01

COMPONENTS





◆ Non-reusable part


M03141

SF0T9–01

INSPECTION

1. **REMOVE V–BANK COVER**
2. **REMOVE INTAKE AIR CONNECTOR**
3. **REMOVE WATER INLET HOUSING ASSEMBLY (See page CO–5)**
4. **DISCONNECT THROTTLE BODY (See page SF–53)**
5. **REMOVE ECT SENSOR**

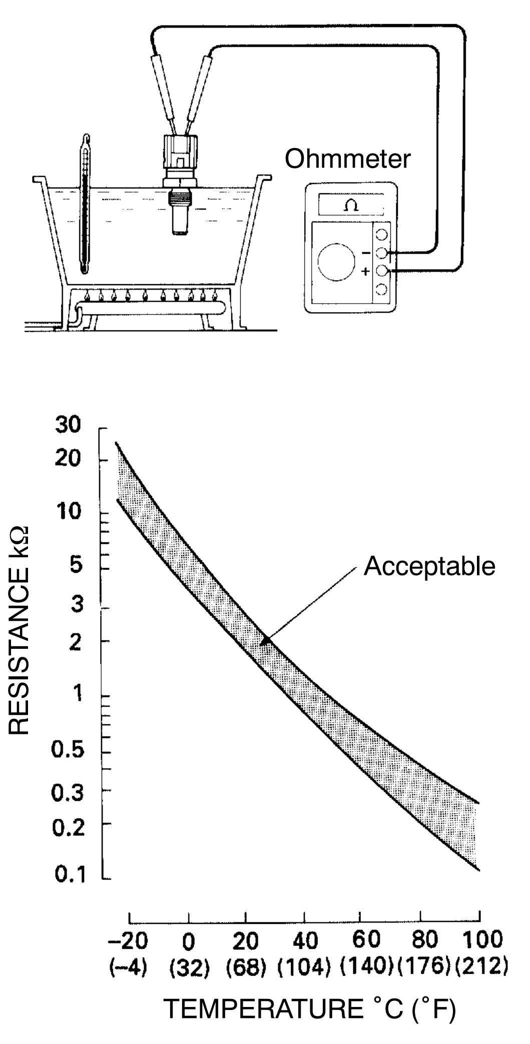
(a) Disconnect the ECT sensor connector.
(b) Remove the ECT sensor and gasket.

6. **INSPECT ECT SENSOR**

Using an ohmmeter, measure the resistance between the terminals.

Resistance:
Refer to the chart graph

If the resistance is not as specified, replace the sensor.



P01627
FI4741
Z02917

7. **REINSTALL ECT SENSOR**

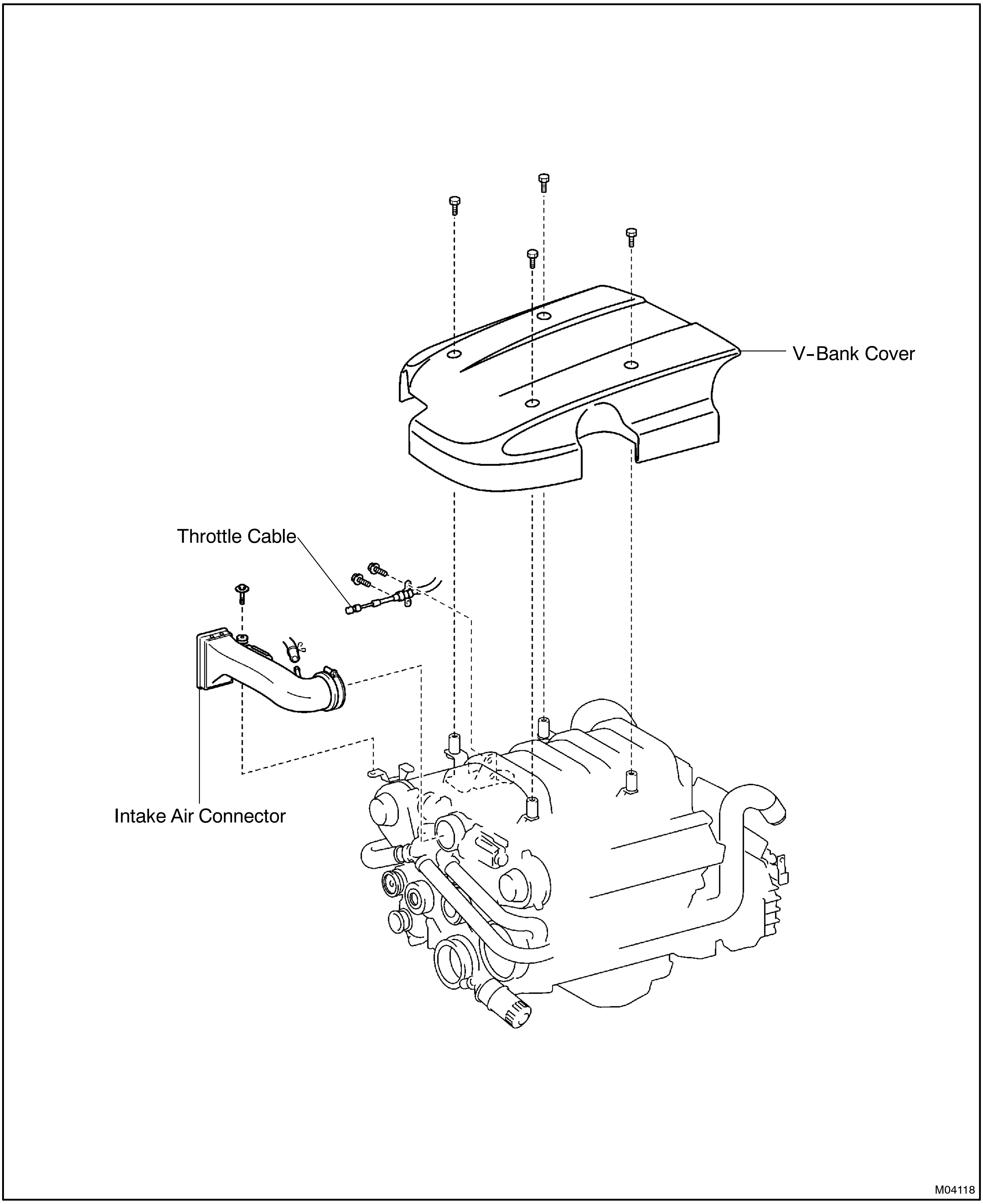
(a) Install a new gasket and the ECT sensor.
Torque: 20 N·m (200 kgf·cm, 14 ft·lbf)
(b) Connect the ECT sensor connector.

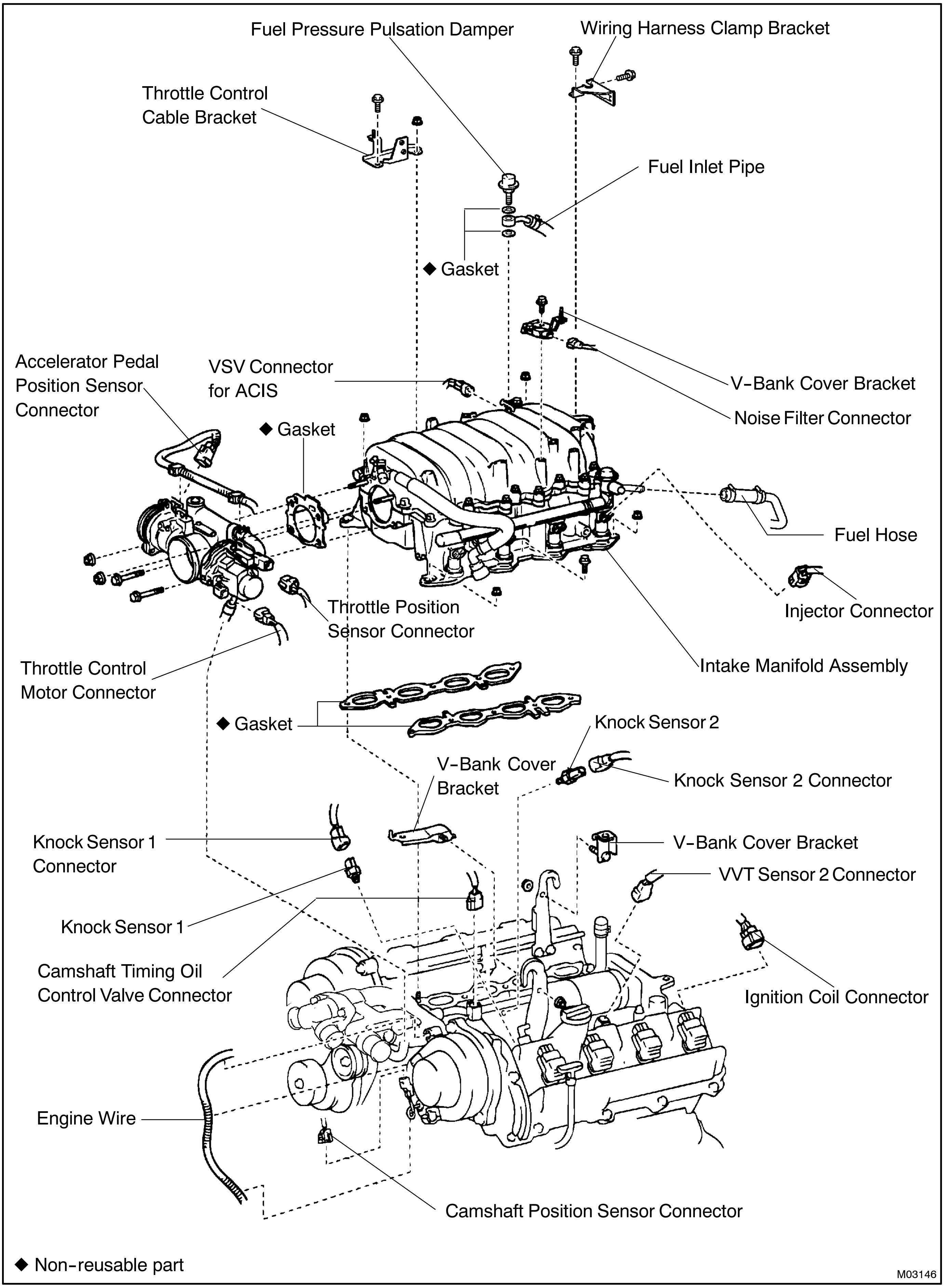
8. **RECONNECT THROTTLE BODY (See page SF–56)**
9. **REINSTALL WATER INLET HOUSING ASSEMBLY (See page CO–7)**
10. **REINSTALL INTAKE AIR CONNECTOR**
11. **REINSTALL V–BANK COVER**

KNOCK SENSOR

COMPONENTS

SF0TF-01

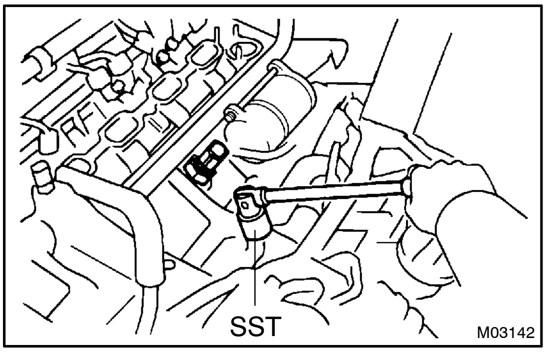



Fuel Pressure Pulsation Damper
Wiring Harness Clamp Bracket
Throttle Control Cable Bracket
Fuel Inlet Pipe
◆ Gasket
Accelerator Pedal Position Sensor Connector
VSV Connector for ACIS
V-Bank Cover Bracket
Noise Filter Connector
◆ Gasket
Fuel Hose
Injector Connector
Throttle Position Sensor Connector
Throttle Control Motor Connector
Intake Manifold Assembly
◆ Gasket
Knock Sensor 2
V-Bank Cover Bracket
Knock Sensor 2 Connector
Knock Sensor 1 Connector
V-Bank Cover Bracket
VVT Sensor 2 Connector
Knock Sensor 1
Camshaft Timing Oil Control Valve Connector
Ignition Coil Connector
Engine Wire
Camshaft Position Sensor Connector
◆ Non-reusable part
M03146

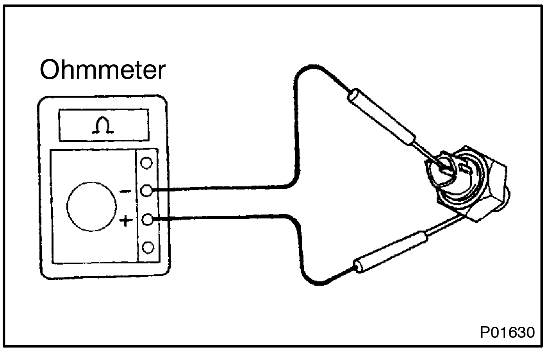
SF0TG-01

INSPECTION

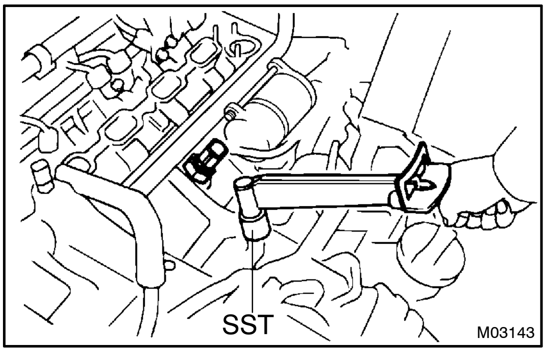
1. **REMOVE V-BANK COVER**
2. **REMOVE INTAKE AIR CONNECTOR**
3. **REMOVE WATER INLET HOUSING ASSEMBLY (See page CO-5)**
4. **DISCONNECT THROTTLE BODY (See page SF-53)**
5. **REMOVE INTAKE MANIFOLD ASSEMBLY (See page EM-29)**



6. **REMOVE KNOCK SENSOR**
(a) Disconnect the knock sensor connectors.
(b) Using SST, remove the 2 knock sensors.
SST 09816-30010



7. **INSPECT KNOCK SENSOR**
Using an ohmmeter, check that there is no continuity between the terminal and body.
If there is continuity, replace the sensor.

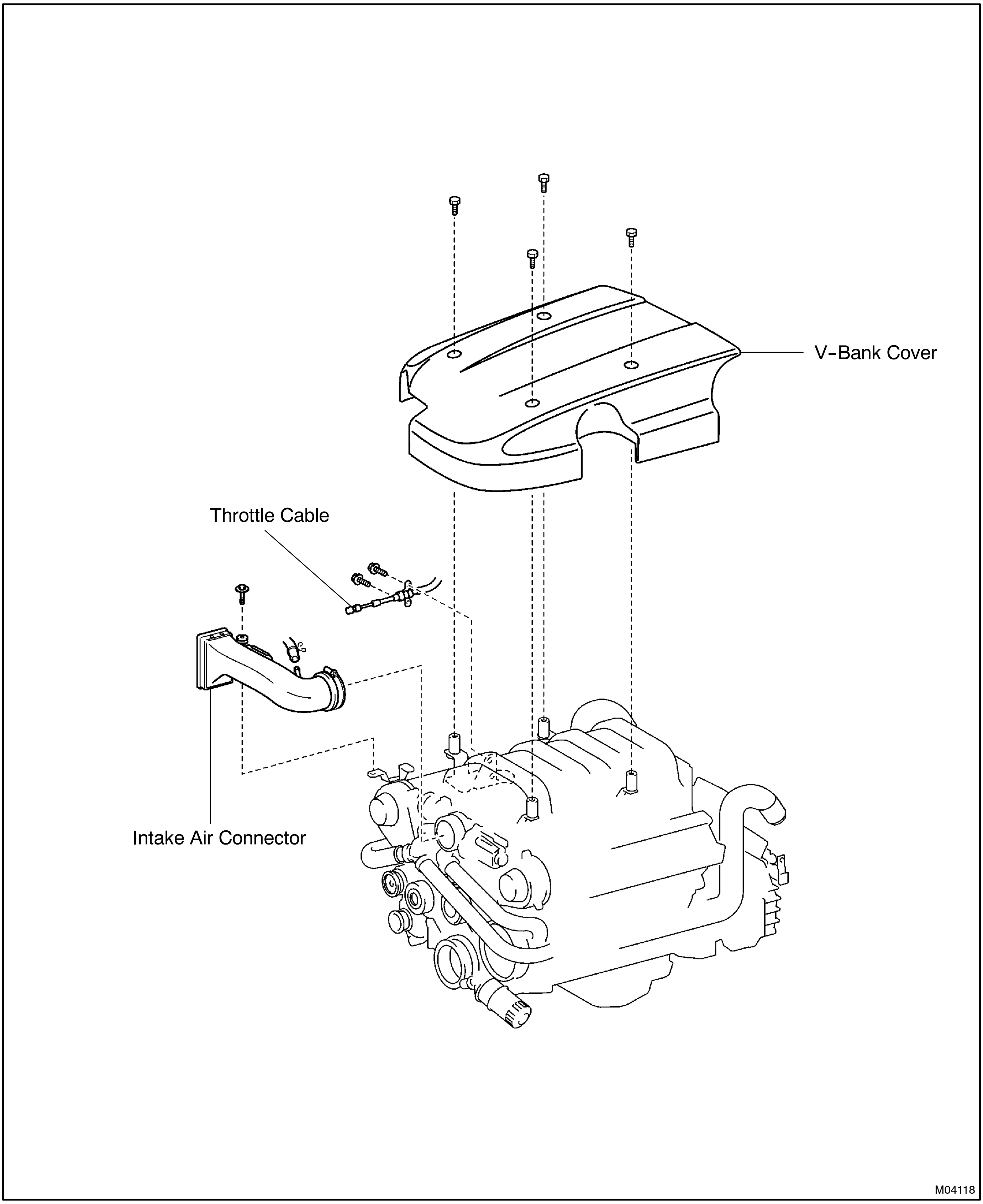


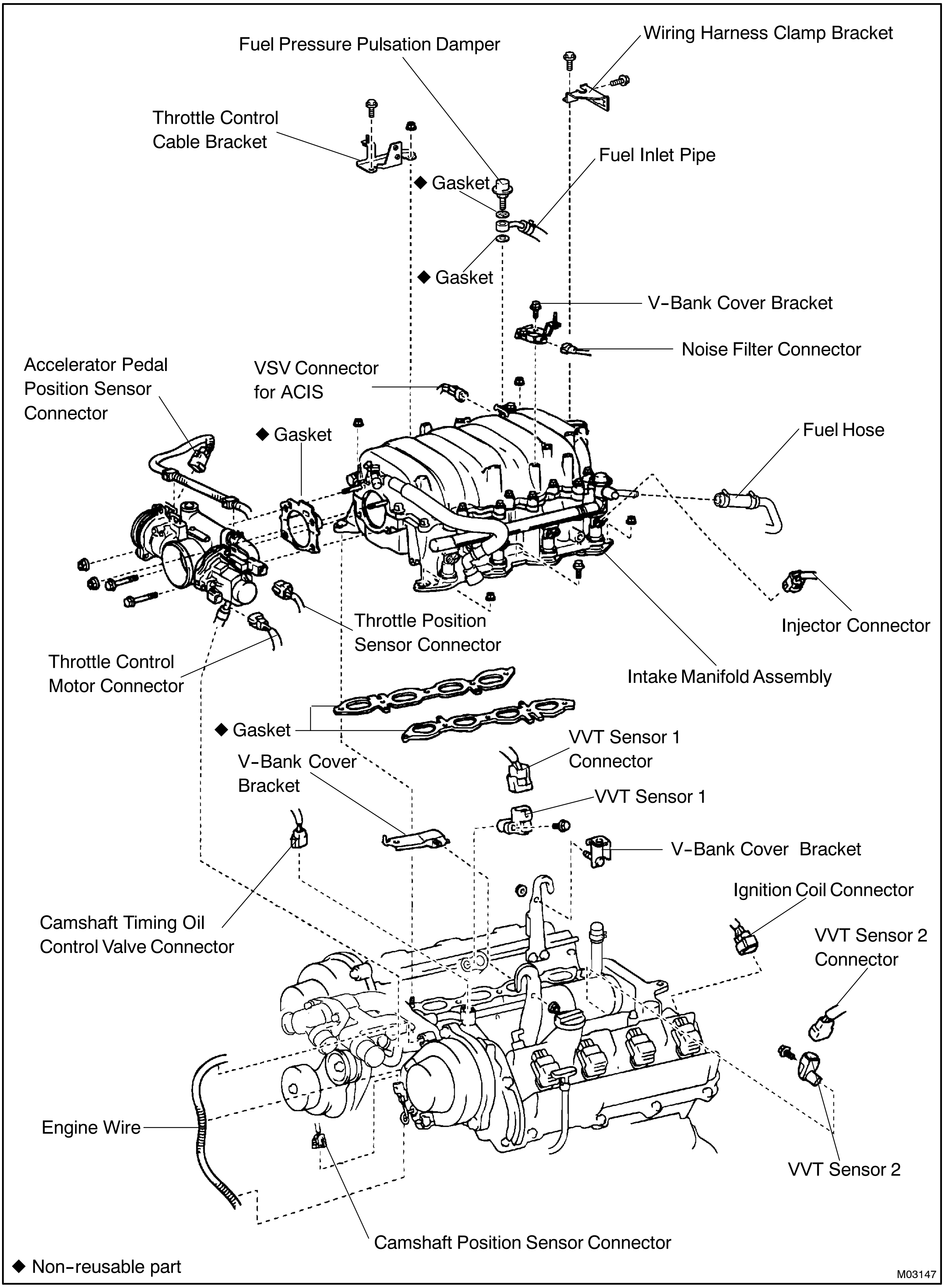
8. **REINSTALL KNOCK SENSOR**
(a) Using SST, install the 2 knock sensors.
SST 09816-30010
Torque:44 N·m (450 kgf·cm, 33 ft·lbf)
(b) Connect the knock sensor connectors.
9. **REINSTALL INTAKE MANIFOLD ASSEMBLY (See page EM-52)**
10. **REINSTALL WATER INLET HOUSING ASSEMBLY (See page CO-7)**
11. **RECONNECT THROTTLE BODY (See page SF-56)**
12. **CHECK FOR FUEL LEAKS (See page SF-1)**
13. **REINSTALL INTAKE AIR CONNECTOR**
14. **REINSTALL V-BANK COVER**

VVT SENSOR

COMPONENTS

SF0TL-01



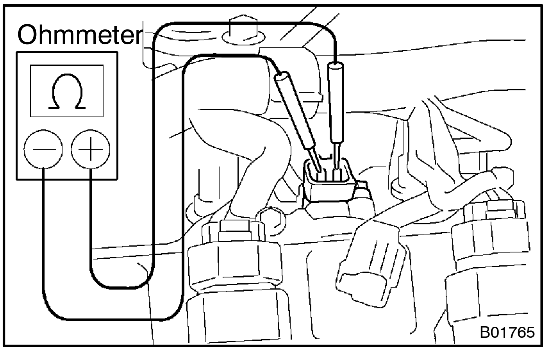

Fuel Pressure Pulsation Damper
Wiring Harness Clamp Bracket
Throttle Control
Cable Bracket
Fuel Inlet Pipe
◆ Gasket
◆ Gasket
V-Bank Cover Bracket
Noise Filter Connector
Accelerator Pedal
Position Sensor
Connector
VSV Connector
for ACIS
◆ Gasket
Fuel Hose
Throttle Position
Sensor Connector
Injector Connector
Throttle Control
Motor Connector
Intake Manifold Assembly
◆ Gasket
VVT Sensor 1
Connector
V-Bank Cover
Bracket
VVT Sensor 1
V-Bank Cover Bracket
Ignition Coil Connector
Camshaft Timing Oil
Control Valve Connector
VVT Sensor 2
Connector
Engine Wire
VVT Sensor 2
Camshaft Position Sensor Connector
◆ Non-reusable part
M03147

SF0TM–01

INSPECTION

NOTICE:
”Cold” and ”Hot in these sentences express the temperature of the sensors themselves. ”Cold” is from – 10 °C (14°F) to 50°C (122°F) and ”Hot” is from 50 °C (122°F) to 100°C (212°F).

1. REMOVE V–BANK COVER



B01765

2. INSPECT VVT SENSOR RESISTANCE

(a) Disconnect the VVT sensor connector.

(b) Using a ohmmeter, measure the resistance between terminals.

Resistance:
835 – 1,400 Ω at cold
1,060 – 1,645 Ω at hot

If the resistance is not as specified, replace the sensor.

(c) Reconnect the VVT sensor connector.

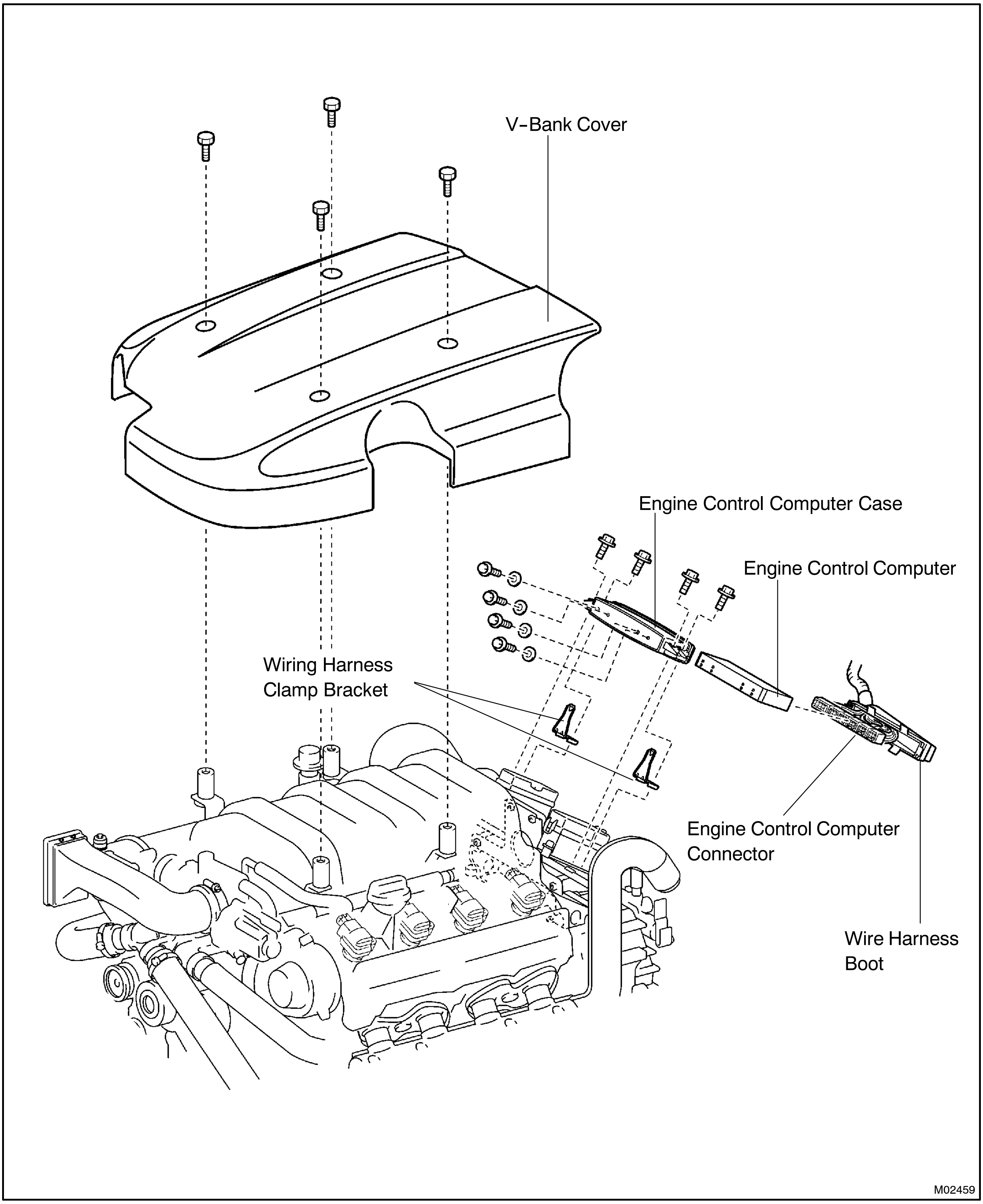
(d) Connect the VVT sensor connector.

3. REINSTALL V–BANK COVER

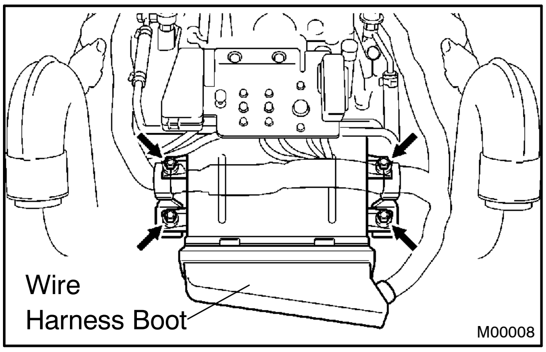
ENGINE CONTROL MODULE (ECM)

COMPONENTS

SF0TR-01



SF0TM–01



INSPECTION

1. REMOVE V–BANK COVER

2. REMOVE ENGINE CONTROL COMPUTER CASE

(a) Remove the wire harness boot from the engine control computer case.

(b) Disconnect the 5 connectors from the engine control computer.

(c) Remove the 4 bolts, then remove the engine control computer case.

3. REMOVE ECM

Rremove the 4 bolts and ECM.

4. INSPECT ECM

(See page DI–18)

5. REINSTALL ECM

Install the ECM with the 4 bolts.

Torque: 3 N·m (30 kgf·cm, 27 in.·lbf)

6. INSTALL ENGINE CONTROL COMPUTER CASE

(a) Install the engine control computer case to the engine control computer bracket with the 4 bolts.

Torque: 8 N·m (80 kgf·cm, 71 in.·lbf)

(b) Connect the 5 connectors to the engine computer.

(c) Install the wire harness boot to the engine control computer case.

7. REINSTALL V–BANK COVER

FUEL CUT RPM

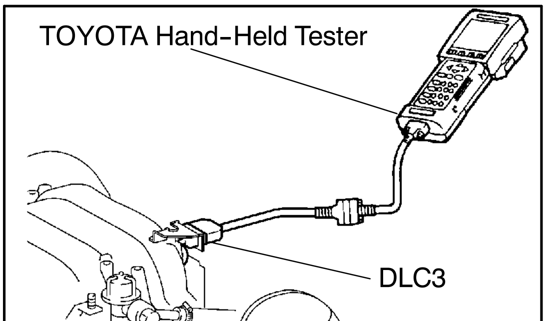
SF0TT-01

INSPECTION

1. REMOVE V-BANK COVER

2. WARM UP ENGINE

Allow the engine to warm up to normal operating temperature.

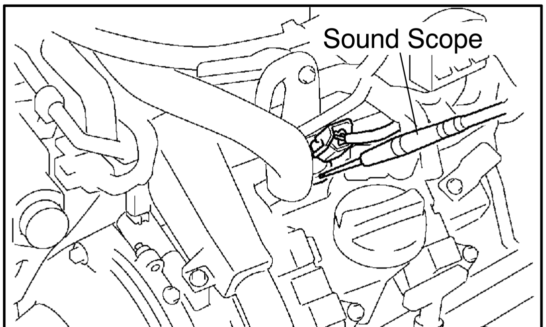


M24637

3. CONNECT TOYOTA HAND-HELD TESTER OR OBD II SCAN TOOL

(a) Connect the TOYOTA hand-held tester or OBD II scan tool to the DLC3.

(b) Please refer to the TOYOTA hand-held tester or OBD II scan tool operator's manual for further details.



B03145

4. INSPECT FUEL CUT OPERATION

(a) Increase the engine speed to at least 2,500 rpm.

(b) Use a sound scope to check for injector operating noise.

(c) Check that when the throttle lever is released, injector operation noise stops momentarily and then resumes.

HINT:

- The boat should be stopped.

  Fuel return rpm:

  1,400 rpm

5. DISCONNECT TOYOTA HAND-HELD TESTER OR OBD II SCAN TOOL

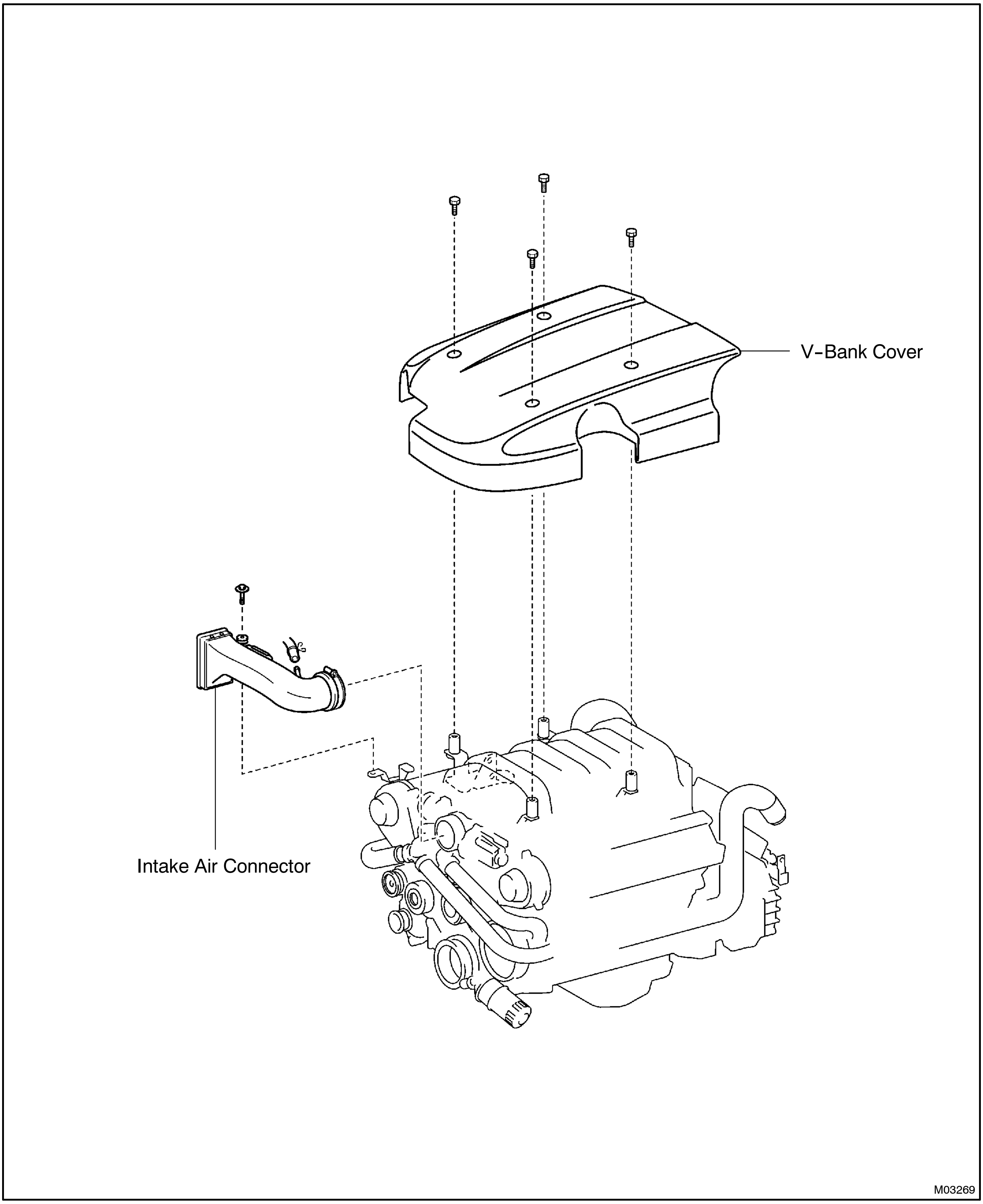
6. REINSTALL V-BANK COVER

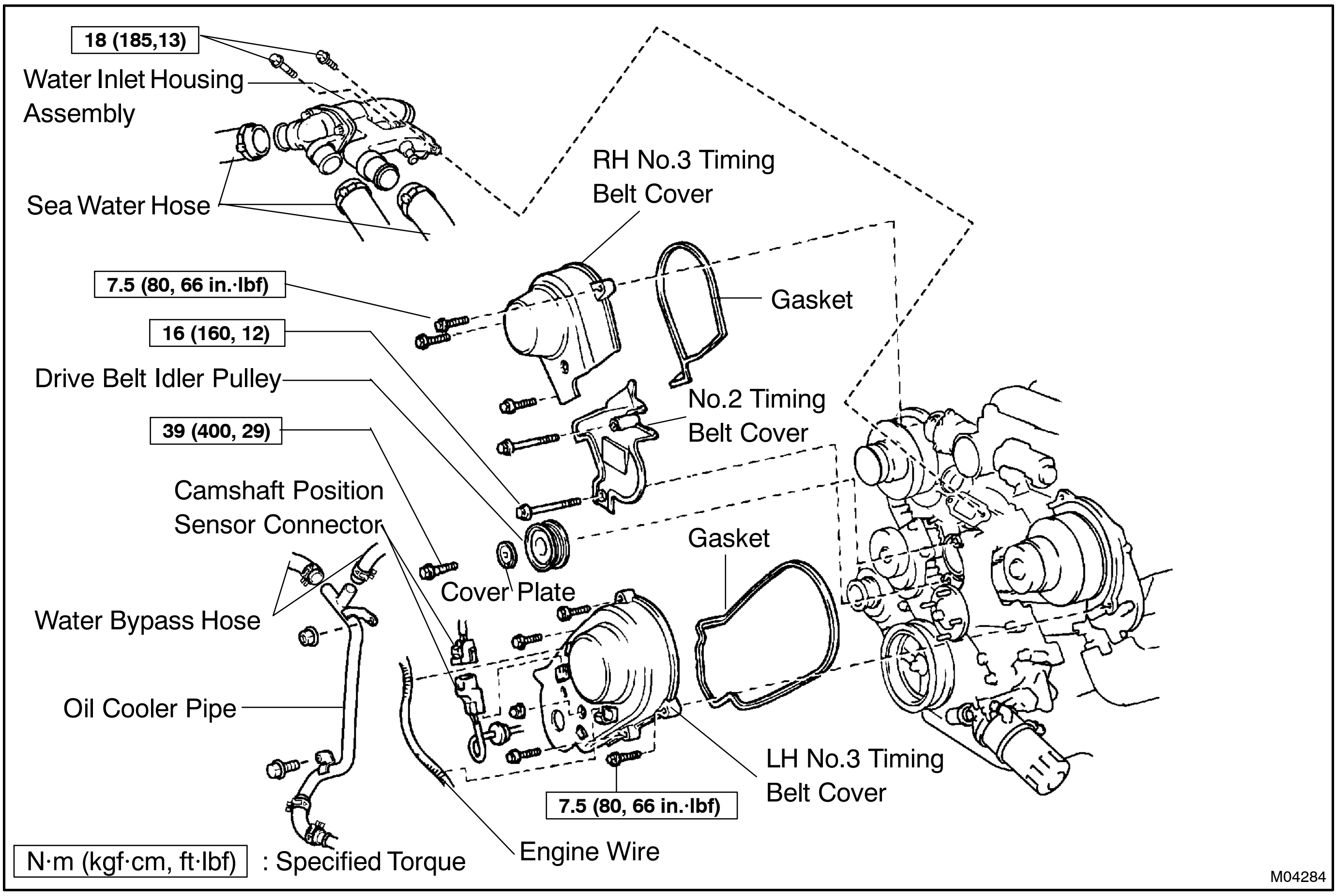
SFI

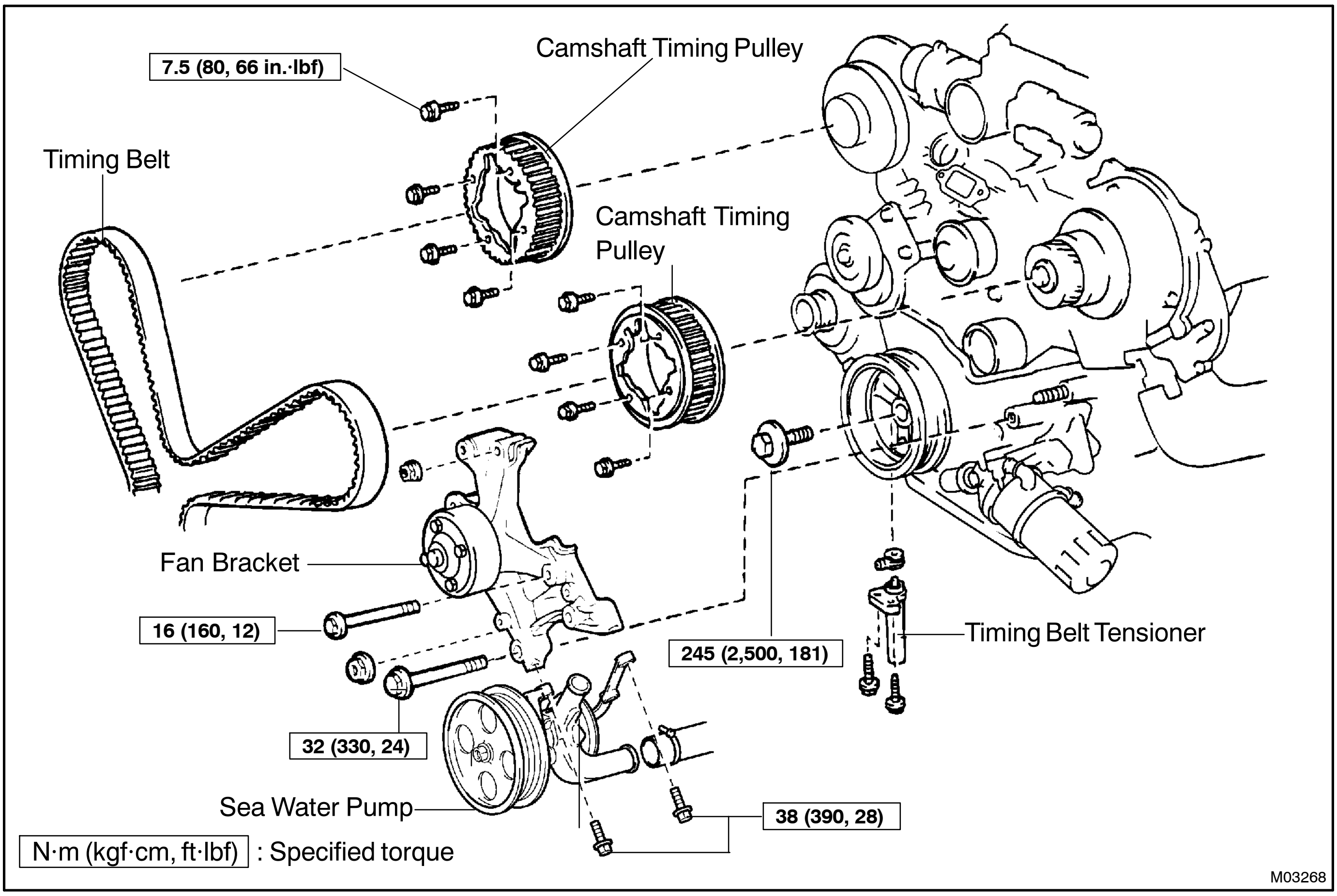
WATER PUMP

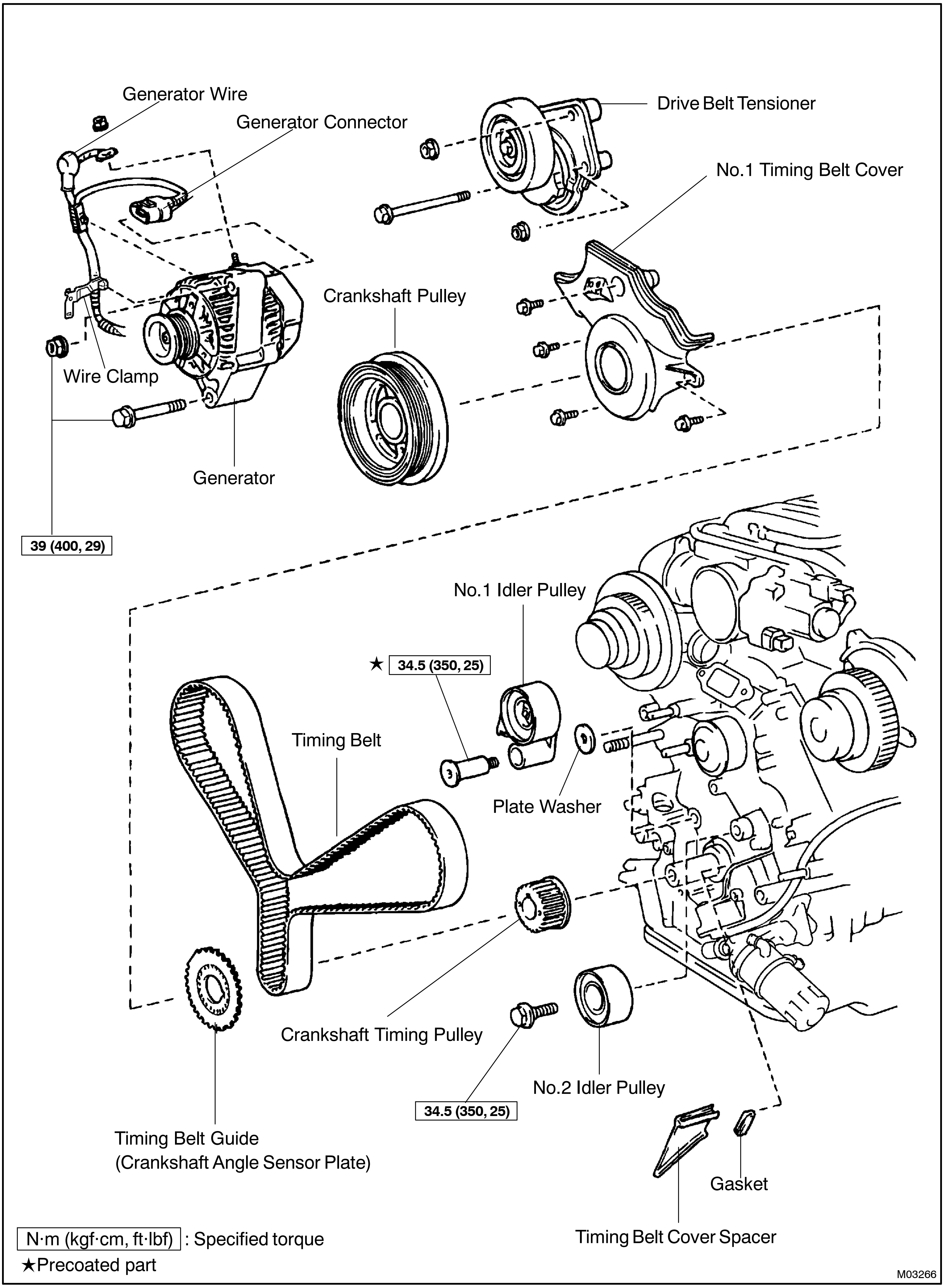
COMPONENTS

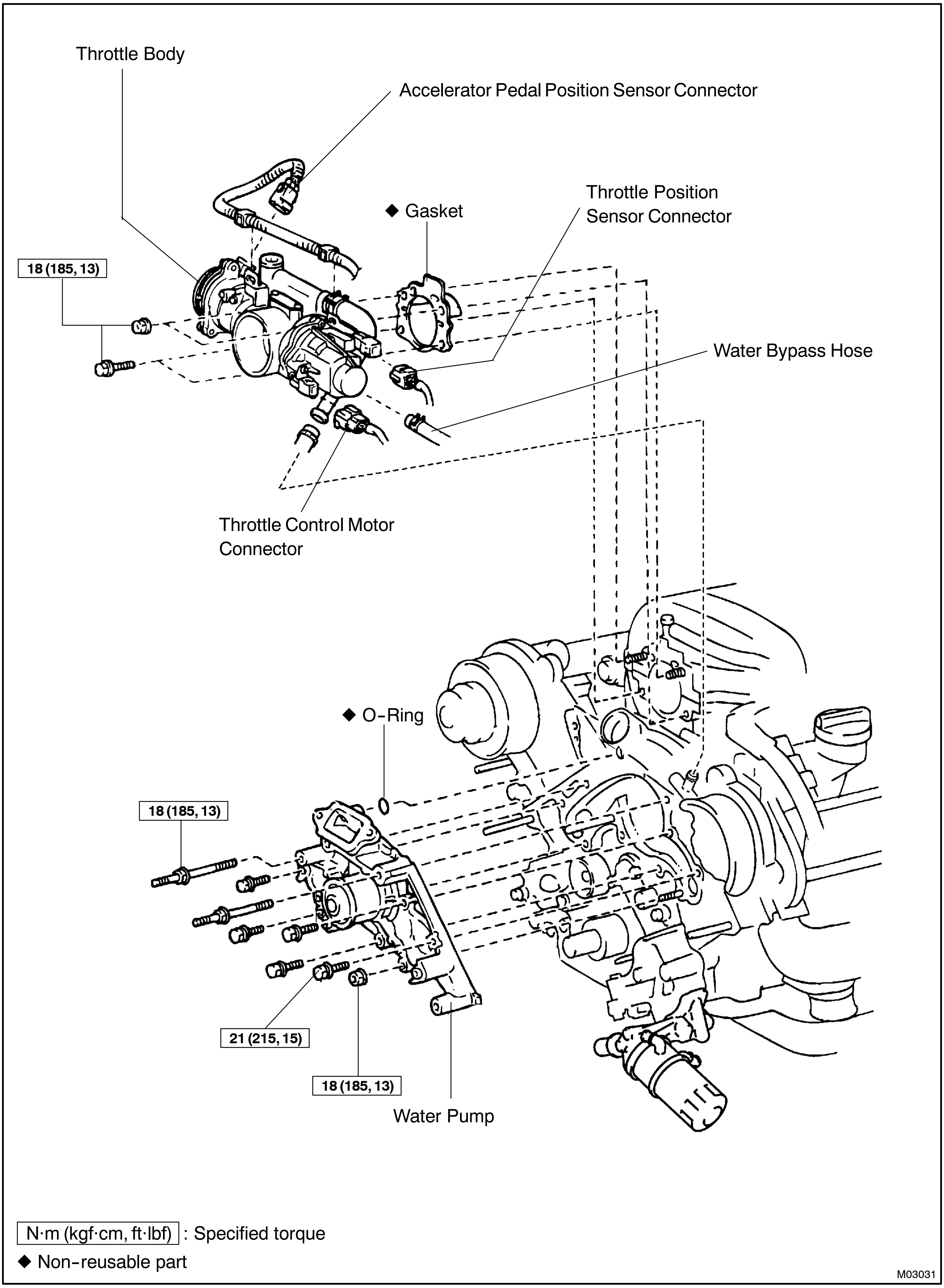
CO0CM-01




18 (185,13)
Water Inlet Housing Assembly
Sea Water Hose
RH No.3 Timing Belt Cover
7.5 (80, 66 in.·lbf)
Gasket
16 (160, 12)
Drive Belt Idler Pulley
No.2 Timing Belt Cover
39 (400, 29)
Camshaft Position Sensor Connector
Gasket
Cover Plate
Water Bypass Hose
Oil Cooler Pipe
LH No.3 Timing Belt Cover
7.5 (80, 66 in.·lbf)
N·m (kgf·cm, ft·lbf) : Specified Torque
Engine Wire
M04284

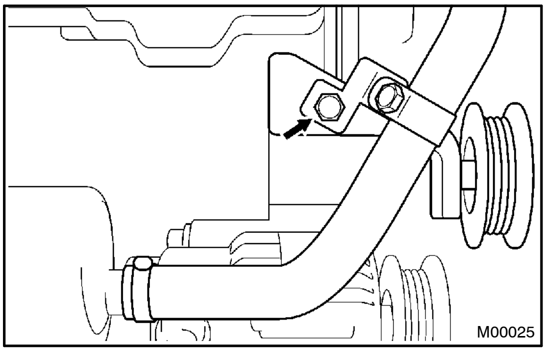

7.5 (80, 66 in.·lbf)
Camshaft Timing Pulley
Timing Belt
Camshaft Timing Pulley
Fan Bracket
16 (160, 12)
Timing Belt Tensioner
245 (2,500, 181)
32 (330, 24)
Sea Water Pump
38 (390, 28)
N·m (kgf·cm, ft·lbf) : Specified torque
M03268

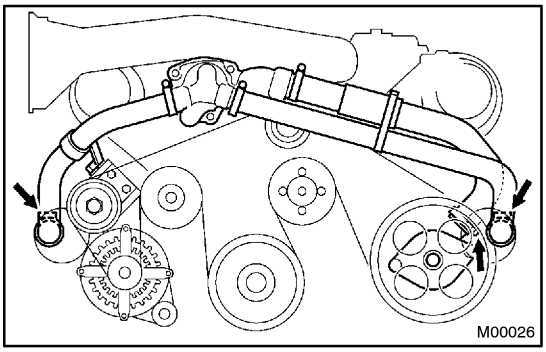

Generator Wire
Generator Connector
Drive Belt Tensioner
No.1 Timing Belt Cover
Crankshaft Pulley
Wire Clamp
Generator
39 (400, 29)
No.1 Idler Pulley
★ 34.5 (350, 25)
Timing Belt
Plate Washer
Crankshaft Timing Pulley
No.2 Idler Pulley
34.5 (350, 25)
Timing Belt Guide
(Crankshaft Angle Sensor Plate)
Gasket
Timing Belt Cover Spacer
N·m (kgf·cm, ft·lbf) : Specified torque
★Precoated part
M03266


Throttle Body
Accelerator Pedal Position Sensor Connector
18 (185, 13)
◆ Gasket
Throttle Position
Sensor Connector
Water Bypass Hose
Throttle Control Motor
Connector
◆ O-Ring
18 (185, 13)
21 (215, 15)
18 (185, 13)
Water Pump
N·m (kgf·cm, ft·lbf) : Specified torque
◆ Non-reusable part
M03031

CO0CN-01

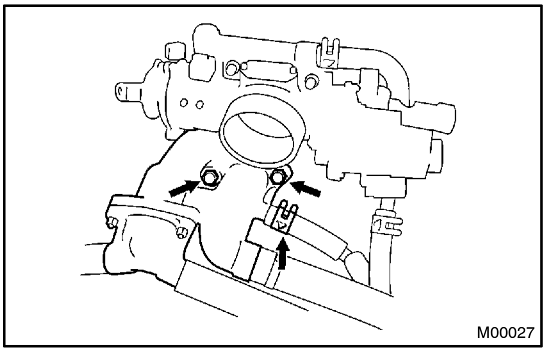
REMOVAL


M00025

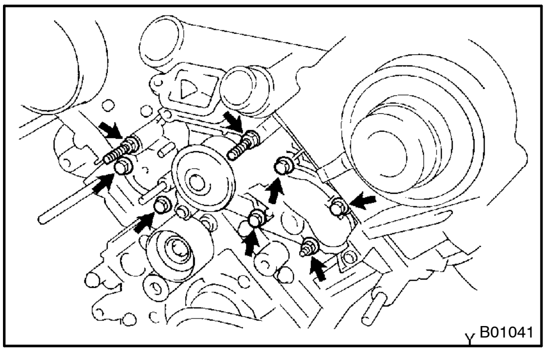

M00026

1. **REMOVE V-BANK COVER**
2. **REMOVE INTAKE AIR CONNECTOR**
3. **REMOVE DRIVE BELT**
   (See page CH-7)
4. **REMOVE WATER INLET, INLET HOUSING, NO.2 SEA WATER HOSE, NO.3 SEA WATER HOSE AND NO.4 SEA WATER HOSE ASSEMBLYS**

(a) Remove the bolt and RH No. 4 sea water hose clamp from the idler pulley bracket.
(b) Loosen the hose clamp, then remove the No. 3 sea water hose and No. 4 sea water hose from the exhaust manifold.
(c) Loosen the hose clamp, then remove the No. 2 sea water hose from the sea water pump.

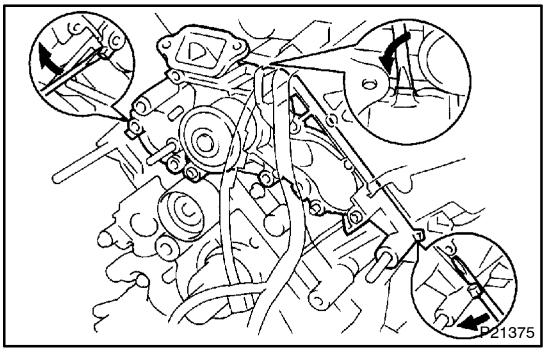

M00027

(d) Remove the water bypass hose from the oil cooler pipe.
(e) Remove the 2 bolts, water inlet, inlet housing, and the No.2 sea water hose and No. 4 sea water hose assemblies.
(f) Remove the O-ring from the water inlet housing.


B01041

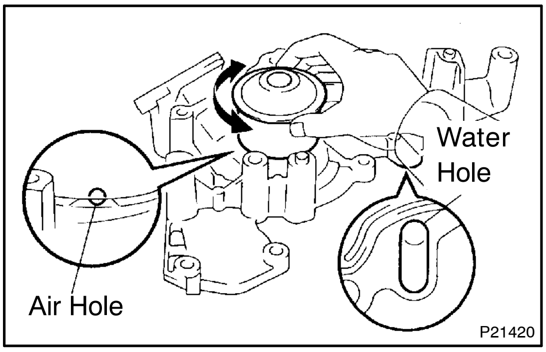
5. **REMOVE TIMING BELT**
   (See page EM-12)
6. **REMOVE NO.2 IDLER PULLY**
   (See page EM-12)
7. **REMOVE THROTTLE BODY**
   (See page SF-36)
8. **REMOVE WATER PUMP**

(a) Remove the 5 bolts, 2 stud bolts and nut.


P21375

(b) Using a screwdriver, remove the water pump by prying the portions between the water pump and cylinder block.
(c) Remove the O-ring from the water bypass pipe.

CO0CO-01



INSPECTION

1. INSPECT WATER PUMP

(a) Visually check the air hole and water hole for coolant leakage.

If leakage is found, replace the water pump and timing belt.

(b) Turn the pulley, and check that the water pump bearing moves smoothly and quietly.

If necessary, replace the water pump.

2. INSPECT TIMING BELT COMPONENTS
(See page EM-17)

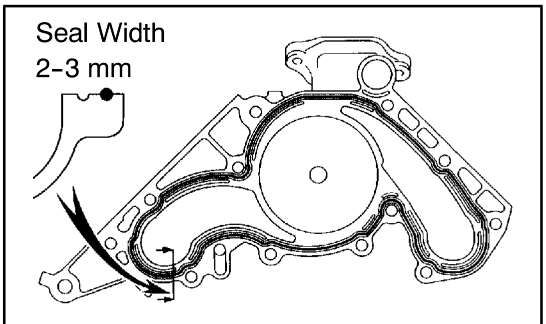
CO0CP-01

INSTALLATION

1. INSTALL WATER PUMP

(a) Remove any old packing (FIPG) material and be careful not to drop any oil on the contact surfaces of the water pump and cylinder block.

- Using a razor blade and gasket scraper, remove all the old packing (FIPG) material from the gasket surfaces and sealing groove.
- Thoroughly clean all components to remove all the loose material.
- Using a non-residue solvent, clean both sealing surfaces.

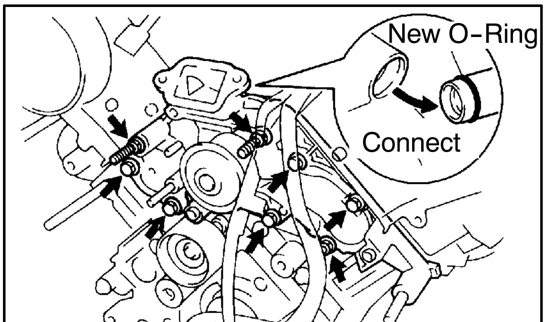


P21421

(b) Apply seal packing to the water pump as shown in the illustration.

Seal packing:
Part No. 08826-00100 or equivalent

- Install a nozzle that has been cut to a 2 - 3 mm (0.08 - 0.12 in.) opening.
- Parts must be assembled within 5 minutes of application. Otherwise the material must be removed and reapplied.
- Immediately remove nozzle from the tube and reinstall cap.



P21399

(c) Install a new O-ring to the water bypass pipe end.

(d) Apply soapy water to the O-ring.

(e) Connect the water pump to the water bypass pipe end.

(f) Install the water pump with the 5 bolts, 2 stud bolts and nut. Uniformly tighten the bolts, stud bolts and nut in several passes.

Torque:
Stud Bolt and Nut: 18 N·m (185 kgf·cm, 13 ft·lbf)
Bolt: 21 N·m (215 kgf·cm, 15 ft·lbf)

HINT:
Use bolts 30 mm (1.18 in.) in length.

2. INSTALL THROTTLE BODY
(See page SF-41)

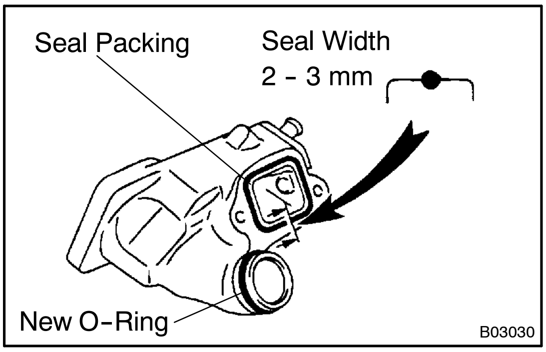
3. INSTALL NO.2 IDLER PULLEY
(See page EM-19)

4. INSTALL TIMING BELT
(See page EM-19)

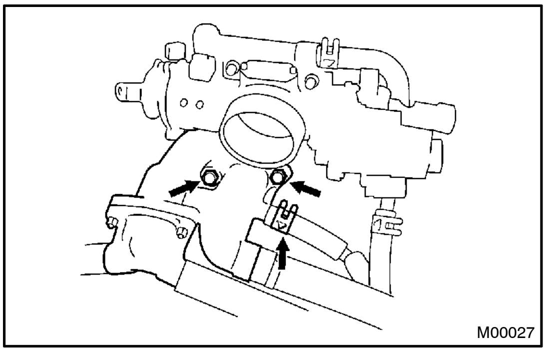
5. INSTALL WATER INLET, INLET HOUSING, NO.2 SEA WATER HOSE, NO.3 SEA WATER HOSE AND NO.4 SEA WATER HOSE ASSEMBLIES

(a) Remove any old packing (FIPG) material and be careful not to drop any oil on the contact surfaces of the water inlet housing and water pump.

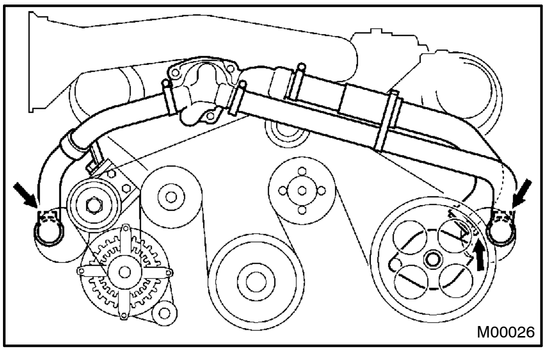
- Using a razor blade and gasket scraper, remove all the old packing (FIPG) material from the gasket surfaces and sealing groove.
- Thoroughly clean all components to remove all the loose material.
- Using a non-residue solvent, clean both sealing surfaces.



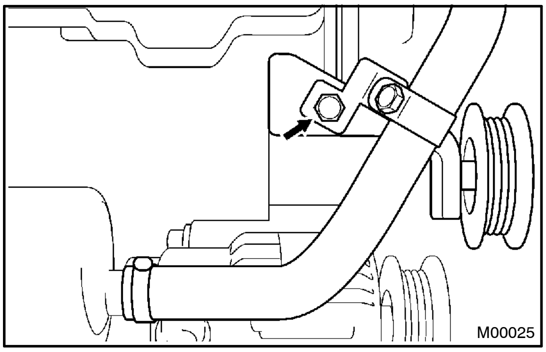
(b) Apply seal packing to the sealing groove of water inlet housing as shown in the illustration.
Seal packing:
Part No. 08826-00100 or equivalent
- Install a nozzle that has been cut to a 2 - 3 mm (0.08 - 0.12 in.) opening.
- Parts must be assembled within 5 minutes of application. Otherwise the material must be removed and reapplied.
- Immediately remove nozzle from the tube and reinstall cap.



(c) Install a new O-ring to the water inlet housing.
(d) Apply soapy water on the O-ring.
(e) Push the water inlet housing end into the water pump hole.
(f) Connect the water bypass hose (from the oil cooler pipe) to the water inlet housing.
(g) Install the water inlet and housing assembly with the 2 bolts. Alternately tighten the bolts.
Torque:
Stud Bolt and Nut 18 N·m (185 kgf·cm, 13 ft·lbf)



(h) Install the No.2 sea water hose to the sea water pump.
Torque:
Stud Bolt and Nut 2.5 N·m (25 kgf·cm, 22 in.·lbf)
(i) Install the No.3 sea water hose and No. 4 sea water hose to the exhaust manifold.
Torque:
Stud Bolt and Nut 2.5 N·m (25 kgf·cm, 22 in.·lbf)



(j) Install the RH No. 4 sea water clamp to the idler pulley bracket.
Torque:
Stud Bolt and Nut 18 N·m (185 kgf·cm, 13 ft·lbf)

6. INSTALL DRIVE BELT
(See page CH-17)

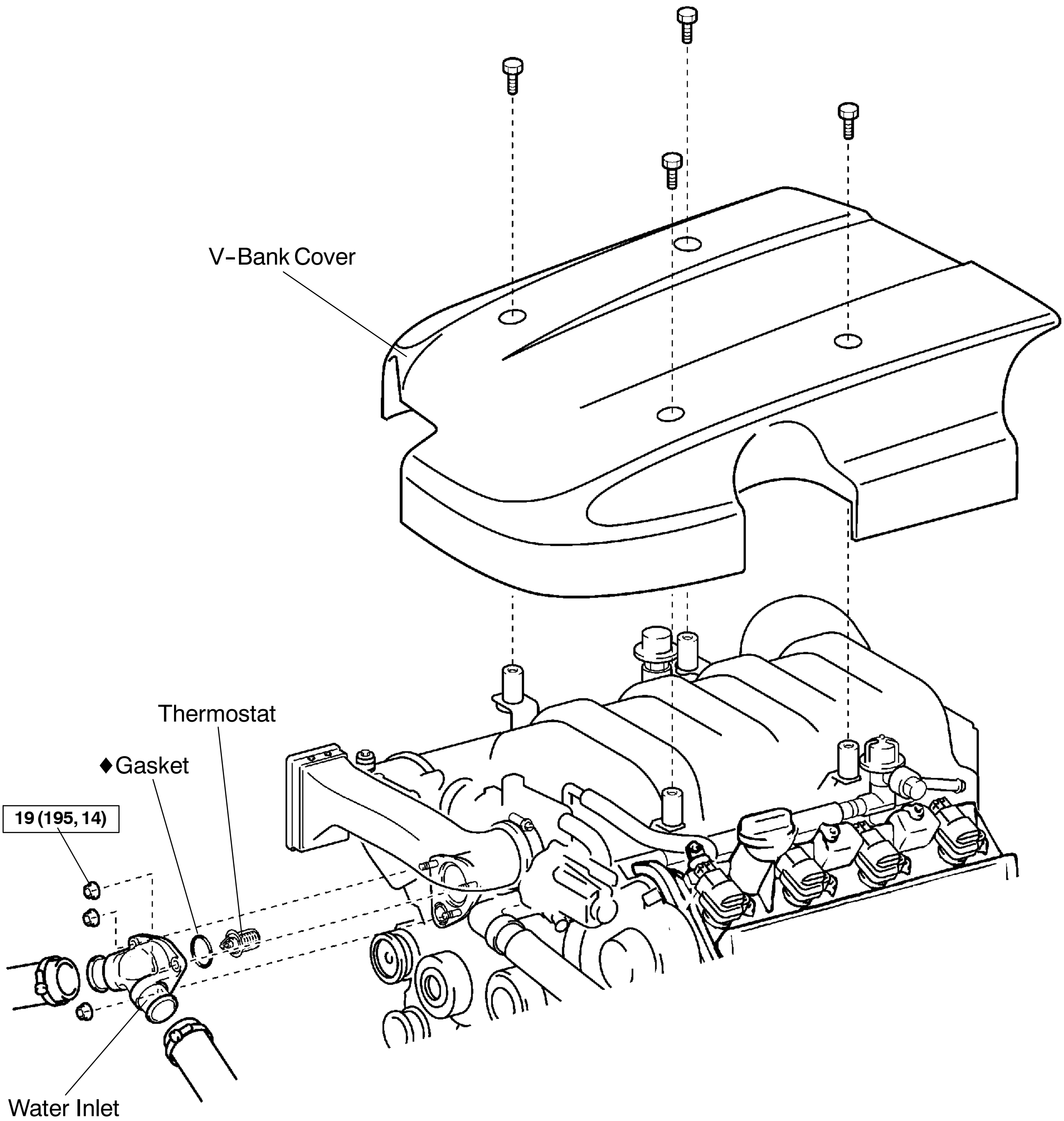
7. INSTALL INTAKE AIR CONNECTOR

8. INSTALL V-BANK COVER

THERMOSTAT

COMPONENTS

CO0CQ-01



N·m (kgf·cm, ft·lbf) : Specified torque

◆ Non-reusable part

M02781

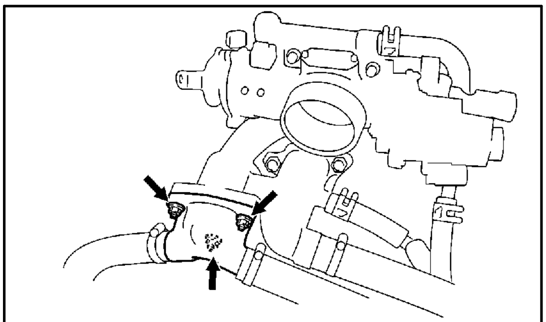
CO0CR–01

REMOVAL

HINT:

Removal of the thermostat would have an adverse effect, causing a lowering of cooling efficiency. Do not remove the thermostat, even if the engine tends to overheat.

1. **REMOVE V–BANK COVER**



M03025

2. **DISCONNECT WATER INLET FROM WATER INLET HOUSING**

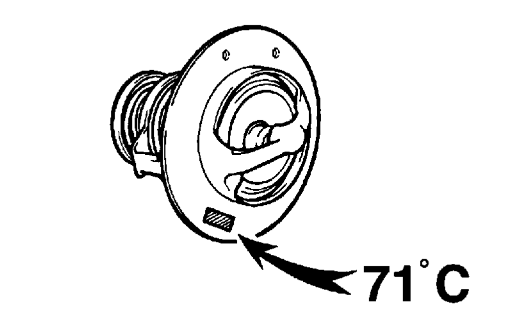
Remove the 3 nuts holding the water inlet to the inlet housing, and disconnect the water inlet together with the sea water hose from the water inlet housing.

3. **REMOVE THERMOSTAT FROM WATER INLET HOUSING**

(a) Remove the thermostat.

(b) Remove the gasket from the thermostat.

CO0CS–01

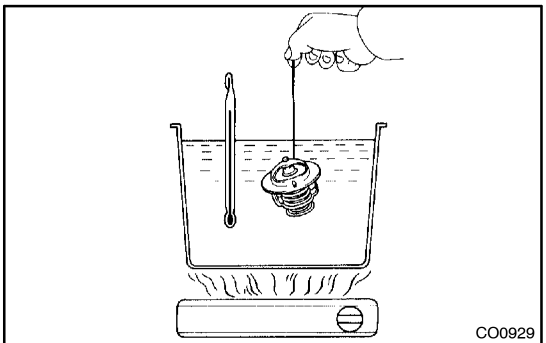


M02744

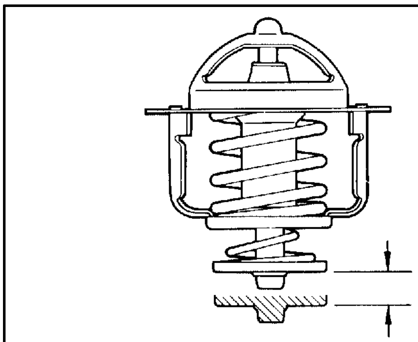
INSPECTION

INSPECT THERMOSTAT

HINT:
The thermostat is numbered with the valve opening temperature.

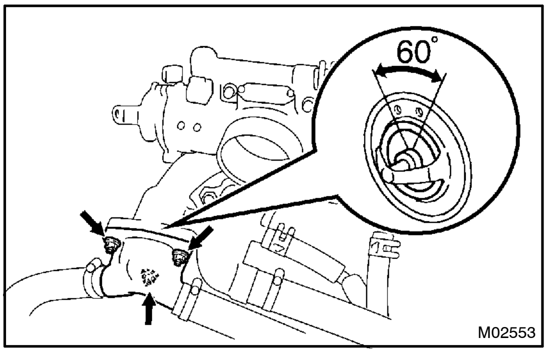

CO0929

(a) Immerse the thermostat in water and gradually heat the water.
(b) Check the valve opening temperature.
Valve opening temperature:
69 – 73°C (156 – 163°F)
If the valve opening temperature is not as specified, replace the thermostat.



CO0949

(c) Check the valve lift.
Valve lift:
10 mm (0.39 in.) or more at 85°C (185°F)
If the valve lift is not as specified, replace the thermostat.
(d) Check that the valve is fully closed when the thermostat is at low temperatures (below 40°C (104°F)).
If not closed, replace the thermostat.



CO0CT–01

INSTALLATION

1. PLACE THERMOSTAT IN WATER INLET HOUSING

(a) Install a new gasket to the thermostat.

(b) Insert the thermostat into the water inlet housing with the bypass hole facing straight upward.

HINT:
Install the thermostat so that the bypass hole faces upward as shown in the illustration.

2. INSTALL WATER INLET
Torque: 19 N·m (195 kgf·cm, 14 ft·lbf)

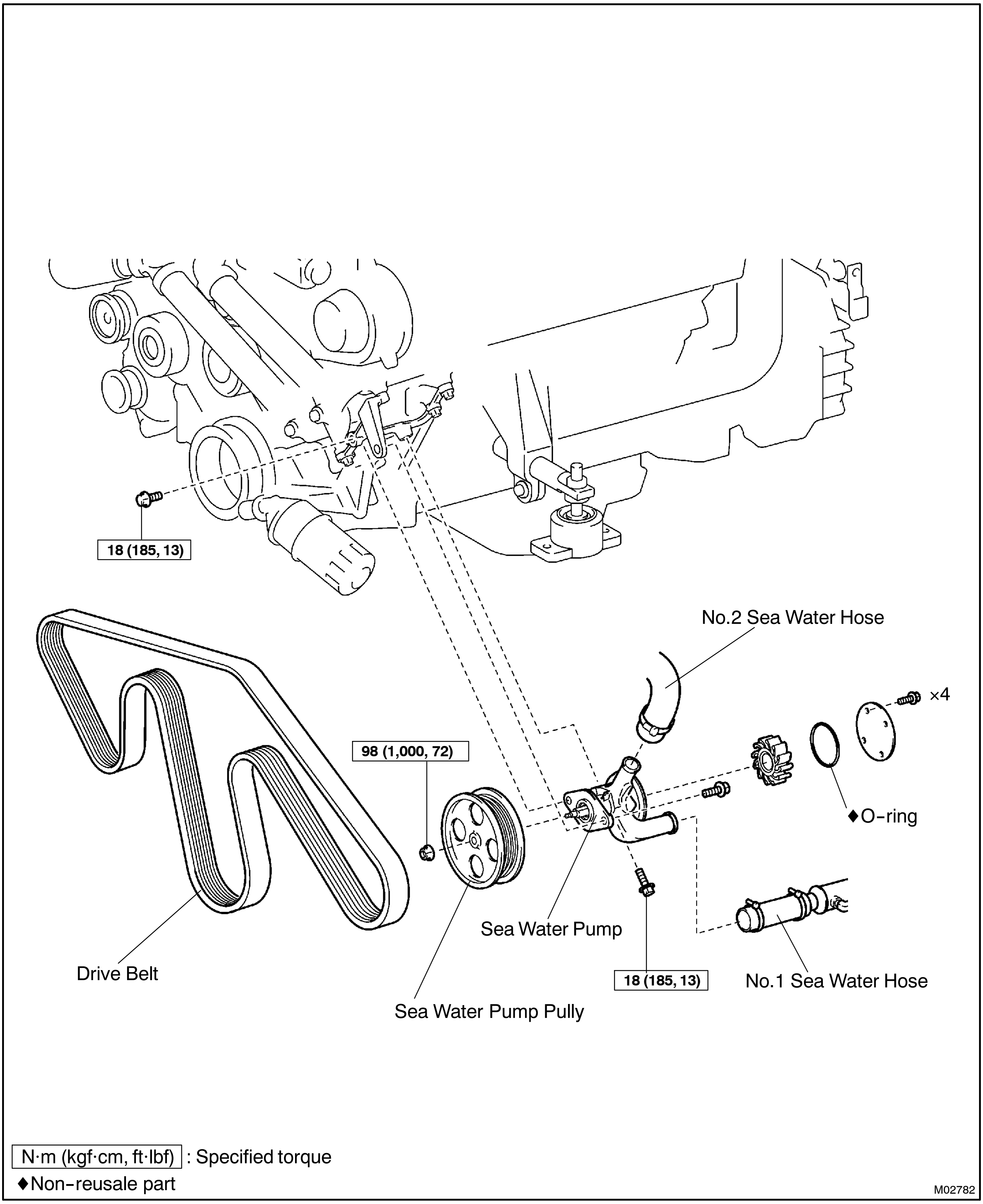
3. START ENGINE AND CHECK FOR COOLANT LEAKS

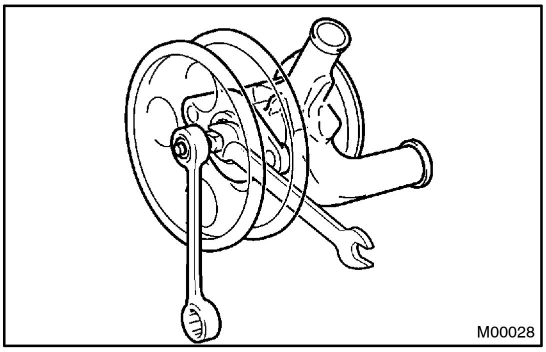
4. INSTALL V–BANK COVER

SEA WATER PUMP

COMPONENTS

CO0CM-01





CO0CN–01

REMOVAL

1. REMOVE DRIVE BELT
(See page CH–7)

2. REMOVE NO.2 SEA WATER HOSE

Loosen the hose clamp, then remove the No. 2 sea water hose.

3. REMOVE SEA WATER PUMP

(a) Loosen the clamp of No. 1 sea water hose.

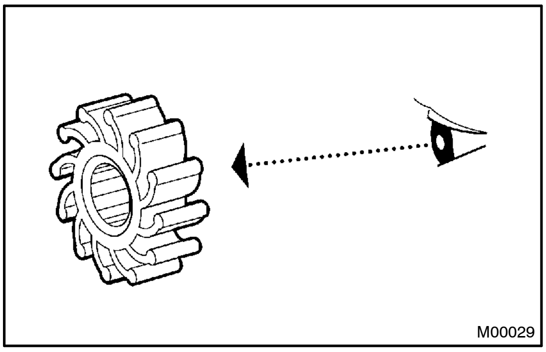
(b) Remove the nut and sea water pump pulley.

HINT:

Before removing the nut, secure the shaft of the sea water pump with a spanner so that it does not rotate.

(c) Remove the 3 bolts and the sea water pump.

CO0CO–01


M00029

INSPECTION

1. REMOVE IMPELLER

(a) Remove the 4 screws and the cover.

(b) Remove the O–ring.

(c) Remove the impeller.

2. INSPECT IMPELLER

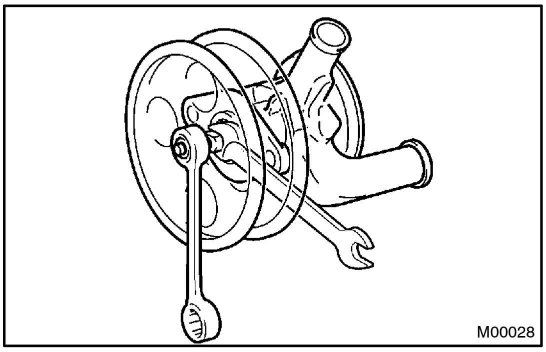
Visually inspect the impeller for damage and wear.
If you find any problem, replace the impeller.

3. INSTALL IMPELLER

(a) Install the impeller to the sea water pump.

(b) Install a new O–ring on the sea water pump.

(c) Install the cover with the 4 screws.


M00028

CO0CP–01

INSTALLATION

1. INSTALL SEA WATER PUMP

(a) Install the sea water pump with the 3 bolts.
Torque: 18 N·m (185 kgf·cm, 13 ft·lbf)

(b) Tighten the hose clamp of No. 1 sea water hose.
Torque: 2.5 N·m (25 kgf·cm, 22 in.·lbf)

(c) Install the nut and sea water pump pulley to the sea water pump.

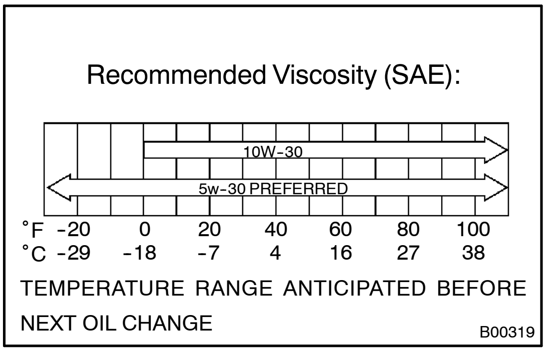
HINT:
Before tightening the nut, secure the shaft of the sea water pump with a spanner so that it does not rotate.

2. INSTALL NO.2 SEA WATER HOSE

Install the No. 2 sea water hose to the sea water pump.
Torque: 2.5 N·m (25 kgf·cm, 22 in.·lbf)

3. INSTALL DRIVE BELT
(See page CH–17)

COOLING



OIL AND FILTER

LU06O-01

INSPECTION

1. CHECK ENGINE OIL QUALITY

Check the oil for deterioration, entry of water, discoloring or thinning.

If oil quality is poor, replace the oil.

Oil grade:
API grade SH, Energy-Conserving II or SJ, Energy-Conserving or ILSAC multigrade engine oil. SAE 5W-30 is the best choice for your vehicle, for good fuel economy, and good starting in cold weather.

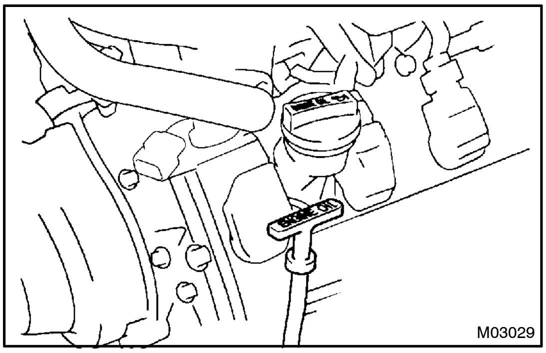
2. CHECK ENGINE OIL LEVEL

The oil level should be between the "L" and "F" marks on the dipstick.

If low, check for leakage and add oil up to the "F" mark.

NOTICE:

- **Do not fill with engine oil above the "F" mark.**

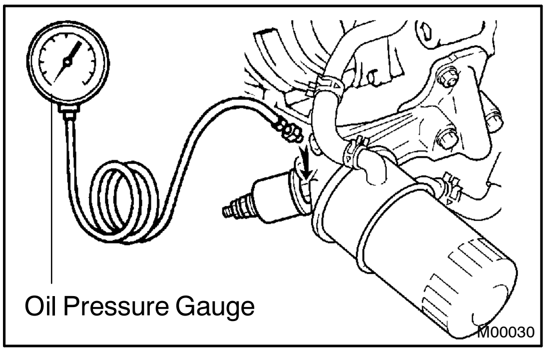


- **Install the oil dipstick and oil filler cap facing the direction shown in the illustration.**

3. REMOVE OIL PRESSURE SENDER GAUGE, AND INSTALL OIL PRESSURE GAUGE

4. WARM UP ENGINE

Allow the engine to warm up to normal operating temperature.

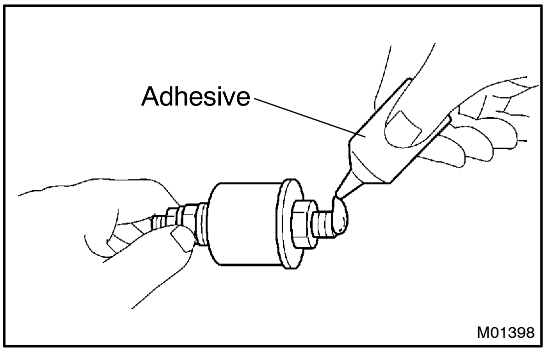


5. CHECK OIL PRESSURE

Oil pressure:
At idle
29 kPa (0.3 kgf/cm^2, 4.2 psi) or more
At 3,000 rpm
294 - 588 kPa (3.0 - 6.0 kgf/cm^2, 43 - 85 psi)

6. REMOVE OIL PRESSURE GAUGE, AND REINSTALL OIL PRESSURE SENDER GAUGE

(a) Remove the oil pressure gauge.



(b) Apply adhesive to 2 or 3 threads of the oil pressure sender gauge.

Adhesive:
Part No. 08833-00080, THREE BOND 1344, LOCTITE 242 or equivalent

(c) Reinstall the oil pressure sender gauge.

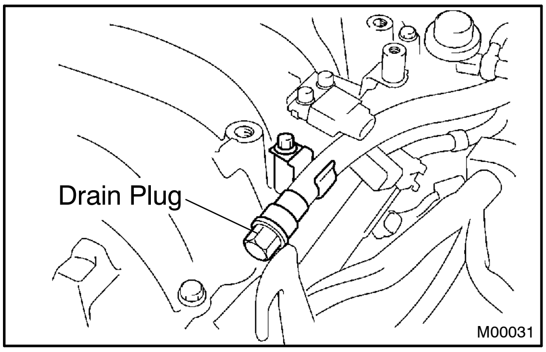
7. START ENGINE, AND CHECK FOR OIL LEAKS

LU06P-01

REPLACEMENT

CAUTION:

- **Prolonged and repeated contact with mineral oil will result in the removal of natural fats from the skin, leading to dryness, irritation and dermatitis. In addition, used engine oil contains potentially harmful contaminants which may cause skin cancer.**
- **Care should be taken, therefore, when changing engine oil to minimize the frequency and length of time your skin is exposed to used engine oil. Protective clothing and gloves that cannot be penetrated by oil should be worn. The skin should be thoroughly washed with soap and water, or use water-less hand cleaner, to remove any used engine oil. Do not use gasoline, thinners, or solvents.**
- **In order to preserve the environment, used oil and used oil filters must be disposed of only at designated disposal sites.**

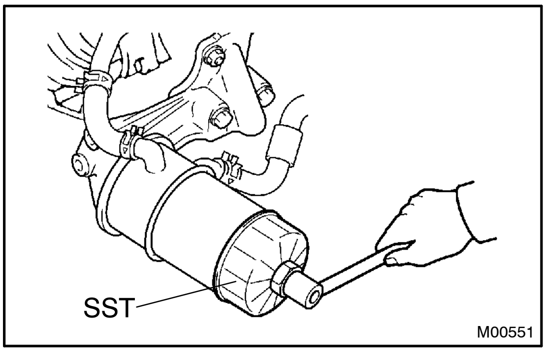


1. DRAIN ENGINE OIL

(a) Remove the oil filler cap.

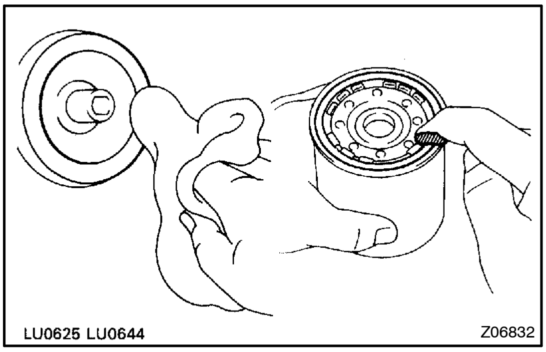
(b) Remove the oil drain plug, and drain the oil into a container.

(c) Use the vacuum pump to drain the engine oil.



2. REPLACE OIL FILTER

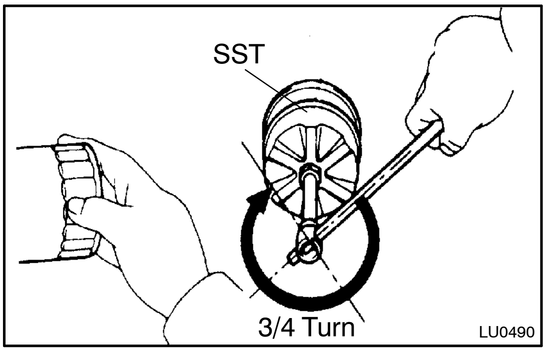
(a) Using SST, remove the oil filter.
SST 09228-07501



(b) Clean the oil filter contact surface on the oil filter mounting.

(c) Lubricate the filter rubber gasket with clean engine oil.

(d) Tighten the oil filter by hand until the rubber gasket contacts the seat of the filter mounting.



(e) Using SST, give it an additional 3/4 turn to seat the filter.
SST 09228-07501

3. REFILL WITH ENGINE OIL

(a) Clean the drain plug, and install a new gasket and it.
Torque: 34 N·m (340 kgf·cm, 24 ft·lbf)

(b) Fill with new engine oil.
Oil grade:
See step 1 in oil pressure check
Capacity:
Drain and refill
w/ Oil filter change
5.3 liters (5.6 US qts, 4.9 Imp. qts)
w/o Oil filter change
5.0 liters (5.3 US qts, 4.4 Imp. qts)
Dry fill
7.0 liters (7.4 US qts, 6.2 Imp. qts)

(c) Reinstall the oil filler cap.

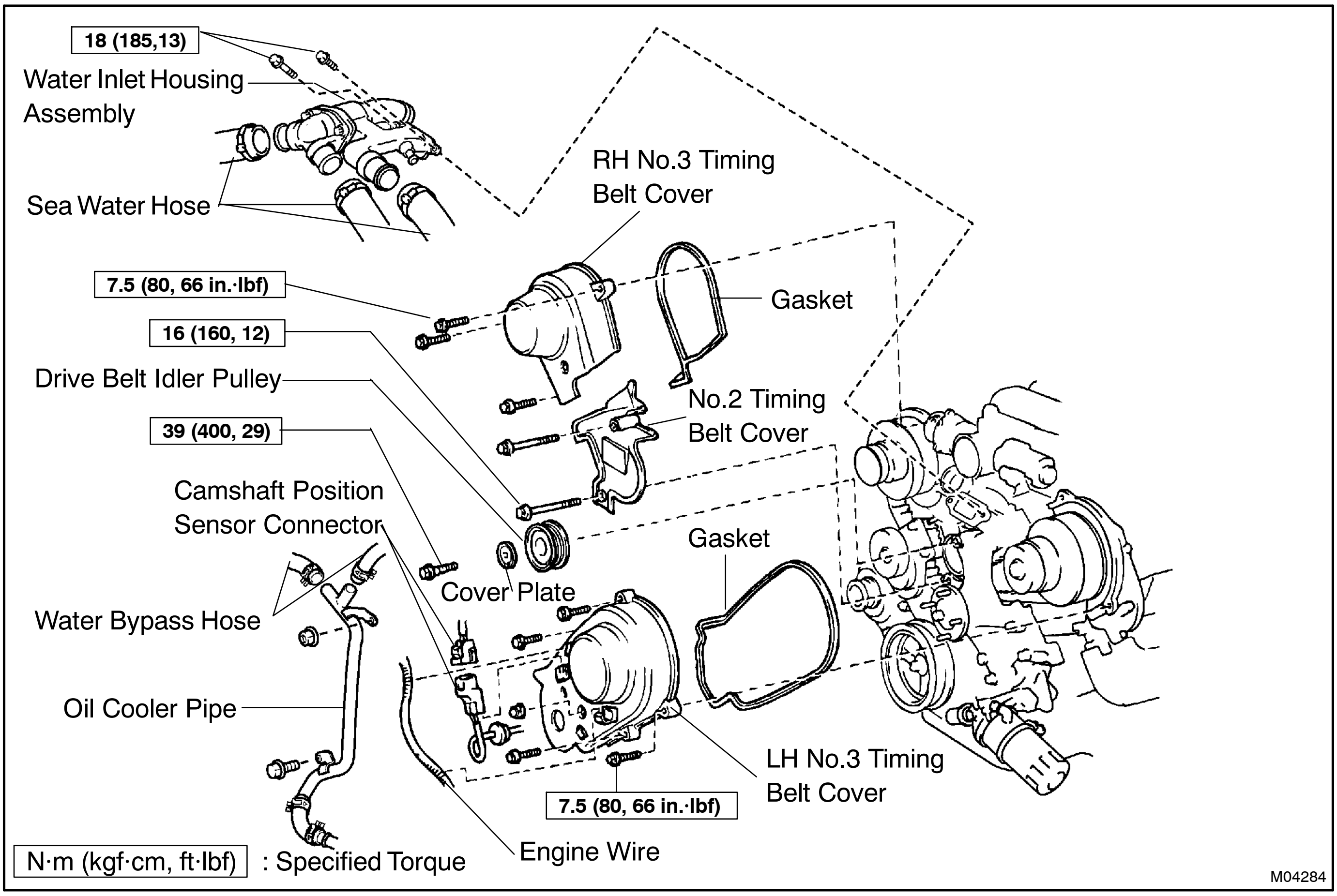
4. START ENGINE AND CHECK FOR OIL LEAKS

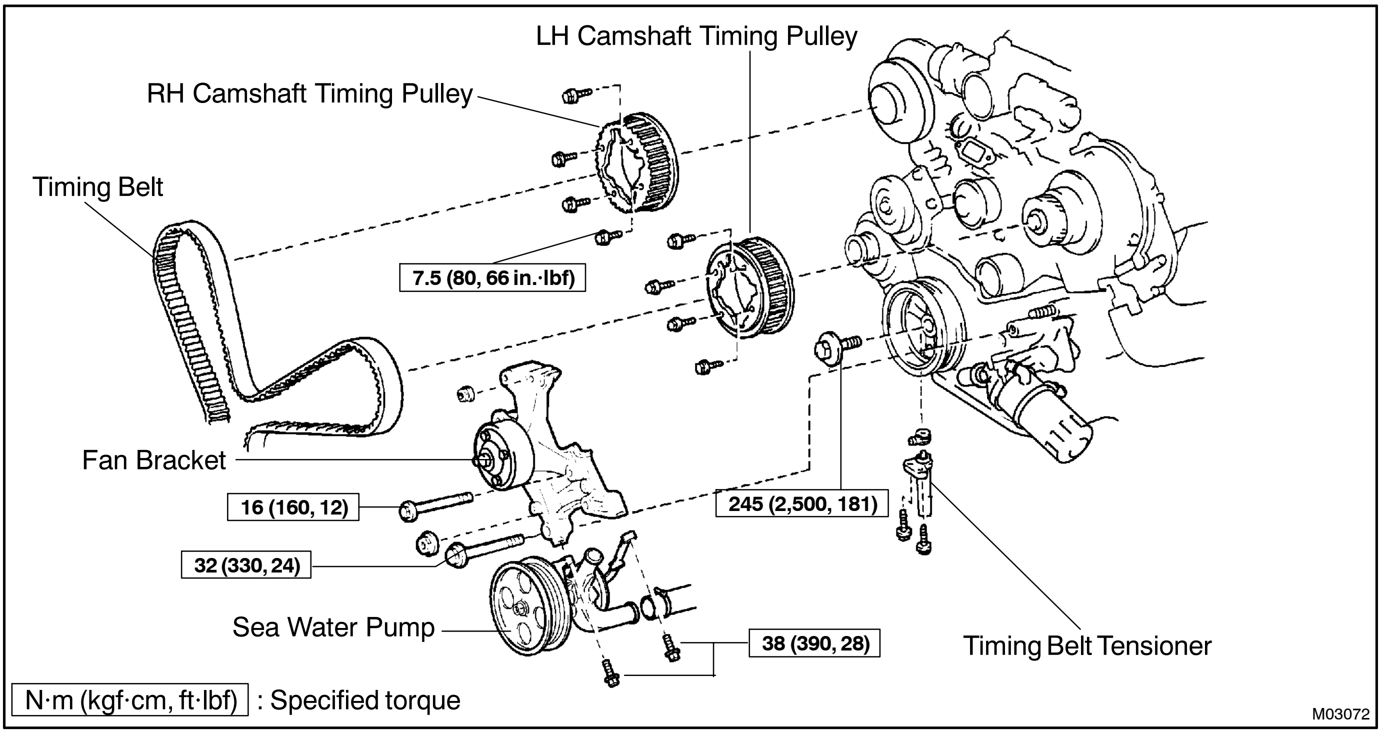
5. RECHECK ENGINE OIL LEVEL

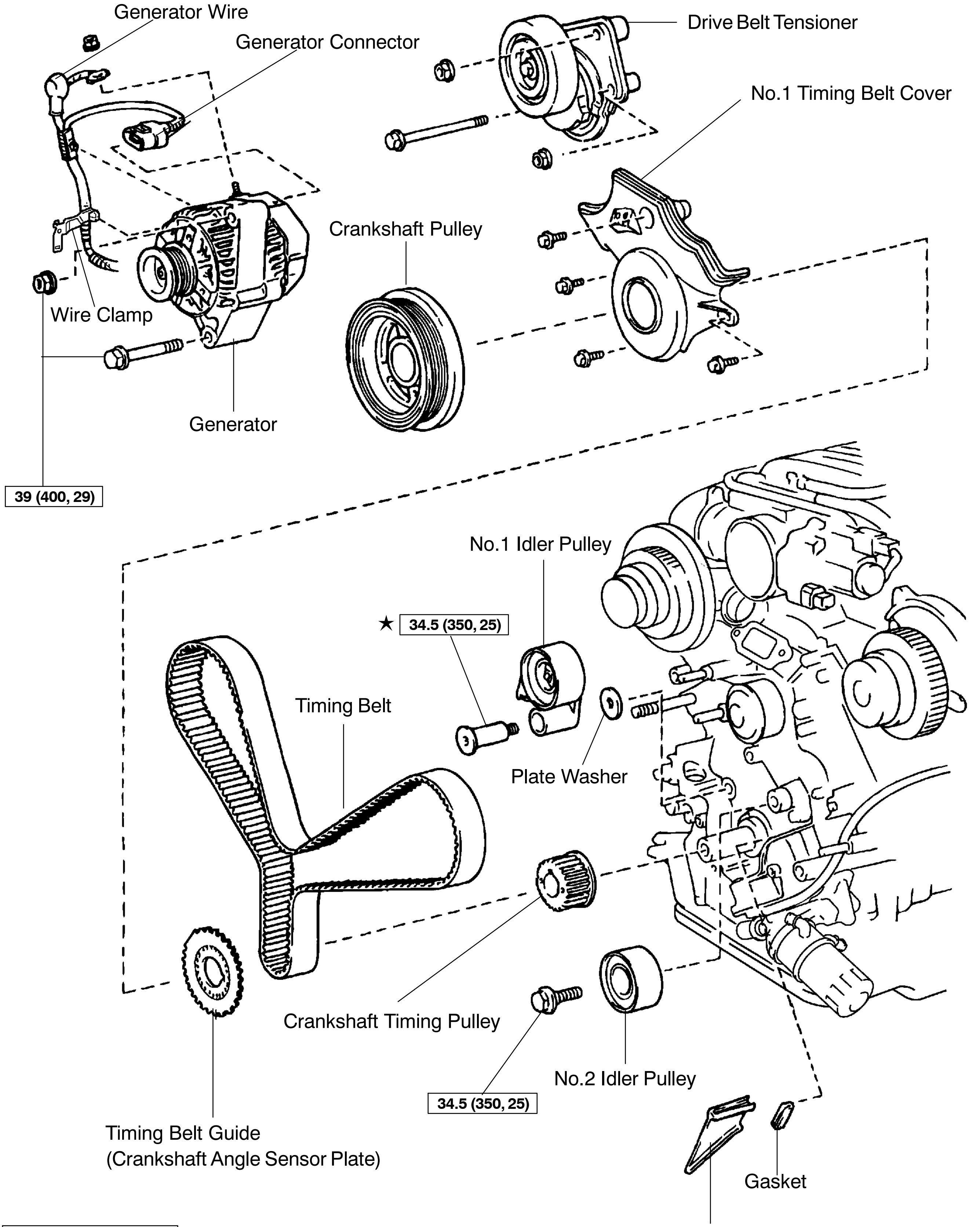
OIL PUMP

COMPONENTS

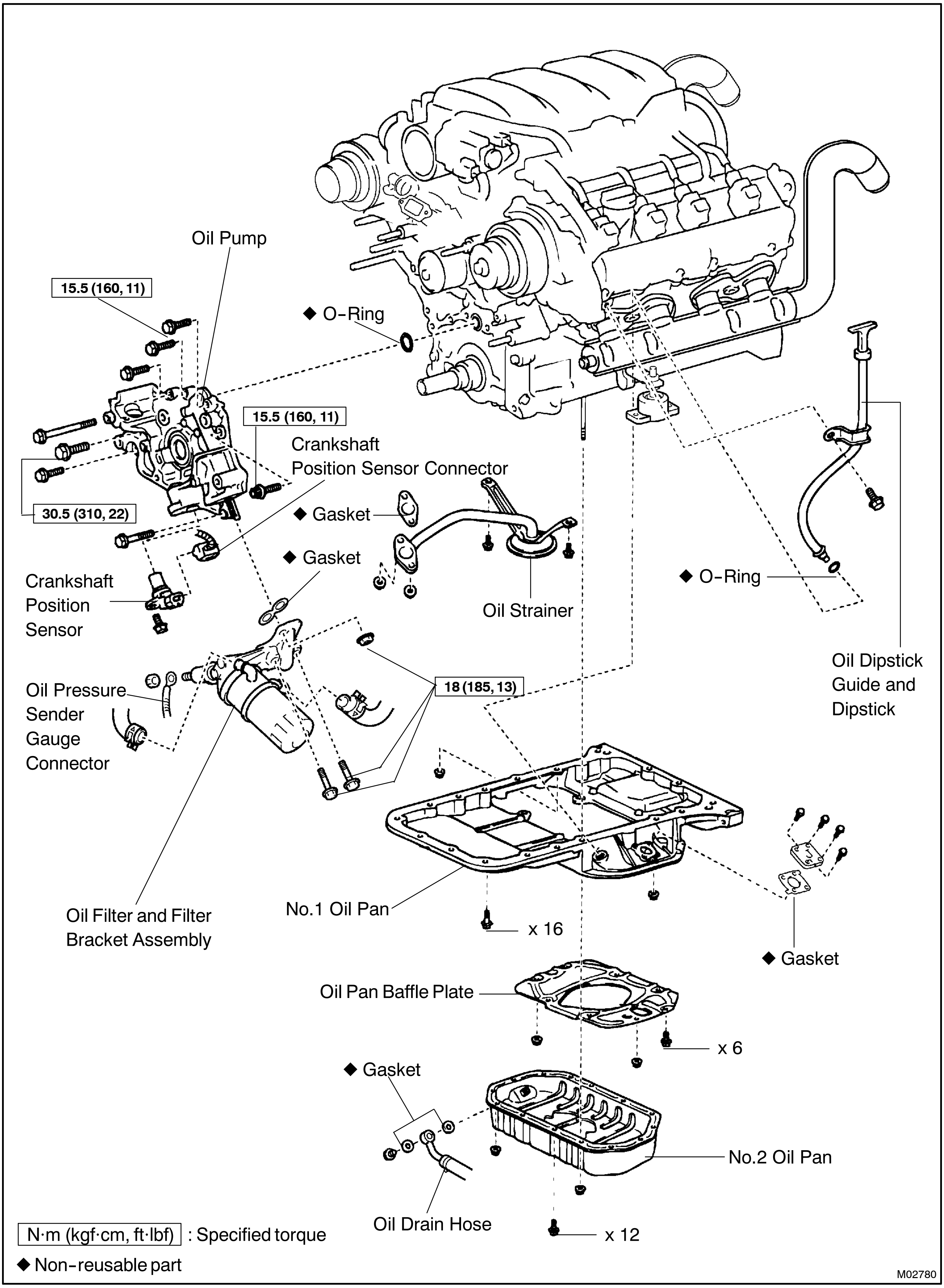
LU06Q–01

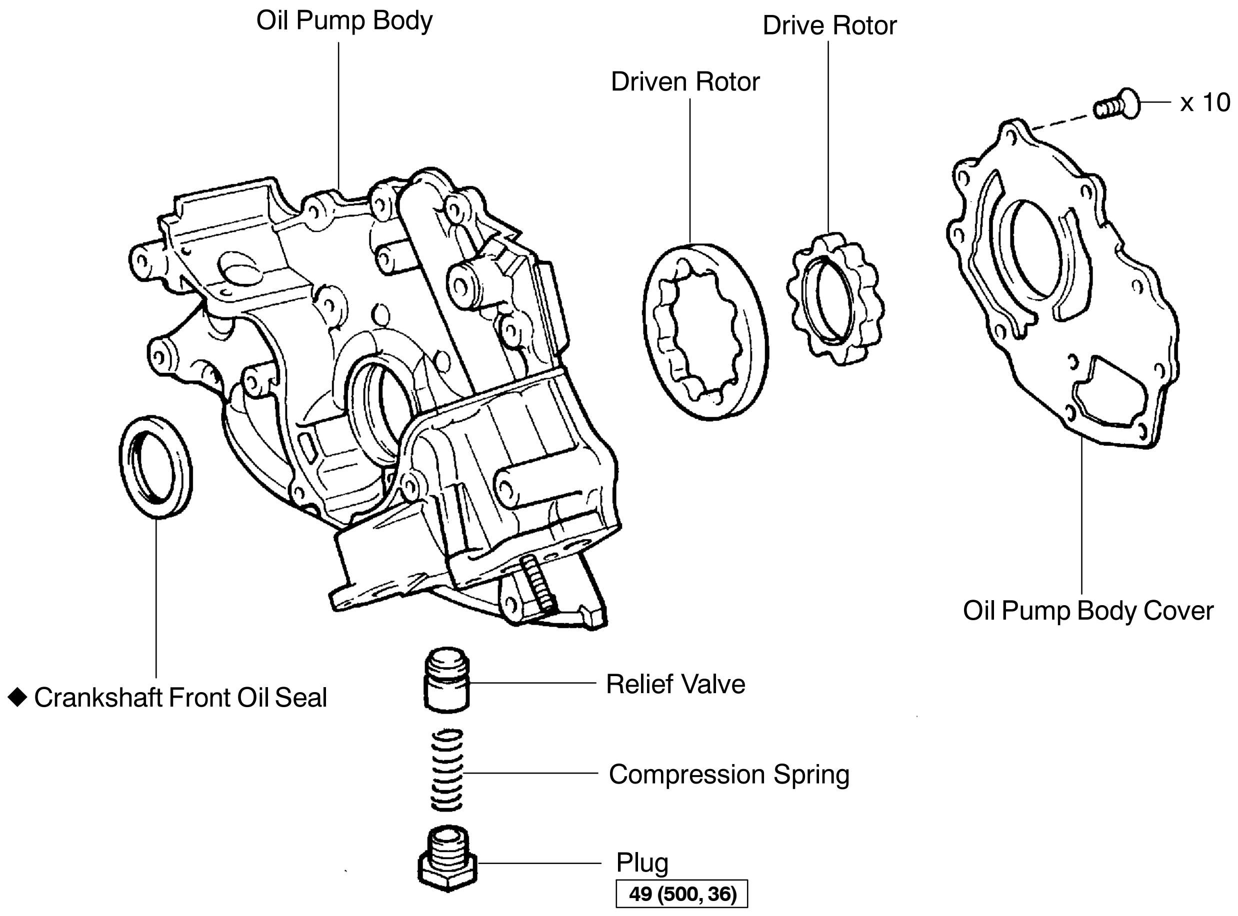






N·m (kgf·cm, ft·lbf) : Specified torque
★ Precoated part


Oil Pump
15.5 (160, 11)
◆ O-Ring
15.5 (160, 11)
Crankshaft Position Sensor Connector
30.5 (310, 22)
◆ Gasket
◆ Gasket
Crankshaft Position Sensor
Oil Strainer
◆ O-Ring
Oil Dipstick Guide and Dipstick
Oil Pressure Sender Gauge Connector
18 (185, 13)
Oil Filter and Filter Bracket Assembly
No.1 Oil Pan
x 16
◆ Gasket
Oil Pan Baffle Plate
x 6
◆ Gasket
No.2 Oil Pan
Oil Drain Hose
x 12
N·m (kgf·cm, ft·lbf) : Specified torque
◆ Non-reusable part
M02780



N·m (kgf·cm, ft·lbf) : Specified torque
◆ Non-reusable part

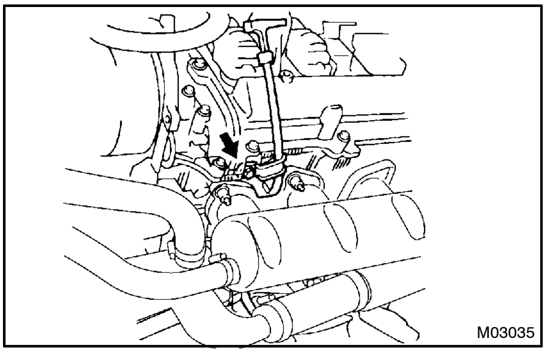
B02772

LU06R-01

REMOVAL

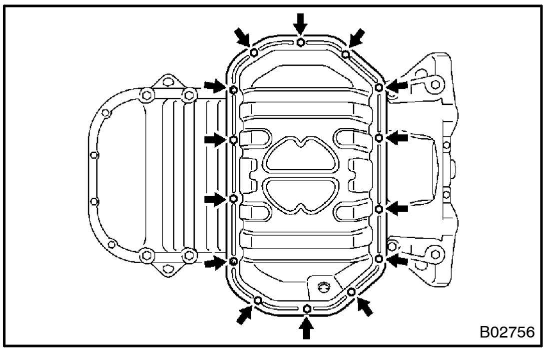
HINT:
When repairing the oil pump, the oil pan and strainer should be removed and cleaned.

1. **REMOVE ENGINE FROM BOAT**
   (See page EM-69)
2. **SEPARATE ENGINE AND TRANSMISSION**
   (See page EM-69)
3. **INSTALL ENGINE TO ENGINE STAND FOR DISASSEMBLY**
4. **REMOVE TIMING BELT**
   (See page EM-12)
5. **REMOVE NO.2 AND NO.1 IDLER PULLEYS**
   (See page EM-12)
6. **REMOVE CRANKSHAFT TIMING PULLEY**
   (See page EM-12)


M03035

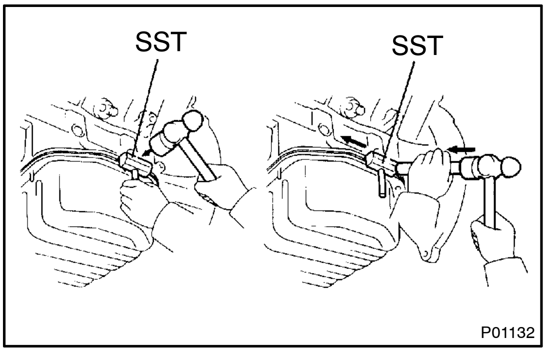
7. **REMOVE OIL DIPSTICK AND GUIDE**

(a) Remove the bolt holding the oil dipstick to the LH cylinder head.
(b) Pull out the dipstick guide together with the dipstick from the No.1 oil pan.
(c) Remove the O-ring from the dipstick guide.


B02756

8. **REMOVE NO.2 OIL PAN**

(a) Remove the 12 bolts and 2 nuts.

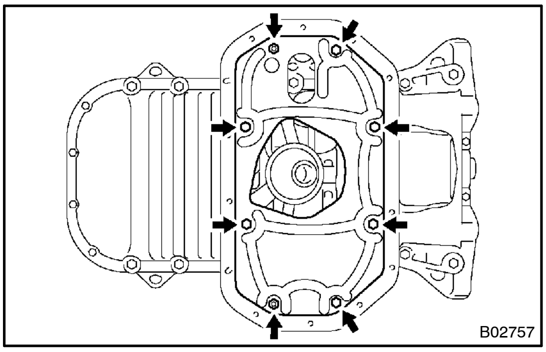


P01132

(b) Insert the blade of SST between the No.1 and No.2 oil pans, cut off applied sealer and remove the No.2 oil pan.
SST 09032-00100

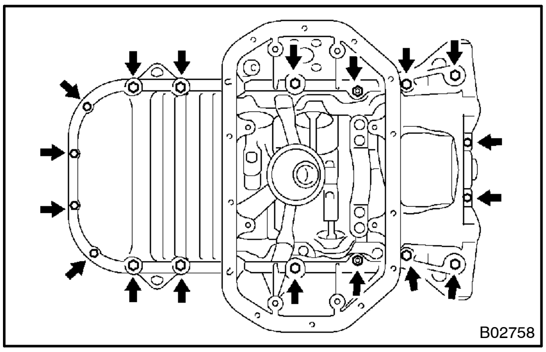
NOTICE:

- **Be careful not to damage the No.2 oil pan contact surface of the No.1 oil pan.**
- **Be careful not to damage the No.2 oil pan flange.**



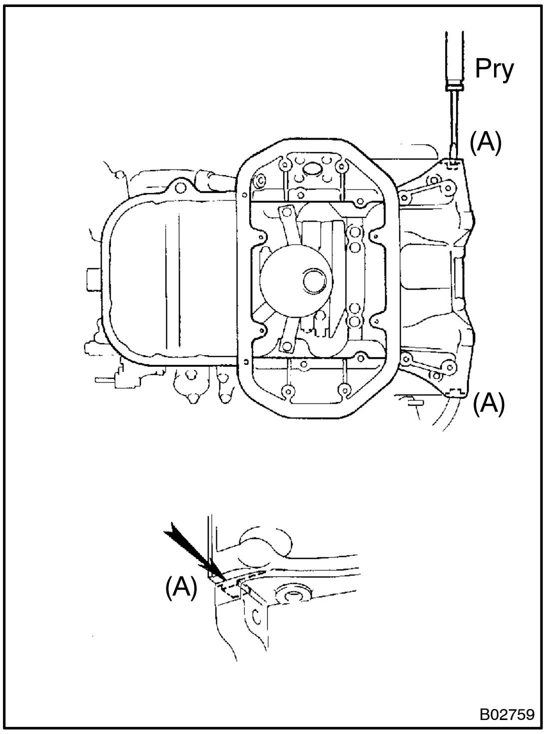
9. REMOVE OIL PAN BAFFLE PLATE

Remove the 6 bolts, 2 nuts and baffle plate.



10. REMOVE NO.1 OIL PAN

(a) Remove the 16 bolts and 2 nuts.



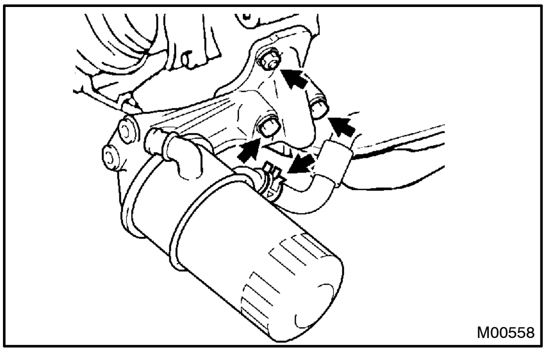
(b) Using a screwdriver, remove the No.1 oil pan by prying the portions (A) between the cylinder block and No.1 oil pan.

NOTICE:

Be careful not to damage the contact surfaces of the cylinder block and No.1 oil pan.

11. REMOVE OIL STRAINER

Remove the 2 bolts, 2 nuts, oil strainer and gasket.



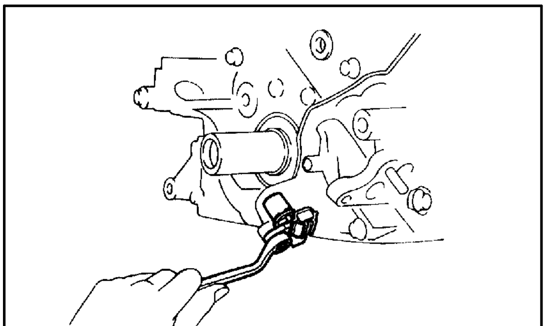
12. REMOVE OIL FILTER AND FILTER BRACKET ASSEMBLY

(a) Disconnect the oil pressure sender gauge connector.

(b) Disconnect the oil cooler hose (from the cooler drain union) from the oil cooler.

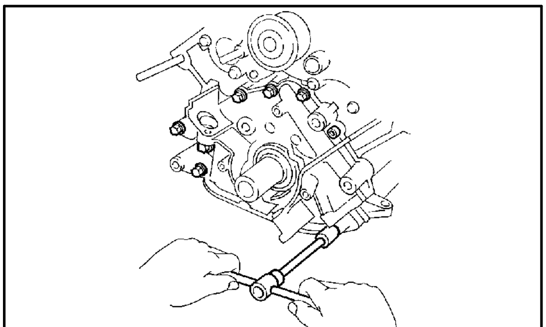
(c) Remove the stud bolt and bolt, nut the oil filter and filter bracket assembly.

(d) Remove the gasket from the filter bracket.


LU1178

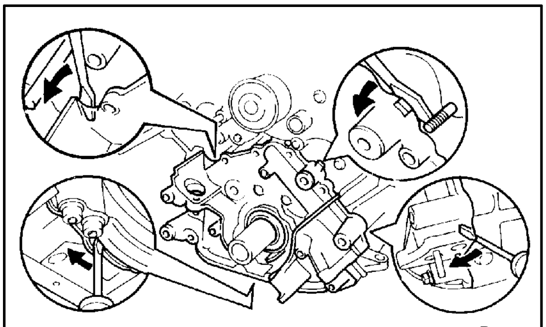
13. REMOVE CRANKSHAFT POSITION SENSOR

(a) Disconnect the crankshaft position sensor connector.
(b) Remove the bolt and crankshaft position sensor.


B02760

14. REMOVE OIL PUMP

(a) Remove the 7 bolts and hexagon socket head bolt.


P00073

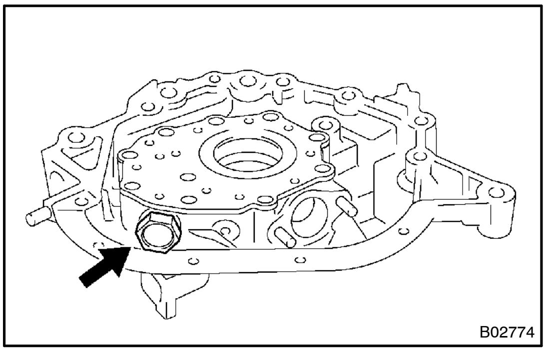
(b) Using a screwdriver, remove the oil pump by prying the portions between the oil pump and cylinder block.

NOTICE:
Be careful not to damage the contact surfaces of the cylinder block and oil pump.

(c) Remove the O-ring from the cylinder block.

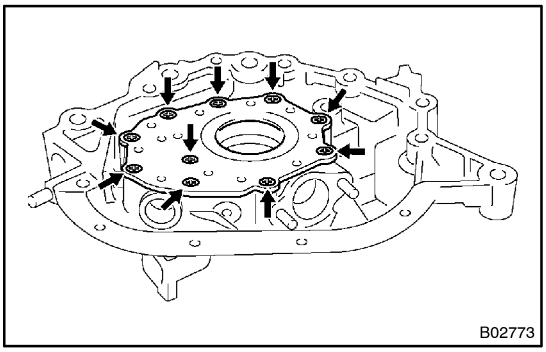
LU06S-01

DISASSEMBLY


B02774

1. REMOVE RELIEF VALVE

Remove the plug,compression spring and relief valve.

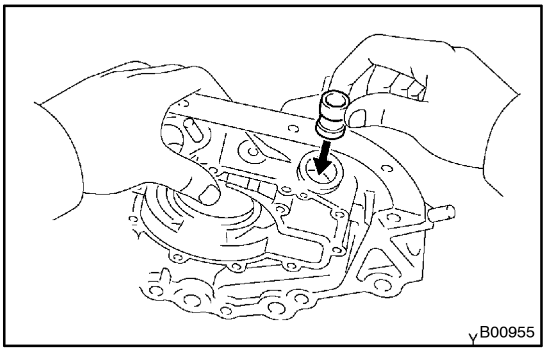

B02773

2. REMOVE DRIVE AND DRIVEN ROTORS

Remove the 10 screws, pump body cover, the drive and driven rotors.

LU06T-01

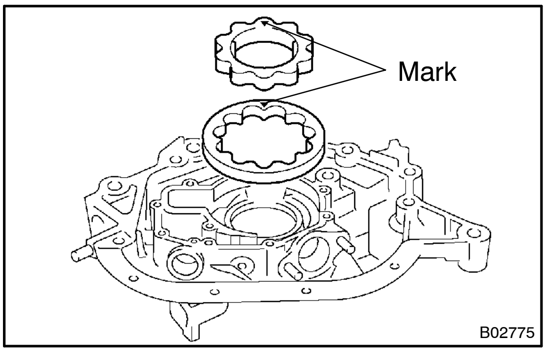
INSPECTION



1. INSPECT RELIEF VALVE

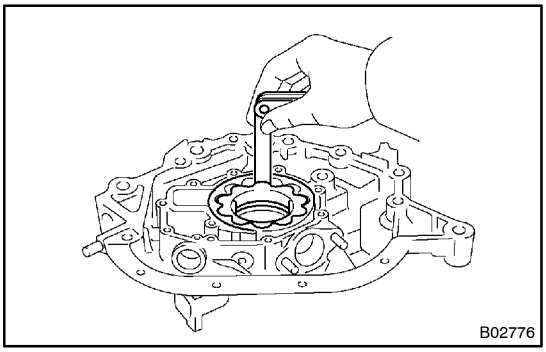
Coat the valve with engine oil and check that it falls smoothly into the valve hole by its own weight.

If it doesn't, replace the relief valve. If necessary, replace the oil pump assembly.



2. PLACE DRIVE AND DRIVEN ROTORS INTO OIL PUMP BODY

Place the drive and driven rotors into the oil pump body with the mark facing upward.

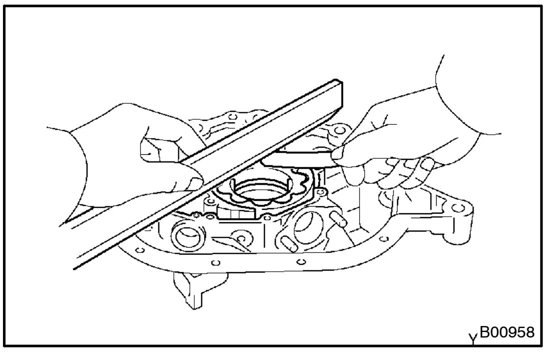


3. INSPECT ROTOR TIP CLEARANCE

Using a feeler gauge, measure the clearance between the drive and driven rotor tips.

Standard tip clearance:
0.110 - 0.240 mm (0.0043 - 0.0094 in.)
Maximum tip clearance:
0.35 mm (0.0138 in.)

If the tip clearance is greater than maximum, replace the rotors as a set.



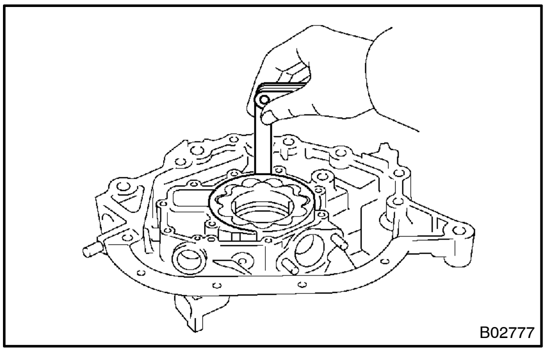
4. INSPECT ROTOR SIDE CLEARANCE

Using a feeler gauge and precision straight edge, measure the clearance between the rotors and precision straight edge.

Standard body clearance:
0.030 - 0.090 mm (0.0012 - 0.0035 in.)
Maximum body clearance:
0.15 mm (0.0059 in.)

If the side clearance is greater than maximum, replace the rotors as a set. If necessary, replace the oil pump assembly.

5. INSPECT ROTOR BODY CLEARANCE



Using a feeler gauge, measure the clearance between the driven rotor and body.

Standard body clearance:
0.100 - 0.175 mm (0.0039 - 0.0069 in.)
Maximum body clearance:
0.30 mm (0.0118 in.)

If the body clearance is greater than maximum, replace the rotors as a set. If necessary, replace the oil pump assembly.

6. REMOVE DRIVE AND DRIVEN ROTORS

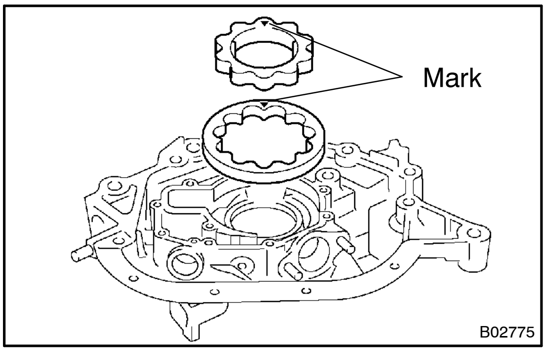
LU06U-01

REPLACEMENT

REPLACE CRANKSHAFT FRONT OIL SEAL

(See page EM-96)

LU06V-01



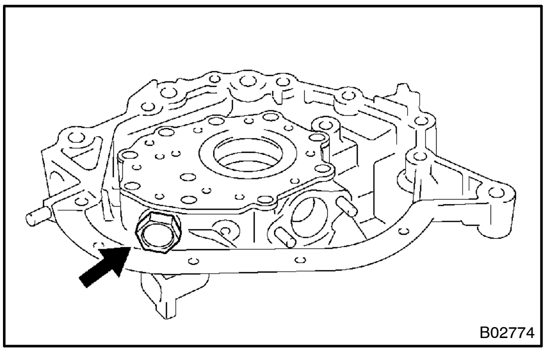
REASSEMBLY

1. INSTALL DRIVE AND DRIVEN ROTORS

(a) Place the drive and driven rotors into pump body with the marks facing the pump body cover side.

(b) Install the oil pump body cover with the 10 screws.

Torque: 10 N·m (105 kgf·cm, 7 ft·lbf)



2. INSTALL RELIEF VALVE

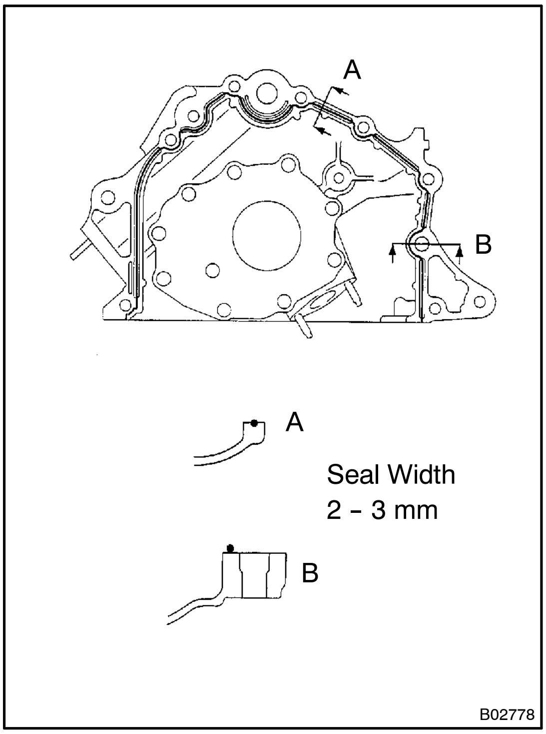
(a) Insert these parts into the oil pump body hole:

- Relief valve
- Compression spring

(b) Install the plug.

Torque: 49 N·m (500 kgf·cm, 36 ft·lbf)

LU06W–01



INSTALLATION

1. INSTALL OIL PUMP

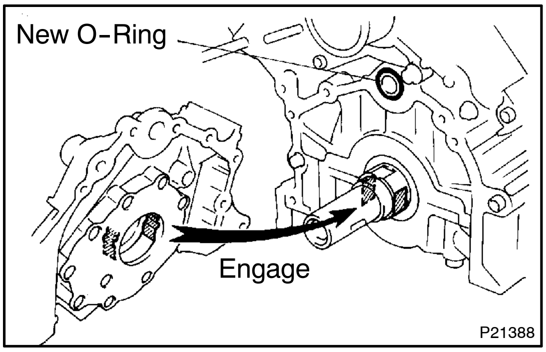
(a) Remove any old packing (FIPG) material and be careful not to drop any oil on the contact surfaces of the oil pump and cylinder block.

- Using a razor blade and gasket scraper, remove all the old packing (FIPG) material from the gasket surfaces and sealing groove.
- Thoroughly clean all components to remove all the loose material.
- Using a non–residue solvent, clean both sealing surfaces.

(b) Apply seal packing to the oil pump as shown in the illustration.

Seal packing:
Part No. 08826–00080 or equivalent

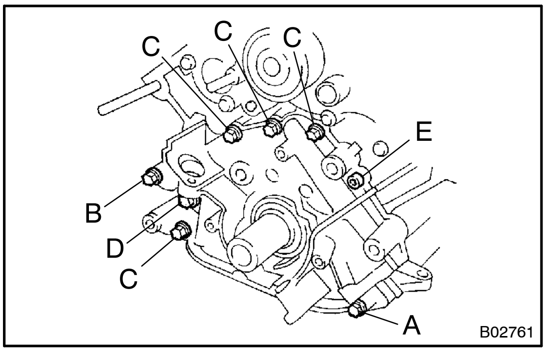
NOTICE:
Avoid applying an excessive amount to the surface. Be particularly careful near oil passage.



- Install a nozzle that has been cut to a 2 – 3 mm (0.08 – 0.12 in.) opening.
- Parts must be assembled within 5 minutes of application. Otherwise the material must be removed and reapplied.
- Immediately remove nozzle from the tube and reinstall cap.

(c) Install a new O–ring to the cylinder block.

(d) Engage the spline teeth of the oil pump drive gear with the large teeth of the crankshaft, and slide the oil pump on the crankshaft.



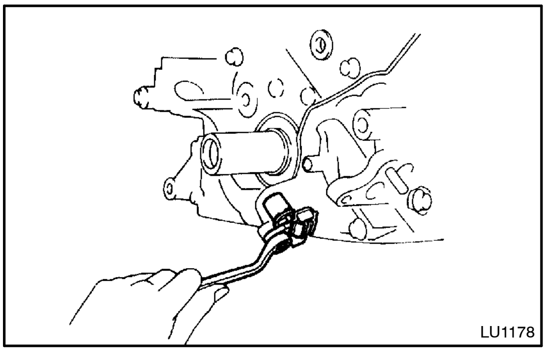
(e) Install the oil pump with the 8 bolts. Uniformly tighten the bolts in several passes.

Torque:
12 mm head and 6 mm hexagon socket head
15.5 N·m (160 kgf·cm, 11 ft·lbf)
14 mm head
30.5 N·m (310 kgf·cm, 22 ft·lbf)

HINT:

- Use a 6 mm hexagon wrench for the hexagon socket head bolt.
- Each bolt length is indicated in the illustration.

Bolt length:
50 mm (1.97 in.) for A of 12 mm head
106 mm (4.17 in.) for B of 12 mm head
30 mm (1.18 in.) for C of 12 mm head
44 mm (1.57 in.) for D of 14 mm head
28 mm (1.18 in.) for E of 6 mm hexagon socket head

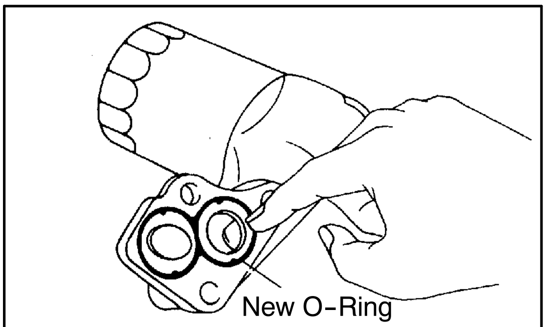

LU1178

2. INSTALL CRANKSHAFT POSITION SENSOR

(a) Install the crankshaft position sensor with the bolt.

Torque: 6.5 N·m (65 kgf·cm, 58 in.·lbf)

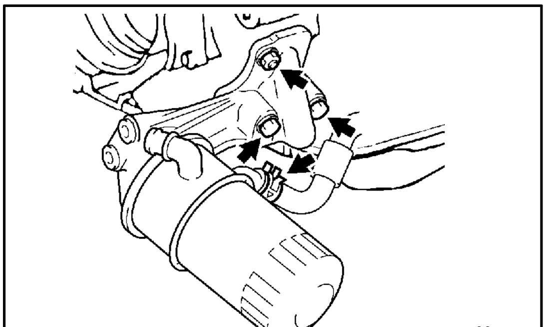
(b) Connect the crankshaft position sensor connector.



P00213

3. INSTALL OIL FILTER AND FILTER BRACKET ASSEMBLY

(a) Install a new gasket to the oil filter bracket.

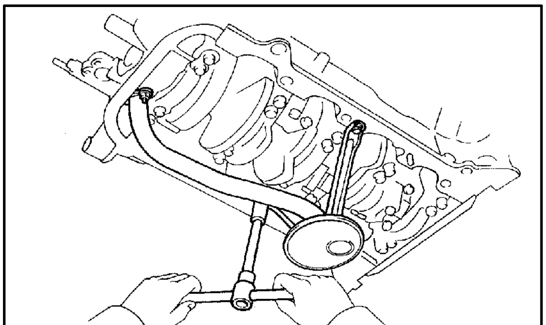

M00558

(b) Install the oil filter and filter bracket assembly with the stud bolt, bolt and nut.

Torque: 18 N·m (185 kgf·cm, 13 ft·lbf)

(c) Connect the oil cooler hose (from the coolant drain union) to the oil cooler.

(d) Connect the oil pressure sender gauge connector.


B02762

4. INSTALL OIL STRAINER

Install a new gasket and the oil strainer with the 2 bolts and 2 nuts.

Torque: 7.5 N·m (80 kgf·cm, 66 in.·lbf)

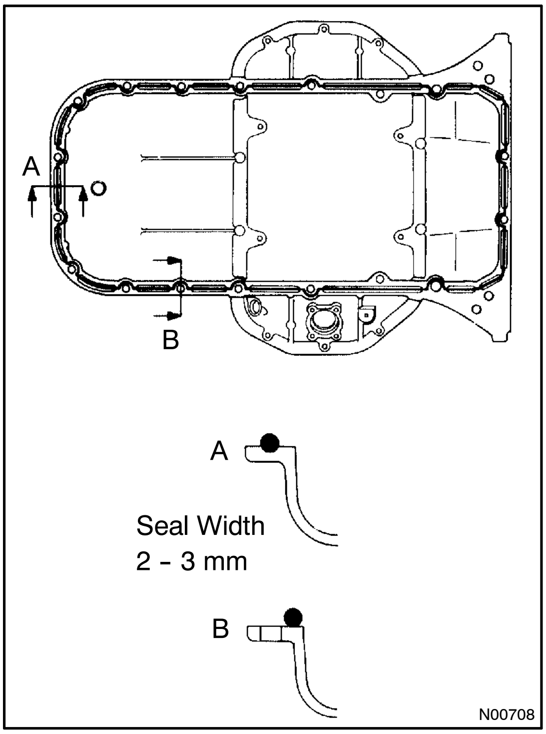
HINT:

Use bolts 12 mm (0.47 in.) in length.

5. INSTALL NO.1 OIL PAN

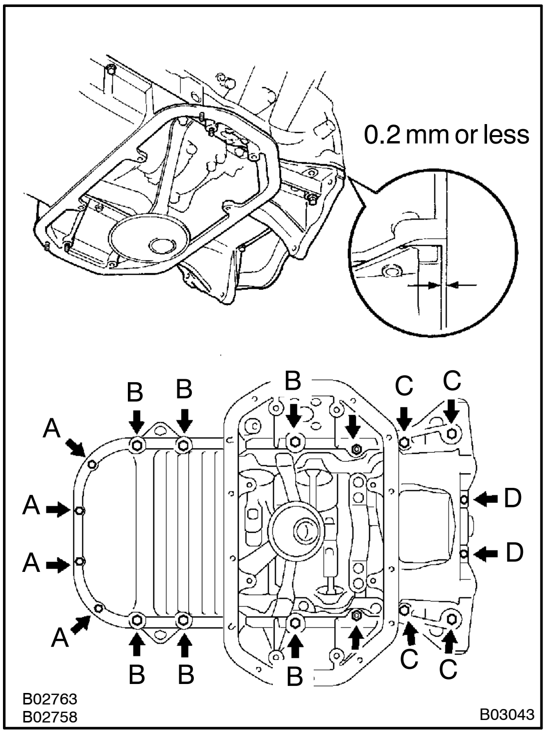
(a) Remove any old packing (FIPG) material and be careful not to drop any oil on the contact surfaces of the No.1 oil pan, cylinder block, oil pump and rear oil seal retainer.

- Using a razor blade and gasket scraper, remove all the old packing (FIPG) material from the gasket surfaces and sealing groove.
- Thoroughly clean all components to remove all the loose material.
- Using a non–residue solvent, clean both sealing surfaces.



(b) Apply seal packing to the No.1 oil pan as shown in the illustration.
Seal packing:
Part No. 08826–00080 or equivalent

- Install a nozzle that has been cut to a 2 – 3 mm (0.08 – 0.12 in.) opening.
- Parts must be assembled within 5 minutes of application. Otherwise the material must be removed and reapplied.
- Immediately remove nozzle from the tube and reinstall cap.



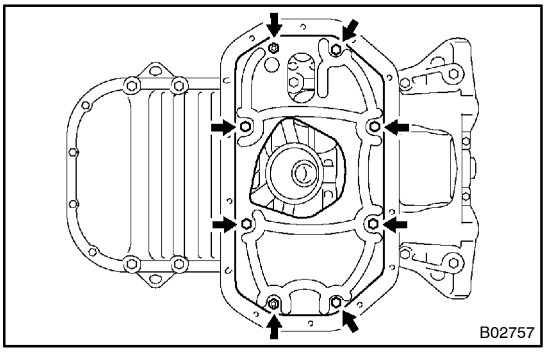
(c) Temporarily install the No.1 oil pan with the 16 bolts and 2 nuts.

HINT:
Each bolt length is indicated in the illustration.
Bolt length:
20 mm (0.78 in.) for A of 10 mm head
25 mm (0.98 in.) for B of 12 mm head
55 mm (2.17 in.) for C of 12 mm head
35 mm (1.38 in.) for D of 10 mm head

(d) Set the No.1 oil pan as shown in the illustration.

NOTICE:
Make sure the clearance between the rear ends of the No.1 oil pan and cylinder block is 0.2 mm (0.008 in.) or less. If the clearance is more than 0.2 mm (0.008 in.), the No.1 oil pan will be stretched.

(e) Uniformly tighten the bolts and nuts in several passes.
Torque:
Bolt: 7.5 N·m (80 kgf·cm, 66 in.·lbf) for 10 mm head
28 N·m (290 kgf·cm, 21 ft·lbf) for 12 mm head
Nut: 28 N·m (290 kgf·cm, 21 ft·lbf)



6. INSTALL OIL PAN BAFFLE PLATE

Install the baffle plate with the 6 bolts and 2 nuts.
Torque: 7.5 N·m (80 kgf·cm, 66 in.·lbf)

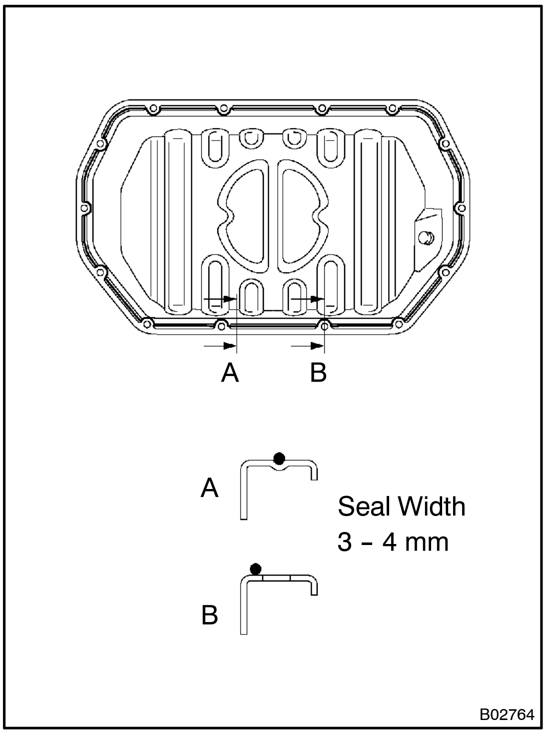
HINT:
Use bolts 14 mm (0.55 in.) in length.

7. **INSTALL NO.2 OIL PAN**

(a) Remove any old packing (FIPG) material and be careful not to drop any oil on the contact surfaces of the No.1 and No.2 oil pans.

- Using a razor blade and gasket scraper, remove all the old packing (FIPG) material from the gasket surfaces and sealing groove.
- Thoroughly clean all components to remove all the loose material.
- Using a non-residue solvent, clean both sealing surfaces.

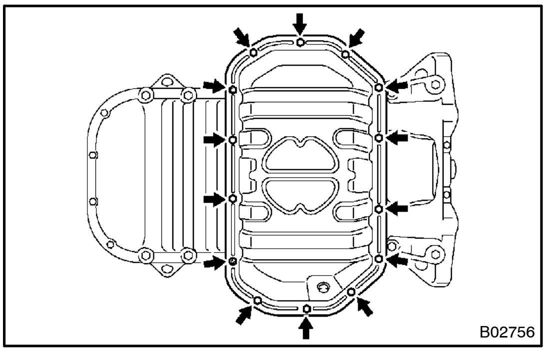
NOTICE:
Do not use a solvent which will affect the painted surfaces.



(b) Apply seal packing to the No.2 oil pan as shown in the illustration.

Seal packing:
Part No. 08826-00080 or equivalent

- Install a nozzle that has been cut to a 3 - 4 mm (0.12 - 0.16 in.) opening.
- Parts must be assembled within 5 minutes of application. Otherwise the material must be removed and reapplied.
- Immediately remove nozzle from the tube and reinstall cap.



(c) Install the No.2 oil pan with the 12 bolts and 2 nuts. Uniformly tighten the bolts and nuts in several passes.

Torque:
Bolt: 7.5 N·m (80 kgf·cm, 66 in.·lbf)
Nut: 28 N·m (290 kgf·cm, 21 ft·lbf)

HINT:
Use bolts 14 mm (0.55 in.) in length.

8. **INSTALL OIL DIPSTICK GUIDE AND DIPSTICK**

(a) Install a new O-ring to the dipstick guide.
(b) Apply soapy water to the O-ring.
(c) Push in the dipstick guide end into the guide hole of the No.1 oil pan.
(d) Install the dipstick guide with the bolt.
(e) Install the dipstick.

9. **INSTALL CRANKSHAFT TIMING PULLEY**
   (See page EM-19)
10. **INSTALL NO.1 AND NO.2 IDLER PULLEYS**
    (See page EM-19)
11. **INSTALL TIMING BELT**
    (See page EM-19)
12. **DISCONNECT ENGINE FROM ENGINE STAND**
13. **REASSEMBLE ENGINE AND TRANSMISSION**
    (See page EM-72)
14. **INSTALL ENGINE TO BOAT**
    (See page EM-72)

LUBRICATION

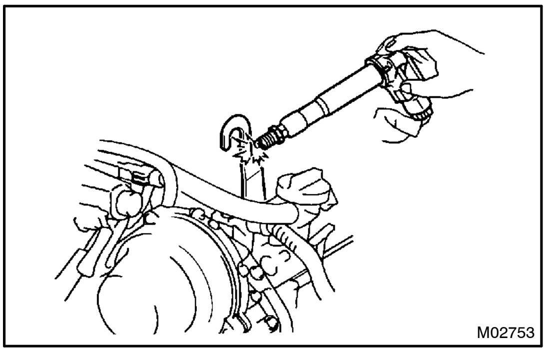
IGNITION SYSTEM

IG06Z-01

ON-BOAT INSPECTION

NOTICE:

"Cold" and "Hot" in these sentences express the temperature of the coils themselves. "Cold" is from -10°C (14°F) to 50°C (122°F) and "Hot" is from 50°C (122°F) to 100°C (212°F).



1. INSPECT IGNITION COIL WITH IGNITER AND SPARK TEST

Check that the spark occurs.

(1) Remove the ignition coil with igniters.
(See page IG-6)

(2) Using a 16 mm plug wrench, remove the spark plugs.

(3) Install the spark plugs to each ignition coil with igniter, and connect the ignition coil with igniter connector.

(4) Disconnect the injector connector.

(5) Ground the spark plug.

(6) Check if spark occurs while engine is being cranked.

NOTICE:
To prevent gasoline from being injected from injectors during this test, crank the engine for no more than 5 – 10 seconds at time. If the spark done not occur, do the test as follows:

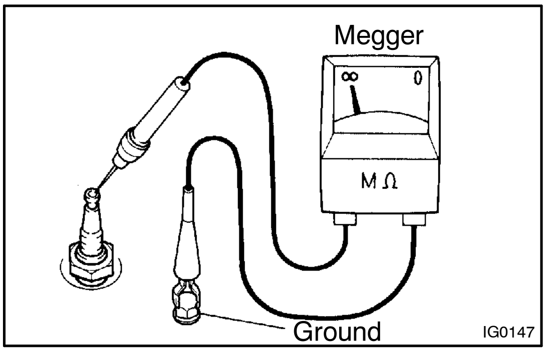
SPARK TEST	NO ↓	
CHECK CONNECTION OF IGNITION COIL WITH IGNITER CONNECTOR	BAD →	Connect securely.
↓ OK		
CHANGE IT TO NORMAL IGNITION COIL WITH IGNITER AND PERFORM SPARK TEST AGAIN	OK →	Replace the ignition coil with igniter.
↓ NO		
CHECK POWER SUPPLY TO IGNITION COIL WITH IGNITER 1. Turn ignition switch to ON. 2. Check that there is battery voltage at ignition coil positive (+) terminal.	BAD →	Check wiring between ignition switch to ignition coil with igniter.
↓ OK		
CHECK RESISTANCE OF CAMSHAFT POSITION SENSOR **(See step 4) Cold Hot** **Resistance: 835 – 1,400 Ω 1,060 – 1,645 Ω**	BAD →	Replace the camshaft position sensor.
↓ OK		
CHECK RESISTANCE OF CRANKSHAFT POSITION SENSOR **(See step 4) Cold Hot** **Resistance: 1,630 – 2,740 Ω 2,065 – 3,225 Ω**	BAD →	Replace the crankshaft position sensor.
↓ OK		
CHECK IGT SIGNAL FROM ECM **(See page DI–66)**	BAD →	Check wiring between ECM and ignition coil with igniter, and then try another ECM.
↓ OK		
TRY ANOTHER IGNITION COIL WITH IGNITER		

(7) Using a 16 mm plug wrench, install the spark plugs.
Torque: 17.5 N·m (180 kgf·cm, 13 ft·lbf)
(8) Reinstall the ignition coil with igniters.
(See page IG–7)

2. INSPECT SPARK PLUGS

NOTICE:
- **Never use a wire brush for cleaning.**
- **Never attempt to adjust the electrode gap on used spark plug.**
- **Spark plug should be replaced every 1,000 Hr.**

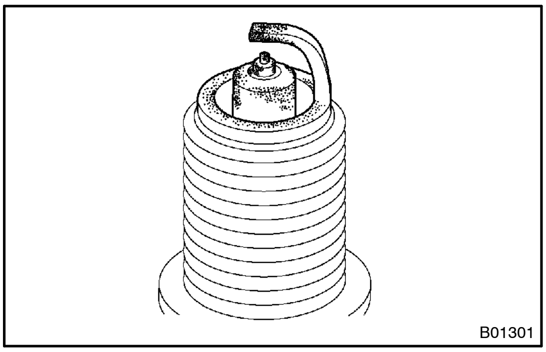
(a) Remove the ignition coil with igniters.
(See page IG–6)

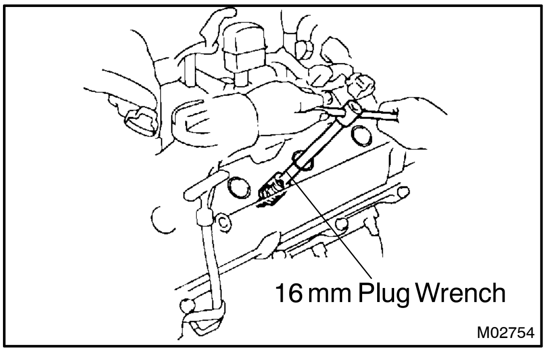


(b) Check the electrode.
- Using a megger (insulation resistance meter), measure the insulation resistance.

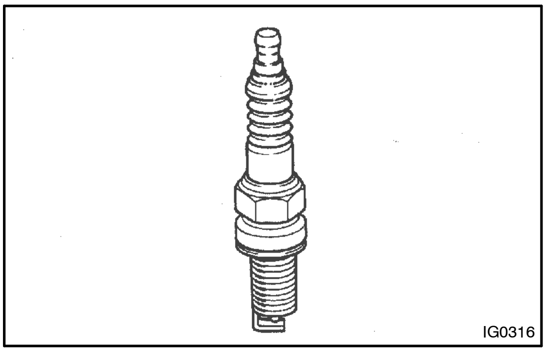
Correct insulation resistance:
10 MΩ or more

If the resistance is less than specified, proceed to step (d).
HINT:
If a megger is not available, the following simple method of inspection provides fairly accurate results.
- Simple Method:
  - Quickly race the engine to 4,000 rpm 5 times.
  - Remove the spark plug. (See step (c))
  - Visually check the spark plug.
    If the electrode is dry ... Okay.
    If the electrode is wet ... Proceed to step (d).
  - Reinstall the spark plug. (See step (g))





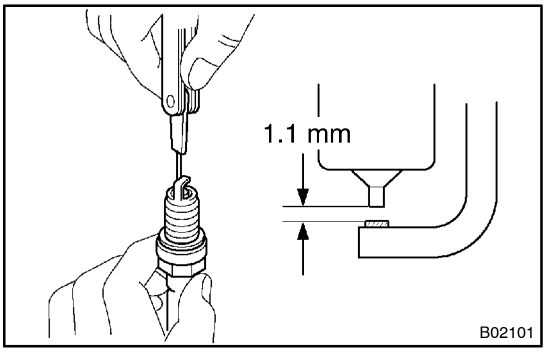
(c) Using a 16 mm plug wrench, remove the spark plugs.



(d) Check the spark plug for thread damage and insulator damage.
If abnormal, replace the spark plug.

Recommended spark plug:

DENSO	SK20R11
NGK	IFR6A11



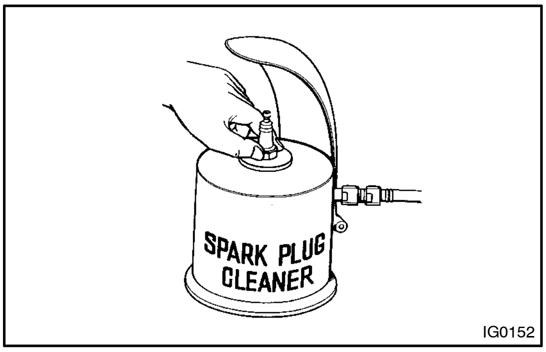
(e) Check the spark plug electrode gap.

Maximum electrode gap for used spark plug:
1.2 mm (0.047 in.)

If the gap is greater than maximum, replace the spark plug.

Correct electrode gap for new spark plug:
1.1 mm (0.043 in.)

NOTICE:
If adjusting the gap of a new spark plug, bend only the base of the ground electrode. Do not touch the tip. Never attempt to adjust the gap on a used plug.



(f) Clean the spark plugs.

If the electrode has traces of wet carbon, allow it to dry and then clean with a spark plug cleaner.

Air pressure:
Below 588 kPa (6 kgf/cm^2, 85 psi)
Duration:
20 seconds or less

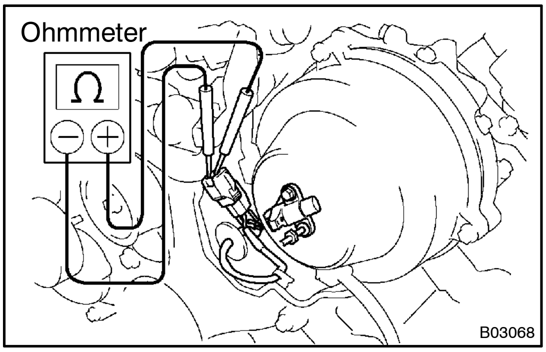
HINT:
If there are traces of oil, remove it with gasoline before using the spark plug cleaner.

(g) Using a 16 mm plug wrench, install the spark plugs.
Torque: 17.5 N·m (180 kgf·cm, 13 ft·lbf)

(h) Reinstall the ignition coil with igniters.
(See page IG–7)

3. INSPECT CAMSHAFT POSITION SENSOR

(a) Remove the V–bank cover.
(b) Disconnect the camshaft position sensor connector.



(c) Using an ohmmeter, measure the resistance between terminals.
Resistance:

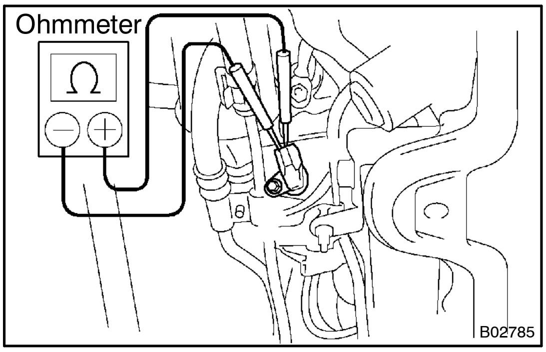
Cold	835 – 1,400 Ω
Hot	1,060 – 1,645 Ω

If the resistance is not as specified, replace the camshaft position sensor.

(d) Reconnect the camshaft position sensor connector.
(e) Reinstall the V–bank cover.

4. INSPECT CRANKSHAFT POSITION SENSOR

(a) Remove the engine under cover and engine under cover No.2.
(b) Disconnect the crankshaft position sensor connector.



(c) Using an ohmmeter, measure the resistance between terminals.
Resistance:

Cold	1,630 – 2,740 Ω
Hot	2,065 – 3,225 Ω

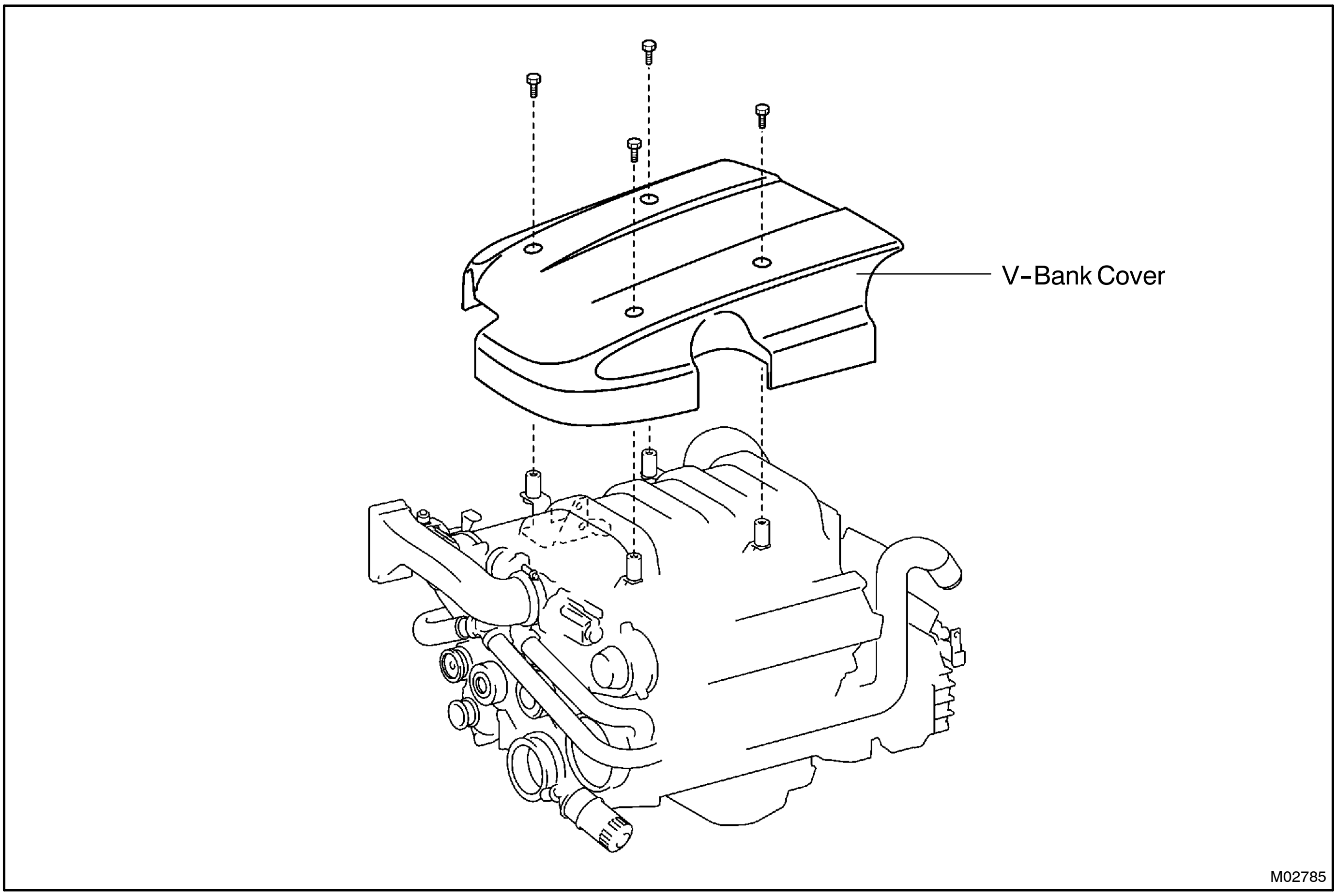
If the resistance is not as specified, replace the crankshaft position sensor.

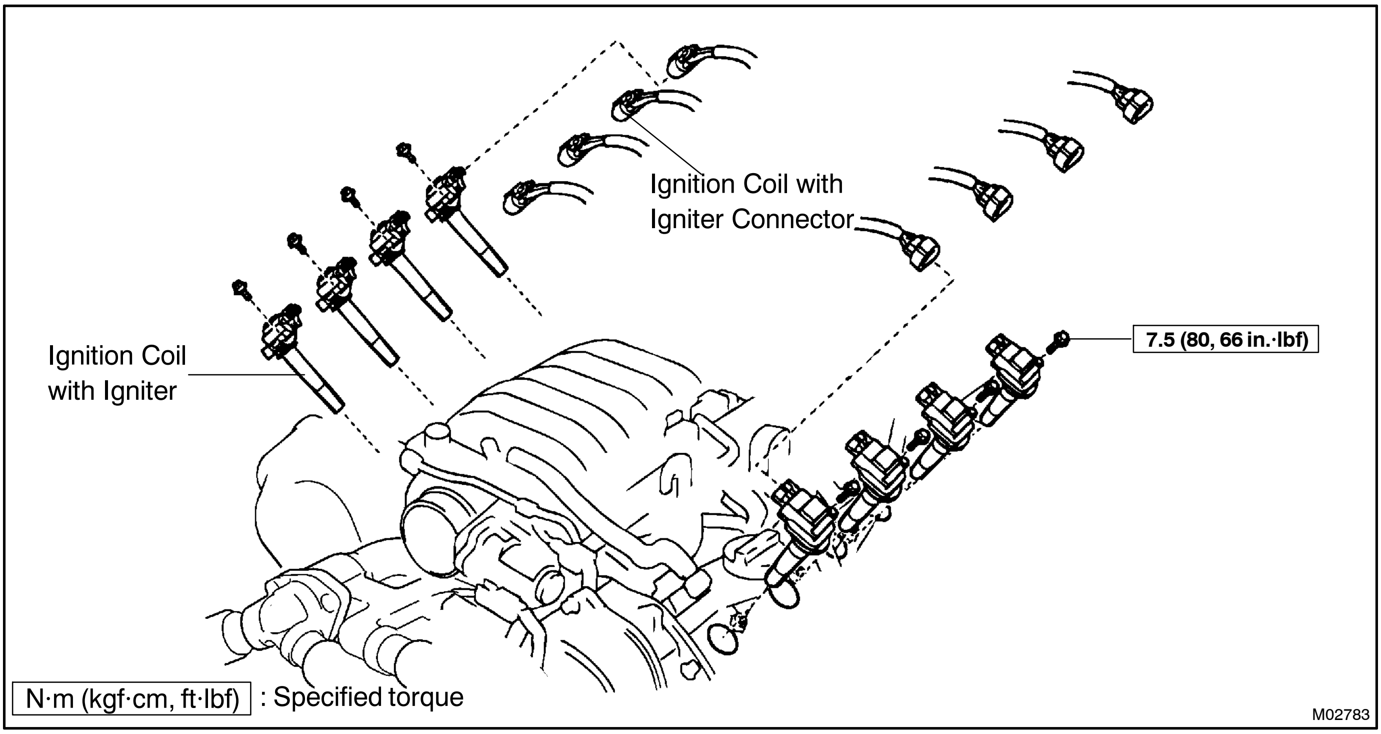
(d) Reconnect the crankshaft position sensor connector.
(e) Reinstall the engine under cover and engine under cover No.2.

IGNITION COIL

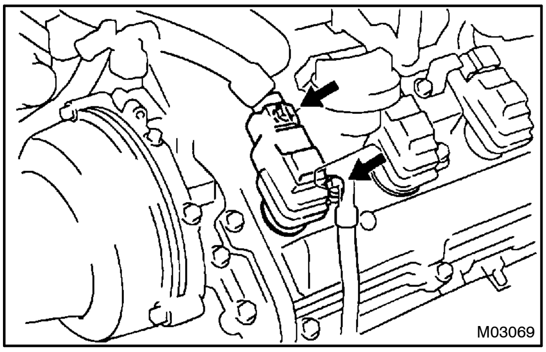
COMPONENTS

IG070-01





IG071-01



REMOVAL

1. **REMOVE V-BANK COVER**
2. **DISCONNECT IGNITION COIL WITH IGNITER CONNECTORS**
3. **REMOVE IGNITION COIL WITH IGNITERS FROM SPARK PLUGS**

Remove the bolt.

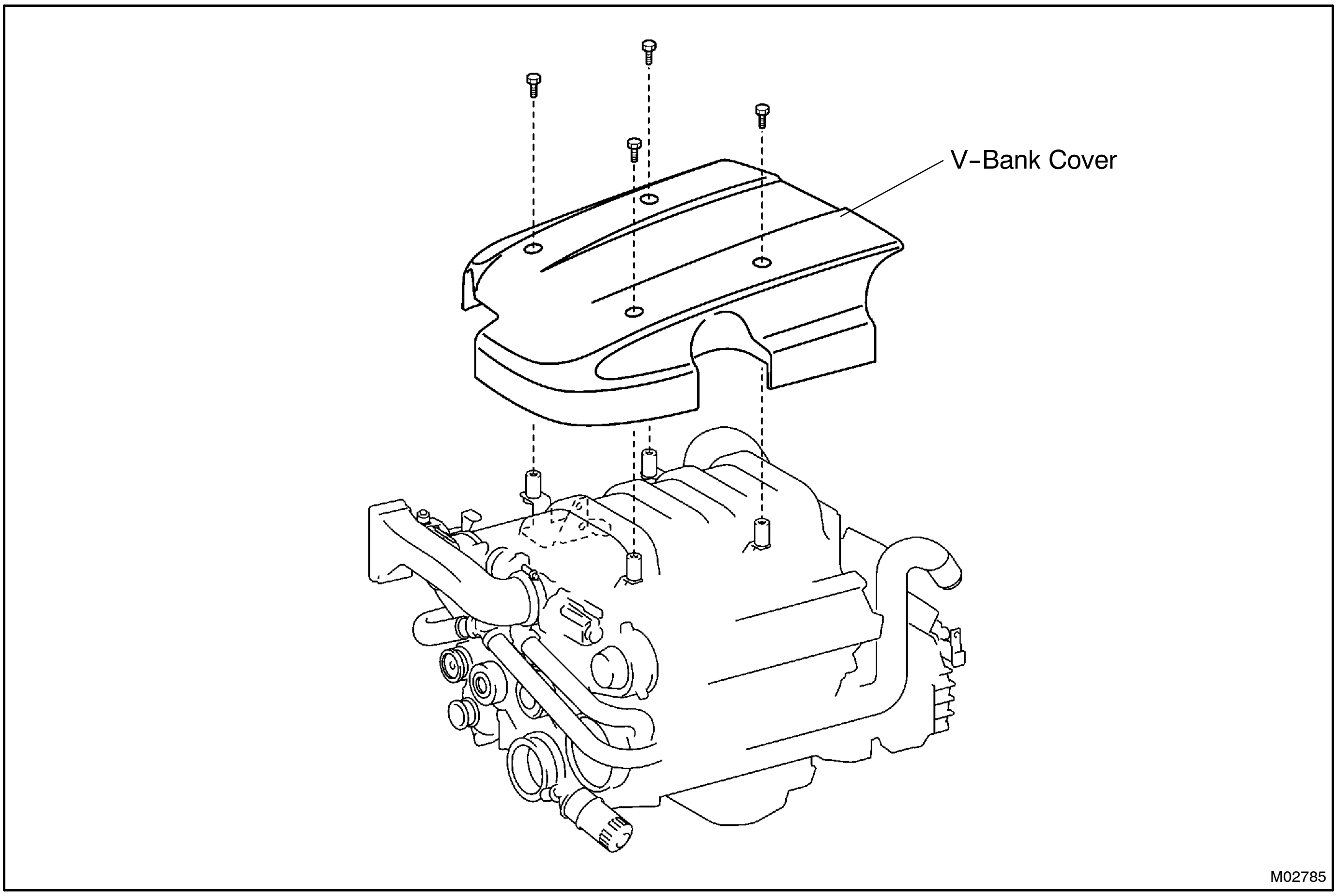
Torque: 7.5 N·m (80 kgf·cm, 66 in.·lbf)

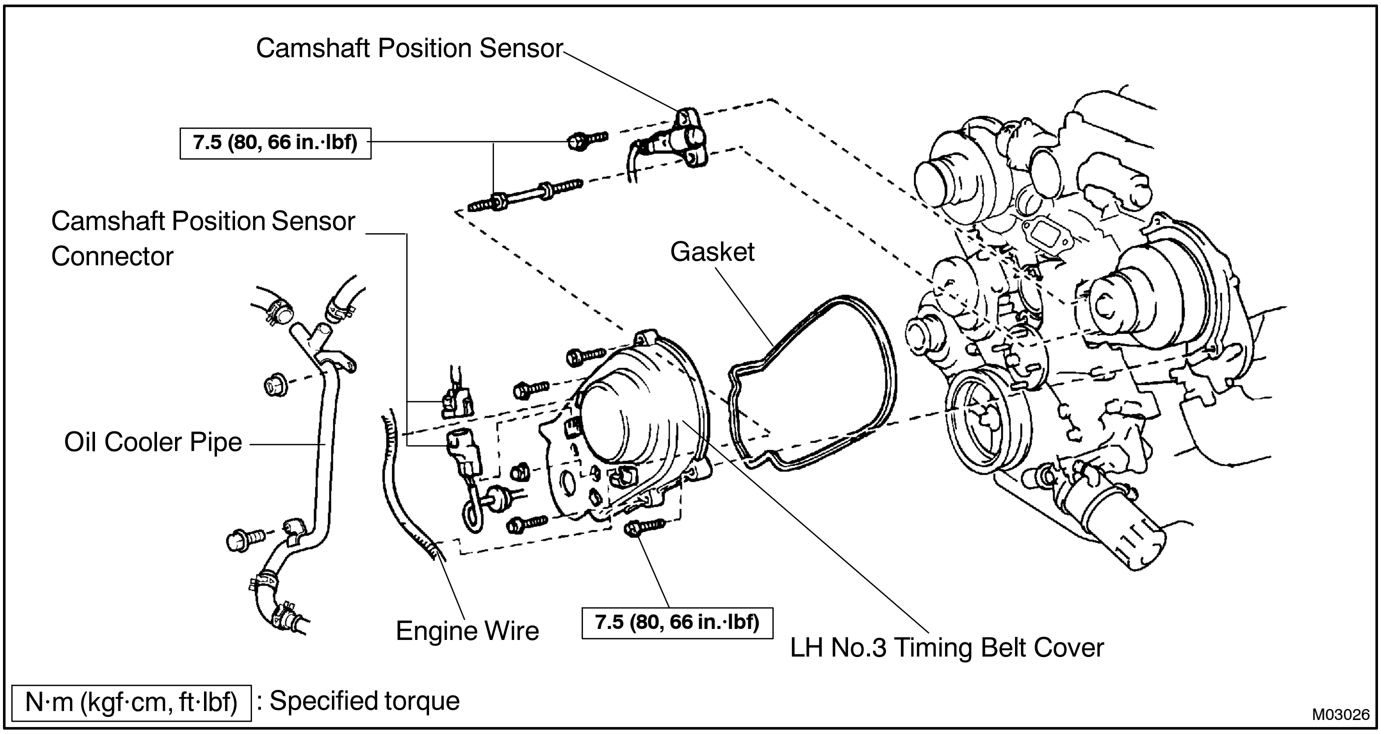
IG072–01
INSTALLATION
Installation is in the reverse order of removal.
(See page IG–6)

CAMSHAFT POSITION SENSOR

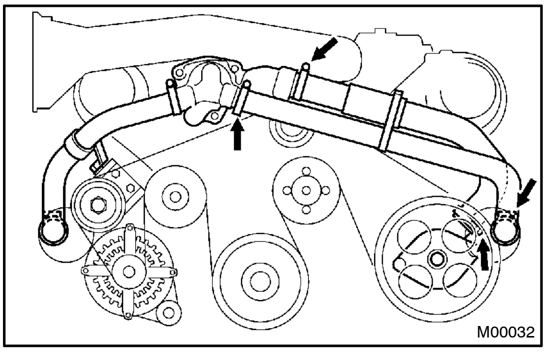
COMPONENTS

IG073-01





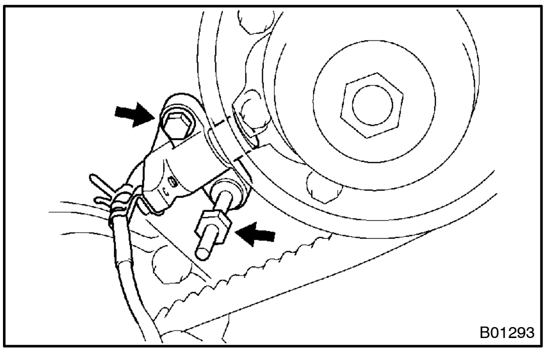
IG074-01



M00032

REMOVAL

1. **REMOVE V-BANK COVER**
2. **REMOVE NO.3 SEA WATER HOSE AND NO.4 SEA WATER HOSE**
3. **REMOVE NO.2 SEA WATER HOSE**
4. **REMOVE NO.3 TIMING BELT COVER**
   (See page EM-12)
5. **DISCONNECT CAMSHAFT POSITION SENSOR CONNECTOR**



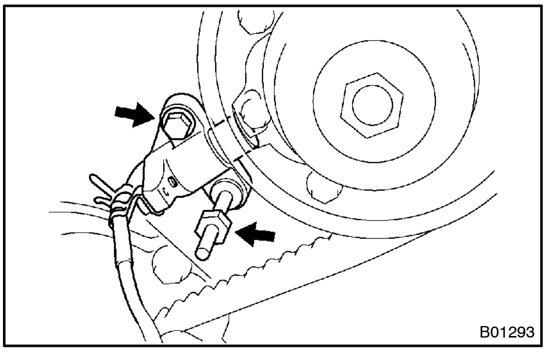
B01293

6. **REMOVE CAMSHAFT POSITION SENSOR**

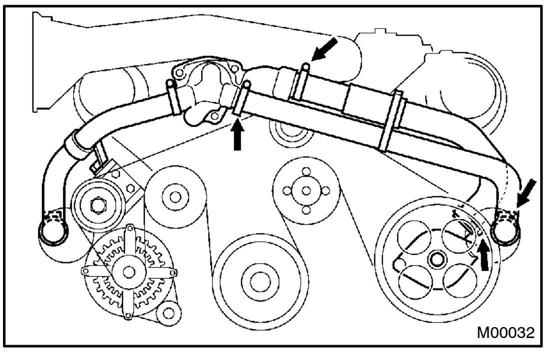
Remove the bolt, stud bolt and camshaft position sensor.

IG075-01

INSTALLATION



1. INSTALL CAMSHAFT POSITION SENSOR
   Torque:
   Bolt: 7.5 N·m (80 kgf·cm, 66 in.·lbf)
   Stud bolt: 7.5 N·m (80 kgf·cm, 66 in.·lbf)
2. CONNECT CAMSHAFT POSITION SENSOR CONNECTOR
3. INSTALL NO.3 TIMING BELT COVER
   (See page EM-19)

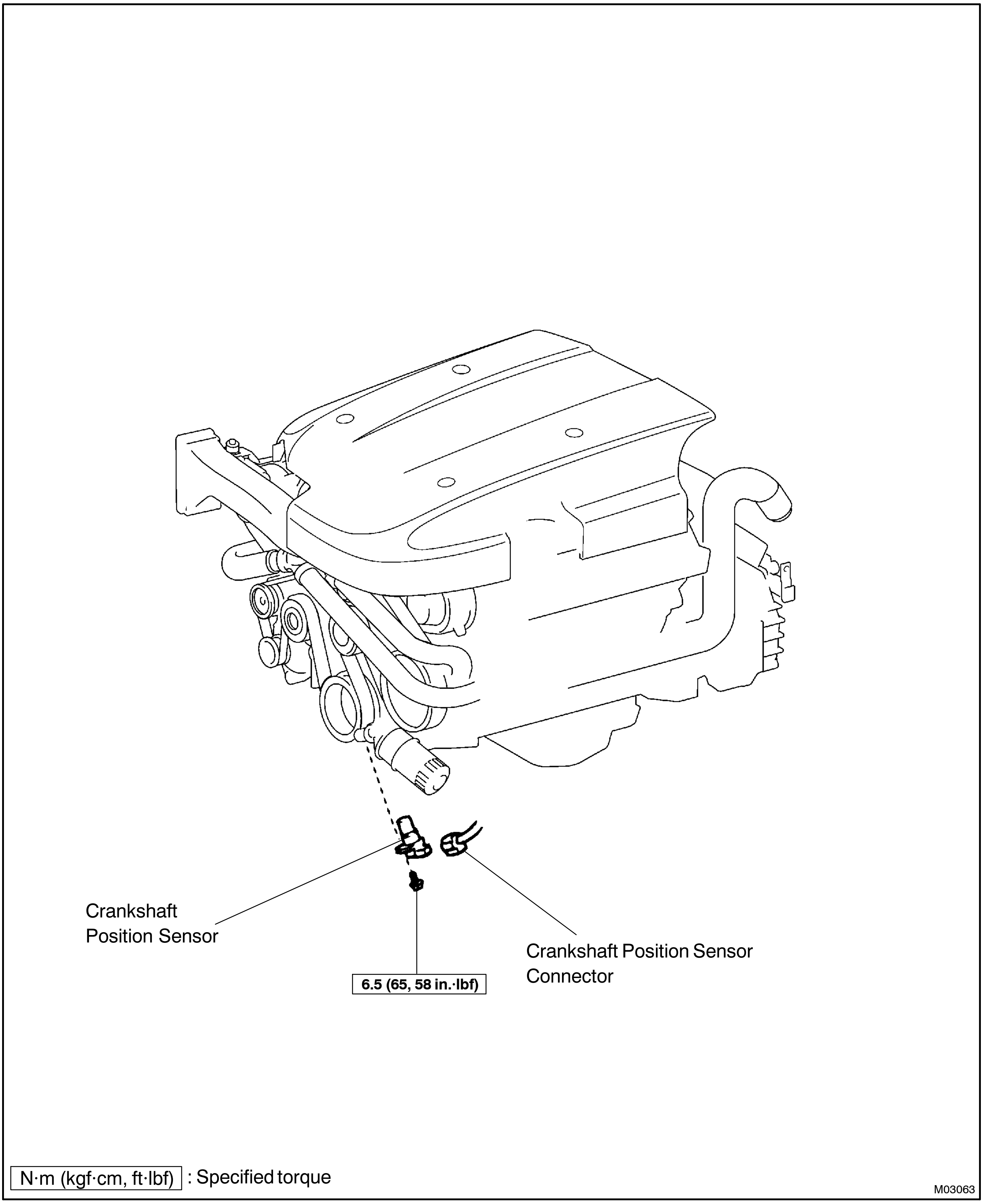


4. INSTALL NO.2 SEA WATER HOSE
5. INSTALL NO.3 SEA WATER HOSE AND NO.4 SEA WATER HOSE
6. INSTALL V-BANK COVER
7. CHECK ENGINE COOLANT FOR LEAKS
8. CHECK IGNITION TIMING
   (See page EM-7)

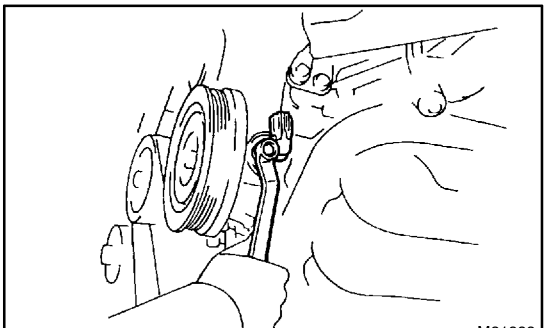
CRANKSHAFT POSITION SENSOR

IG076–01

COMPONENTS



IG077-01


M21883

REMOVAL

1. **DISCONNECT CRANKSHAFT POSITION SENSOR CONNECTOR**
2. **REMOVE CRANKSHAFT POSITION SENSOR**
   Torque: 6.5 N·m (65 kgf·cm, 58 in.·lbf)

IG078–01

INSTALLATION

Installation is in the reverse order of removal.
(See page IG–12)

IGNITION

STARTING SYSTEM

ST063-01

ON-BOAT INSPECTION

NOTICE:

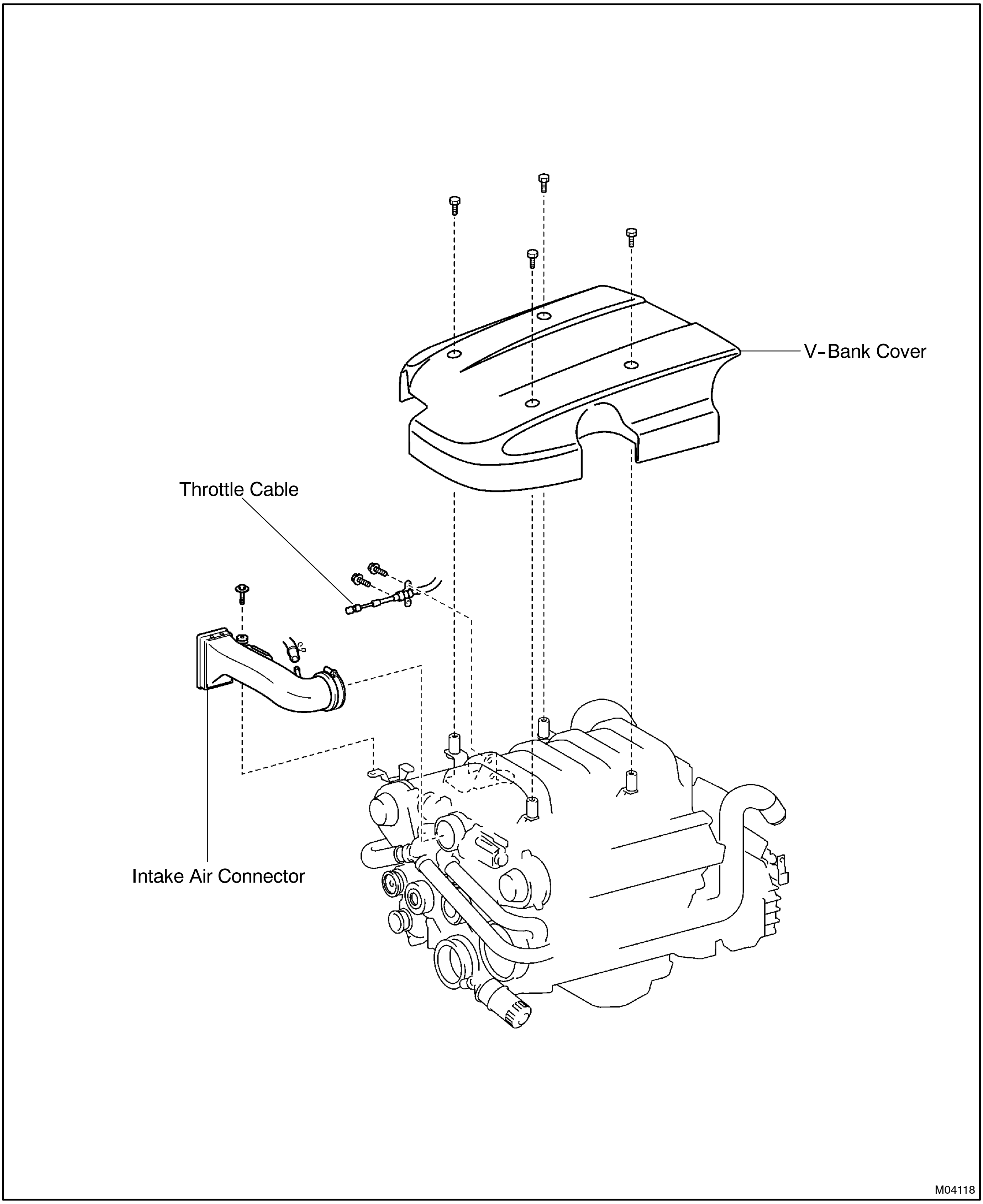
Before changing the starter, check these items again:

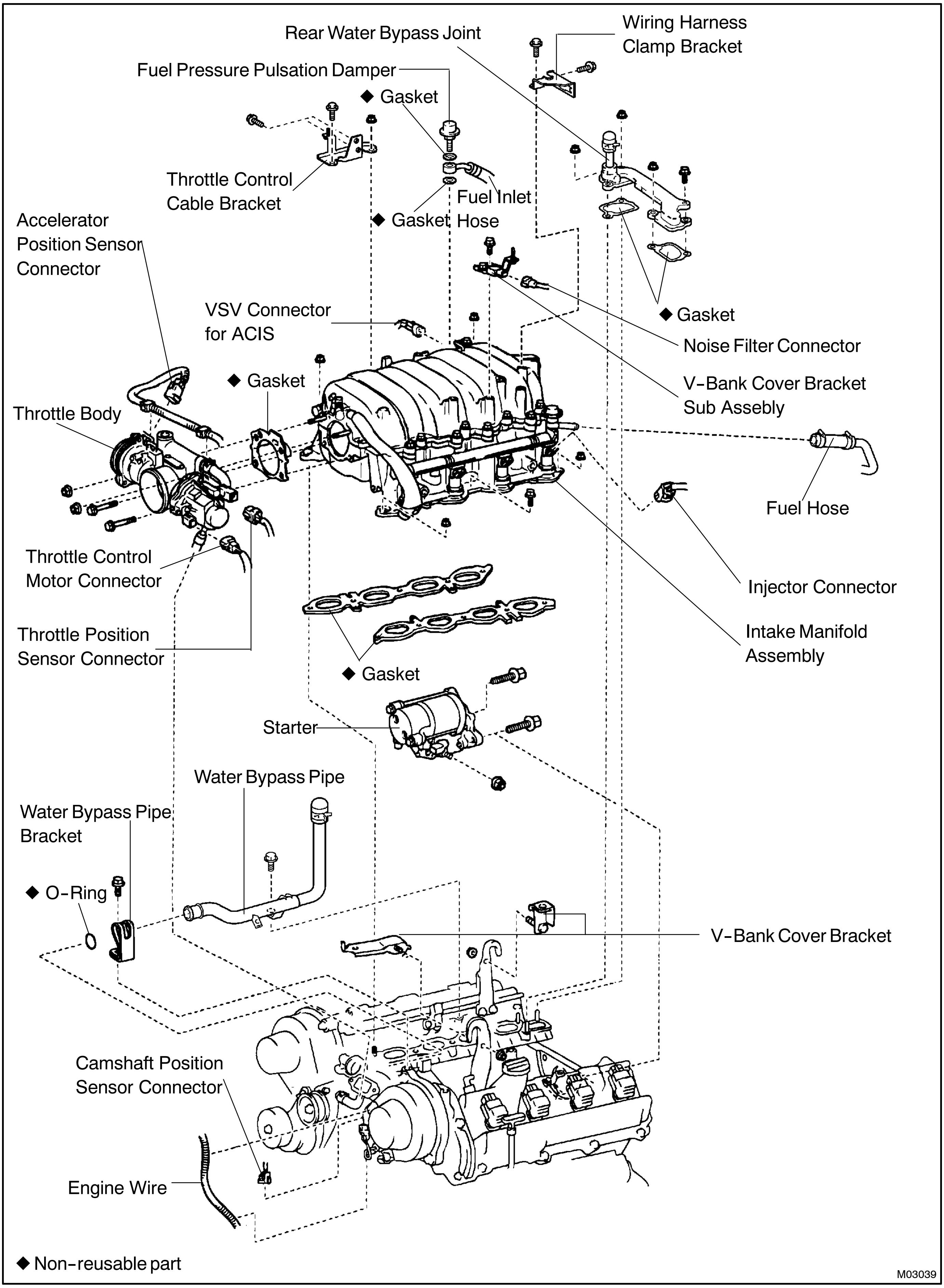
- **Connector connection**
- **Accessory installation, e.g.: theft deterrent system**

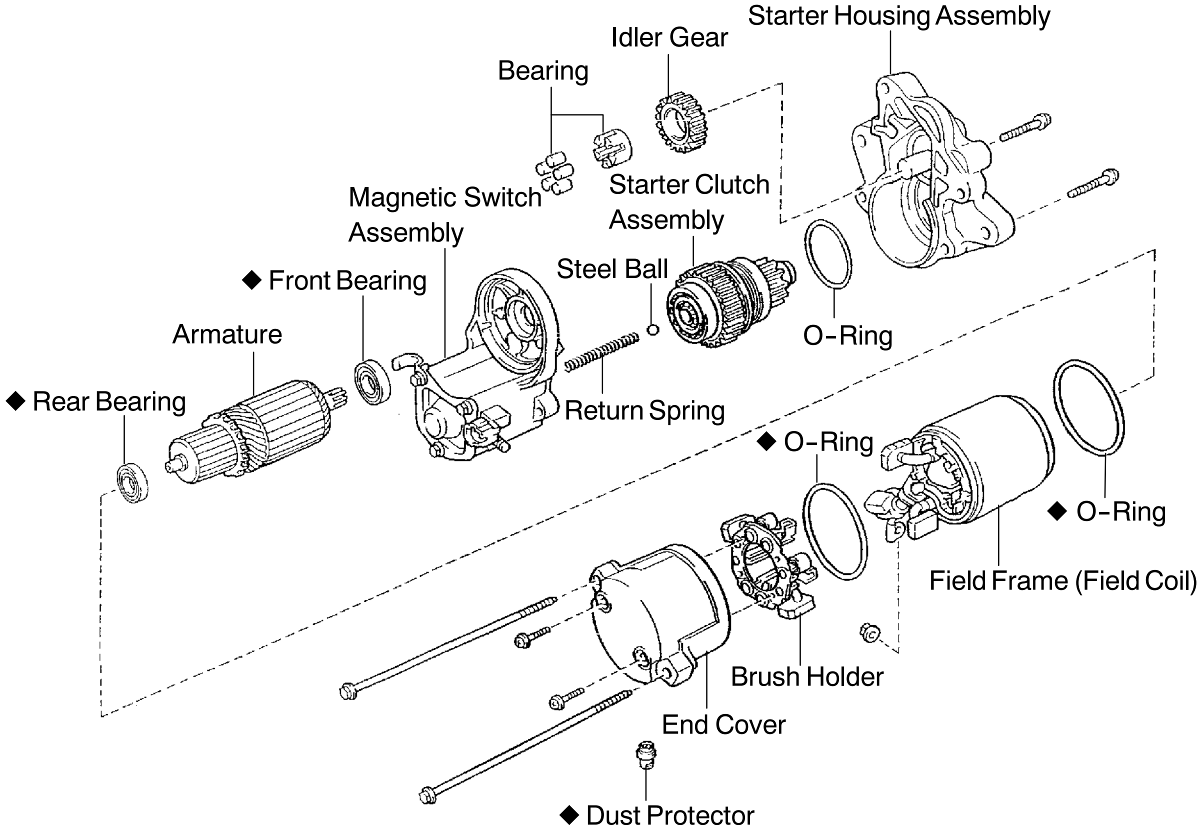
STARTER

COMPONENTS

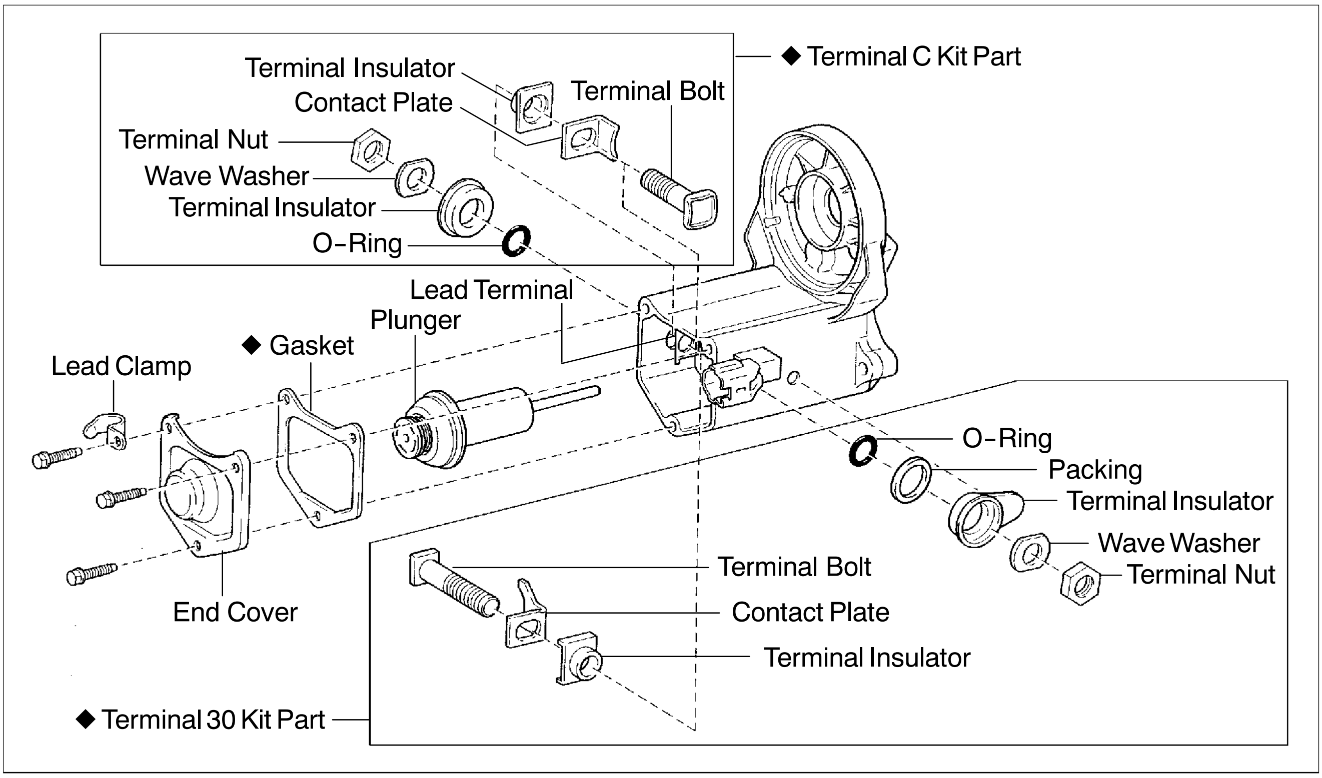
ST064-01




Rear Water Bypass Joint
Wiring Harness Clamp Bracket
Fuel Pressure Pulsation Damper
◆ Gasket
Throttle Control Cable Bracket
Fuel Inlet Hose
◆ Gasket
Accelerator Position Sensor Connector
VSV Connector for ACIS
◆ Gasket
Noise Filter Connector
◆ Gasket
Throttle Body
V-Bank Cover Bracket Sub Assebly
Fuel Hose
Throttle Control Motor Connector
Injector Connector
Throttle Position Sensor Connector
Intake Manifold Assembly
◆ Gasket
Starter
Water Bypass Pipe
Water Bypass Pipe Bracket
◆ O-Ring
V-Bank Cover Bracket
Camshaft Position Sensor Connector
Engine Wire
◆ Non-reusable part
M03039



Magnetic Switch Assembly



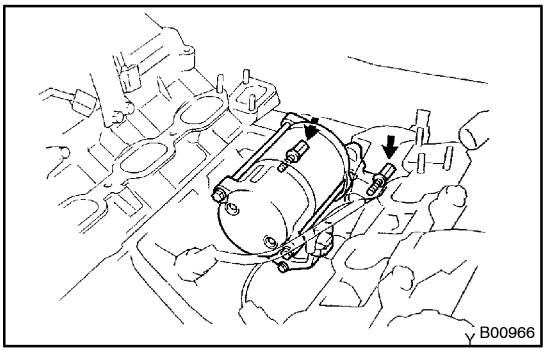
◆ Non-reusable part

B00968

ST065-01

REMOVAL

1. **REMOVE V-BANK COVER**
2. **DISCONNECT THROTTLE CABLE**
3. **REMOVE INTAKE AIR CONNECTOR**
4. **DISCONNECT THROTTLE BODY**
   (See page SF-56)
5. **REMOVE INTAKE MANIFOLD ASSEMBLY**
   (See page EM-29)

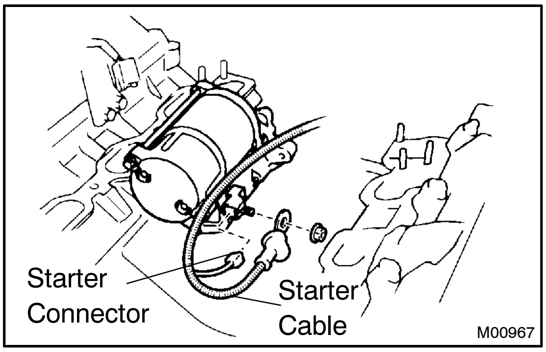


B00966

6. **REMOVE STARTER**

(a) Remove the 2 bolts holding the starter to the cylinder block.

(b) Disconnect the starter from the cylinder block.



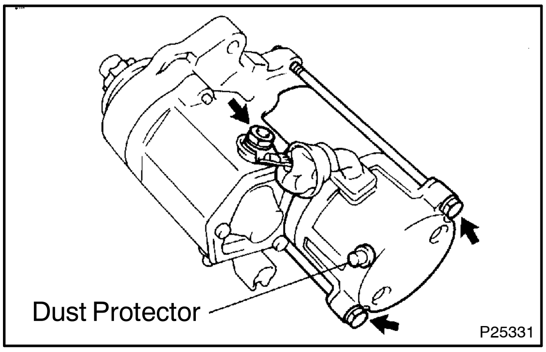
M00967

(c) Disconnect the starter connector.

(d) Remove the nut, and disconnect the starter wire.

ST066-01

DISASSEMBLY



1. REMOVE DUST PROTECTOR

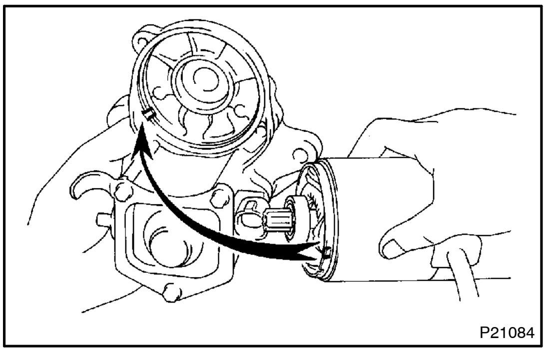
2. REMOVE FIELD FRAME AND ARMATURE

(a) Remove the nut, and disconnect the lead wire from the magnetic switch terminal.

Torque: 5.9 N·m (60 kgf·cm, 52 in.·lbf)

(b) Remove the 2 through bolts.

Torque: 9.3 N·m (95 kgf·cm, 82 in.·lbf)



(c) Pull out the field frame together with the armature.

NOTICE:

At the time of notice, please refer to the following items.

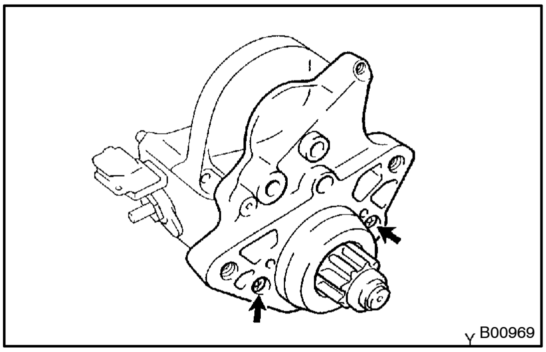
Align the protrusion of the field frame with the groove of the magnetic switch.

(d) Remove the O-ring from the field frame.

HINT:

At the time of assembly, please refer to the following items.

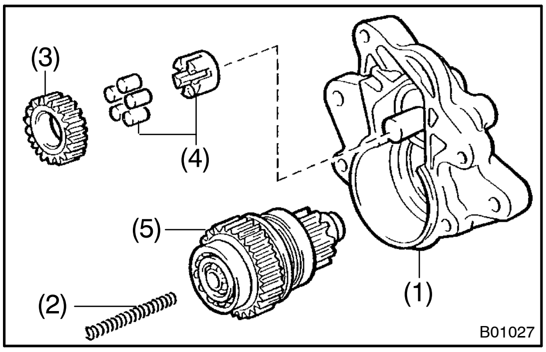
Use a new O-ring.



3. REMOVE STARTER HOUSING, CLUTCH ASSEMBLY AND GEAR

(a) Remove the 2 screws.

Torque: 9.3 N·m (95 kgf·cm, 82 in.·lbf)



(b) Remove these parts from the magnetic switch:

(1) Starter housing

(2) Return spring

(3) Idler gear

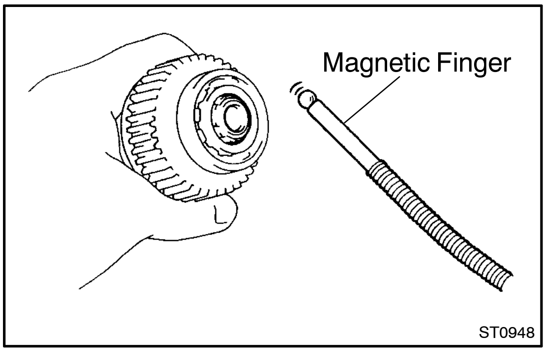
(4) Bearing

(5) Starter clutch assembly

HINT:

At the time of assembly, please refer to the following items.

Apply grease to the return spring and insert the return spring into the clutch shaft hole.



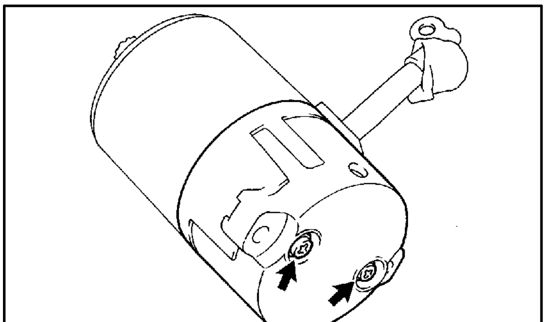
4. REMOVE STEEL BALL

Using a magnetic finger, remove the steel ball from the clutch shaft hole.

HINT:

At the time of assembly, please refer to the following items.

Apply grease to the steel ball and insert the steel ball into the clutch shaft hole.

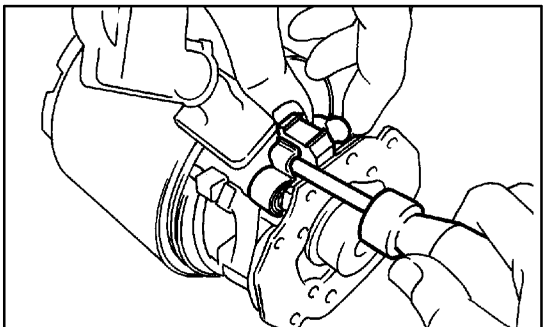

P25332

5. REMOVE BRUSH HOLDER

(a) Remove the 2 screws, and end cover from the field frame.
Torque: 3.8 N·m (39 kgf·cm, 34 in.·lbf)

(b) Remove the O-ring from the field frame.

HINT:
At the time of assembly, please refer to the following items.
Use a new O-ring.

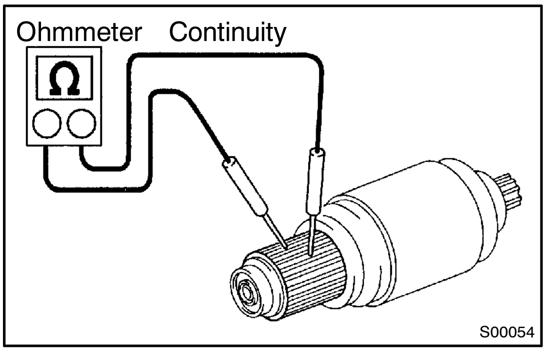

P10568

(c) Using a screwdriver, hold the spring back and disconnect the brush from the brush holder. Disconnect the 4 brushes, and remove the brush holder.

NOTICE:
Check that the positive (+) lead wires are not grounded.

6. REMOVE ARMATURE FROM FIELD FRAME

ST067-01



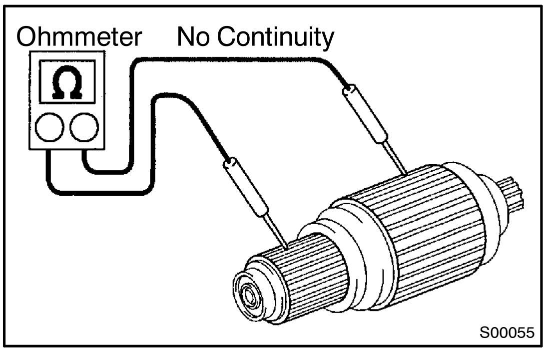
S00054

INSPECTION

1. INSPECT COMMUTATOR FOR OPEN CIRCUIT

Using an ohmmeter, check that there is continuity between the segments of the commutator.

If there is no continuity between any segment, replace the armature.



S00055

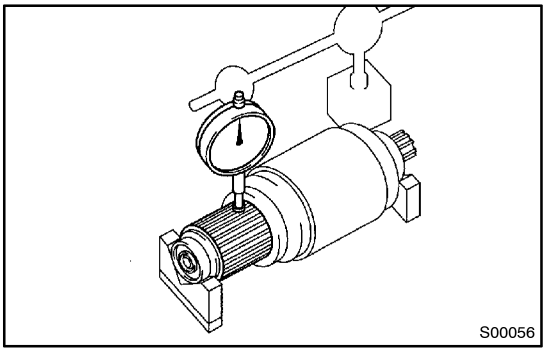
2. INSPECT COMMUTATOR FOR GROUND

Using an ohmmeter, check that there is no continuity between the commutator and armature coil core.

If there is continuity, replace the armature.

3. INSPECT COMMUTATOR FOR DIRTY AND BURNT SURFACE

If the surface is dirty or burnt, correct it with sandpaper (No.400) or on a lathe.


S00056

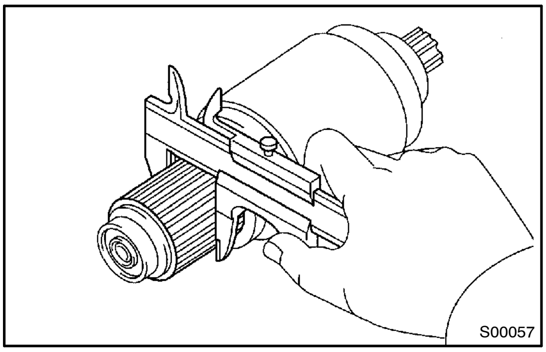
4. INSPECT COMMUTATOR CIRCLE RUNOUT

(a) Place the commutator on V-blocks.

(b) Using a dial indicator the circle runout.

Maximum circle runout:
0.05 mm (0.0020 in.)

If the circle runout is greater than maximum, correct it on a lathe.

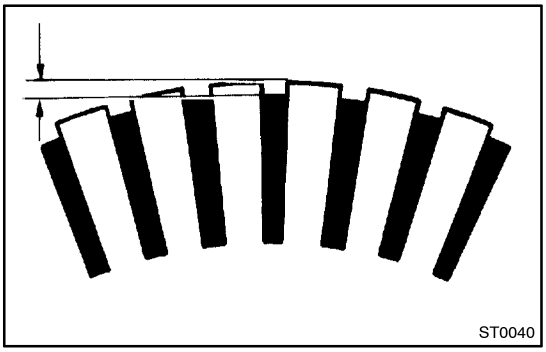

S00057

5. INSPECT COMMUTATOR DIAMETER

Using vernier calipers, measure the commutator diameter.

Standard diameter:
35.0 mm (1.378 in.)
Minimum diameter:
34.0 mm (1.339 in.)

If the diameter is less than minimum, replace the armature.

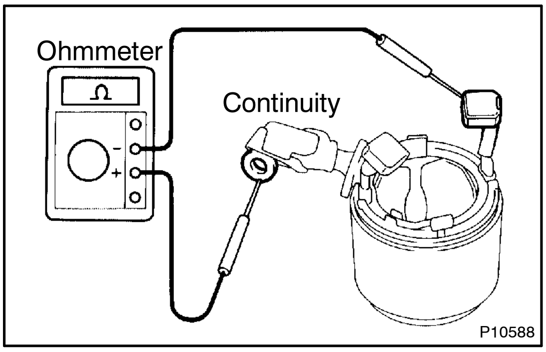

ST0040

6. INSPECT UNDERCUT DEPTH

Check that the undercut depth is clean and free of foreign materials. Smooth out the edge.

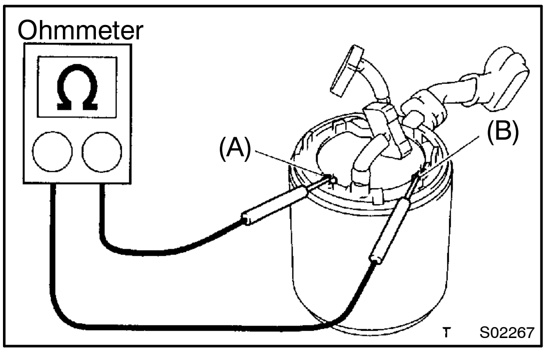
Standard undercut depth:
0.7 mm (0.028 in.)
Minimum undercut depth:
0.2 mm (0.008 in.)

If the undercut depth is less than minimum, correct it with a hacksaw blade.



7. INSPECT FIELD COIL FOR OPEN CIRCUIT

Using an ohmmeter, check that there is continuity between the lead wire and field coil brush lead.
If there is no continuity, replace the field frame.

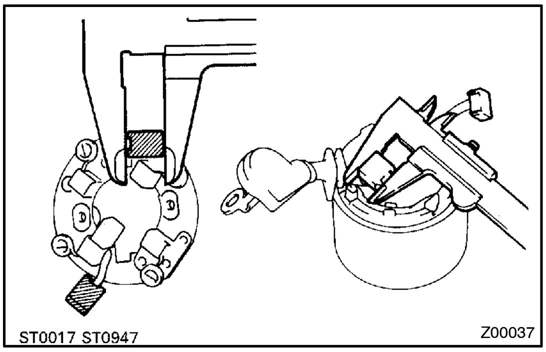


8. INSPECT SHUNT COIL FOR OPEN CIRCUIT

Using an ohmmeter, measure the resistance between shunt coil terminals (A) and (B).

Resistance:
1.5 - 1.9 Ω at 20 °C (68 °F)

If the resistance is not as specified, replace the field frame.

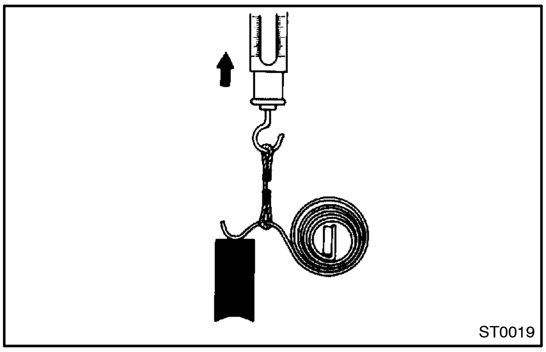


9. INSPECT BRUSH LENGTH

Using vernier calipers, measure the brush length.

Standard length:
15.0 mm (0.591 in.)
Minimum length:
9.0 mm (0.354 in.)

If the length is less than minimum, replace the brush holder and field frame.

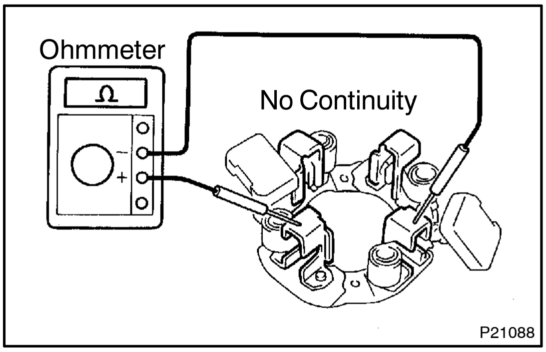


10. INSPECT BRUSH SPRING LOAD

Take the pull scale reading the instant the brush spring separates from the brush.

Standard spring installed load:
21.5 - 27.5 N (2.2 - 2.8 kgf, 4.8 - 6.2 lbf)
Minimum spring installed load:
12.7 N (1.3 kgf, 2.9 lbf)

If the installed load is less than minimum, replace the brush springs.

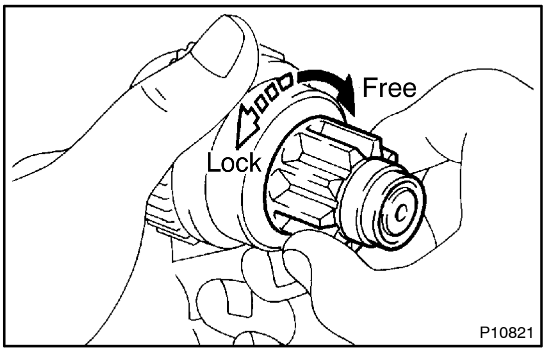


11. INSPECT BRUSH HOLDER INSULATION

Using an ohmmeter, check that there is no continuity between the positive (+) and negative (–) brush holders.
If there is continuity, repair or replace the brush holder.

12. INSPECT GEAR TEETH

Check the gear teeth on the pinion gear, idle gear and the clutch assembly for wear or damage.
If damaged, replace the gear or clutch assembly.
If damaged, also check the drive plate ring gear for wear or damage.



P10821

13. INSPECT CLUTCH PINION GEAR

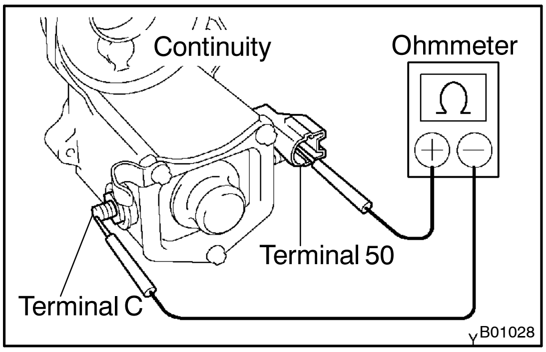
Rotate the pinion gear clockwise, and check that it turns freely.
Try to rotate the pinion gear counterclockwise and check that it locks.
If necessary, replace the clutch assembly.

14. INSPECT REAR BEARING

Turn the bearing by hand while applying inward force.
If resistance is felt or the bearing sticks, replace the bearing.

15. INSPECT FRONT BEARING

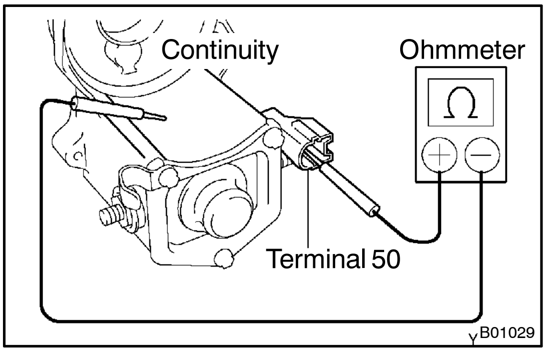
Turn the bearing by hand while applying inward force.
If resistance is felt or the bearing sticks, replace the bearing.



B01028

16. DO PULL-IN COIL OPEN CIRCUIT TEST

Using an ohmmeter, check that there is continuity between terminals 50 and C.
If there is no continuity, check and replace the magnetic switch.

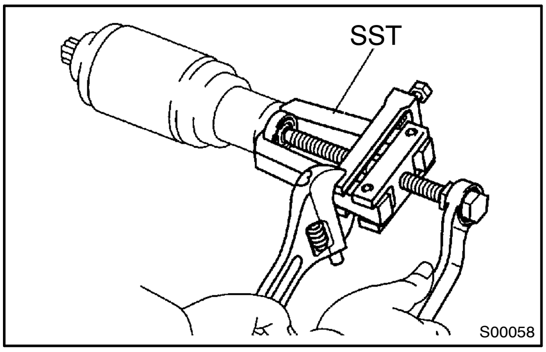


B01029

17. DO HOLD-IN COIL OPEN CIRCUIT TEST

Using an ohmmeter, check that there is continuity between terminal 50 and the switch body.
If there is no continuity, replace the magnetic switch.

ST068-01

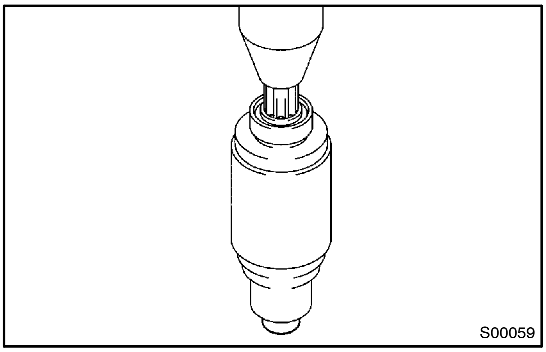


S00058

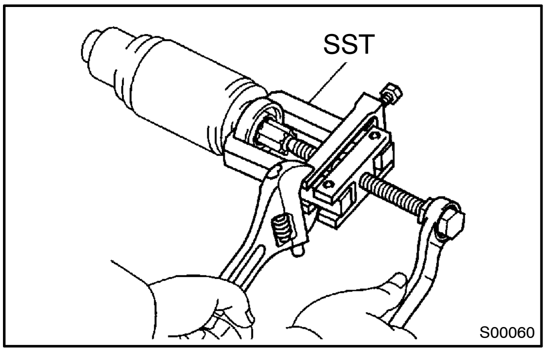
REPLACEMENT

1. REPLACE REAR BEARING

(a) Using SST, remove the bearing.
SST 09286-46011


S00059

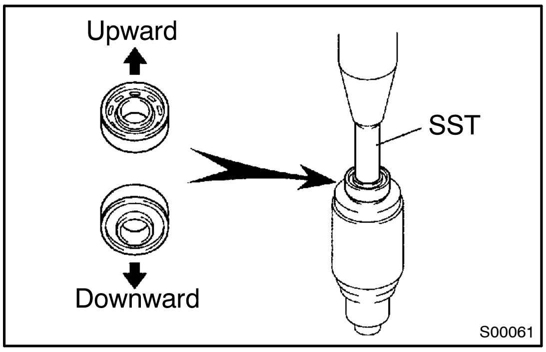
(b) Using a press, press in a new bearing.



S00060

2. REPLACE FRONT BEARING

(a) Using SST, remove the bearing.
SST 09286-46011



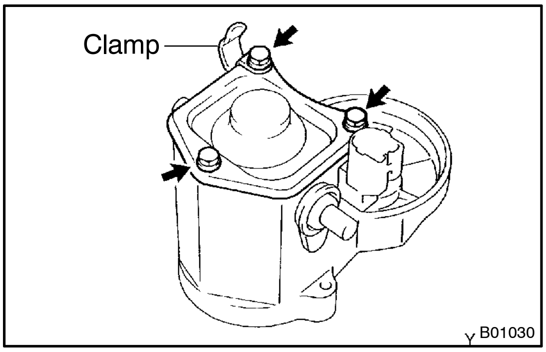
S00061

(b) Using SST and a press, press in a new bearing.

NOTICE:

Be careful of the bearing installation direction.

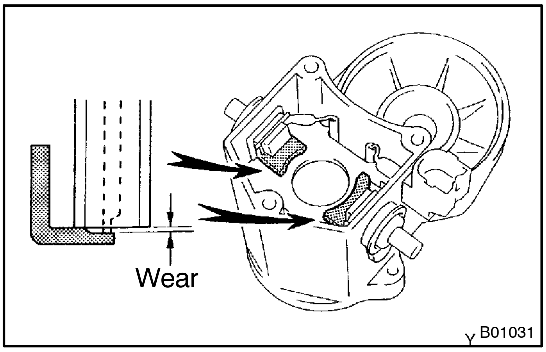
SST 09820-00030



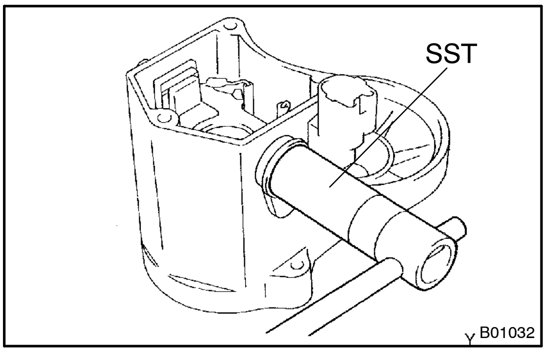
B01030

3. REPLACE MAGNETIC SWITCH TERMINAL KIT PARTS

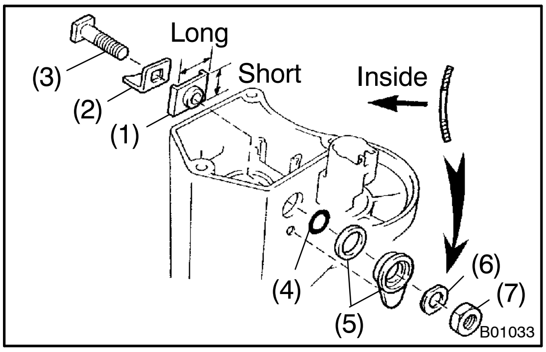
(a) Remove magnetic switch end cover.
Remove the 3 bolts, lead clamp, end cover, gasket and plunger.



(b) Inspect contact plate for wear.
Using vernier calipers, measure the contact plate for depth of wear.
Maximum wear:
0.9 mm (0.035 in.)
If the depth of wear is greater than the maximum, replace the contact plate.



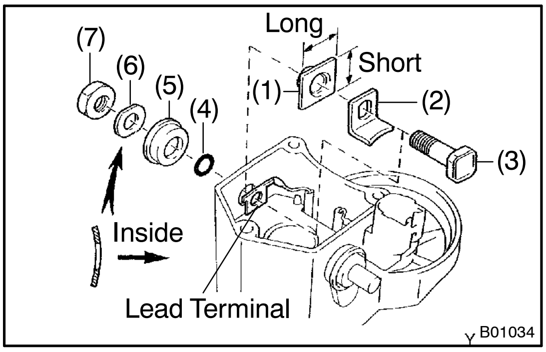
(c) Remove terminal kit parts.
(1) Using SST, loosen the terminal nuts.
SST 09810-38140
(2) Terminal C:
Remove the terminal nut, wave washer, terminal insulator (outside), O-ring, terminal bolt, contact plate and terminal insulator (inside).
(3) Terminal 30:
Remove the terminal nut, wave washer, terminal insulator (outside), O-ring, terminal bolt, contact plate and terminal insulator (inside).



(d) Temporarily install these new terminal 30 kit parts:
(1) Terminal insulator (inside)
(2) Contact plate
(3) Terminal bolt
(4) O-ring
(5) Packing and terminal insulator (outside)
Install the packing to the terminal insulator, and install them.

HINT:
Match the protrusion of the insulator with the indentation of the housing.
(6) Wave washer
(7) Terminal nut

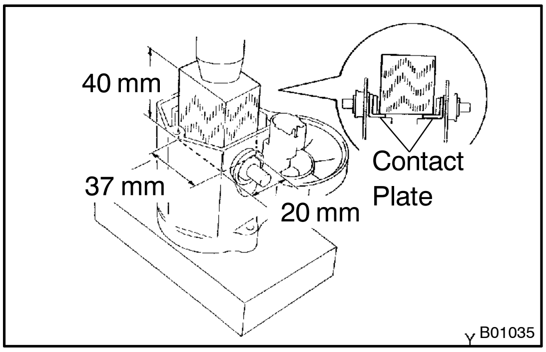
NOTICE:
Be careful to install the terminal insulator (inside) and wave washer in the correct direction.



(e) Temporarily install these new terminal C kit parts:
 (1) Terminal insulator (inside)
 (2) Contact plate
 (3) Terminal bolt
 (4) O-ring
 (5) Terminal insulator (outside)
 (6) Wave washer
 (7) Terminal nut

NOTICE:
Be careful to install the terminal insulator (inside) and wave washer in the correct direction.

(f) Temporarily tighten the terminal nuts.



(g) Tighten terminal nut.
 (1) Put a wooden block on the contact plate and press it down with a hand press.
 Dimensions of wooden block:
 20 x 37 x 40 mm (0.79 x 1.46 x 1.57 in.)
 Press force:
 981 N (100 kgf, 221 lbf)

NOTICE:
- **Check the diameter of the hand press ram. Then calculate the gauge pressure of the press when 981 N (100 kgf, 221 lbf) of force is applied.**
 Gauge pressure:

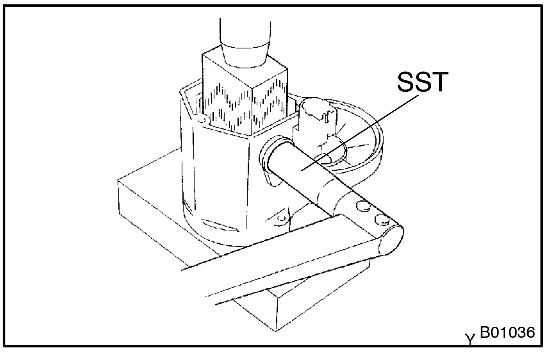
$$(\mathrm{kgf/cm^2}) = \frac{100\ \mathrm{kgf}}{\left(\frac{\text{Ram diameter (cm)}}{2}\right)^2 \times 3.14\ (\pi)}$$

$$(\mathrm{psi}) = \frac{221\mathrm{lbf}}{\left(\frac{\text{Ram diameter (in.)}}{2}\right)^2 \times 3.14\ (\pi)}$$

$$(\mathrm{kPa}) = (\mathrm{kgf/cm^2}) \times 98.1$$

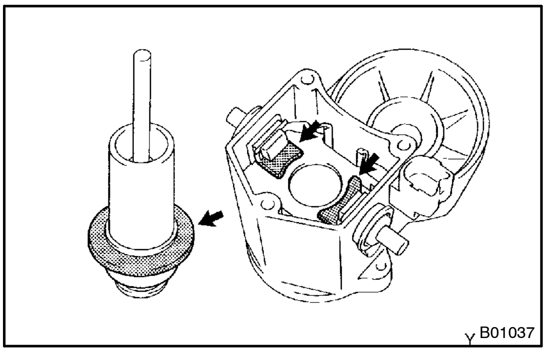
$$(\mathrm{kPa}) = (\mathrm{psi}) \times 6.9$$

- **If the contact plate is not pressed down with the specified pressure, the contact plate may tilt due to coil deformation or the tightening of the nut.**



(2) Using SST, tighten the nuts to the specified torque.
SST 09810-38140
Torque: 17 N·m (170 kgf·cm, 13 ft·lbf)

NOTICE:
If the nut is over tightened, it may cause cracks on the inside of the insulator.



(h) Clean contact surfaces of contact plate and plunger.
Clean the contact surfaces of the remaining contact plate and plunger with a dry shop rag.

(i) Reinstall magnetic switch end cover.
Install the plunger, new gasket, end cover and lead clamp with the 3 bolts.
Torque: 3.6 N·m (37 kgf·cm, 32 in.·lbf)

ST069–01

REASSEMBLY

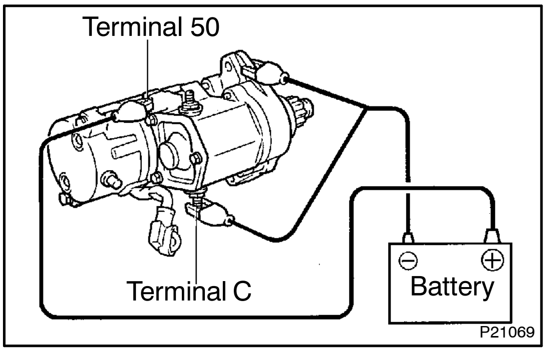
Reassembly is in the reverse order of disassembly.
(See page ST–6)

HINT:
At the time of assembly, please refer to the following items.
Use high–temperature grease to lubricate the bearing and gears when assembling the starter.

ST06A-01

TEST

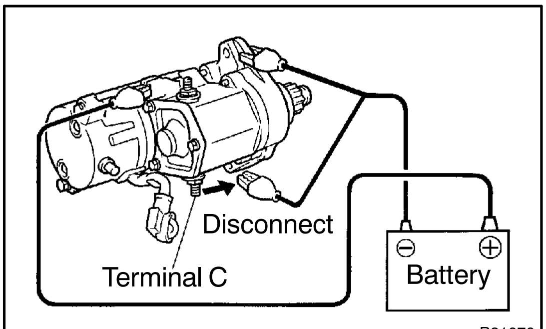
NOTICE:
These tests must be done within 3 to 5 seconds to avoid burning out the coil.



P21069

1. DO PULL-IN TEST

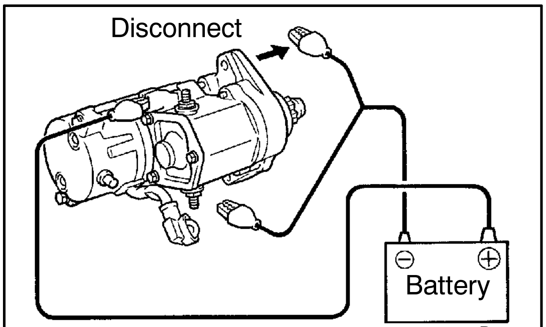
(a) Disconnect the field coil lead wire from terminal C.
(b) Connect the battery to the magnetic switch as shown. Check that the pinion gear moves outward.



P21070

2. DO HOLD-IN TEST

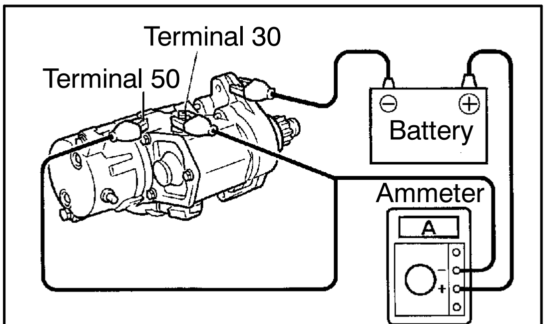
While connected as above with the pinion gear out, disconnect the negative (-) lead from terminal C. Check that the pinion gear remains out.



P21071

3. INSPECT CLUTCH PINION GEAR RETURN

Disconnect the negative (-) lead from the starter body. Check that the pinion gear returns inward.

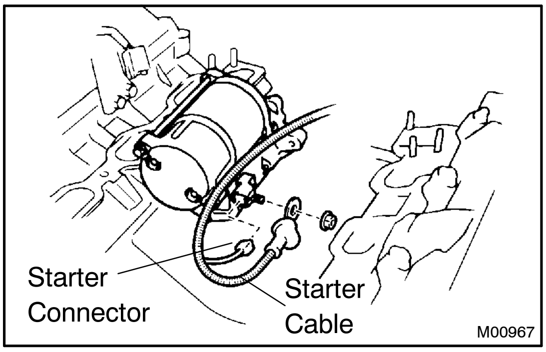


P21072

4. DO NO-LOAD PERFORMANCE TEST

(a) Connect the battery and ammeter to the starter as shown.
(b) Check that the starter rotates smoothly and steadily with the pinion gear moving out. Check that the ammeter shows the specified current.
Specified current:
At 11.5 V: 100 A or less

ST06B–01

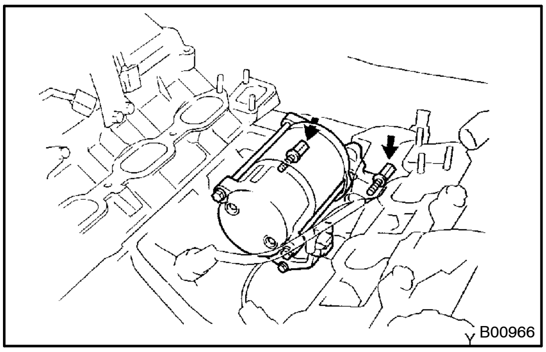


INSTALLATION

1. INSTALL STARTER

(a) Connect the starter wire with the nut.
Torque: 9.81 N·m (98 kgf·cm, 87 in.·lbf)

(b) Connect the starter connector.



(c) Install the starter with the 2 bolts.
Torque: 39 N·m (400 kgf·cm, 29 ft·lbf)

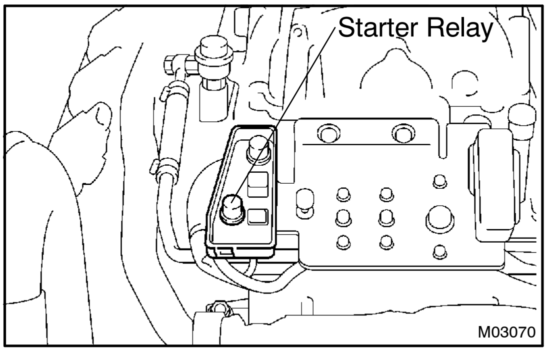
2. INSTALL INTAKE MANIFOLD ASSEMBLY
(See page EM–52)

3. CONNECT THROTTLE BODY
(See page SF–56)

4. INSTALL INTAKE AIR CONNECTOR

5. CONNECT THROTTLE CABLE

6. INSTALL V–BANK COVER



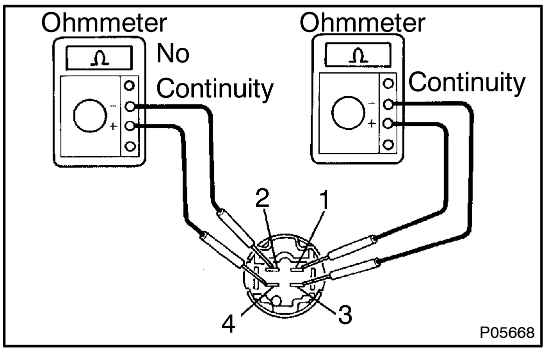
STARTER RELAY

ST06C-01

INSPECTION

1. REMOVE STARTER RELAY (Marking: "ST")

Remove the relay block cover and starter relay.



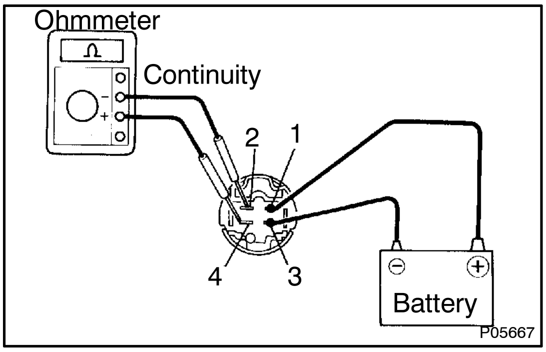
2. INSPECT RELAY CONTINUITY

(a) Using an ohmmeter, check that there is continuity between terminals 1 and 3.

If there is no continuity, replace the relay.

(b) Check that there is no continuity between terminals 2 and 4.

If there is continuity, replace the relay.



3. INSPECT RELAY OPERATION

(a) Apply battery voltage across terminals 1 and 3.

(b) Using an ohmmeter, check that there is continuity between terminals 2 and 4.

If there is no continuity, replace the relay.

4. REINSTALL STARTER RELAY

STARTING

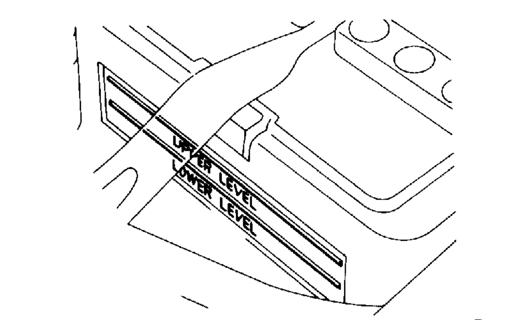
CHARGING SYSTEM

CH054-01

PRECAUTION

1. **Check that the battery cables are connected to the correct terminals.**
2. **Disconnect the battery cables when the battery is given a quick charge.**
3. **Do not perform tests with a high voltage insulation resistance tester.**
4. **Never disconnect the battery while the engine is running.**

CH055-01



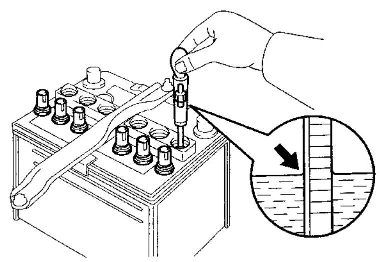
P11586

ON-BOAT INSPECTION

1. CHECK BATTERY ELECTROLYTE LEVEL

Check the electrolyte quantity of each cell.
Maintenance-Free Battery:
If under the lower level, replace the battery (or add distilled water if possible). Check the charging system.
Except Maintenance-Free Battery:
If under the lower level, add distilled water.

Except Maintenance-Free Battery


S05617

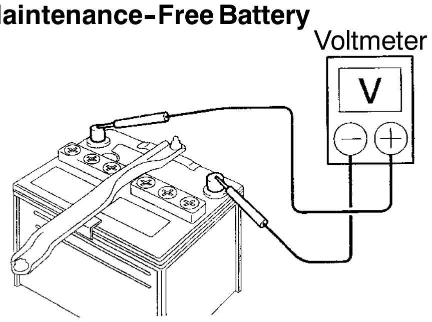
2. Except Maintenance-Free Battery: CHECK BATTERY SPECIFIC GRAVITY

Check the specific gravity of each cell.

Standard specific gravity:
1.25 - 1.29 at 20°C (68°F)

If the specific gravity is less than specification, charge the battery.

Maintenance-Free Battery



S05618

3. Maintenance-Free Battery: CHECK BATTERY VOLTAGE

Measure the battery voltage between the negative (-) and positive (+) terminals of the battery.

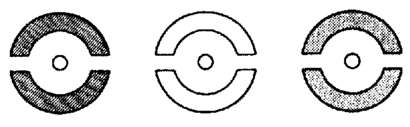
Standard voltage:
12.5 - 12.9 V at 20°C (68°F)

HINT:

- Before measuring the voltage, turn the ignition switch OFF and turn off the electrical systems (headlight, blower motor, rear defogger etc.) to remove the surface charge.
- If the vehicle has been running, wait 20 minutes or more after the vehicle stops before measuring the battery voltage.

If the voltage is less than specification, charge the battery.
HINT:
Check the indicator as shown in the illustration.

Maintenance-Free Battery



CH0712 Z11580

4. CHECK BATTERY TERMINALS AND FUSES

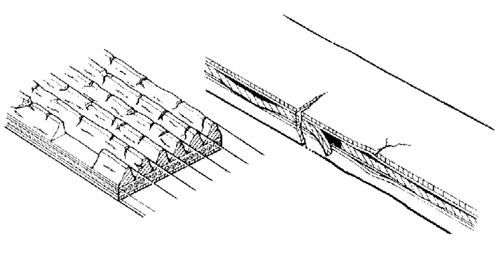
(a) Check that the battery terminals are not loose or corroded.
(b) Check the fuses for continuity.

5. INSPECT DRIVE BELT

HINT:
A belt tensioner is used, so checking the belt tension is not necessary.

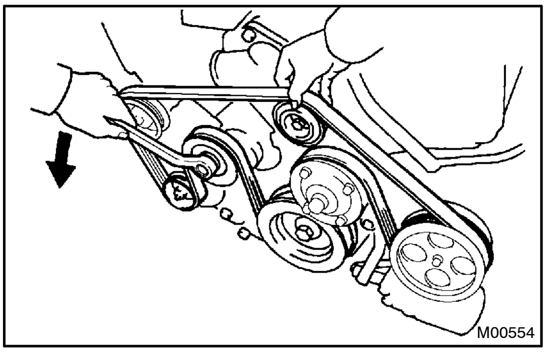
(a) Visually check the drive belt for excessive wear, frayed cords etc.

If necessary, replace the drive belt.


MA0600 CH0004 Z00030

HINT:

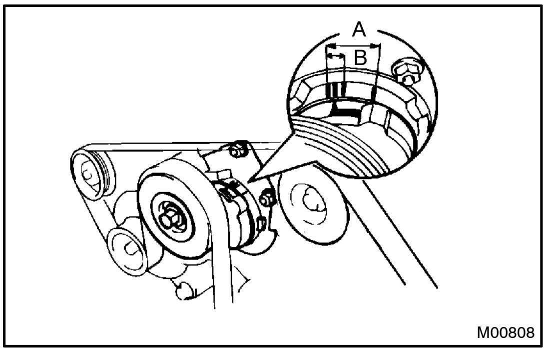
- Cracks on the rib side of a drive belt are considered acceptable. If the drive belt has chunks missing from the ribs, it should be replaced.
- The drive belt tension can be released by turning the belt tensioner counterclockwise. The pulley bolt for the belt tensioner has a left-hand thread.



(b) Check the belt tensioner operation.

- Check that the belt tensioner moves downward when the drive belt is pressed down at the points indicated in the illustration with approx. 98 N (10 kgf, 22.0 lbf) of force.
- Check the alignment of the belt tensioner pulley to make sure the drive belt has not slipped off the pulley.

If necessary, replace the belt tensioner.

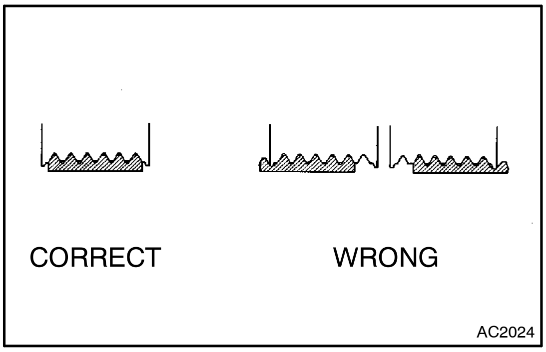


- Check that the arrow mark on the belt tensioner falls within area A of the scale.

If it is outside area A, replace the drive belt.

HINT:

- When a new belt is installed, it should lie within area B. If not, the drive belt is not correct.



- After installing a belt, check that it fits properly in the ribbed grooves.
- Check by hand to confirm that the belt has not slipped out of the groove on the bottom of the pulley.

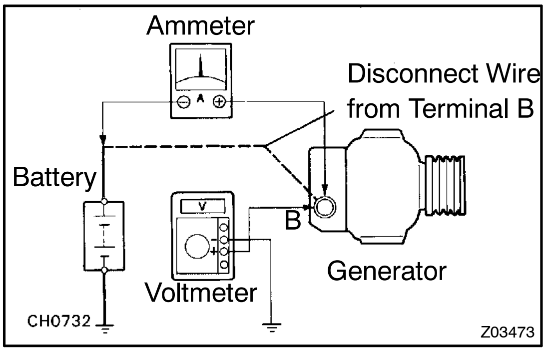
6. VISUALLY CHECK GENERATOR WIRING AND LISTEN FOR ABNORMAL NOISES

(a) Check that the wiring is in good condition.
(b) Check that there is no abnormal noise from the generator while the engine is running.

7. CHECK CHARGE WARNING LIGHT CIRCUIT

(a) Warm up the engine and then turn it off.
(b) Switch off all accessories.
(c) Turn the ignition switch ON, and check that the charge warning light is lit.
(d) Start the engine, and check that the light goes off.

If the light does not go off as specified, troubleshoot the charge light circuit.



8. INSPECT CHARGING CIRCUIT WITHOUT LOAD

HINT:

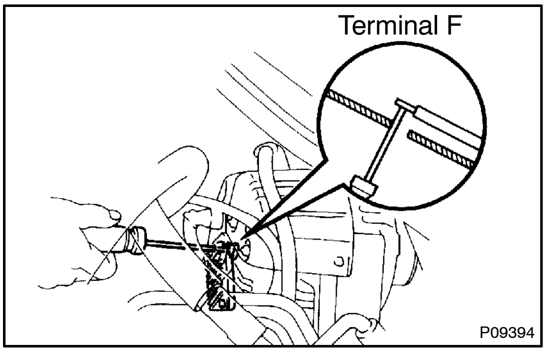
If a battery/generator tester is available, connect the tester to the charging circuit as per manufacturer's instructions.

(a) If a tester is not available, connect a voltmeter and ammeter to the charging circuit as follows:
- Disconnect the wire from terminal B of the generator, and connect it to the negative (-) tester probe of the ammeter.
- Connect the positive (+) tester probe of the ammeter to terminal B of the generator.
- Connect the positive (+) tester probe of the voltmeter to terminal B of the generator.
- Ground the negative (-) tester probe of the voltmeter.

(b) Check the charging circuit as follows:
With the engine running from idling to 2,000 rpm, check the reading on the ammeter and voltmeter.
Standard amperage:
10 A or less
Standard voltage:
13.7 - 14.8 V at 25°C (77°F)
13.2 - 14.0 V at 115°C (239°F)

If the voltmeter reading is more than standard voltage, replace the voltage regulator.

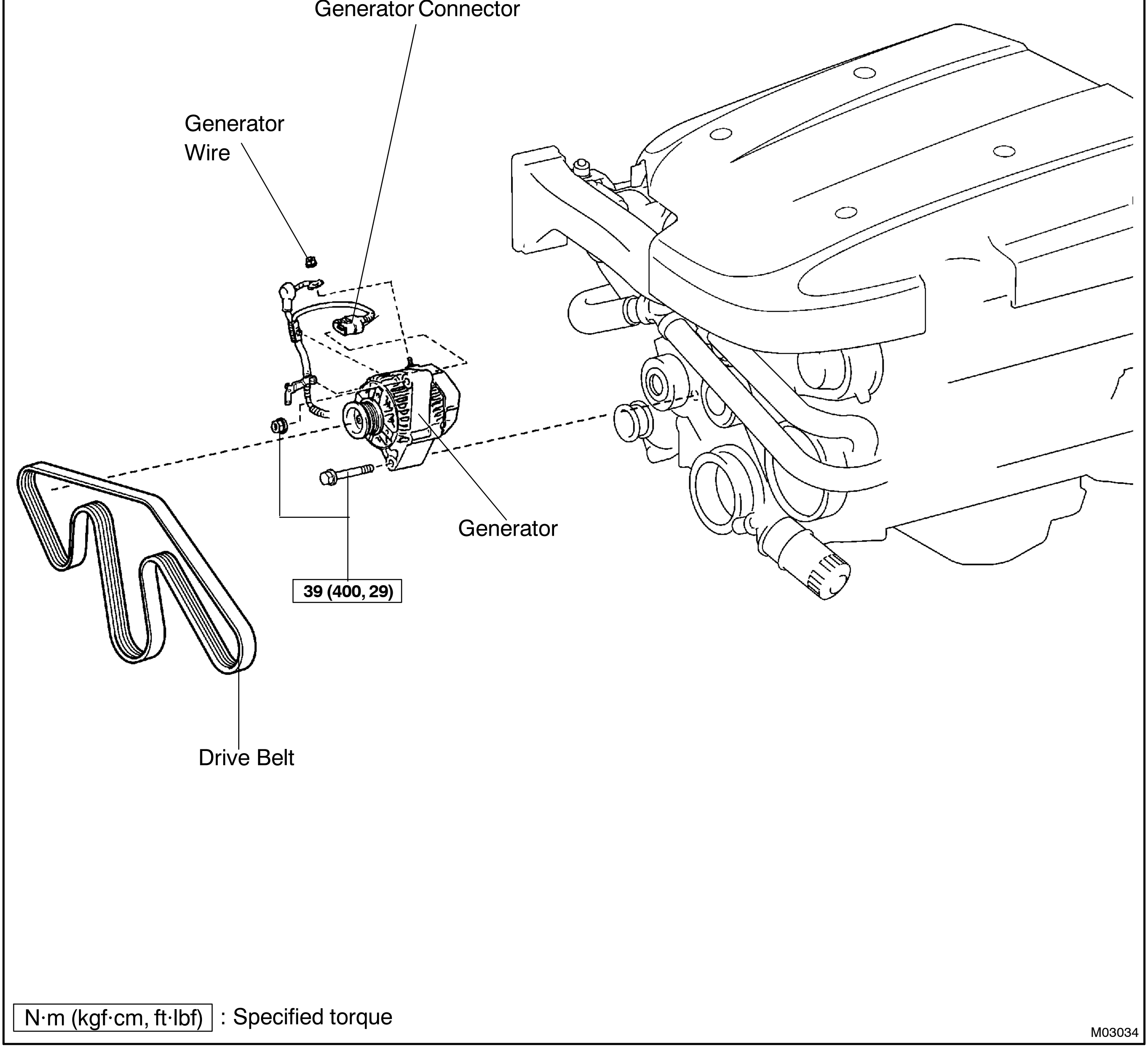
If the voltmeter reading is less than standard voltage, check the voltage regulator and generator as follows:
- With terminal F grounded, start the engine and check the voltmeter reading of terminal B.
- If the voltmeter reading is more than standard voltage, replace the voltage regulator.
- If the voltmeter reading is less than standard voltage, check the generator.

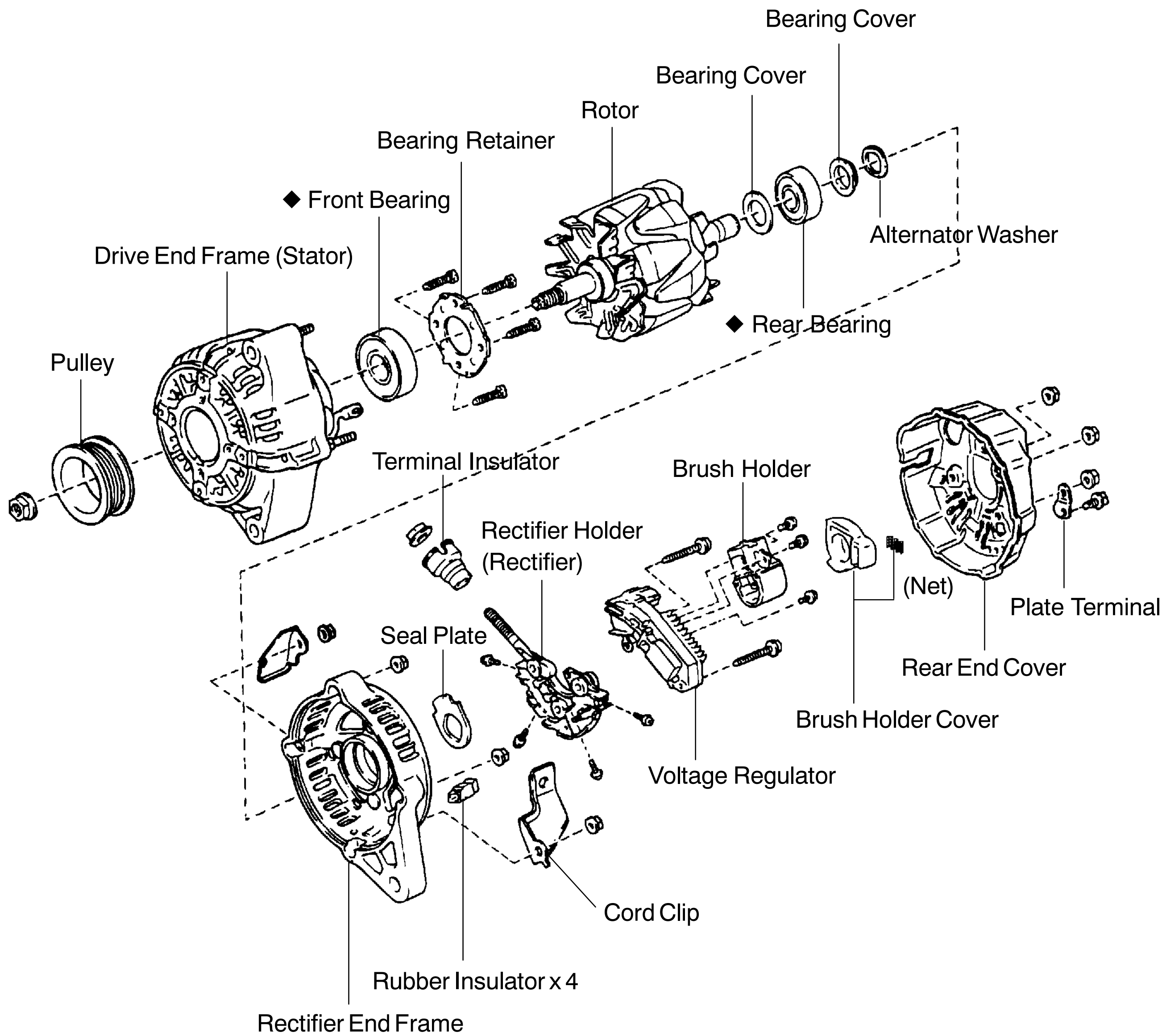


GENERATOR

COMPONENTS

CH056–01



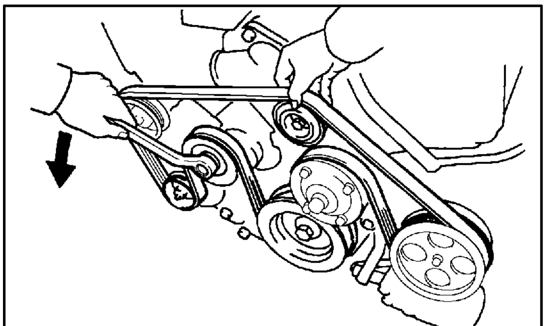


◆ Non-reusable part

M03033

CH057-01

REMOVAL

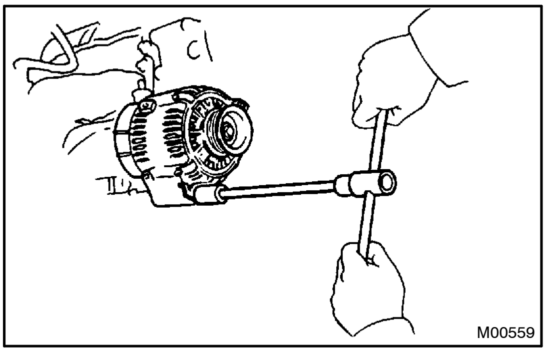

M00554

1. REMOVE GENERATOR DRIVE BELT

Loosen the belt tension by turning the belt tensioner counterclockwise, and remove the drive belt.

HINT:

The pulley bolt for the belt tensioner has a left - hand thread.


M00559

2. REMOVE GENERATOR

(a) Disconnect the generator connector.

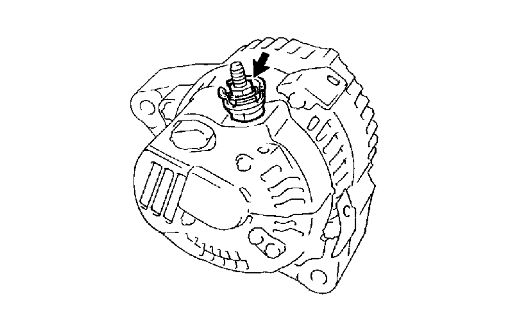
(b) Remove the rubber cap and nut, and disconnect the generator wire.

(c) Disconnect the generator wire clamp from the cord clip on the generator.

(d) Remove the bolt, nut and generator.

CH058–01

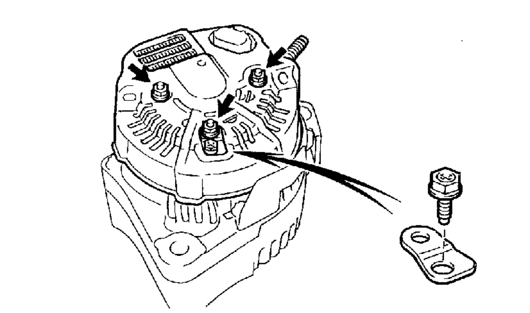
DISASSEMBLY



B00811

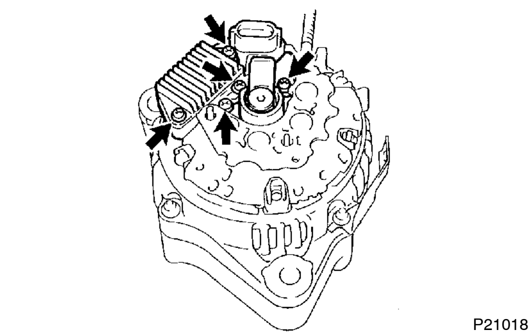
1. REMOVE REAR END COVER

(a) Remove the nut and terminal insulator.



B00812

(b) Remove the 3 nuts, bolt, plate terminal and rear end cover.

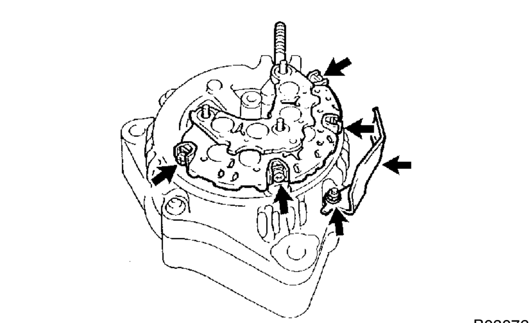


P21018

2. REMOVE BRUSH HOLDER AND VOLTAGE REGULATOR

(a) Remove the brush holder cover from the brush holder.
(b) Remove the 5 screws, brush holder and voltage regulator.
(c) Remove the seal plate from the rectifier end frame.

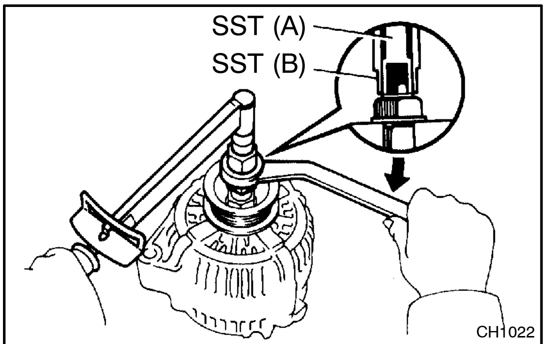
NOTICE:
Do not lose the flame arrester net in the brush holder cover.



B03076

3. REMOVE RECTIFIER HOLDER

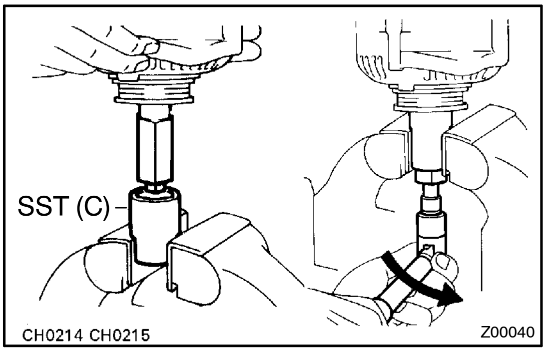
(a) Remove the nut and cord clip.
(b) Remove the 4 screws and rectifier holder.
(c) Remove the 4 rubber insulators.



CH1022

4. REMOVE PULLEY

(a) Hold SST (A) with a torque wrench, and tighten SST (B) clockwise to the specified torque.
SST 09820–63010
Torque: 39 N·m (400 kgf·cm, 29 ft·lbf)
(b) Check that SST (A) is secured to the rotor shaft.



(c) As shown in the illustration, mount SST (C) in a vise, and install the generator to SST (C).

(d) To loosen the pulley nut, turn SST (A) in the direction shown in the illustration.

NOTICE:

To prevent damage to the rotor shaft, do not loosen the pulley nut more than one-half of a turn.

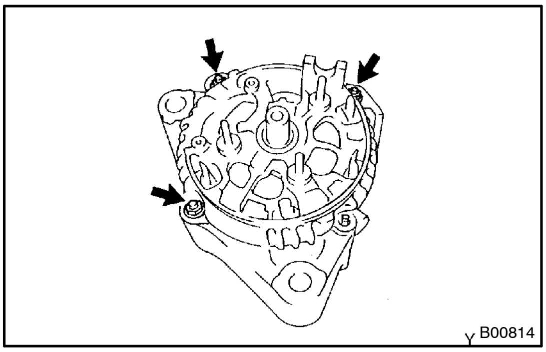
(e) Remove the generator from SST (C).

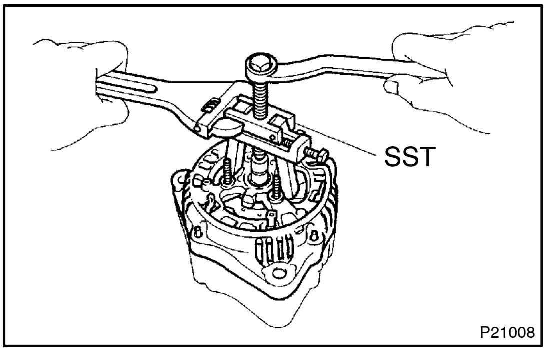
(f) Turn SST (B), and remove SST (A and B).

(g) Remove the pulley nut and pulley.

5. REMOVE RECTIFIER END FRAME

(a) Remove the 3 nuts and cord clip.





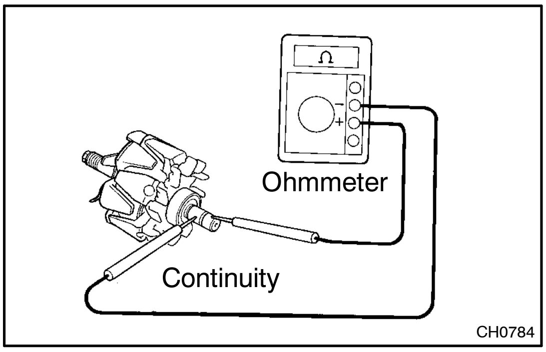
(b) Using SST, remove the rectifier end frame.
SST 09286-46011

(c) Remove the generator washer.

6. REMOVE ROTOR FROM DRIVE END FRAME

CH059-01

INSPECTION



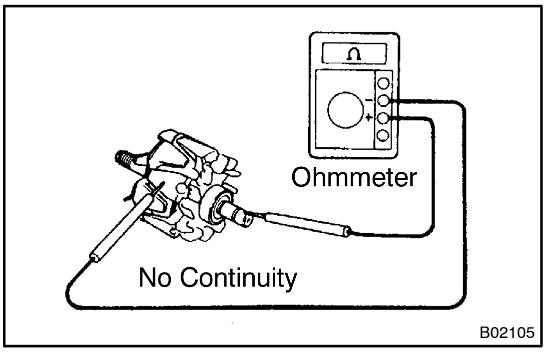
CH0784

1. INSPECT ROTOR FOR OPEN CIRCUIT

Using an ohmmeter, check that there is continuity between the slip rings.

Standard resistance:
2.1 – 2.5 Ω at 20°C (68°F)

If there is no continuity, replace the rotor.

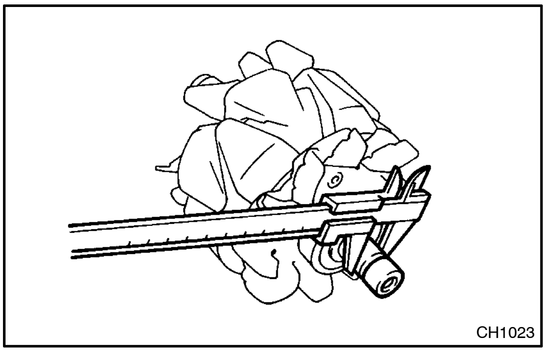


B02105

2. INSPECT ROTOR FOR GROUND

Using an ohmmeter, check that there is no continuity between the slip ring and rotor.

If there is continuity, replace the rotor.


CH1023

3. INSPECT SLIP RINGS

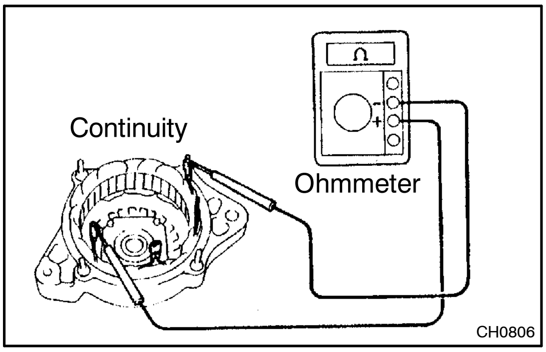
(a) Check that the slip rings are not rough or scored.

If rough or scored, replace the rotor.

(b) Using vernier calipers, measure the slip ring diameter.

Standard diameter:
14.2 – 14.4 mm (0.559 – 0.567 in.)
Minimum diameter:
12.8 mm (0.504 in.)

If the diameter is less than minimum, replace the rotor.

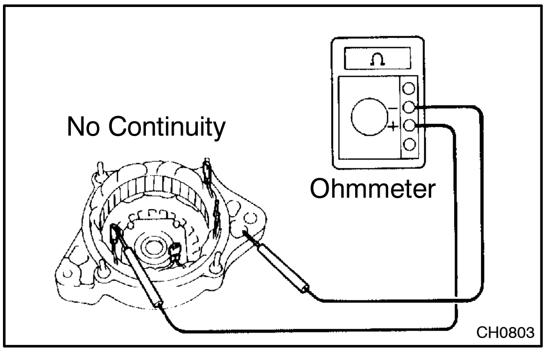


CH0806

4. INSPECT STATOR FOR OPEN CIRCUIT

Using an ohmmeter, check that there is continuity between the coil leads.

If there is no continuity, replace the drive end frame assembly.

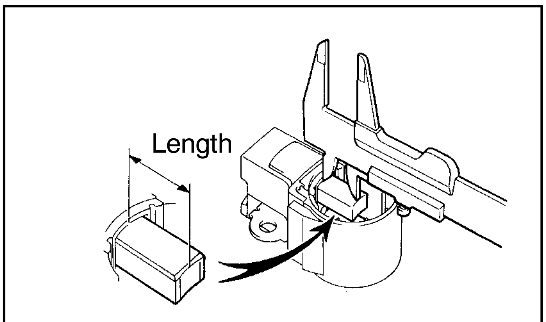


CH0803

5. INSPECT STATOR FOR GROUND

Using an ohmmeter, check that there is no continuity between the coil lead and drive end frame.

If there is continuity, replace the drive end frame assembly.



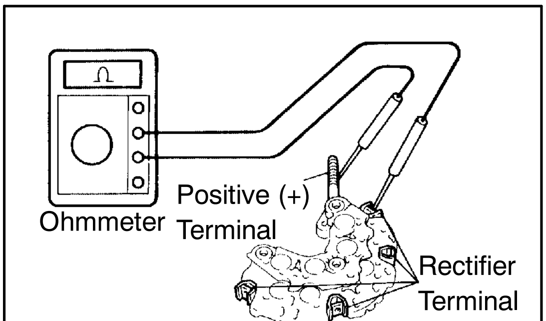
P13535

6. INSPECT EXPOSED BRUSH LENGTH

Using vernier calipers, measure the exposed brush length.

Standard exposed length:
10.5 mm (0.413 in.)
Minimum exposed length:
1.5 mm (0.059 in.)

If the exposed length is less than minimum, replace the brush holder.

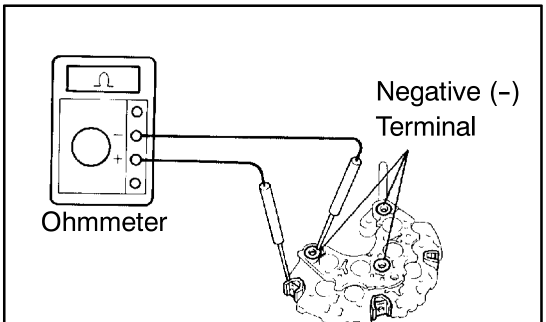


P08486

7. INSPECT POSITIVE RECTIFIER

(a) Using an ohmmeter, connect one tester probe to the positive (+) terminal and the other to each rectifier terminal.
(b) Reverse the polarity of the tester probes and repeat step (a).
(c) Check that one shows continuity and the other shows no continuity.

If continuity is not as specified, replace the rectifier holder.



P08487

8. INSPECT NEGATIVE RECTIFIER

(a) Using an ohmmeter, connect one tester probe to each negative (-) terminal and the other to each rectifier terminal.
(b) Reverse the polarity of the tester probes and repeat step (a).
(c) Check that one shows continuity and the other shows no continuity.

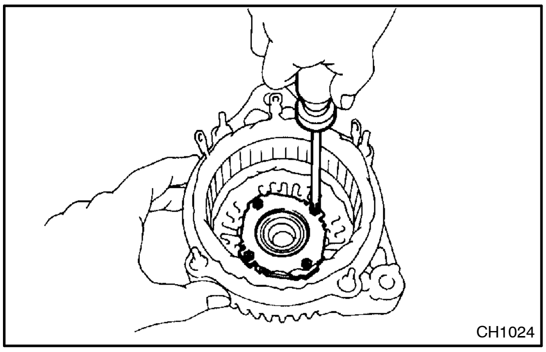
If continuity is not as specified, replace the rectifier holder.

9. INSPECT FRONT AND REAR BEARING

Check that the bearing is not rough or worn.
If necessary, replace the bearing.

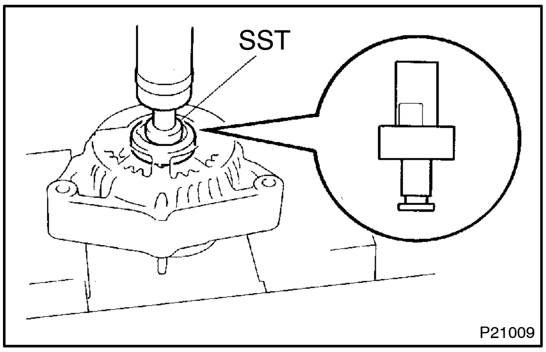
CH05A-01

REPLACEMENT

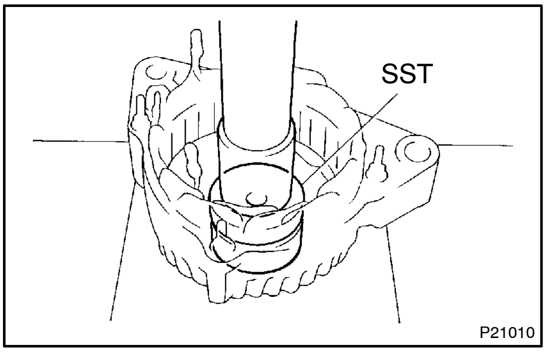


1. REPLACE FRONT BEARING

(a) Remove the 4 screws and bearing retainer.

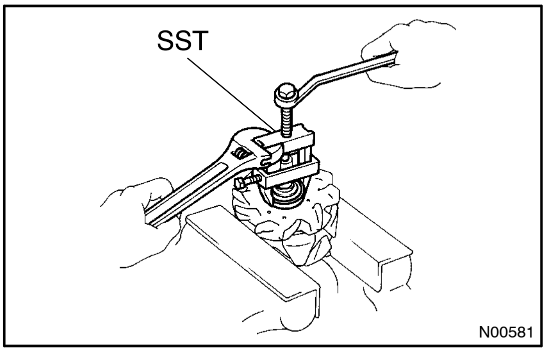


(b) Using SST and a press, press out the bearing.
SST 09950-60010 (09951-00260, 09952-06010)



(c) Using SST and a press, press in a new bearing.
SST 09950-60010 (09951-00500)

(d) Install the bearing retainer with the 4 screws.
Torque: 3.0 N·m (31 kgf·cm, 27 in.·lbf)

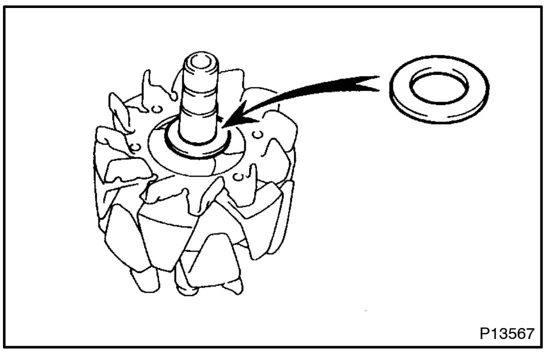


2. REPLACE REAR BEARING

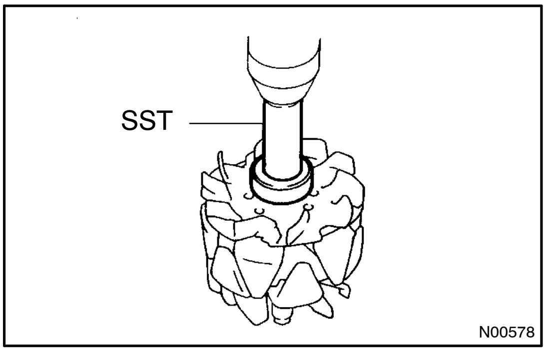
(a) Using SST, remove the bearing cover (outside) and bearing.
SST 09820-00021

NOTICE:
Be careful not to damage the fan.

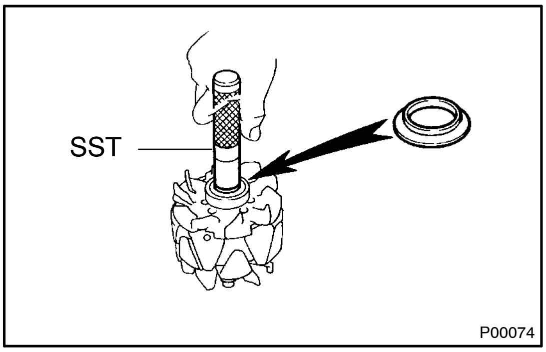
(b) Remove the bearing cover (inside).



(c) Place the bearing cover (inside) on the rotor.

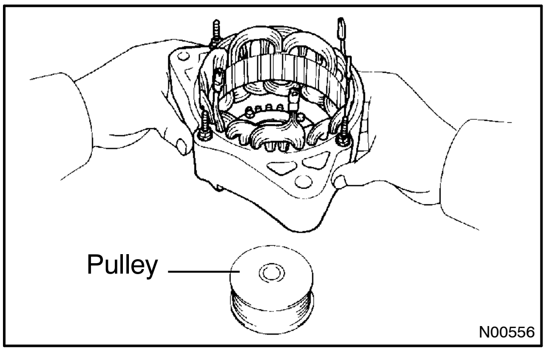


(d) Using SST and a press, press in a new bearing.
SST 09820–00030



(e) Using SST, push in the bearing cover (outside).
SST 09285–76010

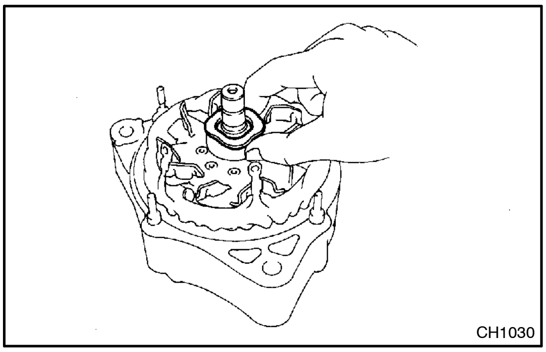
CH05B-01



REASSEMBLY

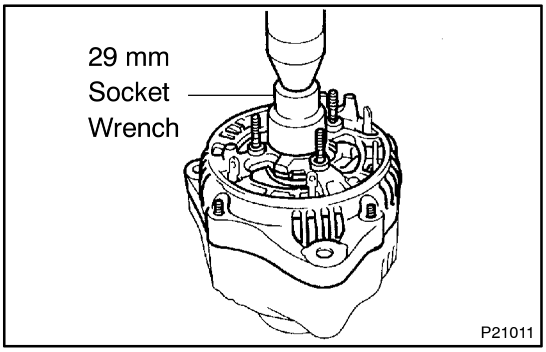
1. PLACE DRIVE END FRAME ON PULLEY

2. INSTALL ROTOR TO DRIVE END FRAME

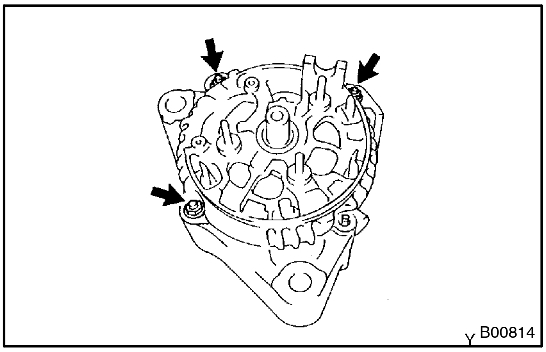


3. INSTALL RECTIFIER END FRAME

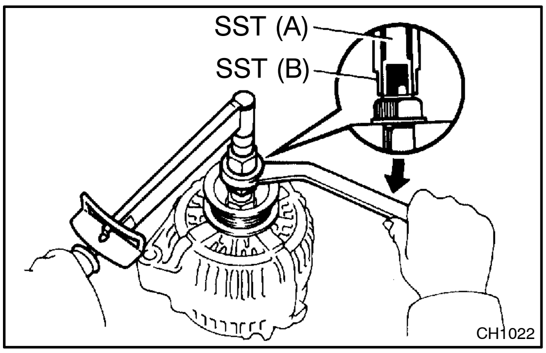
(a) Place the generator washer on the rotor.



(b) Using a 29 mm socket wrench and press, slowly press in the rectifier end frame.



(c) Temporarily install the cord clip and 3 nuts.

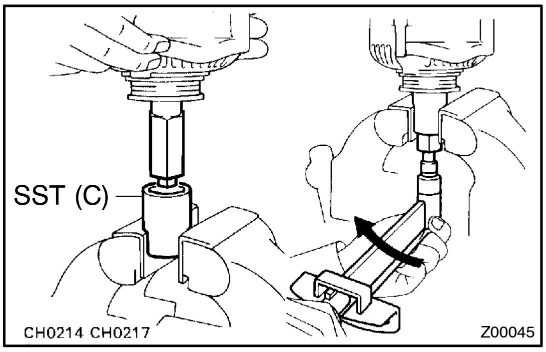


4. INSTALL PULLEY

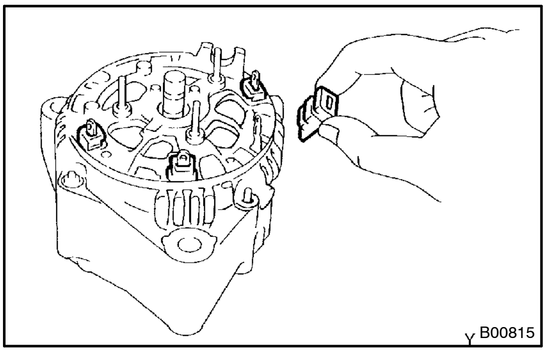
(a) Install the pulley to the rotor shaft by tightening the pulley nut by hand.

(b) Hold SST (A) with a torque wrench, and tighten SST (B) clockwise to the specified torque.
SST 09820-63010
Torque: 39 N·m (400 kgf·cm, 29 ft·lbf)

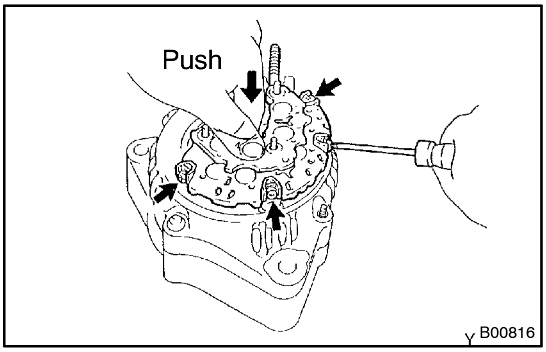
(c) Check that SST (A) is secured to the pulley shaft.



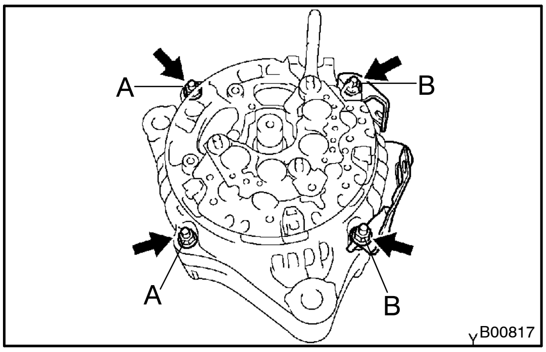
(d) As shown in the illustration, mount SST (C) in a vise, and install the generator to SST (C).
(e) To torque the pulley nut, turn SST (A) in the direction shown in the illustration.
Torque: 110.5 N·m (1,128 kgf·cm, 81 ft·lbf)
(f) Remove the generator from SST (C).
(g) Turn SST (B), and remove SST (A and B).



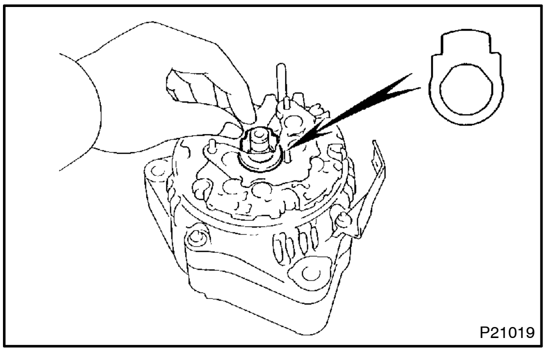
5. INSTALL RECTIFIER HOLDER
(a) Install the 4 rubber insulators on the lead wires.



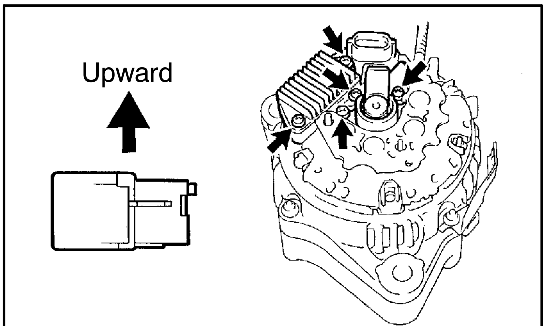
(b) Install the rectifier holder while pushing it with the 4 screws.
Torque: 2.94 N·m (30 kgf·cm, 26 in.·lbf)



(c) Install the cord clip and nut.
Tighten the 4 nuts.
Torque:
A: 4.5 N·m (46 kgf·cm, 40 in.·lbf)
B: 5.4 N·m (55 kgf·cm, 48 in.·lbf)



6. INSTALL VOLTAGE REGULATOR AND BRUSH HOLDER
(a) Place the seal plate on the rectifier end frame.

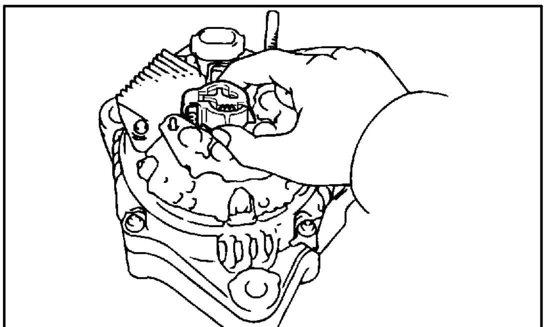


P21280

(b) Place the voltage regulator and brush holder on the rectifier end frame.

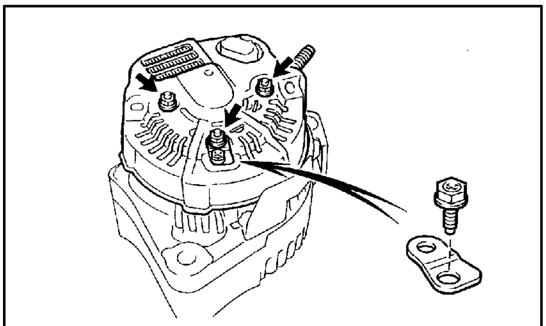
NOTICE:
Be careful of the holder installation direction.

(c) Install the 5 screws.
Torque: 2.0 N·m (20 kgf·cm, 18 in.·lbf)


M21017

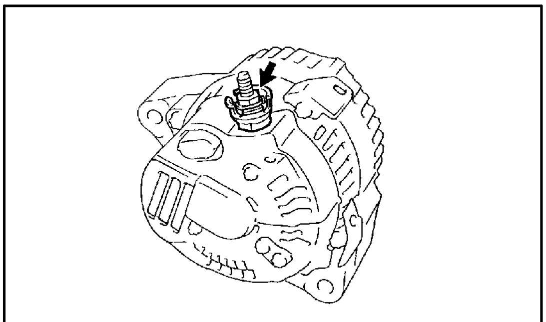
(d) Place the brush holder cover on the brush holder.
(e) Check the flame arrester net for whether losing or no.

NOTICE:
Do not lose the flame arrester net.


B00812

7. INSTALL REAR END COVER

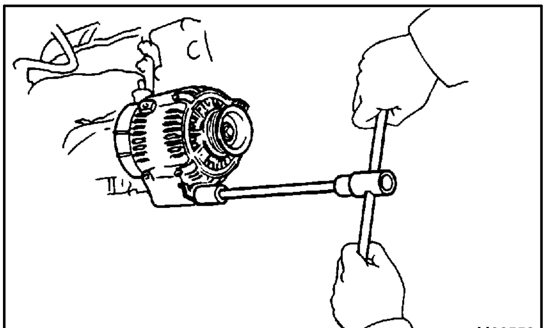
(a) Install the end cover and plate terminal with the 3 nuts and bolt.
Torque:
Bolt: 3.8 N·m (39 kgf·cm, 34 in.·lbf)
Nut: 4.4 N·m (45 kgf·cm, 39 in.·lbf)


B00811

(b) Install the terminal insulator with the nut.
Torque: 6.5 N·m (66 kgf·cm, 58 in.·lbf)

8. CHECK THAT ROTOR ROTATES SMOOTHLY

CH05C-01



M00559

INSTALLATION

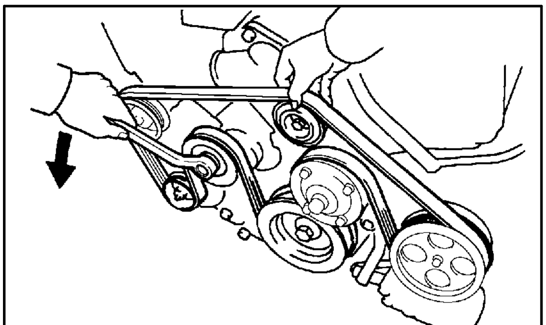
1. INSTALL GENERATOR

(a) Install the generator with the bolt and nut.
Torque: 39 N·m (400 kgf·cm, 29 ft·lbf)

(b) Connect the generator connector.

(c) Connect the generator wire with the nut and rubber cap.

(d) Install the generator wire clamp to the cord clip on the generator.



M00554

2. INSTALL GENERATOR DRIVE BELT

Install the drive belt by turning the drive belt tensioner counter-clockwise.

HINT:

The pulley bolt for the belt tensioner has a left - hand thread.

3. PERFORM ON-BOAT INSPECTION
(See page CH-2)

CHARGING

ALPHABETICAL INDEX

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FOREWORD

This manual contains preparation, specifications, diagnostics and repair procedures for the M1UZ engine.

The manual is divided into 13 sections with a thumb index for each section at the edge of the pages.

All information in this manual is based on the latest product information at the time of publication. However, specifications and procedures are subject to change without notice.

TOYOTA MOTOR CORPORATION

First Printing:

CAUTION

This manual does not include all the necessary items about repair and service. This manual is made for the purpose of the use for the persons who have special techniques and certifications. In the cases that non-specialized or uncertified technicians perform repair or service only using this manual or without proper equipment or tool, that may cause severe injury to you or other people around and also cause damage to your customer's engine.

In order to prevent dangerous operation and damages to your customer's engine, be sure to follow the instruction shown below.

- Must read this manual thoroughly. It is especially important to have good understanding all the contents written in the PRECAUTION of "IN" section.
- The service method written in this manual is very effective to perform repair and service. When performing the operations following the procedures using this manual, be sure to use tools specified and recommended. If using non-specified or recommended tools and service method, be sure to confirm safety of the technicians and any possibility of causing personal injury or damage to the customer's engine before starting the operation.
- If part replacement is necessary, must replace the part with the same part number or equivalent part. Do not replace it with inferior quality.
- It is important to note that this manual contains various "Cautions" and "Notices" that must be carefully observed in order to reduce the risk of personal injury during service or repair, or the possibility that improper service or repair may damage the engine or render it unsafe. It is also important to understand that these "Cautions" and "Notices" are not exhaustive, because it is important to warn of all the possible hazardous consequences that might result from failure to follow these instructions.

ENGINE MECHANICAL

SERVICE DATA

SS0HU–01

Compression pressure	at 250 rpm STD	1,226 kPa (12.5 kgf/cm^2, 178 psi) or more
	Minimum	981 kPa (10.0 kgf/cm^2, 142 psi)
	Difference of pressure between each cylinder	98 kPa (1.0 kgf/cm^2, 14 psi) or less
Valve clearance	at cold Intake	0.15 – 0.25 mm (0.006 – 0.010 in.)
	Exhaust	0.25 – 0.35 mm (0.010 – 0.014 in.)
	Valve clearance adjusting shim No.00	2.000 mm (0.0787 in.)
	No.02	2.020 mm (0.0795 in.)
	No.04	2.040 mm (0.0803 in.)
	No.06	2.060 mm (0.0811 in.)
	No.08	2.080 mm (0.0819 in.)
	No.10	2.100 mm (0.0827 in.)
	No.12	2.120 mm (0.0835 in.)
	No.14	2.140 mm (0.0843 in.)
	No.16	2.160 mm (0.0850 in.)
	No.18	2.180 mm (0.0858 in.)
	No.20	2.200 mm (0.0866 in.)
	No.22	2.220 mm (0.0874 in.)
	No.24	2.240 mm (0.0882 in.)
	No.26	2.260 mm (0.0890 in.)
	No.28	2.280 mm (0.0898 in.)
	No.30	2.300 mm (0.0906 in.)
	No.32	2.320 mm (0.0913 in.)
	No.34	2.340 mm (0.0921 in.)
	No.36	2.360 mm (0.0929 in.)
	No.38	2.380 mm (0.0937 in.)
	No.40	2.400 mm (0.0945 in.)
	No.42	2.420 mm (0.0953 in.)
	No.44	2.440 mm (0.0961 in.)
	No.46	2.460 mm (0.0969 in.)
	No.48	2.480 mm (0.0976 in.)
	No.50	2.500 mm (0.0984 in.)
	No.52	2.520 mm (0.0992 in.)
	No.54	2.540 mm (0.1000 in)
	No.56	2.560 mm (0.1008 in.)
	No.58	2.580 mm (0.1016 in.)
	No.60	2.600 mm (0.1024 in.)
	No.62	2.620 mm (0.1031 in.)
	No.64	2.640 mm (0.1039 in.)
	No.66	2.660 mm (0.1047 in.)
	No.68	2.680 mm (0.1055 in.)
	No.70	2.700 mm (0.1063 in.)
	No.72	2.720 mm (0.1071 in.)
	No.74	2.740 mm (0.1079 in.)
	No.76	2.760 mm (0.1087 in.)
	No.78	2.780 mm (0.1094 in.)
	No.80	2.800 mm (0.1102 in.)
Ignition timing	w/ Terminals TC and E1 connected of DLC1	8 –12° BTDC @ idle
Idle speed	–	780 ± 50 rpm
Timing belt tensioner	Protrusion from housing end	10.5 – 11.5 mm (0.413 – 0.453 in.)

Cylinder head	Warpage	Maximum	0.10 mm (0.039 in.)
	Valve seat		
	Refacing angle		30°, 45°, 60°
	Contacting angle		45°
	Contacting width		1.0 - 1.4 mm (0.039 - 0.055 in.)
	Valve guide bushing bore diameter	STD	10.285 - 10.306 mm (0.4049 - 0.4057 in.)
		O/S 0.05	10.335 - 10.356 mm (0.4069 - 0.4077 in.)
	Cylinder head bolt thread inside diameter	STD	9.770 - 9.960 mm (0.3846 - 0.3921 in.)
		Minimum	9.60 mm (0.3780 in.)
Valve guide bushing	Inside diameter		5.510 - 5.530 mm (0.2169 - 0.2177 in.)
	Outside diameter (for repair part)	STD	10.333 - 10.344 mm (0.4068 - 0.4072 in.)
		O/S 0.05	10.383 - 10.394 mm (0.4088 - 0.4092 in.)
Valve	Valve overall length	STD Intake	94.80 - 95.30 mm (3.7323 - 3.7520 in.)
		Exhaust	94.85 - 95.35 mm (3.7342 - 3.7539 in.)
		Minimum Intake	94.55 mm (3.7224 in.)
		Exhaust	94.60 mm (3.7244 in.)
	Valve face angle		44.5°
	Stem diameter	Intake	5.470 - 5.485 mm (0.2154 - 0.2159 in.)
		Exhaust	5.465 - 5.480 mm (0.2152 - 0.2157 in.)
	Stem oil clearance	STD Intake	0.025 - 0.060 mm (0.0010 - 0.0024 in.)
		Exhaust	0.030 - 0.065 mm (0.0012 - 0.0026 in.)
		Maximum Intake	0.08 mm (0.0031 in.)
		Exhaust	0.10 mm (0.0039 in.)
	Margin thickness	STD	1.0 mm (0.039 in.)
		Minimum	0.5 mm (0.020 in.)
Valve spring	Deviation	Maximum	2.0 mm (0.079 in.)
	Free length		54.05 - 54.15 mm (2.1279 - 2.1319 in.)
	Installed tension	at 35.0 mm (1.378 in.)	204 - 226 N (20.8 - 23.0 kgf·cm, 45.9 - 50.7 lbf)
Valve lifter	Lifter diameter		30.966 - 30.976 mm (1.2191 - 2.2195 in.)
	Lifter bore diameter		31.000 - 31.016 mm (1.2205 - 1.2211 in.)
	Oil clearance	STD	0.024 - 0.050 mm (0.0009 - 0.0020 in.)
		Maximum	0.07 mm (0.0028 in.)
Camshaft	Thrust clearance	STD Intake	0.060 - 0.100 mm (0.0024 - 0.0039 in.)
		Exhaust	0.040 - 0.090 mm (0.0016 - 0.0035 in.)
		Maximum Intake	0.13 mm (0.0051 in.)
		Exhaust	0.12 mm (0.0047 in.)
	Journal oil clearance	STD	0.030 - 0.067 mm (0.0012 - 0.0026 in.)
		Maximum	0.10 mm (0.0039 in.)
	Journal diameter	Intake (A)	30.984 - 31.000 mm (1.2198 - 1.2205 in.)
		Others	26.954 - 26.970 mm (1.0612 - 1.0618 in.)
	Circle runout		0.08 mm (0.0031 in.)
	Cam lobe height	STD Intake	42.610 - 42.710 mm (1.6776 - 1.6815 in.)
		Exhaust	42.630 - 42.730 mm (1.6783 - 1.6823 in.)
		Minimum Intake	42.46 mm (1.6717 in.)
		Exhaust	42.48 mm (1.6724 in.)
	Camshaft gear backlash	STD	0.020 - 0.200 mm (0.0008 - 0.0079 in.)
		Maximum	0.30 mm (0.0188 in.)
	Camshaft gear spring end free distance		18.2 - 18.8 mm (0.712 - 0.740 in.)
Camshaft timing tube	Journal diameter	Green peinted mark	39.958 - 39.964 mm (1.5731 - 1.5734 in.)
		Red peinted mark	39.964 - 39.970 mm (1.5734 - 1.5736 in.)
	Journal oil clearance	Sylinder head mark A	0.036 - 0.050 mm (0.0014 - 0.0020 in.)
		Sylinder head mark B	0.038 - 0.052 mm (0.0015 - 0.0021 in)
		Maximum	0.085 mm (0.0033 in.)
Manifold	Warpage	Maximum Intake	0.15 mm (0.0059 in.)
		Exhaust	0.50 mm (0.0197 in.)

Cylinder block	Cylinder head surface warpage	Maximum	0.07 mm (0.0028 in.)
	Cylinder bore diameter	STD Mark 1	87.500 – 87.510 mm (3.4449 – 3.4453 in.)
		Mark 2	87.510 – 87.520 mm (3.4453 – 3.4457 in.)
		Mark 3	87.520 – 87.530 mm (3.4457 – 3.4461 in.)
		Maximum	87.73 mm (3.4539 in.)
	Main bearing cap bolt tension portion diameter		
		STD	7.500 – 7.600 mm (0.2953 – 0.2992 in.)
		Minimum	7.20 mm (0.2835 in.)
Piston and piston ring	Piston diameter	STD Mark 1	87.406 – 87.416 mm (3.4411 – 3.4416 in.)
		Mark 2	87.416 – 87.426 mm (3.4416 – 3.4420 in.)
		Mark 3	87.426 – 87.436 mm (3.4420 – 3.4424 in.)
	Piston oil clearance	STD	0.084 – 0.104 mm (0.0033 – 0.0041 in.)
		Maximum	0.124 mm (0.0049 in.)
	Piston ring groove clearance	No.1	0.020 – 0.070 mm (0.0008 – 0.0028 in.)
		No.2	0.010 – 0.050 mm (0.0004 – 0.0020 in.)
	Piston ring end gap	STD No.1	0.250 – 0.450 mm (0.0098 – 0.0177 in.)
		No.2	0.500 – 0.700 mm (0.0197 – 0.0276 in.)
		Oil	0.150 – 0.500 mm (0.0059 – 0.0197 in.)
		Maximum No.1	1.05 mm (0.0413 in.)
		No.2	1.30 mm (0.0512 in.)
		Oil	1.10 mm (0.0433 in.)
Connecting rod	Thrust clearance	STD	0.160 – 0.290 mm (0.0063 – 0.0138 in.)
		Maximum	0.35 mm (0.0138 in.)
	Connecting rod thickness		22.880 – 22.920 mm (0.9008 – 0.9024 in.)
	Connecting rod oil clearance	STD	0.027 – 0.053 mm (0.0011 – 0.0021 in.)
		Maximum	0.065 mm (0.0026 in.)
	Connecting rod bearing center wall thickness		
	(Reference)	Mark 2	1.484 – 1.487 mm (0.0584 – 0.0585 in.)
		Mark 3	1.487 – 1.490 mm (0.0585 – 0.0587 in.)
		Mark 4	1.490 – 1.493 mm (0.0587 – 0.0588 in.)
		Mark 5	1.493 – 1.496 mm (0.0588 – 0.0589 in.)
		Mark 6	1.496 – 1.499 mm (0.0589 – 0.0590 in.)
		Mark 7	1.499 – 1.502 mm (0.0590 – 0.0591 in.)
	Rod bend	Maximum per 100 mm (3.94 in.)	0.05 mm (0.0020 in.)
	Rod twist	Maximum per 100 mm (3.94 in.)	0.15 mm (0.0059 in.)
	Bushing inside diameter		22.005 – 22.014 mm (0.8663 – 0.8667 in.)
	Piston pin diameter		21.997 – 22.006 mm (0.8660 – 0.8664 in.)
	Bushing oil clearance	STD	0.005 – 0.011 mm (0.0002 – 0.0004 in)
		Maximum	0.05 mm (0.0020 in.)
	Connecting rod bolt tension portion diameter	STD	7.200 – 7.300 mm (0.2835 – 0.2874 in.)
		Minimum	7.00 mm (0.2756 in.)
Crankshaft	Thrust clearance	STD	0.020 – 0.220 mm (0.0008 – 0.0087 in.)
		Maximum	0.30 mm (0.0118 in.)
	Thrust washer thickness		2.440 – 2.490 mm (0.0961 – 0.0980 in.)
	Main journal bore diameter on cylinder block (with main bearing)		66.986 – 67.000 mm (2.6372 – 2.6378 in.)
	Main journal oil clearance	STD No.1 and No.5	0.017 – 0.033 mm (0.0007 – 0.0013 in.)
		Others	0.029 – 0.045 mm (0.0011 – 0.0018 in.)
		Maximum No.1 and No.5	0.043 mm (0.0017 in.)
		Others	0.055 mm (0.0022 in.)
	Main journal diameter		66.988 – 67.000 mm (2.6373 – 2.6378 in.)

Crankshaft (cont'd)	Main bearing center wall thickness (Reference)	
	No.1 and No.5 Mark 3	2.492 - 2.495 mm (0.0981 - 0.0982 in.)
	Mark 4	2.495 - 2.498 mm (0.0982 - 0.0983 in.)
	Mark 5	2.498 - 2.501 mm (0.0983 - 0.0985 in.)
	Mark 6	2.501 - 2.504 mm (0.0985 - 0.0986 in.)
	Mark 7	2.504 - 2.507 mm (0.0986 - 0.0987 in.)
	Others Mark 1	2.486 - 2.489 mm (0.0979 - 0.0980 in.)
	Mark 2	2.489 - 2.492 mm (0.0980 - 0.0981 in.)
	Mark 3	2.492 - 2.495 mm (0.0981 - 0.0982 in.)
	Mark 4	2.495 - 2.498 mm (0.0982 - 0.0983 in.)
	Mark 5	2.498 - 2.501 mm (0.0983 - 0.0985 in.)
	Crank pin diameter	51.982 - 52.000 mm (2.0465 - 2.0472 in.)
	Circle runout Maximum	0.08 mm (0.0031 in.)
	Main journal taper and out-of-round Maximum	0.02 mm (0.0008 in.)
	Crank pin taper and out-of-round Maximum	0.02 mm (0.0008 in.)

SS0HV–01

TORQUE SPECIFICATION

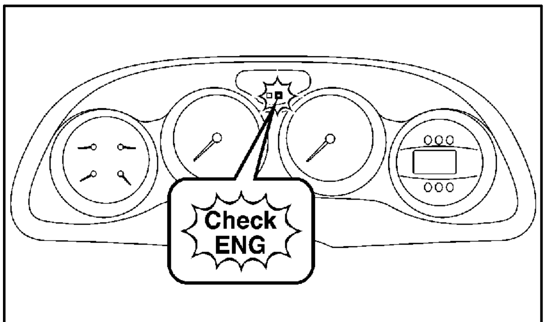
Part tightened		N·m	kgf·cm	ft·lbf
No.1 idler pulley, No.2 idler pulley x Cylinder Block		34.5	350	25
Drive belt tensioner x Cylinder block		16	160	12
Camshaft timing pulley x Camshaft timing tube		7.5	80	66
Timing belt tensioner x Oil pump		26	270	19
Crankshaft pulley x Crankshaft		245	2,500	181
Fan bracket x Cylinder block	12 mm head	16	160	12
	14 mm head	32	330	24
No.2 timing belt cover x Cylinder block		16	160	12
No.3 timing belt cover x Cylinder block, cylinder head		7.5	80	66 in.·lbf
Oil cooler pipe x No.3 timing belt cover, Fan bracket		7.5	80	66 in.·lbf
Drive belt idler pulley x Fan bracket		39	400	29
Exhaust manifold x Cylinder head		44	450	32
Cylinder head x Cylinder block	1st	39	400	29
	2nd	Turn 90°	Turn 90°	Turn 90°
Camshaft drive gear x Camshaft timing tube		7.5	80	66 in.·lbf
Camshaft timing tube x Camshaft		78	790	58
Straight screw plug x Camshaft timing tube		15	150	11
Camshaft bearing cap x Cylinder head	Bolt C	7.5	80	66 in.·lbf
	Others	16	160	12
Cylinder head cover x Cylinder head		6.0	60	53 in.·lbf
Engine hanger x Cylinder head		37	380	27
Front water bypass joint, Rear water bypass joint x Cylinder head		18	185	13
Intake manifold x Cylinder head		18	185	13
V–bank cover bracket x Engine hanger, Intake manifold		7.5	80	66 in.·lbf
Throttle control cable bracket x Intake manifold		18	185	13
Timing belt rear plate x Cylinder head		7.5	80	66 in.·lbf
Main bearing cap x Cylinder block	2 progressive type 1st	27	275	20
	2nd	Turn 90°	Turn 90°	Turn 90°
	Others	49	500	36
Connecting rod cap x Connecting rod	1st	25	250	18
	2nd	Turn 90°	Turn 90°	Turn 90°
Rear oil seal retainer x Cylinder block		8.0	80	71 in.·lbf
Engine coolant drain union x Cylinder block		49	500	36
Water seal plate x Cylinder block		14	145	10
Water bypass pipe x Cylinder Block		18	185	13
Front engine mounting bracket x Cylinder block		39	400	29
Rear engine mounting bracket x Transmission		36	370	27
Engine mounting pin x Engine mounting bracket		68	690	50
Engine mounting insulator x Engine mounting pin		110	1,100	80
Engine mounting insulator x Boat		47	480	35
Flywheel x Crankshaft	1st	29.5	300	22
	2nd	Turn 90°	Turn 90°	Turn 90°
Engine drive coupling x Flywheel		30	300	22
Flywheel housing x Cylinder block	14mm head	39	400	29
	17mm head	57	580	42

Flywheel housing x Transmission	44	450	32
Transmission oil cooler bracket x Exhaust manifold	8.0	80	71in.·lbf
Transmission oil cooler hose x Transmission, Oil cooler	44	450	32
Idler pully bracket x Cylinder head	39	400	29
Idler pully x Idler pully bracket	39	400	29
Engine control computer bracket No.2 x Flywheel housing	8.0	80	71in.·lbf
Engine control computer x Engine control computer case	3.0	30	27in.·lbf
Engine control computer bracket x Engine control computer case	8.0	80	71in.·lbf
V-drive x Engine mounting bracket	36	370	27
Transmission case hanger x V-drive	30	300	22
Transmission x V-drive	44	450	33

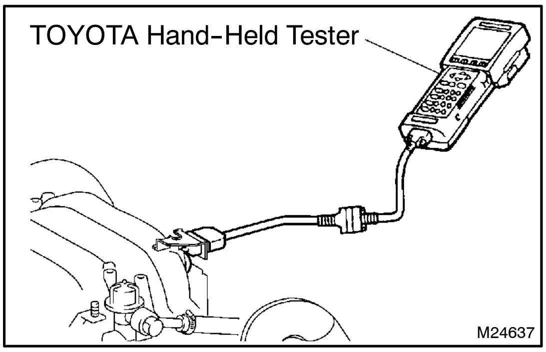
DIAGNOSTICS

PRE-CHECK

DI2OE-01



MI0534



M24637

1. DIAGNOSIS SYSTEM

(a) Description

When troubleshooting M1UZ engine, the only difference from the usual troubleshooting procedure is that you connect to the engine the OBD II scan tool complying with SAE J1978 or TOYOTA hand-held tester, and read off various data output from the engine's ECM.

The Malfunction Indicator Lamp (MIL) lighting up when a malfunction is detected, the applicable Diagnostic Trouble Codes (DTC) prescribed by SAE J2012 are recorded in the ECM memory (See page DI-13). If the malfunction dose not reoccur in 3 trips, the MIL goes off automatically but the DTCs remain recorded in the ECM memory.

To check the DTCs, connect the OBD II scan tool or TOYOTA hand-held tester to Data Link Connector 3 (DLC3) on the engine. The OBD II scan tool or TOYOTA hand-held tester also enables you to erase the DTCs and check freezed frame data and various forms of engine data. (For operating instructions, see the OBD II scan tool's instruction book.)

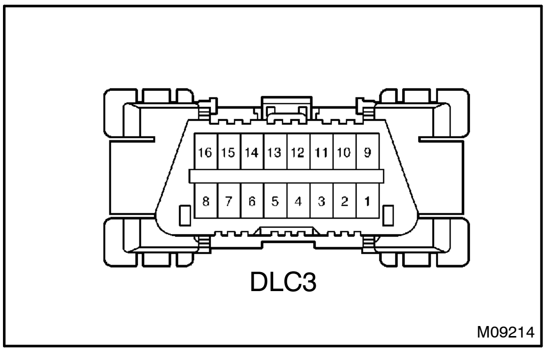
DTCs include SAE controlled codes and manufacturer controlled codes. SAE controlled codes must be set as prescribed by the SAE, while manufacturer controlled codes can be set freely by the manufacturer within the prescribed limits. (See DTC chart on page DI-13)

The diagnosis system operates in normal mode during normal boat use. It also has a check mode for technicians to simulate malfunction symptoms and troubleshoot. Most DTCs use 2 trip detection logic* to prevent erroneous detection, and ensure thorough malfunction detection. By switching the ECM to check mode when troubleshooting, the technician can cause the MIL to light up for a malfunction that is only detected once or momentarily. (TOYOTA hand-held tester only) (See step 2)

*2 trip detection logic: When a logic malfunction is first detected, the malfunction is temporarily stored in the ECM memory. If the same malfunction is detected again during the second drive test, this second detection causes the MIL to light up.

The 2 trip repeats the same mode a 2nd time. (However, the IG switch must be turned OFF between the 1st trip and 2nd trip.)

Freeze frame data:
Freeze frame data records the engine conditions (fuel system, calculator load, engine coolant temperature, fuel trim etc.) when the malfunction is detected, when troubleshooting it is useful for determining whether the engine was running or stopped, the engine warmed up or not, the air-fuel ratio lean or rich, etc. at the time of the malfunction.

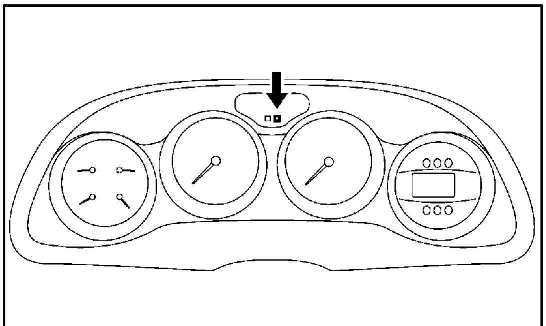


(b) Check the DLC3.
The engine's ECM uses the ISO 9141-2 communication protocol. The terminal arrangement of DLC3 complies with SAE J1962 and matches the ISO 9141-2 format.

Terminal No.	Connection / Voltage or Resistance	Condition
7	Bus ⊕ Line / Pulse generation	During transmission
4	Chassis Ground ↔ Body Ground / 1 Ω or less	Always
16	Battery Positive ↔ Body Ground / 9 ~ 14 V	Always

HINT:
If your display shows "UNABLE TO CONNECT TO ENGINE" when you have connected the cable of the OBD II scan tool or TOYOTA hand-held tester to DLC3, turned the ignition switch ON and operated the scan tool, there is a problem on the engine side or tool side.

- If communication is normal when the tool is connected to another engine, inspect DLC3 on the original engine.
- If communication is still not possible when the tool is connected to another engine, the problem is probably in the tool itself, so consult the Service Department listed in the tool's instruction manual.



2. INSPECT DIAGNOSIS (Normal Mode)

(a) Check the MIL.

(1) The MIL comes on when the ignition switch is turned ON and the engine is not running.

HINT:

If the MIL does not light up, troubleshoot the combination meter.

(2) When the engine started, the MIL should go off. If the lamp remains on, the diagnosis system has detected a malfunction or abnormality in the system.

(b) Check the DTC.

NOTICE:

TOYOTA hand-held tester only: When the diagnosis system is switched from normal mode to check mode, it erases all DTCs and freezed frame data recorded in normal mode. So before switching modes, always check the DTCs and freezed frame data, and note them down.

(1) Prepare the OBD II scan tool (complying with SAE J1978) or TOYOTA hand-held tester.

(2) Connect the OBD II scan tool or TOYOTA hand-held tester to DLC3 at the lower left of the instrument panel.

(3) Turn the ignition switch ON and push the OBD II scan tool or TOYOTA hand-held tester switch ON.

(4) Use the OBD II scan tool or TOYOTA hand-held tester to check the DTCs and freezed frame data, note them down. (For operating instructions, see the OBD II scan tool's instruction book.)

(5) See DI-13 to confirm the details of the DTCs.

NOTICE:

When simulating symptoms with an OBD II scan tool (excluding TOYOTA hand-held tester) to check the DTCs, use normal mode. For code on the DTC chart subject to "2 trip detection logic", turn the ignition switch OFF after the symptom is simulated the first time. Then repeat the simulation process again. When the problem has been simulated twice, the MIL lights up and the DTCs are recorded in the ECM.

(c) Clear the DTC.

The DTCs and freezed frame data will be erased by either action.

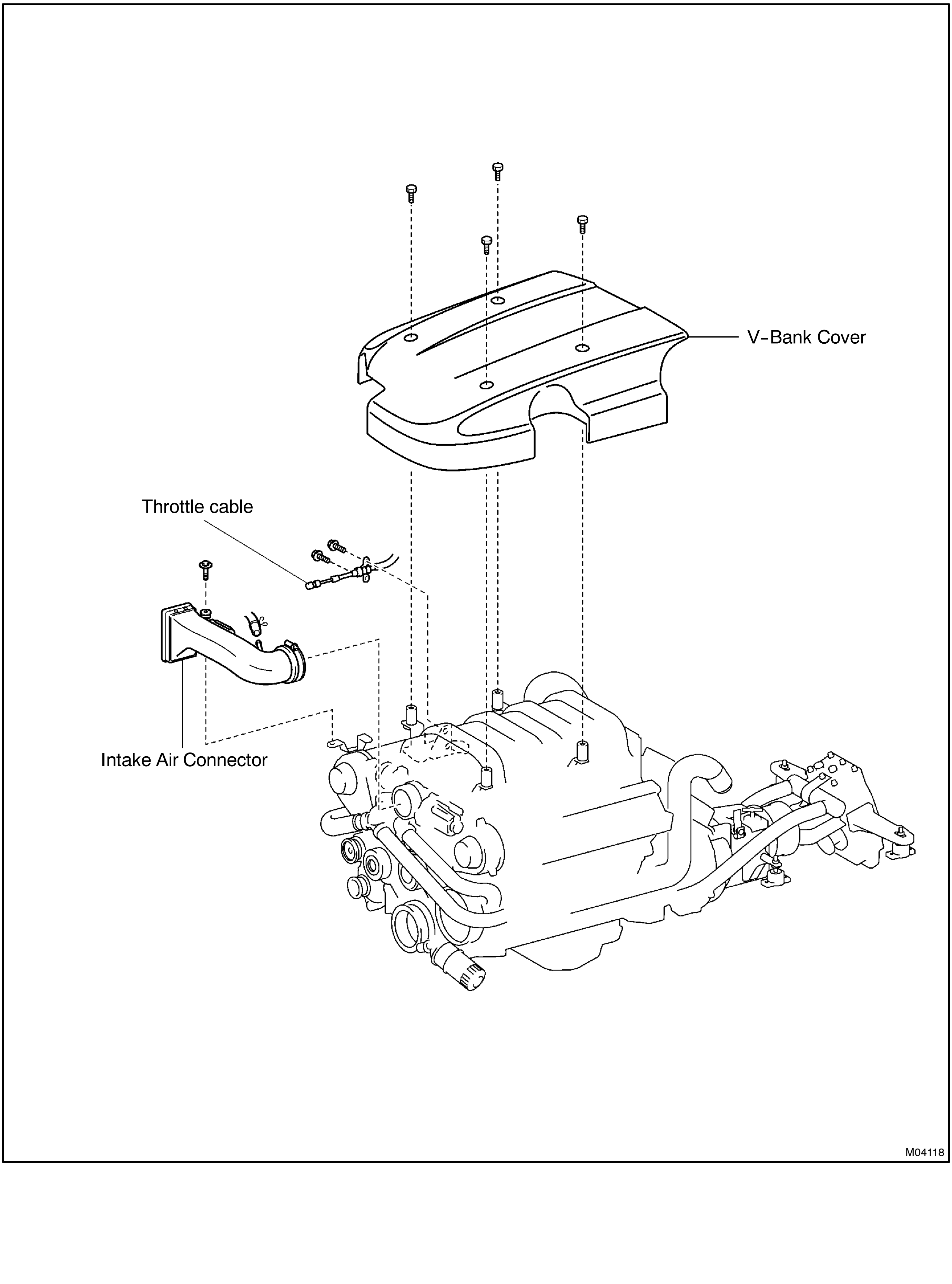
(1) Operating the OBD II scan tool (complying with SAE J1978) or TOYOTA hand-held tester to erase the codes. (See the OBD II scan tool's instruction book for operating instructions.)

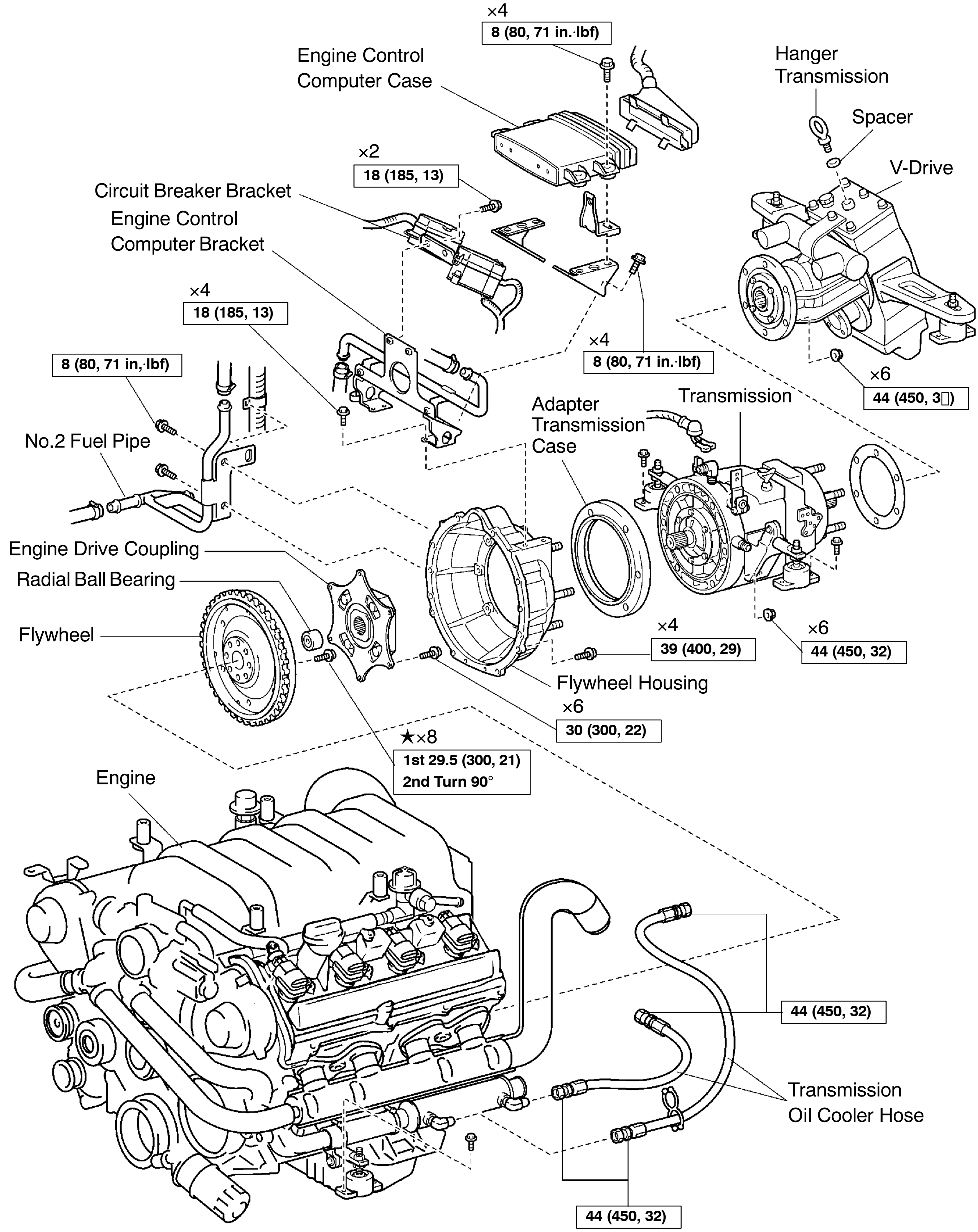
(2) Disconnecting the battery terminals or EFI fuse.

ENGINE UNIT

COMPONENTS

EM0G6-01





N·m (kgf·cm, ft·lbf) : Specified torque

★ Pre coted part

M04120

EM0G7-01

REMOVAL

1. REMOVE V-BANK COVER

2. DISCONNECT THROTTLE CABLE

3. DISCONNECT SHIFT CABLE

4. DISCONNECT ENGINE WIRE CONNECTORS

Disconnect the 2 engine wire connectors.

5. DISCONNECT GROUND CABLE FROM BODY

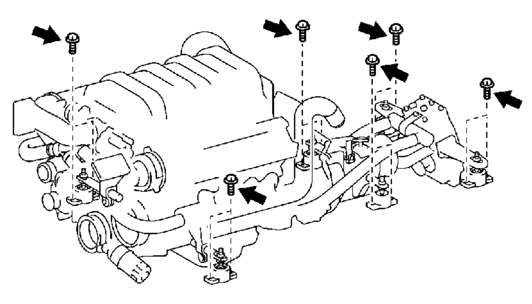
6. DISCONNECT NO.2 ENGINE WIRE FROM BATTERY

7. DISCONNECT HOSES

- Sea water hose from sea water filter
- Exhaust hoses
- Fuel inlet hose
- Fuel return hose

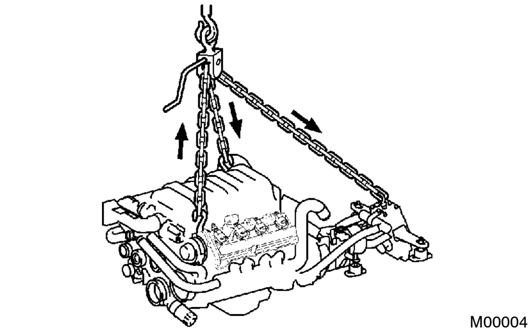
8. DISCONNECT DRIVESHAFT FROM V-DRIVE

Remove the 4 bolts and 4 nuts, then disconnect drive shaft and V-drive.


M00003

9. DISCONNECT ENGINE MOUNTING FROM BOAT BODY

Remove the 12 bolts and 12 nuts, then disconnect engine mounting from boat body.


M00004

10. REMOVE ENGINE AND TRANSMISSION ASSEMBLY FROM BOAT

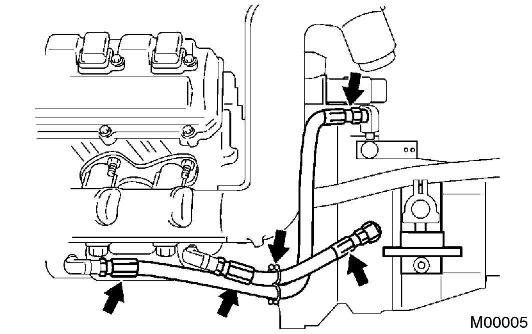
(a) Attach the engine chain hoist to the engine hangers.

(b) Lift the engine out of the boat slowly and carefully.

HINT:

Make sure the engine is clear of all wires, hoses and cables.

(c) Place the engine and transmission assembly onto the stand.


M00005

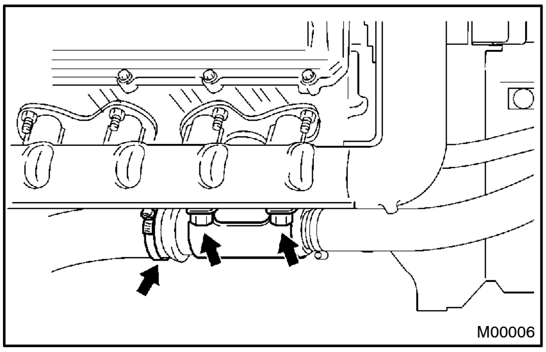
11. REMOVE OIL COOLER HOSES FOR TRANSMISSION

(a) Loosen the 4 union nuts, and remove the 2 oil cooler hoses.

(b) Remove the clamp, hose.

NOTICE:

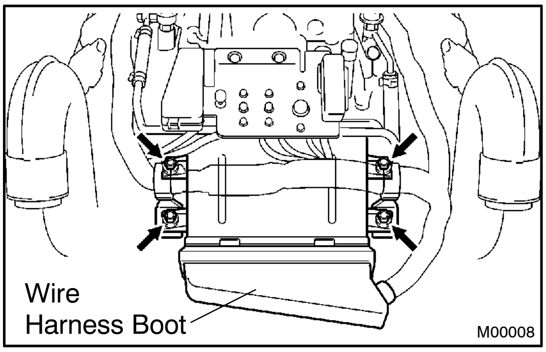
Disconnect the hose, transmission carefully because it is easy to break.



12. REMOVE OIL COOLER FOR TRANSMISSION

(a) Loosen the hose clamp on No. 1 sea water hose.

(b) Remove the 2 bolts, transmission oil cooler and transmission oil cooler bracket.

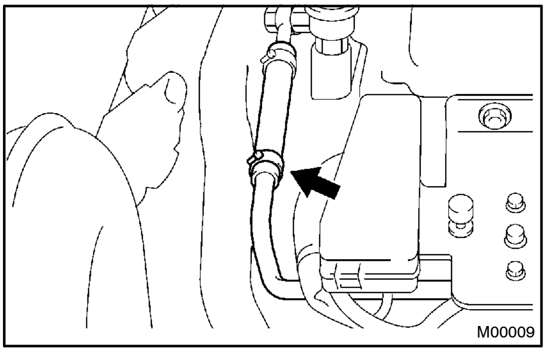


13. REMOVE ENGINE CONTROL COMPUTER CASE

(a) Remove the wire harness boot from the engine control computer case.

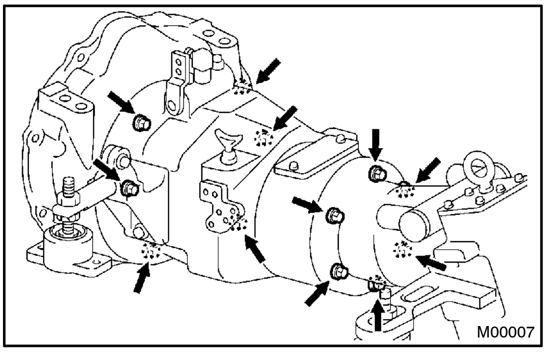
(b) Disconnect the 5 connectors from the engine control computer.

(c) Remove the 4 bolts, then remove the engine control computer case.



14. REMOVE ENGINE CONTROL COMPUTER BRACKET

(a) Loosen the hose clamp, then disconnect the No. 4 fuel hose from the No. 4 fuel pipe.



15. REMOVE V-DRIVE

(a) Remove the 6 nuts, then remove the V-DRIVE and gasket, transfer case from transmission.

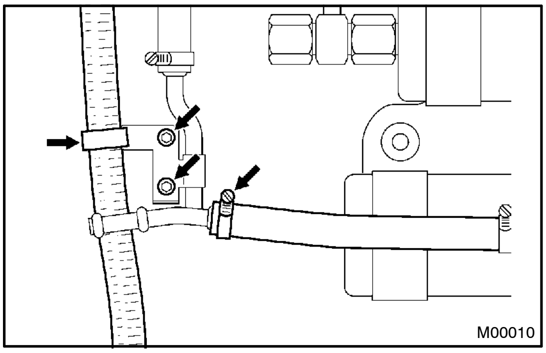
16. REMOVE TRANSMISSION

(a) Remove the neutral switch wiring.

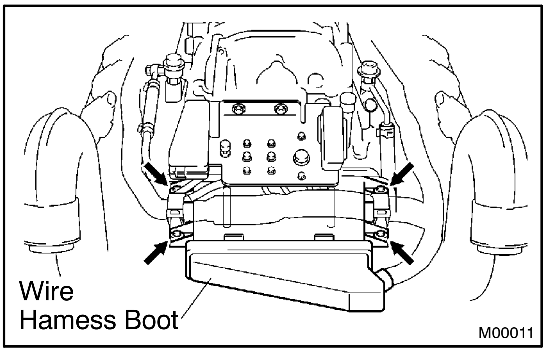
(b) Remove the 6 nuts, then remove the transmission and adapter from the flywheel housing.

NOTICE:

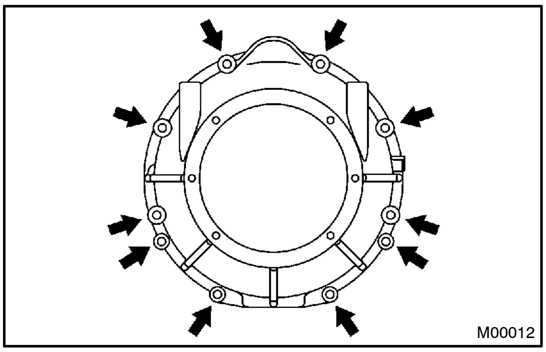
Before you remove the transmission, put supports under the engine to prevent the engine falling from the stand.



(c) Disconnect the engine wire harness from the No. 2 fuel pipe.
(d) Loosen the hose clamp, then disconnect the fuel hose from the No. 2 fuel pipe.
(e) Remove the 2 bolts and the No. 2 fuel pipe.

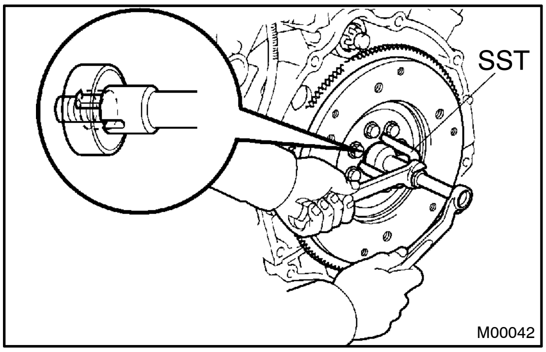


(f) Remove the 2 bolts, then remove the circuit breaker bracket from the engine control computer bracket.
(g) Remove the 4 bolts, then remove the engine control computer bracket from the flywheel housing.



17. REMOVE FLYWHEEL HOUSING

Remove the 10 bolts and flywheel housing.



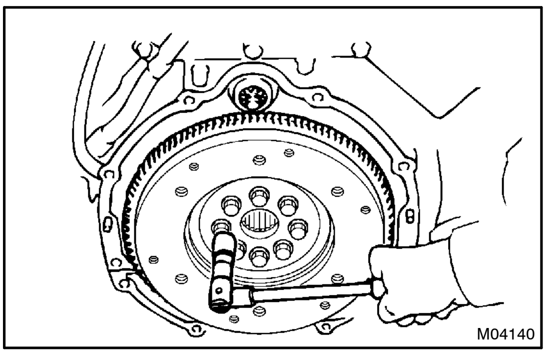
18. REMOVE RADIAL BALL BEARING

Remove the bearing with the special service tool.

SST 09303-35011

NOTICE:

Do not remove the radial ball bearing except when any problem has occurred to it.



19. REMOVE FLYWHEEL

(a) Remove the 6 bolts, engine drive coupling and radial ball bearing.
(b) Remove the 8 bolts, and flywheel.

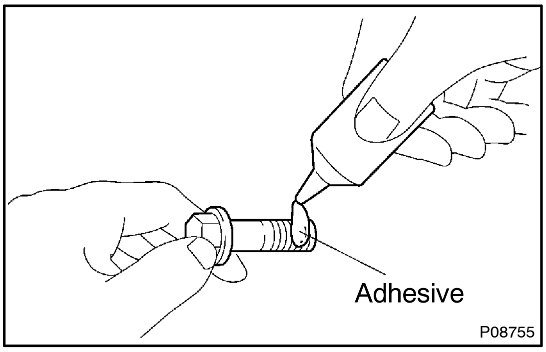
EM0G8-01

INSTALLATION

1. INSTALL FLYWHEEL

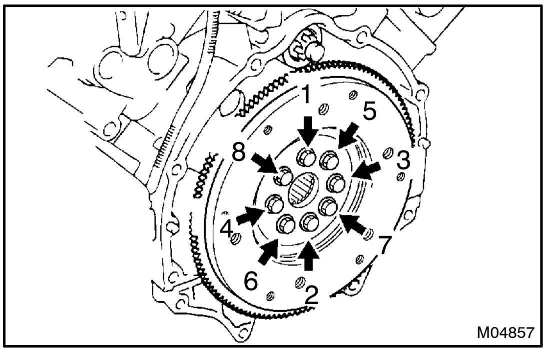
HINT:

- The mounting bolts are tightened in 2 progressive steps (steps (c) and (e)).
- If any one of the mounting bolts is broken or deformed, replace it.



P08755

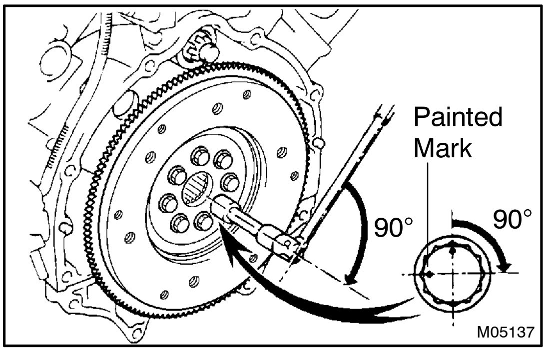
(a) Apply adhesive to 2 or 3 threads of the mounting bolt end.
Adhesive:
Part No. 08833-00070, THREE BOND 1324 or equivalent



M04857

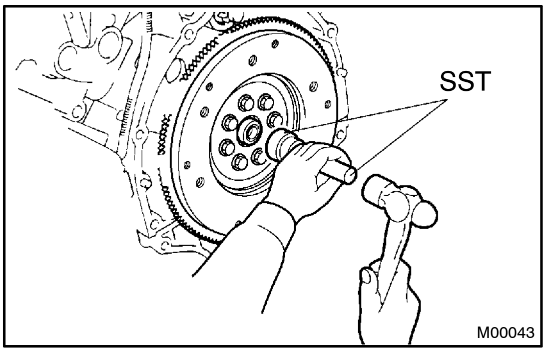
(b) Install the flywheel on the crankshaft.
(c) Install and uniformly tighten the 8 mounting bolts in several passes, in the sequence shown.
Torque: 29.5 N·m (300 kgf·cm, 21 ft·lbf)

If any one of the mounting bolts does not meet the torque specification, replace the mounting bolt.



M05137

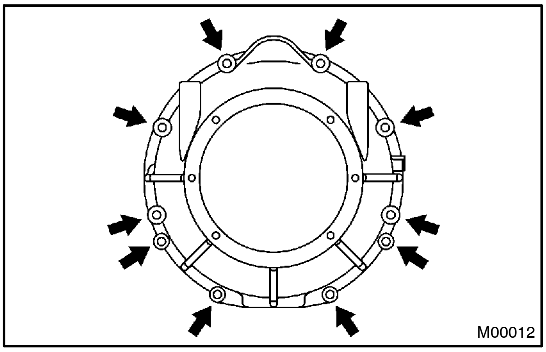
(d) Mark the mounting bolts with paint.
(e) Retighten the mounting bolts by 90° in the numerical order shown.
(f) Check that the painted mark is now at a 90° angle to (e).
(g) Install the radial ball bearing and engine drive coupling with the 6 bolts.
Torque: 30 N·m (300 kgf·cm, 22 ft·lbf)



M00043

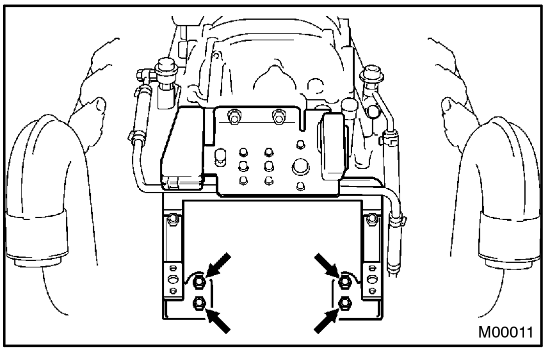
2. INSTALL RADIAL BALL BEARING

(a) Install the new bearing with the special service tool.
SST 09950-60010 (09951-00310)
09950-70010 (09951-07100)



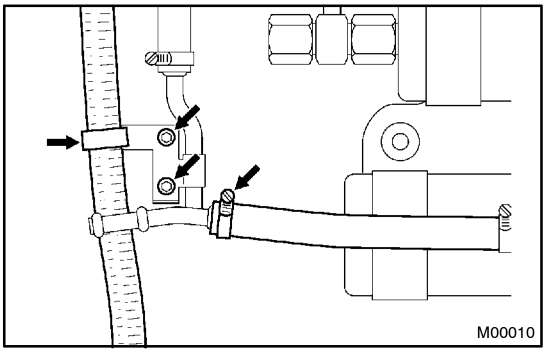
3. INSTALL FLYWHEEL HOUSING

(a) Install the flywheel housing with the 10 bolts.
Torque:
14 mm bolt: 39 N·m (400 kgf·cm, 29 ft·lbf)
17 mm bolt: 57 N·m (580 kgf·cm, 42 ft·lbf)



(b) Install the engine control computer bracket to the flywheel housing with the 4 bolts.
Torque: 8 N·m (80 kgf·cm, 71 in.·lbf)

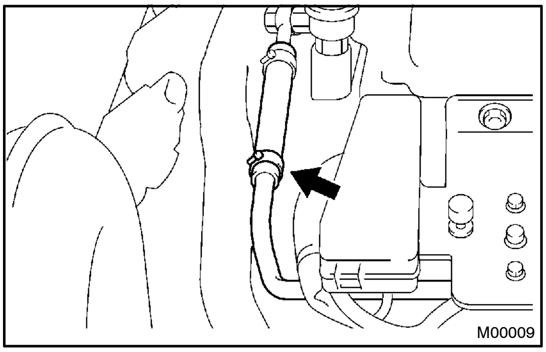
(c) Install the engine control computer bracket No.2 to the engine control computer bracket with the 4 bolts.
Torque: 8 N·m (80 kgf·cm, 71 in.·lbf)



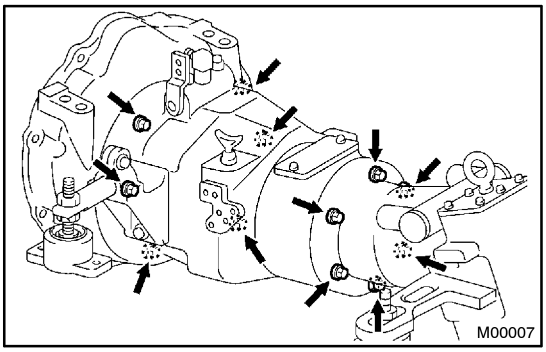
(d) Install the No. 2 fuel pipe to the flywheel housing with the 2 bolts.
Torque: 8 N·m (80 kgf·cm, 71 in.·lbf)

(e) Install the fuel hose to the No. 2 fuel pipe.
Torque: 1.5 N·m (15 kgf·cm, 13 in.·lbf)

(f) Secure the engine wire harness with clamps.



(g) Install the No.4 fuel pipe to the No.4 fuel hose.
Torque: 1.5 N·m (15 kgf·cm, 13 in.·lbf)



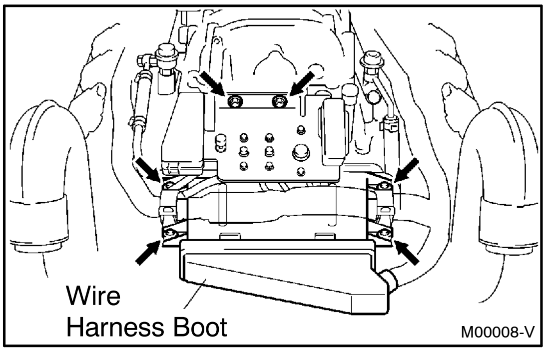
4. INSTALL TRANSMISSION

(a) Install the transmission with the 6 nuts.
Torque: 44 N·m (450 kgf·cm, 32 ft·lbf)

(b) Connect the neutral switch wiring.

5. INSTALL V-DRIVE

(a) Install the V-DRIVE with the 6 nuts, and gasket, transfer case.
Torque: 44 N·m (450 kgf·cm, 32 ft·lbf)



6. INSTALL ENGINE CONTROL COMPUTER CASE

(a) Install the engine control computer case to the engine control computer bracket with the 4 bolts.

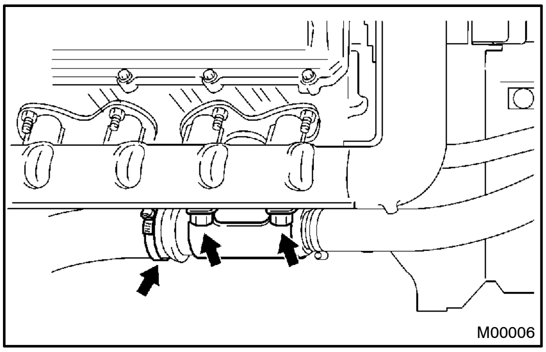
(b) Install the circuit breaker bracket to the engine control computer with the 2 bolts.

Torque: 18 N·m (185 kgf·cm, 13 ft·lbf)

(c) Connect the 5 connectors to the engine computer.

Torque: 8 N·m (80 kgf·cm, 71 in.·lbf)

(d) Install the wire harness boot to the engine control computer case.



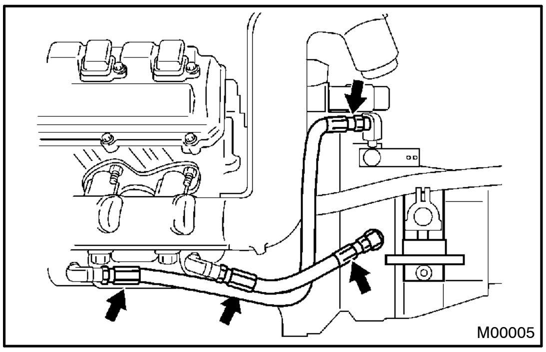
7. INSTALL OIL COOLER FOR TRANSMISSION

(a) Install the transmission oil cooler and transmission oil cooler bracket with the 2 bolts.

Torque: 8 N·m (80 kgf·cm, 71 in.·lbf)

(b) Secure the hose clamp on the No. 1 sea water hose.

Torque: 2.5 N·m (25 kgf·cm, 22 in.·lbf)



8. INSTALL OIL COOLER HOSES FOR TRANSMISSION

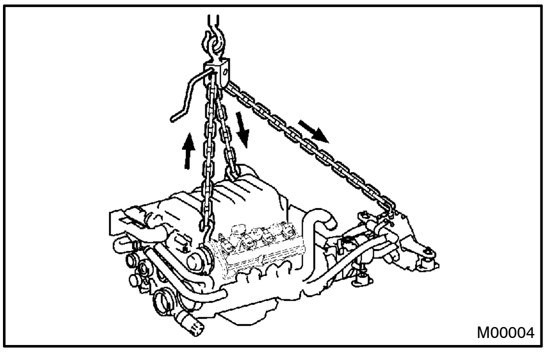
(a) Connect the 2 oil cooler hoses with the 4 union nuts.

Torque: 44 N·m (500 kgf·cm, 32 in.·lbf)

NOTICE:

Connect the hose, transmission carefully because it is easy to break.

(b) Install the clamp, hose



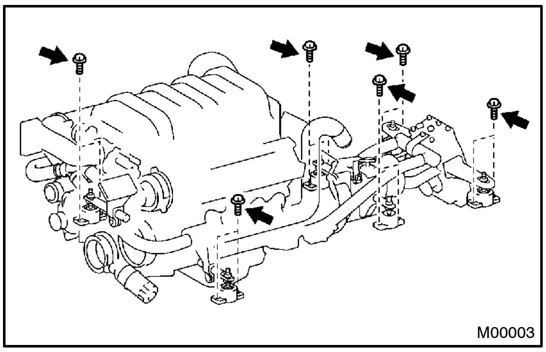
9. INSTALL ENGINE AND TRANSMISSION ASSEMBLY IN BOAT

(a) Attach the engine chain hoist to the engine hangers.

(b) Slowly lower the engine and transmission assembly into the engine compartment.

10. CONNECT DRIVE SHAFT AND TRANSMISSION

Connect the drive shaft and the transmission with the 4 bolts and nuts.



11. INSTALL ENGINE MOUNTINGS TO BOAT

Install the engine mountings at 6 locations with the 12 bolts and nuts.

Torque: 47 N·m (480 kgf·cm, 35 ft·lbf)

12. CONNECT HOSES

- Fuel inlet hose
- Sea water hose to sea water filter
- Exhaust hoses
- Fuel return hose

13. INSTALL NO.2 ENGINE WIRE TO BATTERY

14. INSTALL GROUND CABLE TO BODY

15. CONNECT ENGINE WIRE CONNECTORS

Connect the 2 engine wire connectors.

16. CONNECT SHIFT CABLE

17. CONNECT THROTTLE CABLE

18. INSTALL V-BANK COVER

19. START ENGINE AND CHECK FOR LEAKS

20. CHECK TRANSMISSION FLUID LEVEL

21. DO ENGINE ADJUSTMENT

22. DO ROAD TEST

Check for abnormal noises, shock, slippage, correct shift points and smooth operation.

23. RECHECK AND OIL LEVELS