

INTRODUCTION

Two-wheel-drive vehicles use engine torque to turn either the front or the rear wheels. A differential is required to allow the drive wheels to travel different distances and speeds while cornering or driving over bumps or dips in the road. A four-wheel-drive vehicle, therefore, requires two differentials—one for the front wheels and one for the rear wheels.

Powering all four wheels creates some issues such as:

- Not only do the wheels on the outside travel further while turning than the inside wheels, the rear wheels and tires also travel different distances than the front wheels and tires.
- There is a need for a unit, usually a transfer case, where the engine torque can be split to either one drive axle or both to provide for four-wheel drive.

Four-wheel-drive vehicles can be achieved by using an existing rear-wheel-drive arrangement and adding a transfer case, or a front-wheel-drive arrangement with the addition of rear axle output shaft and center differential assembly. Figure 1.

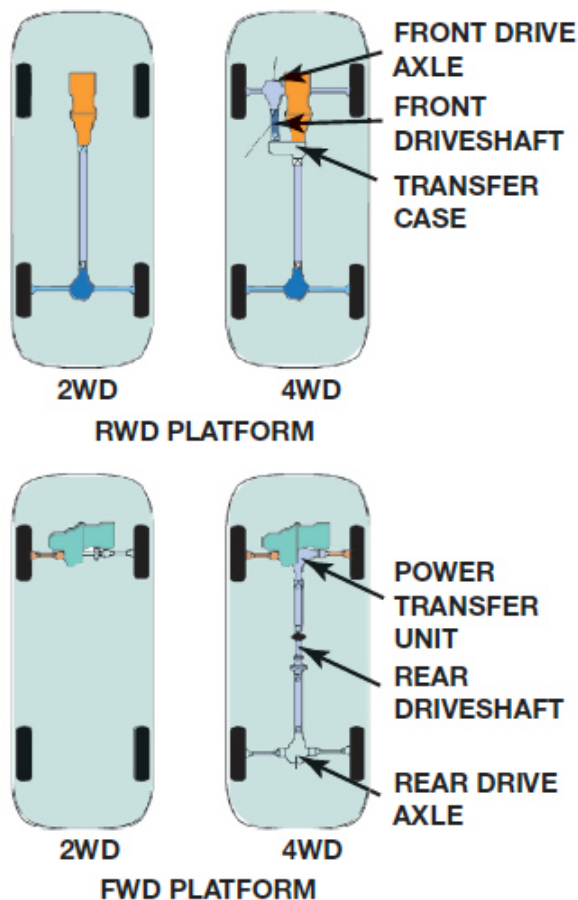


Figure 1. Two-wheel and four-wheel drive configurations.

Part-Time Four-Wheel Drive—In a vehicle equipped with a part-time four-wheel system, both front and rear axles are mechanically connected and locked together. Driving a part-time four-wheel-drive vehicle

on dry pavement can cause the drivetrain to bind unless the front wheels are disconnected usually using locking hubs.

Full-Time Four-Wheel Drive—This type of four-wheel-drive system uses a center (interaxle) differential, which allows for both the front and rear axles to rotate at different speeds.

On-Demand Four-Wheel Drive—With an on-demand type four-wheel-drive system, one axle is driven all the time and engine torque is only sent to the other axle when traction has been lost on the primary axle.

The purpose of the transfer case is to control the power flow to both the front and rear axles. Many transfer cases also provide gear reduction to increase the torque applied to the drive wheels. Figure 2.

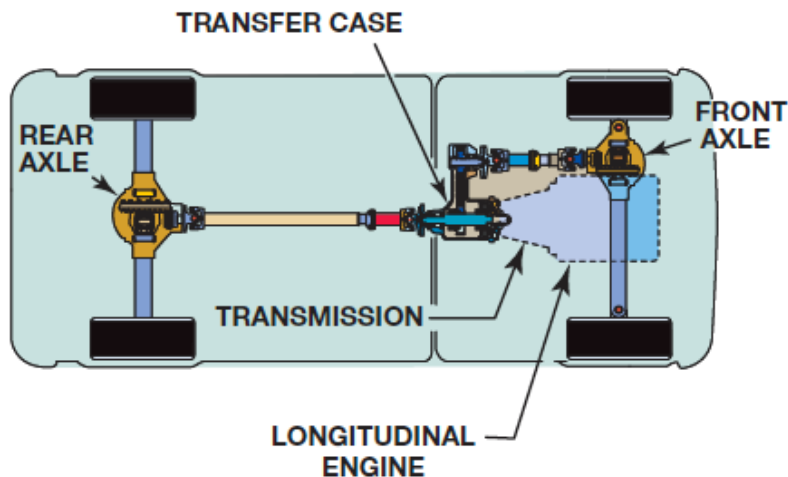


Figure 2. Transfer case location.

On part-time 4WD systems the transfer case also provides for two types of shifts:

- Mode shift—Either two-wheel drive or four-wheel drive may be selected.
- Range shift—A low range may be selected to deliver high torque at low speeds to the drive wheels. High range (usually 1:1 ratio) transfers engine torque at the same speed as the output shaft of the transmission.

ASE TEST TOPICS

1. Diagnose drive systems noise, vibration, leakage and steering problems; determine needed repairs.

Hoist the vehicle safely and perform a thorough visual inspection of the driveline including the following:

- Driveshaft for damage or mud that could affect the balance of the driveshaft
- U-joints for damage or looseness
- Engine and transmission mounts for damage
- Check electrical and mechanical connections to the transfer case
- Check for leaks at the transmission or transfer case

2. Inspect, repair, replace, adjust, and calibrate transfer case manual shifting mechanisms, bushings, mounts, levers, and brackets.

Manually shifted transfer cases include a provision for adjusting the shift linkage to ensure that the unit can be properly engaged or disengaged in the various lever positions. The actual adjustment will vary between the makes and models; always consult service information. Figure 3.



Figure 3. Manual linkage is usually adjusted from under the vehicle.

3. Remove and replace transfer case.

Service information instructions should be followed and usually includes the following steps.

STEP 1 Raise and support the vehicle securely on a hoist or jack stands.

STEP 2 Remove any skid plates and brace rods that block access to the transfer case.

STEP 3 Disconnect the front and rear driveshafts, being sure to make index marks so that the driveshafts can be reinstalled in the same position.

STEP 4 Disconnect the speed sensors and shift connectors and linkage, including encoder motor harness or other wiring connector. Most will come out with wiring attached, for removal on the bench.

STEP 5 Support the transfer case using a transmission jack and remove the bolts that secure the transfer case to the transmission.

STEP 6 Slide the transfer case off the rear of the transmission and remove it from the vehicle.

Installation of most transfer cases is the reverse of the removal procedure. Make sure that the gasket and seals between the transfer case and the transmission are in good condition and that the bolts are tightened to the correct torque.

4. Disassemble transfer case; clean and inspect internal transfer case components; determine needed repairs.

Most transfer case service operations are the same as those used in transmissions, transaxles, and drive axles. Disassembly and inspection operations include:

- Disassembly. Figures 4 and 5.
- Gear and bearing inspection.
- Shift fork clearance and operation. Figure 6.
- Chain wear check, shaft inspection. Figure 7.

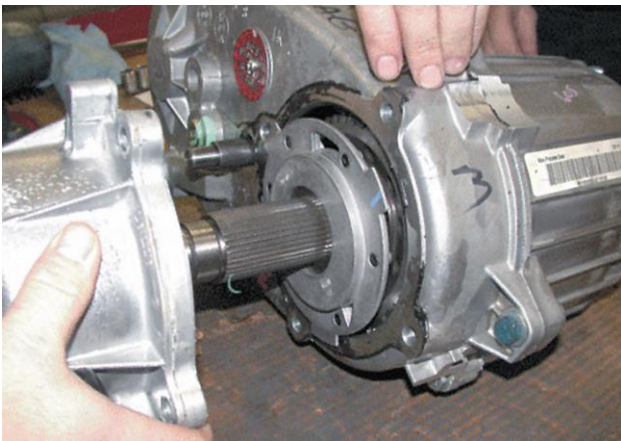


Figure 4. The lubricating oil pump is visible after the cover and bearing assembly have been removed.

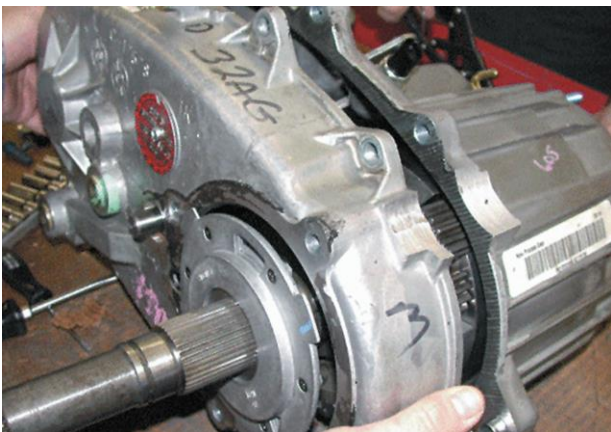


Figure 5. The two case halves are being separated.

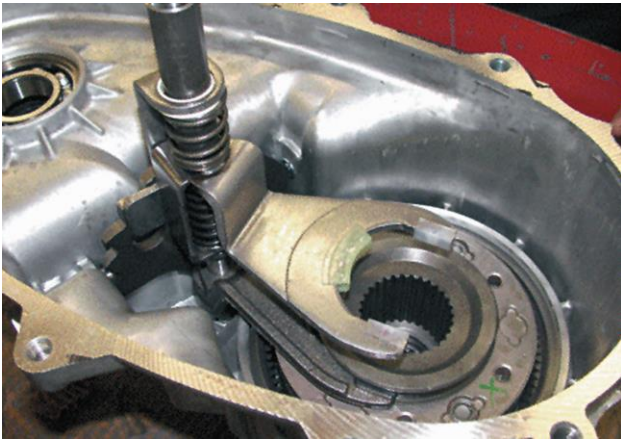


Figure 6. Inspect the shift forks for wear and proper movement.

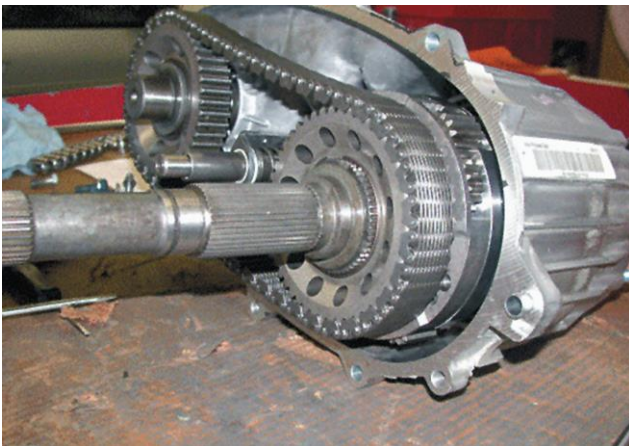


Figure 7. Inspect the drive chain and sprockets.

5. Reassemble transfer case.

Reassembly includes seal replacement. Some units use a double-lip seal, which is a seal that prevents fluid from moving to and from the transfer case to the transmission.

Case halves are usually sealed with RTV silicone. Do not use too much or the oil pump screen can become clogged. Figure 8.



Figure 8. Case sealed with RTV.

6. Check transfer case fluid level; drain and refill with proper fluid; reset service parameters as required.

Most transfer cases and power transfer units have a gear oil-level plug in the side of the case for checking the oil level. Figure 9.

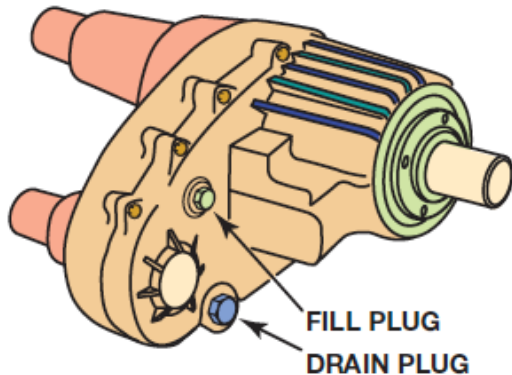


Figure 9. Transfer case fill and drain plugs.

As in a manual transmission, the gear oil-level should be at the bottom of the plug opening. Always use the lubricant specified by the manufacturer. The fluid used in transfer cases can include:

- Automatic transmission fluid (ATF)—check service information for the exact type of ATF to use.
- SAE 80W-90 gear oil—check service information for the exact viscosity and API rating required.
- Special specific transfer case fluid.

7. Inspect, service, and replace drive/propeller shaft and universal/CV joints.

See Study Guide A3D, ASE task 2 for the service and replacement of drive shaft universal and CV joints.

One difference is the driveshaft used on some 4WD vehicles. A double Cardan U-joint is used on the output driveshaft from the transfer case to the front differential assembly. Figure 10.

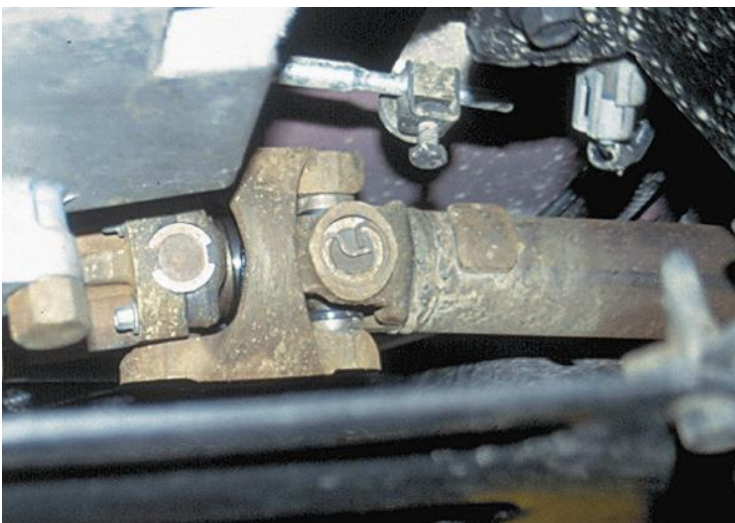


Figure 9. A double Cardon joint on the front drive shaft.

8. Inspect, service, and replace drive axle universal/CV joints and drive/half-shafts.

The purpose and function of the front drive axle is to transfer engine torque to the front wheels. Unlike the rear drive axle, the front drive axle has to be designed to steer the front wheels as well as transmit engine torque. Some front drive axles use an open design with ball joints for the steering pivots and a Cardan U-joint. Figure 11.



Figure 11. U-joint on a front drive axle.

Some 4WDs mount the differential carrier to the vehicle frame or body and use a fully independent suspension. These designs usually use constant velocity-type joints. Figure 12.

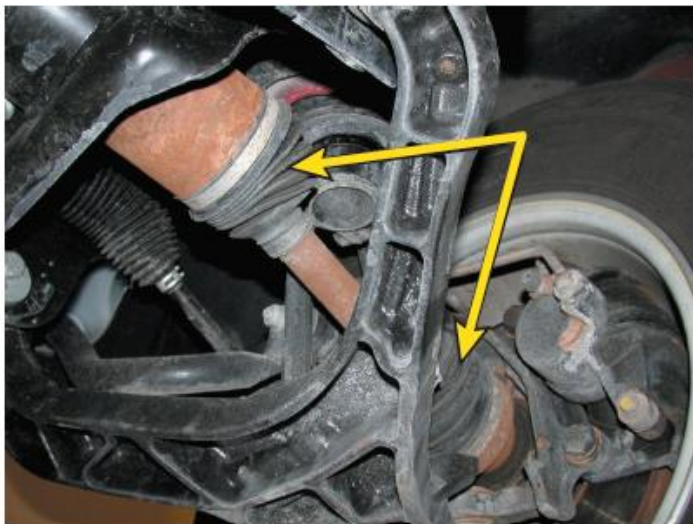


Figure 12. Drive axle using CV joints is the same as that used on a FWD vehicle.

9. Inspect, service, and replace wheel bearings, seals, and hubs.

Service of 4WD hubs and wheel bearings is similar to what is described in Study Guide A3E. Some extra steps are required due to the use of additional 4WD components to the front hubs. This includes automatic and manual locking hubs, which must be disassembled before wheel bearings can be replaced. Figure 13.

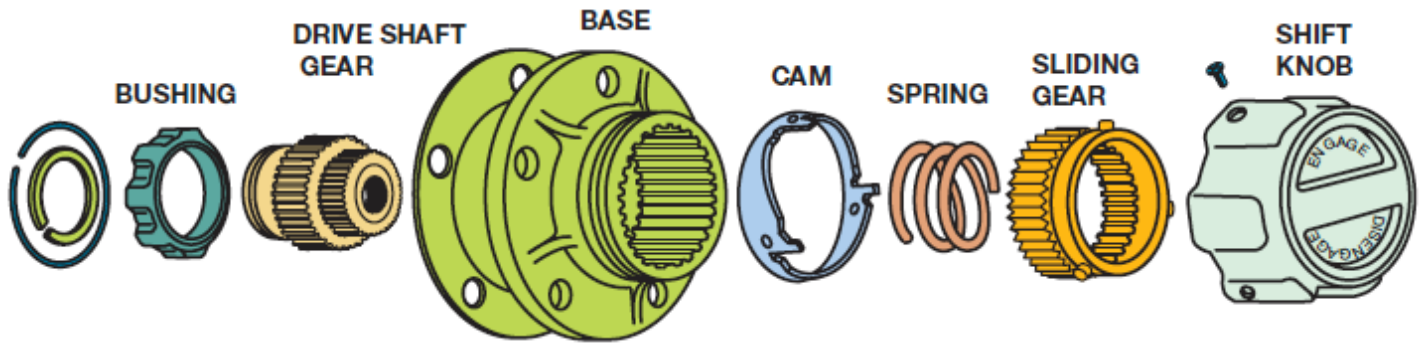


Figure 13. A manual locking hub assembly.

One example is this vacuum operated hub. Figures 14, 15, and 16.



Figure 14. A vacuum operated locking hub.



Figure 15. Removing the outer cover and inner snap ring and washer.

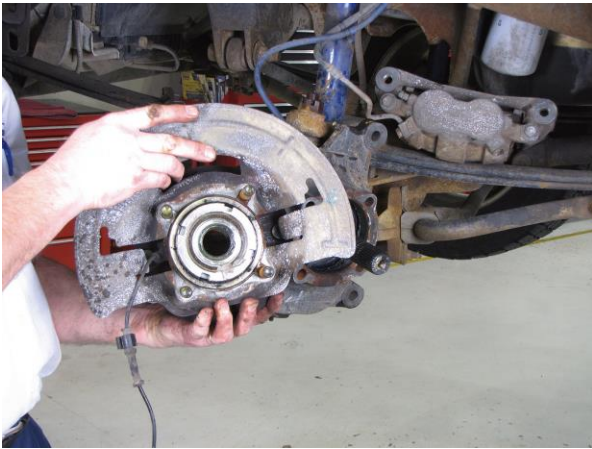


Figure 16. After removing the rotor and the attaching nuts the wheel bearing can be removed.

10. Check transfer case, axle seals, and all vents.

The transfer case has seals on both output shafts that should be inspected for leaks. Check the transfer case vent and hose. Figure 17.

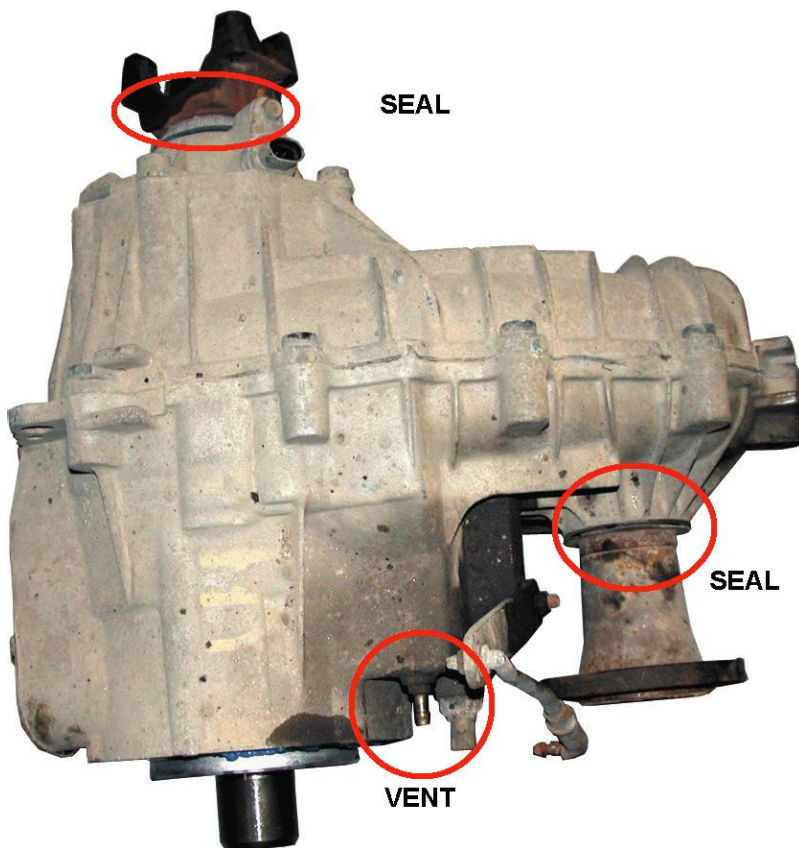


Figure 17. Seal locations. The vent has a hose connected that routes the vent outlet to a protected area.

11. Diagnose drive system actuation and engagement concerns; repair or replace components as necessary (including: viscous, hydraulic, magnetic, mechanical, vacuum, and electrical/electronic); calibrate/ initialize as necessary.

Most transfer cases today use an electric motor to make the mode and range changes and use a dial or push button for each position. Figure 18.



Figure 18. Electronic range and mode selection switches.

When diagnosing a four-wheel-drive fault, use a scan tool or a digital multimeter and check for voltage at the switch for each position of the switch. Typical switches are multiplex switches that use a 5-volt reference and through resistors cause the mode selection signal to change voltage levels. Figure 19.

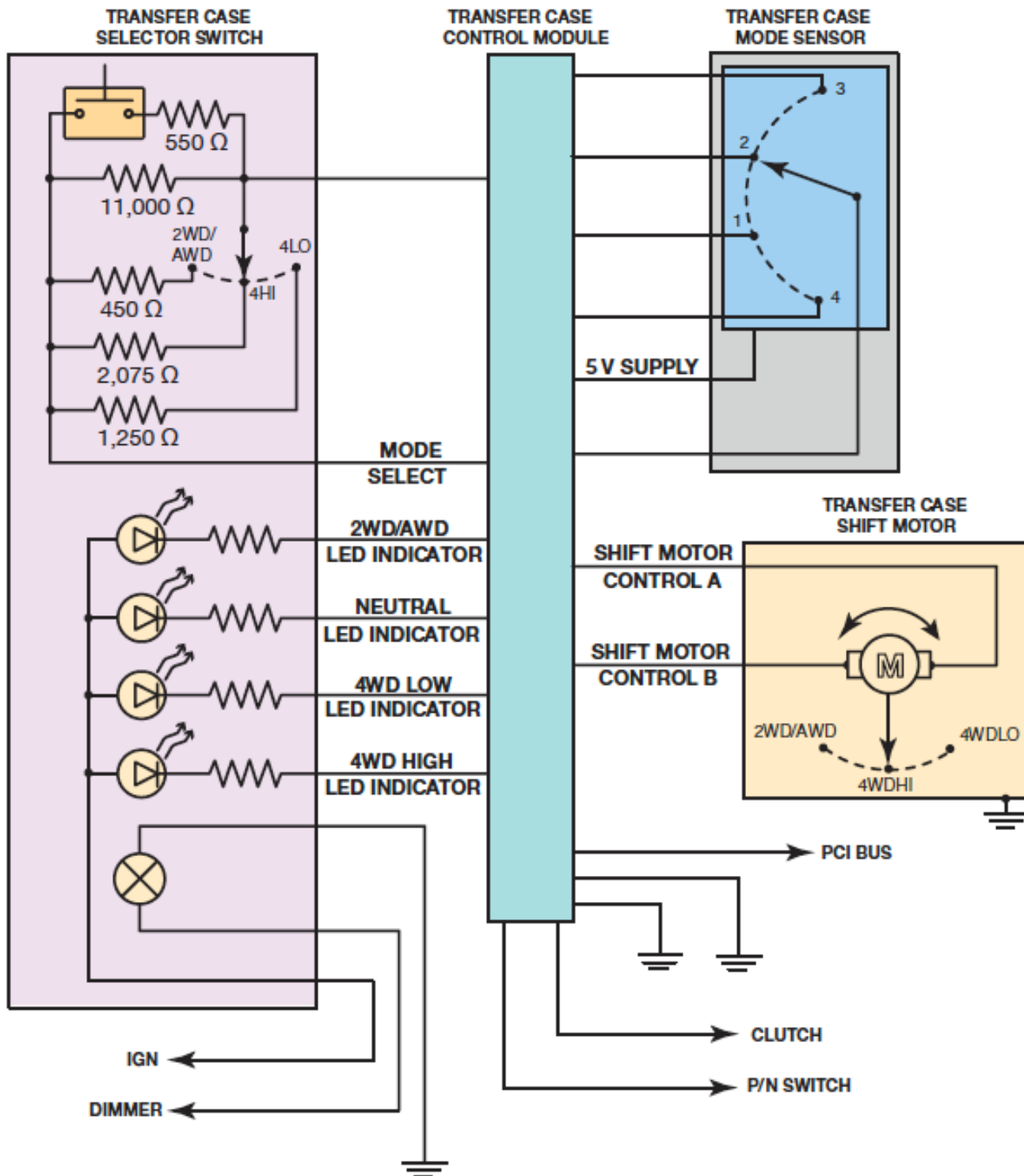


Figure 19. A typical schematic showing an electronic four-wheel-drive control switch and the wiring connections to the transfer case from the TCCM.

In an electronic transfer case, the operation of the range clutch and mode synchronizer assembly is controlled by the motor/encoder assembly. The transfer case motor/ encoder assembly is an electric motor which is used to shift the transfer case from two-wheel high to four-wheel high and can also make a range change between four-wheel high and four-wheel low. Figure 20.

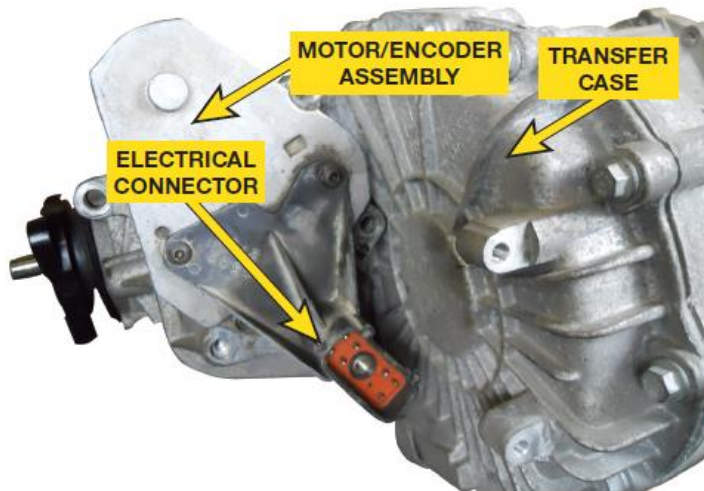


Figure 20. Electronically controlled transfer case.

Part of the motor assembly is an encoder, which is a position sensor that sends the actual position of the transfer case shift shaft to the transfer case control module (TCCM). The TCCM uses the data from the input and output speed sensor to determine when to shift the transfer case to four-wheel drive. If the rear wheels start to slip, the TCCM commands the motor/encoder assembly to make the mode shift. The TCCM also sends a signal to the front axle motor or actuator to engage the front axle when the transfer case is engaging four-wheel high mode.

Some front drive axle assemblies include a feature that allows disconnecting one of the axle shafts. As the vehicle is driven, the wheels will drive the axles, differential, and driveshaft. A collar is shifted to connect or disconnect the two parts of the shaft. Either a vacuum or electric shift motor is used for this with the controls being activated by shifting the transfer case into or out of 4WD. Figure 21.

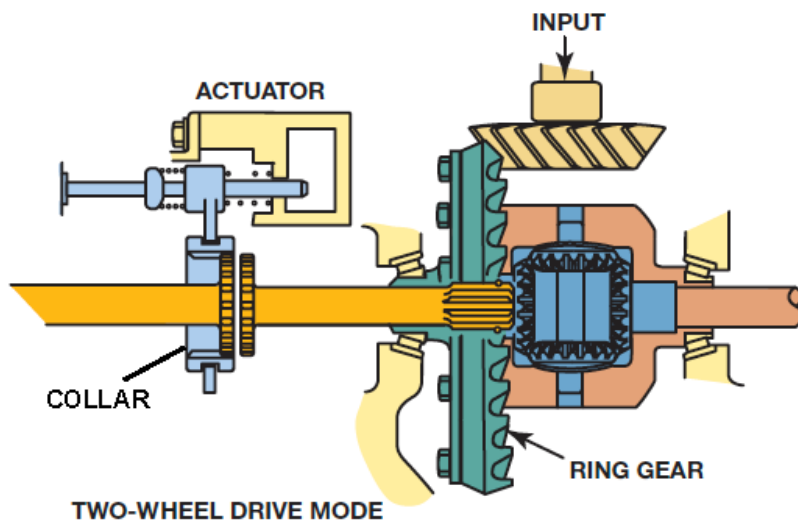


Figure 21. Collar moved to the left; front axle disengaged.

In four-wheel-drive mode, vacuum is applied to the right side of the diaphragm, retracting the shift motor stem. The shift fork and collar move into engagement with both axle shaft gears. Engine torque from the front differential can now be applied to both front axles. Figure 22.

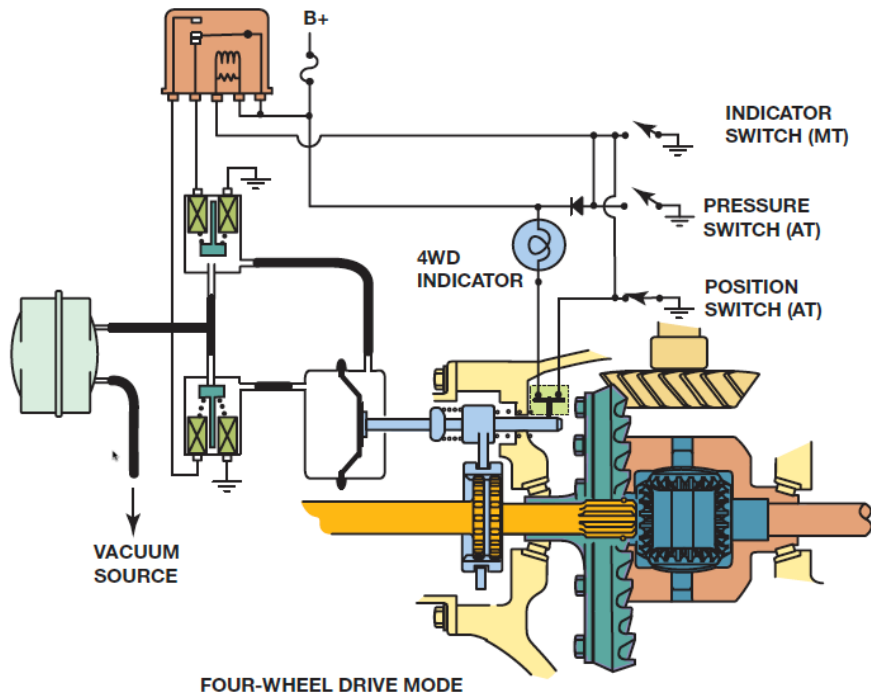


Figure 22. Collar shifted to the right; front axle is engaged.

Full-time 4WD is also called all-wheel drive (AWD). AWD systems use a center differential, also called interaxle differential, to prevent driveline harshness and vibration, commonly referred to as “driveline windup.” Many systems use a viscous coupling for this function. Figure 32.

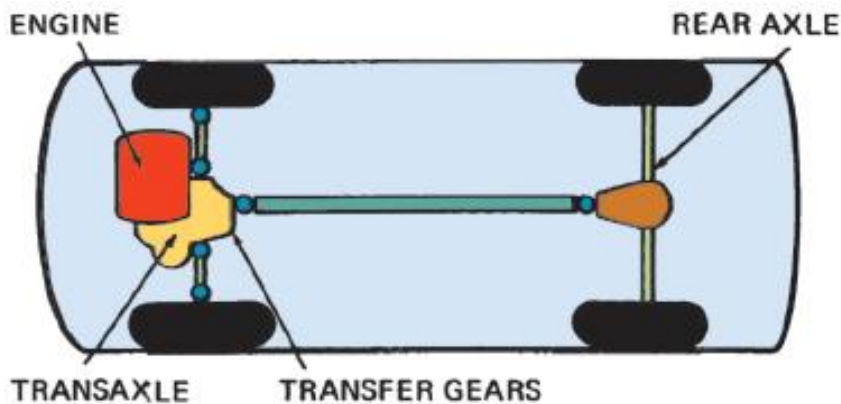


Figure 23. The viscous coupling is inside the transfer gear case.

A viscous coupling is a sealed unit containing many steel discs. One-half of them are splined to the input shaft, with every other disc splined to the output shaft. Surrounding these discs is a thick (viscous) silicone fluid that expands when hot and effectively locks the discs together. Figure 24.

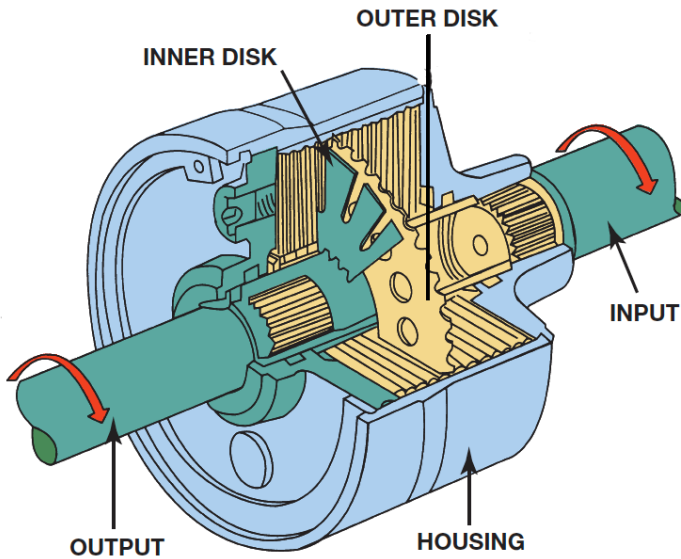


Figure 24. Viscous coupling.

12. Inspect tires for condition and matching circumference; verify proper size for vehicle application.

All tires of a full-time four-wheel-drive or all-wheel-drive vehicle must be within a 1/16 inch (1.6 mm) tread depth of each other. Tire circumference can be checked by wrapping a cloth tape measure around the tread. Figure 25.

Always check that all tires are:

- The exact same size.
- The same brand (different brands even if the same size can vary in the actual diameter and width of the tire).
- The same tread depth within 2/32 inch (1/16 inch).
- The same inflation pressure within 2 PSI for best results.

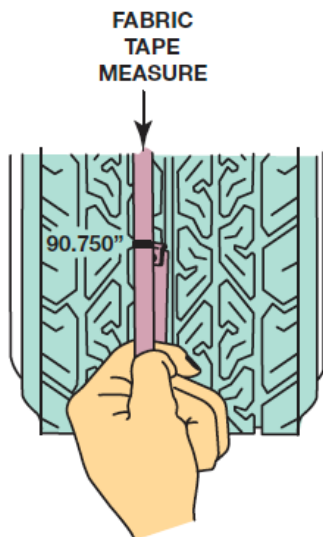


Figure 25. The measuring tape wrapped around the tire shows the circumference is 90 3/4 inch. The other three tires should measure close to the same, usually within 1/4 inch in circumference.