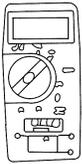
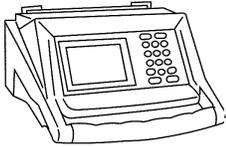
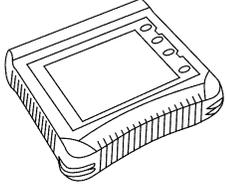


DIAGNOSIS AND TESTING

Starting System

Refer to Wiring Diagrams Cell 20, Starting System for schematic and connector information.

Special Tool(s)

 <p>ST1137-A</p>	<p>73 Digital Multimeter 105-R0051 or equivalent</p>
 <p>ST2173-A</p>	<p>SABRE Premium Battery and Electrical System Tester 010-00730 or equivalent</p>
 <p>ST2332-A</p>	<p>Worldwide Diagnostic System (WDS) Vehicle Communication Module (VCM) with appropriate adapters, or equivalent diagnostic tool</p>

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 instrument cluster 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: When servicing the starter motor or carrying out other underhood work in the vicinity of the starter motor, be aware that the heavy gauge battery input lead at the starter solenoid is “electrically hot” at all times. A protective cap or boot is provided over the terminal of this lead and must be installed after servicing. Failure to follow these instructions may result in personal injury.

⚠ WARNING: When working in the area of the starter motor, be careful to avoid touching hot exhaust components. Failure to follow these instructions may result in 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. 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 • Brackets 	<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"> — 3 (30A) • Anti-theft system • Damaged wiring harness • Loose or corroded connections

3. If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding to the next step.
4. If the cause is not visually evident, connect the diagnostic tool to the data link connector (DLC) and select the vehicle to be tested from the diagnostic tool menu. If the diagnostic tool does not communicate with the vehicle:
 - check that the program card is correctly installed.
 - check the connections to the vehicle.
 - check the ignition switch position.

DIAGNOSIS AND TESTING (Continued)

5. If the diagnostic tool still does not communicate with the vehicle, refer to the diagnostic tool operating manual.
6. Carry out the diagnostic tool data link test. If the diagnostic tool responds with:
 - [appropriate communication networks, such as SCP, ISO, UBP, CAN] circuit fault; all electronic control units no response/not equipped, refer to Section 418-00.
 - No response/not equipped for generic electronic module (GEM), refer to Section 419-10.
- System passed, retrieve and record the continuous diagnostic trouble codes (DTCs), erase the continuous DTCs and carry out the self-test diagnostics for the GEM.
7. If the DTCs retrieved are related to the concern, go to the Generic Electronic Module (GEM) Diagnostic Trouble Code (DTC) Index.
8. If no DTCs related to the concern are retrieved, GO to [Symptom Chart](#).

Passive Anti-Theft System (PATS) — Diagnostic Trouble Code (DTC) Index

DTC	Description	Source	Action
B1213	Anti-Theft Number Of Programmed Keys Is Below Minimum	Powertrain Control Module (PCM)	REFER to Section 419-01B.
B1342	ECU is Defective	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	Passive Anti-Theft System (PATS) Key Transponder Is Not Received — Damaged Key Or Non-PATS Key	PCM	REFER to Section 419-01B.
B1601	PATS Received Incorrect Key-Code From Key Transponder (Unprogrammed PATS Key)	PCM	REFER to Section 419-01B.
B1602 or B2431	PATS Received Invalid Format Of Key-Code From Key Transponder (Partial Key Read)	PCM	REFER to Section 419-01B.
B1681	PATS Transceiver Module Signal Is Not Received (Damaged, Not Connected Or Damaged Wiring)	PCM	REFER to Section 419-01B.
B2103	Internal Transceiver Antenna Damaged	PCM	REFER to Section 419-01B.
P1260	PCM Disabled — Vehicle Disabled	PCM	REPAIR the PCM. REFER to the Powertrain Control/Emissions Diagnosis (PC/ED) manual.

DIAGNOSIS AND TESTING (Continued)**Symptom Chart****Symptom Chart**

Condition	Possible Sources	Action
<ul style="list-style-type: none"> The engine does not crank and the relay does not click 	<ul style="list-style-type: none"> Battery Fuse Starter relay Ignition switch Digital transmission range (TR) sensor (automatic transmission only) Clutch pedal position (CPP) switch (manual transmission only) Circuit 	<ul style="list-style-type: none"> GO to Pinpoint Test A.
<ul style="list-style-type: none"> The engine does not crank and the relay does click 	<ul style="list-style-type: none"> Fuse Battery Starter motor/solenoid Ignition switch Circuit 	<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/solenoid Circuit 	<ul style="list-style-type: none"> GO to Pinpoint Test C.
<ul style="list-style-type: none"> Unusual starter noise 	<ul style="list-style-type: none"> Starter mounting Flexplate or flywheel Starter motor 	<ul style="list-style-type: none"> GO to Pinpoint Test D.
<ul style="list-style-type: none"> The starter spins but the engine does not crank 	<ul style="list-style-type: none"> Starter motor Damaged flexplate or flywheel ring gear teeth 	<ul style="list-style-type: none"> INSPECT the starter motor mounting and engagement. INSTALL a new starter motor. REFER to Starter Motor — 4.0L SOHC or Starter Motor — 4.6L (3V) in this section. INSPECT the flexplate or flywheel for damaged, missing or worn teeth. REPAIR as required.

Pinpoint Tests**Pinpoint Test A: The Engine Does Not Crank And The Relay Does Not Click****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 to the digital transmission range (TR) sensor through circuit 32 (RD/LB). 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, voltage from the SJB is supplied to the clutch pedal position switch (CPP) through circuit 32 (RD/LB). When the clutch pedal is depressed, voltage is supplied from the CPP to the starter relay coil located in the BEC through circuit 32 (RD/LB). The starter relay coil is supplied ground from the PCM through circuit 1419 (LG/YE).

DIAGNOSIS AND TESTING (Continued)

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.

Possible Causes

- Fuse(s)
- An open in battery voltage feed BEC, 2037 (RD) or 113 (YE/LB)
- Starter motor relay
- Starter

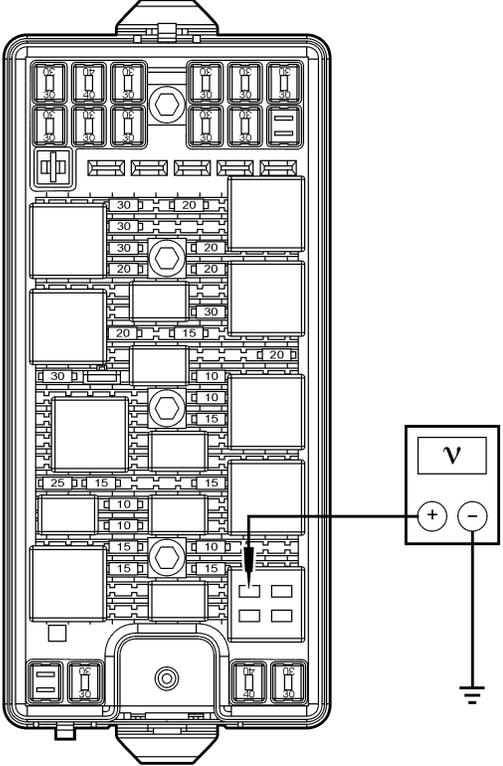
PINPOINT TEST A: THE ENGINE DOES NOT CRANK AND THE RELAY DOES NOT CLICK

Test Step		Result / Action to Take
A1	CHECK THE BATTERY	Yes GO to A2 . No CHARGE or INSTALL a new battery as necessary. REFER to Section 414-01. TEST the system for normal operation.
	<ul style="list-style-type: none"> • Check the battery condition and charge if necessary. Refer to Section 414-01. • Is the battery OK? 	
A2	CHECK FOR PATS DTCS	Yes GO to Section 419-01B to diagnose the PATS DTCS. No GO to A3 .
	<ul style="list-style-type: none"> • NOTE: The 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? 	
A3	CHECK CIRCUIT 33 (WH/PK) (CIRCUIT 32 [RD/LB] MANUAL TRANSMISSION ONLY) FOR VOLTAGE	
	<ul style="list-style-type: none"> • Disconnect: Starter Motor Relay. • Key in START position. • If equipped, fully depress the clutch pedal. 	

(Continued)

DIAGNOSIS AND TESTING (Continued)

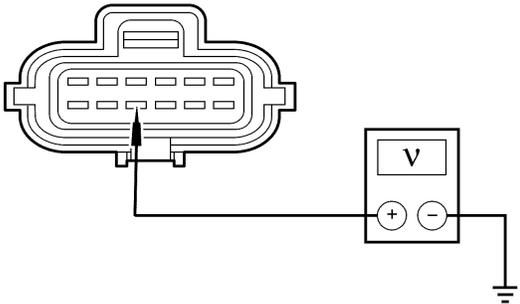
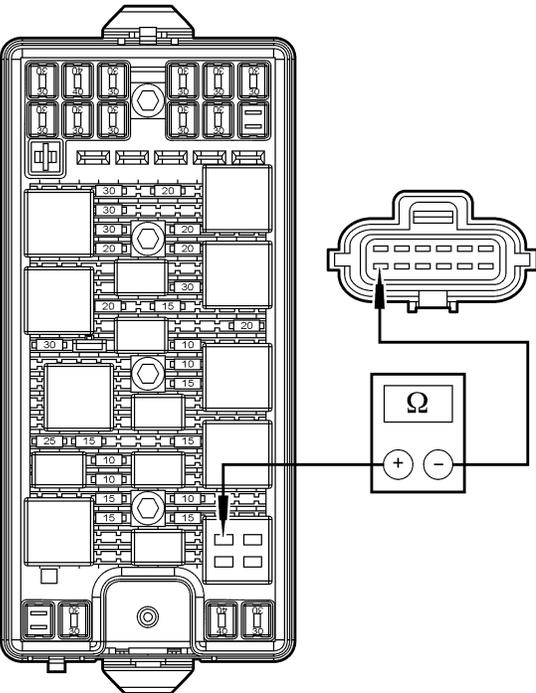
PINPOINT TEST A: THE ENGINE DOES NOT CRANK AND THE RELAY DOES NOT CLICK (Continued)

	Test Step	Result / Action to Take
<p>A3</p>	<p>CHECK CIRCUIT 33 (WH/PK) (CIRCUIT 32 [RD/LB] MANUAL TRANSMISSION ONLY) FOR VOLTAGE (Continued)</p>	
	<ul style="list-style-type: none"> Measure the voltage between starter motor relay C1017-85, circuit 33 (WH/PK) (circuit 32 [RD/LB] manual transmission only) and ground while holding the key in the START position and with the clutch pedal, if equipped, fully depressed.  <p>N0014499</p> <ul style="list-style-type: none"> Is the voltage greater than 10 volts? 	<p>Yes GO to A12.</p> <p>No Vehicles equipped with an automatic transmission, GO to A4. Vehicles equipped with a manual transmission, GO to A7.</p>
<p>A4</p>	<p>CHECK CIRCUIT 32 (RD/LB) FOR VOLTAGE AT THE DIGITAL TR SENSOR (AUTOMATIC TRANSMISSION ONLY)</p>	
	<ul style="list-style-type: none"> Key in OFF position. Disconnect: Digital TR Sensor C167. Key in START position. 	

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DIAGNOSIS AND TESTING (Continued)

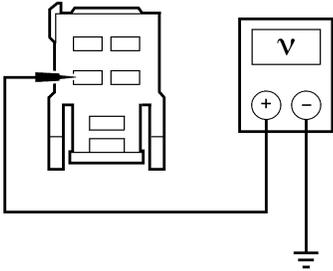
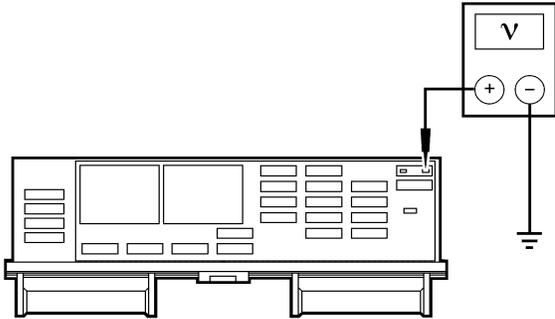
PINPOINT TEST A: THE ENGINE DOES NOT CRANK AND THE RELAY DOES NOT CLICK (Continued)

	Test Step	Result / Action to Take
A4	<p>CHECK CIRCUIT 32 (RD/LB) FOR VOLTAGE AT THE DIGITAL TR SENSOR (AUTOMATIC TRANSMISSION ONLY) (Continued)</p> <ul style="list-style-type: none"> Measure the voltage between digital TR sensor C167-10, circuit 32 (RD/LB) and ground while holding the key in the START position.  <p>A0065013</p> <ul style="list-style-type: none"> Is the voltage greater than 10 volts? 	<p>Yes GO to A5.</p> <p>No GO to A8.</p>
A5	<p>CHECK CIRCUIT 33 (WH/PK) FOR AN OPEN</p> <ul style="list-style-type: none"> Key in OFF position. Measure the resistance between digital TR sensor C167-12, circuit 33 (WH/PK) and starter motor relay C1017-85, circuit 33 (WH/PK).  <p>N0014494</p> <ul style="list-style-type: none"> Is the resistance less than 5 ohms? 	<p>Yes GO to A6.</p> <p>No REPAIR circuit 33 (WH/PK). TEST the system for normal operation.</p>

(Continued)

DIAGNOSIS AND TESTING (Continued)

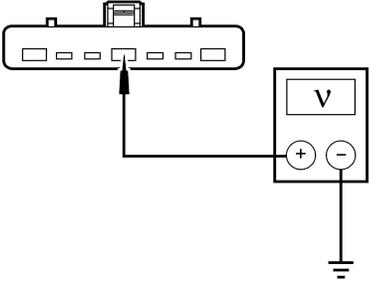
PINPOINT TEST A: THE ENGINE DOES NOT CRANK AND THE RELAY DOES NOT CLICK (Continued)

Test Step		Result / Action to Take
A6	CHECK DIGITAL TR SENSOR ADJUSTMENT	<p>Yes INSTALL a new digital TR sensor. TEST the system for normal operation.</p> <p>No ADJUST the digital TR sensor as necessary. TEST the system for normal operation.</p>
<ul style="list-style-type: none"> Carry out the digital TR sensor adjustment. Refer to Section 307-01. Is the digital TR sensor adjusted correctly? 		
A7	CHECK CIRCUIT 32 (RD/LB) FOR VOLTAGE AT THE CLUTCH PEDAL POSITION (CPP) SWITCH	<p>Yes GO to A11.</p> <p>No GO to A8.</p>
<ul style="list-style-type: none"> Key in OFF position. Disconnect: CPP Switch C257. Key in START position. Measure the voltage between CPP switch C257-1, circuit 32 (RD/LB) and ground while holding the key in the START position. <div style="text-align: center;">  </div> <p>N0014495</p> <ul style="list-style-type: none"> Is the voltage greater than 10 volts? 		
A8	CHECK CIRCUIT 1522 (DG) FOR AN OPEN	<p>Yes REPAIR circuit 32 (RD/LB). TEST the system for normal operation.</p> <p>No GO to A9.</p>
<ul style="list-style-type: none"> Key in OFF position. Disconnect: SJB Fuse 21. Key in START position. Measure the voltage between SJB fuse 21, circuit 1522 (DG) and ground while holding the key in the START position. <div style="text-align: center;">  </div> <p>N0014496</p> <ul style="list-style-type: none"> Is the voltage greater than 10 volts? 		
A9	CHECK CIRCUIT 1050 (LG/PK) FOR VOLTAGE	
<ul style="list-style-type: none"> Key in OFF position. Disconnect: Ignition Switch C250. 		

(Continued)

DIAGNOSIS AND TESTING (Continued)

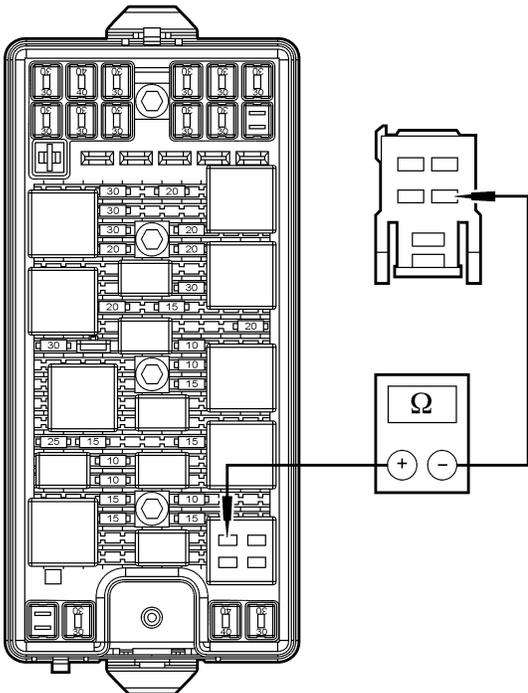
PINPOINT TEST A: THE ENGINE DOES NOT CRANK AND THE RELAY DOES NOT CLICK (Continued)

Test Step		Result / Action to Take
A9	<p>CHECK CIRCUIT 1050 (LG/PK) FOR VOLTAGE (Continued)</p> <ul style="list-style-type: none"> Measure the voltage between ignition switch C250-4, circuit 1050 (LG/PK) and ground.  <p>A0050523</p> <ul style="list-style-type: none"> Is the voltage greater than 10 volts? 	<p>Yes GO to A10.</p> <p>No REPAIR circuit 1050 (LG/PK). TEST the system for normal operation.</p>
A10	<p>CHECK CIRCUIT 1522 (DG) FOR AN OPEN</p> <ul style="list-style-type: none"> Measure the resistance between ignition switch C250-7, circuit 1522 (DG) and SJB fuse 21. Is the resistance less than 5 ohms? 	<p>Yes INSTALL a new ignition switch. REFER to Section 211-05. TEST the system for normal operation.</p> <p>No REPAIR circuit 1522 (DG). TEST the system for normal operation.</p>
A11	<p>CHECK CIRCUIT 32 (RD/LB) FOR AN OPEN</p> <ul style="list-style-type: none"> Key in OFF position. 	

(Continued)

DIAGNOSIS AND TESTING (Continued)

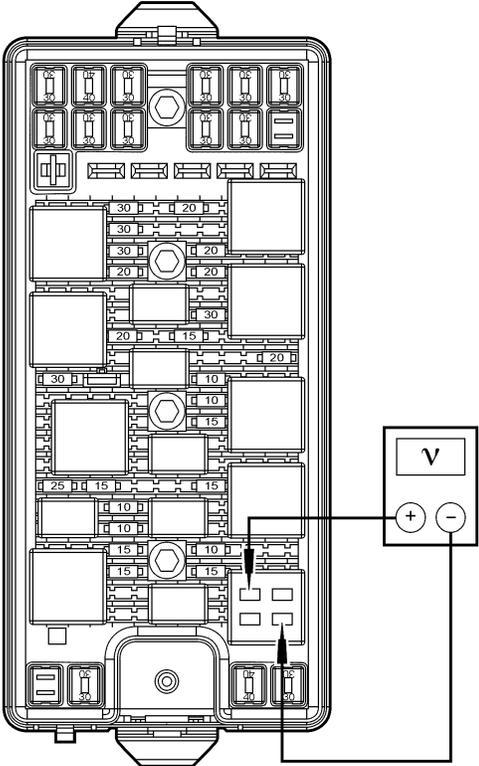
PINPOINT TEST A: THE ENGINE DOES NOT CRANK AND THE RELAY DOES NOT CLICK (Continued)

Test Step		Result / Action to Take
A11	<p>CHECK CIRCUIT 32 (RD/LB) FOR AN OPEN (Continued)</p> <ul style="list-style-type: none"> Measure the resistance between CPP switch C257-2, circuit 32 (RD/LB) and starter motor relay C1017-85, circuit 32 (RD/LB).  <p>N0014497</p> <ul style="list-style-type: none"> Is the resistance less than 5 ohms? 	<p>Yes INSTALL a new CPP switch. REFER to Section 303-14. TEST the system for normal operation.</p> <p>No REPAIR circuit 32 (RD/LB). TEST the system for normal operation.</p>
A12	<p>CHECK THE STARTER MOTOR RELAY GROUND CIRCUIT FOR AN OPEN</p> <ul style="list-style-type: none"> Key in START position. 	

(Continued)

DIAGNOSIS AND TESTING (Continued)

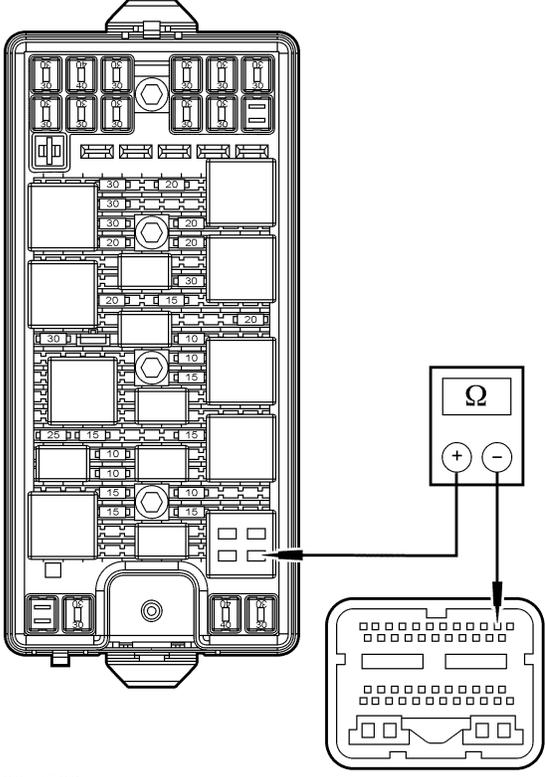
PINPOINT TEST A: THE ENGINE DOES NOT CRANK AND THE RELAY DOES NOT CLICK (Continued)

Test Step		Result / Action to Take
A12	<p>CHECK THE STARTER MOTOR RELAY GROUND CIRCUIT FOR AN OPEN (Continued)</p> <ul style="list-style-type: none"> Measure the voltage between starter motor relay C1017-86, circuit 1419 (LG/YE) and starter motor relay C1017-85, circuit 33 (WH/PK) (circuit 32 [RD/LB] manual transmission only) while holding the key in the START position and clutch pedal, if equipped, fully depressed.  <p>N0014498</p> <ul style="list-style-type: none"> Is the voltage greater than 10 volts? 	<p>Yes INSTALL a new starter motor relay. TEST the system for normal operation.</p> <p>No GO to A13.</p>
A13	<p>CHECK CIRCUIT 1419 (LG/YE) FOR AN OPEN</p> <ul style="list-style-type: none"> Key in OFF position. Disconnect: PCM C175B. 	

(Continued)

DIAGNOSIS AND TESTING (Continued)

PINPOINT TEST A: THE ENGINE DOES NOT CRANK AND THE RELAY DOES NOT CLICK (Continued)

	Test Step	Result / Action to Take
A13	CHECK CIRCUIT 1419 (LG/YE) FOR AN OPEN (Continued)	
	<ul style="list-style-type: none"> Measure the resistance between PCM C175B-2, circuit 1419 (LG/YE) and starter relay C1017-86, circuit 1419 (LG/YE).  <p>N0014500</p>	<p>Yes INSTALL a new PCM. REFER to Section 303-14. TEST the system for normal operation.</p> <p>No REPAIR circuit 1419 (LG/YE). TEST the system for normal operation.</p>
	<ul style="list-style-type: none"> Is the resistance less than 5 ohms? 	

Pinpoint Test B: The Engine Does Not Crank And The Relay Does Click

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 to the digital transmission range (TR) sensor through circuit 32 (RD/LB). 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, voltage from the SJB is supplied to the clutch pedal position switch (CPP) through circuit 32 (RD/LB). When the clutch pedal is depressed, voltage is supplied from the CPP to the starter relay coil located in the BEC through circuit 32 (RD/LB). The starter relay coil is supplied ground from the PCM through circuit 1419 (LG/YE).

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.

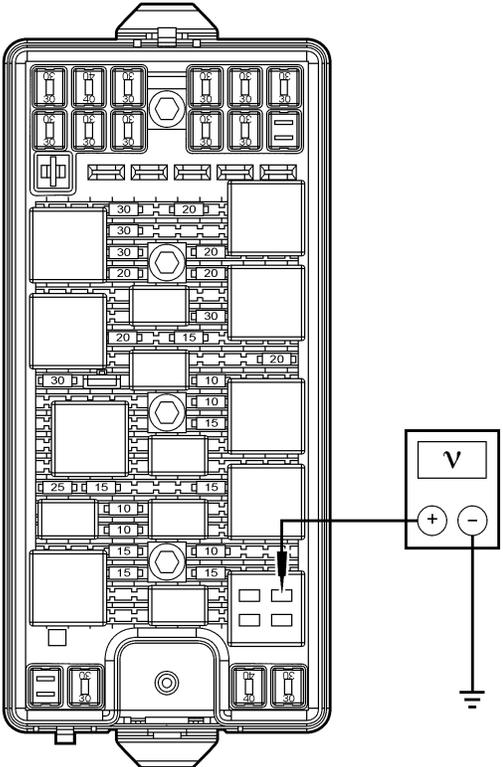
Possible Causes

- Fuse(s)
- An open in circuit 1050 (LG/PK), 1522 (DG), 32 (RD/LB), 33 (WH/PK) or 1419 (LG/YE)
- Powertrain control module (PCM)

DIAGNOSIS AND TESTING (Continued)

- Digital transmission range (TR) switch
- Ignition switch
- Starter motor relay
- Clutch pedal position (CPP) switch

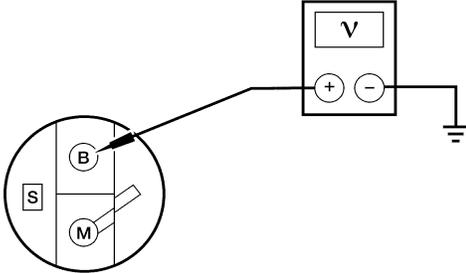
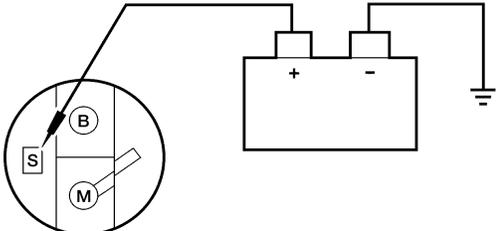
PINPOINT TEST B: THE ENGINE DOES NOT CRANK AND THE RELAY DOES CLICK

	Test Step	Result / Action to Take
B1	CHECK THE VOLTAGE TO THE STARTER RELAY	
	<ul style="list-style-type: none"> • Measure the voltage between starter relay C1017-30 and ground.  <p>The diagram shows a top-down view of an electrical center with various terminals labeled with numbers (e.g., 30, 20, 15, 10, 25). A voltmeter is connected to terminal 30 and a ground symbol. The voltmeter is labeled with a 'V' and '+' and '-' signs.</p> <p>N0014493</p> <ul style="list-style-type: none"> • Is the voltage greater than 10 volts? 	<p>Yes GO to B2.</p> <p>No INSTALL a new bussed electrical center (BEC). TEST the system for normal operation.</p>

(Continued)

DIAGNOSIS AND TESTING (Continued)

PINPOINT TEST B: THE ENGINE DOES NOT CRANK AND THE RELAY DOES CLICK (Continued)

Test Step		Result / Action to Take
B2	<p>CHECK THE VOLTAGE TO THE STARTER MOTOR SOLENOID</p> <ul style="list-style-type: none"> Measure the voltage between starter motor solenoid positive terminal and ground.  <p style="text-align: center;">J6079-A</p> <ul style="list-style-type: none"> Is the voltage 10 volts or greater? 	<p>Yes GO to B3.</p> <p>No REPAIR circuit 2037 (RD) for an open. TEST the system for normal operation.</p>
B3	<p>MANUALLY JUMP THE STARTER MOTOR</p> <ul style="list-style-type: none"> Connect one end of a fused (15A) jumper wire to the positive terminal of the battery and touch the other end to the starter solenoid S-terminal.  <p style="text-align: center;">J6080-A</p> <ul style="list-style-type: none"> Does the starter solenoid engage? 	<p>Yes GO to B4.</p> <p>No INSTALL a new starter motor. REFER to Starter Motor — 4.0L SOHC or Starter Motor — 4.6L (3V) in this section. TEST the system for normal operation.</p>
B4	<p>TEST THE STARTER MOTOR RELAY</p> <ul style="list-style-type: none"> Carry out the relay component test on the starter motor relay. Refer to Wiring Diagrams Cell 149 for component testing. Does the starter motor relay test good? 	<p>Yes REPAIR circuit 113 (YE/LB) for an open. TEST the system for normal operation.</p> <p>No INSTALL a new starter motor relay. TEST the system for normal operation.</p>

Pinpoint Test C: The Engine Cranks Slowly

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 to the digital transmission range (TR) sensor through circuit 32 (RD/LB). 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).

DIAGNOSIS AND TESTING (Continued)

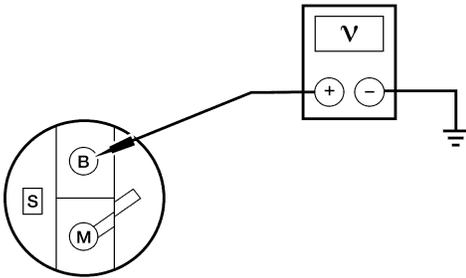
For manual transmission equipped vehicles, voltage from the SJB is supplied to the clutch pedal position switch (CPP) through circuit 32 (RD/LB). When the clutch pedal is depressed, voltage is supplied from the CPP to the starter relay coil located in the BEC through circuit 32 (RD/LB). The starter relay coil is supplied ground from the PCM through circuit 1419 (LG/YE).

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.

Possible Causes

- Fuse(s)
- Circuit 2037 (RD)
- Ground circuit
- Starter motor

PINPOINT TEST C: THE ENGINE CRANKS SLOWLY

Test Step		Result / Action to Take
C1	CHECK THE VOLTAGE TO THE STARTER	
	<ul style="list-style-type: none"> • Key in OFF position. • Measure the voltage between starter motor solenoid positive terminal and ground.  <p style="text-align: center;">J6079-A</p> <ul style="list-style-type: none"> • Is the voltage 12.5 volts or greater? 	<p>Yes GO to C2.</p> <p>No REPAIR circuit 2037 (RD). CLEAN and TIGHTEN the connections at the battery terminals. TEST the system for normal operation.</p>
C2	CHECK MOTOR GROUND CIRCUIT	
	<ul style="list-style-type: none"> • Carry out the Motor Ground Circuit test. Refer to Component Tests in this section. • Is the ground OK? 	<p>Yes INSTALL a new starter motor. TEST the system for normal operation.</p> <p>No REPAIR the ground circuit as necessary. TEST the system for normal operation.</p>

Pinpoint Test D: Unusual Starter Noise

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 to the digital transmission range (TR) sensor through circuit 32 (RD/LB). 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).

DIAGNOSIS AND TESTING (Continued)

For manual transmission equipped vehicles, voltage from the SJB is supplied to the clutch pedal position switch (CPP) through circuit 32 (RD/LB). When the clutch pedal is depressed, voltage is supplied from the CPP to the starter relay coil located in the BEC through circuit 32 (RD/LB). The starter relay coil is supplied ground from the PCM through circuit 1419 (LG/YE).

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.

Possible Causes

- Starter motor mounting
- Starter motor mounting bolts
- Starter motor drive
- Flywheel or flexplate ring gear
- Starter motor

PINPOINT TEST D: UNUSUAL STARTER NOISE

Test Step		Result / Action to Take
D1	CHECK THE STARTER MOTOR MOUNTING	Yes GO to D2 . No REINSTALL the starter motor correctly. REFER to Starter Motor — 4.0L SOHC or Starter Motor — 4.6L (3V) in this section.
	<ul style="list-style-type: none"> • Inspect the starter motor mounting for cracks. • Check the starter motor mounting bolts for looseness. • Is the starter motor mounted correctly? 	
D2	INSPECT THE STARTER MOTOR	Yes INSTALL a new starter motor. TEST the system for normal operation. No CHECK the starter drive. REFER to Component Tests, Starter Drive Test in this section. INSTALL a new starter motor. TEST the system for normal operation.
	<ul style="list-style-type: none"> • Remove the starter motor. Refer to Starter Motor — 4.0L SOHC or Starter Motor — 4.6L (3V) in this section. • Inspect the starter motor for damage. • Is the starter motor damaged? 	

Component Tests

Starter Motor — Load Test

⚠ WARNING: When servicing the starter motor or carrying out other underhood work in the vicinity of the starter motor, be aware that the heavy gauge battery input lead at the starter solenoid is “electrically hot” at all times.

⚠ CAUTION: A protective cap or boot is provided over the battery input terminal on all car lines and must be installed after repair. Be sure to disconnect the battery ground cable before repairing the starter motor.

1. 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.
2. Disconnect the ignition coil connector from the ignition coil.

3. Connect the SABRE tester to the vehicle using the amperage lead clipped around the positive battery cable.
4. Measure the amperage of the starter motor while activating the starting system.
5. A correctly operating starter motor will draw from 130 to 190 amps of current.

Voltage Drop Tests

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

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.

DIAGNOSIS AND TESTING (Continued)

3. Connect the positive (+) lead of the 73 Digital Multimeter 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) 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.

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 73 Digital Multimeter 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 Drive Test

1. Remove the starter motor. Refer to Starter Motor — 4.0L SOHC or Starter Motor — 4.6L (3V) 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.  **CAUTION: 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.

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.

DIAGNOSIS AND TESTING (Continued)

1.  **WARNING: Make sure that the starter motor is securely mounted on a bench because the starter motor may move or jump when it is energized.**

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.