INTRODUCTION

A transaxle is a compact combination of a transmission, the final drive gear reduction, and the differential. It can be either a manual, automatic, or continuously variable transaxle. Transaxles are used in nearly all front-wheel-drive vehicles. Figure 1.

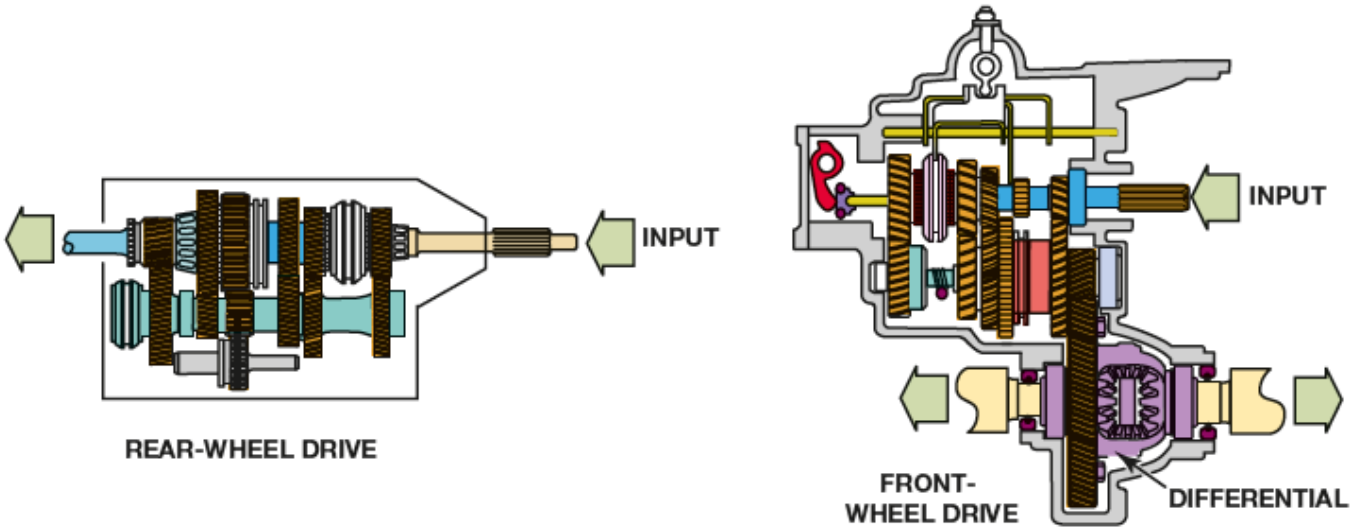


Figure 1. A transmission compared to a transaxle.

Many features of the transmission part of a transaxle are similar to those of a rear-wheel-drive transmission. There are differences, however, in the number of shafts and the power flow. There is also the addition of the final drive gears and the differential.

Most transaxles are made with four parallel shafts, Figure 2.

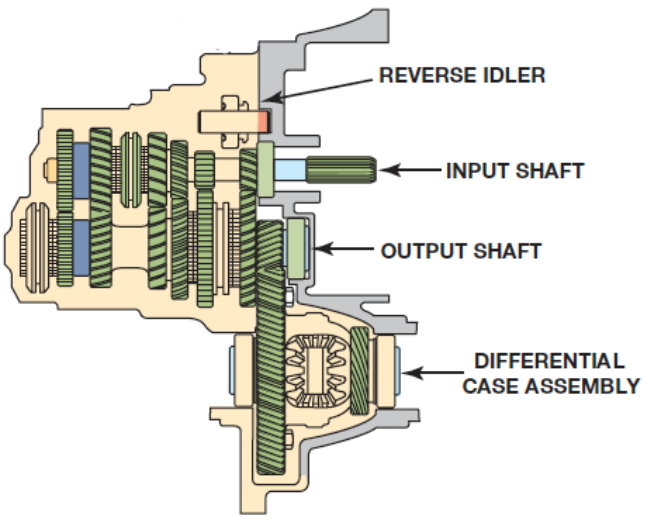


Figure 2. Transaxle shafts.

1. Input shaft—The input shaft is sometimes called the clutch shaft because it is splined to the clutch disc.

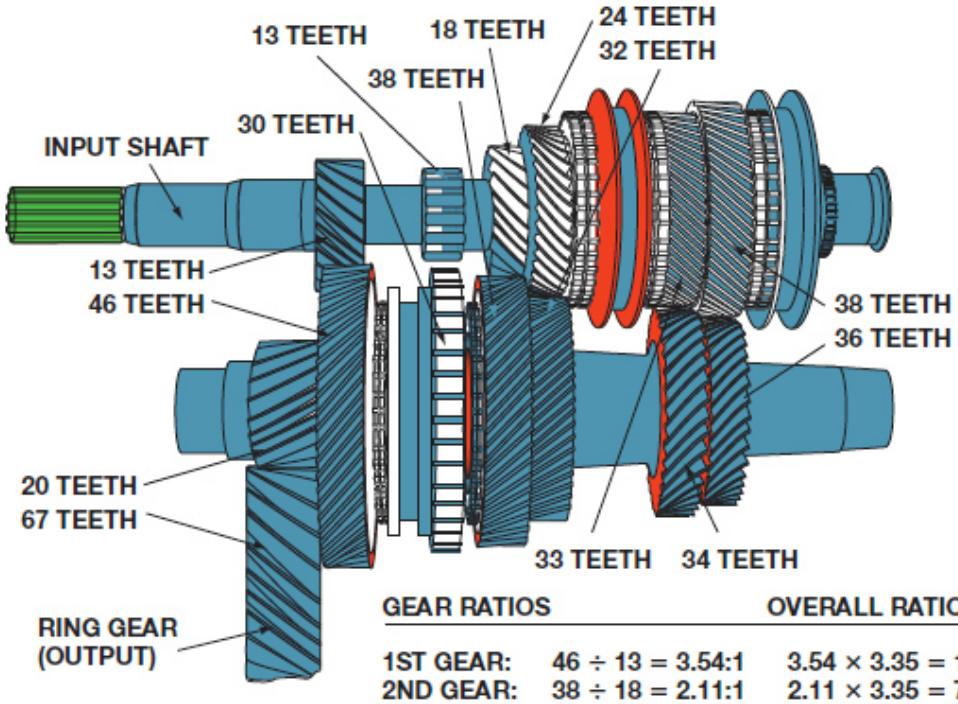
2. Main shaft—The main shaft, also called a countershaft or an intermediate shaft, also includes a gear for each forward speed and these are the driven gears. The main shaft also includes the drive pinion gear.

3. Final drive ring gear—The final drive ring gear is mounted on the differential case. The differential divides the power flow between the two CV joints coupled to the drive shafts and on to the wheels.

4. Reverse idler shaft—All of the gears in a transaxle, with the exception of the reverse idler, are in constant mesh, and each of the gear pairs on the input shaft and main shaft represents the power paths for a particular gear ratio.

The synchronizers are the same as those used in a rear-wheel-drive transmission and their parts and operation are identical.

Because the power passes through only one set of gears, the ratio for that gear speed is determined by that pair of gears. Figure 3.



GEAR RATIOS		OVERALL RATIOS
1ST GEAR:	46 ÷ 13 = 3.54:1	3.54 × 3.35 = 11.86:1
2ND GEAR:	38 ÷ 18 = 2.11:1	2.11 × 3.35 = 7.07:1
3RD GEAR:	32 ÷ 24 = 1.33:1	1.33 × 3.35 = 4.45:1
4TH GEAR:	34 ÷ 33 = 1.03:1	1.03 × 3.35 = 3.45:1
5TH GEAR:	36 ÷ 38 = 0.83:1	0.83 × 3.35 = 2.78:1
REVERSE:	30 ÷ 13 = 2.31:1	3.31 × 3.35 = 7.74:1

FINAL DRIVE: 67 ÷ 20 = 3.35:1

Figure 3. Typical transaxle gear ratios.

The power leaves the transaxle main shaft through the drive pinion, which drives the final drive ring gear. The drive pinion and ring gear are a pair of helical gears. This gear set operates quietly and does not require critical adjustments like a hypoid gear set. Figure 4.

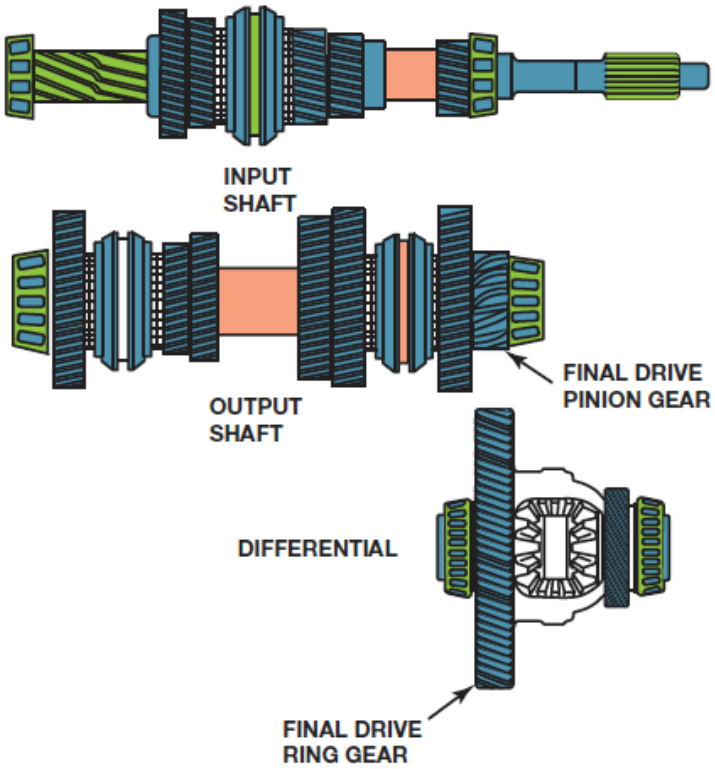


Figure 4. The final drive and differential connect to the front drive axles.

ASE TEST TOPICS

1. Diagnose transaxle noise, difficult shifting, gear clash, jumping out of gear, fluid condition and type, and fluid leakage problems; determine needed repairs.

In-vehicle service, also called on-vehicle service , in most cases is a normal maintenance operation and includes the following:

- Periodic check of the lubricant level
- Linkage/shifter adjustment
- Mount inspection or replacement as needed
- Visual inspection for leaks and other abnormal conditions

The engine-off shift test, also called a static shift test or a shift effort test, measures the effort required to move the synchronizer sleeve or gear, fork, and shift rail past the neutral detent and into mesh. Compare the effort to shift into one gear with the effort to shift into the gears on a similar transmission.

The engine-running shift test, also called a dynamic shift test, is almost a repeat of the engine-off check except that it checks for clutch drag as well as transmission problems.

Incorrect fluid can cause shifting problems. Many transmissions and transaxles do not use SAE 80W-90 gear oil. If the wrong lubricant is used, it can soak into the composite blocker ring linings. Even if drained immediately and refilled with the correct fluid, noise or erratic shifts can result.

Figure 5 lists possible transaxle faults and possible causes.

TRANSMISSION/ TRANSAXLE FAULT	DESCRIPTION OF FAULT	POSSIBLE CAUSE(S)
Leaks	Fluid escapes from the transaxle/ transmission	Leaking gaskets or seals
Hard shifts	Requires an abnormally high amount of force to shift into gear	Possible incorrect lubricant in the transmission and/or shifter/linkage/shift fork problems
Shift block-out	Will not shift into one or more gears	Possible shift linkage and/or interlock concerns. Can be caused by the "shift skip" system which forces a shift to 4th instead of 2nd at lower vehicle speeds to improve fuel economy
Locked into gear	Transmission/transaxle will not shift out of a gear	Shifter/linkage/shift fork problems
Jumps out of gear	Will shift into neutral on its own	Often caused by worn synchronizer assemblies
Clash/grinding during a shift	Gear clash/grinding noise occurs as shift is made	Often caused by worn synchronizer assemblies
Noisy	A grinding, growling noise while in neutral	Worn or defective bearings
No gear at all	Sometimes the teeth are sheared and there is no gear at all (usually second gear)	Usually caused by driver abuse

Figure 5. Faults and possible causes.

2. Inspect, adjust, lubricate and replace transaxle external shift assemblies, linkages, brackets, bushings/ grommets, cables, pivots, and levers.

The exact method of adjusting transaxle shift linkages varies. Some have no adjustment, whereas others provide adjustments with gauging methods. Always follow the procedures found in service information for the vehicle being serviced. A transaxle will often have shift cables, with adjustments inside the vehicle, under the center console. Figure 6.

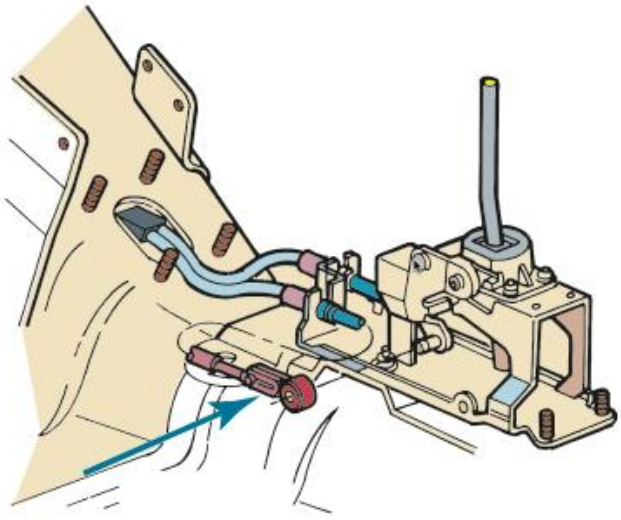


Figure 6. Cable operated shifter and adjustment.

3. Inspect and replace transaxle gaskets, sealants, seals, and fasteners; inspect sealing surfaces.

Most cases include one or more seals, which are normally replaced during a rebuild. These seals include one or two output shaft seals and an input shaft seal. To make a good seal sealants require surfaces that are clean and oil-free when they are applied. Figure 7.

Figure 7. Sealant take the place of a gasket.

4. Remove and replace transaxle; inspect, replace, and align transaxle mounts and subframe/cradle assembly.

Some transaxles are quite heavy and awkward to handle and therefore the shop should have available

- A transmission jack
- A tall safety stand to support the vehicle or the engine
- An engine support fixture must be used to support the engine while removing the unit in and out of the vehicle

STEP 1 Disconnect the negative (–) battery cable.

STEP 2 Disconnect the following accessible parts: shift cables or rods, clutch linkage, backup light switch or wires, and speed sensor connections.

STEP 3 install an engine support tool to keep the engine in the proper location as the transaxle and its mounts are removed. Figure 8.

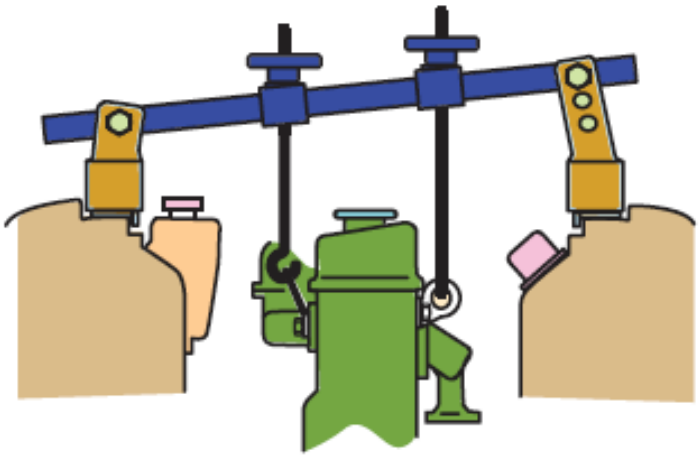


Figure 8. Most front-wheel-drive (FWD) vehicles require the use of a fixture to support the engine before removing the transaxle.

STEP 4 Remove the upper clutch housing bolts and install a guide pin into one or two of the bolt holes.

STEP 5 Raise and securely support the vehicle on a hoist or on jack stands.

STEP 6 If a drain opening is provided, drain the transaxle oil, be sure to check the condition and the amount of fluid that comes out.

STEP 7 Position a transmission jack to support the transaxle, remove any transaxle mounts or supports, remove the remaining clutch housing bolts, and install the second guide pin (if not already installed). Slide the transaxle away from the engine to clear the clutch and right driveshaft. Figure 9.

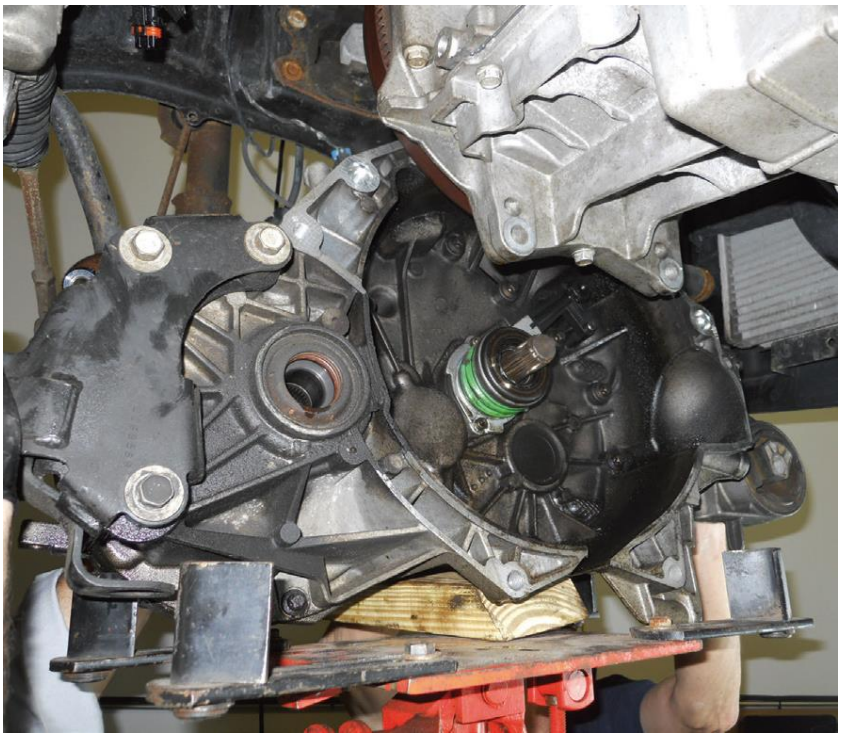


Figure 9. A transaxle being removed from underneath a vehicle and being supported by a transmission jack.

Replacement of the transaxle usually follows the procedure just described, only in reverse. The following points should be observed during transaxle installation:

- Tighten all nuts and bolts to the correct torque.
- If the front suspension mounting points were disturbed, perform a wheel alignment to ensure proper vehicle operation.
- Fill the transaxle to the correct level with the correct lubricant before starting the engine.
- If necessary, check and adjust clutch pedal free travel and the shift linkage.

5. Disassemble and clean transaxle components; reassemble transaxle.

The overhaul operations for a transaxle are similar to a transmission with the addition of final drive service. The steps involved are as follows:

- Disassembly of the unit
- Clean and identify the unit so that the correct parts and specifications can be found
- Gear inspection
- Bearing inspection
- Reconditioning of the subassemblies
- Inspecting and replacing final drive components
- Checking gear end float and adjusting bearing clearances as the unit is reassembled

The exact procedure for carrying out each of these steps will vary depending on the make and model. It is highly recommended that the procedure specified in service information be followed along with the clearances and torque specifications. What is required to remove a part is found in service information. A hydraulic press and special pullers may be required. Refer to figure 10.

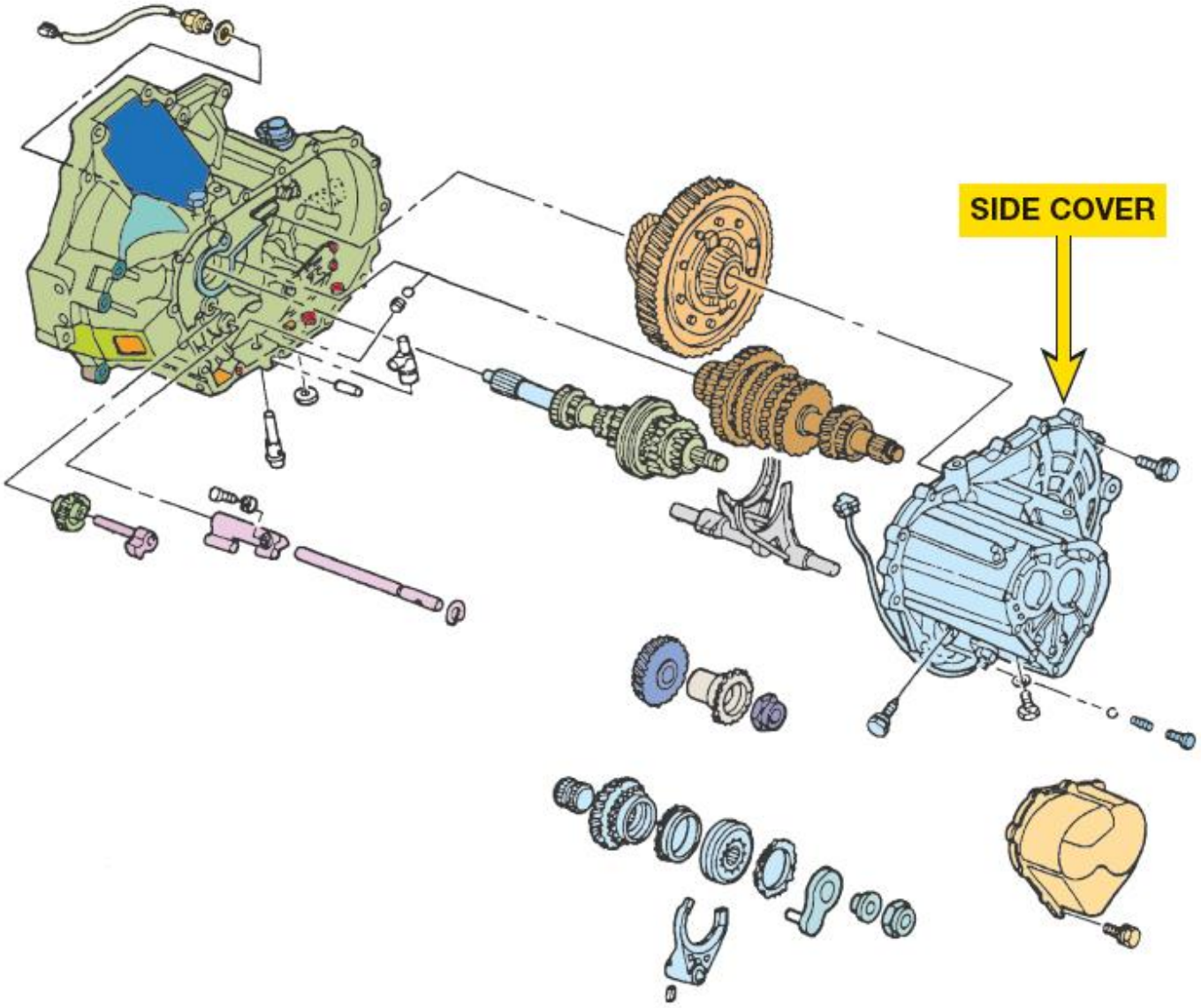


Figure 10. A typical transaxle.

1. Disassembly begins with the removal of the left-side case cover, fifth-gear synchronizer assembly, and the fifth counter gear.

2. Remove the case-to-clutch housing or end-cover-to-case attachment bolts. It will usually be necessary to tap the case with a plastic hammer or pry upward using a small prybar to break the seal between the two parts. Figure 11.

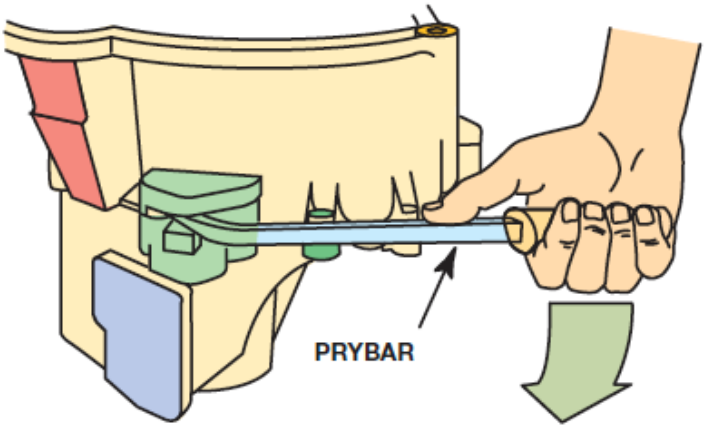


Figure 11. Most transaxles use formed-in-place gaskets that tend to glue the case and covers together. This unit has a slot to allow prying without damaging the gasket surfaces.

3. After removing the cover, remove the shift mechanism, the reverse idler gear, and its shaft, if necessary.

4. Remove the input and main shaft assemblies together, holding them so that the gears stay in mesh until the shafts leave their bearings.

5. Remove the ring gear and differential assembly.

The following are normally checked during disassembly:

- The internal shift linkages for rough operation and wear
- Clearance between all shift forks and sleeves
- All shafts for excessive end play and rough operation
- All floating gears for excess end float or rough rotation
- All blocker rings for free motion and excessive or insufficient clearance or damaged lining
- All gears for chipped or broken teeth

The cleanup of most of the internal parts is done using safety solvent while scrubbing them with a cleaning brush or by running them through a hot-water washer.

To reassemble the transmission, reverse the order of instructions, checking components and assemblies along the way.

6. Inspect, repair, and/or replace transaxle shift cover and internal shift forks, levers, bushings, shafts, sleeves, detent mechanisms, interlocks, and springs.

The shift mechanism contains a fork for each synchronizer sleeve or gear to be shifted, and each fork is mounted on a rail or lever that moves it through its travel. Each shifter includes one or more spring loaded detent balls or cams and some form of interlock that allows only one shift fork to move at a time. Figure 12.

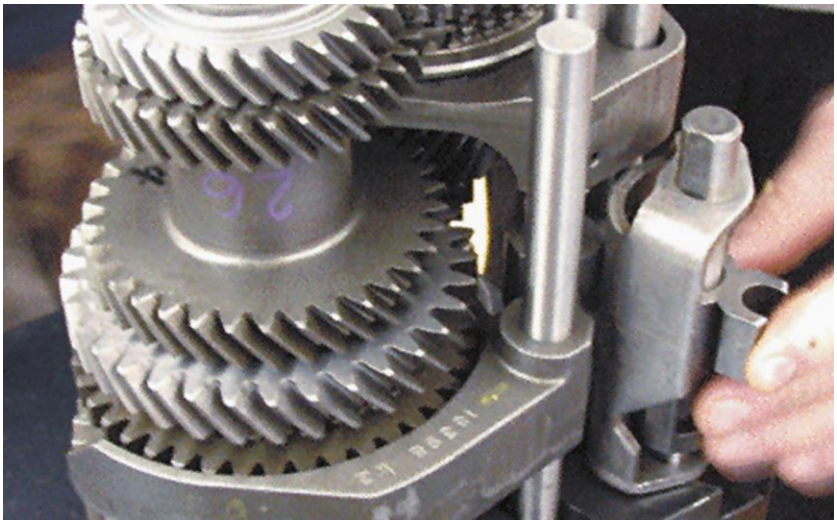


Figure 12. Transaxle shift forks and rails.

Shift forks should be inspected for distortion, bends, cracks, broken or worn inserts, and step wear at both the sleeve and fork contact areas. Figure 13.

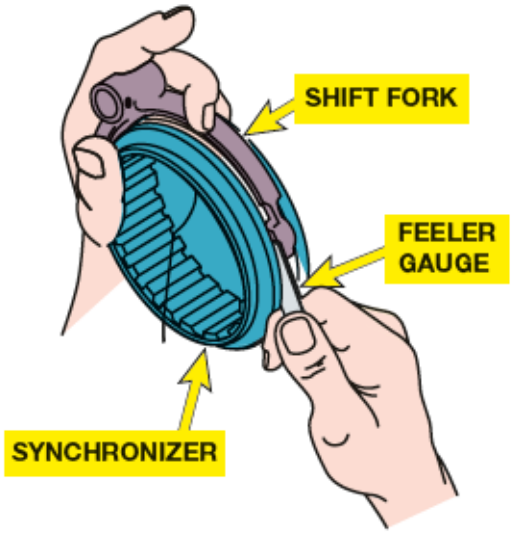


Figure 13. There should be a specified clearance, usually about 0.030 inch (0.8 mm), between the fork and the groove in the sleeve.

7. Inspect and replace input (clutch) shaft and output (main) shaft, gears, thrust washers, bearings, and retainers/snap rings.

After the case is removed the input and output shafts and gears can be inspected. Figure 14.

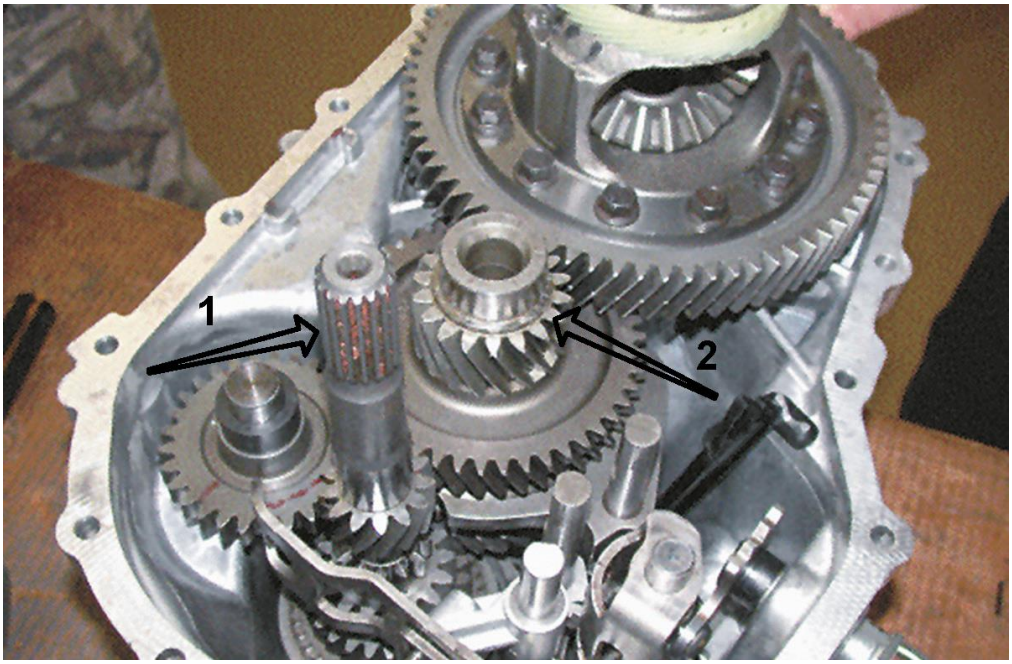


Figure 14. Input (1) and output (2) shafts and gear assemblies.

In some cases, gear damage is quite obvious and easy to locate. With other gears, however, a close inspection is necessary to determine if there is a problem with the teeth or thrust or bearing surfaces.

If one gear of a set has a broken tooth, be aware that a tooth on the mating gear encountered the same load and is probably damaged. The broken gear and its mate are replaced as a set. Figure 15.

Figure 15. The input shaft (left) and the output shaft (right) are checked for proper assembly before being installed into the case.

Inspection of a bearing is normally done by sight, feel, and sound. Visual inspection of a worn bearing can reveal a broken cage or pitted races.

8. Inspect and replace synchronizer hub, sleeve, keys (inserts), springs, and blocking (synchronizing) rings; measure blocking ring clearance.

Synchronizer assemblies are disassembled for cleaning, inspection, and occasionally for deburring the ends of the splines in the sleeve. The sleeve and hub are matched at the factory and should be marked before it is disassembled. To disassemble a synchronizer assembly, remove the energizer springs and slide the sleeve off the hub. The inserts will either fall or slide out of their grooves.

Paper-lined and composite blocker rings should be checked for glazing of the friction surface and discoloration, which often indicates glazing.

The thread-like grooves of a new blocker ring are sharp so that they cut through the lubrication film. They become flattened as they wear, and the flat edges will reflect light. Figure 16.

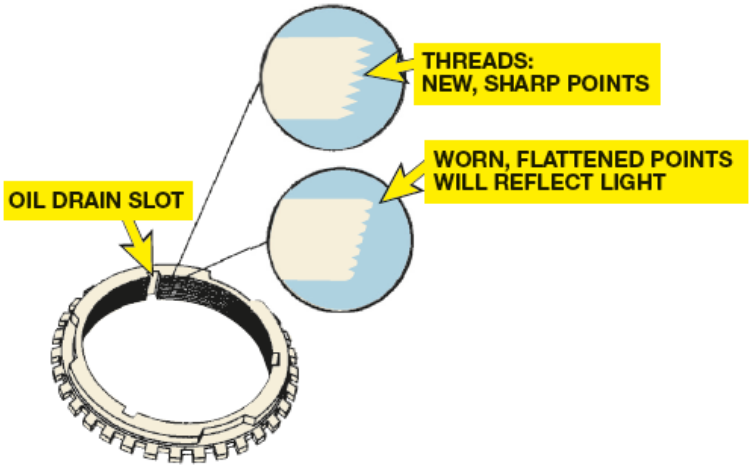


Figure 16. Blocker ring inspection.

When the blocker ring is pushed against the gear, there should be a minimum amount of clearance between the blocker ring and gear clutching teeth. Use a feeler gauge to determine this measurement. Some manufacturers specify a minimum clearance of about 0.020 inch (0.5 mm). Figure 17.

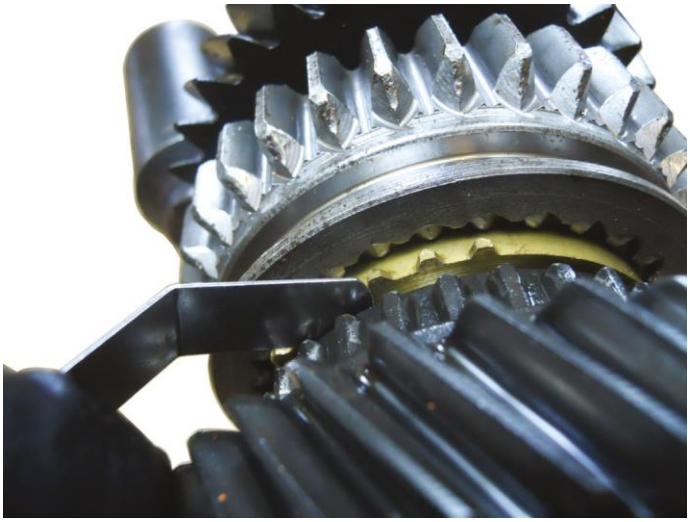


Figure 17. Measuring blocker ring clearance.

9. Inspect and replace reverse idler gear, shaft, bearings/bushings, thrust washers, and retainers/snap rings.

The reverse idler gear is the only gear that is actually shifted into position by sliding it into mesh with two other gears. Because of this the gear teeth are subject to chipping and wear if not shifted correctly. Inspect the idler gear and matching components for worn or broken gear teeth; replace if necessary. Figure 18.

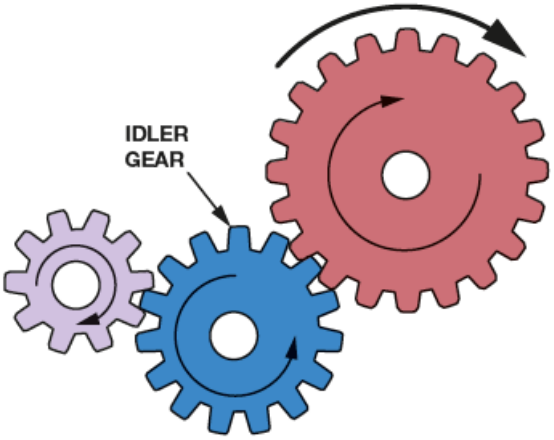


Figure 18. The reverse idler gear slides into mesh with two other gears.

10. Inspect, repair, and/or replace transaxle case mating surfaces, bores, dowels, bushings, bearings, and vents.

The transaxle case should be thoroughly cleaned and carefully checked for cracks, distortion or wear of bearing bores, stripped bolt threads, and worn release (throwout) bearing supports. Damaged cases are normally replaced.

Each transmission includes a vent that should be checked for restriction. The vent normally located at the top of the case. This relieves internal pressure that would occur as the gears and oil warm up while operating. If not relieved, the pressure would force the oil out past the input and output shaft seals.

11. Inspect, test, and replace transaxle sensors, actuators, and switches.

Vehicle speed sensors (VSS) are usually a magnetic-type sensor. A magnetic sensor consists of a notched wheel and a coil consisting of an iron core wrapped with fine wire. The notched wheel causes the magnetic strength changes enough to create a usable varying AC voltage signal. The voltage-generating speed sensor normally uses a two-wire connector and is checked using both an ohmmeter and a voltmeter. Figure 19.

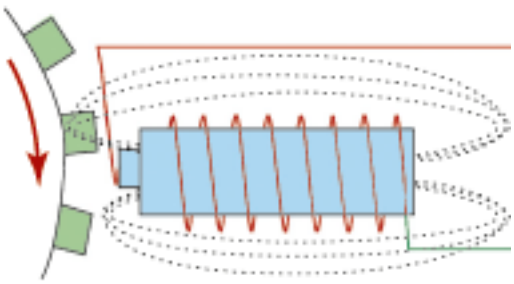


Figure 19. Magnetic speed sensor principle.

12. Diagnose differential assembly noise and wear; determine needed repairs.

Excessive clearance in the differential gear set can cause a clunk as the lash is taken up when either

the transaxle clutch is engaged. This is especially noticeable when changing direction, low to reverse, or reverse to low.

13. Remove and replace differential final drive assembly.

Transaxle final drives (differentials) need to be partially or completely disassembled to replace the bearing cones, ring gear, or differential gears. The differential should be inspected and serviced whenever major transaxle service is performed.

14. Inspect, measure, adjust and replace differential pinion (spider) gears, shaft, side gears, thrust washers, side bearings, and case/carrier.

Differential gear clearance is usually checked by using a dial indicator with the stylus on a side gear tooth. Hold the other side gear stationary as the first gear is moved back and forth against the lash. The amount of lash is shown by the dial indicator needle movement. One manufacturer gives a specification of 0 to 0.009 inch (0 to 23 mm). Too much clearance can be reduced in some differentials by using thicker thrust washers behind the differential pinion and side gears. Figures 20 and 21.

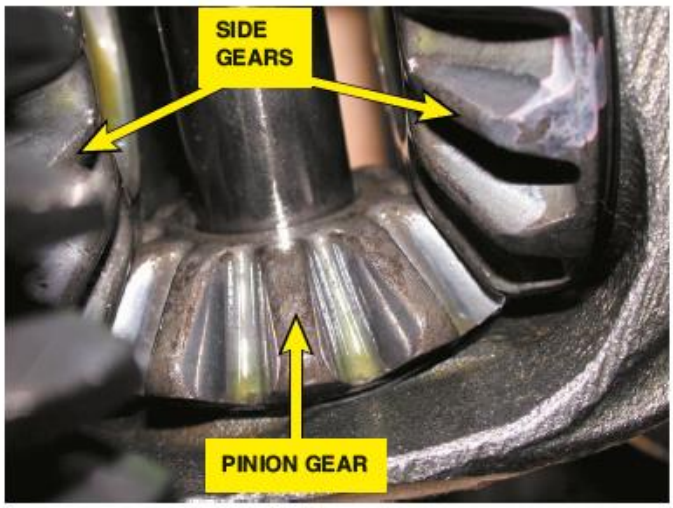


Figure 20. Differential gear set.

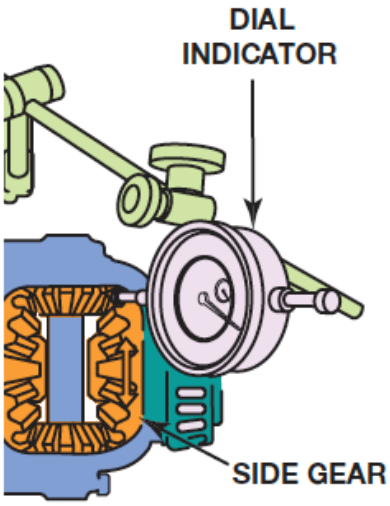


Figure 21. Measuring differential gear lash.

16. Measure and adjust shaft and differential bearing preload and endplay (shim/spacer selection procedure).

During the reassembly of a transmission that uses tapered roller bearings, the preload or end play of each shaft should be checked. A selective shim is located at a bearing at one end of each shaft, and the thickness of this shim controls the amount of preload or end play.

- Preload causes a slight drag as a shaft is rotated, and it is usually measured using a torque wrench or spring scale.
- End play is a free, lengthwise movement of the shaft and is usually measured using a dial indicator or feeler gauge.
- Place the shaft to be checked with its bearings in the case. Use an adjusting shim that is too small, so there will be end play.
- Install the bearing retainer or case cover and tighten all bolts to the correct torque.
- Move the shaft up and down through its free travel several times while reading the end play or clearance on the dial indicator. Figure 22.
- Using service information, select and install a shim of the correct size, replace the bearing retainer/case cover, tighten the bolts and check for end play. On preloaded shafts, there should not be any end play.
- Using a torque wrench or spring scale and adapter, measure the torque required to keep the shaft rotating, not the breakaway or starting torque. Compare the preload reading to the specifications.

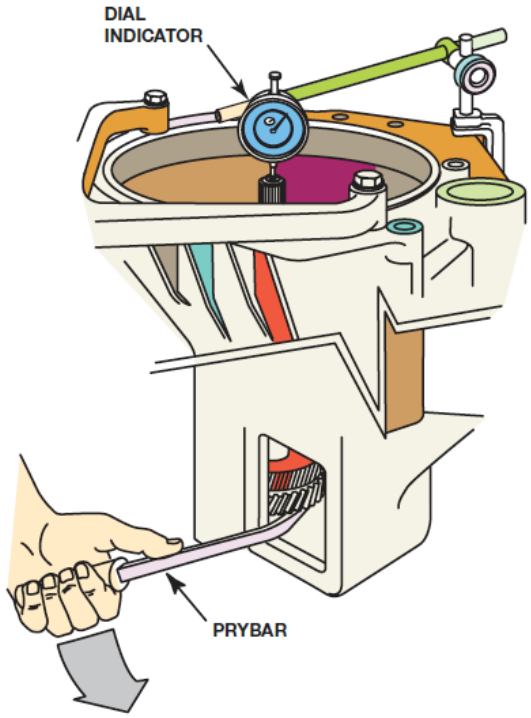


Figure 22. Measuring input shaft free play.

Differential bearing preload is determined by measuring for zero end play; then adding the thickness shim under the bearing cup. Figure 23.

Figure 23. Differential bearing preload shim.

17. Inspect, test, and repair lubrication system, pumps, coolers, and plumbing.

The transaxle gears run in a bath of lubricant, and as they spin, their motion will throw the lubricant throughout the case. The lubricant can be any of the following depending on vehicle manufacturer, model, and year:

- Gear oil such as SAE 80W-90
- Engine oil such as SAE 5W-30

- ATF such as Dexron III/VI
- Manual transmission fluid

18. Check transaxle fluid level; refill with proper fluid.

Transaxles use either a dipstick or level plug to check the oil level. Figure 24.

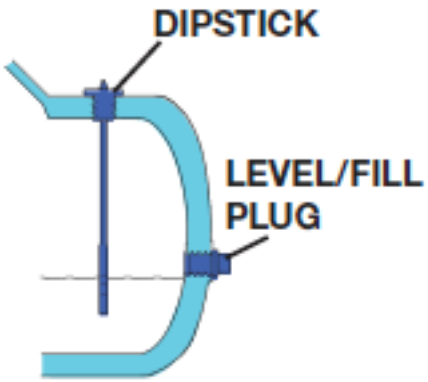


Figure 24. The transaxle may have a dipstick or a level plug. Refer to service information.

Transaxle fluid change.

- Check service information for the exact location of the fill and drain plugs. After lifting the vehicle, locate and loosen the fill plug to make sure that it can be removed before draining the fluid from the transaxle.
- Locate the drain plug at the bottom of the transaxle, place a drain pan under it, and remove the drain plug.
- Check the owner's manual or service information to determine the correct lubricant type and refill quantity.

NOTE: Many transaxles do not use SAE 80W-90 gear oil. If the wrong lubricant is used, it can soak into the composite blocker ring linings. Even if drained immediately and refilled with the correct fluid, noise or erratic shifts can result.

- Refill the transmission to the correct level.

19. Inspect, test, adjust, repair or replace electrical/electronic components and circuits including control modules, solenoids, sensors, relays, terminals, connectors, switches, and harnesses; inspect, test, and verify control module inputs, outputs, and data communications.

A digital voltmeter (DVM) measures the pressure or potential of electricity in units of volts. A voltmeter is connected to a circuit in parallel. Voltage can be measured by selecting either AC or DC volts. The DC volts (DCV) setting is the most common for automotive testing. Use this setting to measure battery voltage and voltage to all lighting and accessory circuits. Figure 25.

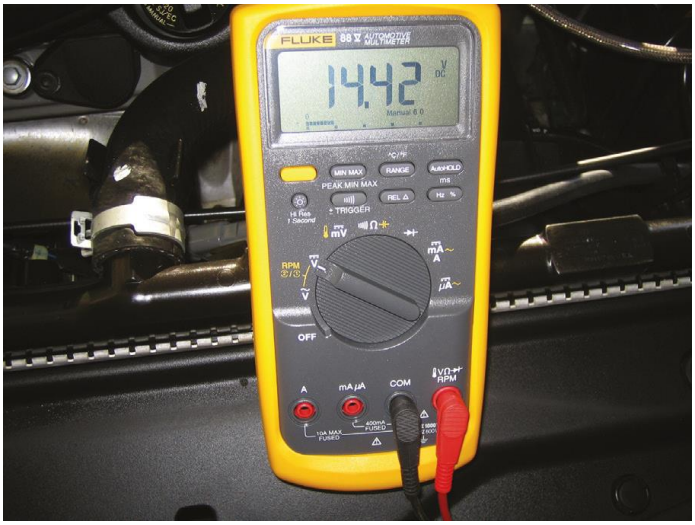


Figure 25. A digital voltmeter measuring battery voltage.

A terminal is a metal fastener attached to the end of a wire, which makes the electrical connection. The term connector usually refers to the plastic portion that snaps or connects together, thereby making the mechanical connection. Wire terminal ends usually snap into and are held by a connector. A small removal tool, sometimes called a pick, is used to release terminals from the connector. Figure 26.

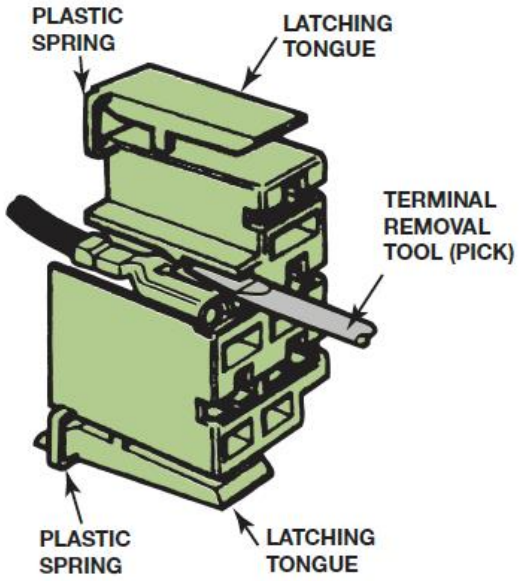


Figure 26. Removing a terminal from a connector.

Since the 1990s, vehicles have used modules to control the operation of most electrical components. A typical vehicle will have 10 or more modules, and they communicate with each other over data lines or hard wiring, depending on the application. Faults in these systems can cause transmission concerns. Figure 27.

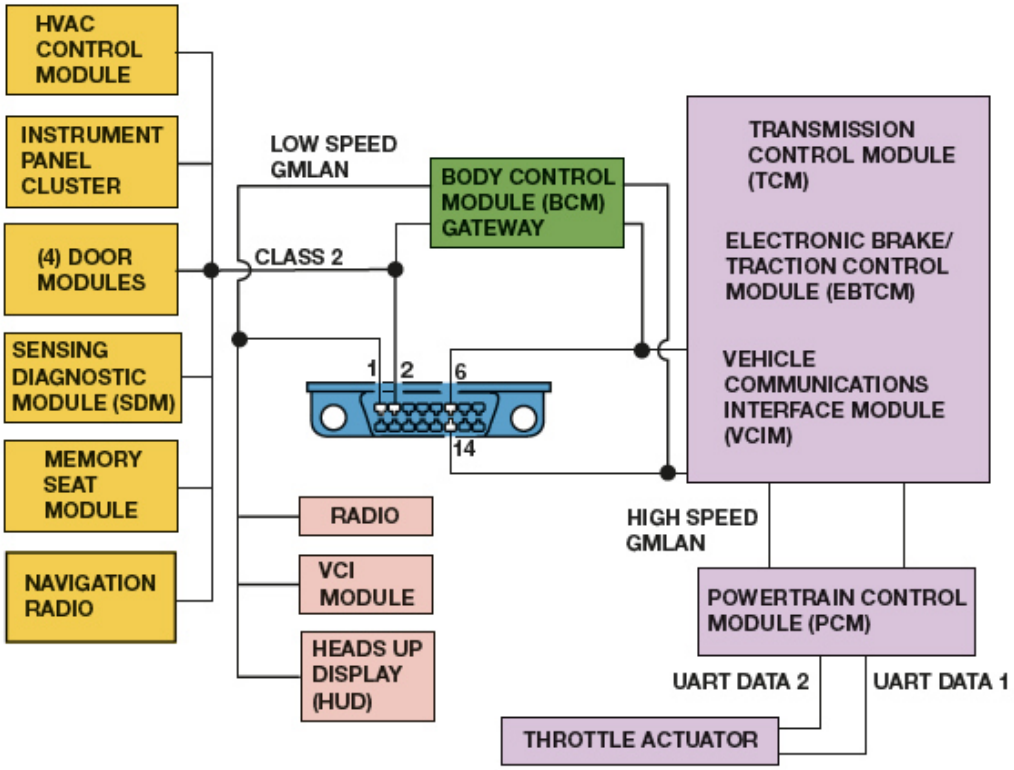


Figure 27. A typical network system shows the transmission control module (TCM)communicates with the PCM over the high speed GMLAN bus.