





Starting System

Special Tool(s)

 ST1137-A	73III Automotive Meter 105-R0057 or equivalent
 ST2574-A	Flex Probe Kit 105-R025C or equivalent
 ST2173-A	SABRE Premium Battery and Electrical System Tester 010-00730 or equivalent
 ST2834-A	Vehicle Communication Module (VCM) and Integrated Diagnostic System (IDS) software with appropriate hardware, or equivalent scan tool

Principles of Operation

The starting system is electronically controlled by the passive anti-theft system (PATS). The PATS recognizes the correct electronically coded ignition key and signals the PCM to provide a ground for the starter relay. The energized relay provides voltage to the starter solenoid with the key in the START position, thereby allowing the starter motor to activate.

Inspection and Verification

⚠️ WARNING: Always disconnect the battery ground cable at the battery before disconnecting the starter motor battery terminal lead. If a tool is shorted at the starter motor battery terminal, the tool can quickly heat enough to cause a skin burn. Failure to follow this instruction may result in serious personal injury.

NOTE: When working on the starter system, make sure the anti-theft system is deactivated, if equipped.

1. Verify the customer concern by operating the starting system.
2. Remove the accessory drive belt. Refer to [Section 303-05](#). Verify the crankshaft and each of the components driven by the accessory drive belt rotate and are not seized or damaged.
3. Visually inspect for obvious signs of mechanical and electrical damage. Refer to the following chart:

Visual Inspection Chart

Mechanical	Electrical
<ul style="list-style-type: none"> • Starter motor • Flexplate • Flywheel 	<ul style="list-style-type: none"> • Battery • Smart junction box (SJB) fuse: <ul style="list-style-type: none"> ▪ 21 (10A) • Bussed electrical center (BEC) fuse: <ul style="list-style-type: none"> ▪ 4 (30A) • Anti-theft system • Damaged wiring harness • Loose or corroded connections

4. If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding to the next step.
5. **NOTE:** *Make sure to use the latest scan tool software release.*
If the cause is not visually evident, connect the scan tool to the data link connector (DLC).
6. **NOTE:** *The vehicle communication module (VCM) LED prove out confirms power and ground from the DLC are provided to the VCM.*
If the scan tool does not communicate with the VCM:
 - check the VCM connection to the vehicle.
 - check the scan tool connection to the VCM.
 - refer to [Section 418-00](#), No Power To The Scan Tool, to diagnose no communication with the scan tool.
7. If the scan tool does not communicate with the vehicle:
 - verify the ignition key is in the ON position.
 - verify the scan tool operation with a known good vehicle.
 - refer to [Section 418-00](#) to diagnose no response from the PCM.
8. Carry out the network test.
 - If the scan tool responds with no communication for one or more modules, refer to [Section 418-00](#).
 - If the network test passes, retrieve and record continuous memory DTCs.
9. Clear the continuous DTCs and carry out the self-test diagnostics for the PCM.
10. If the DTCs retrieved are related to the concern, go to Passive Anti-Theft System (PATS) DTC Chart. For all other DTCs, refer to [Section 419-10](#).
11. If no DTCs related to the concern are retrieved, GO to [Symptom Chart](#).

Passive Anti-Theft System (PATS) — DTC Chart

DTC	Description	Source	Action
B1213	Anti-Theft Number of Programmed Keys is Below Minimum	PCM	REFER to Section 419-01B .
B1232	Transceiver Failure	PCM	REFER to Section 419-01B .
B1342	ECU is Faulted	PCM	CLEAR the DTCs. REPEAT the self-test. If DTC B1342 is retrieved again, INSTALL a PCM. REFER to Section 303-14 . CLEAR the DTCs. REPEAT the self-test.
B1600	PATS Ignition Key Transponder Signal Is Not Received	PCM	REFER to Section 419-01B .
B1601	PATS Received Incorrect Key-Code From Ignition Key Transponder	PCM	REFER to Section 419-01B .
B1602	PATS Received Invalid Format of Key-Code From Ignition Key Transponder	PCM	REFER to Section 419-01B .
B1681	PATS Transceiver Module Signal Is Not Received	PCM	REFER to Section 419-01B .
B2103	Antenna Not Connected	PCM	REFER to Section 419-01B .
B2431	Transponder Programming Failed	PCM	REFER to Section 419-01B .
P1260	Theft Detected, Vehicle Immobilized	PCM	REPAIR the PCM. REFER to Powertrain Control/Emissions Diagnosis (PC/ED) manual.

Symptom Chart

Symptom Chart

Condition	Possible Causes	Action
<ul style="list-style-type: none"> The engine does not crank 	<ul style="list-style-type: none"> Battery Fuse Starter relay Starter motor Ignition switch Circuitry open Digital transmission range (TR) sensor (automatic transmission only) Clutch pedal position (CPP) switch (manual transmission only) 	<ul style="list-style-type: none"> GO to Pinpoint Test A.
<ul style="list-style-type: none"> Unusual starter noise 	<ul style="list-style-type: none"> Starter motor mounting Starter motor Incorrect starter drive engagement Damaged flexplate or flywheel ring gear teeth 	<ul style="list-style-type: none"> GO to Pinpoint Test B.
<ul style="list-style-type: none"> The engine cranks slowly 	<ul style="list-style-type: none"> Battery Starter motor 	<ul style="list-style-type: none"> CARRY OUT the starter motor component test.
<ul style="list-style-type: none"> The starter spins but the engine does not crank 	<ul style="list-style-type: none"> Starter motor Damaged flywheel or flexplate ring gear teeth 	<ul style="list-style-type: none"> INSPECT the starter motor mounting and engagement. REFER to Starter Motor Drive Gear and Flywheel Ring Gear Inspection in this section. INSPECT the flywheel or flexplate for damaged, missing or worn teeth. REPAIR as necessary.

Pinpoint Tests

Pinpoint Test A: The Engine Does Not Crank

Refer to Wiring Diagrams Cell [20](#) , Starting System for schematic and connector information.

Normal Operation

In normal operation, voltage from the bussed electrical center (BEC) is supplied to the ignition switch through circuit 1050 (LG/PK). When the ignition switch is placed in the START position, voltage is supplied through circuit 1522 (DG) to the smart junction box (SJB).

For automatic transmission equipped vehicles, voltage is supplied from the SJB on circuit 32 (RD/LB) to the BEC, from the BEC power is supplied to the digital transmission range (TR) sensor through circuit 33 (WH/PK). In PARK or NEUTRAL, voltage is supplied from the TR sensor through circuit 33 (WH/PK) to the starter relay coil located in the BEC. The starter relay coil is supplied ground from the PCM through circuit 1419 (LG/YE).

For manual transmission equipped vehicles, when the clutch pedal is depressed, the clutch pedal position switch (CPP) supplies a ground to the PCM through circuit 92 (LB/YE). The starter relay coil is supplied ground from the PCM through circuit 1419 (LG/YE). Voltage is supplied to the starter relay coil located in the BEC through circuit 33 (WH/PK).

When the starter relay is energized, voltage supplied to the relay switch is sent to the starter motor solenoid through circuit 113 (YE/LB). Battery voltage is supplied to the starter motor through circuit 2037 (RD) at all times.

This pinpoint test is intended to diagnose the following:

- Fuse(s)
- An open in circuit 1050 (LG/PK), 1522 (DG), 32 (RD/LB), 33 (WH/PK), 1419 (LG/YE), 92 (LB/YE), 113 (YE/LB) or 2037 (RD)
- Starter motor
- Starter relay
- Battery

PINPOINT TEST A : THE ENGINE DOES NOT CRANK

A1 CHECK THE BATTERY

- Check the battery condition and charge. Refer to [Section 414-00](#).

Is the battery OK?

Yes	GO to A2 .
No	CHARGE or INSTALL a new battery. REFER to Section 414-00 . TEST the system for normal operation.

A2 CHECK FOR PASSIVE ANTI-THEFT SYSTEM (PATS) DTCS

- **NOTE:** *The passive anti-theft system (PATS) DTCs are the only DTCs of concern in this step. Only repair retrieved non-PATS DTCs if a customer concern is reported.*

Check for PATS DTCs.

Were any PATS DTCs retrieved?

Yes	GO to Section 419-01B to repair the PATS system DTCs before proceeding with this test.
No	GO to A3 .

A3 CHECK TRANSMISSION RANGE SENSOR OPERATION

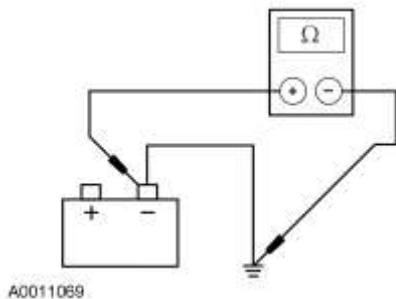
- Enter the following diagnostic mode on the scan tool: PCM Transmission Range Sensor PID.
- While observing the PCM Transmission Range Sensor PID, place the vehicle in PARK and then NEUTRAL.

Does the PID match the gear selection?

Yes	GO to A4 .
No	GO to Section 307-01 to diagnose the transmission range sensor.

A4 CHECK THE BATTERY GROUND CABLE

- Measure the resistance between the negative battery post and the battery ground cable connection on the engine.

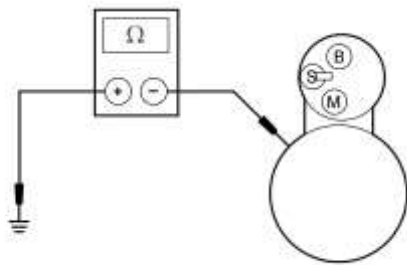


Is the resistance greater than 5 ohms?

No	GO to A5 .
Yes	INSTALL a new battery ground cable. TEST the system for normal operation.

A5 CHECK THE STARTER MOTOR GROUND

- Measure the resistance between the starter motor case and ground.



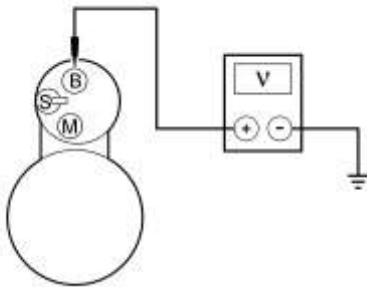
A0011103

Is the resistance greater than 5 ohms?

No	GO to A6 .
Yes	CLEAN the starter motor mounting flange and make sure the starter motor is correctly mounted. TEST the system for normal operation.

A6 CHECK THE POWER SUPPLY TO THE STARTER MOTOR

- Measure the voltage between starter motor B-terminal and ground.



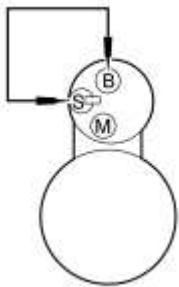
AJ0278-A

Is the voltage greater than 10 volts?

Yes	GO to A7 .
No	INSTALL a new positive battery cable. TEST the system for normal operation.

A7 CHECK THE STARTER MOTOR SOLENOID OPERATION

- Connect a fused jumper wire to the B-terminal of the starter motor. Momentarily connect the other lead of the fused jumper wire to the starter motor S-terminal.



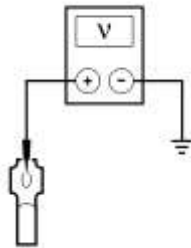
AJ0279-A

Did the starter motor engage and the engine crank?

Yes	GO to A8 .
No	INSTALL a new starter motor. TEST the system for normal operation.

A8 CHECK THE START INPUT TO THE STARTER MOTOR

- Disconnect: Starter Motor S-Terminal.
- Measure the voltage between starter motor S-terminal connector [C197B](#), circuit 113 (YE/LB), and ground, while holding the ignition switch in the START position, depress clutch pedal for manual transmission.



AJ0443-A

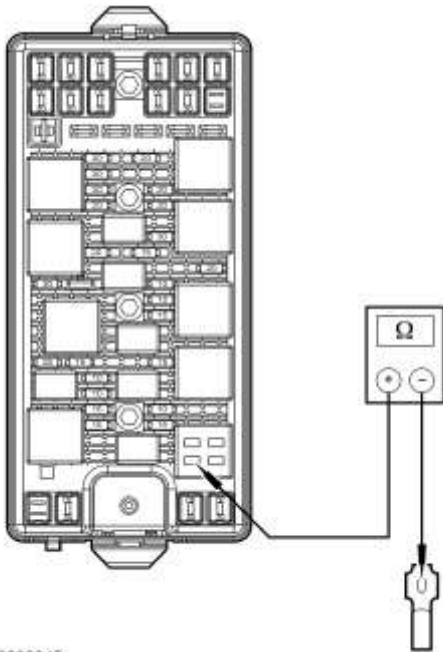
Is the voltage greater than 10 volts in START?

Yes	CLEAN the starter motor S-terminal and connector. CHECK the wiring and the starter motor for a loose connection. TEST the system for normal operation.
No	GO to A9 .

A9 CHECK CIRCUIT 113 (YE/LB) FOR AN OPEN

NOTICE: Use the correct probe adapter(s) when making measurements. Failure to use the correct probe adapter(s) may damage the connector.

- Measure the resistance between BEC starter relay pin 87, circuit 113 (YE/LB), and starter motor S-terminal connector [C197B](#), circuit 113 (YE/LB).



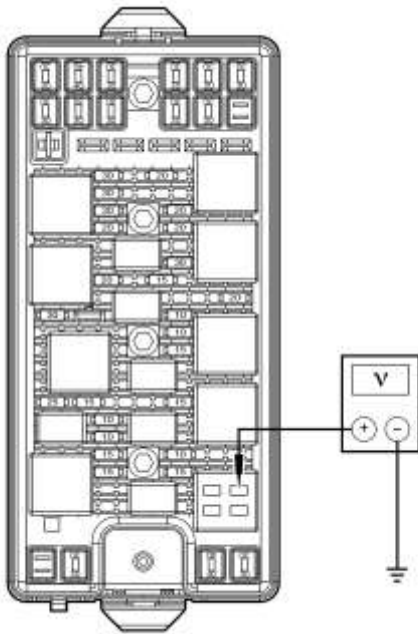
N0060345

Is the resistance less than 5 ohms?

Yes	GO to A10 .
No	REPAIR circuit 113 (YE/LB) for an open. TEST the system for normal operation.

A10 CHECK THE BATTERY SUPPLY TO THE STARTER RELAY

- Measure the voltage between BEC starter relay pin 30, circuit 2037 (RD) and ground.



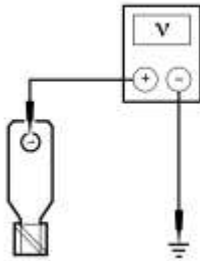
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Is the voltage greater than 10 volts?

Yes	GO to A12 .
No	GO to A11 .

A11 CHECK THE BATTERY SUPPLY TO THE BEC

- Disconnect: BEC Connector 1035E.
- Measure the voltage between BEC [C1035E](#) Pin 1, and ground.



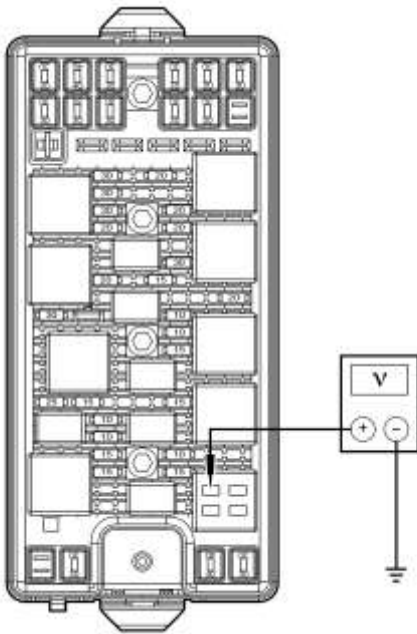
N0060251

Is the voltage greater than 10 volts?

Yes	REPLACE the BEC. TEST the system for normal operation.
No	REPAIR circuit 2037 (RD) for an open. TEST the system for normal operation.

A12 CHECK THE START INPUT TO THE STARTER RELAY

- Disconnect: Starter Relay.
- Measure the voltage between BEC starter relay pin 86, circuit 33 (WH/PK) and ground, while holding the ignition switch in the START position.



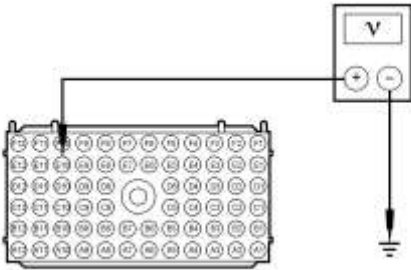
N0014499

Is the voltage greater than 10 volts?

Yes	GO to A16 .
No	GO to A13 .

A13 CHECK THE START INPUT VOLTAGE TO THE BEC

- Disconnect: BEC C1035B.
- Measure the voltage between BEC [C1035B](#) Pin E10, circuit 33 (WH/PK) and ground, while holding the ignition switch in the START position.



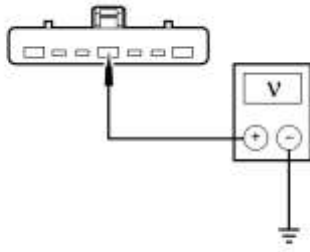
N0060252

Is the voltage greater than 10 volts?

Yes	REPLACE the BEC. TEST the system for normal operation.
No	GO to A14 .

A14 CHECK THE POWER SUPPLY TO THE IGNITION SWITCH

- Disconnect: Ignition Switch C250.
- Measure the voltage between ignition switch [C250](#) Pin 4, circuit 1050 (LG/VT) and ground.



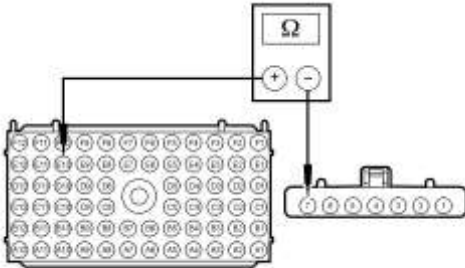
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Is the voltage greater than 10 volts?

Yes	GO to A15 .
No	REPAIR circuit 1050 (LG/VT) for an open. TEST the system for normal operation.

A15 CHECK CIRCUIT 1522 (DG) AND 33 (WH/PK) FOR AN OPEN

- Measure the resistance between ignition switch [C250](#) Pin 7, circuit 1522 (DG) and [C1035B](#) Pin E10, circuit 33 (WH/PK).



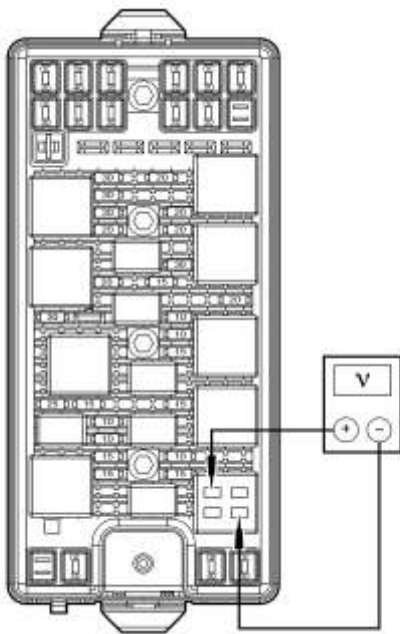
N0060253

Is the resistance less than 5 ohms?

Yes	INSTALL a new ignition switch. REFER to Section 211-05 . TEST the system for normal operation.
No	REPAIR circuit 1522 (DG) or circuit 33 (WH/PK) for an open. TEST the system for normal operation.

A16 CHECK THE GROUND SIGNAL TO THE STARTER RELAY

- Measure the voltage between BEC starter relay pin 85, circuit 1419 (LG/YE), and starter relay pin 86, circuit 33 (WH/PK), while holding the ignition switch in the START position, (depress clutch pedal for manual transmission).



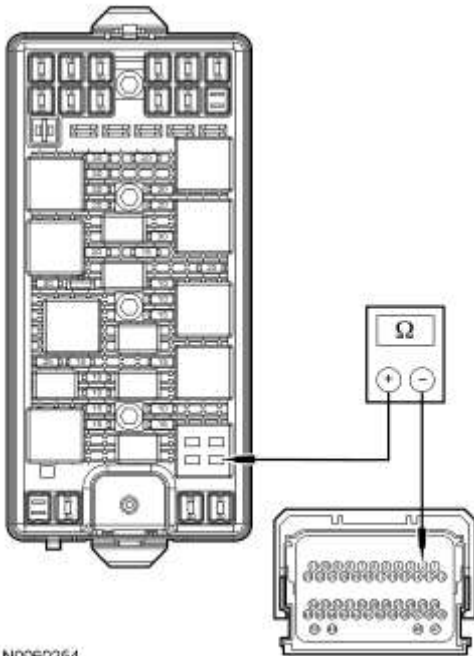
N001449B

Is the voltage greater than 10 volts?

Yes	INSTALL a new starter relay. TEST the system for normal operation.
No	For automatic transmission, GO to A17 . For manual transmission, GO to A18 .

A17 CHECK CIRCUIT 1419 (LG/YE) FOR AN OPEN

- Disconnect: PCM C175B.
- Measure the resistance between BEC starter relay pin 85, circuit 1419 (LG/YE) and PCM [C175B](#) Pin 2, circuit 1419 (LG/YE).



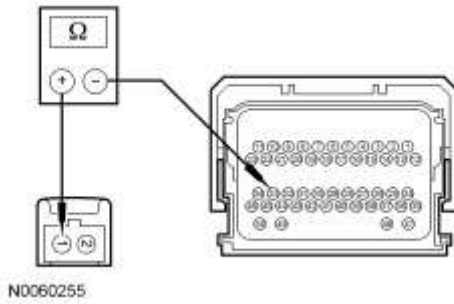
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Is the resistance less than 5 ohms?

Yes	INSTALL a new PCM. REFER to Section 303-14 . TEST the system for normal operation.
No	REPAIR circuit 1419 (LG/YE) for an open. TEST the system for normal operation.

A18 CHECK CIRCUIT 92 (LB/YE) FOR AN OPEN

- Disconnect: PCM C175B and Clutch Pedal Position (CPP) Switch C257.
- Measure the resistance between CPP switch [C257](#) Pin 1, circuit 92 (LB/YE) and PCM [C175B](#) Pin 33, circuit 92 (LB/YE).

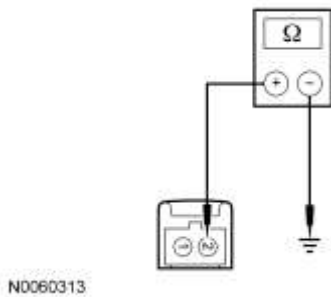


Is the resistance less than 5 ohms?

Yes	GO to A19 .
No	REPAIR circuit 92 (LB/YE) for an open. TEST the system for normal operation.

A19 CHECK CIRCUIT 1205 (BK) FOR AN OPEN

- Measure the resistance between CPP switch [C257](#) Pin 2, and ground.

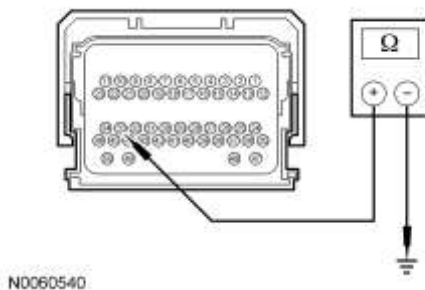


Is the resistance less than 5 ohms?

Yes	GO to A20 .
No	REPAIR circuit 1205 (BK) for an open. TEST the system for normal operation.

A20 CHECK CPP SWITCH

- Connect: CPP Switch C257.
- Measure the resistance between PCM [C175B](#) Pin 33, circuit 92 (LB/YE) and ground, while depressing the clutch pedal.

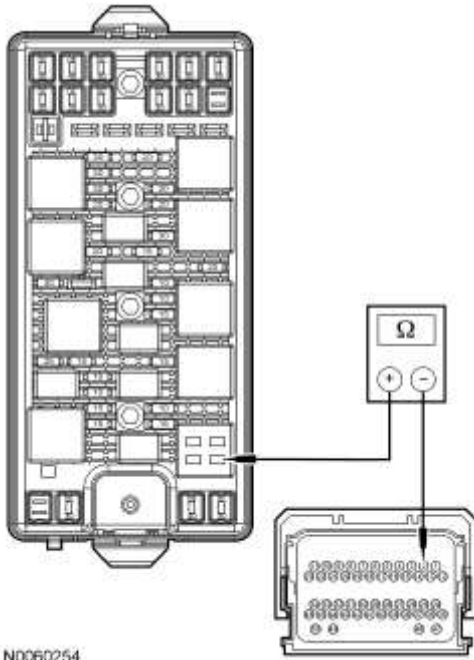


Is the resistance less than 5 ohms?

Yes	GO to A21 .
No	Replace the CPP switch. REFER to Section 303-14 . TEST the system for normal operation.

A21 CHECK CIRCUIT 1419 (LG/YE) FOR AN OPEN

- Disconnect: PCM C175B.
- Measure the resistance between BEC starter relay pin 85, circuit 1419 (LG/YE) and PCM [C175B](#) Pin 2, circuit 1419 (LG/YE).



Is the resistance less than 5 ohms?

Yes	INSTALL a new PCM. REFER to Section 303-14 . TEST the system for normal operation.
No	REPAIR circuit 1419 (LG/YE) for an open. TEST the system for normal operation.

Pinpoint Test B: Unusual Starter Noise

This pinpoint test is intended to diagnose the following:

- Starter motor
- Ring gear

PINPOINT TEST B : UNUSUAL STARTER NOISE

B1 CHECK THE STARTER MOUNTING

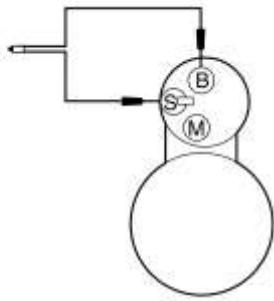
- Inspect the starter mounting bolts and brackets for looseness.

Is the starter motor mounted correctly?

Yes	GO to B2 .
No	INSTALL the starter motor correctly. REFER to Starter Motor — 4.0L SOHC or Starter Motor — 4.6L (3V) or Starter Motor — 5.4L (4V) in this section. TEST the system for normal operation.

B2 CHECK FOR ENGINE NOISE

- Ignition OFF.
- Connect a remote starter switch between the starter solenoid B and S terminals.



AJ0286-A

- Engage the starter motor and verify the noise is due to the starter operation.

Is the noise due to the starter motor engagement?

Yes	GO to B3 .
No	REFER to Section 303-00 to continue diagnosis.

B3 CHECK FOR UNUSUAL WEAR

- Remove the starter motor.
- Inspect the ring gear for damaged or worn teeth. Refer to [Section 303-01A](#), [Section 303-01B](#) or [Section 303-01C](#).

Is the noise due to ring gear tooth damage?

Yes	INSTALL a new ring gear. REFER to Section 303-01A , Section 303-01B or Section 303-01C . EXAMINE the starter pinion teeth. If damaged, INSTALL a new starter motor. REFER to Starter Motor — 4.0L SOHC or Starter Motor — 4.6L (3V) or Starter Motor — 5.4L (4V) in this section TEST the system for normal operation.
No	INSTALL a new starter motor. REFER to Starter Motor — 4.0L SOHC or Starter Motor — 4.6L (3V) or Starter Motor — 5.4L (4V) in this section TEST the system for normal operation.

Component Tests

Starter Motor — Load Test

⚠ WARNING: Always disconnect the battery ground cable at the battery before disconnecting the starter motor battery terminal lead. If a tool is shorted at the starter motor battery terminal, the tool can quickly heat enough to cause a skin burn. Failure to follow this instruction may result in serious personal injury.

NOTE: A protective cap or boot is provided over the battery input terminal and must be installed after repair.

- Before carrying out this test inspection, check the battery to determine its state of charge. Carry out a load test of the battery using the Starter, Alternator, Battery, Regulator and Electrical Tester (SABRE). Refer to [Section 414-00](#) for the test procedure.
- Disconnect the ignition coil connector from the ignition coil.
- Connect the SABRE tester to the vehicle using the amperage lead clipped around the positive battery cable.
- Measure the amperage of the starter motor while activating the starting system.
- A correctly operating starter motor will draw from 130 to 190 amps of current.

Starter Motor — Voltage Drop Tests

The following test procedures will be carried out with the starter motor on the vehicle.

Starter Motor — Motor Feed Circuit

NOTE: Make all multimeter connections at the component terminal rather than the cable or wiring terminal.

1. Disconnect the ignition coil connector from the ignition coil.
2. Connect a remote starter switch between the starter solenoid S-terminal and the battery positive (+) post.
3. Connect the positive (+) lead of the 73III Automotive Meter to the battery positive (+) post. Connect the negative (-) lead of the multimeter to the starter solenoid M-terminal.
4. Engage the remote starter switch. The multimeter reading should be 0.5 volt or less.
5. If the voltage at the M-terminal is greater than 0.5 volt, move the multimeter negative (-) lead to the starter solenoid B-terminal and repeat the test.
6. If the voltage reading at the B-terminal is less than 0.5 volt, the problem is either in the connections at the starter solenoid or the starter solenoid.
7. Remove the wires at the starter solenoid B-, S- and M-terminals. Clean the connections and install the cables. Repeat Steps 1 through 5 above. If the reading is still higher than 0.5 volt at the M-terminal and 0.5 volt or lower at the B-terminal, the problem is in the starter solenoid. Install a new starter motor. Refer to [Starter Motor — 4.0L SOHC](#) or [Starter Motor — 4.6L \(3V\)](#) or [Starter Motor — 5.4L \(4V\)](#) in this section.
8. If the voltage taken at the starter solenoid B-terminal is greater than 0.5 volt, the problem is either the positive (+) battery cable connection or the positive (+) battery cable.

Starter Motor — Motor Ground Circuit

NOTE: Make all multimeter connections at the component terminal rather than the cable or wiring terminal.

A slow cranking condition can be caused by resistance in the ground or return portion of the cranking circuit. Check the voltage drop in the ground circuit as follows:


1. Disconnect the ignition coil connector from the ignition coil.
2. Connect a remote starter switch between the starter solenoid S-terminal and the battery positive (+) terminal.
3. Connect the positive (+) lead of a 73III Automotive Meter to the starter motor housing. The connection must be clean and free of rust or grease. Connect the negative (-) lead to the negative (-) battery terminal.
4. Engage the remote starter switch and read the voltage. The reading should be 0.2 volt or less.
5. If the voltage drop is greater than 0.2 volt, clean the negative (-) battery cable connections at the battery and chassis. Also, clean the engine ground cable connection at the cable mounting bracket. If the voltage drop is still excessive, repair or install a new battery ground cable.

Starter Motor — Starter Drive Test

1. Remove the starter motor. Refer to [Starter Motor — 4.0L SOHC](#) or [Starter Motor — 4.6L \(3V\)](#) or [Starter Motor — 5.4L \(4V\)](#) in this section.
2. Secure the starter motor in a vise.
3. Connect the battery ground cable of a fully charged battery to the case of the starter motor.
4. **NOTE:** Do not leave the positive lead of the battery connected to the starter motor S-terminal for more than 10 seconds.
Touch the positive lead from the battery to the S-terminal and verify that the starter drive ejects.
5. Remove the positive lead from the starter motor. The ejected starter drive should return to its original position.
6. If the starter drive does not eject and return to position, replace the starter motor.
7. Check the starter drive. It should turn freely in one direction, and positively engage to the armature when turned in the opposite direction. If not as specified, install a new starter motor.

Starter Motor — No Load Test

The starter No Load Test will identify open or shorted windings and a possible rubbing starter motor armature or bent starter motor armature shaft.

1.  **WARNING:** Securely mount the starter motor to the bench when bench testing. The starter motor may move or jump when it is energized. Failure to follow this instruction may result in serious personal injury.

Connect a fully charged battery, a Starter, Alternator, Battery, Regulator and Electrical Tester (SABRE) and a remote starter switch to the starter motor. Connect the remote starter switch between the battery positive (+) post and the starter motor S-terminal. Connect the starter motor B-terminal to the battery positive (+) post. Connect the SABRE positive (+) terminal and negative (-) terminal to the corresponding battery post. Make sure that the battery and starter motor are grounded.

2. Engage the remote starter switch.
3. The starter motor should eject the starter drive and run smoothly. If the starter motor does not run smoothly, install a new starter motor.
4. While the starter motor is running, check the voltmeter and ammeter.
5. The voltage should be greater than 11.0 volts and the amperage should be no more than 70 amps.
6. If the voltage is lower than the 11.0 volts, or the amperage is higher than 70 amps, install a new starter motor.