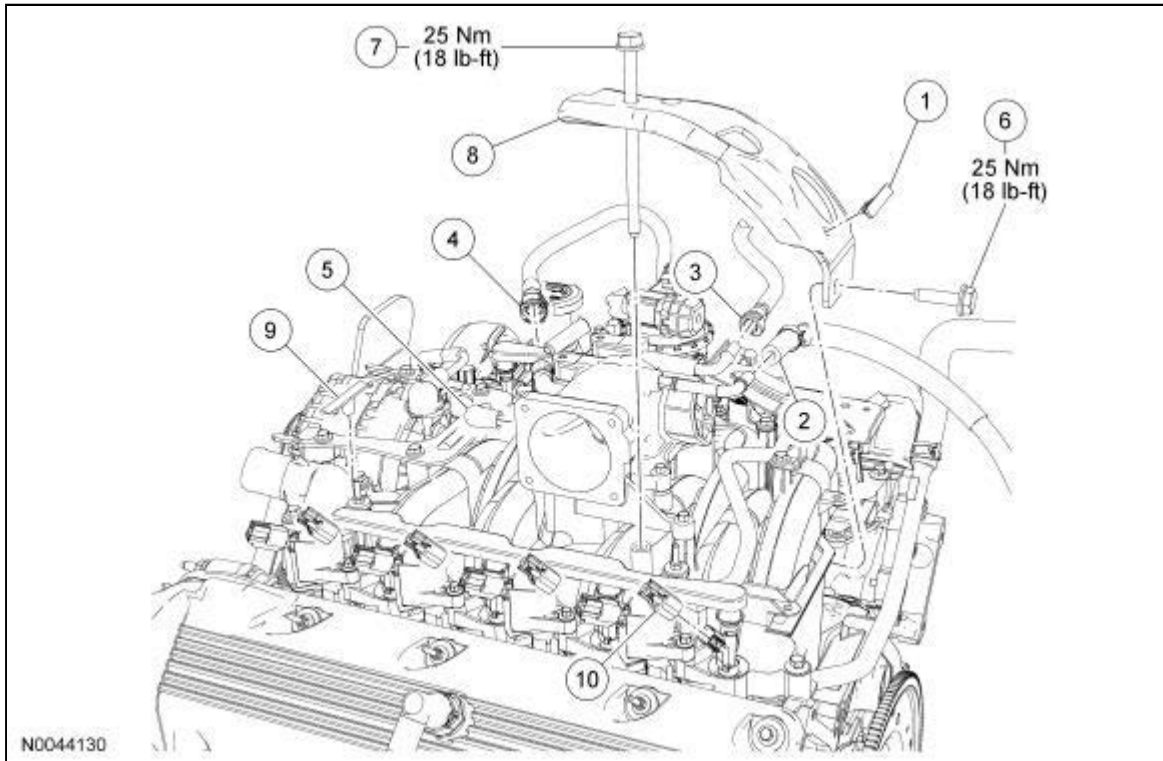
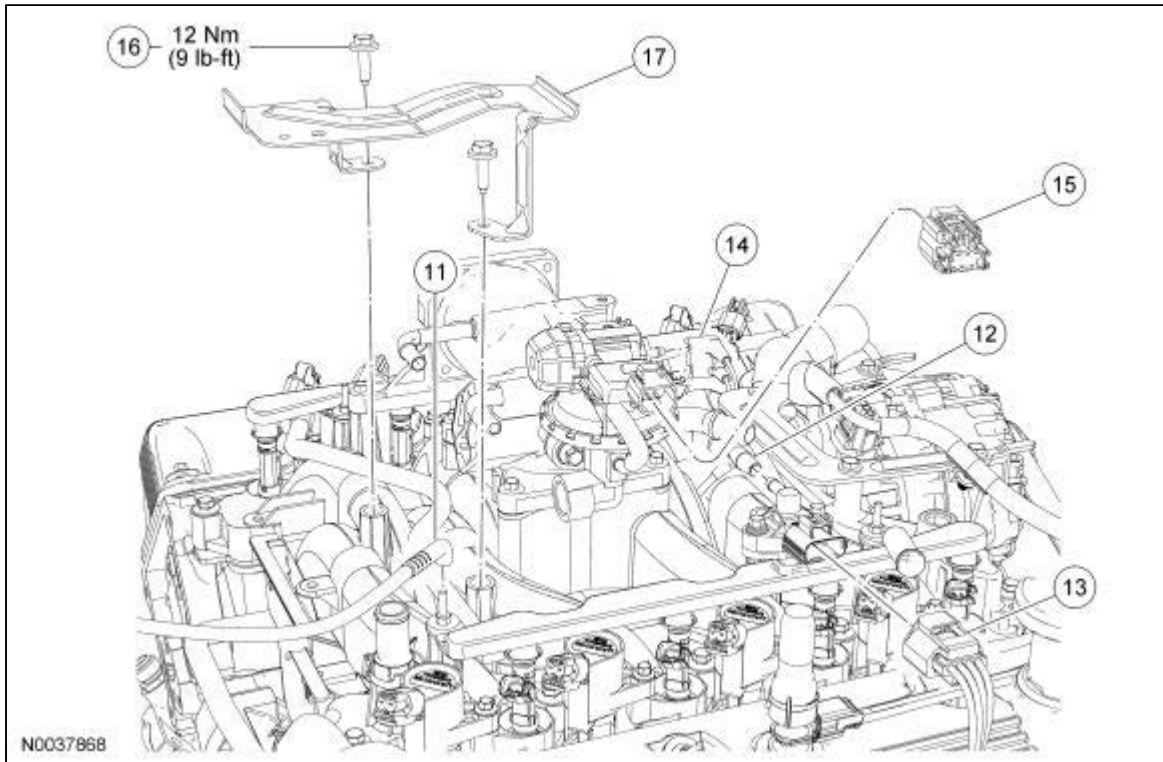


Fuel Rail and Fuel Injector — Exploded View

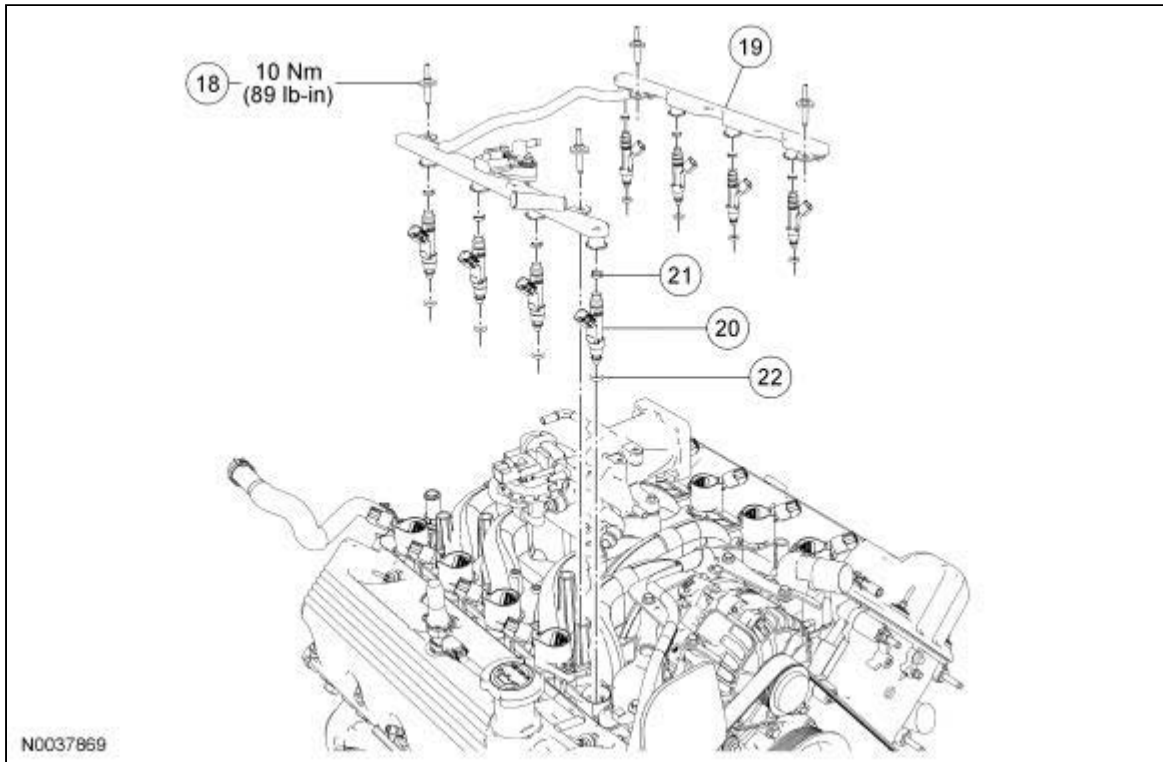
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Item	Part Number	Description
1	13A506	Wire harness retainer
2	9C490	Brake booster vacuum hose
3	9D289	Evaporative emission (EVAP) canister purge valve tube
4	6K817	Positive crankcase ventilation (PCV) tube
5	9E499	Intake manifold vacuum hose
6	W701725	Intake manifold crash bracket bolt
7	W705793	Intake manifold crash bracket bolt
8	9G609	Intake manifold crash bracket
9	13A506	Wire harness retainer
10	14A464	Fuel injector electrical connector (8 required) (part of 12B637)



Item	Part Number	Description
11	14A464	Ground wire connector (part of 12B637)
12	9E489	Fuel rail pressure and temperature sensor vacuum connector
13	14A464	Fuel rail pressure and temperature sensor electrical connector (part of 12B637)
14	9E489	Exhaust gas recirculation (EGR) system module vacuum connector
15	14A464	EGR system module electrical connector (part of 12B637)
16	N807309	Intake manifold shield bolt (2 required)
17	9F460	Intake manifold shield



N0037869

Item	Part Number	Description
18	N811425	Fuel rail stud bolt (4 required)
19	9F792	Fuel rail
20	9F593	Fuel injector (8 required)
21	9229	Fuel injector upper O-ring seal (8 required)
22	9229	Fuel injector lower O-ring seal (8 required)

1. For additional information, refer to the procedures in this section.

Fuel Rail

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Material

Item	Specification
Motorcraft SAE 5W-20 Premium Synthetic Blend Motor Oil XO-5W20-QSP (US); Motorcraft SAE 5W-20 Super Premium Motor Oil CXO-5W20-LSP12 (Canada); or equivalent	WSS-M2C930-A


Removal and Installation



WARNING: Do not smoke or carry lighted tobacco or open flame of any type when working on or near any fuel-related components. Highly flammable mixtures are always present and may be ignited. Failure to follow these instructions can result in personal injury.




WARNING: Fuel in the fuel system remains under high pressure even when the engine is not running. Before servicing or disconnecting any of the fuel system components, the fuel system pressure must be relieved to prevent accidental spraying of fuel, causing personal injury or a fire hazard.

-  **WARNING:** If equipped with fire suppression system, depower the system. For important safety warnings and procedures, refer to [Section 419-03](#).

With the vehicle in NEUTRAL, position it on a hoist. For additional information, refer to [Section 100-02](#).

- Release the fuel system pressure. For additional information, refer to [Section 310-00](#).
- Disconnect the battery ground cable. For additional information, refer to [Section 414-01](#).
- Disconnect the fuel tube spring lock coupling from the fuel rail. For additional information, refer to [Section 310-00](#).
- Remove the throttle body (TB). For additional information, refer to [Throttle Body](#) in this section.
- Remove the exhaust gas recirculation (EGR) system module to exhaust manifold tube. For additional information, refer to [Section 303-08](#).
- Disconnect the brake booster vacuum hose from the TB spacer and position aside.
- Disconnect the evaporative emission (EVAP) canister purge valve hose quick connect coupling from the TB spacer and position aside. For additional information, refer to [Section 310-00](#).
- Disconnect the positive crankcase ventilation (PCV) tube quick connect coupling from the TB spacer and position aside. For additional information, refer to [Section 310-00](#).
- Disconnect the intake manifold vacuum hose from the TB spacer and position aside.

11. If equipped, detach the crash bracket wire harness retainer.
12. Remove the 2 crash bracket bolts, and the bracket.
 - To install, tighten to 25 Nm (18 lb-ft).
13. Remove the wire harness retainer from the LH front fuel rail stud bolt and position aside.
14. Disconnect the 8 fuel injector electrical connectors.
15. Disconnect the ground connector from the RH rear fuel rail stud bolt and position aside.
16. Disconnect the fuel rail pressure and temperature sensor vacuum and electrical connectors.
17. Disconnect the exhaust gas recirculation (EGR) system module vacuum and electrical connectors.
18. Remove the 2 intake manifold shield bolts and the shield.
 - To install, tighten to 12 Nm (9 lb-ft).
19. Remove the 4 fuel rail stud bolts.
 - To install, tighten to 10 Nm (89 lb-in).
20. Remove the fuel rail and the fuel injectors as an assembly.

21.  **CAUTION: Use O-rings seals that are made of special fuel-resistant material. Use of ordinary O-ring seals can cause the fuel system to leak. Do not reuse O-ring seals.**

Separate the fuel injectors from the fuel rail.

- Discard the O-ring seals.

22.  **WARNING: Repower the fire suppression system. For important safety warnings and procedures, refer to [Section 419-03](#).**

To install, reverse the removal procedure. If equipped with fire suppression system, repower the system.

- Lubricate the fuel injectors O-ring seals with clean engine oil prior to installation.
-

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General Specifications

Item	Specification
Drive belt specification	6 rib
Belt tension	Automatic tensioner (non-adjustable)

Torque Specifications

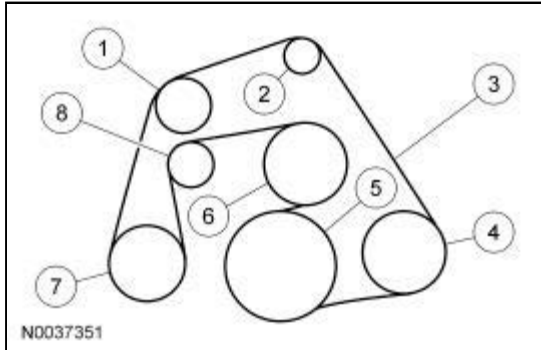
Description	Nm	lb-ft
Belt idler pulley bolt	25	18
Drive belt tensioner bolt ^a	—	—

^a Refer to the procedure.

Accessory Drive

[Printable View \(95 KB\)](#)

Component Locations



Item	Part Number	Description
1	8679	Accessory drive belt idler pulley
2	10344	Generator pulley
3	8620	Accessory drive belt
4	3A733	Power steering pump pulley
5	6312	Crankshaft pulley
6	8509	Coolant pump pulley
7	2E884	A/C clutch pulley
8	6B209	Accessory drive belt tensioner pulley

Accessory Drive

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Inspection and Verification



CAUTION: Under no circumstances should the accessory drive belt, tensioner or pulleys be lubricated as potential damage to the belt material and tensioner damping mechanism will occur. Do not apply any fluids or belt dressing to the accessory drive belt or pulleys.

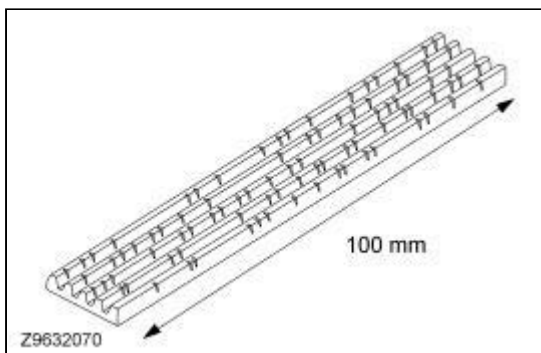
1. Verify the customer concern by operating the system.
2. Visually inspect for obvious signs of mechanical damage.

Visual Inspection Chart

Mechanical
<ul style="list-style-type: none">• Drive belt cracking/chunking/wear• Belt/pulley contamination• Incorrectly routed belt• Pulley misalignment or excessive pulley runout• Loose or mislocated hardware• Incorrectly routed power steering tubes (rubbing)

3. Eliminate all other non-belt related noises that could cause belt misdiagnosis, such as A/C compressor engagement chirp, power steering cavitations at low temperatures, variable camshaft timing (VCT) tick or generator whine.
4. If a concern is found, correct the condition before proceeding to the next step.

V-Ribbed Serpentine Drive Belt With Cracks Across Ribs



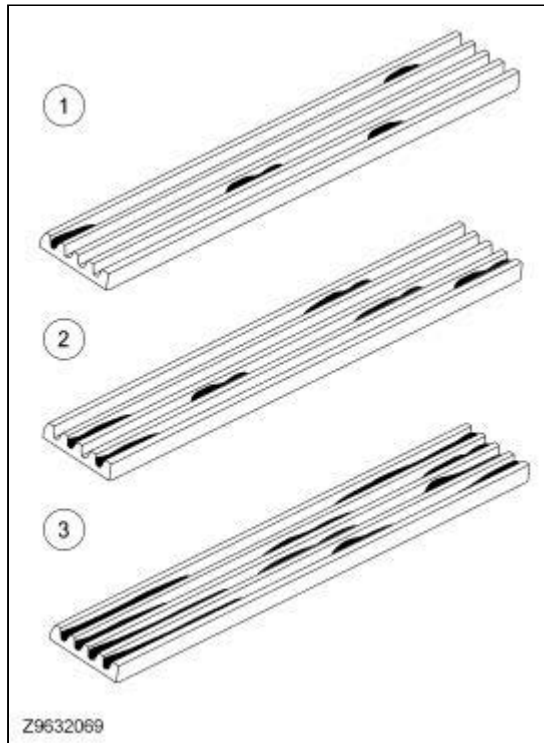
5. **NOTE:** Up to 15 cracks in a rib over a distance of 100 mm (4.0 in) can be considered acceptable. If damage exceeds the acceptable limit or any chunks are found to be missing from the ribs, a new belt must be installed.

Check the belt for cracks. Up to 15 cracks in a rib over a distance of 100 mm (4.0 in) can be considered acceptable. If cracks exceed this standard, install a new belt.

6. The condition of the V-ribbed drive belt should be compared against the illustration and appropriate action taken.
 1. Small scattered deposits of rubber material. This is not a concern, therefore, installation of a new belt is not required.
 2. Longer deposit areas building up to 50% of the rib height. This is not considered a concern but it can result in excessive noise. If noise is apparent, install a new belt.
 3. Heavy deposits building up along the grooves resulting in a possible noise and belt stability concern. If heavy deposits are apparent, install a new belt.

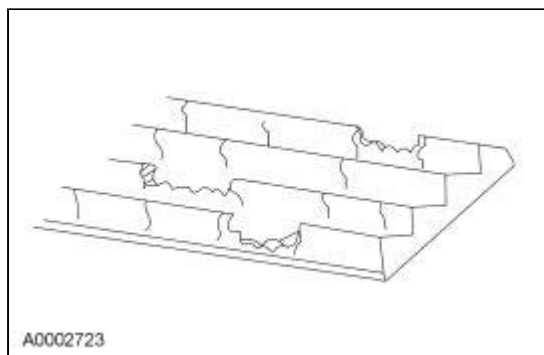
V-Ribbed Serpentine Belt With Piling

NOTE: Piling is an excessive buildup in the V-grooves of the belt.



7. There should be no chunks missing from the belt ribs. If the belt shows any evidence of this, install a new accessory drive belt.

V-Ribbed Serpentine Belt With Chunks of Rib Missing



8. If the concern is not visually evident, verify the symptom and GO to [Symptom Chart](#).

Symptom Chart

Symptom Chart

Condition	Possible Sources	Action
<ul style="list-style-type: none"> Accessory drive belt cracking (over 15 cracks in a rib over a distance of 100 mm [4.0 in]) 	<ul style="list-style-type: none"> Accessory drive belt 	<ul style="list-style-type: none"> INSPECT the accessory drive belt. REFER to Inspection and Verification in this section. INSTALL a new accessory drive belt as necessary.
<ul style="list-style-type: none"> Accessory drive belt chunking 	<ul style="list-style-type: none"> Accessory drive belt 	<ul style="list-style-type: none"> INSPECT the accessory drive belt. REFER to Inspection and Verification in this section. INSTALL a new accessory drive belt as necessary.
<ul style="list-style-type: none"> Accessory drive belt noise, squeal, chirping or flutter 	<ul style="list-style-type: none"> Defective/worn or incorrect accessory drive belt Misaligned pulley (s) Pulley runout Damaged or worn accessories Fluid contamination of accessory drive belt or pulleys Damaged or worn accessory drive belt tensioner 	<ul style="list-style-type: none"> REFER to Component Tests, Drive Belt, Noise/Flutter in this section. REPAIR or INSTALL new parts as necessary. REFER to Component Tests, Belt Tensioner — Mechanical and Belt Tensioner — Dynamics in this section. INSTALL a new accessory drive belt tensioner as necessary.
<ul style="list-style-type: none"> Premature accessory drive belt wear 	<ul style="list-style-type: none"> Defective accessory drive belt Misaligned pulley (s) Pulley runout Damaged accessories Incorrectly installed drive belt Fluid contamination 	<ul style="list-style-type: none"> REFER to Component Tests, Drive Belt Noise/Flutter and Incorrect Drive Belt Installation in this section. REPAIR or INSTALL new parts as necessary.
<ul style="list-style-type: none"> Accessory drive belt does not hold correct tension 	<ul style="list-style-type: none"> Accessory drive belt has excessive cracking, damage or is worn Drive belt tensioner worn or damaged 	<ul style="list-style-type: none"> INSPECT the drive belt. REFER to Inspection and Verification in this section. INSTALL a new drive belt as necessary. CHECK the drive belt tensioner for damage and correct operation. REFER to the Component Tests, Belt Tensioner — Mechanical and Belt Tensioner — Dynamics in this section. INSTALL a new drive belt tensioner as

	<ul style="list-style-type: none"> • Incorrect accessory drive belt • Accessory drive component failure • Accessory drive belt idler pulley bearing failure 	<p>necessary.</p> <ul style="list-style-type: none"> • VERIFY the correct accessory drive belt is installed. • CHECK the accessory drive components. INSTALL new components as necessary. • INSPECT the accessory drive belt idler pulley for freedom of rotation and damage. INSTALL a new accessory drive belt idler pulley as necessary.
--	--	--

Component Tests

Drive Belt — Noise/Flutter

Drive belt chirp occurs due to pulley misalignment or excessive pulley runout. It can be the result of a damaged or incorrectly aligned grooved pulley.

To correct, determine the area where the noise comes from. Check each of the pulleys in that area with a straightedge to the crankshaft pulley. Look for accessory pulleys out of position in the fore/aft direction or at an angle to the straightedge.



CAUTION: Do not apply any fluids or belt dressing to the accessory drive belt or pulleys.

Drive belt squeal may be an intermittent or constant noise that occurs when the drive belt slips on an accessory pulley under certain conditions.

A short intermittent squeal may occur during engine start-up and shut down or during very rapid engine acceleration and decelerations, such as:

- wide open throttle 1-2 and 2-3 shifts or 2-3 and 3-4 back out shifts on automatic transmissions.
- wide open throttle 1-2 and 2-3 shifts and any combination of rapid downshifting on manual transmissions.

These special short-term transient events are expected, and are due to the higher system inertias required to meet the electrical and cooling demands on today's vehicle systems. Constant or reoccurring drive belt squeal can occur:

- if the A/C discharge pressure goes above specifications:
 - the A/C system is overcharged.
 - the A/C condenser core airflow is blocked.
- if the A/C off equalized pressure (the common discharged and suction pressure that occurs after several minutes) exceeds specifications.
- if any of the accessories are damaged or have a worn or damaged bearing. All accessories should be rotatable by hand in the unloaded condition. If not, inspect the accessory.
- if there is evidence of fluid contamination on the accessory drive belt. When the drive belt has been exposed to fluid contamination during vehicle operation, such as leaks from the power steering system, A/C system or cooling system, clean all pulleys with soap and water, rinse with clean water and install a new accessory drive belt. If the drive belt has been exposed to fluids in a localized area during routine vehicle service, such as replacement of hoses or fluids, the drive belt and pulleys should be washed with soap and water immediately (prior to starting the engine), and rinsed with clean water.
- if the accessory drive belt is too long. A drive belt that is too long will allow the accessory drive belt tensioner arm to go all the way to the arm travel stop under certain load conditions, which will

release tension to the drive belt. If the accessory drive belt tensioner indicator is outside the normal installation wear range window, install a new accessory drive belt.

- **NOTE:** The accessory drive belt tensioner arm should rotate freely without binding.

Install a new accessory drive belt tensioner if the drive belt tensioner is worn or damaged.

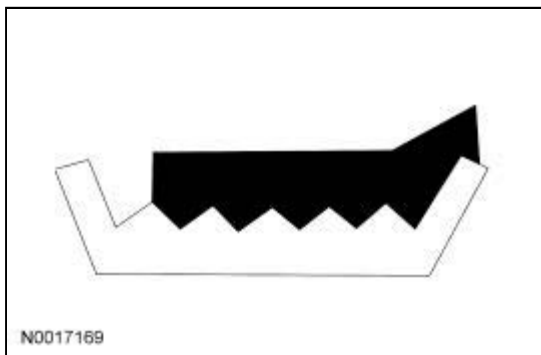
Drive Belt — Incorrect Installation



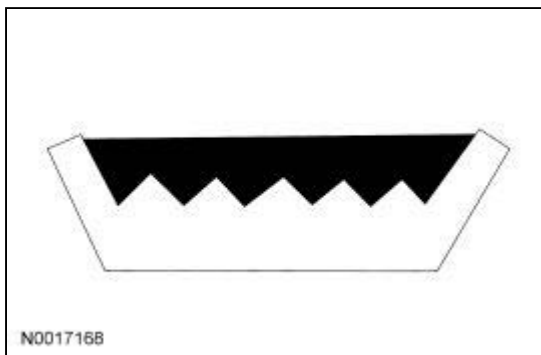
CAUTION: Incorrect accessory drive belt installation will cause excessive drive belt wear and can cause the drive belt to come off the pulleys.

Non-standard accessory drive belts can track differently or incorrectly. If an accessory drive belt tracks incorrectly, install a new accessory drive belt to avoid performance failure or loss of the drive belt.

Incorrect Installation



Correct Installation



With the engine running, check accessory drive belt tracking on all pulleys. If the edge of the accessory drive belt rides beyond the edge of the pulleys, noise and premature wear will occur. Make sure the accessory drive belt rides correctly on the pulley. If an accessory drive belt tracking condition exists, proceed with the following:

- Visually check the accessory drive belt tensioner for damage, especially the mounting pad surface. If the accessory drive belt tensioner is not installed correctly, the mounting surface pad will be out of position. This will result in chirp and squeal noises.
- With the engine running, visually observe the grooves in the pulleys (not the pulley flanges or the pulley forward faces) for excessive wobble. Install new components as necessary.
- Check all accessories, mounting brackets and the accessory drive belt tensioner for any interference that would prevent the component from mounting correctly. Correct any interference condition and recheck the accessory drive belt tracking.
- Tighten all accessories, mounting brackets and accessory drive belt tensioner retaining hardware to specification. Recheck the accessory drive belt tracking.

Belt Tensioner — Mechanical

The only mechanical check that needs to be made is a check for tensioner stick, grab or bind.

1. With the engine off, check routing of the accessory drive belt. Refer to the illustrations under Description and Operation in this section.
2. **NOTE:** The accessory drive belt tensioner spring is very strong and requires substantial force to release.

Using a suitable, commercially available serpentine belt tensioner release tool, release the tension on the belt and detach the accessory drive belt in the area of the tensioner.

3. Using a suitable, commercially available serpentine belt tensioner release tool, move the tensioner from its relaxed position, through its full stroke and back to the relaxed position to make sure there is no stick, grab or bind, and to make sure that there is tension on the tensioner spring.
4. Rotate the tensioner pulley by hand and check for a binding, contaminated or seized condition. Install a new accessory drive belt tensioner if necessary.
5. Inspect the area surrounding the accessory drive belt tensioner for oil leaks or contamination and repair any leaks. Install a new accessory drive belt tensioner as necessary.
6. If the accessory drive belt tensioner meets the above criteria, proceed to testing the tensioner dynamically. If the accessory drive belt tensioner does not meet the above criteria, install a new tensioner.

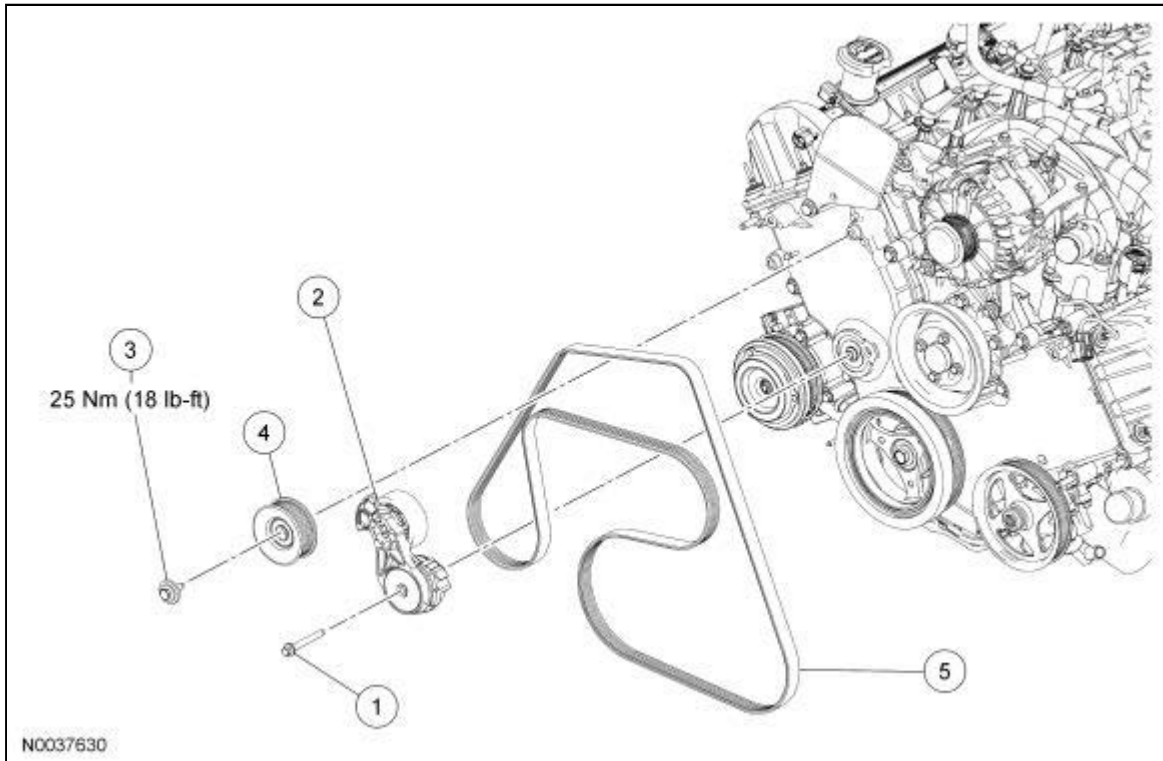
Belt Tensioner — Dynamics

The accessory drive belt tensioner can be checked dynamically as follows:

1. With the engine running, observe the accessory drive belt tensioner movement. The accessory drive tensioner should move (respond) when the air conditioning clutch cycles (if equipped), or when the engine is accelerated rapidly. If the accessory drive belt tensioner movement is excessive without air conditioning clutch cycling or engine acceleration, check belt rideout. Excessive belt rideout (uneven depth of grooves in the belt) can cause excessive accessory drive belt tensioner movement. Check rideout condition by installing a new belt. If excessive accessory drive belt tensioner movement still exists, install a new accessory drive belt tensioner.
-

Front End Accessory Drive (FEAD) — Exploded View

[Printable View \(195 KB\)](#)



Item	Part Number	Description
1	W705738	Accessory drive belt tensioner bolt
2	6B209	Accessory drive belt tensioner
3	N808102	Accessory drive belt idler pulley bolt
4	110028AB	Accessory drive belt idler pulley
5	8620	Accessory drive belt

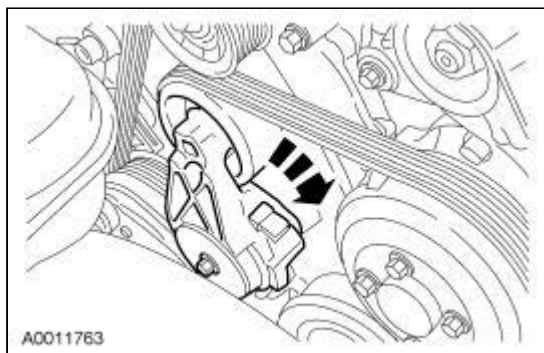
1. For additional information, refer to the procedures in this section.

Accessory Drive Belt

[Printable View \(105 KB\)](#)

Removal and Installation

1. Rotate the tensioner clockwise and remove the accessory drive belt.



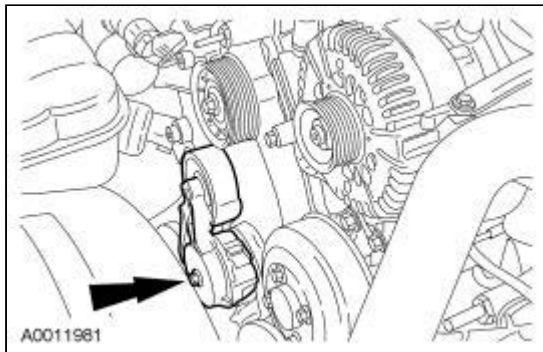
2. To install, reverse the removal procedure.
 - Refer to Component Locations for drive belt routing.
-

Accessory Drive Belt Tensioner

[Printable View \(107 KB\)](#)

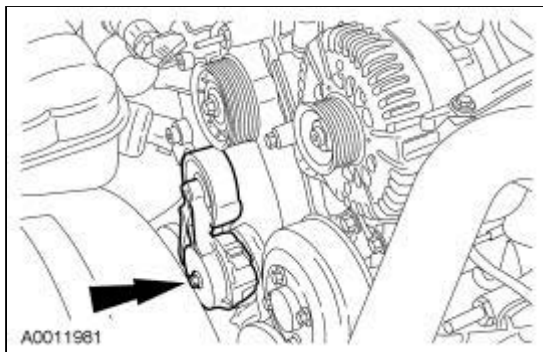
Removal

1. Remove the accessory drive belt. For additional information, refer to [Accessory Drive Belt](#) in this section.
2. Remove the bolt and the accessory drive belt tensioner.



Installation

1. Install the accessory drive belt tensioner.
Tighten the bolt in 2 stages:
 - Stage 1: Tighten to 10 Nm (89 lb-in).
 - Stage 2: Tighten an additional 90 degrees.



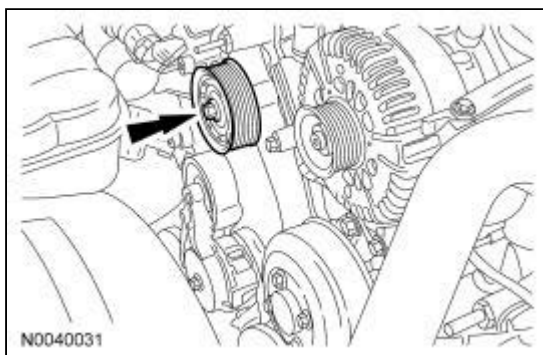
2. Install the accessory drive belt. For additional information, refer to [Accessory Drive Belt](#) in this section.
-

Accessory Drive Belt Idler Pulley

 [Printable View \(106 KB\)](#)

Removal and Installation

1. Remove the accessory drive belt. For additional information, refer to [Accessory Drive Belt](#) in this section.
2. Remove the bolt and the accessory drive belt idler pulley.
 - To install, tighten to 25 Nm (18 lb-ft).



3. To install, reverse the removal procedure.
-

 [Printable View \(62 KB\)](#)

Torque Specifications

Description	Nm	lb-ft	lb-in
Starter motor bolts	25	18	—
Starter solenoid B-terminal nut	12	9	—
Starter solenoid S-terminal nut	6	—	53

Starting System

[Printable View \(63 KB\)](#)

The starting system consists of the following:

- Starter motor
- Ignition switch
- Digital transmission range (TR) sensor
- Mini ISO relay

Starting System — Starter Motor

The starter motor:

- is a permanent-magnet, gear reduction, 12V DC motor.
- has an integral starter solenoid.

Starting System — Starter Relay

The starter relay:

- is a mini ISO relay.
- switches power to the starter solenoid to engage the starter motor when it receives a START signal from the ignition switch.




Starting System — Normal Operation

When the digital TR sensor recognizes that the vehicle is in either PARK or NEUTRAL and the ignition switch is placed in the START position, it sends a signal to the mini ISO relay that, in turn, sends a voltage signal to the starter solenoid, which will engage the starter motor to crank the engine at a speed fast enough to permit the engine to start.

Starting System

[Printable View \(353 KB\)](#)

Special Tool(s)

 ST1137-A	73 Digital Multimeter 105-R0051 or equivalent
 ST1179-A	Starter, Alternator, Battery, Regulator Electrical 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

When the ignition switch is turned to the START position and the vehicle is in the NEUTRAL or PARK position, the starter relay switches power to the starter solenoid causing the starter motor to engage, turning the engine at a speed fast enough to permit the engine to start.

Starting System — Anti-Theft Intervention

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, thereby allowing the starter motor to activate.

Inspection and Verification



WARNING: If equipped with fire suppression system, refer to [Section 419-03](#) for Important Safety Warnings.



WARNING: When repairing 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 new protective cap or boot, which is provided over the terminal of this lead must be installed after repairs. Be sure to disconnect battery ground

cable before servicing starter.



WARNING: When working in area of the starter motor, be careful to avoid touching hot exhaust components.

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• Starter solenoid• Brackets	<ul style="list-style-type: none">• Battery• Fuse• 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. **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).

5. **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.

6. 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 powertrain control module (PCM).

7. 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 diagnostic trouble codes (DTCs).

8. Clear the continuous DTCs and carry out the self-test diagnostics for the Instrument Cluster and Powertrain Control Module (PCM).

9. If the DTCs retrieved are related to the concern, go to Starter and Passive Anti-Theft System (PATS) Diagnostic Trouble Code (DTC) Chart. For all other DTCs, refer to [Section 419-10](#).

10. If no DTCs related to the concern are retrieved, GO to [Symptom Chart](#).

Starter and Passive Anti-Theft System (PATS) Diagnostic Trouble Code (DTC) Chart

DTC	Description	Source	Action
B1213	Anti-Theft Number of Programmed Keys is Below Minimum	Instrument cluster	REFER to Section 419-01B .
B1342	ECU is Defective	Instrument cluster	CLEAR the DTCs. REPEAT the self-test. If DTC B1342 is retrieved again, INSTALL a new instrument cluster. REFER to Section 413-01 .
B1600	Passive Anti-Theft System (PATS) Key Transponder is Not Received — Damaged Key or Non-PATS Key	Instrument cluster	REFER to Section 419-01B .
B1601	PATS Received Incorrect Key-Code From Key Transponder (Unprogrammed PATS Key)	Instrument cluster	REFER to Section 419-01B .
B1602	PATS Received Invalid Format Of Key-Code From Key Transponder (Partial Key Read)	Instrument cluster	REFER to Section 419-01B .
B1681	PATS Transceiver Module Signal is Not Received (Damaged, Not Connected or Damaged Wiring)	Instrument cluster	REFER to Section 419-01B .
B2103	Antenna Not Connected — Defective Transceiver	Instrument cluster	REFER to Section 419-01B .
B2139	Data Mismatch	Instrument cluster	REFER to Section 419-01B .
B2141	NVM Memory Failure	Instrument cluster	REFER to Section 419-01B .
B2431	Transponder Programming Failed	Instrument cluster	REFER to Section 419-01B .
B2477	Module Configuration Failure	Instrument cluster	REFER to Section 418-01 .
U1147	SCP (J1850) Invalid or Missing Data For Vehicle Security	Instrument cluster/ powertrain control module (PCM)	REFER to Section 419-01B .
U1262	SCP Communications BUS Fault	Instrument cluster/PCM	REFER to Section 418-00 .

Symptom Chart

SYMPTOM CHART

Condition	Possible Sources	Action
<ul style="list-style-type: none"> The engine does not crank 	<ul style="list-style-type: none"> Battery Starter motor Starter motor solenoid relay switch Starter motor relay Ignition switch Damaged fuse Anti-theft system Circuitry 	<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 mounting • Flywheel/ring gear • Starter motor 	<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 • Circuitry 	<ul style="list-style-type: none"> • CARRY OUT the Starter Motor — Voltage Drop Test Component Test. REFER to Starter Motor — Voltage Drop Test Component Tests in this section.
<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/ring gear teeth 	<ul style="list-style-type: none"> • INSPECT the starter motor mounting and engagement. REPAIR as required. • INSPECT the flywheel/ring gear for damaged, missing or worn teeth. REPAIR as required.
<ul style="list-style-type: none"> • The engine cranks in reverse and other forward gears 	<ul style="list-style-type: none"> • Shift linkage (adjustment) • Digital transmission range (TR) sensor 	<ul style="list-style-type: none"> • REFER to Section 307-05 . • REFER to Section 307-01 .

Pinpoint Tests

Pinpoint Test A: The Engine Does Not Crank

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


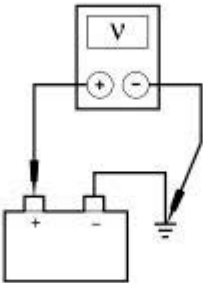
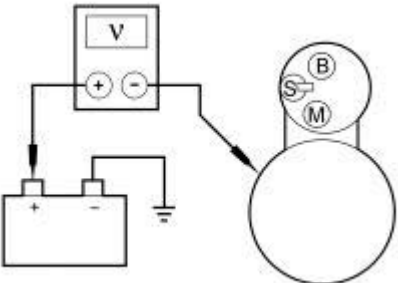
Normal Operation

Under normal operation, the battery junction box (BJB) supplies constant power to the starter relay on circuit 32 (RD/LB) through fuse F105 (30A). When the key is placed in the START position with the vehicle in PARK or NEUTRAL, the transmission range (TR) sensor provides power on circuit 33 (WH/PK) and the powertrain control module (PCM) provides ground on circuit 3405 (GY/RD), activating the starter motor. On police vehicles, the transmission range (TR) sensor provides power on circuit 33 (WH/PK) and ground through circuit 57 (BK), activating the starter motor.

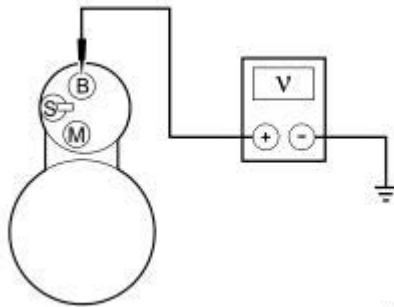
Possible Causes

- Battery
- Starter motor
- Starter motor solenoid relay switch
- Starter motor relay
- Ignition switch
- Damaged fuse
- Anti-theft system
- Circuitry

PINPOINT TEST A: THE ENGINE DOES NOT CRANK

Test Step	Result / Action to Take
<p>A1 CHECK FOR POWERTRAIN CONTROL MODULE (PCM) DTCs</p> <p>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.</p> <ul style="list-style-type: none"> Carry out the powertrain control module (PCM) self-test. Refer to Powertrain Control/Emissions Diagnosis (PC/ED) manual. Were any PATS DTCs retrieved? 	<p>Yes REFER to Section 419-01B to repair the PATS DTCs before proceeding with this test.</p> <p>No GO to A2.</p>
<p>A2 CHECK THE BATTERY</p> <ul style="list-style-type: none"> Check the battery condition and charge. Refer to Section 414-01. Is the battery OK? 	<p>Yes GO to A3.</p> <p>No CHARGE or INSTALL a new battery as required. TEST the system for normal operation.</p>
<p>A3 CHECK THE BATTERY GROUND CABLE</p> <ul style="list-style-type: none">  WARNING: If equipped with fire suppression system, depower the system. For important safety warnings and procedures, refer to Section 419-03. With the vehicle in NEUTRAL, position it on a hoist. Refer to Section 100-02. Measure the voltage between the positive battery post and the battery ground cable connection at the cylinder block.  <p style="text-align: center;">AJ0280-A</p> <ul style="list-style-type: none"> Is the voltage reading greater than 10 volts? 	<p>Yes GO to A4.</p> <p>No INSTALL a new battery ground cable. TEST the system for normal operation. If equipped with fire suppression system, GO to A24.</p>
<p>A4 CHECK THE STARTER MOTOR GROUND</p> <ul style="list-style-type: none"> Measure the voltage between the battery positive post and the starter motor case.  <p style="text-align: center;">AJ0281-A</p> <ul style="list-style-type: none"> Is the voltage reading greater than 10 volts? 	<p>Yes GO to A5.</p> <p>No CLEAN the starter motor mounting flange and make sure the starter motor is correctly mounted. TEST the system for normal operation. If equipped with fire suppression system, GO to A24.</p>
<p>A5 CHECK THE POWER SUPPLY TO THE STARTER MOTOR</p>	

- Key in OFF position.
- Measure the voltage at starter motor solenoid B-terminal.



AJ0278-A

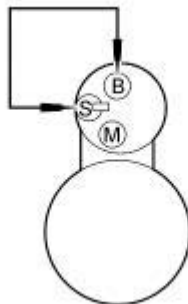
- Is the voltage reading greater than 10 volts?

Yes
GO to [A6](#).

No
INSTALL a new positive battery cable. TEST the system for normal operation. If equipped with fire suppression system, GO to [A24](#).

A6 CHECK THE STARTER MOTOR

- Connect one end of a jumper wire to starter motor solenoid B-terminal and momentarily connect the other end to the starter motor solenoid S-terminal.



AJ0279-A

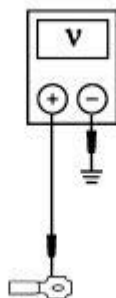
- Does the starter motor engage and the engine crank?

Yes
GO to [A7](#).

No
INSTALL the starter motor. TEST the system for normal operation. If equipped with fire suppression system, GO to [A24](#).

A7 CHECK START INPUT TO THE STARTER MOTOR

- Disconnect: Starter Motor Solenoid S-Terminal.
- Hold the ignition switch to the START position.
- Measure the voltage at the starter motor solenoid S-terminal.



AJ0285-A

- Is the voltage reading greater than 10 volts?

Yes
CLEAN the starter motor solenoid S-terminal stud and connector. CHECK the wiring and the starter motor for a loose or intermittent connection. TEST the system for normal operation. If equipped with fire suppression system, GO to [A24](#).

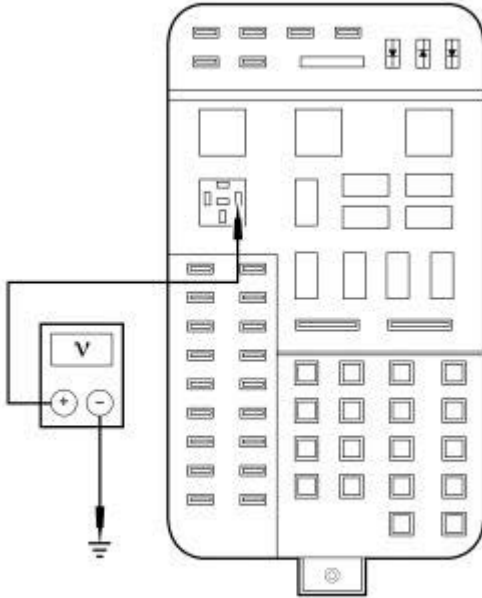
No
GO to [A8](#).

A8 CHECK START INPUT TO THE STARTER RELAY

- Key in OFF position.
- Disconnect: Starter Relay C1017.
- Hold the ignition switch to the START position.
- Measure the voltage at the battery junction box (BJB) at starter relay C1017-86, circuit 33 (WH/PK).

Yes
GO to [A9](#).

No
GO to [A14](#).

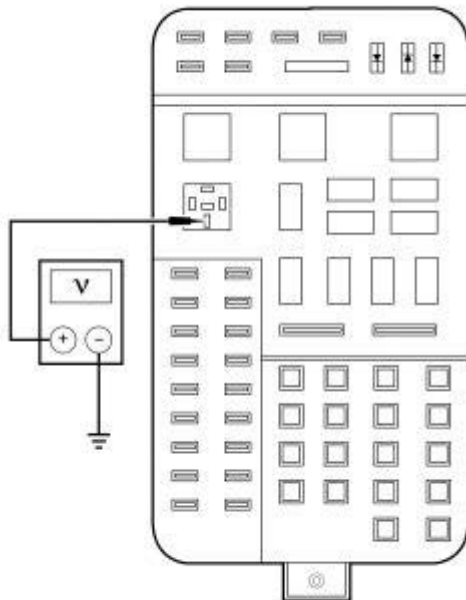


N0058177

- Is the voltage reading greater than 10 volts?

A9 CHECK THE BATTERY SUPPLY TO THE STARTER RELAY

- Key in OFF position.
- Measure the voltage at the BJB at starter relay C1017-30, circuit 32 (RD/LB).



N0047485

- Is the voltage reading greater than 10 volts?

A10 CHECK THE STARTER RELAY GROUND

- On police vehicles, measure the resistance at the BJB between starter relay C1017-85, circuit 57 (BK) and ground.

Yes

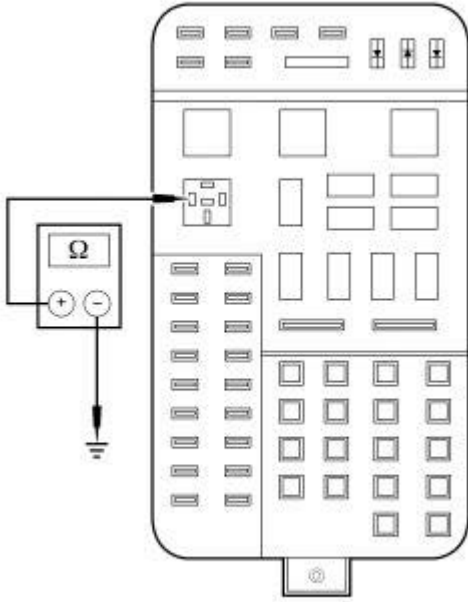
For police vehicles, GO to [A10](#).
For all other vehicles, GO to [A11](#).

No

REPAIR the open in circuit 32 (RD/LB). TEST the system for normal operation. If equipped with fire suppression system, GO to [A24](#).

Yes

GO to [A12](#).



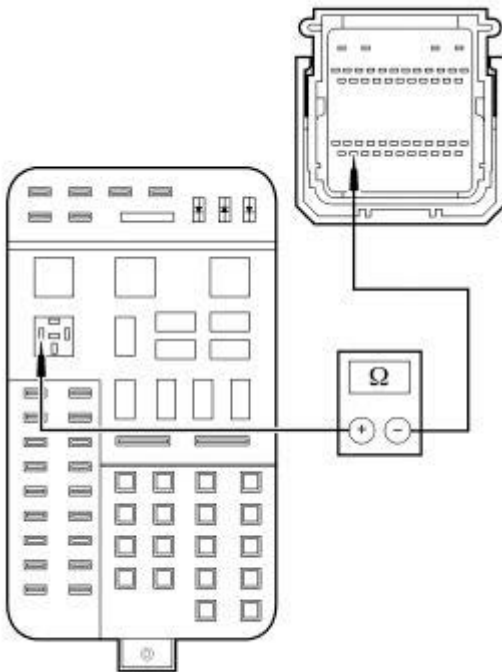
N0058178

- Is the resistance reading less than 5 ohms?

No
REPAIR circuit 57 (BK) for an open. TEST the system for normal operation. If equipped with fire suppression system, GO to [A24](#).

A11 CHECK CIRCUIT 3405 (BK) FOR AN OPEN

- Disconnect: PCM C175.
- Measure the resistance at the BJB between starter relay C1017-85, circuit 3405 (BK) and PCM C175B-2, circuit 3405 (BK).



N0058176

- Is the resistance reading less than 5 ohms?

Yes
GO to [A12](#).

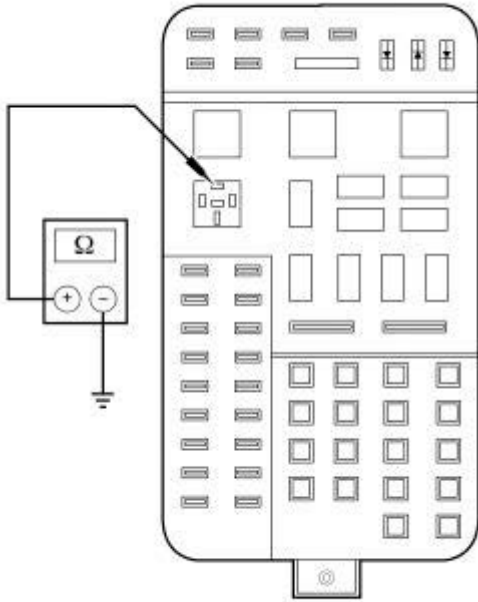
No
REPAIR circuit 33 (WH/PK). TEST the system for normal operation. If equipped with fire suppression system, GO to [A24](#).

A12 CHECK CIRCUIT 113 (YE/LB) FOR A SHORT TO GROUND

- Disconnect: PCM Starter S-Terminal.
- Measure the resistance at the BJB between starter relay

Yes
REPAIR circuit 113 (YE/LB) for a

C1017-87, circuit 113 (YE/LB) and ground.



N0047488

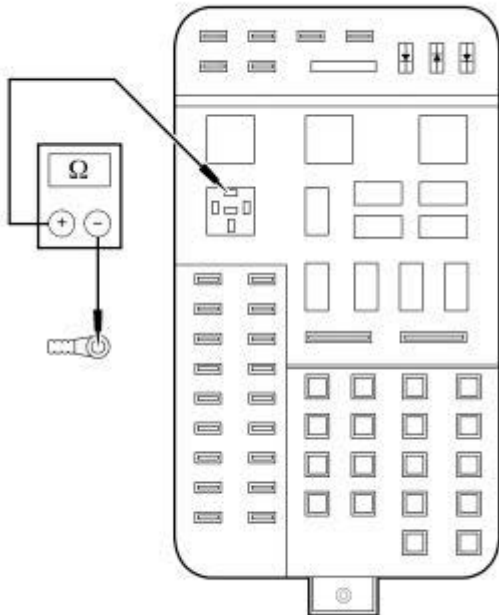
- Is the resistance reading less than 10,000 ohms?

short to ground. TEST the system for normal operation. If equipped with fire suppression system, GO to [A24](#).

No
GO to [A13](#).

A13 CHECK CIRCUIT 113 (YE/LB) FOR AN OPEN

- Measure the resistance at the BJB between starter relay C1017-87, circuit 113 (YE/LB) and starter motor solenoid S-terminal.



N0047489

- Is the resistance reading less than 5 ohms?

Yes
INSTALL a new starter relay. TEST the system for normal operation. If equipped with fire suppression system, GO to [A24](#).

No
REPAIR circuit 113 (YE/LB) for an open. TEST the system for normal operation. If equipped with fire suppression system, GO to [A24](#).

A14 CHECK FUSE 2.12 (10A)

- Key in OFF position.
- Disconnect: Fuse 2.12 (10A).
- Check fuse 2.12 (10A)

Yes
GO to [A15](#).

- Measure the resistance of fuse 2.12 (10A).
- **Is the resistance of fuse 2.12 (10A) zero?**

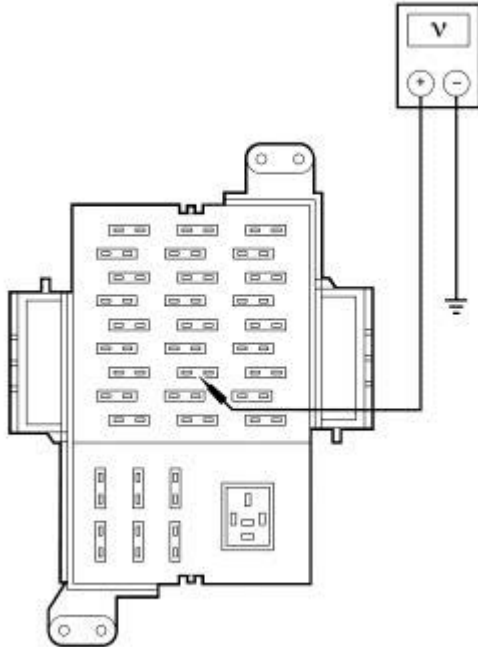
No
GO to [A21](#).

A15 CHECK THE INPUT TO FUSE 2.12 (10A)

- Hold the ignition switch in the START position.
- Measure the voltage at the input cavity of fuse 2.12 (10A).

Yes
GO to [A19](#).

No
GO to [A16](#).



N0037956

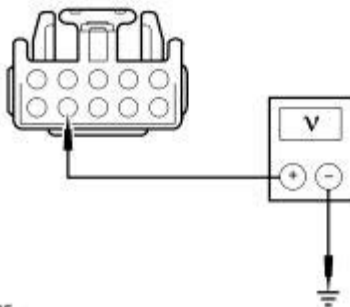
- **Is the voltage reading greater than 10 volts?**

A16 CHECK THE SUPPLY TO THE IGNITION SWITCH

- Disconnect: Ignition Switch C250.
- Measure the voltage at ignition switch C250-9, circuit 1050 (LG/VT).

Yes
GO to [A17](#).

No
REPAIR circuit 1050 (LG/VT) for an open. TEST the system for normal operation. If equipped with fire suppression system, GO to [A24](#).



N0050205

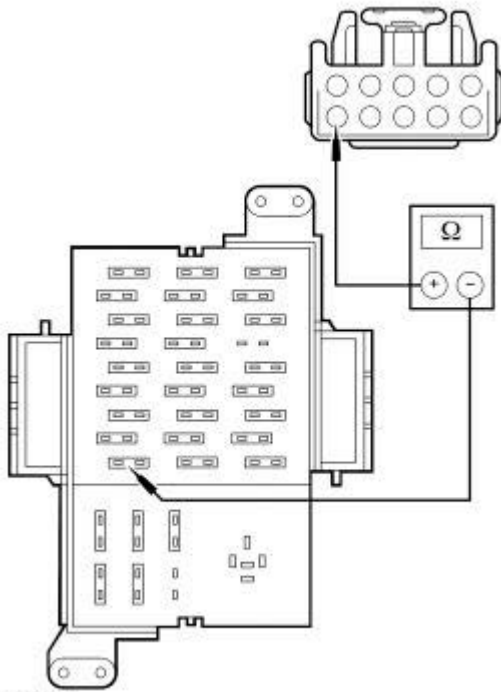
- **Is the voltage reading greater than 10 volts?**

A17 CHECK CIRCUIT 1522 (DG) FOR AN OPEN

- Measure the resistance of circuit 1522 (DG) between ignition switch C250-10 and the input cavity of fuse 2.12 (10A).

Yes
GO to [A18](#).

No
REPAIR circuit 1522 (DG) for an open. TEST the system for normal operation. If equipped with fire suppression system, GO to [A24](#).

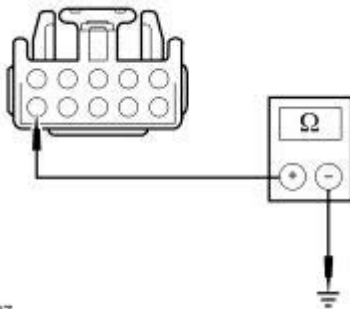


N0050206

- Is the resistance reading less than 5 ohms?

A18 CHECK CIRCUIT 1522 (DG) FOR A SHORT TO GROUND

- Measure the resistance between ignition switch C250-10, circuit 1522 (DG) and ground.



N0050207

- Is the resistance reading less than 10,000 ohms?

A19 CHECK CIRCUIT 262 (BN/PK) FOR AN OPEN

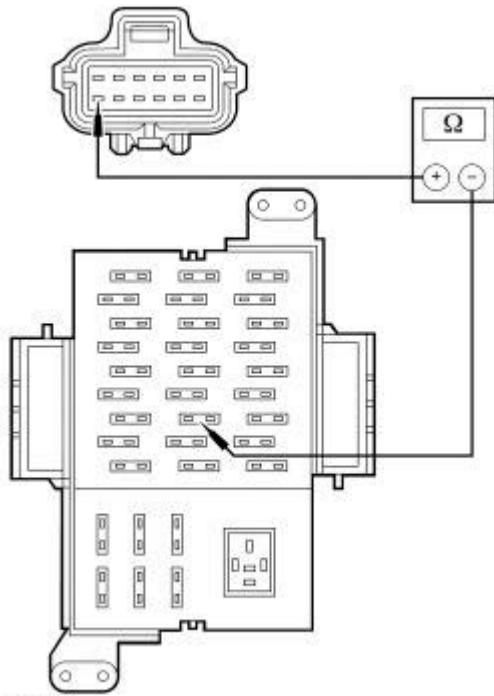
- Disconnect: Digital Transmission Range (TR) Sensor C167.
- Measure the resistance between the digital TR sensor C167-12, circuit 262 (BN/PK) and fuse junction panel fuse 2.12 output cavity.

Yes
REPAIR circuit 1522 (DG) for a short to ground. TEST the system for normal operation. If equipped with fire suppression system, GO to [A24](#).

No
INSTALL a new ignition switch. REFER to [Section 211-05](#). TEST the system for normal operation. If equipped with fire suppression system, GO to [A24](#).

Yes
GO to [A20](#).

No
REPAIR circuit 262 (BN/PK) for an open. TEST the system for normal operation. If equipped with fire suppression system, GO to [A24](#).

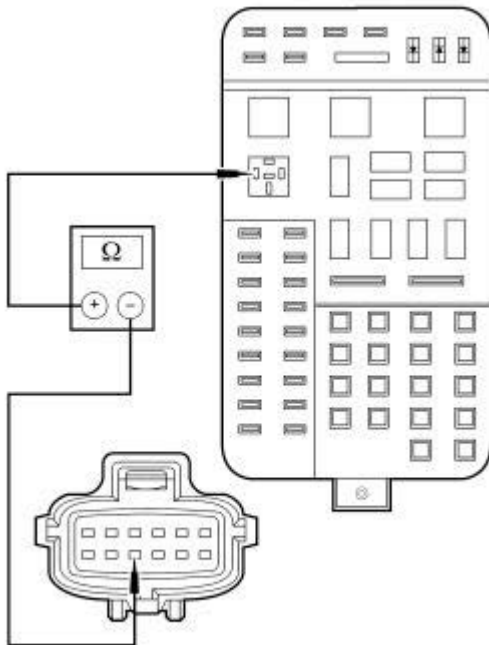


N0037918

- Is the resistance reading less than 5 ohms?

A20 CHECK CIRCUIT 33 (WH/PK) FOR AN OPEN

- Measure the resistance at the BJB between starter relay C1017-86, circuit 33 (WH/PK) and digital TR sensor C167-10.



N0047490

- Is the resistance reading less than 5 ohms?

A21 CHECK FOR A SHORTED SYSTEM

- Disconnect the starter relay.
- Measure the resistance between fuse junction panel fuse 2.12 output cavity, circuit 262 (BN/PK) and ground.

Yes

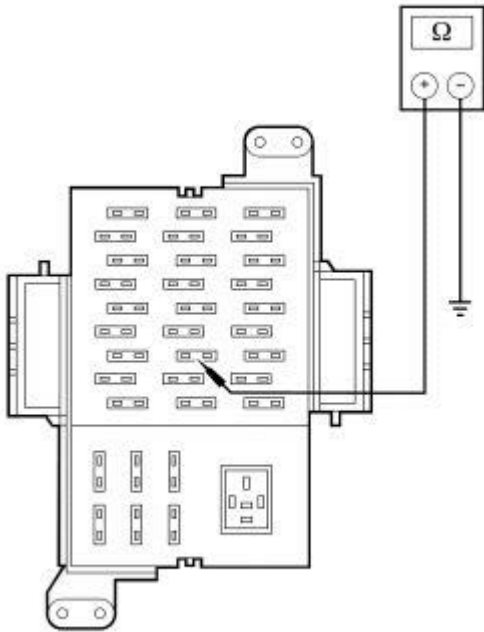
REFER to Section 307-01, Digital Transmission Range Sensor Pinpoint Test. If equipped with fire suppression system, GO to A24.

No

REPAIR circuit 33 (WH/PK) for an open. TEST the system for normal operation. If equipped with fire suppression system, GO to A24.

Yes

INSPECT all circuits and connections. CHECK for chafed wires or an intermittent



N0037919

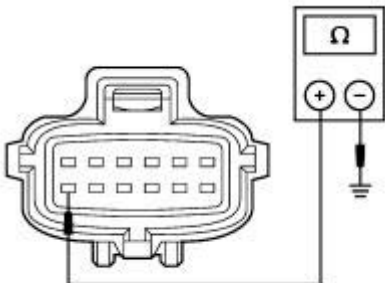
- Is the resistance reading greater than 10,000 ohms?

connection to ground. INSTALL a new fuse 2.12 (10A). TEST the system for normal operation. If equipped with fire suppression system, GO to [A24](#).

No
GO to [A22](#).

A22 CHECK CIRCUIT 262 (BN/PK) FOR A SHORT TO GROUND

- Disconnect: Digital TR Sensor C167.
- Measure the resistance between digital TR sensor C167-12, circuit 262 (BN/PK) and ground.



AJ0345-A

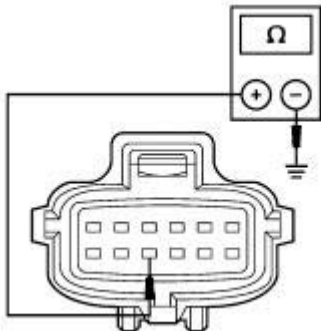
- Is the resistance reading greater than 10,000 ohms?

Yes
GO to [A23](#).

No
REPAIR circuit 262 (BN/PK) for a short to ground. TEST the system for normal operation. If equipped with fire suppression system, GO to [A24](#).

A23 CHECK CIRCUIT 33 (WH/PK) FOR A SHORT TO GROUND

- Measure the resistance between digital TR sensor C167-10, circuit 33 (WH/PK) and ground.




AJ0306-A

- Is the resistance reading greater than 10,000 ohms?

Yes
REFER to [Section 307-01](#), Digital Transmission Range Sensor Pinpoint Test. If equipped with fire suppression system, GO to [A24](#).

No
REPAIR circuit 33 (WH/PK) for a short to ground. TEST the system for normal operation. If equipped with fire suppression system, GO to [A24](#).

A24 REPOWER THE FIRE SUPPRESSION SYSTEM

-  **WARNING:** If equipped with fire suppression system, repower the system. For important safety warnings and procedures, refer to [Section 419-03](#) .
- Verify that the fire suppression system is repowered. Refer to [Section 419-03](#) .
- **Is the fire suppression system repowered?**

Yes

Fire suppression system repowering is complete.

No


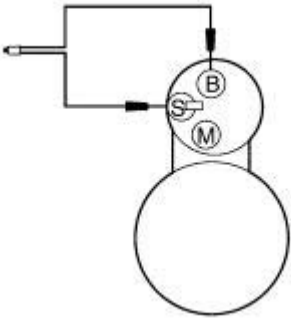
REFER to [Section 419-03](#) for diagnosis and testing of the fire suppression system.


Pinpoint Test B: Unusual Starter Noise

Possible Causes

- Starter mounting
- Flywheel/ring gear
- Starter motor


PINPOINT TEST B: UNUSUAL STARTER NOISE


Test Step	Result / Action to Take
B1 CHECK THE STARTER MOUNTING <ul style="list-style-type: none"> ●  WARNING: If equipped with fire suppression system, depower the system. For important safety warnings and procedures, refer to Section 419-03 . ● With the vehicle in NEUTRAL, position it on a hoist. Refer to Section 100-02 . ● Inspect the starter motor 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 in this section. TEST the system for normal operation. If equipped with fire suppression system, GO to B4 .
B2 CHECK FOR ENGINE NOISE <ul style="list-style-type: none"> ● Key in OFF position. ● Connect a remote starter switch between the starter motor solenoid B- and S-terminals.  <p style="text-align: center;">AJ0286-A</p> <ul style="list-style-type: none"> ● 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 the diagnosis. If diagnosis is complete and vehicle is equipped with fire suppression system, GO to B4 .
B3 CHECK FOR UNUSUAL WEAR <ul style="list-style-type: none"> ● Remove the starter motor; refer to Starter Motor in this section. ● Inspect the flywheel ring gear for damaged or worn teeth. 	Yes INSTALL a new flywheel ring gear. EXAMINE the starter

<ul style="list-style-type: none"> • Is the noise due to flywheel ring gear tooth damage? 	<p>pinion teeth. If damaged, INSTALL a new starter motor. TEST the system for normal operation. If equipped with fire suppression system, GO to <u>B4</u> .</p> <p>No INSTALL a new starter motor. TEST the system for normal operation. If equipped with fire suppression system, GO to <u>B4</u> .</p>
B4 REPOWER THE FIRE SUPPRESSION SYSTEM	
<ul style="list-style-type: none"> •  WARNING: If equipped with fire suppression system, repower the system. For important safety warnings and procedures, refer to <u>Section 419-03</u> . • Verify that the fire suppression system is repowered. Refer to <u>Section 419-03</u> . • Is the fire suppression system repowered? 	<p>Yes Fire suppression system repowering is complete.</p> <p>No REFER to <u>Section 419-03</u> for diagnosis and testing of the fire suppression system.</p>

Component Tests


Starter Motor — Voltage Drop Test

 **WARNING: When repairing 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 new protective cap or boot, which is provided over the battery input terminal on all vehicle lines, must be installed after repairs. Be sure to disconnect the battery ground cable before repairing the starter motor.**

Always connect the 73 Digital Multimeter at the component terminal rather than at the wiring end connector. Making a connection at the wiring end connector could result in false readings because the meter will not pick up a high resistance between the wiring connector and the component.

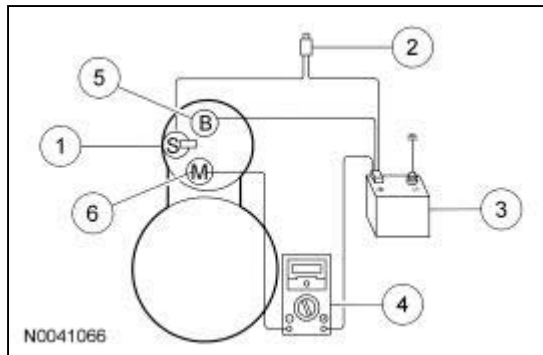
Starter Motor — Motor Feed Circuit

1.  **WARNING: If equipped with fire suppression system, depower the system. For important safety warnings and procedures, refer to Section 419-03 .**


Make sure the battery is fully charged; refer to Section 414-01 .

2. Disconnect the inertia fuel shutoff (IFS) switch.
3. Connect a remote starter switch between the starter motor solenoid S-terminal and the battery positive (+) terminal.
4. Connect the 73 Digital Multimeter positive lead to the battery positive (+) post. Connect the negative lead to the starter motor solenoid M-terminal.

Motor Feed Circuit



Item	Part Number	Description
1	—	S-terminal
2	—	Remote starter switch
3	10653	Battery
4	—	73 digital multimeter
5	—	B-terminal
6	—	M-terminal


5. Engage the remote starter switch. Read and record the voltage. The voltage reading should be 0.5 volts or less.
6. If the voltage reading is 0.5 volts or less, go to the Starter Motor—Motor Ground Circuit Component Test.
7. If the voltage reading is greater than 0.5 volts, indicating excessive resistance, move the 73 Digital Multimeter negative lead to starter motor solenoid B-terminal and repeat the test. If the voltage reading at the B-terminal is lower than 0.5 volts, the concern is either in the connections at the starter motor solenoid or in the starter motor solenoid contacts.
8. Remove the cables from the starter motor solenoid B-, S- and M-terminals. Clean the cables and connections and reinstall the cables to the correct terminals. Repeat Steps 3 through 6. If the voltage drop reading is still greater than 0.5 volts when checked at the M-terminal or less than 0.5 volts when checked at the B-terminal, the concern is in the solenoid contacts. Install a new starter motor.
9. If the voltage reading taken at starter motor solenoid B-terminal is still greater than 0.5 volts after cleaning the cables and connections at the solenoid, the concern is either in the positive (+) battery cable connection or in the positive battery cable itself.
10.  **WARNING: If equipped with fire suppression system, repower the system. For important safety warnings and procedures, refer to [Section 419-03](#).**

By moving the 73 Digital Multimeter negative lead toward the battery and checking each mechanical connection point, the excessive voltage drop can be located. When the high reading disappears, the last mechanical point that was checked is the concern. Repair or install a new connection as required.

Starter Motor — Motor Ground Circuit

A slow cranking condition can be caused by resistance in the ground or return portion of the cranking

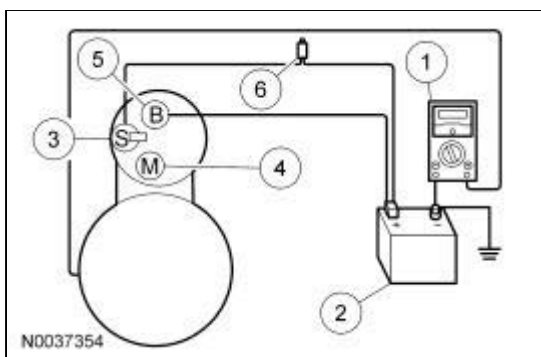
circuit. Check the voltage drop in the ground circuit as follows:

1.  **WARNING: If equipped with fire suppression system, depower the system. For important safety warnings and procedures, refer to [Section 419-03](#).**

Disconnect the inertia fuel shutoff (IFS) switch.


2. Connect a remote starter switch between starter motor solenoid S-terminal and the battery positive (+) terminal.
3. Connect the 73 Digital Multimeter positive lead 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.

Motor Ground Circuit



Item	Part Number	Description
1	—	73 digital multimeter
2	10653	Battery
3	—	S-terminal
4	—	M-terminal
5	—	B-terminal
6	—	Remote starter switch


4. Engage the remote starter switch and crank the engine. Read and record the voltage reading. The reading should be 0.2 volts or less.
5. If the voltage drop is more than 0.2 volts, clean the negative cable connections at the battery and body connections, and retest.
6. If the voltage drop is greater than 0.2 volts, determine which way the current is flowing in the cable. Connect the 73 Digital Multimeter positive lead to the end of the cable nearest battery positive.
7. Connect the multimeter negative lead to the terminal at the other end of the cable.

8.  **WARNING: If equipped with fire suppression system, repower the system. For important safety warnings and procedures, refer to [Section 419-03](#).**

Crank the engine and observe the voltage reading. The voltage reading should be 0.2 volts or lower. If the voltage drop is too high, clean the terminal ends. Retest, and if still high, install a new cable. If the voltage reading is less than 0.2 volts and the engine still cranks slowly, install a new starter motor.

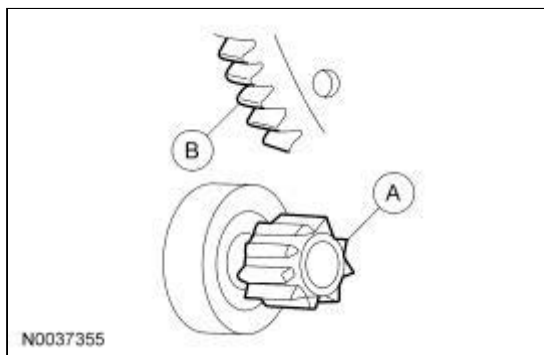
Starter Motor Drive Gear and Flywheel Ring Gear Inspection


[Printable View \(110 KB\)](#)

1.  **WARNING:** If equipped with fire suppression system, depower the system. For important safety warnings and procedures, refer to [Section 419-03](#).

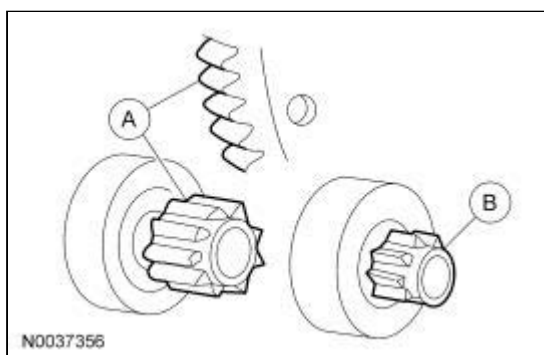
Remove the starter motor. For additional information, refer to [Starter Motor](#) in this section.

2. Check the wear patterns on the (A) starter drive and the (B) flywheel ring gear. If the wear pattern is normal, install the starter motor. For additional information, refer to [Starter Motor](#) in this section.



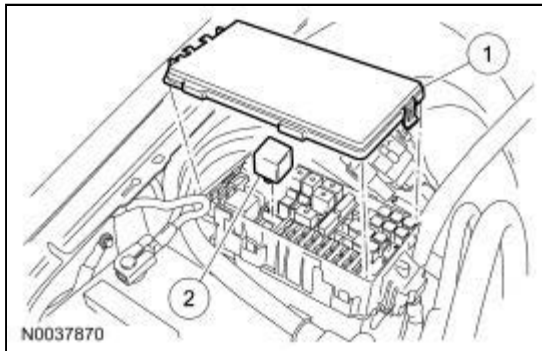
3.  **WARNING:** If equipped with fire suppression system, repower the system. For important safety warnings and procedures, refer to [Section 419-03](#).

If the (A) starter drive gear and the flywheel ring gear are not fully meshing or the gears are (B) milled or damaged, install a new starter motor. For additional information, refer to [Starter Motor](#) in this section. Install a new flywheel ring gear. For additional information, refer to [Section 303-01](#).



Starter Motor Solenoid Relay — ISO Mini

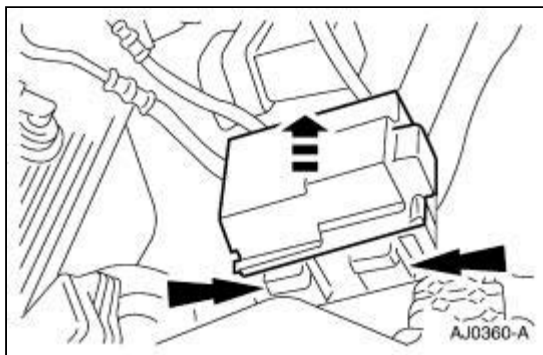
[Printable View \(127 KB\)](#)



Item	Part Number	Description
1	—	Relay junction box lid (part of 14A067)
2	11450	ISO starter relay

Removal and Installation

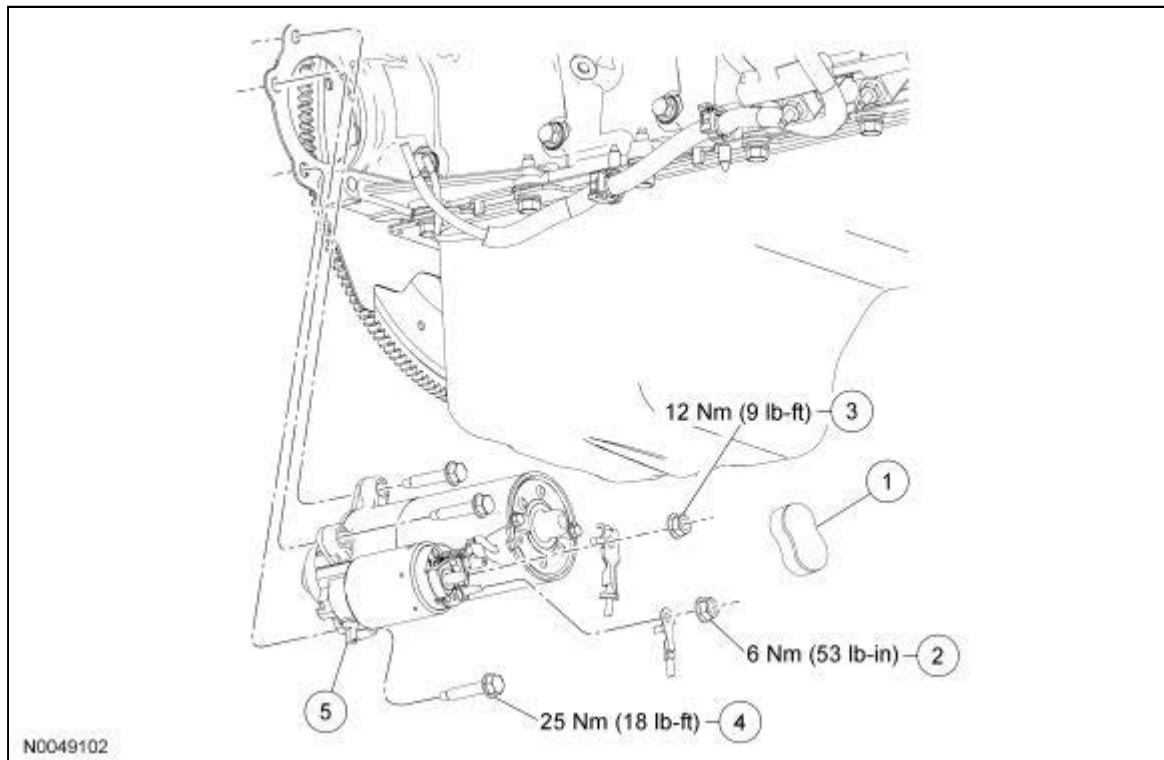
1. Disconnect the battery ground cable. For additional information, refer to [Section 414-01](#).
2. Press the clips inward and open the relay junction box.



3. Remove the ISO starter relay.
4. To install, reverse the removal procedure.

Starter Motor

[Printable View \(155 KB\)](#)



Item	Part Number	Description
1	11N087	Terminal cover
2	W705790	Starter solenoid S-terminal nut
3	W706414	Starter solenoid B-terminal nut
4	W506510	Starter motor bolt (3 required)
5	11000	Starter motor

Removal and Installation


⚠ WARNING: When carrying out maintenance on the starting system, be aware that the heavy gauge leads are connected directly to the battery. Make sure the protective caps are in place when the maintenance is complete.

⚠ WARNING: The electrical power to the air suspension system must be shut off prior to hoisting, jacking or towing an air suspension vehicle. This can be accomplished by turning off the air suspension switch located in the RH kick panel area. Failure to do so may result in unexpected inflation or deflation of the air springs, which may result in shifting of the vehicle during these operations.

- ⚠ WARNING:** If equipped with fire suppression system, depower the system. For important safety warnings and procedures, refer to [Section 419-03](#).

With the vehicle in NEUTRAL, position it on a hoist. For additional information, refer to [Section](#)

100-02.

2. Disconnect the battery ground cable. For additional information, refer to Section 414-01.
3. Remove the red protective cap on the starter solenoid.
4. Remove the B-terminal nut and disconnect the wire.
 - To install, tighten to 12 Nm (9 lb-ft).
5. Remove the S-terminal nut and disconnect the wire.
 - To install, tighten to 6 Nm (53 lb-in).
6. Remove the 3 bolts and the starter motor.
 - To install, the upper and lower starter bolts should first be finger-tight.
 - Tighten the upper 2 bolts to 25 Nm (18 lb-ft).
 - Tighten the lower bolt to 25 Nm (18 lb-ft).
7.  **WARNING: If equipped with fire suppression system, repower the system. For important safety warnings and procedures, refer to Section 419-03.**

To install, reverse the removal procedure. If equipped with fire suppression system, repower the system.

 [Printable View \(63 KB\)](#)

General Specifications

Item	Specification
Base ignition timing	10 degrees BTDC (not adjustable)
Firing order	1-3-7-2-6-5-4-8
Spark plug gap	1.32-1.42 mm (0.052-0.056 in)
Spark plug type (gasoline only)	AGSF-32N
Spark plug type (flexible fuel)	AGSF-22FM1

Torque Specifications

Description	Nm	lb-ft	lb-in
Spark plugs	15	11	—
Coil-on-plug bolts	10	—	89

Engine Ignition

 [Printable View \(63 KB\)](#)

This vehicle uses a coil-on-plug electronic ignition system. The coil-on-plug ignition system consists of the following components:

- Powertrain control module (PCM)
- Crankshaft position (CKP) sensor
- Ignition coil-on-plug
- Spark plugs

The PCM and the CKP sensor are also part of the electronic engine controls system. Refer to [Section 303-14](#).

Eight separate ignition coils:

- are controlled by the PCM for the correct firing sequence.
- are mounted directly above each spark plug.

The spark plugs:

- change the high voltage pulse into a spark which ignites the fuel and air mixture.
 - originally equipped on the vehicle have a nickel alloy electrode for long life.
-

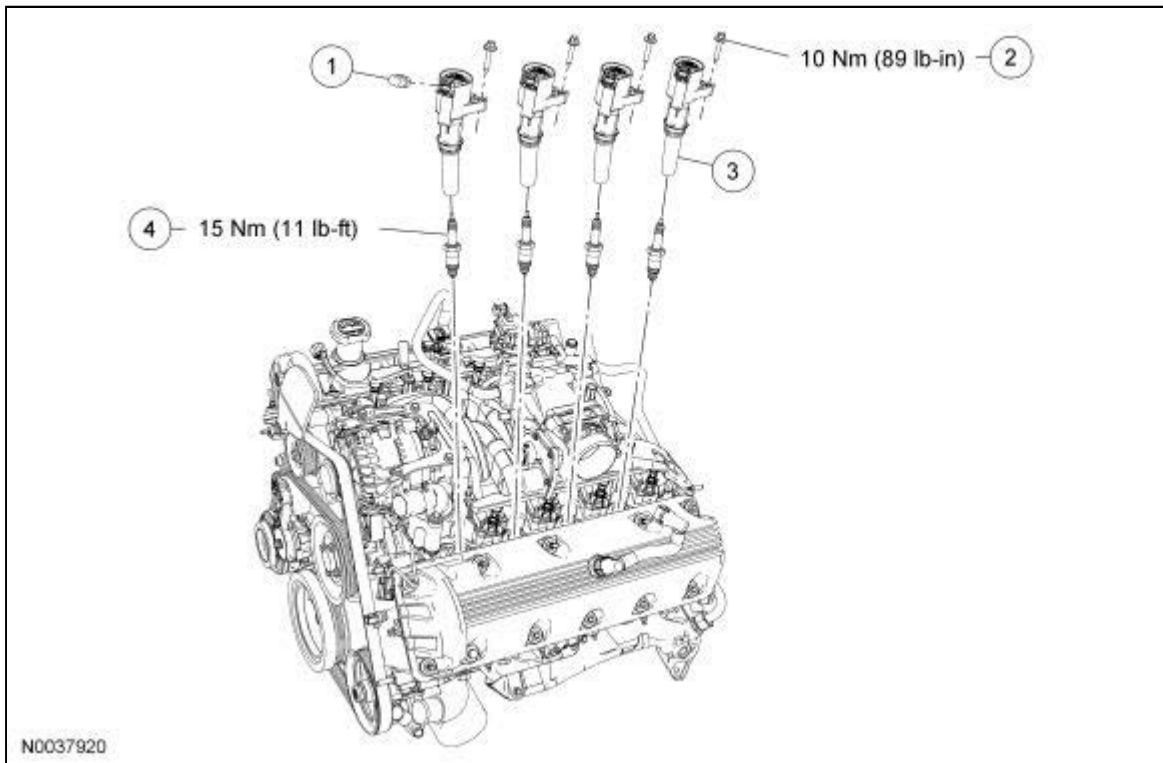
Engine Ignition

 [Printable View \(62 KB\)](#)

Refer to the Powertrain Control/Emissions Diagnosis (PC/ED) manual.

Engine Ignition Components — Exploded View

[Printable View \(168 KB\)](#)



Item	Part Number	Description
1	14A464	Ignition coil-on-plug electrical connectors
2	W706175	Ignition coil-to-intake manifold bolt (8 required)
3	12A366	Ignition coil (8 required)
4	12405	Spark plug (8 required)

1. For additional information, refer to the procedures in this section.

Ignition Coil-On-Plug

 [Printable View \(63 KB\)](#)

Removal and Installation

1. Disconnect the negative battery cable. For additional information, refer to [Section 414-01](#).
 2. Remove the air cleaner outlet pipe. For additional information, refer to [Section 303-12](#).
 3. Disconnect the electrical connector from the ignition coil-on-plug.
 4. Remove the bolt from the ignition coil-on-plug.
 - To install, tighten to 10 Nm (89 lb-in).
 5. Remove the ignition coil-on-plug.
 6. To install, reverse the removal procedure.
-

Spark Plugs

[Printable View \(89 KB\)](#)

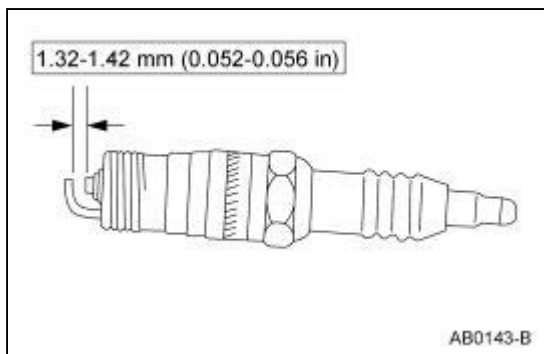
Removal and Installation

1. Remove the ignition coil-on-plugs. For additional information, refer to [Ignition Coil-On-Plug](#) in this section.
2. **NOTE:** Use compressed air to remove any foreign material from the spark plug well before removing the spark plugs.

Remove the spark plugs.

- To install, tighten to 15 Nm (11 lb-ft).

3. Inspect the spark plugs. For additional information, refer to [Section 303-00](#).
4. To install, reverse the removal procedure.
 - Adjust the spark plug gap as required.



 [Printable View \(62 KB\)](#)

Torque Specifications

Description	Nm	lb-ft
Exhaust gas recirculation (EGR) system module bolts	25	18
EGR system module-to-exhaust manifold tube fittings	40	30
Intake manifold shield retaining bolt	12	9

Engine Emission Control

[Printable View \(166 KB\)](#)



CAUTION: Do not remove any part of the engine emission control system. Operating the engine without the engine emission control system will reduce fuel economy and engine ventilation. This will weaken engine performance and shorten engine life.

The engine emission control consists of the:

- positive crankcase ventilation (PCV) system.
- exhaust gas recirculation (EGR) system.

Typical Vehicle Emission Control Information (VECI) Decal

Item	Part Number	Description
1	—	Adjustment procedure notes
2	—	Ignition timing specification
3	—	Engine vacuum hose routing (typical)
4	—	Spark plug gap specification
5	—	Engine type

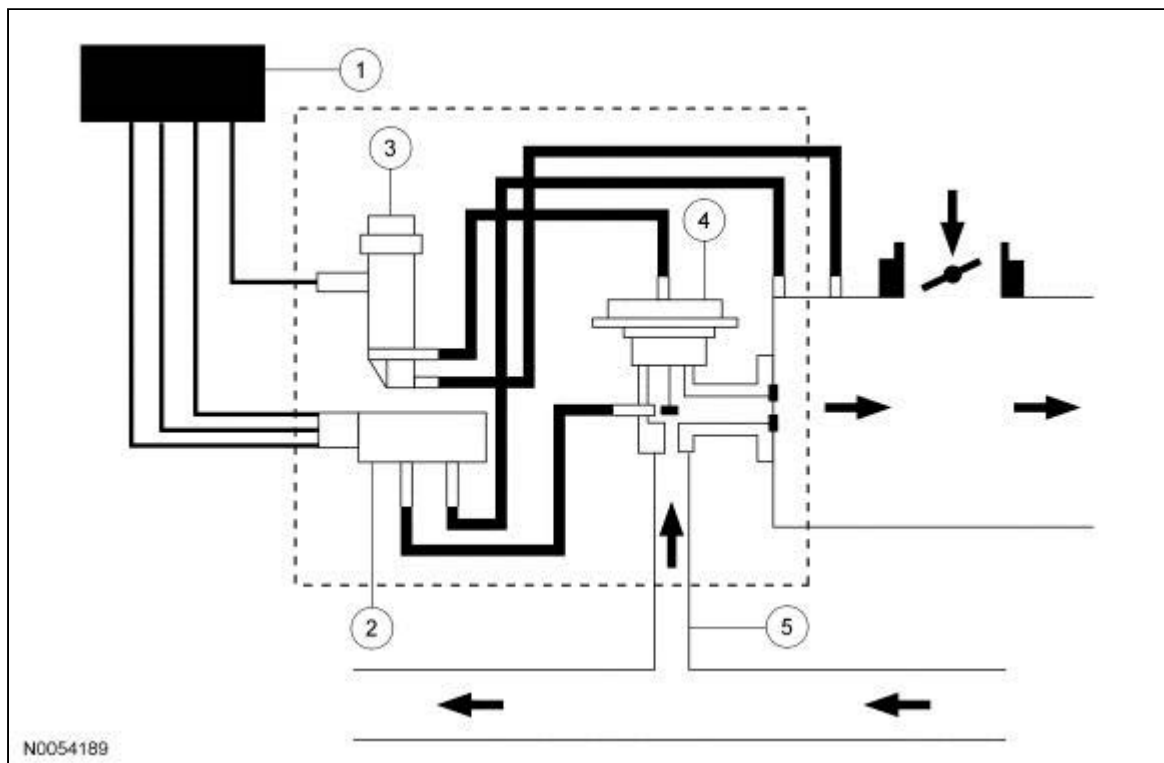
The vehicle emission control information (VECI) decal shows:

- components of the emission control system.
- the correct vacuum hose routing.
- the color stripe of the vacuum hoses.

Refer to [Section 100-01](#) .

The PCV system uses intake manifold vacuum to ventilate the crankcase and return the fumes to the intake manifold for combustion.

EGR System Components



Item	Part Number	Description
1	12A650	Powertrain control module (PCM)
2	—	Differential pressure and manifold absolute pressure (MAP) sensor
3	—	Exhaust gas recirculation (EGR) vacuum regulator
4	9D475	EGR valve
5	9D477	EGR valve-to-exhaust manifold tube

The exhaust gas recirculation (EGR) system returns a portion of the exhaust gas to the intake manifold to reduce the combustion temperature. This results in lower NO_x formation.

The powertrain control module (PCM) controls the EGR valve opening via the vacuum regulator solenoid. When the EGR valve opens, exhaust gas flows to the intake manifold. The EGR system module transducer measures the delta pressure across the orifice located in the EGR system module gasket. This delta pressure signal is sent to the PCM providing an indication of the EGR mass flow that was delivered.

The EGR system module-to-exhaust manifold tube:

- connects the exhaust manifold to the EGR valve and provides a path to deliver exhaust gas to the EGR valve.

The EGR system module transducer:

- measures the delta pressure across the orifice in the EGR system and sends a signal to the PCM indicating the EGR mass flow that was delivered.
- measures the manifold absolute pressure (MAP) and provides this signal to the PCM.

The EGR vacuum regulator solenoid uses input from the PCM to achieve the calibrated level of EGR flow for various engine operating conditions.

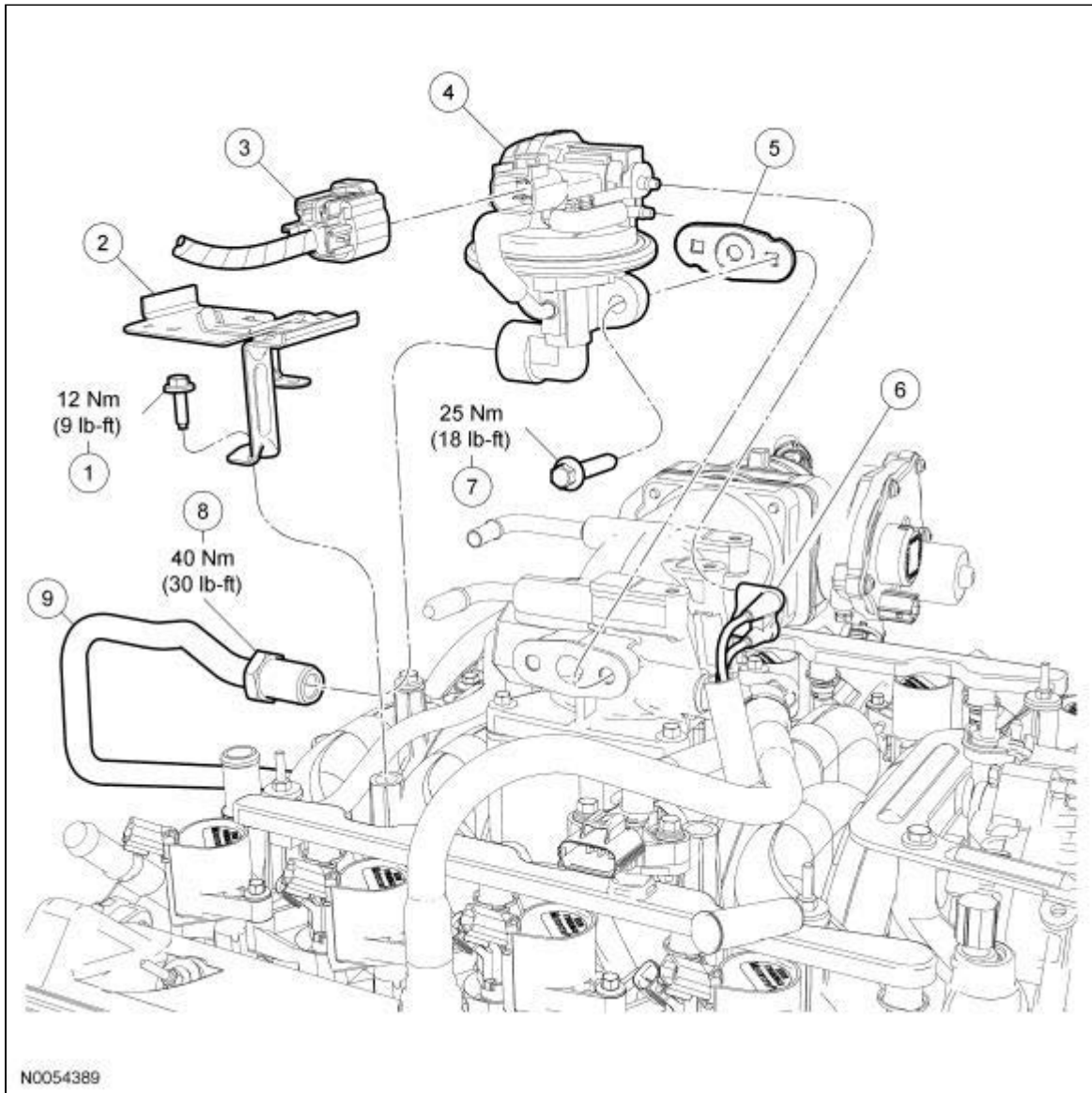
Engine Emission Control

 [Printable View \(62 KB\)](#)

Refer to the Powertrain Control/Emissions Diagnosis (PC/ED) manual.

Exhaust Gas Recirculation (EGR) System Components — Exploded View

[Printable View \(249 KB\)](#)




Item	Part Number	Description
1	N807309S	Intake manifold shield retaining bolt (2 required)
2	9F460A	Intake manifold shield
3	14A464	Exhaust gas recirculation (EGR) system module electrical connector
4	9D475	EGR system module
5	9D476	EGR system module gasket
6	9E499	EGR vacuum connector
7	—	EGR system module retaining bolt (2 required)
8	—	EGR tube fitting (part of 9D475)

1. For additional information, refer to the procedures in this section.
-

Exhaust Gas Recirculation (EGR) System Module

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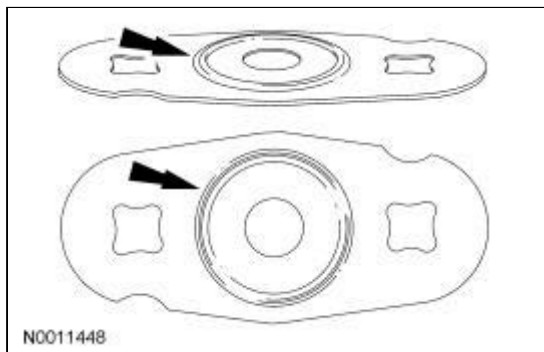
Removal and Installation

1. Disconnect the exhaust gas recirculation (EGR) system module electrical connector and vacuum connector.
2. Remove the 2 bolts and the intake manifold shield.
 - To install, tighten to 12 Nm (9 lb-ft).
3. Disconnect the EGR tube fitting from the EGR system module.
 - To install, tighten to 40 Nm (30 lb-ft).
4. Remove the 2 bolts and the EGR system module.
 - To install, tighten to 25 Nm (18 lb-ft).
5. Remove the EGR system module gasket and discard.
6.  **CAUTION: Do not use metal scrapers, wire brushes, power abrasive discs or other abrasive means to clean the sealing surfaces. These tools cause scratches and gouges that make leak paths. Use a plastic scraping tool to remove all traces of the EGR system module gasket.**

NOTE: If there is no residual gasket material present, metal surface prep can be used to clean and prepare the surfaces.

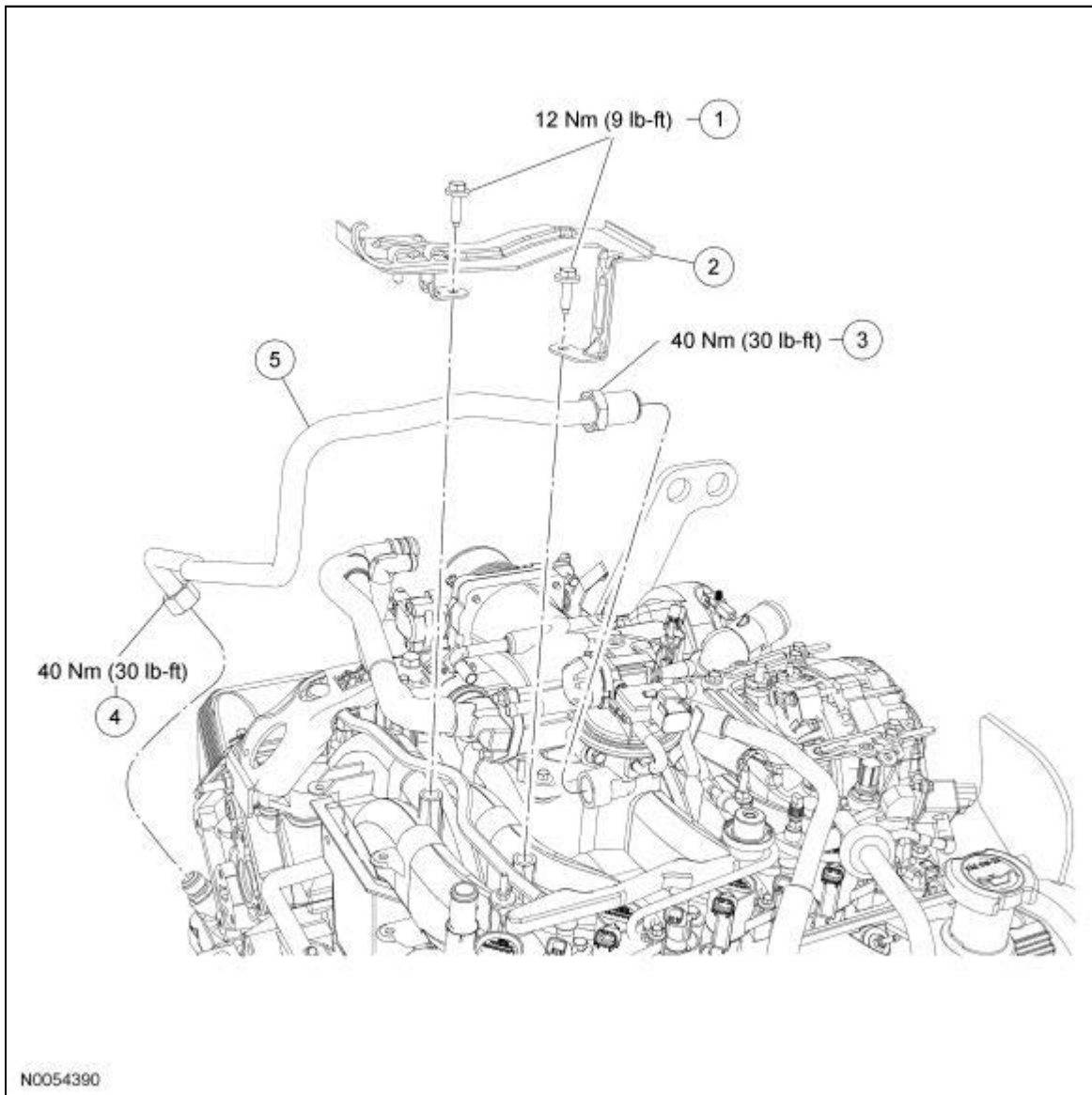
Clean the mating surfaces of any residual gasket material.

7. To install, reverse the removal procedure.
 - Install a new EGR system module gasket with the side that has the raised circle facing the intake manifold.



Exhaust Gas Recirculation (EGR) System Module Tube

[Printable View \(223 KB\)](#)



Item	Part Number	Description
1	N807309S	Intake manifold shield retaining bolts
2	9F460A	Intake manifold shield
3	—	Exhaust gas recirculation (EGR) system tube fitting (part of 9D477)
4	—	EGR system tube nut (part of 9D477)
5	9D477	EGR system tube

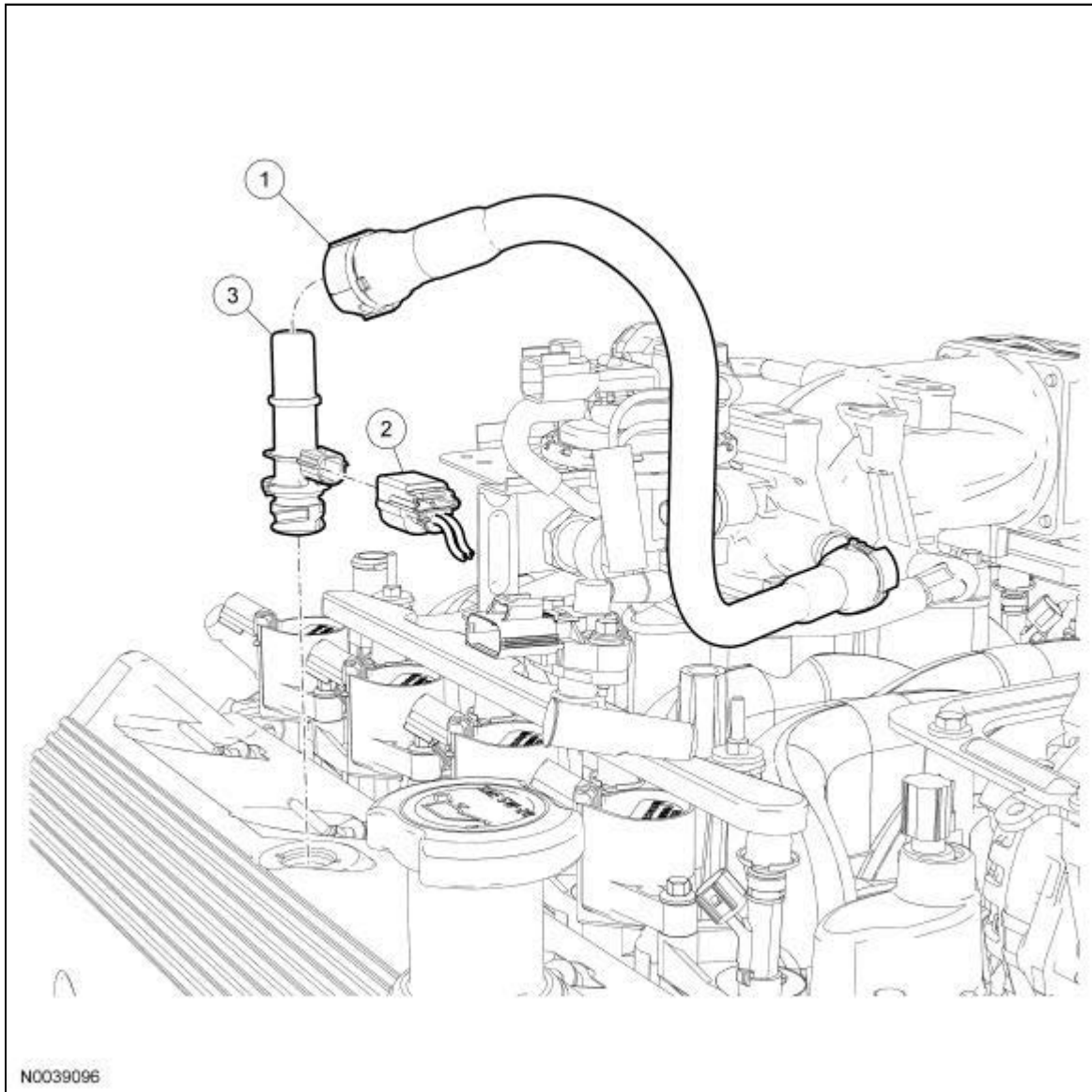
Removal and Installation

1. With the vehicle in NEUTRAL, position it on a hoist. For additional information, refer to [Section 100-02](#).

2. Remove the 2 bolts and the intake manifold shield.
 - To install, tighten to 12 Nm (9 lb-ft).
 3. Disconnect the tube fitting at the exhaust gas recirculation (EGR) system module.
 - To install, tighten to 40 Nm (30 lb-ft).
 4. Disconnect the EGR tube nut at the exhaust manifold.
 - To install, tighten to 40 Nm (30 lb-ft).
 5. Remove the EGR tube from the vehicle.
 6. To install, reverse the removal procedure. If equipped with fire suppression system, repower the system.
-

Positive Crankcase Ventilation (PCV) Valve


[Printable View \(251 KB\)](#)



Item	Part Number	Description
1	—	Crankcase ventilation tube quick connect coupling (part of 9E499A)
2	14A466	Positive crankcase ventilation (PCV) valve electrical connector
3	6A666B	PCV valve

Removal and Installation

1. Disconnect the crankcase ventilation tube quick connect coupling from the PCV valve. For additional information, refer to [Section 310-00](#).
2. Disconnect the PCV valve electrical connector.

3.  **CAUTION: A new PCV valve must be installed if removed. Upon removal, the plastic retaining ears of the PCV valve are sheared.**

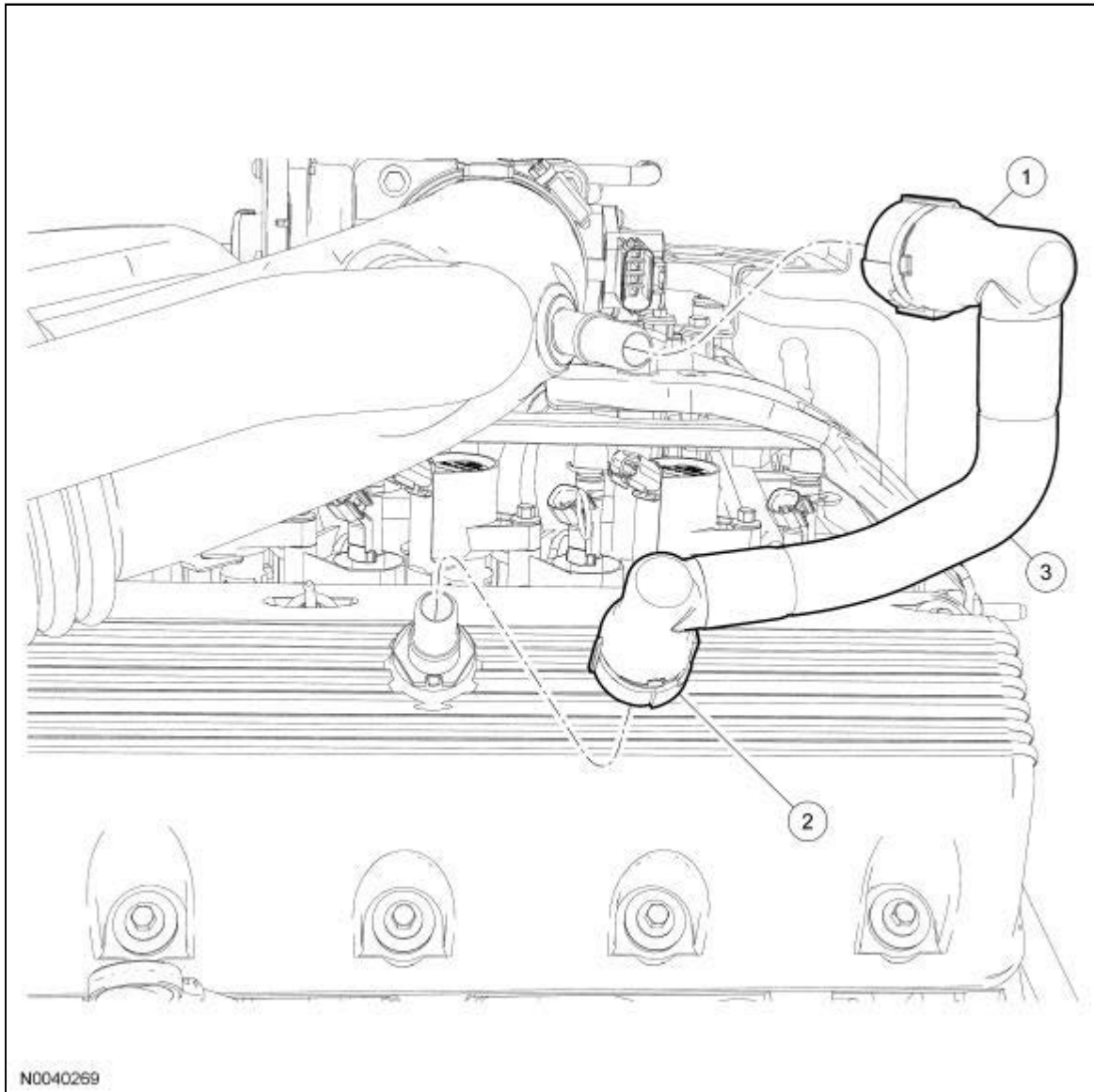
Rotate the PCV valve and remove.

4. To install, reverse the removal procedure.
-

Crankcase Ventilation Tube

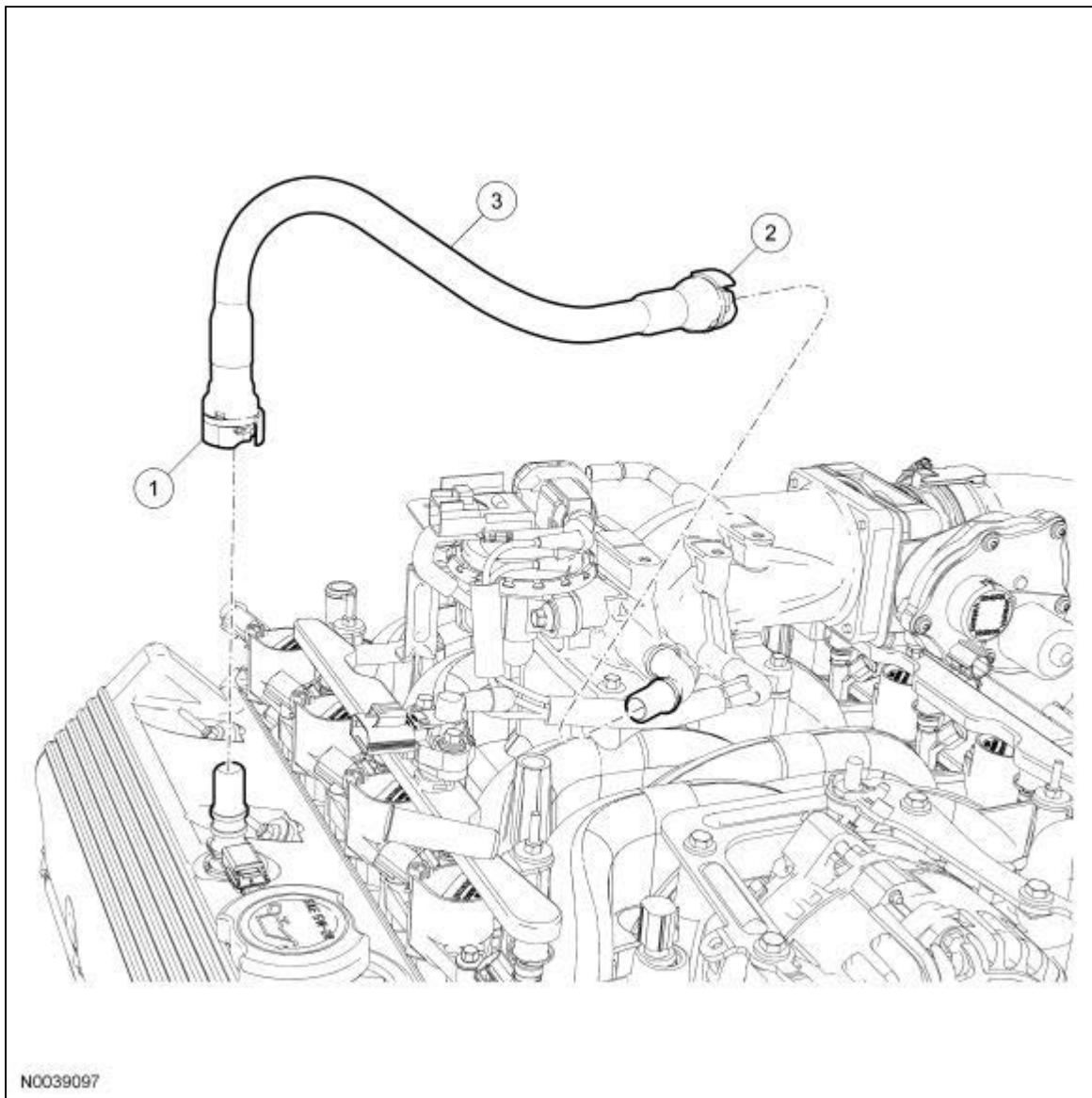
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LH Crankcase Ventilation Tube



Item	Part Number	Description
1	—	LH crankcase ventilation tube quick connect coupling-to-air cleaner outlet pipe (part of 9G499B)
2	—	LH crankcase ventilation tube quick connect coupling-to-valve cover (part of 9G499B)
3	9G499B	LH crankcase ventilation tube

RH Crankcase Ventilation Tube



N0039097

Item	Part Number	Description
1	—	RH crankcase ventilation tube quick connect coupling-to-positive crankcase ventilation (PCV) valve (part of 9E499A)
2	—	RH crankcase ventilation tube quick connect coupling-to-throttle body adapter (part of 9E499A)
3	9E499A	RH crankcase ventilation tube

Removal and Installation

LH crankcase ventilation tube

1. Release the LH crankcase ventilation tube quick connect coupling from the throttle body (TB) inlet tube. For additional information, refer to [Section 310-00](#).
2. Release the LH crankcase ventilation tube quick connect coupling from the LH valve cover crankcase vent tube nipple and remove the tube. For additional information, refer to [Section 310-00](#).

RH crankcase ventilation tube

3. Release the RH crankcase ventilation tube quick connect coupling from the TB adapter. For additional information, refer to [Section 310-00](#).
4. Release the RH crankcase ventilation tube quick connect coupling from the positive crankcase ventilation (PCV) valve and remove the tube. For additional information, refer to [Section 310-00](#).

RH and LH crankcase ventilation tubes

5. To install, reverse the removal procedure.
-

 [Printable View \(62 KB\)](#)

Torque Specifications

Description	Nm	lb-in
Air cleaner outlet pipe clamps	4	35
Air cleaner assembly mounting nuts	6	53

Intake Air Distribution and Filtering

 [Printable View \(63 KB\)](#)

The air intake system consists of the:

- engine air cleaner.
- air cleaner element.
- mass air flow (MAF) sensor.
- air cleaner outlet tube and resonator assembly.

The air intake system:

- cleans intake air with a replaceable air cleaner element.
 - measures airflow and intake air temperature with a MAF sensor. Refer to [Section 303-14](#).
-

Intake Air Distribution and Filtering

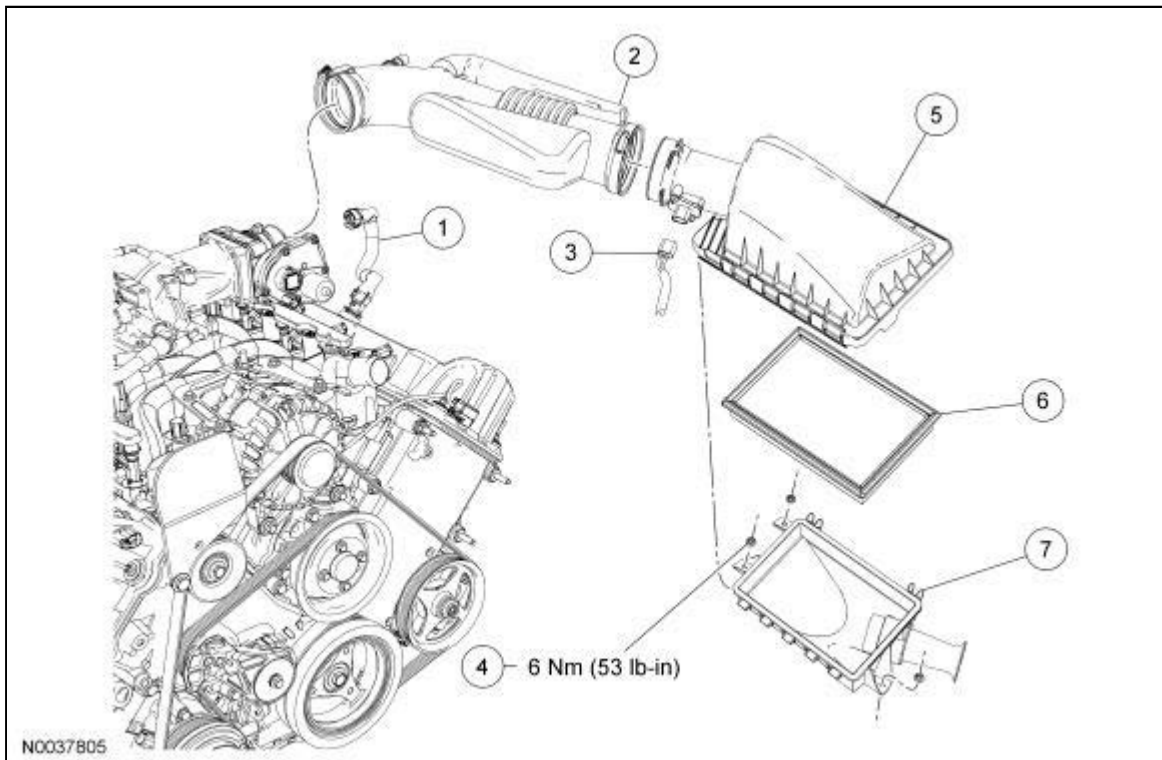


[Printable View \(62 KB\)](#)

Refer to Powertrain Control/Emissions Diagnosis (PC/ED) manual.

Intake Air System Components — Exploded View

[Printable View \(203 KB\)](#)



Item	Part Number	Description
1	6758	Crankcase ventilation hose
2	9F805	Air cleaner outlet pipe
3	14A464	Mass air flow (MAF) sensor electrical connector
4	N621906	Air cleaner retainer nut (3 required)
5	9600	Air cleaner cover
6	9601	Air cleaner element
7	—	Air cleaner tray (part of 9600)

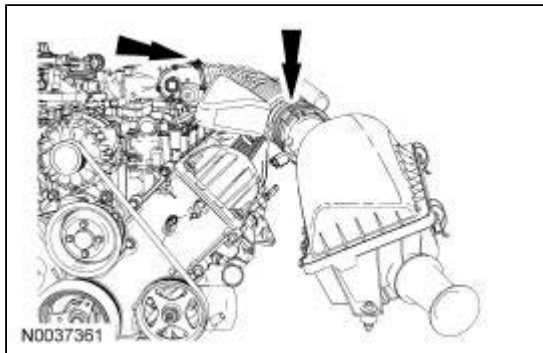
1. For additional information, refer to the procedures in this section.

Air Cleaner Outlet Pipe

[Printable View \(112 KB\)](#)

Removal and Installation

1. Disconnect the crankcase ventilation hose quick release coupling from the air cleaner outlet pipe. For additional information, refer to [Section 310-00](#).
2. Loosen the clamps on both ends of the air cleaner outlet pipe.
 - To install, tighten to 4 Nm (35 lb-in).



3. Remove the air cleaner outlet pipe.
 4. To install, reverse the removal procedure.
 - Upon installation, position the air cleaner outlet pipe on the throttle body first and line up the alignment tabs to properly seat the pipe.
-

Air Cleaner

 [Printable View \(63 KB\)](#)

Removal and Installation

1. Disconnect the battery ground cable. For additional information, refer to [Section 414-01](#).
 2. Disconnect the mass air flow (MAF) sensor electrical connector.
 3. Loosen the clamp and disconnect the air cleaner outlet tube from the air cleaner cover.
 - To install, tighten to 4 Nm (35 lb-in).
 4. Remove the 3 nuts and the engine air cleaner assembly.
 - To install, tighten to 6 Nm (53 lb-in).
 5. To install, reverse the removal procedure.
-

Air Cleaner Element

[Printable View \(78 KB\)](#)

Removal

1. Release the air cleaner lid retaining clips from the air cleaner cover.
2. Lift the air cleaner lid and remove the air cleaner element.

Installation

1. Lift the air cleaner lid and install the air cleaner element.
2. **NOTE:** It is important that all hinge features are fully engaged from the cover to the tray after servicing the air filter element.

Install the air cleaner lid retaining clips to the air cleaner cover.

 [Printable View \(78 KB\)](#)

General Specifications

Item	Specification
Lubricant	
P80 Rubber Lubricant Emulsion	WSE-M99C45-A2
Motorcraft SAE 5W-20 Premium Synthetic Blend Motor Oil XO-5W20-QSP (US); Motorcraft SAE 5W-20 Super Premium Motor Oil CXO-5W20-LSP12 (Canada); or equivalent	WSS-M2C930-A

Torque Specifications

Description	Nm	lb-in
Evaporative emissions canister nuts	6	53

Evaporative Emissions

[Printable View \(79 KB\)](#)

The evaporative emission system:

- prevents hydrocarbon emissions from reaching the atmosphere.
- stores fuel vapors in the evaporative emissions (EVAP) canister that are generated during vehicle operation, hot soak or vehicle refueling, until they can be consumed by the engine during normal engine operation.
- routes the stored fuel vapors to the engine during engine operation.
- is controlled by the powertrain control module (PCM), which uses various sensor inputs to calculate the desired amount of EVAP purge flow. The PCM regulates the purge flow induced by the application of intake manifold vacuum, by varying the duty cycle applied to the canister purge valve.

The fuel vapors are routed:

- from the fuel tank through the fill limit valve and fuel vapor vent valve.
- to the EVAP canister(s) through a vapor tube.
- to the engine when the EVAP canister purge valve is opened by the PCM.

The fuel tank pressure (FTP) sensor:

- is part of the fuel vapor control tube assembly valve.
- monitors the pressure levels in the fuel tank.
- communicates the pressure reading to the PCM during the OBD II leak test.

The EVAP canister:

- is located under the rear of the vehicle, just behind the fuel tank.
- contains activated carbon.
- stores fuel vapors.

The fuel tank filler cap:

- relieves system vacuum below 3.8 kPa (15.26 inches H₂O).

The EVAP canister vent solenoid:

- is normally open.
- seals the evaporative emissions system for the inspection and maintenance (I/M 240) test and OBD II leak and pressure tests.
- is mounted to the evaporative emissions canister.
- is repaired as a separate item.

The EVAP canister purge valve:

- is normally closed.
- regulates the purging of the EVAP canister.
- is controlled by the PCM.

The EVAP system monitor:

- is a self-test strategy within the PCM, which tests the integrity of the EVAP system.
- monitors the EVAP system for leaks.
- monitors electronic EVAP components for abnormally high or low voltages.
- monitors for correct EVAP system operation.
- uses negative and positive leak test methods to test and activate the EVAP system.

The EVAP Running Loss System leak test:

- utilizes intake manifold vacuum to test the system and involves several stages.
-