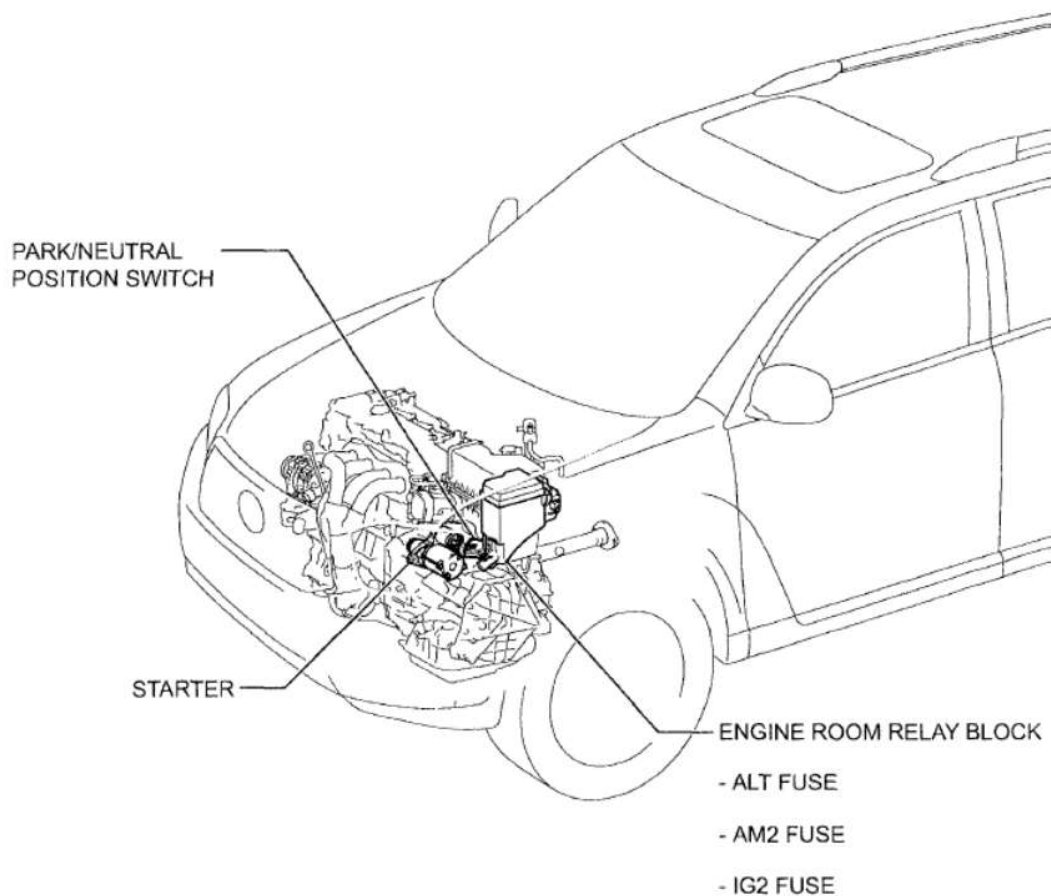


**2009 Toyota Highlander Limited**

2009 ENGINE Starting (1AR-FE) - Highlander

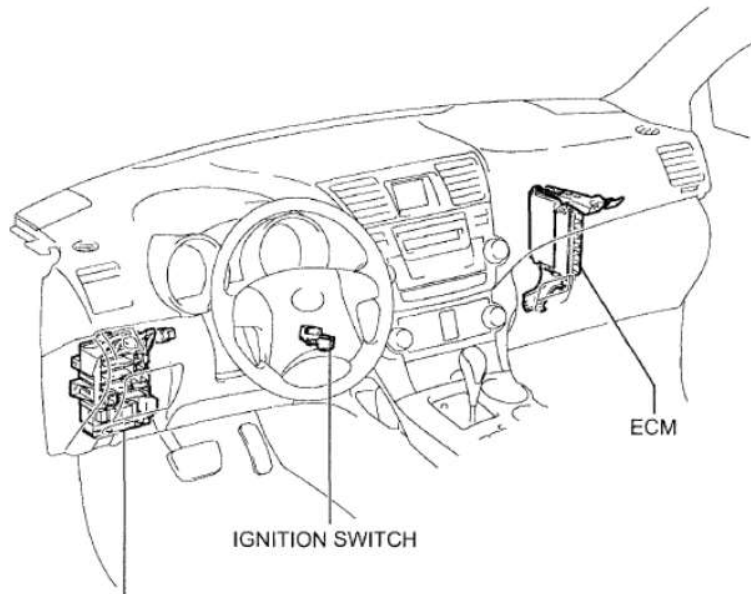
**2009 ENGINE****Starting (1AR-FE) - Highlander****STARTING SYSTEM****PARTS LOCATION**

A207675E01

**Fig. 1: Identifying Starting System Parts Location (1 Of 2)**

**2009 Toyota Highlander Limited**

## 2009 ENGINE Starting (1AR-FE) - Highlander



MAIN BODY ECU (INSTRUMENT PANEL JUNCTION BLOCK)

- IGNITION RELAY

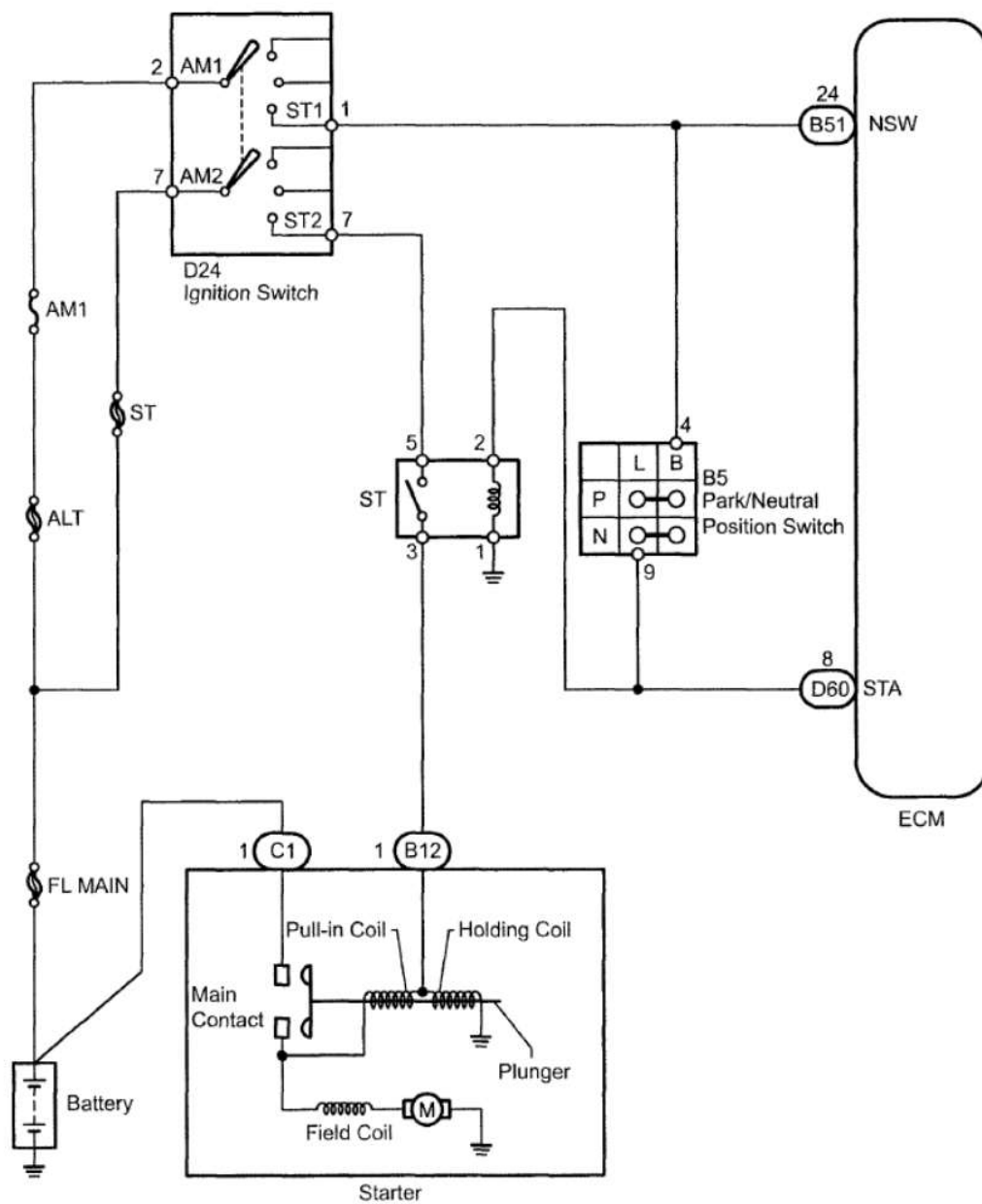
- IGN FUSE

A207878E01

**Fig. 2: Identifying Starting System Parts Location (2 Of 2)****SYSTEM DIAGRAM**

**2009 Toyota Highlander Limited**

## 2009 ENGINE Starting (1AR-FE) - Highlander



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**Fig. 3: Starting System Diagram****STARTER****COMPONENTS**

2009 Toyota Highlander Limited

2009 ENGINE Starting (1AR-FE) - Highlander

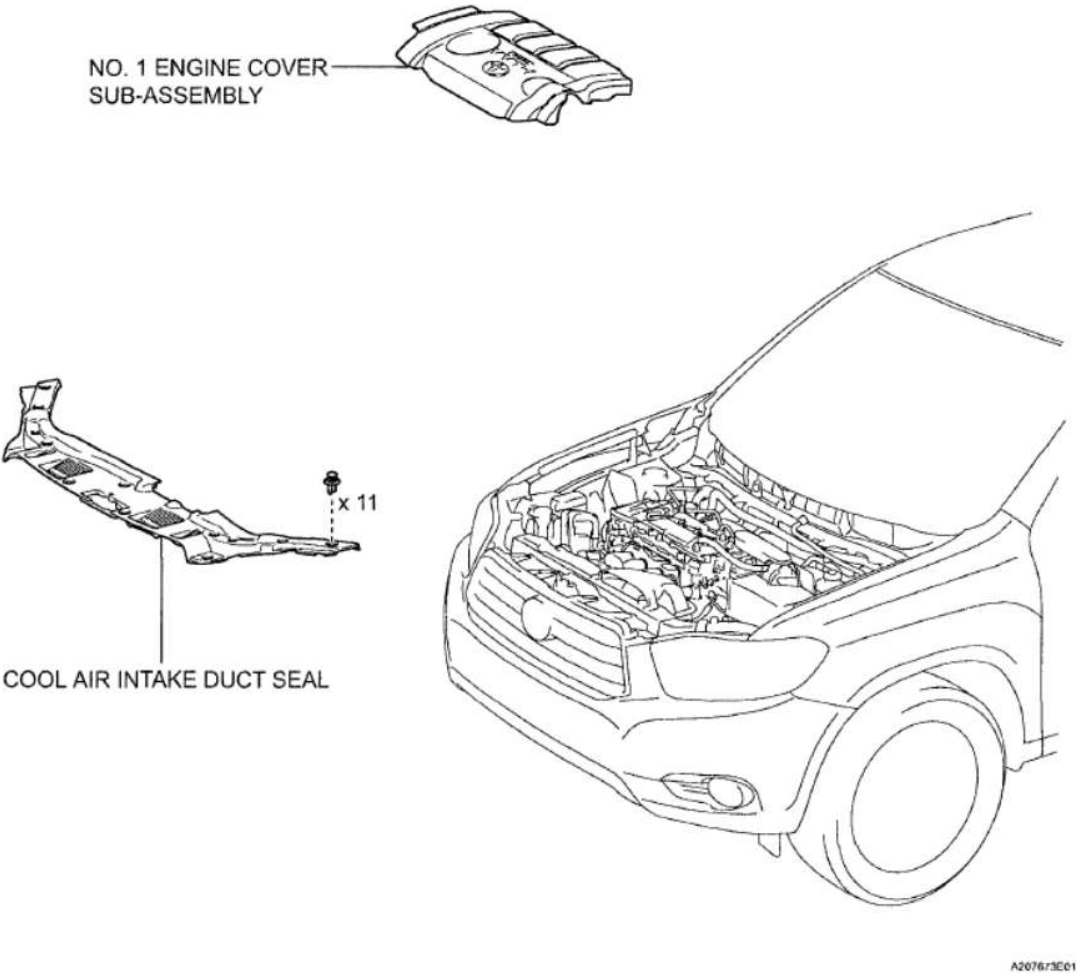


**Fig. 4: Identifying Starter Components (1 Of 3)**

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2009 ENGINE Starting (1AR-FE) - Highlander

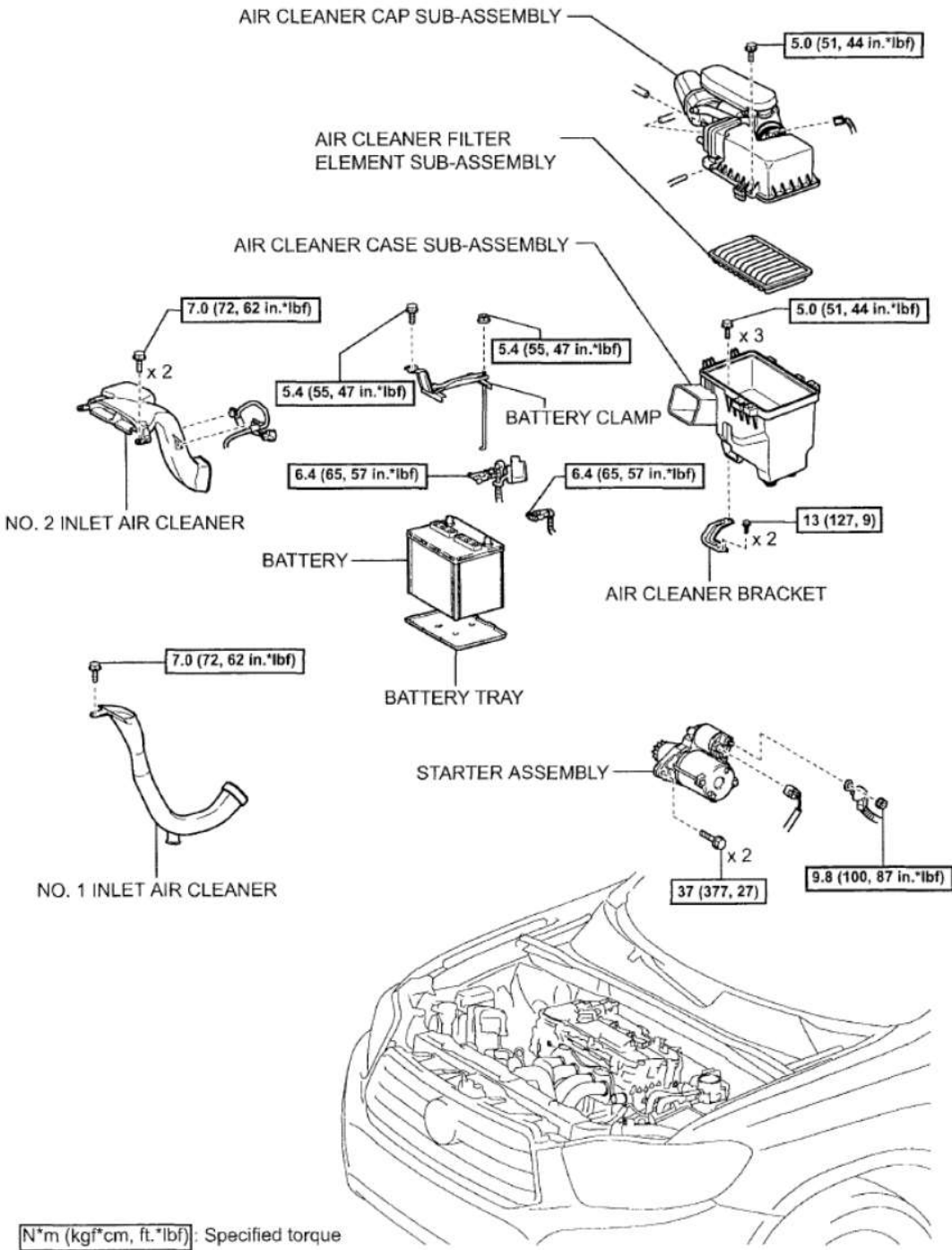


Fig. 5: Identifying Starter Components (2 Of 3)

## 2009 Toyota Highlander Limited

### 2009 ENGINE Starting (1AR-FE) - Highlander

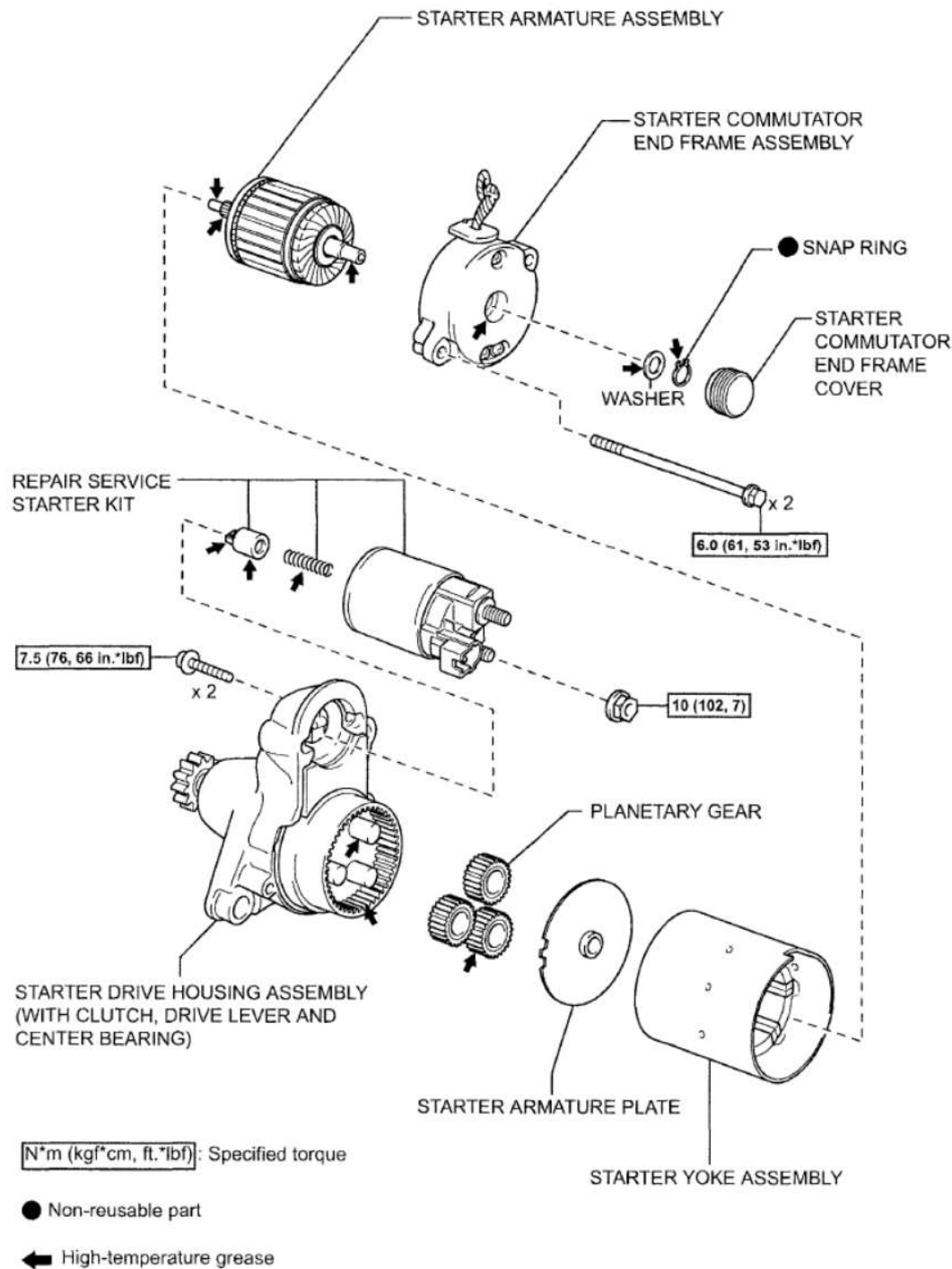


**Fig. 6: Identifying Starter Components (3 Of 3)**

## REMOVAL

### 1. DISCONNECT CABLE FROM NEGATIVE BATTERY TERMINAL

**2009 Toyota Highlander Limited**

## 2009 ENGINE Starting (1AR-FE) - Highlander

**NOTE:** When disconnecting the cable, some systems need to be initialized after the cable is reconnected (See INITIALIZATION ).

2. REMOVE COOL AIR INTAKE DUCT SEAL (See REMOVAL )
3. REMOVE NO. 1 ENGINE COVER SUB-ASSEMBLY (See REMOVAL )
4. REMOVE BATTERY (See REMOVAL )
5. REMOVE NO. 2 INLET AIR CLEANER (See REMOVAL )
6. REMOVE AIR CLEANER CAP SUB-ASSEMBLY (See REMOVAL )
7. REMOVE AIR CLEANER FILTER ELEMENT SUB-ASSEMBLY (See REMOVAL )
8. REMOVE AIR CLEANER CASE SUB-ASSEMBLY (See REMOVAL )
9. REMOVE AIR CLEANER BRACKET (See REMOVAL )
10. REMOVE NO. 1 INLET AIR CLEANER (See REMOVAL )
11. REMOVE STARTER ASSEMBLY
  - a. Disconnect the starter connector.
  - b. Open the terminal cap, remove the nut and disconnect the starter wire.

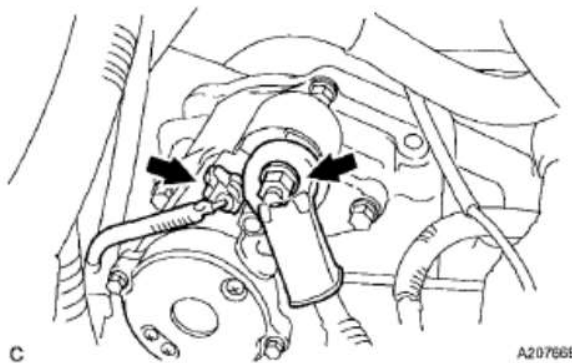


**Fig. 7: Locating Starter Connector And Starter Wire Terminal Nut**

- c. Remove the 2 bolts and starter.

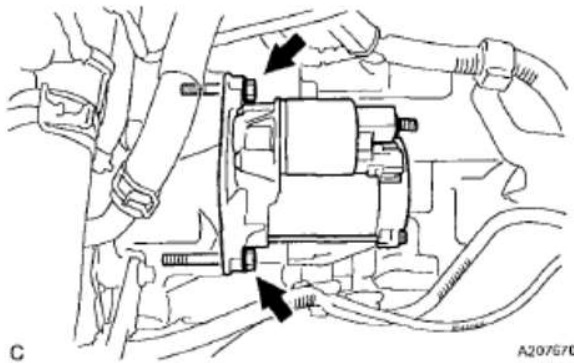


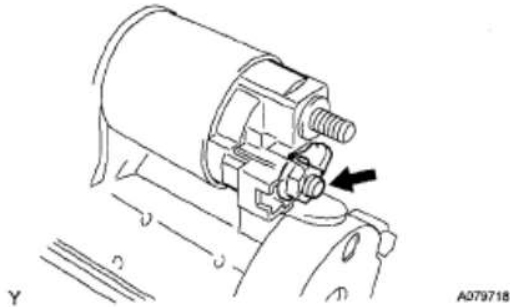
**Fig. 8: Locating Starter Bolts**

**2009 Toyota Highlander Limited**

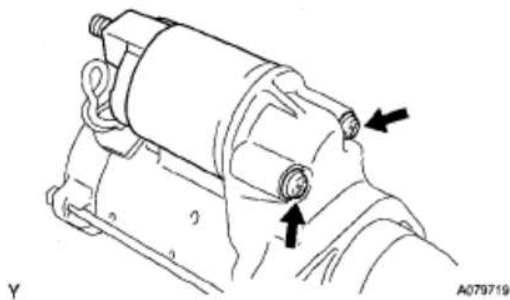
2009 ENGINE Starting (1AR-FE) - Highlander

**DISASSEMBLY****1. REMOVE REPAIR SERVICE STARTER KIT**

- a. Remove the nut and disconnect the lead wire from the magnetic switch assembly.

**Fig. 9: Locating Lead Wire Nut**

- b. Remove the 2 screws holding the magnetic switch to the starter drive housing.
- c. Remove the magnet starter switch assembly.
- d. Remove the return spring and plunger from the starter drive housing.

**Fig. 10: Locating Magnetic Switch Screws****2. REMOVE STARTER YOKE ASSEMBLY**

- a. Remove the 2 through-bolts, and pull out the starter yoke assembly together with the starter commutator end frame assembly.

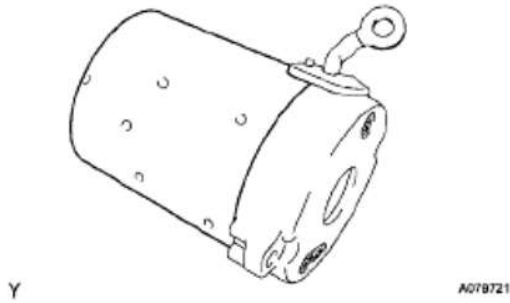


**2009 Toyota Highlander Limited**

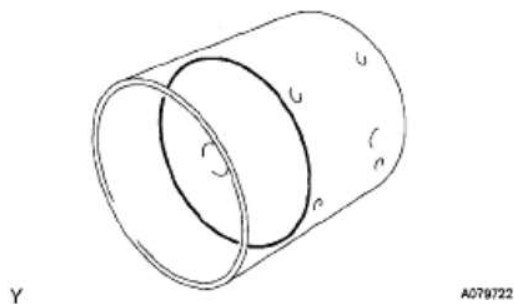
## 2009 ENGINE Starting (1AR-FE) - Highlander

**Fig. 11: Locating Starter Yoke Assembly Through-Bolts**

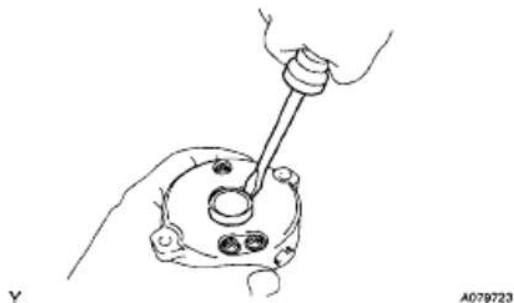
- b. Remove the starter yoke assembly from the starter commutator end frame assembly.

**Fig. 12: Identifying Starter Yoke Assembly****3. REMOVE STARTER ARMATURE PLATE**

- a. Remove the starter armature assembly plate from the starter yoke assembly.

**Fig. 13: Identifying Starter Armature Assembly Plate****4. REMOVE STARTER COMMUTATOR END FRAME COVER**

- a. Using a screwdriver, pry out the starter commutator end frame cover to remove it.

**Fig. 14: Prying Out Starter Commutator End Frame Cover****5. REMOVE STARTER ARMATURE ASSEMBLY**

- a. Using snap ring pliers, remove the snap ring and plate washer.

## 2009 Toyota Highlander Limited

### 2009 ENGINE Starting (1AR-FE) - Highlander

- b. Remove the starter armature assembly from the starter commutator end frame assembly.

**NOTE:** Do not drop the starter armature assembly.

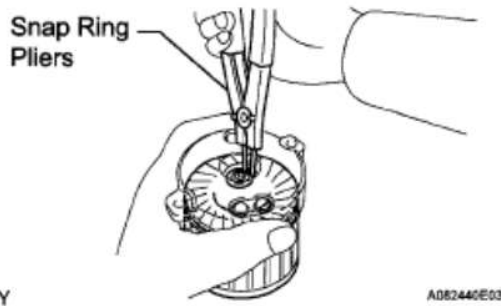


**Fig. 15: Removing Snap Ring And Plate Washer**

#### 6. REMOVE PLANETARY GEAR

- a. Remove the 3 planetary gears from the starter drive housing.

#### INSPECTION

##### 1. INSPECT STARTER ASSEMBLY

**NOTE:** These tests must be performed within 3 to 5 seconds to avoid burning out the coil.



**Fig. 16: Locating Planetary Gears In Starter Drive Housing**

- a. Perform a pull-in test.
1. Remove the nut and disconnect the lead wire from terminal C.
  2. Connect the battery to the magnet starter switch assembly as shown in the illustration. Check that the clutch pinion gear extends. If the clutch pinion gear does not move, replace the magnet starter switch assembly.

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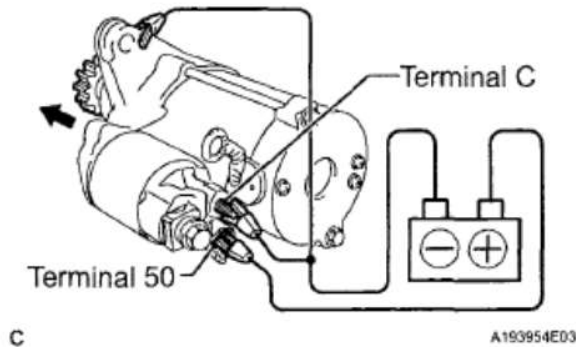


**Fig. 17: Connecting Battery To Magnet Starter Switch Assembly**

- b. Perform a hold-in test.
  1. While maintaining the battery connections of the pull-in test above, disconnect the negative (-) lead from terminal C. Check that the pinion gear remains extended.

If the clutch pinion gear returns inward, replace the magnet starter switch assembly.

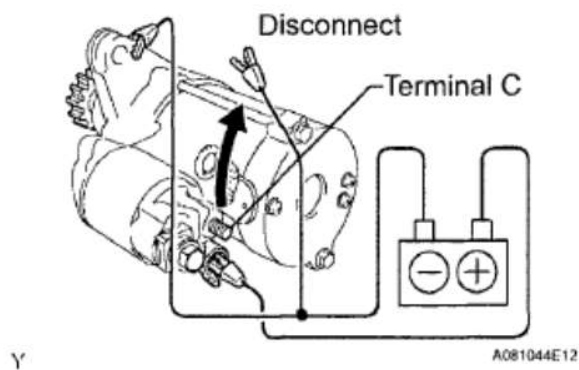


**Fig. 18: Identifying Starter - Hold-In Test**

- c. check the clutch pinion gear return test.
  1. Disconnect the negative (-) lead from the starter body. Check that the clutch pinion gear returns.

If the clutch pinion gear does not return, replace the magnet starter switch assembly.

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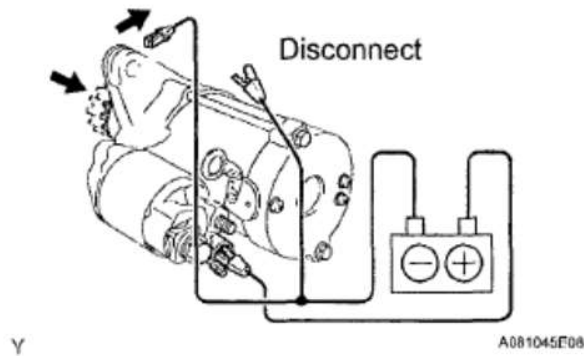


**Fig. 19: Identifying Starter - Clutch Pinion Gear Return Test**

d. Perform a no-load performance test.

1. Connect the lead wire to terminal C with the nut. Make sure that the lead is not grounded.

**Torque: 10 N\*m (102 kgf\*cm, 7 ft.\*lbf)**

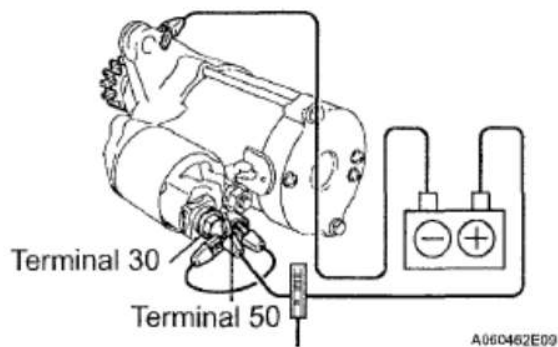


**Fig. 20: Identifying Starter - No-Load Performance Test**

2. Clamp the starter in a vise.
3. Connect the battery and an ammeter to the starter as shown in the illustration.
4. Check that the starter rotates smoothly and steadily while the pinion gear is moving out. Then measure the current.

**Standard current:**

**90 A or less at 11.5 V**

If the result is not as specified, replace the starter assembly.

## 2. INSPECT MAGNETIC SWITCH ASSEMBLY

a. Check the plunger.

1. Push in the plunger and check that it returns quickly to its original position.

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### 2009 ENGINE Starting (1AR-FE) - Highlander

If necessary, replace the magnetic switch assembly.

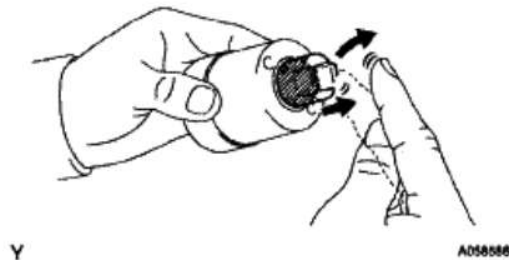


**Fig. 21: Checking Plunger**

- b. Check if the pull-in coil has an open circuit.
  1. Measure the resistance between terminals 50 and C.

#### Standard Resistance

#### STANDARD RESISTANCE

| Tester Connection        | Condition | Specified Condition |
|--------------------------|-----------|---------------------|
| Terminal 50 - Terminal C | Always    | Below 1 ohms        |

If the result is not as specified, replace the magnetic switch assembly.

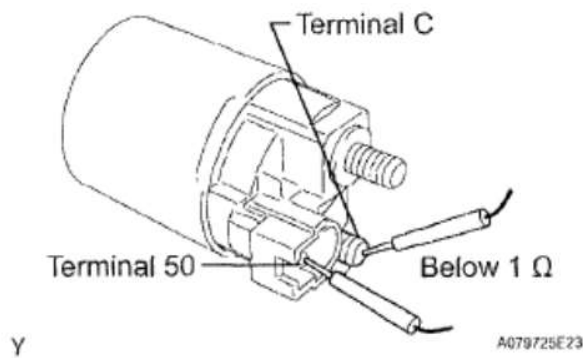


**Fig. 22: Checking Pull-In Coil Has An Open Circuit**

- c. Check if the hold-in coil has an open circuit.
  1. Measure the resistance between terminal 50 and the switch body.

#### Standard Resistance

#### STANDARD RESISTANCE

| Tester Connection         | Condition | Specified Condition |
|---------------------------|-----------|---------------------|
| Terminal 50 - Switch body | Always    | Below 2 ohms        |

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If the result is not as specified, replace the magnetic switch assembly.

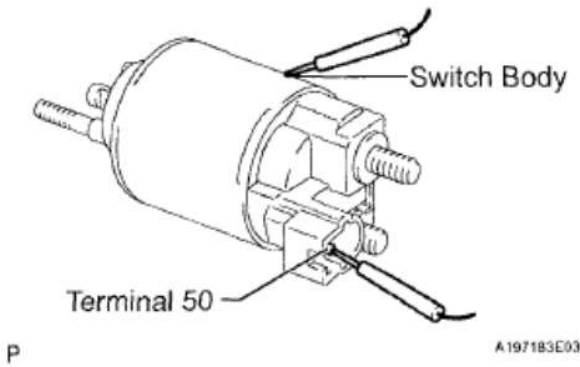


**Fig. 23: Checking Hold-In Coil Has An Open Circuit**

3. INSPECT STARTER ARMATURE ASSEMBLY

HINT:

If there is no commutator between any segment, replace the starter armature assembly.

- a. Check the surface of the commutator for dirt and burns.

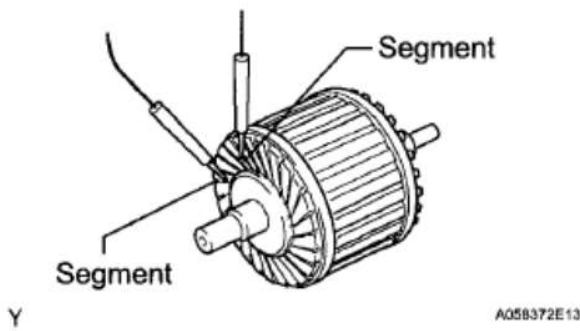
If the surface is dirty or burnt, correct it with sandpaper (No. 400) or a lathe.

- b. Inspect the commutator for an open circuit.
  - 1. Measure the resistance between the segments of the segment.

**Standard Resistance**

| STANDARD RESISTANCE |           |                     |
|---------------------|-----------|---------------------|
| Tester Connection   | Condition | Specified Condition |
| Segment - Segment   | Always    | Below 1 ohms        |

If the result is not as specified, replace the starter armature assembly.



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**Fig. 24: Inspecting Commutator For An Open Circuit**

- c. Check if the commutator is grounded.
  - 1. Measure the resistance between the commutator and armature coil core.

**Standard Resistance**

**STANDARD RESISTANCE**

| Tester Connection               | Condition | Specified Condition |
|---------------------------------|-----------|---------------------|
| Commutator - Armature coil core | Always    | 10 kohms or higher  |

If the result is not as specified, replace the starter armature assembly.

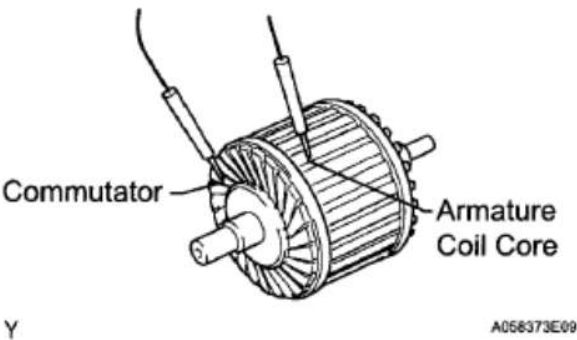


**Fig. 25: Checking Commutator Is Grounded**

- d. Using a vernier caliper, measure the commutator length.

**Standard length:**

**3.1 to 3.8 mm (0.122 to 0.149 in.)**

**Maximum length:**

**3.8 mm (0.149 in.)**

If the length is more than the maximum, replace the starter armature assembly.

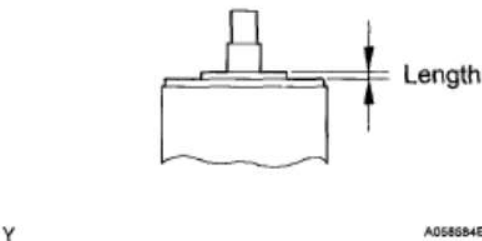


**Fig. 26: Identifying Commutator Length**

**2009 Toyota Highlander Limited****2009 ENGINE Starting (1AR-FE) - Highlander****4. INSPECT STARTER COMMUTATOR END FRAME ASSEMBLY**

- a. Using a vernier caliper, measure the brush length.

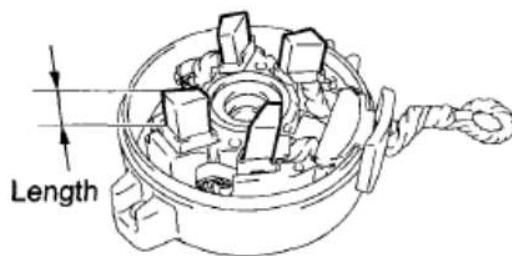
**Standard length:**

**4.0 to 9.0 mm (0.158 to 0.354 in.)**

**Minimum length:**

**4.0 mm (0.158 in.)**

If the length is less than the minimum, replace the starter commutator end frame assembly.



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**Fig. 27: Identifying Brush Length**

- b. Inspect the insulation.
1. Measure the resistance according to the value(s) in the table below.

**Standard Resistance**

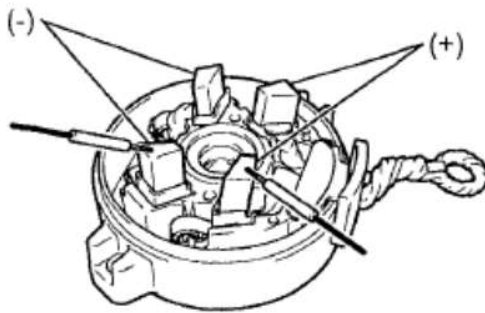
**STANDARD RESISTANCE**

| Tester Connection                       | Condition | Specified Condition |
|-----------------------------------------|-----------|---------------------|
| Positive (+) brush - Negative (-) brush | Always    | 10 kohms or higher  |

If the result is not as specified, replace the starter commutator end frame assembly.

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### 2009 ENGINE Starting (1AR-FE) - Highlander



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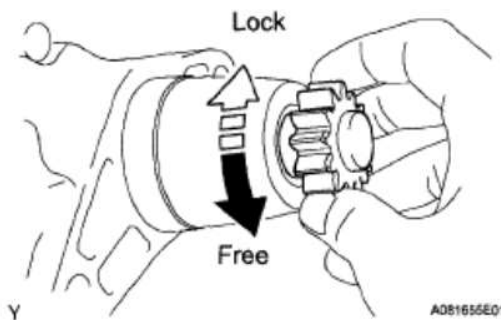
**Fig. 28: Inspecting Insulation**

#### 5. INSPECT STARTER CLUTCH

##### a. Check the starter clutch.

1. Rotate the clutch pinion gear counterclockwise and check that it turns freely. Try to rotate the clutch pinion gear clockwise and check that it locks.

If necessary, replace the starter repair the starter drive housing assembly.



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**Fig. 29: Checking Starter Clutch**

#### REASSEMBLY

##### HINT:

Use high-temperature grease to lubricate the bearings, gears and return spring when assembling the starter.

#### 1. INSTALL PLANETARY GEAR

- a. Apply grease to the planetary gears and pin parts of the planetary shaft.
- b. Install the 3 planetary gears.

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2009 ENGINE Starting (1AR-FE) - Highlander

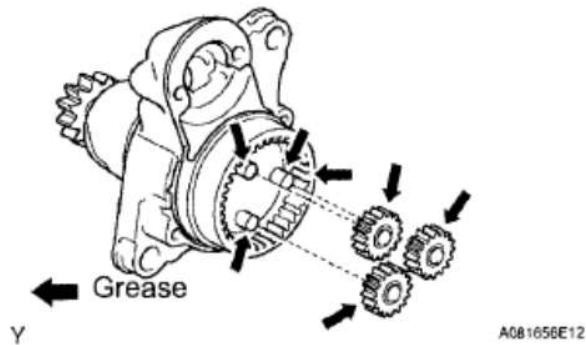


**Fig. 30: Identifying Planetary Gears Grease Applying Areas**

### 2. INSTALL STARTER ARMATURE ASSEMBLY

- a. Apply grease to the plate washer and the armature shaft.

**NOTE:**

- Be sure to install the snap ring in the armature shaft groove securely.
- Be sure to properly install the snap ring because it expands easily.

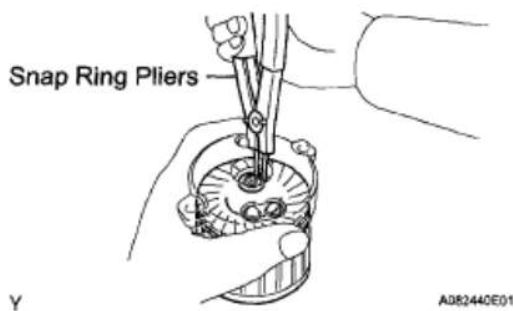


**Fig. 31: Installing Plate Washer And Snap Ring**

- b. Install the starter armature assembly to the starter commutator end frame assembly.
- c. Using snap ring pliers, install the plate washer and a new snap ring.
- d. Using a vernier caliper, measure the length of the snap ring.

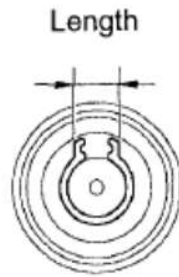
**Maximum length:**

**5.0 mm (0.197 in.)**

If the length is greater than the maximum, replace it with a new snap ring.

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2009 ENGINE Starting (1AR-FE) - Highlander



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A058810E23

**Fig. 32: Identifying Length Of Snap Ring**

### 3. INSTALL STARTER COMMUTATOR END FRAME COVER

- a. Install the starter commutator end frame cover to the starter commutator end frame assembly.



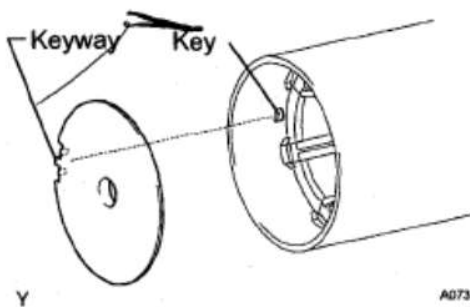
Y

A081178

**Fig. 33: Installing Starter Commutator End Frame Cover To Starter Commutator End Frame Assembly**

### 4. INSTALL STARTER ARMATURE PLATE

- a. Insert the starter armature plate into the starter yoke assembly.
- b. Align the keyway of the starter armature plate with the key inside the starter yoke assembly, and install the starter armature plate.



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A073991E04

**Fig. 34: Aligning Keyway Of Starter Armature Plate With Key Inside Starter Yoke Assembly**

### 5. INSTALL STARTER COMMUTATOR END FRAME ASSEMBLY

- a. Align the rubber of the end frame assembly with the cutout of the starter yoke assembly.
- b. Install the end frame assembly to the starter yoke assembly.

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2009 ENGINE Starting (1AR-FE) - Highlander

**NOTE:** The magnet of the starter yoke assembly may attract the starter armature assembly when the starter commutator end frame assembly is installed, causing the magnet to break.

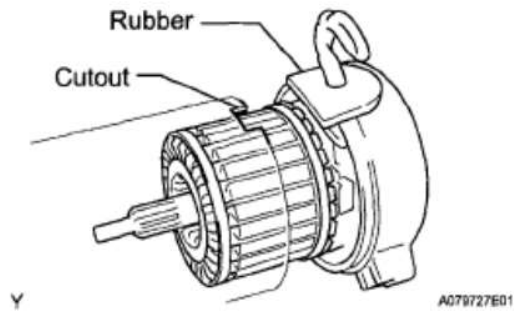


**Fig. 35: Aligning Rubber Of End Frame Assembly With Cutout Of Starter Yoke Assembly**

### 6. INSTALL STARTER YOKE ASSEMBLY

- a. Align the protrusion of the starter yoke assembly with the cutout of the starter drive housing.

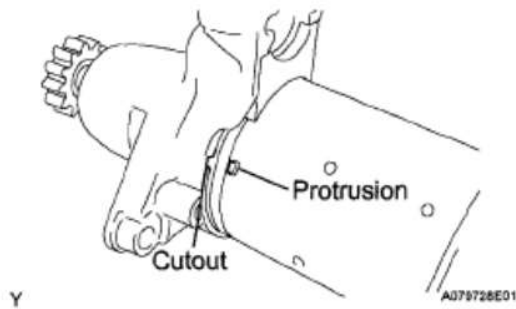


**Fig. 36: Aligning Protrusion Of Starter Yoke Assembly With Cutout Of Starter Drive Housing**

- b. Install the starter yoke assembly with the 2 through-bolts.

**Torque: 6.0 N\*m (61 kgf\*cm, 53 in.\*lbf)**



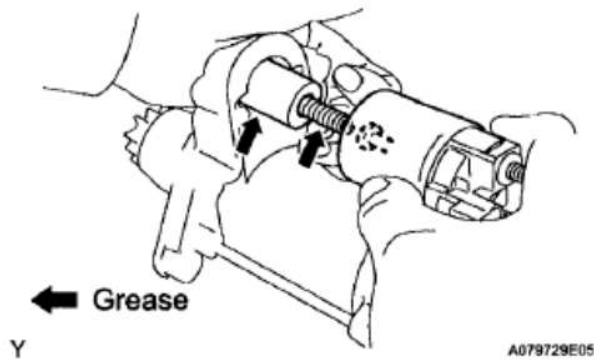
**Fig. 37: Locating Starter Yoke Assembly Through-Bolts**

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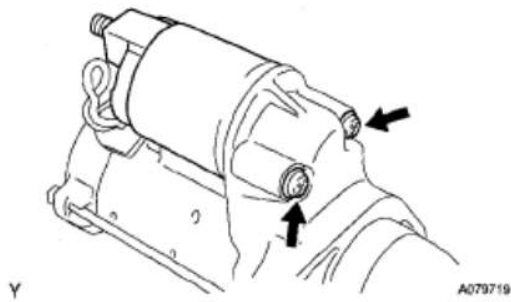
2009 ENGINE Starting (1AR-FE) - Highlander

**7. INSTALL REPAIR SERVICE STARTER KIT**

- a. Apply grease to the plunger and the hook.
- b. Hang the plunger hook of the magnetic switch to the drive lever.
- c. Install the plunger and return spring.

**Fig. 38: Installing Plunger And Return Spring**

- d. Install the magnetic switch with the 2 screws.

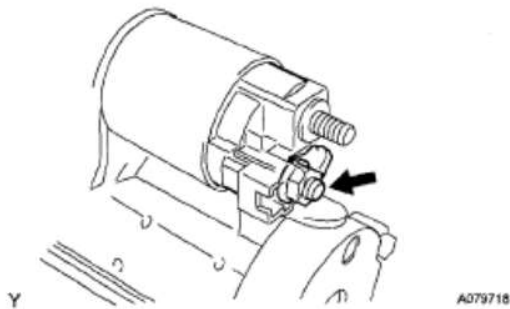
**Torque: 7.5 N\*m (76 kgf\*cm, 66 in.\*lbf)****Fig. 39: Locating Magnetic Switch Screws**

- e. Connect the lead wire to the magnet starter switch with the nut.

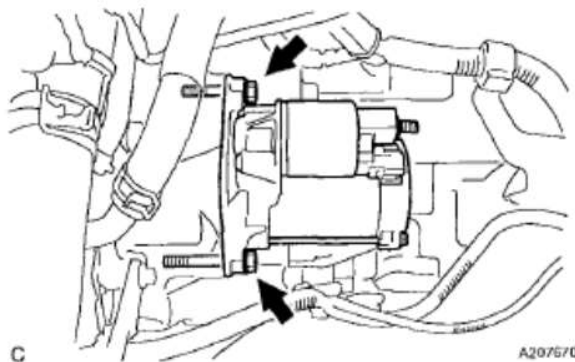
**Torque: 10 N\*m (102 kgf\*cm, 7 ft.\*lbf)**

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**Fig. 40: Locating Magnet Starter Switch Lead Wire Nut****INSTALLATION****1. INSTALL STARTER ASSEMBLY**

- a. Install the starter with the 2 bolts.

**Torque: 37 N\*m (377 kgf\*cm, 27 ft.\*lbf)****Fig. 41: Locating Starter Bolts**

- b. Connect the starter connector.
- c. Install the terminal nut and cover the nut with the cap.

**Torque: 9.8 N\*m (100 kgf\*cm, 87 in.\*lbf)**

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2009 ENGINE Starting (1AR-FE) - Highlander

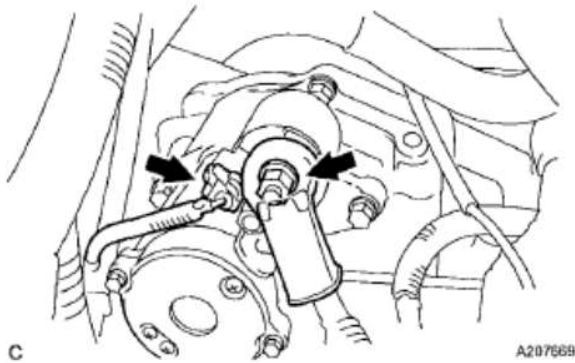


**Fig. 42: Locating Starter Connector And Terminal Nut**

2. INSTALL NO. 1 INLET AIR CLEANER (See INSTALLATION )
3. INSTALL AIR CLEANER BRACKET (See INSTALLATION )
4. INSTALL AIR CLEANER CASE SUB-ASSEMBLY (See INSTALLATION )
5. INSTALL AIR CLEANER FILTER ELEMENT SUB-ASSEMBLY (See INSTALLATION )
6. INSTALL AIR CLEANER CAP SUB-ASSEMBLY (See INSTALLATION )
7. INSTALL NO. 2 INLET AIR CLEANER (See INSTALLATION )
8. INSTALL BATTERY (See INSTALLATION )
9. INSTALL NO. 1 ENGINE COVER SUB-ASSEMBLY (See INSTALLATION )
10. INSTALL COOL AIR INTAKE DUCT SEAL (See INSTALLATION )
11. CONNECT CABLE TO NEGATIVE BATTERY TERMINAL

**NOTE:** When disconnecting the cable, some systems need to be initialized after the cable is reconnected (See INITIALIZATION ).

## STARTER RELAY

### ON-VEHICLE INSPECTION

1. INSPECT STARTER RELAY (ST)
  - a. Measure the resistance according to the value(s) in the table below.

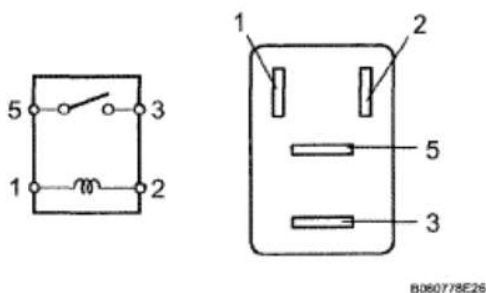


**Fig. 43: Inspecting Starter Relay (ST)**

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2009 ENGINE Starting (1AR-FE) - Highlander

**Standard Resistance****STANDARD RESISTANCE**

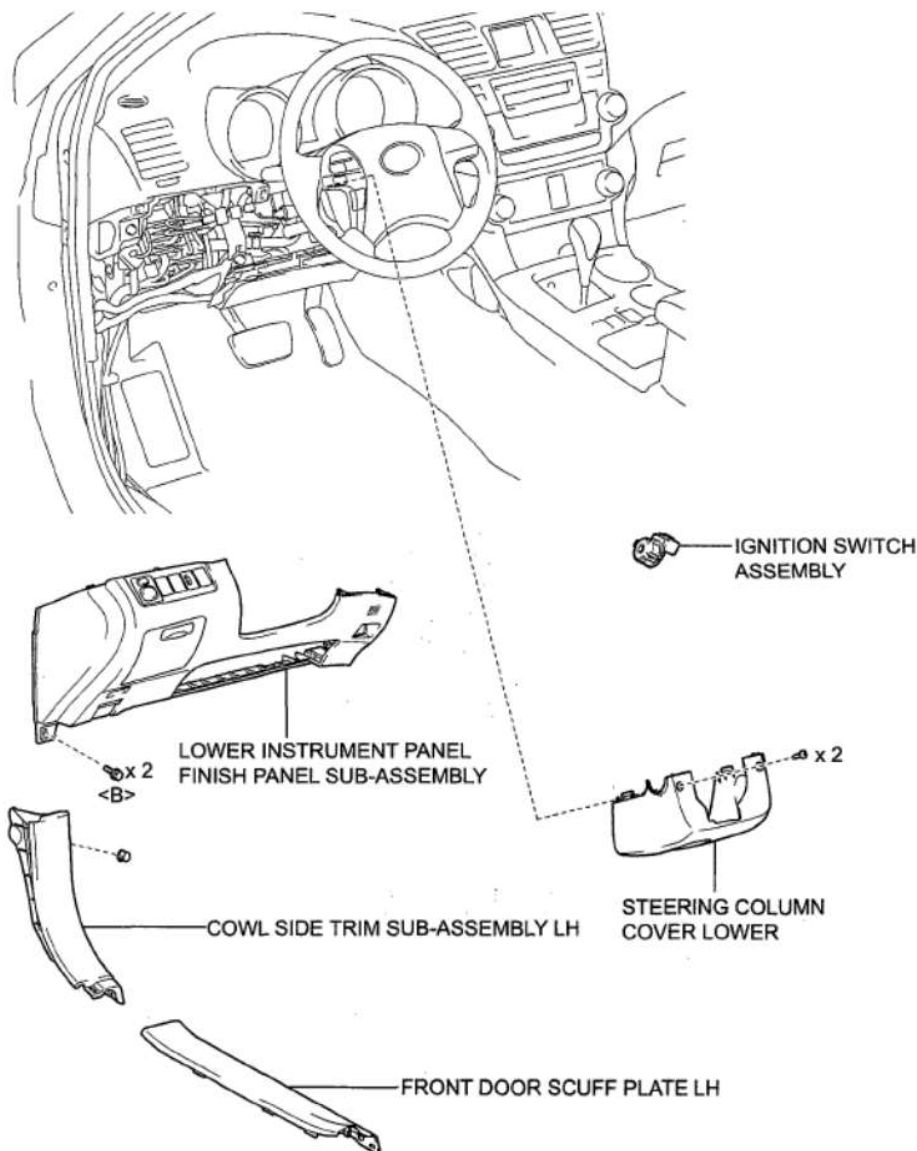
| Tester Connection | Condition                                        | Specified Condition |
|-------------------|--------------------------------------------------|---------------------|
| 3 - 5             | Battery voltage not applied to terminals 1 and 2 | 10 kohms or higher  |
|                   | Battery voltage applied to terminals 1 and 2     | Below 1 ohms        |

If the result is not as specified, replace the relay.

**IGNITION SWITCH****COMPONENTS**

## 2009 Toyota Highlander Limited

2009 ENGINE Starting (1AR-FE) - Highlander



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**Fig. 44: Identifying Ignition Switch Components**

### REMOVAL

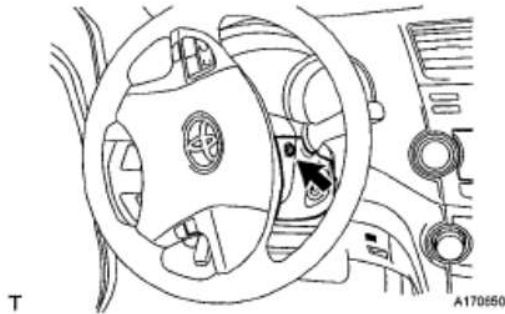
#### 1. DISCONNECT CABLE FROM NEGATIVE BATTERY TERMINAL

**CAUTION:** Wait at least 90 seconds after disconnecting the cable from the negative (-) battery terminal to disable the SRS system.

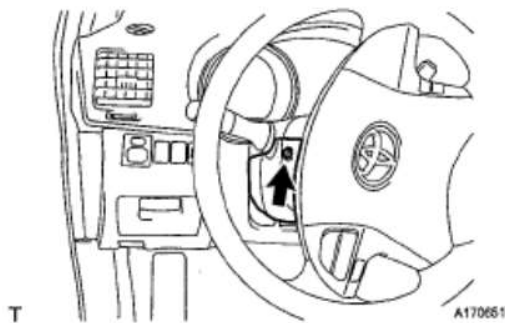
**NOTE:** When disconnecting the cable, some systems need to be initialized after the cable is reconnected (See INITIALIZATION ).

**2009 Toyota Highlander Limited****2009 ENGINE Starting (1AR-FE) - Highlander****2. REMOVE STEERING COLUMN COVER LOWER**

- a. Insert the key into the ignition key cylinder and release the steering lock.
- b. Turn the steering wheel clockwise to gain access to the screw and remove the screw.

**Fig. 45: Locating Steering Column Cover Lower Screw**

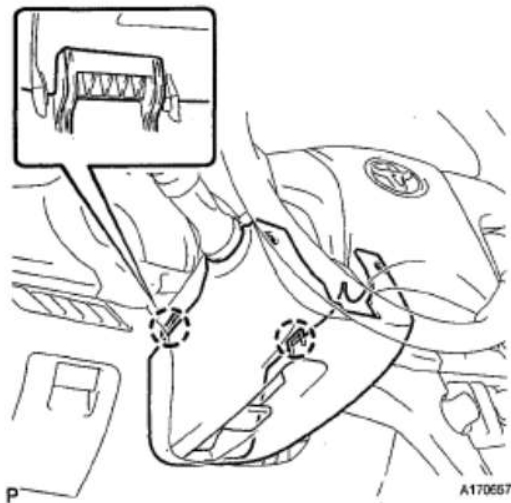
- c. Turn the steering wheel counterclockwise to gain access to the screw and remove the screw.
- d. Release the tilt lever.

**Fig. 46: Locating Steering Column Cover Lower Screw**

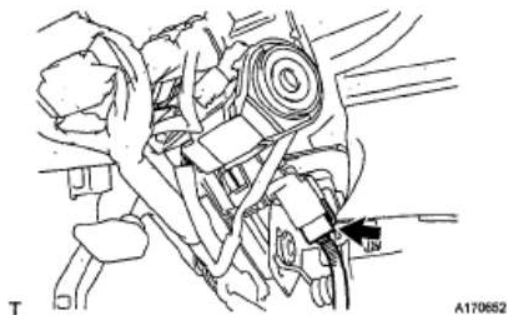
- e. Disengage the 2 claws and remove the steering column cover lower.
3. **REMOVE FRONT DOOR SCUFF PLATE LH** (See **REMOVAL** )
4. **REMOVE COWL SIDE TRIM SUB-ASSEMBLY LH** (See **REMOVAL** )
5. **REMOVE LOWER INSTRUMENT PANEL FINISH PANEL SUB-ASSEMBLY** (See **REMOVAL** )

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**Fig. 47: Identifying Steering Column Cover Lower Claws****6. REMOVE IGNITION SWITCH ASSEMBLY**

- a. Disconnect the ignition switch connector.

**Fig. 48: Locating Ignition Switch Connector**

- b. Disengage the 2 claws and remove the ignition switch.

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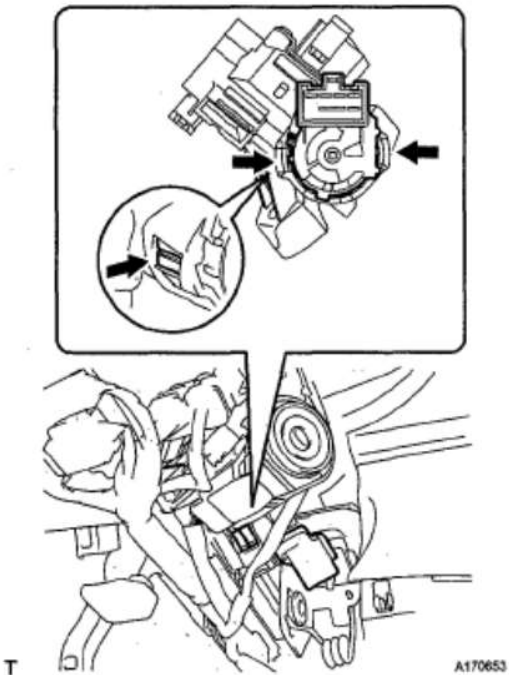


Fig. 49: Locating Ignition Switch Claws

INSPECTION

1. INSPECT IGNITION SWITCH ASSEMBLY
- a. Measure the resistance according to the value(s) in the table below.

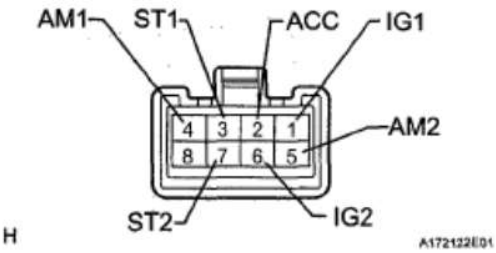


Fig. 50: Identifying Ignition Switch Connector Terminals

Standard Resistance

STANDARD RESISTANCE

| Tester Connection                                           | Switch Condition | Specified Condition |
|-------------------------------------------------------------|------------------|---------------------|
| Between each terminal                                       | LOCK             | 10 kohms or higher  |
| 4 (AM1) - 2 (ACC)                                           | ACC              | Below 1 ohms        |
| 4 (AM1) - 2 (ACC)<br>4 (AM1) - 1 (IG1)<br>5 (AM2) - 6 (IG2) | ON               | Below 1 ohms        |

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|                   |       |              |
|-------------------|-------|--------------|
| 4 (AM1) - 1 (IG1) | START | Below 1 ohms |
| 4 (AM1) - 3 (ST1) |       |              |
| 5 (AM2) - 6 (IG2) |       |              |
| 5 (AM2) - 7 (ST2) |       |              |

If the result is not as specified, replace the switch assembly.

## INSTALLATION

### 1. INSTALL IGNITION SWITCH ASSEMBLY

- a. Engage the 2 claws to install the ignition switch.

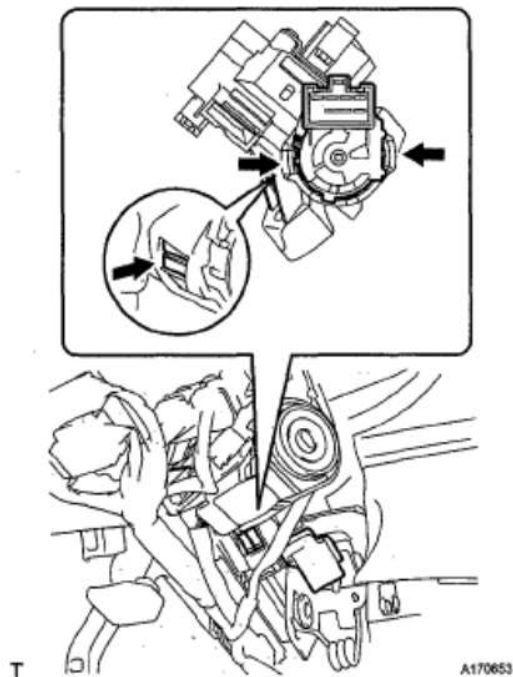


**Fig. 51: Locating Ignition Switch Claws**

- b. Connect the ignition switch connector.
2. **INSTALL LOWER INSTRUMENT PANEL FINISH PANEL SUB-ASSEMBLY** (See **INSTALLATION** )
3. **INSTALL COWL SIDE TRIM SUB-ASSEMBLY LH** (See **INSTALLATION** )
4. **INSTALL FRONT DOOR SCUFF PLATE LH** (See **INSTALLATION** )

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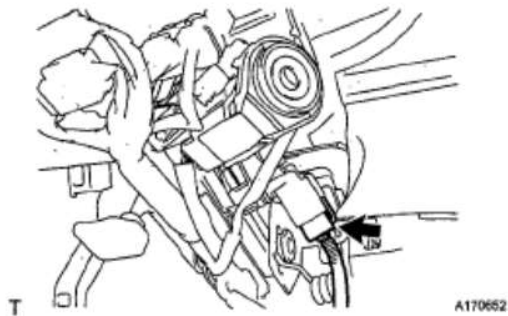


**Fig. 52: Locating Ignition Switch Connector**

### 5. INSTALL STEERING COLUMN COVER LOWER

- a. Engage the 2 claws to install the steering column cover lower.

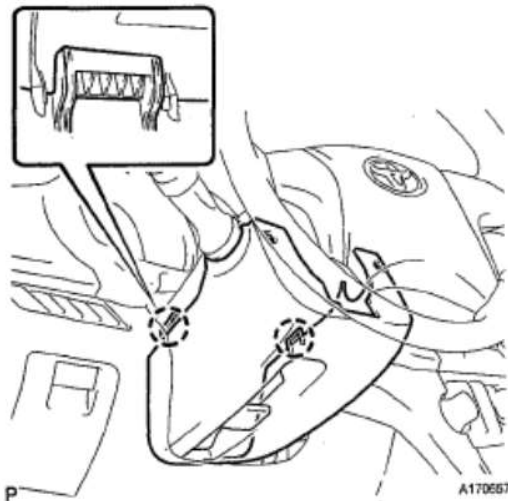


**Fig. 53: Identifying Steering Column Cover Lower Claws**

- b. Insert the key into the ignition key cylinder and release the steering lock.
- c. Turn the steering wheel counterclockwise and install the screw.

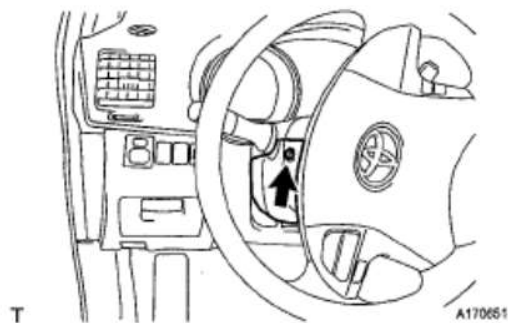


**Fig. 54: Locating Steering Column Cover Lower Screw**

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d. Turn the steering wheel clockwise and install the screw.

**6. CONNECT CABLE TO NEGATIVE BATTERY TERMINAL**

**NOTE:** When disconnecting the cable, some systems need to be initialized after the cable is reconnected (See INITIALIZATION ).

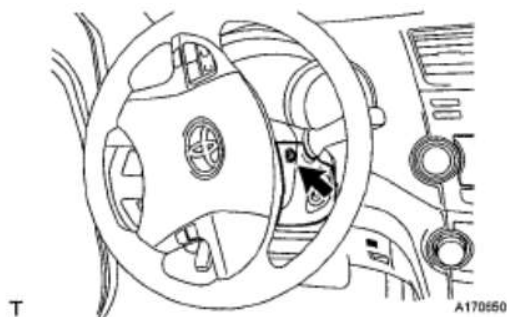


**Fig. 55: Locating Steering Column Cover Lower Screw**