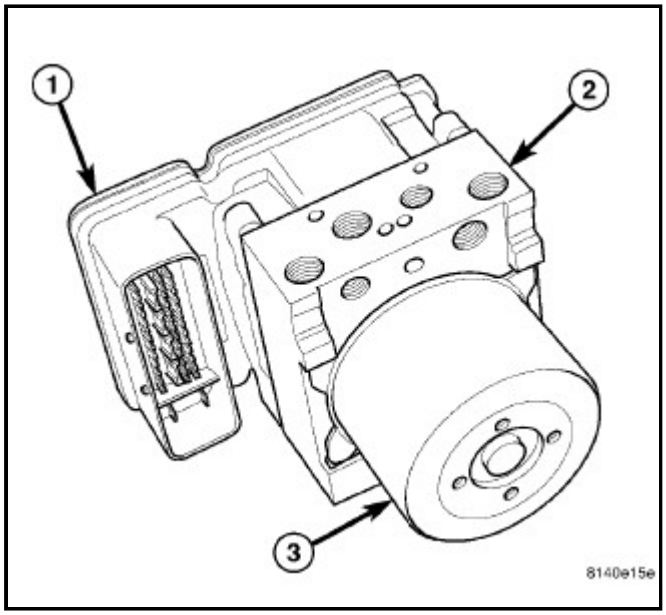
ANTILOCK BRAKE SYSTEM WITH ELECTRONIC STABILITY PROGRAM

This vehicle uses the Continental Mk25e electronic brake control system. The system includes ABS (Anti-lock Brake System), EVBP (Electronic Variable Brake Proportioning), TCS (Traction Control System), BAS (Brake Assist System), Electronic Roll Mitigation (ERM) and ESP (Electronic Stability Program). These systems work together to enhance vehicle stability and control in various driving conditions and are commonly referred to as ESP. ESP is standard on this vehicle.



This electronic brake control system uses the following components to operate:

- Integrated Control Unit (ICU) - Hydraulic Control Unit (HCU) (2) and Antilock Brake Module (ABM) (1)
- Wheel Speed Sensors (WSS) - Four sensors (one sensor at each wheel)
- Dynamics Sensor - The Dynamics Sensor includes the Yaw Rate Sensor and the lateral Acceleration Sensor.
- Steering Angle Sensor (SAS) - The steering angle sensor is located in the Steering Column Control Module (SCCM) mounted on the steering column.
- Brake Pressure Sensor - The brake pressure sensor is located in the HCU and is not serviceable separate from the HCU.

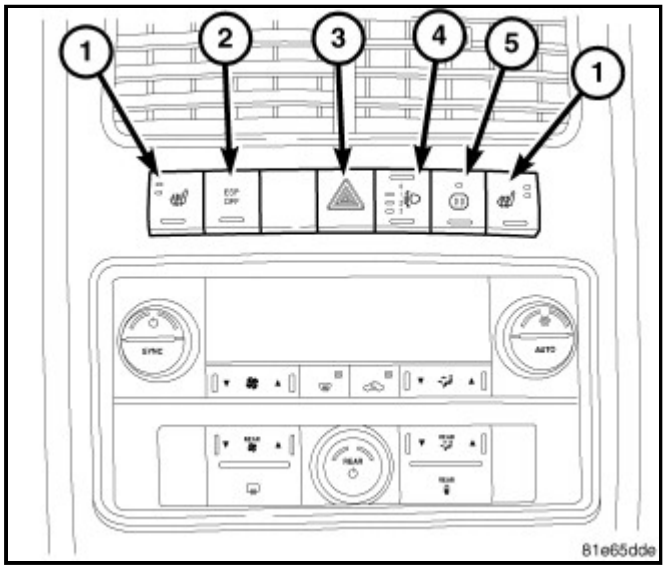
ABS

The purpose of the Antilock Brake System (ABS) is to prevent wheel lockup under braking conditions on virtually any type of road surface. Antilock braking is desirable because a vehicle that is stopped without locking the wheels retains directional stability and some steering capability. This allows the driver to retain greater control of the vehicle during braking.

All vehicles equipped with ABS use Electronic Variable Brake Proportioning (EVBP) to balance front-to-rear braking when the brakes are applied in the partial braking range.

ALL-SPEED TRACTION CONTROL

The traction control system (TCS) is an all-speed traction control. All-Speed Traction Control enhances mobility and prevents wheel slip when accelerating on slippery surfaces. It also provides a measure of directional stability control. Using the wheel-speed sensors, it can detect excessive yaw and help keep the car on the intended course, as for instance, when accelerating around a curve.



All-Speed Traction Control is effective up to 85 mph (137 km/h).

The traction control system may be turned off or on by depressing the ESP Off switch button (2) located in the instrument panel switch pod located in center of the instrument panel.

MODULE-ASBM

ELECTRONIC STABILITY PROGRAM

The Electronic Stability Program (ESP) enhances control and stability of the vehicle under various driving conditions. ESP corrects for over/under steering of the vehicle by applying the brake of the appropriate wheel to assist in counteracting the over/under steer condition. Engine power may also be reduced to help the vehicle maintain the desired path. ESP uses sensors in the vehicle to determine the vehicle path intended by the driver and compares it to the actual path of the vehicle. When the actual path does not match the intended path, ESP applies the brake of the appropriate wheel to assist in counteracting the oversteer or understeer condition.

- Oversteer - When the vehicle is turning more that appropriate for the steering wheel position.
- Understeer - When the vehicle is turning less than appropriate for the steering wheel position.

The "ESP/TCS" indicator light located in the instrument cluster starts to flash as soon as the tires lose traction and the ESP system becomes active. The "ESP/TCS" indicator light also flashes when the TCS is active.

The ESP® default mode is Full-On with every key-on. Pressing the ESP Off button once activates what is referred to as Partial mode. In Partial mode, Traction Control is deactivated and ESP® operates at a higher threshold, therefore, it will not come on as aggressively as in the Full-On mode. The system can be returned to “normal” Full-On mode by pressing and releasing the ESP Off switch. The ESP function lamp is illuminated in the cluster whenever the ESP system is turned off.

ELECTRONIC ROLL MITIGATION

Electronic Roll Mitigation (ERM) is a software feature in addition to ESP control that focuses on preventing wheel lift in NHTSA Fish Hook maneuvers. These very extreme situations are well out of normal everyday driving, but if by chance an extreme dynamic maneuver occurs, ERM can help reestablish vehicle stability and return control to the driver. ERM determines when a vehicle is in a potential roll over condition and applies the appropriate braking force to reduce the likelihood that such an event will occur. ERM will not aid vehicle stability in “trip” situations, such as when a vehicle slides sideways into a curb, etc. which could still cause the wheels opposite the curb to lift and the vehicle to roll.

HILL START ASSIST

The Hill Start Assist (HSA) system is designed to assist the driver when starting a vehicle from a stop on a hill. HSA will maintain the level of brake pressure the driver applied for a short period of time after the driver takes his foot off of the brake pedal.

TRAILER SWAY CONTROL

Trailer Sway Control (TSC) is safety feature made possible by ESP. TSC does not require driver input; it activates once the yaw sensor recognizes the unique vehicle motion associated with trailer sway and no steering input. It becomes clear that this motion has to be from a trailer and thus activates the brakes to eliminate the trailer sway.

BRAKE ASSIST SYSTEM

The Brake Assist System (BAS) is designed to optimize the vehicle's braking capability during emergency braking maneuvers. The system detects an emergency braking situation by sensing the rate and amount of brake application and then applies optimum pressure to the brakes. This can help reduce braking distances. The BAS complements the antilock brake system (ABS). Applying the brakes very quickly results in the best BAS assistance.

ELECTRONIC VARIABLE BRAKE PROPORTIONING

Electronic Variable Brake Proportioning (EVBP) is used to balance front-to-rear braking in place of a traditional rear proportioning valve. The EVBP system uses the ABS system to control the slip of the rear wheels in partial braking range. The braking force of the rear wheels is controlled electronically by using the inlet and outlet valves located in the integrated control unit (ICU).

EVBP activation is nearly invisible to the customer since there is no pump motor noise and minimal brake pedal feedback.

ANTILOCK BRAKE SYSTEM WITH ELECTRONIC STABILITY PROGRAM

ABS

There are a few performance characteristics of the Antilock Brake System (ABS) that may at first seem abnormal, but in fact are normal. These characteristics are described below.

NORMAL BRAKING

Under normal braking conditions, the ABS functions the same as a standard base brake system with a diagonally split master cylinder and conventional vacuum assist.

ABS BRAKING

ABS operation is available at all vehicle speeds above 3–5 mph (5–8 km/h) If a wheel locking tendency is detected during a brake application, the brake system enters the ABS mode. During ABS braking, hydraulic pressure in the four wheel circuits is modulated to prevent any wheel from locking. Each wheel circuit is designed with a set of electric solenoids to allow modulation. Wheel lockup may be perceived at the very end of an ABS stop and is considered normal.

During an ABS event, the Integrated Control Unit (ICU) regulates hydraulic pressure at all four of the vehicle's wheels.

The hydraulic pressure at each wheel is controlled independently (relative to the amount of slip at each wheel) in order to maximize the braking force generated by the front brakes.

The system can build and release pressure at each wheel, depending on signals generated by the Wheel Speed Sensors (WSS) at each wheel and received at the Antilock Brake Module (ABM).

NOISE AND BRAKE PEDAL FEEL

During ABS braking, some brake pedal movement may be felt. In addition, ABS braking will create ticking, popping, or groaning noises heard by the driver. This is normal and is due to pressurized fluid being transferred between the master cylinder and the brakes. If ABS operation occurs during hard braking, some pulsation may be felt in the vehicle body due to fore and aft movement of the suspension as brake pressures are modulated.

At the end of an ABS stop, ABS is turned off when the vehicle is slowed to a speed of 3–4 mph (5–6 km/h). There may be a slight brake pedal drop anytime that the ABS is deactivated, such as at the end of the stop when the vehicle speed is less than 3 mph (5 km/h) or during an ABS stop where ABS is no longer required. These conditions exist when a vehicle is being stopped on a road surface with patches of ice, loose gravel, or sand on it. Also, stopping a vehicle on a bumpy road surface activates ABS because of the wheel hop caused by the bumps.

TIRE NOISE AND MARKS

Although the ABS system prevents complete wheel lockup, some wheel slip is desired in order to achieve optimum braking performance. Wheel slip is defined as follows: 0 percent slip means the wheel is rolling freely and 100 percent slip means the wheel is fully locked. During brake pressure modulation, wheel slip is allowed to reach up to 25–30 percent. This means that the wheel rolling velocity is 25–30 percent less than that of a free rolling wheel at a given vehicle speed. This slip may result in some tire chirping, depending on the road surface. This sound should not be interpreted as total wheel lockup.

Complete wheel lockup normally leaves black tire marks on dry pavement. The ABS will not leave dark black tire marks since the wheel never reaches a fully locked condition. However, tire marks may be noticeable as light patched marks.

START-UP AND DRIVE-OFF CYCLES

When the ignition is turned on, a popping sound and a slight brake pedal movement may be noticed. The ABS warning lamp will also be on for up to 5 seconds after the ignition is turned on.

When the vehicle is first driven off, a humming may be heard or felt by the driver at approximately 12–25 mph (20–40 km/h). All of these conditions are a normal function of ABS as the system is performing a diagnosis check.

PREMATURE ABS CYCLING

Symptoms of premature ABS cycling include: clicking sounds from the solenoid valves; pump/motor running; and pulsations in the brake pedal. Premature ABS cycling can occur at any braking rate of the vehicle and on any type of road surface. Neither the red BRAKE indicator lamp, nor the amber ABS indicator lamp, illuminate and no faults are stored in the ABM.

Premature ABS cycling is a condition that needs to be correctly assessed when diagnosing problems with the antilock brake system. It may be necessary to use a scan tool to detect and verify premature ABS cycling.

Check the following common causes when diagnosing premature ABS cycling: damaged wheel bearings (causing tone wheel issues); damaged wheel speed sensor mounting bosses; damaged teeth on the sensor tone wheel; and loose wheel speed sensor mounting screws.

After diagnosing the defective component, repair or replace it as required. When the component repair or replacement is completed, test drive the vehicle to verify that premature ABS cycling has been corrected.

ALL-SPEED TRACTION CONTROL

Traction control systems sense impending wheel spin based on a model of the rate of change of wheel speed under normal traction conditions. The All-Speed Traction Control uses signals from the same wheel speed sensors as ABS to determine when to apply the brakes to one or more wheels and when to reduce engine torque output using the electronic throttle control (ETC) to prevent wheel slip during acceleration. Throttle control makes the vehicle less reliant on brake application alone to maintain traction, increasing the operating speed range and more closely modulates speed, resulting in smoother operation. With All-Speed Traction Control reducing engine torque as well as applying the brakes, it is possible to achieve almost seamless torque application at the wheels.

If the wheel slip is severe enough to require throttle intervention, All-Speed Traction Control will reduce engine torque and sometimes upshift the transmission to avoid the condition. In milliseconds, All-Speed Traction Control interrogates the engine control system to determine the current torque output, determines how much the torque output the current conditions will allow, and signals this requirement to the engine control system, which reduces the torque by partially closing the throttle. With execution of the torque reduction, the brake system reduces brake pressure to make the transition smooth, while maintaining forward progress. By reducing engine power, braking effectiveness is maintained and the system can operate throughout the normal vehicle speed range. That is why the system is identified as providing “all-speed” traction control.

The traction control system is enabled at each ignition cycle. It may be turned off by depressing the ESP OFF switch button. The ESP/TCS function indicator lamp illuminates immediately upon depressing the button. Pressing this button again or turning off and restarting the vehicle will enable the traction control system.

ELECTRONIC STABILITY PROGRAM

To determine whether the car is responding properly to cornering commands, ESP® uses steering wheel angle, yaw (turning) rate and lateral acceleration sensors (combined into Dynamics Sensor). Using signals from these sensors, in addition to individual wheel speed sensor signals, the system determines appropriate brake and throttle actions. Once initiated, ESP® operates much like All-Speed Traction Control, except that the goal is directional stability. If the vehicle yaw response, or rate of turning, is inconsistent with the steering angle and vehicle speed indications, the ESP® system applies the brakes and, if necessary closes the throttle, to restore control. This occurs whether the vehicle is turning too rapidly (oversteering) or not rapidly enough (understeering).

ELECTRONIC ROLL MITIGATION

Typically when a vehicle makes a sudden turn, the outside tires provide the majority of cornering force. In order for the vehicle to make a turn, a significant amount of grip must exist at the tire contact patch. The body tilt that occurs during this event increases the weight on the outside tires. These conditions, plus the lateral acceleration of the vehicle, combined with the center of gravity position in the vehicle can cause the two inside wheels to lift in the turn and the vehicle rolls over the outside tires. ERM uses the principle that a slipping tire creates less cornering force than one that has full grip by applying enough brake pressure to intentionally make the outside tires slip close to the point of lockup. This reduces the cornering force of the outside tires and increases the turning radius. This straighter path reduces the amount of lateral acceleration and transfers some of the weight back to the inside tires, thus preventing a rollover.

HILL START ASSIST

Hill Start Assist (HSA) will maintain the level of brake pressure the driver applied for a short period of time after the driver takes his foot off of the brake pedal. If the driver does not apply the throttle during this short period of time the system will

release brake pressure and the vehicle may roll down the hill. The system will release brake pressure in proportion to the amount of throttle applied as the vehicle starts to move in the intended direction of travel.

TRAILER SWAY CONTROL

Programmed into the ESP, Trailer Sway Control will be activated once critical amplitude and frequency of oscillation of the vehicle-trailer system is reached. TSC builds up pressure to decelerate the vehicle-trailer system to below the critical speed. Depending on the oscillation conditions, TSC software can build up an additional asymmetric pressure to counter the trailer oscillation. The ESP function lamp will flash when TSC is activated.

HYDRAULIC BRAKE ASSIST

Brake Assist is programmed into the ESP® system. During a panic stop, a pressure sensor determines when the driver is doing so by measuring the brake pedal pressure application rate. A high rate of pedal pressure application causes the ESP® system to apply maximum available pressure to the brakes and the vehicle stops as quickly as available traction will allow.

ELECTRONIC VARIABLE BRAKE PROPORTIONING

Upon entry into EVBP the inlet valve for the rear brake circuit is switched on so that the fluid supply from the master cylinder is shut off. In order to decrease the rear brake pressure, the outlet valve for the rear brake circuit is pulsed. This allows fluid to enter the low pressure accumulator (LPA) in the hydraulic control unit (HCU) resulting in a drop in fluid pressure to the rear brakes. In order to increase the rear brake pressure, the outlet valve is switched off and the inlet valve is pulsed. This increases the pressure to the rear brakes. This back-and-forth process will continue until the required slip difference is obtained. At the end of EVBP braking (brakes released) the fluid in the LPA drains back to the master cylinder by switching on the Electronic Shuttle Valve.

The EVBP will remain functional during many ABS fault modes. If both the red BRAKE and amber ABS warning indicators are illuminated, the EVBP may not be functioning.

CAUTION

The antilock brake system uses an electronic control module known as the Antilock Brake Module (ABM). This module is designed to withstand normal current draws associated with vehicle operation. Care must be taken to avoid overloading the circuits.

CAUTION: In testing for open or short circuits, do not ground or apply voltage to any of the circuits unless instructed to do so for a diagnostic procedure.

CAUTION: These circuits should only be tested using a high impedance multi-meter or the designated scan tool as described in this section. Power should never be removed or applied to any control module with the ignition in the ON position. Before removing or connecting battery cables, fuses, or connectors, always turn the ignition to the OFF position.

CAUTION: The ABM 47-way connector should never be connected or disconnected with the ignition switch in the ON position.

CAUTION: This vehicle utilizes active wheel speed sensors. Do not apply voltage to wheel speed sensors at any time.

CAUTION: Use only factory wiring harnesses. Do not cut or splice wiring to the brake circuits. The addition of aftermarket electrical equipment (car phone, radar detector, citizen band radio, trailer lighting, trailer brakes, etc.) on a vehicle equipped with antilock brakes may affect the function of the antilock brake system.

CAUTION: When performing any service procedure on a vehicle equipped with ABS, do not apply a 12-volt power source to the ground circuit of the pump motor in the HCU. Doing this will damage the pump motor and will require replacement of the entire HCU.

CAUTION: An attempt to remove or disconnect certain system components may result in improper system operation. Only those components with approved removal and installation procedures in this manual should be serviced.

CAUTION: If welding work is to be performed on the vehicle using an electric arc welder, the ABM connector should be disconnected during the welding operation.

CAUTION: Many components of the ABS are not serviceable and must be replaced as an assembly. Do not disassemble any component which is not designed to be serviced.

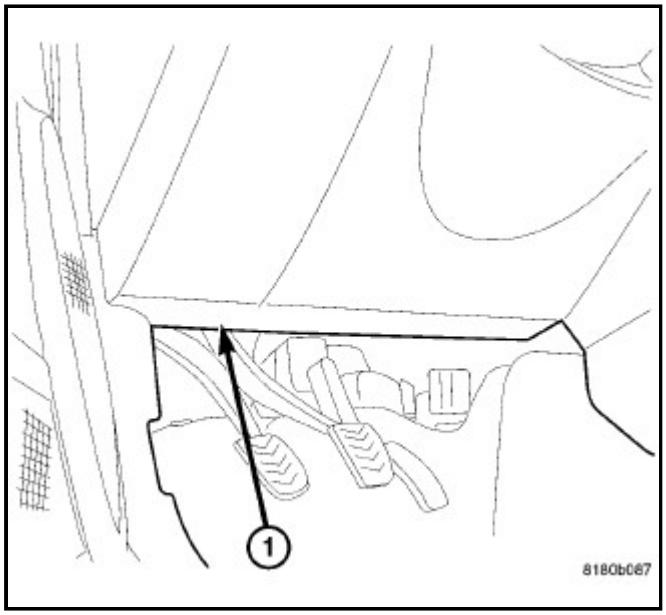
CAUTION: Brake fluid will damage painted surfaces. If brake fluid is spilled on any painted surface, wash off with water immediately.

CAUTION: Only the recommended jacking or hoisting positions for this vehicle are to be used whenever it is necessary to lift a vehicle.

INSPECTION AND ROAD TEST

1. Visually inspect the ABS for damaged or disconnected components and connectors.
2. Verify the brake lamps are operational. If they are not, repair them prior to continuing.

3. Connect a scan tool to the Data Link Connector located under the instrument panel to the left of the steering column (1). If the scan tool does not power-up, check the power and ground supplies to the connector.
4. Turn the ignition key to the ON position.
5. Using the scan tool, read and record any Diagnostic Trouble Codes (DTCs). If any DTCs are present, refer to the appropriate diagnostic information.



If no problems are observed, it will be necessary to road test the vehicle.

Many ABS conditions judged to be a problem by the driver may be normal operating conditions. To become familiarized with the normal operating characteristics of this antilock brake system, (Refer to 05 - Brakes - Operation) .

WARNING: Conditions that result in turning on the red brake warning indicator lamp may indicate reduced braking ability.

Before road testing a brake complaint vehicle, note whether the red BRAKE warning indicator lamp, amber ABS warning indicator lamp, or both are turned on. If it is the red BRAKE warning indicator, there is a brake hydraulic problem that must be corrected before driving the vehicle (Refer to 05 - Brakes - Diagnosis and Testing) .

If the amber ABS warning indicator is on, road test the vehicle as described below. While only the amber ABS warning indicator is on, the ABS is not functional. The ability to stop the car using the base brake system should not be affected.

6. Turn the key to the OFF position and then back to the ON position. Note whether the amber ABS warning indicator lamp continues to stay on.
7. If the amber ABS warning indicator lamp stays on, shift into gear and drive the car to a speed of approximately 25 km/h (15 mph) to complete the ABS Start-Up and Drive-Off Cycles (Refer to 05 - Brakes - Operation) . If at this time the amber ABS warning indicator lamp stays on, refer to the appropriate diagnostic information.
8. If the amber ABS warning indicator lamp goes out at any time, drive the vehicle a short distance. Accelerate the vehicle to a speed of at least 64 km/h (40 mph). Bring the vehicle to a complete stop, braking hard enough to cause the ABS to cycle. Repeat this action several times. Using the scan tool, read and record any Diagnostic Trouble Codes (DTCs). If any DTCs are present, refer to the appropriate diagnostic information.

ANTILOCK BRAKE SYSTEM BLEEDING

The base brake's hydraulic system must be bled anytime air enters the hydraulic system. The ABS must always be bled anytime it is suspected that the HCU has ingested air.

Brake systems with ABS must be bled as two independent braking systems. The non-ABS portion of the brake system with ABS is to be bled the same as any non-ABS system.

The ABS portion of the brake system must be bled separately. Use the following procedure to properly bleed the brake hydraulic system including the ABS.

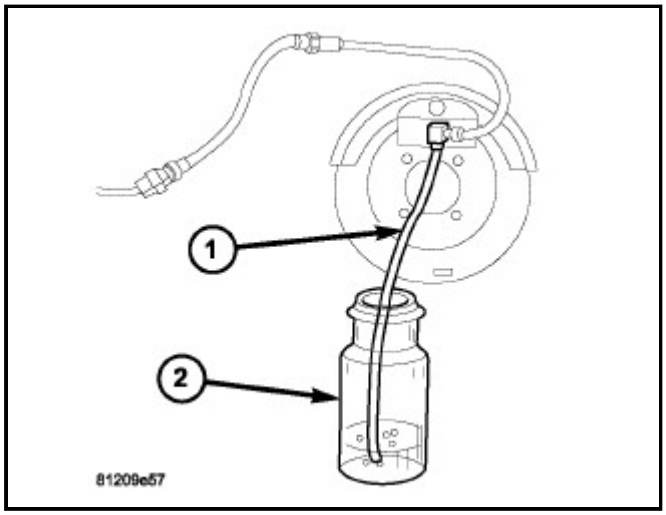
NOTE: During the brake bleeding procedure, be sure the brake fluid level remains close to the FULL level in the master cylinder fluid reservoir. Check the fluid level periodically during the bleeding procedure and add Mopar® DOT 3 brake fluid as required.

BLEEDING

When bleeding the ABS system, the following bleeding sequence must be followed to insure complete and adequate bleeding.

1. Make sure all hydraulic fluid lines are installed and properly torqued.
2. Connect the scan tool to the diagnostics connector. The diagnostic connector is located under the lower steering column cover to the left of the steering column.
3. Using the scan tool, check to make sure the ABM does not have any fault codes stored. If it does, clear them.

WARNING: When bleeding the brake system wear safety glasses. A clear bleed tube (1) must be attached to the bleeder screws and submerged in a clear container filled part way with clean brake fluid (2). Direct the flow of brake fluid away from yourself and the painted surfaces of the vehicle. Brake fluid at high pressure may come out of the bleeder screws when opened.



NOTE: Pressure bleeding is recommended to bleed the base brake system to ensure all air is removed from system. Manual bleeding may also be used, but additional time is needed to remove all air from system.

4. Bleed the base brake system. (Refer to 05 - Brakes - Standard Procedure)
5. Using the scan tool, select ECU VIEW, followed by ABS MISCELLANEOUS FUNCTIONS to access bleeding. Follow the instructions displayed. When finished, disconnect the scan tool and proceed.
6. Bleed the base brake system a second time. Check brake fluid level in the reservoir periodically to prevent emptying, causing air to enter the hydraulic system.
7. Fill the master cylinder fluid reservoir to the FULL level.
8. Test drive the vehicle to be sure the brakes are operating correctly and that the brake pedal does not feel spongy.

BRAKE FASTENER TORQUE

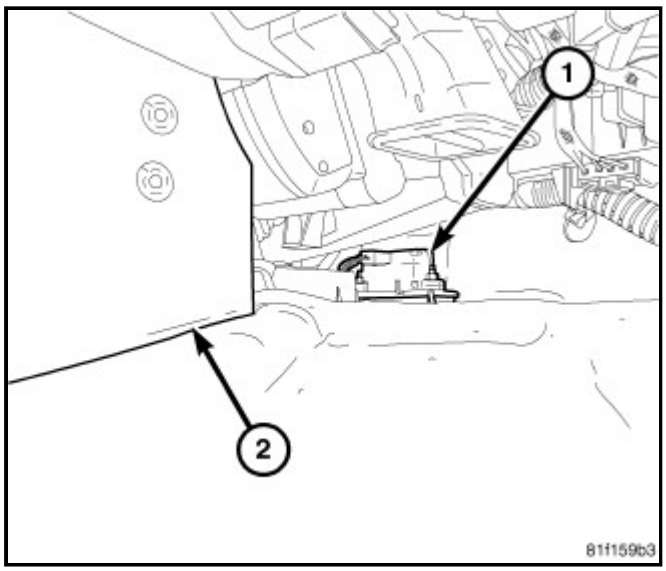
DESCRIPTION	N·m	Ft. Lbs.	In. Lbs.
ABS ABM Mounting Screws (To HCU)	2	—	17
ABS ICU Mounting Bolt (To Bracket)	11	8	97
ABS ICU Mounting Pins	11	8	97
ABS ICU Mounting Bracket Screws (To Frame)	23	17	203
ABS ICU Mounting Bracket Screw And Nut (To Body) - Right-Hand-Drive	23	17	203
ABS Wheel Speed Sensor Head Mounting Bolt - Front	12	9	106
ABS Wheel Speed Sensor Head Mounting Bolt - Rear	6	4.5	55
ABS Wheel Speed Sensor Routing Bracket Screws - Front	20	15	177
ABS Wheel Speed Sensor Routing Bracket Screws - Rear	20	15	177
Brake Tube Nuts	17	12.5	150
Brake Hose Bracket Bolt	18	13	160
Brake Hose Caliper Banjo Bolt	26	19	230
Brake Shield Mounting Screws	8	6	71
Disc Brake Caliper Adapter Mounting Bolts - Front	169	125	—
Disc Brake Caliper Adapter Mounting Bolts - Rear	100	74	—
Disc Brake Caliper Guide Pin Bolts - Front	35	26	—
Disc Brake Caliper Guide Pin Bolts - Rear	35	26	—
Disc Brake Caliper Bleeder Screw	10	7	88
Dynamics (ESP) Sensor Mounting Nuts	9	6.5	80
Master Cylinder Mounting Nuts	25	19	225
Pedal Bracket Upper Mounting Nuts	28	21	250
Power Brake Booster Mounting Nuts	28	21	250
Parking Brake Cable Mounting Screws to Hand Lever - Front	28	21	250
Parking Brake Cable Routing Clamp Screws/Nuts	6	4.5	55
Parking Brake Cable Routing Loop Mounting Nuts	6	4.5	55
Parking Brake Lever Mounting Nuts - Foot Lever System	28	21	250
Parking Brake Lever Mounting Nuts - Hand Lever System	20	15	177
Wheel Mounting (Lug) Nuts	135	100	—

DESCRIPTION

The Yaw Rate and Lateral Acceleration Sensors are housed into one unit known as the Dynamics Sensor (1). The sensor is used to measure side-to-side (Lateral) motion and vehicle rotational sensing (how fast the vehicle is turning - Yaw).

The Dynamics Sensor (1) is located on the floor tunnel just forward of the center floor console (2), below the instrument panel.

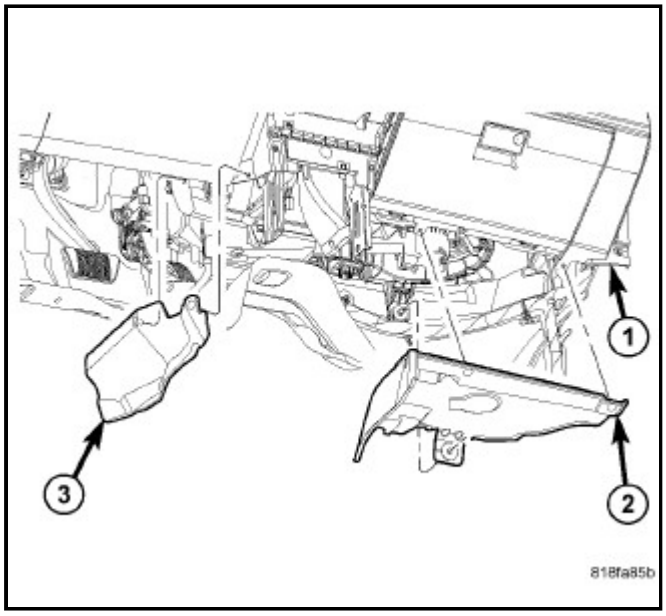
Yaw and Lateral Acceleration Sensors cannot be serviced separately. The entire Dynamics Sensor must be replaced when necessary.



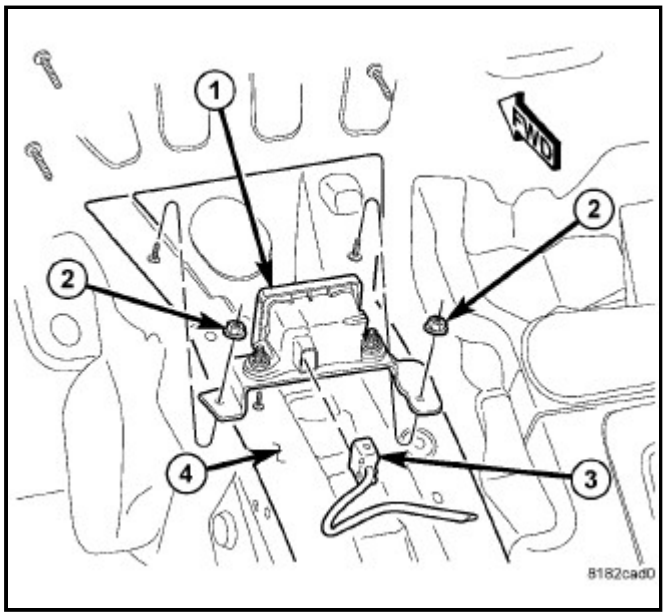
REMOVAL

1. Disconnect and isolate the battery negative cable from the battery post.

2. Remove the lower instrument panel trim on each side of console below instrument panel.

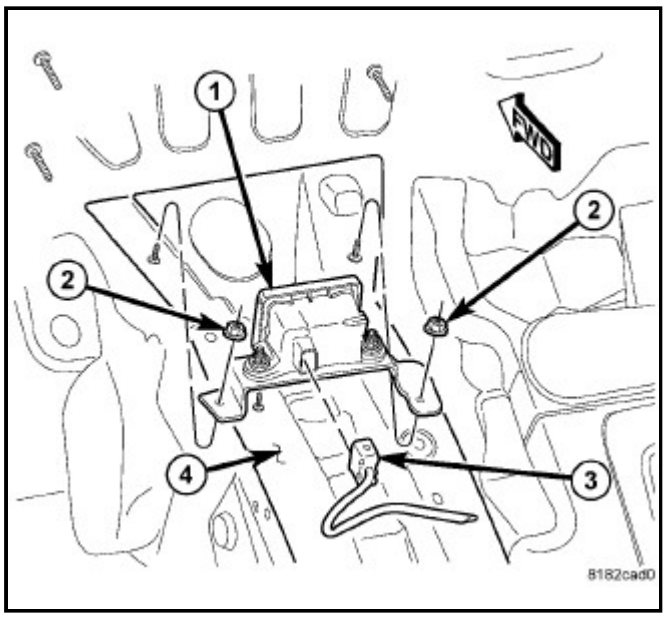


3. Disconnect the wiring harness connector (3) at the dynamics sensor (1).
4. Working on each side of the floor tunnel, remove the nuts (2) mounting the dynamics sensor to the floor pan tunnel (4).
5. Remove the dynamics sensor (1).

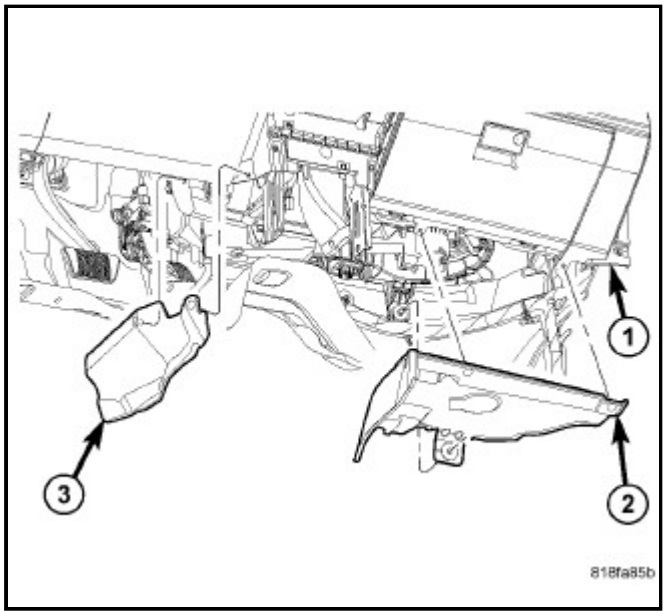


INSTALLATION

1. Install the dynamics sensor (1) over the studs mounted to the floor pan tunnel (4).
2. Working on each side of the floor pan tunnel (4), install the two mounting nuts (2). Tighten the nuts to 9 N·m (80 in. lbs.).
3. Connect the wiring harness connector (3) to the dynamics sensor (1).

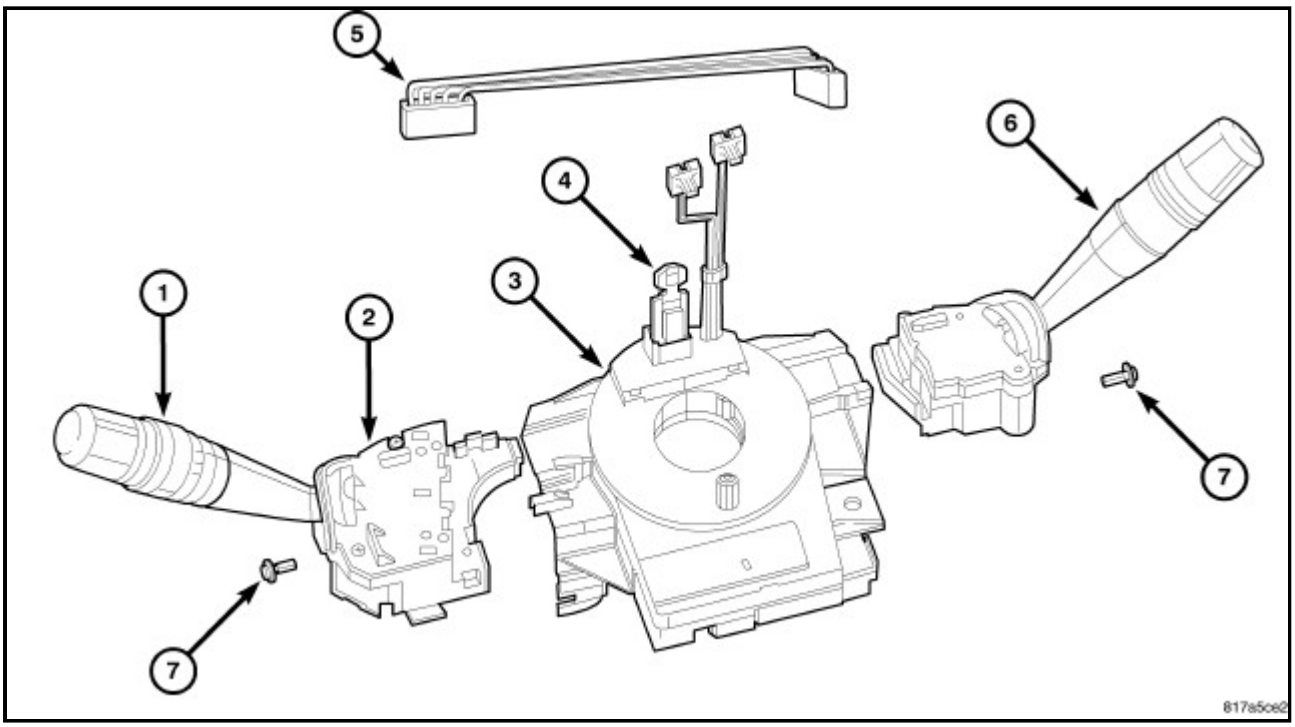


4. Install the lower instrument panel trim on each side of console below the instrument panel.



5. Connect the battery negative cable to the battery post. It is important that this be performed properly. (Refer to 08 - Electrical/8F - Engine Systems/Battery System - Standard Procedure)
6. Perform the Verification Test and clear any faults. (Refer to 05 - Brakes - Standard Procedure)

DESCRIPTION



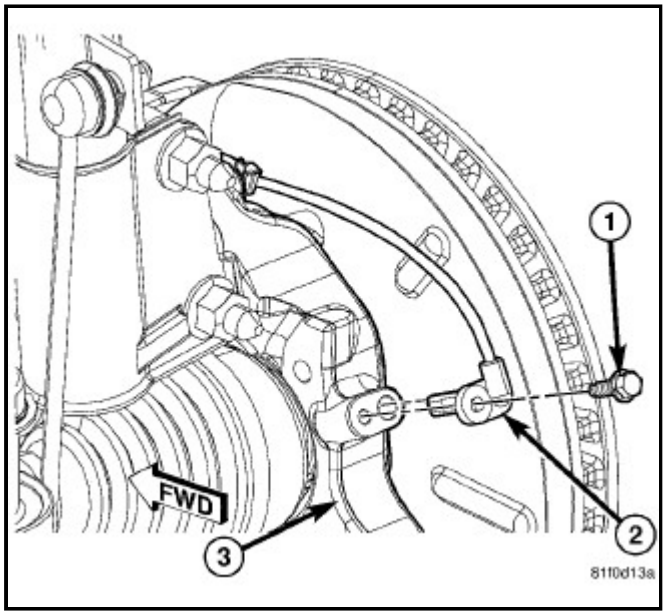
The steering angle sensor is an integral part of the clockspring (3) mounted on the steering column. (Refer to 10 - Restraints/CLOCKSPRING - Description)

DESCRIPTION

The antilock brake system uses two-wire wheel speed sensors, known as active wheel speed sensors. The sensors use an electronic principle known as magnetoresistive to help increase performance and durability. The sensors convert wheel speed into a small digital signal. A Wheel Speed Sensor (WSS) is used at each wheel. A magnetic pole encoder serves as the trigger mechanism for each sensor. At each wheel of the vehicle there is one wheel speed sensor and one encoder.

A front wheel speed sensor (2) is attached to a mounting boss on each front knuckle (3). The encoder is an integral part of the hub and bearing.

WSS air gaps are not adjustable.



OPERATION

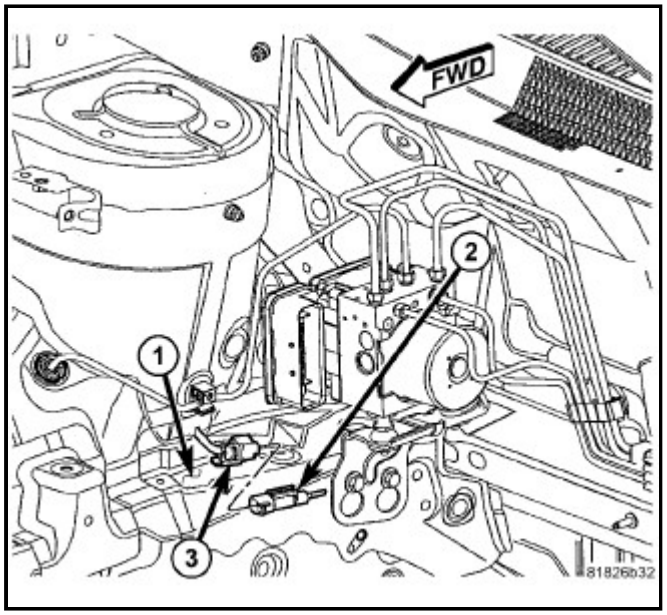
The ABM sends 12 volts to power an Integrated Circuit (IC) in the sensor. The IC supplies a constant 7 mA power supply to the ABM. The relationship of the magnetic pole encoder to the permanent magnet in the sensor, signals the IC to enable a second 7 mA power supply. The output of the sensor, sent to the ABM, is a DC voltage signal with changing voltage and current levels. The ground for the IC and the current sense circuit is provided by the ABM.

When a pole is properly aligned with the sensor, the voltage signal is approximately 0.8 volts and a constant 7 mA current is sent to the ABM. As the magnetic pole encoder rotates, the encoder shifts the magnetic field and the IC enables a second 7 mA current source. The ABM senses a voltage signal of approximately 1.6 volts and 14 mA. The ABM measures the amperage of the digital signal for each wheel. The resulting signal is interpreted by the ABM as the wheel speed.

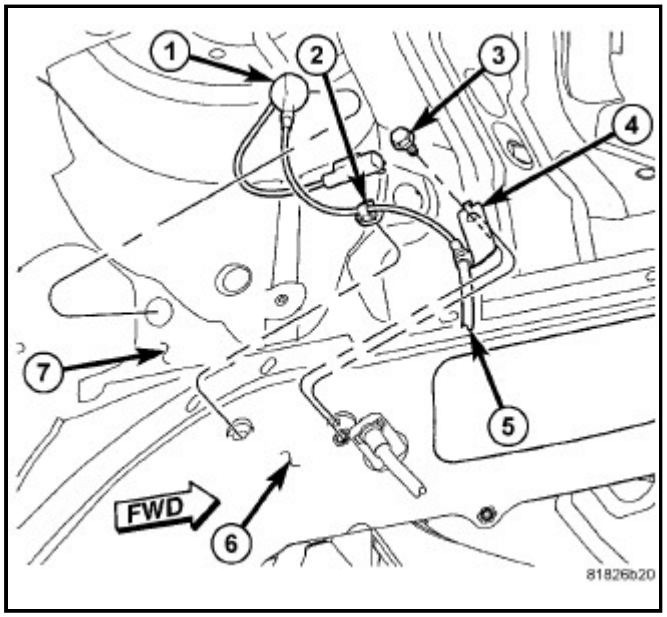
REMOVAL

NOTE: **Before proceeding,** **(Refer to 05 - Brakes - Warning) (Refer to 05 - Brakes - Caution) .**

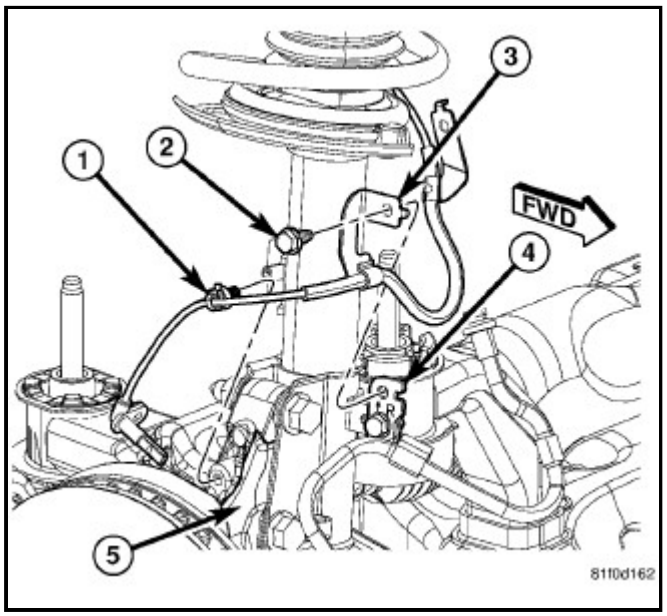
1. Open the hood.
2. Disconnect the wheel speed sensor cable connector (2) from the wiring harness connector (3) on top of the frame rail (1) to the inside of the strut tower.
3. Raise and support the vehicle. (Refer to 04 - Vehicle Quick Reference/Hoisting - Standard Procedure)



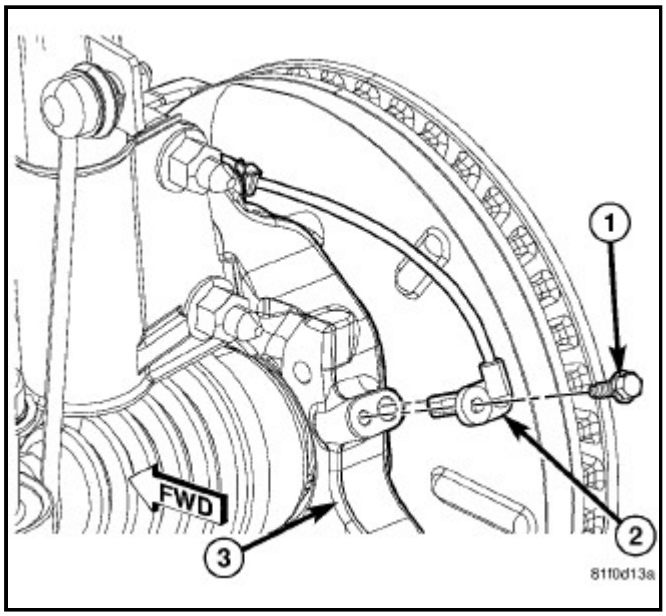
4. Remove the grommet (1) from the hole in the body (7) and pull the wheel speed sensor cable out of the hole.
5. Remove the speed sensor cable routing clip (2) from the outside frame rail (6).
6. Remove the screw fastening the cable routing clamp (3) to the outside frame rail (6).



7. Remove the screw (2) securing the wheel speed sensor routing bracket (3) to the brake flex hose bracket (4).
8. Remove the routing clip (1) securing wheel speed sensor cable to the knuckle (5).



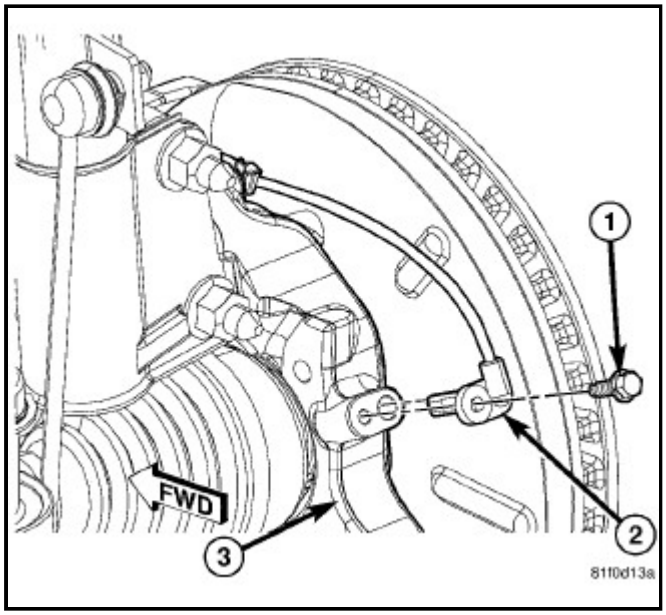
9. Remove the mounting screw (1) fastening the wheel speed sensor head (2) to the knuckle (3). Pull the sensor head out of the knuckle and remove the sensor from the vehicle.



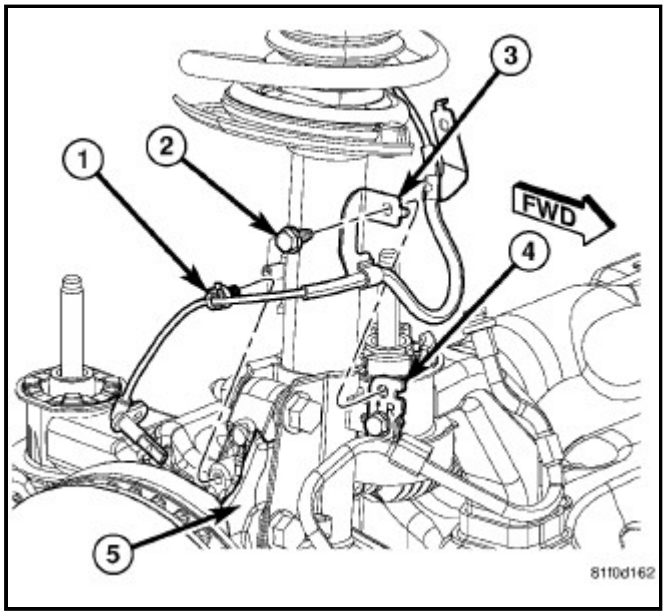
INSTALLATION

CAUTION: Failure to install speed sensor cables properly may result in contact with moving parts or an over extension of cables causing an open circuit. Be sure that cables are installed, routed, and clipped properly.

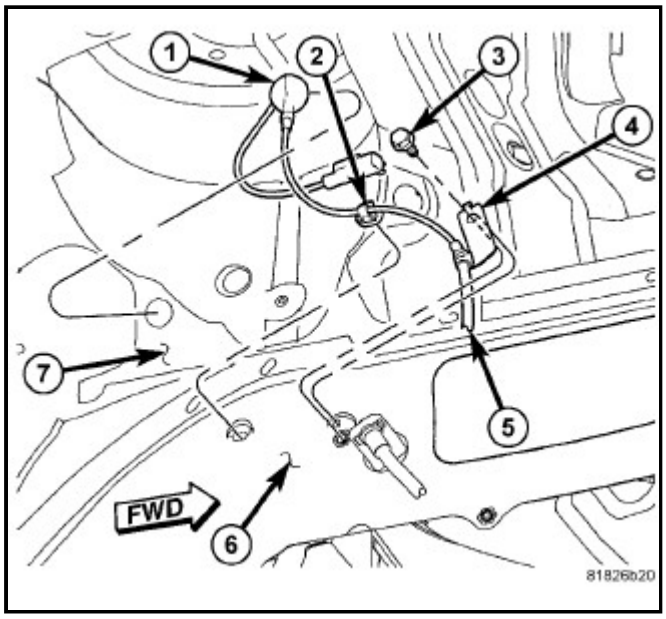
1. Install the wheel speed sensor head (2) into the knuckle (3). Install the mounting screw (1) and tighten it to 12 N·m (106 in. lbs.).



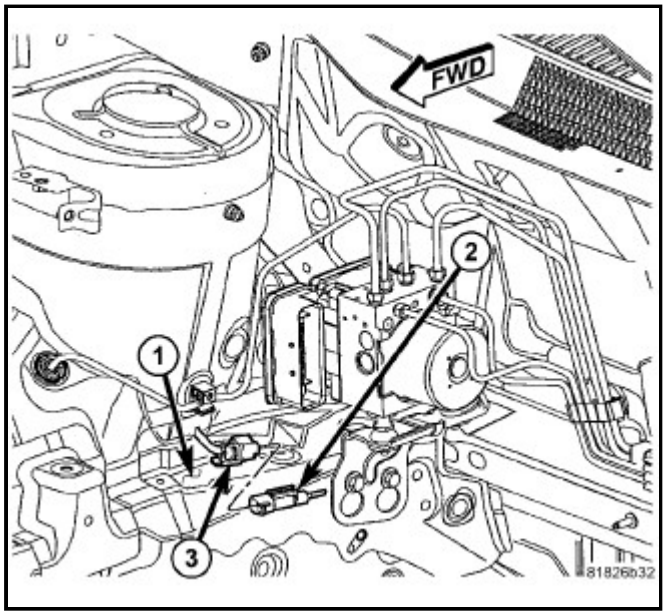
2. Install the routing clip (1) securing the wheel speed sensor cable to the knuckle (5).
3. Position the wheel speed sensor routing bracket (3) on the brake flex hose bracket (4) and install the mounting screw (2). Tighten the mounting screw to 20 N·m (15 ft. lbs.).



4. Position the wheel speed sensor cable routing clamp (4) on the outside frame rail (6) and install the mounting screw (3). Tighten the mounting screw to 20 N·m (15 ft. lbs.).
5. Install the speed sensor cable routing clip (2) on the outside frame rail (6).
6. Insert the wheel speed sensor cable through the hole in the body (7) and install the grommet (1) in the hole.



7. Lower the vehicle.
8. Connect the wheel speed sensor cable connector (2) to the wiring harness connector (3) on top of the frame rail (1).
9. Perform the Diagnostic Verification Test and clear any faults. (Refer to 05 - Brakes - Standard Procedure)

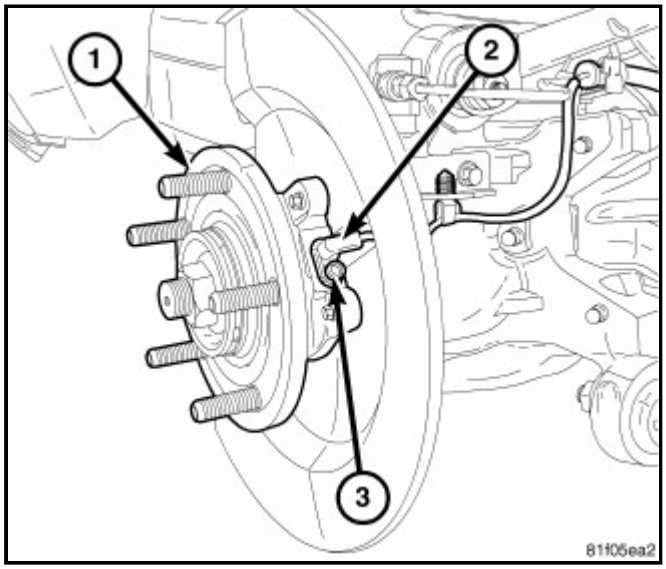


DESCRIPTION

The antilock brake system uses two-wire wheel speed sensors, known as active wheel speed sensors. The sensors use an electronic principle known as magnetoresistive to help increase performance and durability. The sensors convert wheel speed into a small digital signal. A Wheel Speed Sensor (WSS) is used at each wheel. A magnetic pole encoder serves as the trigger mechanism for each sensor. At each wheel of the vehicle there is one wheel speed sensor and one encoder.

The rear wheel speed sensor (2) head is mounted to the rear hub and bearing (1). The encoder is integral to the hub and bearing assembly. The encoder is serviced as part of the rear hub and bearing.

WSS air gaps are not adjustable.



OPERATION

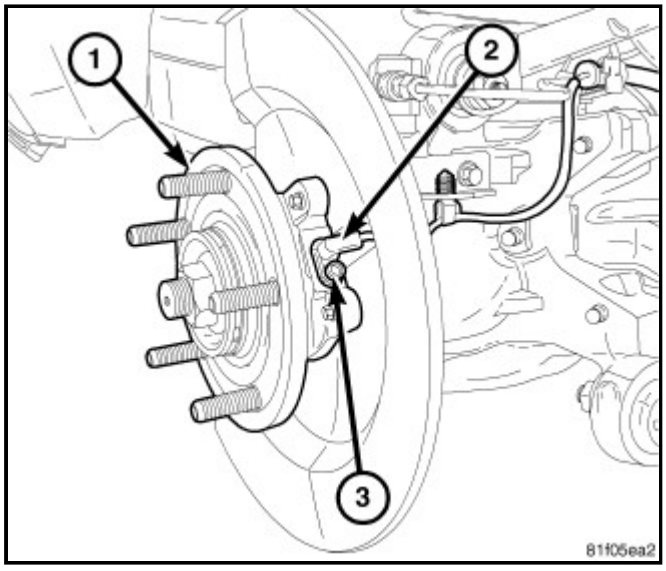
The ABM sends 12 volts to power an Integrated Circuit (IC) in the sensor. The IC supplies a constant 7 mA power supply to the ABM. The relationship of the magnetic pole encoder to the permanent magnet in the sensor, signals the IC to enable a second 7 mA power supply. The output of the sensor, sent to the ABM, is a DC voltage signal with changing voltage and current levels. The ground for the IC and the current sense circuit is provided by the ABM.

When a pole is properly aligned with the sensor, the voltage signal is approximately 0.8 volts and a constant 7 mA current is sent to the ABM. As the magnetic pole encoder rotates, the encoder shifts the magnetic field and the IC enables a second 7 mA current source. The ABM senses a voltage signal of approximately 1.6 volts and 14 mA. The ABM measures the amperage of the digital signal for each wheel. The resulting signal is interpreted by the ABM as the wheel speed.

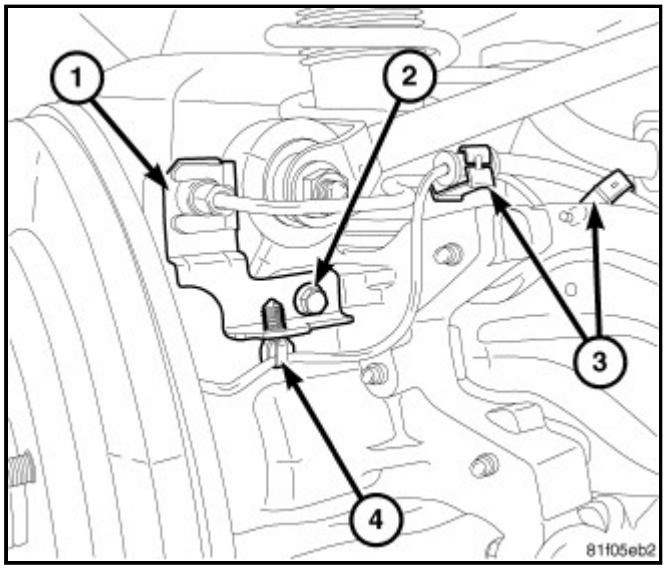
REMOVAL

1. Access and remove the rear brake rotor. (Refer to 05 - Brakes/Hydraulic/Mechanical/ROTOR, Brake - Removal)

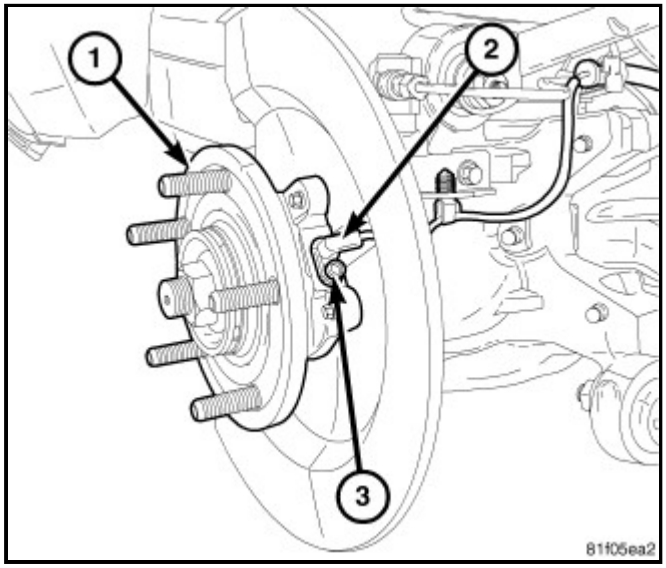
CAUTION: Prior to removal, clean area around sensor head to help prevent contaminants from entering bearing when sensor head is removed.



2. Remove the screw (3) fastening the speed sensor head (2) to the hub and bearing (1).

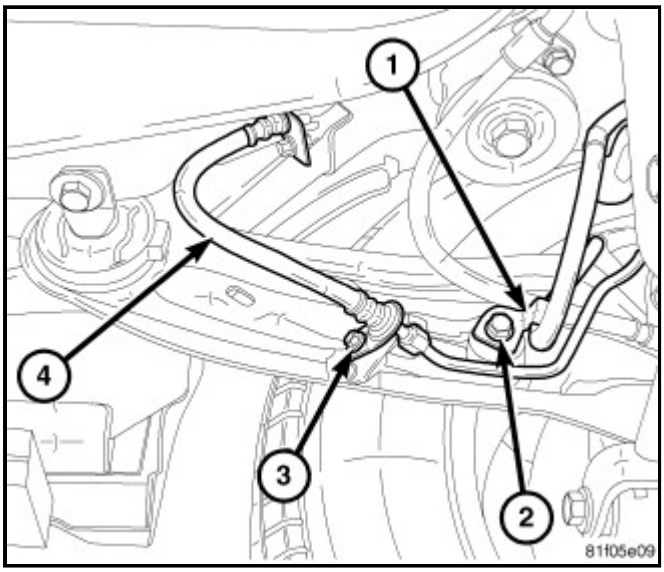


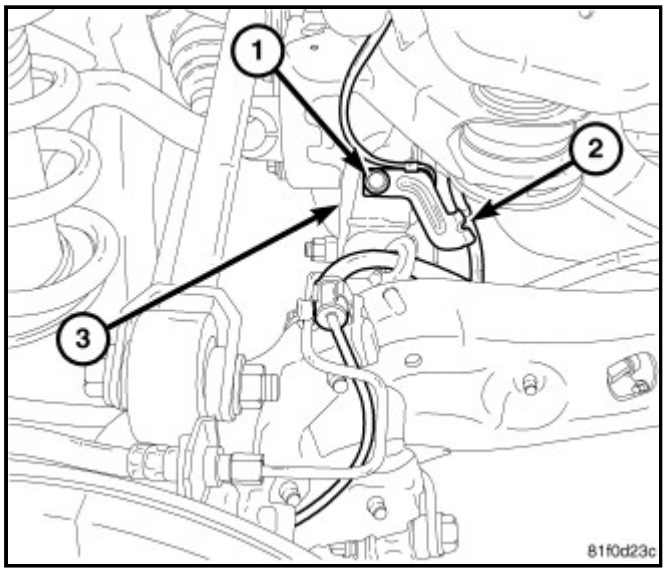
3. Remove the wheel speed sensor routing clip (4) from the brake tube routing bracket (1).
4. Remove the wheel speed sensor cable from the routing clips (3) above the trailing arm.



5. Remove the wheel speed sensor head (2) from the hub and bearing (1), then pass it through the brake shield.

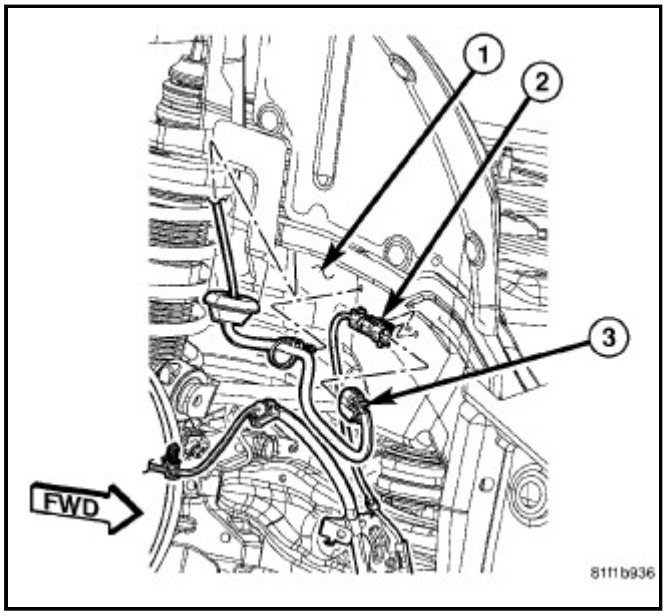
6. Remove the screw (1) fastening the wheel speed sensor routing clamp (2) to the rear suspension crossmember (3).





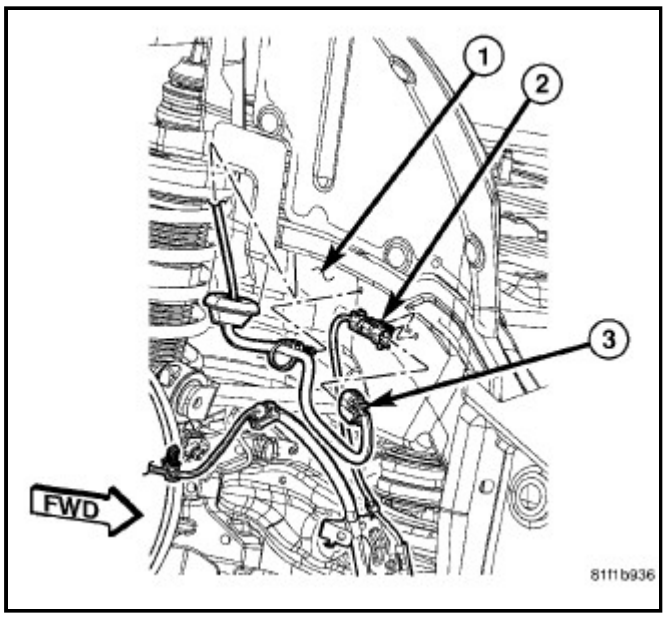
7. Remove the screw (2) securing the wheel speed sensor routing clamp (1) to the trailing link.

8. Disconnect the vehicle wiring harness (3) from the wheel speed sensor connector (2) on the body (1).
9. Disengage the wheel speed sensor connector from the routing clip fastened to the body using a screwdriver. Pull the connector forward off the routing clip. Or, if a NEW routing clip is available, remove the routing clip from the body with the connector attached.
10. Remove the wheel speed sensor from the vehicle.

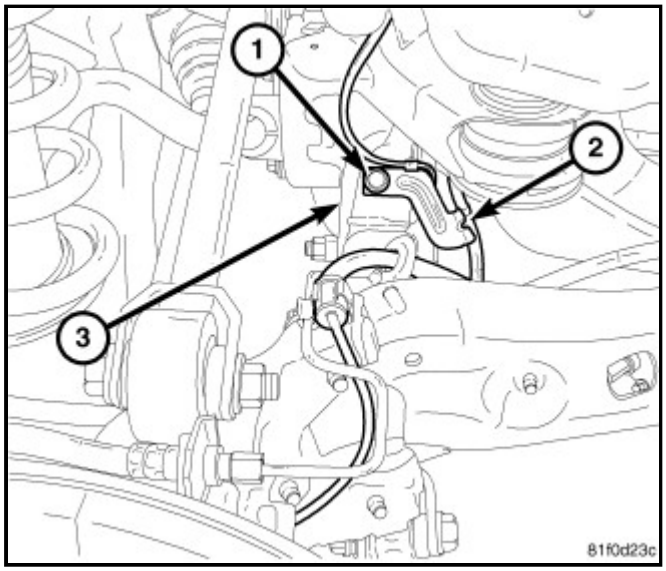


INSTALLATION

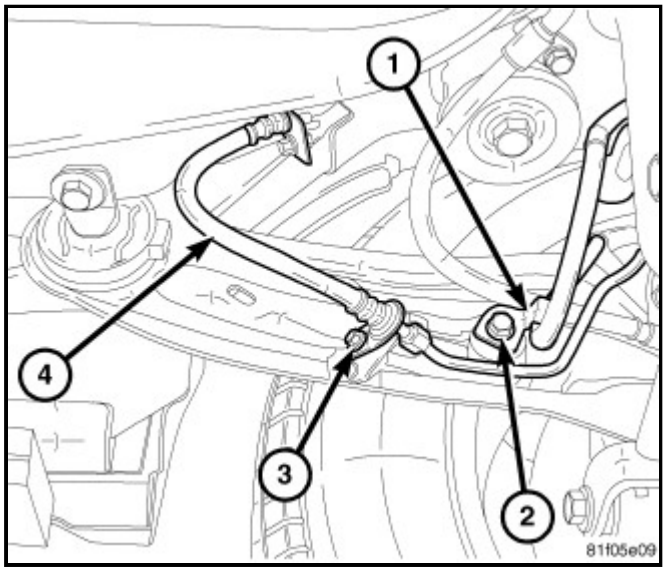
1. Slide the wheel speed sensor wiring connector (2) onto the routing clip mounted on the body until it locks into place or if a NEW routing clip is attached to the connector, push it into the mounting holes on the body.
2. Connect the vehicle wiring harness (3) to the wheel speed sensor connector (2).



3. Attach the wheel speed sensor routing clamp (2) to the rear suspension crossmember (3) using the mounting screw (1). Tighten the mounting screw to 20 N·m (15 ft. lbs.).



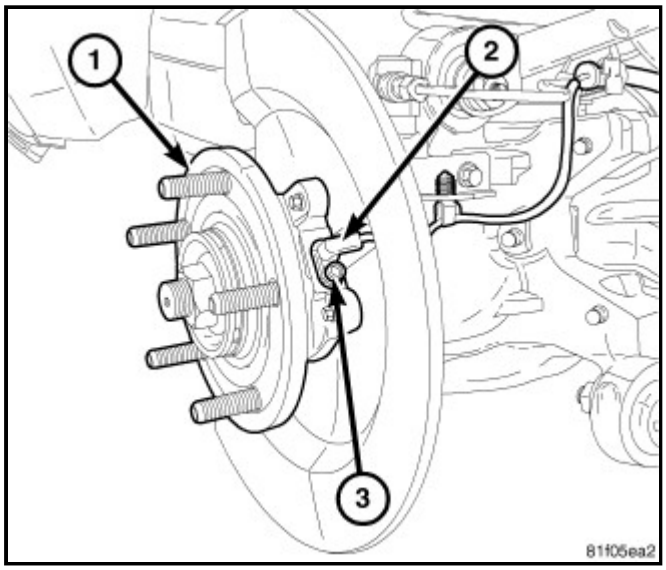
4. Attach the wheel speed sensor routing clamp (1) to the trailing link using the mounting screw (2). Tighten the mounting screw to 20 N·m (15 ft. lbs.).



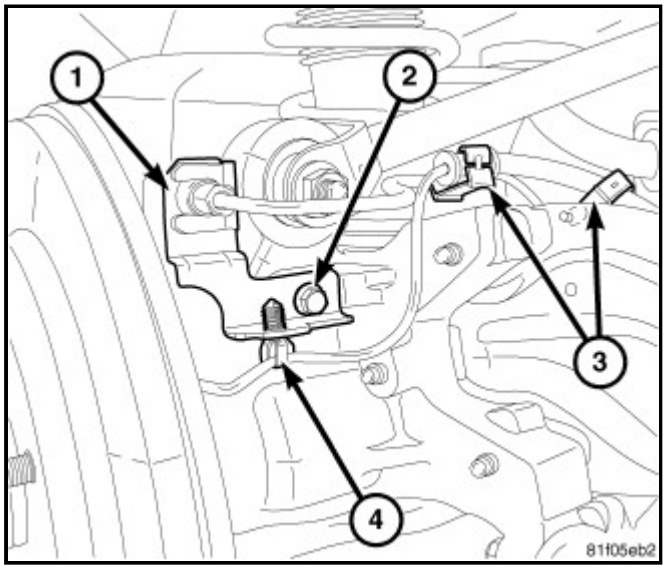
5. Apply bearing grease (supplied with part) to sensor head shaft and O-ring.

CAUTION: **Ensure that sensor mounting surface on bearing is clean before sensor installation.**

6. Pass the wheel speed sensor head through the hole in the brake shield, then push it into the mounting hole in hub and bearing (3) and align the mounting screw hole.
7. Install a NEW mounting screw (2). Tighten the mounting screw to 6 N·m (55 in. lbs.).



8. Install the wheel speed sensor routing clip (4) in the brake tube routing bracket (1).
9. Install the wheel speed sensor cable into the routing clips (3) above the trailing arm.



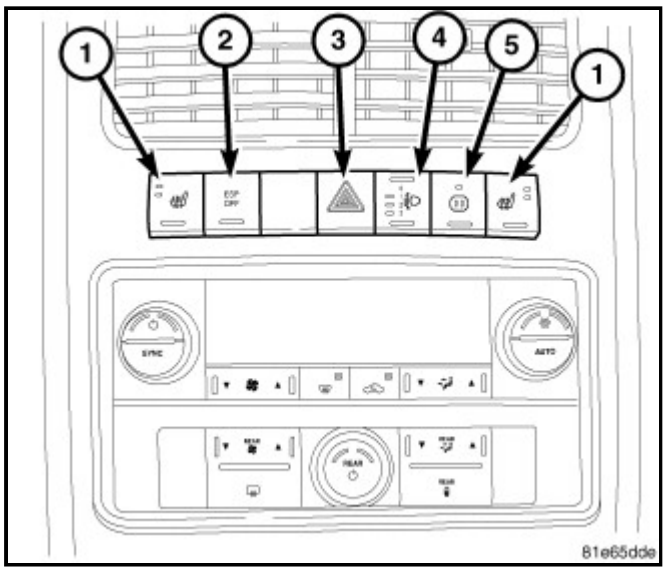
10. Install brake rotor as well as all components necessary to access it. (Refer to 05 - Brakes/Hydraulic/Mechanical/ROTOR, Brake - Installation)
11. Perform the ABS Verification Test and clear any faults. (Refer to 28 - DTC-Based Diagnostics/MODULE, Antilock Brake (ABS) - Standard Procedure)

DESCRIPTION

The ESP Off Switch (2) is part of the accessory switch bank module located in the center bezel (2) on the instrument panel above the radio. The ESP Off switch turns the Electronic Stability Program off whenever the switch is depressed. Depressing the switch a second time turns the ESP® back on. The switch resets itself each time the ignition is cycled.

When the ESP Off switch is depressed and released, turning ESP® off, it does not completely turn the system off. The ESP® system reduces torque management to a lesser amount, but ESP® function can still occur if the system perceives the need.

The ESP Off switch is serviced as part of the accessory switch bank. There are different accessory switch banks available based on the option content of the vehicle. Ensure the accessory switch bank being installed matches the vehicle options.



MODULE-ASBM

REMOVAL

NOTE: The ESP Off switch is integral to the accessory switch bank and cannot be serviced separately.

1. Disconnect and isolate the negative battery cable.
2. Remove the center bezel from the instrument panel and place it on a work bench (Refer to 23 - Body/Instrument Panel/BEZEL, Instrument Panel - Removal) .
3. Remove the screws that secure the accessory switch bank to the back of the center bezel and remove the accessory switch bank.

INSTALLATION

NOTE: **The ESP Off switch is serviced as part of the accessory switch bank.**

NOTE: **There are different instrument panel accessory switch banks available based on the option content of the vehicle. Ensure the accessory switch bank being installed matches the vehicle options.**

1. Position the accessory switch bank onto the back of the instrument panel center bezel.
2. Install the screws that secure the accessory switch bank to the center bezel. Tighten the screws to 2 N·m (17 in. lbs.).
3. Install the center bezel onto the instrument panel (Refer to 23 - Body/Instrument Panel/BEZEL, Instrument Panel - Installation) .
4. Reconnect the negative battery cable.
5. Perform the ABS Verification Test and make sure the ESP Off switch operates properly. (Refer to 05 - Brakes - Standard Procedure)
6. Verify proper operation of all components controlled by the switch bank.

DESCRIPTION

The Hydraulic Control Unit (HCU) is mounted to the Antilock Brake Module (ABM) as part of the Integrated Control Unit (ICU). The HCU controls the flow of brake fluid to the brakes using a series of valves and accumulators. A pump/motor is mounted on the HCU to supply build pressure to the brakes during TCS and ESP events and to empty the low pressure accumulators during ABS events.

NOTE: The HCU is not serviceable from the ICU for vehicles equipped with Hill Start Assist (HSA).

For more information, (Refer to 05 - Brakes/Hydraulic/Mechanical/INTEGRATED CONTROL UNIT (ICU) - Description) - DESCRIPTION)

REMOVAL

NOTE: The HCU is not serviceable from the ICU for vehicles equipped with Hill Start Assist (HSA).

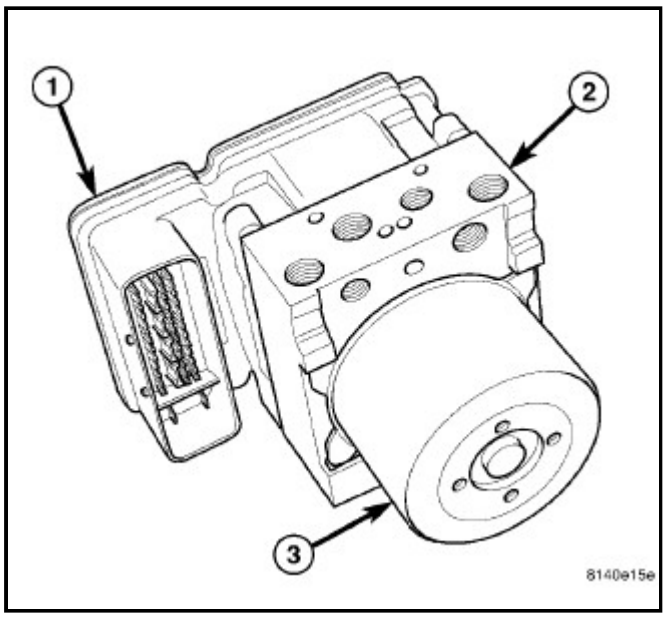
To remove the HCU, the ICU must be removed and disassembled. (Refer to 05 - Brakes/Hydraulic/Mechanical/INTEGRATED CONTROL UNIT (ICU) - Removal) - REMOVAL)(Refer to 05 - Brakes/Hydraulic/Mechanical/INTEGRATED CONTROL UNIT (ICU) - Disassembly) - DISASSEMBLY)

INSTALLATION

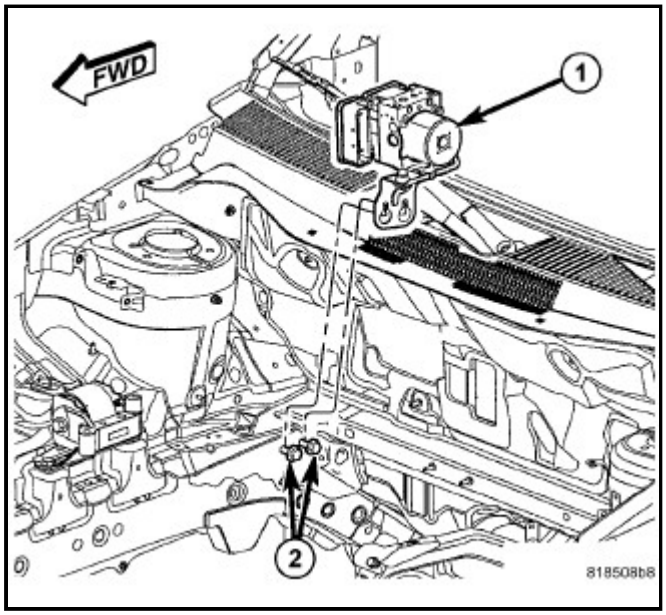
To install the HCU, assemble and install the ICU. (Refer to 05 - Brakes/Hydraulic/Mechanical/INTEGRATED CONTROL UNIT (ICU) - Assembly) - ASSEMBLY)(Refer to 05 - Brakes/Hydraulic/Mechanical/INTEGRATED CONTROL UNIT (ICU) - Installation) - INSTALLATION)

DESCRIPTION

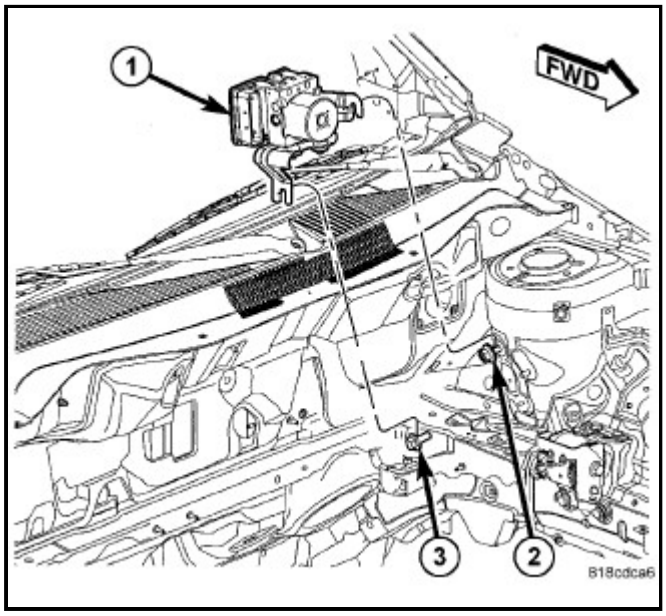
The Hydraulic Control Unit (HCU) (2) and the Antilock Brake Module (ABM) (1) used with this antilock brake system are combined (integrated) into one unit, which is called the Integrated Control Unit (ICU).



The ICU (1) is located in the engine compartment, mounted to the right side body frame rail near the strut tower.



On Right-Hand-Drive vehicles, the ICU (1) is located in the engine compartment, mounted to the left side body frame rail and strut tower.



The ABS with ESP® and All-Speed Traction Control ICU consists of the following components: the ABM, 8 (build/decay) solenoid valves, two traction control solenoid valves, two electronic shuttle valves, valve block, fluid accumulators, a pump, and an electric pump/motor.

NOTE: The HCU and the ABM are not serviceable separately from the ICU for vehicles equipped with Hill Start Assist (HSA).

The replaceable components of the ICU are the HCU and the ABM. No attempt should be made to service any components of the HCU or ABM. The ABM can be serviced without removing the entire assembly from the vehicle.

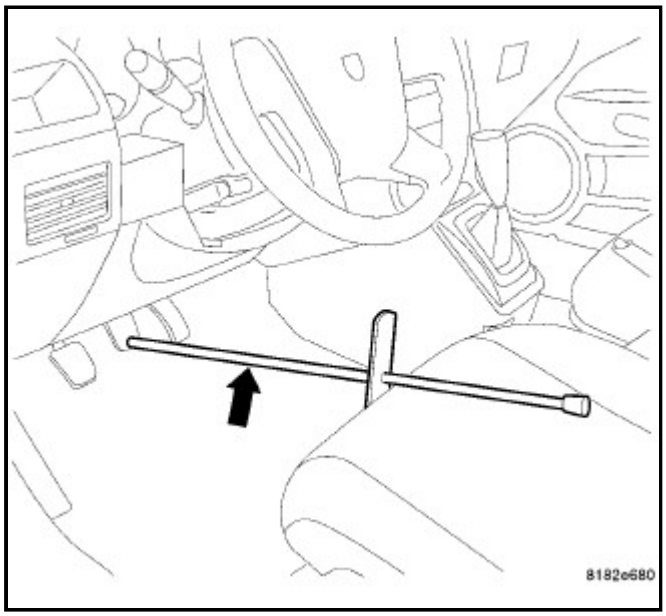
For additional information on the ABM, (Refer to 08 - Electrical/8E - Electronic Control Modules/Electronic Control Modules/MODULE, Anti-Lock Brake System - Description) . For additional information on the HCU, (Refer to 05 - Brakes/Hydraulic/Mechanical/HYDRAULIC CONTROL UNIT (HCU) - Description) - DESCRIPTION).

LEFT-HAND-DRIVE

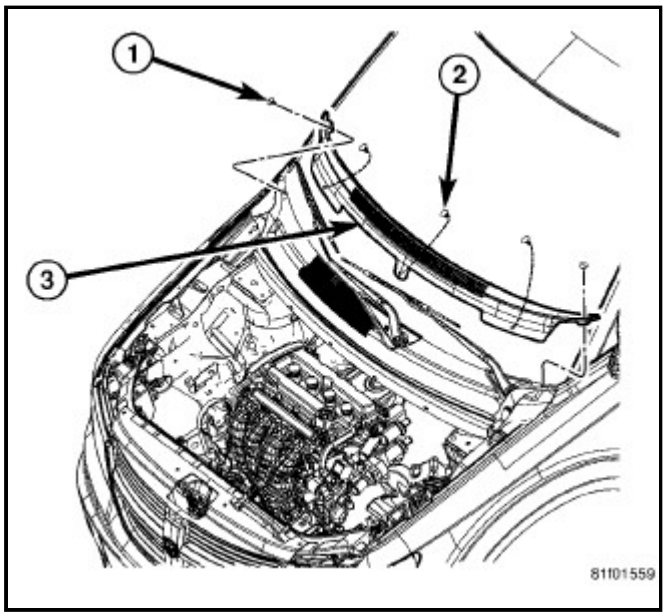
NOTE: **Before proceeding, (Refer to 05 - Brakes - Warning) (Refer to 05 - Brakes - Caution) .**

NOTE: **If servicing the ABM only, (Refer to 08 - Electrical/8E - Electronic Control Modules/Electronic Control Modules/MODULE, Anti-Lock Brake System - Removal)**

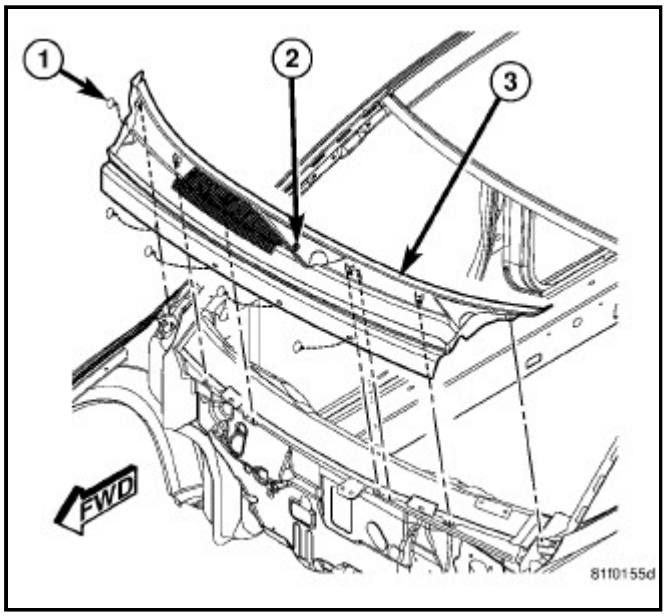
1. Disconnect and isolate battery negative cable from battery post.
2. Using a brake pedal holding tool as shown, depress the brake pedal past its first 25 mm (1 inch) of travel and hold it in this position. This will isolate the master cylinder from the brake hydraulic system and will not allow the brake fluid to drain out of the master cylinder reservoir while the lines are disconnected.
3. Remove the engine appearance cover.



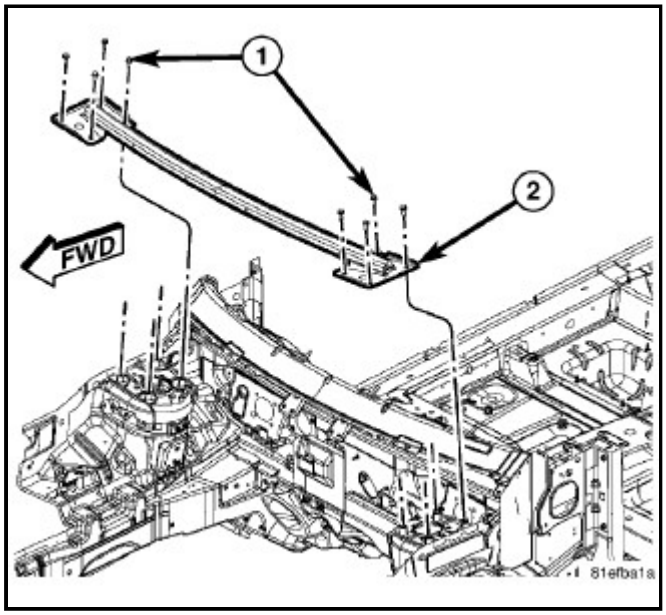
4. Remove the two push-pins (1) securing the cowl top screen at the ends. Remove the remaining push-pins (2). Remove the cowl top screen (3).
5. Remove the wiper arms. (Refer to 08 - Electrical/8R - Wipers/Washers/Wipers/Washers/ARM, Wiper - Removal)



6. Remove the push-pins (1) securing the cowl screen to the wheelhouse brace and cowl. Rotate the screw (2) in the center of the cowl screen 90° clockwise to release the screen. Remove the cowl screen (3).

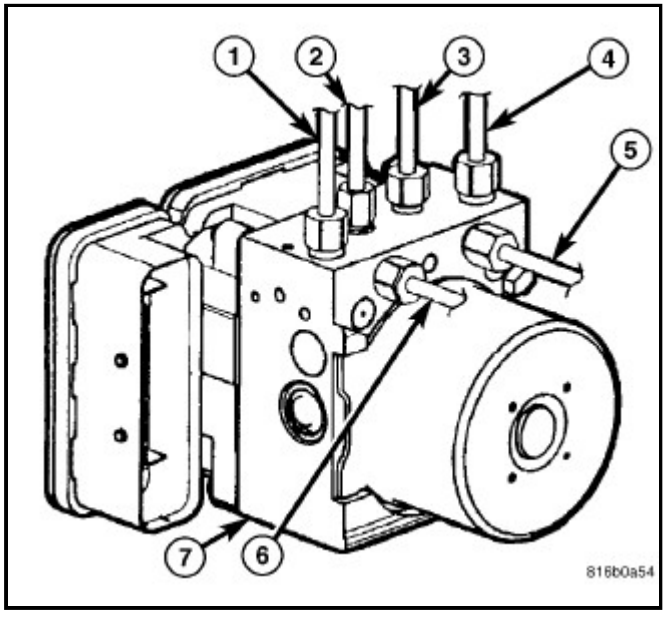


7. Remove the eight mounting bolts (four each side) (1) securing the wheel house brace to the strut towers.
8. Remove the wheelhouse brace (2).

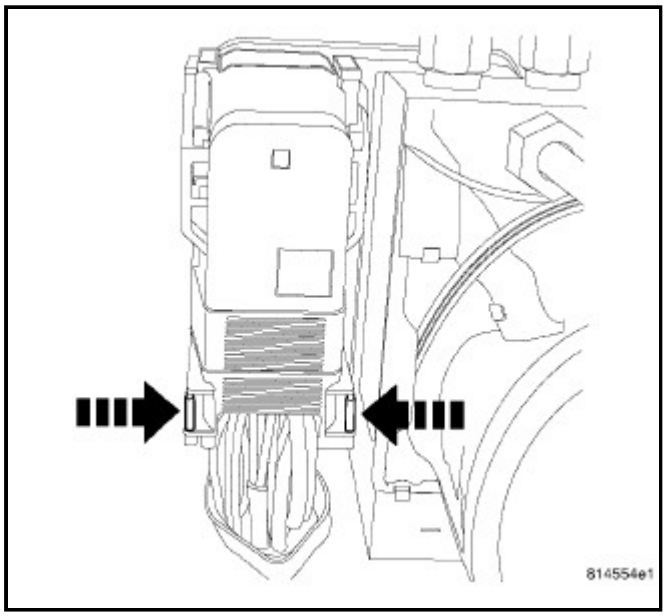


9. Remove two screws, then remove the fresh air plenum.
10. Pull the brake tube bundle routing clips (with tubes) loose from studs on the dash panel.

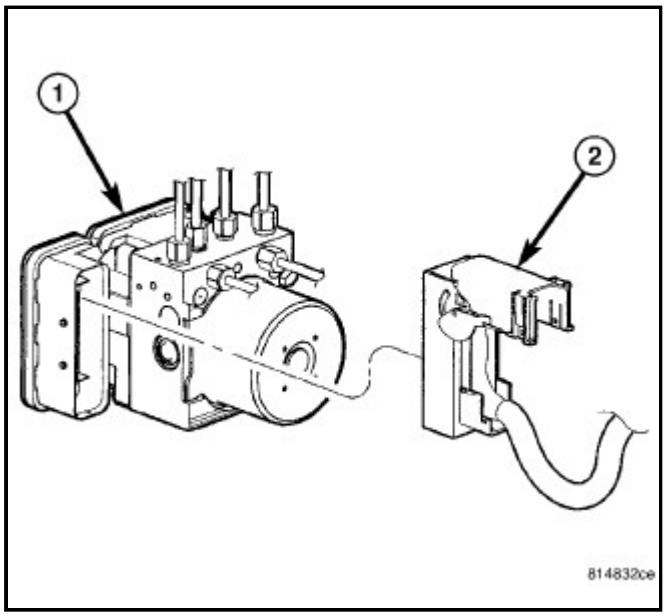
11. Remove the primary (4) and secondary (1) brake tubes (from master cylinder) at the hydraulic control unit (7).
12. Remove the remaining brake tubes (2, 3, 5, 6) at the hydraulic control unit (7).



NOTE: Use this figure in the following step to release the ABM harness connector cover. It shows the location of the release tabs.



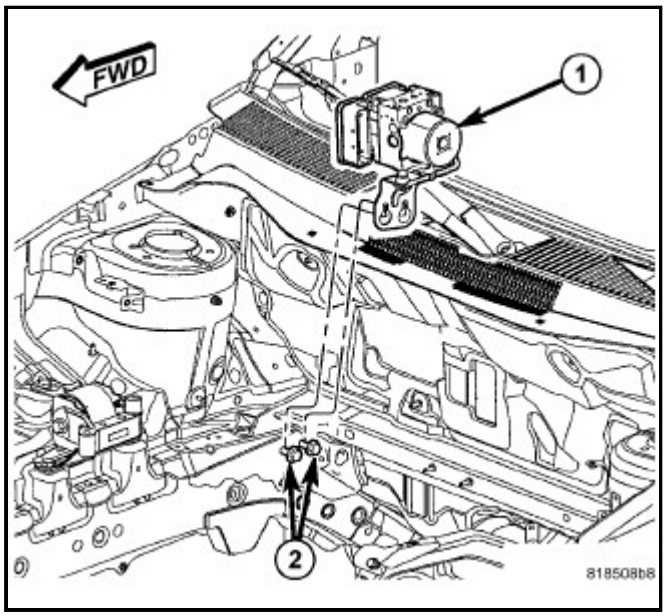
13. Disconnect the ABM harness connector from the Antilock Brake Module (ABM). To do so:
    a. Depress the tabs on each side of the connector cover, then
    b. Pull outward and upward on the lower half of the cover until it locks into position pointing straight outward (2). The connector can then be pulled straight outward off the ABM (1).



14. Loosen, but do not remove, the two mounting screws (2) attaching the ICU (1) mounting bracket to the body.
15. Lift the ICU and mounting bracket (1) off the mounting screws (2).
16. Move the brake tubes around as necessary without bending them and remove the ICU with bracket.

NOTE: The HCU and the ABM are not serviceable separately from the ICU for vehicles equipped with Hill Start Assist (HSA).

17. To separate the ABM from the HCU, (Refer to 05 - Brakes/Hydraulic/Mechanical/INTEGRATED CONTROL UNIT (ICU) - Disassembly) - DISASSEMBLY).

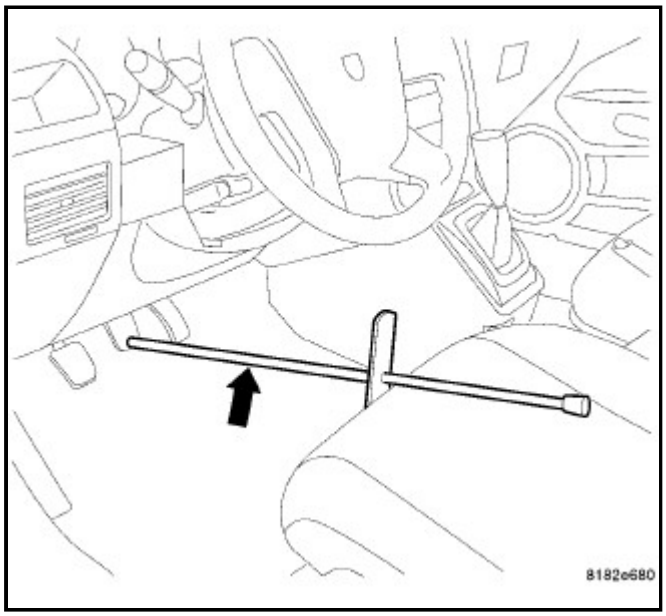


RIGHT-HAND-DRIVE

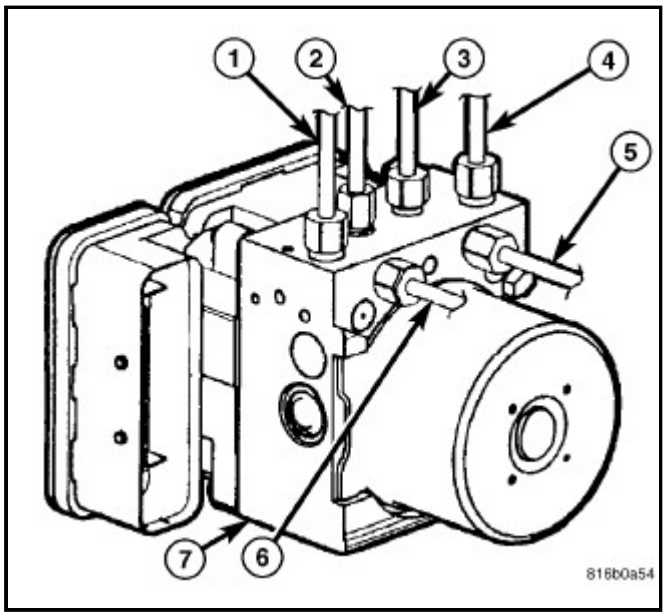
NOTE: **Before proceeding, (Refer to 05 - Brakes - Warning) (Refer to 05 - Brakes - Caution) .**

NOTE: **If servicing the ABM only, (Refer to 08 - Electrical/8E - Electronic Control Modules/Electronic Control Modules/MODULE, Anti-Lock Brake System - Removal)**

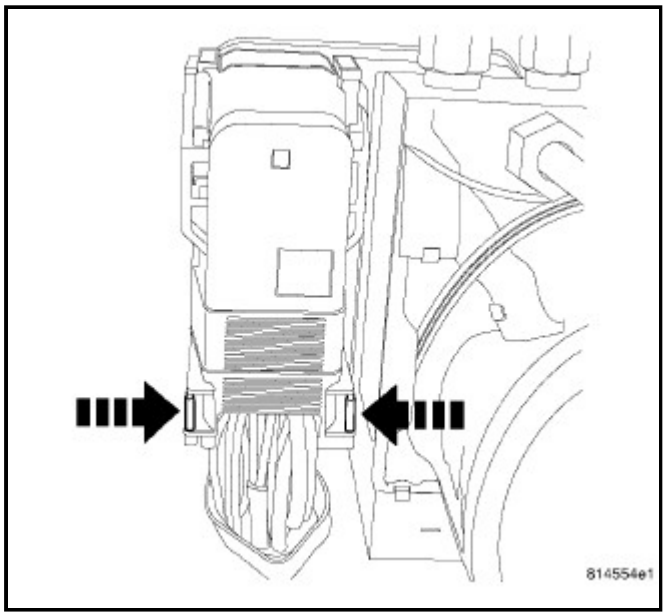
1. Disconnect and isolate battery negative cable from battery post.
2. Using a brake pedal holding tool as shown, depress the brake pedal past its first 25 mm (1 inch) of travel and hold it in this position. This will isolate the master cylinder from the brake hydraulic system and will not allow the brake fluid to drain out of the master cylinder reservoir while the lines are disconnected.
3. Remove the engine appearance cover.



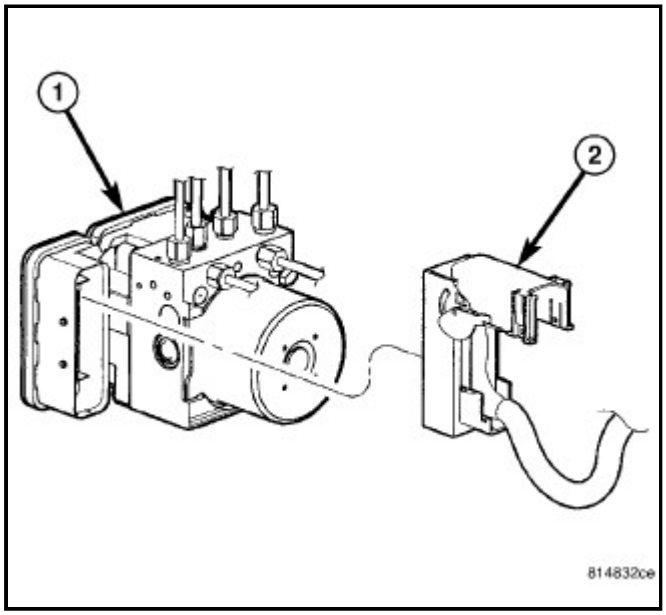
4. Remove the primary (4) and secondary (1) brake tubes (from master cylinder) at the Hydraulic Control Unit (HCU) (7).
5. Remove the remaining brake tubes (2, 3, 5, 6) at the HCU (7).



NOTE: **Use this figure in the following step to release the Antilock Brake Module (ABM) harness connector cover. It shows the location of the release tabs.**



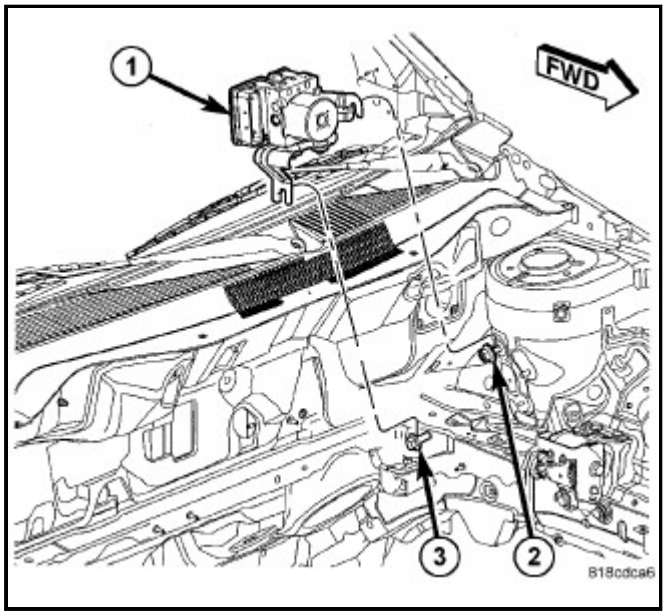
6. Disconnect the ABM harness connector from the Antilock Brake Module (ABM). To do so:
   a. Depress the tabs on each side of the connector cover, then
   b. Pull outward and upward on the lower half of the cover until it locks into position pointing straight outward (2). The connector can then be pulled straight outward off the ABM (1).



7. Loosen, but do not remove, the mounting nut (2) and screw (3) attaching the Integrated Control Unit (ICU) (1) mounting bracket to the body.
8. Lift the ICU and mounting bracket (1) off the mounting stud and screw.

NOTE: The HCU and the ABM are not serviceable separately from the ICU for vehicles equipped with Hill Start Assist (HSA).

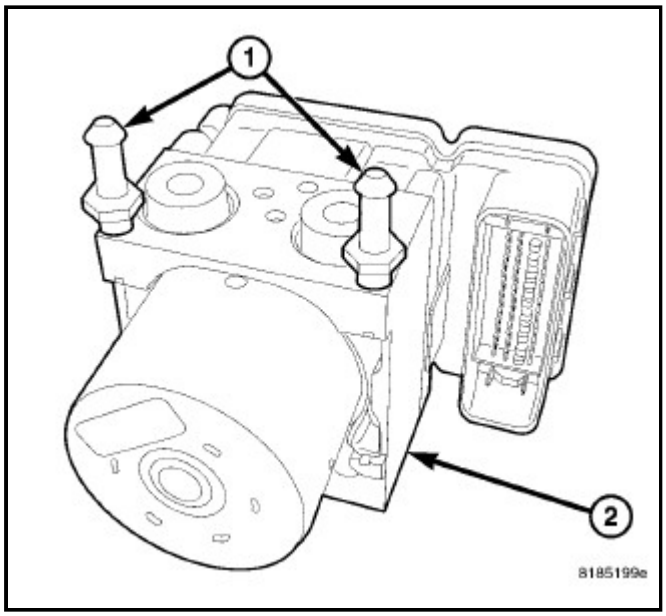
9. To separate the ABM from the HCU, (Refer to 05 - Brakes/Hydraulic/Mechanical/INTEGRATED CONTROL UNIT (ICU) - Disassembly) - DISASSEMBLY).



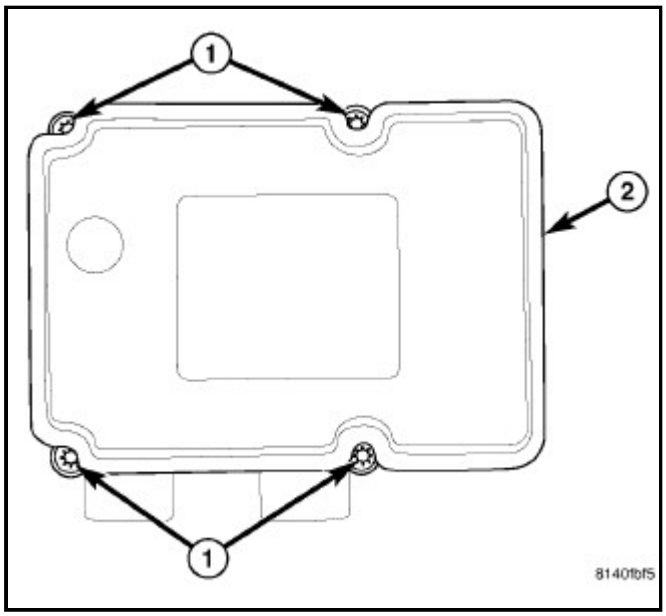
DISASSEMBLY

NOTE: The HCU and the ABM are not serviceable separately from the ICU for vehicles equipped with Hill Start Assist (HSA).

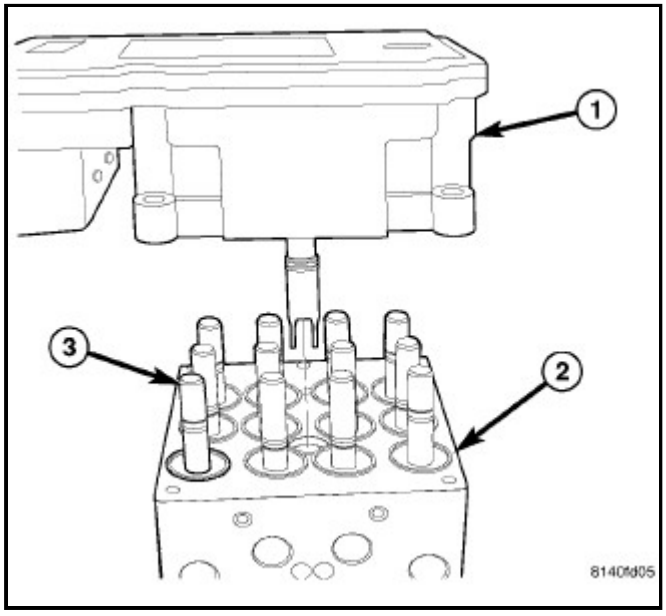
1. If necessary, remove the mounting pins from the ICU.



2. Remove the four screws (1) attaching the ABM (2) to the HCU.



3. Separate the ABM (1) from the HCU (2).

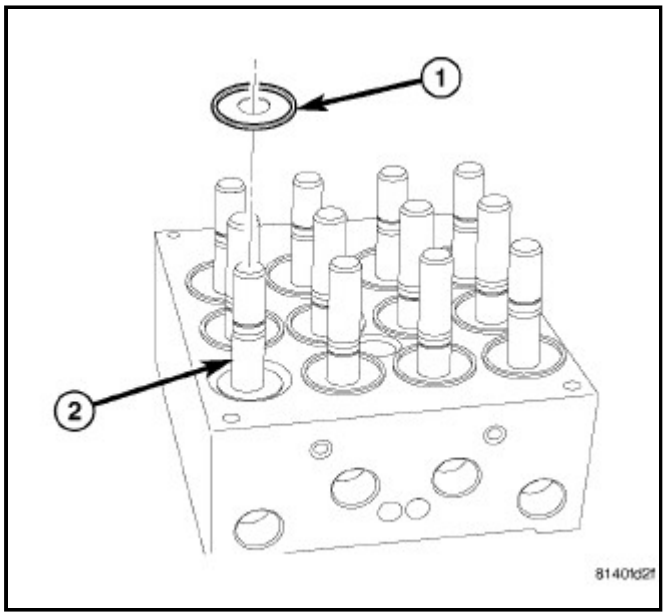


ASSEMBLY

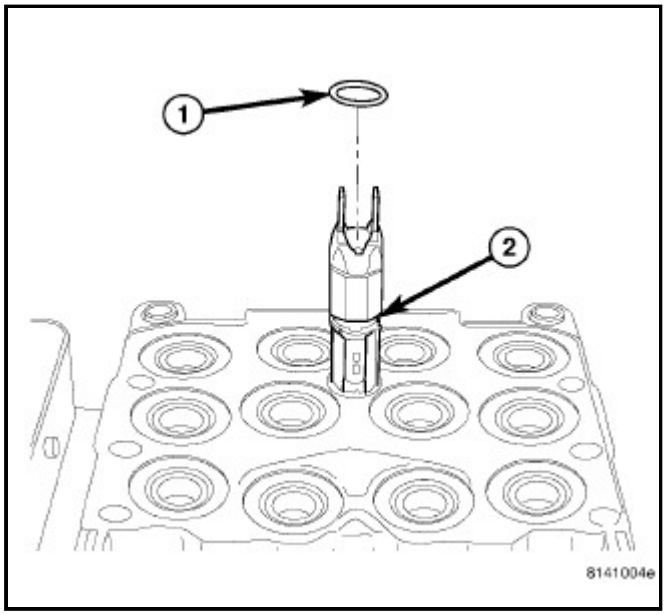
1. Clean any debris off the mating surfaces of the HCU and ABM.

CAUTION: When installing new O-rings or solenoid valve stem seals, do not use any type of lubricant.

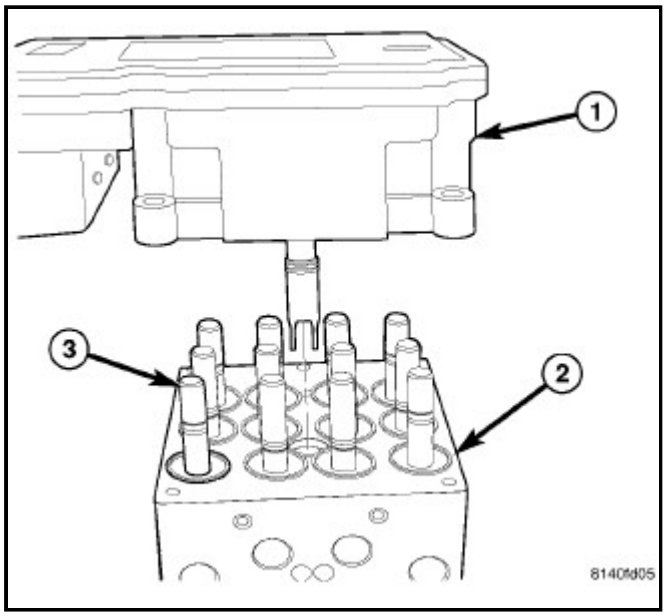
2. If the seals (1) on the solenoid valve stems (2) are not new, replace them all. Each of the solenoid valve stem seals must be new to keep out moisture and debris; **do not reuse solenoid valve stem seals.**



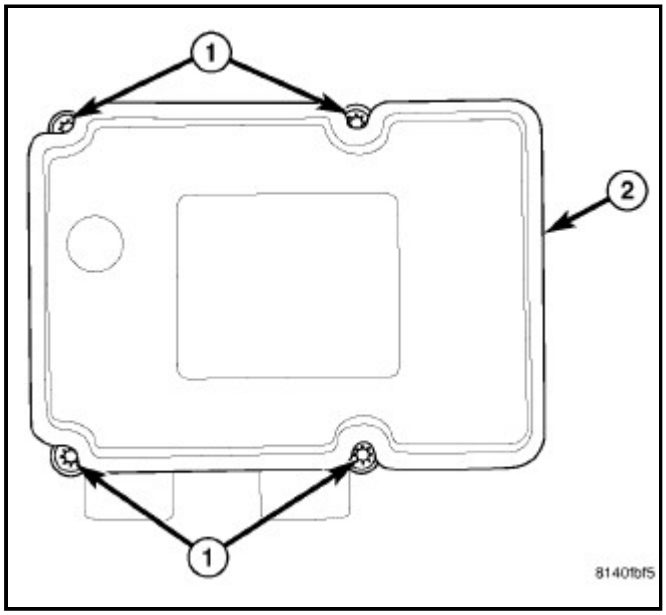
3. Replace the pump/motor connector O-ring (1) if it is not new. Be sure the O-ring is properly seated in the mounting groove (2).



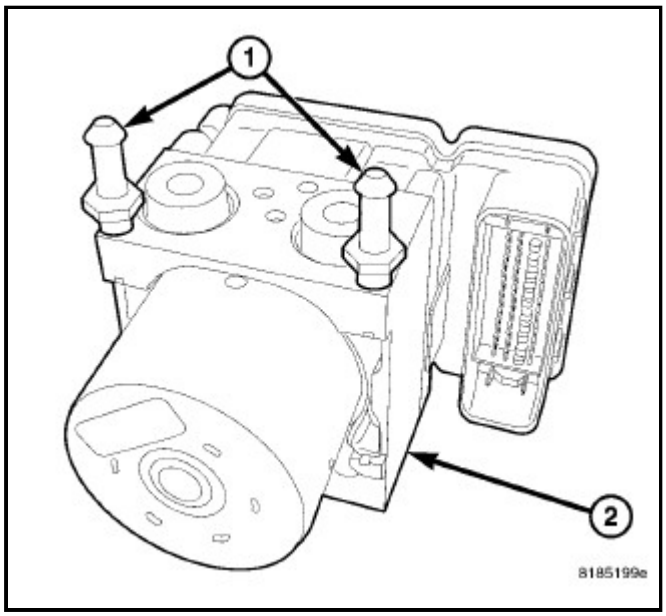
4. Align components and install the ABM (1) on the HCU (2).



5. Install the four screws (1) attaching the ABM (2) to the HCU. Tighten the mounting screws to 2 N·m (17 in. lbs.).



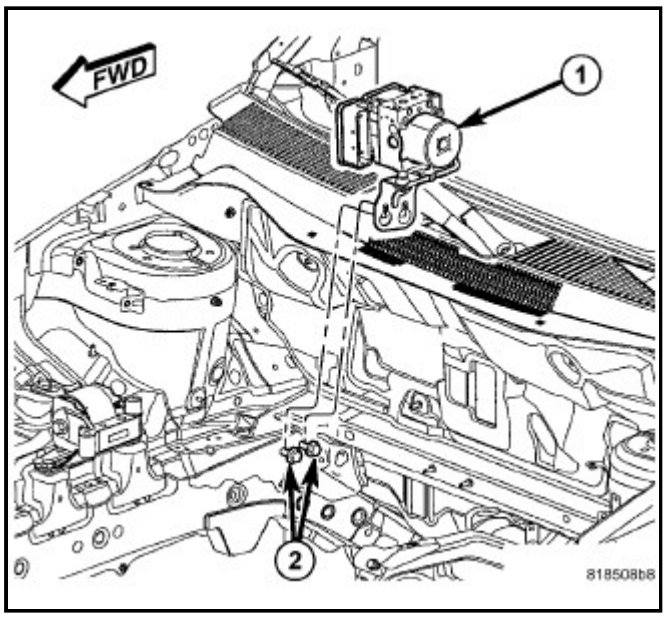
6. If necessary, install the mounting pins (1) in the ICU (2) and tighten to 11 N·m (97 in. lbs.).



7. Install the ICU in the vehicle. (Refer to 05 - Brakes/Hydraulic/Mechanical/INTEGRATED CONTROL UNIT (ICU) - Installation) - INSTALLATION)

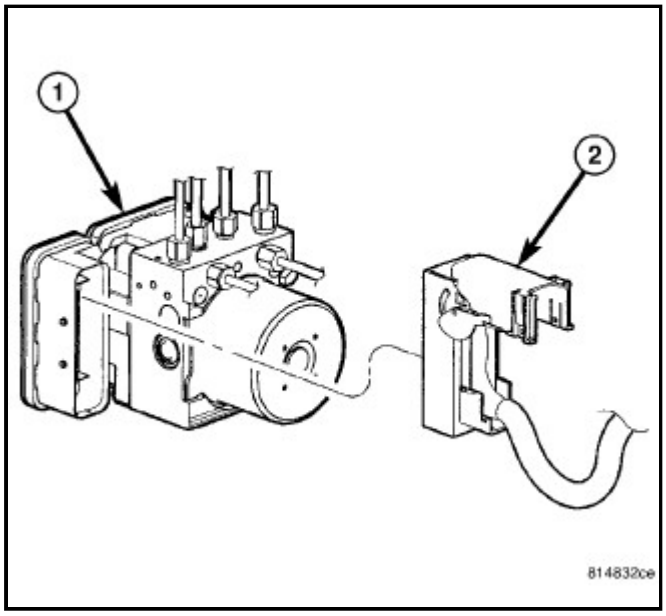
LEFT-HAND-DRIVE

1. Install the ICU with bracket (1) through the opening between the A/C lines and the exhaust manifold using the opposite of how it was removed.
2. Place the mounting bracket for the ICU (1) over the mounting screws (2) and hang the assembly in place. Tighten the two mounting screws (2) to 23 N·m (17 ft. lbs.).



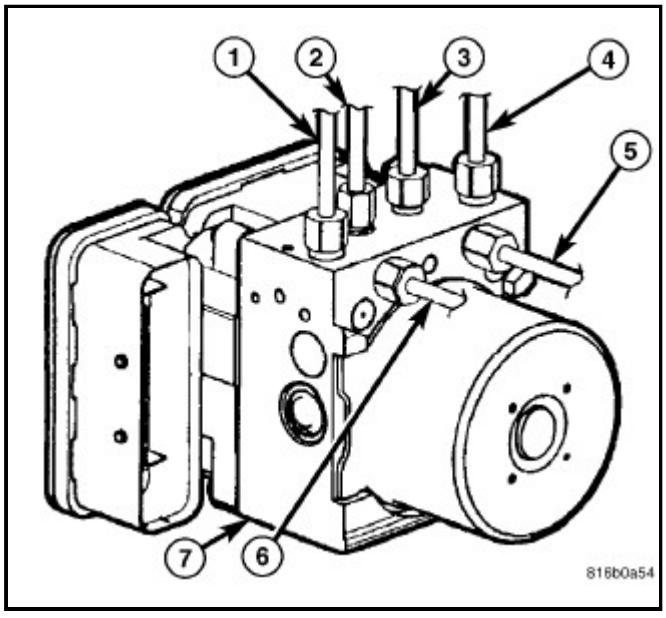
CAUTION: Before installing the ABM harness connector on the ABM, be sure the seal is properly installed in the connector.

3. Insert the ABM wiring harness connector (2) into the socket of the ABM (1) and close the cover, locking the connector in place.



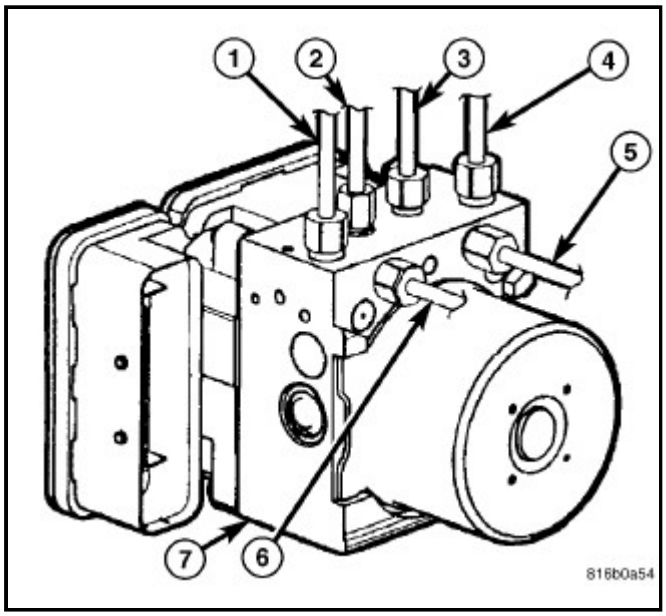
CAUTION: The brake tubes must be routed to the correct ports. Improper routing can lead to degraded or undesirable system performance including external brake fluid leaks.

- **(1) Master Cylinder Secondary**
- **(2) Front Left**
- **(3) Front Right**
- **(4) Master Cylinder Primary**
- **(5) Rear Left**
- **(6) Rear Right**

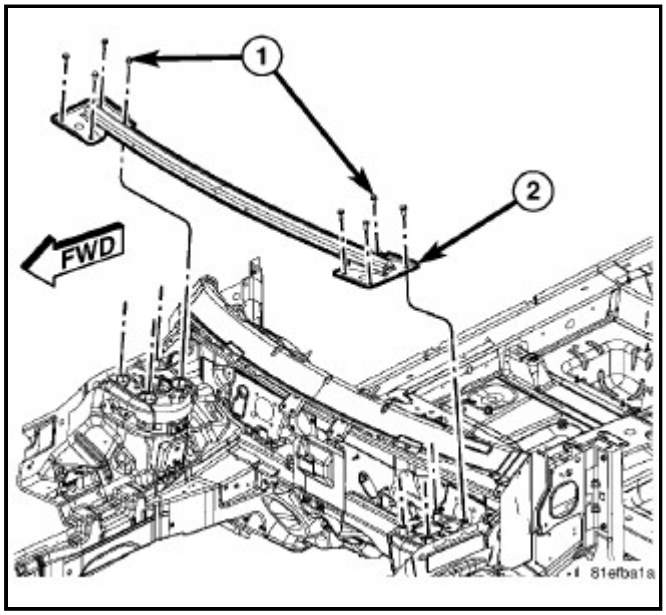


4. Install the four chassis brake tubes (2, 3, 5, 6) at the ICU hydraulic control unit (7). Tighten the tube nuts to 17 N·m (150 in. lbs.).

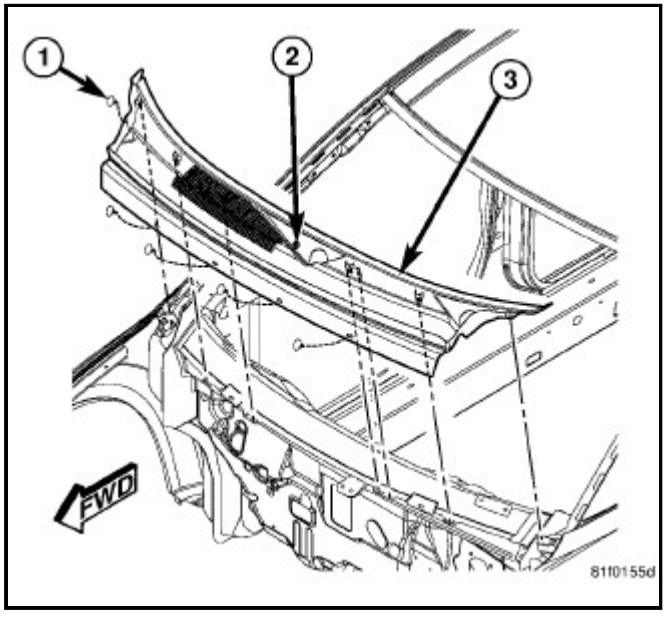
5. Install the primary (4) and secondary (1) brake tubes at the ICU hydraulic control unit (7). Tighten the tube nuts to 17 N·m (150 in. lbs.).



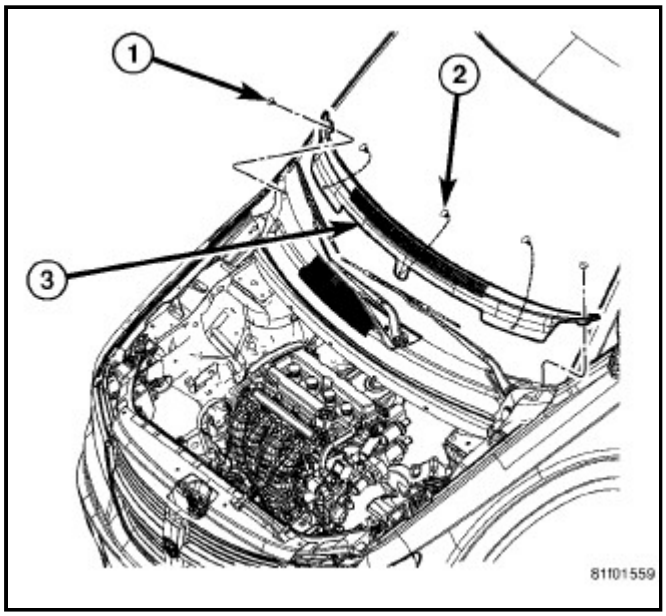
6. Push the brake tube bundle routing clips (with tubes) onto the studs on the dash panel.
7. Position the fresh air plenum and install the two mounting screws.
8. Install the wheelhouse brace (2). Install and tighten the eight mounting bolts (four each side) (1) to 48 N·m (35 ft. lbs.).



9. Install the cowl screen. Install the push-pins (1) securing the cowl screen to the wheelhouse brace and cowl. Rotate the screw (2) in the center of the cowl screen 90° counterclockwise to lock the screen in place.
10. Install the wiper arms. (Refer to 08 - Electrical/8R - Wipers/Washers/Wipers/Washers/ARM, Wiper - Installation)

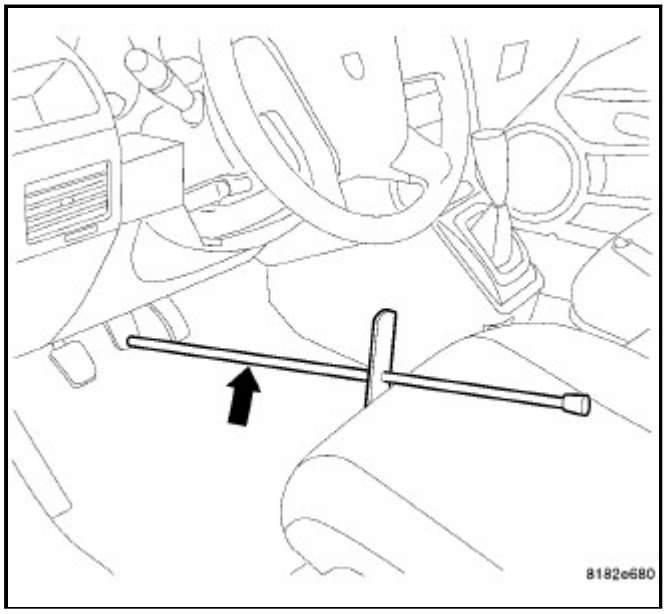


11. Install the cowl top screen (3). Install the two push-pins (1) securing the cowl top screen at the ends. Install the remaining push-pins (2).

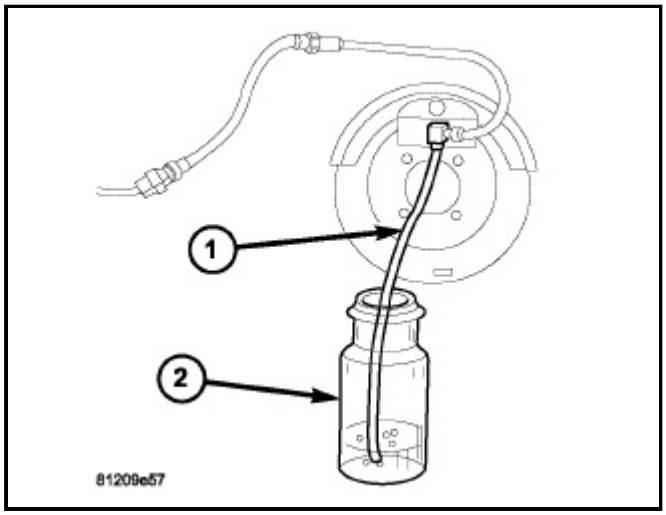


12. Install the engine appearance cover.

13. Remove the brake pedal holding tool.
14. Connect the battery negative cable to the battery post. It is important that this be performed properly. (Refer to 08 - Electrical/8F - Engine Systems/Battery System - Standard Procedure)

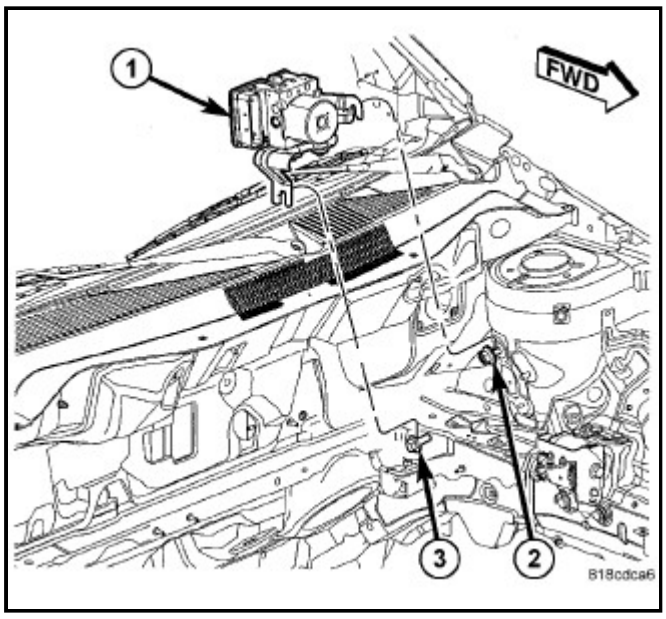


15. Hook up the scan tool to initialize the ABM and perform the following:
    a. Clear any faults.
    b. Fill the master cylinder to the proper fill level and bleed the base and ABS hydraulic systems. (Refer to 05 - Brakes - Standard Procedure)
    c. Check for leaks.
    d. Perform the ABS Verification Test and road test the vehicle. (Refer to 28 - DTC-Based Diagnostics/MODULE, Antilock Brake (ABS) - Standard Procedure)



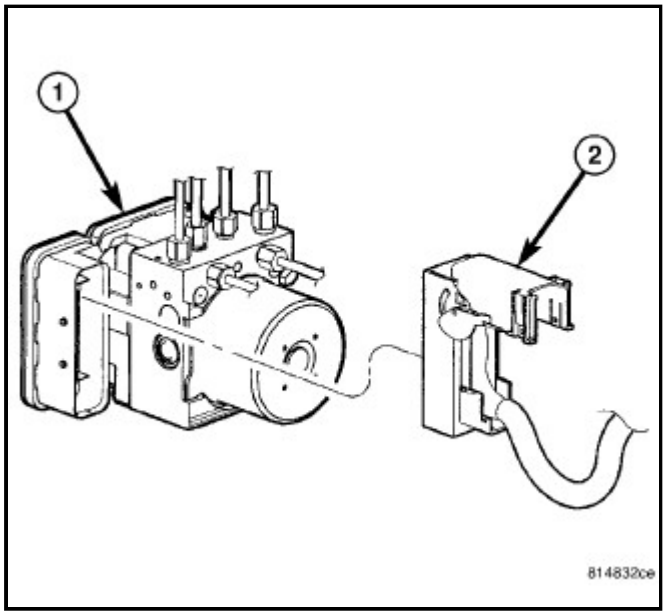
RIGHT-HAND-DRIVE

1. Install the ICU with bracket (1) through the opening between the A/C lines and the exhaust manifold using the opposite of how it was removed.
2. Install the ICU with bracket (1) into the engine compartment. Place the mounting bracket for the ICU (1) over the mounting stud and screw (3) and hang the assembly in place. Tighten the mounting nut (2) and mounting screw (3) to 23 N·m (17 ft. lbs.).



CAUTION: Before installing the ABM harness connector on the ABM, be sure the seal is properly installed in the connector.

3. Insert the ABM wiring harness connector (2) into the socket of the ABM (1) and close the cover, locking the connector in place.



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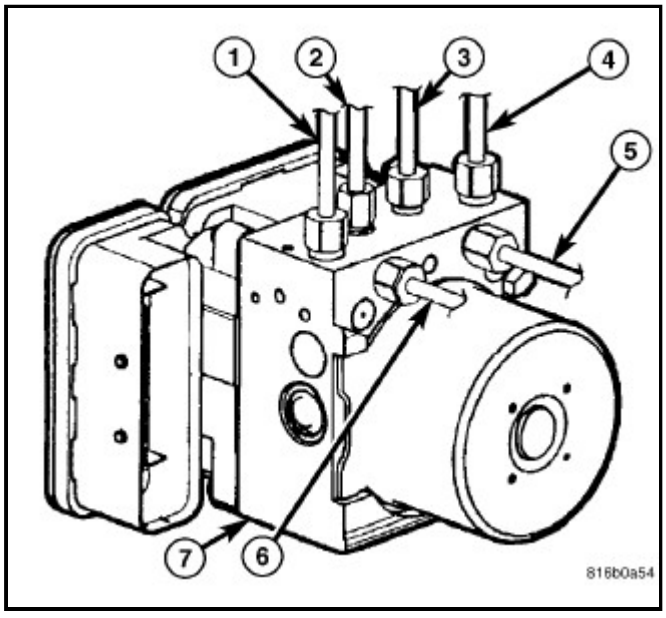
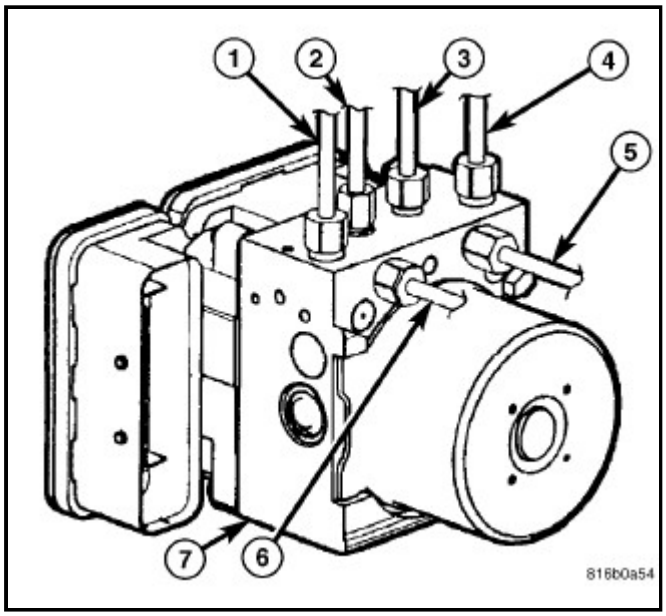
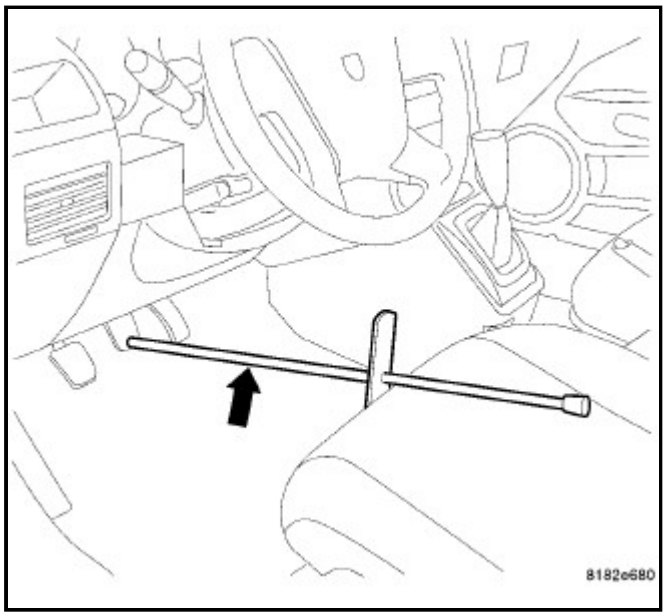


4. Install the four chassis brake tubes (2, 3, 5, 6) at the ICU hydraulic control unit (7). Tighten the tube nuts to 17 N·m (150 in. lbs.).

5. Install the primary (4) and secondary (1) brake tubes at the ICU hydraulic control unit (7). Tighten the tube nuts to 17 N·m (150 in. lbs.).



6. Remove the brake pedal holding tool.
7. Install the engine appearance cover.
8. Connect the battery negative cable to the battery post. It is important that this be performed properly. (Refer to 08 - Electrical/8F - Engine Systems/Battery System - Standard Procedure)



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