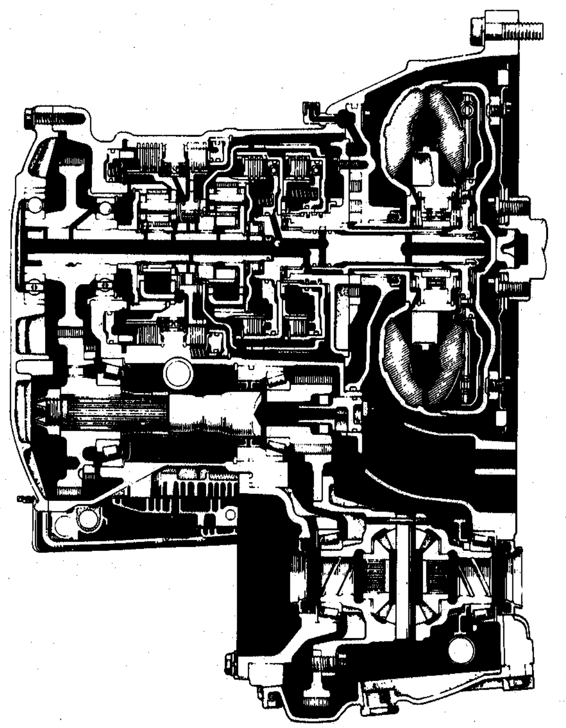
Section 1

FUNDAMENTALS OF AUTOMATIC TRANSMISSIONS



Lesson Objectives

1. Compare the function of automatic transmission systems of front- and rear-wheel drive transmissions.
2. List the three major component systems used in Toyota automatic transmissions which:
   a. Transfer torque from the engine.
   b. Provide varying gear ratios.
   c. Regulate shift quality and timing.
3. Identify the three types of holding devices used in Toyota automatic transmissions.

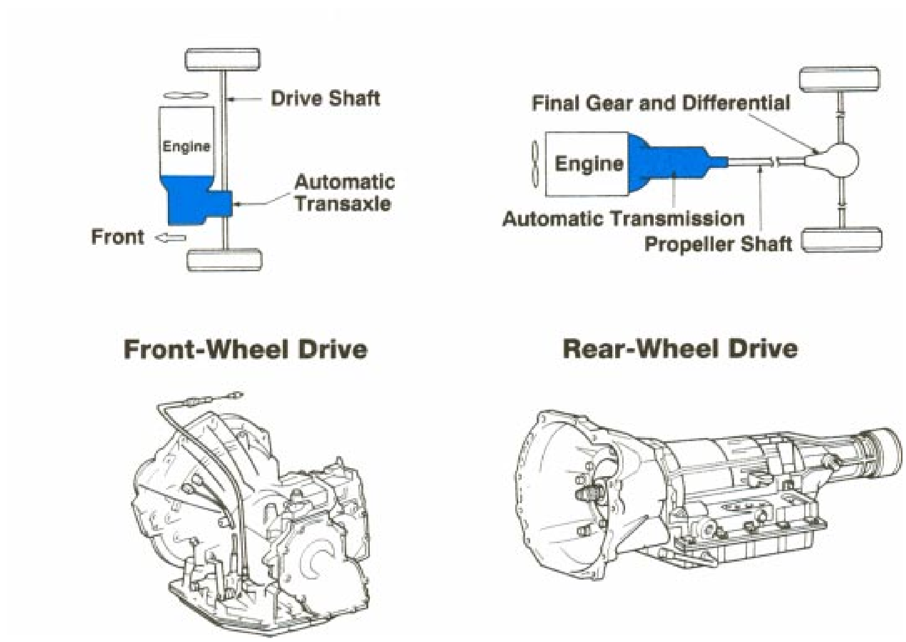
Types of Automatic Transmissions

Automatic transmissions can be basically divided into two types: those used in front-engine, front-wheel drive (FF) vehicles and those used in front-engine, rear-wheel drive (FR) vehicles.

Transmissions used in front-wheel drive vehicles are designed to be more compact than transmissions used in rear-wheel drive vehicles because they are mounted in the engine compartment. They are commonly referred to as a ”transaxle.”

Automatic Transmission Types

The basic function and purpose for either front or rear drive automatic transmissions are the same.



The differential is an integral part of the front-wheel drive transmission, whereas the differential for the rear-wheel drive transmission is mounted externally. The external differential is connected to the transmission by a driveshaft.

The basic function and purpose for either front or rear drive automatics are the same. They share the same planetary gear train design which is used in all Toyota automatic transmissions and the majority of automatics in production today.

The automatic transmission is composed of three major components:

- Torque converter
- Planetary gear unit
- Hydraulic control unit

For a full understanding of the operation of the automatic transmission, it is important to understand the basic role of these components.

The torque converter provides a means of power transfer from the engine to the input shaft of the transmission. It acts like an automatic clutch to engage engine torque to the transmission and also allows the engine to idle while the vehicle is standing still with the transmission in gear.

The planetary gear unit provides multiple gear ratios in the forward direction and one in reverse. The design includes two simple planetary gear sets and a common sun gear. These ratios are provided by use of holding devices which hold members of the planetary set. These holding devices can be multiplate clutches or brakes, brake bands or one-way clutches.

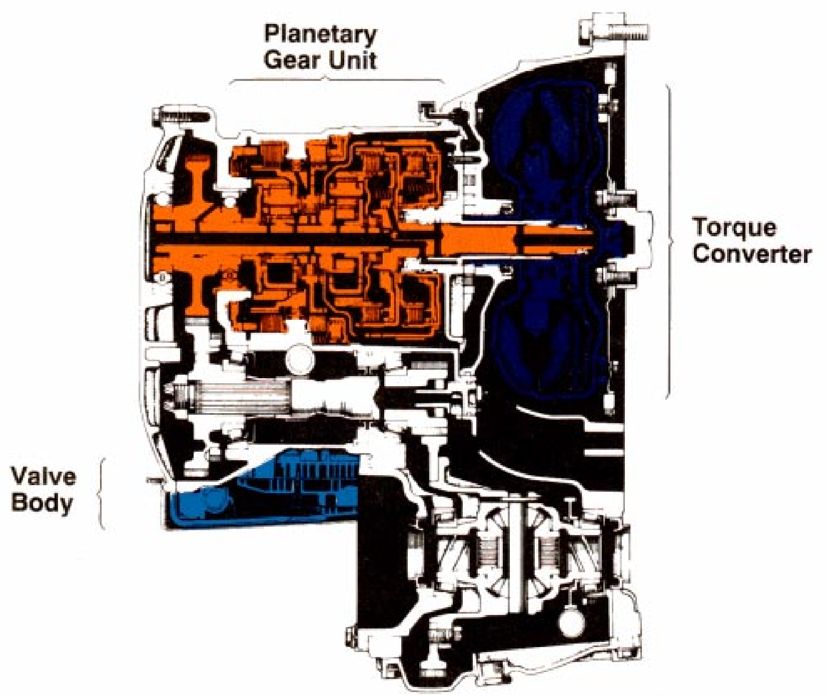
The hydraulic control unit regulates hydraulic pressure and shift points based on vehicle speed and throttle position. It is made up of a highly precision housing and spool valves which are balanced between spring tension and hydraulic pressure. The spool valves in turn control hydraulic passages to holding devices and regulate pressure.

Major Transmission Components

Torque Converter
- Transfers engine torque..

Planetary Gear
- Multiple gear ratios.

Valve Body
- Hydraulic control unit



WORKSHEET 1
Disassembly

Transmission

Transmission Symptoms:

1. Measure input shaft end play: ______________________
2. Remove transmission pan and valve body.
3. Measure piston stroke of second coast brake: ______________________
4. Air test the following: Air test pressure: ________psi

	OK	NG
OD Brake (B0)	☐	☐
2nd Coast Brake (B1)	☐	☐
2nd Brake (B2)	☐	☐
1st and Reverse Brake (B3)	☐	☐
Underdrive Brake (B4)*	☐	☐
OD Direct Clutch (C0)	☐	☐
Forward Clutch (C1)	☐	☐
Direct and Reverse Clutch (C2)	☐	☐
Underdrive Direct Clutch (C3)*	☐	☐

STOP! Do not proceed. Obtain instructor sign-off. ______________________

5. Check "one-way" clutches as they are removed:
   Indicate locking direction.

		OK	NG
FO	______________	☐	☐
F1	______________	☐	☐
F2	______________	☐	☐
F3*	______________	☐	☐

6. Measure pinion gear thrust clearance on front and rear planetaries.

   Front Measurement: ______________ Rear Measurement: ______________

   Specification: ______________ Specification: ______________

7. Measure total preload of counter shaft and differential. ______________ **Ft.-Lbs.**

   Do not remove counter shaft or differential until prompted by your instructor.

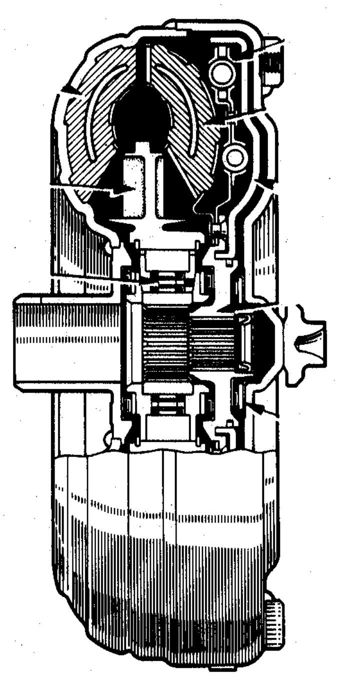
Instructor sign-off: ______________________

*A240 Series only

Notes

Section 2

TORQUE CONVERTER



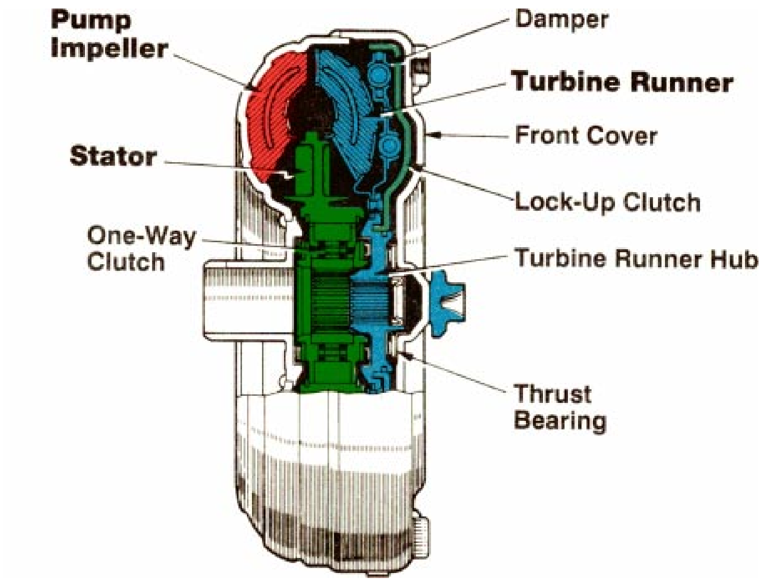
Lesson Objectives

1. Describe the function of the torque converter.
2. Identify the three major components of the torque converter that contribute to the multiplication of torque.
3 Describe the operation of each major torque converter component.
4. Describe the operation of the lock-up mechanism of the torque converter.
5. Distinguish between vortex flow and rotary flow in a torque converter.
6. Identify two symptoms of a failed stator one-way clutch.
7. Determine when replacement or service of the converter is appropriate.

The torque converter is mounted on the input side of the transmission gear train and connected to a drive plate. The drive plate, or flex plate as it is sometimes referred to, is used to connect the converter to the crankshaft flywheel flange of the engine. The ring gear, which the starter motor engages to turn the engine, is attached to the drive plate.

Torque Converter

Transmits engine torqueto the transmissioninput shaft.



Role of the torque converter:

- Multiplies torque generated by the engine.
- Serves as an automatic clutch which transmits engine torque to the transmission.
- Absorbs torsional vibration of the engine and drivetrain.
- Smoothes out engine rotation.
- Drives the oil pump of the hydraulic control system.

The torque converter is filled with automatic transmission fluid, and transmits the engine torque to the transmission. The torque converter can either multiply the torque generated by the engine or function as a fluid coupling.

The torque converter also serves as the engine flywheel to smooth out engine rotation as its inertia helps to maintain crankshaft rotation between piston power pulses. It tends to absorb torsion vibration from the engine and drivetrain through the fluid medium since there is no direct mechanical connection through the converter.

In addition, the rear hub of the torque converter body drives the transmission oil pump, providing a volume of fluid to the hydraulic system. The pump turns any time the engine rotates, which is an important consideration when a vehicle is towed. If the vehicle is towed with the drive wheels on the ground and the engine is not running, the axles drive the transmission output shaft and intermediate shaft on bearings that receive no lubrication. There is a great potential for damage if the vehicle is towed for a long distance or at greater than low speeds.

Torque Converter Components

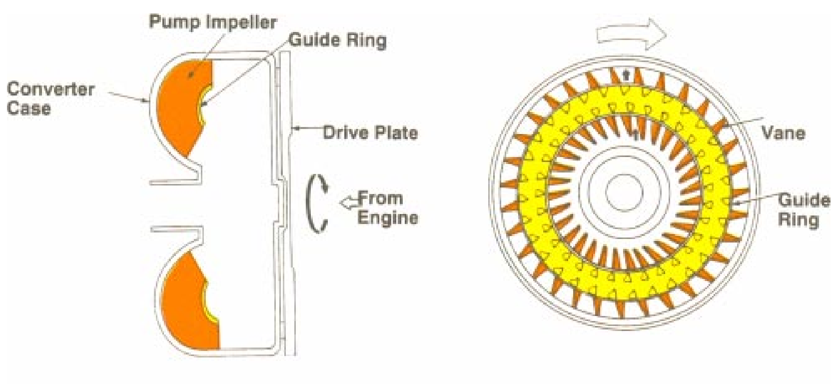
The torque converter's three major components are; the pump impeller, turbine runner and the stator. The pump impeller is frequently referred to as simply the impeller and the turbine runner is referred to as the turbine.

Pump Impeller

The impeller is integrated with the torque converter case, and many curved vanes that are radially mounted inside. A guide ring is installed on the inner edges of the vanes to provide a path for smooth fluid flow.

Torque Converter - Impeller

The vanes of the stator catch the fluid as it leaves the turbine and redirects it back to the impeller.



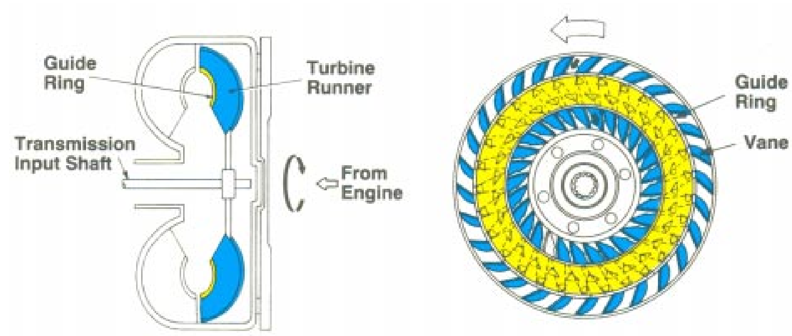
When the impeller is driven by the engine crankshaft, the fluid in the impeller rotates with it. When the impeller speed increases, centrifugal force causes the fluid to flow outward toward the turbine.

Turbine Runner

The turbine is located inside the converter case but is not connected to it. The input shaft of the transmission is attached by splines to the turbine hub when the converter is mounted to the transmission. Many cupped vanes are attached to the turbine. The curvature of the vanes is opposite from that of the impeller vanes. Therefore when the fluid is thrust from the impeller, it is caught in the cupped vanes of the turbine and torque is transferred to the transmission input shaft, turning it in the same direction as the engine crankshaft.

Torque Converter - Turbine

Fluid is caught in the cupped vanes of the turbine and torque is transferred to the input shaft.



Fluid Coupling

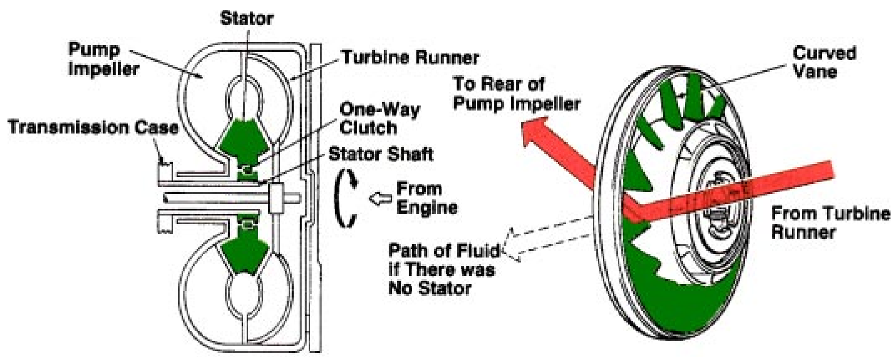
Before moving on to the next component of the torque converter we need to examine the fluid coupling whose components we have just described. When automatic transmissions first came on the scene in the late 1930s, the only components were the impeller and the turbine. This provided a means of transferring torque from the engine to the transmission and also allowed the vehicle to be stopped in gear while the engine runs at idle. However, those early fluid couplings had one thing in common; acceleration was poor. The engine would labor until the vehicle picked up speed. The problem occurred because the vanes on the impeller and turbine are curved in the opposite direction to one another. Fluid coming off of the turbine is thrust against the impeller in a direction opposite to engine rotation.

Notice the illustration of the torque converter stator on the following page; the arrow drawn with the dashed lines represents the path of fluid if the stator were not there, such as in a fluid coupling. Not only is engine horsepower consumed to pump the fluid initially, but now it also has to overcome the force of the fluid coming from the turbine. The stator was introduced to the design to overcome the counterproductive force of fluid coming from the turbine opposing engine rotation. It not only overcomes the problem but also has the added benefit of increasing torque to the impeller.

Stator The stator is located between the impeller and the turbine. It is mounted on the stator reaction shaft which is fixed to the transmission case. The vanes of the stator catch the fluid as it leaves the turbine runner and redirects it so that it strikes the back of the vanes of the impeller, giving the impeller an added boost or torque. The benefit of this added torque can be as great as 30% to 50%.

Torque Converter - Stator

The vanes of the stator catch the fluid as it leaves the turbine and redirects it back to the impeller



The one-way clutch allows the stator to rotate in the same direction as the engine crankshaft. However, if the stator attempts to rotate in the opposite direction, the one-way clutch locks the stator to prevent it from rotating. Therefore the stator is rotated or locked depending on the direction from which the fluid strikes against the vanes.

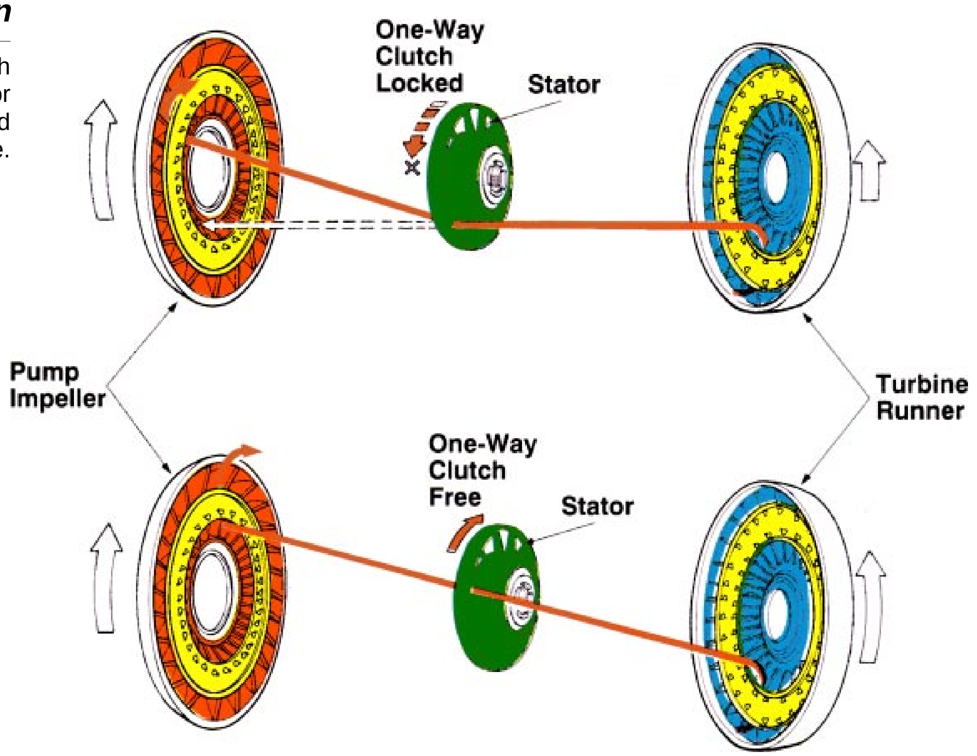
Converter Operation

Now that we've looked at the parts which make up the torque converter, let's look at the phenomenon of fluid flow within the torque converter. When the impeller is driven by the engine crankshaft, the fluid in the impeller rotates in the same direction. When the impeller speed increases, centrifugal force causes the fluid to flow outward from the center of the impeller and flows along the vane surfaces of the impeller. As the impeller speed rises further, the fluid is forced out away from the impeller toward the turbine. The fluid strikes the vanes of the turbine causing the turbine to begin rotating in the same direction as the impeller.

After the fluid dissipates its energy against the vanes of the turbine, it flows inward along the vanes of the turbine. When it reaches the interior of the turbine, the turbine's curved inner surface directs the fluid at the vanes of the stator, and the cycle begins again.

Stator Operation

The stator one-way clutch locks the stator counterclockwise and freewheels clockwise.



Converter Fluid Flow

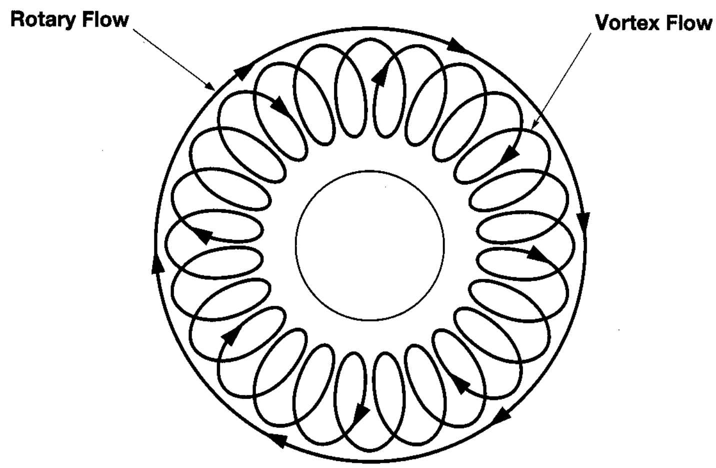
We've already mentioned that the impeller causes the fluid to flow to the turbine and transfers torque through the fluid medium and then passes the stator and back to the impeller. But there are times when this flow is quicker and more powerful than at other times, and there are times when this flow is almost nonexistent.

Vortex and Rotary Flow

There are two types of fluid flow within the converter: one is vortex flow, and the other is rotary flow. In the illustration of the converter fluid flow below, vortex flow is a spiraling flow which continues as long as there is a difference in speed between the impeller and the turbine. Rotary flow is fluid flow which circulates with the converter body rotation.

Converter Fluid Flow

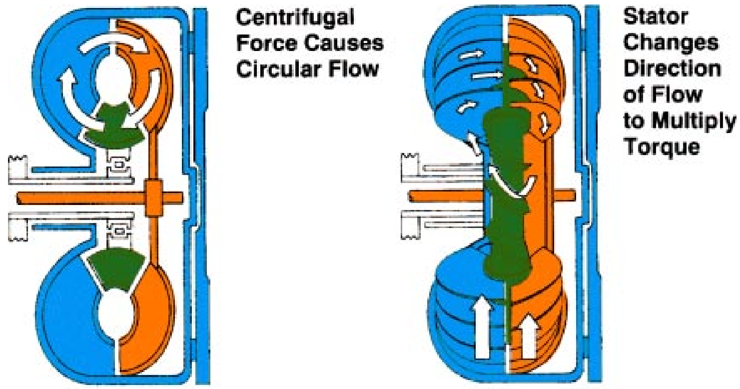
Vortex flow is strongest when the difference in impeller and turbine speed is the greatest



The flow is stronger when the difference in speed between the impeller and the turbine is great, as when the vehicle is accelerating for example. This is called high vortex. During this time the flow of fluid leaving the turbine strikes the front of the vanes of the stator and locks it on the stator reaction shaft, preventing it from rotating in the counterclockwise direction. The fluid passing through the stator is redirected by the shape of the vanes and strikes the back of the vanes of the impeller resulting in an increase in torque over that which is provided by the engine. Without the stator, the returning fluid would interfere with normal impeller rotation, reducing it severely.

Fluid Flow While Vehicle is Accelerating

Impeller turning much faster than turbine.

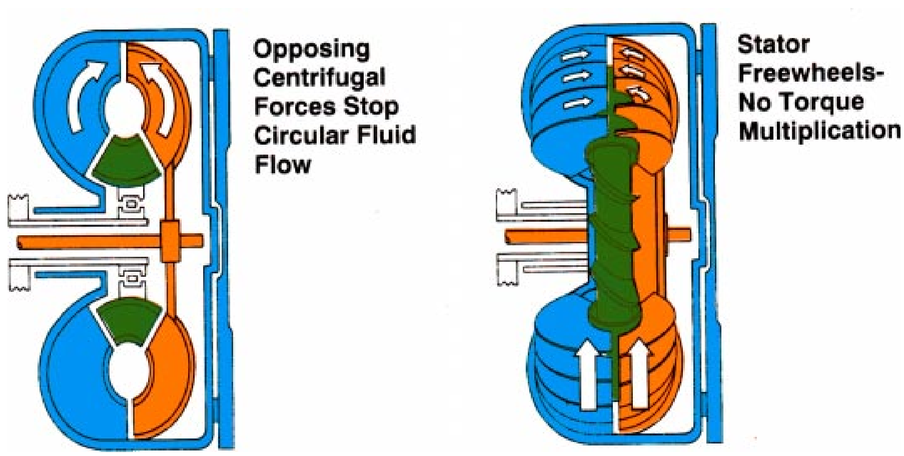


During times of low vortex flow the fluid coming from the turbine strikes the convex back of the vane rather than the concave face of the vane. This causes the one-way clutch to release and the stator freewheels on the reaction shaft. At this point there is little need for torque multiplication.

As the rotating speed of the impeller and the turbine become closer, the vortex flow decreases and the fluid begins to circulate with the impeller and turbine. This flow is referred to as rotary flow. Rotary flow is the flow of fluid inside the torque converter in the same direction as torque converter rotation. This flow is great when the difference in speed between the impeller and turbine is small, as when the vehicle is being driven at a constant speed. This is called the coupling point of the torque converter. At the coupling point, like the low vortex, the stator must freewheel in the clockwise direction. Should the stator fail to freewheel, it would impede the flow of fluid and tend to slow the vehicle.

Fluid Flow While Vehicle is Cruising

Impeller and Turbine at almost same speed



Converter Diagnosis

Now that we understand the operation of the stator, let's examine what would happen if the stator was to malfunction. First, if the stator was to lock-up in both directions, at periods of high vortex the stator would function just perfectly. The fluid would be redirected, hit the back side of the impeller vanes and multiply torque and performance at low end would be just fine. But, as the impeller and turbine reach the coupling point, the fluid would hit the back of the stator vanes and disrupt the flow of fluid. This would hinder the flow of fluid and cause fluid to bounce off the vanes in a direction that would oppose the flow from the impeller to the turbine. This would cause the converter to work against itself and cause performance at top end to be poor. Continued operation at this coupling point would cause the fluid to overheat and can also affect the operating temperature of the engine.

A typical scenario might be that the customer operates the vehicle around town on surface streets and there is no indication of a problem. However when the vehicle is driven on the expressway for any appreciable distance, the engine overheats and does not have the top end performance it once had.

Second, if the stator was to free-wheel in both directions, the fluid from the turbine hitting the vanes of the stator would cause it to turn backwards and would not redirect the fluid and strike the impeller vanes in the opposite direction of engine rotation, in effect, reducing the torque converter to a fluid coupling with no benefit of torque multiplication. Performance on the lower end would be poor, acceleration would be sluggish. However, top end performance when the stator freewheels would be normal.

Service

The torque converter is a sealed unit and, as such, it is not serviceable. However, if contamination is found in the transmission then it will also be found in the torque converter. If the contamination in the converter is not dealt with, it will contaminate the overhauled transmission and cause a come-back. So for non-lock-up converters, flush the converter off the vehicle with specialized equipment. Flushing the converter with specialized equipment is not recommended for lock-up converters as it may deteriorate the clutch material. If contamination exists and it is a lock-up converter, replacement is required.

Torque Converter Testing

There are two ways to test a torque converter. The first method of testing is while it is in the vehicle; this is called a torque converter stall test. The second test method is while the converter is on the bench, and special tools are used to determine the condition of the stator one-way clutch.

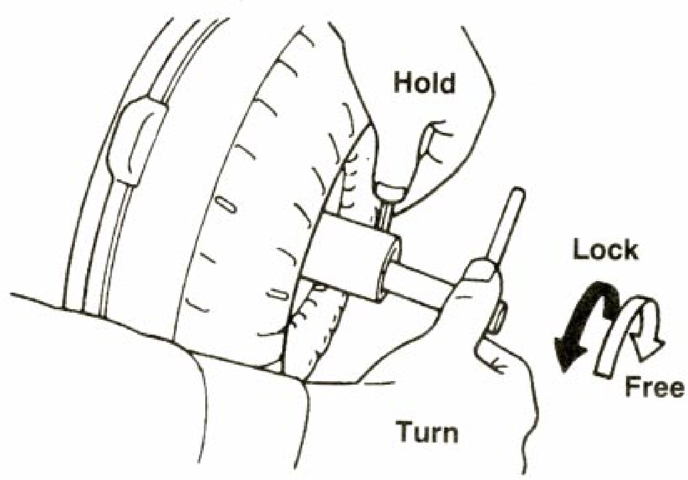
Bench Testing

In order to bench test the converter, the stator one-way clutch must lock in one direction and freewheel in the other. Two special service tools are used to perform the test: the stator stopper and the one-way clutch test tool handle. Refer to the vehicle repair manual under the heading of "Torque Converter and Drive Plate" for the appropriate tool set because there are several different tool sets. The tool set number is listed before the tool number in the text of the repair manual.

Since the one-way clutch is subject to greater load while in the vehicle (while on the bench is only subject to the load you can place by hand), final determination is made when it is in the vehicle. You need to be familiar with the symptoms of the test drive, customer complaint and the condition of the holding devices in the transmission upon disassembly. All this information is important to determine the condition of the converter.

Bench Testing the Torque Converter

Place the converter on its side and use the stator stopper which locks the stator to the converter case while the test tool handle is turned clockwise and then counterclockwise.



Stall Testing

The term stall is the condition where the impeller moves but the turbine does not. The greatest amount of stall happens when the pump impeller is driven at the maximum speed possible without moving the turbine. The engine speed at which this occurs is called the torque converter stall speed.

Before stall testing a torque converter, consider the customer complaint and your test drive symptoms. The symptoms discussed previously regarding poor top end performance or poor acceleration may already point to the torque converter as the problem. A road test of the vehicle's acceleration and forced downshift will indicate a slipping stator if acceleration is poor. Poor top end performance will indicate a stator which does not freewheel.

When a stall test is performed and engine rpm falls within the specifications, it verifies several items:

- The one-way clutch in the torque converter stator is holding.
- Holding devices (clutches, brakes, and one-way clutches) used in first and reverse gears are holding properly.
- If the holding devices hold properly, the transmission oil pressure must be adequate.
- Engine is in a proper state of tune.

In preparing the vehicle for a stall test, the engine and transmission should both be at operating temperature and the ATF level should be at the proper level. Attach a tachometer to the engine. Place chocks at the front and rear wheels, set the hand brake and apply the foot brakes with your left foot. With the foot brakes fully applied, start the engine, place transmission in drive, and accelerate to wide open throttle and read the maximum engine rpm.

CAUTION

Do not stall test for a time period greater than five seconds as extreme heat is generated as the fluid is sheared in the torque converter. Allow at least one minute at idle speed for the fluid in the converter to cool.

Converter Installation

The torque converter installation to the drive plate is frequently overlooked and taken for. granted. The concerns regarding installation are: vibration, oil sealing, and oil pump gear breakage. To ensure proper installation, measure the runout of drive plate and then the runout of the torque converter hub sleeve. Should runout exceed 0.0118" (0.30 mm) remove the converter and rotate its position until runout falls within specification. Mark the converter and drive plate position for installation when the transmission is installed. Should you be unable to obtain runout within the specification, replace the converter.

CAUTION When replacing a converter or installing a remanufactured or dealer overhauled transmission, use only converter bolts to attach to flex plate. Similar bolts are too long and will dimple the converter clutch surface. See Transmission & Clutch TSB Numbers 016 and 036 of Volume 10.

The converter should be attached to the transmission first. Measure from the mounting lugs to the mating surface of the bell-housing. This ensures that the input shaft, stator reaction shaft, and the pump drive hub have all been properly seated. It also prevents any undue pressure on the front seal and hub sleeve while the transmission is maneuvered in place.

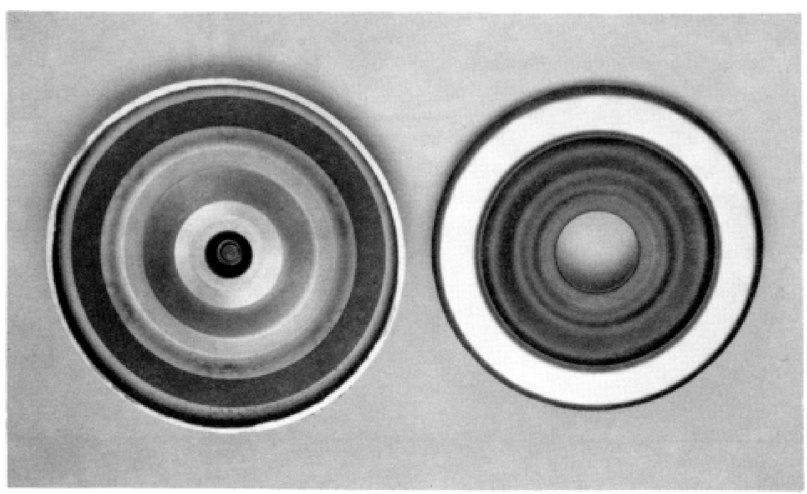
Lock-Up Clutch Mechanism

When the impeller and the turbine are rotating at nearly the same speed, no torque multiplication is taking place, the torque converter transmits the input torque from the engine to the transmission at a ratio of almost 1:1. There is however approximately 4% to 5% difference in rotational speed between the turbine and impeller. The torque converter is not transmitting 100% of the power generated by the engine to the transmission, so there is energy loss.

To prevent this, and to reduce fuel consumption, the lock-up clutch mechanically connects the impeller and the turbine when the vehicle speed is about 37 mph or higher. When the lock-up clutch is engaged, 100% of the power is transferred through the torque converter.

Converter Piston

To reduce fuel consumption, the converter piston engages the cnverter case to lock the impeller and the turbine



Construction

The lock-up clutch is installed on the turbine hub, in front of the turbine. The dampening spring absorbs the torsional force upon clutch engagement to prevent shock transfer.

The friction material bonded to the lock-up piston is the same as that used on multiplate clutch disks in the transmission. When installing a new lockup converter be sure to fill it part way through the rear hub with approved automatic transmission fluid as it requires at least a 15-minute soak period prior to installation, similar to multiplate clutch discs.

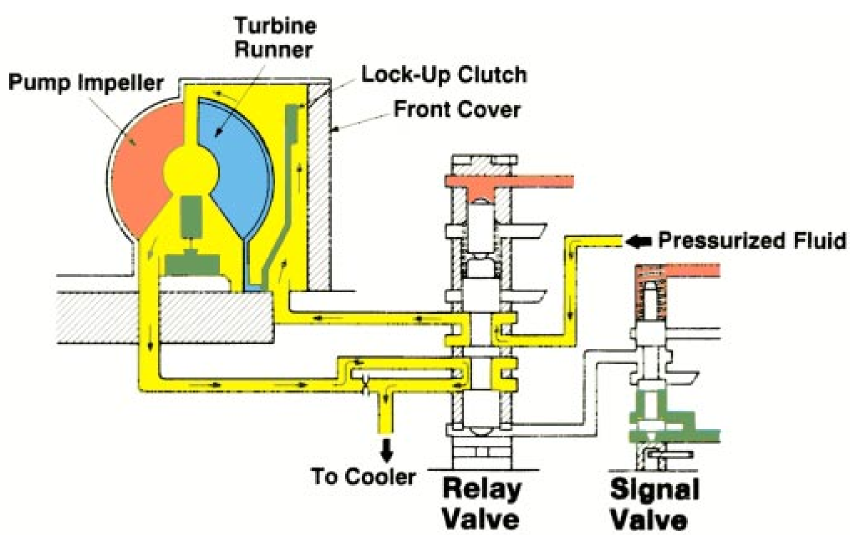
Lock-up Operation

When the lock-up clutch is actuated, it rotates together with the impeller and turbine. Engaging and disengaging of the lock-up clutch is determined by the point at which the fluid enters the torque converter. Fluid can either enter the converter in front of the lock-up clutch or in the main body of the converter behind the lock-up clutch. The difference in pressure on either side of the lock-up clutch determines engagement or disengagement.

The fluid used to control the torque converter lock-up is also used to remove heat from the converter and transfer it to the engine cooling system through the heat exchanger in the radiator.

Lock-Up Clutch Disengaged

Converter pressure flows through the relay valve to the front of the lock-up clutch.



Valve Control Operation

Control of the hydraulic fluid to the converter is accomplished by the relay valve and signal valve. Both valves are spring loaded to a position which leaves the clutch in a disengaged position. In the illustration above, converter pressure flows through the relay valve to the front of the lock-up clutch. Notice that the main body of the converter hydraulic circuit is connected to the transmission cooler through the bottom land of the relay valve.

The signal valve controls line pressure to the base of the relay valve. When governor pressure or line pressure is applied to the base of the signal valve, line pressure passes through the signal valve and is applied to the base of the relay valve. The relay valve moves up against spring tension diverting converter pressure to the main body of the converter.

Lock-Up Clutch Disengaged

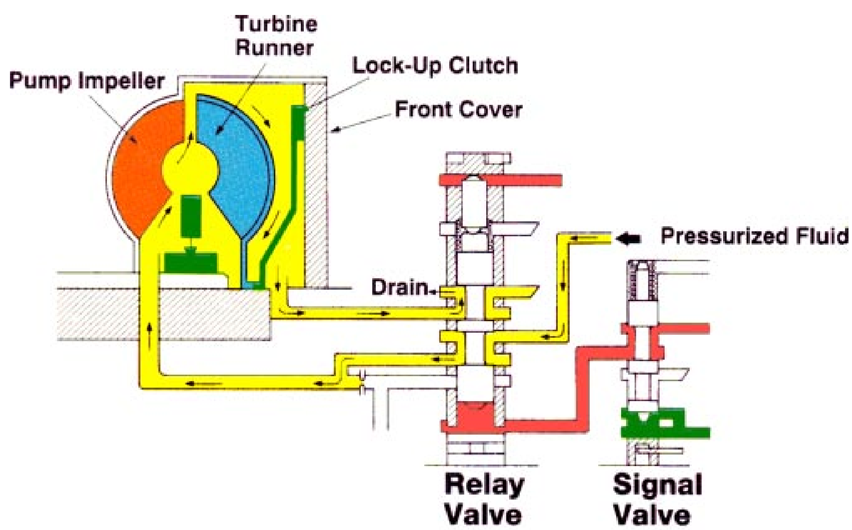
When the vehicle is running at low speeds (less than 37 mph) the pressurized fluid flows into the front of the lock-up clutch. The pressure on the front and rear sides of the lock-up clutch remains equal, so the lock-up clutch is disengaged.

Lock-Up Clutch Engaged

When the vehicle is running at medium to high speeds (greater than 37 mph) the pressurized fluid flows into the area to the rear of the lock-up clutch. The relay valve position opens a drain to the area in front of the lock-up clutch, creating an area of low pressure. Therefore, the lock-up piston is forced against the converter case by the difference in hydraulic pressure on each side of the lock-up clutch. As a result, the lock-up clutch and the converter case rotate together.

Lock-Up Clutch Engaged

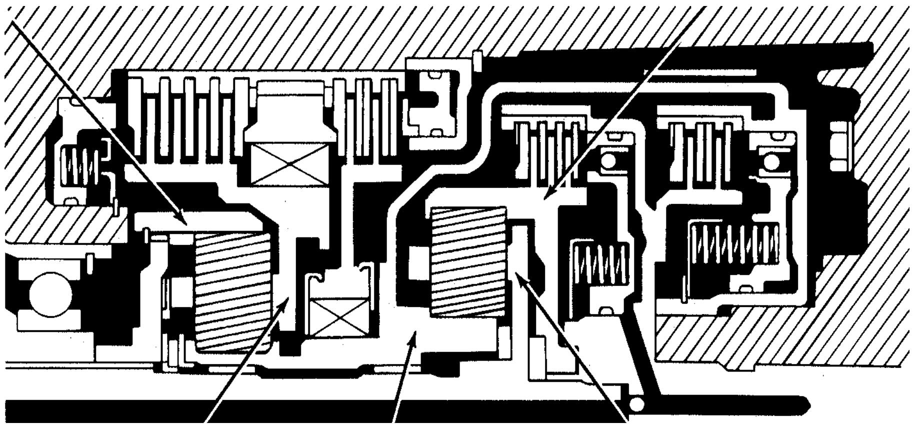
Converter pressure flows into the area to the rear of the lock-up cluch while a drain is open to the front of the clutch.



Notes

Section 3

SIMPSON PLANETARY GEAR UNIT



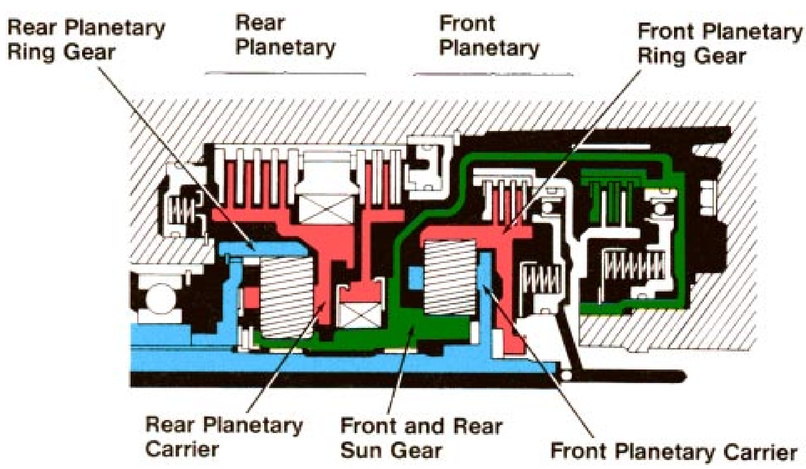
Lesson Objectives

1. Manipulate transmission components to demonstrate power flow through a simple planetary gear set for:
   - Gear reduction
   - Gear increase (overdrive)
   - Reverse
2. Identify the three major components of the simple planetary gear set.
3. Describe the function of the simple planetary gear set to provide:
   - Rotational speed change
   - Rotational torque change
   - Change in rotational direction
4. Demonstrate the measurement for wear on planetary carrier assembly and determine serviceability.
5. Describe the operation of the following holding devices:
   - Multiplate clutch
   - Brake band
   - One-way clutch

Toyota automatic transmissions use the Simpson-type planetary gear unit. This unit is made up of two simple planetary gear sets arranged on the same axis with a common sun gear. These gear sets are called the front planetary gear set and the rear planetary gear set, based on their position in the transmission. These two planetary gear sets result in a three-speed automatic transmission having three forward gears and one reverse gear.

Simpson Planetary Gear Set

Made up of two simple planetary gear sets arranged on the same axis with a common sun gear.



These planetary gear sets, the brakes and clutches that control their rotation, and the bearings and shafts for torque transmission are called the planetary gear unit.

The planetary gear unit is used to increase or decrease engine torque, increase or decrease vehicle speed, reverse direction of rotation or provide direct drive. It is basically a lever that allows the engine to move heavy loads with less effort.

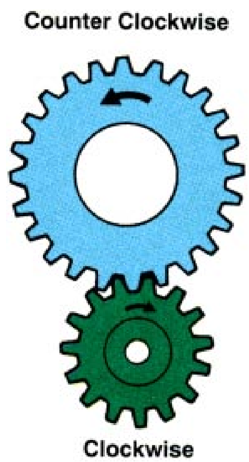
There is an inverse relationship which exists between torque and speed. For example: when a vehicle is stopped it requires a great deal of torque to get it to move. A low gear is selected which provides high torque at low vehicle speed. As the heavy load begins to move, less leverage is required to keep it in motion. As the load remains in motion and speed increases, torque requirements are low. With a suitable number of levers or torque ratios, improved performance and economy are possible.

Gear Rotational Direction and Gear Ratio

Before getting into simple planetary gears, it is necessary to understand gear rotation and gear ratios or leverage. When two external gears are in mesh as illustrated below, they will rotate in opposite directions. That is, when the small gear is rotated in a clockwise direction, it will cause the larger gear to rotate in a counter-clockwise direction. This is important to obtain a change in output direction, such as in reverse.

Gear Rotational Direction

When two external gears are in mesh, they will rotate in opposite directions.



The gear ratio that these two gears provide will be a lever advantage. The rotating speed of an output gear is determined by the number of teeth of each gear. The gear ratio, and thus the rotational speed of the output gear, can be found by dividing the number of output gear teeth by the number of input gear teeth. These gear ratios are determined by the engineers and fixed in the manufacture of the transmission.

$$\text{Gear ratio} = \frac{\text{Number of output gear teeth}}{\text{Number of input gear teeth}}$$

$$\text{Gear ratio} = \frac{24}{15} = 1.6{:}1$$

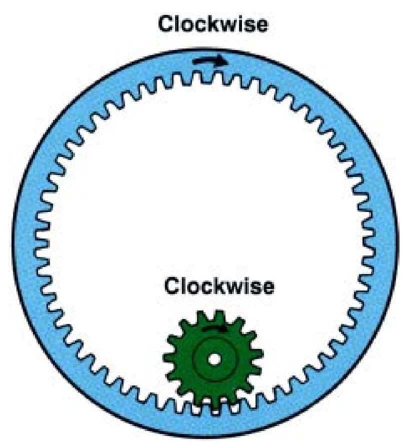
In the illustration above, if the input gear has 15 teeth and the output gear has 24 teeth, the gear ratio is 1.6 to 1 (1.6:1). In other words, the input gear has to turn slightly more than one and one-half turns to have the output gear turn once. The output gear would turn slower than the input gear which would be a speed decrease. The advantage in this example is an increase in torque capability.

To contrast this illustration, let's assume that a set of gears have the same diameter with the same number of teeth. If we determine the gear ratio using the formula above, the ratio is 1 to 1 (1:1). In this example there is no leverage or speed increase. One rotation of the input gear results in one rotation of the output gear and there is no lever advantage.

When an external gear is in mesh with an internal gear as illustrated below, they will rotate in the same direction. This is necessary to get a change in output gear ratio. The gear ratio here can be determined in the same manner as was just discussed. Since the ratio is only accomplished when all members of the planetary gear set function together, we'll examine gear ratios of the planetary gear set under the Simple Planetary Gear Set.

Gear Rotational Direction

When an external gear is in mesh with an internal gear, they will rotate in the same direction.



Simple Planetary Gear Set

Our introduction to Toyota automatic transmissions will begin with a simple planetary gear set. A planetary gear set is a series of three interconnecting gears consisting of a sun gear, several pinion gears, and a ring gear. Each pinion gear is mounted to a carrier assembly by a pinion shaft. The sun gear is located in the center of the assembly; several pinion gears rotate around the sun gear; and a ring gear surrounds the pinion gears. This gear assembly is called the “planetary” gears because the pinion gears resemble planets revolving around the sun.

In a planetary gear design, we are able to get different gear ratios forward and reverse, even though the gear shafts are located on the same axis.

Simple Planetary Gear Operation

HELD	POWER INPUT	POWER OUTPUT	ROTATIONAL		ROTATIONAL DIRECTION
			SPEED	TORQUE	
Ring gear	Sun gear	Carrier			
	Carrier	Sun gear			
Sun gear	Ring gear	Carrier			
	Carrier	Ring gear			
Carrier	Sun gear	Ring gear			
	Ring gear	Sun gear			

Planetary Gear Ratios

Gear ratios can also be determined in a planetary gear set although it is not something that can easily be changed. The gear ratio of the planetary gear set is determined by the number of teeth of the carrier, ring gear, and sun gear. Since the carrier assembly has no teeth and the pinion gears always operate as idle gears, their number of teeth is not related to the gear ratio of the planetary gear set. However, an arbitrary number needs to be assigned to the carrier in order to calculate the ratio. Simply count the number of teeth on the sun gear and the ring gear. Add these two numbers together and you have the carrier gear number for calculation purposes.

The number of carrier teeth (Zc) can be obtained by the following equation:

$Zc = Zr + Zs$
where
Zc = Number of carrier teeth
Zr = Number of ring gear teeth
Zs = Number of sun gear teeth

For example, assume the number of ring gear teeth (Zr) to be 56 and that of sun gear (Zs) to be 24. When the sun gear is fixed and the ring gear operates as the input member, the gear ratio of the planetary gear set is calculated as follows:

$$\text{Gear ratio} = \frac{\text{Number of output gear teeth}}{\text{Number of input gear teeth}}$$

$$= \frac{\text{Number of carrier teeth (Zc)}}{\text{Number of ring gear teeth (Zr)}}$$

$$= \frac{56 + 24}{56} = \frac{80}{56}$$

$$= 1.429$$

In other words, the input member would have to turn almost one and a half times to one turn of the output member.

Now let's assume that the carrier is the input member and the ring gear is the output member. We would use the same equation in determining the gear ratio.

$$\text{Gear Ratio} = \frac{56}{56 + 24} = \frac{56}{80}$$

$$= 0.7$$

In this case, the input member would only turn a little more than a half turn for the output member to turn once.

Operation

The operation of a simple planetary gear set is summarized in the chart below: different speeds and rotational directions can be obtained by holding one of the planetary members in a fixed position providing input torque to another member, with the third member used as an output member.

This chart represents more ratios and combinations than are used in Toyota automatics, but are represented here to show the scope of its design. The shaded areas represent the combinations used in Toyota transmissions and are, therefore, the only combinations we will discuss.

Simple Planetary Gear Operation

HELD	POWER INPUT	POWER OUTPUT	ROTATIONAL		ROTATIONAL DIRECTION
			SPEED	TORQUE	
Ring gear	Sun gear	Carrier	Reduced	Increased	Same direction as drive member
	Carrier	Sun gear	Increased	Reduced	
Sun gear	Ring gear	Carrier	Reduced	Increased	Same direction as drive member
	Carrier	Ring gear	Increased	Reduced	
Carrier	Sun gear	Ring gear	Reduced	Increased	Opposite direction as drive member
	Ring gear	Sun gear	Increased	Reduced	

Forward Direction

When the ring gear or sun gear is held in a fixed position, and either of the other members is an input member, the output gear rotational direction is always the same as the input gear rotational direction.

When the internal teeth of the ring gear turns clockwise, the external teeth of the pinion gears walk around the fixed sun gear while rotating clockwise. This causes the carrier to rotate at a reduced speed.

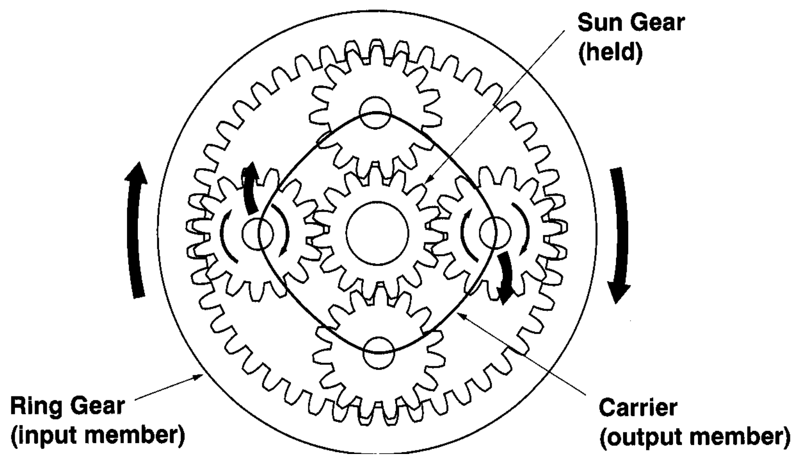
Reduction

Example: Speed reduction - torque increase

Sun gear - Held member (15 teeth)

Ring gear - Input member (45 teeth)

Carrier - Output member (45 + 15 teeth)



The gear ratio is computed as follows:

$$\text{Gear ratio} = \frac{\text{Number of output gear teeth}}{\text{Number of input gear teeth}}$$

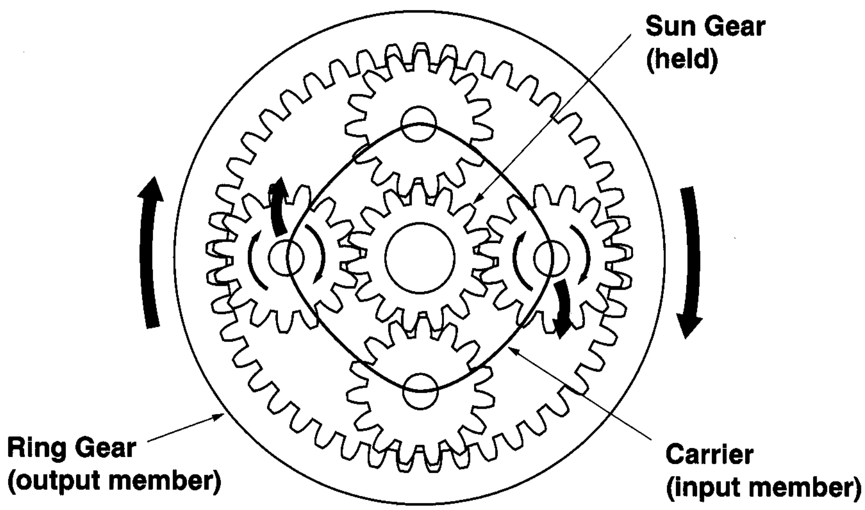
$$\text{Gear ratio} = \frac{45 + 15}{45} = 1.3:1$$

In this example, the input gear (ring gear) must turn 1.3 times to 1 rotation of the output gear (carrier). This example is used in second gear.

When the carrier turns clockwise, the external toothed pinion gears walk around the external toothed sun gear while rotating clockwise. The pinion gears cause the internal toothed ring gear to accelerate to a speed greater than the carrier speed in a clockwise direction.

Overdrive

Example:	Speed increase - torque reduction	
Sun gear	-	Held member (15 teeth)
Carrier	-	Input member (45 + 15 teeth)
Ring Gear	-	Output member (45 teeth)



The gear ratio is computed as follows:

$$\text{Gear ratio} = \frac{45}{45 + 15} = .75:1$$

In this example, the input gear (carrier) must turn three-quarters of a turn (.75) to 1 rotation of the output gear (ring gear). This example is used in overdrive.

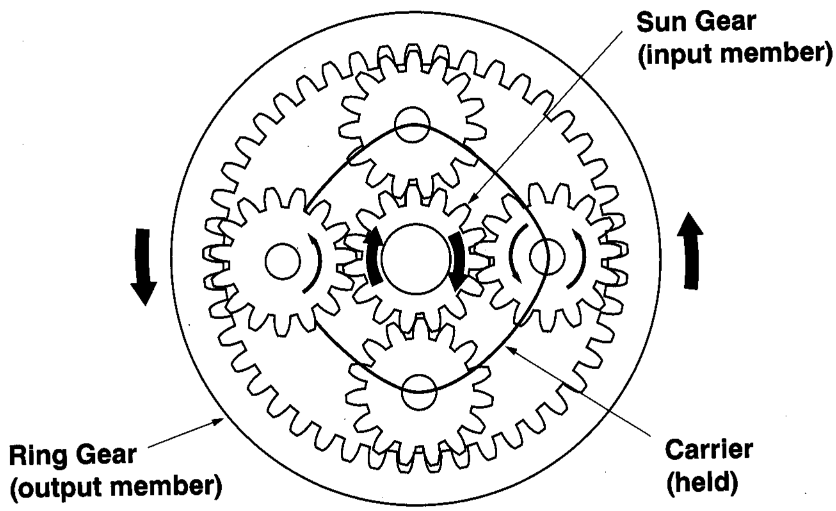
Reverse Direction

Whenever the carrier is held and either of the other gears are input members, the output gear will rotate in the opposite direction.

With the carrier held, when the external toothed sun gear turns clockwise, the external toothed pinion gears on the carrier idle in place and drive the internal toothed ring gear in the opposite direction.

Reverse

Example:		Speed reduction - torque increase
Carrier	-	Held member (45 + 75 teeth)
Sun gear	-	Input member (15 teeth)
Ring gear	-	Output member (45 teeth)



The gear ratio is computed as follows:

$$\text{Gear ratio} = \frac{45}{15} = 3:1$$

In this example, the input gear (sun) must turn three (3) times to 1 rotation of the output gear (ring gear). This example is used in first gear and reverse gear.

Direct Drive - (One-To-One Ratio)

When any two members are held together and another member provides the input turning force, the entire assembly turns at the same speed as the input member.

Now the gear ratios from a single planetary set do not give us the desired ratios which take advantage of the optimum torque curve of the engine. So it is necessary to use two single planetary gear sets which share a common sun gear. This design is basic to most all automatic transmissions in production today.

Inspection and Measurement

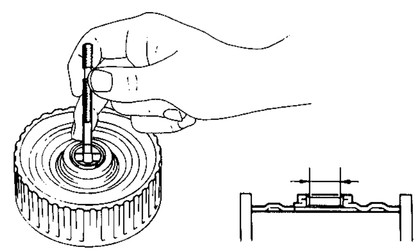
Planetary Gear Assembly

The planetary gear assembly is a very strong gear unit. Input torque is transmitted to both front and rear planetary gear assemblies, which makes this unit very durable. However, since there are no seals and 0 rings to replace, this unit can be easily overlooked during inspection. It is very critical that it be inspected and measured for excessive wear during the overhaul process. Excessive wear may be the source for future failure or noise.

Begin with a visual inspection of the gear teeth. Any chips of the gears would warrant replacement. Also check thrust surfaces to ensure that the bushing or bearing has a smooth surface to mate to. With the visual inspection complete, measure the bushing inside diameter and compare it to the repair manual specifications. If it is outside the wear tolerance, replace the assembly.

Bushing Inside Diameter

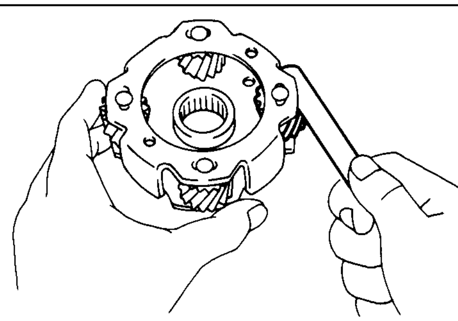
Measure the diameter in three positions. If any is outside the wear tolerance, replace the assembly.



Use a feeler gauge to measure the clearance of the pinion gear to carrier housing and compare to the specifications. Standard clearance is 0.0079” to 0.0197”. Clearance in excess of the standard on any planetary gear would require the replacement of the carrier assembly.

Pinion Gear Clearance

Excess clearance at any planetary gear requires replacement of the assembly.



Holding Devices For Planetary Gear Set

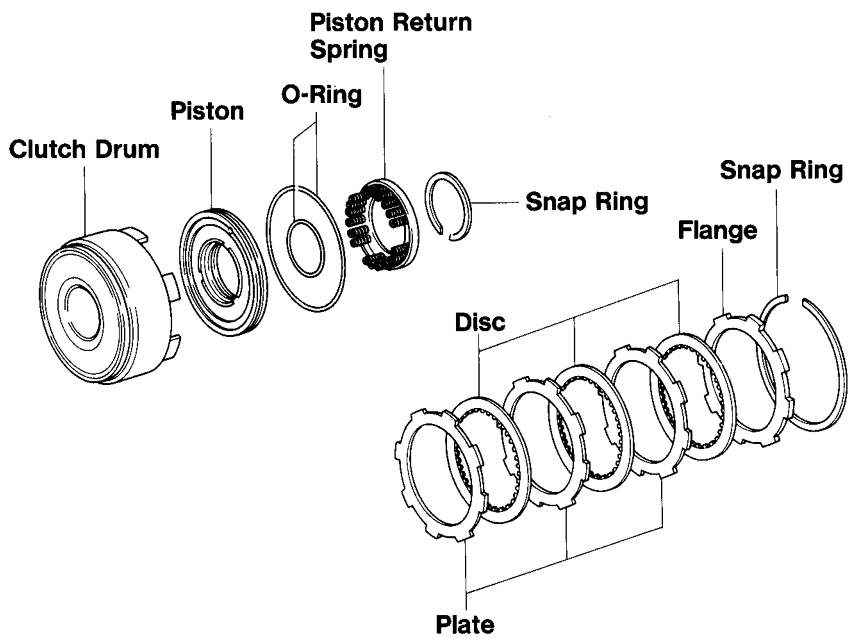
There are three types of holding devices used in the planetary gear set. Each type has its specific design advantage. The three include multiplate clutches/brakes, brake bands and one-way clutches.

- Multiplate Clutch – holds two rotating planetary components
- Brake – holds planetary components to the housing
  - multiplate brake
  - brake band
- Roller or Sprag One-Way Clutch – holds planetary components in one rotational direction

The multiplate clutch and multiplate brake are the most common of the three types of holding devices; they are versatile and can be modified easily by removing or including more friction discs. The brake band takes very little space in the cavity of the transmission housing and has a large surface area to create strong holding force. One-way clutches are small in size and release and apply quickly, giving good response for upshifts and downshifts.

Multiplate Clutch

The multiplate clutch connects two rotating components of the planetary gear set.



Multiplate Clutch

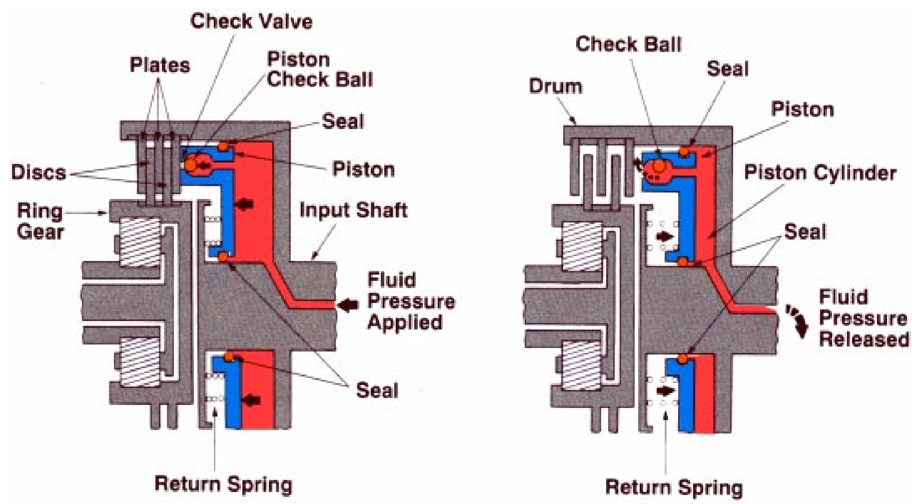
The multiplate clutch connects two rotating components of the planetary gear set. The Simpson planetary gear unit uses two multiplate clutches, the forward clutch (C1) and the direct and reverse clutch (C2). Each is made up of a clutch drum which is splined to accept the input shaft and turning torque from the engine. The drum also provides the bore for the clutch piston. Because this assembly rotates while the vehicle is in motion, it presents a unique challenge to ensure fluid under pressure reaches the clutch and holds the clutch engaged for thousands of miles of service.

The piston houses a seal on its inner diameter and on its outer diameter which seals the fluid which actuates the piston. A relief ball valve is housed in the piston body of the multiplate clutch. This valve has an important function in releasing hydraulic fluid pressure. When the clutch is released, some fluid still remains behind the piston. As the drum rotates, centrifugal force will force the fluid to the outside of the drum, which will try to apply the clutch. This pressure may not fully engage the clutch; however, it may reduce the clearance between the discs and metal plates, promoting heat and wear. The relief ball valve is designed to release the fluid after pressure is released. Centrifugal force causes the ball to move away from the valve seat, and fluid escapes.

Since the multiplate brake does not rotate, this phenomenon does not occur. The return springs force the fluid out of the cylinder, and the brake is released.

Multiplate Clutch Operation

Hydraulic pressure applies the clutch, and the return springs release it.



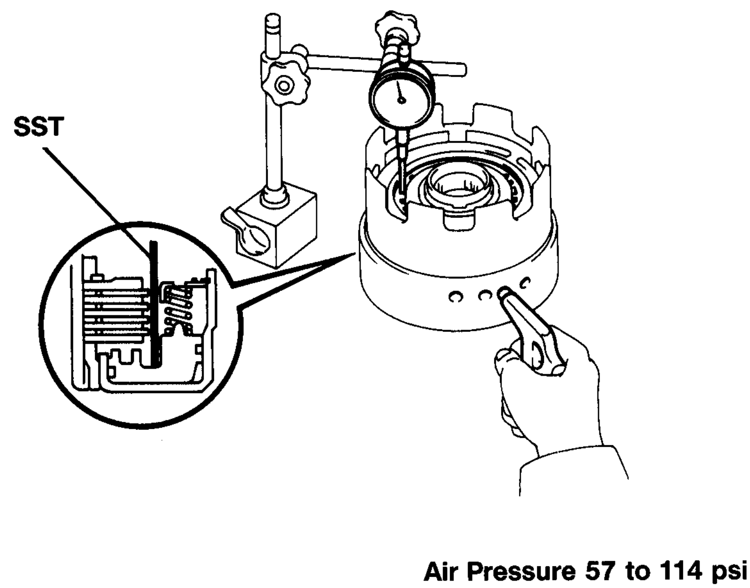
Hydraulic pressure actuates the piston and return springs return the piston to the rest position in the clutch drum when pressure is released. Friction discs are steel plates to which friction material is bonded. They are always located between two steel plates. The friction disc inner diameter is slotted to fit over the splines of the clutch hub.

Adjustments and Clearances

Clearance for the clutch pack can be checked using a feeler gauge or dial indicator as shown in the illustration below. Apply air pressure in the range of 57 to 114 psi to ensure that the clutch is fully compressed. Proper clearance ensures that disc and steel plates do not wear prematurely and ensures proper shift timing. To obtain the desired clearance, steel flange plates are available in varying thicknesses.

Clutch Pack Clearance

The dial indicator measures the travel of the piston as it compresses the clutch pack.



Assembly Inspection

Verify the proper assembly of holding devices by air testing each multiplate clutch unit prior to its placement in the transmission case. It takes less time to correct a problem while the part is on the bench than when the transmission is assembled. When the holding device is installed, other factors such as sealing rings on the shafts and placement of thrust washers and bearings may contribute to leakage. Knowing that the holding device air checked OK will help to narrow the diagnosis. Follow your repair manual for specifics regarding air test points. Air pressure should not be greater than 50 psi while testing holding devices for leakage.

Diagnosis Multiplate Clutch Assemblies

Proper diagnosis is the key to inspection so that you know where to look for the cause of the problem. Based on the customer complaint and your test drive, determining the holding devices deserves particular attention during your visual inspection before disassembly.

Visually inspect piston seals and piston surfaces to verify a fault or damage. The seals should be replaced when the transmission is overhauled. Visually check steel plates and clutch discs for heat discoloration, distortion, and surface scoring or scuffing. Check the plates and discs for free movement on the hub or drum splines. This free movement will ensure that the steel plates and discs do not have contact, which causes heat and premature wear.

Make sure that the ball valve in the piston moves freely by shaking it to hear it rattle. Some carburetor cleaner may be used to dissolve any varnish build-up that may cause the valve to stick.

Sealing rings on the various shafts should also be checked for deformation or breakage, especially if the fault has been determined to be in this particular holding device and no fault has been found. Particular care for these sealing rings during reassembly is critical as well.

Brakes

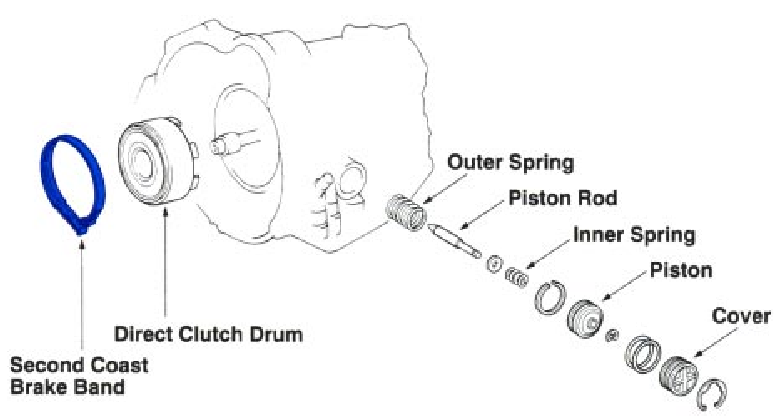
There are two types of brakes: the band type and the wet multiplate type. The band type is used for the second coast brake (B1) on some transmission models. The multiplate type is used on the overdrive brake (B0), second coast brake on some models and the second brake (B2).

Brake Band

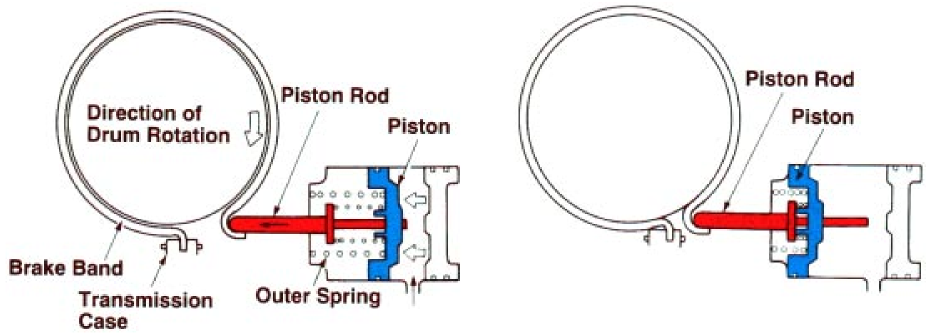
The brake band is located around the outer circumference of the direct clutch drum. One end of this brake band is located to the transmission case with a pin, while the other end contacts the brake piston which is operated by hydraulic pressure.

Band Type Brake

The brake band locks a planetary gear component to the case of the transmission.



Band Operation



When hydraulic pressure is applied to the piston, the piston moves to the left in the piston cylinder, compressing the outer spring. The inner spring transfers motion to the piston rod, moving it to the left with the piston, and pushes one end of the brake band. This reduces the harsh engagement of the band. As the inner spring compresses, the piston comes in direct contact with the piston rod shoulder and a high frictional force is generated between the brake band and drum. As the other end of the brake band is fixed to the transmission case, the diameter of the brake band decreases. The brake band clamps down on the drum, holding it immovable, which causes the drum and a member of the planetary gear set to be held to the transmission case.

When the pressurized fluid is drained from the cylinder, the piston and piston rod are pushed back by the force of the outer spring so the drum is released by the brake band.

Brake Band Assembly Inspection

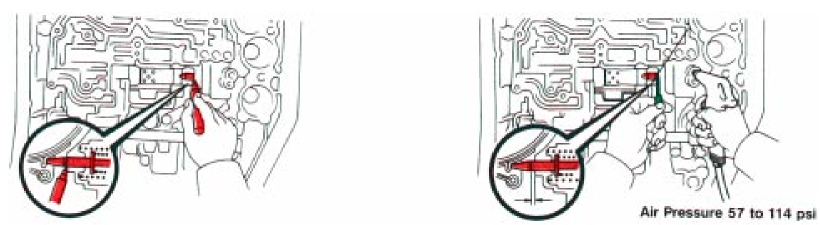
The piston oil sealing rings should be visually inspected for damage. Also inspect the cylinder bore for any damage which may destroy the new sealing ring. Inspect the 0 rings on the cover to ensure against leaks. Visually inspect the brake band clutch material for damage. If the clutch material is discolored or parts of the printed numbers are no longer visible, replace the brake band. Visually inspect the direct clutch drum for any damage to the band mating surface.

Adjustment and Clearance

Adjustment for the brake band is accomplished by piston rods of two different lengths. Rods are available to enable the clearance between the brake band and drum to be adjusted. By placing a mark on the piston rod and then applying air to the B1 port, measure between the mark and the cylinder housing to determine the clearance. Air pressure should be in the range of 57 to 114 psi in order to achieve full application and travel. This specification should not be confused with the 30 psi specification for air testing holding devices.

Brake Band Adjustment

Adjustment is accomplished by a piston rod of two different lengths.



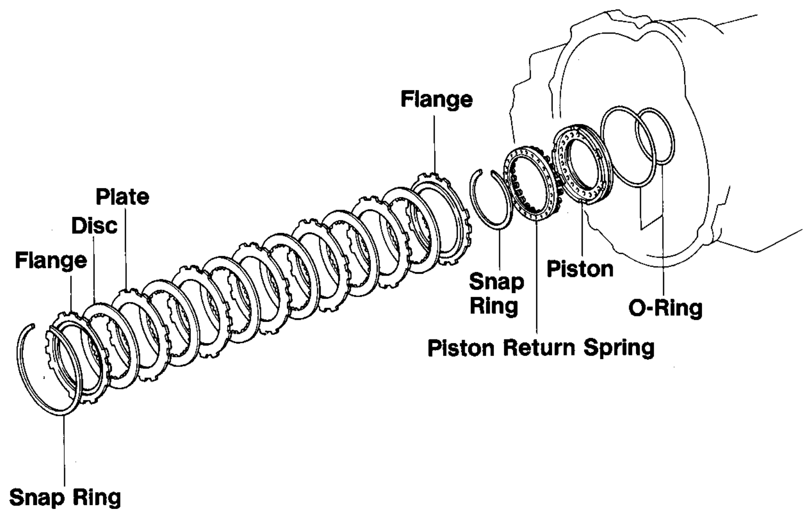
Multiplate Brake

The multiplate brake serves the same function as the brake band and is constructed in a similar manner to the multiplate clutch. It locks or holds a rotating component of the planetary gear set to the case of the transmission.

Hydraulic pressure actuates the piston and return springs return the piston to the rest position in the clutch drum when pressure is released. Friction discs are steel plates to which friction material is bonded. They are always located between two steel plates. The friction disc inner diameter is slotted to fit over the splines of the clutch hub, similar to the multiplate clutch; however, the steel plates spline to the transmission case, thus providing an anchor.

Multiplate Brake

Holds a rotating component of the planetary gear set to the case of the transmission.



Multiplate Brake Inspection

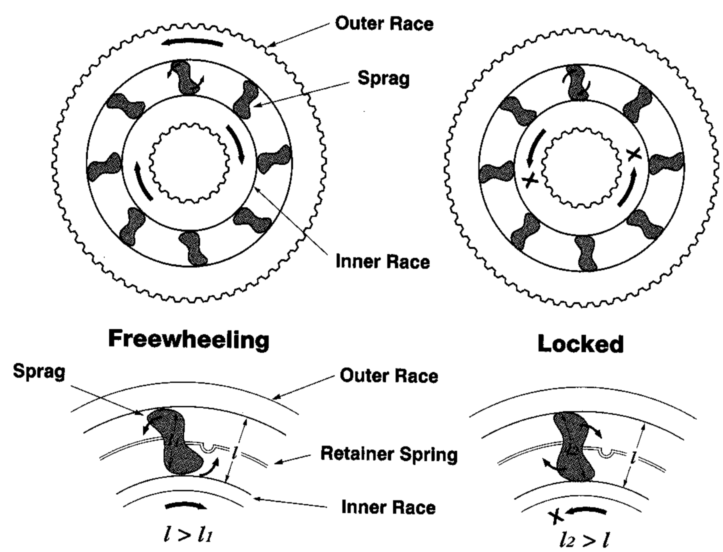
The inspection is very similar to multiplate clutches except there is no ball valve in the piston and sealing rings on the shafts. The apply circuits are found in the case of the transmission. Visually inspect piston seals and piston surfaces to verify a fault or damage. The seals should be replaced when the transmission is overhauled. Visually check steel plates and clutch discs for heat discoloration, distortion, and surface scoring or scuffing. Check the plates and discs for free movement on the hub or drum splines. This free movement will ensure that the steel plates and discs do not have contact, which causes heat and premature wear.

One-Way Clutch

A one-way clutch is a holding device which requires no seals or hydraulic pressure to apply. They are either a roller clutch or sprag clutch. Although the sprag clutch is most often used in Toyota automatics, we'll mention both. Their operation is similar in that they both rely on wedging metal between two races. Two one-way clutches are used in the Simpson Planetary Gear Set. The one-way clutch No. 1 is used in second gear and the one-way clutch No. 2 is used in first gear.

A one-way sprag clutch consists of a hub as an inner race and a drum, or outer race. The two races are separated by a number of sprags which look like a figure "8" when looking at them from the side view. In the illustration below, the side view of the sprag shows four lobes. The two lobes identified by L1 are shorter than the distance between the two races. The opposite lobes are longer than the distance between the races. As a result, when the center race turns clockwise, it causes the sprag to tilt and the short distance allows the race to turn.

One-Way Clutch

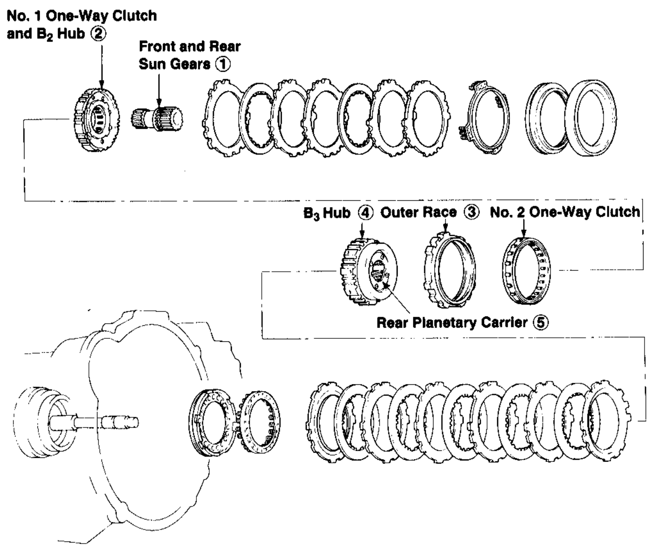


When the center race turns counterclockwise, it tries to move the sprag so that the long distance is wedged against the outer race. This causes the center race to stop turning. To assist the sprags in their wedging action, a retainer spring is installed, which keeps the sprags slightly tilted at all times in the direction which will lock the turning race.

A one-way roller clutch consists of a hub, rollers and springs surrounded by a cam-cut drum. The cam-cut is smaller on one end than the other. The spring pushes the roller toward the narrow cut. When the race rotates clockwise, the rollers compress the spring and the race is allowed to turn. If the race is rotated in a counterclockwise direction, it forces the roller into the narrow end of the cam cut and locks the race.

No. 1 and No. 2 One-Way Clutch

F1 operates with the second brake (B2) to hold the sun gear from turning counter-clockwise. F2 prevents the rear planetary carrier from turning counterclockwise.



One-way clutch No. 1 (F1) operates with the second brake (B2) prevent the sun gear from turning counterclockwise. The one-way clutch No. 2 (F2) prevents the rear planetary carrier from turning counterclockwise.

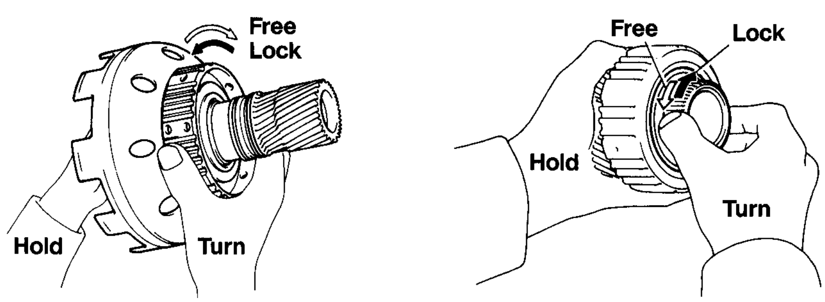
One-Way Clutch Assembly Inspection

Visually check for signs of slippage, overheating, or galled races. Lubrication holes to the races should be clear of debris to ensure adequate lubrication. Check the clutch to ensure that it rotates in one direction and is locked in the opposite direction. A clutch which locks by hand may slip under the torque produced by the engine. So it is imperative to properly diagnose prior to disassembly to ensure that it is repaired properly the first time. Your diagnosis will also require a familiarity with the holding devices to know where to inspect for a fault.

CAUTION

One-way clutches can be installed backwards, so be careful; follow the repair manual instructions!

Check Installation of One-Way Clutches



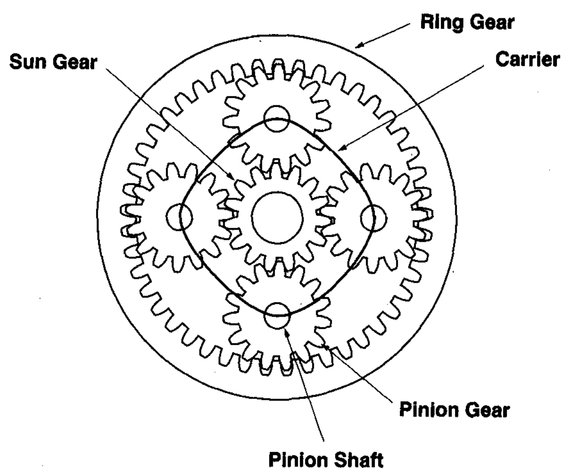
Notes

WORKSHEET 2
Planetary Gear Set Operation

On each of the planetary gear set diagrams, draw arrows to show the direction of rotation for each of the components under the conditions listed in the tables. Also write in the table whether an increase or reduction is taking place.

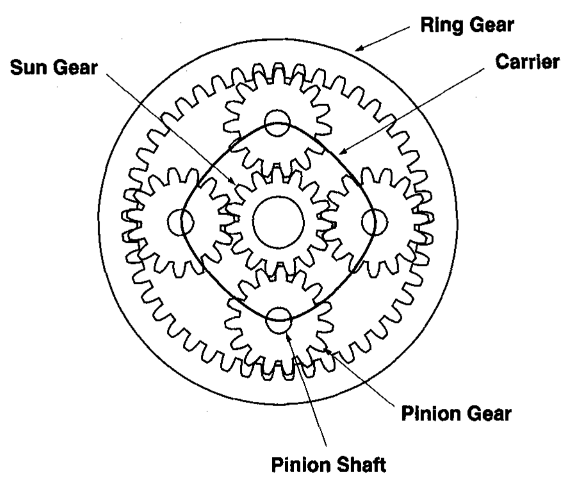
1.

Fixed Member	Drive Member	Driven Member	Rotational		Direction
			Speed	Torque	
Sun Gear	Ring Gear	**Carrier**			



2.

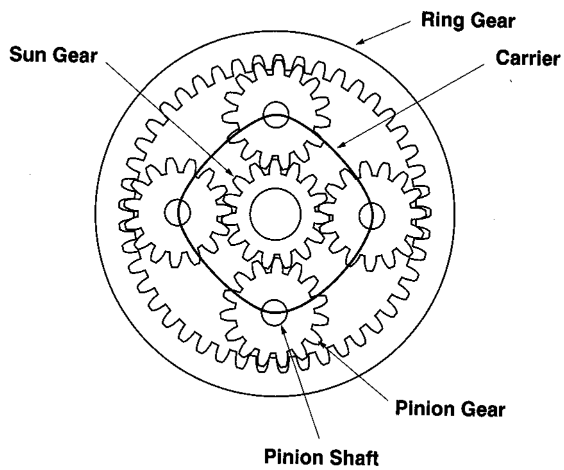
Fixed Member	Drive Member	Driven Member	Rotational		Direction
			Speed	Torque	
Sun Gear	Carrier	**Ring Gear**			



WORKSHEET 2
Planetary Gear Set Operation (Continued)

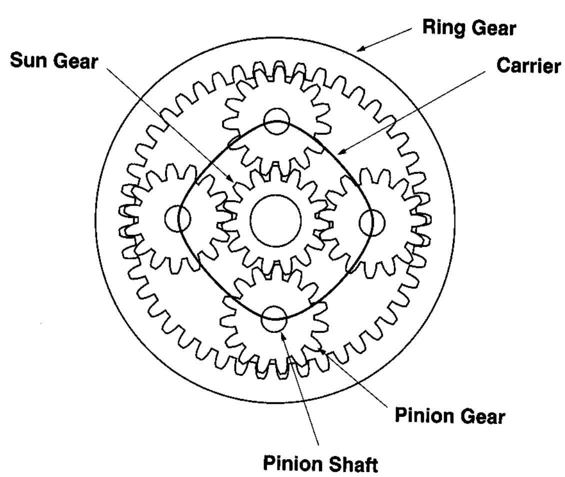
1.

Fixed Member	Drive Member	Driven Member	Rotational Speed	Rotational Torque	Direction
Ring Gear	Sun Gear	**Carrier**			



2.

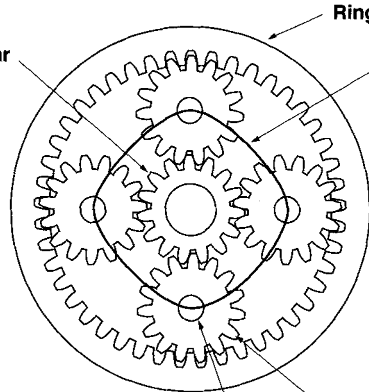
Fixed Member	Drive Member	Driven Member	Rotational Speed	Rotational Torque	Direction
Ring Gear	Carrier	**Sun Gear**			



WORKSHEET 2
Planetary Gear Set Operation (Continued)

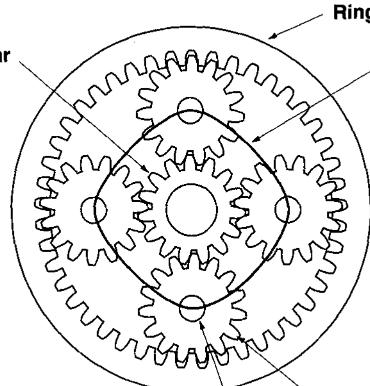
1.

Fixed Member	Drive Member	Driven Member	Rotational		Direction
			Speed	Torque	
Carrier	Ring Gear	**Sun Gear**			



2.

Fixed Member	Drive Member	Driven Member	Rotational		Direction
			Speed	Torque	
Carrier	Sun Gear	**Ring Gear**			



Notes

Section 4

GEAR SELECTION AND FUNCTION

- **P Locks drive wheels; engine should start; no torque transmitted to transmission**
- **R Allows vehicle to back up; engine should not start**
- **N Wheels free to turn; engine should start; no torque transmitted to transmission**
- **D Transmission automatically selects best available gear based on speed and load; engine no start**
- **2 Two speed auto transmission, starts in 1st, mild engine braking in 2nd only; engine no start**
- **L Locked in low gear, strong engine braking, diagnostic gear position; engine no start**

Lesson Objectives:

1. Identify the function for each of the following gear selector positions:
   - Park
   - Reverse
   - Neutral
   - Drive
   - Manual 2
   - Manual Low
2. Identify the gear selector positions in which engine braking occurs.
3. Identify the gear selector positions in which the engine can be started.
4. Identify the only gear selector position in which the transmission is entirely automatic.
5. Identify the gear selector positions which can be used to diagnose a fault in drive range.

The shift lever quadrant has six positions to indicate selected gear position. These gear positions determine different combinations of holding devices. Understanding what the transmission is required to do in each position will aid us in diagnosing system malfunctions.

Park (P) This gear position is a safety feature in that it locks the output shaft to the transmission housing. This, in effect, locks the drive wheels, preventing the vehicle from rolling forward or backward. This gear position should not be selected unless the vehicle is at a complete stop as the parking lock pawl mechanically engages with the output shaft and may damage the transmission. The engine can be started and performance tested in the park position.

Reverse (R) Reverse gear position allows the vehicle to back up. Can test for maximum oil pump pressure during a stall test.

NOTE: The engine should not start in this gear position.

Neutral (N) Neutral gear position allows the engine to start and operate without driving the vehicle. The vehicle is able to be moved with or without the engine running. The engine can be restarted while the vehicle is moving.

Manual Low (L) This gear can be selected at any vehicle speed; however, it will not downshift directly into first gear until approximately 29 to 39 mph depending on the model. This gear range provides for maximum engine braking and inhibits an upshift to third and second gear while in manual low.

NOTE: The engine should not start in this gear position.

Manual Second (2) This gear can be selected at any vehicle speed and will downshift to second gear; however, in Electronic Control Transmissions and on A40 and A340 series transmissions with a D-2 Downshift Timing Valve, the transmission downshifts from OD to third gear and then to second gear. This gear range provides for strong engine braking and inhibits an upshift to overdrive and third gear while in manual second; however, there are exceptions to the third gear upshift. At higher vehicle speeds of approximately 64 mph, the A340 will upshift to third gear while the selector is in manual second. While the selector is in manual second, the transmission will start in first gear and upshift to second and remain in second until the selector is moved again.

NOTE: The engine should not start in this gear position.

Drive (D) Each gear position which has been discussed requires a manual selection by the driver. The automatic transmission cannot select these positions automatically on its own. The next selector position is the only position from which the transmission is fully automatic.

In drive, the transmission has three gear ratios forward. First and second gear are gear reduction ratios which provide for greater torque in bringing the vehicle up to speed. Third gear is direct drive, and if the transmission has overdrive, it provides the fourth forward gear.

The drive position is the only position in which the transmission is automatic; that is, it upshifts and downshifts based on vehicle speed and load. Increased load is sensed through an increased opening of the throttle, and the transmission downshifts to a lower gear. With a decrease in throttle opening, load is decreased and the transmission upshifts to a higher gear.

We mentioned that in manual low gear and manual second gear, engine braking occurred while the vehicle was decelerating. The contrast to this characteristic in manual gears is that in "drive first" and "drive second" gears there is no engine braking. In other words, the vehicle coasts during deceleration.

NOTE The engine should not start in this gear position.

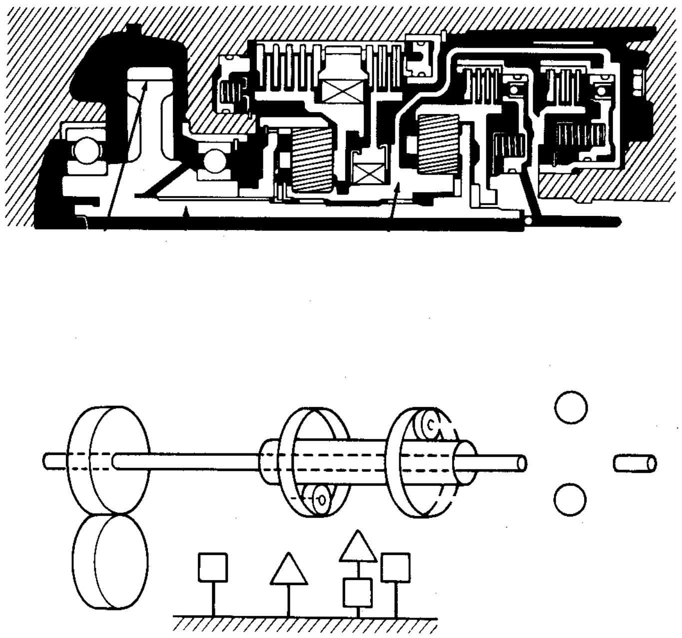
Instructions: Complete the area to the right of the gear selector positions (P, R, N, D, 2 and L) with your notes as your instructor presents them.

Gear Selector Positions

- **P**
- **R**
- **N**
- **D**
- **2**
- **L**

Section 5

POWER FLOW



Lesson Ojectives

1. Given a clutch application chart, identify which holding devices are applied for each gear range
2. Given a clutch application chart and the powerflow model, identify the planetary gear components held for each gear range.
3. Describe the poer flow through the planetary gear sets for the following gear ranges

   a. First gear
   b. Second gear
   c. Third gear
   d. Reverse

5. Identify the gear selector positions which can be used to diagnose a fault in drive range.

Power Flow Model

The planetary gear set cutaway and model shown below are found in Toyota Repair Manuals and New Car Features Books. The model will help you visualize the workings of the holding devices, gear shafts and planetary gear members for all gear positions.

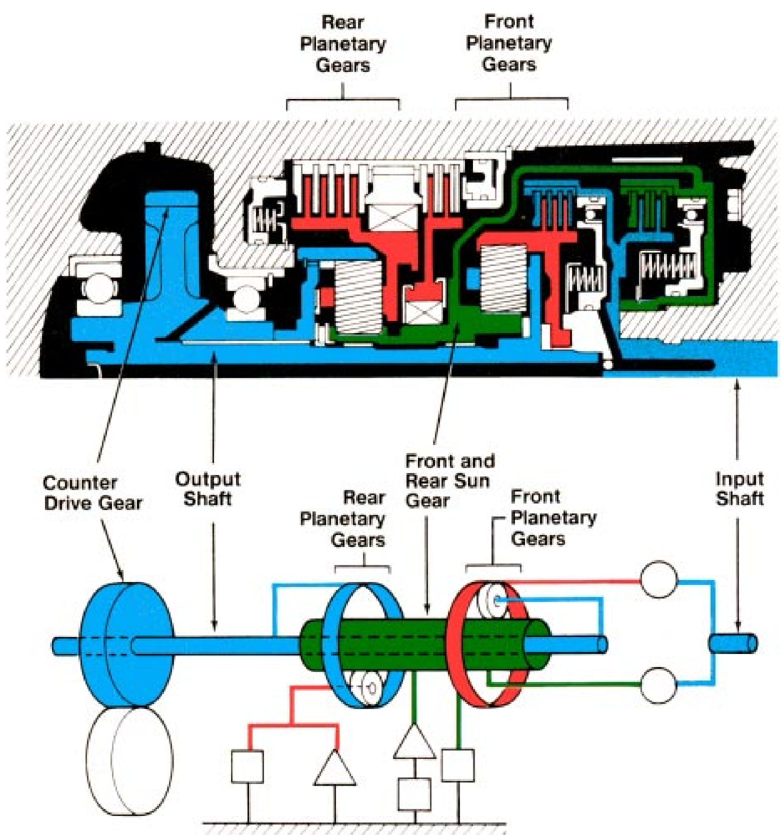
Gear Train Shafts

There are three shafts in the Simpson planetary: the input shaft, sun gear, and the output shaft. The input shaft is driven from the turbine in the torque converter. It is connected to the front planetary ring gear through the multiplate clutches. The sun gear, which is common to both the front and rear planetary gear sets, transfers torque from the front planetary set to the rear planetary set. The output shaft is splined to the carrier of the front planetary gear set and to the ring gear of the rear planetary and then provides turning torque to the rear wheels or the overdrive unit.

The output shaft, for the purposes of power flow, refers to the output of the Simpson planetary gear set. It may be referred to as the intermediate shaft in other references. However, for our purposes in discussing power flow, it will be referred to as the output shaft.

Planetary Gear Shafts

The planetary gear set cutaway and model will help visualize the workings of holding devices, gear shafts, and planetary gear memebers



Holding Devices Multiplate clutches and brakes were discussed in detail earlier, and in the cutaway model on the next page, we can identify their position and the components to which they are connected. The holding devices for the Simpson planetary gear set are identified below with the components they control:

FUNCTION OF HOLDING DEVICES

HOLDING DEVICE		FUNCTION
C_1	Forward Clutch	Connects input shaft and front planetary ring gear.
C_2	Direct Clutch	Connects input shaft and front and rear planetary sun gear.
B_1	2nd Coast Brake	Prevents front and rear planetary sun gear from turning either clockwise or counterclockwise.
B_2	2nd Brake	Prevents outer race of F1i from turning either clockwise or counterclockwise, thus preventing front and rear planetary sun gear from turning counterclockwise.
B_3	1 st and Reverse Brake	Prevents rear planetary carrier from turning either clockwise or counterclockwise.
F_1	No. 1 One-Way Clutch	When B2 is operating, prevents front and rear planetary sun gear from turning counterclockwise.
F_2	No. 2 One-Way Clutch	Prevents rear planetary carrier from turning counterclockwise.

The value of this model can be appreciated when observing the control of the rear carrier by the first and reverse brake (B3) and the one-way clutch No. 2 (F2) and control of the sun gear by the second brake (B2) and the one-way clutch No. 1 (Fl).

Notice that the first and reverse brake (B3) and one-way clutch No. 2 (F2) both hold the rear planetary carrier. Together they provide a great holding force on the carrier to prevent it from turning during low first gear.

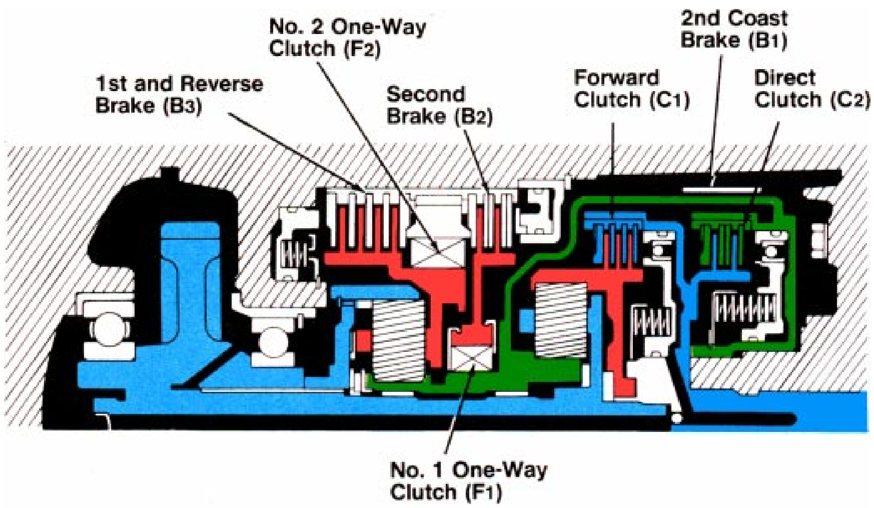
Note also that the second brake (B2) and the one-way clutch No. 1 (Fl) work together to hold the sun gear. The second coast brake (B1) holds the sun gear too. The benefit to this design will be discussed as the power flow is covered for each gear position.

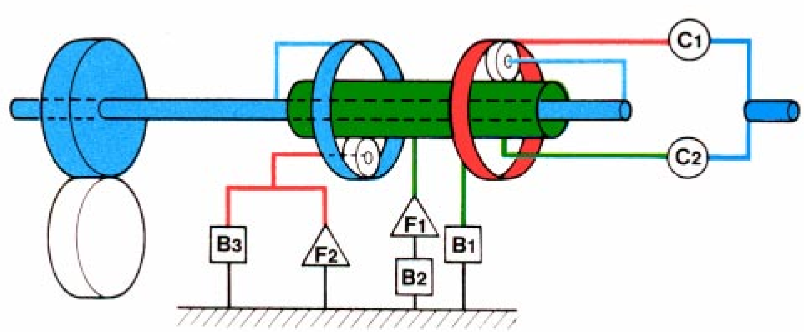
Planetary Holding Devices

The first and reverse brake (B3) and one-way clutch No. 2 (F2) both hold the rear planetary carrier.

The second brake (B2) and the one-way clutch No. 1 (F1) work together to hold the sun gear.

The second coast brake (B1) holds the sun gear also.





Clutch Application Chart

The gear position in which these holding devices are applied can be found on the clutch application chart below. The chard describes which holding devices are applied for a given gear position. If you follow down the left side of the chart to shift lever position ”D” and ”first” gear position, the shaded boxesto the right of the gear position indicate the holding devices used in drive first gear. At the top of the column above the shaded box you will find the code designation for the holding device. For example, in drive first gear, the *forward clutch* (C1) and the *one-way clutch* No. 2 (F2) are applied to achieve first gear.

Clutch Application Chart for A130 Trans

Shift Lever Position	Gear Position	C_1	C_2	B_1	B_2	B_3	F_1	F_2
P	Parking							
R	Reverse		■			■		
N	Neutral							
D	1st	■						■
	2nd	■			■		■	
	3rd	■	■		■			
2	1st	■						■
	2nd	■		■	■		■	
L	1st	■				■		■
	2nd*	■		■	■		■	

***Down-shift in Lrange, 2nd gear only—no up-shift**

The clutch application chart is you key to diagnosis. When a transmission malfunction occurs and your diagnosis leads you to a specific gear, you can refer to this chart to pinpoint the faulty honding device. When the holding device you suspect is used in another gear position, you should be able to detect a failure in that gear position also.

Segments of this application chart will be used in the Power Flow section to familiarize you with their use.

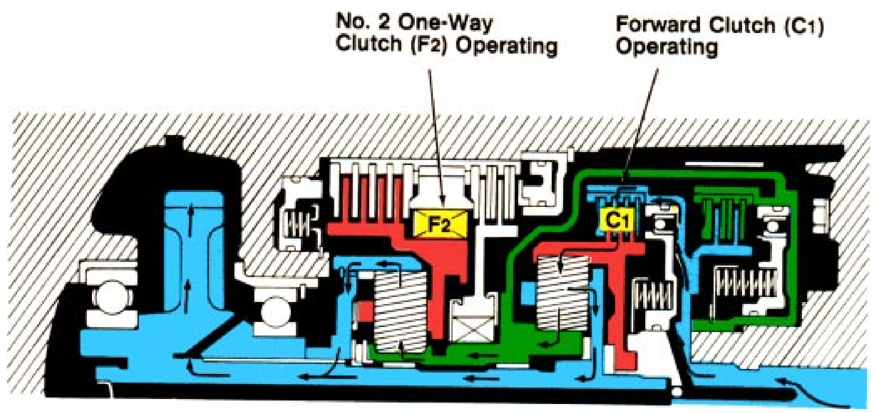
Power Flow Through Simpson Planetary Gear Set

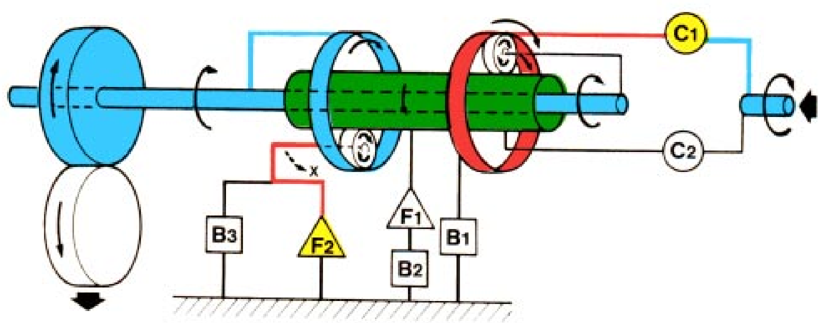
D- or 2-Range First Gear

First gear is unique because it uses both the front and rear planetary gear sets. The forward clutch (C1) is applied in all forward gears and drives the ring gear of the front planetary gear set. When the ring gear rotates clockwise, it causes the pinions to rotate clockwise since the sun gear is not held to the case. The sun gear rotates in a counterclockwise direction. The front planetary carrier, which is connected to the output shaft, rotates, but more slowly than the ring gear; so for practical purposes, it is the held unit. In the rear planetary gear set, the carrier is locked to the case by the one-way clutch No. 2 (F2). Turning torque is transferred to the rear planetary by the sun gear, which is turning counterclockwise. With the carrier held, the planetary gears rotate in a clockwise direction and cause the rear planetary ring gear to turn clockwise. The rear planetary ring gear is connected to the output shaft and transfers torque to the drive wheels.

D- or 2-Range First Gear

First gear is unique because it uses both the front and rear planetary gear sets.





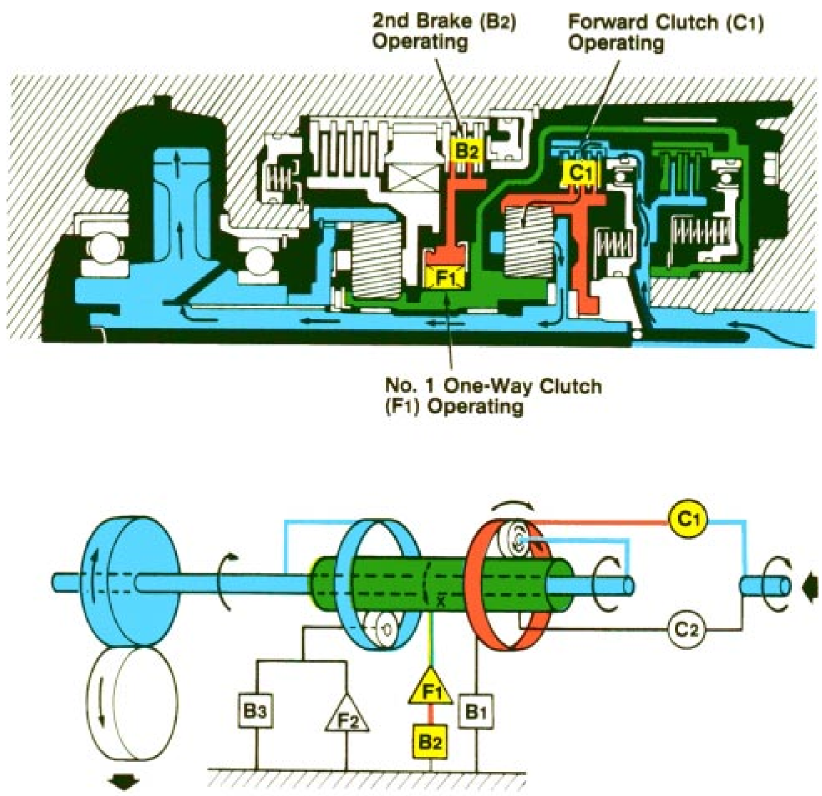
Shift Lever Position	Gear Position	C1	C2	B1	B2	B3	F1	F2
D	1st							

D-Range Second Gear

The forward clutch (C1) connects the input shaft to the front planetary ring gear. The sun gear is driven in a counterclockwise direction in first gear, and by simply applying the second brake (B2), the sun gear is stopped by the one-way clutch No. 1 (Fl) and held to the case. When the sun gear is held, the front pinion gears driven by the ring gear walk around the sun gear and the carrier turns the output shaft.

D-Range Second Gear

Second gear uses the front planetary gear set only.



Shift Lever Position	Gear Position	C1	C2	B1	B2	B3	F1	F2
D	1st							
	2nd							

The advantage of the one-way clutch No. 2 (F2) is in the automatic upshift and downshift. Only one multiplate clutch is applied or released to achieve an upshift to second gear or downshift to first gear.

Notice how the second brake (B2) and the one-way clutch (Fl) both hold the sun gear. The second brake holds the outer race of the one-way clutch to the transmission case when applied. The one-way clutch prevents the sun gear from rotating counterclockwise only when the second brake is applied.

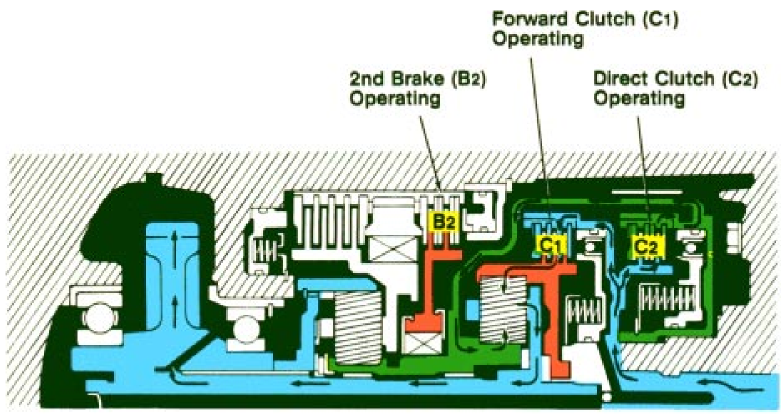
D-Range Third Gear

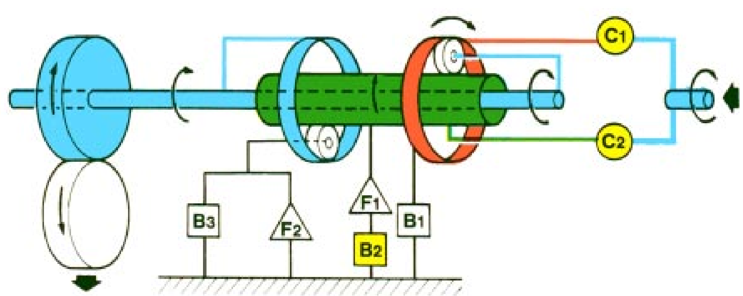
The forward dutch (C1) is applied in all forward gears and connects the input shaft to the front planetary ring gear as it does in all forward gears. The direct clutch (C2) connects the input shaft to the common sun gear. By applying both the direct clutch and the forward clutch, we have locked the ring gear and the sun gear to each other through the direct clutch drum and the input sun gear drum. Whenever two members of the planetary gear set are locked together, direct drive is the result.

Notice that the second brake (B2) is also applied in third gear; however, since the one-way clutch No. 1 (Fl) does not hold the sun gear in the clockwise direction, the second brake has no effect in third gear. So why is it applied in third gear? The reason lies in a downshift to second gear. All that is necessary for a downshift to second gear is to release the direct and reverse clutch (C2). The ring gear provides input torque and the sun gear is released. The carrier is connected to the output shaft and final drive so the output shaft tends to slow the carrier. The pinion gears rotate clockwise turning the sun gear counterclockwise until it is stopped by the one-way clutch No. 1 (Fl). The carrier provides the output to the final drive.

D-Range Third Gear

Third gear uses the front planetary gear set only.





Shift Lever Position	Gear Position	C_1	C_2	B_1	B_2	B_3	F_1	F_2
D	2nd							
	3rd							

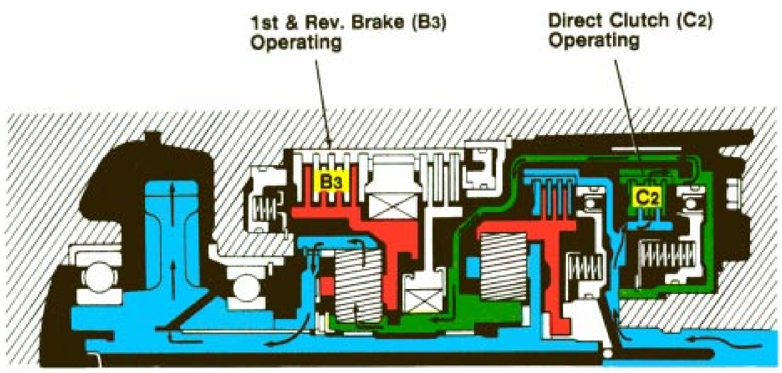
Reverse Range

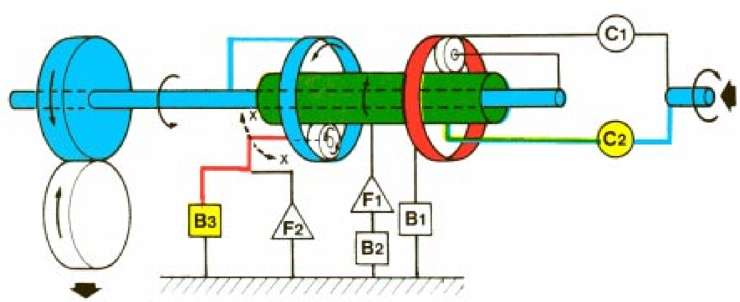
Direct and reverse clutch (C2) is applied in reverse, which connects the input shaft to the sun gear. The first and reverse brake (B3) is also applied, locking the rear carrier to the case. With the carrier locked in position, the sun gear turning in the clockwise direction causes the planetary gears to rotate counterclockwise. The planetary gears will then drive the ring gear and the output shaft counterclockwise.

Up to this point we have examined reverse gear and those forward gear positions which are automatic. That is, with the gear selector in D-position all forward gears are upshifted automatically. The gears can also be selected manually, utilizing additional holding devices. This feature not only provides additional characteristics to the drivetrain but also allows a means of diagnosis for faults in certain holding devices.

Reverse Range

Reverse gear uses the rear planetary gear set only.





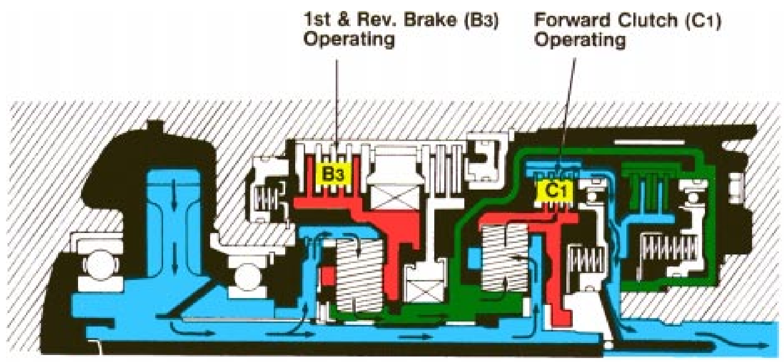
Shift Lever Position	Gear Position	C_1	C_2	B_1	B_2	B_3	F_1	F_2
P	Parking							
R	Reverse							

Differences Between D1- and L-Range First Gear

When the gear selector is placed in the L-position, the first and reverse brake (B3) is applied through the position of the manual valve. The first and reverse brake does the same thing as the one-way clutch No. 2 (F2) in the forward direction, as seen in the illustration. When the first and reverse brake (B3) is applied it holds the rear planetary gear carrier from turning in either direction. Whereas the one-way clutch No. 2 only holds the carrier in the counterclockwise direction. The advantage that the first and reverse brake has is that engine braking can be achieved to slow the vehicle on deceleration. In "D1" only, the one-way clutch No. 2 holds the carrier, so while decelerating, the one-way clutch would release and no engine braking would occur.

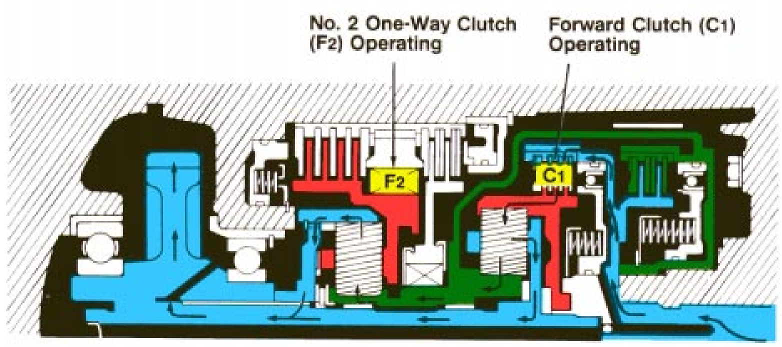
First Gear

First and Reverse Brake (B3) holds the rear carrier.



"L" Range-Engine Braking

The No. 2 On-Way Clutch holds the rear carrier

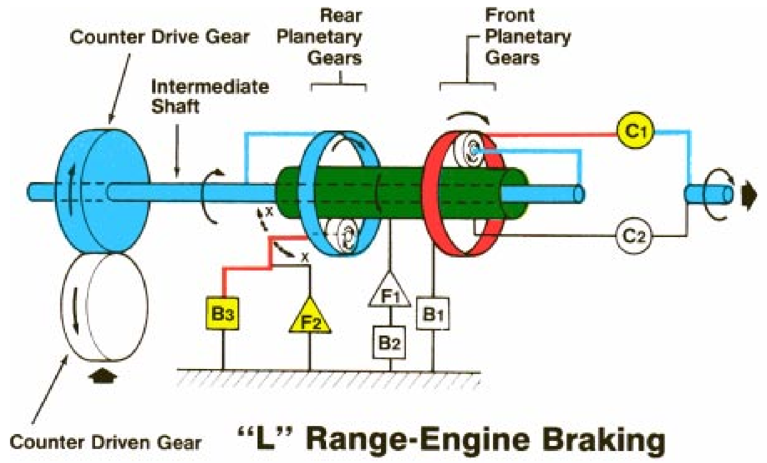


"D" or "2" Range

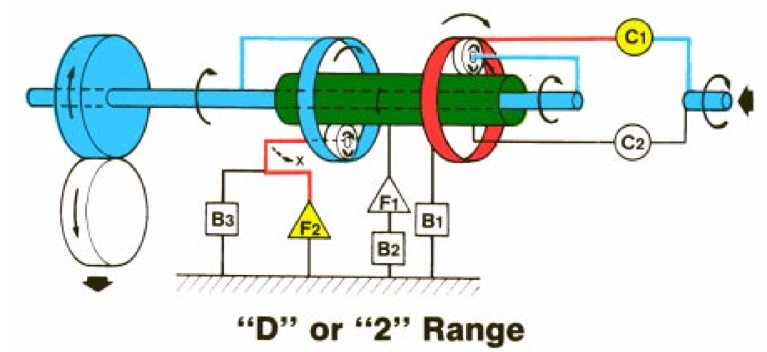
Shift Lever Position	Gear Position	C_1	C_2	B_1	B_2	B_3	F_1	F_2
D	1st							
L	1st							

First Gear

The rear planetary carrier cannot rotate in either direction.



The rear planetary carrier is held counter-clockwise only and freewheels in the clockwise direction.



Shift Lever Position	Gear Position	C_1	C_2	B_1	B_2	B_3	F_1	F_2
D	1st							
L	1st							

Three diagnostic scenarios:

1. If there was slippage in reverse gear but none in "L" position, and no engine braking when decelerating in "L," the first and reverse (B3) would be at fault. Slippage in first gear did not occur because the one-way clutch No. 2 (F2) would have held the rear carrier from turning counterclockwise.
2. If first gear slips in "D1l" and there is no slippage in "L," the one-way clutch No. 1 (Fl) is at fault.
3. There is slippage in first gear with the selector in "D" and "L." The holding device common to both gear positions would be the forward clutch (C1).

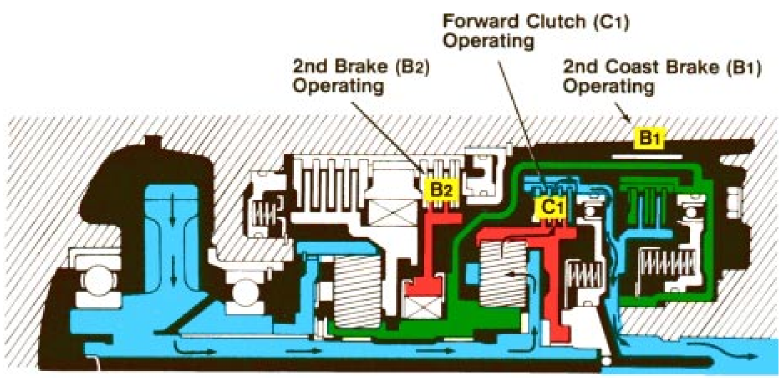
Differences Between D2- and 2-Range Second Gear

When the gear selector is placed in the 2-position, the second coast brake (Bl) is applied by way of the manual valve. When the second coast brake is applied, it holds the sun gear from rotating in either direction. Power flow is the same as when the transmission is driving the wheels with the selector in 2, as when the selector is in D. However, when the transmission is being driven by the wheels on deceleration, the force from the output shaft is transmitted to the front carrier, causing the front planetary pinion gears to revolve clockwise around the sun gear. Since the sun gear is held by the second coast brake, the planetary gears walk around the sun clockwise and drive the front planetary ring gear clockwise through the input shaft and torque converter to the crankshaft for engine braking. In contrast, while in second gear with the selector in D-position, the sun gear is held in the counterclockwise direction only and the sun gear rotates in a clockwise direction and there is no engine braking.

The advantage that ”2” range has over ”D2” is that the engine can be used to slow the vehicle on deceleration, and this feature can be used to aid in diagnosis. For example, a transmission which does not have second gear in D-position but does have second gear while manually shifting can be narrowed to the second brake (B2) or one-way clutch #1 (Fl). These components and related hydraulic circuits become the primary focus in our diagnosis.

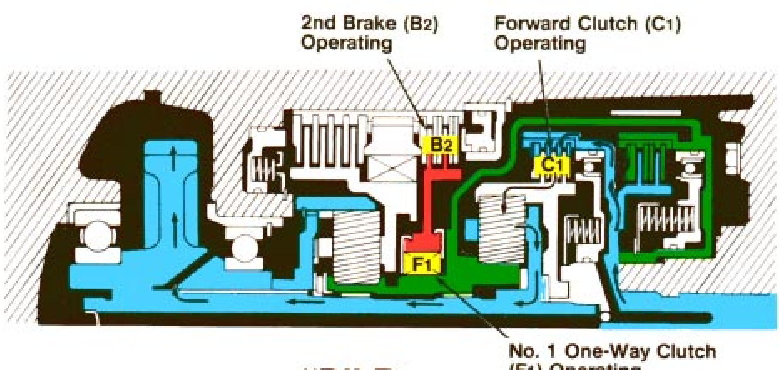
Second Gear

The second coast brake (B1) holds the sun gear.



"2" Range-Engine Braking

The second brake (B2) and No. 1 One-Way Clutch (F1) hold the sun gear.

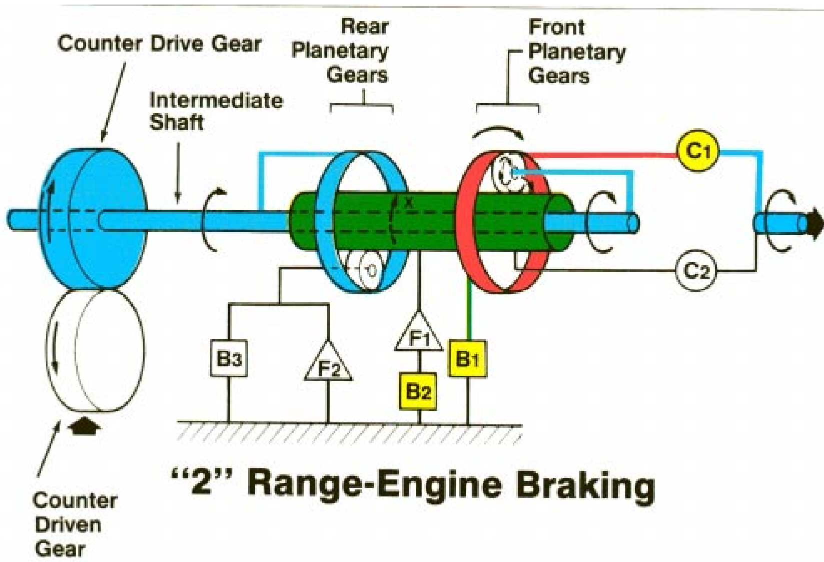


"D" Range

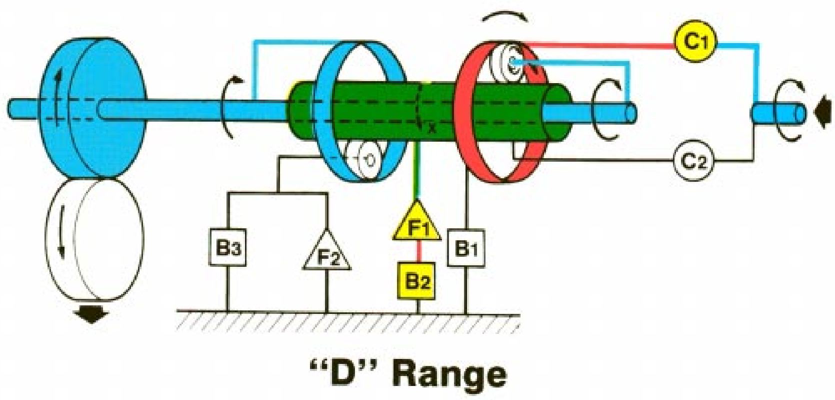
Shift Lever Position	Gear Position	C1	C2	B1	B2	B3	F1	F2
D	2nd							
2	2nd							

Second Gear

The sun gear cannot rotate in either direction.



The sun gear is held in the counter-clockwise direction only and freewheels in clockwise direction.



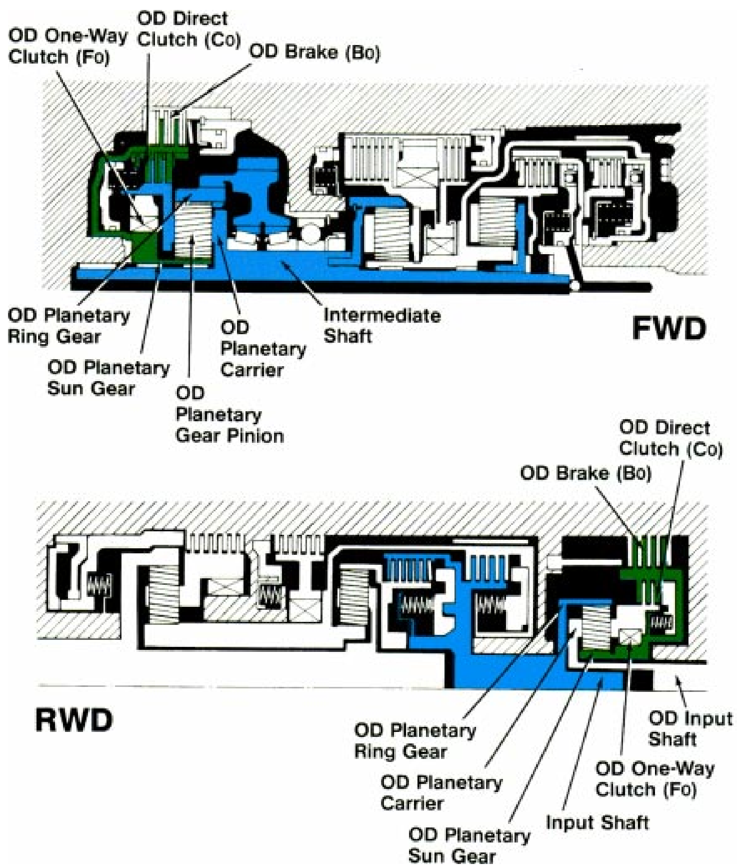
Shift Lever Position	Gear Position	C_1	C_2	B_1	B_2	B_3	F_1	F_2
D	2nd							
2	2nd							

Power Flow Through OD Unit

One simple planetary gear set is added to the 3-speed automatic transmission to make it a 4-speed automatic transmission (three speeds forward and one overdrive). This additional gear set can be added in front of or behind the Simpson Planetary Gear Set to accomplish overdrive. When the vehicle is driving in overdrive gear, the speed of the output shaft is greater than that of the input shaft.

OD Planetary Units

This simple planetary gear set can be in front of the Simpson planetaary gear set or behind it.



Holding Devices The holding devices for the overdrive transmission are identified in the following chart with the components they control.

Function of Holding Devices

HOLDING DEVICE		FUNCTION
C_0	O/D Direct Clutch	Connects overdrive sun gear and overdrive carrier.
B_0	O/D Brake	Prevents overdrive sun gear from turning either clockwise or counterclockwise.
F_0	O/D One-Way Clutch	When transmission is being driven by engine, connects overdrive sun gear and overdrive carrier
C_1	Forward Clutch	Connects input shaft and front planetary ring gear.
C_2	Direct Clutch	Connects input shaft and front and rear planetary sun gear.
B_1	2nd Coast Brake	Prevents front and rear planetary sun gear from turning either clockwise or counterclockwise.
B_2	2nd Brake	Prevents outer race of F1 from turning either clockwise or counterclockwise, thus preventing front and rear planetary sun gear from turning counterclockwise.
B_3	1st and Reverse Brake	Prevents rear planetary carrier from turning either clockwise or counterclockwise.
F_1	No. 1 One-Way Clutch	When B2 is operating, prevents front and rear planetary sun gear from turning counterclockwise.
F_2	No. 2 One-Way Clutch	Prevents rear planetary carrier from turning counterclockwise.

Clutch Application Chart

The gear position in which these holding devices are applied can be found on the following clutch application chart. The clutch application chart is similar to the one seen earlier while discussiong power flow through the Simpson planetary gear set; however, three additional holding devices for overdrive have been added. The overdrive direct clutch (C0) and the overdrive one-way clutch (F0) are applied in reverse and all forward gears **except** overdrive. The overdrive brake (B0) is applied in overdrive only.

Clutch Application Chart for A340 Trans

Shift Lever Position	Gear Position	C_0	C_1	C_2	B_0	B_1	B_2	B_3	F_0	F_1	F_2
P	Parking	●									
R	Reverse	●		●				●	●		
N	Neutral	●									
D	1st	●	●						●		●
	2nd	●	●				●		●	●	
	3rd	●	●	●			●		●		
	O/D		●	●	●		●				
2	1st	●	●						●		●
	2nd	●	●			●	●		●	●	
	3rd	●	●	●			●		●		
L	1st	●	●					●	●		●
	2nd*	●	●			●	●		●	●	

***Down-shift only in Lrange and 2nd gear—no up-shift**

Segments of this clutch application chart will be used in the overdrive Power Flow section to familiarize you with their use.

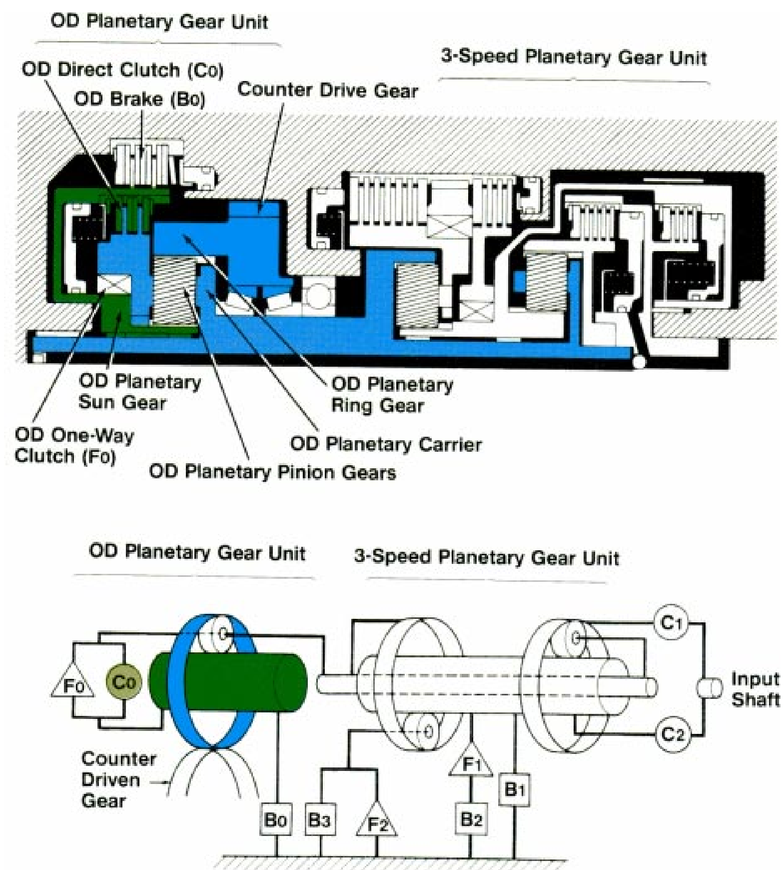
Overdrive is designed to operate at vehicle speeds above 25 mph in order to reduce the required engine speed when the vehicle is operating under a light load. The overdrive planetary gear unit consists mainly of one simple planetary gear set, an overdrive brake (BO) for holding the sun gear, an overdrive clutch (CO) and an overdrive one-way clutch (F0) for connecting the sun gear and carrier.

Power is input through the overdrive planetary carrier and output from the overdrive ring gear. The operation of holding devices and planetary members in the forward direction is the same whether it is a front wheel drive or rear wheel drive vehicle. In reverse, however, the overdrive one-way clutch (F0) in the front wheel drive transmission does not hold.

The direction of rotation in the front-mounted OD unit is always clockwise. The direction of rotation in the rear-mounted OD units is mostly clockwise, with the exception of reverse, in which case the intermediate shaft rotates counterclockwise. When the input torque comes into the overdrive unit in a counterclockwise direction, the overdrive one-way clutch (F0) free-wheels. Therefore, when a vehicle with the rear-mounted OD unit is placed in reverse, the overdrive direct clutch (CO) is the only unit holding the OD unit in direct drive. For this reason, when the overdrive direct clutch fails, the vehicle will go forward but will not go in reverse.

OD Planetary Gear Unit

Power is input through the overdrive planetary carrier and output from the overdrive ring gear.

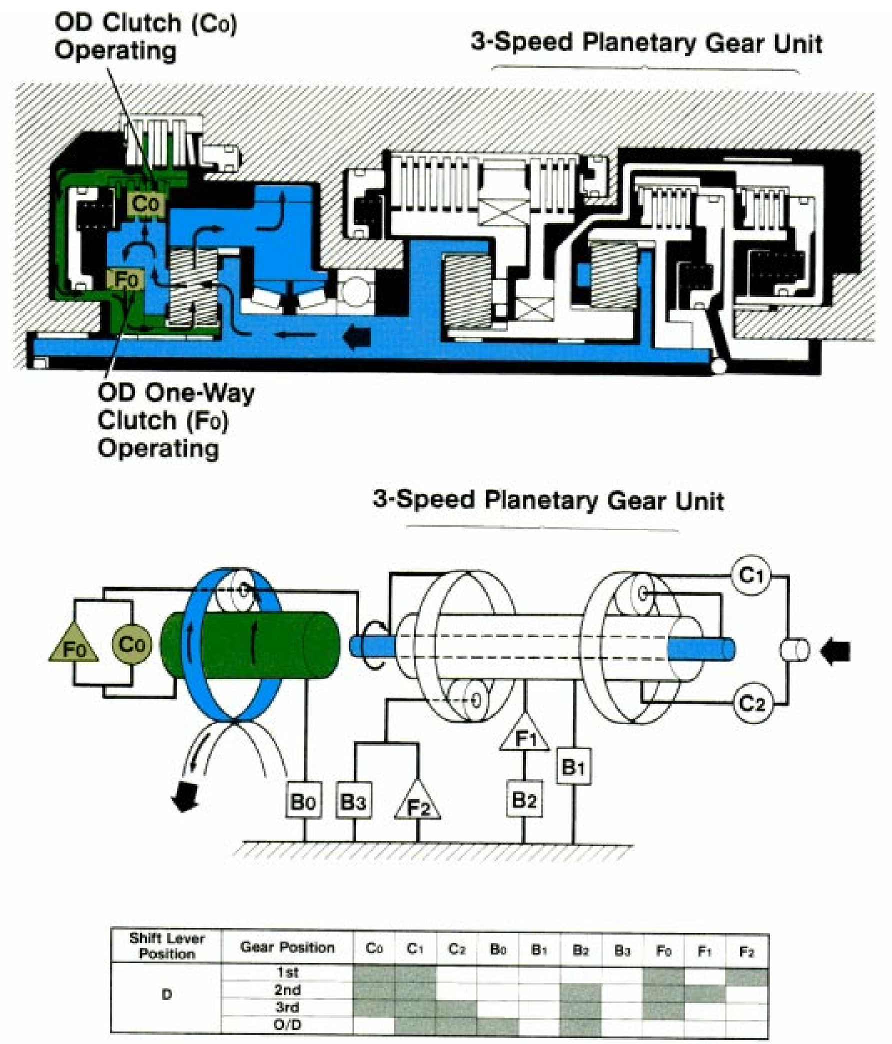


Direct Drive (Not in Overdrive)

The overdrive planetary unit is in direct drive (1:1 gear ratio) for reverse and all forward gears except overdrive. In direct drive the OD direct clutch (CO) and OD one-way clutch (F0) are both applied locking the sun gear to the carrier. With the sun gear and carrier locked together, the ring gear rotates with the carrier and the OD assembly rotates as one unit.

Not in Overdrive

The overdrive planetary unit is in direct drive for reverse and all forward gears except overdrive.

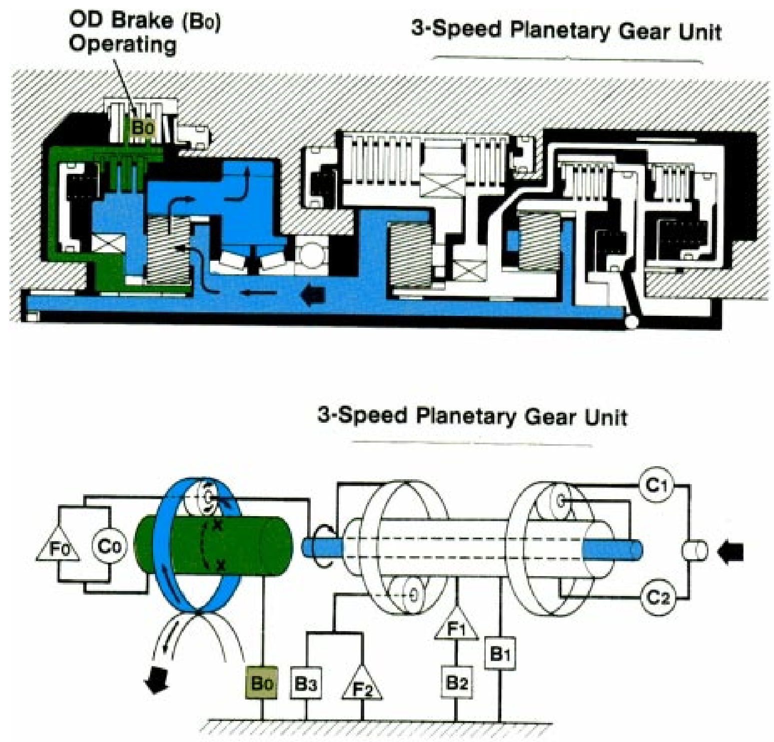


Overdrive

In overdrive, the OD brake (BO) locks the OD sun gear, so when the overdrive carrier rotates clockwise, the overdrive pinion gears revolve clockwise around the overdrive sun gear while rotating around the pinion shafts. Therefore, the overdrive ring gear rotates clockwise faster than the overdrive carrier.

Overdrive

The overdrive ring gear rotates clockwise faster than the overdrive carrier.



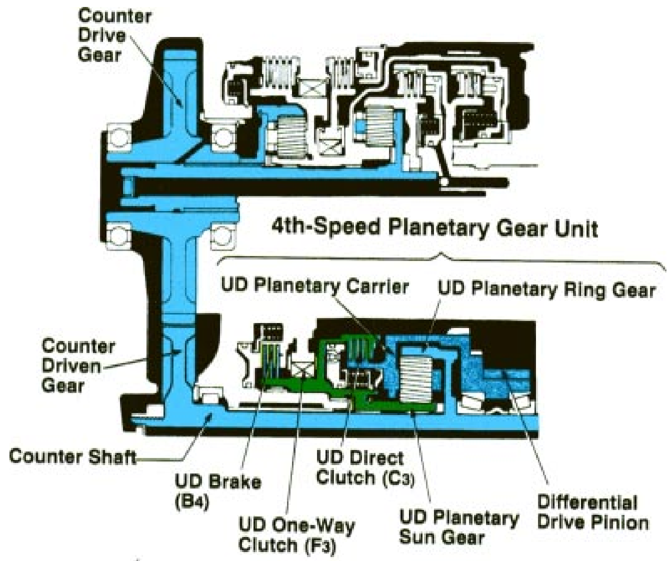
Shift Lever Position	Gear Position	C_0	C_1	C_2	B_0	B_1	B_2	B_3	F_0	F_1	F_2
D	1st	■	■						■		■
	2nd	■	■				■		■	■	
	3rd	■	■	■			■		■		
	O/D		■	■	■		■				

Power Flow Through Underdrive Unit of A240

The fourth-speed planetary gear unit of the A240 automatic transaxle is mounted on the counter shaft. Both the construction and operation of this unit differ from those of the overdrive planetary gear unit discussed earlier.

Underdrive Planetary Gear Unit

Overdrive is accomplished through the counter drive and driven gears



The overdrive ratio is accomplished through the counter drive and driven gears on the rear of the transmission. The counter drive gear is larger in diameter and has more gear teeth than the counter driven gear. The input torque to the underdrive unit is already in overdrive and the underdrive unit runs at a reduction gear ratio in first through third gears and reverse.

Holding Devices

The holding devices for the underdrive transmission are identified in the following chart with the components they control.

Function of Holding Devices

HOLDING DEVICE		FUNCTION
C_1	Forward Clutch	Connects input shaft and front planetary ring gear.
C_2	Direct Clutch	Connects input shaft and front and rear planetary sun gear.
C_3	U/D Clutch	Connects underdrive sun gear and underdrive planetary carrier.
B_1	2nd Coast Brake	Prevents front and rear planetary sun gear from turning either clockwise or counterclockwise.
B_2	2nd Brake	Prevents outer race of F_1 from turning either clockwise or counterclockwise, thus preventing the front and rear planetary sun gear from turning counterclockwise.
B_3	1st and Reverse Brake	Prevents rear planetary carrier from turning either clockwise or counterclockwise.
B_4	U/D Brake	Prevents underdrive sun gear from turning either clockwise or counterclockwise.
F_1	No. 1 One-Way Clutch	When B_2 is operating, this clutch prevents the front and rear planetary sun gear from turning counterclockwise.
F_2	No. 2 One-Way Clutch	Prevents rear planetary carrier from turning counterclockwise.
F_3	U/D One-Way Clutch	Prevents underdrive planetary sun gear from turning clockwise.

Clutch Application Chart

The gear position in which these holding devices are applied can be found on the following clutch application chart. The clutch application chart is similar to the one seen earlier; however, three additional holding devices for the underdrive have replaced those of the overdrive unit. The *underdrive brake* (B4) is applied in reverse and all forward gears except overdrive. The *underdrive one-way clutch* (F3) is applied in all forward gears only. The *underdrive clutch* (C3) is applied in overdrive only.

Clutch Application Chart for A240 Trans

Shift Lever Position	Gear Position	C_1	C_2	C_3	B_1	B_2	B_3	B_4	F_1	F_2	F_3
P	Parking							●			
R	Reverse		●				●	●			
N	Neutral							●			
D	1st	●						●		●	●
	2nd	●				●		●	●		●
	3rd	●	●			●		●			●
	O/D	●		●		●					
2	1st	●						●		●	●
	2nd	●			●	●		●	●		●
	3rd*	●	●			●		●			●
L	1st	●					●	●		●	●
	2nd*	●			●	●		●	●		●

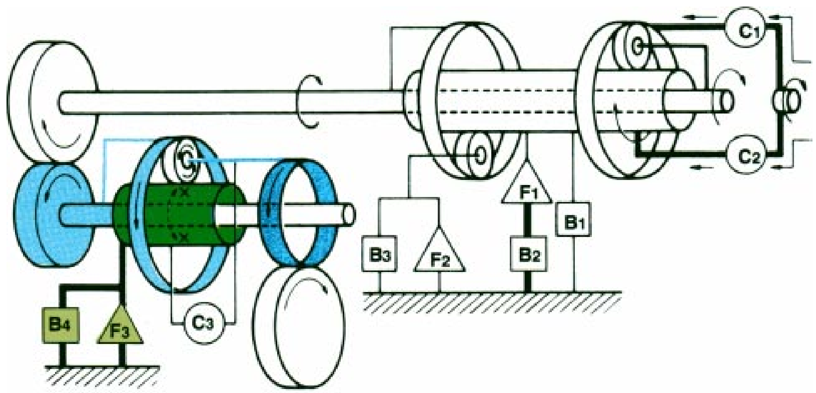
***Down-shift only in the 3rd gear for the 2 range and 2nd gear for the L range—no up-shift**

Other Than Fourth Gear

When the transmission is in a gear other than fourth gear, the *underdrive brake* (B4) and the *underdrive one-way clutch* (F3) operate, locking the underdrive sun gear to the transmission case. When the sun gear is locked, the ring gear drives the pinion gears and they walk around the sun gear while rotating counterclockwise. The result is that rotation of the carrier is a slower speed than the ring gear rotation. In truth we have a gear reduction through the underdrive planetary gear set.

Underdrive Power Flow Other Than Fourth Gear

The sun gear is held to the case, output is a gear reduction from the planetary carrier.



Other Than 4th Gear

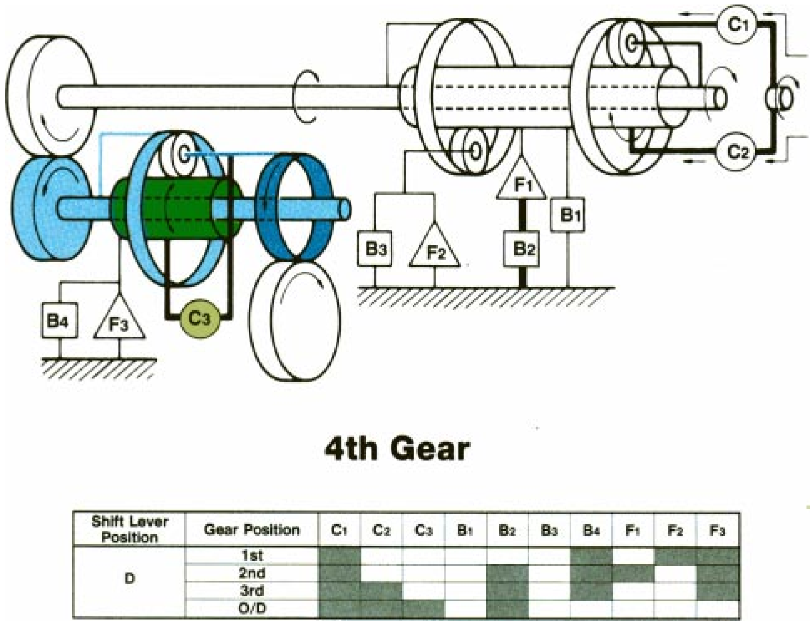
Shift Lever Position	Gear Position	C1	C2	C3	B1	B2	B3	B4	F1	F2	F3
D	1st	■						■		■	■
	2nd	■				■		■	■		■
	3rd	■	■			■		■			■
	O/D	■	■	■		■					

Fourth Gear

In fourth gear, the *underdrive direct clutch* (C3) is operating locking the sun gear with the planetary carrier and the planetary gear set rotates as a unit. The differential drive pinion is driven by the planetary carrier. The actual overdrive gear ratio takes place in the counter drive and driven gears.

Underdrive Power Flow Fourth Gear

The sun gear and the carrier are locked together probiding direct drive within the underdrive planetary gear set.



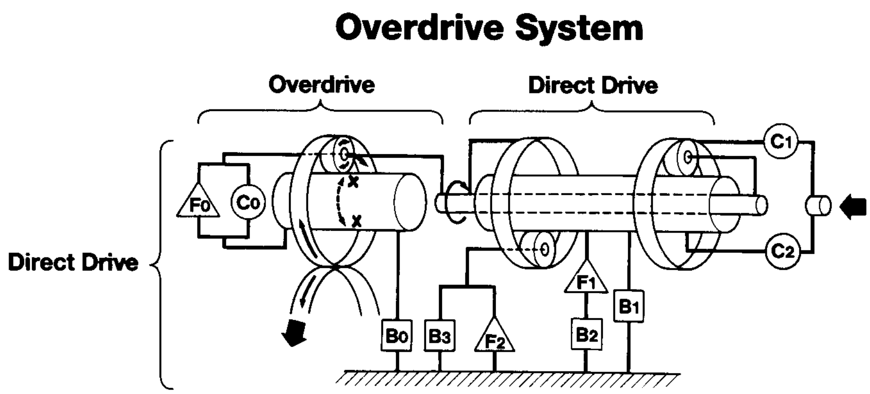
Shift Lever Position	Gear Position	C_1	C_2	C_3	B_1	B_2	B_3	B_4	F_1	F_2	F_3
D	1st	■						■		■	■
	2nd	■				■		■	■		■
	3rd	■	■			■		■			■
	O/D	■	■	■		■					

Contrasting Overdrive and Underdrive Systems

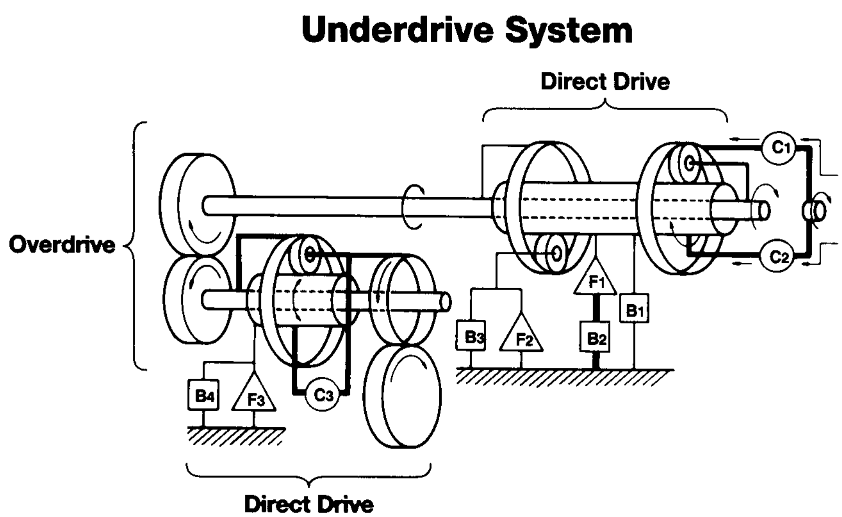
The single greatest advantage that the underdrive system has over other overdrive systems is that while cruising, all planetary gear sets are in direct drive and fewer parts are moving. For example, the Simpson planetary is in direct drive, the underdrive is in direct drive, overdrive is accomplished in the drive and driven gears. The overdrive system, on the other hand, has the Simpson planetary gear set in direct drive, the overdrive unit in the overdrive mode with the sun gear held, the planetary carrier driving the ring gear in overdrive, and the drive and driven gears providing direct drive.

Comparing Fourth Gear

Overdrive is accomplished through OD planetary gear set.

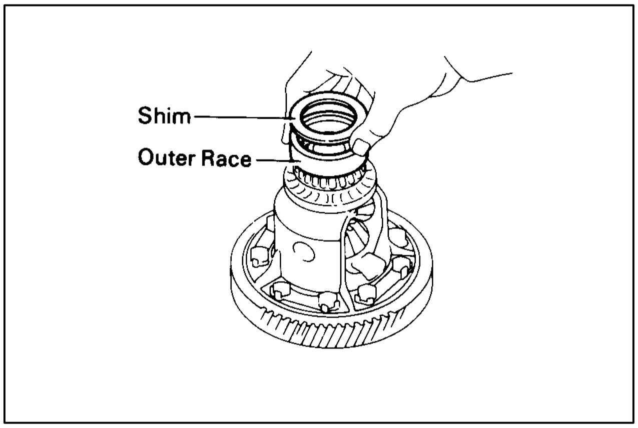


Overdrive is accomplished through the drive and driven gear.



PROCEDURE
Adjustment of Differential Side Bearing Preload

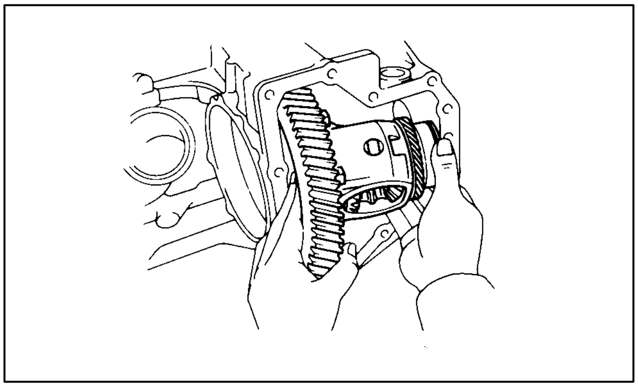
Perform the following procedures. Write-in the measurement or specification in each of the boxes.



1. **Place outer race and adjusting shim onto RH side bearing.**

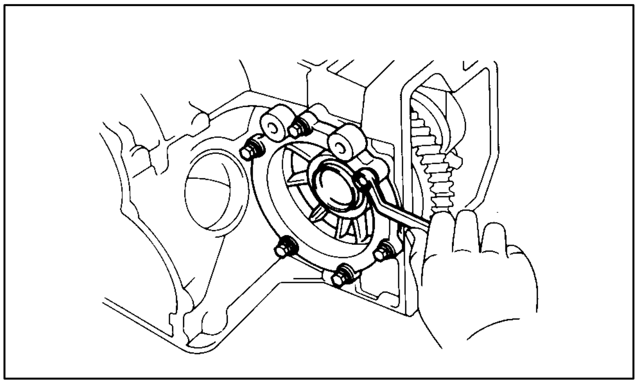
   Use the adjusting shim which was removed or one 2.40 mm (0.0945 in.) thick.

   Adjustment Shim Thickness: [ ]



2. **Place differential case into transaxle case.**

   Be sure to install the adjusting shim.

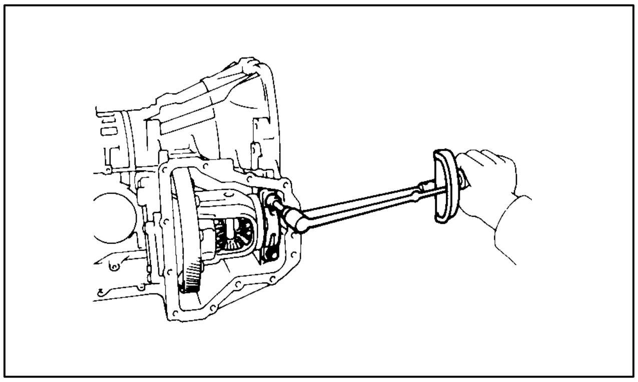


3. **Install LH bearing retainer.**

   a. DO NOT install the O-ring yet.

   b. Do not coat the bolt threads with sealant yet.

   c. Temporarily tighten the bolts evenly and gradually while turning the ring gear.

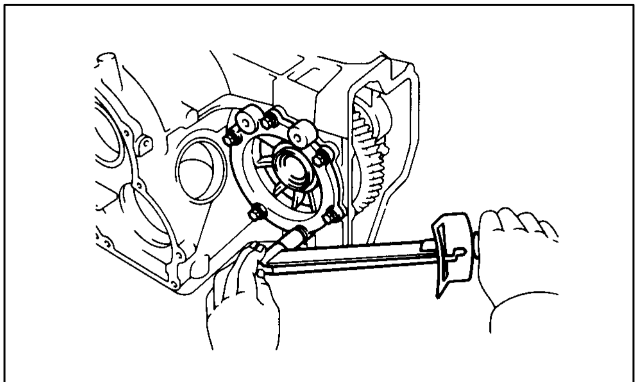


4. **Install RH side bearing cap.**

   Tighten the bolts evenly and gradually while turning the ring gear.

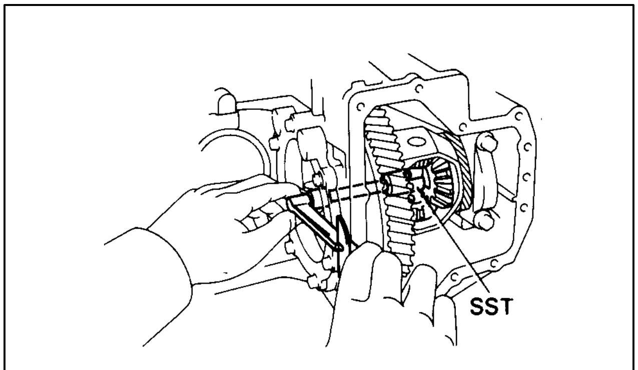
   Torque: [ ] **Ft.-Lbs.**

PROCEDURE
Adjustment of Differential Side Bearing Preload



5. Tighten LH bearing retainer

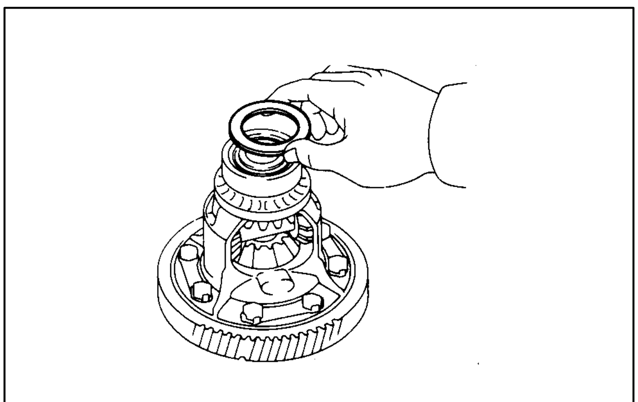
Torque:	**Ft.-Lbs.**



6. Adjust Side Bearing Preload

Using SST and a torque wrench, measure the preload of the ring gear. (SST 09564-32011)

Preload (at Starting)	Spec.	Measured
New Bearing		
Reused Bearing		



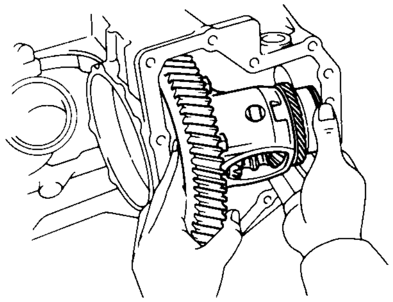
If the preload is not within specification, remove the differential case assembly. Reselect the RH adjusting shim.

Thickness mm (in.)	Thickness mm (in.)
1.90 (0.0748)	2.40 (0.0945)
1.95 (0.0768)	2.45 (0.0965)
2.00 (0.0787)	2.50 (0.0984)
2.05 (0.0807)	2.55 (0.1004)
2.10 (0.0827)	2.60 (0.1024)
2.15 (0.0846)	2.65 (0.1043)
2.20 (0.0866)	2.70 (0.1063)
2.25 (0.0886)	2.75 (0.1083)
2.30 (0.0906)	2.80 (0.1103)

Hint:
The preload will change about 3-4 kg-cm (2.6-3.5 in.-lbs, 0.3 - 0.4 Nm) with each shim thickness.

Original Shim:	**mm**
Torque Change required	**in.lbs.**
Recommendend Shim	**mm**

PROCEDURE
Adjustment of Differential Side Bearing Preload



7. **Remove differential case and component parts.**

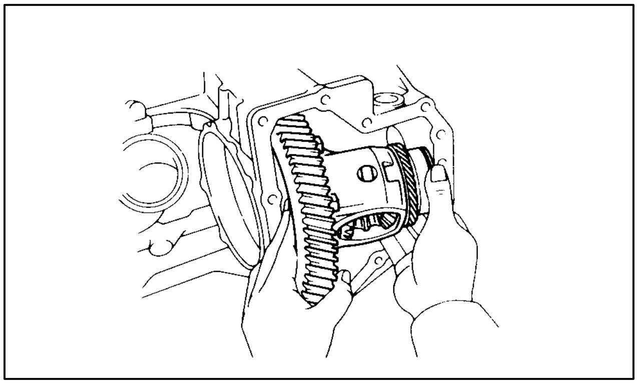
   If the preload is adjusted within specification, remove the bearing retainer, differential case, RH side bearing, and shim.

   Be careful not to lose the adjusted shim.

Instructor OK

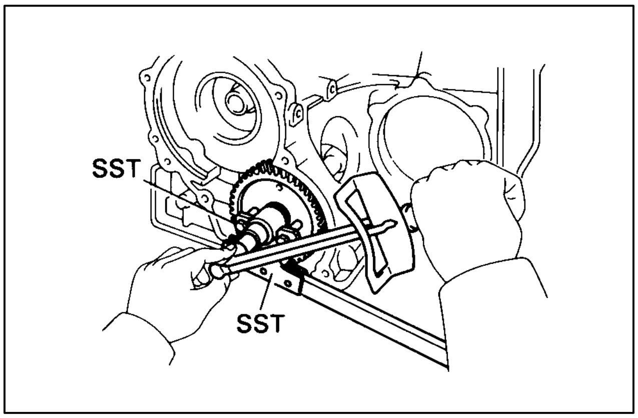
PROCEDURE

Drive Pinion Preload



Perform the following procedures. Write in the measurement or specification in each of the boxes.

1. Remove the differential case, outer race, and adjusting shim.



2. Adjust drive pinion preload.

a. Coat the threads and surface of the nut with MP grease

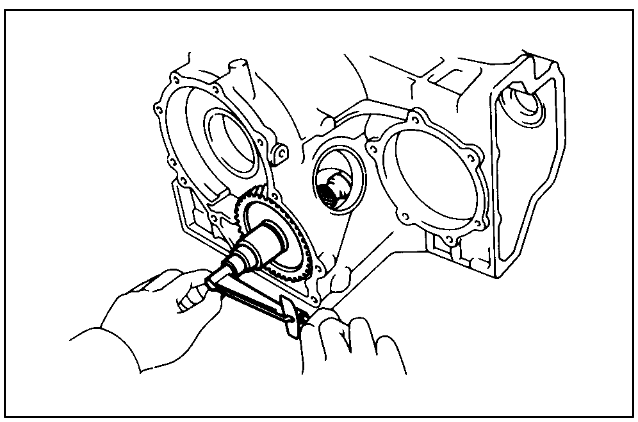
b. Using SST to hold the gear, tighten the nut.

Torque: [   ] **Ft.-Lbs.**

SST 09330-00021, 09350-32014 (09351-32031)

c. Turn the gear counterclockwise and clock-wise several times.

d. Using a torque wrench, measure the preload of the drive pinion.



Preload (at Starting)	Spec.	Measured
New Bearing		
Reused Bearing		

- If the preload is greater than specified, replace the bearing spacer.
- If the preload is less than specified, retighten the nut [   ] ft.-lbs., at a time until the specified preload is reached.

If the maximum torque is exceeded while retightening the nut, replace the bearing spacer and repeat the preload procedure.

Do not back off the nut to reduce the preload.

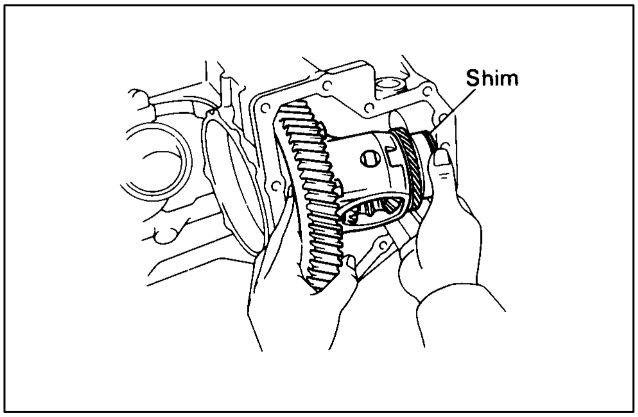
Maximum Torque: [   ] **Ft.-Lbs.**

e. If the preload is adjusted within specification, make a note of it.

Preload: [   ] **In.-Lbs.**

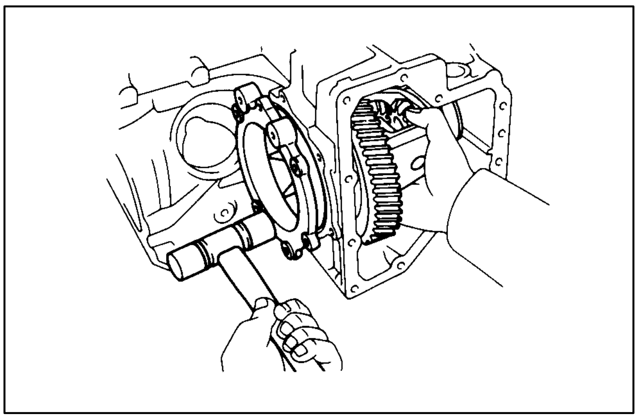
PROCEDURE

Drive Pinion Preload (Continued)



3. Place differential case into transaxle case.

Be sure to install the adjusting shim.

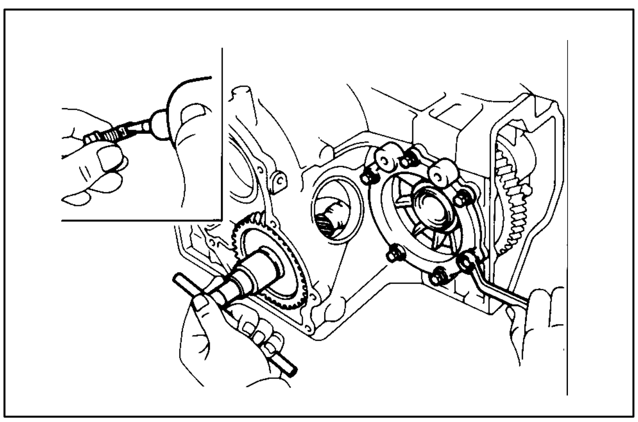


4. Install LH Bearing Retainer

a. Install a new O-ring.

b. Position the retainer by tapping it while holding the differential case center with the retainer.

c. Clean the threads of the bolts and case with white gasoline.

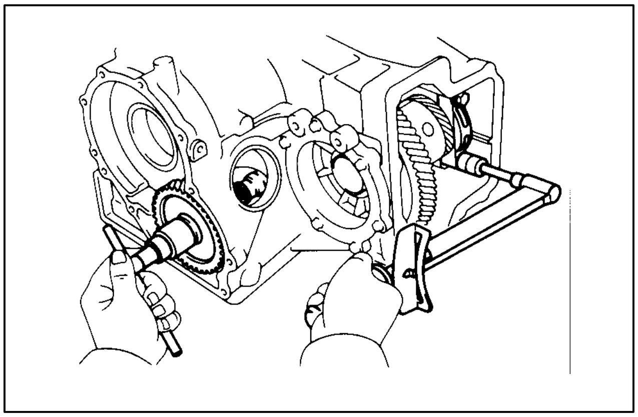


d. Coat the threads of the bolts with sealer.

Sealer: Part No. 08833-00070, THREE BOND 1324 or equivalent.

e. Temporarily tighten the bolts evenly and gradually while turning the ring gear.

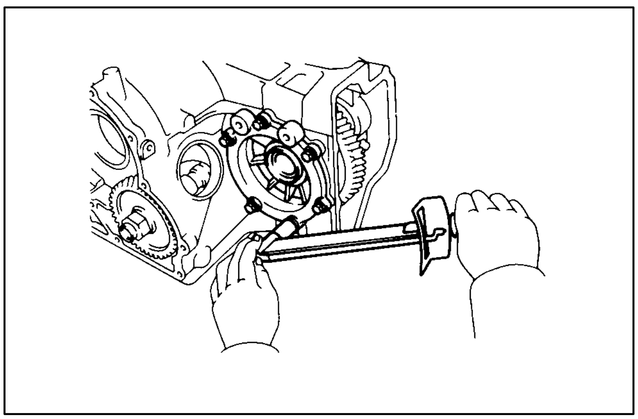
PROCEDURE
Drive Pinion Preload (Continued)



5. Install RH Side Bearing Cap

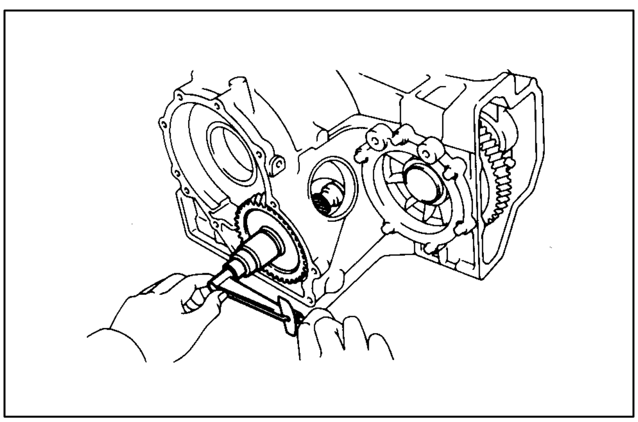
Tighten the bolts evenly and gradually while turning the ring gear.

Torque: ______ **Ft.-Lbs.**



6. Tighten LH Bearing Retainer

Torque: ______ **Ft.-Lbs.**



7. Measure Total Preload

Using torque meter, measure the total preload of the drive pinion shaft.

Total preload specification (at starting):

Drive pinion preload	**in.-lbs.**
ADD: New bearing	**in.-lbs.**
Reused bearing	**in.-lbs.**
Total preload specification	**in.-lbs.**
Measured Preload:	**in.-lbs.**

If the preload is not within specification, redis-assemble and readjust.

Instructor OK ______

Section 6

AUTOMATIC TRANSMISSION FLUID

- **Transmits engine torque**
- **Controls hydraulic system**
- **Applies clutches and brakes**
- **Lubricates moving parts**
- **Removes heat from internal parts**
- **Cleans**

Lesson Objectives:

1. Describe the purpose for the following oil additives:

   a. Viscosity index improver
   b. Oxidation inhibitors
   c. Anti-foaming agent
   d. Corrosion inhibitors

2. List the three types of ATF and their application in Toyota automatic transmissions.

3. Identify automatic transmission fluid conditions and their cause.

The automatic transmission hydraulic system requires special fluid for the transmission to operate properly and provide a long service life. A filter is used to clean the fluid and prevent wear and damage from occurring to the components of the transmission. An oil to water cooler is also provided in the radiator of the cooling system in order to remove excessive heat from the fluid. In addition, since the engine cooling system reaches operating temperature quicker than the transmission, the cooler helps to warm-up the transmission fluid.

Function of ATF

Automatic transmission fluid is a high-grade petroleum product containing several kinds of special chemical additives and is abbreviated as ATF. This fluid plays various important functions in the automatic transmission. It is pressurized by the transmission oil pump and fed to the torque converter and transmits the torque generated by the engine to the transmission. The pressurized ATF flows through the passages and valves to operate the clutches and brakes that control the planetary gears and other moving parts. In addition it cools, cleans and lubricates all moving parts.

ATF Additives

In order to perform all these functions for thousands of miles and deliver satisfactory performance, a number of additives are used to deal with the environment of close tolerances, high heat and rotating components.

Viscosity

ATF is subjected to a wide range of temperatures from -77°F to 338°F. When temperatures are low, viscosity increases and ATF does not flow well. As a result, shift timing may be delayed, slippage at bands and multiple disc holding devices may occur. On the other hand, if the temperature is too hot, the fluid thins out and the lubrication film may break down, causing metal to metal contact and wear. Therefore viscosity is one of the most important factors affecting ATF's ability to operate the torque converter, valve body components and the holding devices. ATF includes a viscosity index improving agent to maintain viscosity at high temperatures and pour point depressants to improve low temperature flowability.

Thermal and Oxidation Stability

ATF temperatures reach around 212°F at normal speeds and up to about 300°F under severe operating conditions. The surface temperature of clutch disc may heat up to 660°F or more. Therefore ATF must have good thermal resistance. If it does not, deterioration due to heat causes a chemical reaction to occur, leading to greater oxidation of its oil molecules which causes formation of varnish, sludge and acids which leads to internal damage. Oxidation inhibitors are used to combat heat related fluid breakdown.

Defoaming Characteristics

ATF is violently churned and sheared between the impeller and turbine in the torque converter. During periods of high vortex, the shearing of ATF creates a tremendous amount of heat. The churning and shearing of fluid causes it to foam as air is mixed with the fluid. Foam reduces pressure and promotes slippage, wear and oxidation of the fluid. An anti-foaming agent is added to ATF to prevent air bubbles and reduce the lifespan of bubbles that do form.

Corrosion Inhibitors

Water and oxygen cause rust formation or etching of metal components. Corrosion inhibitors are added to coat and adhere to metal components and prevent moisture from accumulating and causing damage.

ATF Types

Three types of fluid have been used in Toyota automatic transmissions. Type T is the latest type to be used and is found in All-Trac transaxles (A241H and A540H). Type F was used in early Toyota automatics up until August 1982. All front engine front drive transaxles used Dexron II. In July 1983 all Toyota transmissions, front wheel drive and rear wheel drive used Dexron II.

ATF Used by Toyota

- **Type "T"**
  All-Trac Transaxles A241H & A540H
- **Dexron II**
  All Toyota Automatic Transmissions since 1984 (except All-Trac)
  Prior to 1984 — A55 (1983), A41, & A140
- **Type "F"**
  All Toyota Automatic Transmissions prior to 1984

Fluid Condition

While checking the fluid level, the condition of the fluid should be evaluated. The condition of the fluid can tell you about what can be expected inside the transmission and may confirm the test drive symptoms.

If the fluid is dark reddish brown or brown-black and smells burnt, this may indicate that the fluid has not been changed at proper intervals. Removing the pan may reveal large amounts of sediment, indicating a failed multiplate clutch or brake. Flakes in the fluid indicate a massive internal failure.

If the fluid is milky colored, coolant is mixed with the ATF. In advanced stages, the engine may overheat and you will find oil in the coolant system. In some cases, water may enter the transmission case through the breather cap or dip stick tube due to flooding or driving in adverse weather conditions with a filler tube that has not been capped with the dip stick.

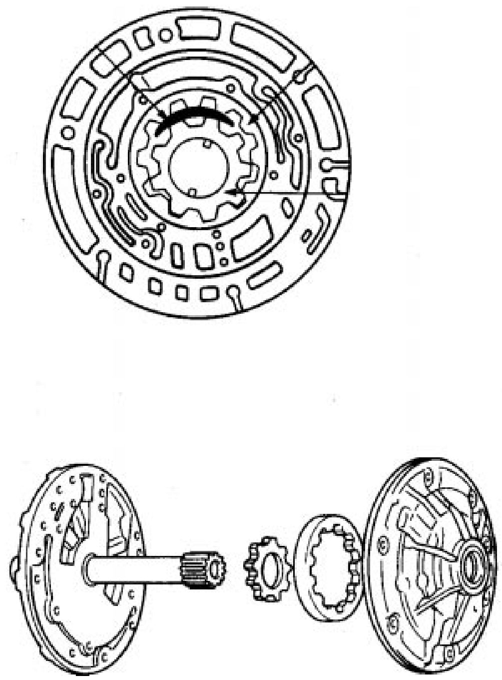
Aerated fluid can be caused by low fluid level or high fluid level as discussed earlier. Small bubbles will cover the dip stick as an indication of this condition. In advanced stages, it will cause oxidation and varnish buildup. Air is whipped into the fluid and heat will cause the fluid to oxidize. Varnish build-up will cause the valves in the valve body to stick.

As a rule of thumb, transmission fluid should last 100,000 miles if the operating temperature remains no higher than 175°F. For every 20 degrees of temperature increase, the projected service life of the fluid is cut in half. For example, if operating temperature is allowed to remain at 195°F, the service life of the fluid would be 50,000 miles.

Notes

Section 7

TRANSMISSION OIL PUMP



Lesson Objectives:

1. Demonstrate the measurement of the oil pump gears to determine the serviceability of the oil pump.
2. Demonstrate the measurement of oil pump bushings to determine the serviceability of the oil pump.
3. Describe the operation of the gear type oil pump.

Purpose of the Oil Pump

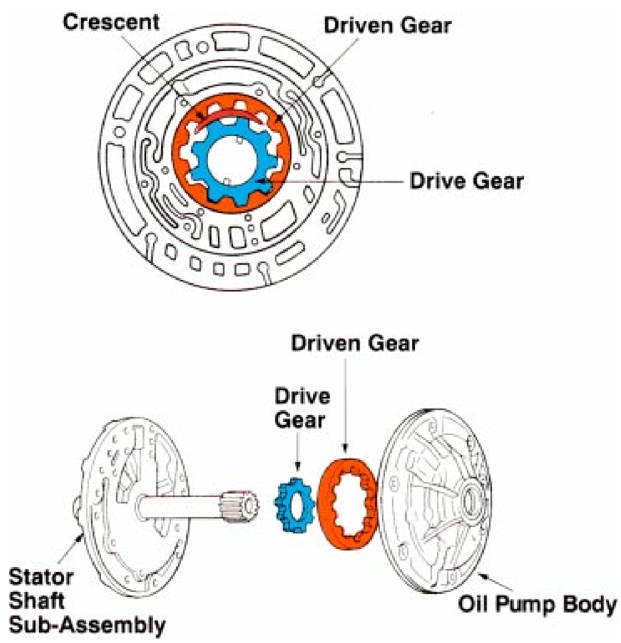
The pump used in Toyota automatic transmissions is the crescent type. It is designed to:

- Provide fluid to lubricate the planetary gear set.
- Provide continuous fluid to the torque converter.
- Provide a volume of fluid to the clutches and brakes.
- Supply operating pressure to the hydraulic control system.
- Provide support for the torque converter stator (stator reaction shaft) as well as the front of planetary gear set.

Oil Pump Operation

The oil pump is driven by the torque converter. The center drive gear is driven by the torque converter drive hub. The external teeth of the drive gear mesh with the internal teeth of the driven gear, causing it to rotate in the same direction. Located between the two gears is the crescent, which separates the inlet of the pump from the outlet. As the gears rotate in a clockwise direction, a low pressure develops on the inlet side of the pump as the gear teeth move away from each other. On the other end of the crescent, the gear teeth come together forcing the fluid through the outlet.

Oil Pump



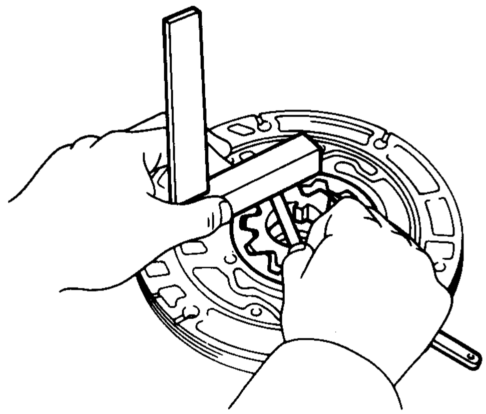
The pump therefore controls the volume of fluid being delivered. Pressure is determined by the amount of leakage and controlled drains on the outlet circuits and engine speed. The pressure regulator valve in the valve body controls pressure by allowing for leakage based on vehicle speed and engine load. Maximum pressure is regulated by the pressure relief valve that allows for leakage when the oil pressure overcomes the tension of a calibrated spring. More detail about these valves will be discussed in the section on the valve body.

The oil pump can be checked in two ways: by means of a pressure gauge set while the transmission is still in the vehicle or mechanically by the use of feeler gauges when the pump has been removed and disassembled.

Gear Height Measurement

Place a straight edge across the pump housing and drive and driven gear. Measure the clearance between the straight edge and each gear using a feeler gauge. If the clearance is greater than the maximum, the gears should be replaced.

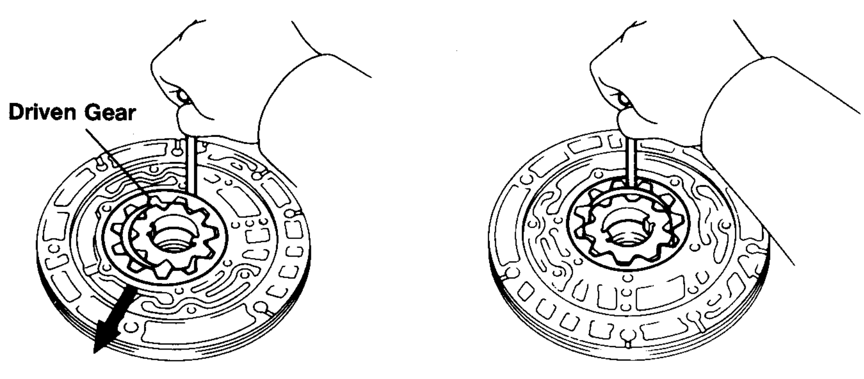
Pump Gear Height



Gear Clearance Measurement

Check pump body clearance by pushing the driven gear to one side and measuring the clearance between the gear and the pump body on the opposite side. Then measure the driven gear to crescent clearance. If the clearances exceed the maximum specification, replace the pump subassembly.

Pump Gear Clearance



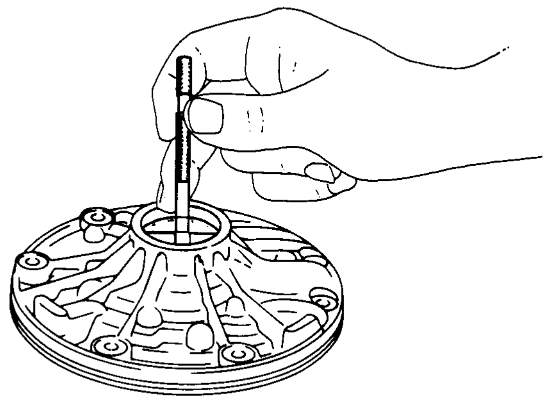
CAUTION

If the gears are removed from the pump housing, make sure that you mark the gears with machinist blue. The importance here is that both gears face up when reinstalled because the gear teeth have worn-in. It is not important that the same teeth are matched. Do not scratch the gears to mark them as this may damage the housing when the pump is assembled.

Pump Bushing Diameter

The oil pump bushing supports the torque converter drive hub. If the bushing is worn excessively, the front transmission seal may wear prematurely. To measure the diameter, first remove the oil seal and then using a snap gauge or other measuring device, measure the inside diameter of the bushing in three positions. If the largest diameter is greater than the specification, replace the oil pump body.

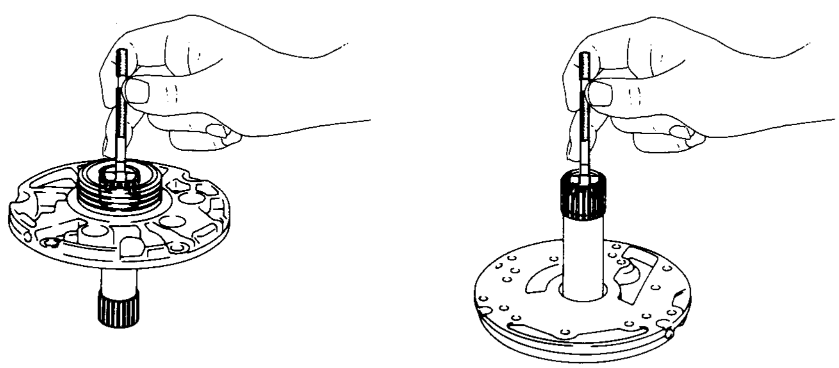
Pump Bushing Diameter



Stator Shaft Bushing Inspection

The stator shaft bushings support the input shaft of the transmission. Measure the inside diameter of the bushings with a snap gauge or other measuring device in three different positions. If the largest diameter is greater than the specification, replace the stator shaft assembly.

Stator Shaft Bushing



NOTE: When the stator shaft bushings are worn, also check the ring grooves of the input shaft. Worn bushings allow the input shaft to wobble and the top surface of the grooves will wear, closing the width of the groove.

WORKSHEET 3
Oil Pump Inspection

Perform the following procedures. Write in the measurement or specification in each of the boxes.

1. Check body clearance of driven gear.

Push the driven gear to one side of the body.

Using a feeler gauge, measure the clearance.

	Spec.	Measured	OK/NG
Standard Body Clearance			
Maximum Body Clearance			

2. Check tip clearance of driven gear.

Measure between the driven gear teeth and the crescent shaped part of the pump body.

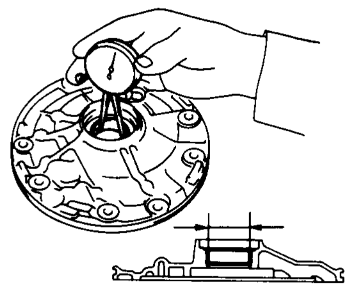
	Spec.	Measured	OK/NG
Standard Body Clearance			
Maximum Body Clearance			

3. Check side clearance of both gears.

Using a steel straightedge and a feeler gauge, measure the side clearance of both gears.

	Spec.	Measured	OK/NG
Standard Body Clearance			
Maximum Body Clearance			

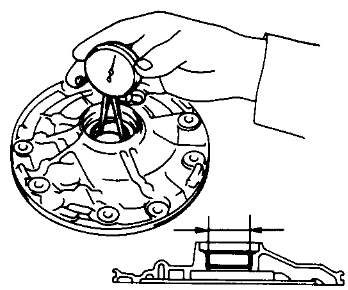
WORKSHEET 3
Oil Pump Inspection



4. Check oil pump body bushing.

Using a dial indicator, measure the inside diameter of the oil pump body bushing.

	Spec.	Measured	OK/NG
Maximum Inside Diameter			



5. Check stator shaft bushings.

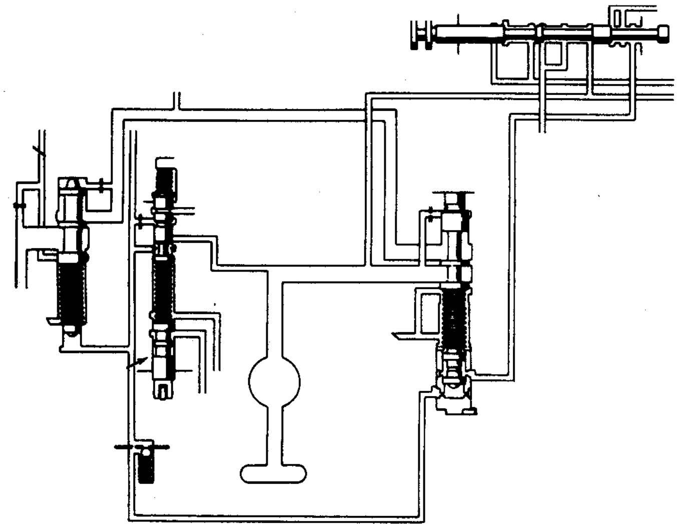
Using a dial indicator, measure the inside diameter of the stator shaft bushing.

Maximum Inside Diameter	Spec.	Measured	OK/NG
Front Side			
Rear Side			
Recommendation			

STOP! Do not proceed! Obtain Instructor OK.

Section 8

VALVE BODY CIRCUITS



Lesson Objectives:

1. Describe the function of pressure control valves in the valve body as they apply to:
   - Slippage
   - Upshifting
   - Downshifting
   - Lubrication
2. Describe the function of shift control valves in the valve body as they apply to:
   - Line pressure distribution
   - Downshifting
   - Upshifting
3. Describe the function of timing (sequencing) valves in the valve body as they apply to:
   - Manual second gear downshift quality
   - Manual low gear shift quality
   - Reverse gear engagement quality
   - Automatic upshift and downshift engagement
4. Describe the function of pressure modulating valves in the valve body as they apply to:
   - Manual second gear downshift quality
   - Manual low gear shift quality
   - Control of line at cruise speed
5. Explain the effect that throttle pressure and governor pressure have on the shift valves and clutch application.
6. Describe the effect of the shift solenoids on the position of the shift valves in each of the following gear ranges:
   - First gear
   - Second gear
   - Third gear
   - Fourth gear

The valve body consists of an upper valve body, a lower valve body and a manual valve body. The two body halves are separated by a separator plate which contains openings that control the flow of fluid between valve circuits. The valves contained therein control fluid pressure and switch fluid from one passage to another. Hydraulic circuits extend to the transmission housing and are connected either by direct mounting or through oil tube passages.

The valves are a precision fit to the bore in the body, and their position is determined by a balance between spring tension and hydraulic pressure. Hydraulic pressure within the valve body will vary based on throttle position or pressure modulating valves. In the case of a non-ECT transmission, pressure also varies based on vehicle speed through the governor valve.

In order to understand what the many valves do in the valve body, they have been separated by function as listed below:

- Pressure control valves
- Hydraulic control valves
- Timing (Sequencing) valves
- Pressure modulating valves

Pressure Control Valves

Pressure control valves regulate pressure within the transmission. Hydraulic pressure is necessary to apply the clutches, brakes, and bands that hold planetary gear components of the transmission. There are times when high pressure is necessary and other times when it is less important. The primary concern with high pressure is that engine power is lost and excessive heat is generated. Heat breaks down the transmission fluid and robs it of its properties. On the other hand, fuel economy is important to achieve, so by regulating pressure, less load is placed on the engine.

Primary Regulator Valve

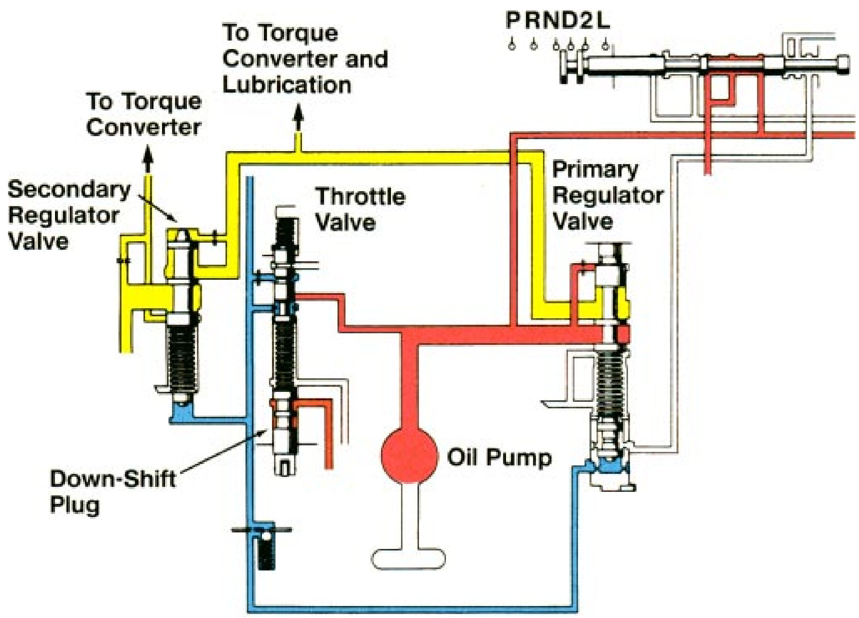
This valve adjusts the pressure from the oil pump to all the hydraulic circuits in the transmission. The purpose of the valve is to reduce engine load and power loss. If pressure remained high, it would cause hard shifting and would create more heat which would be a problem for fluid life, and additional engine power is lost just turning the pump. By reducing pressure, less power is required to rotate the pump and less heat is generated.

The amount of pressure has a direct effect on the holding force of clutches and brakes. It should be high when accelerating the vehicle in first or reverse gear. As the vehicle picks up speed, less holding force is needed, and therefore, pressure is decreased.

The output of the valve is called the ”line pressure,” the highest oil pressure anywhere in the transmission. Line pressure is shown in the color red at all times in Toyota publications.

The position of the primary regulator valve is determined by throttle pressure, line pressure and spring tension. Spring tension pushes the valve up for higher line pressure. Line pressure is routed to the top of the valve and counters spring tension to reduce line pressure. The overall effect is a balance between line pressure and spring tension.

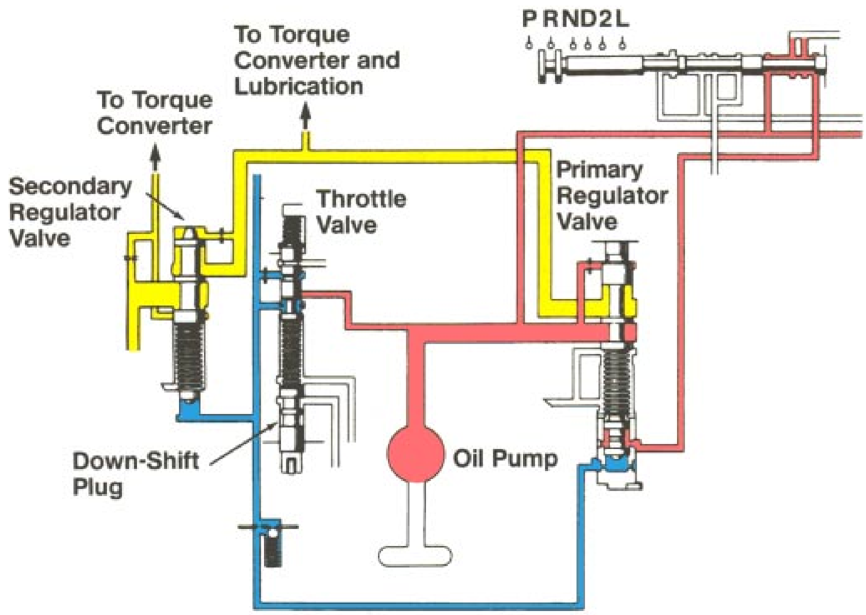
Primary Regulator Valve



At the base of the valve, throttle pressure is applied to push the valve upward, increasing line pressure. The greater the throttle opening, the greater line pressure becomes as the pressure regulator valve bleeds off less pressure.

Line pressure is also increased when reverse gear is selected. Line pressure from the manual valve is directed to the bottom of the valve pushing it upward, increasing line pressure by as much as 50%.

Primary Regulator Valve in R-Range

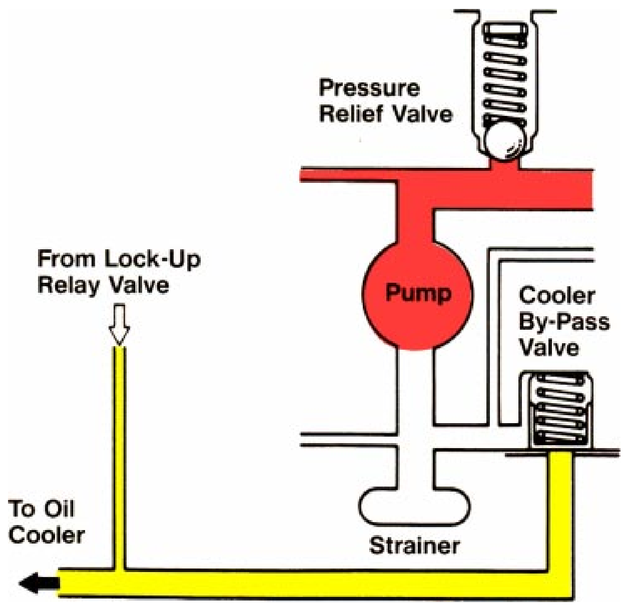


This valve regulates the converter pressure and lubrication pressure. Spring tension pushes the valve upward to increase converter pressure. Converter pressure acts on the top of the vvalve to create a alance between it and spring tension. In addition, in some applicatio

Oil Cooler By-Pass Valve

This valve prevents excessive pressure in the circuit to the oil cooler. The circuit is a low pressure system which routes oil through the oil cooler in the tank of the radiator and back to the sump of the transmission. The valve is spring loaded in the closed position. When pressure exceeds the spring rate, excess pressure is relieved.

Oil Cooler By-Pass Valve and Pressure Relief Valve



Pressure Relief Valve

This valve regulates the oil pump pressure so that it does not rise above a predetermined maximum value. A calibrated spring-is used to control the pressure by holding the valve against its seat.

Notes

Governor Valve

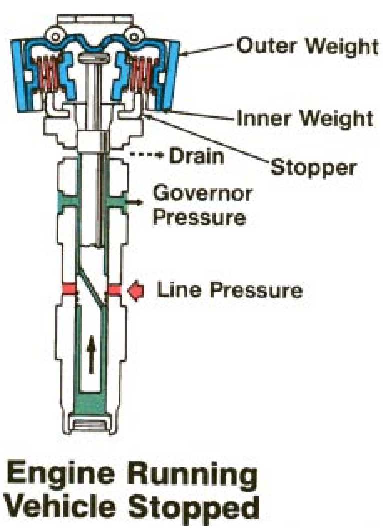
This valve is found on all non-ECT transmissions. It is mounted on the output shaft of rear-wheel drive transmissions or is driven from the drive gear on the differential drive pinion/output shaft on front-wheel drive transmissions. It balances the line pressure routed from the manual valve and the centrifugal force of the governor weights to produce hydraulic pressure in proportion to vehicle speed. The greater the speed of the output shaft, the greater the governor pressure.

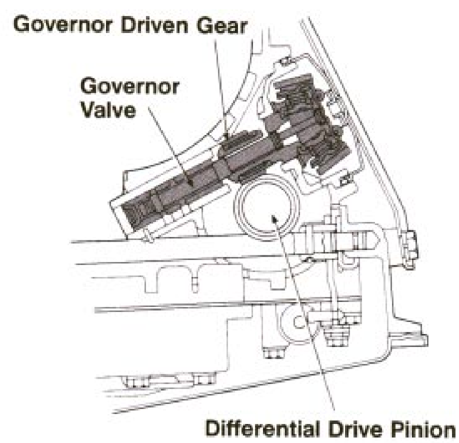
The parts which make up the governor include an inner weight and an outer weight mounted to the governor body. Both weights are hinged at their axis point. The calibrated springs push the outer weights in toward the center of the governor. The lever ends of the inner weights push down on the governor valve. The governor valve is located in the center of the governor body and is pushed upward by governor pressure through a drilled passage in the valve.

Below 10 mph, centrifugal force is low and line pressure entering through the drilled passage in the valve to the base of the valve pushes the valve upward, blocking the line pressure passage and opening the drain at the top land.

Governor Valve

Line pressure to the base of the valve moves it upward, opening the drain pport. Centrifugal force does not begin to push the valve down until approximately 10 mph.





As the governor turns, the centrifugal force of the inner and outer weights along with the spring cause the weights to open outward. As the weights move outward, the governor valve is pushed downward by the lever of the inner weights. The governor valve position is balanced between centrifugal force acting on the lever at the top of the valve and governor pressure at the base of the valve. The balance of these two forces becomes the governor pressure at that vehicle speed.

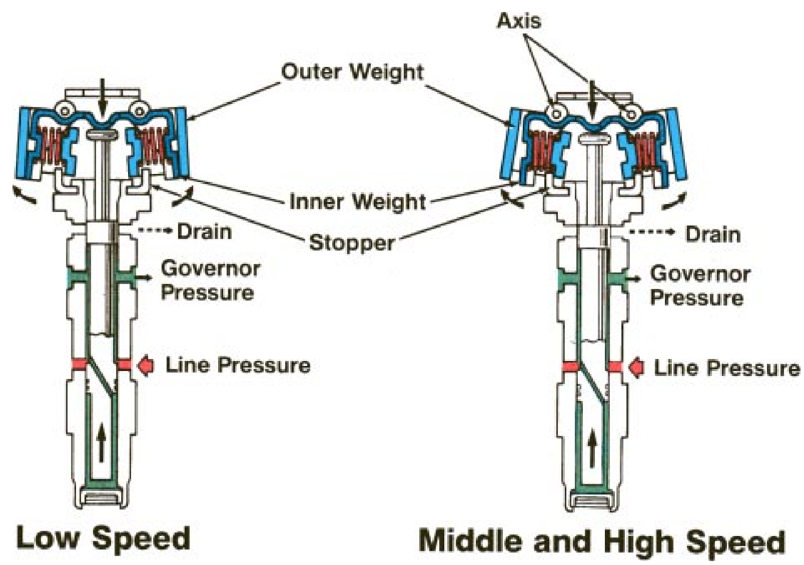
As the rpm increases (middle and high speed) the outer weight movement is limited by the stopper of the governor body. Increased governor pressure acting on the base of the valve works against spring tension. With increased rpms the centrifugal force of the inner weight and spring tension places additional force to push the valve down.

Governor pressure will remain at 0 psi until approximately 10 mph. For specific governor pressures, be sure to check the appropriate repair manual which will give a pressure and vehicle speed relationship.

Governor pressure shown in Toyota publications is always green.

Governor Valve

Governor pressure increases as weights move outward by centrifugal force



Throttle Valves

The throttle valve produces throttle pressure in response to throttle opening angle. When the accelerator pedal is depressed, the downshift plug is pushed upward via the throttle cable and throttle cam. The throttle valve therefore moves upward by means of the spring, opening the pressure passage and modifying line pressure to throttle pressure.

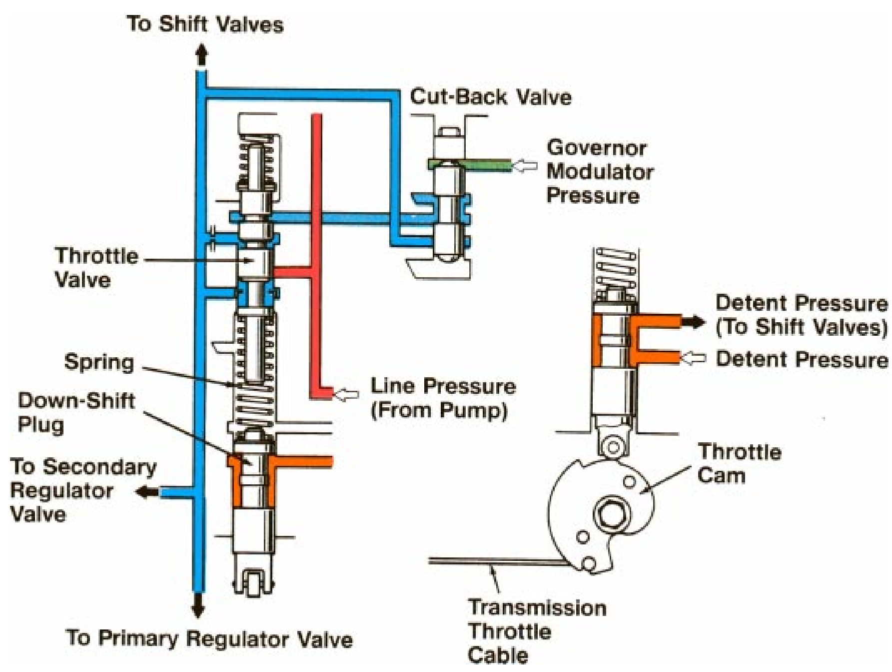
Throttle pressure shown in Toyota publications is always blue.

This throttle pressure also acts on the throttle valve, pushing it down against the spring tension. The throttle valve supplies throttle pressure to each shift valve and acts in opposition to governor pressure.

Throttle pressure also affects line pressure either directly or through throttle modulator pressure. Hydraulic pressure affected by throttle opening is directed to the base of the pressure regulator valve to increase line pressure when engine torque is increased. Additional line pressure serves to provide additional holding force at the holding devices to prevent slippage.

Throttle Valve

Throttle pressure is provided to each shift valve to counter governor pressure.



Shift Control Valves

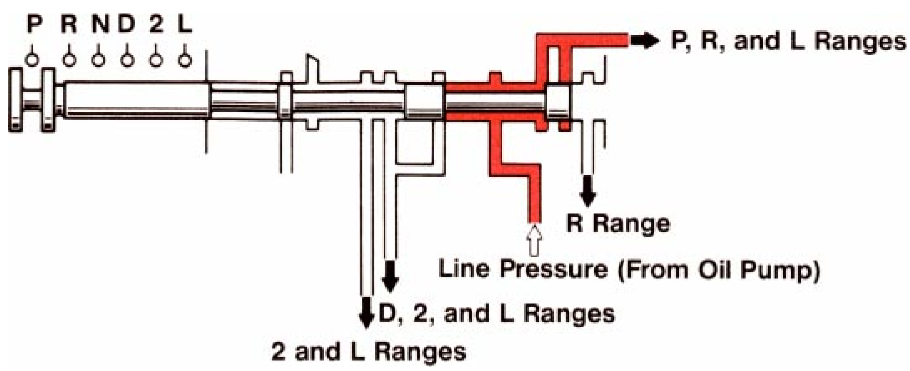
Shift control valves are responsible for directing fluid to different passages in the transmission. They can be manually controlled, solenoid controlled, or hydraulically controlled. They block hydraulic passages while other lands of the valve open passages.

Manual Valve

This valve directs line pressure to various passages in the valve body. It is linked to the driver's selector lever and shifts the transmission into and out of the P, R, N, D, 2 and L ranges as directed by the driver. As the valve moves to the right, it exposes passages to line pressure which will determine the gear selected. The various positions of the valve are maintained by a detent mechanism which also provides feedback to the driver.

Manual Valve

Directs line pressure to various passages in the valve body.



1-2 Shift Valve

This valve controls shifting between first and second gears based on governor and throttle pressures. The valve is held in position by a calibrated spring located between the low coast shift valve and the 1-2 shift valve. When governor pressure is low but throttle pressure is high, this valve is pushed down by throttle pressure and spring tension. In first gear the forward clutch (Cl) is applied through the manual valve, and the one-way clutch No. 2 (F2) is holding. Line pressure is blocked by the valve from the second brake (B2) and the transmission is held in first gear.

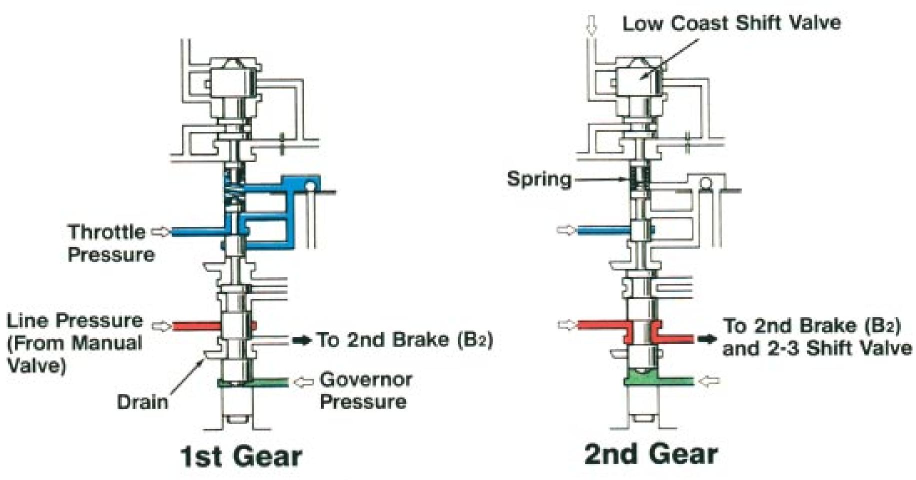
As vehicle speed becomes greater, governor pressure increases and overcomes throttle pressure and spring tension at the 1-2 shift valve. The valve is pushed up by governor pressure, and the circuit to the second brake piston opens, causing the transmission to shift to second gear. When the shift valve moves up, it covers the throttle pressure passage; thus the downshift to first gear depends on spring tension and governor pressure only. This occurs when coasting to a stop. The downshift occurs when spring tension overcomes governor pressure. This happens at such a low speed that it is hardly noticeable.

Forced downshifts from second to first gear occurs when the downshift plug at the base of the throttle valve opens to allow detent regulator pressure to act on the top of the 1-2 shift valve. This forces the shift valve down, which opens the second brake piston to a drain and the downshift occurs as the second brake releases.

When the selector is placed in the L range, low modulator pressure is applied to the top of the low coast shift valve, holding the 1-2 shift valve in the first gear position.

1-2 Shift Valve

Controls line pressure to the 2nd brake (B2) and the 2-3 shift valve



2-3 Shift Valve

This valve controls shifting between second and third gears based on throttle and governor pressures. The valve is positioned by a calibrated spring located between the intermediate shift valve and the 2-3 shift valve. When governor pressure is low but throttle pressure is high, such as under acceleration, this valve is pushed down by throttle pressure and spring tension, holding the transmission in second gear.

When governor pressure rises with increased vehicle speed, this valve is moved upward against throttle pressure and spring tension opening the passage to the direct clutch (C2) piston and causing a shift into third gear. As vehicle speed decreases with the same or increased throttle position, throttle pressure at the top of the 2-3 shift valve causes the valve to move downward, closing the passage to the direct clutch (C2). The pressure in the direct clutch drains and the transmission is downshifted into second gear.

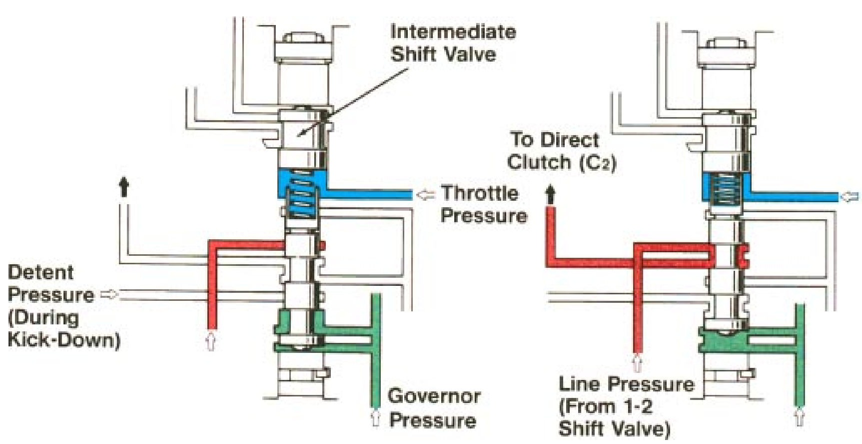
In the event that the accelerator is depressed at or near full throttle, the detent pressure acts on the 2-3 shift valve to permit quicker downshifting to second gear. As the throttle is opened wider, the cam at the base of the throttle valve pushes the detent valve upward. This allows detent pressure to assist throttle pressure at the top of the 2-3 shift valve pushing down on the valve, resulting in faster valve movement.

In addition, take note that the line pressure which applies the direct clutch (C2) comes through the 1-2 shift valve. So if this 1-2 shift valve is stuck, there can be no third gear because the direct clutch cannot be applied.

When the gear selector is placed in the 2-range, line pressure from the manual valve acts on the intermediate shift valve. The 2-3 shift valve descends, causing a downshift into second gear and preventing an upshift to third gear. Also, line pressure passages through the second modulator valve and 1-2 shift valve and acts on the second coast brake to effect engine braking.

2-3 Shift Valve

Controls line pressure to the direct clutch (C2). This line pressure comes through the 1-2 shift valve in the second gear position.



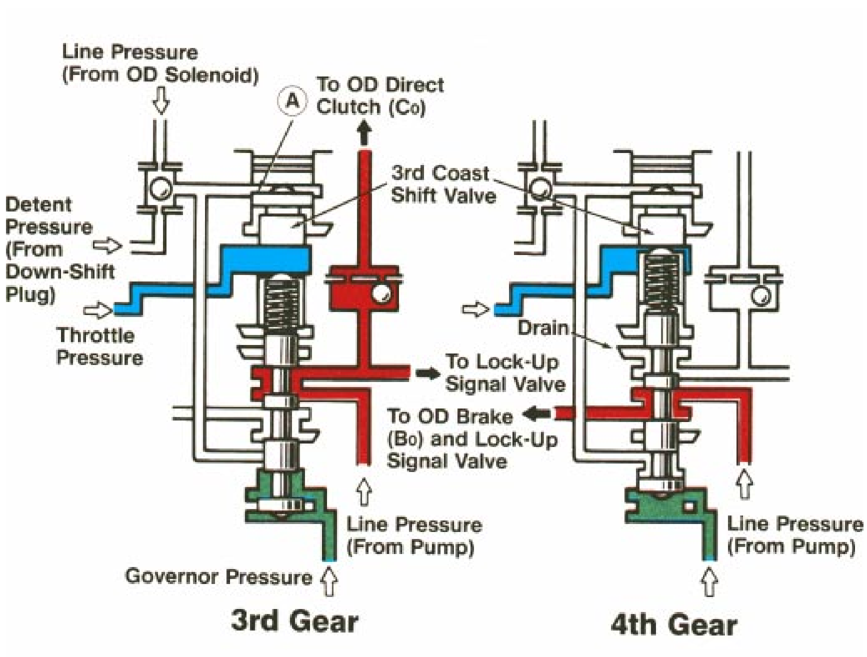
3-4 Shift Valve

This valve controls shifting between third and fourth gears based on governor and throttle pressures. The valve is held in position by a calibrated spring located at the top of the 3-4 coast shift valve which transfers the tension and holds the 3-4 shift valve down. Line pressure controlled by the 3-4 shift valve comes from the oil pump directly. Whenever the pump is turning, pressure is present through the 3-4 shift valve to either the overdrive direct clutch or the overdrive brake. When the overdrive direct clutch is applied, the overdrive unit is in direct drive. When the overdrive brake is applied, the overdrive unit is in overdrive.

When governor pressure is low but throttle pressure is high, this valve is pushed down by throttle pressure and spring tension. When vehicle speed increases, governor pressure rises. At some point, it overcomes throttle pressure and moves the valve upward, diverting line pressure from the overdrive direct clutch (CO) to the overdrive brake (BO) and resulting in an upshift to overdrive.

3-4 Shift Valve

Controls line pressure to the OD brake (B0) and OD direct clutch (C0).



NOTE!

The operation of overdrive can be overridden to prevent a shift into fourth gear or force a downshift into third gear by closing the OD main switch. Line pressure is directed to the top of the third coast shift valve from moving upward.

Downshift Plug

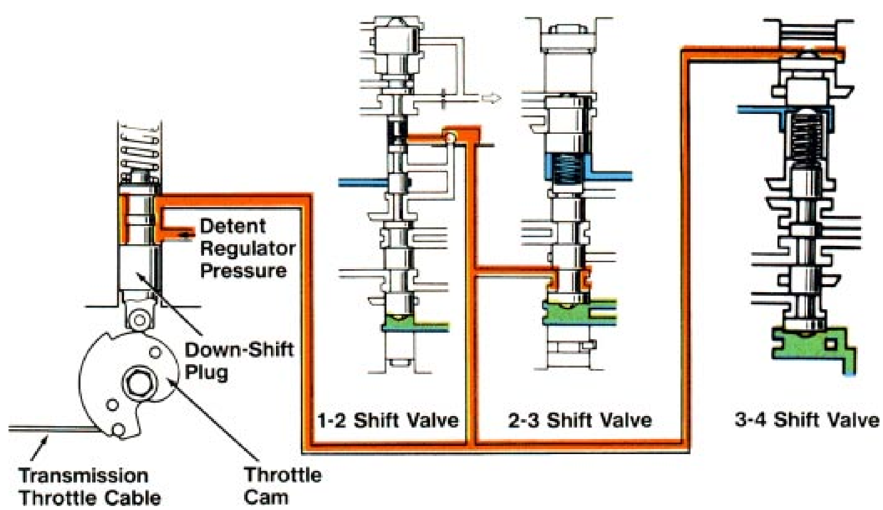
The downshift plug is located below the throttle valve. It is actuated by the throttle cam in response to engine throttle movement when the driver presses down on the accelerator, opening it more than 85%. It is used in a governor-controlled transmission to enhance downshifting rather than relying on throttle pressure alone to overcome governor pressure and move the shift valve down. The net result is that a downshift occurs at a higher vehicle speed than if relied on throttle pressure alone.

When the throttle is opened 85% or more, the downshift valve moves upward and detent regulator pressure is directed to each shift valve to counter governor pressure. Detent pressure provides added force in addition to throttle pressure and spring tension to move the valve downward against governor pressure. Depending on the vehicle speed, governor pressure may be great enough to allow the 1-2 shift valve and 2-3 shift valve to remain up, whereas the 3-4 shift valve may immediately move downward to cause a 4 to 3 downshift.

Electronic control transmissions will use the throttle sensor input to the ECT ECU to control kickdown through the No. 1 and No. 2 solenoids.

Downshift Plug

Enhance downshifting rather than relying on throttle pressure alone to overcome governor pressure in a forced downshift.



Timing Valves

These valves are responsible to finesse the quality of transmission shift characteristics. In some cases the apply clutch is a dual piston application and one is applied before the other. In other cases the pressure which applies a holding device or forces a shift valve to downshift is reduced to enhance the application.

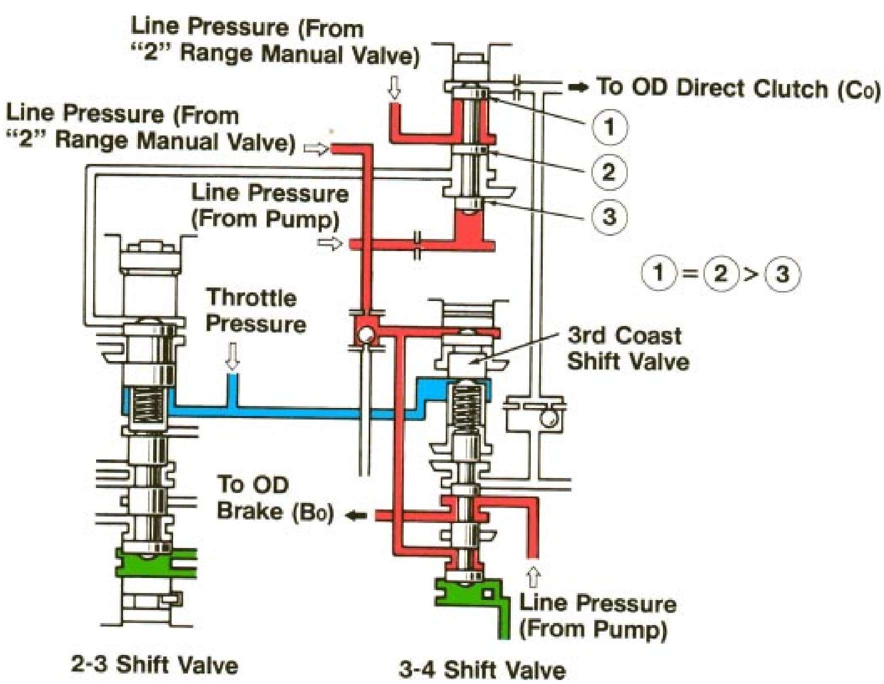
D-2 Downshift Timing Valve

This valve serves to prevent a direct downshift from overdrive to second gear in the A40 Series transmissions. If the shift selector lever is put into 2-range while the vehicle is running in overdrive, the transmission automatically shifts into third gear for a moment before shifting into second. This is to avoid shift shock that would occur if the transmission went directly from overdrive into second gear. After the line pressure acting on the intermediate shift valve is switched from the overdrive brake (BO) to overdrive direct clutch (CO), it acts on the 2-3 shift valve, causing it to shift from third gear to second gear.

When the selector is shifted from D-range to the 2-range, line pressure from the manual valve is applied to the area between the upper and middle land of the timing valve and to the top of the third coast shift valve. This causes the 3-4 shift valve to move down, and the direct clutch (C2) is applied to give us third gear. The same pressure applying the direct clutch also acts on the top of the timing valve which directs pressure to the top of the intermediate shift valve, resulting in a downshift to second gear.

D-2 Downshift Timing Valve

Requires a downshift to 3rd gear before going into manual second in a manual downshift.

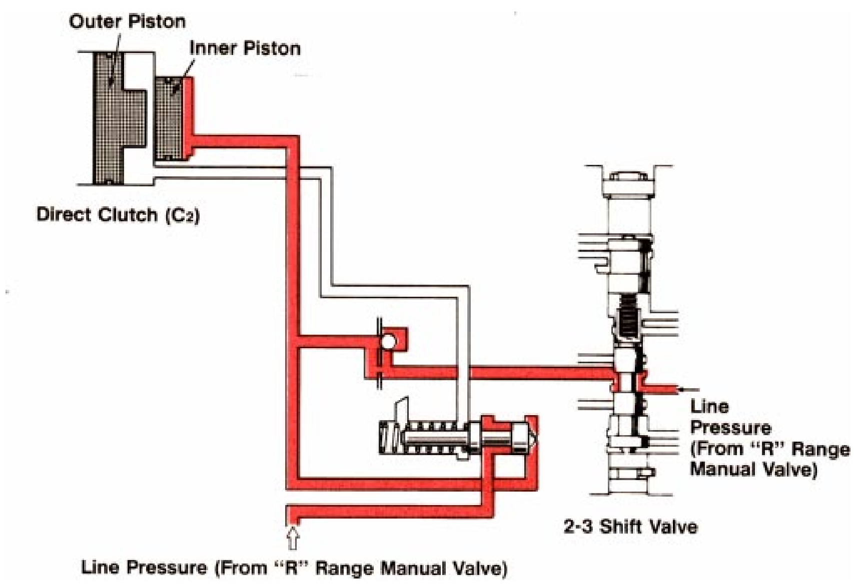


Reverse Clutch Sequencing Valve

This valve controls the timing of the application of the double piston direct and reverse clutch (C2) found in the A40 Series transmissions. It acts to reduce shift shock when the transmission is shifted into reverse. When the selector is shifted into the R-range, the passage to the outer piston of the direct and reverse clutch (C2) is blocked by the sequencing valve. As pressure builds and the inner piston begins to apply, the valve moves to the left. Line pressure from the manual valve is applied between the two lands. When the spring is compressed, line pressure is applied to the outer piston for full engagement of the direct and reverse clutch. This causes the outer piston to begin operating after the inner piston operates, which softens engagement.

Reverse Clutch Sequencing Valve

Reduces shift shock when the transmission is shifted into reverse.

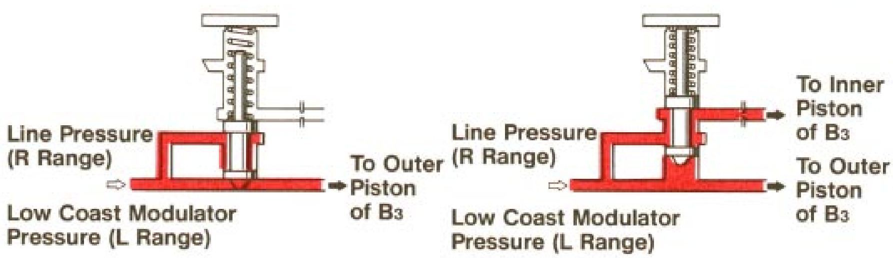


Reverse Brake Sequencing Valve

Similar to the reverse clutch sequencing valve discussed above, this valve controls the timing of the application of the double piston first and reverse brake (B3) found in the A40 Series transmissions. It acts to reduce shift shock when the transmission is shifted into low or reverse gear. When the selector is shifted into the low 1 or R-range, the passage to the outer piston of the direct and reverse clutch (C2) is blocked by the sequencing valve. As pressure builds and the outer piston begins to apply, the valve moves to the left. Line pressure from the manual valve is applied between the two lands. When the spring is compressed, line pressure is applied to the inner piston for full engagement of the first and reverse brake. This causes the inner piston to begin operating after the outer piston operates, which softens engagement. This operation is the opposite of the reverse clutch sequence valve, where the inner piston is applied before the outer piston.

Reverse Brake Sequencing Valve

Acts to reduce shsift shock when the transmission is shifted into low or reverse gear.



Accumulators

The accumulators act to cushion shifting shock. These valves are basically pistons located in a bore with a heavy calibrated spring to counter hydraulic pressure. They are located in the hydraulic circuit between The shift valve and the holding device. When the shift valve moves, fluid is directed to the circuit of the holding device. As the piston begins to compress the clutch return springs, pressure in the circuit begins to build. As pressure builds, it acts to load the spring in the accumulator. Pressure in the circuit cannot reach its potential until the spring is compressed and the piston is seated. The pressure builds more slowly, and the clutch engagement is softened.

Clutch application can be tailored even more closely by providing hydraulic pressure to the spring side of the accumulator. Line pressure applying the holding device has to overcome spring tension and additional fluid pressure, and therefore, higher pressure is exerted on the holding device before full pressure is applied. Hydraulic pressure to the accumulator is controlled by the accumulator control valve, which will be discussed next.

Application of accumulators are found on the following circuits:

Overdrive Direct Clutch (CO)
Forward Clutch (Cl)
Direct & Reverse Clutch (C2)
Underdrive Direct Clutch (C3)
Overdrive Brake (BO)
Second Brake (B2)

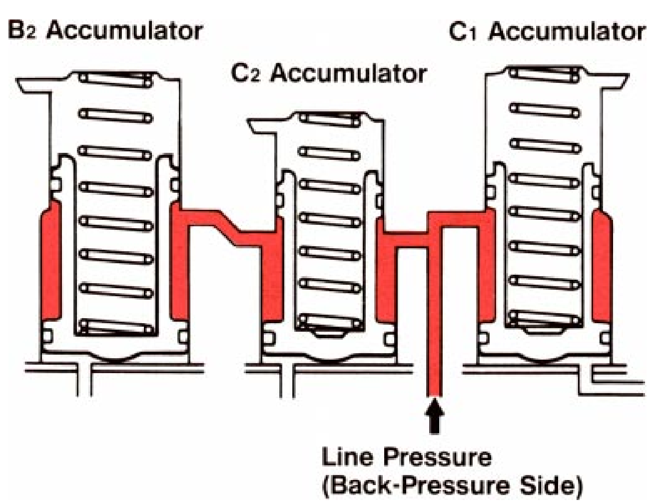
REFERENCE

AT TYPE	ACCUMULATOR	BACK PRESSURE (From Accumulator Control Valve)
A40 Series	C_1, C_2, B_2*	C_1, C_2, B_2*
A240 Series	C_1, C_2, C_3, B_2, B_4	C_2, C_3, B_3
A440 Series	C_1, C_2, B_0, B_2	C_1, C_2, B_2
A540 Series (ECT)	C_0, C_1, C_2, B_2	C_2, B_2
A340E, H (ECT)	C_0, B_0, C2, B_2	C_2, B_0, B_2
A341 E (ECT)	C_0, C_2, B_0, B_2	C_0, C_2, B_0, B_2

*** Except A40D automatic transmission**

Accumulators

Reduce shift shock



Pressure Modulating Valves

Pressure modulating valves change controlling pressures to tailor operational characteristics of the automatic transmission. Line pressure, throttle pressure and governor pressure all have an effect on how the automatic transmission operates.

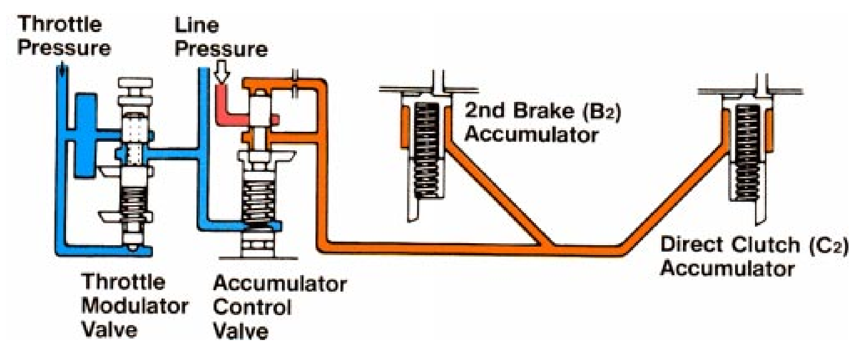
Accumulator Control valve

This valve modifies line pressure from the pump to the accumulators based on engine load. It reduces shift shock by lowering the back pressure of the direct clutch (C2) accumulator and second brake (B2) accumulator when the throttle opening is small. Since the torque produced by the engine is low when the throttle opening is small, accumulator back pressure is reduced. This prevents shift shock when the brakes and clutches are applied.

Conversely, engine torque is high when the throttle angle is large, during moderate to heavy acceleration. Not only is line pressure increased, but throttle pressure acting at the base of the accumulator control valve increases back pressure to the accumulators. Accumulator pressure is increased to prevent slippage when the clutches and brakes are applied.

Accumulator Control Valve

Modifies line pressure to the accumulators based on engine load.



Reference:

- On all transmissions, hydraulically controlled or ECT with the exception of the A40 Series, throttle pressure acts directly on the bottom of the accumulator control valve to increase accumulator control pressure.

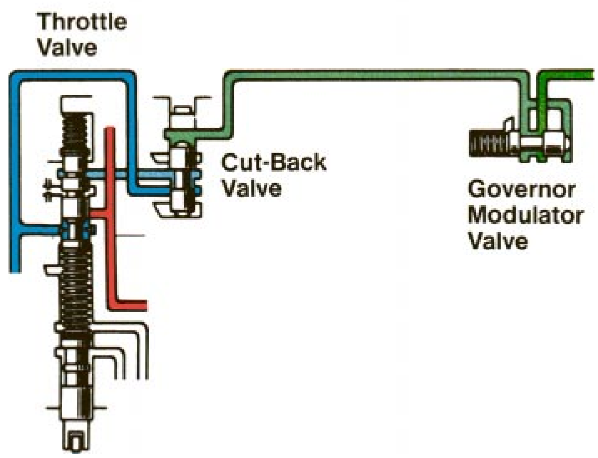
- There is no accumulator control valve in the A40 Series automatic transmissions; line pressure acts directly on the rear of each accumulator.

Governor Modulator Valve

This valve is located between the governor valve and the cut-back valve. It modifies the governor pressure generated by the governor valve. The governor modulator valve is pushed to the right by a spring, while governor modulator pressure acts on the right side of the valve, pushing it toward the left. The governor modulator valve maintains a pressure constant between governor pressure and spring tension.

Governor Modulator Valve and Cut-Back Valve

Governor modulator valve provides the aspect of vehicle speed to the cut-back valve which acts to reduce throttle pressure.



Cut-Back Valve

This valve modifies throttle pressure. It regulates the cut-back pressure acting on the throttle valve and is actuated by governor pressure and throttle pressure. Applying cut-back pressure to the throttle valve in this manner lowers the throttle pressure and ultimately lowers line pressure to prevent unnecessary power loss due to the transmission oil pump at higher speeds.

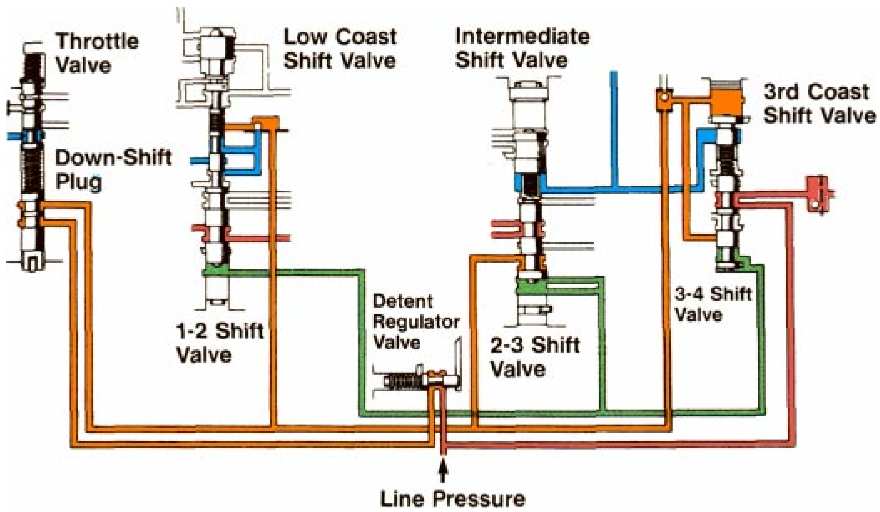
Governor pressure acts on the upper portion of this valve. As the valve is pushed downward, a passage from the throttle valve is opened and throttle pressure is applied. The cut-back valve is pushed upward as a result of the difference in the diameters of the valve pistons. The balance between the downward force due to governor pressure and the throttle pressure becomes the cut-back pressure.

Detent Regulator Valve

This valve modifies line pressure during kick-down to stabilize the hydraulic pressure acting on the 1-2, 2-3 and 3-4 shift valves. It is located between the oil pump and the downshift plug. A calibrated spring pushes the valve to the right. Line pressure acts on the left land of the valve to move it to the left, which lowers line pressure to the top of the shift valves.

Detent Regulator Valve

Modifies line pressure controlled by the downshift plug during forced downshifts.

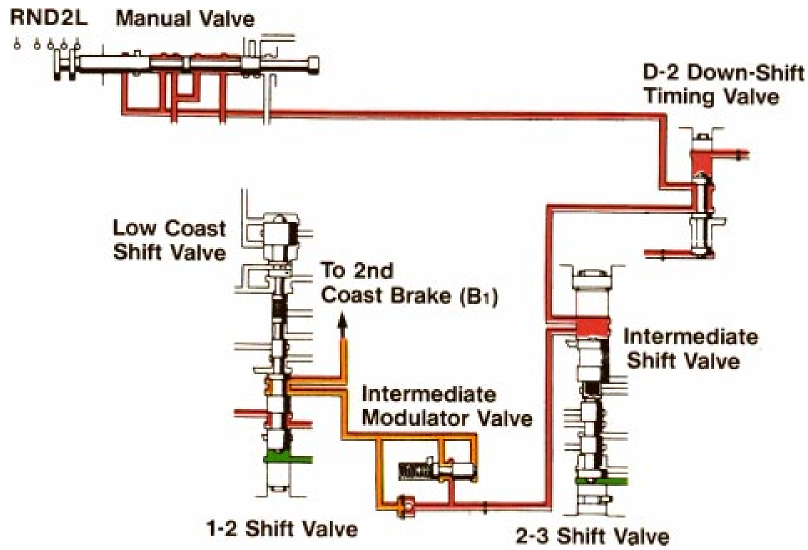


Intermediate Modulator Valve

In 2-range, this valve reduces line pressure from the intermediate shift valve (second modulator pressure). The second modulator pressure acts on the second coast brake (B1) through the 1-2 shift valve to reduce shifting shock.

Intermediate Modulator Valve

Reduces line pressure to the second coast brake (B1) to reduce shift shock during manual downshift.

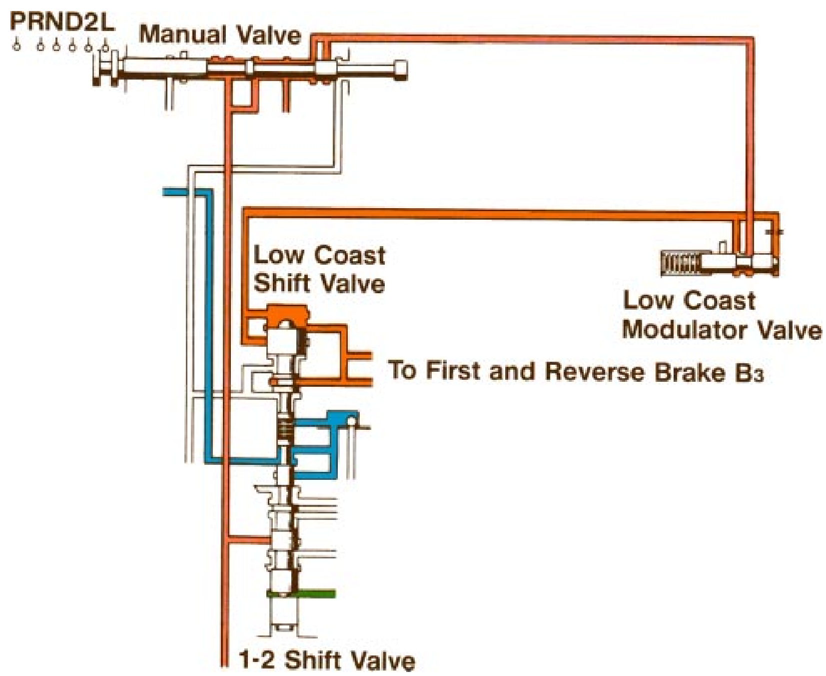


Low Coast Modulator Valve

The low modulator valve reduces the line pressure from the manual valve to reduce shock when the transmission is shifted into the L range. The low modulator pressure pushes the low coast shift valve down and also acts on the first and reverse brake (B3) to buffer the shock. It also causes low modulator pressure to act on the primary regulator valve to raise line pressure, thus increasing pressure and preventing the clutches and brakes from slipping.

Low Coast Modulator Valve

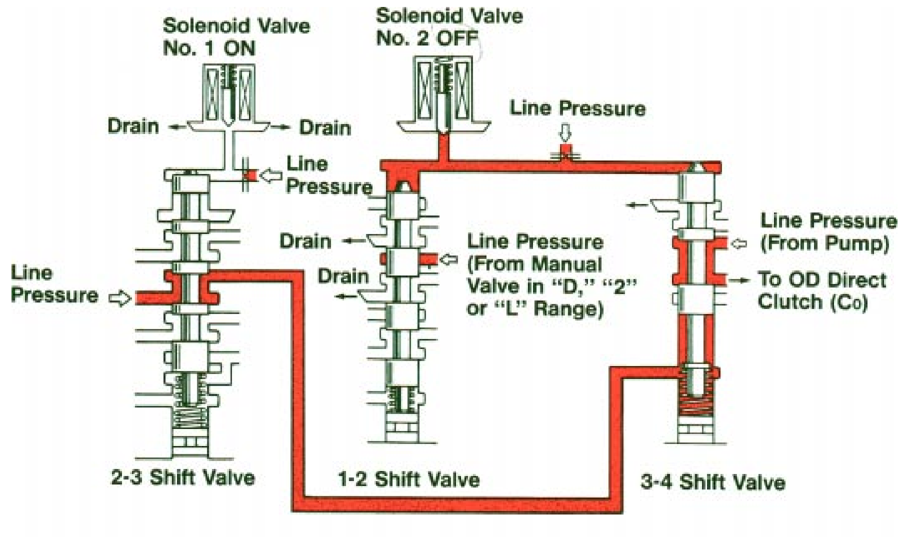
Reduces line pressure from the manual valve in the "L" position to reduce shock when shifting into manual low.



ECT Shift Valve Operation

Two electrically operated solenoids control the shifting of all forward gears in the Toyota electronic control four speed automatic transmission. These solenoids are controlled by an ECU which uses throttle position and speed sensor input to determine when the solenoids are turned on. The solenoids normal position is closed, but when it is turned on, it opens to drain fluid from the hydraulic circuit. Solenoid No. 1 controls the 2-3 shift valve. It is located between the manual valve and the top of the 2-3 shift valve. Solenoid No. 2 controls the 1-2 shift valve and the 3-4 shift valve.

Shift Solenoid Operation ECT - First Gear



First Gear

During first gear operation, solenoid No. 1 is on and solenoid No. 2 is off. With line pressure drained from the top of the 2-3 shift valve by solenoid No. 1, spring tension at the base of the valve pushes it upward. With the shift valve up, line pressure flows from the manual valve through the 2-3 shift valve and on to the base of the 3-4 shift valve.

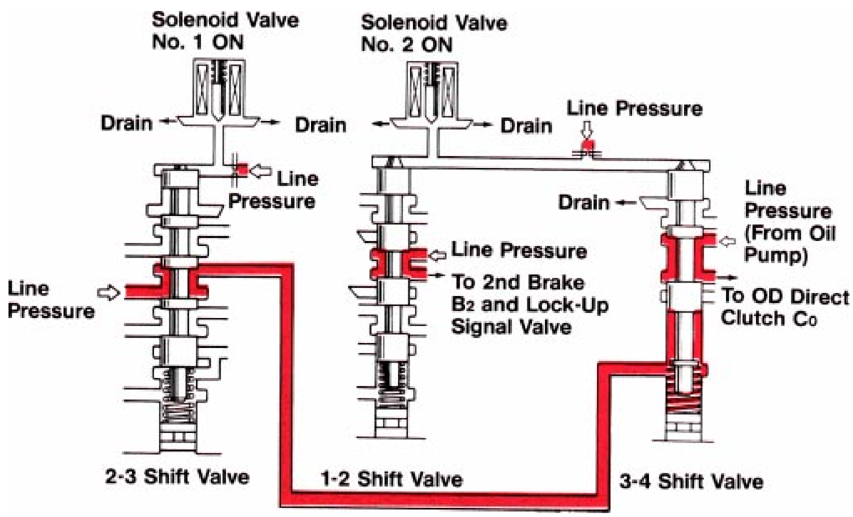
With solenoid No. 2 off, line pressure pushes the 1-2 shift valve down. In this position, the 1-2 shift valve blocks line pressure from the manual valve. Line pressure and spring tension at the base of the 3-4 shift valve push it upward.

Second Gear

During second gear operation, solenoid No. 1 and No. 2 are on. Solenoid No. 1 has the same effect that it had in first gear with the 2-3 shift valve being held up by the spring at its base. Pressure from the manual valve flows through the 2-3 shift valve and holds the 3-4 shift valve up.

With solenoid No. 2 on, line pressure from the top of the 1-2 shift valve bleeds through the solenoid. Spring tension at the base of the 1-2 shift valve pushes it upward. Line pressure which was blocked, now is directed to the second brake (B2), causing second gear. The 3-4 shift valve maintains its position with line pressure from the 2-3 shift valve holding it up.

Second Gear

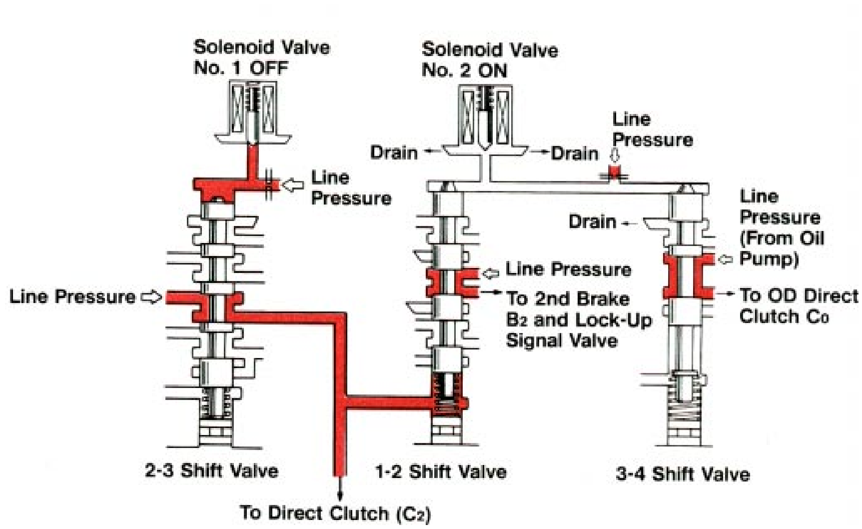


Third Gear

During third gear operation, solenoid No. 1 is off and Solenoid No. 2 is on. When solenoid No. 1 is off, it closes its drain and line pressure from the manual valve pushes the 2-3 shift valve down. Line pressure from the manual valve is directed to the direct clutch (C2) and to the base of the 1-2 shift valve.

With solenoid No. 2 on, it has the same effect that it had in second gear; pressure is bled at the top of the 1-2 shift valve and spring tension pushes it up. Line pressure is directed to the second brake (B2). However in third gear, the second brake (B2) has no effect since it holds the one-way clutch No. 1 (F1) and freewheels in the clockwise direction. The second coast brake is ready in the event of a downshift when the OD direct clutch (C2) is released.

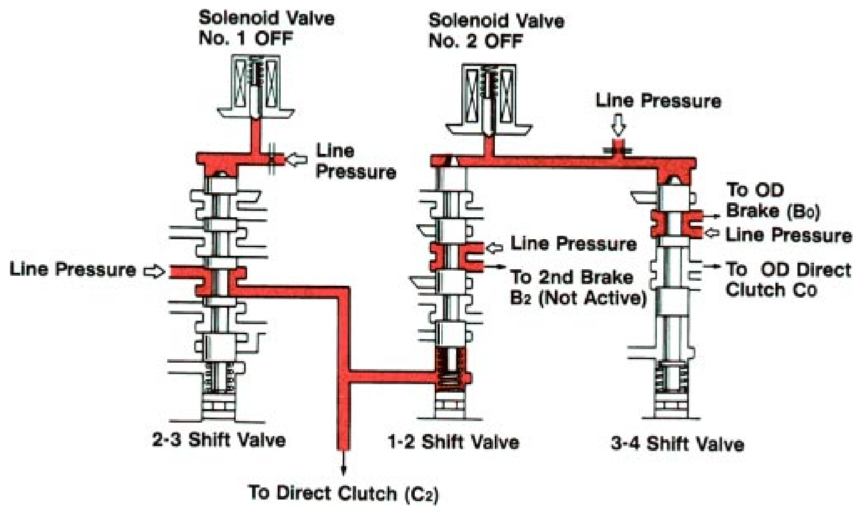
Third Gear



Fourth Gear During fourth gear operation, both solenoids are off. When solenoid No. 1 is off, its operation is the same as in second and third gears.

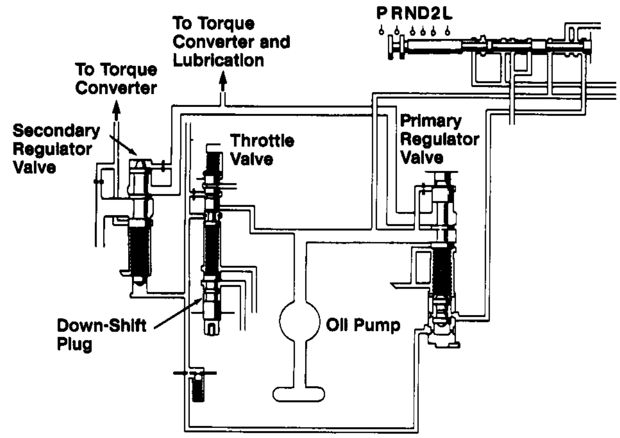
A third solenoid controls lock-up operation.

Fourth Gear



WORKSHEET 4
Pressure Control Valves

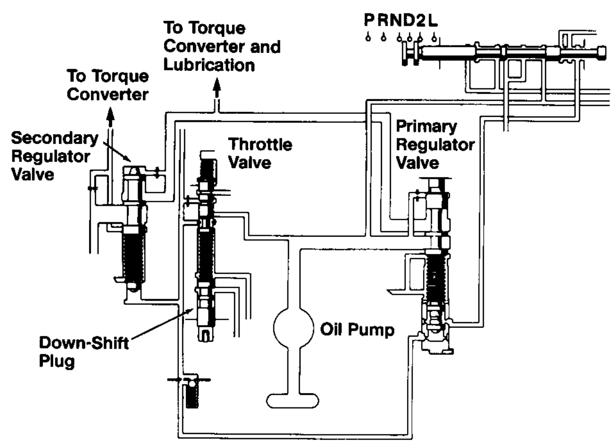
Primary Regulator Valve in R Range



1. Primary Regulator Valve

- Modifies pressure directly from the oil pump based on ________________.
- Throttle pressure is at the bottom of the valve. As it increases, the valve is ____________, increasing the ____________.
- In Reverse range, line pressure increases because the________________ valve applies pressure to the bottom side of the ________ valve.

Pressure Regulator Valves

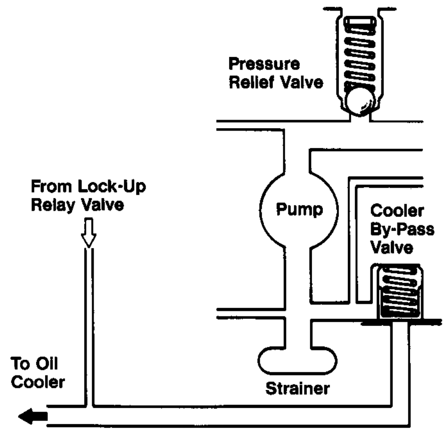


2. Secondary Regulator Valve

- Regulates______________________ pressure and ___________________ pressure based on _____________________________.
- Throttle pressure and spring tension push the valve ______ to increase pressure.
- Converter pressure at the top of the valve opens the valve, to reduce________________.

WORKSHEET 4
Pressure Control Valves (Continued)

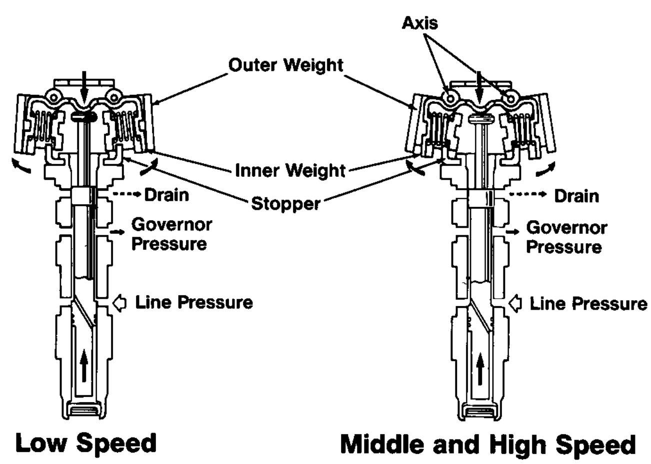
Oil Cooler By-Pass Valve/Pressure Relief Valve



3. Oil Cooler By-Pass and Pressure Relief Valves

- The cooler by-pass valve regulates pressure applied to the transmission cooler to prevent _________________ converter pressure.
- The pressure relief valve _______________oil pump pressure. This is done with a calibrated ____________ valve.

Governor Valve

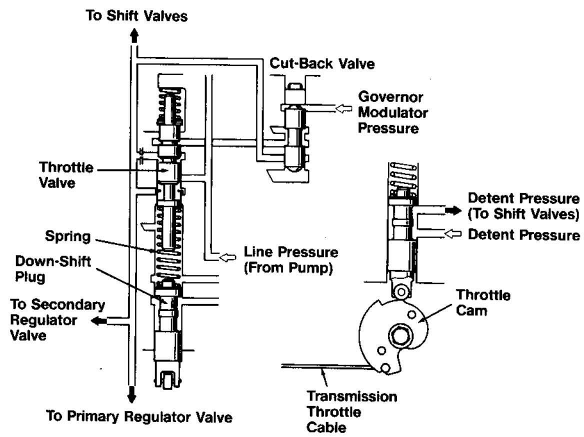


4. Governor Valve

- Located on the transmission ____________shaft, it produces pressure based on ______. Increase in vehicle speed = _____________ governor pressure.
- Decrease in vehicle speed = ____________ governor pressure.
- The primary function of governor pressure is to create transmission ________________.

WORKSHEET 4
Pressure Control Valves (Continued)

Throttle Valve



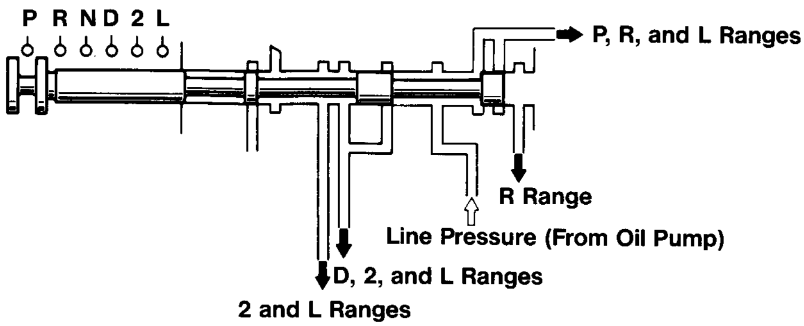
5. Throttle Pressure

- Modulates line pressure by the movement of the transmission _________ which moves the throttle _________________. It pushes the ___________ valve up, via the _________.
- As the throttle valve opens, it increases _______________ pressure.
- In a hydraulic transmission, throttle pressure is used to increase ___________________ and affect ___________________________.
- In an electronic control transmission, throttle pressure is used only to modify ___________.

Notes

WORKSHEET 5
Shift Values

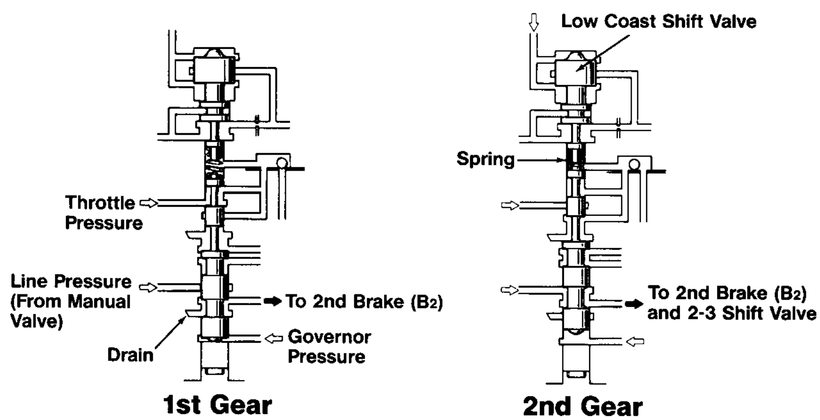
Manual Valve



1. Manual Valve

- This valve is connected to the ____________. It directs fluid to __________ based on the shift lever position.

1-2 Shift Valve



2. 1-2 Shift Valve

a. First Gear Position

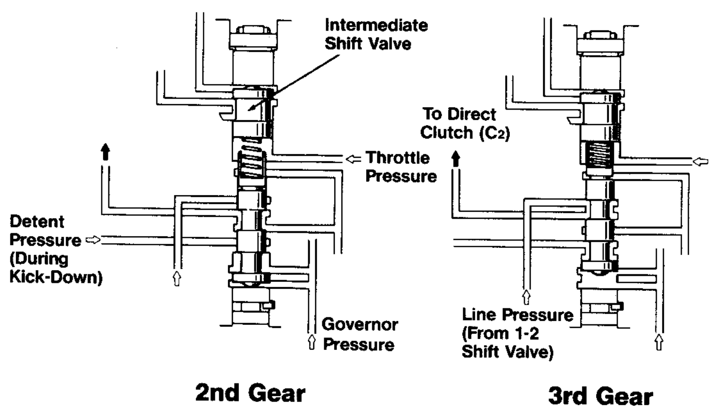
- Controls shifting between first and second gears based on _____________ pressure and ______________________ pressure.
- Line pressure from the manual valve is _________________ at the shift valve.
- The hydraulic circuit to the _______________ is open to a drain.

WORKSHEET 5
Shift Valves (Continued)

b. Second Gear Position

- The shift valve moves up when __________ pressure overcomes ____________ pressure.
- Line pressure from the manual valve is applied to the passage of the ____.

2-3 Shift Valve



3. **2-3 Shift Valve**

a. Second Gear Position

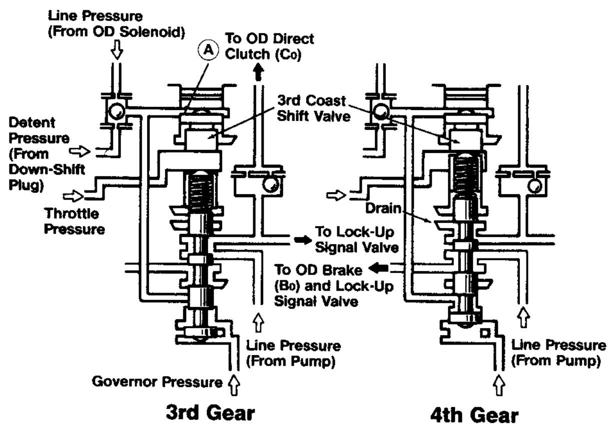
- Line pressure from the ________________ is blocked, so no pressure is available to the ______________________________.

b. Third Gear Position

- The shift valve moves up when governor pressure overcomes _________ pressure and the valve moves _____________.
- Line pressure from the 1 -2 shift valve is now applied to the _______________________.

WORKSHEET 5
Shift Valves (Continued)

3-4 Shift Valve



4. **3-4 Shift Valve**

a. Third Gear Position

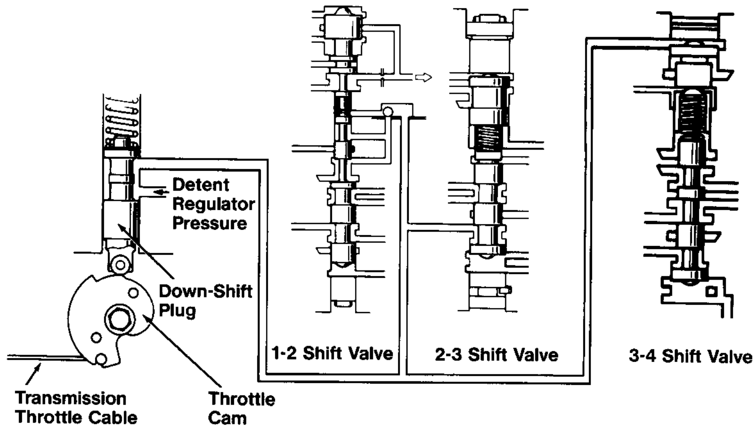
- Line pressure from the pump is applied to __ while line pressure to the ___ is blocked.

b. Fourth Gear Position

- The shift valve moves up when __________ pressure overcomes _______________ pressure.
- The OD direct clutch (CO) is exposed to a ______________ through the 3-4 shift valve.
- Line pressure from the _________________ is applied to the passage of the ______________.

WORKSHEET 5
Shift Valves (Continued)

Downshift Plug

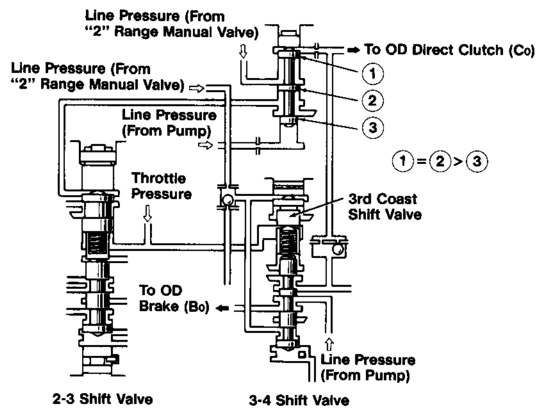


5. Downshift Plug

- Operated by the action of the ________________________.
- Controls ________________ pressure.
- The downshift plug opens when the throttle is open to or greater.
- Detent regulator pressure is applied to the _____________, ___________, and _______ shift valves, countering ________________________________, creating a downshift.
- Detent regulator pressure, in addition to _______________, is applied to the upper land of the shift valve to provide an earlier downshift.

WORKSHEET 6
Timing Valves

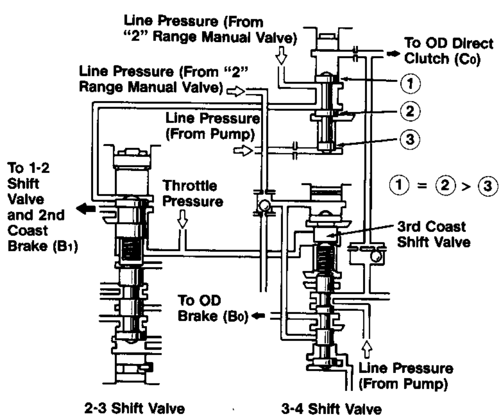
D-2 Downshift Timing Valve



1. D-2 Downshift Timing Valve

- Controls downshift when manually selecting ____________ from overdrive.
- Line pressure from the _________________ applied to the area between the ______________ and _________________________________ land of the timing valve.

D-2 Downshift Timing Valve - 4-3 Downshift

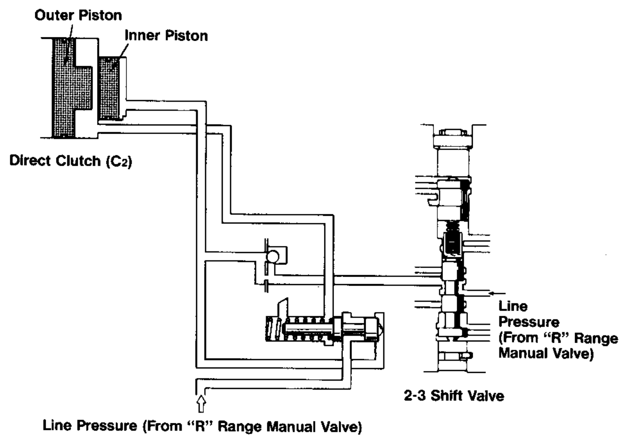


2. D-2 Downshift Timing Valve 4-3 Downshift

- Line pressure from the _____ is also applied to the top of the __________ valve. This creates a _______________________ to __________ gear.
- Line pressure from the oil pump moves through the __________________ valve to the top of the _____________________ valve which moves the valve ____________. This allows line pressure to push __________ on the ______________________________ valve, producing a _ to second gear.

WORKSHEET 6
Timing Valves (Continued)

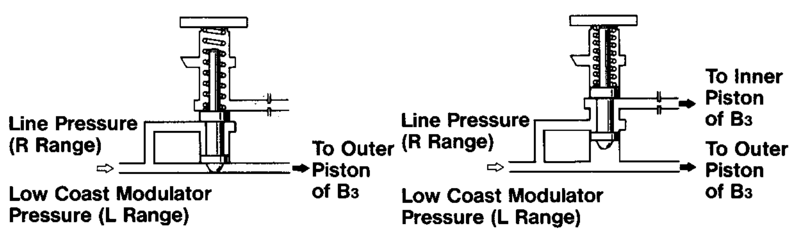
Reverse Clutch Sequencing Valve



3. Reverse Clutch Sequencing Valve

- Designed to ______________ shift shock when shifting to _____________ gear.
- Valve blocks line pressure to the _____________________ piston of the _____________.
- As pressure to the _________ piston increases, it pushes the sequencing valve to the right against __________________ tension, ___________ the passage to the ________ piston.

Reverse Brake Sequencing Valve

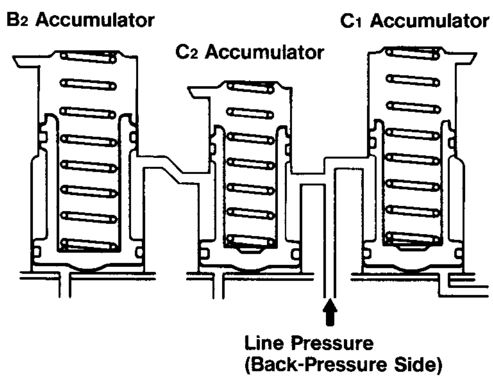


4. Reverse Brake Sequencing Valve

- Designed to reduce shift shock when shifting into ________ or _________ gear range.
- The valve is positioned to be a ___________ which blocks pressure to the ____________ piston of the______________.
- As pressure builds in the outer piston circuit, the valve ____________________________ the passage to the ________________________ piston.

WORKSHEET 6
Timing Valves (Continued)

Accumulators



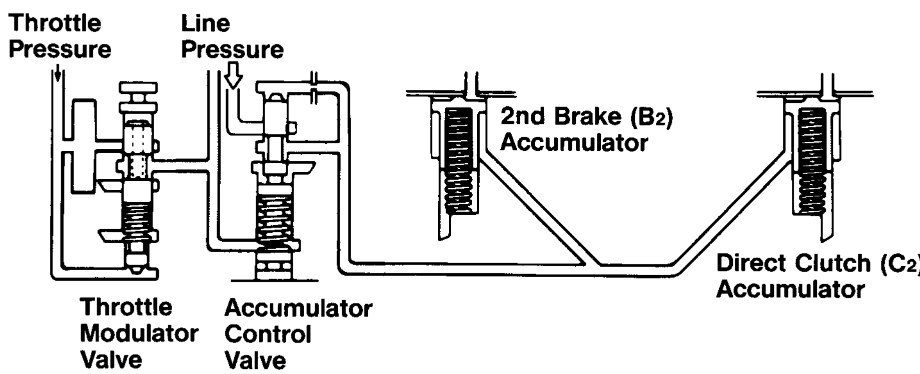
5. Accumulators

- Located in the hydraulic circuit between the ____________ and the _________________.
- Designed to reduce ____________________.
- Apply pressure must overcome ______________________ and _________________________ pressure to fully apply the brake or clutch.

Notes

WORKSHEET 7
Pressure Modulating Valves

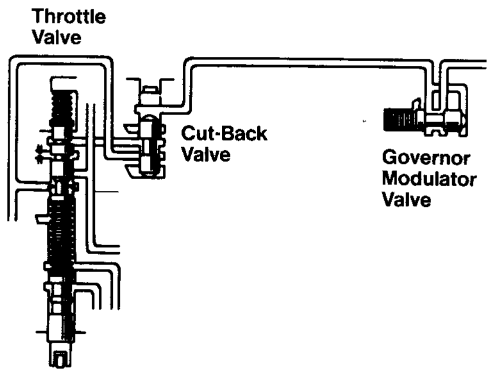
Accumulator Control Valve



1. **Accumulator Control Valve**
   - Adjusts line pressure in accordance to ________________.
   - Modulated pressure is applied to the back side (small area) of the ______________________ valves to counter the _______ pressure applying the clutch or brake at the top of the valve.
   - ____________ tension and _____________ pressure push the accumulator valve upward.
   - Increased engine load results in _________ accumulator control pressure to ensure a ______ application to reduce slippage at the clutch or brake.

WORKSHEET 7
Pressure Modulating Valves (Continued)

Governor Modulator Valve—Cut-Back Valve

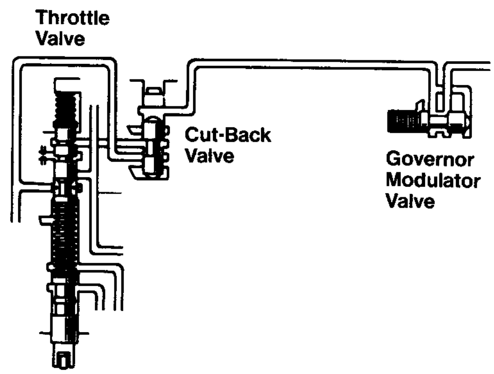


2. Governor Modulator Valve

- Regulates governor pressure to the ___________________ valve.
- Creates a pressure called _______________________________________ pressure.
- Spring tension acts to __________________ the valve. As governor pressure increases, modulated pressure is applied to the ______ of the valve, causing it to _______________.
- As governor pressure increases with vehicle speed, governor modulator pressure will _____________________.

WORKSHEET 7
Pressure Modulating Valves (Continued)

Governor Modulator Valve—Cut-Back Valve

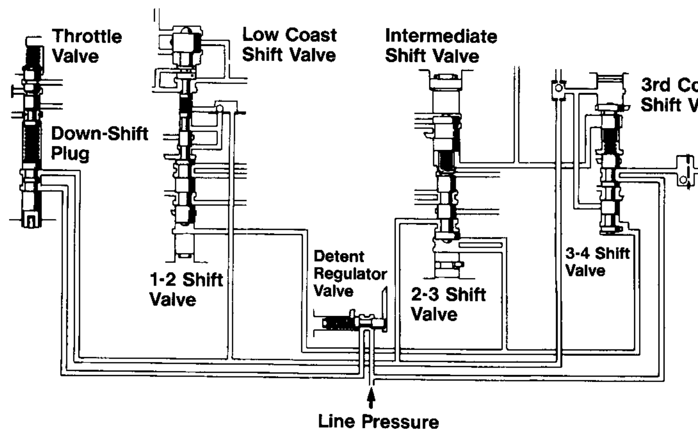


3. Cut-Back Valve

- Governor modulator pressure pushes on the top of the _______________ valve and opens a passage from the _________.
- Throttle pressure acts to _______________ the cut-back valve against governor modulator pressure resulting in __________________ pressure.
- Cut-back pressure acts on the top land of the throttle valve and pushes it downward, ________ throttle pressure.
- With lower throttle pressure, line pressure is also ___________________.

WORKSHEET 7
Pressure Modulating Valves (Continued)

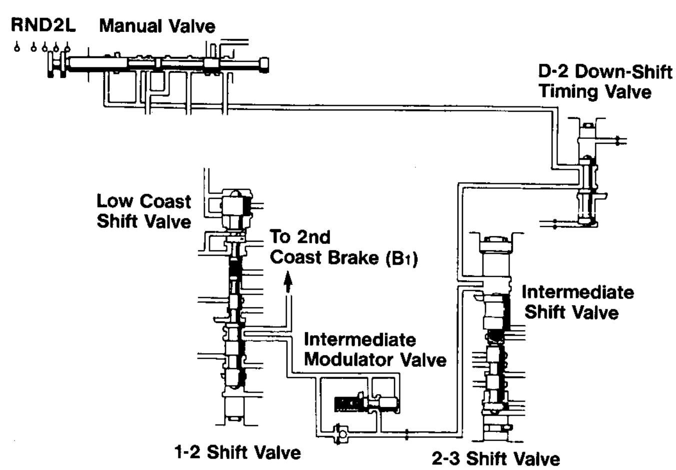
Detent Regulator Valve



4. Detent Regulator Valve

- This valve modifies _____________ pressure to stabilize the pressure acting on the _______ used for forced _______________.
- Spring tension pushes the valve to the _______________ position. Line pressure overcomes spring tension and begins to _______________________ the valve and limiting pressure.
- The available detent pressure is controlled by the __________________.

Intermediate Modulator Valve

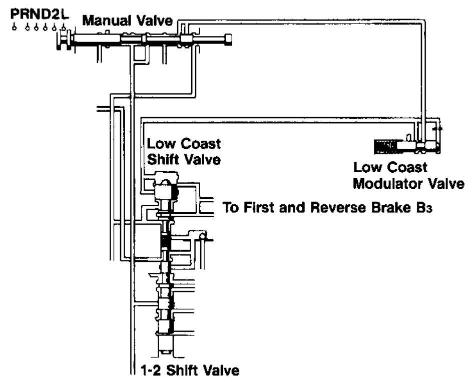


5. Intermediate Modulator Valve

- Pressure is applied to this valve in ____ range.
- Lowers line pressure, which is applied to the ______________________________________ .

WORKSHEET 7
Pressure Modulating Valves (Continued)

Low Coast Modulator Valve



6. Low Coast Modulator Valve

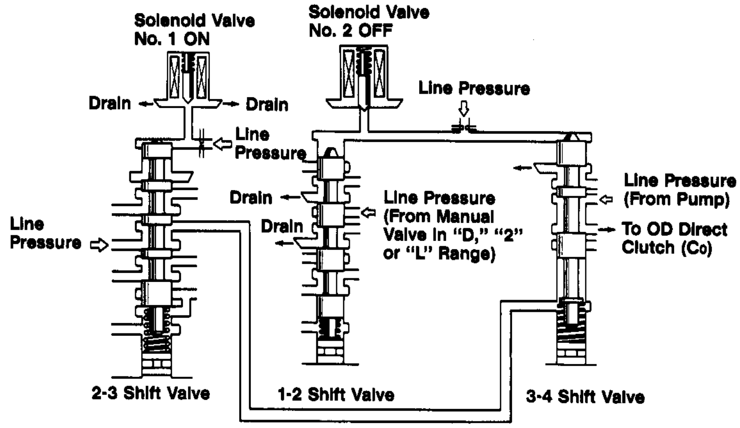
- Pressure is applied to this valve in ____________________ range.
- Lowers line pressure, which is applied to the ____________________________________.
- Low coast pressure is applied to the top of the ______________________ valve, above the 1-2 shift valve.

Notes

WORKSHEET 8

ECT Shift Valve Operation

Shift Solenoid Operation ECT—First Gear



1. First Gear

- Solenoid number one controls the ________ shift valve, while solenoid number two controls both the ______________________________ and ____________________ shift valves.

Solenoid number one ON:

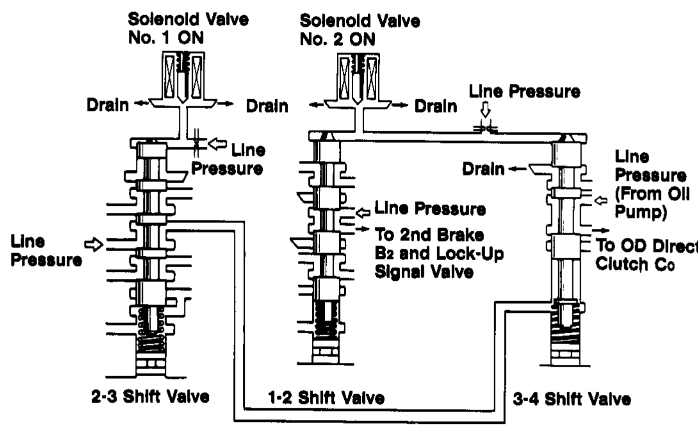
- Line pressure from the manual valve is ________________ through the opening in the solenoid.
- ____________ tension pushes the ____________________ shift valve _______________.
- Line pressure flows through the __________ shift valve to the base of the ____________ shift valve.

Solenoid number two OFF:

- Line pressure is applied to the top of the _______________ and ____________________ shift valves.
- The 1 -2 shift valve is pushed ____________, while the 3-4 shift valve is up because of ______ and line pressure from the ______________ shift valve.

WORKSHEET 8
ECT Shift Valve Operation (Continued)

Shift Solenoid Operation—ECT Second Gear



2. Second Gear

Solenoid number one is ON:

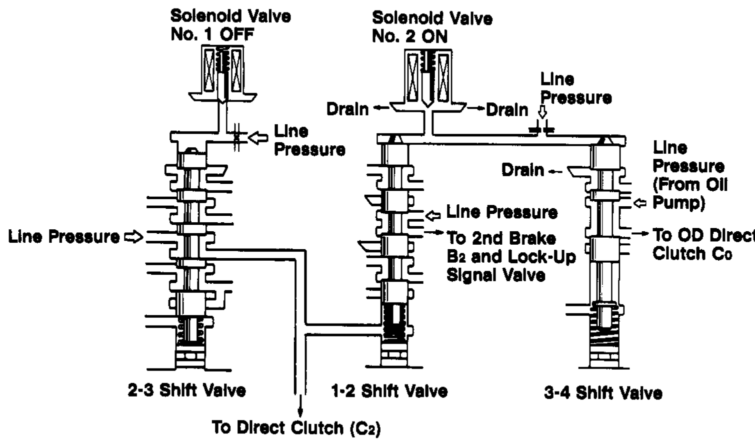
- The same condition as found in first gear.

Solenoid number two is ON:

- The solenoid opens a ______________________________.
- ____________ tension pushes ___________ shift valve _______________.
- Line pressure now flows through the valve applying the ___________________________.

WORKSHEET 8
ECT Shift Valve Operation (Continued)

Shift Solenoid Operation—ECT Third Gear



3. Third Gear

Solenoid number one is OFF:

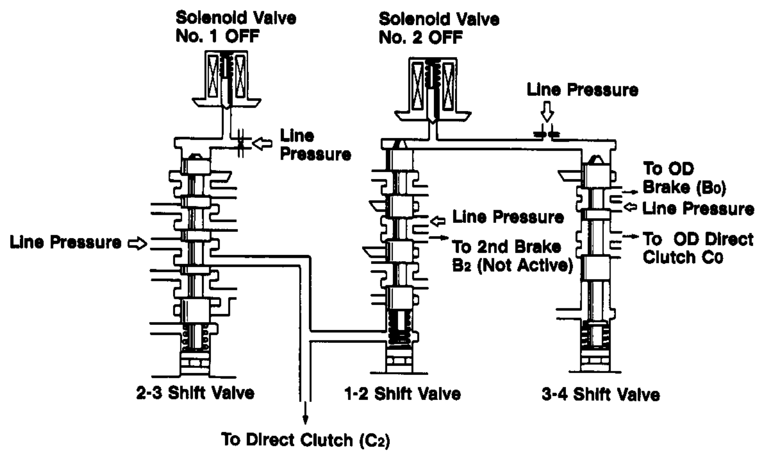
- The drain for the solenoid is now ____________________.
- Line pressure pushes the ______________ shift valve _________________________.
- Line pressure flows through the valve to apply the ______________________________ and apply pressure to the base of the ________ shift valve.

Solenoid number two is ON:

- Line pressure and ____________________ tension push up on the 1 -2 shift valve while spring tension alone holds up the ________ shift valve.

WORKSHEET 8
ECT Shift Valve Operation (Continued)

Shift Solenoid Operation—ECT OD Gear



4. OD Gear

Solenoid number one is OFF:

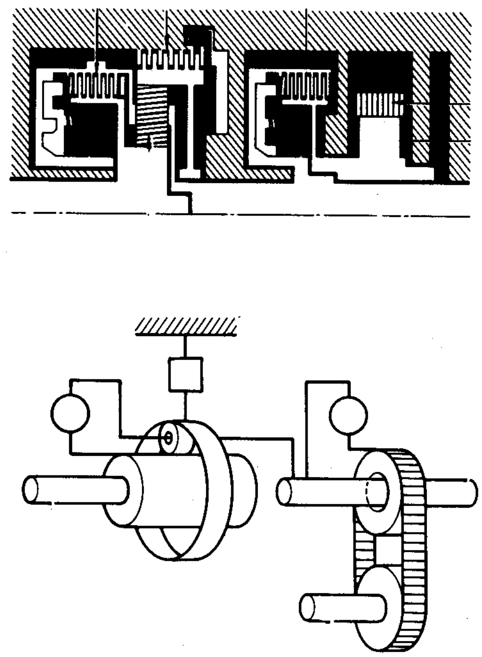
- The same condition as found in third gear.

Solenoid number two is OFF:

- The drain for solenoid number two is _________________.
- Line pressure and spring tension at the base of the 1 -2 shift valve keep it pushed _____, while the line pressure will push the 3-4 shift valve __________________. This cuts pressure to the __________________ and directs pressure to the _____________.

Section 9

A340H TRANSFER



Lesson Objectives:

1. Given the clutch application chart for the A340H Transfer Unit, identify the holding devices applied in the following gear positions:
   - High gear two-wheel drive
   - High gear four-wheel drive
   - Low gear four-wheel drive
2. Describe the operation of the sprocket and drive chain in transferring torque to the front axle.

The A340H automatic transfer unit is bolted to the rear of the transmission housing and provides a means of selecting between 2-wheel drive (H2), 4-wheel drive (H4) and low 4-wheel drive (L4), while the vehicle is moving. There is no restriction on vehicle speed while shifting between H2 and H4. There is, however, a speed requirement when shifting between H4 and L4, and that speed is less than 19 mph.

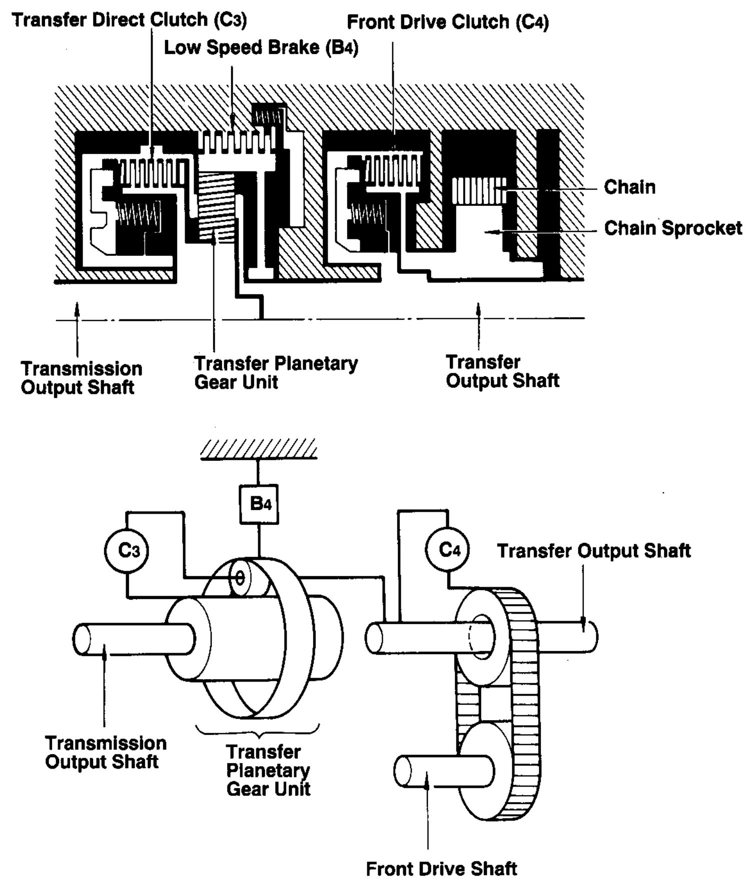
CAUTION Never move the front drive control lever if the wheels are slipping.

Components

The transfer unit uses a simple planetary gear assembly to accomplish high and low gear ratios. High gear is a direct drive through the planetary gear set. Low gear is a reduced gear ratio when increased torque is required.

Transfer Planetary Gear

Provides direct drive in two-wheel and four-wheel drive as well as low-gear four-wheel drive.



The transfer unit has three shafts:

- The transmission output shaft
- The transfer output shaft
- The front drive shaft

The transmission output shaft is connected to the planetary sun gear, and the transfer output shaft is connected to the planetary carrier. The ring gear is connected to the transfer housing through a holding device. A chain sprocket idles around the transfer output shaft, and a drive chain transfers driving torque from the chain sprocket to the front drive shaft.

Holding Devices

Three holding devices are used to control the planetary gear set; they are:

- Transfer Direct Clutch (C3)
- Low Speed Brake (B4)
- Front Drive Clutch (C4)

The *transfer direct clutch (C3)* locks the sun gear to the carrier, and the planetary gear set rotates as a unit. The carrier is connected to the transfer output shaft.

The *low speed brake (B4)* locks the ring gear to the transfer case. The sun gear is the drive gear. With the ring gear locked, the pinion gears walk around the ring and the carrier turns the transfer output shaft at a gear reduction.

The *front drive clutch (C4)* locks the transfer output shaft to the chain sprocket which in turn drives the front drive shaft with the drive chain.

Hydraulic Control

A separate valve body, electric solenoid and manual valve operate the transfer hydraulic circuit. The manual valve has three positions for ”high 2-wheel drive” (H2), ”high 4-wheel drive” (H4) and ”low 4-wheel drives” (L4). The manual valve alone controls the high 2- and 4-wheel drives; however, when shifted to the low 4-wheel drive position, the number four solenoid prevents the low speed brake from being applied until it is energized.

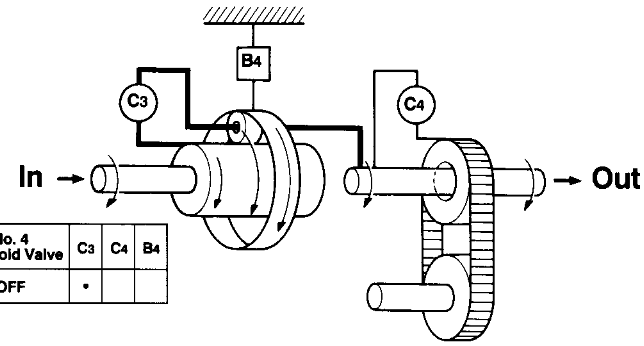
The number four solenoid is energized only for low 4-wheel drive (L4). The solenoid is controlled by the TCCS/ECT ECU which monitors throttle angle, transfer position switch and vehicle speed. When the transfer position switch is placed in the L4 position and the ECU senses light throttle and vehicle speed below 19 mph, it energizes the solenoid.

Power Flow

High 2-Wheel Drive (H2)

In high 2-wheel drive, the *transfer direct clutch (C3)* is applied which locks the sun gear to the carrier. Since the input torque is on the sun gear and two members of the planetary gear set are locked together, we have direct drive to the output shaft.

Shift Position H2

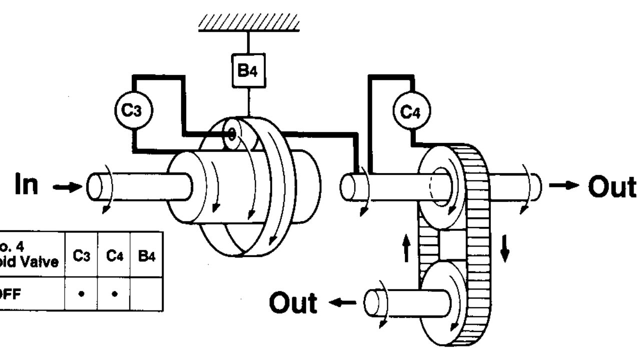


Transfer Gear Position	No. 4 Solenoid Valve	C3	C4	B4
H2	OFF	•		

High 4-Wheel Drive (H4)

In high 4-wheel drive, the *transfer direct clutch (C3)* and the *front drive clutch (C4)* are applied. Power flow through the *transfer direct clutch (C3)* is described in the previous paragraph. When the *front drive clutch (C4)* is applied, it locks the chain sprocket to the transfer output shaft. Torque is transferred to the front drive shaft through the chain. The transfer front drive shaft drives the front propeller shaft, front differential and wheels.

Shift Position H4

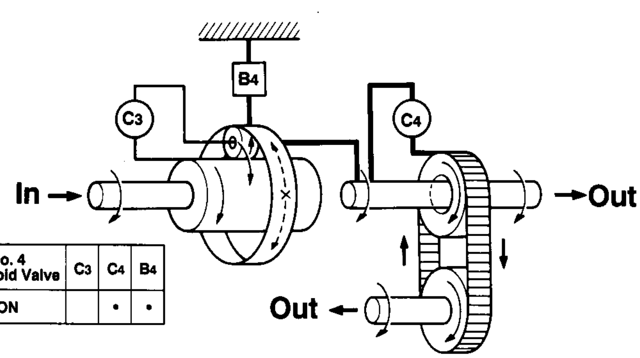


Transfer Gear Position	No. 4 Solenoid Valve	C3	C4	B4
H4	OFF	•	•	

Low 4-Wheel Drive (H4)

In low 4-wheel drive, not only is torque available to all wheels but a speed reduction and torque increase is also provided through the transfer case. The *transfer direct clutch (C3)* is released and the *low speed brake (B4)* is applied, locking the ring gear to the transfer case. Input torque is on the sun gear, which causes the planetary gears to walk around the ring gear and drive the transfer output shaft at a reduced speed. With the *front drive clutch (C4)* applied, torque is transferred to the transfer front drive shaft and all four wheels are driven.

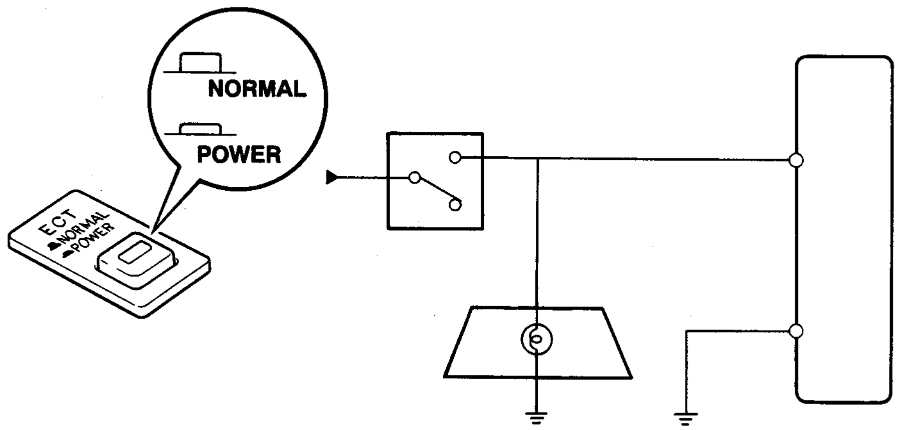
Shift Position L4



Transfer Gear Position	No. 4 Solenoid Valve	C3	C4	B4
L4	ON		•	•

Section 10

ELECTRICAL CONTROL



Driving Pattern	"PWR" Terminal Voltage
NORMAL	0 V
POWER	12 V

Lesson Objectives:

1. Describe the operation of the OD Main Switch and its control of fourth gear.
2. List the three items which control overdrive in a Non-ECT transmission.
3. Describe the effect of the OD solenoid on the torque converter lock-up control for Non-ECT transmissions.
4. Describe the effect of the pattern select switch on the upshift pattern.
5. Explain the effect of the neutral start switch in maintaining manual select positions in ECT transmissions.
6. Given the solenoid back-up function chart, describe the ECU control of the remaining solenoid to allow the vehicle to operate.

Non-ECT Transmission

Electrical control in a non-ECT transmission consists of overdrive and torque converter lock-up operation.

Overdrive Control System

Overdrive enables the output rpm of the transmission to be greater than the input rpm, so the vehicle can maintain a certain road speed with lower engine rpm. The control system provides line pressure at the top of the 3-4 shift valve to hold it in the third gear position. It also provides a solenoid to open and close a drain for this line pressure to control the shift valve position.

In a hydraulic-controlled transmission, the hydraulic circuit is controlled by the No. 3 solenoid, sometimes called the OD solenoid. The solenoid controls the drain on the hydraulic circuit at the top of the 3-4 shift valve which will counteract governor pressure when the drain is closed.

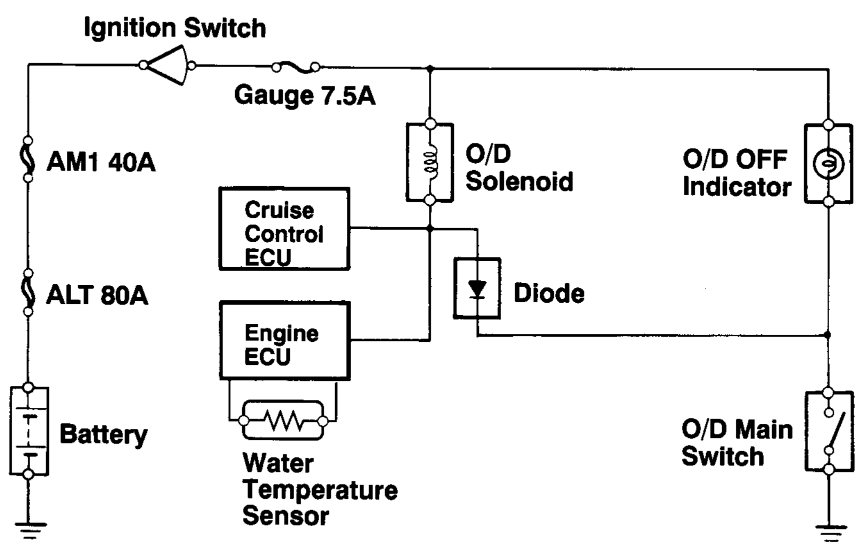
The components which make up this system include:

- OD main switch
- OD off indicator light
- Water temperature sensor
- OD solenoid valve

OD Wiring Diagram

OD Solenoid can be grounded by:

- Cruise Control ECU
- Water Temperature Sensor
- OD Main Switch

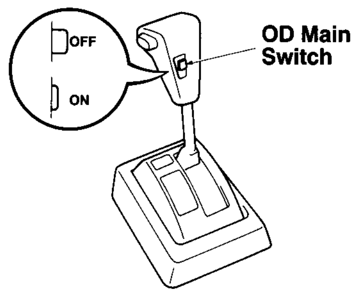


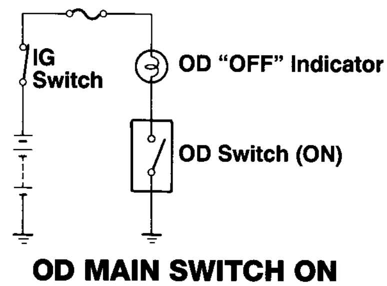
OD Main Switch

The OD main switch is located on the gear selector. Generally we think of a switch as closed when it is on and open when it is off. However, the OD main switch is just the opposite. When the OD switch is in the ON position, the switch contacts are open and the overdrive system is working. When the OD switch is in the OFF position, the switch contacts are closed and the overdrive system is not working. This enables the system to be in overdrive without having the solenoid energized.

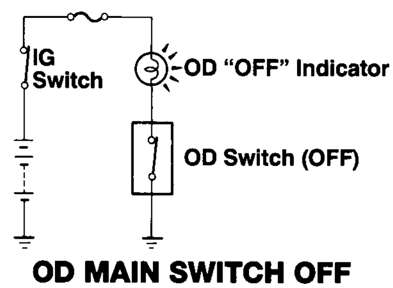
OD Main Switch

The operation of the switch is the opposite of its description





	OD SWITCH	
	ON	OFF
CONTACTS OF OD SWITCH	Open	Closed
UPSHIFTING	Enabled	Disabled
OD "OFF" INDICATOR	Off	On



OD Off Indicator Light

This indicator light remains on as long as the overdrive main switch is off (OD switch contacts closed). It is located in the combination meter.

Water Temperature Sensor

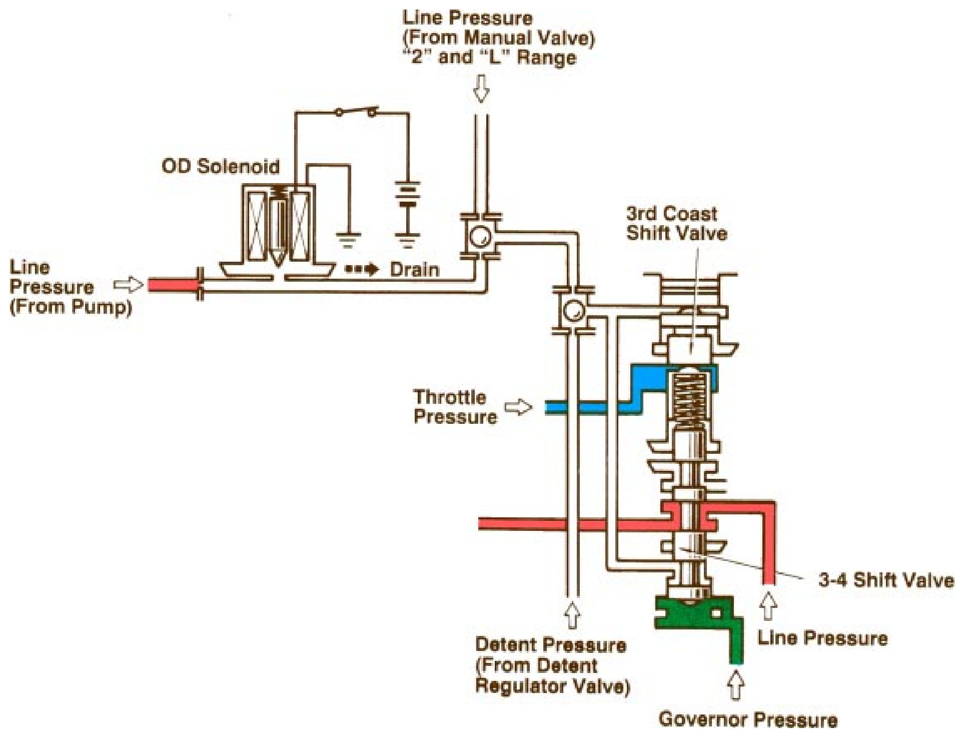
The water temperature sensor monitors the temperature of the engine coolant and is connected to the engine ECU. The engine ECU grounds the circuit through the ECT terminal. It prevents the transmission from shifting into overdrive until the engine coolant is greater than 122°F. This threshold temperature may vary depending on the vehicle model. While the engine temperature is below the threshold temperature, the lock-up solenoid circuit will be open, preventing movement of the 3-4 shift valve. On some earlier models, this sensor function was accomplished by a water thermo switch. The outcome is the same; however, the thermo switch controls the circuit without the engine ECU.

OD Solenoid Valve

The OD solenoid valve is a normally closed solenoid; that is, the valve is spring loaded in the closed position. When the solenoid is energized, the valve opens a drain in the hydraulic circuit to the top of the 3-4 shift valve. This allows governor pressure to overcome spring tension and throttle pressure to allow an upshift to overdrive. The OD main switch can manually disable this system as described previously.

Overdrive Solenoid Operation

OD solenoid is a normally closed solenoid



OD Main Relay

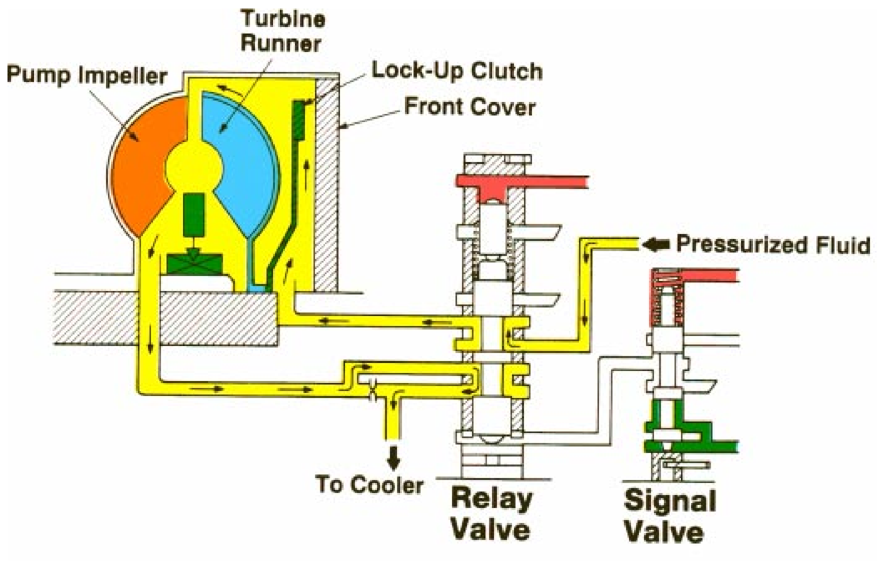
An overdrive main relay is used in Truck and Van systems where the transmission is hydraulically controlled as opposed to electronically (ECT) controlled. The relay is controlled by either the OD main switch, the water temperature sensor (in some cases through the engine ECU) or the cruise control ECU grounding the circuit.

Converter Lock-Up

Lock-up in a non-ECT transmission is controlled hydraulically by governor pressure and line pressure. Lock-up occurs only in the top gear position. For example: in an A130L series transmission, lock-up occurs only in third gear; in an A140L or A240L series transmission, lock-up occurs only in fourth gear.

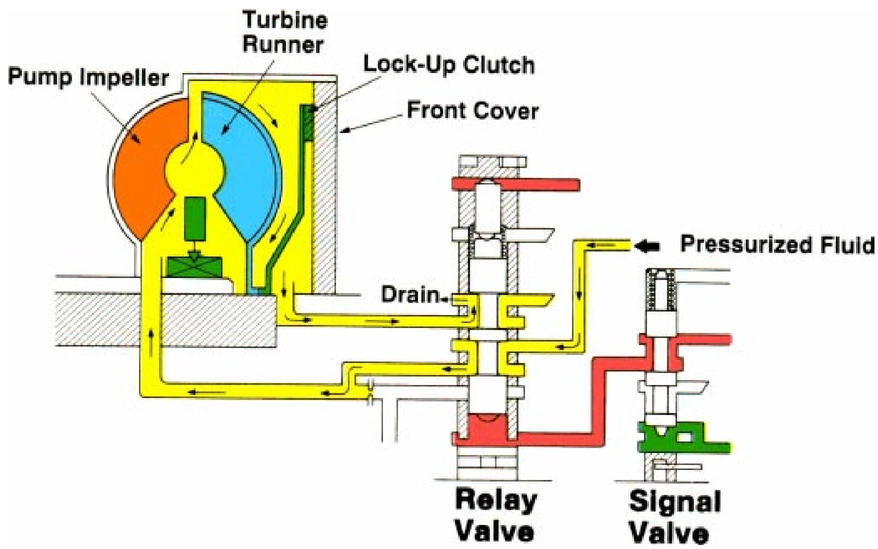
Lock-Up Clutch — Disengaged

When overdrive is disabled through solenoid No. 3, the lock-up clutch is also disabled



Two valves control the operation of the lock-up converter. The lock-up relay valve controls the distribution of converter/lubrication pressure to the torque converter. Line pressure and spring tension hold the relay valve in its normal down position. The signal valve blocks line pressure from the 3-4 shift valve. Governor pressure increases with vehicle speed to overcome spring tension at the top of the signal valve. When the signal valve moves up, line pressure flows through the valve to the base of the relay valve. The relay valve has a larger surface area at the base than at the top, and it moves upward, changing the flow of converter pressure to the converter and opening a drain to the front of the lock-up clutch, engaging the clutch with the converter housing.

Lock-Up Clutch — Engaged



Electronic Control Transmission

The Electronic Control Transmission is an automatic transmission which uses modern electronic control technologies to control the transmission. The transmission itself, except for the valve body and speed sensor, is virtually the same as a full hydraulically controlled transmission, but it also consists of electronic parts, sensors, an electronic control unit and actuators.

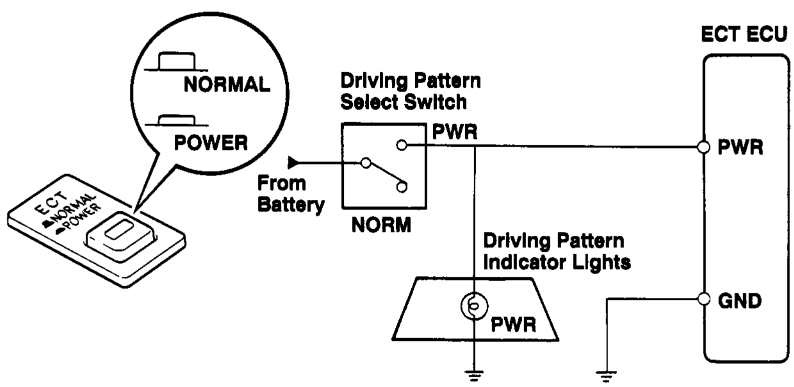
The electronic sensors monitor the speed of the vehicle, gear position selection and throttle opening, sending this information to the ECU. The ECU then controls the operation of the clutches and brakes based on this data and controls the timing of shift points and torque converter lock-up.

Driving Pattern Select Switch

The pattern select switch is controlled by the driver to select the desired driving mode, either ”Normal” or ”Power.” Based on the position of the switch, the ECT ECU selects the shift pattern and lock-up accordingly. The upshift in the power mode will occur later, at a higher speed depending on the throttle opening. For example, an upshift to third gear at 50% throttle will occur at about 37 mph in normal mode and about 47 mph in power mode.

Drive Pattern Select Switch

When the ECU does not receive 12 volts at the PWR terminal, it determines that normal has been selected.



Driving Pattern	“PWR” Terminal Voltage
NORMAL	0 V
POWER	12 V

The ECU has a ”PWR” terminal but does not have a ”Normal” terminal. When ”Power” is selected, 12 volts are applied to the ”PWR” terminal of the ECU and the power light illuminates. When ”Normal” is selected, the voltage at ”PWR” is 0 volts. When the ECU senses 0 volts at the terminal, it recognizes that ”Normal” has been selected.

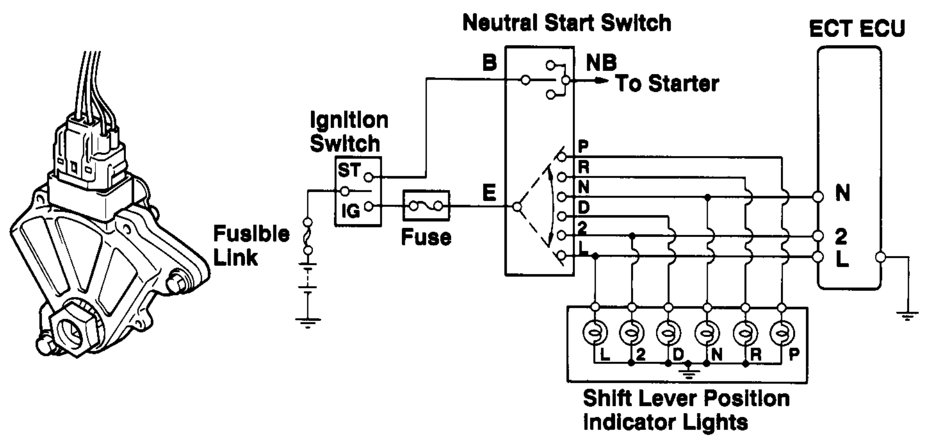
Beginning with the 1990 MR2 and Celica and the 1991 Previa, the pattern select switch was discontinued. In the Celica and Previa systems, several shift patterns are stored in the ECU memory. Utilizing sensory inputs, the ECU selects the appropriate shift pattern and operates the shift solenoids accordingly. The MR2 and 1993 Corolla have only one shift pattern stored in the ECU memory.

Neutral Start Switch

The ECT ECU receives information on the gear range into which the transmission has been shifted from the shift position sensor, located in the neutral start switch, and determines the appropriate shift pattern. The neutral start switch is actuated by the manual valve shaft in response to gear selector movement.

Neutral Start Switch

ECU monitors gear position through the neutral start switch.



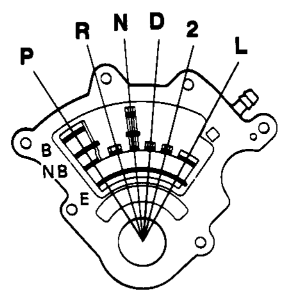
The ECT ECU only monitors positions ”2” and ”L.” If either of these terminals provides a 12-volt signal to the ECU, it determines that the transmission is in neutral, second gear or first gear. If the ECU does not receive a 12-volt signal at terminals ”2” or ”1,” the ECU determines that the transmission is in the ”D” range.

Some neutral start switches have contacts for all gear ranges. Each contact is attached to the gear position indicator lights if the vehicle is so equipped.

In addition to sensing gear positions, the neutral switch prevents the starter from cranking the engine unless it is in the park or neutral position. In the park and neutral position, continuity is established between terminals ”B” and ”NB” of the neutral start switch illustrated below.

Starter Control

In Park and Neutral positions, continuity exists between terminals ”B” and ”NB”.



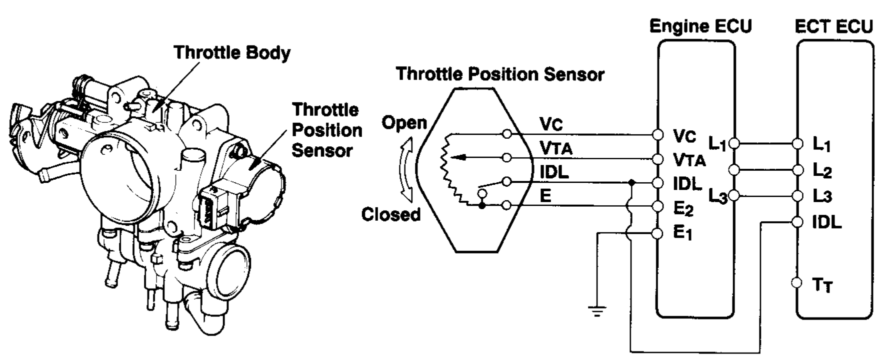
Throttle Position Sensor

This sensor is mounted on the throttle body and electronically senses how far the throttle is open and then sends this data to the ECU. The throttle position sensor takes the place of throttle pressure in a fully hydraulic control transmission. By relaying the throttle position, it gives the ECU an indication of engine load to control the shifting and lock-up timing of the transmission.

There are two types of throttle sensors associated with ECT transmissions. The type is related to how they connect to the ECT ECU. The first is the indirect type because it is connected directly to the engine ECU, and the engine ECU then relays throttle position information to the ECT ECU. The second type is the direct type which is connected directly to the ECT ECU.

Throttle Positoin Sensor—Indirect Type

Throttle sensor signals converted in Engine ECU are relayed to the ECT ECU.

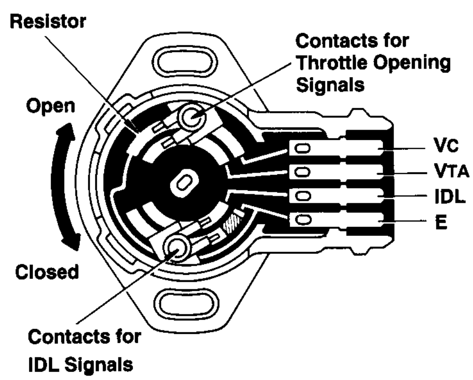


Indirect Type

This throttle position sensor converts the throttle valve opening angle into voltage signals. It has four terminals: Vc, VTA, IDL and E. A constant 5 volts is applied to terminal VC from the engine ECU. As the contact point slides along the resistor with throttle opening, voltage is applied to the VTA terminal. This voltage increases linearly from 0 volts at closed throttle to 5 volts at wide-open throttle.

Throttle Position Sensor

A linear voltage signal indicates throttle opening position and idle contacts indicate when the throttle is closed.

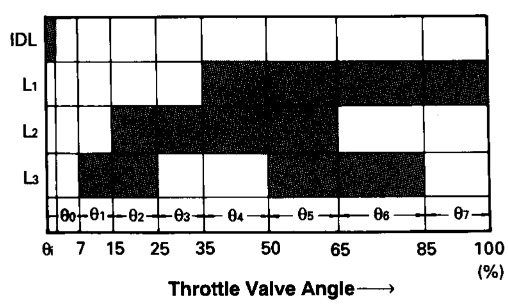


The engine ECU converts the VTA voltage into one of eight different throttle opening angle signals to inform the ECT ECU of the throttle opening. These signals consist of various combinations of high and low voltages at ECT ECU terminals as shown in the chart below. The shaded areas of the chart represent low voltage (about 0 volts). The white areas represent high voltage (LI, L2, L3: about 5 volts; IDL: about 12 volts).

Throttle Valve Angle Signal Chart

Shaded are = low voltage (about 0 v).

Clear area = high voltage (about 5 v).



When the throttle valve is completely closed, the contact points for the IDL signal connect the IDL and E terminals, sending an IDL signal to the ECT ECU to inform it that the throttle is fully closed.

As the ECT ECU receives the LI, L2 and L3 signals, it provides an output voltage from 1 to 8 volts at the TT or ECT terminal of the diagnostic check connector. The voltage signal varies depending on the throttle opening angle and informs the technician whether or not the throttle opening signal is being input properly.

Direct Type

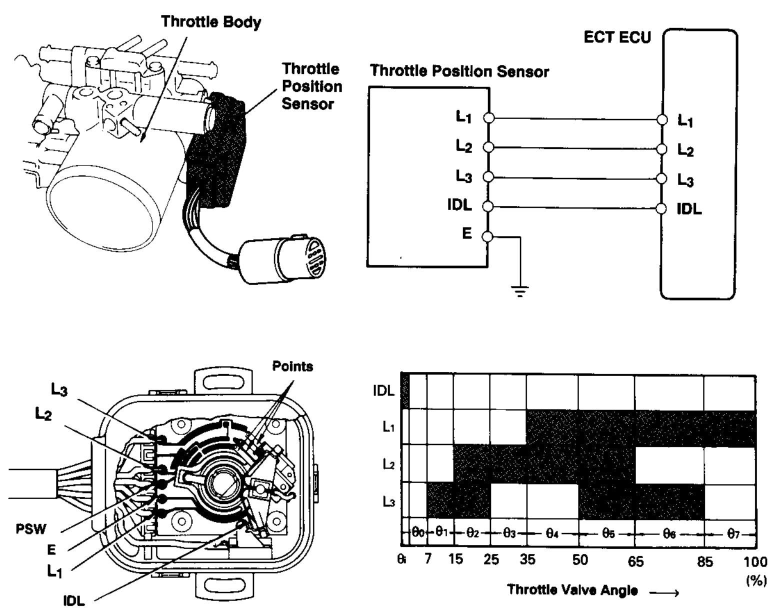
With this type of throttle sensor, signals are input directly to the ECT ECU from the throttle position sensor. Three movable contact points rotate with the throttle valve, causing contacts LI, L2, L3 and IDL to make and break the circuit with 'contact E (ground). The grid which the contact points slide across is laid out in such a way as to provide signals to the ECT ECU depicted in the chart below. The voltage signals provided to the ECT ECU indicate throttle position just as they did in the indirect type of sensor.

If the idle contact or its circuit on either throttle sensor malfunctions, certain symptoms occur. If it is shorted to ground, lock-up of the torque converter will not occur. If the circuit is open, neutral to drive squat control does not occur and a harsh engagement may be the result. If the LI, L2, L3 signals are abnormal, shift timing will be incorrect.

Refer to the ECT Diagnostic Information chart in the appendix of this book to determine which throttle position sensor is used in each model.

Throttle Position Sensor—Direct Type

Throttle sensor printed circuit board and contract points probide the ECT ECU with the same signal pattern for throttle opening as the indirect type of throttle senosor.

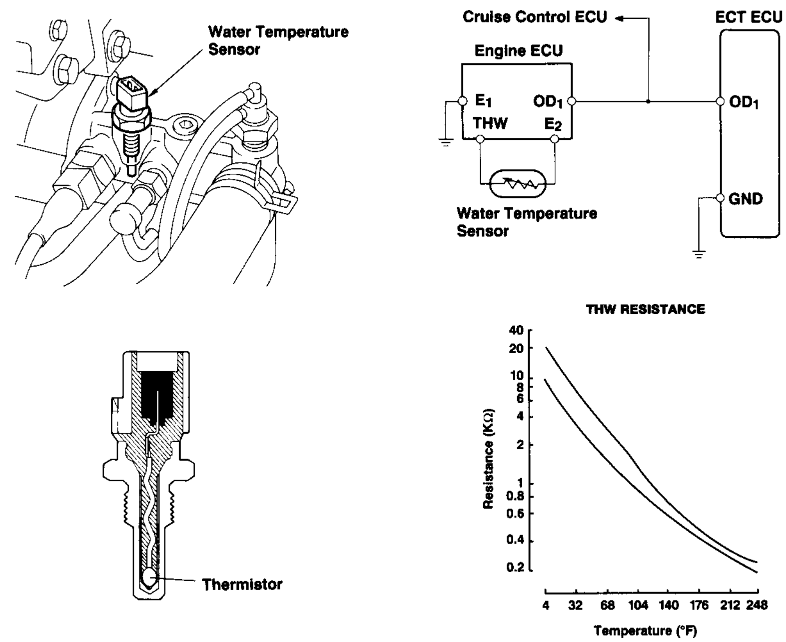


Water Temperature Sensor

The water temperature sensor monitors engine coolant temperature and is typically located near the cylinder head water outlet. A thermistor is mounted within the temperature sensor, and its resistance value decreases as the temperature increases. Therefore, when the engine temperature is low, resistance will be high.

Water Temperature Sensor

Coolant temperature is monitored by the engine ECU which controls the signal to OD1 of the ECT ECU to cancel overdrive.



When the engine coolant is below a predetermined temperature, the engine performance and the vehicle's drivability would suffer if the transmission were shifted into overdrive or the converter clutch were locked-up. The engine ECU monitors coolant temperature and sends a signal to terminal GDI of the ECT ECU. The ECU prevents the transmission from upshifting into overdrive and lock-up until the coolant has reached a predetermined temperature. This temperature will vary from 122°F to 162°F depending on the transmission and vehicle model. For specific temperatures, refer to the ECT Diagnostic Information chart in the appendix of this book.

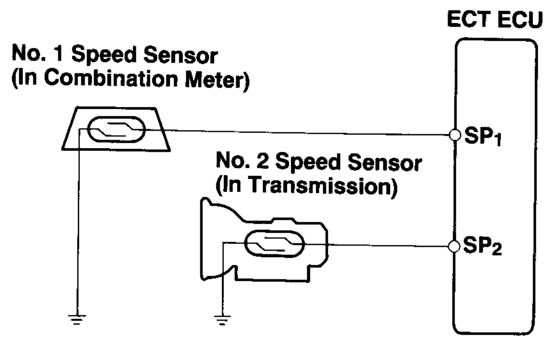
Some models, depending on the model year, cancel upshifts to third gear at lower temperatures. This information is found in the appendix and is indicated in the heading of the OD Cancel Temp column of the ECT Diagnostic Information chart by listing in parenthesis the temperature for restricting third gear.

Speed Sensors

To ensure that the ECT ECU is kept informed of the correct vehicle speed at all times, vehicle speed signals are input into it by two speed sensors. For further accuracy, the ECT ECU constantly compares these two signals to see whether they are the same. The speed sensor is used in place of governor pressure in the conventional hydraulically controlled transmission.

Speed Sensors

Speed sensors are used in place of the governor valve in non-ECT transmissions.

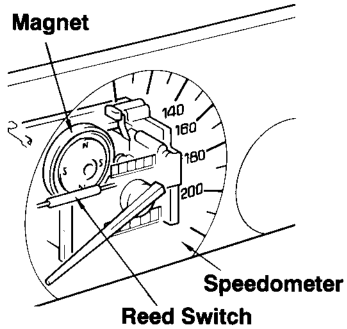


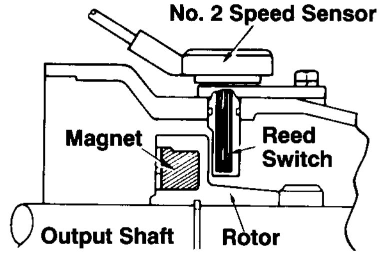
Main Speed Sensor (No. 2 Speed Sensor)

The main speed sensor is located in the transmission housing. A rotor with built-in magnet is mounted on the drive pinion shaft or output shaft. Every time the shaft makes one complete revolution, the magnet activates the reed switch, causing it to generate a signal. This signal is sent to the ECU, which uses it in controlling the shift point and the operation of the lock-up clutch. This sensor outputs one pulse for every one revolution of the output shaft.

Beginning with the 1993 Corolla A245E, the No. 2 speed sensor has been discontinued and only the No. 1 speed sensor is monitored for shift timing.

Main and Back-Up Speed Sensors





Back-Up Speed Senosr (No. 1 Speed Sensor)

The back-up speed sensor is built into the combination meter assembly and is operated by the speedometer cable. The sensor consists of an electrical reed switch and a multiple pole permanent magnet assembly. As the speedometer cable turns, the permanent magnet rotates past the reed switch. The magnetic flux lines between the poles of the magnet cause the contacts to open and close as they pass. The sensor outputs four pulses for every one revolution of the speedometer cable.

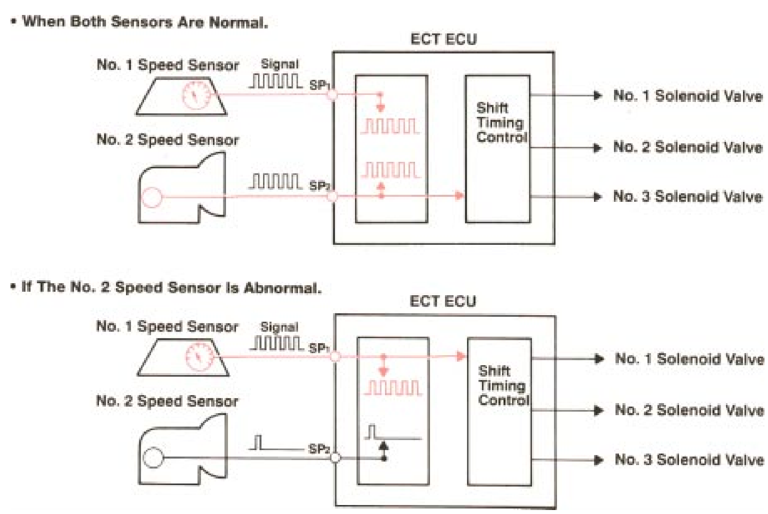
The sensor can also be a photocoupler type which uses a photo transistor and light-emitting diode (LED). The LED is aimed at the phototransistor and separated by a slotted wheel. The slotted wheel is driven by the speedometer cable. As the slotted wheel rotates between the LED and photo diode, it generates 20 light pulses for each rotation. This signal is converted within the phototransistor to four pulses sent to the ECU.

Speed Sensor Failsafe

If both vehicle speed signals are correct, the signal from the main speed sensor is used in shift timing control after comparison with the output of the back-up speed sensor. If the signals from the main speed sensor fail, the ECU immediately discontinues use of this signal and uses the signals from the back-up speed sensor for shift timing.

Speed Sensor—Failsafe

ECT ECU compares the back-up speed sensor with the main speed sensor for shift timing control.

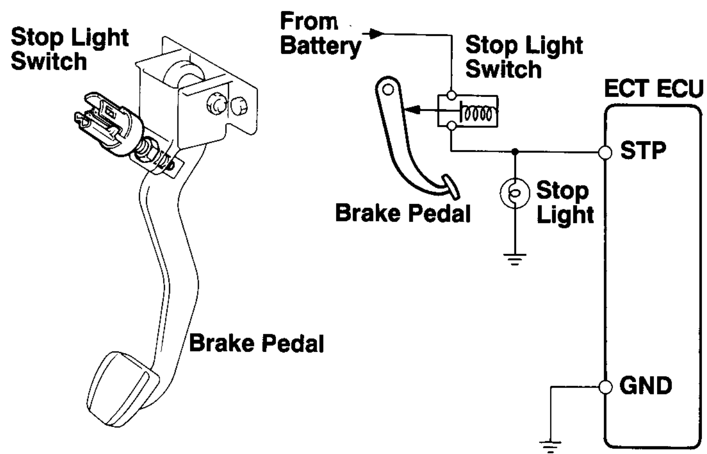


Stop Light Switch

The stop light switch is mounted on the brake pedal bracket. When the brake pedal is depressed, it sends a signal to the STP terminal of the ECT ECU, informing it that the brakes have been applied.

Stop Light Switch

The ECU cancels torque converter lock-up and Neutral to Drive squal control based on the stop light switch.



Brake Pedal	STP Terminal Voltage
Depressed	12 V
Released	0 V

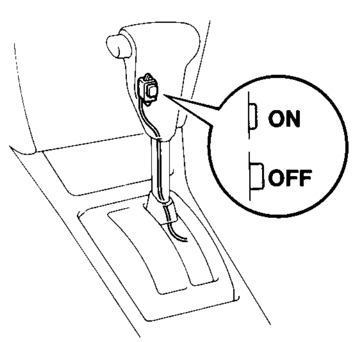
The ECU cancels torque converter lock-up when the brake pedal is depressed, and it cancels ”N” to ”D” squat control when the brake pedal is not depressed and the gear selector is shifted from neutral to drive.

Overdrive Main Switch

The overdrive main switch is located on the gear selector. It allows the driver to manually control overdrive. When it is turned on, the ECT can shift into overdrive. When it is turned off, the ECT is prevented from shifting into overdrive.

Overdrive Main Switch

Allows driver to manually control overdrive.



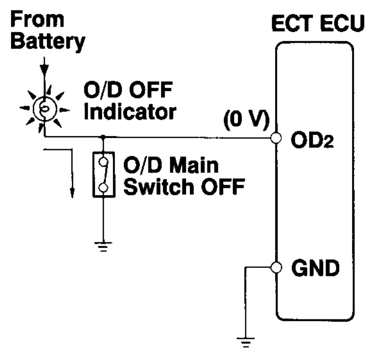
	O/D Main Switch	
	ON	OFF
Contacts of O/D Main Switch	Open	Closed
O/D Gear	Enabled	Disabled
O/D OFF Indicator Light	Off	On

O/D Main Switch ON

When the O/D switch is in the ON position, the electrical contacts are actually open and current from the battery flows to the OD2 terminal of the ECT ECU as shown below.

Overdrive (O/D) Main Switch—ON

When O/D main switch is on, OD_2 terminal has 12 v.

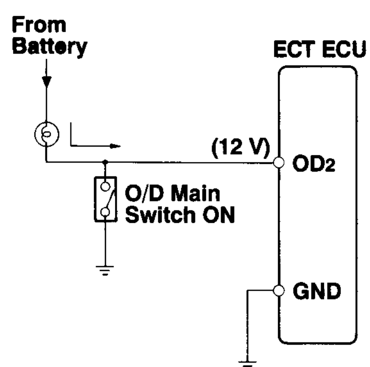


O/D main Switch OFF

When the O/D switch is in the OFF position, the electrical contacts are actually closed and current from the battery flows to ground and 0 volts is present at the OD2 terminal as shown below. At the same time, the O/D OFF indicator is illuminated.

Overdrive (O/D) Main Switch—OFF

When O/D main switch is on, OD_2 terminal has 0 v.



Solenoid Valves

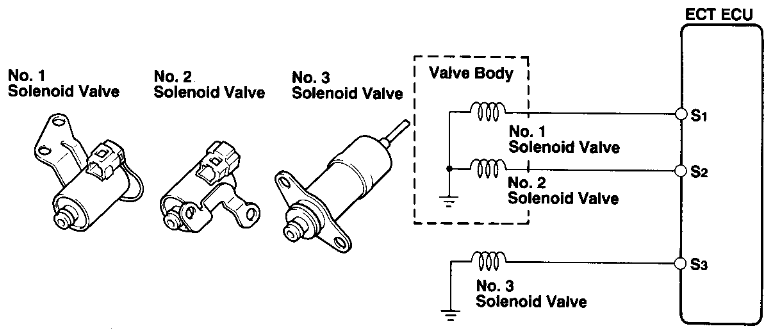
Solenoid valves are electro-mechanical devices which control hydraulic circuits by opening a drain for pressurized hydraulic fluid. Of the solenoid valves, No. 1 and No. 2 control gear shifting while No. 3 controls torque converter lock-up.

No. 1 and No. 2 Solenoid Valves

These solenoid valves are mounted on the valve body and are turned on and off by electrical signals from the ECU, causing various hydraulic circuits to be switched as necessary. By controlling the two solenoids' on and off sequences, we are able to provide four forward gears as well as prevent upshifts into third or fourth gear.

Solenoid Valves

Solenoids provide electrical control over shifting and torque converter lock-up.



The No. 1 and No. 2 solenoids are normally closed. The plunger is spring-loaded to the closed position, and when energized, the plunger is pulled up, allowing line pressure fluid to drain. The operation of these solenoids by the ECT ECU is described on pages 123 - 126 of this book.

No. 3 Solenoid Valve

This solenoid valve is mounted on the transmission exterior or valve body. It controls line pressure which affects the operation of the torque converter lock-up system. This solenoid is either a normally open or normally closed solenoid. The A340E, A340H, A540E and A540H transmissions use the normally open solenoid.

No. 4 Solenoid Valve

This solenoid is found exclusively on the A340H transfer unit described on page 152 of this book. This solenoid is a normally closed solenoid which controls the shift to low 4-wheel drive. It is controlled by the ECT ECU when low 4-wheel drive has been selected at vehicle speeds below 18 mph with light throttle opening.

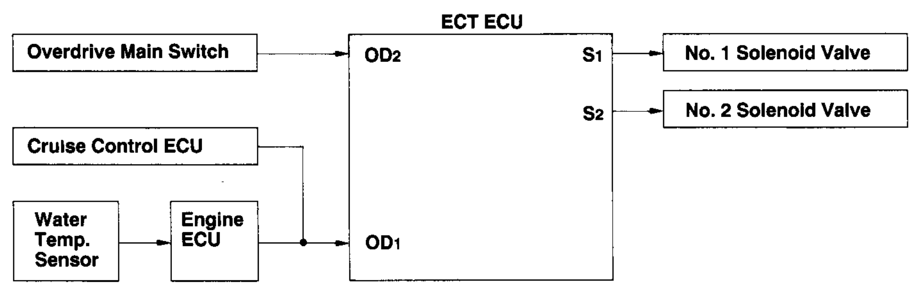
Functions of ECT ECU

Control of Shift Timing

The components which make up this system include:

- OD main switch
- OD Off indicator light
- ECT ECU
- Water temperature sensor
- Cruise control ECU
- No. 1 and No. 2 solenoid valves (shift solenoids)

Overdrive Control System—ECT



The ECU controls No. 1 and No. 2 solenoid valves based on vehicle speed, throttle opening angle and mode select switch position.

The ECT ECU prevents an upshift to overdrive under the following conditions:

- Water temperature is below 122°F to 146°F*.
- Cruise control speed is 6 mph below set speed.
- OD main switch is off (contacts closed).

In addition to preventing the OD from engaging below a specific engine temperature, upshift to third gear is also prevented in the Supra and Cressida below 96°F and the V6 Camry below 100°F.

* Consult the specific repair manual or the ECT Diagnostic Information Technician Reference Card for the specific temperature at which overdrive is enabled.

Control of Lock-Up

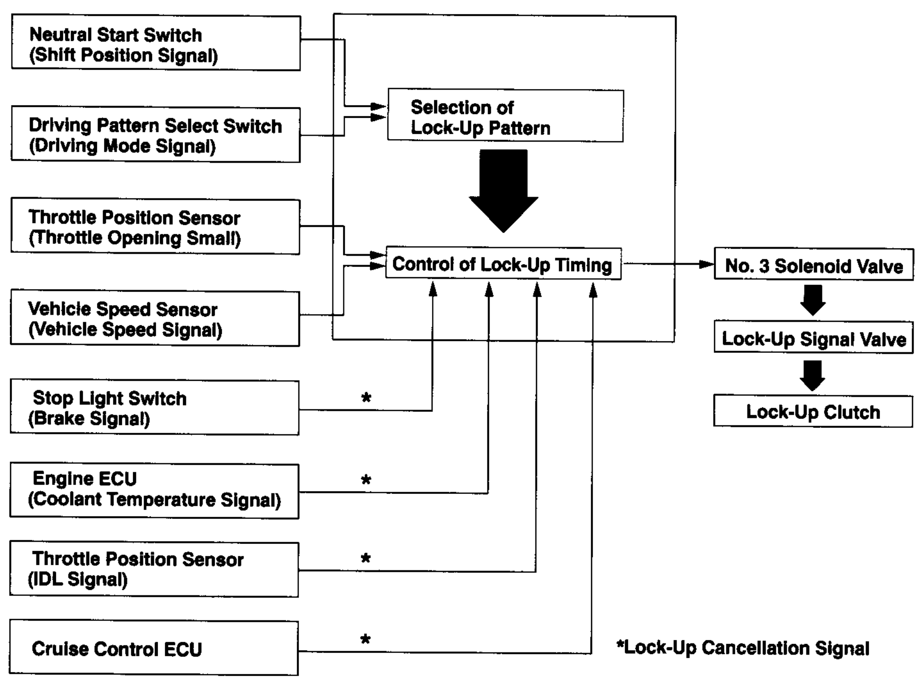
The ECT ECU has lock-up clutch operation pattern for each driving mode (Normal and Power) programmed in its memory. The ECU turns the No. 3 solenoid valve on or off according to vehicle speed and throttle opening signals. The lock-up control valve changes the fluid passages for the converter pressure acting on the torque converter piston to engage or disengage the lock-up clutch.

In order to turn on solenoid valve No. 3 to operate the lock-up system, the following three conditions must exist simultaneously:

- The vehicle is traveling in second, third, or overdrive (”D” range).
- Vehicle speed is at or above the specified speed and the throttle opening is at or above the specified value.
- The ECU has received no mandatory lock-up system cancellation signal.

The ECU controls lock-up timing in order to reduce shift shock. If the transmission up-shifts or down-shifts while the lock-up is in operation, the ECU deactivates the lock-up clutch.

Lock-Up Control System—ECT



The ECU will cancel lock-up if any of the following conditions occur:

- The stop light switch comes on.
- The coolant temperature is below 122°F to 145°F depending on the model. Consult the vehicle repair manual or the ECT Diagnostic Information Technician Reference Card.
- The IDL contact points of the throttle position sensor close.

The vehicle speed drops about 6 mph or more below the set speed while the cruise control system is operating.

The stop light switch and IDL contacts are monitored in order to prevent the engine from stalling in the event that the rear wheels lock up during braking. Coolant temperature is monitored to enhance drivability and transmission warm-up. The cruise control monitoring allows the engine to run at higher rpm and gain torque multiplication through the torque converter.

Neutral to Drive Squat Control

When the transmission is shifted from the neutral to the drive range, the ECU prevents it from shifting directly into first gear by causing it to shift into second or third gear before it shifts to first gear. It does this in order to reduce shift shock and squatting of the vehicle.

Engine Torque Control

To prevent shifting shock on some models, the ignition timing is retarded temporarily during gear shifting in order to reduce the engine's torque. The TCCS and ECT ECU monitors engine speed signals (Ne) and transmission output shaft speed (No. 2 speed sensor) then determines how much to retard the ignition timing based on shift pattern selection and throttle opening angle.

Fail-Safe Operation

The ECT ECU has several fail-safe functions to allow the vehicle to continue operating even if a malfunction occurs in the electrical system during driving. The speed sensor fail-safe has already been discussed on page 169 of this book.

Solenoid Valve Back-Up Function

In the event that the shift solenoids malfunction, the ECU can still control the transmission by operating the remaining solenoid to put the transmission in a gear that will allow the vehicle to continue to run.

The chart below identifies the gear position the ECU places the transmission if a given solenoid should fail. Notice that if the ECU was not equipped with fail-safe, the items in parenthesis would be the normal operation. But because the ECU senses the failure, it modifies the shift pattern so the driver can still drive the vehicle. For example, if No. 1 solenoid failed, the transmission would normally go to overdrive in drive range first gear. But instead, No. 2 solenoid turned it on to give 3rd gear.

Solenoid Valve Back-Up Function Chart

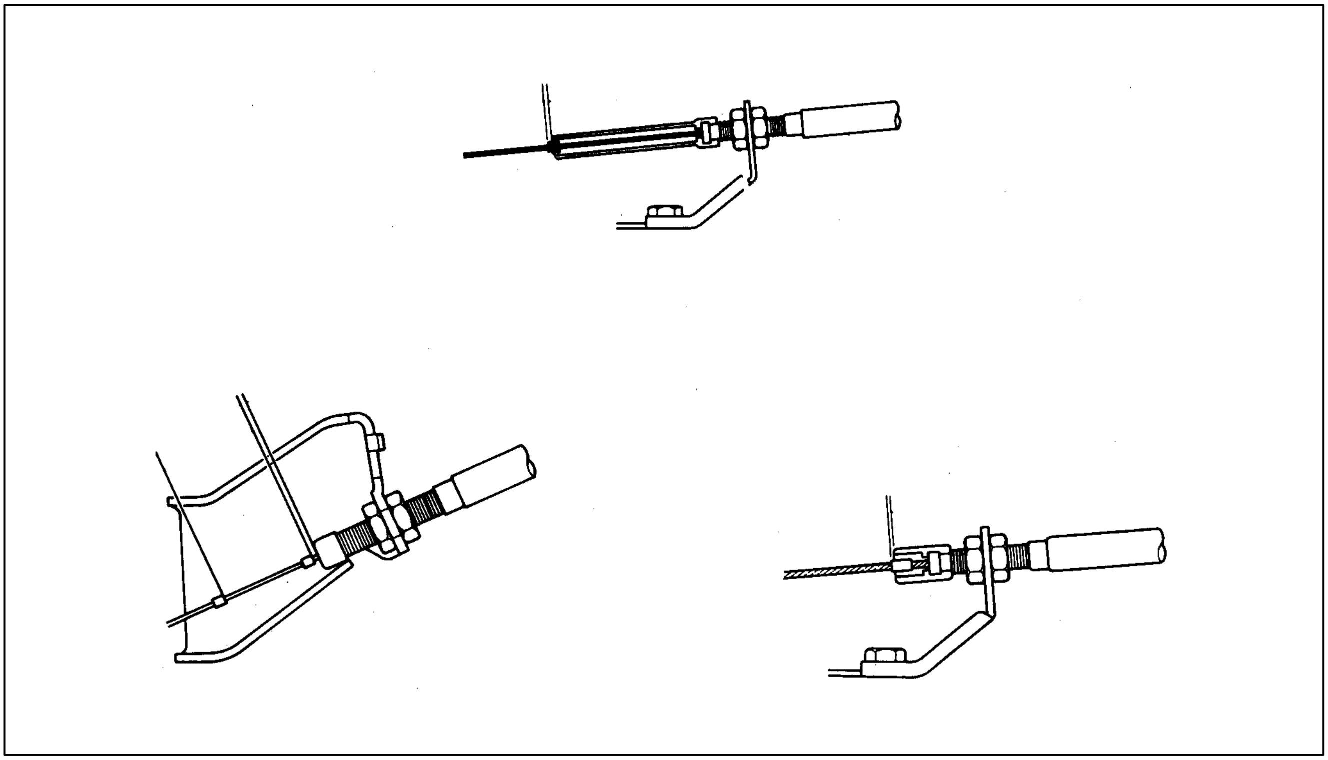
RANGE	NORMAL			NO. 1 SOLENOID MALFUNCTIONING			NO. 2 SOLENOID MALFUNCTIONING			BOTH SOLENOIDS MALFUNCTIONING
	Solenoid valve		Gear	Solenoid valve		Gear	Solenoid valve		Gear	Gear when shift lever is manually operated
	NO. 1	NO. 2		NO. 1	NO. 2		NO. 1	NO. 2		
"D"	ON	OFF	1st	x	ON (OFF)	3rd (O/D)	ON	x	1st	O/D
"D"	ON	ON	2nd	x	ON	3rd	OFF (ON)	x	O/D (1st)	O/D
"D"	OFF	ON	3rd	x	ON	3rd	OFF	x	O/D	O/D
"D"	OFF	OFF	O/D	x	OFF	O/D	OFF	x	O/D	O/D
"2"	ON	OFF	1st	x	ON (OFF)	3rd (O/D)	ON	x	1st	3rd*
"2"	ON	ON	2nd	x	ON	3rd	OFF (ON)	x	3rd* (1st)	3rd*
"2"	OFF	ON	3rd	x	ON	3rd	OFF	x	3rd*	3rd*
"L"	ON	OFF	1st	x	OFF	1st	ON	x	1st	1st
"L"	ON	ON	2nd	x	ON	2nd	ON	x	1st	1st

( ): If no fail-safe function were provided x: Malfunctions *O/D in the A540E, A540H

Should both solenoids malfunction, the driver can still safely drive the vehicle by operating the shift lever manually.

Section 11

TRANSMISSION CHECK, ADJUSTMENTS AND DIAGNOSIS



Lesson Objectives:

1. -Perform pressure test of the automatic transmission using appropriate pressure gauge set.
2. Perform stall test of automatic transmission vehicle using procedure described in appropriate repair manual.
3. Using an ECT Analyzer, distinguish between mechanical and electrical failures in electronic control transmissions.
4. Using a voltmeter at the diagnostic connector, determine if the ECT ECU is processing input and directing output signals correctly.
5. Using a voltmeter at the diagnostic connector, determine if the throttle position switch and brake switch inputs to the ECT computer are correct.

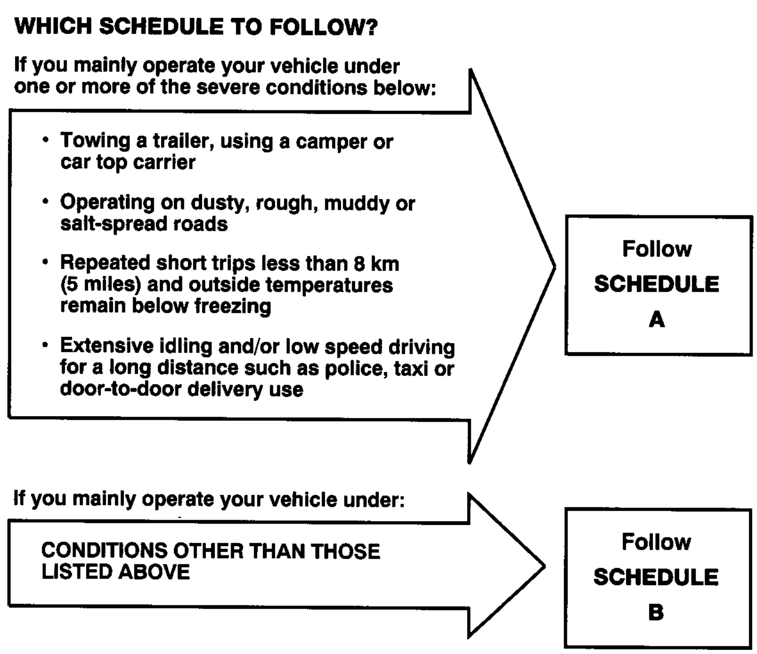
Checks and Adjustments

The transmission requires regular maintenance intervals if it is to continue to operate without failure. As we discussed in previous sections, transmission fluid loses certain properties over time and especially due to heat.

The Maintenance Schedules found in the repair manual or the Owners Manual indicate the appropriate replacement schedules based on how the vehicle is used. Schedule A for example, recommends replacement of the fluid every 20,000 miles or 24 months. Whereas Schedule B recommends just an inspection of the fluid every 15,000 miles or 24 months and no replacement interval.

The chart below indicates which maintenance schedule to follow based on the use of the vehicle.

Maintenance Schedule Selection



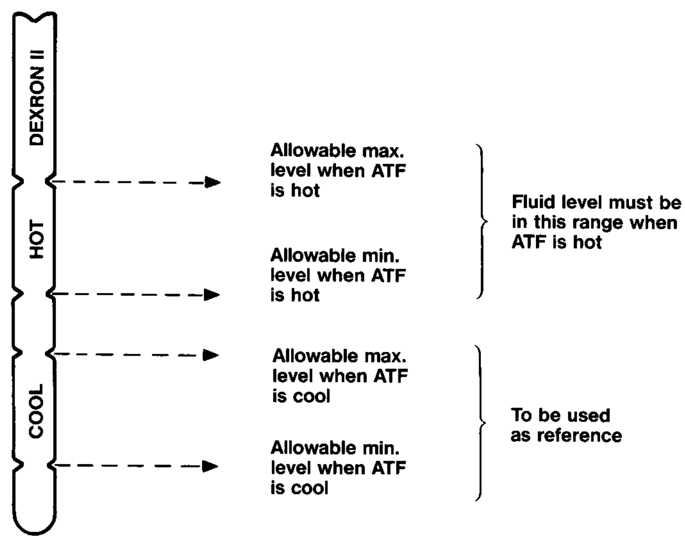
Fluid Level

The fluid level in the automatic transmission should be inspected by means of the dipstick after the transmission has been warmed up to ordinary operating temperature, approximately 158°F to 176°F. As a rule of thumb, if the graduated end is too hot to hold, the fluid is at operating temperature. The fluid level is proper if it is in the hot range between hot maximum and hot minimum.

NOTE

The cool level found on the dip stick should be used as a reference only when the transmission is cold. The correct fluid level can only be found when the fluid is hot.

Fluid Level Check



It is important to keep the fluid at the correct level at all times to ensure proper operation of the automatic transmission. If the fluid level is too low, the oil pump will draw in air, causing air to mix with the fluid. Aerated fluid lowers the hydraulic pressure in the hydraulic control system, causing slippage and resulting in damage to clutches and bands. If the fluid level is excessive, planetary gears and other rotating components agitate the fluid, aerating it and causing similar symptoms as too little fluid. In addition, aerated fluid will rise in the case and may leak from the breather plug at the top of the transmission or through the dipstick tube.

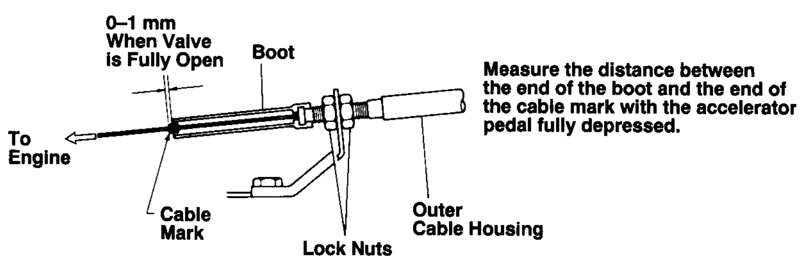
In addition, be sure to check the differential fluid level in a transaxle. This fluid is sealed off and separate from the transmission cavity in some applications.

Throttle Cable

The throttle cable is adjustable on all automatic transmissions. And in each case it controls throttle pressure. Throttle pressure is an indication of load. When the throttle is depressed, the cable transfers this motion to the base of the throttle valve and moves it upward to increase throttle pressure. Throttle pressure causes the primary regulator valve to increase line pressure. As the throttle is depressed, greater torque is produced by the engine and the transmission may also downshift to a lower gear. If line pressure did not increase, slippage could occur which would result in wear of the clutch plate surface material.

Throttle pressure's affect on transmission operation differs between a hydraulically controlled transmission (non-ECT) and an electronically controlled transmission (ECT). In a non-ECT transmission, throttle pressure affects shift points and line pressure; whereas in an ECT transmission it only affects line pressure. Control of line pressure will affect the quality of the shift, not the shift points, in an ECT transmission.

Throttle Cable Adjustment



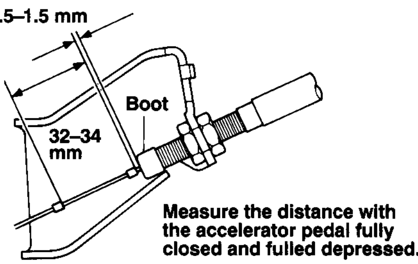
Inspect and Adjust the Throttle Cable

To inspect the throttle cable adjustment, the engine should be off. Depress the accelerator pedal completely, and make sure that the throttle valve is at the maximum open position. If the throttle valve is not fully open, adjust as needed.

With the throttle fully open, check the throttle cable stopper at the boot end and ensure that there is no more than one millimeter between the end of the stopper and the end of the boot. If adjustment is required, make the adjustment with the throttle depressed. Loosen the locking nuts on the cable housing and reposition the cable housing and boot as needed until the specification is reached.

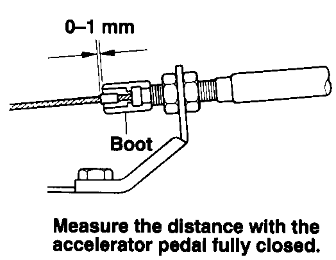
The Land Cruiser A440 automatic transmission throttle cable is adjusted differently, as seen below. It is measured in two positions. The first measurement is made with the throttle fully closed. The distance varies in that the measurement is made from the end of the boot to the front of the stopper. Measure the same distance with the throttle in the fully open position.

Throttle Cable Adjustment



The illustration below represents yet another adjustment type. The rubber boot has a shallow extension when compared to the first one discussed earlier. The procedure differs in that the throttle is left in the fully closed position when the distance is measured from the front of the boot to the front of the stopper.

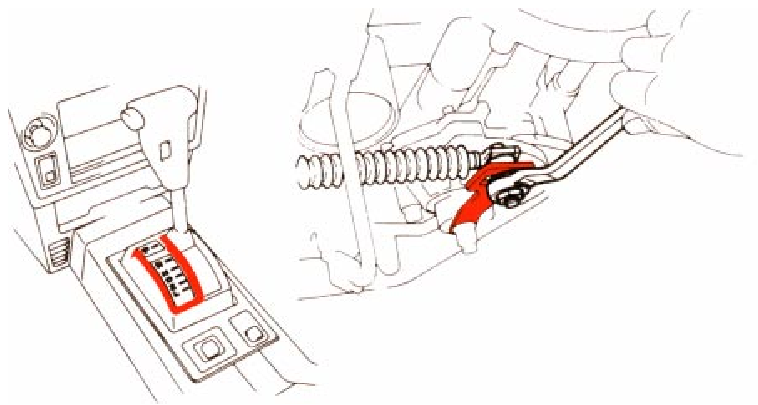
Throttle Cable Adjustment



Inspect and Adjust the Shift Cable

To inspect the shift cable, move the gear selector from neutral to each position. The gear selector should move smoothly and accurately to each gear position. Adjust the shift cable if the indicator does not line-up with the position indicator while in the proper detent. To adjust, loosen the swivel nut on the shift linkage. Push the manual lever at the transmission fully toward the torque converter end of the transmission. Then pull the lever back two notches from Park through Reverse to the Neutral position. Set the selector lever to the Neutral position and tighten the swivel nut while holding the lever lightly toward the reverse position.

Shift Cable Adjustment



Check Idle Speed and Adjust if Applicable

Idle speed is an important aspect for transmission engagement. If set too high, when shifting from neutral to drive or reverse, the engagement will be too abrupt, causing not only driver discomfort, but also affecting the components of the transmission as well. And, of course, if the idle is too low, it may cause the engine to stall or idle roughly.

To adjust the idle speed:

- The engine should be at operating temperature.
- All accessories should be off.
- Set the parking brake.
- Place the transmission in park or neutral position.
- Engine cooling fan should be off.

Diagnosis

During diagnosis, always verify the customer complaint. If the verification includes a test drive, be sure to check the level of ATF first. This will ensure that a low level is not contributing to the problem and give you an idea as to the condition and service that the vehicle has seen. Although preliminary checks suggest making adjustments, drive the vehicle before any adjustments in order to experience the same condition as the customer. If you are unable to verify the problem, ask the customer to accompany you on the test drive and point-out when the condition occurs.

When test driving a vehicle, have a plan and record your findings. The chart that follows is quite thorough and provides room for comments. Rather than trying to remember the results of a specific test, simply refer to the diagnostic form. Not only do you want to find out what has failed, but also what is functioning properly. Armed with this information, you will save time in your diagnosis and be more thorough.

Road Test — Automatic Transmission

Vehicle ____________________

Driver ____________________ Recorder ____________________

Tach Reader ____________________ Speedometer Reader ____________________

1. D Range Upshifts:

		NORMAL	POWER
Quarter Throttle		1-2 ________ mph	1-2 ________ mph
		2-3 ________ mph	2-3 ________ mph
		3-4 ________ mph	3-4 ________ mph
Half Throttle		1-2 ________ mph	1-2 ________ mph
		2-3 ________ mph	2-3 ________ mph
		3-4 ________ mph	3-4 ________ mph

Shift Quality: ☐ Normal ☐ Excess Shock ☐ Slippage

2. 2-Range Upshifts:

Quarter Throttle 1-2 ________ mph

Half Throttle 1-2 ________ mph

Shift Quality: ☐ Normal ☐ Excess Shock ☐ Slippage

3. 2-Range Engine Braking: ☐ OK ☐ NG

4. L Range Engine Braking: ☐ OK ☐ NG

5. D Range Kick-Down:

	OK	NG
OD to 3	________	________
OD to 2	________	________
3 to 2	________	________
2 to 1	________	________

6. Manual Down-Shifts:

ECT Transmission—At 35 mph in OD, press OD OFF button; record engine rpm change. ________ rpm

At 35 mph, shift from D to 2; engine speed increases. ________ rpm

At 25 mph, shift from 2 to 1; engine speed increases. ________ rpm

Comments: ____

____

____

For example, if the transmission does not slip while accelerating from a stop with wide open throttle, line pressure is sufficient. If shift points occur at the proper speeds, throttle pressure and governor pressure are sufficient. Or for ECT transmissions, throttle sensor and speed sensor inputs are being received by the ECU and the circuit and solenoids are working properly.

Upshift quality is important to consider during the road test because it is an indicator of proper line pressure and accumulator operation. If all upshifts are harsh, it indicates a common problem such as line pressure and should be verified with a pressure test. If a harsh upshift is evident in a specific gear, check the accumulator which is associated with the holding device for that specific gear.

Following the road test, compare your findings with the troubleshooting matrix chart in the repair manual. (An example can be found on page 223 of the appendix to this book.) The matrix chart will assist you in identifying components or circuits which can be repaired while the transmission is mounted in the vehicle. Or identify the components which should be inspected with the transmission on the bench.

Based on your diagnosis, if the transmission can be repaired with an on-vehicle repair, the off-vehicle repair should be attempted first. Should the transmission require removal from the vehicle, a remanufactured transmission should be evaluated against the cost of an in-house overhaul.

Electrical Diagnostic Testing

Onboard Diagnostics

The ECU is equipped with a built-in self diagnostic system, which monitors the speed sensors, solenoid valves and their electrical circuitry. If the ECU senses a malfunction:

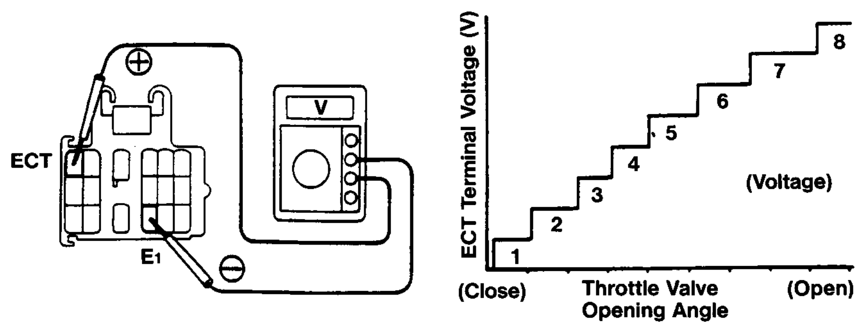
1. It blinks the OD OFF light to warn the driver.
2. It stores the malfunction code in its memory.
3. (When properly accessed) it will output a diagnostic code indicating the faulty component or circuit.

Once a malfunction is stored in the memory system, it will be retained until canceled (erased). The vehicle battery constantly supplies 12 volts to the ECU B terminal to maintain memory even if the ignition switch is turned off. If the malfunction is repaired or returns to normal operation, the warning light will go off but the malfunction code will remain in memory. In order to erase a diagnostic code from the memory, a specified fuse must be removed for approximately 30 seconds while the ignition switch is off. The fuse is identified in the repair manual or on the ECT Diagnostic Information technician reference card. A copy of this card can be found in the appendix of this book.

Throttle Posistion Sensor Signal

In order to determine if the throttle position sensor signal and brake switch signal are being received by the ECU, place the ignition switch to the ON position with the engine off, connect a digital voltmeter to the diagnostic check connector and slowly depress the throttle. On models prior to 1987, if the vehicle does not have a diagnostic check connector in the engine compartment, connect the voltmeter to the DG Terminal. Its location can be found in the appropriate repair manual.

ECT Terminal Voltage Check



The ECT terminal can be designated as TT or Tl depending on the vehicle model. The position in the diagnostic check connector remains the same. The voltage will increase in one volt increments from 1 to 8 volts as the throttle is slowly opened. To verify the brake signal, apply the brake pedal while the throttle is wide open. The voltage displayed on the voltmeter screen will go to zero.

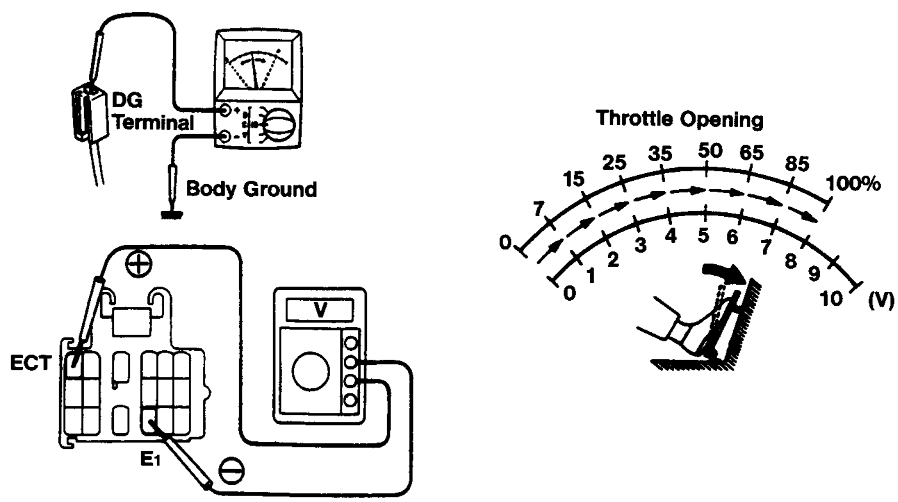
If the voltage readings progress in a step-like fashion, it indicates proper operation of the following:

- Throttle sensor
- Circuit integrity from the sensor to the ECU
- Circuit integrity from the ECU to the diagnostic check connector.

If the voltage remains at 0 volts as the accelerator is depressed, possible causes are:

- Brake signal remains on.
- IDL signal remains on.
- ECU power supply circuit.
- Faulty ECU.

ECT Terminal Voltage Check

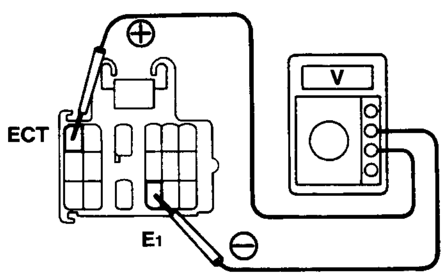


The voltage chart above provides a voltage value for the corresponding throttle opening. This can be used to establish accelerator position for a given throttle opening.

Terminal voltage and Gear Position

To check for shift timing while the vehicle is driven, connect a voltmeter and drive the vehicle. Voltage will increase in one volt increments from 0 to 7 volts. These voltage signals are output from the ECU to indicate a response to system sensors. The lock-up voltages in second and third gear may not be consistently output with throttle opening under 50%. In order to output each voltage signal, the throttle will need to be open greater than 50%. If the gears fail to shift in response to the changes in voltage readings, the solenoids may be sticking or the electrical circuit to the solenoid may have an open.

Terminal Voltage and Gear Position

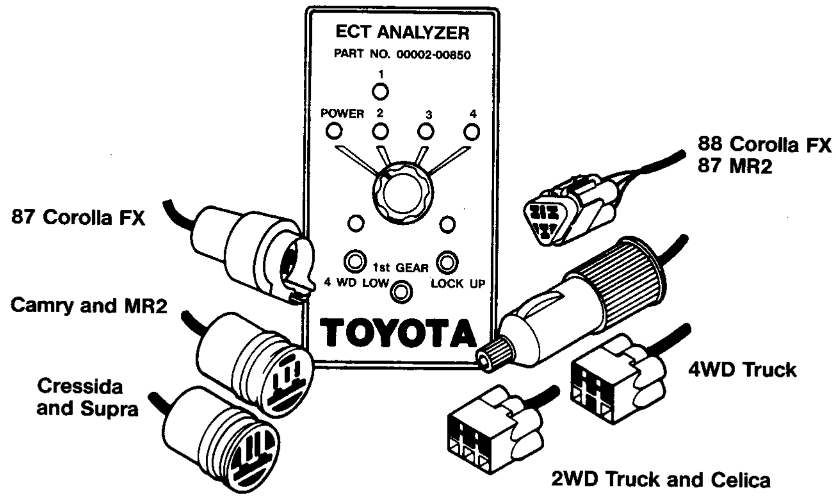


ECT Terminal (V)	Gear Position
0	1st
2	2nd
3	2nd Lock-Up
4	3rd
5	3rd Lock-Up
6	O/D
7	O/D Lock-Up

ECT Analyzer

The ECT Analyzer is designed to determine if a transmission malfunction is ECU/electrical circuit related or in the transmission. The analyzer is connected at the solenoid electrical connector using appropriate adapter harnesses. The vehicle is driven using the analyzer to shift the transmission.

ECT Analyzer (Checker)



If the transmission operates properly with the ECT Analyzer, the fault lies between the solenoid connectors up to and including the ECU. On the other hand, if the transmission does not operate properly with the analyzer, the fault is likely to be in the transmission. This would include a failure of the solenoid or a mechanical failure of the transmission. A solenoid may test out electrically and fail mechanically because the valve sticks. Apply air pressure to the solenoid; air should escape when the solenoid is energized and should not escape when the solenoid is not energized.

Operating Instructions

Two technicians are required when testing with the ECT Analyzer. One technician must actually drive the vehicle, and the second technician will change gears.

CAUTION

The analyzer leads should be routed away from hot or moving engine components to avoid damage to the tester.

Choose a safe test area where there are no pedestrians, traffic and obstructions.

Testing for proper gear shifting:

1. The driver and passengers should wear seat belts.
2. Depress the service brake pedal.
3. Start the engine and move the vehicle gear selector to Drive.
4. Rotate the gear selector knob on the ECT Analyzer to the ”1-2” position. The transmission will shift to second gear.
5. Press and hold the first gear button. The transmission will shift to first gear.
6. Release the parking brake.
7. Accelerate to 10 mph.
8. Release the first gear button. The transmission should shift to second gear.
9. Accelerate to 20 mph.
10. Rotate the selector knob to the number ”3” position. The transmission should shift into third gear.
11. Accelerate to 25 mph.
12. Rotate the selector knob to the number ”4” position. The transmission should shift to fourth gear.
13. Release the accelerator and coast.
14. Rotate the selector knob to the number ”3” position. The transmission should downshift into third gear.
15. Apply the brakes, and stop the vehicle. Testing is complete.

Testing for lockup operation:

1. Operate the vehicle and ECT Analyzer up to fourth gear.
2. Accelerate to 40 mph.
3. Press and hold the ”Lockup” button to engage the lockup clutch. Observe the tachometer and note a slight reduction in the engine rpm. (Is more noticeable when the vehicle is going up a slight hill due to converter slippage.)
4. Release the ”Lockup” button to disengage the lockup clutch.
5. Apply vehicle brakes, and bring the vehicle to a halt. Test is complete.

NOTE

Testing for lockup can also be performed with the vehicle stopped, but with the engine running, With the gearshift selector in ”D,” press the ”Lockup” button to engage the lockup clutch. With the converter in lockup, the engine idle rpm will drop significantly or stall. If there is no change in the engine idle rpm, the lockup function is not operational.

Notes

PROCEDURE

Preliminary Checks and Adjustments

Vehicle	Year/Prod. Date	Engine	Transmission

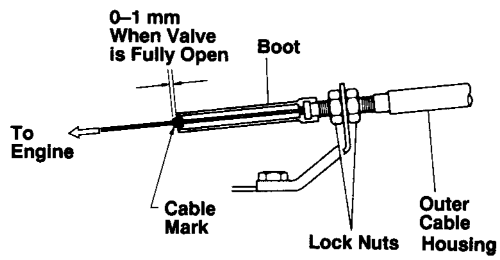


Fig.

1. **Inspect and Adjust Throttle Cable (Long Boot Type)**

   a. Depress the accelerator pedal all the way and check that the throttle valve opens fully.

   HINT:
   If the valve does not open fully, adjust the accelerator link.

   b. Fully depress the accelerator pedal and measure the distance:

		OK/NG
Measured Distance	mm	

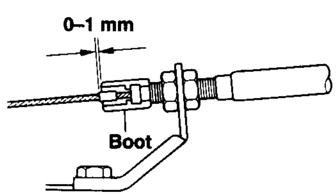
   c. Loosen the adjustment nuts.

   d. Adjust the outer cable so that the distance between the end of the boot and stopper on the cable is the standard.

   Standard Distance: 0 -1 mm (0 - 0.04 in.)

   e. Tighten the adjusting nuts.

   f. Recheck the adjustments.



2. **Inspect and Adjust Throttle Cable (Short Boot Type)**

   a. Check that the accelerator pedal is fully released.

   b. Check that the inner cable has no slack.

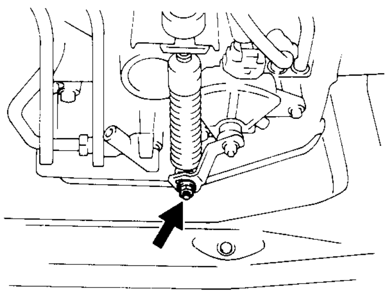
   c. Measure the distance between the outer cable end and the stopper on the cable.

   Standard Distance: 0 • 1 mm (0 - 0.04 in.)

Measured Distance	**mm**

   If the distance is not standard, adjust the cable by the adjusting nuts.

PROCEDURE
Preliminary Checks and Adjustments (Continued)

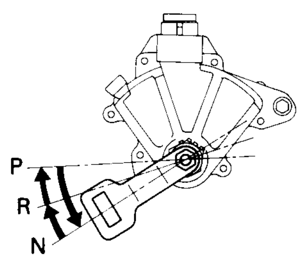


3. Inspect and Adjust Shift Cable

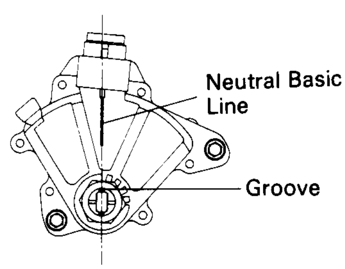
When shifting the shift lever from the N position to other positions, check that the lever can be shifted smoothly and accurately to each position and that the position indicator correctly indicates the position.

	OK/NG
Shift Cable Adjustment	

If the indicator is not aligned with the correct position, carry out the following adjustment procedures.



a. Loosen the swivel nut on the manual shift lever.
b. Push the manual lever fully toward the right of the vehicle.
c. Return the lever two notches to NEUTRAL position.
d. Set the shift lever to N.
e. While holding the lever lightly toward the R range side, tighten the swivel nut.



4. Inspect Neutral Start Switch

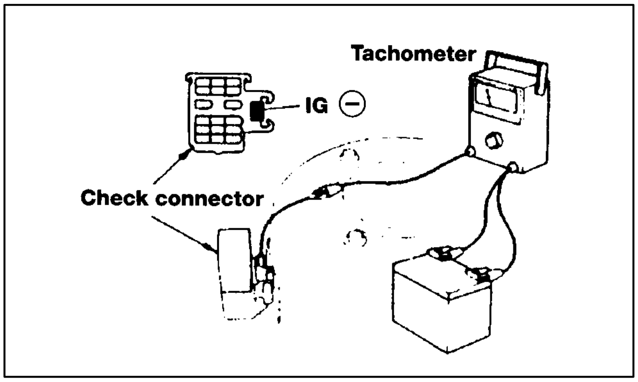
Check that the engine can be started with the shift lever only in the N or P position, but not in other positions.

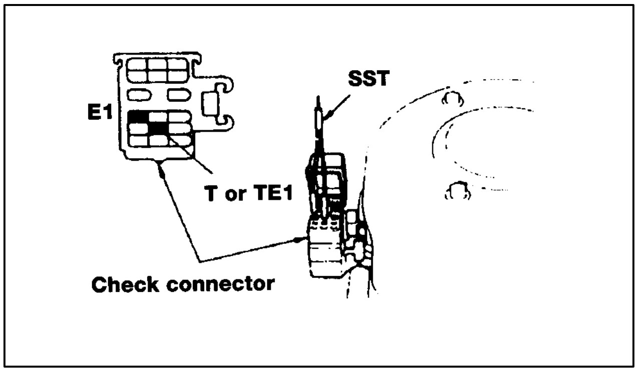
If not as stated above, carry out the following adjustment procedures.

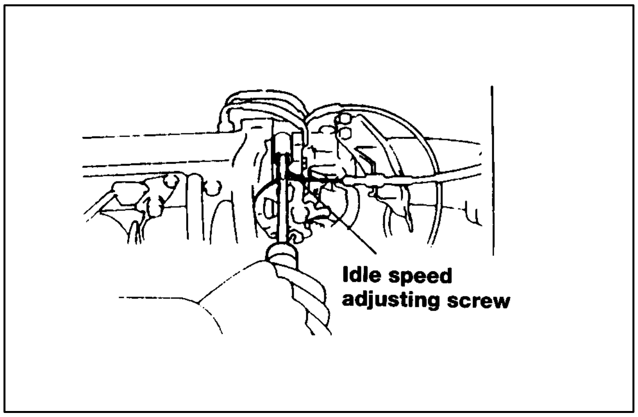
a. Loosen the neutral start switch bolt and set the shift lever to the N position.
b. Align the groove and neutral base line.
c. Hold in position and tighten the bolt.
Torque: 48 in. lb.

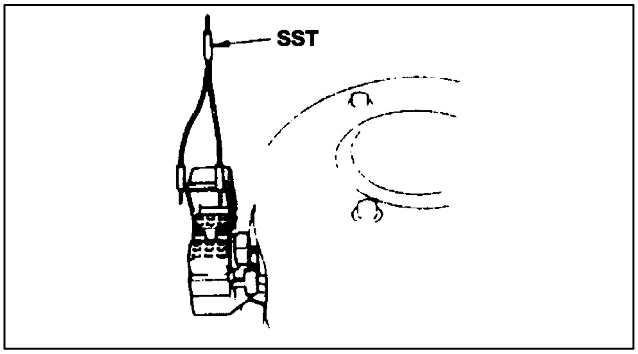
Torque: 48 in. lb.

PROCEDURE
Preliminary Checks and Adjustments (Continued)









5. Inspect Idle Speed (Models W/TWC)

a. Initial Conditions

(1) Air cleaner installed.

(2) All pipes and hoses of the air induction system connected.

(3) All vacuum lines connected.

HINT:
All vacuum hoses for the EGR system should be properly connected.

(4) All accessories switched off.

(5) EFI system wiring connectors securely connected.

(6) Ignition timing correctly set.

(7) Transmission in N range.

b. Warm Up Engine

Allow the engine to reach its normal operating temperature.

c. Connect Tachometer

Connect the test probe of the tachometer to the IG-terminal of the check connector.

NOTICE:

- **NEVER allow the tachometer terminal to touch ground as it could result in damage to the igniter and/or ignition coil.**
- **As some tachometers are not compatible with this ignition system, we recommend that you confirm the compatibility of your unit before use.**

d. Check Air Valve Operation

e. Check and Adjust Idle Speed

(1) Race the engine at 2,500 rpm for about 90 seconds.

(2) Using the SST, connect terminal T or TE1 with terminal E1 of the check connector.

SST 09843-18020

PROCEDURE

Preliminary Checks and Adjustments (Continued)

(3) Check the idle speed.

Idle speed (cooling fan off):

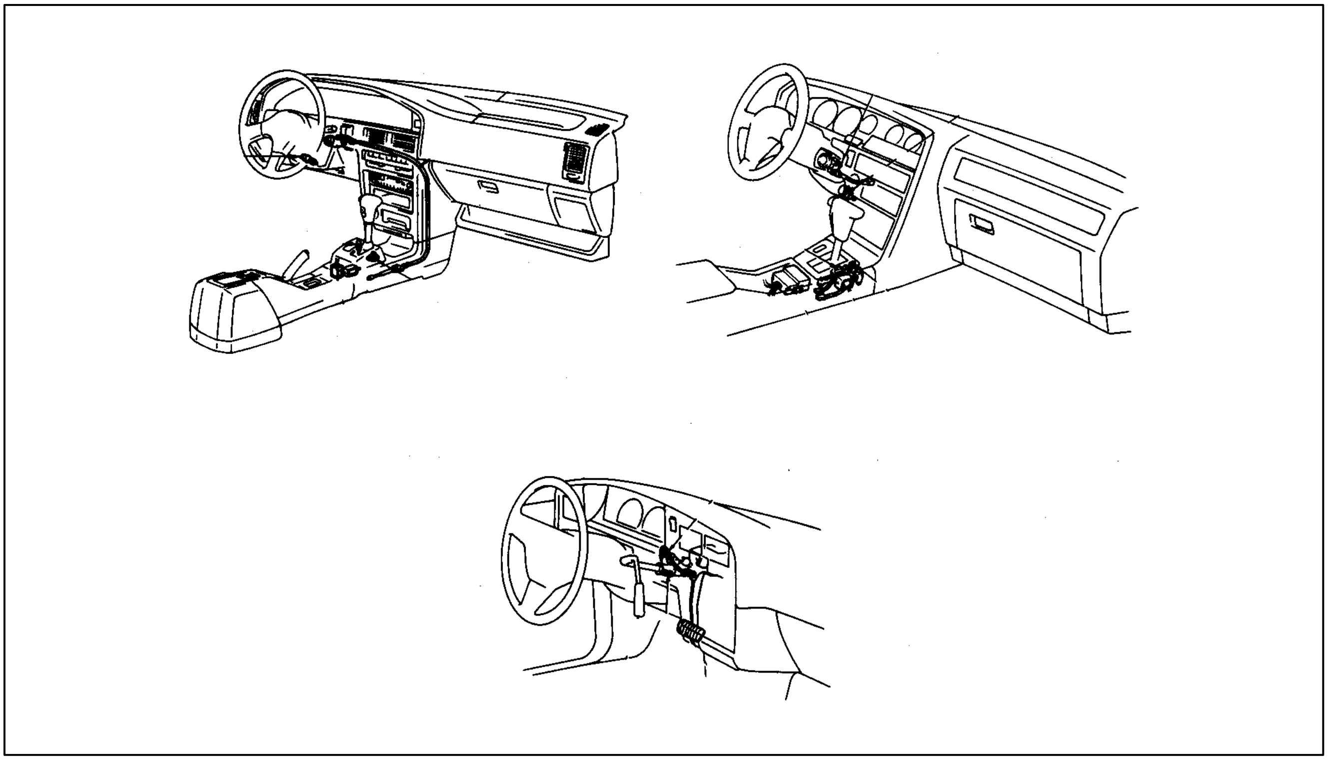
Specification	**RPM**
Measured	**RPM**

If not as specified, adjust the idle speed by turning the idle speed adjusting screw.

f. Remove the Tachometer and SST.

Section 12

SHIFT LOCK SYSTEM



Lesson Objectives:

1 Describe the control of the key lock mechanism for the mechanical shift lock system.

2. Describe the control of the shift lock mechanism for the mechanical shift lock systems.

3. Describe the effect of the brake pedal input on the shift lock mechanism for electrical and electrical/mechanical systems.

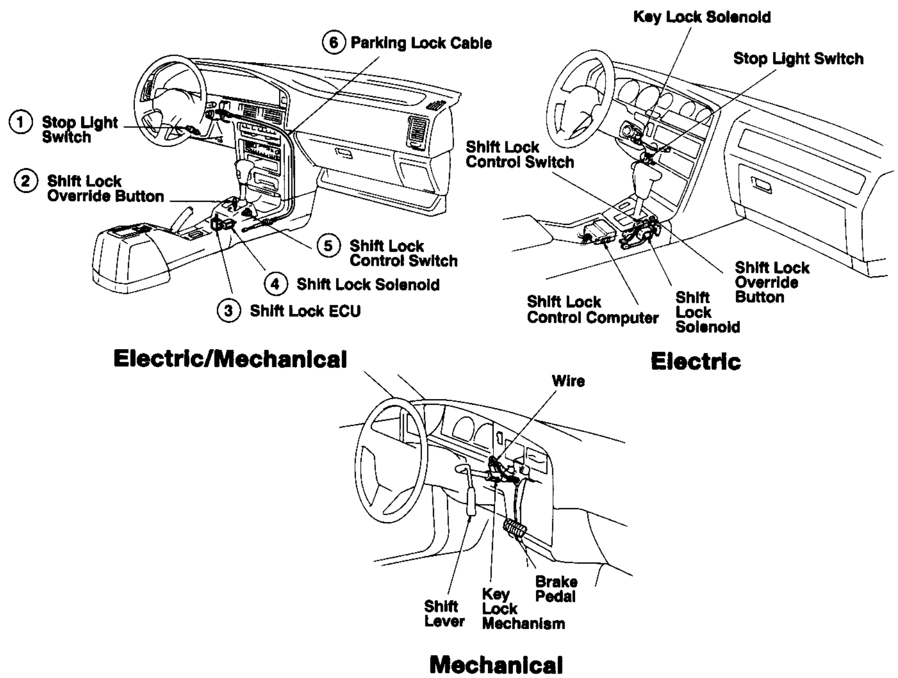
4. Describe the effect of the gear shift selector position on the key lock mechanism for electrical systems.

5. Given a voltmeter and repair manual, demonstrate the pin checks of the shift position switch.

The shift lock system is designed to ensure the proper operation of the automatic transmission. The driver must depress the brake pedal in order to move the gear selector from Park to any other range. In addition, the ignition key cannot be turned to the Lock position and removed from the ignition switch unless the gear selector is placed in the Park position.

There are three systems available in Toyota models; electrical, electrical/ mechanical and mechanical. We will not cover the application by model but rather by system type. For the specifics on a particular model, consult the repair manual.

Shift Lock Systems



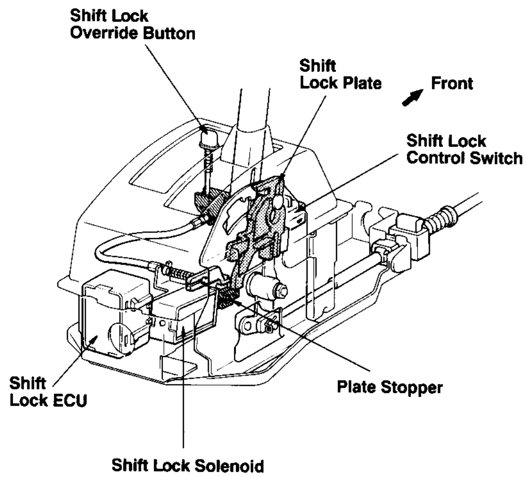
Electrical Shift Lock Type

The electrical type uses electrical control of the shift lock mechanism, as well as the key lock mechanism.

Shift Lock Mechanism

The shift lock mechanism is made up of a number of components as seen in the illustration below.

Shift Lock Mechanism



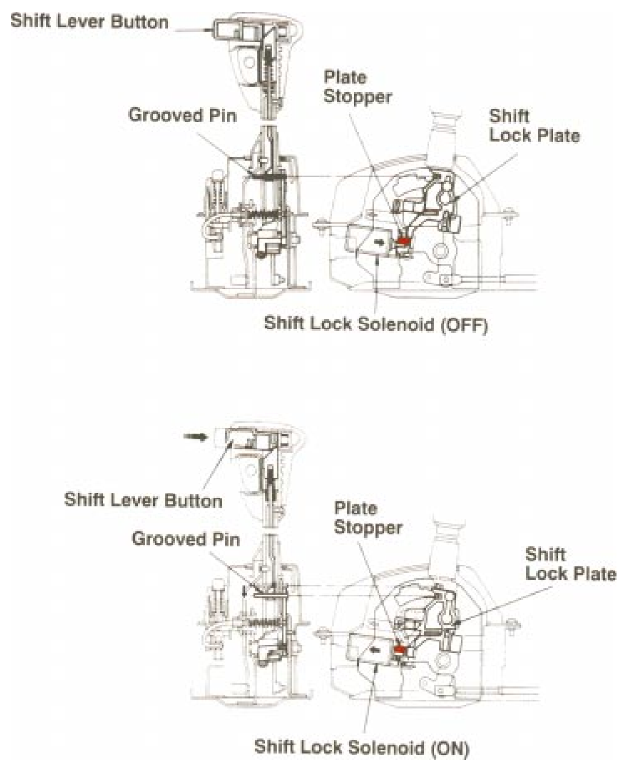
The shift position switch (shift lock control switch) is used to detect the position of the shift lever. It has two contacts, PI and P2. When the select lever is in the Park position, PI is on (closed) and P2 is off (open). In this position, the key can be removed but the select lever is locked in position.

When the select lever is in a position other than Park, PI is off (open) and P2 is on (closed). In this position, the key cannot be removed.

The grooved pin is part of the normal detent mechanism which requires that the shift lever button be depressed in order to move the gear selector into and out of Park position and also into Manual 2 or Manual Low positions. The shift lock plate is mounted next to the detent plate. In the Park position, the grooved pin fits into the slot at the top of the shift plate. The shift lock plate movement is limited by the plate stopper when the solenoid is not energized.

Shift Lock Mechanism Operation

The shift lock plate is blocked by the shift lock solenoid and plate stopper holding the shift lever in teh park position until energized.



In order to move the shift lever out of Park, the ignition switch must be in the Accessory or ON position and the brake pedal must be depressed. When the brake pedal is depressed, the ECU turns on the solenoid, moving the plate stopper and allowing the shift lock plate to move down with the grooved pin.

Shift Lock Override Button

If the shift lock solenoid becomes inoperative, the shift lever cannot be moved and the vehicle cannot be moved. The shift lock override button can be used to release the plate stopper from the shift lock plate, releasing the shift lever so it can be moved from the Park position.

Shift Lock ECU

The ECU is generally found near the shift select lever. The shift lock system computer controls operation of the key lock solenoid and the shift lock solenoid based on signals from the shift position switch and the stop light switch.

Key Interlock System

A camshaft is provided at the end of the key cylinder rotor. This camshaft has a cam with the cut-out portion of its stroke from the ACC position to the ON or Start position. The pin of the key lock solenoid protrudes out against the cam when the current is on and is pulled back by the return spring when the current is off.

When the shift lever is shifted to a range other than the P range, current flows from the computer to the key lock solenoid, causing the pin to protrude out. If the key cylinder is turned with the pin in this position, it can be turned to the ACC position but cannot be turned further, due to the pin pushing against the cam. This prevents the key cylinder from being turned to the Lock position.

The current to the key lock solenoid is cut off when the shift lever is shifted to the P range and the pin is pulled back by the return spring. This allows the key cylinder to be turned to the Lock position, and the key can be removed.

Shift Lock System Computer

The shift lock system computer controls operation of the key lock solenoid and the shift lock solenoid based on signals from the shift position switch and the stop light switch.

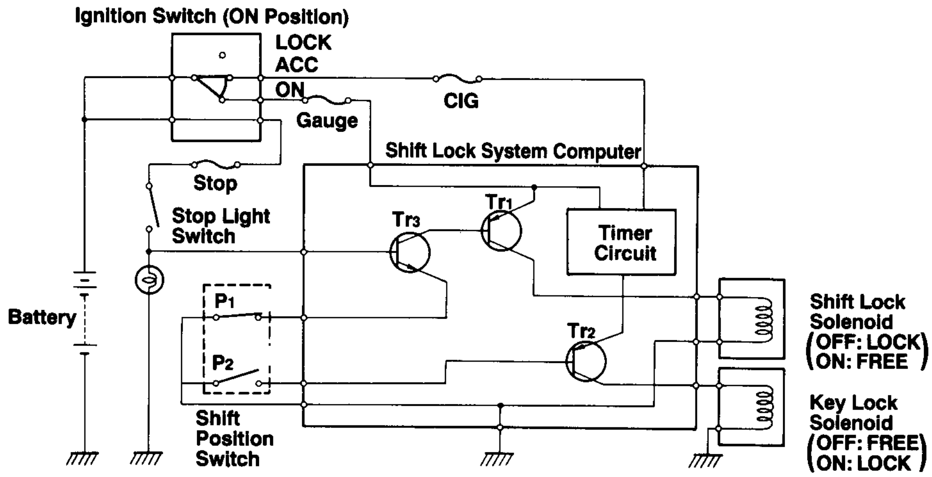
Key Lock Solenoid Control

The shift position switch P2 is on (closed) when the shift lever is in a range other than the Park range. Current from the ACC and ON terminals of the ignition switch flows to Tr2 through the timer circuit. The base circuit of Tr2 is grounded by switch P2, and Tr2 goes on, energizing the key lock solenoid, preventing the key from going to the Lock position. The timer circuit cuts off the flow of current to Tr2 approximately one hour after the ignition switch is turned from ON to ACC, switching off the key lock solenoid. The timer circuit prevents the battery from being discharged.

By placing the gear selector in the Park position, switch P2 is off (open), current no longer flows to the base of Tr2 and it goes off. The solenoid is no longer energized, and the solenoid plunger is retracted, and the key can be removed.

Shift Lock System Control

The shift position switch provides the primary input to control the operation of the shift lock and key lock solenoids.



Shift Lock Solenoid Control

When the shift lever is in the Park range, shift position switch PI is on and the emitter circuit of Tr3 is grounded. Base current for Tr3 is provided through the stop light switch which is open while the brake is not applied, so Tr3 is off. Tr3 controls the base of Trl, and as long as Tr3 is off, the shift lock solenoid will remain off and the gear selector will be locked in the Park position.

When the brake pedal is depressed, the stop light switch goes on, providing current to the base of Tr3. When Tr3 goes on, base current flows in Trl and it then goes on, causing current to flow to the shift lock solenoid and freeing the shift lever. When the shift lever is shifted out of Park, the shift position switch PI goes off and Trl switches the shift lock solenoid off.

Electrical/ Mechanical Shift Lock Type

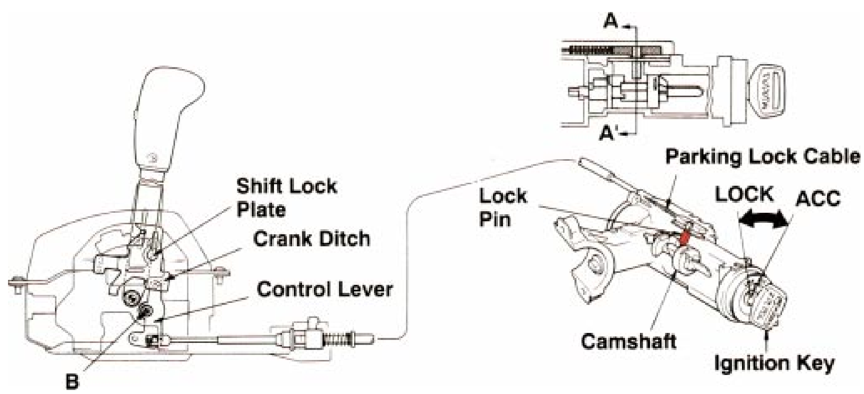
The electrical/mechanical type uses electrical control of the shift lock mechanism and a mechanical control of the key lock mechanism.

Key Interlock Device

Similar to the construction discussed previously, a camshaft is provided at the end of the key cylinder rotor. This camshaft has a cam with the cut-out portion of its stroke from the ACC position to the ON or Start position. The lock pin is attached to the end of the parking lock cable and slides with the movement of the control lever mounted to the shift lever mechanism. The control lever is separate from the shift lock plate but is actuated by it.

Notice the crank ditch slot in the shift lock plate. It is cut at an angle so that when the shift lock plate moves up or down, it causes the control lever to pivot at point B in the illustration below.

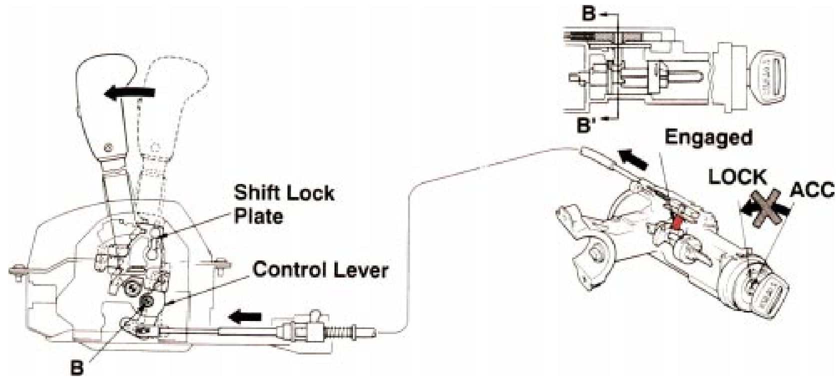
Key Interlock Released



When the shift lever is in the Park position, the control lever rotates around B counterclockwise, pushing the parking lock cable so that the lock pin does not interfere with the camshaft. In this position, the key can be turned to the Lock position and removed.

When the shift lever is moved from the Park position, the shift lock plate is pushed downward by the shift lever button and the grooved pin. When the shift lock plate moves downward the control lever rotates clockwise, pulling the parking lock cable and lock pin into engagement with the camshaft. In this position, the key cannot be turned to the Lock position and removed from the ignition as seen in the following illustration.

Key Interlock Engaged

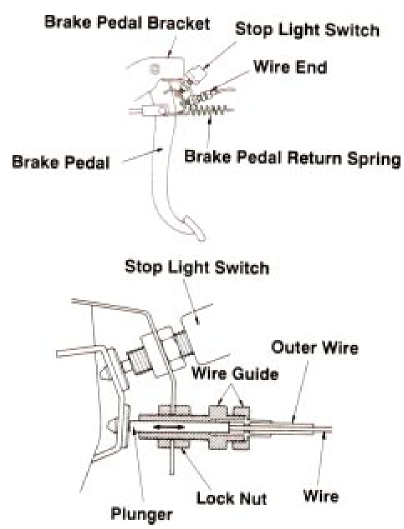


Mechanical Shift Lock Type

The mechanical type uses mechanical control of the shift lock mechanism and the key lock mechanism. A cable extends from the brake pedal bracket to the shift lever control shaft bracket. A lock pin engages the shift lever shaft to lock it into the Park position until the brakes are applied.

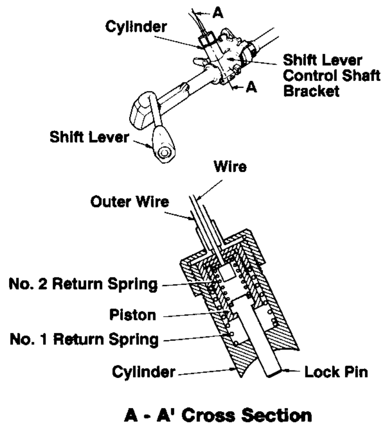
The cable (wire) end on the brake pedal bracket is mounted just below the stop light switch. The plunger is attached to the cable and is mounted in a wire guide and is able to slide in and out. When the brake pedal is not depressed, the plunger is held in position by the brake pedal return spring.

Brake Pedal Cable End



The other end of the cable is attached to a lock pin located in the shift lever control shaft bracket. The lock pin is spring loaded to release the lock pin from the inner shaft of the shift lever.

Shift Lever Cable End



Shift Lever Cable End

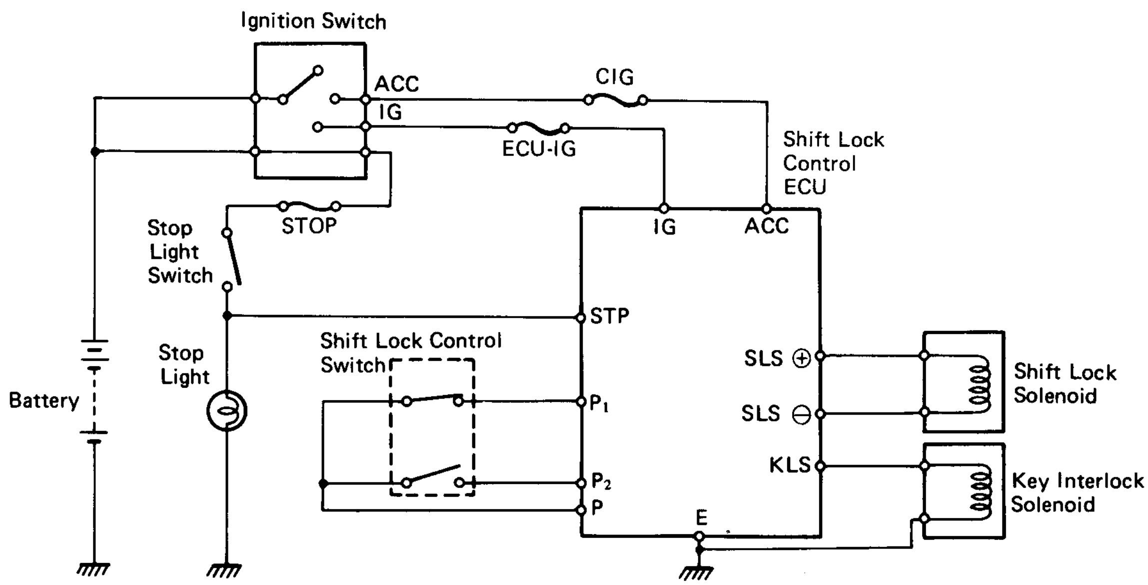
When the shift lever is in the Park range and brakes are not applied, the cable compresses the No. 1 return spring and pushes the lock pin engaging the round hole in the inner shaft, locking the shift lever in Park.

When the brakes are applied with the transmission in Park, the No. 1 spring pushes the cable, lock pin and plunger out toward the brake pedal. With the plunger released, the shift lever can be moved from Park.

When the shift lever is in positions other than Park with the brakes released, the brake pedal return spring pushes the plunger and cable back toward the shift lever control shaft. The lock pin cannot enter the inner shaft, so the No. 2 return spring compresses. With the lock pin spring loaded, when the gear selector is moved to the Park position, it will immediately lock.

WORKSHEET 9
Shift Lock System,

Vehicle	Year/Prod. Date	Engine	Transmission



Check System for Proper Operation

1. With the key ON, can the shift lever be moved from the PARK position?

___

2. With the key ON, can the shift lever be moved out of the PARK position if the brake pedal is depressed?

___

3. With the shift lever NOT in the PARK position, can the key be turned to the LOCK position and removed?

___

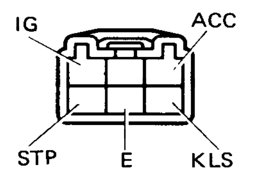
4. Can the key be turned to the LOCK position and removed with the shift lever in the PARK position?

___

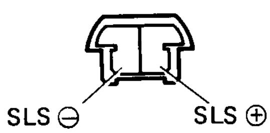
WORKSHEET 9
Shift Lock System,

Inspection and Testing of the Shift Lock Computer

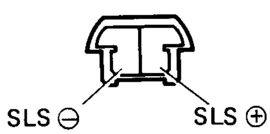
Use a voltmeter and measure the voltage at each of the following terminals of the Shift Lock Computer by backprobing each connector. **Note: Do not disconnect the computer connector.**



Terminals	Condition	Measured Voltage
ACC - E	Ign. sw. ACC position	
IG - E	Ign. sw. ON position	
STP - E	Brake pedal depressed	
KLS - E	Ign. sw. ON position, Shift lever in P	
KLS - E	Ign. sw. ON position, Shift lever not in P	



Terminals	Condition	Measured Voltage
SLS+ - SLS-	Ign. sw. ON position, Shift lever in P	
SLS+ - SLS-	Ign. sw. ON position, Shift lever in P, Brake pedal depressed	
SLS+ - SLS-	Ign. sw. ON position, Shift lever not in P, Brake pedal depressed	



Terminals	Condition	Measured Voltage
P1 - P	Ign. sw. ON position, Shift lever in P, Brake pedal depressed	
P1 - P	Ign. sw. ON position, Shift lever not in P, Brake pedal depressed	
P2 - P	Ign. sw. ACC position, Shift lever in P	
P2 - P	Ign. sw. ACC position, Shift lever not in P	

Inspection of Solenoids

Disconnect solenoid connectors. Using an ohmmeter, measure the resistance of each solenoid:

Solenoid	Resistance
Shift Lock Solenoid	
Key Lock Solenoid	

Appendix A

GLOSSARY OF TERMS

A

Accumulator – Used in transmission hydraulic systems to control shift quality. Absorbs the shock of pressure surges within a hydraulic circuit.

Axis – The center line around which a gear or shaft rotates.

C

Cam-Cut Drum – A one-way roller clutch drum whose inner surface is machined with a series of ramped grooves into which rollers are wedged.

Centrifugal Force – The tendency of objects to move away from the center of rotation when rotated.

Clutch Pack – The assembly of clutch discs and steel plates that provides the frictional surfaces in a multiplate clutch or brake.

Cut-Back Pressure – Modulated throttle pressure controlled by governor pressure and is used to reduce throttle pressure. Reduced throttle pressure results in a reduction of line pressure.

Coupling Range – The range of torque converter operation when there is no torque multiplication and the stator rotates with the impeller and turbine at nearly the same speed.

D

Differential – The assembly of a carrier, pinion gears and side gears that allows the drive axles to rotate at different speeds as a vehicle turns a corner.

Direct Drive – A one to one (1:1) gear ratio in which the input shaft and output shaft rotate at the same speed.

E

Endplay – The total amount of axial (fore and aft) movement in a shaft.

F

Flexplate – The thin metal plate used in place of the flywheel that connects the engine crankshaft to the torque converter.

G

Gear Ratio – The number of turns made by a drive gear compared to the number of turns by the driven gear. Computed by the number of driven gear teeth divided by the number of drive gear teeth.

Gear Reduction – A condition when the drive gear rotates faster than the driven gear. Speed is reduced but torque is increased.

Governor Pressure – Modified line pressure that is directly related to vehicle speed. Governor pressure increases as vehicle speed increases and is one of the principle pressures used to control shift points.

H

Holding Device – Hydraulically operated bands, multiplate clutches, multiplate brakes and mechanically operated one-way clutches that hold members of the planetary gear set.

Hysteresis – The range between the switching on and switching off point of an actuator or sensor. This range prevents a condition in which the sensor closes and opens repeatedly.

I

Internal Ring Gear – A gear with teeth on its inner circumference.

L

Land – The large outer circumference of a valve spool that slides against the valve bore. Each land is separated by a valley.

Line Pressure – Pressure developed by the transmission oil pump and regulated by the primary regulator valve. Line pressure applies all clutches and brakes. The source of all other pressures in the hydraulic system.

M

Multiplate Brake – Consists of alternating friction discs and steel plates, forced together by hydraulic pressure. Holds a planetary component to the transmission case.

Multiplate Clutch – A clutch consisting of alternating friction discs and steel plates, forced together by hydraulic pressure. Holds one rotating planetary component to another rotating component.

O

One-Way Clutch – A mechanical holding device that prevents rotation of a planetary component in one direction and freewheels in the other direction.

Orifice – A small opening or restriction in a hydraulic passage used to regulate pressure and flow.

Overdrive – Occurs when the drive gear rotates at a slower speed than the driven gear. Speed of the driven gear is increased but torque is decreased.

P

Planetary Gear Set – A gear assembly consisting of a sun gear, ring gear and carrier assembly with planetary pinion gears.

Planetary Gear Unit – The assembly which includes the planetary gear set, holding devices and shafts which provide different gear ratios in the automatic transmission.

Planetary Carrier – Member of the planetary gear set that houses the planetary pinion gears.

Planetary Pinion Gears – Mounted to the planetary carrier by pinion shafts.

R

Rotary Flow – The flow of oil in a torque converter that is in the same direction as the rotation of the impeller. Causes the stator to unlock and rotate.

S

Simpson Planetary Gear Set – Two planetary gear sets which share a common sun gear.

Sprag – A figure-eight shaped locking element of a one-way sprag clutch. Multiple sprags are used to maintain' the distance between the inner and outer race of the sprag clutch.

Stall Speed – The maximum possible engine speed, measured in rpm with the turbine held stationary and the engine throttle wide open.

Sun Gear – The center gear of a planetary gear set around which the other gears rotate.

T

Torque – Twisting or turning force measured in foot-pounds or inch-pounds.

Throttle Pressure – Modified line pressure which is directly related to engine load. Throttle pressure increases with throttle opening. It is one of the major pressures used to control shift points.

Torque Converter – A fluid coupling used to connect the engine crankshaft and the input shaft of an automatic transmission. It is capable of increasing the torque developed by the engine by redirecting the flow of fluid to the vanes of the impeller.

V

Valley – The small diameter of the spool valve located between two lands. Fluid flows past these valleys when the lands expose fluid passages as they are moved within their bore of the valve body.

Valve Body – An aluminum casting which houses the valves in the transmission hydraulic system. Provides the passages for the flow of transmission fluid.

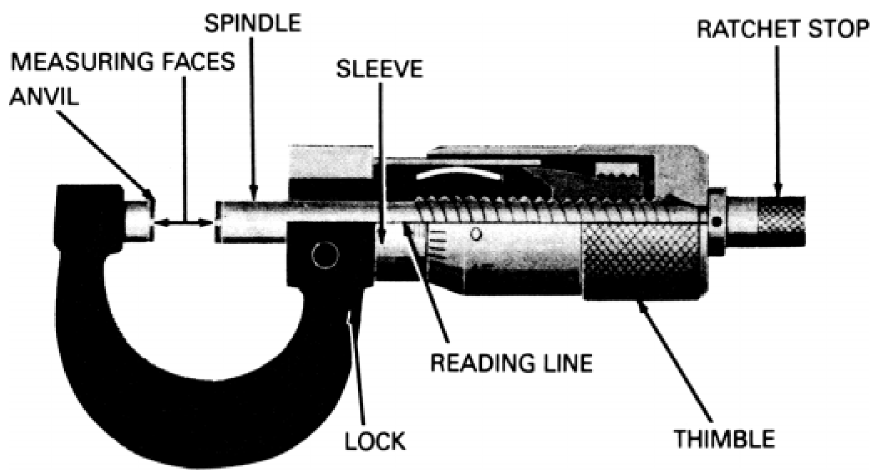
Viscosity – The tendency of a liquid to resist flowing. High viscosity fluid is thick. Low viscosity fluid flows easily.

Vortex Flow – The path of oil flow in the torque converter that is at a right angle to the rotation of the impeller. The fluid flows from the impeller to the turbine and back to the impeller through the stator.

Notes

MICROMETERS

The outside micrometer illustrated below is used to measure the outside diameter or thickness of material. It can also be used to measure the inside diameter when used in conjunction with a snap gauge as illustrated in the section on transmission oil pumps.



The object to be measured is placed between the anvil and the spindle of the micrometer. The spindle moves closer to the anvil and the object placed between them as the thimble turns. The ratchet stop is used to provide the same pressure on the spindle each time something is measured. When the ratchet begins to click, the spindle is touching the object with sufficient pressure to determine the thickness. Use the lock to secure the spindle so the measurement can be made without accidentally moving the thimble.

Micrometers can be found in english, and read in thousandths of an inch or metric, and read in hundredths of a millimeter.

English

Each number division on the reading line equals 0.1 inch or 100/1000 inch. There are ten number divisions which total 1000/1000 of one inch. Between each number division is a half way point marked by a line. For example, between 0 and 1 is a line which signifies half of 100/1000, which is 50/1000 inch (0.050 inch.) Between this point and the next number division is another line which is half of 50/1000. This line represents the smallest increment on the number line which is 25/1000 inch or 0.025 inch. Each division on the reading line of the sleeve equals 0.025 inch or 25/1000 of an inch. The table below represents how each division is pronounced.

100/1000 = 0.100 = one hundred thousandths
50/1000 = 0.050 = fifty thousandths
25/1000 = 0.025 = twenty-five thousandths

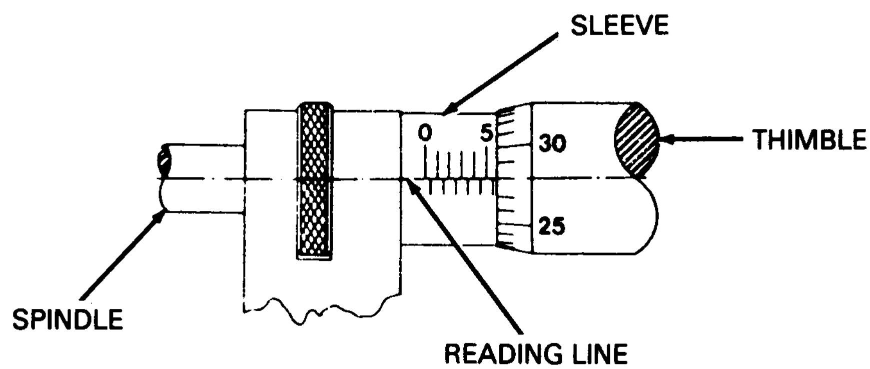
As the thimble rotates one complete revolution, it will move the spindle 0.025 of an inch. The nose of the thimble is divided into 25 increments. Each increment is equal to 1/1000 of an inch (0.001 of an inch.) The line on the nose of the thimble that aligns with the read line, represents the increments in one thousandths between the thimble nose and the last visible line on the sleeve.

Metric

Each number division along the top of the reading line equals 1 millimeter. There are ten number divisions which total 100/100 or one millimeter. Between each number division is a half way point marked by a line. For example, between 0 and 1 is a line which signifies half of 100/100, which is 50/100 mm (0.50 mm). Each division on the reading line of the sleeve equals 0.50 mm or 50/100 of a millimeter. The table below represents how each division is pronounced.

100/100 = 1.00 = one hundred hundredths or one millimeter 50/100 = 0.50 = fifty hundredths millimeter 25/100 = 0.25 = twenty-five hundredths millimeter 1/100 = 0.01 = one hundredths millimeter

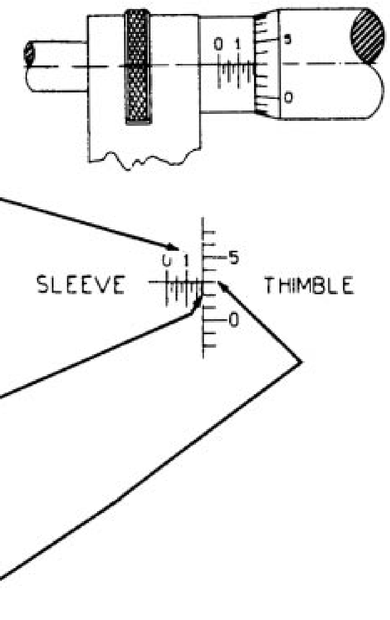
As the thimble rotates one complete revolution, it will move the spindle 0.050 millimeter. The nose of the thimble is divided into 50 increments. Each increment is equal to 1/100 of a millimeter (0.01 of a millimeter.) The line on the nose of the thimble that aligns with the read line, represents the increments in one hundredths between the thimble nose and the last visible line on the sleeve.



Reading a Micrometer

There are three steps to reading a micrometer. Using the illustrations shown below, it will be easy to understand how the measurement is read. The distance being measured appears between the zero on the number line and the edge of the thimble.

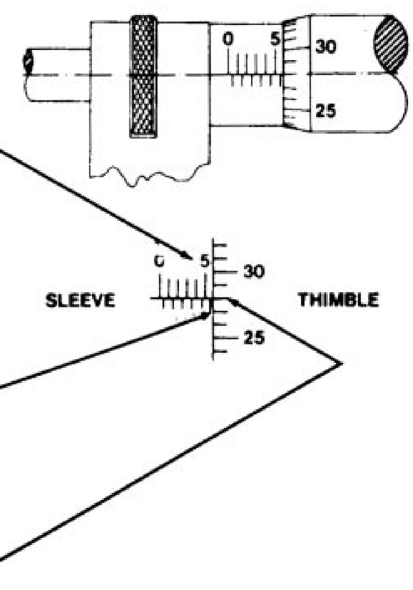
English



1. Count the number of one hundred thousandth (0.100) divisions that are visible on the reading line = 1 or 0.100
2. Count the number of twenty-five thousandth (0.025) divisions that are visible on the reading line between 1 and the edge of the thimble = 3 or 0.075
3. Count the number of one thousandth (0.001) divisions on the thimble from 0 to the reading line = 3 or 0.003

Add the three values = 1.178"

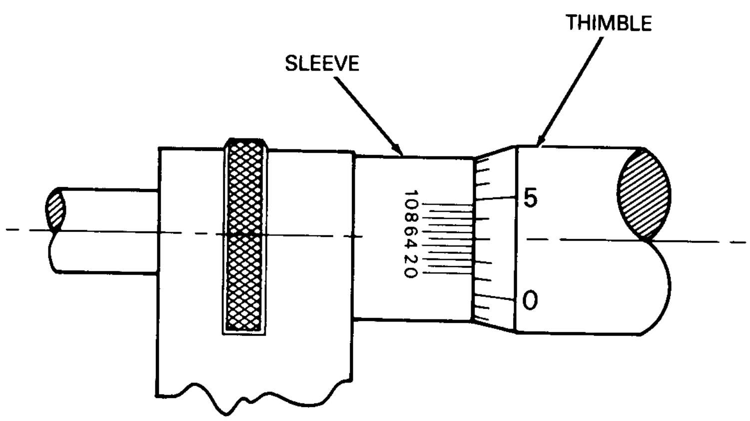
Metric



1. Count the number of millimeter divisions visible on the reading line = 5 or 5.00
2. Count the number of fifty hundredth millimeter divisions that are visible on the reading line between the last millimeter division and the edge of the thimble = 1 or 0.50
3. Count the number of one hundredth (0.01) millimeter divisions on the thimble from 0 to the reading line = 28 or 0.28

Add the three values = 5.78 mm

Some outside micrometers are available to measure to the nearest one ten thousandths of an inch (0.0001). The veneir scale is on the sleeve of the micrometer and has ten divisions equaling 0.0001” each.

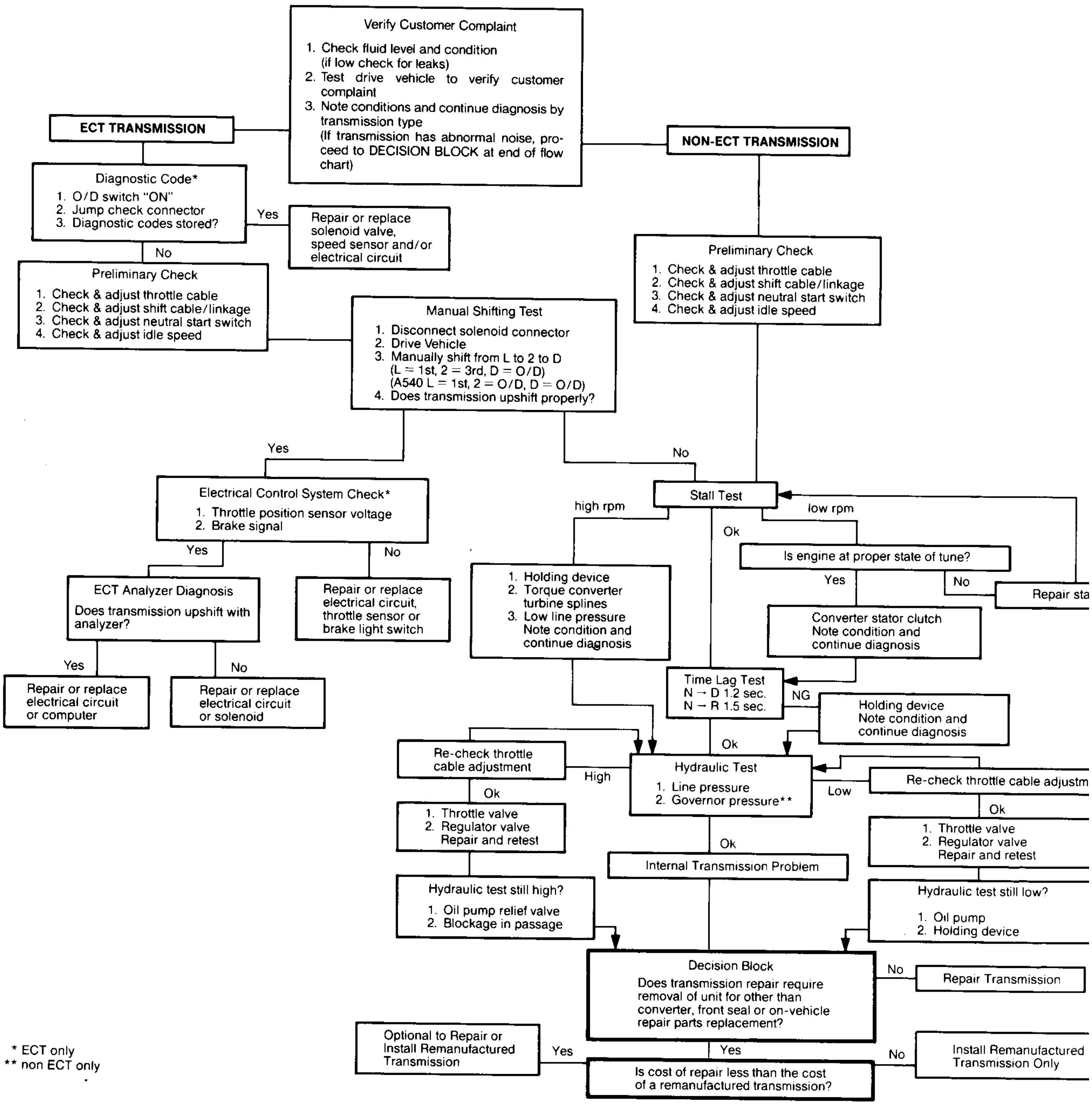


To determine the number of ten thousandths increments, compare the lines on the nose of the thimble and the lines of the vernier scale to determine the one that lines up. For example, in the illustration above the 0.004” mark lines up with the 8 mark on the vernier scale which equals eight ten thousandths of an inch (0.0008”) which is added to the measurement.

Notes

DIAGNOSTIC REFERENCE

AUTOMATIC TRANSMISSION TROUBLESHOOTING



AUTOMATIC TRANSMISSION CLUTCH APPLICATION CHART

A132L EL, AE

Shift lever position	Gear position	C_1	C_2	B_1	B_2	B_3	F_1	F_2
P	Parking							
R	Reverse		■			■		
N	Neutral							
D	1st	■						■
	2nd	■			■		■	
	3rd	■	■		■			
2	1st	■						■
	2nd	■		■	■		■	
L	1st	■				■		■
	2nd*	■		■	■		■	

*Downshift in L range, 2nd gear only - no upshift.

A140L, A140E, A540E, A540H SV, VV, ST

Shift lever position	Gear position	C_0	C_1	C_2	B_0	B_1	B_2	B_3	F_0	F_1	F_2
P	Parking	■									
R	Reverse	■		■				■			
N	Neutral	■									
D	1st	■	■						■		■
	2nd	■	■				■		■	■	
	3rd	■	■	■			■		■		
	O/D		■	■	■		■				
2	1st	■	■						■		■
	2nd	■	■			■	■		■	■	
	3rd[1]*	■	■	■			■		■		
L	1st	■	■					■	■		■
	2nd*	■	■			■	■		■	■	

*Downshift only - no upshift. [1]Does Not Apply to A140L.

A240E, A240L, A241E, A241H AW, AE

Shift lever position	Gear position	C_1	C_2	C_3	B_1	B_2	B_3	B_4	F_1	F_2	F_3
P	Parking							■			
R	Reverse		■				■	■			
N	Neutral							■			
D	1st	■						■		■	■
	2nd	■				■		■	■		■
	3rd	■	■			■		■			■
	O/D	■	■	■		■					
2	1st	■						■		■	■
	2nd	■			■	■		■	■		■
	3rd[1]	■	■			■		■			■
L	1st	■					■	■		■	■
	2nd	■			■	■		■	■		■

[1]AW Only A241E.

A340E, A340H MX, MA, RN, VN

Shift lever position	Gear position	C_0	C_1	C_2	B_0	B_1	B_2	B_3		F_0	F_1	F_2
								I.P.	O.P.			
P	Parking	■										
R	Reverse	■		■				■	■	■		
N	Neutral	■										
D	1st	■	■							■		■
	2nd	■	■				■			■	■	
	3rd	■	■	■			■			■		
	O/D		■	■	■		■					
2	1st	■	■							■		■
	2nd	■	■			■	■			■	■	
	3rd	■	■	■			■			■		
L	1st	■	■					■	■	■		■
	2nd*	■	■			■	■			■	■	

*Downshift only in the L range and 2nd gear - no upshift.

A43D RN

Shift lever position	Gear position	C_0	C_1	C_2		B_0	B_1	B_2	B_3		F_0	F_1	F_2
				I.P.	O.P.				I.P.	O.P.			
P	Parking	■							■	■			
R	Reverse	■		■	■				■	■	■		
N	Neutral	■											
D	1st	■	■								■		■
	2nd	■	■					■			■	■	
	3rd	■	■		■			■			■		
	O/D		■		■	■		■					
2	1st	■	■								■		■
	2nd	■	■				■	■			■	■	
L	1st	■	■						■	■	■		■

A45DL, A45DF YR, A43DE, A44DL MX, MA

Shift lever position	Gear position	C_0	C_1	C_2		B_0	B_1	B_2	B_3		F_0	F_1	F_2
				I.P.	O.P.				I.P.	O.P.			
P	Parking	■							■	■			
R	Reverse	■		■	■				■	■	■		
N	Neutral	■											
D	1st	■	■								■		■
	2nd	■	■					■			■	■	
	3rd	■	■	A45DL A45DF	A43DE A44DL			■			■		
	O/D		■	A45DL A45DE	A43DE A44DL	■		■					
2	1st	■	■								■		■
	2nd	■	■				■	■			■	■	
L	1st	■	■						■	■	■		■

TRANSFER

CLUTCH, BRAKE AND SOLENOID

Transfer gear position	No. 4 Solenoid	C_3	C_4	B_4
H2	OFF	■		
H4	OFF	■	■	
L4	ON		■	■

I.P. ......Inner Pistor
O.P.. .... Outer Pist

ECT DIAGNOSTIC INFORMATION

Transmission Model	Engine Model	Vehicle Model	U.S., Canada	Driving Mode	Throttle Position Sensor	N — D Squat Control	Diagnostic Codes	Cancel Out Diagnostic Codes	Check Terminal*	OD Cancel Temp. (3rd)	Manual Mode "L" "2" "D" "R"	ECU
A340E	22R-TE	85 thru 88 TRUCK	•	P, N	IDL, VTA, E, Vcc	3rd — 1st	42 thru 64 (5)	STOP 10A	DG	122°F	1st, 3rd, OD, R	ECT
	3VZ-E	89 thru 92 TRUCK	•					EFI 15A	ECT, TE_1			TCCS
	7M-GE	86 thru 92 SUPRA	•					RADIO No. 1 15A	ECT	140°F (95°F)		ECT
		89 thru 92 CRESSIDA	•					EFI 15A	TT, TE_1			TCCS
	7M-GTE	87 thru 92 SUPRA	•					RADIO No. 1 15A	ECT			ECT
	5M-GE	87, 88 CRESSIDA	•					DOME 7.5A				
A340H	22R-E	85, 86 TRUCK	•	P, N	IDL, VTA, E, Vcc	Without	42 thru 65 (6)	STOP 10A	DG	122°F	1st, 3rd, OD, R	ECT
		87, 88 TRUCK	•			3rd — 1st						
		89 thru 92 TRUCK	•					EFI 15A	ECT, TE_1			TCCS
	22R-TE	86 TRUCK	•			Without		STOP 10A	DG			ECT
		87 TRUCK	•			3rd — 1st						
	3VZ-E	88 TRUCK	•									
		89 thru 92 TRUCK	•					EFI 15A	ECT, TE_1			TCCS
A340F	22R-E	90 thru 92 TRUCK	•	P, N	IDL, VTA, E, Vcc	3rd — 1st	42 thru 64 (5)	EFI 15A	ECT, TE_1	122°F	1st, 3rd, OD, R	TCCS
A43DE	5M-GE	85, 86 CRESSIDA	•	P, N	IDL, VTA, E, Vcc	3rd — 1st	42 thru 64 (5)	DOME 7.5A	ECT	145°F (95°F)	1st, 3rd, OD, R	ECT
		85, 86 SUPRA	•					ECU B 15A	DG			
A46DE, A46DF	2TZ-FE	91 PREVIA	•	N	IDL, VTA, E, Vcc	3rd — 1st	42 thru 64 (5)	EFI 15A	ECT, TE_1	122°F	1st, 3rd, OD, R	TCCS
A140E	2S-E	85 CAMRY	•	P, N	IDL, L_1, L_2, L_3	Without	0, 4, 8 Volt (3)	Ignition S/W Off	ECT	158°F	1st, 3rd, OD, R	ECT
		86 CAMRY	Canada									
		86 CAMRY	US			2nd — 1st	42 thru 64 (5)	ECU B 15A				
	3S-FE	87, 88 CAMRY	•		IDL, VTA, E, Vcc			RADIO No. 1 15A		122°F		
		89 thru 91 CAMRY	•					DOME 20A				
	3S-GE	86, 87 CELICA	•					RADIO No. 1 15A		158°F		
		88, 89 CELICA	•					DOME 20A				
	5S-FE	92 CAMRY	•	P, N	IDL, VTA, E, Vcc	2nd — 1st	42 thru 64 (5)	EFI 15A	ECT, TE_1	122°F	1st, 3rd, OD, R	TCCS
A141E	4A-GE	86 MR2	•	P, N	IDL, VTA, E, Vcc	2nd — 1st	42 thru 64 (5)	AM_2 7.5A	ECT	122°F	1st, 3rd, OD, R	ECT
A240E	4A-GE	87 thru 89 MR2	•	P, N	IDL, VTA, E, Vcc	2nd — 1st	42 thru 64 (5)	AM_2 7.5A	ECT	122°F	1st, 3rd, OD, R	ECT
		87, 88 FX	US					STOP 15A				
A241E	4A-GZE	88, 89 MR2	US	P, N	IDL, VTA, E, Vcc	2nd — 1st	42 thru 64 (5)	AM_2 7.5A	ECT	162°F	1st, 3rd, OD, R	ECT
	5S-FE	90 thru 92 CELICA	•					EFI 15A	ECT, TE_1	122°F		TCCS
		91, 92 MR2	•	N								
A244E	5E-FE	92 PASEO	•	P, N	IDL, VTA, E, Vcc	2nd — 1st	42 thru 64 (5)	EFI 15A	ECT, TT	122°F	1st, 3rd, OD, R	TCCS
A540E	2VZ-FE	88 thru 91 CAMRY	•	P, N	IDL, VTA, E, Vcc	2nd — 1st	42 thru 64 (5)	EFI 15A	ECT, TE_1	145°F (100°F)	1st, OD, OD, R	TCCS
	3VZ-FE	92 CAMRY	•							140°F		
A540H	3S-FE	89 thru 92 CAMRY	•	P, N	IDL, VTA, E, Vcc	2nd — 1st	44 thru 74 (7)	DOME 20A	ECT	122°F	1st, OD, OD, R	ECT

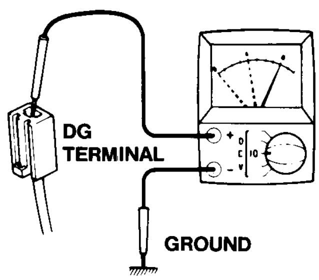
• US and Canada

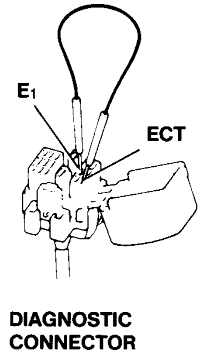
* ECT: ECT or TT in the check connector
TT: TT in the TDCL
DG: DG 2 pin connector
TE_1: T or TE_1 in the check connectors or TDCL

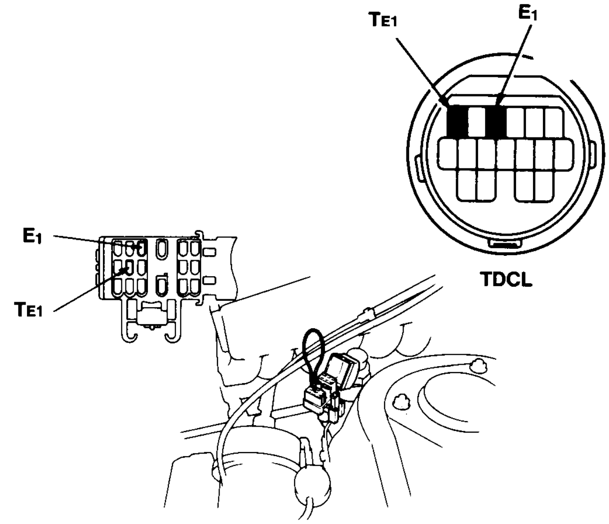
( ) Number of codes
W: W in the check connector

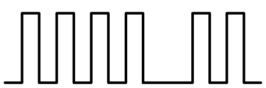
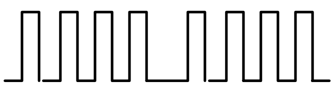
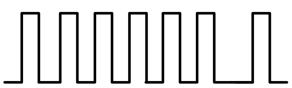
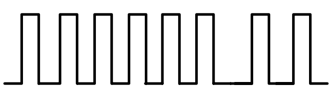
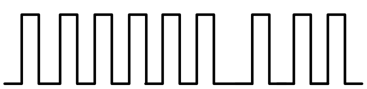
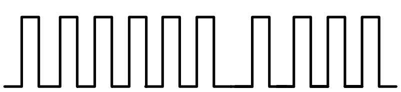
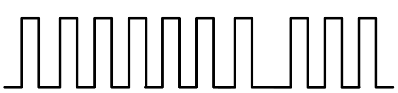
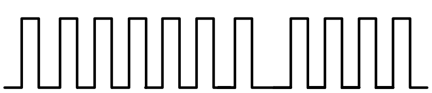
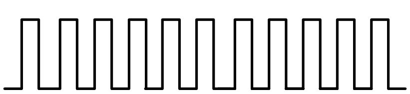
P/N 00414-42944
92-SVC-163

ECT DIAGNOSTIC INFORMATION







CODE	OD OFF INDICATOR	DIAGNOSIS
42		Speed sensor No. 1 (back-up speed sensor) bad, or wire in its wire harness disconnected or shorted
44*		Rear wheel speed sensor bad (no speed sensor signal), wire in harness disconnected/shorted
61		Speed sensor No. 2 (main speed sensor) bad, no ”FR” signal (on All-Trac Camry), or wire in harness disconnected/shorted
62		Wiring of solenoid valve No. 1 disconnected/ shorted, or wire in its wire harness disconnected/ shorted
63		Wiring of solenoid valve No. 2 disconnected/ shorted, or wire in its wire harness disconnected/ shorted
64		Wiring of solenoid valve No. 3 disconnected/ shorted, or wire in its wire harness disconnected/ shorted
65**		Severed No. 4 solenoid or short circuit, or severed wire harness or short circuit
73*		Wiring of No. 1 center differential control solenoid valve disconnected/ shorted, or wire in its wire harness disconnected/shorted
74*		Wiring of No. 2 center differential control solenoid valve disconnected/ shorted, or wire in its wire harness disconnected/shorted
-		Normal

* A540H All-Trac Camry Only
** A340H 4x4 Truck Only

1. Electronic Circuit

Symptom		No.1, No.2 speed sensor circuit	No.1, No.2 solenoid circuit	No.3 Solenoid circuit	Throttle position sensor circuit	IDL switch circuit	Neutral start switch circuit	Stop light circuit	Pattern select switch circuit	O/D switch and O/D OFF indicator switch circuit	O/D cancel signal circuit	Water Temperature sensor circuit	Engine & ECT ECU	On-Vehicle repair matrix chart	OFF-Vehicle repair matrix chart
See page		AXT-42 AXT-44	AXT-46	AXT-50	AXT-52	EG-412	AXT-54	AXT-56	AXT-58	AXT-62	AXT-68	EG-374	IN-32	AXT-32	AXT-34
Vehicle does not move in any forward range and reverse range														1	2
Vehicle does not move in particular range or ranges														1	2
No up-shift	1st → 2nd	3	2		1								4	5	6
	2nd → 3rd	3	2		1								4	5	6
	3rd → O/D	4	3							1	2	5	6	7	8
No down-shift	O/D → 3rd	2	1								3		4	5	–
	3rd → 2nd	2	1		3								4	5	–
	2nd → 1st	2	1		3								4	5	6
No lock-up		3		1	2			5			4	6	7	8	9
No lock-up off				1	2	3		4				5	6	7	8
Shift point too high or too low		2		3	1				5		4		6	–	–
Up-shifts to 2nd while in L range Up-shifts to 3rd while in L range							1						2	–	–
Up-shifts to O/D from 3rd while O/D switch is OFF										1			2	–	–
Up-shifts to O/D from 3rd while engine is cold												1	2	3	4
Harsh engagement	N → D													1	2
	Lock-up			1									2	3	4
	Any driving range													1	2
Slip or Shudder	Forward and reverse													1	2
	Particular range													1	2
No engine braking														1	2
Poor acceleration		2	1										3	–	4
No kick-down		2	1										3	4	–
No pattern select		2							1				3	–	–
Large shift shock or Engine stalls when starting off or stopping.														–	1

3. Off-Vehicle Repair

Symptom		Torque converter	Parking lock pawl	C_0 O/D direct clutch	C_1 Forward clutch	C_2 Direct clutch	B_0 O/D brake	B_1 2nd coast brake	B_2 Second brake	B_3 1st and reverse brake	F_0 O/D one-way clutch	F_1 No.1 one-way clutch	F_2 No.2 one-way clutch	O/D planetary gear	Front planetary gear	Rear planetary gear
See page		✱	★	★	★	★	★	★	★	★	★	★	★	★	★	★
Vehicle does not move in any forward range					1	6		4	5	3			2			
Vehicle does not move in reverse range				5		4		1		6					2	3
Vehicle does not move in any forward range and reverse range			1	3			4				2			7	5	6
No lock-up		1														
No lock-up OFF		1														
Large shock during lock-up		1														
E/G stalls when starting off and stopping		1														
No up-shift	1st → 2nd								1			2				
	2nd → 3rd					1										
	3rd → O/D						1									
No down shift 2nd → 1st								1								
Harsh engagement	N → R					1				2						
	N → D				1											
	1st → 2nd (D range)									1						
	2nd → 3rd							1								
	3rd → O/D			1			2							3		
Slip or shudder	Forward and reverse (After warm-up)	1		3								2				
	Forward and reverse (Directly after E/G start)	1														
	R range			2		1					3					
	1st				1								2			
	2nd								1			2				
	2nd → 3rd (Up-shift)					1										
	3rd					1										
	O/D						1									
No engine braking	1st ~ 3rd			1												
	1st									1						
	2nd							1								
Poor acceleration	All ranges	1														
	O/D			1										2		
	Other than O/D						1							2		
	Other than 2nd							1	2							
	1st and 2nd						1									
	1st and R range									1						
	R range				1											

★: Refer to '92 A540E Automatic Transaxle Repair Manual (Pub. No. RM245U)
✱: Refer to '92 CAMRY Repair Manual Volume 2 (Pub. No. RM222U2)

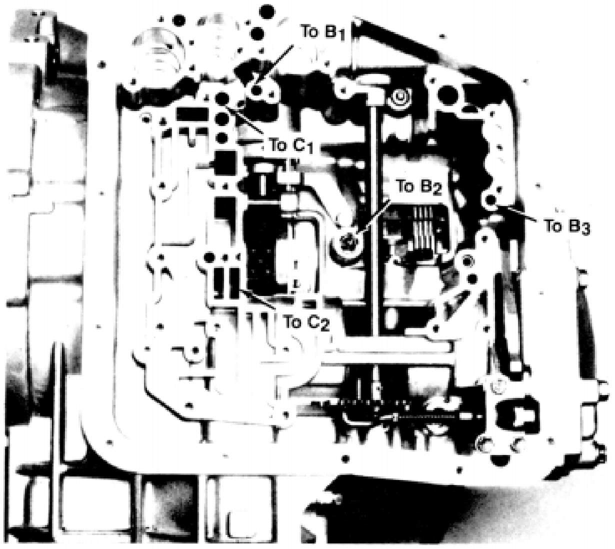
2. On-Vehicle Repair

Symptom		Oil strainer	Manual valve	1–2 shift valve	2–3 shift valve	3–4 shift valve	C_1 accumulator	B_2 accumulator	C_2 accumulator	B_0 accumulator	C_0 accumulator	Accumulator control valve	Low modulator valve	2nd modulator valve	Throttle modulator valve	Lock-up relay valve	Throttle valve	Cut back valve	Primary regulator valve	OFF-Vehicle repair matrix chart
See page		✱	★	★	★	★	★	★	★	★	★	★	★	★	★	★	★	★	★	★
Vehicle does not move in R range				1	2															3
Vehicle does not move in any forward range or reverse range			1																2	3
No lock-up																1				2
No lock-up OFF																1				2
No kick-down				1	2	3														
No engine braking	1st												1							2
	2nd													1						2
No up-shift	1st → 2nd			1																2
	2nd → 3rd				1															2
	3rd → O/D					1														2
No down-shift	O/D → 3rd					1														
	3rd → 2nd				1															
	2nd → 1st			1																2
Harsh engagement	N → R								2			1					3			4
	N → D						1										2			3
	N → L																1			
	1st → 2nd (D range)							1												2
	1st → 2nd (2 range)																			
	1st → 2nd → 3rd																			
	1st → 2nd → 3rd → O/D												4	3	1		2	5		
	2nd → 3rd								1											
	3rd → O/D									1										2
	O/D → 3rd									2	1									
	3rd → 2nd							1		3	2			4						5
Slip or shudder in forward and reverse (Directry after E/G start)		2															1			2

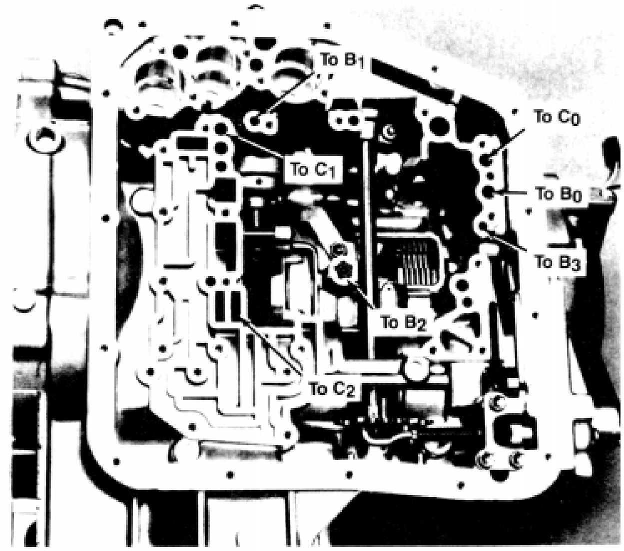
★: Refer to '92 A540E Automatic Transaxle Repair Manual (Pub. No. RM245U)
✱: Refer to '92 CAMRY Repair Manual Volume 2 (Pub. No. RM222U2)

Notes

AUTOMATIC TRANSMISSION AIR CHECK



A130



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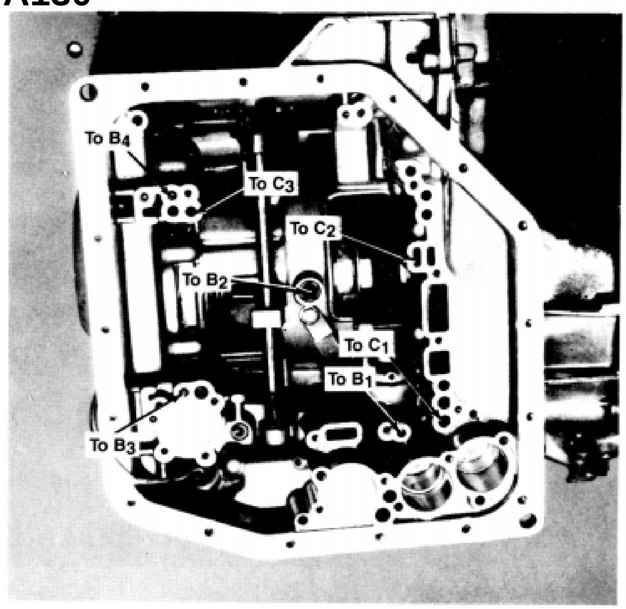
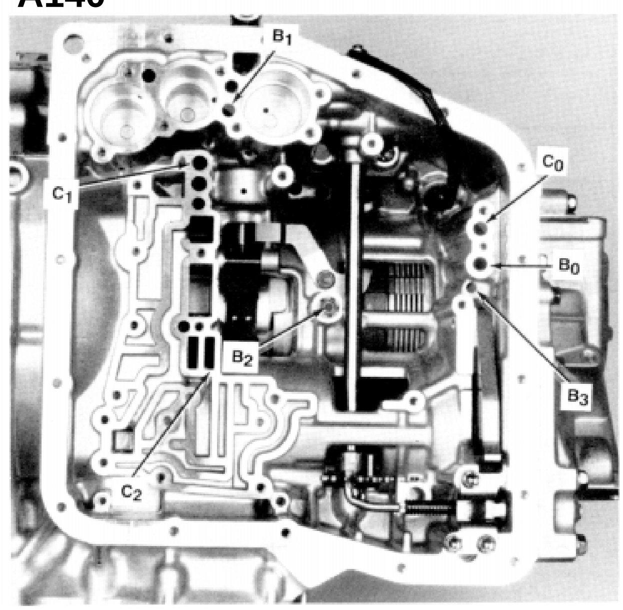


A240



A540

Test Sequence

1. Use rubber tip air nozzle to form seal with test point.

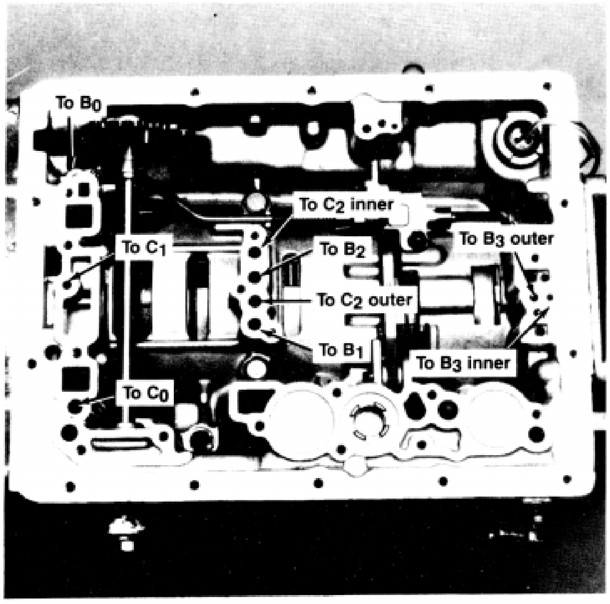
2. Apply 30-50 psi air pressure DO NOT exceed psi specifications!

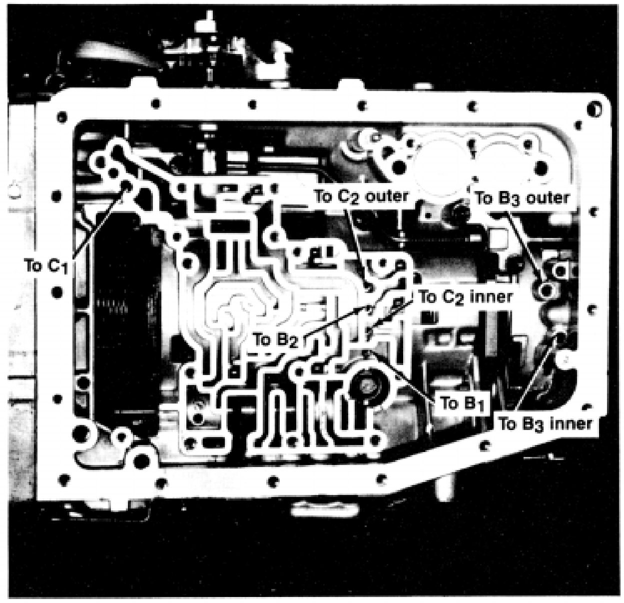
3. Result at each point:

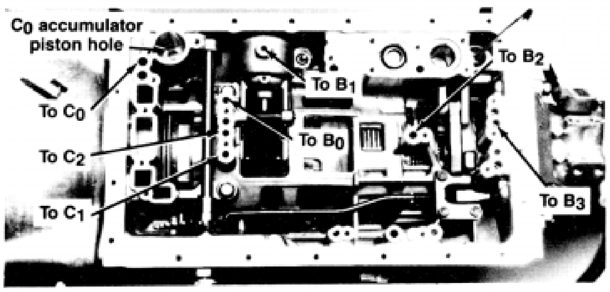
A. “Dull thud”- System O.K.

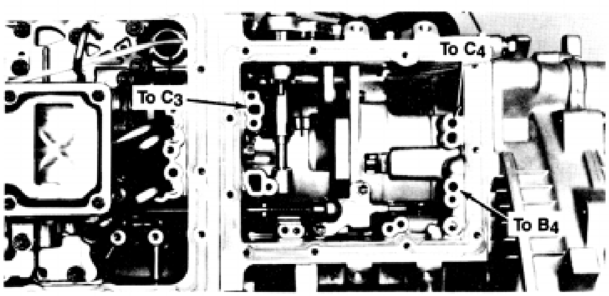
B. ”Hissing”- System leak.

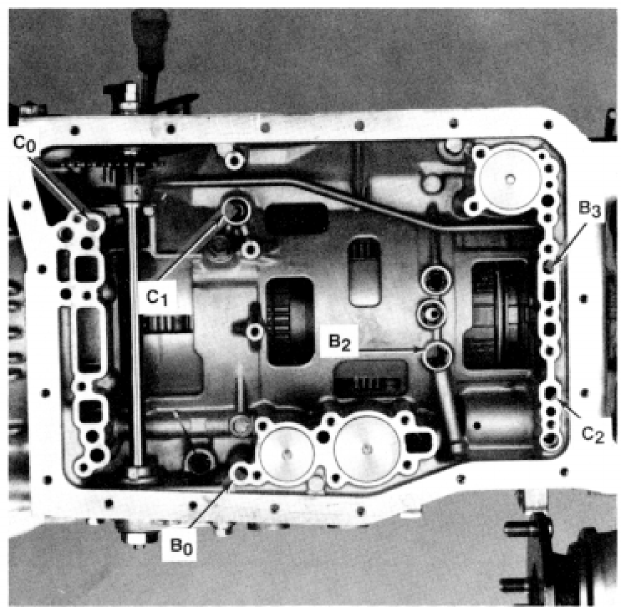
Use compressed air to check clutch, brake and servo function and as diagnostic step in conjunction with stall, road or pressure test.











C0	Overdrive Direct Clutch
C1	Forward Clutch
C2	Direct and Reverse Clutch
C3	Underdrive Direct Clutch
B0	Overdrive Brake
B1	2nd Coast Brake
B2	2nd Brake
B3	1 st and Reverse Brake
B4	Underdrive Brake

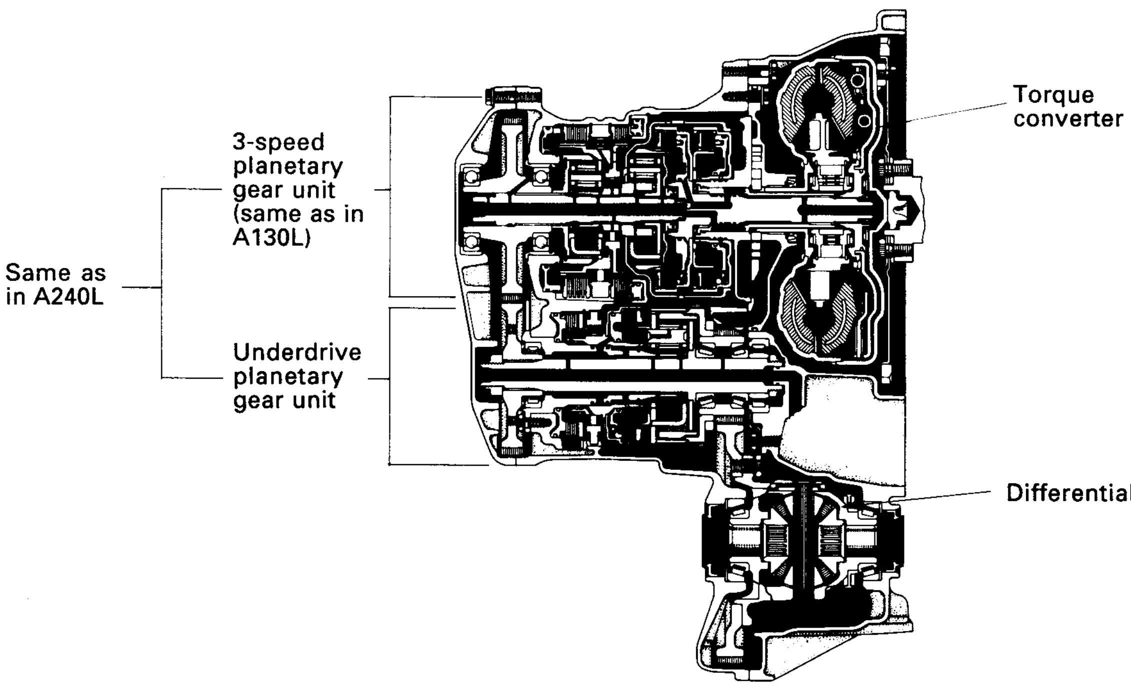
F0	Overdrive One-Way Clutch
F1	One-Way Clutch #1
F2	One-Way Clutch #2
F3	Underdrive One-Way Clutch

GENERAL REFERENCE

CONSTRUCTION OF ECTs

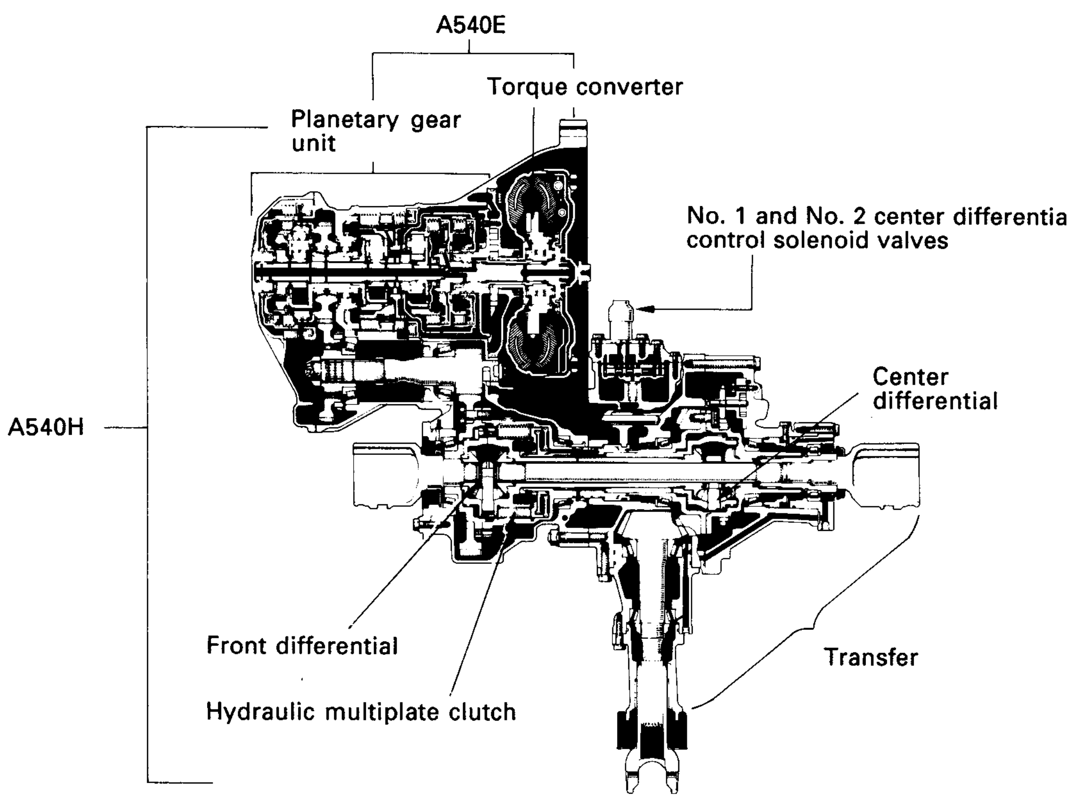
1. A240E and A241E

The main difference between the A240E and the A241E is in the final reduction ratios.



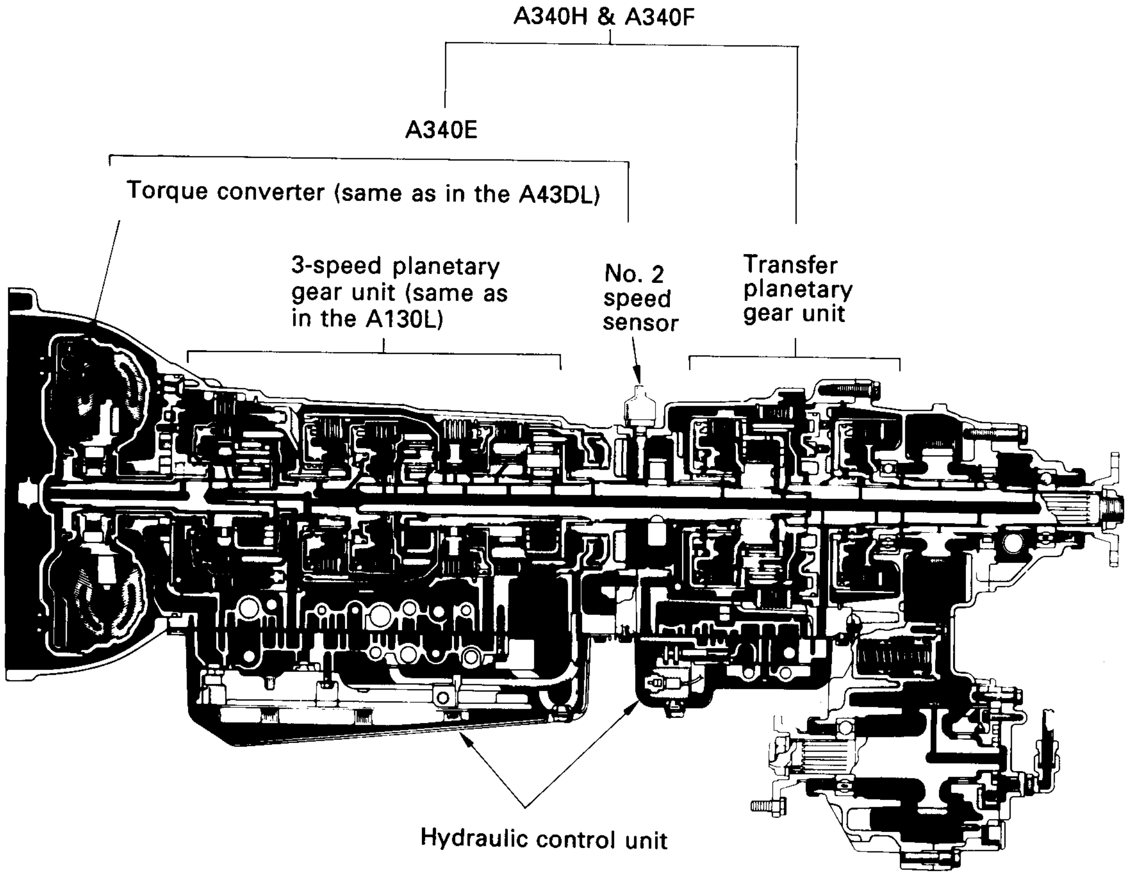
2. A540E and A540H

The A540H is basically the A540E with a transfer added to it to make it a 4WD transmission.



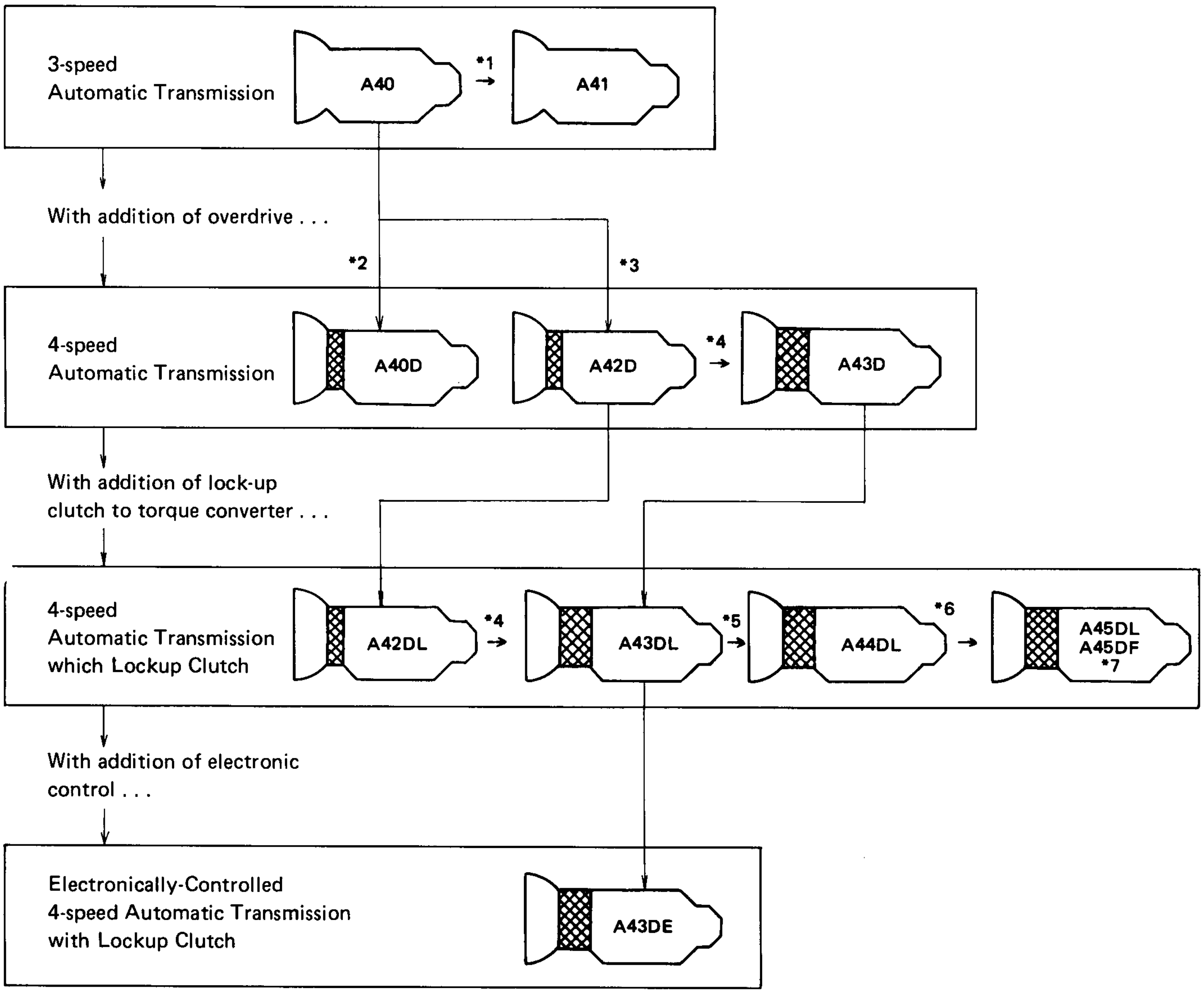
3. A340E, A340H and A340F

The transfer in the A340F is a manual shift transfer. The transfer in the A340H is an automatic shift transfer. The illustration shows the A340H.



OVERALL COMPARISON OF TOYOTA'S VARIOUS AUTOMATIC TRANSMISSIONS

1. A40 SERIES



*1 The gear ratio has been changed.

*2 The A40D is an A40 with added overdrive unit, but without brake No. 2 (B2) and one-way clutch No. 1 (F1).

*3 The A42D is an A40 (including brake No. 2 (B2) and one-way clutch No. 1 (F1) with added overdrive unit.

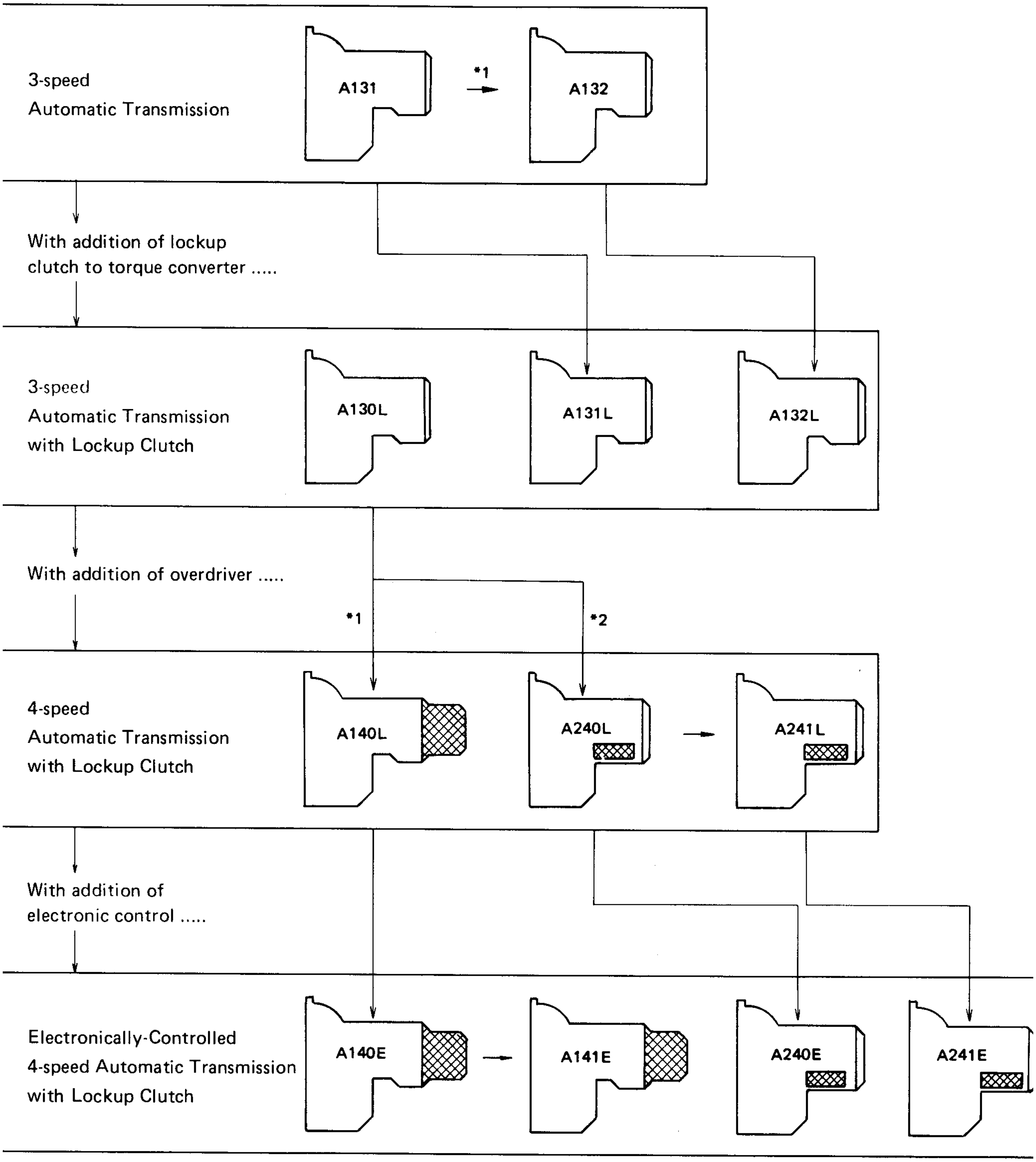
*4 To enable it to be used with larger, higher-performance engines, the capacity and performance of the A42D have been upgraded (i.e., the planetary gear has been made larger, the number of discs used has been increased, the two C2 pistons have been combined into one double-acting piston, and the surface area of this piston to which hydraulic pressure is applied in 3rd gear or overdrive (in the "D" range) has been increased).

*5 The gear ratio has been changed and a three-stage governor valve used.

*6 The gear ratio has been changed.

*7 The A45DF is on A45DL modified for 4WD vehicles.

5. A100, 200 SERIES



*1 The A140L is an A130L with added overdrive unit on the rear of transaxle case.

*2 The A240L is an A130L with added underdrive (4th speed) unit on the inside of transaxle case.