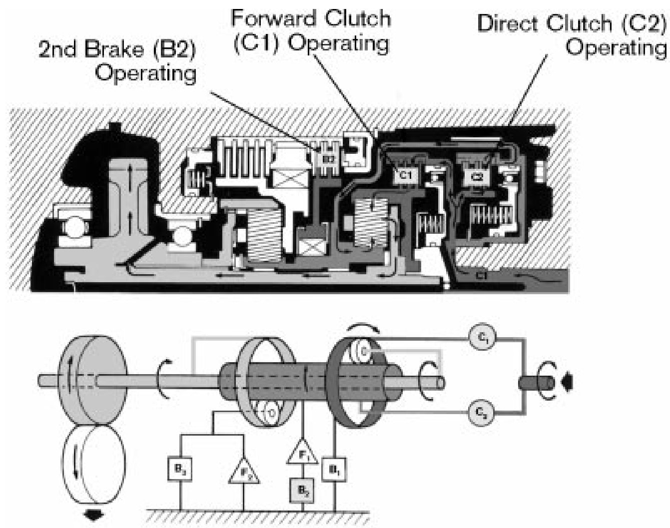
Automatic Transmission Basics



Shift Lever Position	Gear Position	C1	C2	B1	B2	B3	F1	F2
D	2nd	■			■		■	
	3rd	■	■		X			

T273f027/T273f028

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. Identify the three major components of the simple planetary gear set.
6. Describe the function of the simple planetary gear set to provide speed change, torque change and directional change.
7. Describe the operation of multi-plate clutches, brake bands and one-way clutches.
8. Describe the effect of centrifugal fluid pressure on the operation of a multi-plate clutch.
9. Given a clutch application chart and planetary gear model:
   a. identify which holding devices are applied for each gear range.
   b. identify the planetary gear components held for each gear range.
   c. use a process of elimination to determine the proper function of holding devices by testing it's operation in another gear range.
   d. use parallel holding devices to narrow diagnosis to faulty clutch or brake.
10. Describe the difference between overdrive operation in the front wheel drive and rear wheel drive automatic transmissions.

Notes

Torque Converter Components

The torque converter provides an automatic means of coupling engine torque to the input shaft of the transmission. The torque converter's three major components are; the pump impeller, the turbine runner and the stator. The hydraulic fluid in the converter transfers torque through the kinetic energy of the transmission fluid as it is forced from the impeller to the turbine. The faster the engine rotates, the greater the torque applied to the turbine. At low engine speeds, the turbine can be held stationary as the force of the fluid's kinetic energy is not great enough to overcome the holding force of the light brake system application.

Torque Converter

Made of three major components; the pump impeller, turbine runner and the stator.

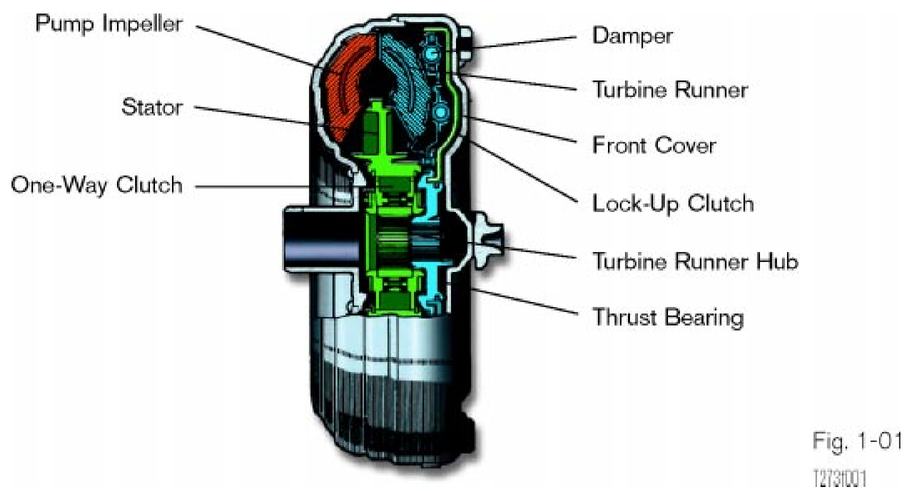


Fig. 1-01

Pump Impeller

The impeller is integrated with the torque converter case, with many curved vanes evenly spaced and 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 impeller rotates whenever the engine is running, causing the fluid to flow outward toward the turbine.

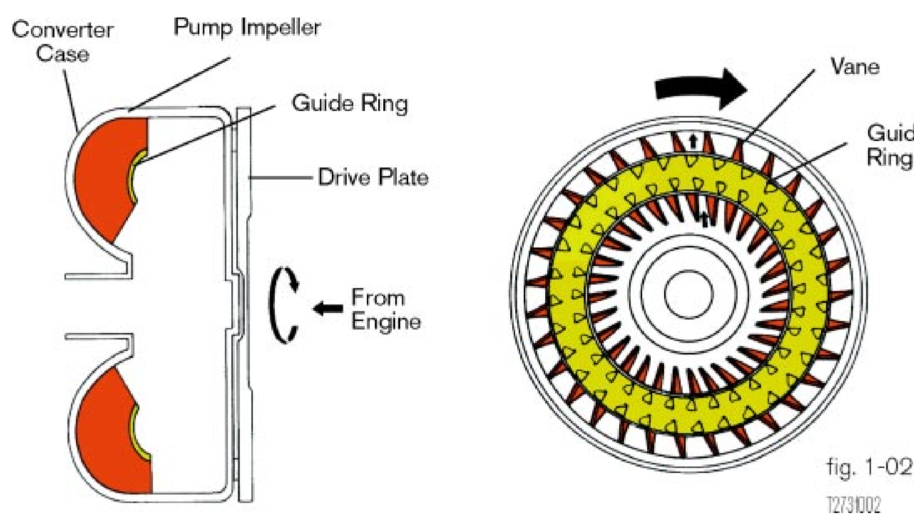


fig. 1-02

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. A guide ring similar to the impeller is installed to the inner edge of the vanes.

Torque Converter - Turbine

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

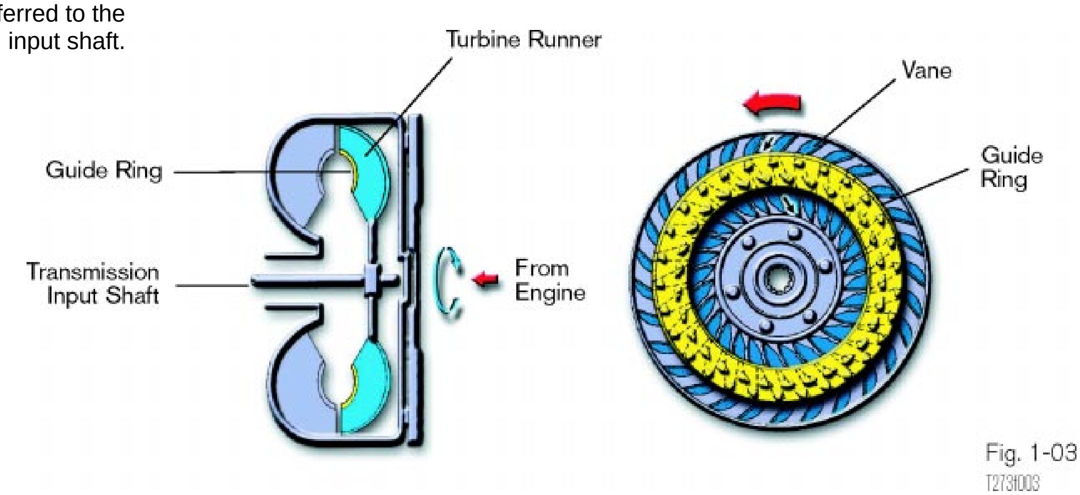


Fig. 1-03

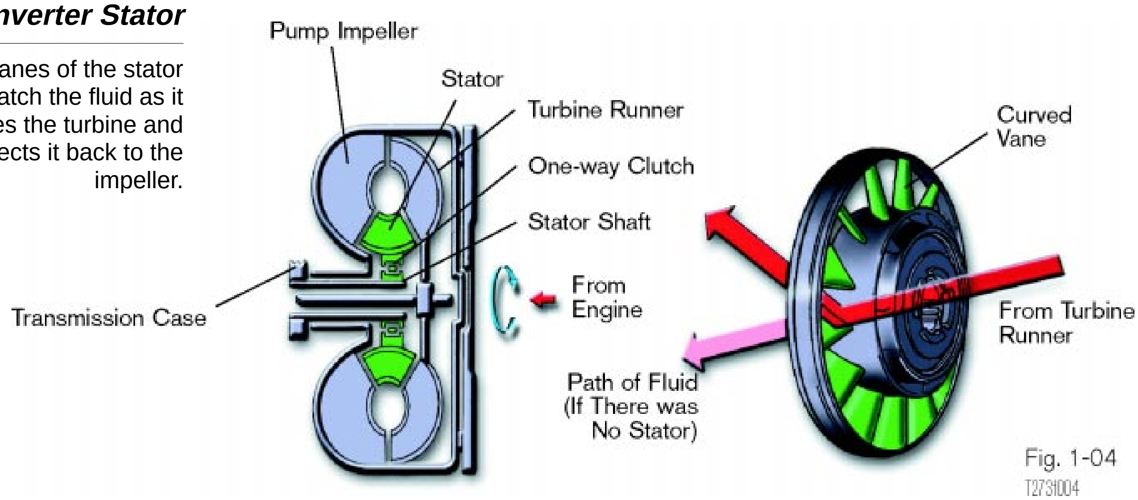
Stator

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 added boost or torque. The benefit of this added torque can be as great as 30% to 50%.

The one-way clutch mounted to the stator allows it 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.

Torque Converter Stator

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



Converter Operation

When the impeller is driven by the engine crankshaft, the fluid around the impeller rotates in the same direction. As 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 speed increases further, fluid is forced out away from the impeller toward the turbine. The fluid strikes the vanes of the turbine causing it to rotate 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. Fluid strikes the curved vane of the stator causing the one-way clutch to lock the stator and redirects fluid at the impeller vanes in the direction of engine rotation, increasing engine torque.

As the impeller and turbine approach the same speed, fluid strikes the back of the stator vanes, releasing the one-way clutch and allows the stator to freewheel. Unless the stator freewheels, being mounted to the transmission body, fluid will strike the vanes of the stator and limit engine rpm and upper engine performance.

Stator Operation

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

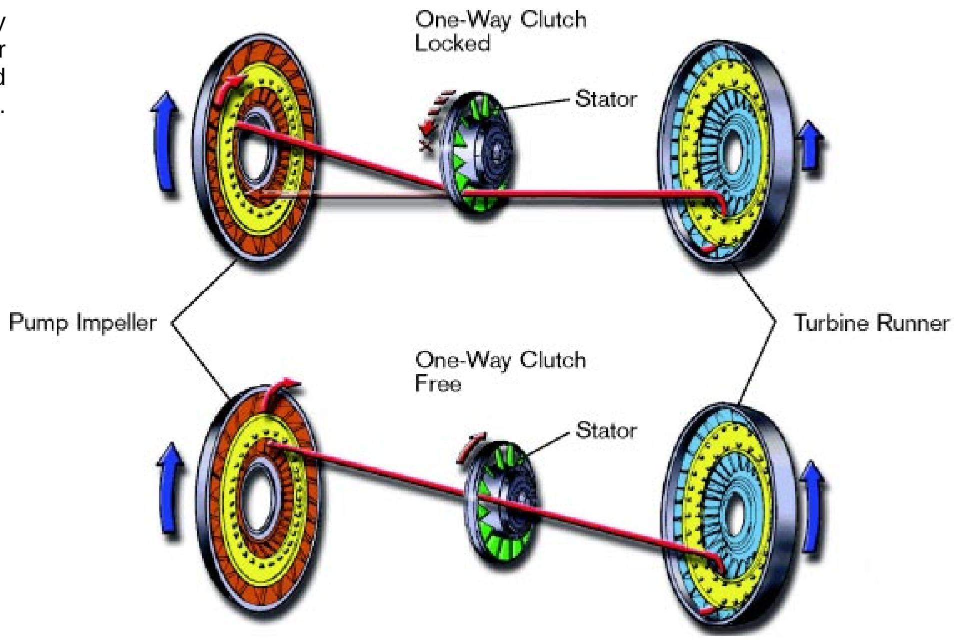


Fig. 1-05
T273f005

Converter Lock-Up Clutch

At lower vehicle speeds the torque converter provides multiple gear ratios when high torque is needed. As the impeller and the turbine rotate 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 reduce energy loss and improve fuel economy, 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 Lock-Up Clutch

To reduce fuel consumption, the lock-up clutch engages the converter case to lock the impeller and the turbine.

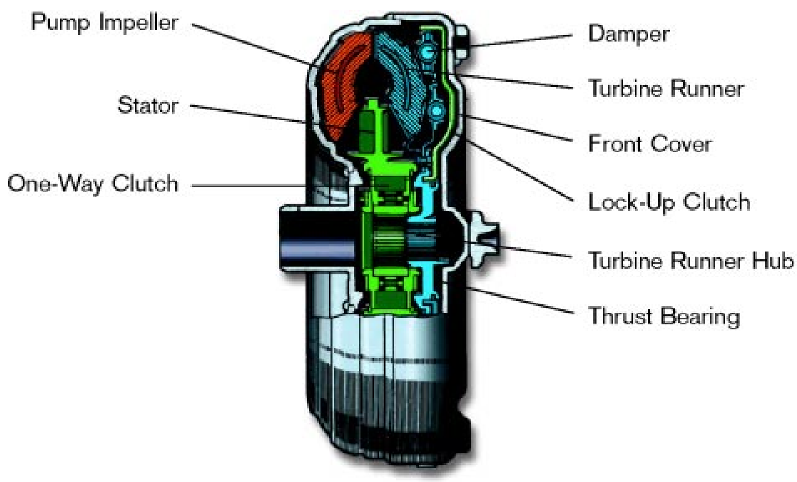


Fig. 1-06

T273f001

The lock-up clutch is installed on the turbine hub between the turbine and the converter front cover. Hydraulic pressure on either side of the converter piston causes it to engage or disengage the converter front cover. A set of dampening springs absorb 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.

Lock-Up Operation

When the lock-up clutch is engaged, it connects the impeller and turbine. Engaging and disengaging the lock-up clutch is determined by which side of the lock-up clutch the fluid enters the torque converter. The difference in pressure on either side of the lock-up clutch determines engagement or disengagement. Fluid can either enter the body of the converter behind the lock-up clutch engaging the clutch, or in front of the lock-up clutch to disengage it.

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.

Simple Planetary Gear

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 combination we will discuss.

Simple Planetary Gear Operation

The shaded area represents the combinations used in Toyota transmissions.

HELD	POWER INPUT	POWER OUTPUT	ROTATIONAL		ROTATIONAL DIRECTION
			SPEED	TORQUE	
Ring Gear	SunGear	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 from drive member
	Ring Gear	Sun Gear	Increased	Reduced	

Fig. 1-07

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.

Reduction

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

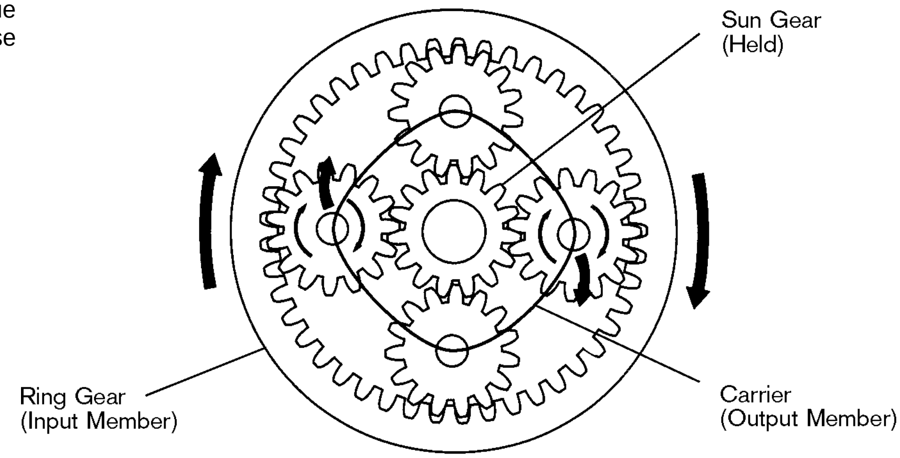


Fig. 1-08
T273f007

Overdrive 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

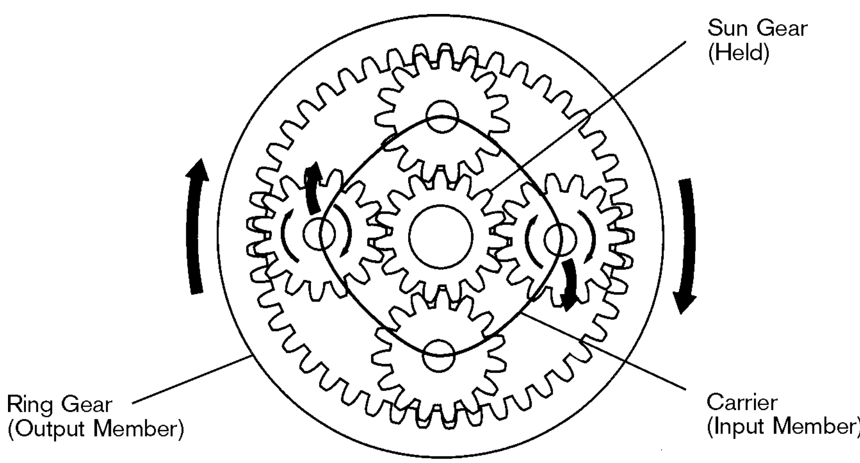


Fig. 1-09
T273f008

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

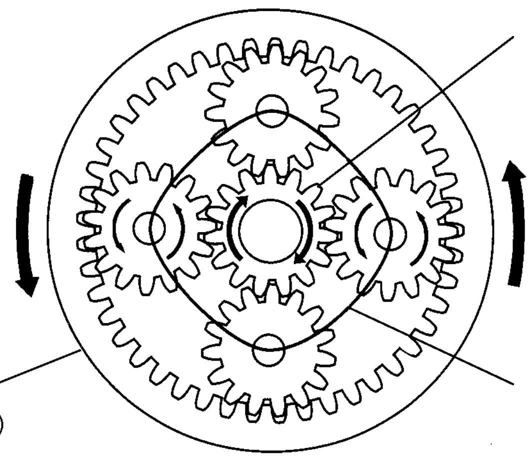


Fig. 1-10
T273f009

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. This design is basic to most all automatic transmissions in production today.

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.
- Roller or Sprag One-Way Clutch – holds planetary components in one rotational direction and freewheels in the other direction.
- Multiplate Brake and Brake Band – holds planetary components to the transmission case.

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.

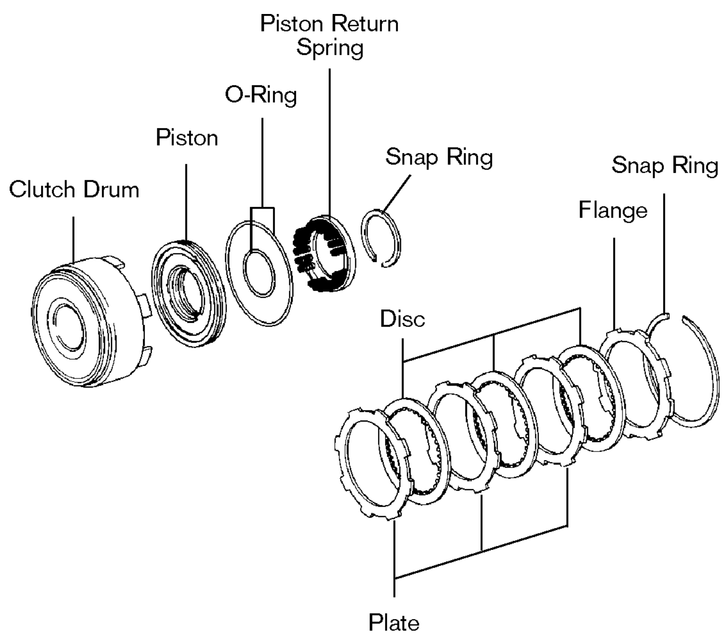


Fig. 1-11
T273f010

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 clutch (C2). Each clutch drum is slotted on the inner diameter to engage the steel plates and transfer turning torque from the engine. The drum also provides the bore for the clutch piston.

Friction discs are steel plates which have friction material bonded to them. They are always located between two steel plates. The friction disc inner diameter is slotted to fit over the splines of the clutch hub.

Steel plates are slotted on the outer diameter to fit the slots of the clutch drum or transmission case. They provide a smooth surface for the friction discs to engage with. Steel plates can be installed next to one another to give a specific clearance for the clutch pack.

Multiplate Operation

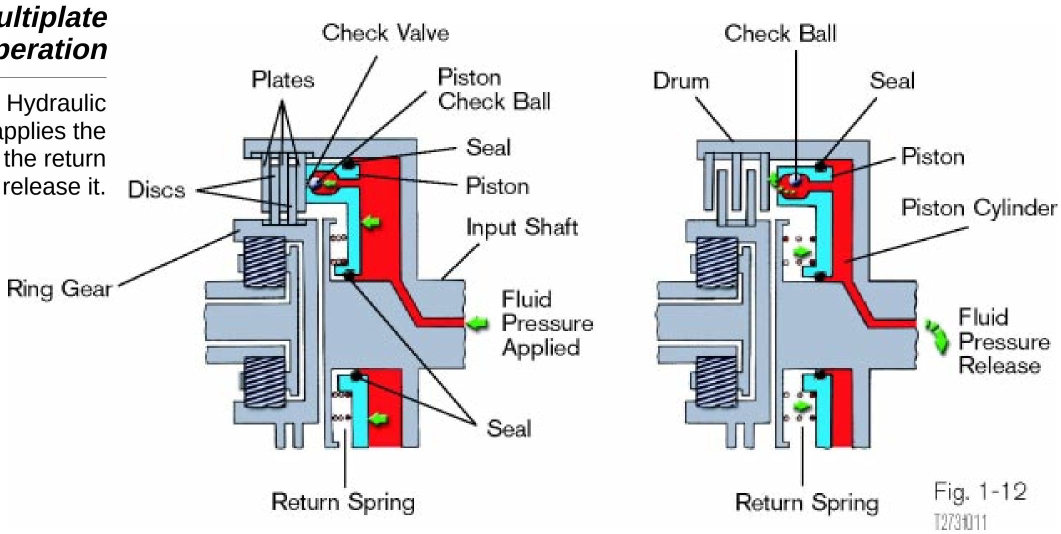
Because this assembly rotates while the vehicle is in motion, it presents a unique challenge to ensure pressurized fluid reaches the clutch and holds the clutch engaged for many tens of thousands of miles of service. Oil seal rings seal the fluid passage between the clutch drum and oil pump stator support and transmission center support.

Seals are mounted on the piston inner and outer diameter which seal the fluid applying the piston. A relief ball valve is housed in the piston body to release hydraulic fluid when the clutch is released. As the drum rotates, some fluid remains behind the piston and centrifugal force causes the fluid to flow to the outer diameter of the drum causing pressure. 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 allow fluid to escape when pressure is released. As pressure drops, centrifugal force causes the ball to move away from the valve seat, allowing fluid to escape so the piston can be seated, providing proper clearance between the disc and steel plates.

Multiplate Clutch Operation

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



U-Series Transmission Counter Centrifugal Force

The U-series transmissions first introduced in the 2000 Echo and Celica, utilizes centrifugal fluid pressure to cancel the effect of centrifugal force on the piston when pressure is released in the clutch. Fluid used for lubrication is caught between the clutch spring retainer and the clutch piston. As the clutch drum rotates, fluid in the canceling fluid pressure chamber counters the pressure built up inside the drum pressure chamber, canceling the pressure build-up.

Centrifugal Fluid Pressure Canceling

As the clutch drum rotates, fluid in the canceling fluid pressure chamber, counters the pressure built up inside the drum pressure chamber, and counteracts the pressure build-up.

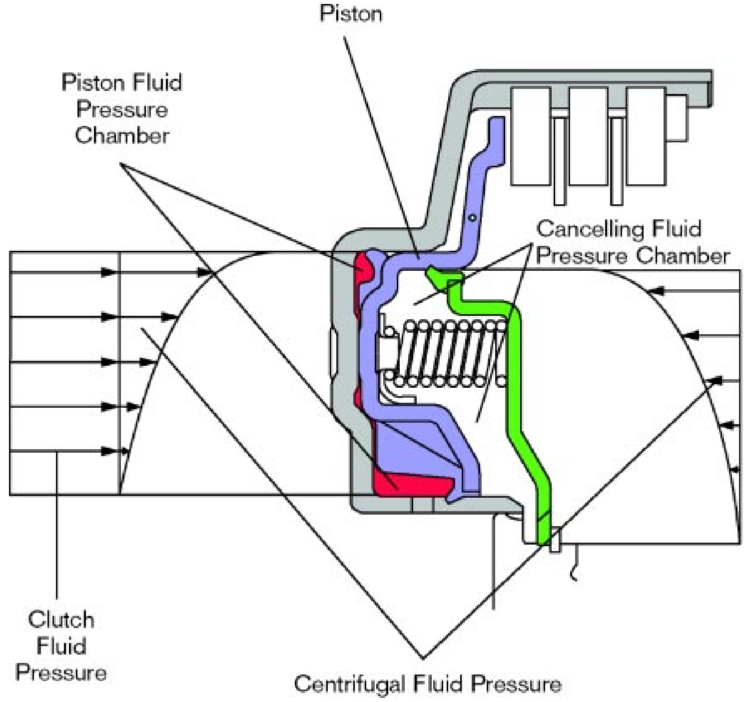


Fig. 1-13
T273f012

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. Their operation is similar in that they both rely on wedging the metal sprags between two races. Two one-way clutches are used in the Simpson Planetary Gear Set. The *No. 1 one-way clutch* (F1) is used in second gear and the *No. 2 one-way clutch* (F2) 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 in figure 1-14, 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.

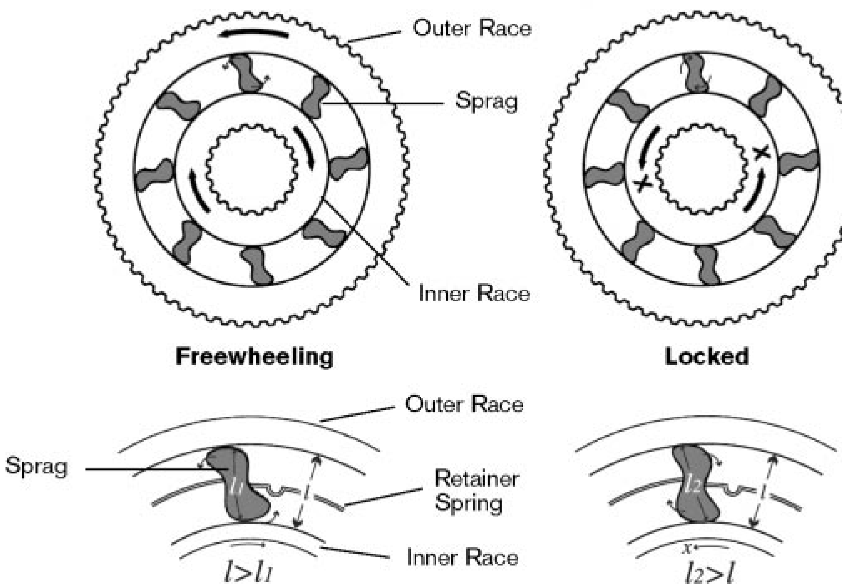


Fig. 1-14
T273f013

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.

Although the sprag clutch is used most often in Toyota automatics, a second design can be found in the U-series transmission and other transmission models. A one-way roller clutch consists of a hub, rollers, and springs surrounded by a cam-cut drum. The cam-cut is in the shape of a wedge, smaller on one end than the other. The spring pushes the rollers toward the narrow end of the wedge. When the inner race rotates in the counterclockwise direction, the rollers compress the spring and the race is allowed to turn. If the race is rotated in the opposite direction, it forces the rollers into the narrow end of the cam cut and locks the race.

One-Way Roller Clutch

When the inner race is rotated in the clockwise direction, it forces the rollers into the narrow end of the wedge and locks the race.

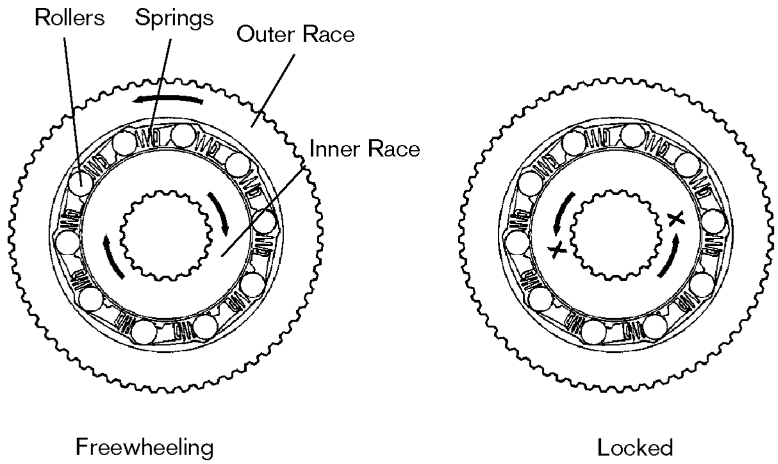


Fig. 1-15
T273f014

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

No. 1 and No. 2 One-Way Clutch

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

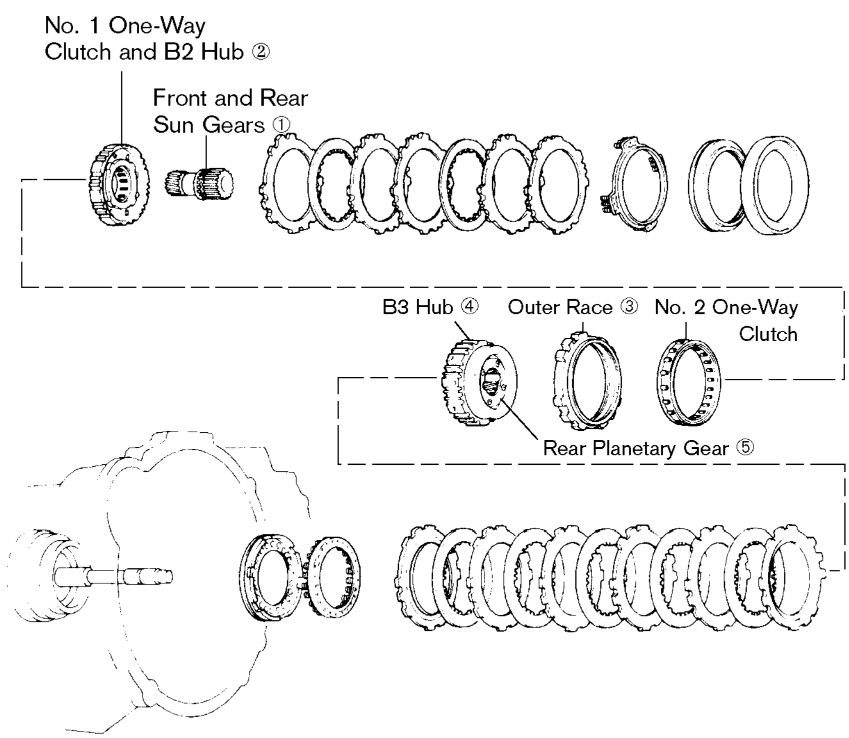


Fig. 1-16
T273f018

Brakes

There are two types of brakes; the wet multiplate type and the band type. The multiplate type is used on the *overdrive brake* (B0), *second coast brake* (B1), *second brake* (B2), and the first and reverse brake (B3).

Multiplate Brakes

The multiplate brake 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

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

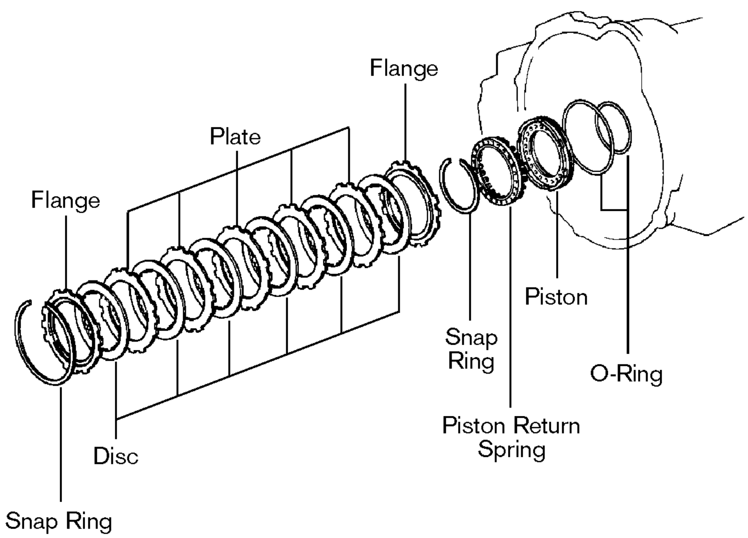


Fig. 1-17
T273f015

Brake Band The brake band performs the same functions as the multiplate brake and is located around the outer circumference of the direct clutch drum. One end of this brake band is anchored to the transmission case with a pin, while the other end contacts the brake piston rod which is controlled by hydraulic pressure and spring tension.

Band Type Brake

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

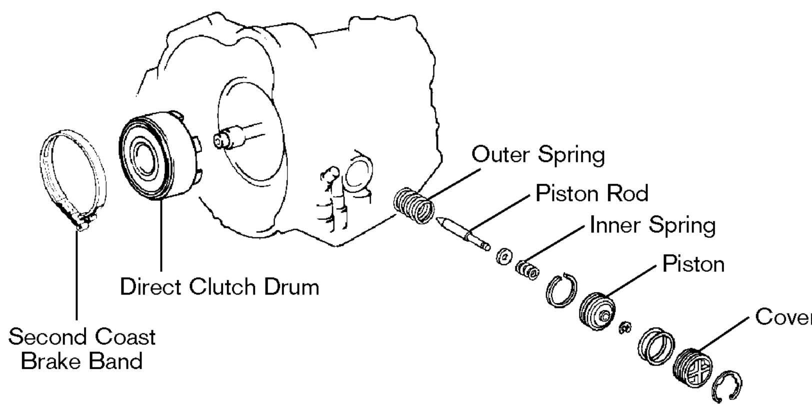


Fig. 1-18
T273f016

Band Operation

The inner spring transfers motion from the piston to the piston rod, applying pressure to the end of the brake band.

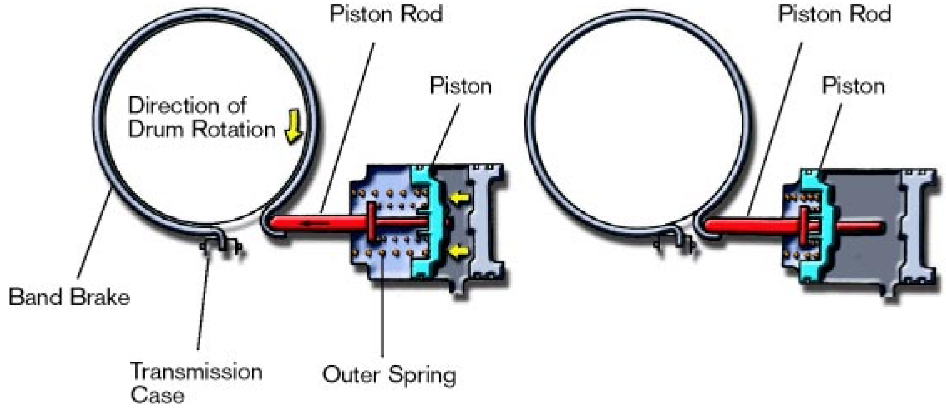


Fig. 1-19
T273f0D17

Band Operation

The band is applied by a piston and piston rod located in the transmission case. When hydraulic pressure is applied to the piston, the piston moves to the left compressing the outer spring. The inner spring transfers motion from the piston to the piston rod, applying pressure to the end of the brake 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. The brake band clamps down on the drum 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.

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 member.

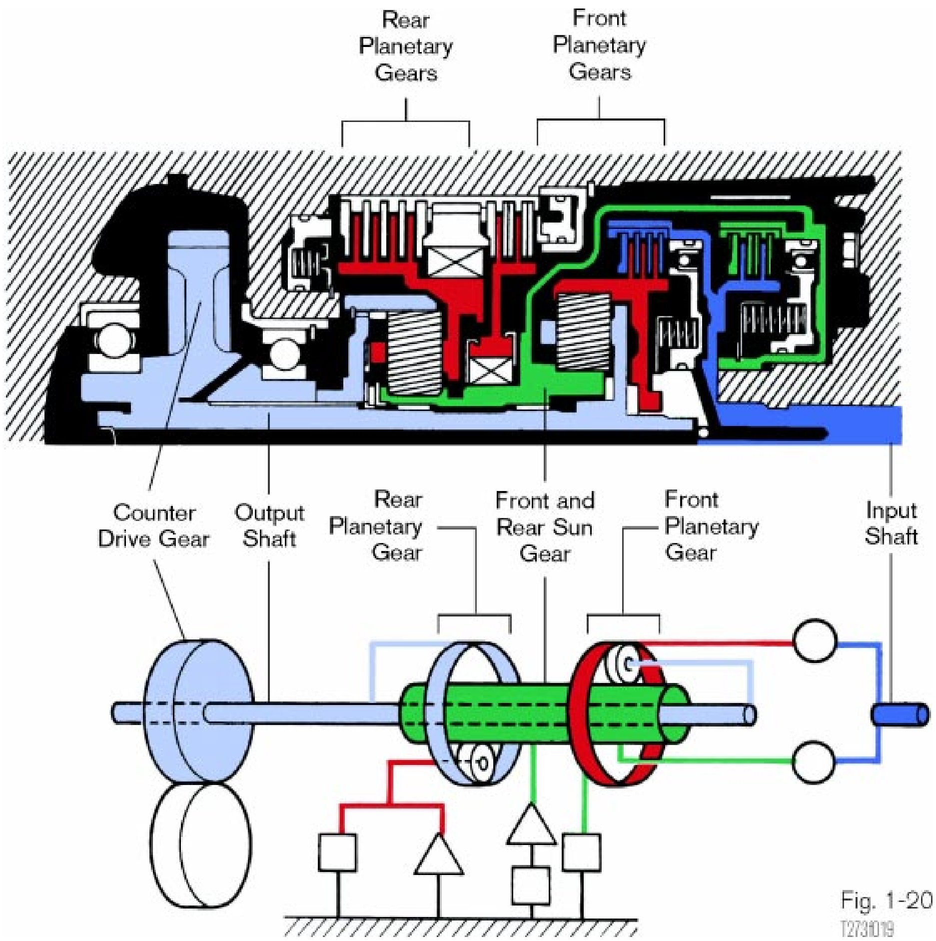


Fig. 1-20

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

Each holding device and the component it controls is identified in this chart.

Holding Device		Function
C0	O/D Direct Clutch	Connects overdrive sun gear and overdrive carrier.
B0	O/D Brake	Prevents overdrive sun gear from turning either clockwise or counterclockwise.
F0	O/D One-Way Clutch	When transmission is being driven by engine, connects overdrive sun gear and overdrive carrier.
C1	Forward Clutch	Connects input shaft and front planetary ring gear.
C2	Direct Clutch	Connects input shaft and front and rear planetary sun gear.
B1	2nd Coast Brake	Prevents front and rear planetary sun gear from turning either clockwise or counterclockwise.
B2	2nd Brake	Prevents outer race of F1 from turning either clockwise or counterclockwise, thus preventing front and rear planetary sun gear from turning counterclockwise.
B3	1st and Reverse Brake	Prevents rear planetary carrier from turning either clockwise or counter clockwise.
F1	No. 1 One-Way Clutch	When B2 is operating, prevents front and rear planetary sun gear from turning counterclockwise.
F2	No. 2 One-Way Clutch	Prevents rear planetary carrier from turning counterclockwise.

Fig. 1-21

The value of this model can be appreciated when observing the control of the rear carrier and the sun gear. The *first and reverse brake* (B3) and the *No. 2 one-way clutch* (F2) control the rear carrier in parallel. Together they provide a great holding force on the carrier to prevent it from turning during low first gear.

The *second brake* (B2) and the *No. 1 one-way clutch* (F1) control the sun gear in series. This allows the sun gear to turn clockwise only when B2 is applied

The *second coast brake* (B1) holds the sun gear, preventing it from turning in either direction. This feature provides for engine braking on deceleration while in 2-range second gear.

Planetary Holding Devices

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

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

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

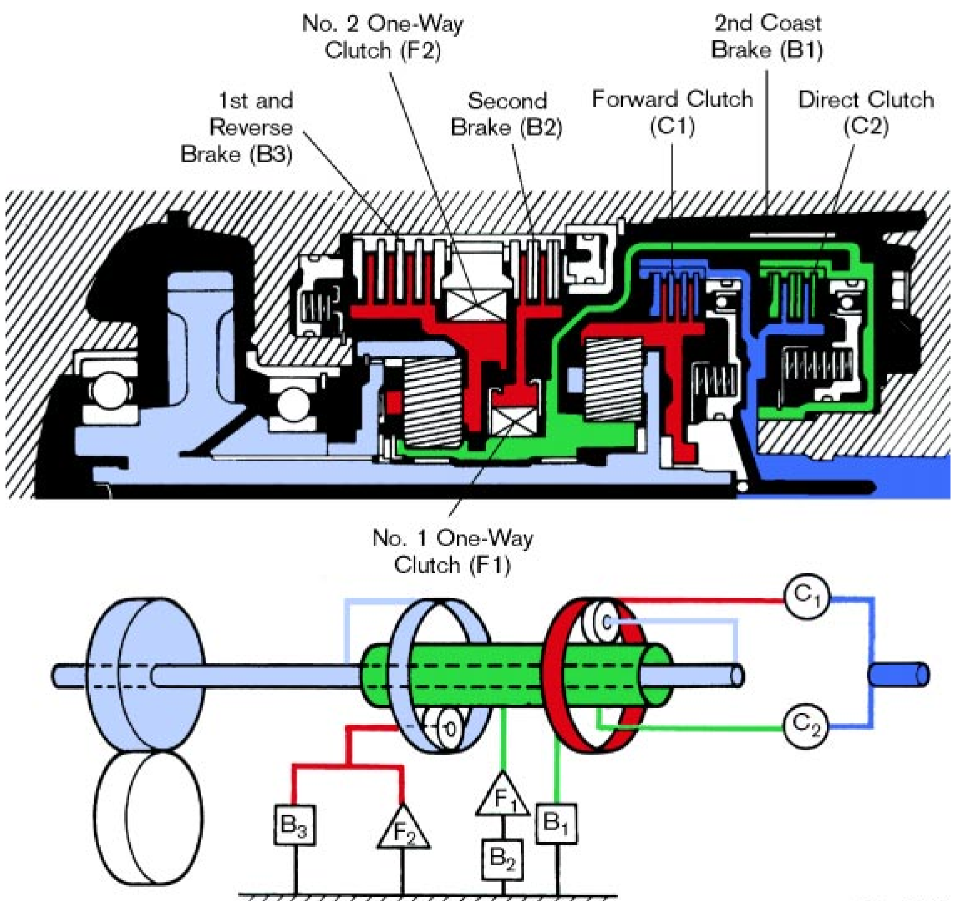


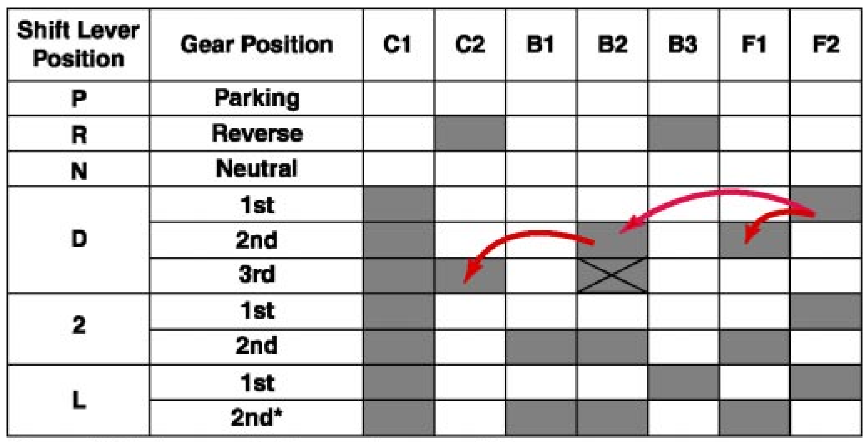
Fig. 1-22
T273f021

Three Speed Clutch Application Chart

The gear position in which these holding devices are applied can be found on the clutch application chart below. The chart 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 boxes to 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 *No. 2 one-way clutch* (F2) are applied to achieve first gear. The clutch

Clutch Application Chart for A130 Transmission

The chart describes which holding devices are applied for a given gear position.



*Down-shift in L range, 2nd gear only–no up-shift.

Indicates that holding device is applied but not a funtion of the current gear position.

Fig. 1-23
T273f022

application chart shows that as the transmission upshifts to the next gear, an additional holding device is engaged in addition to those clutches and brakes already applied. For example, when upshifting to second gear, B2 is applied while C1 remains applied; and when upshifting to third gear, C2 is applied while B2 and C1 remain applied. The one way clutches are the only holding devices to release as an upshift occurs, but they remain ready to automatically apply when the rotating member turns in a counterclockwise direction.

This stacking feature allows the transmission to remain in the lower gear when a clutch/brake fails to engage on an upshift and also provides a downshift by simply disengaging one clutch.

The clutch application chart is your key to diagnosis. When a transmission malfunction occurs and the diagnosis leads you to a specific gear, you can refer to this chart to pinpoint the faulty holding 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 while either accelerating or decelerating. If that gear position does not exhibit a problem, look for another device shared with another gear position and look for a malfunction to occur. Using a process of elimination, you can pinpoint the holding device which is causing the malfunction.

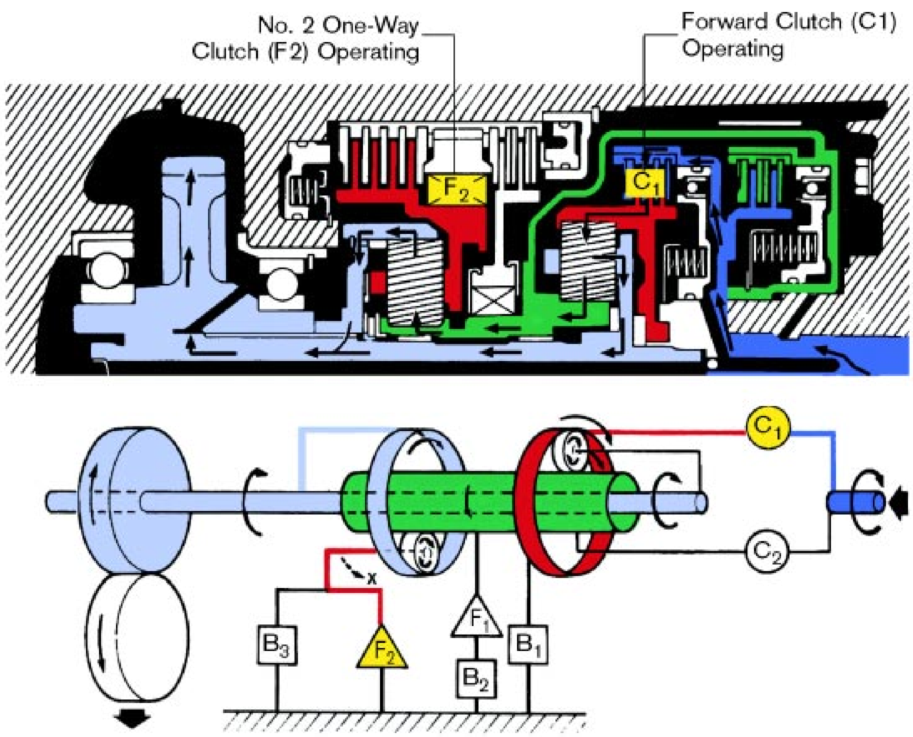
Power Flow Through Simpson Planetary Gear Set - D or 2-Range First Gear

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 *No. 2 one-way clutch* (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							

Fig. 1-24
T2731023/T2731024

D-Range Second Gear

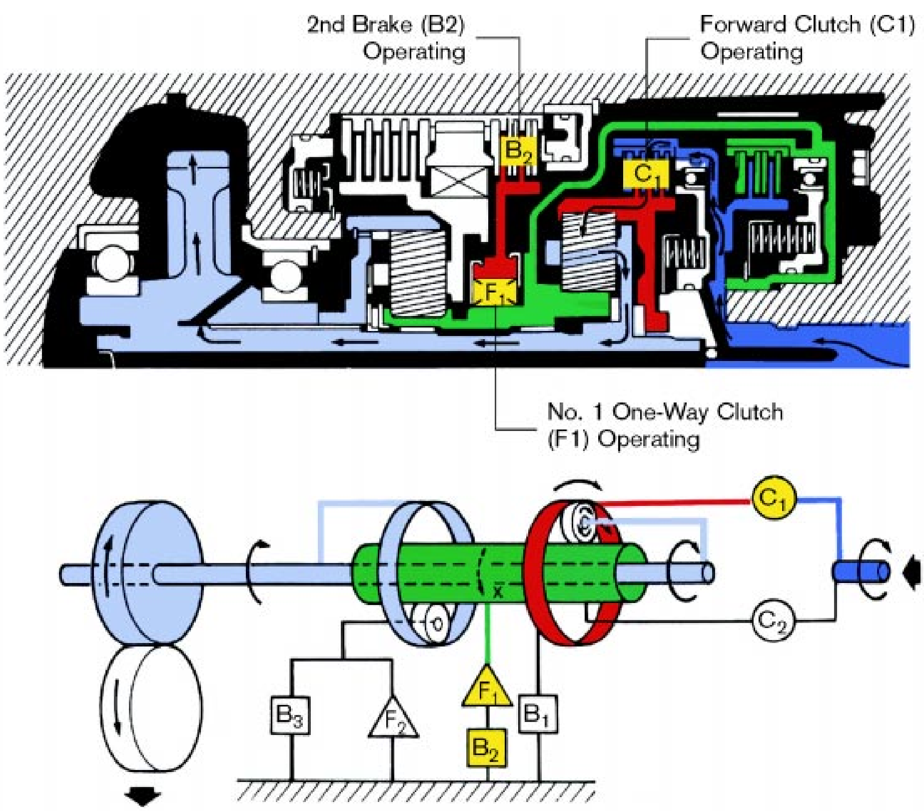
The *forward clutch* (C1) connects the input shaft to the front planetary ring gear. The sun gear is driven in a counterclockwise direction in first gear and by simply applying the *second brake* (B2) the sun gear is stopped by the *No. 1 one-way clutch* (F1) and held to the case. When the sun gear is held, the front pinion gears driven by the ring gear walks around the sun gear and the carrier turns the output shaft.

The advantage of the *No. 2 one-way clutch* (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* (F1) both hold the sun gear in series. 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 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	■			■		■	

Fig. 1-25
T273f025/T273f026

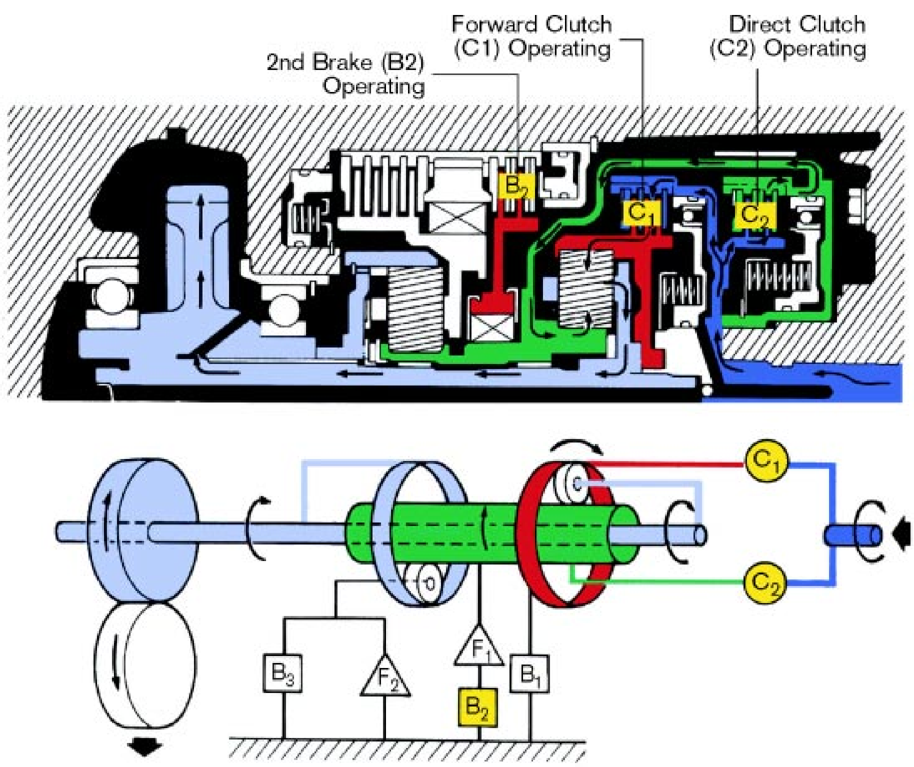
D-Range Third Gear

The *forward clutch* (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 *No. 1 one-way clutch* (F1) 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 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 *No. 1 one-way clutch.* 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	C1	C2	B1	B2	B3	F1	F2
D	2nd	■			■		■	
	3rd	■	■		X			

Fig. 1-26
T273f027/T273f028

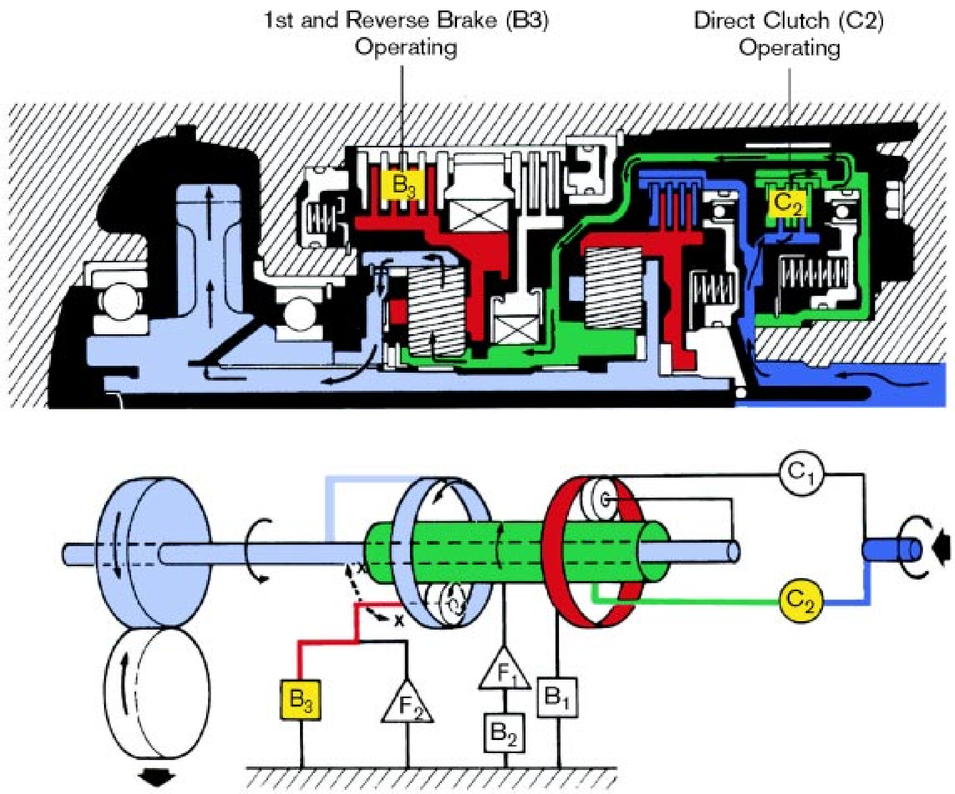
Reverse Range

The *direct 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	C1	C2	B1	B2	B3	F1	F2
P	Parking							
R	Reverse		●			●		

Fig. 1-27
T273f029/T273f030

Comparison of D and L-Range First Gear

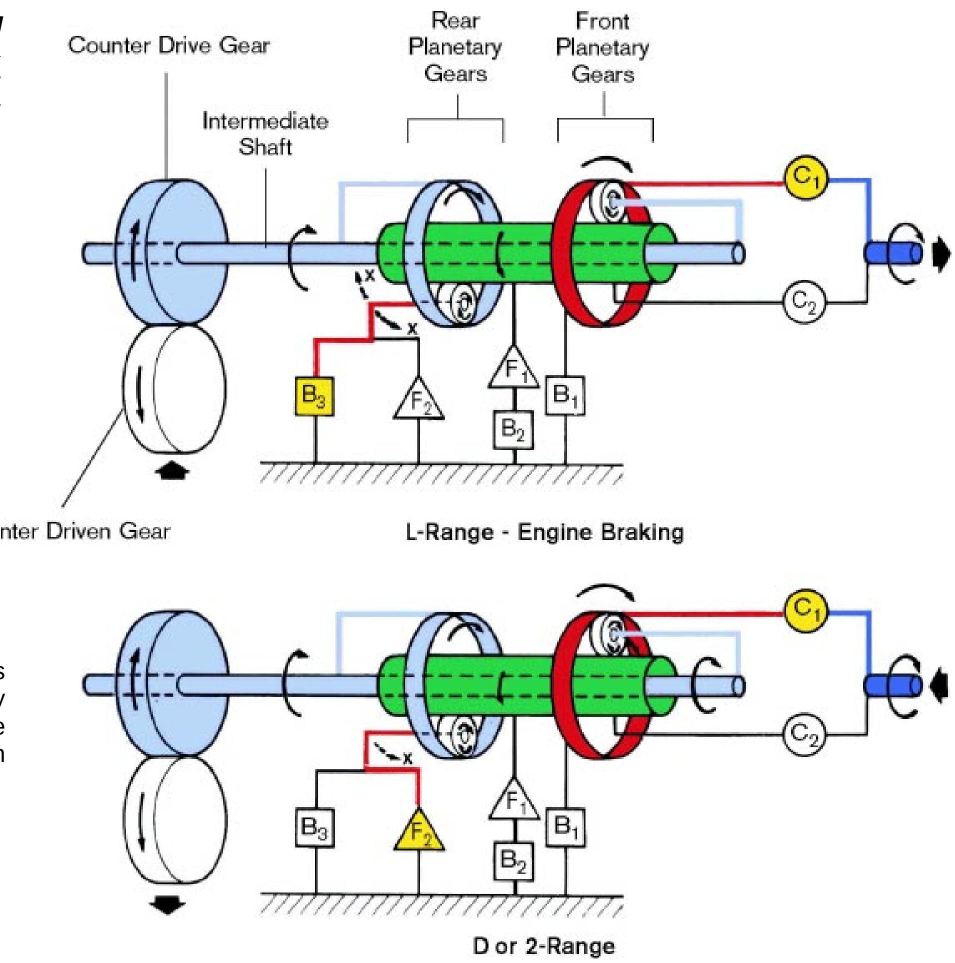
When the gear selector is placed in the L-position, the *first and reverse brake* (B3) is applied through the position of the manual valve. The *first and reverse brake* performs the same function as the *No. 2 one-way clutch* (F2) does in the forward direction. When the *first and reverse brake* (B3) is applied it holds the rear planetary gear carrier from turning in either direction, whereas the *No. 2 one-way clutch* holds the carrier in the counterclockwise direction only.

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 *No. 2 one-way clutch* holds the carrier, so while decelerating, the *one-way clutch* would release and no engine braking would occur.

First Gear Model

The rear planetary carrier cannot rotate in either direction

The rear planetary carrier is held counterclockwise only and freewheels in the clockwise direction



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

Fig. 1-28
T273f031/T273f033

Comparison of D2 and 2-Range Second Gear

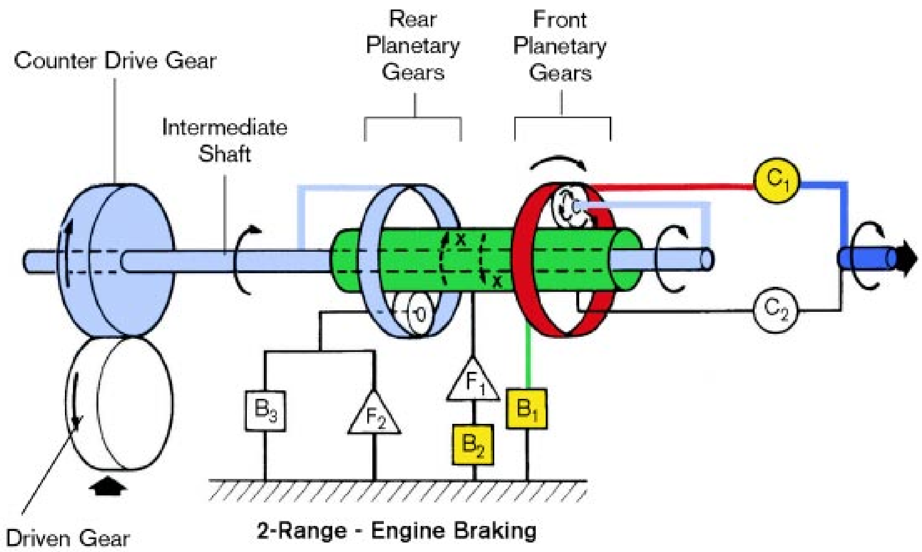
When the gear selector is placed in the 2-position, the *second coast brake* (B1) is applied by way of the manual valve. When the *second coast brake* is applied, it holds the sun gear from rotating in either direction. Power flow is the same with the selector in “2,” as when the selector is in “D” because the *second coast brake* is parallel to the *second brake* and *No. 1 one-way clutch*.

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.

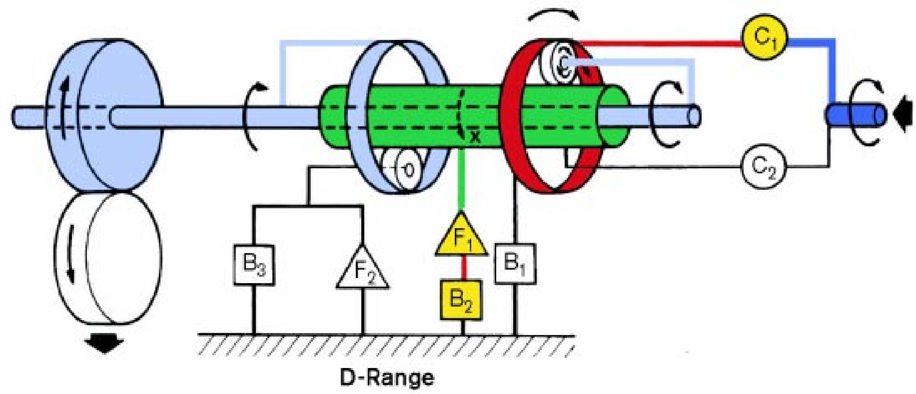
The advantage that 2-range has over “D2” is that the engine can be used to slow the vehicle on deceleration, and this feature can be used to aid in diagnosis. For example, a transmission which does not have second gear in D-position but does have second gear while manually shifting can be narrowed to the *second brake* (B2) or *No. 1 one-way clutch* (F1). These components and related hydraulic circuits become the primary focus in our diagnosis.

Second Gear Model

The sun gear cannot rotate in either direction.



The sun gear is held in the counterclockwise direction only in a clockwise direction.



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

Fig. 1-29
T273f034/T273f035
T273f036

Power Flow Through O/D 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.

O/D Planetary Units

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

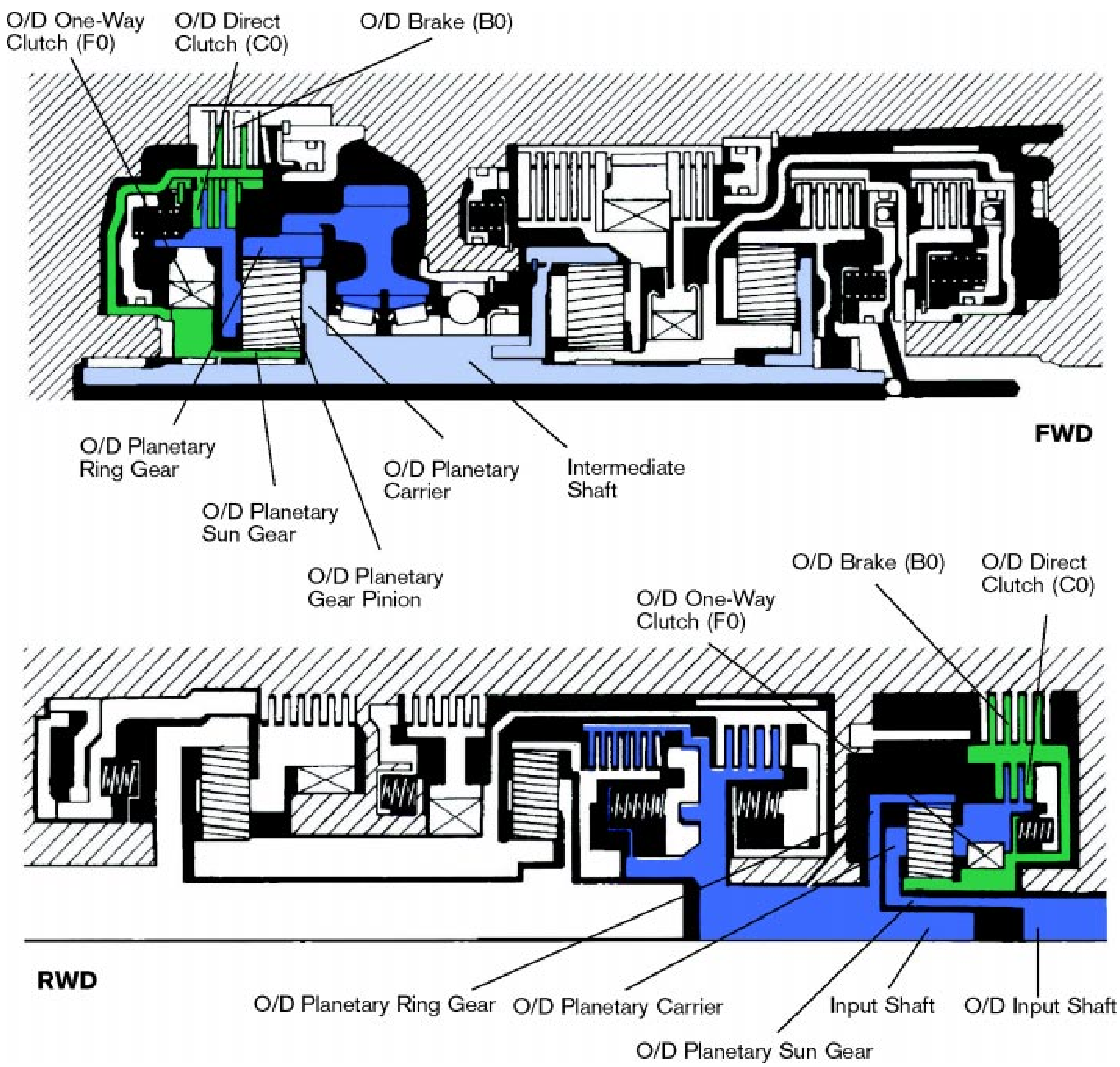


Fig. 1-30
T273f037

Four Speed Clutch Application Chart

The clutch application chart is similar to the one seen earlier while discussing 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 forward gears through third gear. In overdrive, the *overdrive brake* (B0) is applied and the *overdrive direct clutch* (C0) is released.

Four Speed Clutch Application Chart

Three additional holding devices are required for overdrive

Shift Lever Position	Gear Position	C0	C1	C2	B0	B1	B2	B3	F0	F1	F2
P	Park	■									
R	Reverse	■		■				■			
N	Neutral	■									
D	1st	■	■						■		■
	2nd	■	■				■		■	■	
	3rd	■	■	■			⊠		■		
	O/D		■	■	■		⊠				
2	1st	■	■						■		■
	2nd	■	■			■	■		■	■	
	3rd*	■	■	■			⊠		■		
L	1st	■	■					■	■		■
	2nd**	■	■			■	■		■	■	

* Does Not Apply to A-140L ** Downshift only - no upshift

⊠ Indicates that holding device is applied but not a funtion of the current gear position.

Fig. 1-31
T273f039

O/D Operation

Overdrive is designed to operate at vehicle speed above 25 mph in order to reduce the required engine speed when the vehicle is operating under a light load. 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 O/D unit is always clockwise. The direction of rotation in the rear-mounted O/D 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 O/D unit is placed in reverse, the *overdrive direct clutch* (C0) is the only unit holding the O/D unit in direct drive. For this reason, when the *overdrive direct clutch* fails, the vehicle will go forward but will not go in reverse and there is no engine braking in low or D2.

O/D Planetary Gear Unit

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

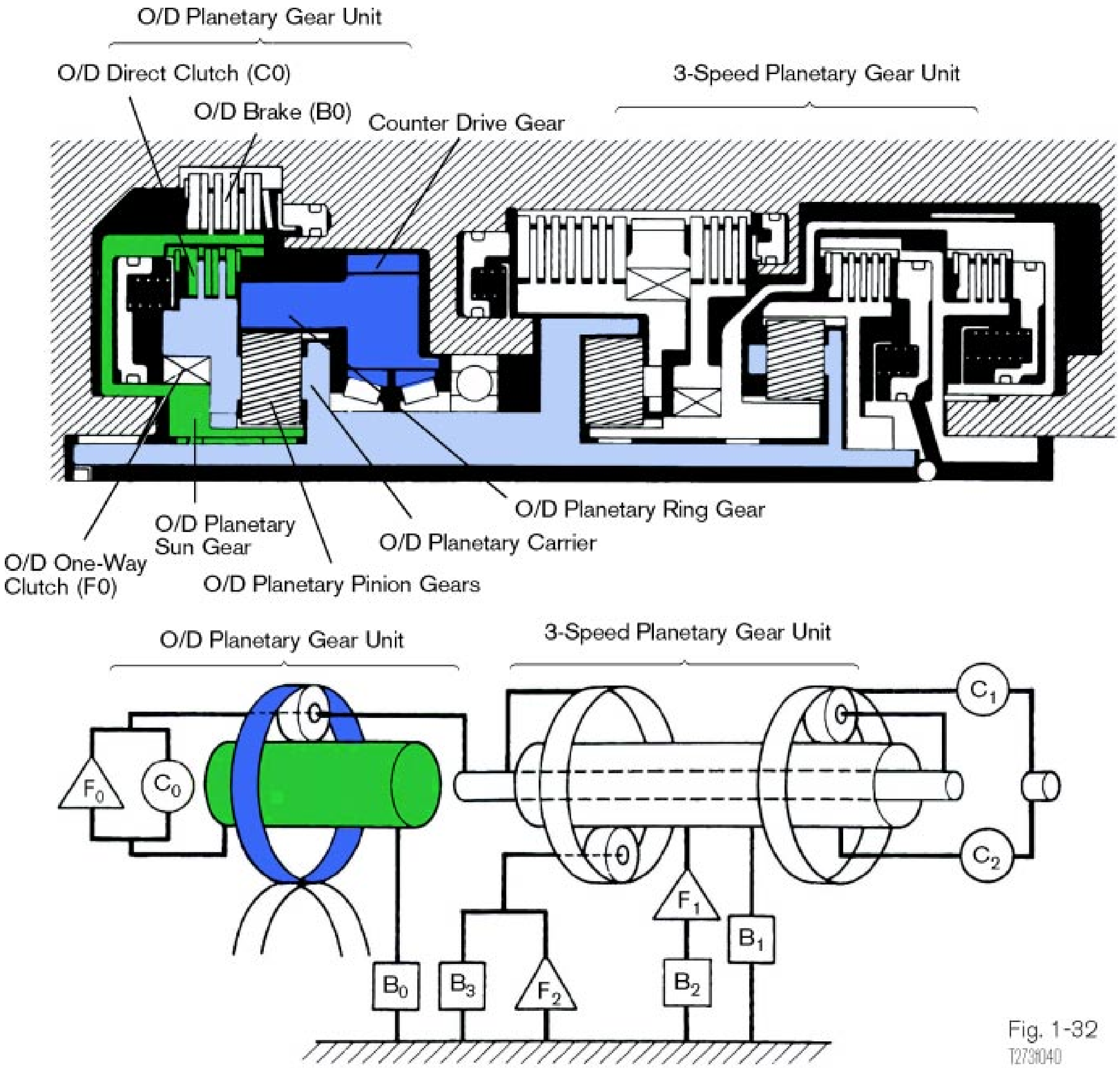


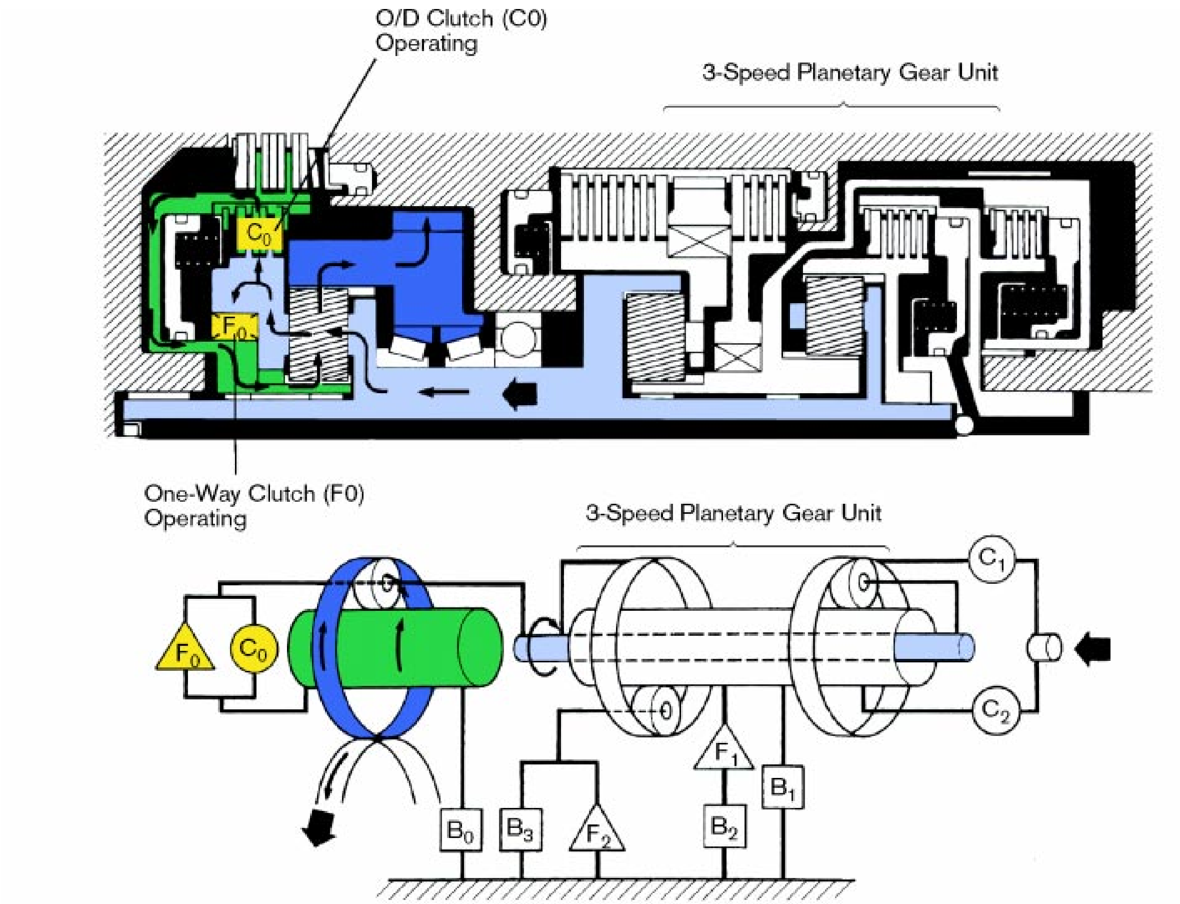
Fig. 1-32
T273f040

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 *overdrive direct clutch* (C0) and *overdrive 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 O/D assembly rotates as one unit.

Direct Drive

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



Shift Lever Position	Gear Position	C0	C1	C2	B0	B1	B2	B3	F0	F1	F2
D	1st	■	■						■		■
	2nd	■	■				■		■	■	
	3rd	■	■	■			⊠		■		
	O/D		■	■	■		⊠				

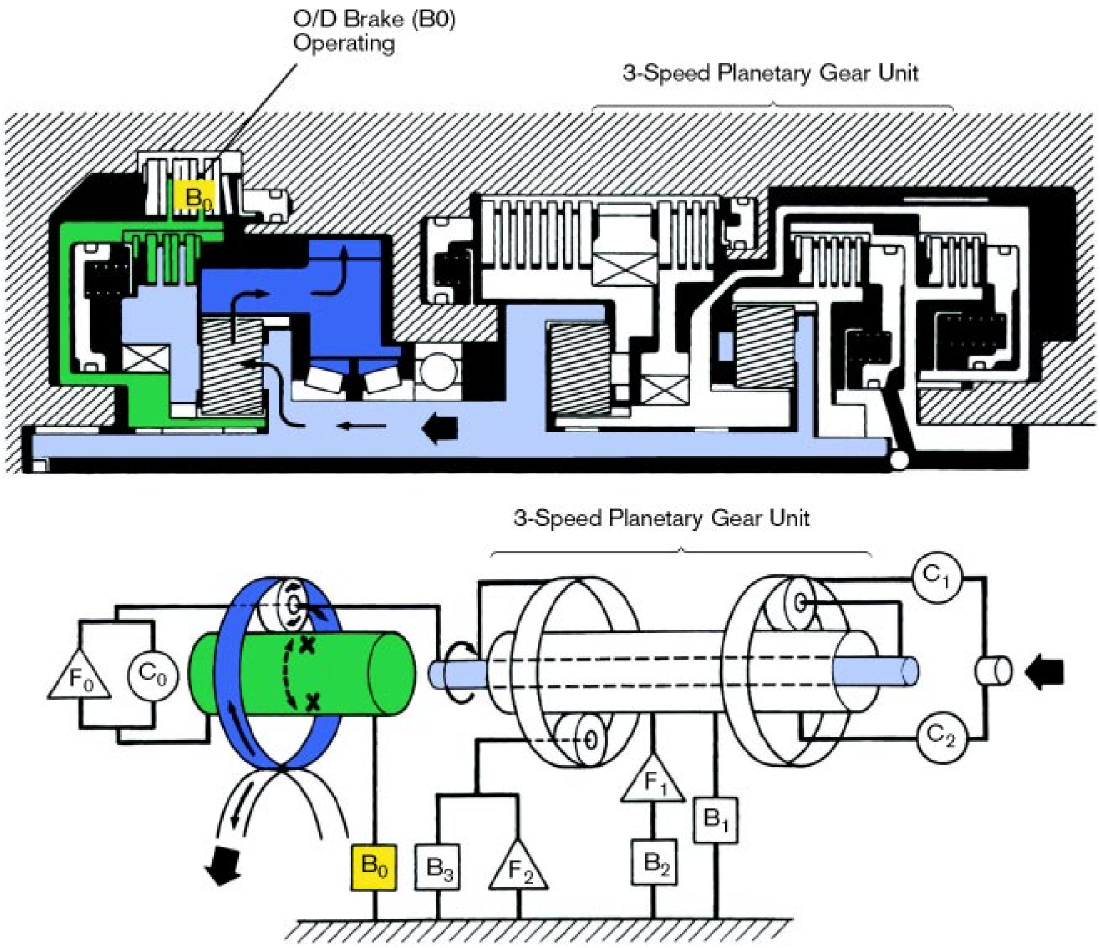
Fig. 1-33
T273f041/T273f042

Overdrive

In overdrive, the *overdrive brake* (B0) locks the O/D sun gear, so when the overdrive carrier rotates clockwise, the overdrive pinion gears revolve clockwise around the sun gear, carrying the overdrive ring gear clockwise at a speed faster than the overdrive carrier.

Overdrive

The overdrive ring gear rotates clockwise at a speed faster than the overdrive carrier.

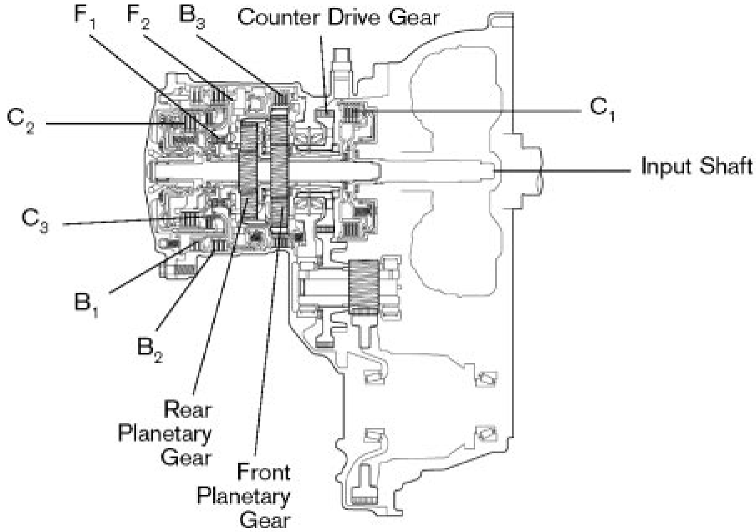


Shift Lever Position	Gear Position	C0	C1	C2	B0	B1	B2	B3	F0	F1	F2
D	1st	●	●						●		●
	2nd	●	●				●		●	●	
	3rd	●	●	●			⊠		●		
	O/D		●	●	●		⊠				

Fig. 1-34
T273f043/T273f044

Section 2

U-Series Transaxles



Lesson Objectives

1. Explain the unique difference between the U-series planetary gear set and the Simpson planetary gear set.
2. Describe the primary difference in power flow between the U-240 and U-341 transaxles.
3. Given the Clutch/Brake Designation Chart, differentiate the names for clutches based on the transmission model.
4. Given the Clutch Application Chart and the power flow model, identify the planetary gear components held for each gear range.

Notes

Transaxle Overview

The U-Series automatic transaxles are compact, lightweight, electronically controlled, four speed transmissions introduced in model year 2000 Echos and Celicas. The counter drive gear assembly is located in front of the planetary gear sets rather than behind them as in the earlier transaxle models which contributes to the compact, lightweight design.

The transmission's planetary gear design is a unique departure from the familiar Simpson planetary gear design used in all previous Toyota transmissions. The Simpson planetary gear design uses two planetary gear sets with a common single sun gear for first, second, third and reverse gears. The U-series departs from this design with two planetary gear sets with separate sun gears.

U-341E

The U-341E gets four forward gears and one reverse gear from this compact design. Additionally, ring gears and planetary carriers of the two planetaries are connected.

U-341E Planetary Gear Unit

The U-Series transaxles has two planetary gear sets and separate sun gears. Additionally, ring gears and planetary carriers of the two planetaries are connected.

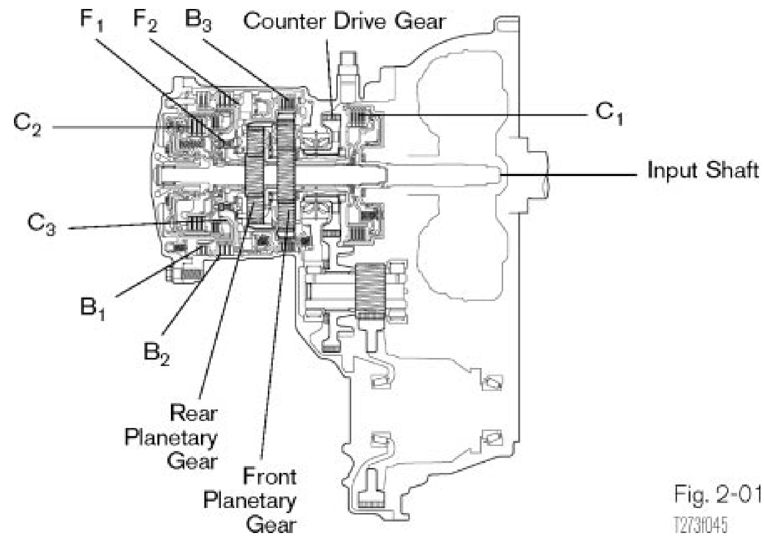


Fig. 2-01

The front planetary ring gear is connected to the rear planetary carrier. They are held to the case in the counterclockwise direction by the *No. 2 one-way clutch* (F2) and held in both directions by the *1st and reverse brake* (B3). The rear planetary carrier can be driven by the intermediate shaft through the *direct clutch* (C2)

The front planetary carrier is connected to the rear planetary ring gear. The carrier is also connected to the counter drive gear providing output torque. The rear sun gear is connected to the intermediate shaft through the *reverse clutch* (C3) or to the transmission case through the *O/D & 2nd brake* (B1) or *2nd brake* (B2) and *No. 1 one-way clutch* (F1).

U-341E Power Flow Model

The front planetary ring gear is connected to the rear planetary carrier. The front planetary carrier is connected to the rear planetary ring gear.

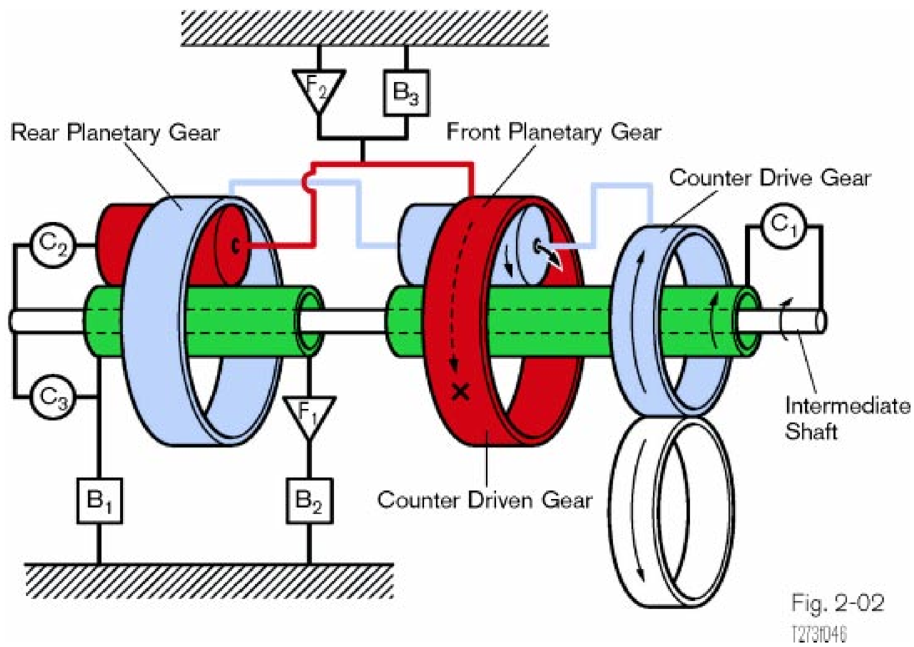


Fig. 2-02

U-240E

The U-240E has a similar planetary gear configuration to the U-341E which provides three forward gears and reverse gear. But similar to the A-240 transmission, it provides an additional planetary gear set on the counter shaft which operates in an underdrive mode until 4th gear, when it provides direct drive.

U-240E Planetary Gear Unit

The U-240E transaxle provides an additional planetary gear set on the counter shaft which operates in an underdrive mode

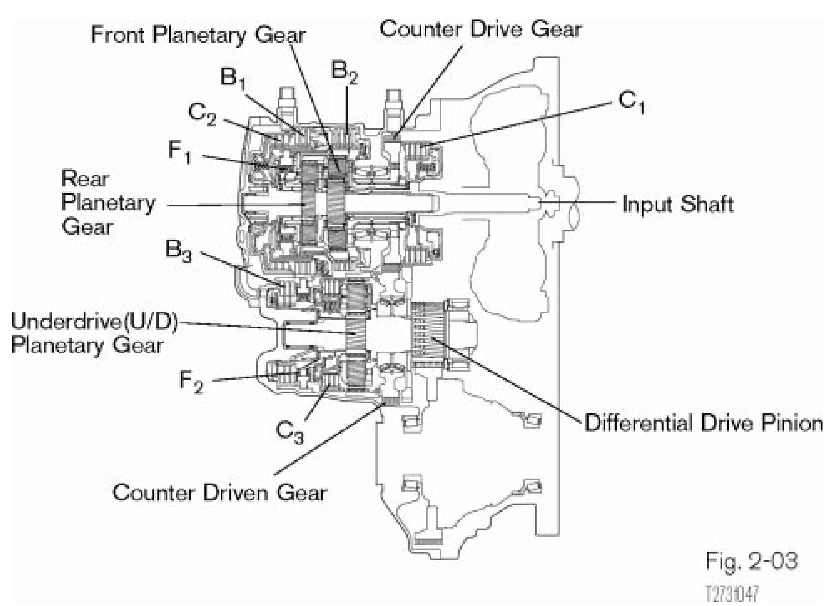


Fig. 2-03

The front planetary ring gear and the rear planetary carrier are held to the case in the counterclockwise direction by the *No. 1 one-way clutch* (F1) and held in both directions by the *1st and reverse brake* (B2). The rear sun gear can be driven by the intermediate shaft through the *direct clutch* (C2)

The front planetary carrier and the rear planetary ring gear are connected to the counter drive gear providing output torque. The rear sun gear is connected to the intermediate shaft through the *direct clutch* (C2) or to the transmission case through the *2nd brake* (B1).

U-240E Power Flow Model

The front planetary ring gear is connected to the rear planetary carrier. The front planetary carrier is connected to the rear planetary ring gear.

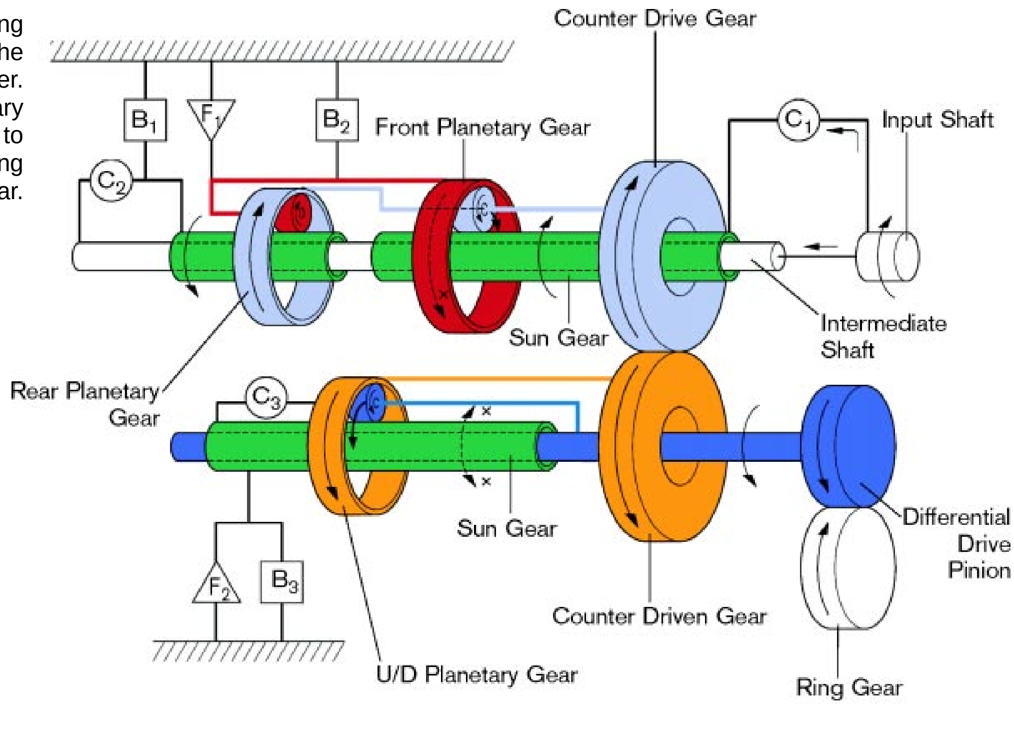


Fig. 2-04
T273f048

Clutch/Brake Designation

The alphanumeric clutch designations (i.e. C1, B1, F1, etc.) have shared a common identifying name and function throughout the transmission model lines for many years. However, the U-series transaxles changed the identifying name as indicated in the shaded boxes in the chart below. For example, B2 has been known as the *2nd brake*, but is called *1st and reverse brake* in the U-240E and *2nd brake* in the U-341E.

Clutch/Brake Designation

The shaded cells in the chart below indicate departures from the familiar designations.

	A-140, A-540, A-340, A-240	U-140, U-240	U-341
C0	O/D Direct Clutch		
C1	Forward Clutch	Forward Clutch	Forward Clutch
C2	Direct Clutch	Direct Clutch	Direct Clutch
C3	U/D Clutch (A-240)	U/D Direct Clutch	Reverse Clutch
B0	O/D Brake		
B1	2nd Coast Brake	2nd Brake	O/D and 2nd Brake
B2	2nd Brake	1st and Reverse Brake	2nd Brake
B3	1st and Reverse Brake	U/D Brake	1st and Reverse Brake
F0	O/D One-Way Clutch		
F1	No. 1 One-Way Clutch	No. 1 One-Way Clutch	No. 1 One-Way Clutch
F2	No. 2 One-Way Clutch	U/D One-Way Clutch	No. 2 One-Way Clutch
F3	U/D One-Way Clutch (A-240)		

Fig. 2-05
T273f049

Clutch/Brake Function

The clutches and brakes hold specific components of the planetary gear sets. The chart on the following page identifies the specific components for each of the U-series transmissions. Using this chart, the clutch application chart and the planetary gear model will assist you in understanding power flow through the transaxles.

Clutch Application Charts

Although the U-240 and the U-341 planetary gear configuration is similar, control of planetary components by the holding devices is different as reflected by the clutch application charts. As stated earlier, the clutch application charts and the planetary gear models are your key to diagnosis and pinpointing the problem component.

Clutch/Brake Function

The chart identifies the specific components that each holding device connects to for each of the U-series transmissions.

	Clutch Name (U-240/U-341)	U-240	U-341
C1	Forward Clutch	Connects input shaft and front planetary sun gear.	Connects intermediate shaft and front sun gear.
C2	Direct Clutch	Connects intermediate shaft and rear planetary sun gear.	Connects intermediate shaft and rear planetary carrier.
C3	U/D Direct Clutch/Reverse Clutch	Connects U/D sun gear and U/D planetary carrier.	Connects intermediate shaft and rear sungear.
B1	2nd Brake/O/D & 2nd Brake	Prevents rear planetary sun gear from turning either clockwise or counterclockwise.	Prevents rear planetary sun gear from turning either clockwise or counterclockwise.
B2	1st and Reverse Brake/2nd Brake	Prevents rear planetary carrier and front planetary ring gear from turning either clockwise or counterclockwise.	Prevents outer race of F1 from turning either clockwise or counterclockwise thus preventing the rear sun gear turning counter- clockwise.
B3	U/D Brake/1st and Reverse Brake	Prevents U/D sun gear from turning either clockwise or counterclockwise.	Prevents rear planetary carrier and front planetary ring gear from turning either clockwise or counterclockwise.
F1	No. 1 One-Way Clutch	Prevents rear planetary carrier and front ring gear from turning counterclockwise.	When B2 is operating, this clutch prevents rear sun gear from turning counterclockwise.
F2	U/D One-Way Clutch/No. 2 One-Way Clutch	Prevents U/D planetary sun gear from turning clockwise.	Prevents rear planetary carrier and front planetary ring gear from turning counterclockwise.

Fig. 2-06
T273f050

U-Series Clutch Application Charts

Control of planetary components by the holding devices differs as reflected by these clutch application charts.

U-240 Shift Lever Position	Gear Position	C1	C2	C3	B1	B2	B3	F1	F2
P	Park						■		
R	Reverse		■			■	■		
N	Neutral						■		
D	1st	■					■	■	■
	2nd	■			■		■		■
	3rd	■	■				■		■
	O/D	■	■	■					
2	1st	■					■	■	■
	2nd	■			■		■		■
L	1st	■				■	■	■	■

U-341 Shift Lever Position	Gear Position	C1	C2	C3	B1	B2	B3	F1	F2
P	Park								
R	Reverse			■			■		
N	Neutral								
D	1st	■							■
	2nd	■				■		■	
	3rd	■	■			■			
	O/D		■		■	■			
2	1st	■							■
	2nd	■			■	■		■	
L	1st	■					■		■

Fig. 2-07
T2731051/T2731052

U-341E Transaxle

The U-341E transaxle power flow will introduce you to the U-series planetary gear operation.

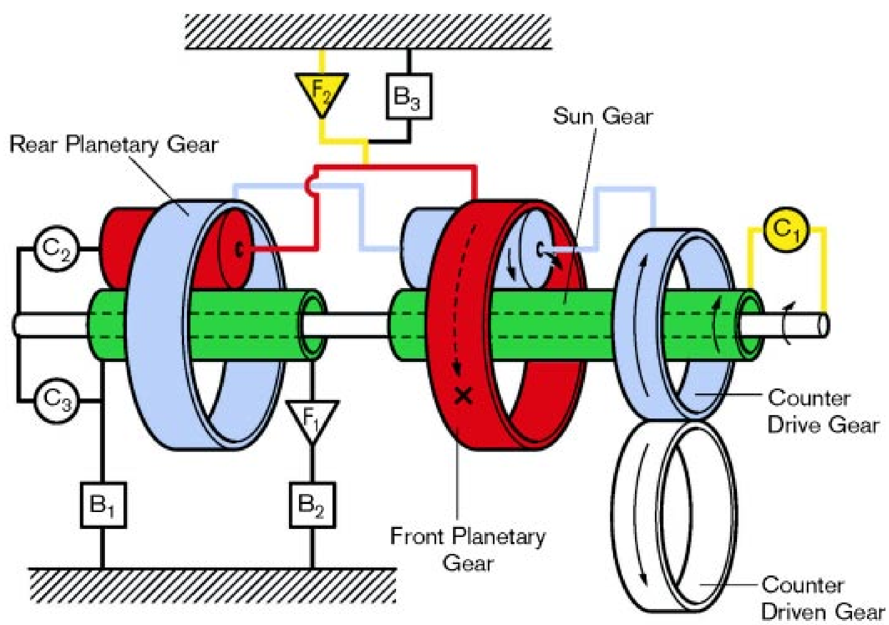
D-Range First Gear

First gear uses the front planetary gear set only. The *forward clutch* (C1) is applied in all forward gears except overdrive. It connects the intermediate shaft to the front planetary sun gear. The *No. 2 one-way clutch* (F2) prevents the front planetary ring gear from rotating counterclockwise by holding it to the transmission case. When the ring gear is held and the sun gear is driven, it causes the planetary gears to rotate at a reduced speed in the same direction as the sun gear. The front planetary carrier is connected to the counter drive gear which drives the differential ring gear through the counter driven gear.

To provide engine braking on deceleration, the *1st and reverse brake* (B3) is applied when the gear selector is placed in the L position. B3 is a parallel holding device to F2 and prevents the planetary carrier from turning either clockwise or counterclockwise . So if slippage occurs in drive first gear, but holds in low, F2 is likely slipping.

U-341E First Gear Power Flow

The forward clutch (C1) is applied in all forward gears except overdrive and connects the intermediate shaft to the front planetary sun gear.



U-341 Shift Lever Position	Gear Position	C1	C2	C3	B1	B2	B3	F1	F2
N	Neutral								
D	1st	■							■
	2nd	■				■		■	
L	1st	■					■		■

Fig. 2-08
T273f053/T273f054

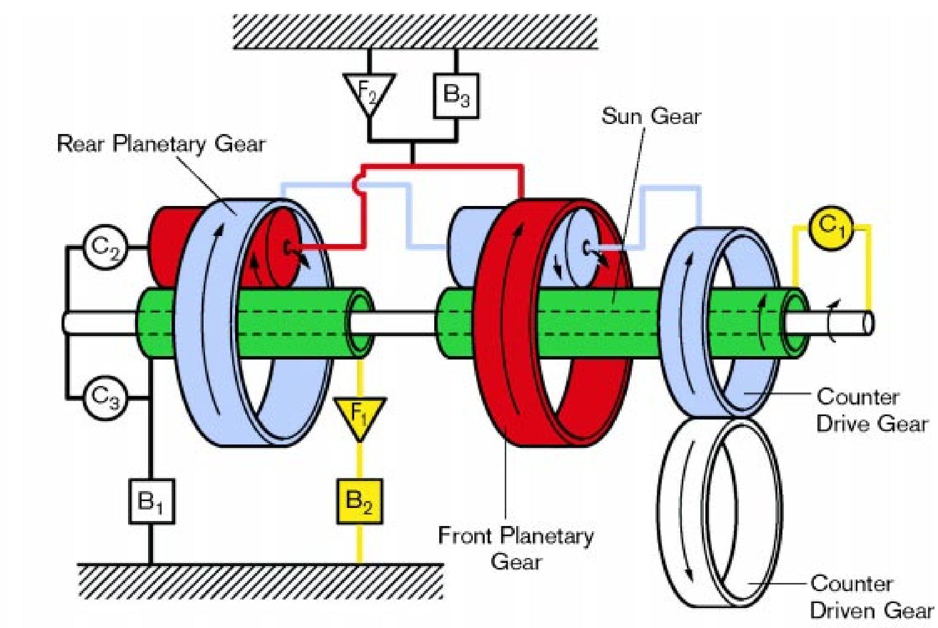
D-Range Second Gear

Second gear uses both the front and rear planetary gear sets. Since second gear builds on first gear, it will help to check out the dynamics of the rear planetary gear set in first gear. In first gear the front sun gear drives the planetary gears against a stationary ring gear, causing the planetary carrier to drive the counter drive gear. The front planetary carrier is connected to the rear ring gear causing the planetary gears to rotate and drive the sun gear, but since it is not held or connected to another member, it idles.

When second brake is applied for second gear, the rear sun gear (which had been idling) is held, causing the rear planetary carrier, driven by the rear ring gear, to drive the front ring gear. As the front ring gear is driven clockwise, the front planetary carrier rotates at a faster speed than first gear.

U-341E Second Gear Power Flow

When B2 is applied for second gear, the rear sun gear (which had been idling) is held, causing the rear planetary carrier, driven by the rear ring gear, to drive the front ring gear. The front planetary carrier, rotates at a faster speed than first gear.



U-341 Shift Lever Position	Gear Position	C1	C2	C3	B1	B2	B3	F1	F2
D	1st								
	2nd								
2	2nd								

Fig. 2-09
T2731055/T2731056

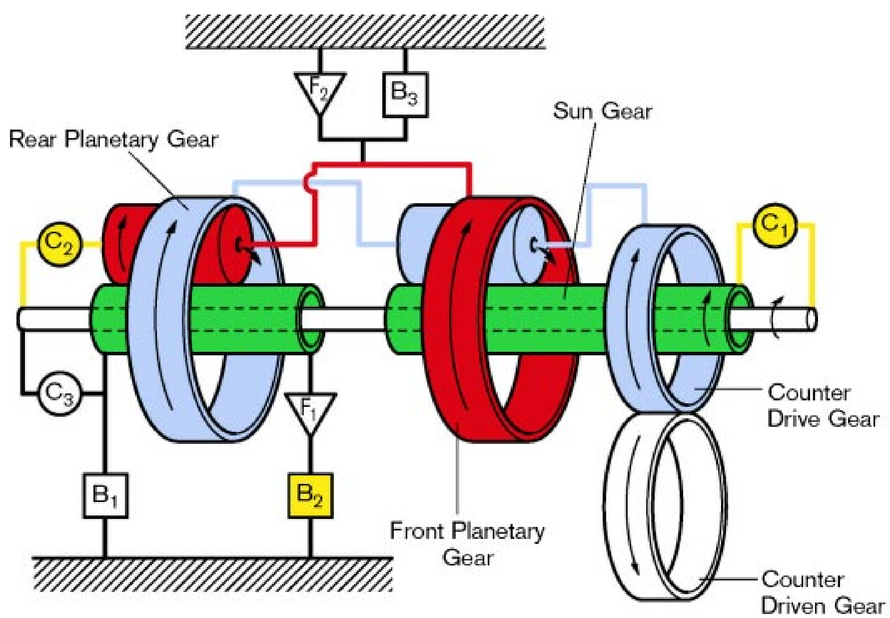
To provide engine braking on deceleration, the *overdrive and 2nd brake* (B1) is applied when the gear selector is placed in the 2-range position. B1 is a parallel holding device to F1 and B2 and prevents the planetary carrier from turning either clockwise or counterclockwise. So if slippage occurs or the transmission remains in first gear in an automatic upshift to second gear, but holds in 2-range, F1 or B2 is likely slipping.

D-Range Third Gear

Third gear uses both the front and rear planetary gear sets to provide a direct drive. The *forward clutch* (C1) is connected to the front planetary sun gear and intermediate shaft. When the upshift to third gear occurs, the *direct clutch* (C2) is applied, connecting the intermediate shaft to the rear planetary carrier. Both planetary gear sets rotate as a unit driving the counter drive gear. The *No. 1 one-way clutch* (F1) releases the rear sun gear as the unit begins to rotate.

U-341E Third Gear Power Flow

When the upshift to third gear occurs, the direct clutch (C2) is applied connecting the intermediate shaft to the rear planetary carrier.



U-341 Shift Lever Position	Gear Position	C1	C2	C3	B1	B2	B3	F1	F2
D	2nd	■				■		■	
	3rd	■	■			X			

Fig. 2-10
T273f057/T273f058

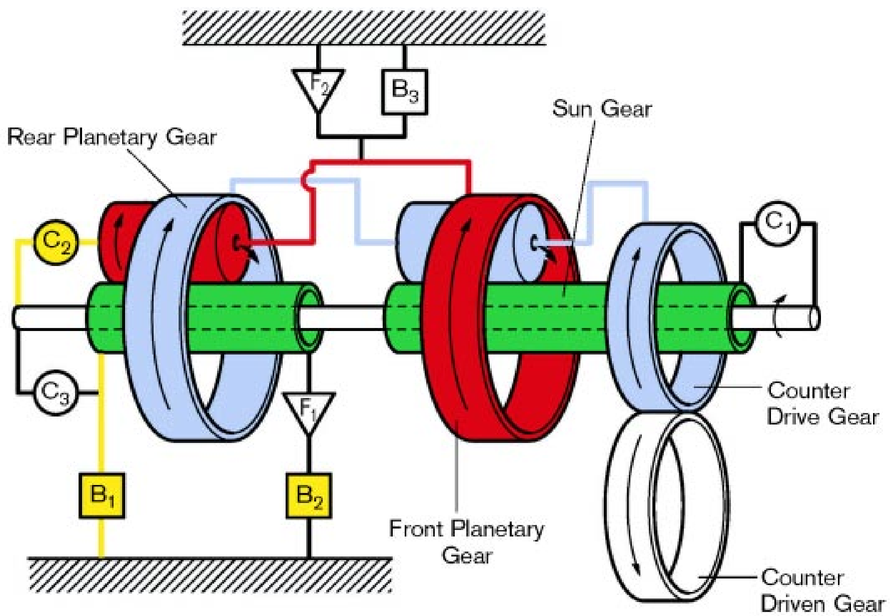
D-Range Fourth Gear

Fourth gear uses the rear planetary gear set only. The *overdrive and 2nd brake* (B1) is applied as the *forward clutch* (C1) is released. When C1 releases, the front sun gear is released but the *direct clutch* (C2) continues to connect the intermediate shaft and the rear planetary carrier. The *overdrive and 2nd brake* (B1) holds the rear sun gear to the transmission case. The planetary carrier causes the pinions to walk around the sun gear and causes the rear ring gear to turn at an overdrive speed. The rear ring gear is attached to the front planetary carrier and drives the counter drive gear.

Since B1 holds the rear sun gear from rotating clockwise or counterclockwise, this gear position should also have engine braking on deceleration. If B1 slips, allowing the rear sun gear to rotate clockwise, the carrier would not drive the ring gear and engine speed will flare.

U-341E Fourth Gear Power Flow

When fourth gear is applied the overdrive and 2nd brake (B1) is applied as the forward clutch (C1) is released.



U-341 Shift Lever Position	Gear Position	C1	C2	C3	B1	B2	B3	F1	F2
D	3rd								
	O/D								

Fig. 2-11
T2731059/T2731060

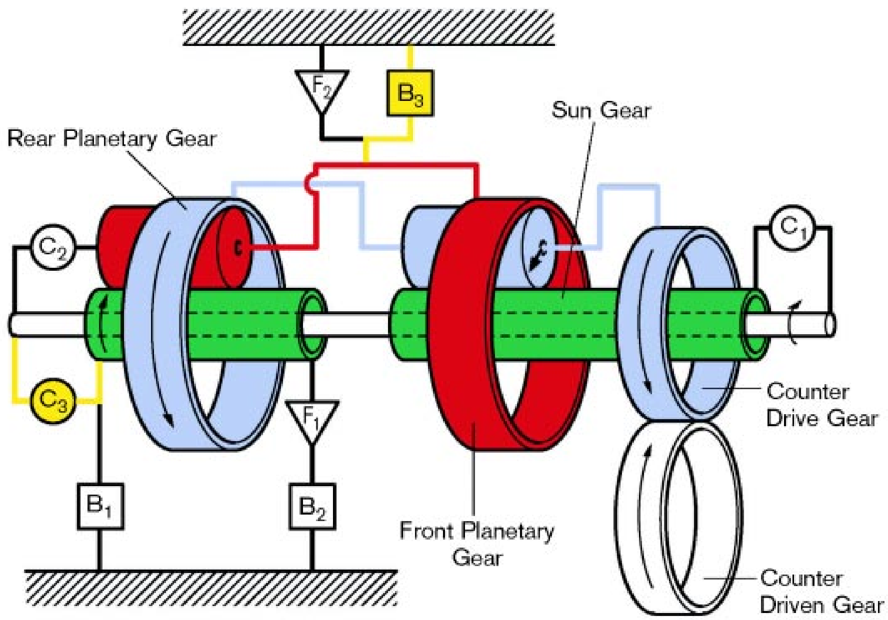
Reverse Gear

Reverse gear uses the rear planetary gear set only. The *1st and reverse brake* (B3) connects the rear planetary carrier to the transmission case. The *reverse clutch* (C3) connects the intermediate shaft to the rear sun gear. With the input torque delivered to the sun gear and the planetary carrier being held stationary, the planetary gears change the direction of input torque and drives the ring gear in the opposite direction of the sun gear. The rear ring gear connects to the front planetary carrier and drives the counter drive gear.

Since C3 is applied in reverse only, if slippage occurs, placing the transmission in low gear to apply B3. If no slippage occurs while decelerating in low, C3 is faulty.

U-341E Reverse Gear Power Flow

The 1st and reverse brake (B3) connects the rear planetary carrier to the case while the reverse clutch (C3) connects the intermediate shaft to the rear sun gear.



U-341 Shift Lever Position	Gear Position	C1	C2	C3	B1	B2	B3	F1	F2
P	Park								
R	Reverse			■			■		
N	Neutral								

Fig. 2-12
T2731061/T2731062

U-240E Transaxle

The U-240E uses the same basic planetary gear design as the U-341E, however, holding devices are different and fourth gear or overdrive is accomplished through a third planetary gear set. The third planetary gear set operates in an underdrive mode until fourth gear, when it operates as a direct drive.

The following section will deal with the power flow, identifying holding devices, component operation and diagnosing certain holding device operations. Since the third planetary gear set operates in underdrive in first, second, third, and reverse it will be covered in first gear only.

D-Range First Gear

First gear uses the front planetary gear only. The *forward clutch* (C1) is applied in all forward gears including overdrive. It connects the intermediate shaft to the front planetary sun gear. The *No. 1 one-way clutch* (F1) prevents the front planetary ring gear from rotating counterclockwise. When the ring gear is held and the sun gear is driven, it causes the planetary carrier to rotate at a reduced speed in the same direction as the sun gear. The planetary carrier is connected to the counter drive gear which provides turning torque to the underdrive planetary gear set.

Underdrive Operation

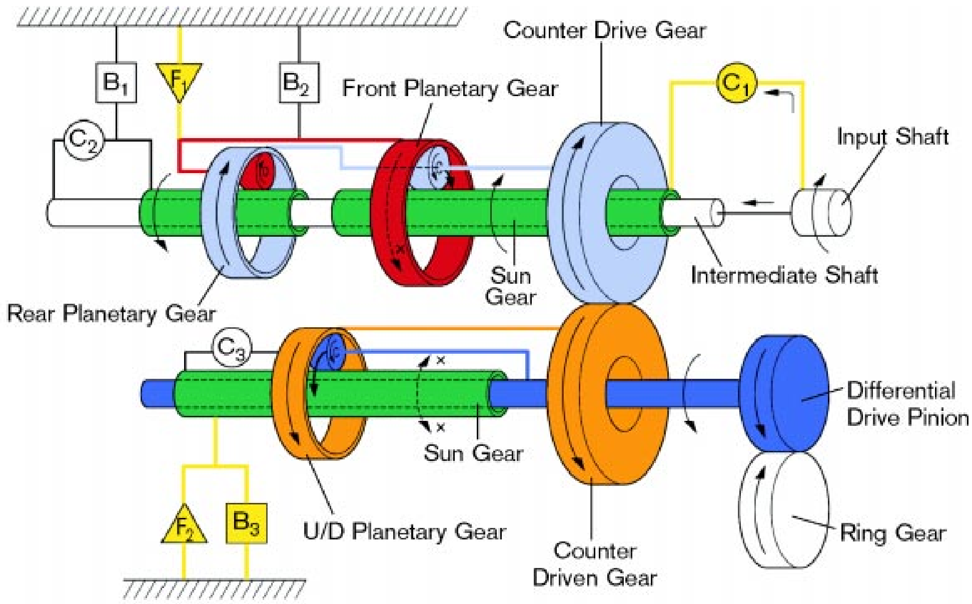
The ring gear of the underdrive planetary gear set receives input torque from the counter driven gear. The output shaft is connected to the planetary carrier and drives the differential drive pinion and ring gear. In first, second, and third gear the *underdrive brake* (B3) and the *underdrive one-way clutch* (F2) hold the sun gear to the transmission case. With the sun gear held, and the ring gear driven, the planetary carrier rotates at a lower speed than the ring gear.

Low Range First Gear

To provide engine braking on deceleration, the *1st and reverse brake* (B2) is applied when the gear selector is placed in the L position. B2 is a parallel holding device to F1 and prevents the planetary carrier from turning either clockwise or counterclockwise. If slippage occurs in drive first gear, but holds in low, F1 is likely slipping. If slippage occurs in reverse, check for engine braking in low to verify if B2 is functioning properly.

U-240E First Gear Power Flow

When the front ring gear is held and the sun gear is driven, it causes the planetary gear to rotate at a reduced speed in the same direction as the sun gear.



U-240 Shift Lever Position	Gear Position	C1	C2	C3	B1	B2	B3	F1	F2
N	Neutral						■		
D	1st	■					■	■	■
L	1st	■				■	■	■	■

Fig. 2-13
T2731063/T2731064

D-Range Second Gear

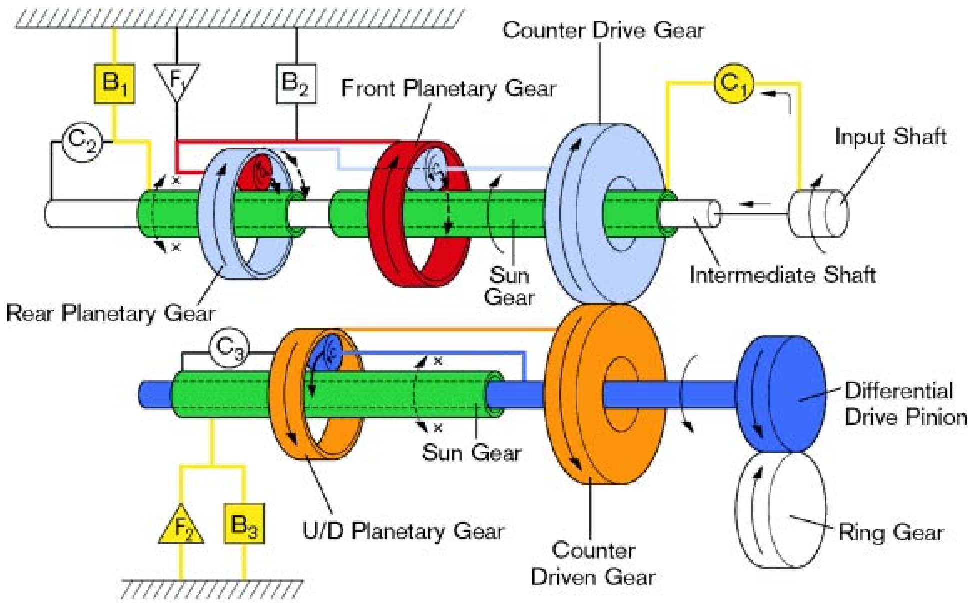
Second gear uses both the front and rear planetary gear sets. Since second gear builds on first gear, it will help to check out the dynamics of the rear planetary gear set in first gear. In first gear the front sun gear drives the front planetary gears against a stationary front ring gear, causing the planetary carrier to drive the counter drive gear. The front planetary carrier is connected to the rear ring gear causing the rear planetary gears to rotate and drive the rear sun gear. Since the sun gear is not held or connected to another member, it idles.

When the *2nd brake* (B1) is applied for second gear, the rear sun gear is held causing the rear planetary carrier, driven by the rear ring gear, to drive the front ring gear. As the front ring gear is driven clockwise, the front planetary carrier rotates at a faster speed than first gear. The underdrive planetary gear set remains in underdrive just like first gear.

Engine braking on deceleration is accomplished whenever B1 is applied as it holds the sun gear directly and prevents it from turning either clockwise or counterclockwise. If slippage occurs or the transmission remains in first gear in an automatic upshift to second gear, B1 is likely slipping.

U-240E Second Gear Power Flow

When B1 is applied for second gear, the rear sun gear (which had been idling) is held, causing the rear planetary carrier, driven by the rear ring gear, to drive the front ring gear. The front planetary carrier rotates at a faster speed than first gear.



U-240 Shift Lever Position	Gear Position	C1	C2	C3	B1	B2	B3	F1	F2
N	Neutral						■		
D	1st	■					■	■	■
	2nd	■			■		■		■
2	1st	■					■	■	■
	2nd	■			■		■		■

Fig. 2-14
T273f065/T273f066

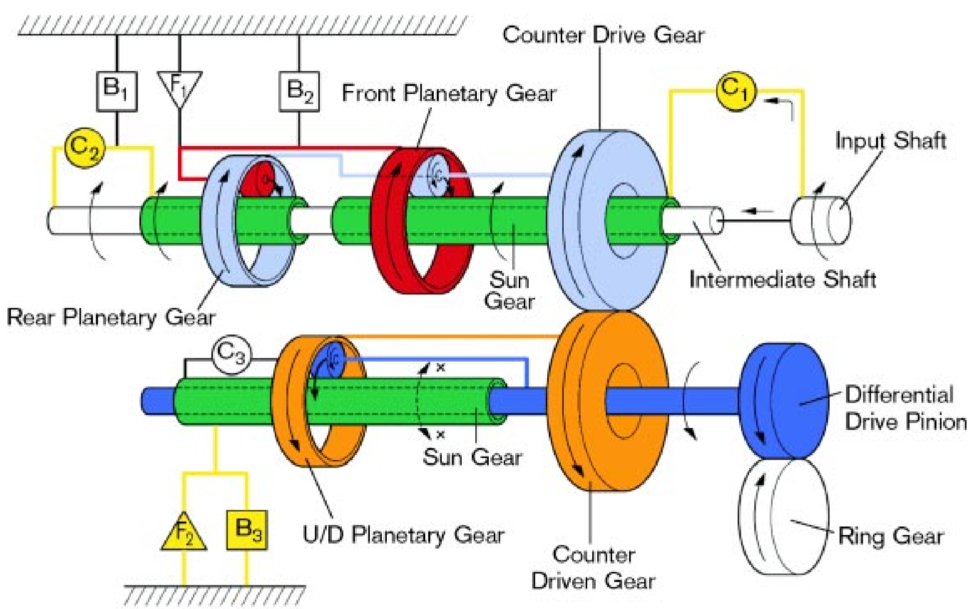
D-Range Third Gear

Third gear uses both the front and rear planetary gear sets to provide a direct drive. The *forward clutch* (C1) is connected to the front planetary sun gear and input shaft. When the upshift to third gear occurs, the *2nd brake* (B1) releases as the *direct clutch* (C2) is applied connecting the intermediate shaft to the rear sun gear. Because the two planetary gear sets are connected through the planetary carriers and ring gears, both planetary gear sets rotate as a unit driving the counter drive gear. The underdrive planetary gear set remains in underdrive just like first and second gears.

B1 is applied during second gear and is released when the upshift to third gear occurs. Because B1 releases, the transmission does not remain in second if C2 does not apply. Instead, slippage and engine flare will occur if C2 fails.

U-240E Third Gear Power Flow

When the upshift to third gear occurs, the 2nd brake (B1) releases as the direct clutch (C2) is applied connecting the intermediate shaft to the rear sun gear.



U-240 Shift Lever Position	Gear Position	C1	C2	C3	B1	B2	B3	F1	F2
D	2nd	■			■		■		■
	3rd	■	■				■		■

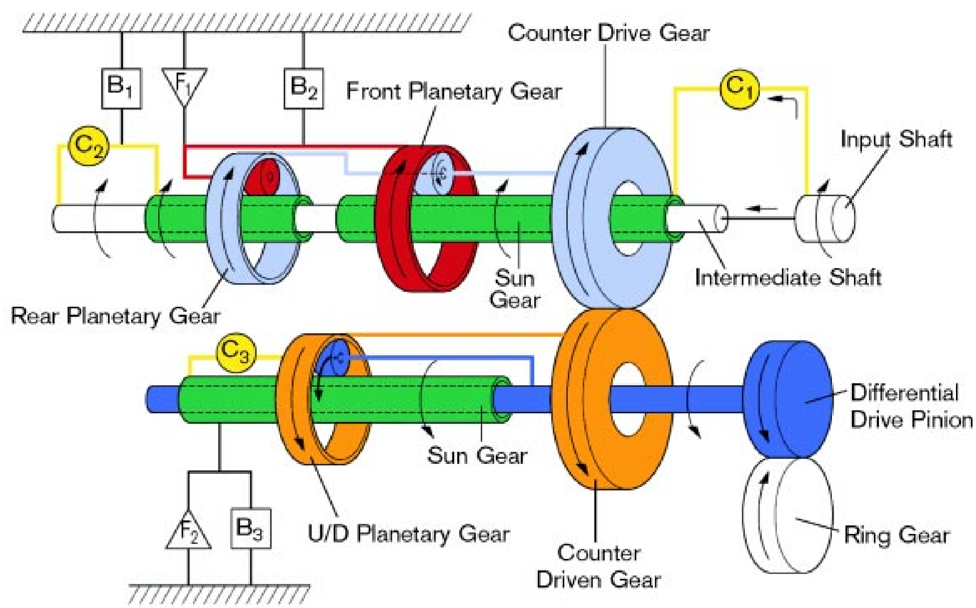
Fig. 2-15
T273f067/T273f068

D-Range Fourth Gear

The upshift from third gear to fourth gear occurs in the underdrive unit which operates in underdrive in all gears except fourth. The upshift occurs when the underdrive unit shifts into direct drive. In fourth gear the *forward clutch* (C1) connects the front planetary sun gear and intermediate shaft. The *direct clutch* (C2) is applied, connecting the intermediate shaft to the rear sun gear and both planetary gear sets rotate as a unit driving the counter drive gear. The counter driven gear drives the underdrive planetary ring gear. When the upshift occurs, the *underdrive brake* (B3) releases the sun gear as the *underdrive clutch* (C3) applies connecting the sun gear to the planetary carrier. When two components of a planetary gear set are connected, the result is direct drive.

U-240E Fourth Gear Power Flow

The upshift to fourth occurs when the underdrive unit shifts into direct drive.



U-240 Shift Lever Position	Gear Position	C1	C2	C3	B1	B2	B3	F1	F2
	3rd	■	■				■		■
	O/D	■	■	■					

Fig. 2-16
T2731069/T2731070

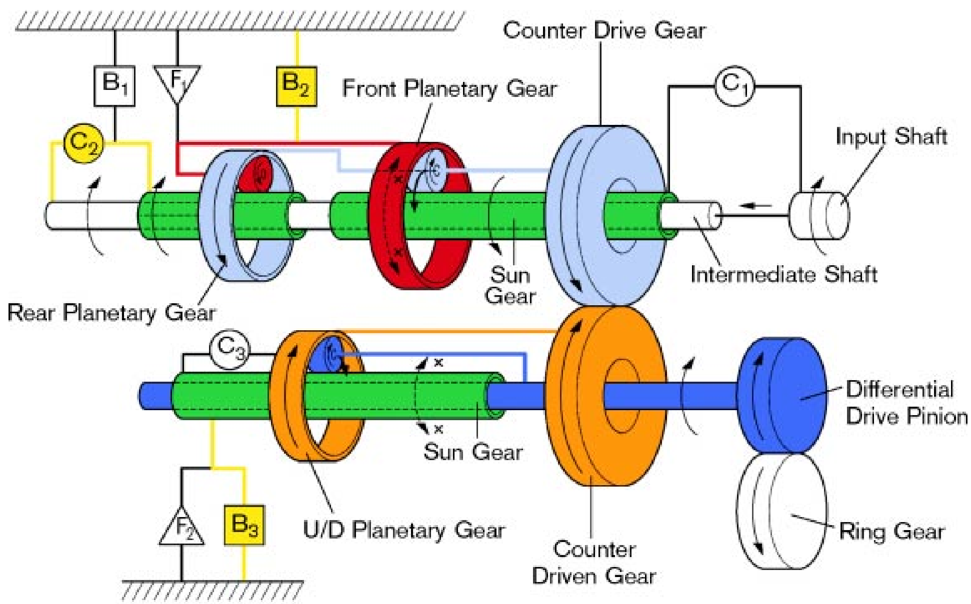
Reverse Gear

Reverse gear uses the rear planetary gear set only. The *1st and reverse brake* (B2) connects the rear planetary carrier to the transmission case. The *direct clutch* (C2) connects the intermediate shaft to the rear sun gear. With the input torque delivered to the sun gear and the planetary carrier being held stationary, the planetary gears change the direction of input torque and drives the ring gear in the opposite direction of the sun gear. The rear ring gear connects to the front planetary carrier and drives the counter drive gear.

If slippage occurs in reverse, place the transmission in low gear to apply B2. If no slippage occurs while decelerating in low, C2 is likely at fault. Although C2 is applied in 3rd and O/D, slippage is less likely to be detected as the vehicle is in motion when the upshifts occur. In reverse, the engine must overcome the inertia of a vehicle at rest with a high amount of torque. If slippage occurs in reverse and there is no engine braking in low, B3 is the likely fault.

U-240E Reverse Gear Power Flow

The 1st and reverse brake (B2) connects the rear planetary carrier to the case. The direct clutch (C2) connects the intermediate shaft to the rear sun gear driving the ring gear in the opposite direction.



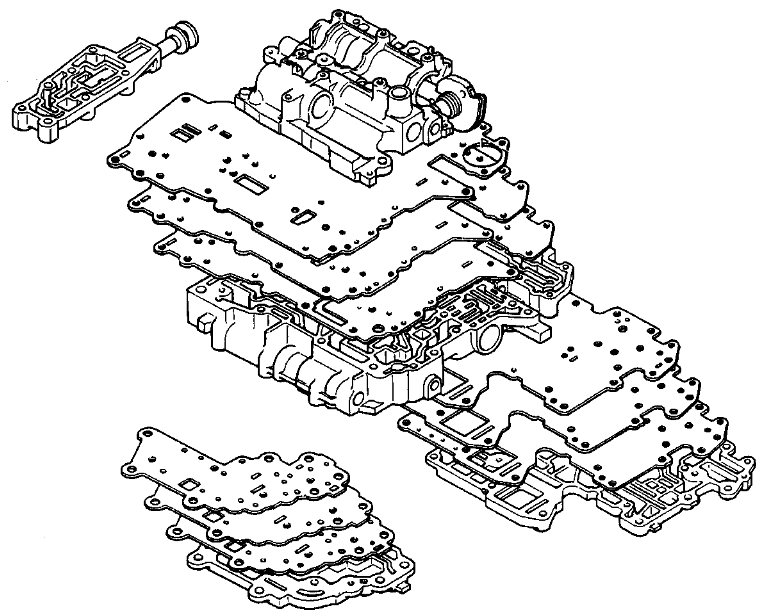
U-240 Shift Lever Position	Gear Position	C1	C2	C3	B1	B2	B3	F1	F2
P	Park								
R	Reverse								
N	Neutral								

Fig. 2-17
T273f071/T273f072

Notes

Section 3

Valve Body Circuits



Lesson Objectives

1. Describe the function of pressure control valves.
2. Describe the function of shift control valves.
3. Describe the function of timing (sequential) valves.
4. Describe the function of pressure modulating valves.
5. Explain the effect that throttle pressure and governor pressure have on the shift valves and clutch application.

Notes

Valve Body Introduction

The valve body consists of an upper valve body, a lower valve body, a manual valve body and various covers. The body halves are separated by a separator plate which contains openings that control the flow of fluid between valve circuits. The valves 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 their bore in the body, and their position in the bore 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

Valve Body

The body halves are separated by a separator plate which contains openings that control the flow of fluid between valve circuits.

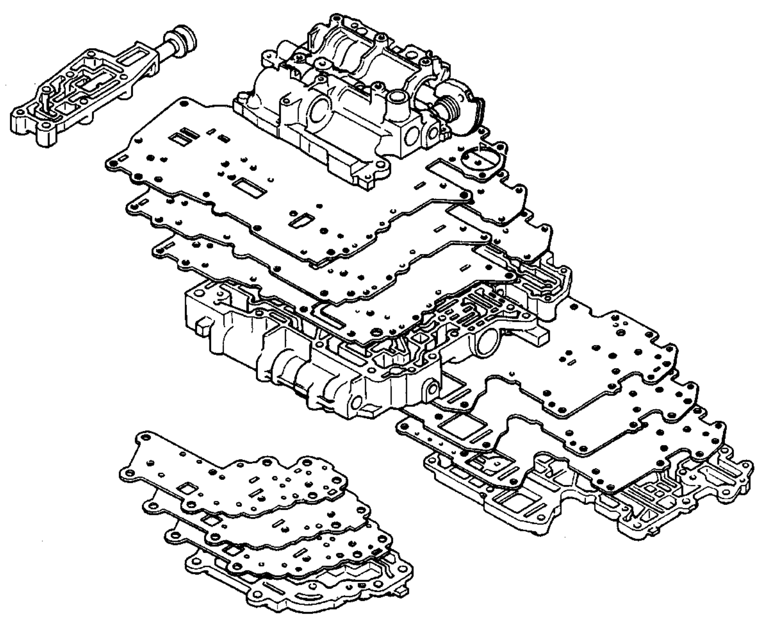


Fig. 3-01
T273f073

Pressure Control Valves

Pressure control valves regulate hydraulic pressure within the transmission. Hydraulic pressure is required to lubricate and remove heat from the fluid. Pressure is also 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 not. 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. Additional load on the engine affects fuel economy, 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. High pressure causes hard shifting and creates more heat reducing fluid life. By reducing pressure, less power is required to rotate the pump and less heat is generated.

Pressure has a direct effect on the holding force of clutches and brakes. It should be higher when accelerating the vehicle and lower as the vehicle picks up speed.

The output of the valve is called “line pressure,” the highest oil pressure in the transmission. Line pressure is shown in the color red in Toyota publications. It is used to apply most clutches and brakes.

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.

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 from the oil pump. This is why adjustment of the throttle cable results in a change in shift feel due to the change in line pressure.

Primary Regulator Valve

The position of the primary regulator valve is determined by throttle pressure, line pressure and spring tension.

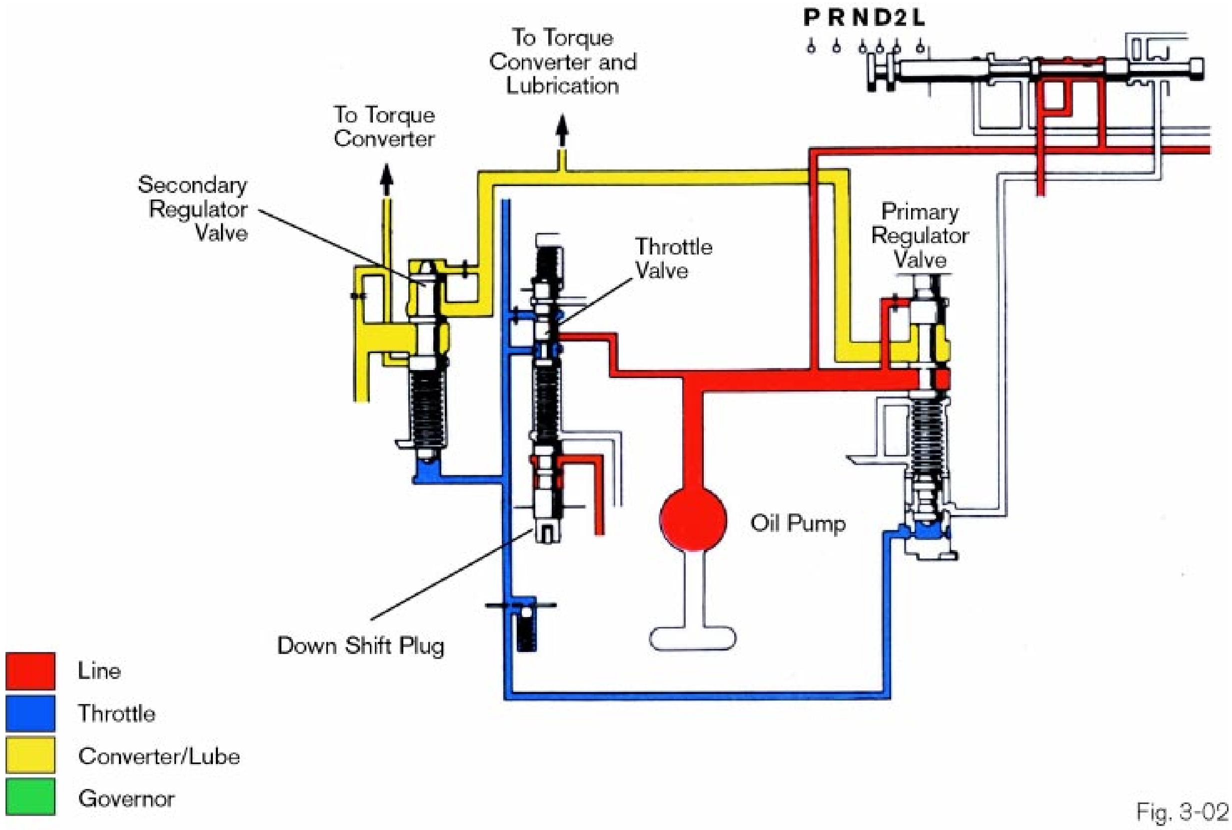


Fig. 3-02
T273f074

Primary Regulator Valve In R-Range

Line pressure from the manual valve is directed to the bottom of the valve, increasing line pressure in reverse.

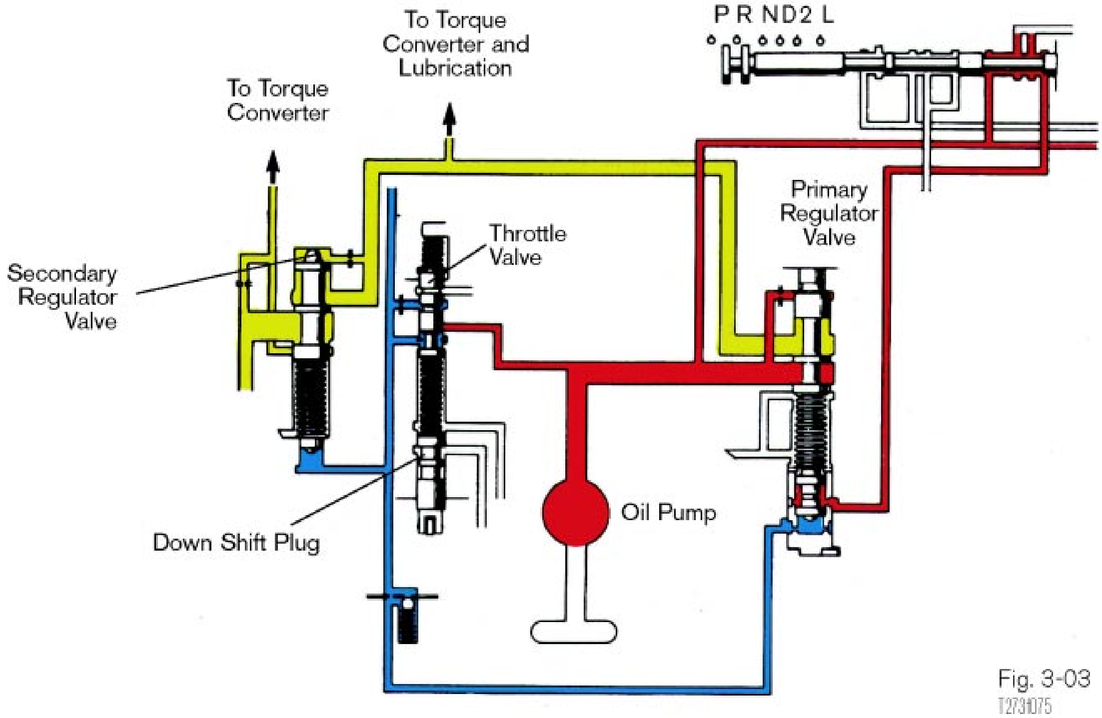


Fig. 3-03

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%.

Secondary Regulator Valve

This valve regulates pressure to the torque converter and lubrication pressure. Spring tension pushes the valve upward to increase converter pressure. Converter pressure acts on the top of the valve to create a balance between it and spring tension. In some applications throttle pressure is used to assist the spring in increasing converter pressure. Increased secondary regulator pressure provides for a firmer application of the lock-up clutch under higher torque conditions.

Secondary regulator pressure, cooler and lubrication circuits are shown in yellow in Toyota publications.

Oil Cooler Bypass 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 cooler in the tank of the radiator and back to the sump of the transmission. The valve is spring loaded in the closed position and opens when pressure exceeds the spring rate.

Oil Cooler Bypass

The valve is spring loaded in the closed position and opens when pressure exceeds the spring rate.

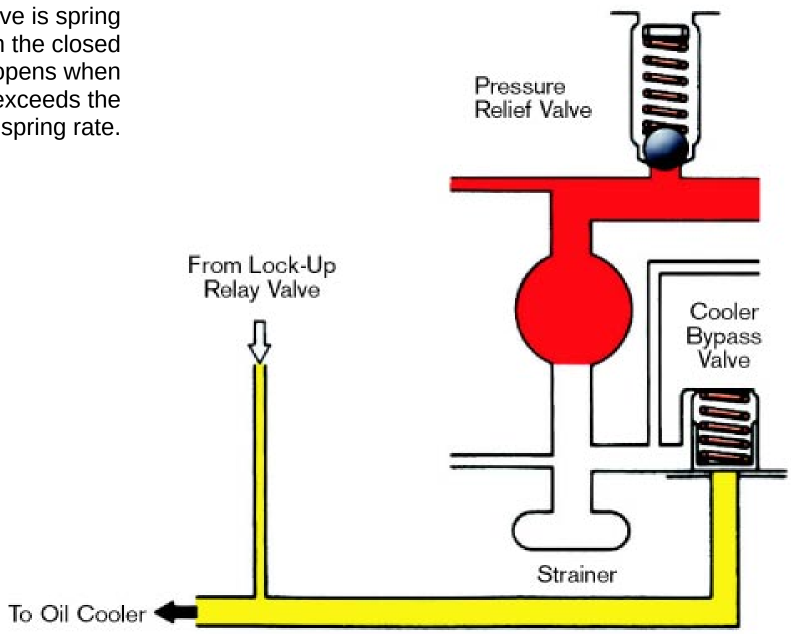


Fig. 3-04
T273f076

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.

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.

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 port. Centrifugal force does not begin to push the valve down until approximately 10 mph.

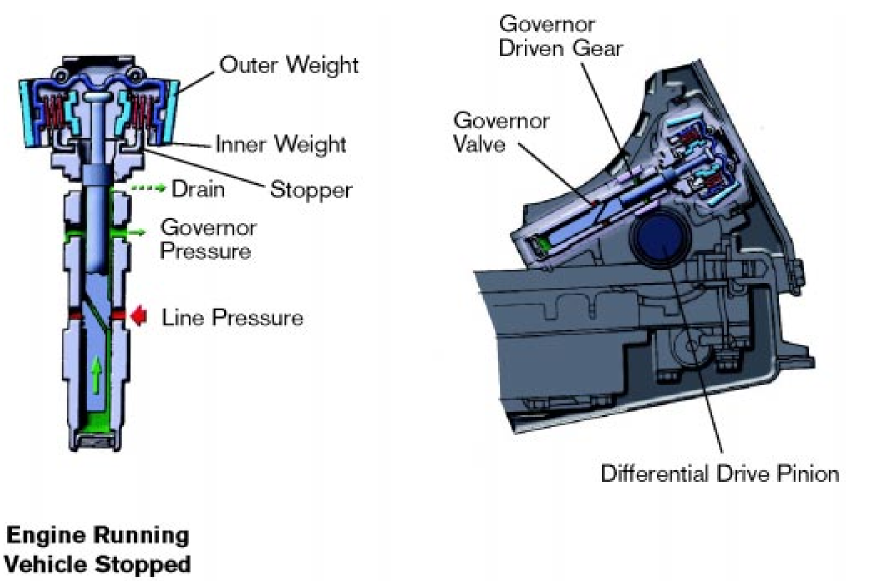


Fig. 3-05
T273f077

As vehicle speed increases, the weights move outward and the governor valve is pushed down 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.

As the governor 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 shown in Toyota publications is always green.

Governor Valve

Governor pressure increases as weights move outward by centrifugal force.

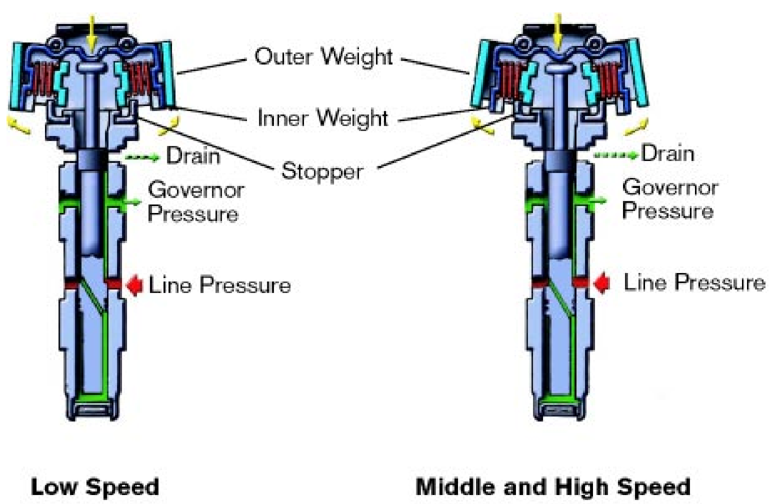


Fig. 3-06
T273f078

Throttle Valve

Throttle pressure is produced in response to throttle opening angle. When the accelerator pedal is depressed, the downshift plug pushes the throttle valve upward by means of the spring, creating throttle pressure. The throttle valve supplies throttle pressure to each shift valve and acts in opposition to governor pressure. This is why throttle cable adjustment affects shift timing in non-ECT transmissions.

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 pressure shown in Toyota publications is always blue.

Throttle Valve

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

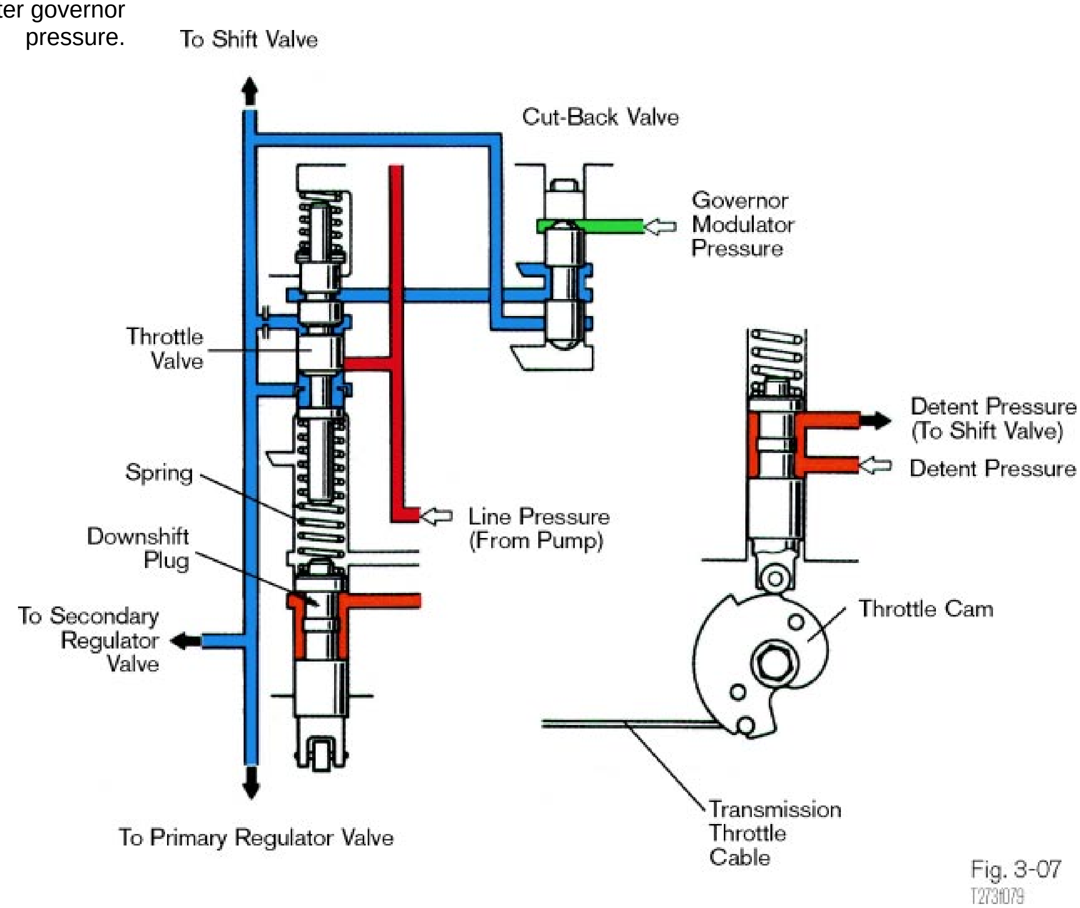


Fig. 3-07

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.

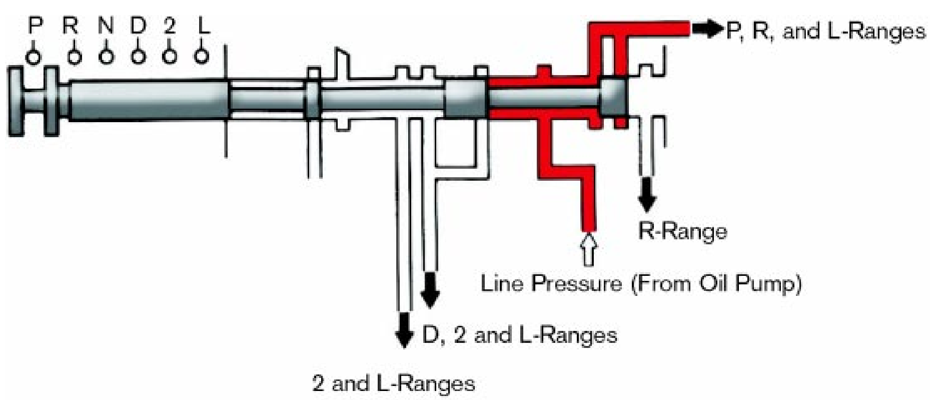


Fig. 3-08
T273f080

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. As long as there is no governor pressure, there will be no upshift and if throttle pressure is low, upshifts will be early. In first gear the *forward clutch* (C1) is applied through the manual valve, and the *No. 2 one-way clutch* (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 increases, governor pressure overcomes throttle pressure and spring tension at the 1-2 shift valve. 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. The downshift occurs when coasting to a stop as spring tension overcomes governor pressure. This happens at such a low speed that it is hardly noticeable.

A forced downshift 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.

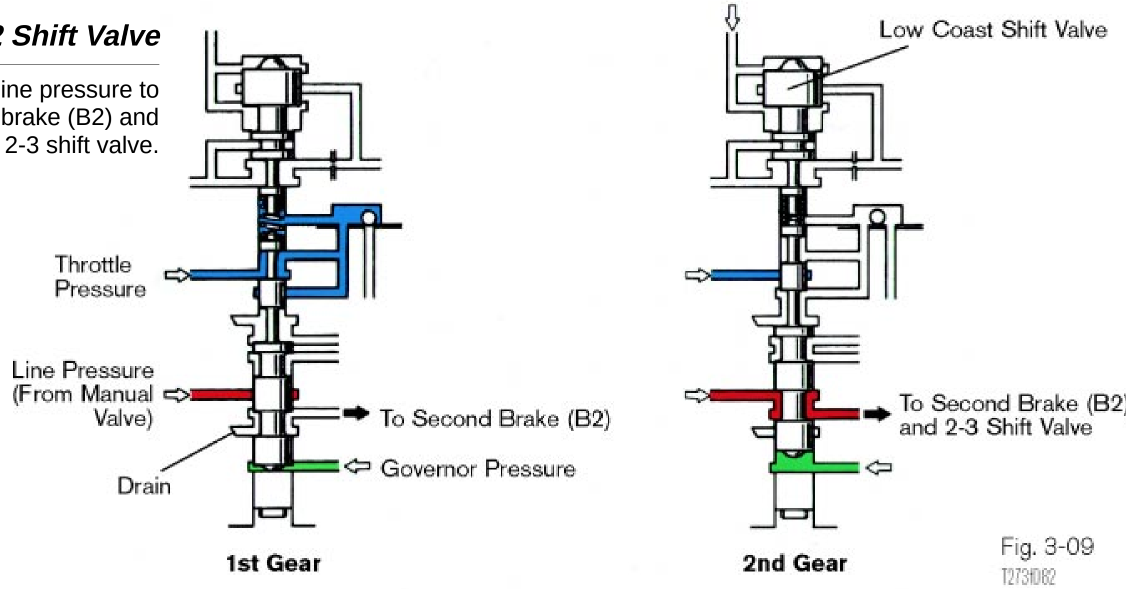


Fig. 3-09

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 throttle pressure increases with throttle opening, 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 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 the 1-2 shift valve is stuck there will be no 2nd gear, but also no third gear because the *direct clutch* cannot be applied.

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.

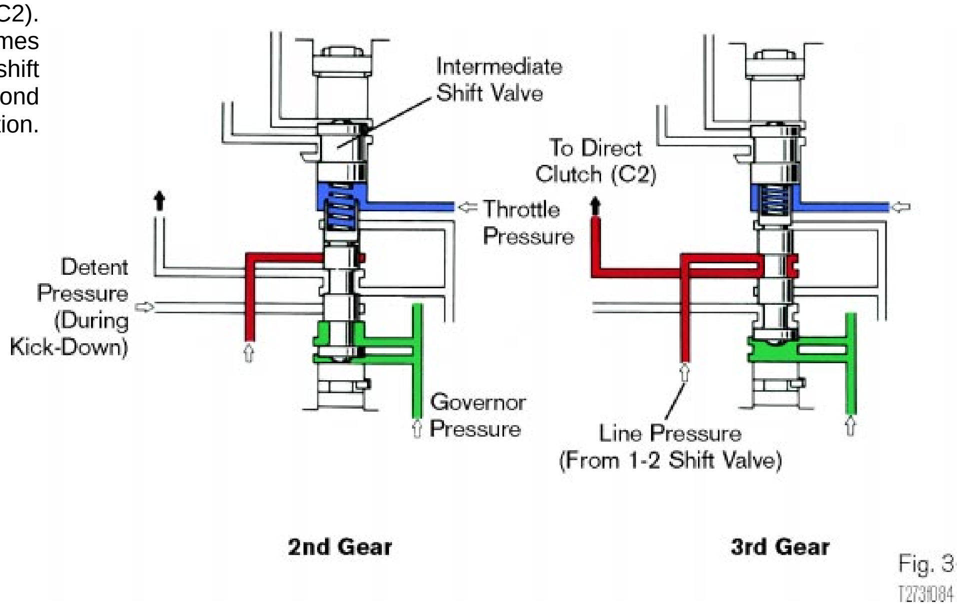


Fig. 3-10

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 passes through the second modulator valve and 1-2 shift valve and acts on the *second coast brake* (B1) to effect engine braking.

3-4 Shift Valve

This valve controls shifting between third and forth 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 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 directed through the 3-4 shift valve to either the *overdrive direct clutch* (C0) or the *overdrive brake* (B0). 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* (C0) to the *overdrive brake* (B0) and resulting in an upshift to overdrive.

3-4 Shift Valve

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

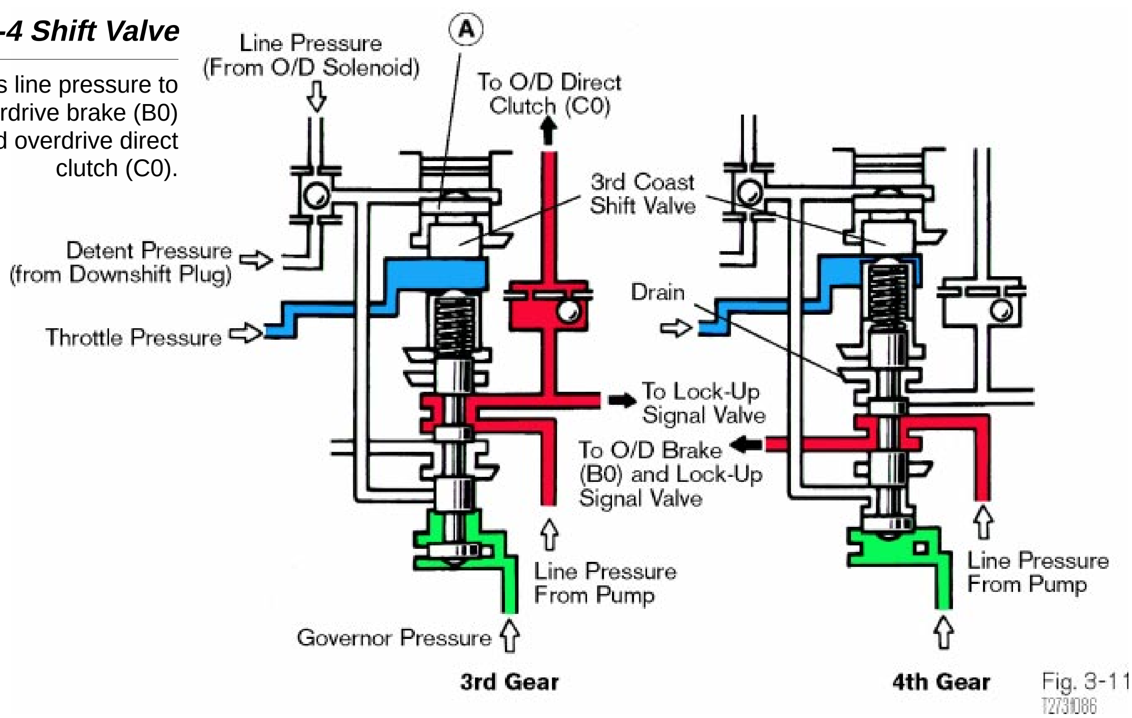


Fig. 3-11

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 relying 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.

Downshift Plug

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

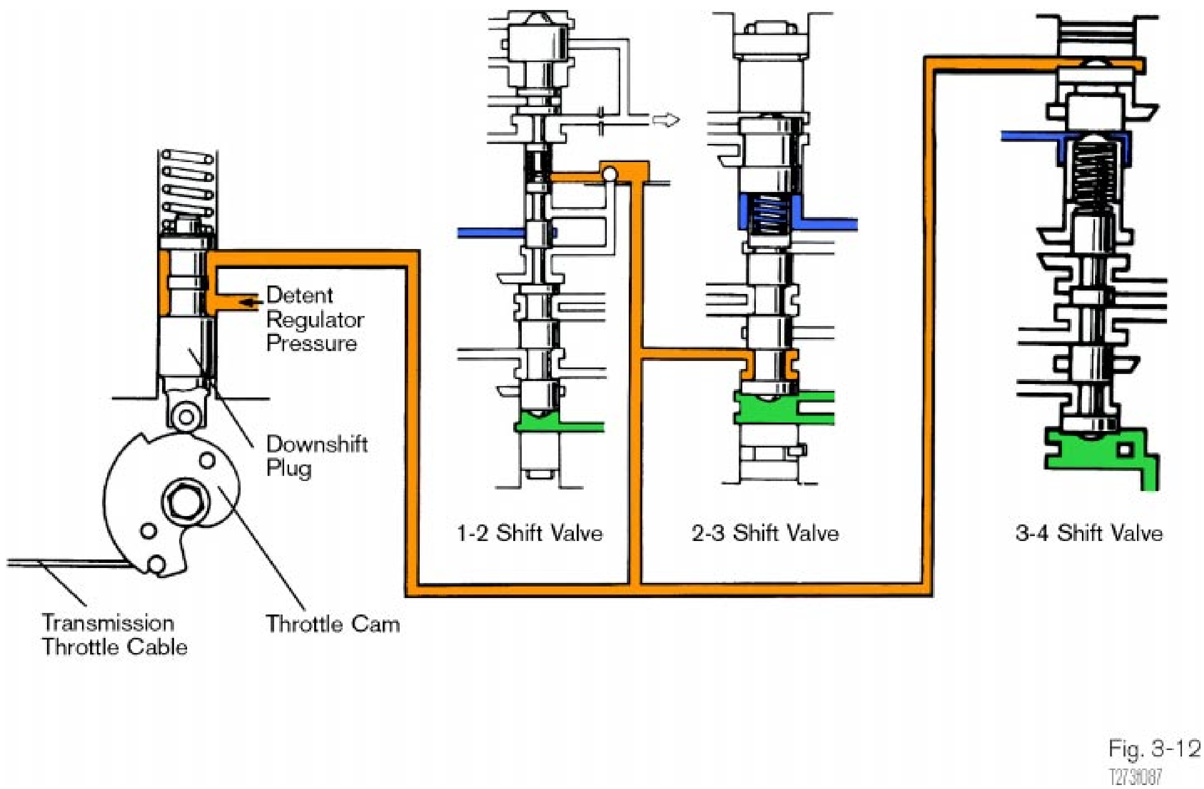


Fig. 3-12

Timing Valves

These valves are responsible to finesse the quality of transmission shift characteristics. In some cases the applied 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 A-40 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* (B0) to the *overdrive direct clutch* (C0), 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, 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.

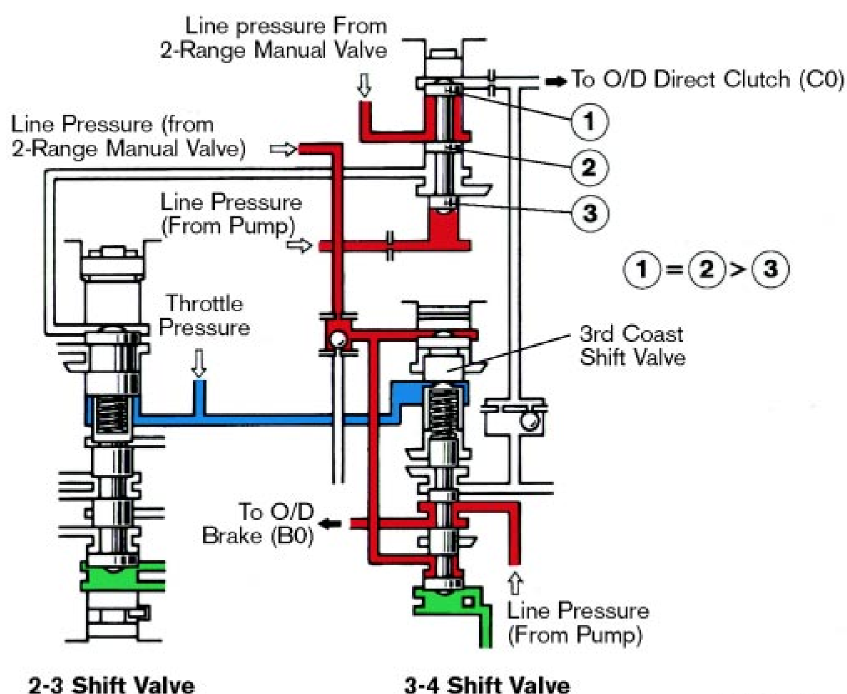


Fig. 3-13

Reverse Clutch and Brake Sequencing Valves

The sequencing valves control the timing of the application of the double piston *direct clutch* (C2) and *1st and reverse brake* (B3) found in the A-40 series transmissions. Remember that line pressure is increased in reverse. A sequencing valve reduces shift shock when the transmission is shifted into reverse. Although each clutch is controlled with a separate sequencing valve, the operation of the *direct clutch* is explained.

When moving the selector to the R-range, the passage to the outer piston of the *direct clutch* (C2) is blocked by the sequencing valve. As pressure builds and the inner piston begins to apply, the valve moves to the left compressing the spring. Line pressure is applied to the outer piston for full engagement of the *direct clutch.* Staggering the engagement of the two pistons softens the engagement of the *direct clutch*.

Reverse Clutch Sequencing Valve

Reduces shift shock when the transmission is shifted into reverse.

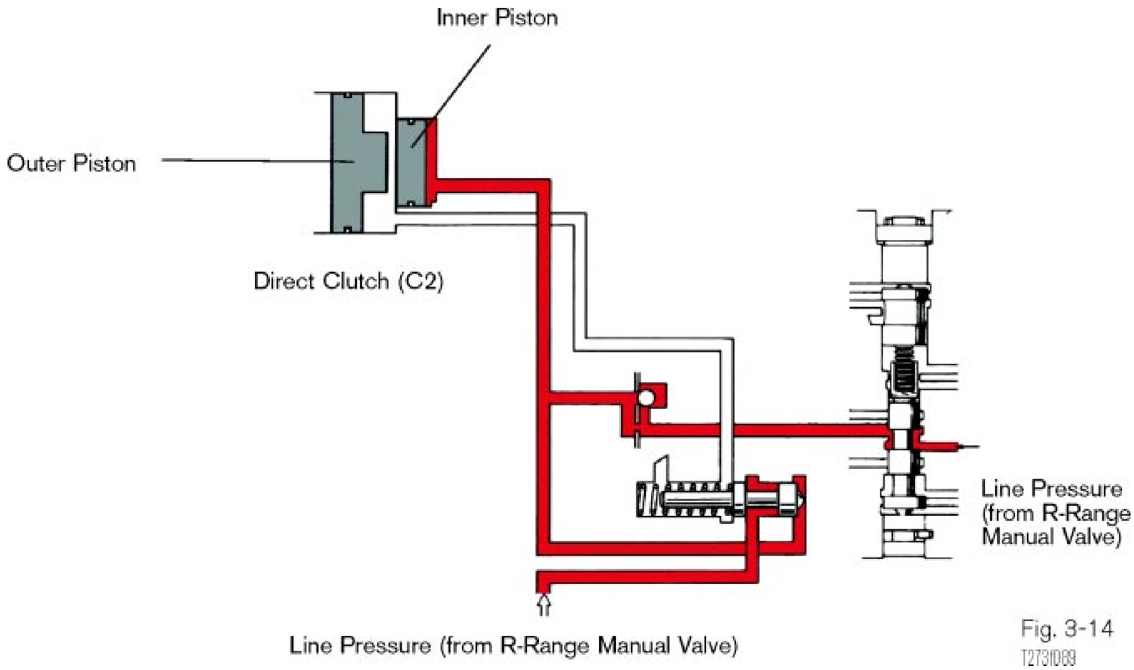


Fig. 3-14
T273f069

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, or electronically controlled solenoid.

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. Modulator valves further reduce these controlling pressures to finesse the transmission's operation.

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 *2nd brake* (B2) accumulator when the throttle opening is small. The valve is balanced between throttle pressure and spring tension at it's base and metered line pressure at the top of the valve.

Accumulator Control Valve

Modifies line pressure to the accumulators based on engine load.

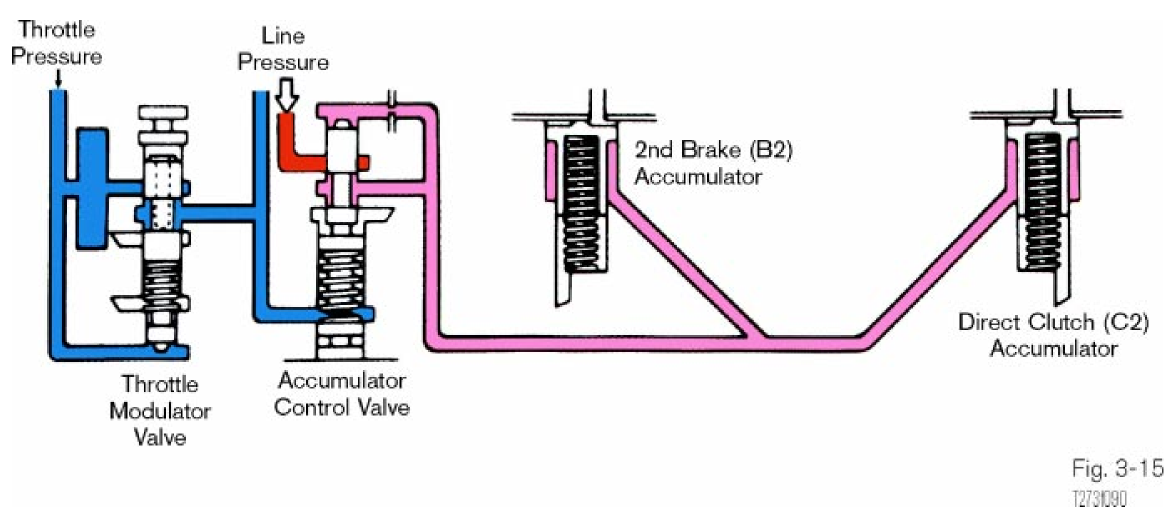


Fig. 3-15

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.

Governor Modulator Valve

The governor modulator valve works in conjunction with the cut-back valve to reduce engine load at high speed. It modifies governor pressure to the cut-back valve as the vehicle speed component.

Cut-Back Valve

The cut-back valve modifies throttle pressure based on vehicle speed. Lowering line pressure prevents unnecessary power loss at the transmission oil pump during higher speeds.

Detent Regulator Valve

The detent regulator valve modifies line pressure to the Down-Shift Plug during kick-down to stabilize the hydraulic pressure acting on the 1-2, 2-3, and 3-4 shift valves. Detent pressure provides a pressure in addition to throttle pressure to improve downshift response.

Intermediate Modulator Valve

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

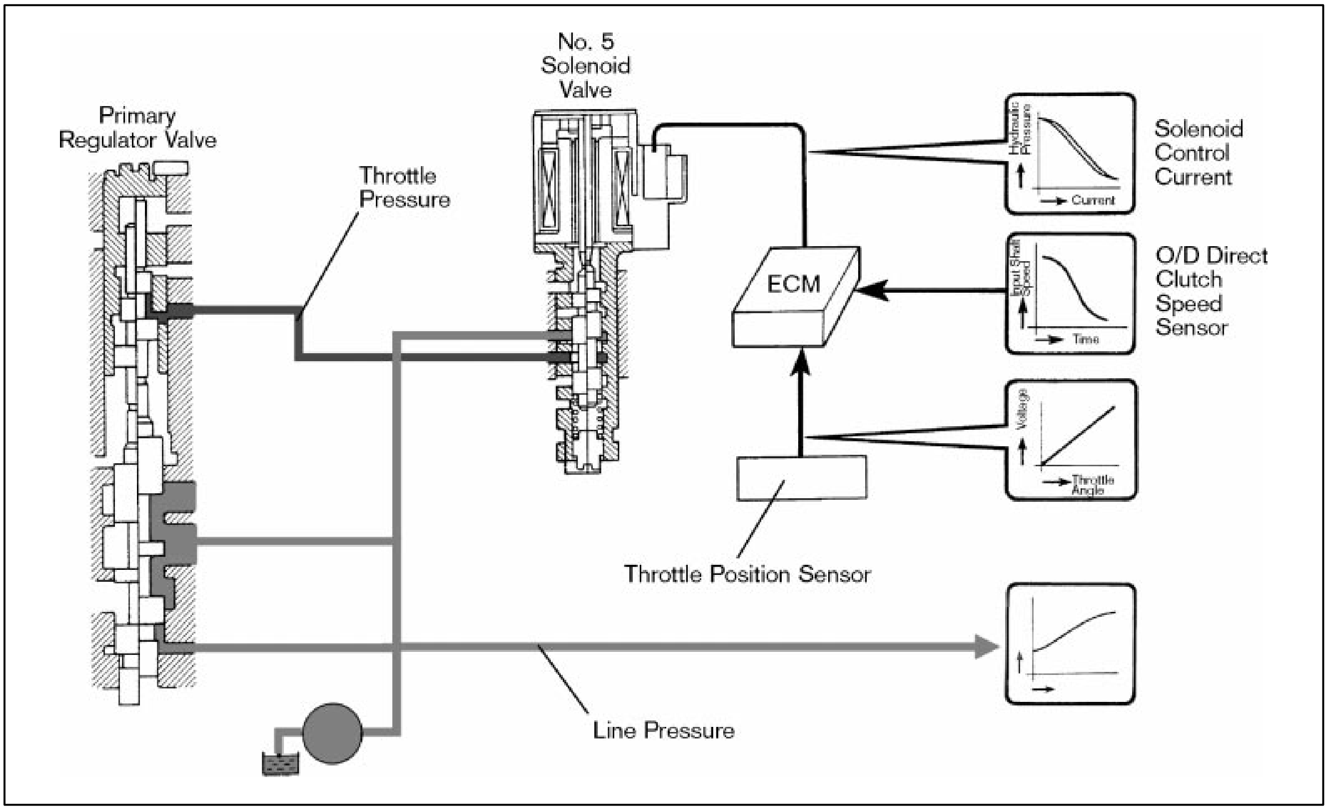
Low Coast Modulator Valve

The low coast modulator valve reduces line pressure from the manual valve to reduce shock when the gear selector is moved to the L-range. The low coast modulator pressure pushes the low coast shift valve down and applies the *1st and reverse brake* (B3) to buffer the shock.

Notes

Section 4

Electronic Control System



Lesson Objectives

1. Describe the operation of the O/D Main Switch and its control of fourth gear.
2. Describe the effect of the O/D solenoid on the torque converter lock-up control of non-ECT transmissions.
3. Explain the effect of the neutral start switch in maintaining manual select positions in ECT transmissions.
4. Given the solenoid back-up function chart, describe the ECU control of the remaining solenoid to allow the vehicle to operate.
5. Describe the coolant temperature sensor's affect on transmission operation.
6. Describe the affect to the throttle position sensor and speed sensor on the transmission ability to upshift.
7. Describe the A-series ECT transmission shift control operation.
8. Differentiate the operation of the linear and ON/OFF solenoids.
9. Describe how the three/four shift in a U-341 transaxle is accomplished with the ST solenoid.

Notes

Non-ECT Transmission

The Non-ECT transmission operates on a balance of hydraulic pressure based on vehicle speed and throttle opening. Overdrive and torque converter lock-up operation are the only functions controlled electronically.

Overdrive Control System

Overdrive enables the output rpm of the transmission to be greater than the input rpm, so the vehicle can maintain road speed with lower engine rpm. The control system manages line pressure at the top of the 3-4 shift valve to hold it in the third gear position or allow a shift to O/D.

The hydraulic circuit is controlled by the No. 3 solenoid, also referred to as the O/D solenoid. The solenoid controls the drain on the hydraulic circuit at the top of the 3-4 shift valve which will counteract governor pressure at the valve base when the solenoid drain is closed.

O/D Solenoid Valve

The O/D solenoid valve below is a normally closed solenoid; that is, the valve is spring loaded in the closed position. This solenoid is controlled by a normally closed relay. 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.

Overdrive Solenoid Operation

O/D solenoid is a normally closed solenoid.

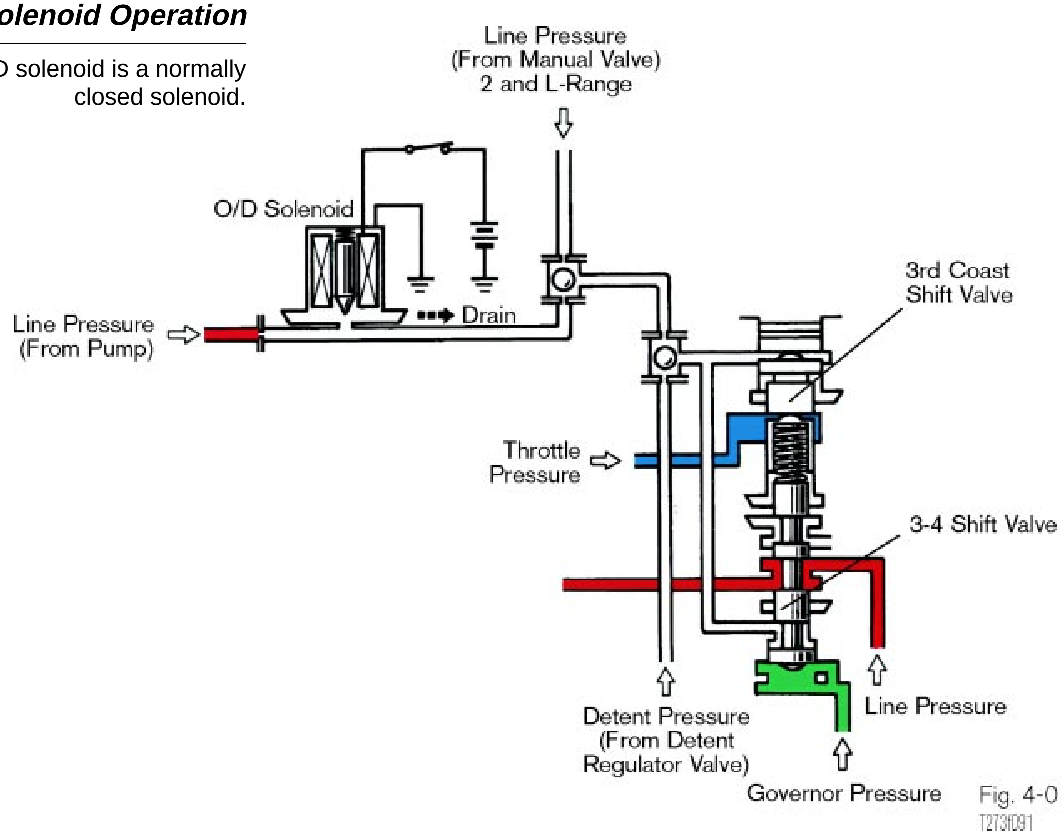


Fig. 4-01

The components which make up this system include:

- O/D main switch
- O/D off indicator light
- Water temperature sensor
- O/D solenoid valve

O/D Wiring Diagram

O/D solenoid can be grounded by:
- Cruise Control ECM
- Water Temperature Sensor
- O/D Main Switch

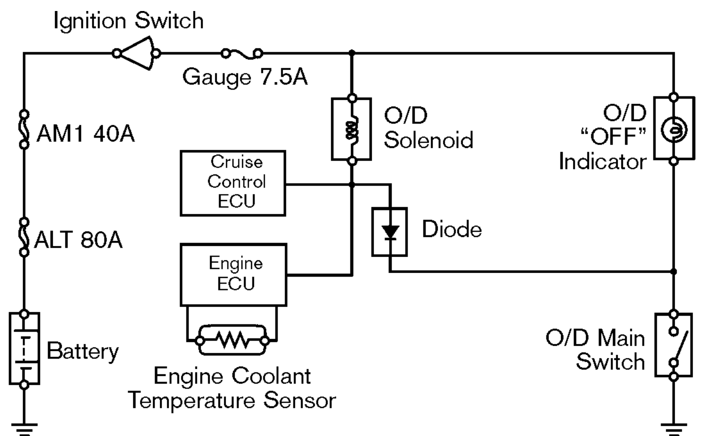


Fig. 4-02
T273f092

O/D Main Switch

The O/D 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 O/D main switch is just the opposite. When the O/D switch is in the ON position, the switch contacts are open and the overdrive system is working. When the O/D switch is in the OFF position, the switch contacts are closed and the overdrive system is not working and the top gear is third gear.

O/D Off Indicator Light

This indicator light remains on as long as the overdrive main switch is off (O/D switch contact closed). It is located in the combination meter.

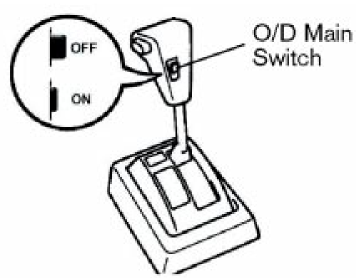
Water Temperature Sensor

The water temperature sensor monitors the temperature of the engine coolant and is connected to the engine ECM. The engine ECM 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 ECM.

O/D Main Switch

The operation of the switch is the opposite of its description.



	O/D Switch	
	ON	OFF
CONTACTS OF O/D SWITCH	Open	Closed
UPSHIFTING	Enabled	Disabled
O/D "OFF" INDICATOR	Off	On

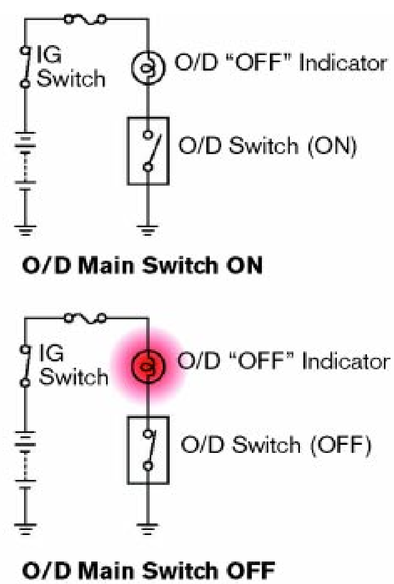


Fig. 4-03
T273f093

Cruise Control

The cruise control ECU sends a signal to the ECM to cancel the overdrive when vehicle speed drops 2.5 mph below the set speed. Cruise control will resume when vehicle speed is within 1.2 mph of set speed.

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 A-130L series transmission, lock-up occurs only in third gear; in an A-140L or A-240L 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.

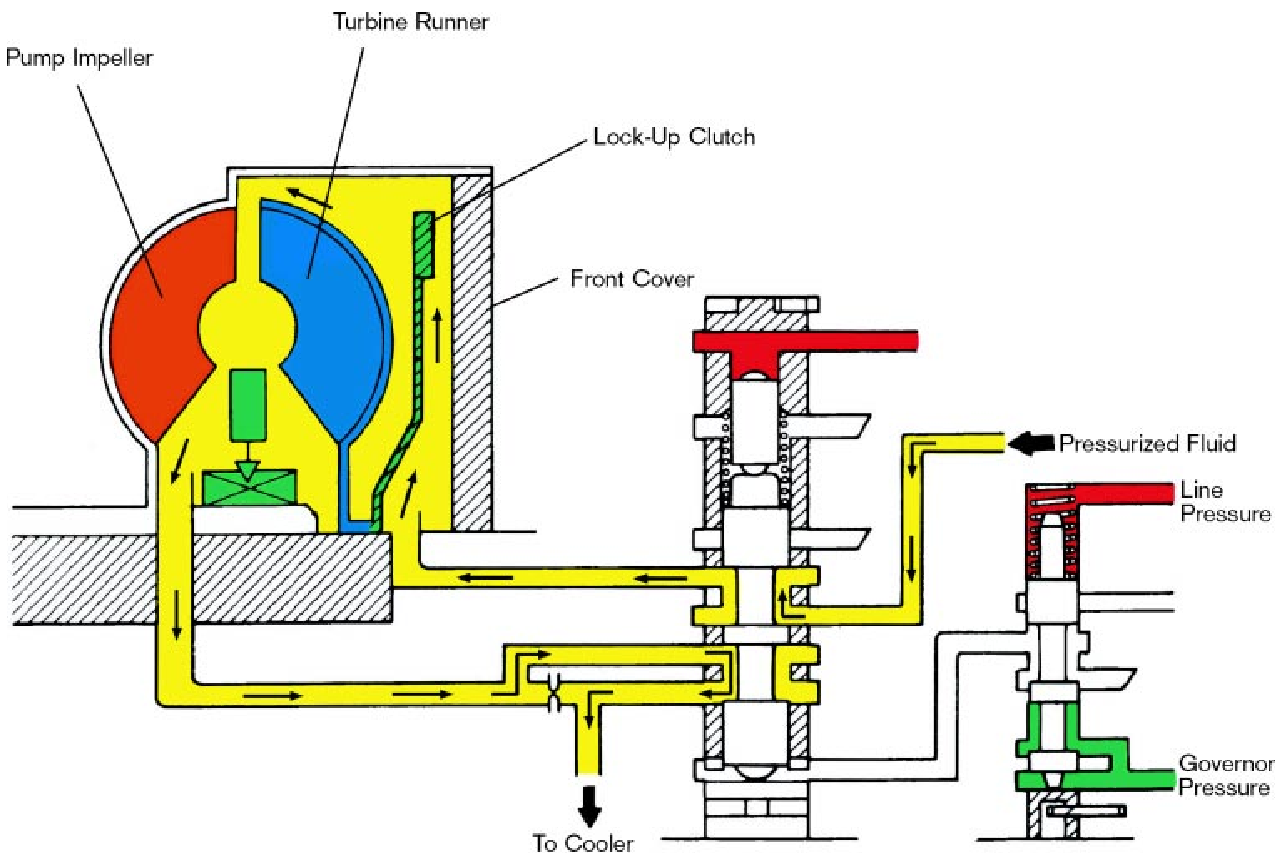


Fig. 4-04
T273f094

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. In fourth gear, 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

The relay valve changes the flow of converter pressure to the converter and opens a drain to the front of the lock-up clutch, engaging the clutch with the converter housing.

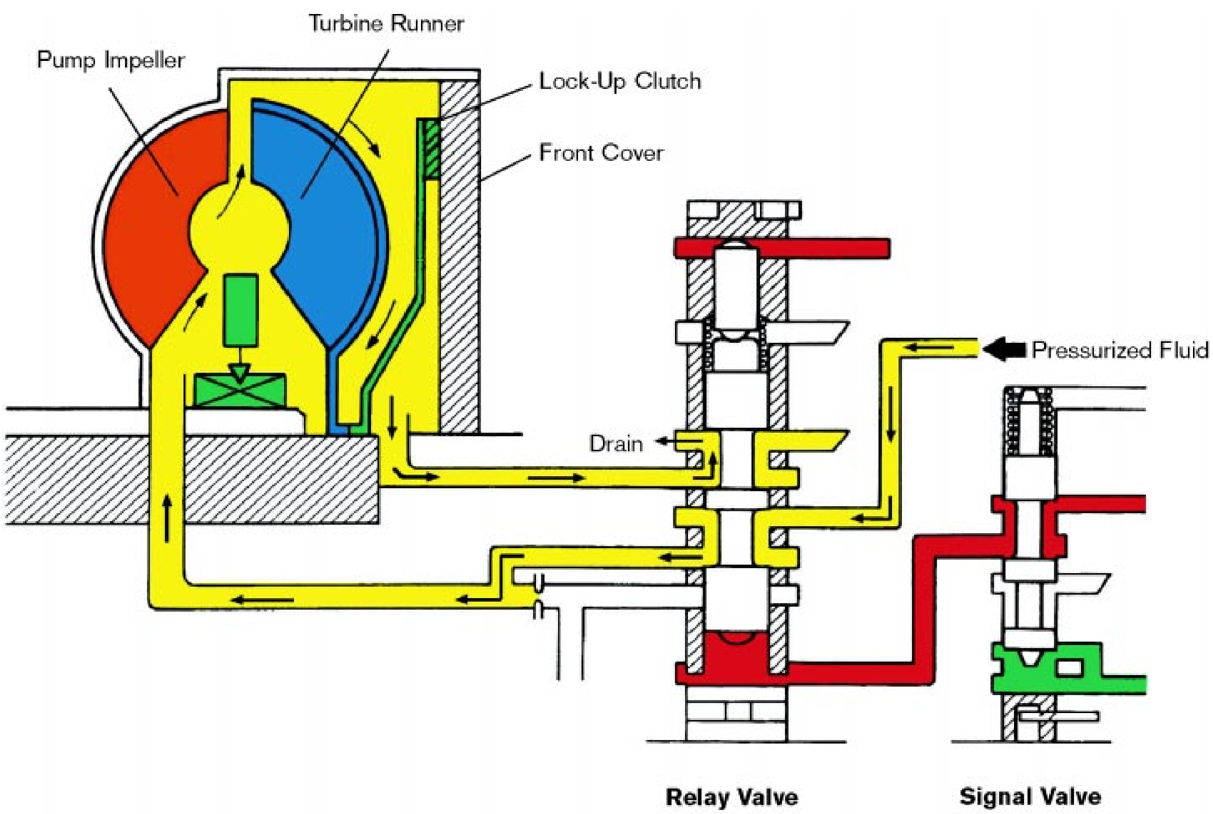


Fig. 4-05

T273f095

Electronic Control Transmission (ECT)

The Electronic Control Transmission is an automatic transmission which uses electronic technology to control transmission operation. The transmission, except for the valve body and speed sensor, is virtually the same as a fully hydraulic controlled transmission. It includes electronic solenoids, sensors, and an electronic control unit.

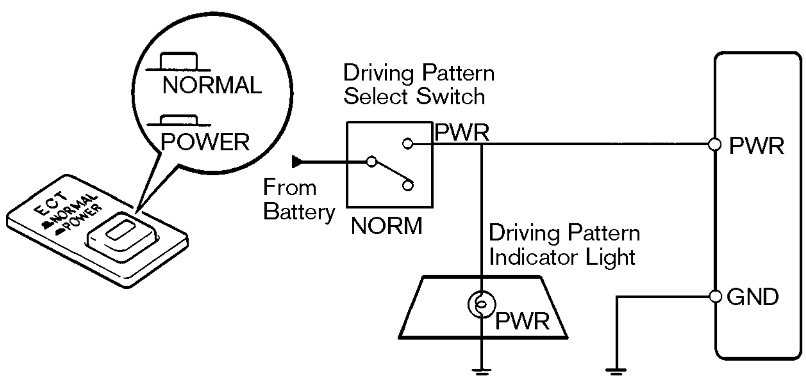
The electronic sensors monitor the speed of the vehicle, speed of the input shaft, gear position selection and throttle opening, providing this information to the ECM. The ECM then controls the operation of the clutches and brakes based on this data and controls the timing of shift points and torque converter lock-up and maintains on-board diagnosis.

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



Driving Pattern	“PWR” Terminal Voltage
Normal	0V
Power	12V

Fig. 4-06
T273f096

The ECM 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 ECM and the power light illuminates. When “Normal” is selected, the voltage at “PWR” is 0 volts. When the ECM senses 0 volts at the terminal, it recognizes that “Normal” has been selected.

Beginning with the 1990 MR2 and Celica and 1991 Previa, pattern select switches were discontinued as models went through major body style changes. In the Celica and Previa systems, several shift patterns are stored in the ECM memory. Utilizing sensory inputs, the ECM selects the appropriate shift pattern and operates the shift solenoids accordingly. The MR2 and 1993 Corolla have only one shift pattern stored in the ECM memory. As of the 1999 model year, RAV4, Tacoma, Land Cruiser and 4Runner all have a pattern select switch.

Neutral Start Switch

The ECM receives information on the selected gear range 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

ECM monitors gear position through the neutral start switch.

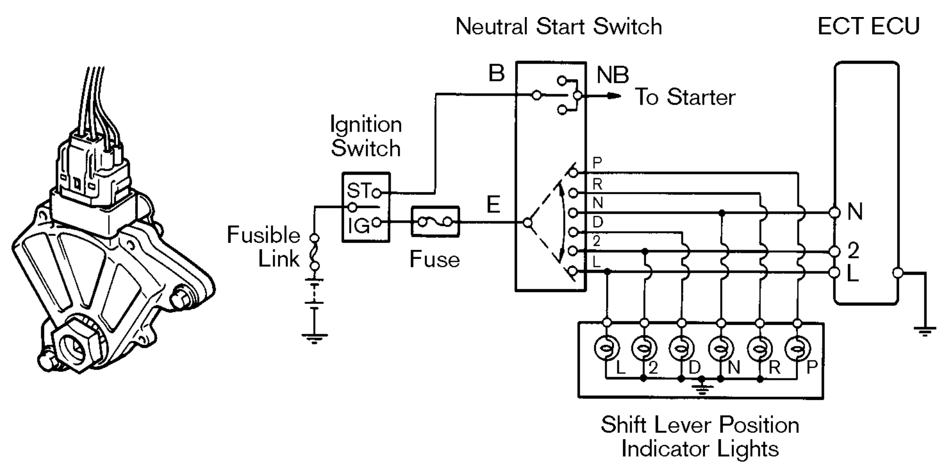


Fig. 4-07

T273f097

Some ECMs monitor positions “2” and “L”. If either of these terminals provides a 12-volt signal to the ECM, it determines that the transmission is in neutral, second gear or first gear. If the ECM does not receive a 12-volt signal at terminals “2” or “L,” the ECM determines that the transmission is in the D-range. Yet, others monitor all gear ranges. Each contact is attached to the gear position indicator lights in the combination meter.

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.”

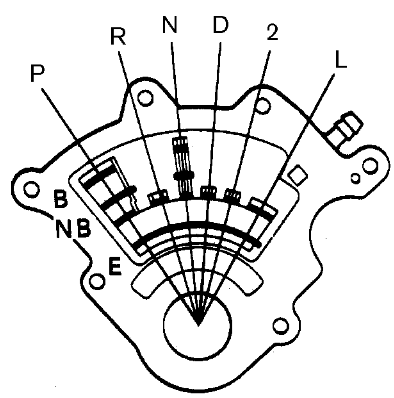


Fig. 4-08
T273f098

Throttle Position Sensor (TPS)

This sensor is mounted on the throttle body and electronically senses how far the throttle is open and then sends this data to the ECM. The throttle position sensor takes the place of throttle pressure for shifting purposes. By relaying the throttle position, it gives the ECM an indication of engine load to control the shifting and lock-up timing of the transmission. A throttle cable controls line pressure based on throttle opening. In models where the throttle cable is eliminated, the TPS’s input to the ECM controls shift timing and line pressure.

Throttle Position Sensor (TPS)

The throttle position sensor converts the throttle valve opening angle into voltage signals.

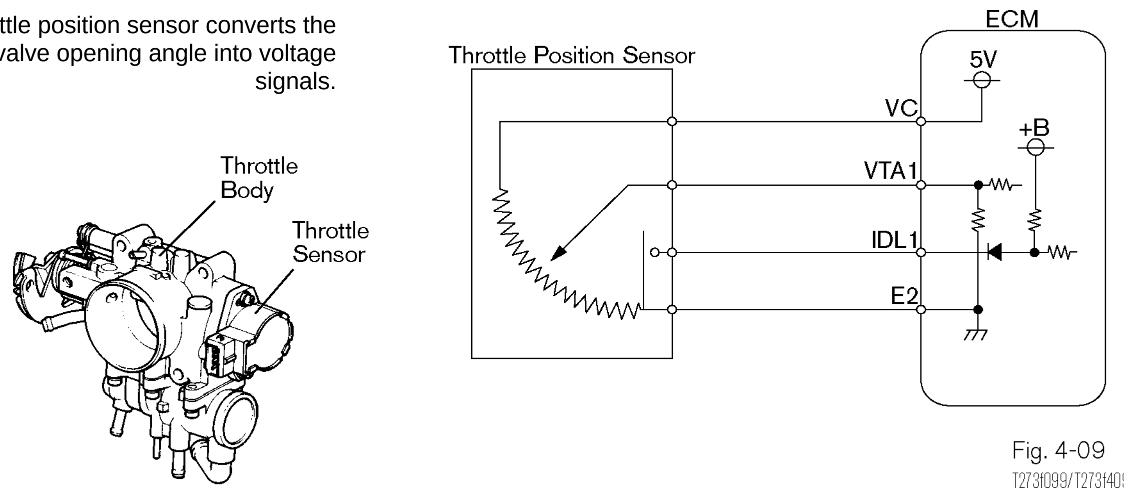


Fig. 4-09
T273f099/T273f409

Five volts are supplied from the VC terminal of the engine ECM. As the contact point slides along the resistor with throttle opening, voltage is applied to the VTA terminal. This voltage increases linearly from 0.6 - 0.9 volts at closed throttle to 3.5 - 4.7 volts at wide-open throttle. 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 ECM to inform it that the throttle is fully closed.

Throttle Position Terminals

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

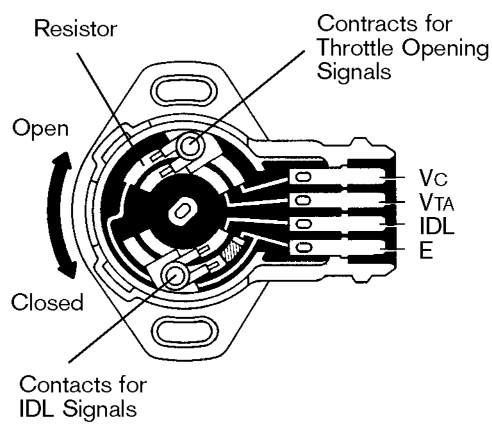


Fig. 4-10
T273f101

Throttle Position Sensor without Idle Control

Throttle sensor printed circuit board and contact points provide the ECM with the same signal pattern for throttle opening as the indirect type throttle sensor.

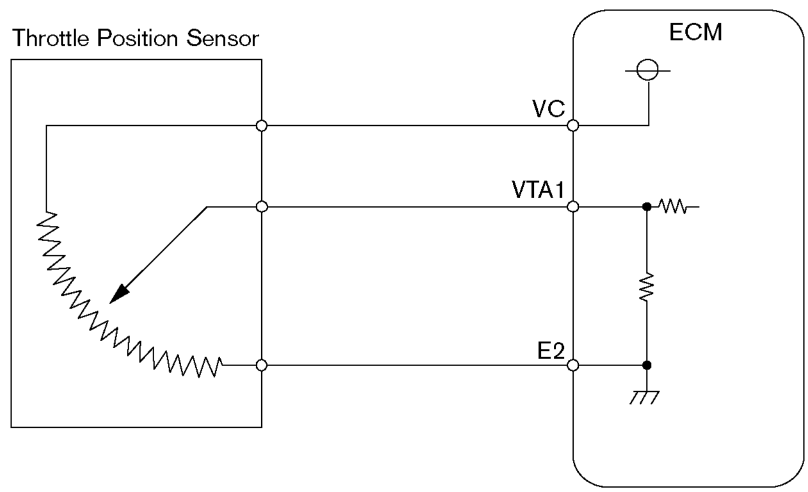


Fig. 4-11

T273f112

Later models no longer use the idle contact. The closed throttle position is a learned position determined by the VTA voltage signal to the ECM.

Engine Coolant Temperature Sensor

The engine coolant 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.

When the engine coolant is below a predetermined temperature, the engine performance and the vehicle's driveability would suffer if the transmission were shifted into overdrive or the converter clutch were locked-up. The engine ECM monitors coolant temperature and 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.

Some models cancel upshifts to third gear at lower temperatures. This information is found in the appendix, ECT Diagnostic Information chart, under the column heading “O/D Cancel Temp”. The temperature in parenthesis is the temperature to which third gear is restricted.

Engine Coolant Temperature Sensor

Coolant temperature is monitored by the engine ECM which controls the signal to O/D1 of the ECM to cancel overdrive.

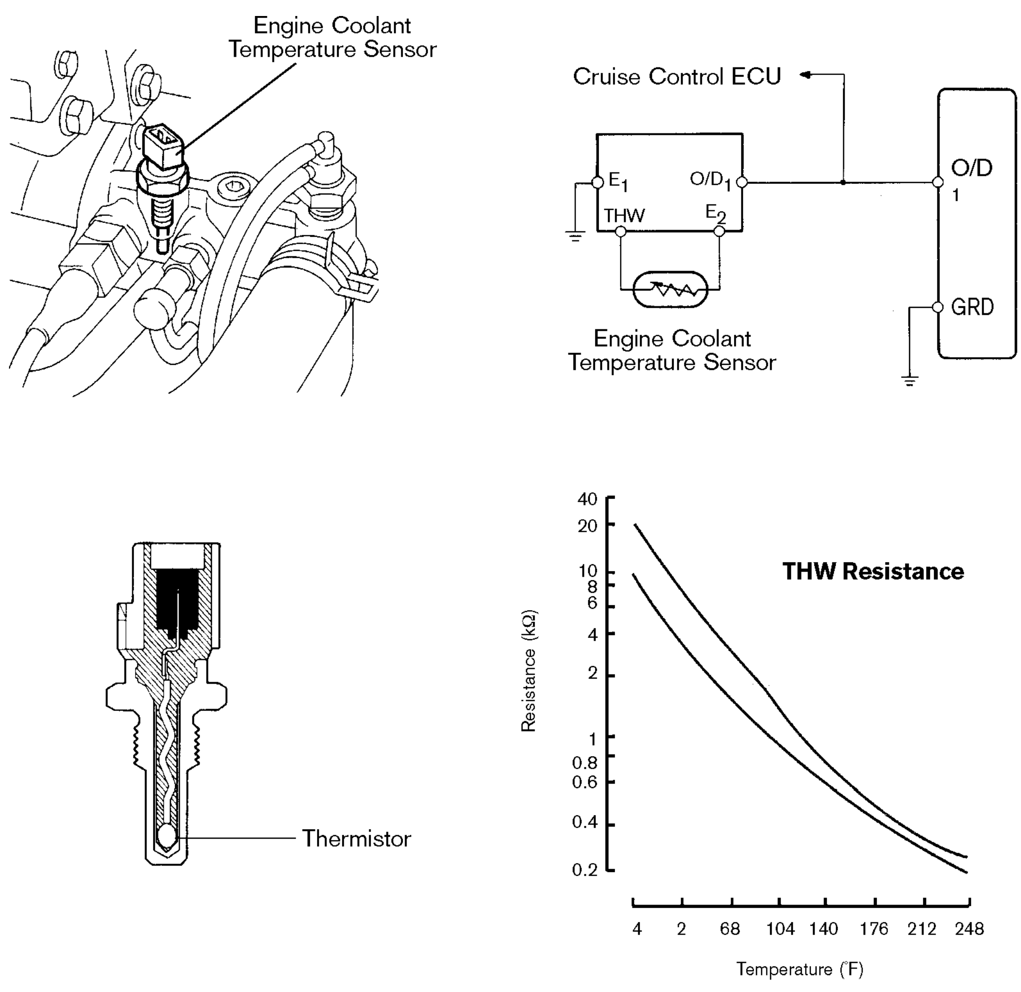


Fig. 4-12
T273f107/T273f108
T273f109/T273f110

Speed Sensors

The speed sensor in an ECT transmission is used in place of governor pressure in the conventional hydraulically controlled transmission. Lock up converter operation and transmission shifting are based on vehicle speed and throttle position.

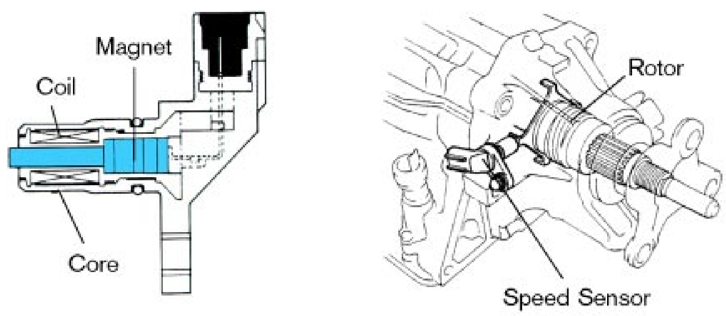
The speed sensor signal originates from a sensor measuring transmission/transaxle output speed or wheel speed. Different types of sensors have been used depending on models and applications. On some vehicles, the vehicle speed sensor signal is processed in the combination meter and then sent to the ECM.

Pickup Coil (Variable Reluctance) Type

This speed sensor consists of a permanent magnet, yoke and coil. The sensor is mounted close to a toothed gear. As each tooth moves by the sensor, an AC voltage pulse is induced in the coil. Each tooth produces a pulse. As the gear rotates faster more pulses are produced. The ECM determines the speed the component is revolving based on the number of pulses.

Speed Sensors

In ECT transmissions, speed sensors are used in place of the governor valve.



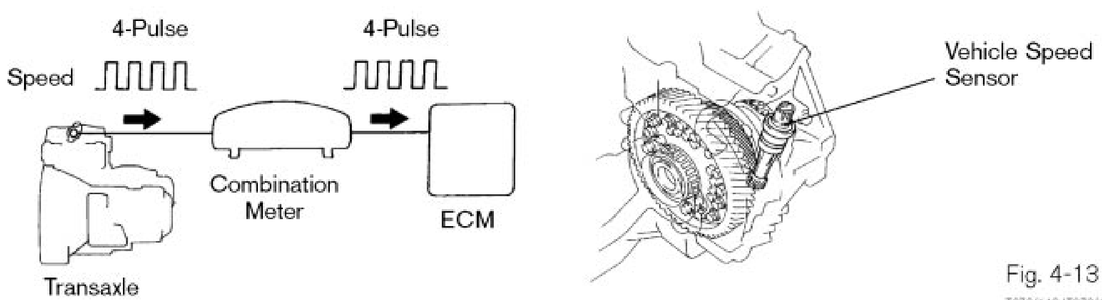


Fig. 4-13
T273f119/T273f113
T273f114/T273f115

The distance between the rotor pickup coil is critical. The further apart they are, the weaker the signal.

Reed Switch Type

The reed switch type is driven by the speedometer cable. The main components are a magnet, reed switch, and the speedometer cable. As the magnet revolves the reed switch contacts open and close four times per revolution. The action produces 4 pulses per revolution. From the number of pulses put out by the speed sensor, the combination meter/ECM is able to determine vehicle speed.

Reed Switch Type Speed Sensor

As the magnet revolves the reed switch contacts open and close four times per revolution.

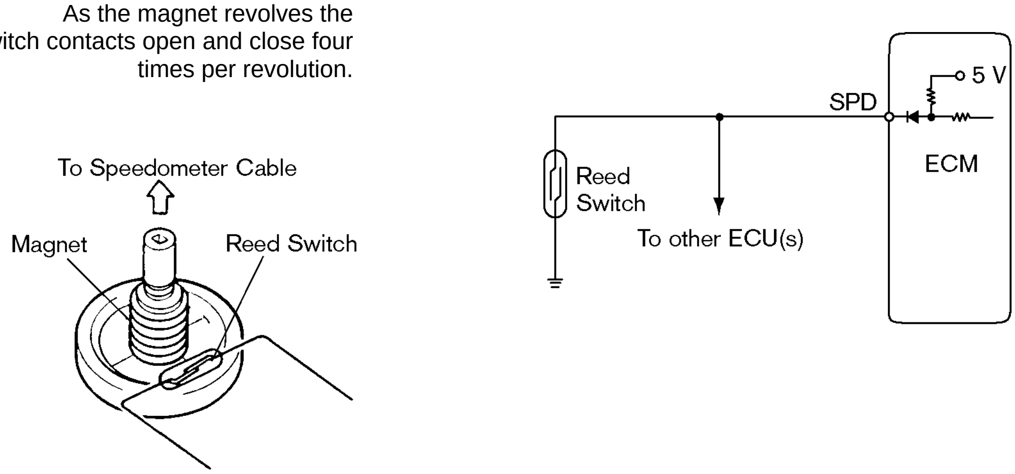


Fig. 4-14
T273f241/T273f267

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 ECM informing it that the brakes have been applied.

Stop Light Switch

The ECM Cancels torque converter lock-up and neutral-to-drive squat control based on stop light switch.

Brake Pedal	STP Terminal Voltage
Depressed	12V
Released	0V

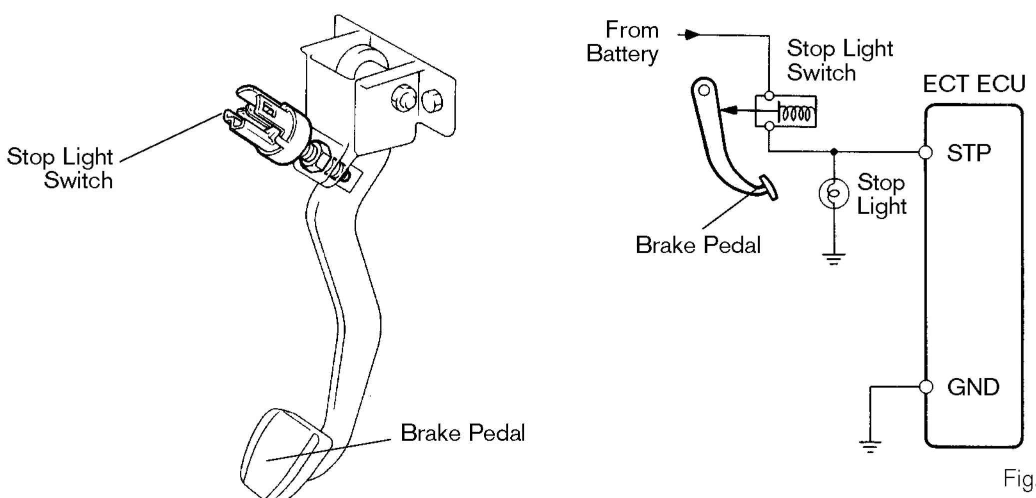


Fig. 4-15
T273f116/T273f117

The ECM cancels torque converter lock-up when the brake pedal is depressed. It also 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

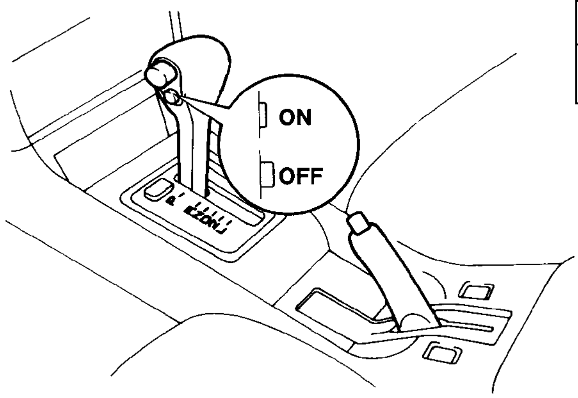
The overdrive main switch is located on the gear selector. It allows the driver to manually control overdrive. When it is turned on, the transmission can shift into overdrive. When it is turned off, the transmission is prevented from shifting into overdrive.

Locking Type O/D Main Switch

The locking type O/D main switch maintains its set position when selected. When the switch is in the off position, overdrive will be locked out until the switch is placed in the ON position. When the O/D switch is in the ON position, the electrical contacts are actually open and current from the battery voltage is available at the O/D2 terminal of the ECM as shown below.

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

Fig. 4-16
T273f118

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 are present at the O/D2 terminal and the O/D OFF indicator is illuminated.

Locking Type O/D Main Switch Circuit

When the O/D main switch is ON, O/D2 terminal has 12V. When O/D main switch is OFF, O/D2 has 0V.

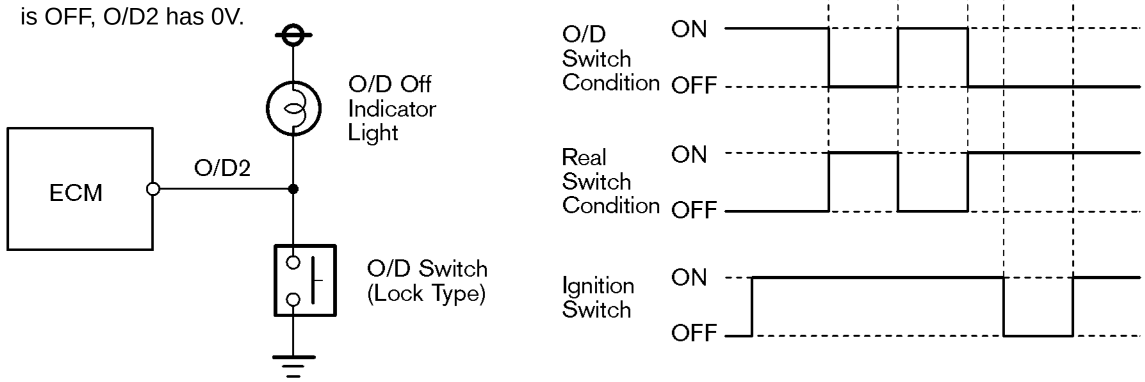


Fig. 4-17
T273f121/T273f122

Momentary Type O/D Main Switch

A new type O/D switch has been implemented as new models are introduced beginning with the 2000 model year. The switch is input directly to the ECM and the O/D solenoid is controlled by the ECM. Pressing the switch once turns the O/D OFF while pressing the switch a second time turns it ON. When the O/D is OFF, cycling the ignition switch from OFF to ON turns the overdrive to the default ON position.

Momentary O/D Switch

When the O/D is OFF, cycling the ignition switch from OFF to ON turns the overdrive to the default ON position.

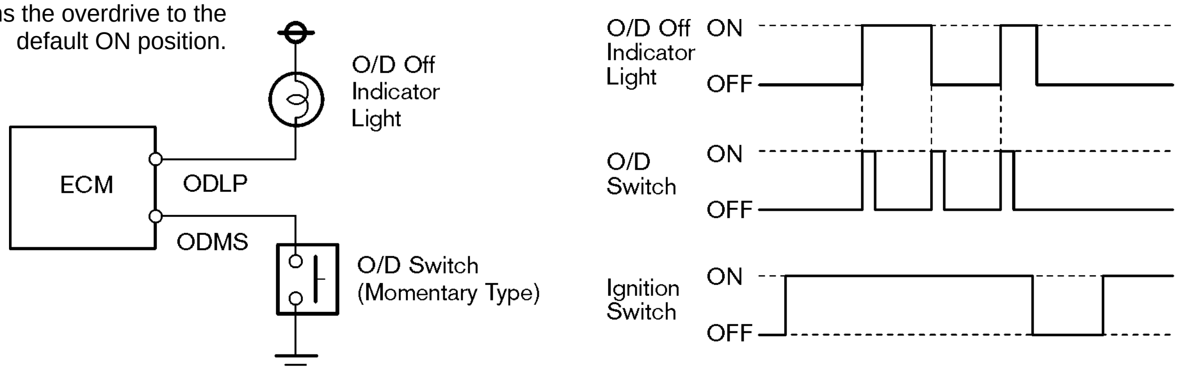


Fig. 4-18
T273f120

Transmission Sport Shift System

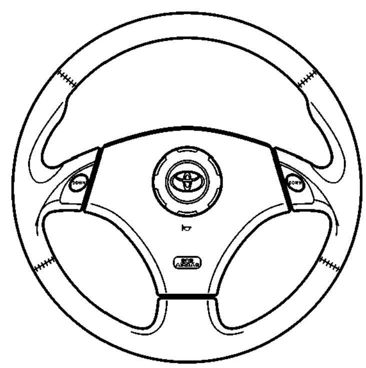
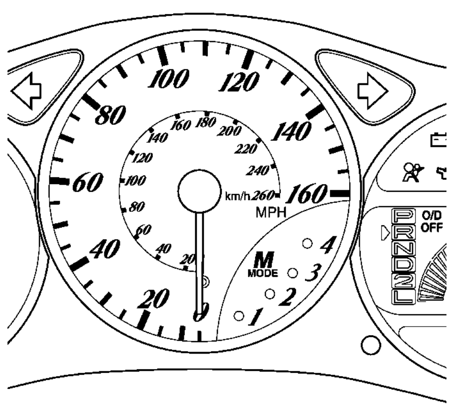
The sport shift feature, starting with the 2000 Celica, allows the driver to manually upshift and downshift by operating the shift switches located on the steering wheel. There are two pairs of switches located on either side of the steering wheel. The two DOWN switches are located on the front of the wheel, and the two UP switches are located on the back side of the wheel.

To enable the use of the shift switches, the gear selector must be placed in the "M" position. A gear position indicator located on the combination meter illuminates the gear position. The only automatic function while in the "M" position will be to downshift to first gear when the vehicle comes to a stop.

The "M" indicator light flashes if the transmission fluid is too hot or too cold when the gear selector is moved to the "M" position. If it continues to flash after the fluid has normalized, check for DTC PO710, which is the ATF Temperature Sensor or it's circuit.

Sport Shift System

The Sport switch must be closed before the engine ECM permits the shift switch to control shifting.

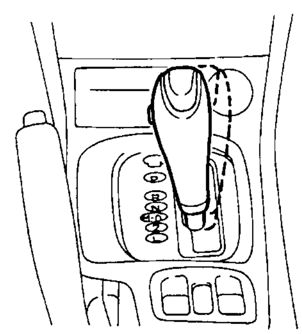


Fig. 4-19
T273f123/T273f135
T273f136

Solenoid Valves

Solenoid valves are electro-mechanical devices which control hydraulic circuits by opening a drain for pressurized hydraulic fluid. Solenoid valves control gear shift timing, torque converter lock-up control, throttle pressure control, and accumulator back pressure control.

Shift Solenoid Valves (No. 1 and No. 2)

These solenoid valves are mounted on the valve body and are turned on and off by electrical signals from the ECM, causing various hydraulic circuits to be switched as necessary. By controlling the two solenoids' on and off sequences, we are able to control four forward gear ranges.

Solenoid Valves

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

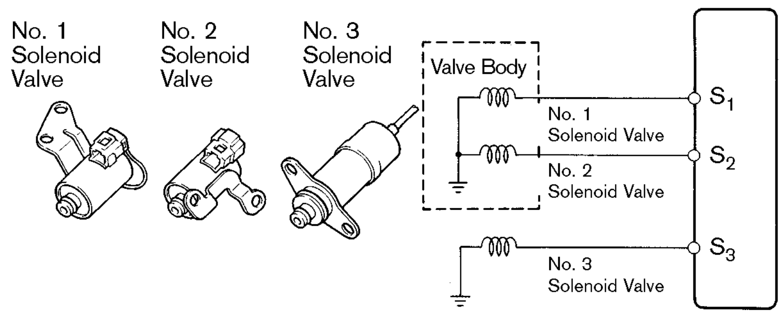


Fig. 4-20
T273f124

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 ECM is described on pages 4-20 to 4-23 of this book.

Lock-Up Control Solenoid Valve (No. 3 or SL)

The Lock-up Control 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 A-340E, A-340H, A-540E and A-540H transmissions use the normally open solenoid.

Accumulator Back Pressure Control Solenoid Valve (SLN)

The accumulator back pressure control solenoid (SLN) is controlled by the ECM to temporarily lower the accumulator back pressure to ensure a smooth shift. The ECM controls the duty cycle based on shift select mode (normal or power), throttle valve opening, direct clutch drum speed and vehicle speed. For example, if vehicle speed is low and throttle opening is large, accumulator back pressure should be higher to prevent slippage. Additionally, if the speed difference between the direct clutch drum and the vehicle was higher than the parameters of the ECU, accumulator back pressure should increase to reduce slippage.

Line Pressure Control Solenoid Valve

The line pressure control solenoid valve (SLT) is found on '93.5 and later Supras and '98 and later Land Cruisers. Beginning in the 2000 model year, Echo, Celica, and Tundra also include the SLT solenoid. The solenoid receives a duty cycle signal from the ECM based on throttle position sensor input and O/D direct clutch speed. It provides throttle pressure to the primary regulator valve to precisely control line pressure to ensure smooth shift characteristics.

Line Pressure Control Solenoid

The solenoid provides throttle pressure to the primary regulator valve to precisely control line pressure to ensure smooth shift characteristics.

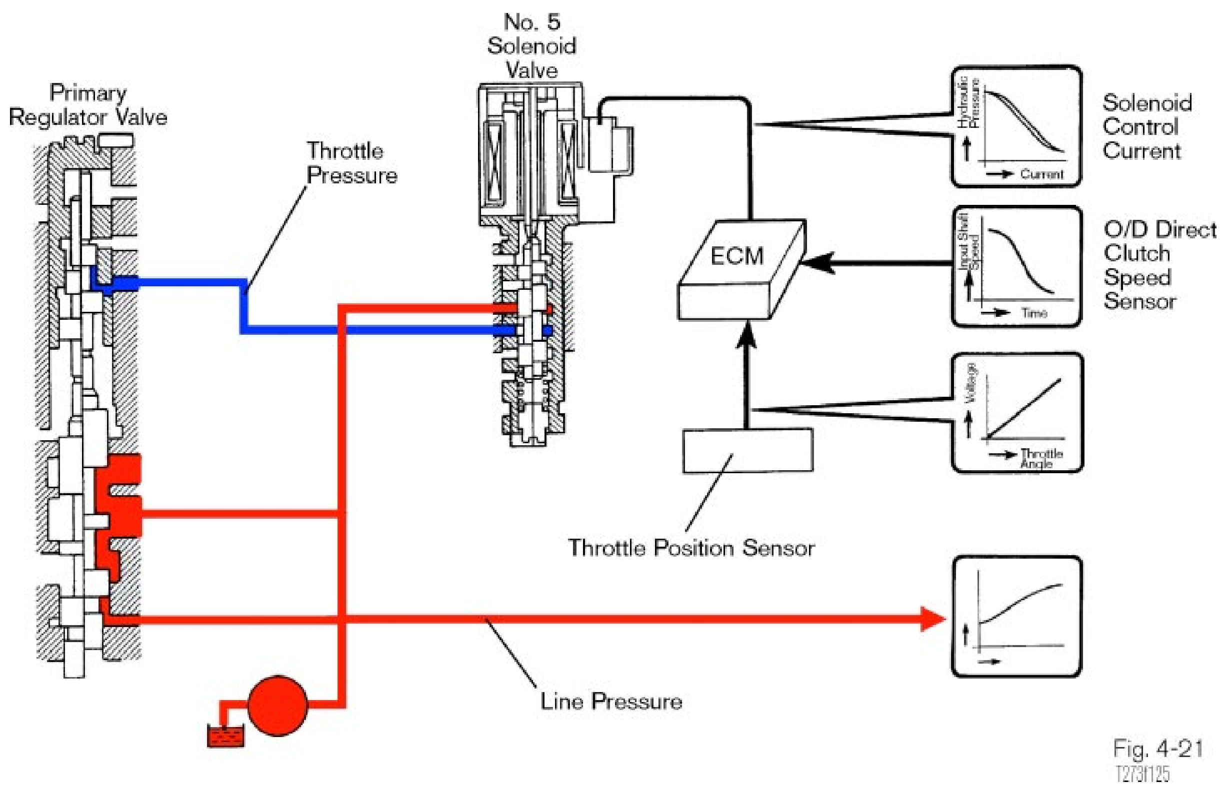


Fig. 4-21
T273f125

Shift Timing Control

The components which make up this system include:

- O/D Main switch
- O/D Off indicator light
- ECM
- Water temperature sensor
- Cruise control ECM
- No. 1 and No. 2 solenoid valves (shift solenoids)

Overdrive Control System - ECT

When O/D main switch is on,
O/D2 terminal has 12V.

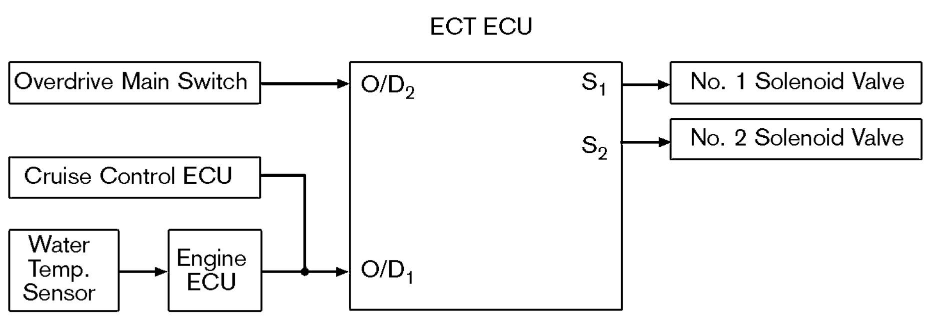


Fig. 4-22
T273f126

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

The ECM 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.
- O/D main switch is off (contacts closed).

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

A-Series 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 ECM 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

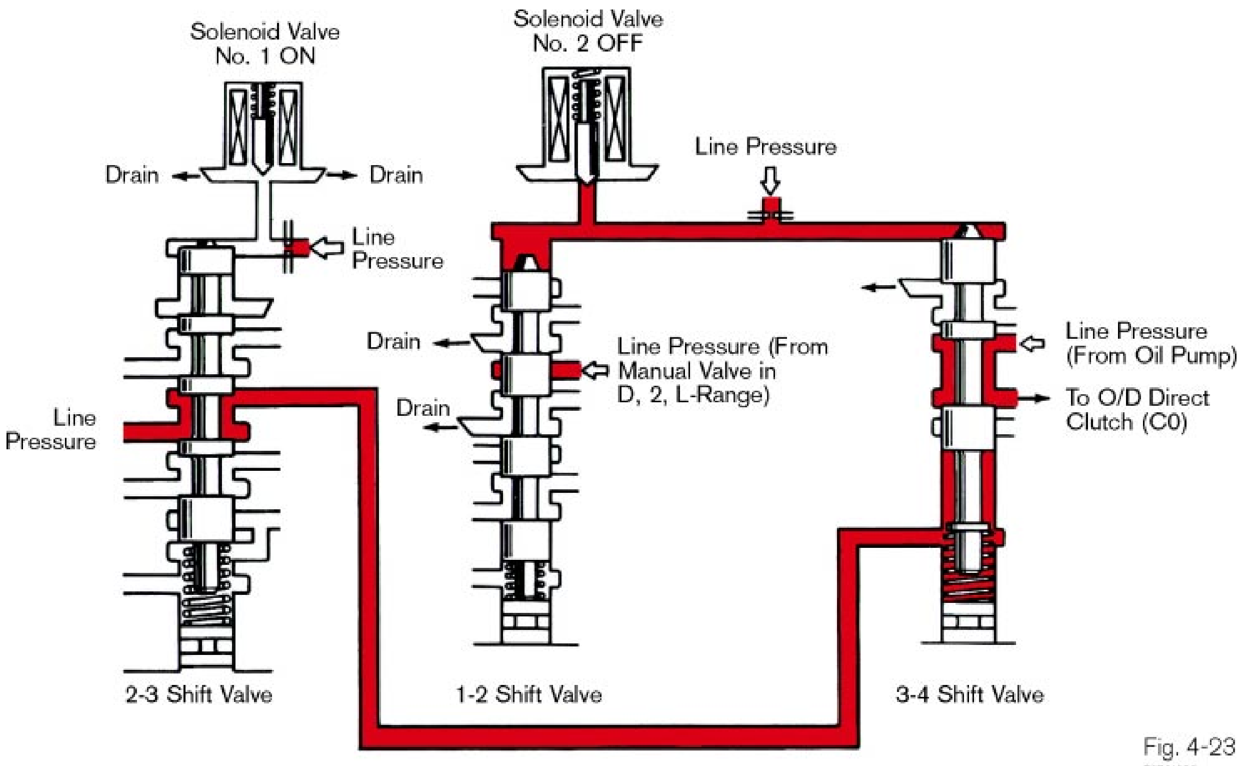


Fig. 4-23
T2731200

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.

Shift Solenoid Operation ECT - Second Gear

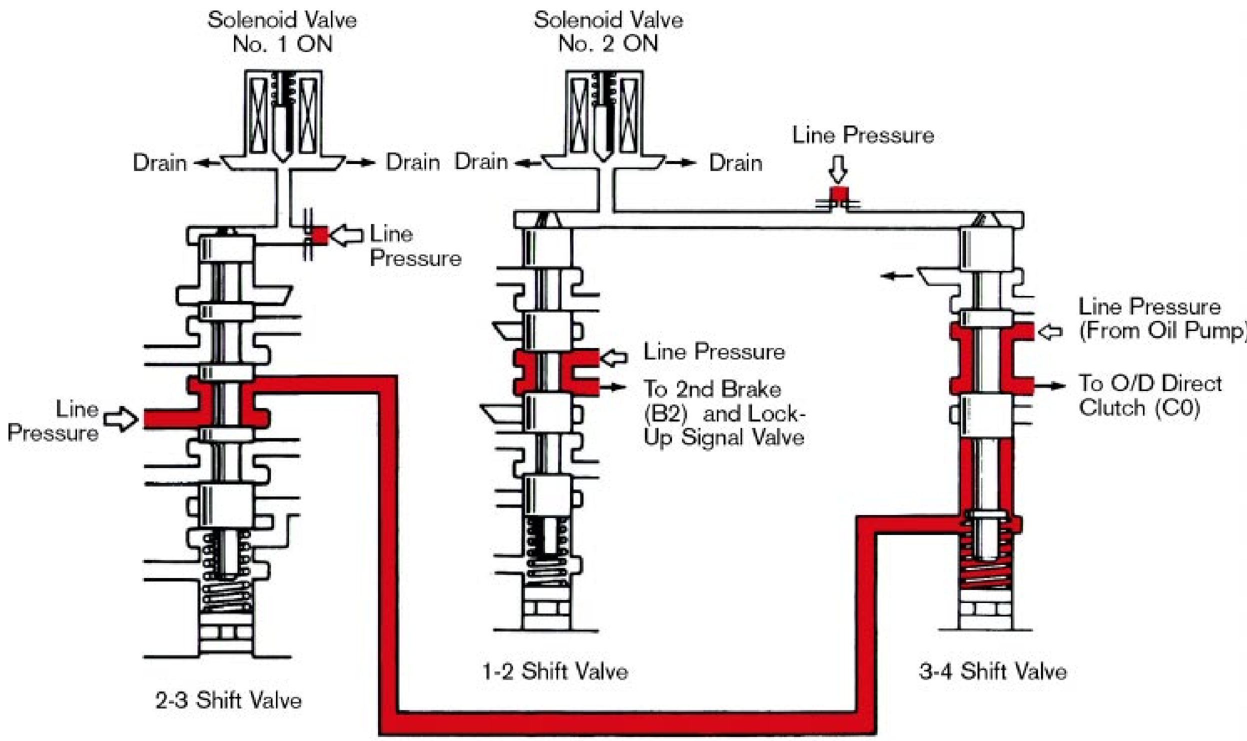


Fig. 4-24
T273f201

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 *No. 1 one-way clutch* (F1) and freewheels in the clockwise direction. The *2nd coast brake* (B1) is ready in the event of a downshift when the overdrive *direct clutch* (C2) is released.

Shift Solenoid Operation ECT - Third Gear

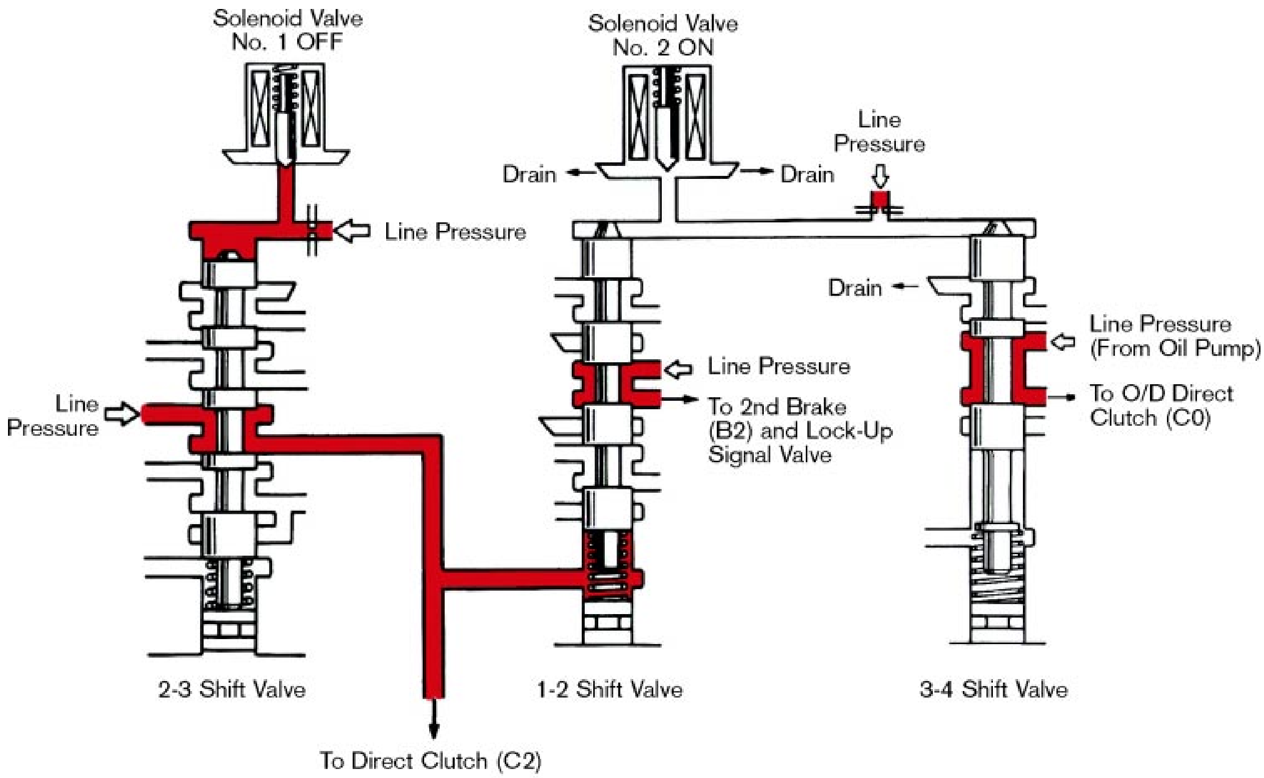


Fig. 4-25
T273f202

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. Line pressure holds the 2-3 shift valve down. Line pressure is maintained to the *direct clutch* (C2) and to the base of the 1-2 shift valve. Spring tension and line pressure at the base of the 1-2 shift valve holds the valve in the 2nd gear position.

When solenoid No. 2 is OFF, line pressure builds in the circuit, pushing the 3-4 shift valve down. Line pressure is directed to the *O/D Brake* (B0) and exposing the *O/D Direct Clutch* (C0) circuit to a drain.

Shift Solenoid Operation ECT - Fourth Gear

When solenoid No. 2 is OFF, line pressure builds in the circuit, pushing the 3-4 shift valve down. Line pressure is directed to the O/D Brake (B0) and exposing the O/D Direct Clutch (C0) circuit to a drain.

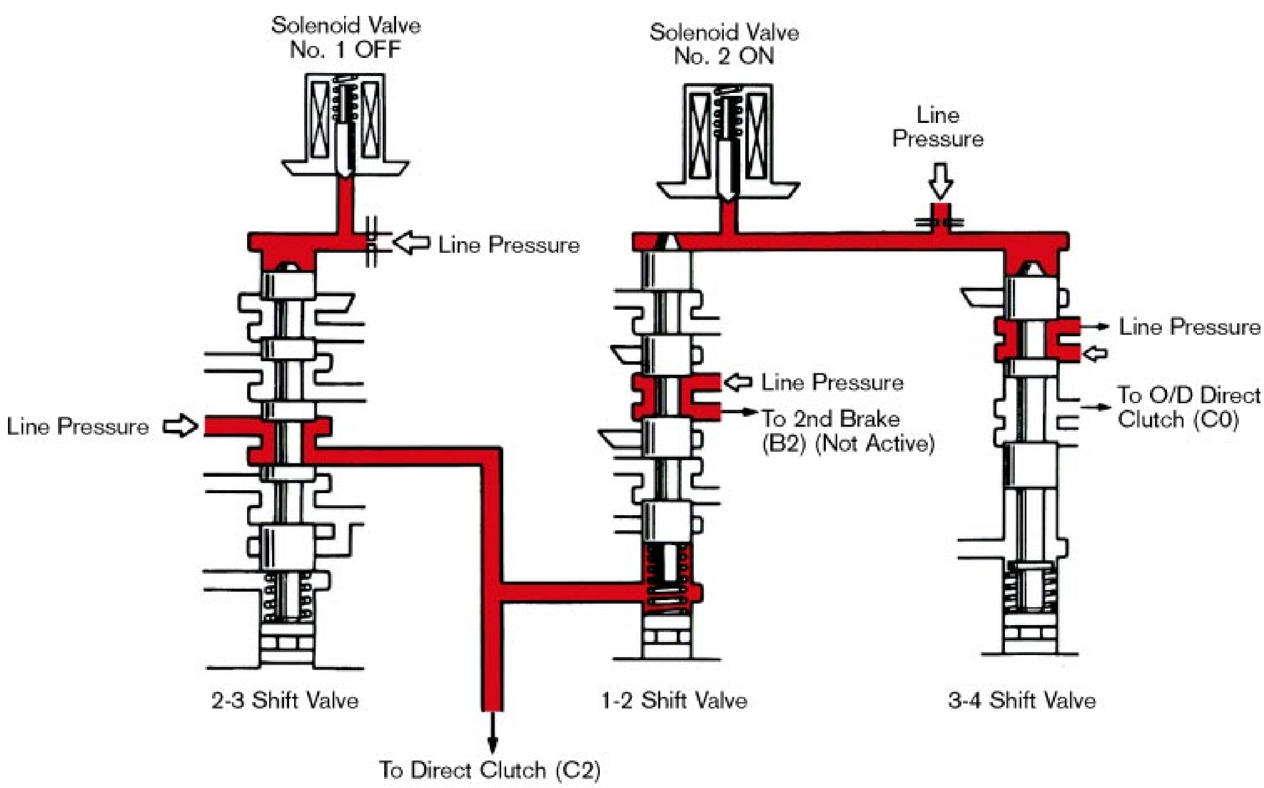


Fig. 4-26
T273f203

U-Series Solenoids

The U-series transmissions have multiple solenoids that control:

- shifting.
- clutch application pressure.
- system line pressure.
- converter lock-up.
- clutch to clutch control.

Solenoids are controlled by the ECM based on:

- engine RPM.
- engine load.
- throttle position.
- ATF temperature.
- input turbine speed sensor.

Linear solenoids regulate hydraulic pressure based on current flow. Current flow is duty cycle controlled from the ECM. The longer the ON cycle, the higher the current flow and the lower the hydraulic pressure.

ON/OFF solenoids control hydraulic circuits by opening or closing the circuit. They do not vary the pressure like the linear solenoids. They are spring loaded in the closed position, exposing a drain to the controlled circuit and when energized will open the controlled circuit to line pressure.

U-Series Solenoid Operation

The Linear solenoids regulate hydraulic pressure based on current flow. ON/OFF solenoids control hydraulic circuits by opening or closing the circuit.

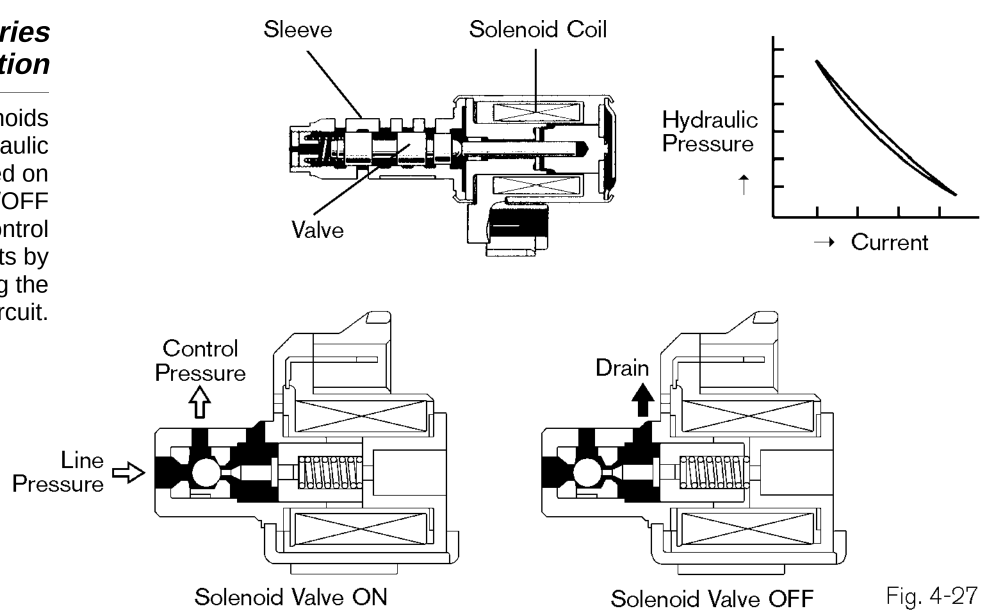


Fig. 4-27
T273f204/T273f083
T273f081/T273f085

U-240E Solenoid Operation

The U-240E transaxle uses five solenoids to control line pressure, converter lock-up and transmission shifting. Three solenoids are linear controlled to regulate pressure and two are ON/OFF solenoids which apply or release line pressure. Linear valves regulate hydraulic pressure based on current flow. Current flow is duty cycle controlled from the ECM. The longer the ON cycle, the higher the current flow and the lower the hydraulic pressure. The ECU monitors the input turbine speed and the counter gear speed to detect the timing of the shift as well as any slipping that might occur.

U-240E Solenoids

The U-240 series transaxle uses five solenoids to control line pressure, converter lockup and transmission shifting.

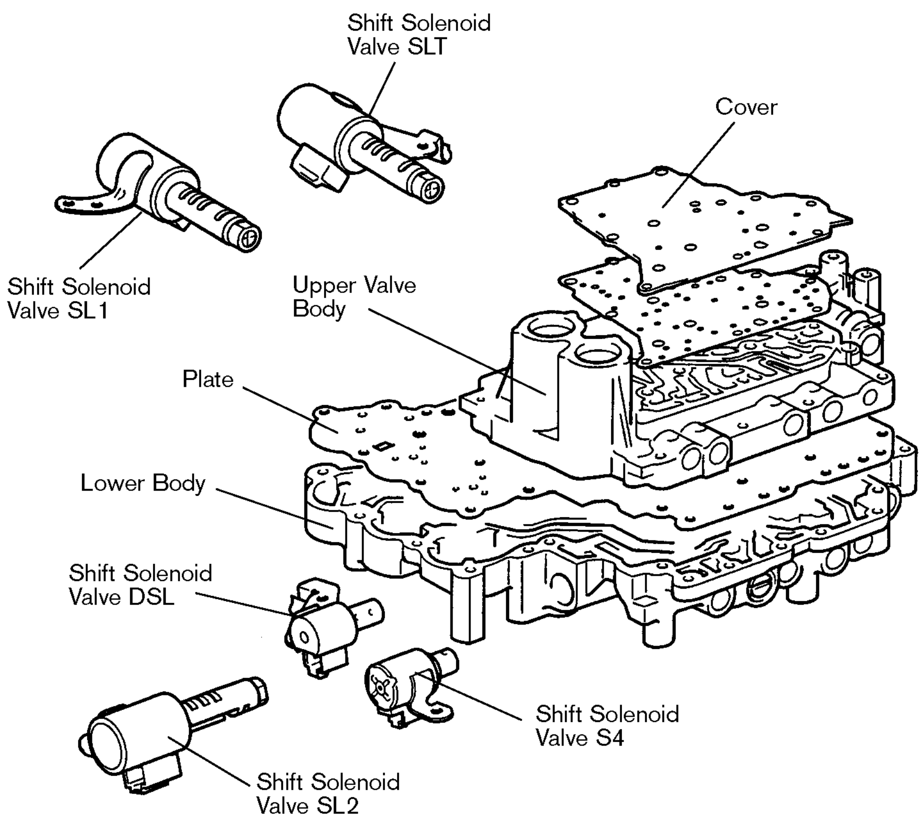


Fig. 4-28
T273f205

SL1 & SL2 - Shift Timing

Solenoids SL1 & SL2 are linear solenoids which control shifting of the transmission. The linear design also provides a means of controlling pressure to more closely tailor clutch application. Because the applied pressure is directly regulated by the solenoid, there is no need to provide back pressure to the B1 and C2 accumulators.

The B1 Control Valve is located between SL1 and the *second brake* (B1). SL1 controls the B1 Control Valve which meters line pressure to B1. When the solenoid is ON, as in first gear, the B1 Control Valve opens a drain for the *second brake* (B1). When the solenoid is OFF, line pressure is metered to B1 through the B1 Control Valve.

SL1 and SL2 Operation

Solenoid SL1 controls the B1 Control Valve which controls line pressure to the second brake (B1).

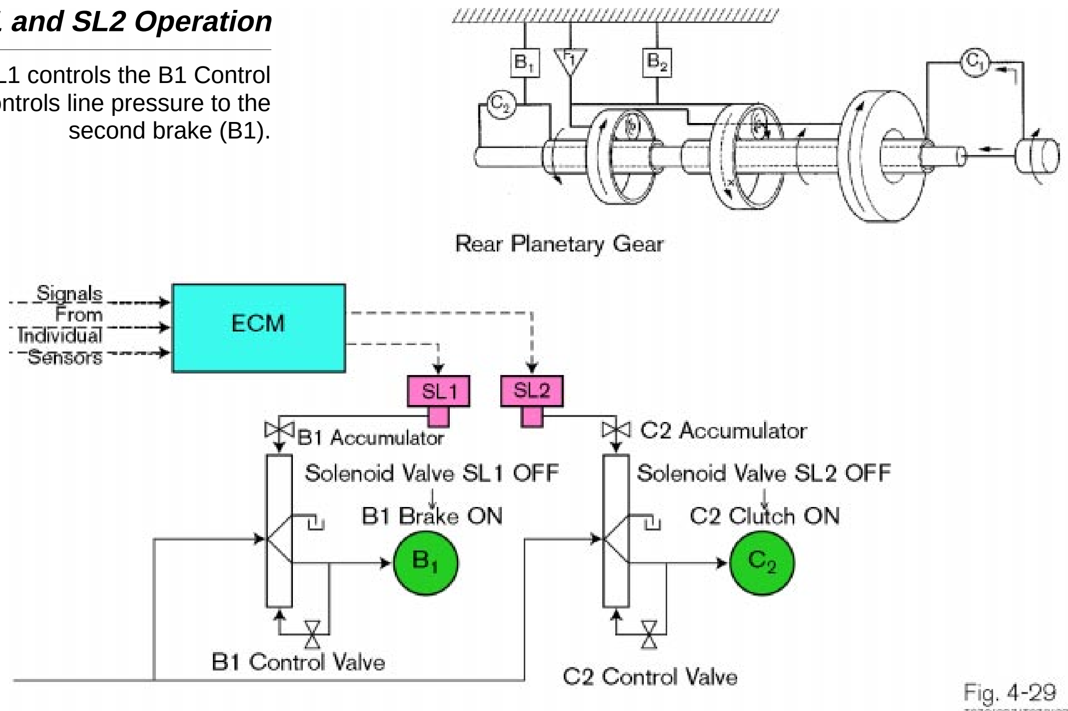


Fig. 4-29
T273I207/T273I206

The *second brake* (B1) and the *direct clutch* (C2) both control the rear planetary sun gear. The shift from second gear to third requires the application of one holding device while the other is released. In an upshift to third gear, C2 connects the intermediate shaft to the sun gear while B1 releases the sun gear from the transmission case.

The C2 Control Valve is located between SL2 and the *direct clutch* (C2). Solenoid SL2 controls the C2 Control Valve which regulates line pressure to C2. When SL2 is ON, as in second gear, the C2 Control Valve opens a drain for C2. When the solenoid is OFF, the control valve moves up and line pressure is metered to C2 and it is engaged for third gear. Because B1 and C2 are attached to the same planetary component, it makes this shift critical as B1 must be released as C2 is applied for the upshift to third gear, or the transmission will slip and engine speed will flare.

The ECM monitors the shift via inputs from engine rpm and vehicle speed. It is capable of tailoring SL1 and SL2 to control the transition from 2nd to 3rd gears.

S4 Solenoid

Solenoid S4 is an ON/OFF solenoid that controls the 3-4 upshift. The *underdrive direct clutch* (C3) and *underdrive brake* (B3) both control the underdrive sun gear. B3 connects the sun gear to the case so there is a gear reduction through the underdrive unit in all gears except fourth gear. C3 connects the sun gear to the planetary carrier to provide direct drive through the underdrive unit in fourth gear. When the upshift to fourth gear occurs, C3 is applied while B3 is released through the action of the 3-4 shift valve.

The 3-4 shift valve is spring loaded to allow B3 to be applied and C3 to be released. When the S4 solenoid is turned ON, line pressure forces the 3-4 shift valve to compress the spring applying C3 and releasing B3.

S4 Operation

When the S4 solenoid is turned ON, line pressure forces the 3-4 shift valve to compress the spring applying C3 and releasing B3.

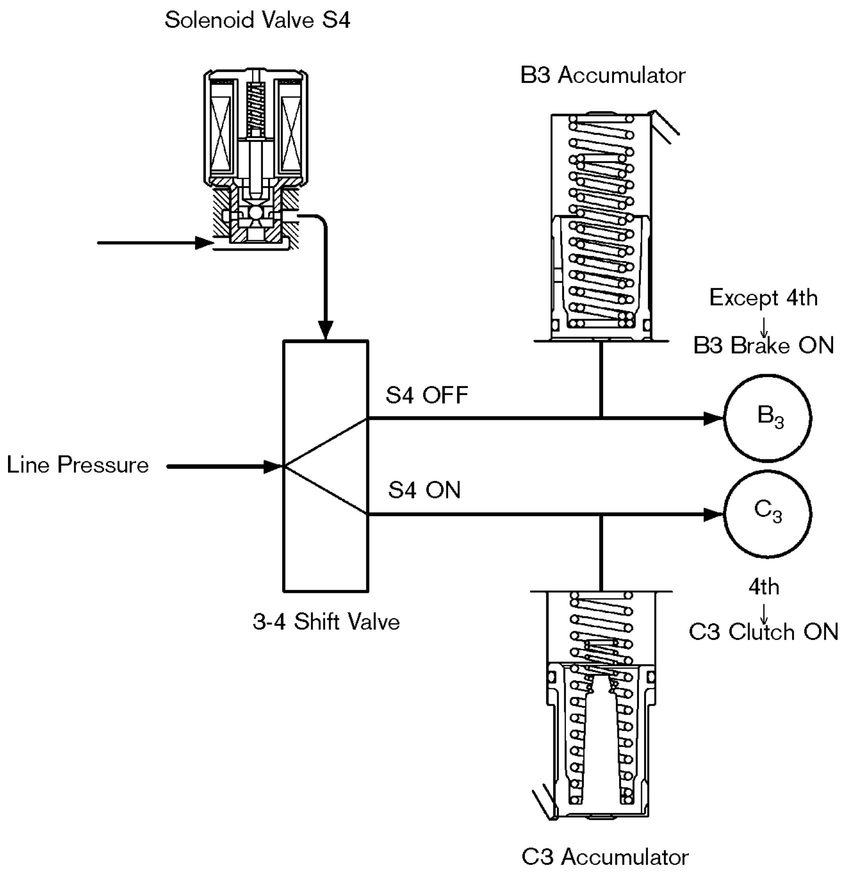


Fig. 4-30

DSL Solenoid

The DSL solenoid is an ON/OFF solenoid used to control the *first and reverse brake* (B2) which is applied in reverse and low gear only. The C2 lock valve and B2 control valve are located between the DSL solenoid and B2. Line pressure from the manual valve in low and reverse is controlled by the B2 control valve.

Reverse In reverse gear, C2 and B2 are applied. The B2 control valve is spring loaded pushing the valve upward exposing pressure from the manual valve to apply B2.

Low In low gear, B2 is applied in parallel with F1 to provide engine braking. The C2 lock valve controls the application of B2 when low is selected. The lock valve is pushed down allowing DSL controlled pressure to push the B2 control valve down. In this position, pressure from the manual valve applies B2 for low gear.

Lock-Up The lock-up relay valve is spring loaded in the lock-up off position where secondary pressure is directed to the lock-up off chamber in front of the torque converter lock-up clutch. Line pressure holds the C2 lock valve down until C2 is applied in third and fourth gear. When the C2 lock valve moves up, it opens the passage from the DSL solenoid to the base of the lock-up relay valve. At the appropriate speed the ECM turns the DSL solenoid on to push up on the lock up relay valve. Secondary pressure is directed to the lock-up on chamber applying the lock-up clutch.

B2 and Lock-Up Control

The DSL solenoid is an ON/OFF solenoid used to control the first and reverse brake (B2) and lock-up clutch operation.

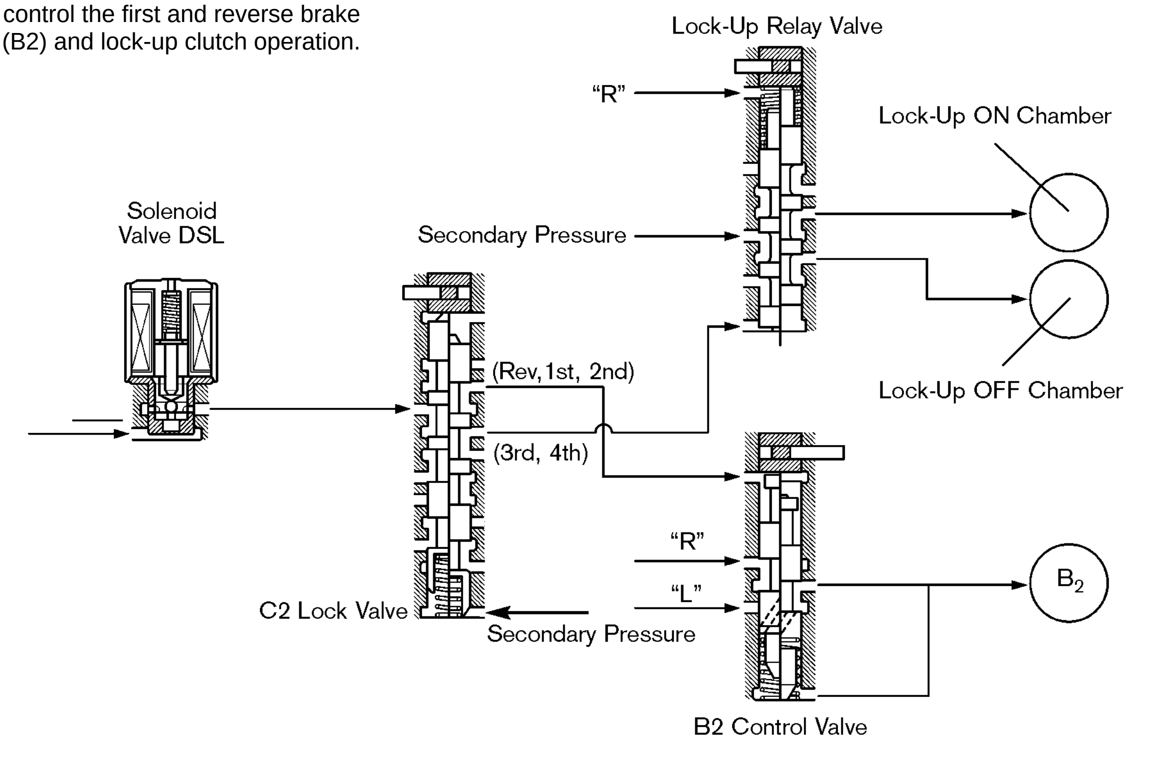


Fig. 4-31
T273f209

U-341E Solenoid Operation

The U-341E transaxle uses five solenoids to control line pressure, converter lock-up and transmission shifting. Two solenoids are linear controlled to regulate pressure and three are ON/OFF solenoids which control line pressure. The ECU monitors the input turbine speed and vehicle speed to detect the timing of the shift as well as any slipping that might occur.

U-341E Solenoids

The U-341E transaxle uses five solenoids to control line pressure, converter lockup and transmission shifting.

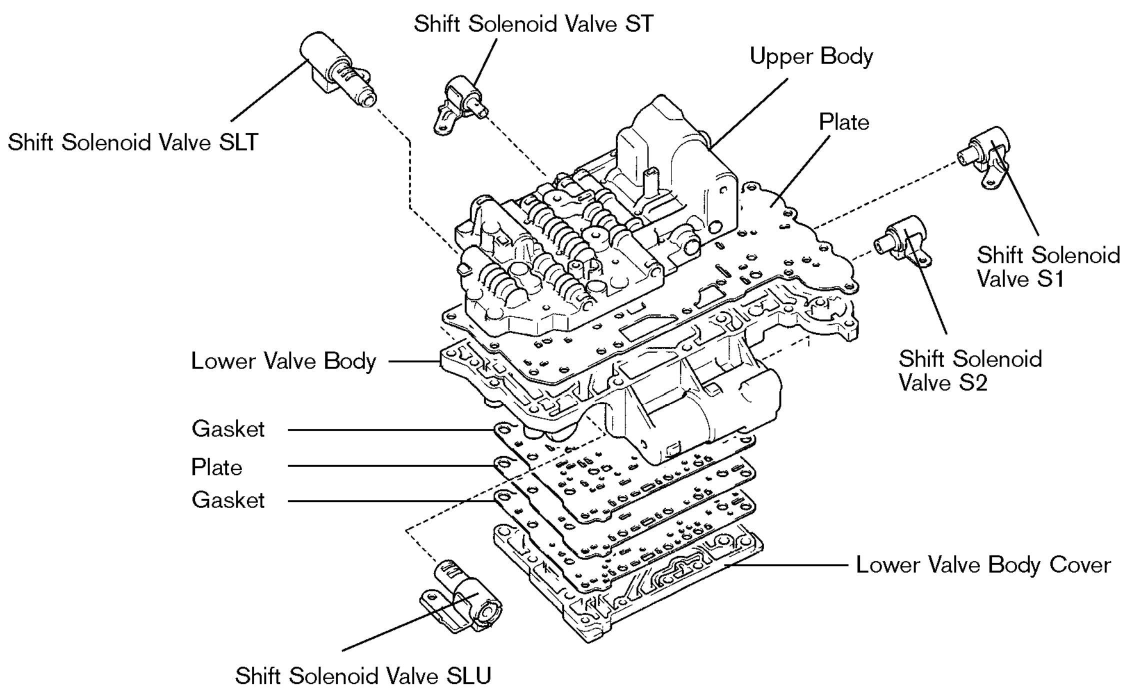


Fig. 4-32
T273f210

Solenoids S1 & S2 are ON/OFF solenoids which control shifting of the transmission. When the gear selector is placed in drive, both solenoids are turned ON. The *forward clutch* (C1) is applied by the manual valve. When solenoid S2 is turned off, the *2nd brake* (B2) is applied for second gear. When S1 is also turned off, the *direct clutch* (C2) is applied locking the planetary gear sets together for direct drive. S2 is turned on for fourth gear, causing the 3-4 shift valve to open a drain for the *forward clutch* (C1) and allow line pressure to apply *overdrive and 2nd brake* (B1).

ST Solenoid The ST solenoid regulates the shift quality between third and fourth gears. It is an ON/OFF solenoid which controls the release of one clutch and the application of a second clutch.

ST controls shift timing by regulating pressure control through the 3-4 and 4-3 timing valves. Passages to C1 and B1 have an orifice restriction which delays clutch engagement. The timing valve controlled by ST provides a parallel circuit to C1 and B1 which bypass the orifice, providing metered application or release of C1 & B1.

SLT Solenoid The SLT solenoid is a linear solenoid which regulates the accumulator backpressure for each accumulator to improve shift quality.

ST Solenoid Operation

The O/D & 2nd brake (B1) is applied as the forward clutch (C1) is released.

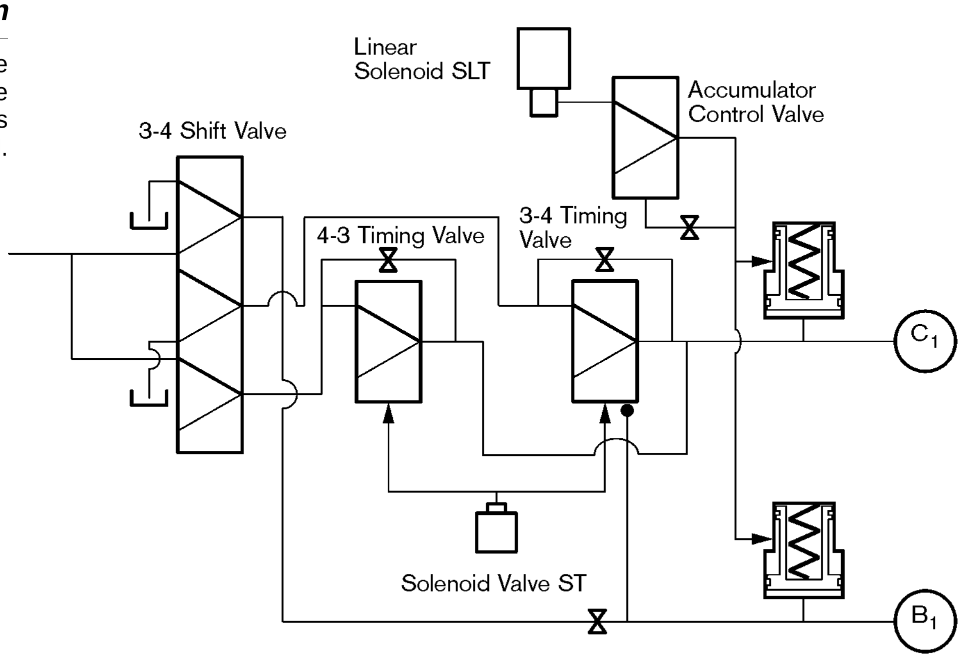


Fig. 4-33
T273f211

Lock-Up Control

The ECM has lock-up clutch operation pattern for each driving mode (Normal and Power) programmed in its memory. The ECM 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 overdrive.
- Vehicle speed is at or above the specified speed and the throttle opening is at or above the specified value.
- The ECM has received no mandatory lock-up system cancellation signal.

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

Lock-Up Control System - ECT

The EMC monitors multiple sensors to determine torque converter operations.

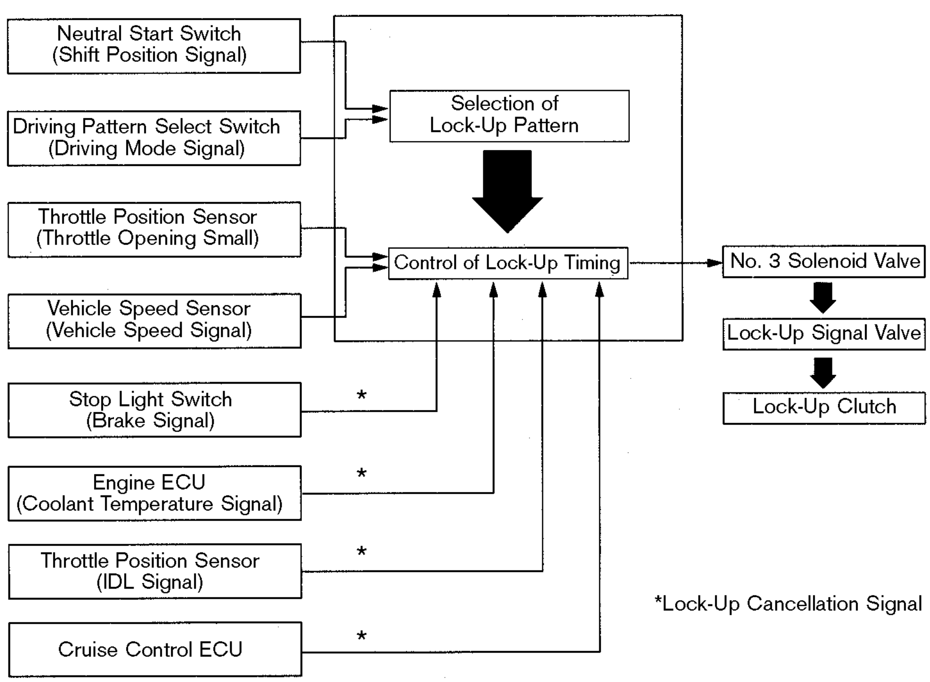


Fig. 4-34
T273f212

The ECM will cancel lock-up if any of the following condition 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 drive wheels lock up during braking. Coolant temperature is monitored to enhance driveability 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

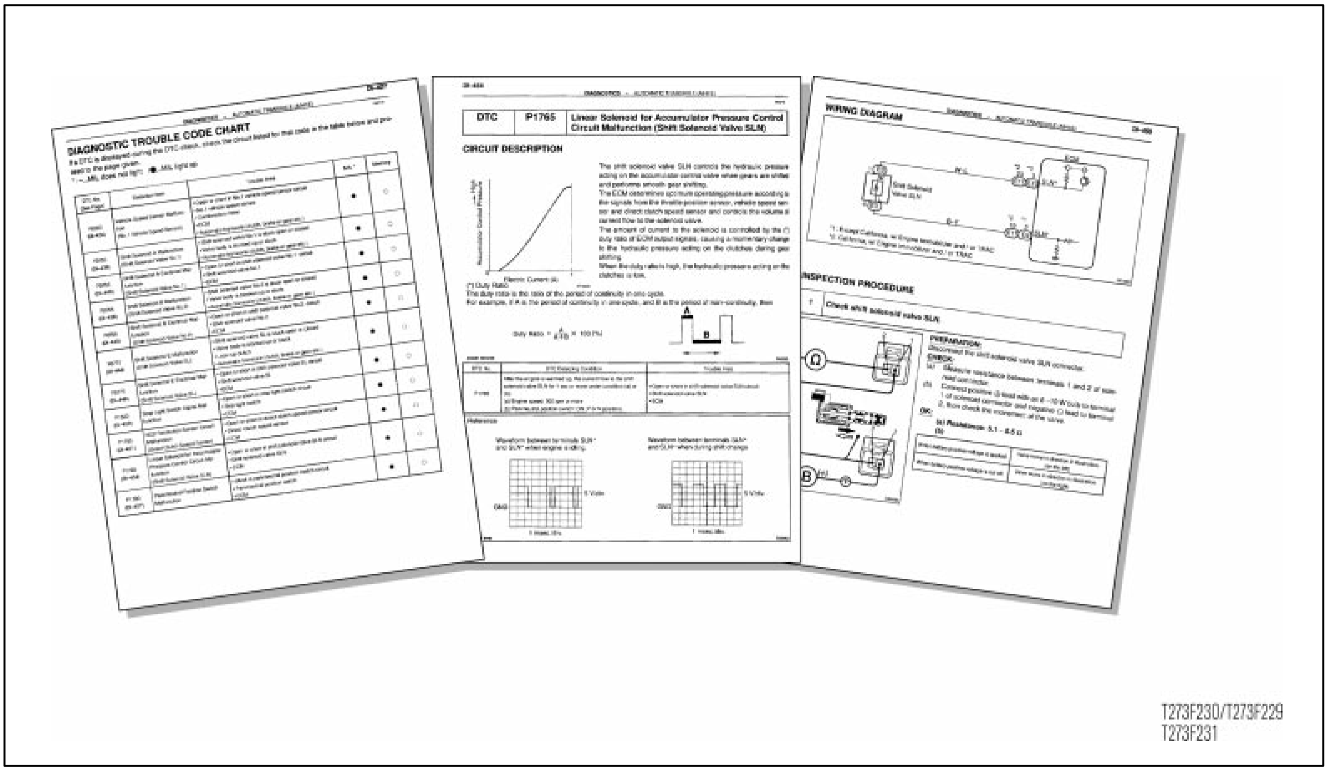
When the transmission is shifted from the neutral to the drive range, the ECM prevents it from shifting directly into first gear by causing it to shift into second or third gear before it shifts to first gear. It does this in order to reduce shift shock and squatting of the vehicle.

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 ECM 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.

Section 5

Diagnostic Procedures



Lesson Objectives

1. Perform all preliminary checks prior to test driving.
2. Relate the importance that verifying the customer concern plays in diagnosis.
3. Explain the types of fluid contaminants.
4. Explain holding device diagnosis based on a time lag test.
5. Perform a thorough test drive for transmission diagnosis.
6. Perform a manual shift test of an ECT transmission vehicle.
7. Access diagnostic codes using the diagnostic tester or flashing O/D OFF Light in earlier models.
8. Check line pressure at idle and stall speed.
9. Monitor line pressure during automatic and manual upshift operation.
10. Explain Repair Manual features which assist in diagnosis.

Notes

Diagnostic Procedures

Diagnosis of an automatic transmission requires a logical step by step procedure that establishes the cause of the problem. The procedure must eliminate as many causes as possible before the transmission is removed. To accomplish this, it is as important to determine what is working, as it is to determine what is not working. Time spent in diagnosis will help isolate the problem to one of the following:

- engine driveability
- internal mechanical or friction disc failure
- hydraulic logic control
- electronic system failure

Many diagnostic clues are no longer available once the transmission is removed and spread out on a bench. Once diagnosis has narrowed the cause, determine whether the repair can be done with the transmission in the vehicle or if it needs to be removed. Additionally, will it be cost effective to repair the transmission or replace it with a re-manufactured unit?

Diagnostic Sequence of Events

Diagnosis of automatic transmission complaints should follow a systematic sequence of events which resolves the customer's concern.

1. **Verify the Customer Complaint**
   Is there enough information?
2. **Fluid Checks.**
   Ensure the proper level and condition of the fluid.
3. **Time Lag Test**
   Verify clutch engagement for first gear and reverse.
4. **Test Drive**
   Duplicate the condition to experience the customer's concern.
5. **Road Test**
   Thorough evaluation of the transmission operation.
6. **Diagnostic Trouble Codes**
   The ECM monitors the sensors and solenoids and sets a trouble code in memory.
7. **Preliminary Checks and Adjustments**
   Verifies communication between the engine and transmission.
8. **Manual Shift Test**
   Disconnect shift solenoid and verify transmission manual operation.
9. **Diagnostic Tester Usage**
   Analyzing the test drive results.

Verify the Customer Complaint

Verifying the customer complaint is the single most important step in diagnosis. The technician needs to experience the condition and be able to duplicate it to accurately diagnose it. It is impossible to repair a complaint that cannot be verified or repair a condition that is a normal characteristic of the vehicle's transmission. To repair a problem found during diagnosis without ensuring that it fits the customer concern, runs the risk of failing to meet the customer's expectation.

Customer Interview Sheet

Communication between the customer and the technician is essential to verifying the complaint. The technician is frequently isolated from the customer and receives his information third-hand from the Service Writer. To bridge this gap, a customer interview sheet is strongly recommended to ensure the technician has as much information as possible to begin his diagnostic effort. The more details that are available, the more likely the condition can be found quickly. A sample Customer Interview Sheet can be found in Appendix E.

If the complaint cannot be verified, it may be necessary to speak with the customer and have him/her accompany you on the test drive to identify their concern.

Customer and Vehicle Data

The customer and vehicle data are for administrative purposes for tracking the customer or vehicle. Additionally, it's important to determine if the person bringing the vehicle for service is the primary operator who has first-hand knowledge of the complaint.

Automatic Transmission Data

Ask the customer to identify the symptom(s) by checking the appropriate box as well as any subsequent boxes that clarify the selection. Next, identify whether the condition occurs constantly or intermittently.

Three questions should be answered before you begin your diagnostic procedure to ensure a proper repair the first time.

1. What is the specific complaint or *concern*?
   Details of what the customer sees, feels, and hears as abnormal.
2. Under what conditions does the complaint occur?
   Cold or hot operation, occurs always, intermittently or first engagement after sitting overnight.
3. What is the vehicle's recent service history?
   All service both mechanical and body/paint.

Preliminary Fluid Checks

A preliminary fluid check ensures the transmission has sufficient fluid and indicates the condition of the fluid prior to the test drive. There is no need to top off the fluid unless it is extremely low and could cause further damage. Do not attempt to make any adjustments or repairs prior to the test drive as this may mask the symptoms. Be sure to make notes of your findings on the RO for future reference.

Fluid Level

The fluid level should be inspected when the fluid has been warmed up to normal operating temperature, approximately 158°F to 176°F. As a rule of thumb, if the graduated end of the dipstick is too hot to hold, the fluid is hot enough. Proper fluid level is in the hot range between hot maximum and hot minimum. Check the fluid level yourself and don't assume that someone else has done it properly.

NOTE

The cool range found on the dipstick should be used as a reference only when the transmission is cold, to ensure adequate lubrication while the fluid is brought up to temperature. The correct fluid level can only be determined when the fluid is hot.

Fluid Level Check

The fluid is at the proper level if in the hot range between hot maximum and hot minimum.

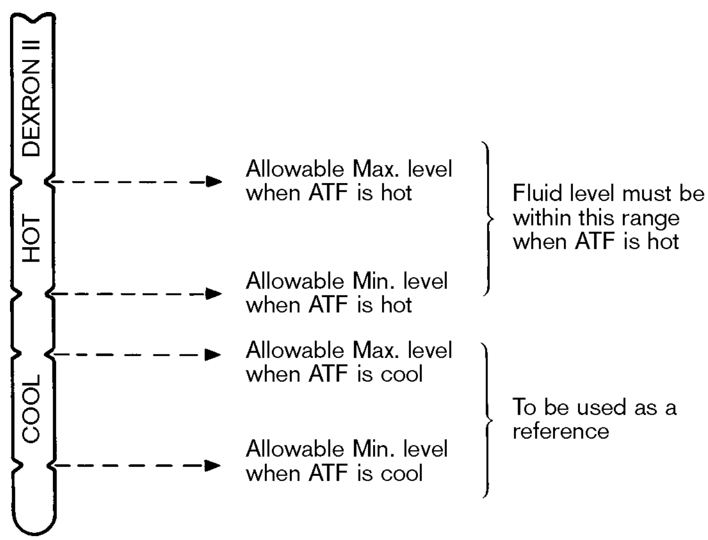


Fig. 5-01
T273F213

Proper fluid levels ensure proper operation of the holding devices, the torque converter and lubrication of the automatic transmission. A low fluid level causes delayed engagement in both drive and reverse and slipping when upshifting. Slipping causes overheating and rapid wear of clutches and bands. Additionally, fluid may migrate away from the oil pickup under heavy deceleration, resulting in a lack of oil volume required to disengage the lockup converter clutch.

Aeration occurs when fluid level is too low or too high. With low fluid level the oil pump draws air, causing it to mix with the fluid. If fluid level is high, the planetary gears and other rotating components agitate the fluid, aerating it and causing similar symptoms.

The aerated fluid combined with overheating due to slippage, causes the fluid to oxidize and varnish builds up on components. Varnish interferes with normal valve, clutch and accumulator operation. Additionally, aerated fluid will rise in the case and leak from the breather plug at the top of the transmission housing or through the dipstick tube.

If the level appears to be correct, check for an air leak on the suction side of the pump. Check the filter installation, paying particular attention to the gasket or O-ring.

Differential Fluid Level

In addition to the transaxle fluid level, some transaxles require a separate check of the differential fluid level. The fluid is separated from the main body of the transaxle by a pair of seals on the drive pinion. Fluid level is checked by removing the filler plug. Fluid should be level with the filler plug hole. This chamber is drained and filled separately from the transaxle. Although some transaxles are open to the differential, be sure to check the differential for proper level when refilling the transaxle.

Differential Fluid Level Check

Some transaxles require a separate check of the differential fluid level.

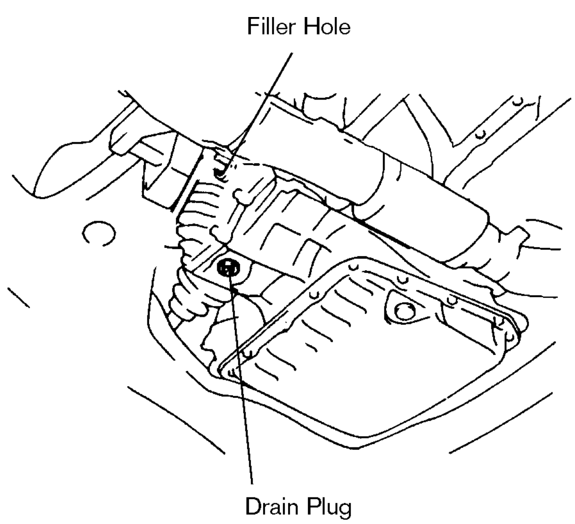


Fig. 5-02
T273F214

Fluid Condition

Two indicators of fluid condition have been color and smell, but these can no longer be relied upon for definitive diagnosis. Since the removal of asbestos from friction material and the added resin content, the chemical formulations of new fluids and resin have contributed to the smell and color changes in current fluids. A dark clear brown or dark clear red fluid color does not by itself indicate a failed unit even if it smells burned.

To get a better indication of fluid condition, place a sample of the fluid on a white paper towel.

Analyzing Fluid Condition

Place a sample of the fluid on a white paper towel for closer analysis of fluid condition.

Fig. 5-03

T273F215

If any of the conditions listed below are found in the fluid sample, the transmission should be rebuilt or replaced with a re-manufactured unit:

- residue or flaky particles of metal or friction material.
- heavily varnished fluid which is tacky and no longer clear.
- milky appearing fluid caused by engine coolant entering the transmission. The coolant may cause the friction facing to loosen from the clutch plates and torque converter clutch

If you're just not sure about the fluid condition and residue on the dipstick, the transmission pan can be removed after the test drive to evaluate the residue content. Residue can be particles of steel, bronze, plastic or friction material reflecting damage to bushings, thrust washers, clutch plates or other parts. Some residue at the bottom of the pan is not uncommon. You will find two or more magnets positioned in the pan to attract metal particles, trapping them from suspension in the fluid and being transported through the transmission. They are usually covered with some metal shavings.

Remove Pan to Inspect Residue

Residue can be particles of steel, bronze, plastic or friction material reflecting damage to bushings, thrust washers, clutch plates or other parts.

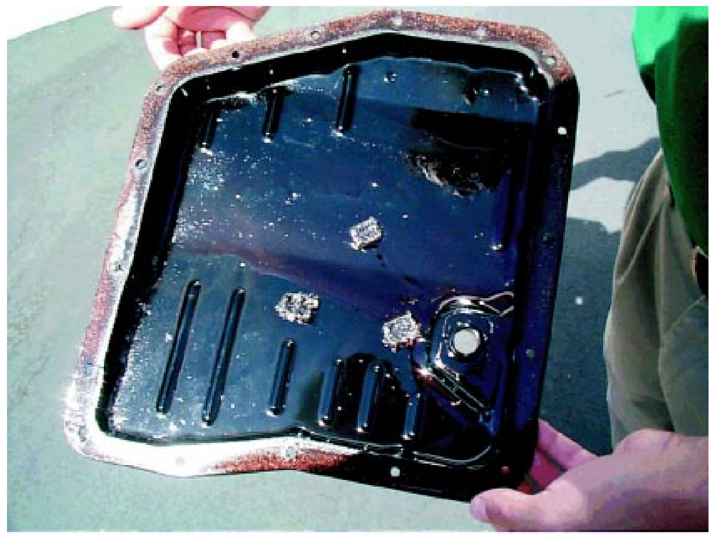


Fig. 5-04
T273F216

When the fluid is clean and residue is minimal, chances are the problem will not be resolved by removing the transaxle and overhauling it or replacing it with a re-manufactured unit. The problem is likely to be outside the transmission.

Time Lag Test

The time lag test is the measurement of time from the movement of the shift lever from neutral to drive or reverse, until the engagement shock of the holding devices is felt. This is useful to determine the integrity of the hydraulic line pressure, the *overdrive direct clutch* (C0), *forward clutch* (C1) and the *first and reverse brake* (B3). Low line pressure or worn clutch seals can cause engagement shock to be delayed.

- The transmission fluid should be at normal operating temperature before conducting the test.
- Apply the parking brake
- Start the engine and check idle speed
- Using a stop watch, make three measurements of the lag time in drive and reverse.
- Allow one minute between tests to allow fluid to exhaust from the holding devices.
- Use the average time to compare against the specifications

The chart below lists several transmissions and the holding devices applied in "drive first gear" and "reverse." For example, an A-540E's proper lag time is 1.2 seconds from neutral to drive and 1.5 seconds from neutral to reverse. If the average lag time to drive is longer than 1.2 seconds, one or more of the following may be worn: *forward clutch* (C1), *No. 2 one-way clutch* (F2), or *overdrive one-way clutch* (F0) and *overdrive direct clutch* (C0). Low line pressure may cause late engagement in both drive and reverse.

Time Lag Test

Holding devices engaged in drive and reverse differ depending on the transmission application.

Transmission	Lag Time	Neutral to Drive	Neutral to Reverse
A-130	D=1.2 R=1.5	C1, F2	C2, B3
A-140/A-540	D=1.2 R=1.5	C1, F2, F0	C2, C0, B3
A-340/A-4#	D=1.2 R=1.5	C1, F2, F0	C2, B3, F0
A-240	D=0.7 R=1.2	C1, F2, F3, B4	C2, B3, B4
U-140/U-240	D=1.2 R=1.5	C1, B3, F1, F2	C2, B2, B3
U-340	D=1.2 R=1.5	C1, F2	C2, B3

Fig. 5-05

T273F038

Test Drive

The test drive is important for two reasons. It provides an opportunity to experience the transmission operational characteristics first hand and ultimately allows for the confirmation of your repairs. Your primary purpose should be to duplicate the customers concern.

If the concern cannot be verified during your diagnosis, more information is needed and therefore it is necessary to speak with the customer.

It may be necessary for the customer to accompany you on the test drive to identify the concern.

Road Test

The engine and transmission should be at normal operating temperature. While in neutral position with the engine running, the vehicle should not move either forward or rearward. If the vehicle does move or creep, note the condition and be sure to check the manual linkage adjustment.

During your road test, operate the transmission through each selector range as well as forced and manual downshifts. Check for engine flare or clutch slipping, engagement quality, noise and vibration. Note your findings on the Repair Order, or a copy of the Road Test Procedure Worksheet for each gear position.

D-Range

From a standstill, move the gear selector into D-range. Accelerate the vehicle at 1/4 and 1/2 throttle opening and note each upshift. All upshifts should occur regardless of the throttle opening. However, upshifts will vary at different throttle openings. For example, on a level surface the upshift from 2nd to 3rd will occur at a higher speed at half throttle than at quarter throttle.

While in 4th gear, moderately apply the throttle to test the 4-3 downshift. Note the result and repeat the last step at full throttle. At full throttle, depending on vehicle speed, the transmission may downshift to third or second gear.

2-Range

From a standstill, move the gear selector into 2-range. Accelerate the vehicle at 1/4 and 1/2 throttle opening. The transmission should shift from 1st to 2nd and hold in 2nd gear. This manual 2nd position should provide engine braking on deceleration

L-Range

With the gear selector in the L-range, the transmission should not upshift to 2nd and should have engine braking on deceleration.

R-Range

Bring the vehicle to a complete stop and place the gear selector in R-range. Accelerate at part throttle and again at full throttle for a short distance to check the operation.

CAUTION

When test driving a vehicle under heavy acceleration, particularly in reverse, be sure to exercise extreme caution. Be aware of vehicles, traffic and pedestrians in the area.

Manual Downshift

Press the O/D OFF button on the gear selector and check for a downshift to 3rd gear. At 35 mph or less, move the gear selector from the D position to the 2 position and check for a downshift to 2nd gear. At 25 mph or less, move the gear selector from the 2 position to the L position and check for a downshift to first gear.

On-Board Diagnostic Codes

On-board diagnostics (OBD) have been available on Toyota electronic control transmissions since the mid-eighties. The ECM monitors input and output circuits and compares them to known parameters. When a circuit operates outside these parameters, trouble codes are set, maintained in the ECM memory and the O/D OFF light is illuminated.

In generation two on-board diagnostics (OBD II), not only does the ECM monitor input and output circuits, but it is also capable of determining slippage and shift timing. The ECM causes the overdrive OFF lamp or MIL to illuminate in the event there is a fault either in the engine or trans-mission. The diagnostic codes provide direction to the person diagnosing a customer's concern; be sure to make a note of all codes and freeze data stored in memory.

Diagnostic Tester

Toyota's Diagnostic Tester can be connected to OBD II models equipped with a DLC2 or DLC3 connector located under the instrument panel. All stored trouble codes can be read directly from the tester's screen.

Checking Diagnostic Codes With the Diagnostic Tool

All stored trouble codes can be read directly from the tester's screen.

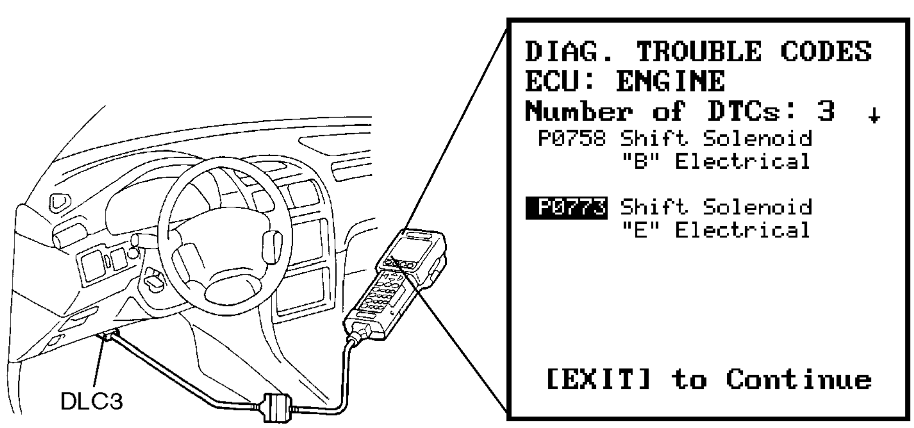


Fig. 5-06
T273F127/T273F217

Some Toyota models in 1994 and 1995, such as the Previa, LandCruiser and Supra, had diagnostic tester capability via the DLC1 connector located in the engine compartment. Common to these models is a TE2 terminal located in the DLC1 connector which allows the scan tool to display codes.

Flashing O/D OFF Light

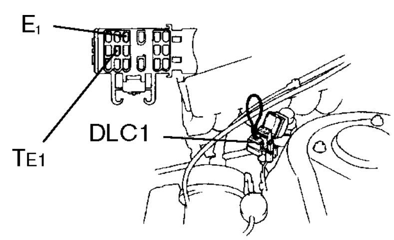
To retrieve codes on earlier models:

- Turn the ignition switch to the ON position.
- Place O/D switch in the ON position.
- Jumper connectors TE1 and E1 of the DLC1 or DLC2 connector.

Identify the diagnostic code by observing the overdrive OFF indicator light on the instrument panel. Consult the applicable repair manual to determine the procedure appropriate for the vehicle.

Checking Diagnostic Codes with Flashing Lights

Jumper connectors TE1 and E1 of the DLC1 or DLC2 connector and observe the flashing indicator light to determine the diagnostic code.



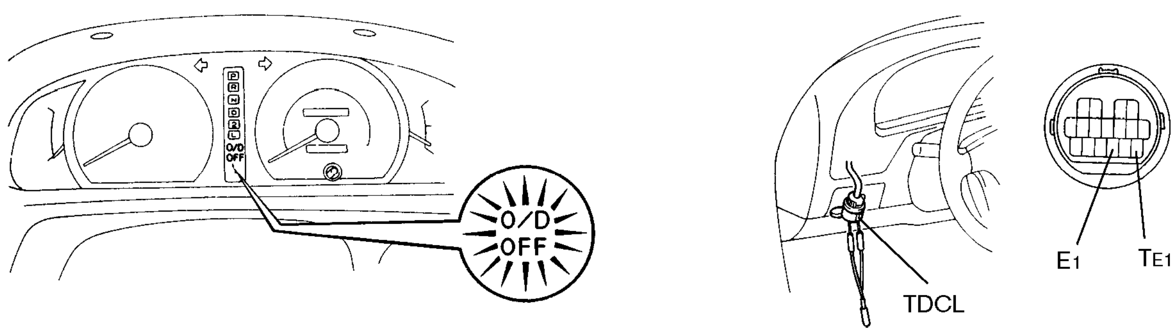


Fig. 5-07
T273F218/T273F219
T273F220

The overdrive OFF light will flash a normal code if the ECM has not detected a malfunction and a two digit code if a malfunction is detected. A normal code flashes twice every second. A malfunction code will flash one time per second with a one and a half second pause between digits. If two or more codes are stored, there will be a two and half second pause between codes. The string of codes will repeat after a four and a half second pause. The codes will always start with the smaller number and end with the larger number.

Trouble code charts can be found in Appendix C in the back of this handbook as well as the vehicle Repair Manual.

Diagnostic Codes

A normal code is output when there is no fault found. If more than one fault is detected, each code is displayed.

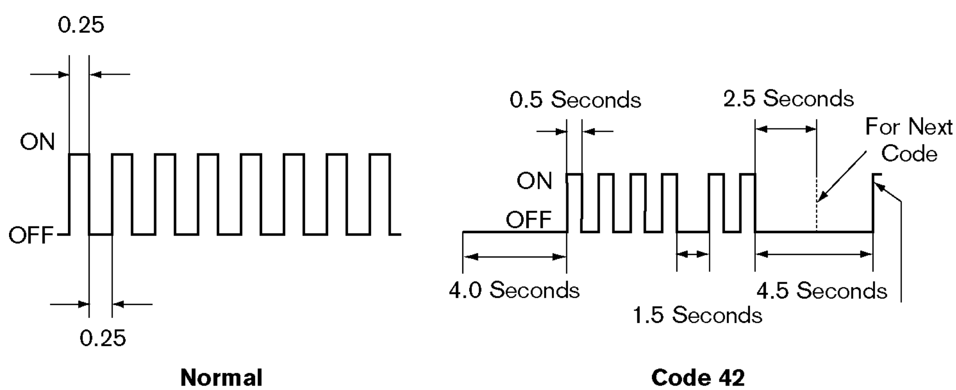


Fig. 5-08
T273F221/T273F222

Code Setting Parameters

Each component monitored by the ECM has its own parameters by which it is evaluated. Any time a code is set for a component, the electrical circuit from the component to the ECM is suspect as well. Some components and faults set a code immediately while others require a two trip detection logic. The two trip logic prevents the MIL light from illuminating and a code being set, until the problem has duplicated itself a second time with a key off cycle in between.

Preliminary Checks and Adjustments

The transmission receives mechanical input from the engine throttle and the gear selector. To optimize transmission operation, these mechanical linkages should be inspected and adjusted as needed.

Throttle Cable

The throttle cable connects the throttle linkage and the transmission throttle valve. As the throttle opens, greater torque is produced by the engine and the transmission may also downshift to a lower gear. Line pressure increases to provide greater holding force to prevent the hydraulic holding devices from slipping. When the throttle is opened, the cable transfers this motion to the base of the throttle valve and increases throttle pressure. This increase in throttle pressure causes the primary regulator valve to increase line pressure.

Throttle Cable Adjustment

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.

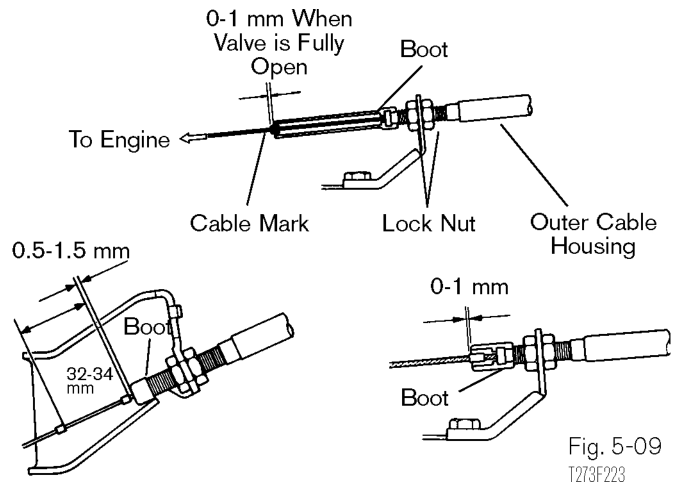


Fig. 5-09
T273F223

Inspection and Adjustment

To inspect the throttle cable adjustment, the engine should be off. Verify the procedure in the repair manual, as early model adjustment was done with the throttle wide open, later models are set with the throttle fully closed.

- With the accelerator fully depressed, ensure the throttle opens fully. Check for obstruction below the accelerator and adjust the accelerator control cable as needed.
- 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.

To adjust the throttle cable:

- Loosen the locking nuts on the cable housing.
- Verify with the repair manual whether the throttle is closed or open during the procedure.
- Reposition the cable housing and boot as needed until the specification is reached.

When a new cable is installed, the stopper must be positioned and clamped into place on the cable.

- Pull the inner cable lightly until a slight resistance is felt.
- Position the end of the stopper at a measurement of 0.8 to 1.5 mm from the end of the outer cable housing.
- Clamp the stopper in place on the cable.

When the throttle cable is misadjusted, it will affect line pressure and shift quality in both ECT and non-ECT transmissions. Shift timing will be affected in non-ECT transmissions only.

Shift Cable

The shift cable connects the shift selector to the transmission control shaft lever which moves the manual valve in the valve body. If out of adjustment, the manual valve may send fluid to multiple circuits resulting in loss of pressure and slipping holding devices. It may also cause the vehicle to creep forward or rearward with the selector in neutral position.

Inspection and Adjustment

This inspection is done from the passenger compartment with the engine off. Move the gear selector through each gear selection range noting the detent of the control shaft as it moves the manual valve. As the detent is felt, the position of the gear selector indicator should line up properly. Observe the gear selector indicator to ensure that only one indicator light is illuminated at one time. If more than one is lit, the ECM may sense a 2 or low position rather than a D position.

Adjust the shift cable if the indicator does not line up properly.

- Loosen the swivel nut on the shift linkage.
- Push the manual lever at the transmission fully toward the torque converter end of the transmission.
- 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

Set the selector lever to the Neutral position and tighten the swivel nut while holding the lever lightly toward the reverse position.

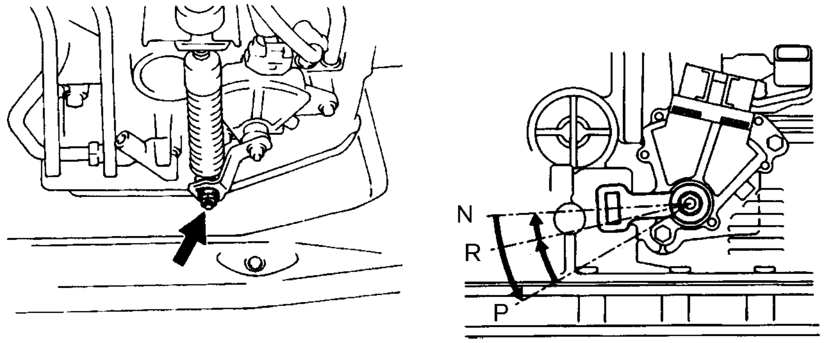


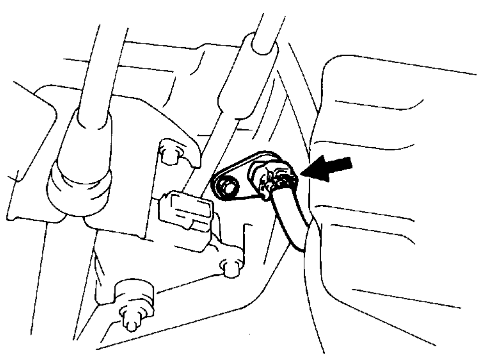
Fig. 5-10
T273F224/T273F225

Manual Shift Test

The manual shift test is used to determine if the cause of the malfunction is electrical or hydraulic. The electrical connector for the solenoid is disconnected at the transmission, disabling the shift solenoids. The transmission is shifted by moving the gear selector to Manual Low to start the vehicle moving. The first upshift occurs when the gear selector is moved to Manual Second. The transmission should shift into third or overdrive gear depending on the transmission model. An A-140, A-240 and A-340 series transmission will shift into third gear in Manual Two position, whereas an A-540 will shift into overdrive. The A-140, A-240 and A-340 will shift into overdrive when the gear selector is moved to the Drive position.

Manual Shift Test

Disconnect the solenoid connector at the transmission and manually upshift the transmission.



Shift Selector Position	A-140, A-240, A-340	U-240, A-540	U-140, U-340
R	Reverse	Reverse	Reverse
D	Overdrive	Overdrive	Third
2	Third	Overdrive	Third
1	First	First	Third

Fig. 5-11
T273F226/T273F128

If the transmission upshifts as described, the problem is likely to be found in the electrical system. To narrow the electrical troubleshooting, two tools are available. The Diagnostic Tool Set for OBD II vehicles and the ECT Analyzer for earlier models. The Diagnostic Tool Set connects to the DLC3 connector and is used to control the upshifts under 30 mph. The ECT Analyzer connects at the transmission solenoid connector and controls upshifts.

If the transmission does not upshift as described, the problem is likely to be found in the hydraulic system.

Stall Testing

The stall test is used to determine the condition of:

- the engine state of tune.
- specific holding devices in the transmission.
- the torque converter.

The stall condition occurs when the engine driven impeller rotates, but the turbine connected to the transmission input shaft and drive train does not. The torque converter stall speed occurs when the engine is unable to drive the impeller at a higher rpm due to the resistance of fluid flow to the turbine.

Before stall testing a torque converter, consider the customer complaint and your road test symptoms. The symptoms 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. Stall speed and line pressure at stall are required information on the Reman Core Information/Credit Request form.

In preparing the vehicle for a stall test:

- consider safety when staging the vehicle so it is not headed toward walls, other vehicles and pedestrians.
- the engine and transmission should be at operating temperature and at the proper level.
- attach a tachometer to the engine.
- the full weight of the vehicle should rest on the wheels.
- place chocks at the front and rear wheels.
- set the parking brake and apply the foot brakes with your left foot.

Stall testing should be checked in drive and reverse by moving the accelerator to wide open throttle and read the maximum engine rpm.

When engine rpm falls within specifications during a stall test, it verifies the following 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.
- The transmission oil pressure is adequate.
- Engine is in a proper state of tune.

When engine rpm falls below specification, it may be due to poor engine state-of-tune or an engine control timing change for torque control. Monitor the engine timing advance with the Diagnostic Tester while re-checking the stall speed. If stall speed is several hundred rpm under specification, and the ignition timing is retarded, the torque converter is not likely to be faulty.

If stall speed exceeds the specification limit or unusual noises are heard, release the accelerator immediately to avoid further damage to the transmission.

When a torque converter is determined faulty, be sure to closely inspect the splines of the stator support attached to the oil pump. If the splines are worn, it will also cause the new stator to slip.

CAUTION

Do not stall the converter for more 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 to cool before retesting or turning off the engine.

Line Pressure Testing

Line pressure is produced and maintained by a number of components in the hydraulic control system. Based on the hydraulic pressure created in the oil pump, the hydraulic control system governs the pressure acting on the torque converter clutch, the hydraulic clutches and brakes, and the accumulators. The hydraulic control system components are the pressure regulator valve, the throttle valve (based on throttle position), and the governor valve (non-ECT) (based on vehicle speed).

Pressure readings are taken at idle, during engine stall speed, and also during normal transmission operation.

- Pressure taken when the pump is turning at its slowest speed provides information on the integrity of the hydraulic control system. If the pump is worn, pressure regulator improperly adjusted, or a leak in the system could cause low line pressure.
- Pressure taken during engine stall speed are the maximum system pressure.
- Observing line pressure during normal vehicle operation provides information regarding engine load and vehicle speed as well as pinpointing leakage in a clutch or brake hydraulic circuit.

Because the pump is located above the level of fluid, fluid must be drawn from the oil pan through the filter and passages of the valve body. Any open point between the pump and pickup screen will draw in air and reduce system pressure.

Line Pressure Testing

The hydraulic control system governs the pressure acting on the torque converter clutch, the hydraulic clutches and brakes, and the accumulators.

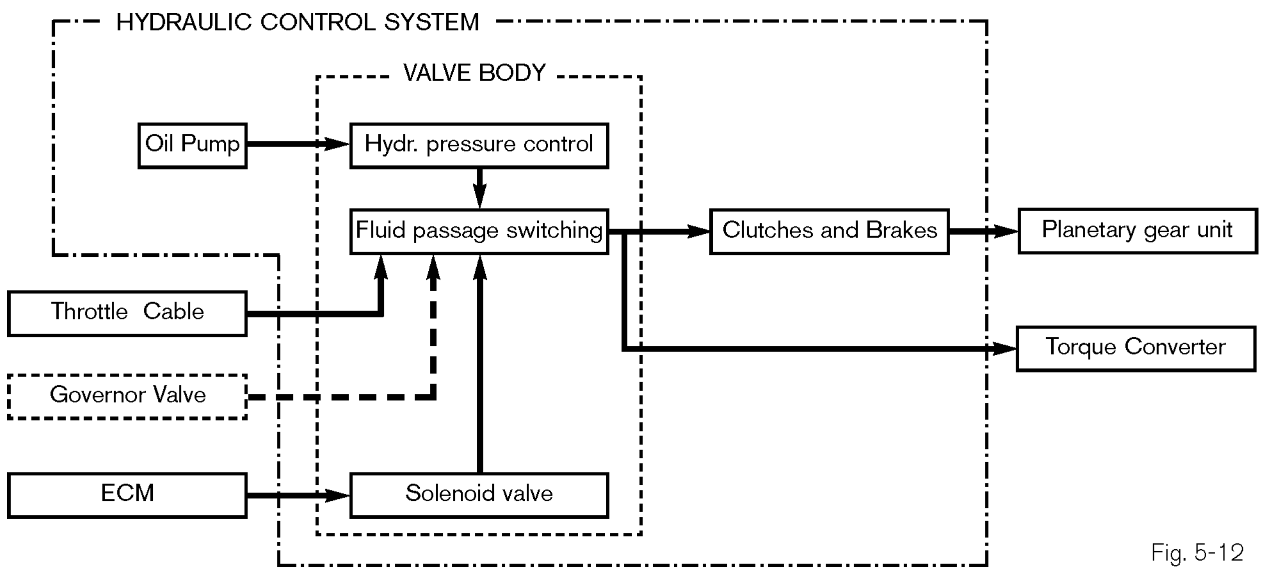


Fig. 5-12
T273f227

Preparation

Prepare the vehicle for pressure testing by installing the high pressure gauge (0 to 300 psi) to the transmission. Refer to the vehicle's repair manual for the test port location. When measuring line pressure at stall speed in the shop, be sure to chock all four wheels as a safety precaution.

Before checking line pressure at engine stall speed, test the line pressure at roughly 2400 rpm, while pulling the throttle cable, check for an increase in line pressure. When adequate line pressure is available and line pressure increases considerably when the throttle cable is pulled, it is safe to perform the stall test and reduce the possibility of additional damage to the transmission. The line pressure measurement at engine stall speed must appear on the Reman Transmission Core request form.

- Route the hose away from hot surfaces such as exhaust pipes and mufflers and place the gauge where it can be observed by the driver.
- Transmission fluid should be at the proper level and at operating temperature.
- Engine should be in a proper state of tune and idling within specifications.
- Move the gear selector to Drive and Reverse recording line pressure in each position.
- Stall test the transmission in Drive and Reverse and record the pressure in each position.

Line Pressure Chart

The chart identifies possible causes based on the pressure test findings.

Problem	Possible Cause
If the measured values at all positions are higher.	• Throttle cable out of adjustment • Throttle valve defective • Regulator valve defective
If the measured values at all positions are lower.	• Throttle cable out of adjustment • Throttle valve defective • Regulator valve defective • Oil pump defective • O/D Direct clutch defective
If pressure is low in the D position only.	• D position circuit fluid leakage • Forward clutch defective
If pressure is low in the R Position.	• R position circuit fluid leakage • Direct clutch defective • 1st and reverse brake defective

Fig. 5-13

Compare your readings with the repair manual line pressure specifications at idle and at stall in both Drive and Reverse. Compare your results with the chart above to determine the possible cause.

Advanced Diagnosis

Line pressure can also be observed to monitor each hydraulic clutch in succession as the transmission upshifts. The colored blocks in the chart below identify the clutch or brake added to the series of holding devices to provide the up-shift. A different hydraulic clutch/brake is applied for each upshift and therefore its integrity can be monitored with a pressure gauge.

For example, in A-series transmissions, C0 is applied in all gears except overdrive. When the gear selector is placed in drive, C1 is applied and remains applied in all forward gears. When B2 is applied, an upshift to second gear occurs. If pressure is normal in first and second gear, but drops in third and the engine speed does not drop (transmission remains in 2nd), it would indicate a leak in the circuit to the *direct clutch* (C2).

- Move the gear selector to Park or Neutral to check the pump circuit and the overdrive direct clutch (C0)
  - If line pressure is low - the pump or C0 could be bad.
  - If pressure comes up when shifting into overdrive, chances are, C0 is bad.
- Move the gear selector to Drive introduces the *forward clutch* (C1) and the transmission is in first gear.
  - If pressure drops, there is likely to be a leak in the seal to C1 or the hydraulic circuit to C1.
  - An upshift to second gear would bring on the *2nd brake* (B2). A drop in pressure would indicate a leak in B2 or its hydraulic circuit.
  - An upshift to third gear would bring on the *direct clutch* (C2). A drop in pressure would indicate a leak in C2 or its hydraulic circuit.
  - An upshift to fourth gear would bring on the *overdrive brake* (B0) and release C0. A drop in pressure would indicate a leak in B0 or it's hydraulic circuit.

Clutch Application Chart

The chart identifies the clutch/brake applied for each upshift gear position based on the pressure test findings.

Shift Lever Position	Gear Position	C0	C1	C2	B0	B1	B2	B3	F0	F1	F2
P	Park	Applied									
R	Reverse	Applied		Applied				Applied			
N	Neutral	Applied									
D	1st	Applied	Applied						Applied		Applied
	2nd	Applied	Applied				Upshift		Applied	Applied	
	3rd	Applied	Applied	Upshift			Not functional		Applied		
	O/D		Applied	Applied	Upshift		Not functional				
2	1st	Applied	Applied						Applied		Applied
	2nd	Applied	Applied			Applied	Applied		Applied	Applied	
	3rd*	Applied	Applied	Applied			Not functional		Applied		
L	1st	Applied	Applied					Applied	Applied		Applied
	2nd**	Applied	Applied			Applied	Applied		Applied	Applied	

* Does Not Apply to A-140L ** Downshift only - no upshift

(gray) Indicates the applied holding device.

(blue) Indicates the single clutch/brake applied to provide the gear change for automatic upshift.

(red) Holding device applied but not functional.

Fig. 5-14
T273F514

- Move the gear selector to 2 Range introduces the *second coast brake* (B1) when the transmission shifts into second gear.
    - If pressure drops but did not drop in automatic upshift to second in drive, there is likely to be a leak in the seal of B1 or the hydraulic circuit to B1.
- Move the gear selector to L Range introduces the *first and reverse brake* (B3) when the transmission shifts into first gear.
    - If pressure is lower, there is likely to be a leak in the seal of B3 or the hydraulic circuit to B3.

Monitoring line pressure during a test drive will provide valuable information when a fault is detected in the transmissions operation. In our previous example, slippage occurred in the *direct clutch* (C2). If system pressure did not drop when shifting into third gear, you can save time by eliminating pressure as a cause of the slippage. Instead, you could look at proper number of plates and discs or component assembly as the potential cause of the slipping clutch.

Repair Manual Troubleshooting

Retrieving diagnostic codes is just the beginning of troubleshooting. It identifies the component and its related circuit and requires isolating the problem to the component or wiring level.

To find the appropriate repair manual diagnostic procedure to follow:

- Refer to the first column of the repair manual Diagnostic Trouble Code Chart.
- Just below the trouble code, a page reference is given directing attention to the “trouble code circuit or system description” and “inspection procedure.”
- The description provides information regarding the circuit operation as well as code setting parameters.
- Following the inspection procedure will lead to a diagnosis of the circuit as well as the sensor or component.

Repair Manual Troubleshooting

The Trouble Code Chart provides the page reference to the system or circuit inspection.

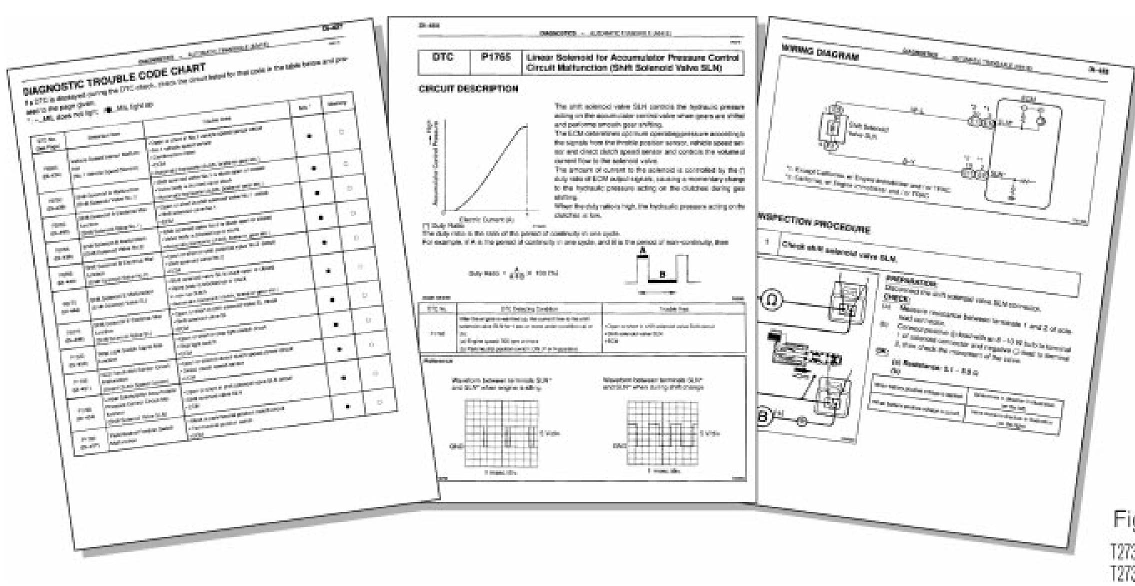


Fig. 5-15
T273F230/T273F229
T273F231

Symptom Chart Diagnosis

When a normal code is displayed, but you have been able to confirm a legitimate customer's complaint using the repair manual Symptom Charts will direct you toward a specific component or test procedure. The charts are based on whether the transmission is in the vehicle or on the bench. The symptom tables are divided into three chapters:

- Chapter 1: Electronic Circuit Matrix Chart
- Chapter 2: On-vehicle Repair Matrix Chart
- Chapter 3: Off-vehicle Repair Matrix Chart

Electronic Circuit Matrix Chart

When the ECM is suspected as a fault, the electronic circuit matrix chart refers you to a specific page in the Introduction (IN) section of the repair manual. This section guides you through the process of checking for opens, short circuits and grounds on harnesses. The chart may also provide a page reference for a component if it relates to the symptom.

NOTE

Before getting too deeply involved in harnesses and connectors be sure to utilize the diagnostic tester or ECT analyzer to verify the operation of sensors and actuators.

Electronic Circuit Matrix Chart

The chart refers you to the Introduction (IN) section of the repair manual with a page reference.

Symptom	Suspect Area	See page
No up-shift (1st→2nd)	ECM	IN-30
No up-shift (1st→3rd)	ECM	IN-30
No up-shift (3rd→O/D)	1. O/D main switch circuit 2. O/D cancel signal circuit 3. ECM	DI-465 DI-462 IN-30
No downshift (O/D→3rd)	ECM	IN-30
No downshift (3rd→2nd)	ECM	IN-30
No downshift (2nd→1st)	ECM	IN-30
No lock-up or No lock up off	ECM	IN-30
Shift point too high or too low	ECM	IN-30
Up-shift to 2nd while in L position	ECM	IN-30
Up-shift to 3rd while in L position	ECM	IN-30
Up-shift to O/D from 3rd	1. O/D main switch circuit 2. ECM	DI-465 IN-30
Up-shift to O/D from 3rd while engine is cold	ECM	IN-30

Fig. 5-16
T273F131

On-Vehicle Repair Matrix Chart

The On-Vehicle repair chart identifies components in the transmission that can contribute to the specific symptom. These components can be accessed without removing the transmission. The repair manual reference indicated by the star, can be found at the top of the chart. (for example: A-540E AUTOMATIC TRANSAXLE Repair Manual Pub. No. RM530U) The overhaul repair manual for automatic transmissions is a separate silver and black publication for each transmission model.

On-Vehicle Repair Matrix Chart

The chart refers you to a separate transmission repair manual and identifies the components which contribute to the symptom.

Symptom	Suspect Area	See page
Vehicle does not move in any forward position and reverse position	1. Manual Valve 2. Throttle Valve 3. Primary regulator valve 4. Off-vehicle repair matrix chart	* * * DI-431
Vehicle does not move in R position	1. Off-vehicle repair matrix chart	DI-431
No up-shift (1st→2nd)	1. 1-2 shift valve 2. Off-vehicle repair matrix chart	* DI-431
No up-shift (2nd→3rd)	1. 2-3 shift valve 2. Off-vehicle repair matrix chart	* DI-431
No up-shift (3rd→O/D)	1. 3-4 shift valve 2. Off-vehicle repair matrix chart	* DI-431
No downshift (O/D →3rd)	1. 3-4 shift valve	*
No downshift (3rd →2nd)	1. 2-3 shift valve	*
No downshift (2nd →1st)	1. 1-2 shift valve	*
No lock-up or No lock-up off	1. Lock-up relay valve 2. Off-vehicle repair matrix chart	* DI-431

*Refer to the *Overhaul Repair Manual.*

Fig. 5-17
T273F132

Off-Vehicle Repair Matrix Chart

The Off-Vehicle repair chart identifies components in the transmission that can contribute to the specific symptom. With the exception of the torque converter, these components require removal of the transmission and disassembly. Removal of the pan may be the determining factor whether to go with a reman unit or overhaul. With minimal debris in the pan and an accurate diagnosis, overhaul can come in under the cost of a reman.

Off-Vehicle Repair Matrix Chart

The chart refers you to internal components which may have failed based on the symptom.

Symptom	Suspect Area	See page
Vehicle does not move in any forward position and reverse position	1. Front and rear planetary gear	*
	2. O/D planetary gear	*
	3. O/D One-way clutch (F0)	*
	4. O/D Direct clutch (C0)	*
	5. Forward clutch (C1)	*
	6. O/D Brake (B0)	*
Vehicle does not move in R position	1. Front and rear planetary gear unit	*
	2. Direct clutch (C2)	*
	3. O/D Direct clutch (C0)	*
	4. 1st and reverse brake (B3)	*
No up-shift (1st→2nd)	1. No. 1 one-way clutch (F1)	*
	2. 2nd brake (B2)	*
No up-shift (2nd→3rd)	Direct clutch (C2)	*
No up-shift (3rd→O/D)	O/D Brake (B0)	*
No lock-up or No lock-up off	Torque converter	*
Harsh engagement (N→D)	1. Forward clutch (C1)	*
	2. O/D one-way clutch (F0)	*
	3. No. 2 one-way clutch (F2)	*

Fig. 5-18
T273F133

Analyzing Test Drive Results

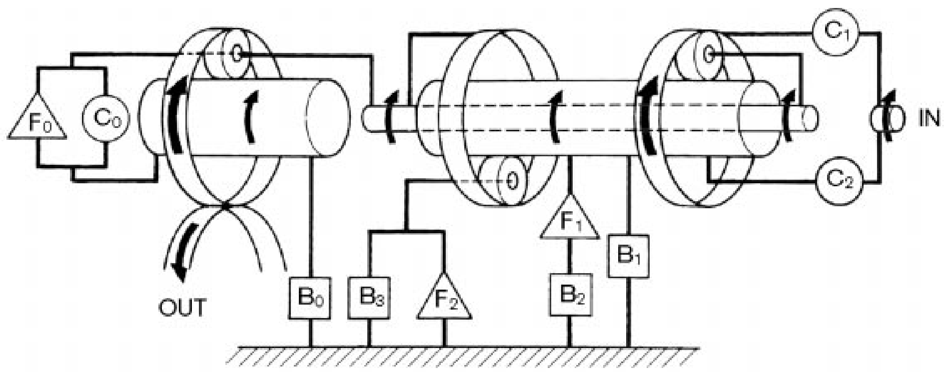
At the conclusion of a thorough test drive, you have most of the information necessary to make an accurate diagnosis. You will need to know which holding devices are necessary for each gear. The clutch application chart will provide this information and the gear train model will provide a visual reference for each holding device and its relationship to the drive components.

Clutch Application Chart

The chart used in the diagnostic examples on the next few pages are based on the A-140 and A-540 transaxle. This same chart can apply to rear wheel drive transmissions (A-43, A-45, A-340). The primary difference is the *overdrive one-way clutch* (F0) which locks in both forward and reverse in the rear wheel drive transmissions, but does not lock in reverse in the front drive transaxles.

Clutch Application Chart and Gear Train Model

The clutch application chart provides a ready reference of each holding device for each gear position and the gear train model provides a visual reference.



Shift Lever Position	Gear Position	C0	C1	C2	B0	B1	B2	B3	F0	F1	F2
P	Park	■									
R	Reverse	■		■				■			
N	Neutral	■									
D	1st	■	■						■		■
	2nd	■	■				■		■	■	
	3rd	■	■	■			☒		■		
	O/D		■	■	■		☒				
2	1st	■	■						■		■
	2nd	■	■			■	■		■	■	
	3rd*	■	■	■			☒		■		
L	1st	■	■					■	■		■
	2nd**	■	■			■	■		■	■	

* Does Not Apply to A-140L ** Downshift only - no upshift

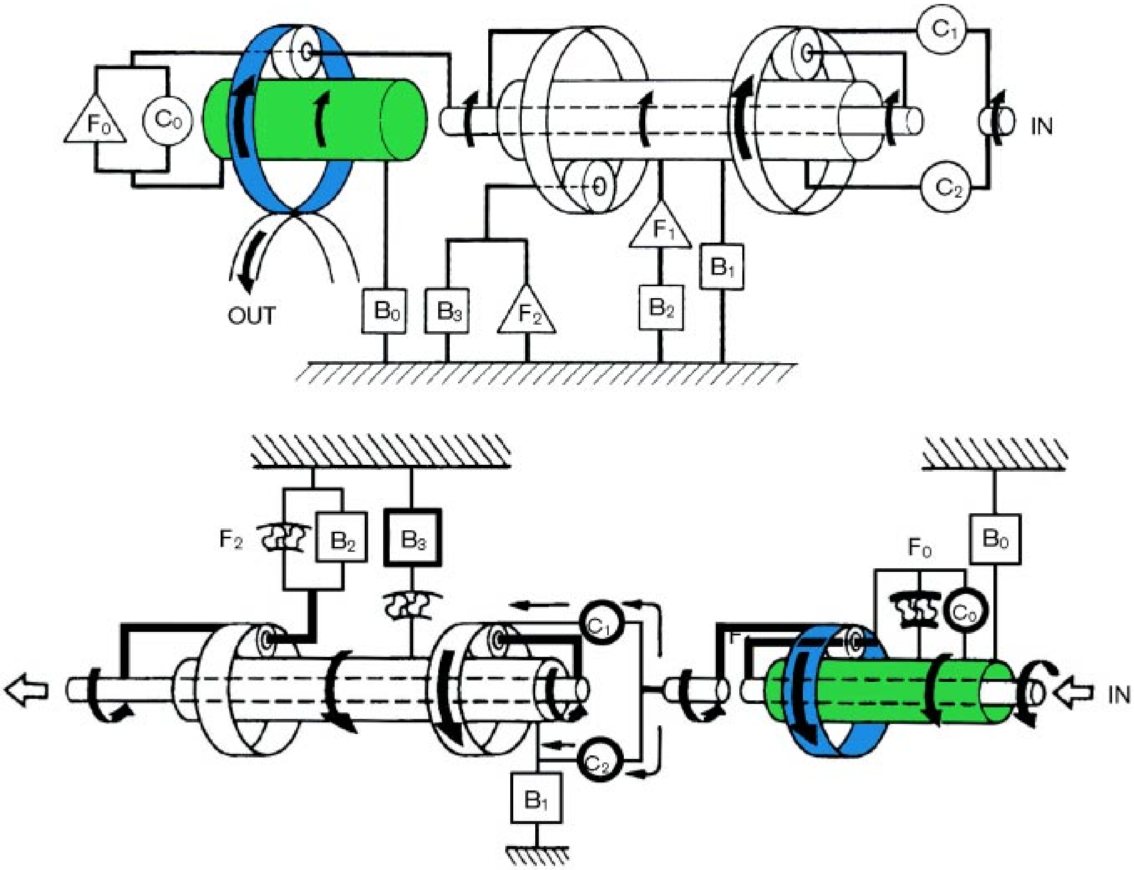
Fig. 5-19
T273F235/T273F236

The *overdrive direct clutch* (C0) is applied in all gears and shift positions except overdrive. It is a parallel holding device to the overdrive one-way clutch (F0). In a rear wheel drive transmission the overdrive unit is positioned before the planetary gear set and both are holding. In a front drive transaxle, however, the overdrive unit is located after the planetary gear set and the overdrive one-way clutch freewheels in reverse as the intermediate shaft rotates counterclockwise. That's why if the C0 is bad, it slips in reverse and there is no engine braking in third, second or low, but forward gears work because the F0 holds.

The *forward clutch* (C1) is applied in all forward gears and shift positions. If all forward gears slip but reverse holds, C1 is the likely cause.

Transmission Power Flow Models

In a rear wheel drive transmission the overdrive unit is located before the planetary gear set. In a front drive transaxle, however, the overdrive unit is located after the planetary gear set.

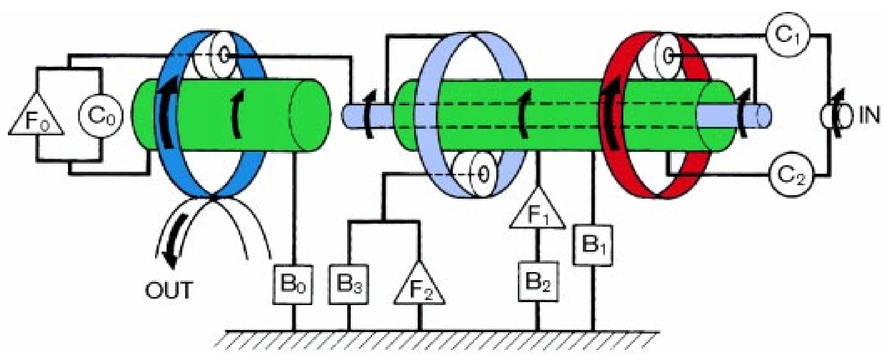


5-20
T273F237/T273F238

D-Range Move the gear selector into D-range, the *forward clutch* (C1) is applied and the *No. 2 one-way clutch* (F2) locks; engagement should be felt. If there is delayed engagement, or slippage, the forward clutch may be the cause. To determine if slippage is caused by C1 or F2, move the gear selector to L-range. In L-range the *1st and reverse* (B3) is a parallel holding device with F2. If slippage stops, then F2 is the cause. If slippage still occurs, C1 is the cause.

D-Range Power Flow

As the upshift to second occurs, B2 applies and remains applied when the upshift to third and O/D occurs. Likewise, when third upshift occurs C2 applies and remains applied when the upshift to O/D occurs.



Shift Lever Position	Gear Position	C0	C1	C2	B0	B1	B2	B3	F0	F1	F2
N	Neutral	■									
D	1st	■	■						■		■
	2nd	■	■				■		■	■	
	3rd	■	■	■			✕		■		
	O/D		■	■	■		✕				
2	1st	■	■						■		■
L	1st	■	■					■	■		■

Fig. 5-21
T273F239/T273F240

Second Gear Upshift

When the upshift to second gear occurs, the *2nd brake* (B2) applies which locks *No. 1 one-way clutch* (F1). These two apply in series to hold the planetary sun gear. F1 freewheels on deceleration and allows the vehicle to coast. If slippage occurs when upshifting to second gear, either the engine speed drops slowly as the clutch engages or the transmission remains in first gear and engine speed remains the same. In either event, B2 or F1 is the likely cause.

Third Gear Upshift

When third gear upshift occurs, the *direct clutch* (C2) applies providing a direct drive through the Simpson planetary gear set. As C2 is applied, *No.1 one-way clutch* (F1) freewheels as the sun gear turns clockwise. Although B2 remains applied, it has no affect on 3rd and 4th gears because F1 freewheels. If slippage occurs, engine speed will drop slowly as the clutch applies. As slippage becomes more severe, engine speed will not change as the transmission remains in second gear. C2 is the likely cause.

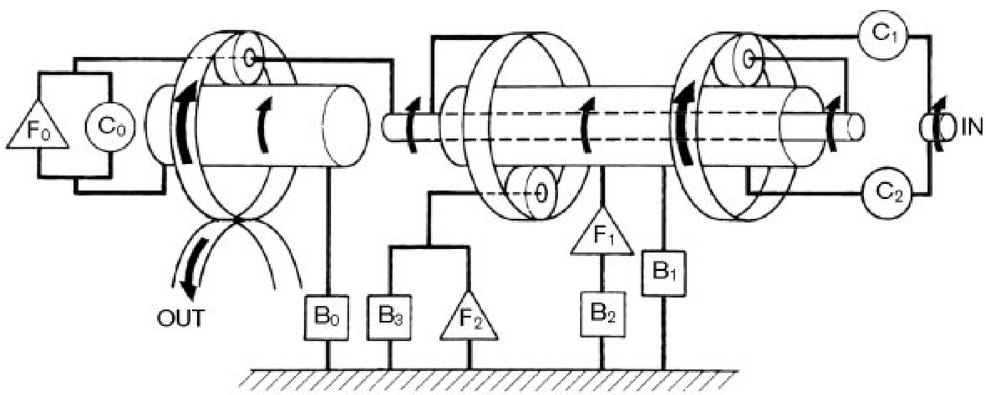
Fourth Gear Upshift When fourth gear upshift occurs, the *overdrive brake* (B0) applies and *overdrive direct clutch* (C0) releases with the same movement of the 3-4 shift valve. The *overdrive one-way clutch* (F0) freewheels. If slippage occurs, engine speed will drop slowly as the clutch applies. As slippage becomes more severe, engine speed will not change as the transmission remains in third gear. Although C0 is released, F0 holds on acceleration. However, engine rpm will fall to idle speed as F0 freewheels when the accelerator is released and the vehicle decelerates. B0 is the likely cause.

2-Range

Move the gear selector into 2-range, the *forward clutch* (C1) is applied and the *No. 2 one-way clutch* (F2) locks just like D-range; engagement should be felt. When 2nd gear upshift occurs, the *2nd coast brake* (B1) applies in parallel with *2nd brake* (B2) and *No. 1 one-way clutch* (F1). The *2nd coast brake* holds the sun gear from turning either way and therefore prevents the transmission from freewheeling on deceleration. This position uses the engine to slow the vehicle while decelerating and provides additional holding force on the planetary sun gear.

2-Range

The 2nd coast brake (B1) applies in parallel with 2nd brake (B2) and No 1 one way clutch (F1) to hold the sun gear.



Shift Lever Position	Gear Position	C0	C1	C2	B0	B1	B2	B3	F0	F1	F2
N	Neutral	■									
2	1st	■	■						■		■
	2nd	■	■			■	■		■	■	
L	1st	■	■					■	■		■

Fig. 5-22
T273F235/T273F242

L-Range

Move the gear selector into the L-range, the *1st and reverse brake* (B3) and the *No. 2 one-way clutch* work in parallel to hold the rear planetary carrier. Engagement should be felt. This position uses the engine to slow the vehicle while decelerating and provides additional holding force on the planetary carrier.

Slippage in any one of the previous scenarios or abnormal noise may be sufficient to warrant an overhaul or replacement of the transmission. However, if the findings were power related or shift timing either too early or late, or harsh shifting will require further testing.

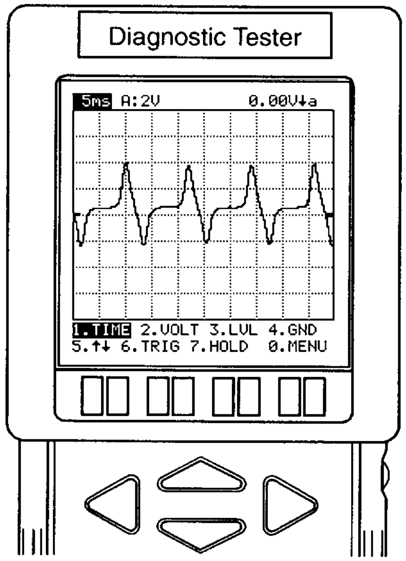
The following will require further testing:

- Early shift timing.
- Late shift timing.
- Harsh shifting.
- Erratic shifting.

Notes

Section 6

Diagnostic Tester



Lesson Objectives

1. Describe the various functions the diagnostic tester is capable of performing.
2. Use the diagnostic tester to:

   a. select and display specific automatic transmission serial data.

   b. display line graph of voltage signals.

   c. monitor voltage signals using the oscilloscope.
3. Use the diagnostic tester and printer to print out a strip chart monitoring five voltage signals.
4. Use the diagnostic tester and breakout box to display voltage signals.

Notes

Diagnostic Tester Usage

The Diagnostic Tester is a very useful tool when diagnosing electronic control transmission problems. It can be used for more than pulling codes. It can be used to:

- Display and monitor sensor and actuator data and switch inputs.
- Display data graphically.
- Laboratory oscilloscope analysis.
- Active actuator function tests.
- Record and recall data using the snapshot feature.
- Print data lists, graphs, scope displays and test results.

Use and Limitations

The diagnostic tester provides access to large quantities of information from a conveniently located diagnostic connector rather than performing tedious pin checks with a DVOM.

- A diagnostic tester allows a “quick check” of sensors, actuators, and ECM calculated data. For example, when checking for sensor signals which may be shifted out of normal range, scan data allows you to quickly compare selected data to repair manual specifications or known good vehicle data.
- When checking for intermittent fault conditions, it provides an easy way to monitor input signals while wiring or components are manipulated, heated or cooled.

Some important limitations to consider when attempting to diagnose certain types of problems using serial data.

- Serial data is processed information rather than a live signal. It represents what the ECM “thinks” it is seeing rather than the actual signal which would be measured at the ECM terminal. Serial data can also reflect a signal value the ECM has defaulted to, rather than the actual signal.

Serial Data

Serial data is electronically coded information which is transmitted by one computer and received and displayed by another computer. The transmitting computer digitizes the data sensors, actuators and other calculated information and is received and displays it as an analog voltage, temperature, speed, time or other familiar unit of measurement.

There are three different types of serial data which can be received and displayed by the Diagnostic Tester, depending on the application. These are OBD, OBD II, and V-BoB. In all three cases, data is digitized by the transmitting computer and displayed by the Diagnostic Tester.

Serial Data

Scan tool allows a "quick check" of sensors actuators, and ECM calculated data.

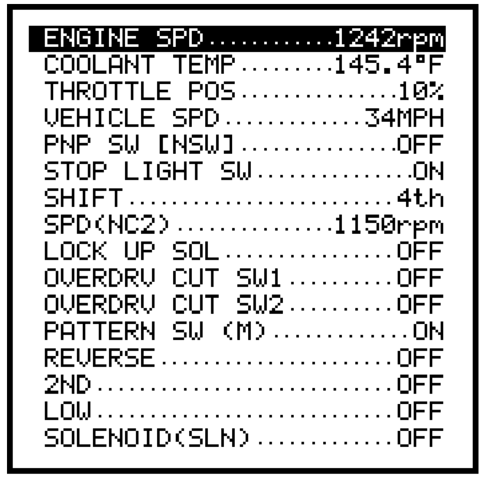


Fig. 6-01

T273f243

Line Graph Mode

The line graph mode displays the voltage signal of two data parameters simultaneously over time. It can be selected from any data list display with the active key (F4). The time line can be changed to scales of 5, 10, 15, 30, 60, 100, 200, and 300 seconds by pressing the left and right arrow keys.

The data parameters are displayed at the top of the screen. They can be replaced by highlighting the one you want to change using the up and down arrow keys. By pressing the YES key the next parameter on the data list is selected and pressing the NO key, the previous parameter is selected. The entire data list can be scanned one item at a time until the desired parameter is found. Each time the YES or NO key is pressed the new parameter is displayed on the screen. Press the ENTER key to freeze the display and # and SEND to print what's on the screen.

Line Graph Mode

The Data parameters are displayed at the top of the screen.

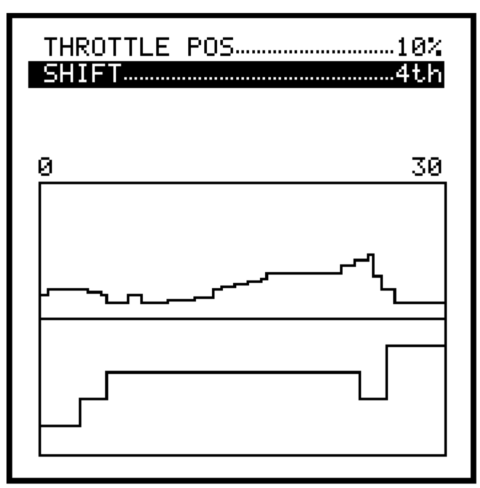


Fig. 6-02

T273f244

Strip Chart Mode

The strip chart mode can be selected from any Data List display by pressing the F6 key. It will only work if the VP-411 printer is connected to the diagnostic tester. Up to five parameters can be displayed on the printer at one time allowing you to map five events simultaneously for future reference. The diagnostic tester screen displays the sensor data parameters and not the actual strip chart. These parameters can be changed by highlighting the parameter you wish to replace and pressing the YES or NO keys to move to the next parameter or the previous one similar to the Line Graph mode. To move through the selection process quicker, use the Star key and YES or NO to select the next parameter not currently displayed.

To start strip chart, press the # and F8 at the same time. Press # and F9 to stop strip chart.

Strip Chart Mode

Up to five parameters can be displayed on VP-411 printer at one time.

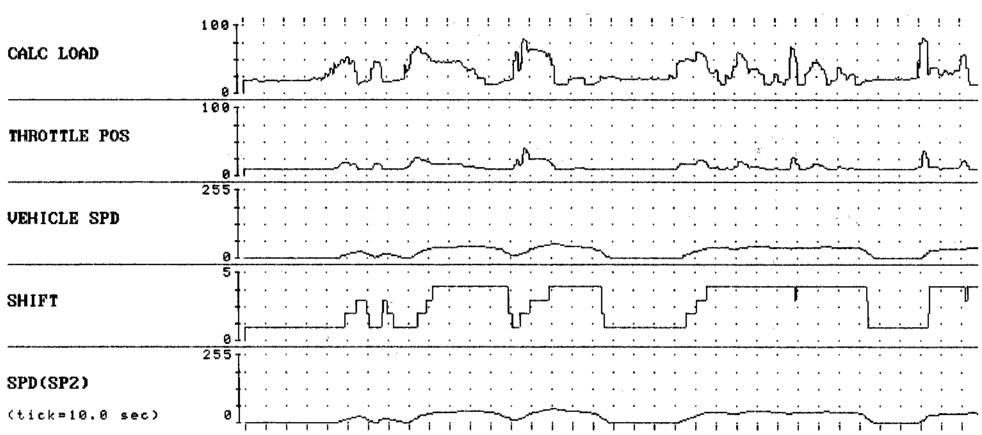


Fig. 6-03

T273f245

Snapshot Features

The snapshot feature allows you to record data before and after a fault occurs. This provides for careful examination of all data parameters in the seconds just before and after the vehicle exhibits a driveability condition, or sets a diagnostic trouble code.

The snapshot feature allows you to record up to four events which can be stored for replay at a later time. Triggering the snapshot function can be done manually, or set automatically when a code is set. The trigger point can be adjusted allowing you to examine the data before, after, or on either side of the trigger point.

Snapshot Features

Provides for careful explanation of all data parameters in the seconds just before and after the vehicle sets a diagnostic trouble code.

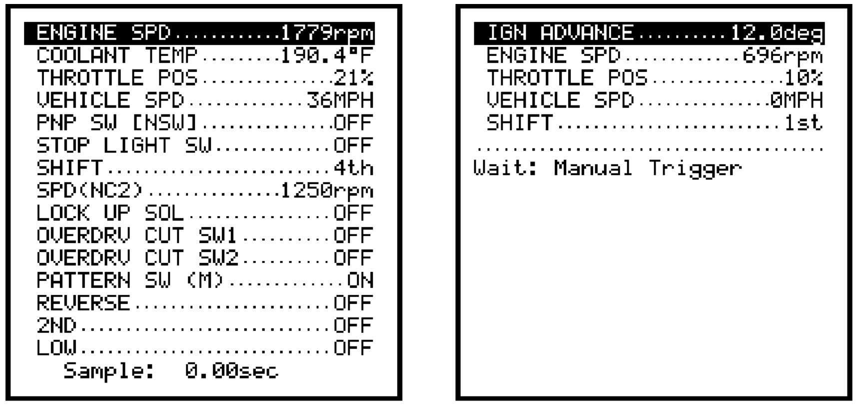


Fig. 6-04

T273f246/T273f247

Manual Trigger

Select Manual Snapshot from the current data menu. Select All Data, User List or Custom Data for the snapshot capture. Depending on the data list you choose, each data frame can represent a snapshot taken as frequently as every 200 ms, for small user data lists, to as infrequently as every 1.5 seconds for an All Data list. The more data you request, the slower the frame to frame refresh rate.

The trigger point can be adjusted to your own diagnostic needs. Setting the Trigger Point closer to the START of the snapshot allows you to look at more data after the trigger point. Setting the Trigger Point closer to the END of the snapshot allows you to look at the data before the trigger point

Adjusting Trigger Point

Setting the trigger point closer to the END of the snapshot allows you to look at the data before the trigger point.

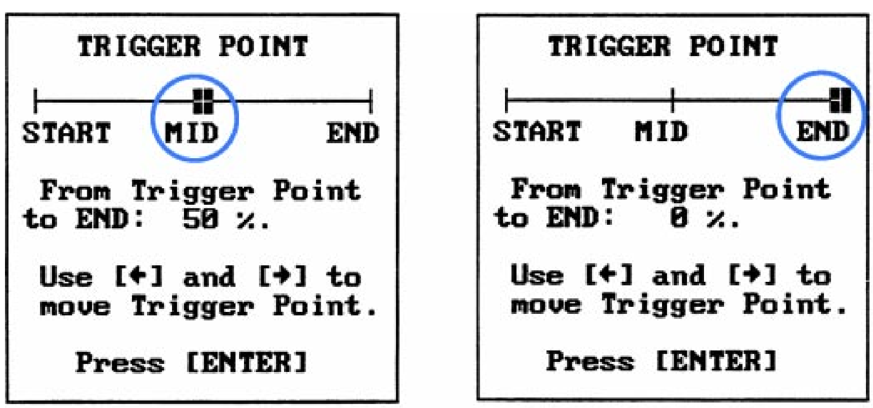


Fig. 6-05

T273f248/T273f249

To change the trigger point, select TRIGGER POINT from the Current Data Menu. Use the left and right arrows to move the trigger point between Start and End. Pressing the ENTER key, triggers the snapshot. The time you have selected for the snapshot will count down on the display screen.

Automatic Trigger

To set the snapshot to trigger automatically, select Codes Snapshot from the Current Data menu. Select the data list similar to the manual trigger (All Data, User List or Custom Data) for the snapshot capture. The Codes Snapshot function captures a snapshot of data after a trouble code is received. When the trigger occurs, “Trigger” is displayed on the screen while data is being saved.

Replay Snapshot

After completing the data capture, the snapshot can be saved for later review. The screen prompts you to either save the snapshot or quit. Pressing YES will save the data set and pressing NO will continue without saving. Selecting NO will allow you to review the last snapshot by putting the screen in Data Display phase.

Snapshot Save

Pressing YES will save the data set and pressing NO will continue without saving.

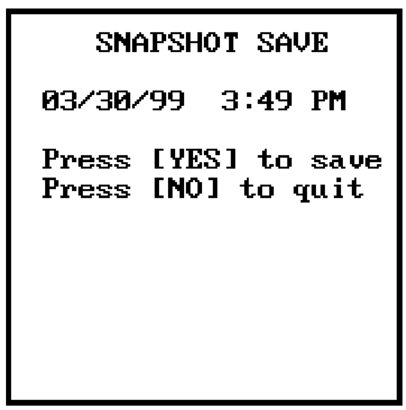


Fig. 6-06

T273f250

To view stored data, select Replay Snapshot from the Current Data Menu. Each snapshot is time and date stamped . Using the up/down arrows, highlight the snapshot you wish to display. Pressing ENTER will display the snapshot data.

Data captured in the Snapshot mode can be displayed in the following modes:

- Data List mode (F1 key)
- LED List mode (F2 key)
- Bar Graph mode (F3 key)
- Line Graph mode (F4 key)

Using the left and right arrow, the snapshot time can be scanned to observe component value changes. The left and right arrow keys will sequence through the data samples displayed. Press SEND to print the data list. To delete the snapshot, press * and ENTER simultaneously.

Snapshot Display Options

The snapshot can be in either Data List, LED List, Bar Graph, or line graph mode.

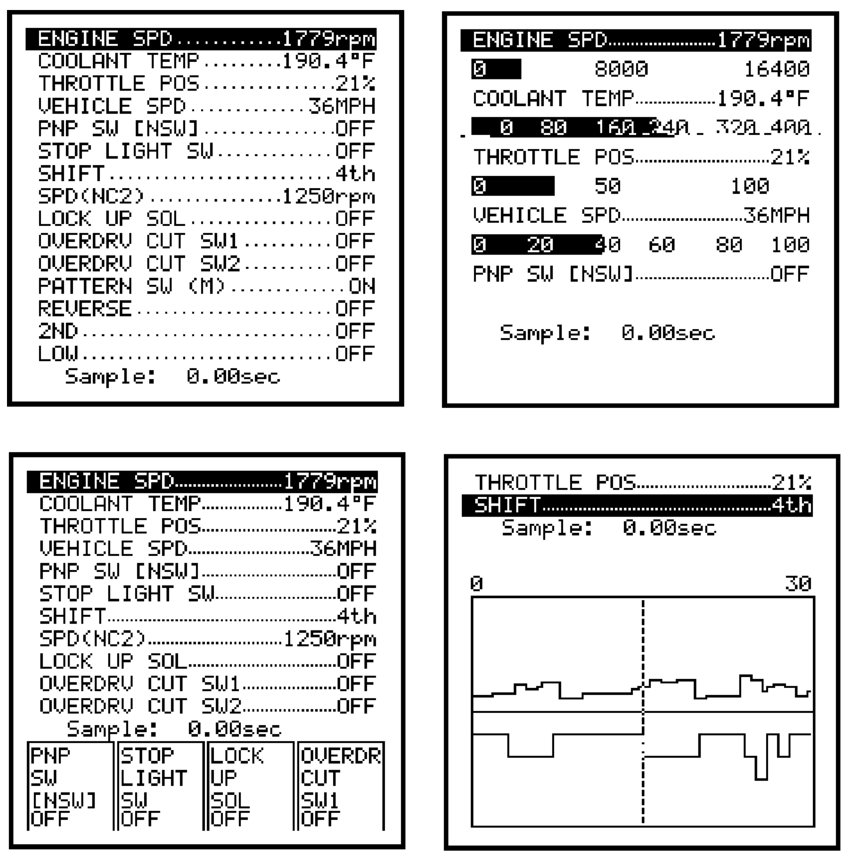


Fig. 6-07

T273f246/T273f252
T273f253/T273f254

Oscilloscope

The oscilloscope feature of the diagnostic tester gives you the ability to accurately display electronic signals which are difficult or impossible to read using a digital multimeter.

An oscilloscope is an electronic measurement instrument which is capable of plotting rapid changes in electrical signals on a graphic display. The vertical scale of the scope display represents signal voltage. The horizontal scale represents time. The scope can be adjusted so that each division on the grid represents specific increments of voltage and time. The diagnostic tester oscilloscope can display voltages ranging from less than 100 mv to 20 volts and times ranging from less than 1 ms to more than 3 minutes.

Oscilloscope Display

An Oscilloscope allows you to plot changing electrical signals on a graphic display. Voltage is displayed on the vertical scale time on the horizontal scale.

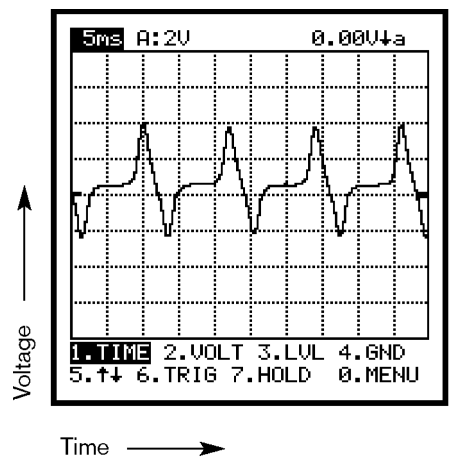


Fig. 6-08

T273f255

The rate at which the scope trace moves horizontally across the display is referred to as the sweep rate and is determined by the trigger. The trigger is usually the input signal so that the scope trace can be synchronized to the signal event. The input signal can come from either the autoprobe or directly from the V-BoB. This is similar to a timing light. The trigger is the inductive pickup hooked around the #1 plug wire. This synchronizes the light to the signal. The diagnostic tester also has an automatic trigger feature which drives the sweep independently of the input signal. Automatic trigger is used for displaying analog signals which cannot trigger the sweep.

Autoprobe

The Autoprobe is used to manually probe specific terminals to monitor the circuit. The Autoprobe is connected to the Instrument Port (I/P) connector at the bottom of the diagnostic tester. It provides the following test capabilities: voltage, frequency and oscilloscope functions.

For more accurate readings, it is recommended that the autoprobe be calibrated before measuring voltage or using the oscilloscope. Select Calibrate from the Autoprobe Menu and ground the autoprobe at the battery negative terminal or body ground. Press and hold the switch on the Autoprobe. The tester screen confirms that the calibration is complete.

Refer to the Tester Operator's Manual to check the internal circuits of the autoprobe.

Autoprobe

The autoprobe is connected to the I/P connector at the bottom of the diagnostic tester and monitors individual terminals.

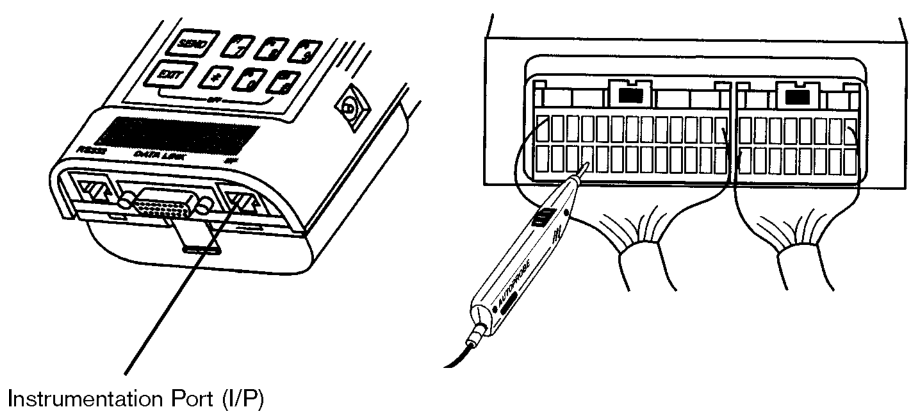


Fig. 6-09

T273f256/T273f257

Oscilloscope Features

The oscilloscope's Display Control Menu at the bottom of the display window has many features used to change the oscilloscope settings and trigger control:

- manual adjustment of voltage and time scales.
- adjustment of the voltage trigger level.
- selection of the leading or trailing edge of the signal.
- selection of the GND level.
- vary the cursor display.
- vary the background grid.

The screen captures displayed on the following pages represent the transmission speed sensor at approximate 30 miles per hour.

Input Signal and Trigger

The scope trace is typically triggered by the input signal to synchronize the sweep with the signal. This prevents the signal from walking across the display. The signal can also be triggered independent of the input signal by selecting the automatic trigger feature.

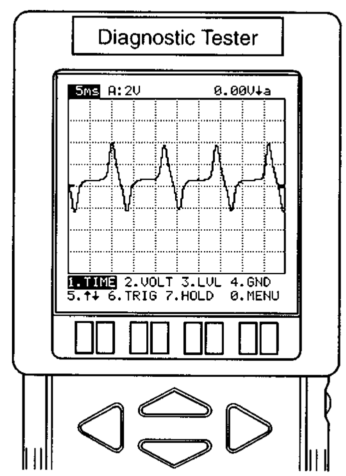
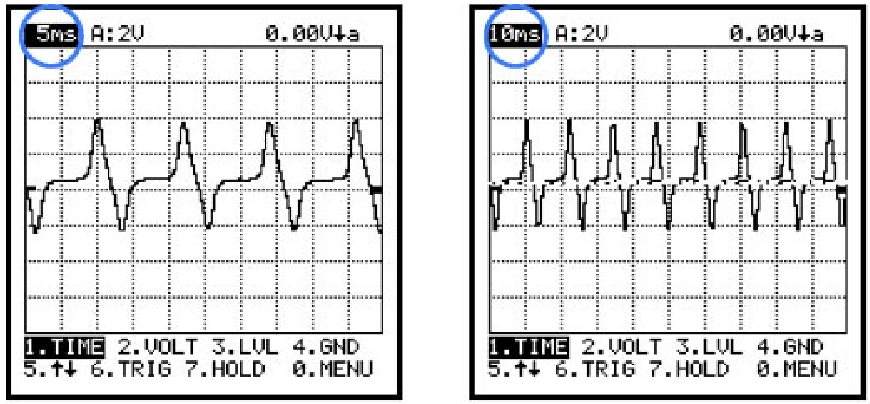


Fig. 6-10
T273f258

Time Scale

Selecting 1.TIME allows adjustment of time per division by pressing the up and down keys. Each division can be adjusted to represent from .2ms to 20 seconds.



5 Milliseconds

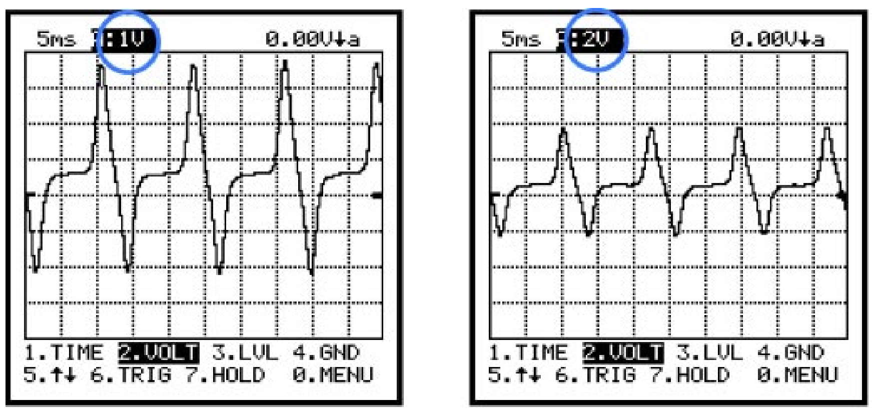
10 Milliseconds

Fig. 6-11

T273f255/T273f260

Voltage Scale

Selecting 2.VOLT, allows adjustment of volts per division by pressing the up and down arrow keys. Each division can be adjusted to represent from 0.1 to 5 volts.



1 Volt

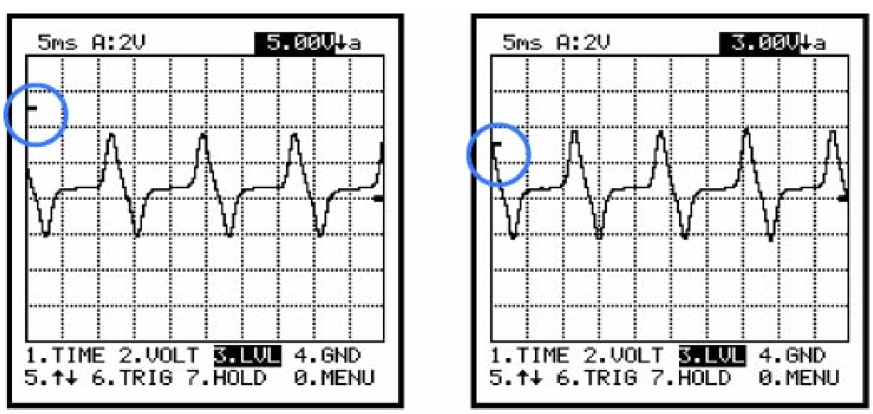
2 Volts

Fig. 6-12

T273f261/T273f262

Trigger Level Adjustment

Selecting 3.LVL allows adjustment of trigger level by pressing the up and down keys. This is the voltage above or below which the signal must go to trigger the sweep. Trigger level is set in 1/2 division increments.



Trigger voltage set higher than peak voltage. Waveform walks across the screen

Trigger voltage set lower than peak voltage. Waveform is steady.

Fig. 6-13

T273f263/T273f264

GND Level Adjustment

Selecting 4.GND allows adjustment of the GRD level by pressing the up and down keys. The trigger level indicator moves along with the GND level.

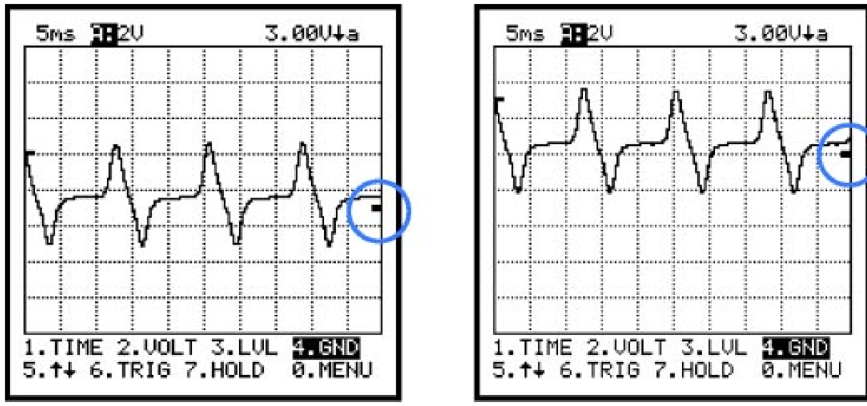


Fig. 6-14

T273f265/T273f266

Shifting the Pattern Display

Selecting 5.↑↓ allows you to select the leading or trailing edge of the signal as the trigger point. The trigger slope is indicated on the top right of the screen. An up arrow indicates a trigger on the rising edge (upslope). A down arrow indicates a trigger on the falling edge (downslope). Toggling the "5" key would start the slope at either the signal's maximum voltage (downslope) or minimum voltage level (upslope). This feature has more significance when monitoring DC signals.

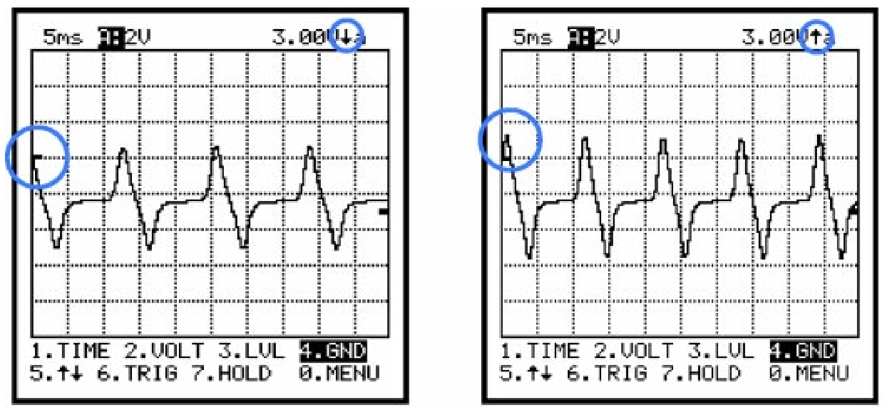


Fig. 6-15

T273f265/T273f268

Trigger Option

Selecting 6.TRIG allows you to select three different types of trigger options by toggling the “6” key. The trigger mode selected (n, a, or s) is displayed in the upper right corner of the display.

- The normal trigger (n) uses the input signal to trigger and synchronize the display. If there is no signal past the trigger, there will be no trace on the screen.
- The automatic trigger (a) uses an internal trigger built into the Diagnostic Tester to drive the scope sweep. If a trigger does not occur for 250 ms, a trigger is forced to occur. This makes it a greater place to start and then further adjustments can be made.
- The single shot trigger (s) uses the input signal to trigger the sweep, however, the pattern display freezes after a single trigger signal is sensed. Pressing the ENTER key or the button on the autoprobe resets the trigger. The trigger is only activated when the signal crosses the trigger level, or the ENTER key is pressed. While waiting for the trigger the single shot indicator shows an upper case “S.”

Trigger Options

Selecting 6.TRIG allows you to select from three different types of trigger options:

normal trigger (n), automatic trigger (a), and single shot trigger (s).

Trigger level is set in 1/2 division increments

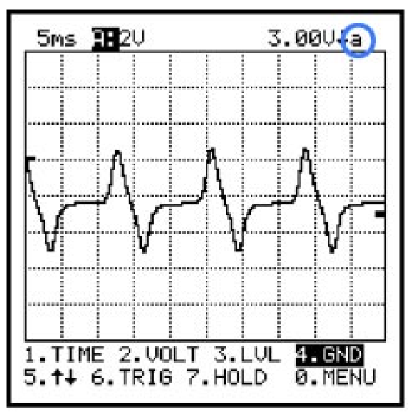


Fig. 6-16
T273f265

Hold Option

Pressing 7.HOLD causes the current display to freeze so that the waveform can be analyzed. When the hold mode is active, the red LED on the right side of the tester is turned ON.

Waveform Freeze

Selecting 7.HOLD allows you to freeze the current display so the waveform can be analyzed.

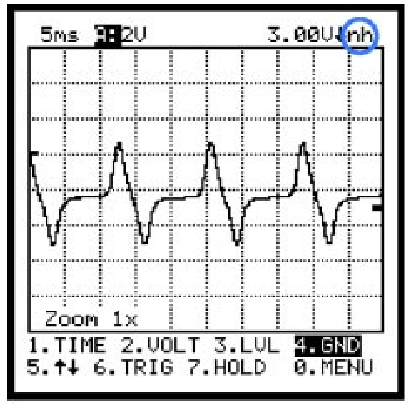


Fig. 6-17

T273f270

Pop-Up Menu

When 0.MENU is selected, a menu will "pop-up" on the screen. This menu allows selection of additional display controls. The additional functions available are: Auto Setup, Cursor, Grid Display, Zoom and Waveform.

Selecting 1.AUTO from the pop-up menu, the Tester automatically sets the Time Scale, Volt Scale, and Trigger Level based on the signal measured. Further manual adjustments may be made to configure displayed waveforms in the most useful format.

The waveform can be saved, recalled or deleted by selecting 5.WAVEFORM from the "pop-up" menu.

Pop-Up Menu

Pressing 0.MENU provides for a selection of additional display controls. Additionally, this menu allows for saving and recalling stored wave forms.

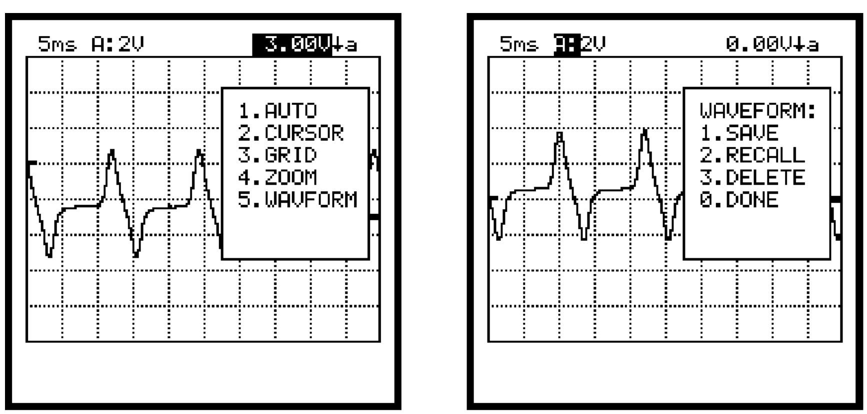


Fig. 6-18

T273f271/T273f272

Vehicle Break-Out Box

The Vehicle Break-out Box allows you to observe serial data using the Diagnostic Tester, even though the vehicle does not have a serial data line. Depending on the diagnostic need, the V-BoB may be used instead of serial data accessed through the DLC because of the wide variety of data signals available and the high speed data transmission.

By connecting V-BoB in series with the ECT or ECM, you can perform any of the tester functions that can be performed on vehicles with a serial data stream expect active test and clear codes. Data can be displayed in list form or graphically.

The Break-out Box Kit comes with a number of ECU interface boxes. Accessing the break-out Box function and identifying the vehicle, engine, transmission, and system, the tester screen identifies the ECU interface box. The interface box may have more connectors than are needed to attach the vehicle harness and interface box. In this event, each connector is labeled with a letter, which corresponds with those identified on the tester screen.

Break-out Box Components

The V-BoB is connected in series with the ECM and the vehicle harness to provide serial data.

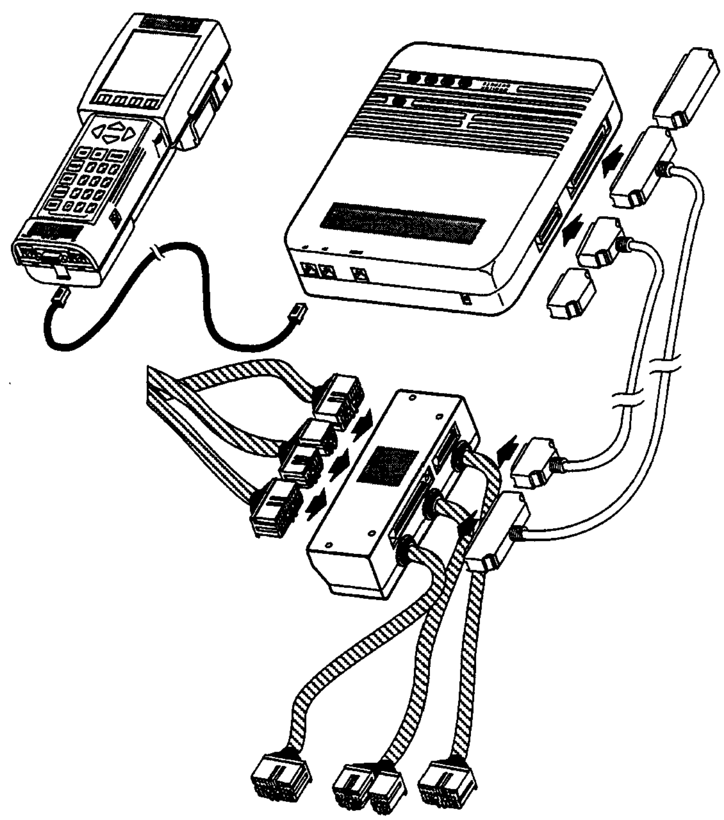


Fig. 6-19

T273f2273

The Diagnostic Tester and Break-out Box are connected via an I/P cable and each is powered by the DC Power Cable from the cigarette lighter. The interface box and the Break-out Box are connected using the 50 and 80 pin data cables.

Interface Box Identification

The tester identifies the ECU interface box and connectors.

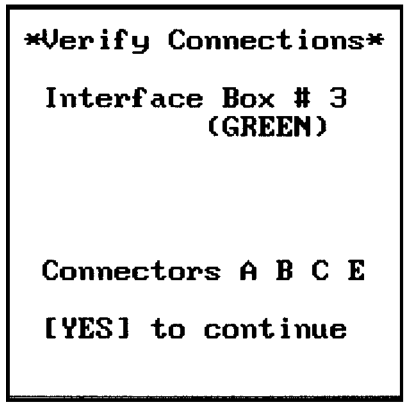


Fig. 6-20

T273f274

V-BoB Data Display

With the break-out box connected, the diagnostic tester is ready to display data from the vehicle ECM. The diagnostic tester features are essentially the same receiving data from the vehicle Break-out Box, as when receiving data from DLC1, 2 and 3. Data lists can be displayed in the following ways:

- Data List Mode.
- Custom Data List Mode.
- LED/Switch Status List Mode.
- Bar Graph Mode.
- Line Graph Mode.

Data List Mode

The Data List Mode displays the entire pre-selected data list stacked vertically on the screen. If there is more data than fits on the screen, it can be accessed by scrolling with the up and down arrow key commands.

Custom Data List Mode The Custom Data List allows you to select from all possible data words available (every live pin on the ECM) to create your own custom list. This feature is useful when specific data is not conveniently located on the pre-programmed data list. Scroll commands are the same as the Data List Mode. Use the YES or NO keys to select or deselect items from the list.

LED/Switch Status List Mode The LED/Switch Status List Mode displays the status of four user selectable switches with LEDs. These switches can be selected by moving the cursor with the up and down arrow keys to the desired location, then using the YES/NO keys to scroll through the various switch inputs.

Bar Graph Mode The Bar Graph List displays data and a bar graph for any six user selectable items. Data can be rearranged by moving the cursor to the desired location using the up and down arrow keys, then scroll through the data choices using the YES/NO keys.

Line Graph Mode The Line Graph List displays two user selectable data items as line graphs plotted against each other. Data can be rearranged by moving the cursor to the desired location using the up and down arrow keys, then scrolling through the data choices using the YES/NO keys.

Snapshot Display Options

The snapshot can be displayed in either Data List, LED List, Bar Graph or Line Graph mode.

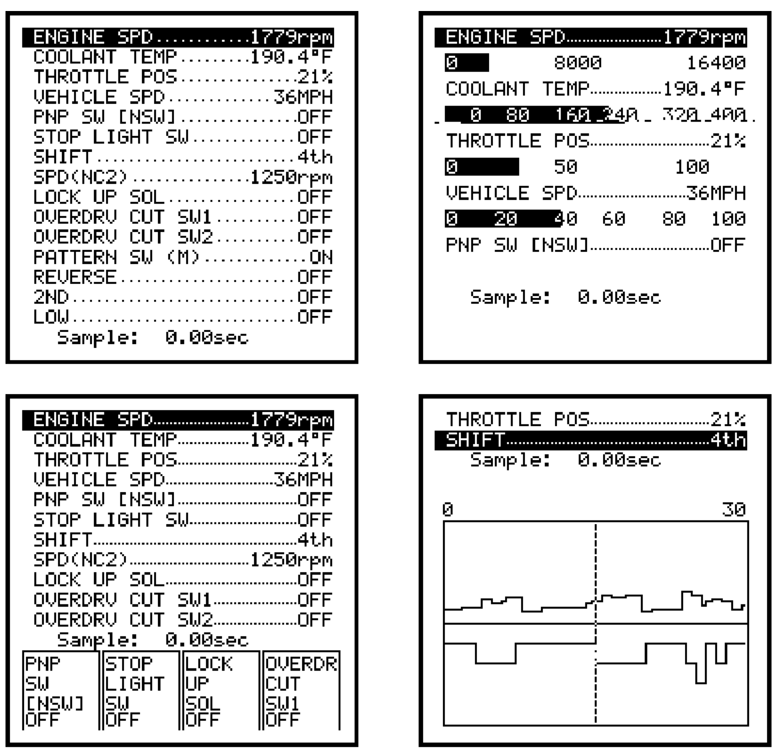


Fig. 6-21

T273f246/T273f252
T273f253/T273f254

Any wire connected to the ECM can be displayed on the Diagnostic tester oscilloscope when interfaced to the vehicle through Vehicle Break-out Box. To select a signal for oscilloscope display, select OSCILLOSCOPE from the Break-out Box Menu to gain access to the Signal Select Menu. The Signal Select Menu allows you to choose and display any ECM pin on the oscilloscope. V-BoB allows two signals to be displayed at a time.

To select the desired signal, scroll the cursor to the desired location using the up and down keys. To select the signal for display, press the YES key. The selected item will flash rapidly when selected. Once the desired signal has been selected, press the ENTER key to display the live signal on the oscilloscope grid. To deselect the signal, exit to the signal select menu and press the NO key.

Displaying V-BoB Parameters on the Oscilloscope

Any ECM terminal can easily be displayed on the diagnostic tester oscilloscope.

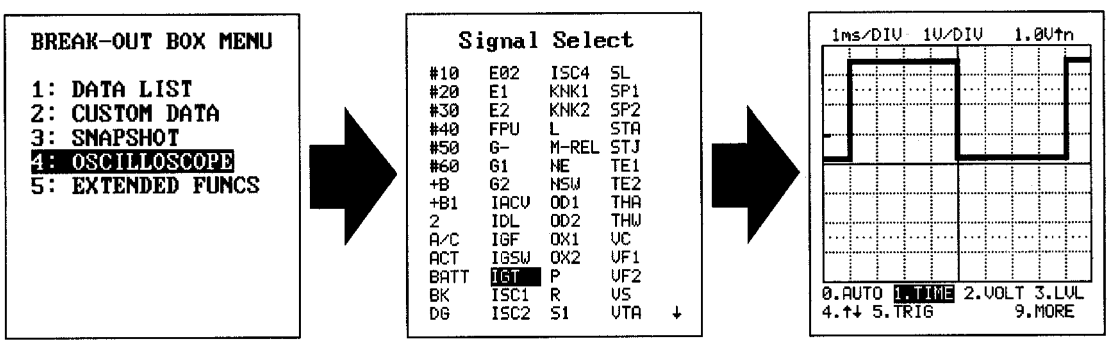
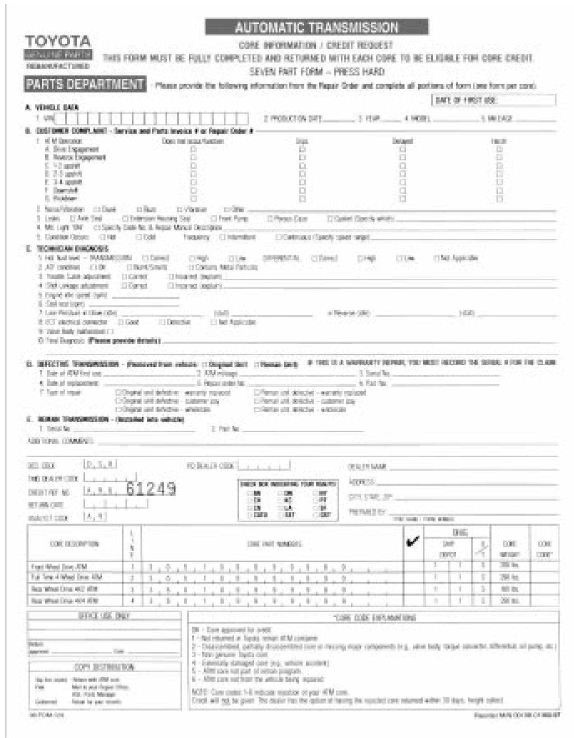


Fig. 6-22

T273f279

Remanufactured Transmissions


TOYOTA
GENUINE PARTS
REMANUFACTURED
AUTOMATIC TRANSMISSION
CORE INFORMATION / CREDIT REQUEST
THIS FORM MUST BE FULLY COMPLETED AND RETURNED WITH EACH CORE TO BE ELIGIBLE FOR CORE CREDIT.
SEVEN PART FORM – PRESS HARD
PARTS DEPARTMENT – Please provide the following information from the Repair Order and complete all portions of form (one form per core).

T273F283

Lesson Objectives

1. Explain the remanufactured transmission and core requirements necessary for reimbursement of core deposit.
2. Explain the circumstances under which a core credit request would be denied.
3. Identify technical information items requested under the Technician Diagnosis section of the Core Credit Request form.

Notes

Introduction

The remanufactured transmission program provides a single source for a complex component overhaul. The advantage is that all work is performed at a single location ensuring continuity of workmanship. In addition, each transmission is tested on a dynamometer to ensure proper operation. The advantages to the customer are two fold; the customer's vehicle is down for less time, and he receives a 1 year unlimited mile warranty.

The diagnosis of a customer concern is essential in determining the need for an overhaul or replacement with a reman transmission. Your diagnosis should provide information which conclusively establishes a fault inside the transmission. If the transmission can be repaired without disassembling the transmission, by either replacing the torque converter, pump seal or repairing or replacing the valve body, the cost of repair will be much less than a reman transmission. The cost of an overhaul is increased dramatically when hard parts are damaged and require replacement. Therefore, as a rule of thumb, if the transmission must be disassembled for repair, it should be replaced with a reman unit.

The chart below identifies transmissions and vehicle models included in the reman program. All other transmissions would require the technician to overhaul the transmission or replace it with a new unit.

Remanufactured Transmission Models

This chart identifies transmissions and vehicle models included in the reman program.

Transmission Model	Vehicle Model
A-131L	Corolla, Tercel
A-140E & L	Camry, Celica, Solara
A-240E & H, A-245E, A-246E	Corolla, Celica
A-340E & H, A-341E	Cressida, Truck, Tacoma
A-540E & H, A-541E	Avalon, Camry, Sienna, Solara
A-43, A-44, A-45	Truck, Van

Fig. 7-01

Core Return Procedure

When a reman transmission is shipped, a significant core deposit is debited to the dealership parts department account to ensure a supply of rebuildable cores. Specific criteria described below, are required to receive credit for the core deposit when it is received by the company that remanufactures the transmissions, AWTEC. Both the Service

Department and the Parts Department have responsibilities to ensure accurate information is provided. The Core Information/Credit Request form is completed with all the pertinent vehicle information.

Vehicle Data

At the top of the form, vehicle data such as the vehicle identification number, production date, year, model and vehicle mileage, must be provided.

Customer Complaint

In the customer complaint section, check the boxes that apply to the customer's complaint as identified on the RO. The following items are included:

- Repair Order number.
- ATM operation.
- Drive and reverse engagement.
- Each upshift condition.
- Downshift condition.
- Forced downshift (Kickdown).
- Noise/Vibration.
- Leaks.
- MIL Light and Code.
- Condition when problem occurs.

Technician Diagnosis

The Technician Diagnosis section should be completed as accurately as possible. Here is where keeping thorough notes of your diagnosis on the RO plays an important role. This information assists the remanufacturer in determining the extent of internal damage and complaint verification. The following items are requested under technician diagnosis:

- Hot fluid level in the transmission and differential.
- ATF condition.
- Throttle cable adjustment.
- Shift linkage adjustment.

- Engine idle speed rpm.
- Engine stall speed.
- Line pressure at idle and stall speed in both drive and reverse.
- Valve body malfunction.
- Final detailed written diagnosis.

Core Information and Credit Request Form

TOYOTA
GENUINE PARTS
REMANUFACTURED

AUTOMATIC TRANSMISSION

CORE INFORMATION / CREDIT REQUEST

THIS FORM MUST BE FULLY COMPLETED AND RETURNED WITH EACH CORE TO BE ELIGIBLE FOR CORE CREDIT.

SEVEN PART FORM – PRESS HARD

PARTS DEPARTMENT - Please provide the following information from the Repair Order and complete all portions of form (one form per core).

DATE OF FIRST USE:

A. VEHICLE DATA

1. VIN ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ 2. PRODUCTION DATE ______ 3. YEAR ______ 4. MODEL ______ 5. MILEAGE ______

B. CUSTOMER COMPLAINT - Service and Parts Invoice # or Repair Order # ______

1. ATM Operation:	Does not occur/function	Slips	Delayed	Harsh
A. Drive Engagement	☐	☐	☐	☐
B. Reverse Engagement	☐	☐	☐	☐
C. 1-2 upshift	☐	☐	☐	☐
D. 2-3 upshift	☐	☐	☐	☐
E. 3-4 upshift	☐	☐	☐	☐
F. Downshift	☐	☐	☐	☐
G. Kickdown	☐	☐	☐	☐

2. Noise/Vibration ☐ Clunk ☐ Buzz ☐ Vibration ☐ Other ______
3. Leaks ☐ Axle Seal ☐ Extension Housing Seal ☐ Front Pump ☐ Porous Case ☐ Gasket (Specify which) ______
4. MIL Light "ON": ☐ Specify Code No. & Repair Manual Description ______
5. Condition Occurs: ☐ Hot ☐ Cold Frequency: ☐ Intermittent ☐ Continuous (Specify speed range) ______

C. TECHNICIAN DIAGNOSIS

1. Hot fluid level – TRANSMISSION: ☐ Correct ☐ High ☐ Low DIFFERENTIAL: ☐ Correct ☐ High ☐ Low ☐ Not Applicable
2. ATF condition: ☐ OK ☐ Burnt/Smells ☐ Contains Metal Particles
3. Throttle Cable adjustment: ☐ Correct ☐ Incorrect (explain) ______
4. Shift Linkage adjustment: ☐ Correct ☐ Incorrect (explain) ______
5. Engine idle speed (rpm): ______
6. Stall test (rpm): ______
7. Line Pressure in Drive (idle) ______ (stall) ______ in Reverse (idle) ______ (stall) ______
8. ECT electrical connector: ☐ Good ☐ Defective ☐ Not Applicable
9. Valve Body malfunction ☐
10. Final Diagnosis **(Please provide details)** ______

D. DEFECTIVE TRANSMISSION - (Removed from vehicle: ☐ Original Unit ☐ Reman Unit) IF THIS IS A WARRANTY REPAIR, YOU MUST RECORD THE SERIAL # FOR THE CLAIM

1. Date of ATM first use: ______ 2. ATM mileage ______ 3. Serial No. ______
4. Date of replacement: ______ 5. Repair order No. ______ 6. Part No. ______
7. Type of repair
   - ☐ Original unit defective - warranty replaced
   - ☐ Original unit defective - customer pay
   - ☐ Original unit defective - wholesale
   - ☐ Reman unit defective - warranty replaced
   - ☐ Reman unit defective - customer pay
   - ☐ Reman unit defective - wholesale

E. REMAN TRANSMISSION - (Installed into vehicle)

1. Serial No. ______ 2. Part No. ______

ADDITIONAL COMMENTS: ______

DCS CODE: D S R
TMD DEALER CODE: ______
CREDIT REF. NO.: A R 6 61249
RETURN DATE: ______
ANALYST CODE: A 9

PD DEALER CODE: ______

CHECK BOX INDICATING YOUR RGN/PD

☐ BN ☐ DN ☐ NY
☐ CH ☐ KC ☐ PT
☐ CN ☐ LA ☐ SF
☐ CATD ☐ SET ☐ GST

DEALER NAME: ______
ADDRESS: ______
CITY, STATE, ZIP: ______
PREPARED BY: ______ PRINT NAME / PHONE NUMBER

CORE DESCRIPTION	LINE	CORE PART NUMBERS	✔	ORIG. SHIP DEPOT		O/T	CORE WEIGHT	CORE CODE*
Front Wheel Drive ATM	1	3 0 5 1 0 9 9 9 9 9 8 9		1	1	S	200 lbs.	
Full Time 4 Wheel Drive ATM	2	3 0 5 1 0 9 9 9 9 9 9 9		1	1	S	290 lbs.	
Rear Wheel Drive 4X2 ATM	3	3 5 0 1 0 9 9 9 9 9 8 9		1	1	S	180 lbs.	
Rear Wheel Drive 4X4 ATM	4	3 5 0 1 0 9 9 9 9 9 9 9		1	1	S	290 lbs.	

OFFICE USE ONLY

Return approved ______ Date: ______

COPY DISTRIBUTION

Top five copies - Return with ATM core
Pink - Mail to your Region Office, Attn: Parts Manager
Goldenrod - Retain for your records

*CORE CODE EXPLANATIONS

OK - Core approved for credit.
1 - Not returned in Toyota reman ATM container.
2 - Disassembled, partially disassembled core or missing major components (e.g., valve body, torque converter, differential, oil pump, etc.)
3 - Non genuine Toyota core.
4 - Externally damaged core (e.g., vehicle accident).
5 - ATM core not part of reman program.
6 - ATM core not from the vehicle being repaired.

NOTE! Core codes 1-6 indicate rejection of your ATM core.
Credit will not be given. The dealer has the option of having the rejected core returned within 30 days, freight collect.

98-PDM-129

Reorder M/N 00108-01060-97

Fig. 7-02
T273F283

In preparing the core for shipment to AWTEC the transmission must be completely assembled. Be sure to include each of the following:

- all plastic or rubber shipping plugs should be transferred from the reman unit to the transmission core.
- all fluids must be drained from the transmission, the differential on front wheel drive transaxles and transfer cases.
- the torque converter must be attached and held in place with the bracket provided with the reman unit.
- the following parts must be attached to the transmission core:
    - speed sensor or governor.
    - throttle cable.
    - wiring harness.
    - breather assembly.
    - differential assembly on transaxles.
    - transaxle left side engine mounting bracket.
    - transfer case (four/all wheel drive models).
- The transmission must be shipped in the reman ATM container.

The Core Credit Request may be denied if the transmission core is:

- returned in a container other than the reman ATM container.
- fully or partially disassembled.
- missing major components.
    - valve body.
    - torque converter.
    - differential.
    - oil pump.
- damage by external force.
- a transmission model which is not part of the reman program.

Notes

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.

Autoprobe - A signal measurement device that when interfaced with the Diagnostic Tester Instrumentation port can be used for voltage, frequency, duty cycle, and pulse width measurements. When interfaced with the V-BoB the autoprobe provides signal input for oscilloscope functions.

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 what provides the frictional surfaces in 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

Data List - A preprogrammed list of information being transmitted from vehicle to scan tool. Depending on the vehicle and system being tested, the data list could have as few as 10 parameters or as many as 80.

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.

Duty Cycle - An on-off electrical pulse applied to an electrical device. This cycle typically occurs at a fixed frequency and at a variable duty ratio.

Duty Ratio - The duty ratio is the percentage of time during one complete cycle that electrical current flows. A high duty ratio, 90% for example, means that current flow is on longer than it is off. A low duty ratio, 10% for example, means that current flow is off longer than it is on. A duty ration of 50% would be on half of the time and off half of the time.

F

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

Freeze Frame - A single frame of stored data, representing data parameters at the moment a fault is stored.

Frequency - Number of times every second an alternating current goes through a complete cycle. Measured in the unit Hertz (Hz).

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. A valley separates each land.

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 by 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. Operate between the ring gear and sun gear.

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

Sensor - The generic name for a device that senses either the absolute value or a change in a physical quantity such as temperature, pressure or flow rate and converts that change into an electrical quantity signal.

Serial Data - Information about a computer system inputs, outputs, and other operating parameters which is transmitted from the vehicle to the scan tool on a single wire in the Data Link Connector (DLC).

Simpson Planetary Gear Set - Two planetary gear sets that share a common sun gear.

Snapshot - A mode of operation where basic diagnostic parameters are stored in the Diagnostic Tester during a road test and can be examined, printed, or transferred to a computer at the end of the test.

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.

Square Wave - A digital, electronic signal which is either on or off. There is virtually no time between the on and off states.

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 gears of a planetary gear set around which the other gears rotate.

T

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

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.

Trip Cycle - Vehicle operation (following an engine off period) of duration and driving modes, such that all components and systems are monitored at least once by the diagnostic system.

Two-Trip Detection Logic - ECU diagnosis strategy which prevents a diagnostic code or the check engine light from coming on until the problem has duplicated itself twice, with a key off cycle in between.

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.

V-BoB - Vehicle Break-out Box.

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.

Circuit Inspection

Input Signals

Sensors produce different types of signals, that are either analog (variable voltage) or digital signal (on or off). The ECM will measure either voltage, amperage, or frequency of these signals.

Analog and Digital Signals

Fig. B-01

T852f363

Analog Signal

An analog signal is a variable signal and is usually measured by voltage or frequency. The voltage of the signal can be at any given point in a given range.

Digital Signal

A digital signal has only two states; high or low. This signal is often measured in volts or frequency. Digital signals are useful for indicating on/off, yes/no, high/low, or frequency. A digital signal is a signal that stays high or low for an extended period of time, sometimes called a discrete signal. Typically in circuits that involve switches, such as the Stop Lamp signal and Park/Neutral switch signal, the ECM is looking for a change in mode. Some sensors, such as the MRE speed sensor produce a digital signal and the ECM is measuring the frequency.

Amplitude

Amplitude is a measurement of strength, such as voltage. Amplitude can be measured from peak to peak, or from a reference point.

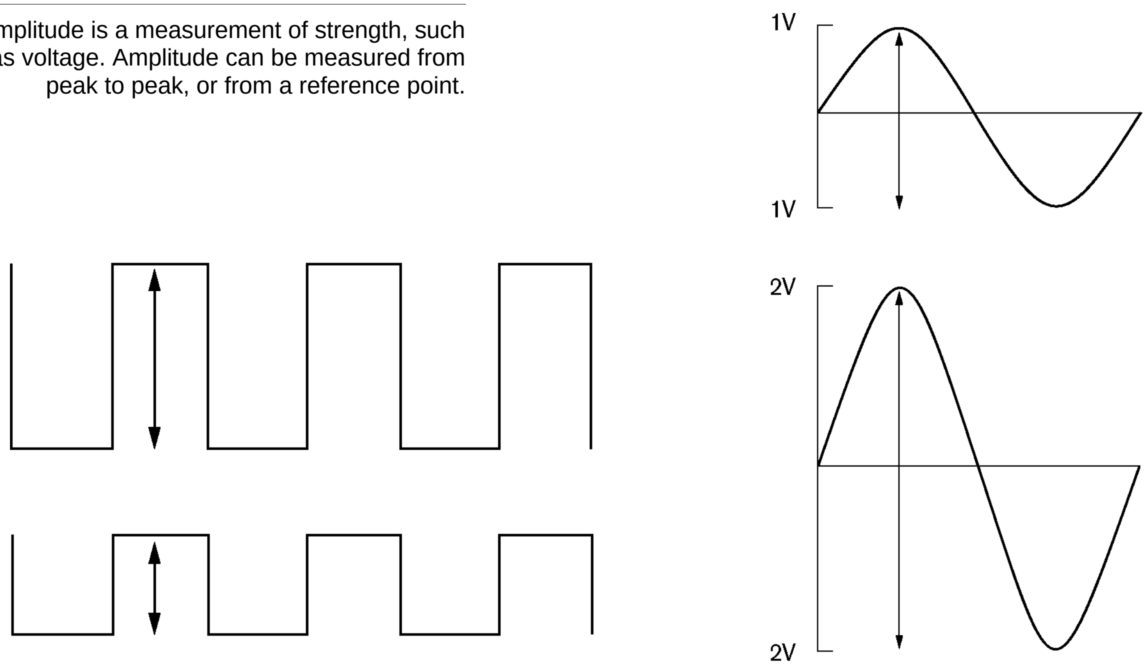


Fig. B-02

T852f364/T852f380

Frequency

Some signals are measured by frequency. A frequency is defined as the number of cycles per second. A cycle is a process that repeats from a common starting point. The unit for measuring frequency is called Hertz (Hz).

Frequency should not be confused with period. A period is the time it takes for the signal to repeat and is expressed as time. A 1 Hz signal lasts 1 second. A 2 Hz signal has a period of 0.5 seconds.

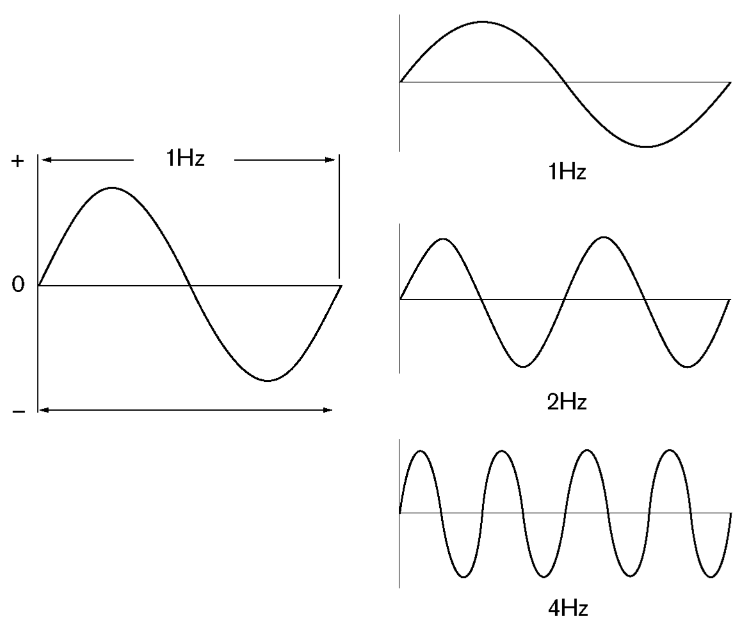


Fig. B-03

T852f365/T852f381

DC Voltage

Direct current is where the current flows in one direction. Though current flow and voltage can be variable, the direction always remains the same. The DVOM must be in the DC scale to measure DC voltage.

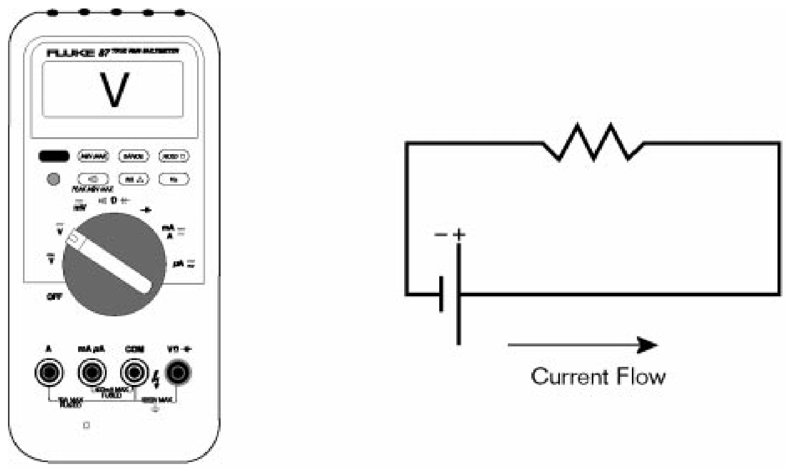


Fig. B-04

T8521380/T8521387

AC Voltage

Alternating current is where the direction of current flow changes. Current will travel from positive to negative, and then reverse course going to negative then positive. The DVOM must be in AC scale to measure AC voltage. There are different methods for measuring AC voltage and some DVOMs use what is known as a True RMS (Root Mean Square) to measure voltage. It is important for you to realize that the meter specified by the manufacturer must be used to obtain accurate results when compared to manufacturer's specifications.

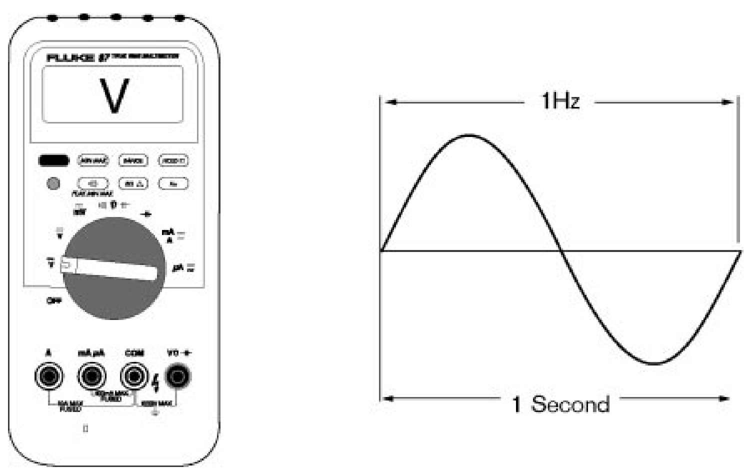


Fig. B-05

T8521388/T8521365

Output Signals and Circuits

To correctly interpret an oscilloscope pattern and DVOM reading, the technician needs to know the type of output circuit and how the test device is connected to the circuit.

Power Side Switched Circuit

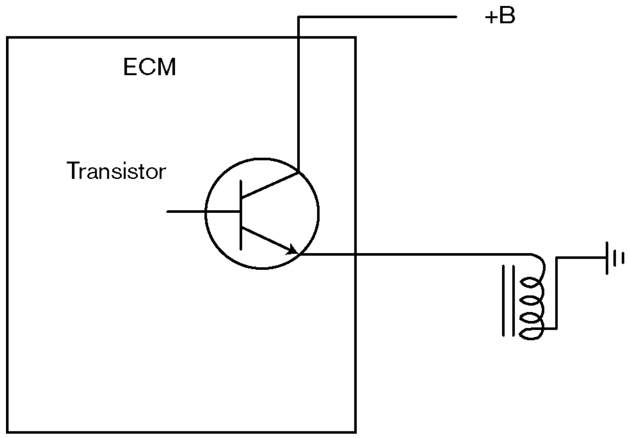


Fig. B-06
T852f366

Power Side Switched Circuit

A power side switched circuit will have voltage applied to the device when the circuit is switched on. When the transistor (think of the transistor as a switch) is turned on, current and voltage are applied to the device turning it on. The transistor is between power and the device. This is why they are commonly called power or power side switched circuits.

Ground Side Switched Circuit

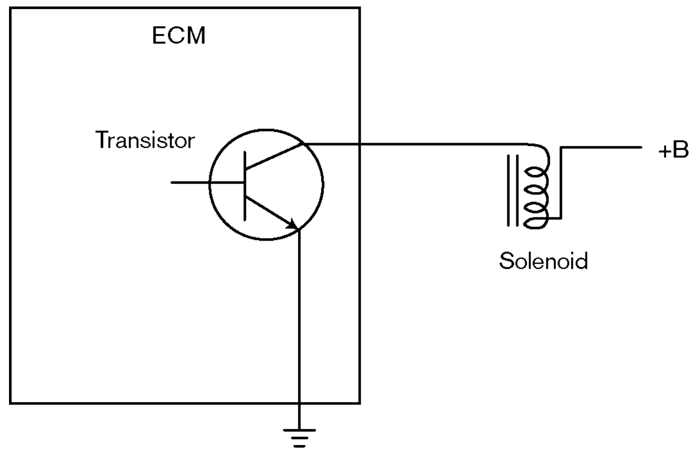


Fig. B-07
T852f367

Ground Side Switched Circuit

A ground side switched circuit has the transistor (switch) placed between the device and ground. When the transistor is turned on, the circuit now has a ground and current flows in the circuit. When the transistor is turned off current flow stops. Note that there is voltage present at the load and up to the transistor whenever the transistor is off.

Square Wave Duty Ratio Signals

When A and B are equal in length, the pulsewidth is 50%. This is a true square wave signal. A voltmeter connected to this circuit will measure half the supply voltage. The signal is said to have a low duty ratio when the on time is less than 50%.

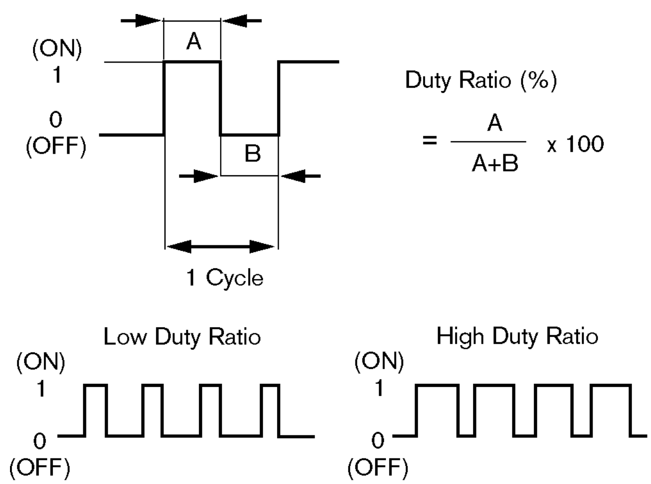


Fig. B-08
T852f368

Notes

Output Control Signals

Many devices, such as fuel injectors, EVAP purge, EGR VSV, rotary solenoid, alternator field circuit, etc. need to be modulated so that the desired output is achieved. There are a variety of control signals that can be used to regulate devices. Typically, the control signal changes the on/off time. This type of signal is often referred to as a pulse width modulated (PWM) signal and the on time is referred to as the pulsewidth. The duty cycle is the time to complete the on/off sequence. This can be expressed as a unit of time or as a frequency. The duty ratio is the comparison of the time the circuit is on versus the time the circuit is off in one cycle. This ratio is often expressed as a percentage or in milliseconds (ms).

PWM Signal

Each signal has the same frequency, only the pulsewidth has changed. The low duty ratio will have a lower current output.

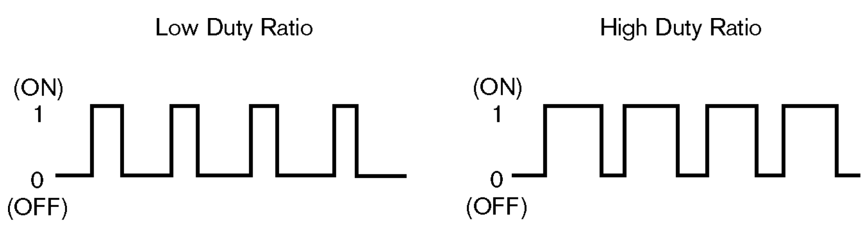


Fig. B-09

T852f368

Duty Ratio Solenoid

As the duty ratio (On time) increases, current flow through the solenoid increases moving the control valve. Oil pressure is then applied to the component that needs to be regulated, such as the variable valve timing mechanism, or lock-up control. In this example, Oil pressure increases as current increases. Other duty ratio solenoids can work in the opposite manner. Increasing current will decrease oil flow.

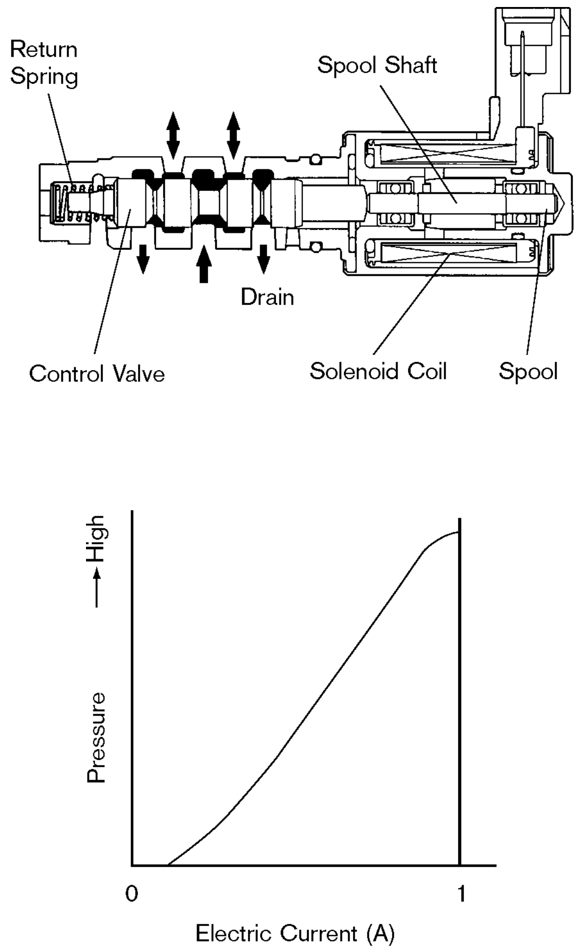


Fig. B-10

T852f370/T852f371

Fixed Duty Cycle Variable Duty Ratio (Pulse Width Modulated) Signal

This type of output control signal is defined by having a fixed duty cycle (frequency) with a variable duty ratio. With this type of signal only the ratio of on to off time varies. The ratio of on to off time modulates the output.

Variable Duty Cycle Variable Duty Ratio Signal

Duty cycle frequency has changed.
Duty ratio has changed.

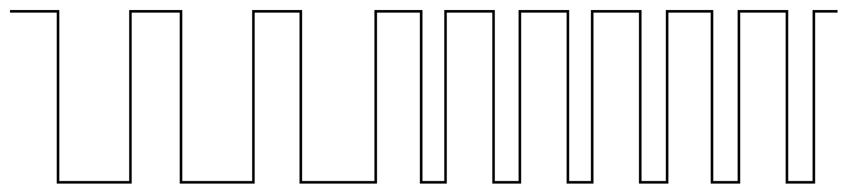


Fig. B-11

T852f372

Variable Duty Cycle/Variable Duty Ratio Signal

This signal varies the frequency of the duty cycle and the duty ratio. An excellent example is the signal used to control the fuel injector. As engine RPMs increase the fuel injector activation increases. As engine load increases, the duration of the fuel injector increases. It is easy to observe this type of control signal on the oscilloscope. With the oscilloscope connected to the fuel injector ECM terminal, as the engine RPMs (frequency) increase there will be more fuel injector cycles on the screen. As engine load increases, the on time (pulsewidth) also increases.

Measuring and Interpreting Signals

Oscilloscopes and many DVOMs can measure the pulsewidth, duty ratio, and frequency. For the technician to correctly interpret the reading oscilloscope line trace, the technician needs to know how the DVOM/oscilloscope is connected and the type of circuit.

Measuring Available Voltage On a Ground Side Switched Circuit

When the circuit is on, the DVOM will measure nearly 0 volts at the ECM.

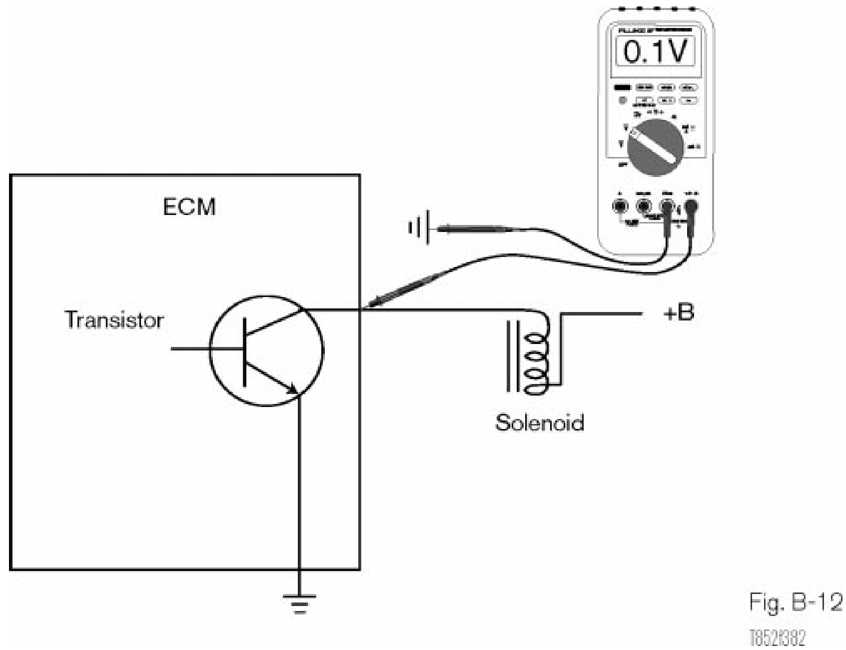


Fig. B-12
T852f382

Ground Side Switch Voltage Pattern Interpretation

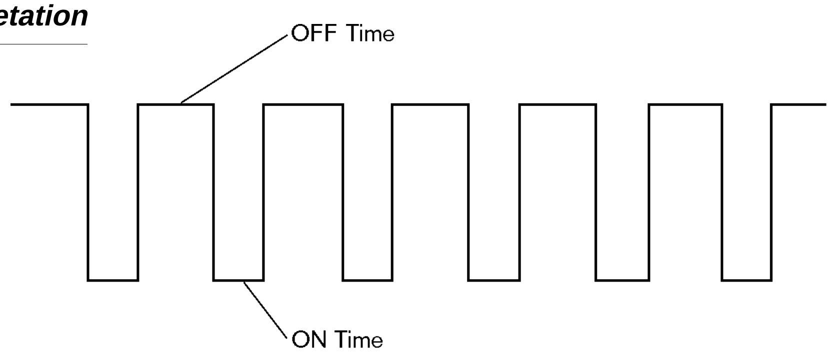


Fig. B-13
T852f373

Ground Side Switch Circuit Interpretation

With an oscilloscope connected at the ECM on a ground side switched circuit, the on time will be represented by the low (nearly 0 volts) voltage line trace. The voltage trace should be at supply voltage when the circuit is off and nearly 0 volts when the circuit is on. The on time (pulsewidth) is amount of time at 0 volts. If trace line does not go to nearly 0 volts, there may be a problem with the ground side of the circuit.

A DVOM in many cases can be substituted for the oscilloscope. When using a DVOM with a positive (+) or negative (-) trigger, select negative (-) trigger. Then the DVOM reading will represent the on time, usually as a percentage or in ms. On the voltage scale, the DVOM will read +B when the circuit is off and nearly 0 volts when the circuit is on.

Measuring Across the Load

Connecting at the ECM is the most common point used in the Repair Manual procedures. However, it is also possible to connect the oscilloscope or DVOM across the device. If this is done, the interpretation is different. The DVOM will read 0 volts when the circuit is off, and nearly +B when the circuit is on.

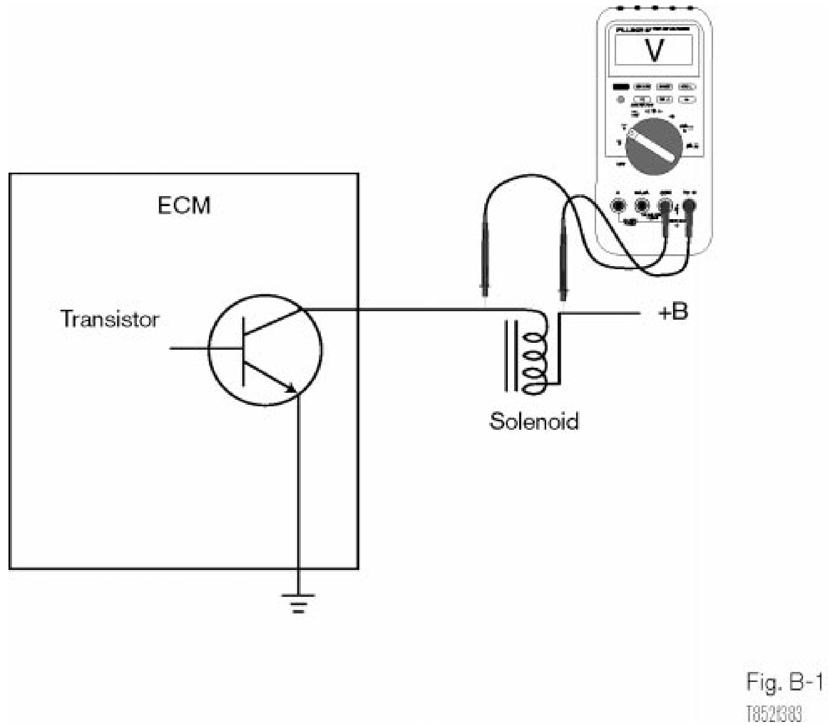


Fig. B-14

Measuring Across the Load Pattern Interpretation

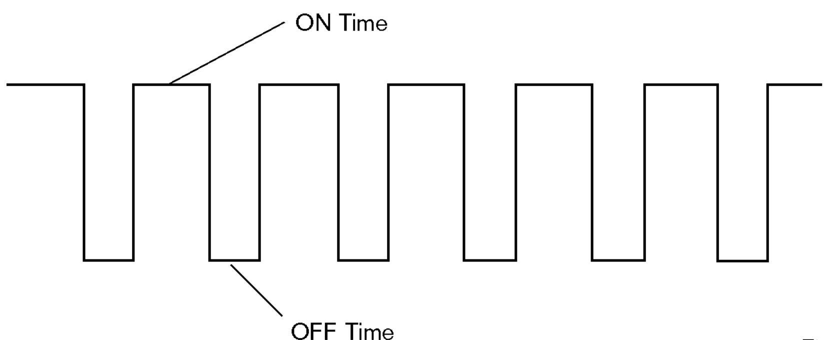


Fig. B-15

Measuring Available Voltage on a Power Side Switched Circuit

When the circuit is on, the DVOM will measure +B at the ECM.

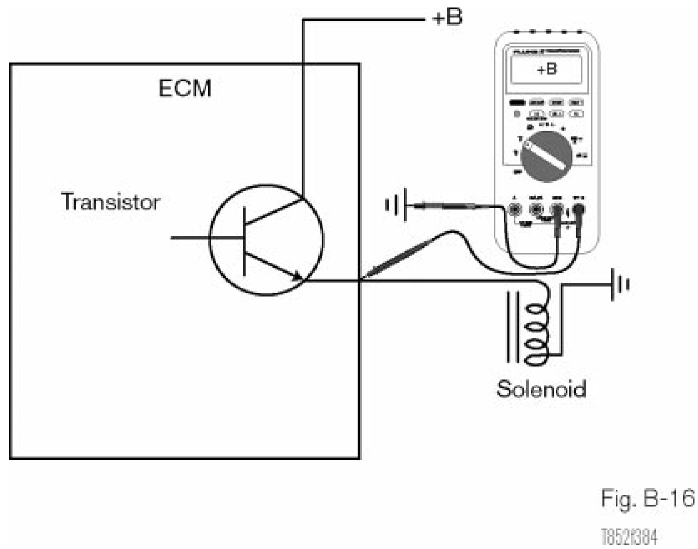


Fig. B-16

Pattern Interpretation for a Power Side Switched Circuit

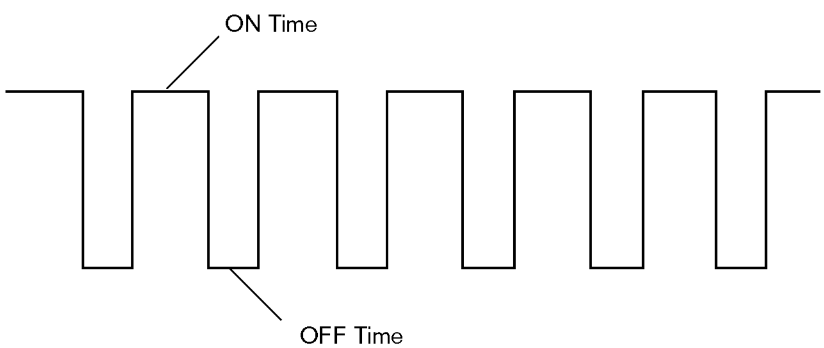


Fig. B-17

Power Side Switch Circuit Interpretation

With an oscilloscope/DVOM connected at the ECM on a hot side switched circuit, the on time will be represented by the high (supply voltage) voltage line trace. The voltage trace should be at supply voltage when the circuit is on and at 0 volts when the circuit is off. The on time (pulsewidth) is the amount of time at supply voltage. If trace line does not go to supply voltage, there may be a problem with the supply side of the circuit.

When using a DVOM select positive (+) trigger. Then the DVOM reading will represent the on time, usually as a percentage or in ms.

Checking Circuit Operation Across The Load

The DVOM will measure nearly +B volts when the circuit is on.

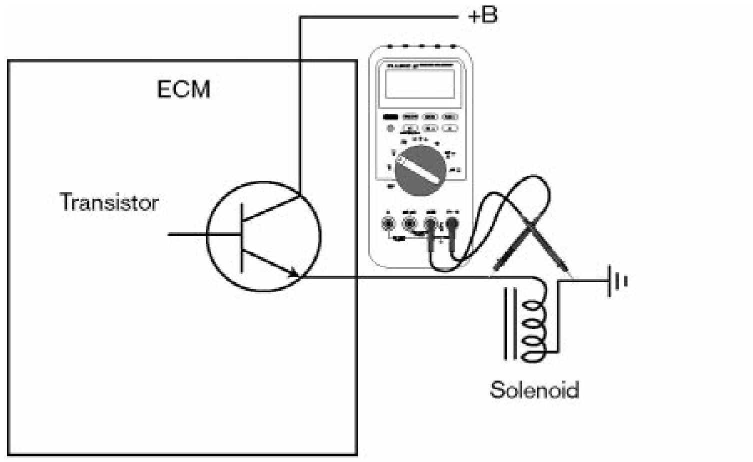


Fig. B-18

T852f369

ECT Diagnostic Information

Fig. 1

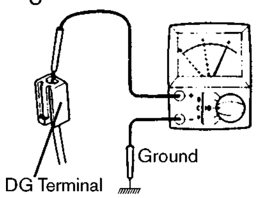


Fig. 2

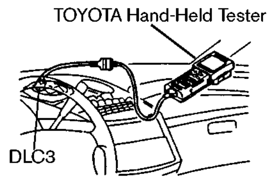


Fig. 3

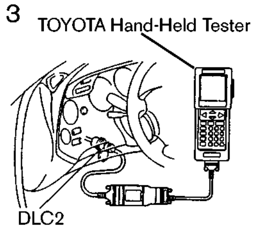


Fig. 4

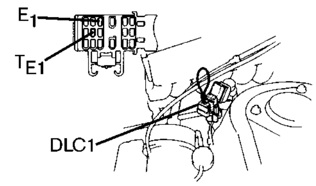


Fig. 5

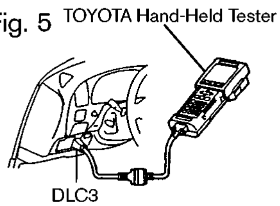


Fig. 6

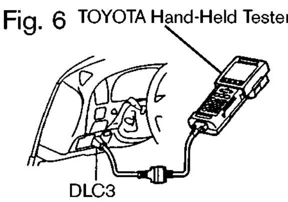


Fig. 7

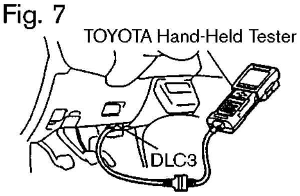
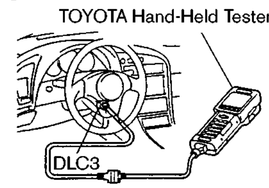


Fig. 8



CODE	TROUBLE AREA
38****	Open or short circuit in fluid temerature sensor or harness
41***	Severed throttle position sensor or short circuit, or severed wire harness or short circuit
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
46****	Wiring of solenoid valve No. 4 disconnected/ shorted, or wire in its wire 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
67****	O/D direct clutch speed sensor, or wire in its harness disconnected/shorted
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
77****	Wiring of solenoid valve No. 5 disconnected/ shorted, or wire in its wire harness disconnected/shorted
86***	Open or shorted engine speed sensor or wire harness
88***	Open or shorted ECM, TCM or wire harness
88****	Open or short circuit in communication circuit between TRAC ECU and TCM; TRAC ECU malfunction

* A540H All-Trac Camry Only
** A340H 4x4 Truck Only
*** A442F Land Cruiser
**** A340E Supra (JZA)

SCAN CODE	TROUBLE AREA
P0500	Open or short in (No. 1[a]) vehicle speed sensor or circuit, combination meter, ECM, automatic transaxle[1], [ABS speed sensor or circuit ABS ECU][3]
P0710	Open or short in ATF temperature sensor or circuit, ECM, automatic transmission assembly
P0711	Open in ATF temperature sensor or circuit, ECM
P0715	Open or short in O/D direct clutch speed sensor or circuit, ECM
P0720	No. 1 vehicle speed sensor, combination meter, harness or connector between No. 1 vehicle speed sensor and ECM, ECM
P0750	Shift solenoid valve No. 1 is stuck open or closed, valve body is blocked up or stuck, automatic transaxle[1]
P0753	Open or short circuit in shift solenoid valve No. 1 or circuit, ECM
P0755	Shift solenoid valve No. 2 is stuck open or closed, valve body is blocked up or stuck, automatic transaxle[1]
P0758	Open or short circuit in shift solenoid valve No. 2 or circuit, ECM
P0765	Shift solenoid S4 stuck, valve body blocked or stuck
P0768	Open or short in solenoid S4 or circuit, ECM
P0770	Shift solenoid valve SL (SLU[†]) is stuck open or closed, valve body is blocked or stuck, lock-up clutch, automatic transaxle[1]
P0773	Open or short in shift solenoid valve SL or circuit, ECM
P1520	Open or short in stop light switch or circuit, ECM
P1700	Open or short in No. 2 (front[2]) vehicle speed sensor or circuit, ECM
P1705	Open or short in direct clutch speed sensor or circuit, ECM
P1715	Open or short in rear speed sensor or circuit, ECM
P1725	Open or short in input turbine speed sensor or circuit, ECM
P1730	Open or short in counter gear speed sensor or circuit, ECM
P1755	Open or short in shift solenoid valve SLU or circuit, ECM
P1760	Open or short in shift solenoid valve ST (SLU[‡]) or circuit, ECM
P1765	Open or short in shift solenoid valve SLN or circuit, ECM
P1770	Open or short in shift solenoid valve SLD or circuit, ECM
P1780	Short in park/neutral position switch or circuit, ECM
P1790	Open or short in ST solenoid or circuit, ECM

[1] Except 1998 T100/1998-99 4Runner, Tacoma, and Land Cruiser/ 2000 Tundra
[2] 1998-99 RAV4 (A540H)
[3] 1998-99 Sienna, 4Runner
[a] 1998 T100/1998-99 Camry, Celica, 4Runner/1999 Tacoma, Land Cruiser
[†] 1998 Supra (2JZ-GE)
[‡] 1998 Supra, 1998-99 Land Cruiser

Transmission Model	Engine Model	Vehicle Model	N D Squat Control	Diagnostic Codes	Cancel Out Diagnostic Codes	Diagnostic Code Access	O/D Cancel Temperature (3rd)	Manual Mode "L" "2" "D" "R"
A-340E	3RZ-FE	96-98 T100	3rd - 1st	P0500-P1780 (11)	Scan Tool	Fig. 5, 6	140°F	1st, 3rd, O/D, R
		96-00 4Runner						
	3VZ-E	89-95 Truck		42 thru 64 (5)	EFI 15A	Fig. 4	158°F	
		93, 94 T100					140°F	
	5VZ-FE	95-98 T100		P0500-P1780 (11)	Scan Tool	Fig. 5, 6		
		98, 01 4Runner				Fig. 6		
		95-97 Tacoma				Fig. 5, 6		
		98, 01 Tacoma						
	7M-GE	87-92 Supra		42 thru 64 (5)	RADIO No. 1 15A	Fig. 4	140°F (95°F)	
		89-92 Cressida			EFI 15A			
	7M-GTE	87-92 Supra			RADIO No. 1 15A			
	2JZ-GE	93.5-95 Supra		38 thru 64 (6)	EFI 15A	Fig. 4, 5		
		96, 97 Supra		P0500-P1780 (11)	Scan Tool			
		98 Supra		P0500-P1780 (12)		Fig. 5	140°F	
	2JZ-GTE	93.5-96 Supra		38 thru 89 (10)	EFI 15A	Fig. 3, 5	140°F (95°F)	
		97, 98 Supra		P0500-P1780 (14)	Scan Tool			
	2TZ-FZE	94.5, 95 Previa		P0720-P1780 (9)		Fig. 4, 4	158°F	
		96, 97 Previa		P0500-P1780 (11)				
	5VZ-FE	00-01 Tundra		P0500-P1780 (13)		Fig. 6	140°F	
		01 Sequoia						
A-340E	2UZ-FE	00-01 Tundra	3rd - 1st	P0500-P1780 (13)	Scan Tool	Fig. 6	140°F	1st, 3rd, O/D, R
		01 Sequoia						
A-340H	3VZ-E	89-95 Truck	3rd - 1st	42 thru 65 (6)	EFI 15A	Fig. 4	158°F	1st, 3rd, O/D, R
A-340F	22R-E	90-95 Truck	3rd - 1st	42 thru 64 (5)	EFI 15A	Fig. 4	158°F	1st, 3rd, O/D, R
	3RZ-FE	95, 96 Tacoma		P0500-P1780 (11)	Scan Tool	Fig. 5, 6	140°F	1st, 3rd, O/D, R
		96-00 4Runner						
		97-01 Tacoma						
	3VZ-E	93, 94 T100		42 thru 64 (5)	EFI 15A	Fig. 4		
	5VZ-FE	95, 96 Tacoma		P0500-P1780 (11)	Scan Tool	Fig. 5,6		
		95-98 T100						
		96-01 4Runner						
		97-01 Tacoma						
	2TZ-FZE	94.5, 95 Previa		P0720-P1780 (9)		Fig. 2	158°F	
		96, 97 Previa		P0500-P1780 (11)				
	5VZ-FE	00-01 Tundra		P0500-P1780 (13)		Fig. 6	140°F	
	2UZ-FE	00-01 Tundra		P0500-P1780 (13)		Fig. 6		
		01 Sequoia						
A-343F	1FZ-FE	96, 97 Land Cruiser	3rd - 1st	P0500-P1780 (11)	Scan Tool	Fig. 5	131°F	1st, 3rd, O/D, R
	2UZ-FE	98, 01 Land Cruiser		P0500-P1780 (13)		Fig. 6		1st, 3rd, O/D, R
A-442F	1FZ-FE	93, 94 Land Cruiser	3rd - 1st	41 thru 88 (9)	DOME 10A	Fig. 4	131°F	1st, 3rd, O/D, R
		95 Land Cruiser		P0710--P1780 (10)	Scan Tool			
A-46DE, A-46DF	2TZ-FZE	91-94 Previa	3rd - 1st	42 thru 64 (5)	EFI 15A	Fig. 4	158°F	1st, 3rd, O/D, R
A-140E	3S-FE	89-91 Camry	2nd - 1st	42 thru 64 (5)	DOME 20A	Fig. 4	122°F	
	3S-GE	88, 89 Celica					158°F	
	5S-FE	92-95 Camry		42 thru 64 (4)	EFI 15A	Fig. 4, 5	122°F	
		96-01 Camry 99-01 Solara		P0500-P1780 (9)	Scan Tool	Fig. 5, 6		
		94, 95 Celica		42 thru 64 (4)	EFI 15A	Fig. 4		
		96-99 Celica		P0500-P1780 (9)	Scan Tool	Fig. 5, 6 Fig. 8 (99)		
	5S-FNE	00-01 Camry				Fig. 7		
A-241E	5S-FE	90-93 Celica	2nd -1st	42 thru 64 (5)	EFI 15A	Fig. 4	122°F	1st, 3rd, O/D, R
		91-93 MR2						
		94, 95 MR2						
	3S-FE	96, 97 RAV4		P0750-P1780 (9)	Scan Tool	Fig. 5		
A-244E	5E-FE	92-95 Paseo	2nd - 1st	42 thru 64 (5)	EFI 15A	Fig. 4	127°F	1st, 3rd, O/D, R
		96, 97 Paseo		P0500-P1780 (10)	Scan Tool	Fig. 6		
A-245E	7A-FE	93-95 Corolla	2nd - 1st	42 thru 64 (4)	EFI 15A	Fig. 4	131°F	1st, 3rd, O/D, R
		96, 97 Corolla		P0500-P1780 (9)	Scan Tool	Fig. 5		
	1ZZ-FE	98, 01 Corolla				Fig. 6	140°F	
A-246E	7A-FE	94, 95 Celica	2nd - 1st	42 thru 64 (4)	EFI 15A	Fig. 4	131°F	1st, 3rd, O/D, R
		96, 97 Celica		P0500-P1780 (9)	Scan Tool	Fig. 5		
A-247E	3S-FE	98, 00 RAV4	2nd - 1st	P0500-P1780 (9)	Scan Tool	Fig. 7	140°F (98) 122°F (99)	1st, 3rd, O/D, R
A-540E	2VZ-FE	88-91 Camry	2nd - 1st	42 thru 64 (5)	EFI 15A	Fig. 4	145°F (100°F)	1st, O/D, O/D, R
	3VZ-FE	92, 93 Camry					140°F	
	1MZ-FE	98, 00 Sienna		P0500-P1780 (10)	Scan Tool	Fig. 6		
A-541E	1MZ-FE	94-01 Camry 99-01 Solara	2nd - 1st	P0500-P1780 (11)	Scan Tool	Fig. 5, 6	131°F (94) 140°F (95-01)	1st, 3rd, O/D, R (94) 1st, O/D, O/D, R (95-01)
		95-01 Avalon		P0500-P1780 (11)*		Fig. 5, 6	140°F	1st, 3rd, O/D, R (94) 1st, O/D, O/D, R (95-01)
		01 Sienna		P0500-P1780 (11)		Fig. 6		1st, O/D, O/D, R
A-540H	3S-FE	89-91 Camry	2nd - 1st	44 thru 74 (7)	DOME 20A	Fig. 4	122°F	1st, O/D, O/D, R
		96-00 RAV4	3rd - 1st 2nd - 1st (98-00)	P0500-P1780 (13)	Scan Tool	Fig. 5 (96,97) Fig. 7 (98-00)	140°F	1st, 3rd, O/D, R (96, 97) 1st, O/D, O/D, R (98, 00)
U-140F	1AZ-FE	01 RAV4	3rd - 1st	P0500-P1790 (16)	Scan Tool	Fig. 6	140°F	3rd, 3rd, 3rd, R
	1AZ-FE	01 Highlander						
U-140E	1MZ-FE	01 Highlander	3rd - 1st	P0500-P1790 (16)	Scan Tool	Fig. 6	140°F	3rd, 3rd, 3rd, R
U-240E	2ZZ-FE	00-01 Celica	3rd - 1st	P0500-P1790 (16)	Scan Tool	Fig. 6	140°F	1st, O/D, O/D, O/D
U-241E	1AZ-FE	01 RAV4	3rd - 1st	P0500-P1790 (16)	Scan Tool	Fig. 6	140°F	3rd, 3rd, 3rd, R
	2AZ-FE	01 Highlander						
U-340E	1NZ-FE	00-01 ECHO	3rd - 1st	P0500-P1790 (14)	Scan Tool	Fig. 6	140°F	3rd, 3rd, 3rd, R
U-341E	1ZZ-FE	00-01 Celica	3rd - 1st	P0500-P1790 (16)	Scan Tool	Fig. 6	140°F	3rd, 3rd, 3rd, R

A/T Clutch Application Chart

U-140E, U-140F, U-240E, U-241E

Shift Lever Position	Gear Position	C1	C2	C3	B1	B2	B3	F1	F2
P	Park						■		
R	Reverse		■			■	■		
N	Neutral						■		
D	1st	■					■	■	■
	2nd	■			■		■		■
	3rd	■	■				■		■
	O/D	■	■	■					
2	1st	■					■	■	■
	2nd	■			■		■		■
L	1st	■				■	■	■	■

A14-0L, A-140E, A-540E, A-540H, A-541E

Shift Lever Position	Gear Position	C0	C1	C2	B0	B1	B2	B3	F0	F1	F2
P	Park	■									
R	Reverse	■		■				■			
N	Neutral	■									
D	1st	■	■						■		■
	2nd	■	■				■		■	■	
	3rd	■	■	■			■		■		
	O/D		■	■	■		■				
2	1st	■	■						■		■
	2nd	■	■			■	■		■	■	
	3rd*	■	■	■			■		■		
L	1st	■	■				■		■		■
	2nd**	■	■			■	■		■	■	

* Downshift only - no upshift   ** Does Not Apply to A-140L

U-340E, U-341E

Shift Lever Position	Gear Position	C1	C2	C3	B1	B2	B3	F1	F2
P	Park								
R	Reverse			■			■		
N	Neutral								
D	1st	■							■
	2nd	■				■		■	
	3rd	■	■			■			
	O/D		■		■	■			
2	1st	■							■
	2nd	■			■	■		■	
L	1st	■					■		■

A-240E, A-240L, A-241E, A-241H

Shift Lever Position	Gear Position	C1	C2	B0	B1	B2	B3	F0	F1	F2	F3
P	Park										
R	Reverse		■				■				
N	Neutral										
D	1st	■						■		■	■
	2nd	■				■		■	■		■
	3rd	■	■			■		■			■
	O/D	■	■	■		■					
2	1st	■						■		■	■
	2nd	■			■	■		■	■		■
	3rd*	■	■			■		■			■
L	1st	■					■	■		■	■
	2nd	■			■	■		■	■		■

* AW Only A-240E, A-241E

A-43D, A-43DE, A-44DL, A-45DL, A-45DF

Shift Lever Position	Gear Position	C0	C1	C2		B0	B1	B2	B3		F0	F1	F2
				I.P.	O.P.				I.P.	O.P.			
P	Park	■							■	■			
R	Reverse	■		■	■				■	■	■		
N	Neutral	■											
	1st	■	■								■		■
D	2nd	■	■					■			■	■	
	3rd	■	■	A45DL A45DF	A45DE A45DL			■			■		
	O/D		■	A45DL A45DE	A45DE A45DL	■		◪					
2	1st	■	■								■		■
	2nd	■	■				■	■			■	■	
L	1st	■	■						■	■	■		■

I.P. - Inner Piston   O.P. - Outer Piston

A-340E, A-340F, A-340H, A-343F

Shift Lever Position	Gear Position	C0	C1	C2	B0	B1	B2	B3		F0	F1	F2
								I.P.	O.P.			
P	Park	■										
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

I.P. - Inner Piston   O.P. - Outer Piston

TRANSFER

CLUTCH, BRAKE AND SOLENOID

Transfer gear position	No. 4 Solenoid	C3	C4	B4
H2	OFF	■		
H4	OFF	■	■	
L4	OFF		■	■

Customer Interview Sheet

Customer Interview Sheet

Automatic Transmission/Transaxle

Date:	Service Advisor Name:
Customer's Name:	Vehicle License No.:
	Vehicle VIN:
Repair Order No.	Vehicle Model:
Odometer Reading	Production Date:

Date Problem Occurred:		
How Often Does Problem Occur?	◯ Continuously	◯ Intermittently (_____times a day)
When Does the Problem Occur?	◯ Shortly after start-up in AM.	◯ After engine at operating temperature.

Symptoms	Vehicle does not move ◯ Any position ◯ Particular position ____
	No up-shift (◯ 1st to 2nd ◯ 2nd to 3rd ◯ 3rd to O/D)
	No down-shift (◯ O/D to 3rd ◯ 3rd to 2nd ◯ 2nd to 1st)
	Harsh Upshift (◯ 1st to 2nd ◯ 2nd to 3rd ◯ 3rd to 4th)
	Shift point (◯ Too high ◯ Too low)
	Converter lock-up malfunction
	Harsh engagement (◯ N to D ◯ N to R ◯ Lock-up ◯ Any drive position)
	Slip or shudder
	No kick-down
	No engine braking on deceleration
	Other

MIL Light	◯ Goes OFF when engine starts	◯ Remains ON when engine starts

ECT Analyzer

ECT Analyzer

The ECT Analyzer is designed to determine if a transmission malfunction is ECM/electrical circuit related or in the transmission. The analyzer is connected at the solenoid electrical connector either directly or by using an adapter harness. Each adapter harness has a tag attached to it to identify the model application. Also, consult TSB SS94-003 for the specific harness application and part number. The checker is used on models as early as 1983 on up to 1994. The Diagnostic Tester performs a similar function on vehicles with DLC2 or 3 and therefore no harnesses were developed for later models.

ECT Analyzer (Checker)

The analyzer is connected at the solenoid electrical connector either directly or by using an adapter harness.

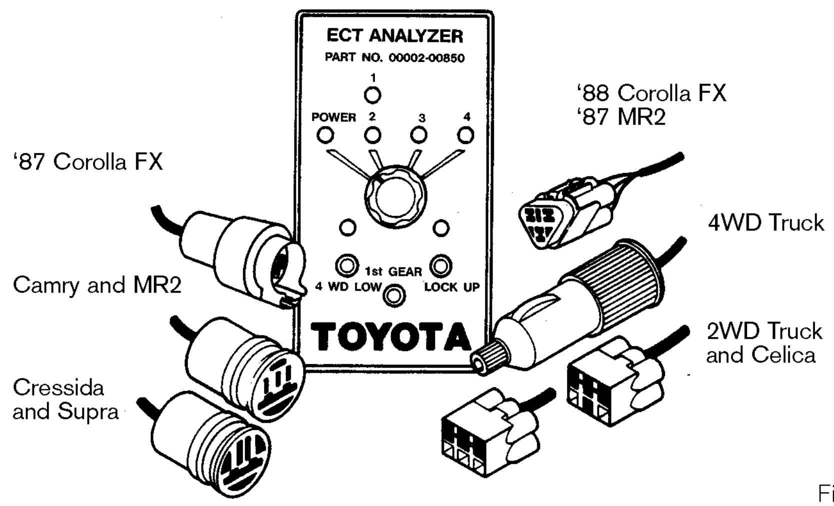


Fig. 7-01
T273f282

The vehicle is driven using the analyzer to shift the transmission. If the transmission operates properly with the ECT Analyzer, the fault lies between the solenoid connectors up to and including the ECM. 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 by rotating the knob.

CAUTION

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

CAUTION Choose a safe test area where there are no pedestrians, traffic or 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.

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

WORKSHEET 1 (Classroom)
Powerflow Application

Vehicle	Year/Prod. Date	Engine	Transmission

Worksheet Objectives

In this worksheet you will become familiar with the application of the powerflow chart for specific automatic transmission symptoms.

Tools and Equipment

- Vehicle Repair Manual
- Technician Handbook

Section 1:

1. RO Primary Concern: Transmission slips on take off.

2. Read the following diagnostic scenario and use the power flow chart to determine the cause.

Vehicle	1998 Camry 5S-FE
Transmission	A-140E
RO Description	trans slips on take off
Fluid level and condition	level correct, condition good
Throttle cable	adjustment correct
Pre test drive diagnostic codes	none
Test drive:	
Reverse	no slip and has engine braking
D 1st	slips
D 2nd	shift quality good, no slip
3rd	shift quality good, no slip, has engine braking
O/D	shift quality good, no slip, has engine braking
M 1st	no slip, has engine braking
M 2nd	no slip, has engine braking
Hot fluid level	correct
Stall test	stall speed high in D 1st, correct in R and M 1st
Line pressures	within spec at both idle and stall in D & R
Diagnostic codes	none
Trans pan inspection	lots of metal (steel) in pan

3. What is the most likely cause of the primary concern found on the R.O.?

Section 2

1. RO Primary Concern: Transmission slips in reverse.

2. Read the following diagnostic scenario and use the power flow chart to determine the cause.

Vehicle	Late model Camry
Transmission	any A-140E or A-540E or A-541E
RO Description	trans slips in reverse
Diagnostic info:	
Fluid level and condition	over full and trans is not at operating temperature fluid is very dark and smells burned
Throttle cable	correct
Pre test drive diagnostic codes	no codes
Test drive:	
Reverse	harsh, slow engagement slips
D 1st	no slip
D 2nd	shift quality good, no slip
3rd	shift quality good, no slip, has engine braking
O/D	shift quality good, no slip, has engine braking
M 1st	no slip but no engine braking
M 2nd	no slip, has engine braking
Hot fluid level	2 inches over full mark and aerated
Stall test	D in spec, R over spec, M 1st in spec
Line pressures	low at both idle and stall in D & R
Diagnostic codes	none
Trans pan inspection	lots of friction material in pan

3. What is the most likely cause of the primary concern found on the R.O.?

Section 3

1. RO Primary Concern: Transmission slips

2. Read the following diagnostic scenario and use the power flow chart to determine the cause.

Vehicle	93 V6 Camry
Transmission	A-540E
RO Description	Trans slips
Diagnostic info:	
Fluid level and condition	Level ok cold, condition very poor, smells burned and looks very dark
Throttle cable	Misadjusted, bead inside housing
Pre test drive diagnostic codes	none
Test drive:	
Reverse	late engagement, slips, poor engine braking
D 1st	good engagement, no slip
D 2nd	good shift quality, no slip
3rd	flare on shift, slips, poor engine braking
O/D	shift quality fair, slips, poor engine braking
M 1st	good engagement, no slip, has good engine braking
M 2nd	shift quality good, no slip, has engine braking
Hot fluid level	level ok hot
Stall test	in spec in D over spec in R
Line pressures	in spec both D & R at idle below spec both D & R at stall
Diagnostic codes	none
Trans pan inspection	lots of friction material in pan

3. What is the most likely cause of the primary concern found on the R.O.?

____

____

Section 4

1. RO Primary Concern: Transmission slips

2. Read the following diagnostic scenario and use the power flow chart to determine the cause.

Vehicle	99 V6 4x2 Tacoma
Transmission	A-340E
RO Description	Poor fuel mileage trans slips on freeway
Diagnostic info:	
Fluid level and condition	cold fluid level ok, condition poor, and smells burnt
Throttle cable	adjustment correct
Pre test drive diagnostic codes	none
Test drive:	
Reverse	good engagement, no slip, has engine braking
D 1st	good engagement, no slip
D 2nd	good shift quality, no slip
3rd	good shift quality, no slip, has engine braking
O/D	poor shift quality (soft and slow), slips, no engine braking
M 1st	good engagement, no slip, has engine braking
M 2nd	good shift quality, no slip, has engine braking
Hot fluid level	in spec
Stall test	in spec both D & R
Line pressures	in spec D & R both idle and stall
Diagnostic codes	none
Trans pan inspection	friction material in pan

3. What is the most likely cause of the primary concern found on the R.O.?

WORKSHEET 2 (On-Car)
Preliminary Checks

Vehicle	Year/Prod. Date	Engine	Transmission

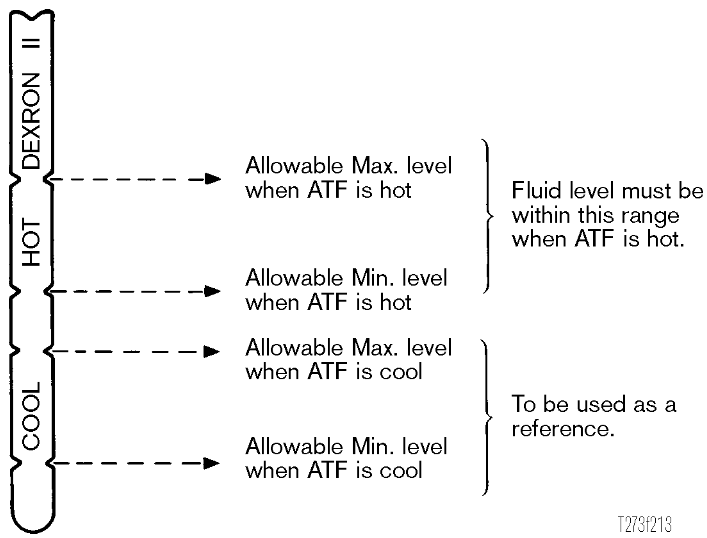
In this worksheet, you will use the Repair Manual to perform the following preliminary checks to determine the condition of the fluid and external adjustments:

1. Transmission fluid.
2. Throttle cable adjustment.
3. Shift cable adjustment.

Worksheet Objective

In this worksheet you will be applying the published information and techniques on a “training” vehicle to:

- Quickly assess the condition of an automatic transmission through the preliminary checks.
- Choose the next course of action based on the results of the preliminary checks.



Tools and Equipment:

- Repair Manual
- Assorted hand tools
- Vernier caliper or metric steel ruler

Section 1

Fluid Level and Condition

1. What is the recommended fluid temperature to accurately check fluid level? How is the temperature determined?

   List four possible fluid conditions that would indicate a concern?

2. What is the difference in the quantity of fluid between a “drain and refill” and a dry fill? Where is the difference stored?

3. What is the purpose of shifting the transmission through all gears prior to checking the fluid level?

____

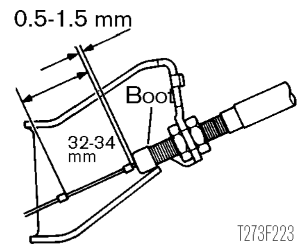
Section 2

Inspect and Adjust Throttle Cable

a. Ensure that accelerator pedal is fully released.

b. Inner cable should have no slack.

c. Measure the distance between the outer cable boot and the cable stopper.



Cable Measurement	Specification	Pass/Fail

1. Is the throttle cable adjustable? If Yes, explain how.

____

____

2. What effect does the throttle cable adjustment have on the transmission types below?

Non-ECT transmission: ____

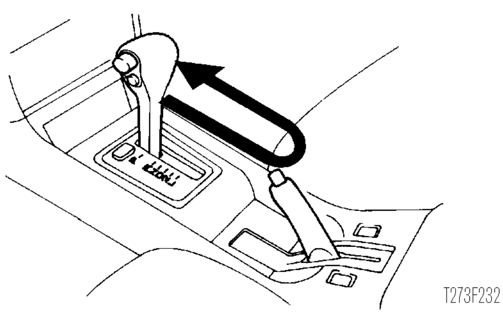
____

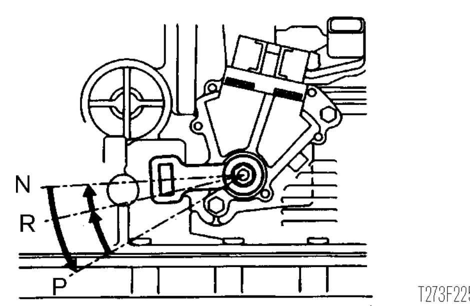
ECT transmission: ____

____

Section 3

Shift cable adjustment





While moving the shift lever through its range, check the position indicator alignment. If it is not aligned, adjust the shift cable.

1. Loosen the shift cable nut on the shift lever. (may have to remove the cable from the lever)
2. Rotate the control shaft fully (counterclockwise if lever on right side of trans) toward the Park position.
3. Return the control shaft lever two notches to Neutral position.
4. Set the shift lever to Neutral position.
5. While placing pressure on the shift lever toward the Reverse position, tighten the shift lever nut.

1. What effect would a misadjusted shift cable have on the operation of the transmission?

2. What are the vehicle operation safety concerns associated with a mis-adjusted shift cable?

3. What are some likely problems which could occur in an ECT transmission if two or more gear selector position indicators illuminated at the same time as the gear selector was moved from park to low?

Notes

$WORKSHEET 3 (On Car)
Roadtest Procedures

Vehicle	Year/Prod. Date	Engine	Transmission

In this worksheet, you will road test a vehicle to monitor up-shifts and downshifts noting the quality of the shift as well as the speed at which they occur and recording the results.

Worksheet Objectives

In this Worksheet you will be applying the tools and techniques discussed during this course to:

1. Monitor up-shift quality at two throttle positions.
2. Verify proper operation of 2-range and L-range.
3. Verify proper kick-down operation in D-range.

Section 1

D-Range Up-shifts

Note the vehicle speed in the chart below

1. Drive the vehicle at a quarter throttle and half throttle and record the vehicle speed at the time of the upshift.
2. Note the quality of the upshift by checking the appropriate box in the last row.

Throttle Position	Shift	Normal*	Power*	N**	H**	S**
Quarter Throttle	1-2 2-3 3-4	mph mph mph	mph mph mph			
Half Throttle	1-2 2-3 3-4	mph mph mph	mph mph mph			
**Shift Quantity:	N = Normal	H = Harsh	S = Slippage			

* If no pattern select switch record in Normal column.

1. Why are the upshift vehicle speeds different between quarter and half throttle?

____

2. What shift timing difference is noticed between Normal and Power upshift speeds?

____

3. At what temperature does the ECM (ECU) allow an upshift to 4th gear? converter lock-up?

Section 2

2-Range Up-shifts

1. Place the shift selector in 2-range and accelerate first at a quarter throttle and next at half throttle.

2. Record the vehicle speed and shift quality when the upshift occurs.

Throttle Position	Shift	Speed
Quarter Throttle	1-2	mph
Half Throttle	1-2	mph
Shift Quantity: ○ Normal ○ Excess Shock ○ Slippage		

Section 3

Engine Braking

1. While driving with the gear selector in 2-range in 2nd gear, release the accelerator and check for engine braking

   ○ OK ○ NG

2. While driving with the gear selector in L-range in 1st gear, release the accelerator and check for engine braking

   ○ OK ○ NG

Section 4

D-Range Kick-Down

Record the results in the table below.

1. Accelerate to 35 mph, while in O/D apply the accelerator to achieve a downshift to 3rd gear.

2. At 35 mph in O/D, accelerate heavily to achieve a downshift to 2nd gear.

3. Lock out O/D with the O/D cancel switch. While driving at 30 mph in 3rd gear, apply the accelerator to achieve a 2nd gear downshift.

4. While driving at 15 mph, select 2-range and accelerate to achieve a downshift to 1st gear.

Throttle Position	Shift	Speed
O/D to 3rd		
O/D to 2nd		
3rd to 2nd		
2nd to 1st		

Section 5

Manual Downshift

1. ECT transmission - at 35 mph in O/D, press the O/D Off button, record engine speed *increase*:

   __________ rpm

2. At 35mph, shift from D to 2, (note engine speed increase)

   ○ OK ○ NG

3. At 25 mph, shift from 2 to 1, (note engine speed increase)

   ○ OK ○ NG

4. What electrical components are functioning properly when the transmission downshifts from O/D to 3rd gear?

   ____

   ____

5. What mechanical components are functioning properly when the transmission downshifts from O/D to 3rd gear?

   ____

6. What mechanical components are functioning properly when the transmission downshifts from 3rd gear to 2nd?

   ____

7. What mechanical components are functioning properly when the transmission downshifts from 2rd gear to 1st?

   ____

Notes

WORKSHEET 4 (On-Car)
Stall Test

Vehicle	Year/Prod. Date	Engine	Transmission

Worksheet Objectives

In this worksheet, you will use the Repair Manual to perform a stall test, pressure test and time lag test to determine the condition of the following:

1. Line pressure.

2. Torque converter stator operation.

3. Forward Clutch (C1), No. 2 One-Way Clutch (F2), O/D Direct Clutch (CO), Direct Clutch (C2), 1st and Reverse Brake (B3), O/D One-Way Clutch (FO).

4. Engine state of tune.

Tools and Equipment

- Automatic Transmission Pressure Gauge Set
- Basic hand tools
- Wheel Chocks
- Vehicle repair manual

Section 1

Vehicle Preparation

1. Install the pressure gauge to the transmission line pressure port. (route the hose around any hot surfaces).

2. Run the engine to allow the ATF to reach normal operating temperature.

3. Set the parking brake and chock the wheels.

4. On vehicles with a throttle cable, increase engine speed to 2400 rpm and pull the throttle cable. What happened to line pressure?

____

Section 2

Stall Test

1. During the stall test you will record both the engine rpm and the line pressure.

2. Place the gear selector in Drive position and while applying firm pressure on the brake pedal with your left foot, press the accelerator fully. (Do not run this test longer than 5 seconds)

3. Perform the same test above in reverse gear.

	Drive	Reverse	Stall Speed Spec.
Full Throttle Stall Speed	rpm	rpm	rpm
Line Pressure at Stall	psi	psi	psi

4. Identify at least two possible causes for low stall speed in Drive and Reverse.

5. List two possible causes of high stall speed in Drive position only.

Section 3

Time Lag Test

Using a stop watch, note the time it takes to engage drive and reverse from neutral.

1. Transmission fluid should be at normal operating temperature.

2. Apply the parking brake.

3. Start the engine and check idle speed.

4. Shift from neutral to drive and record the time from engagement of the gear selector to D, until the gear engages. Record the time in the chart below.

5. Allow a one minute interval between tests to allow fluid to escape clutch cylinders.

6. Perform step 4 two additional times and record the times.

7. Perform the same procedure as in step 4, but shift from neutral into reverse.

Vehicle:				**RPM**	
	1st	2nd	3rd	Average	Specifications
Drive					
Reverse					

8. If the lag time into Drive was longer than specified, what are three possible causes?

9. If the lag time into Reverse was longer than specified, list four possible causes?

Section 4

Governor Pressure Test (Celica Simulator)

1. Install the low pressure gauge to the transmission governor pressure port. (Route the hose around any hot surfaces)

2. Refer to the vehicle repair manual for the vehicle speed and corresponding governor pressure specification.

3. Drive the vehicle and record the governor pressure reading at the specific vehicle speed.

Vehicle Speed	Specified Pressure	Governor Pressure
0 mph		psi
mph	psi	psi
mph	psi	psi
mph	psi	psi

4. If the governor pressure is lower than that specified in the repair manual, what are three possible causes?

5. How does low governor pressure affect shift timing?

6. What affect would there be if governor pressure was present in neutral, with the vehicle stopped and the gear selector is then placed in drive?

Notes

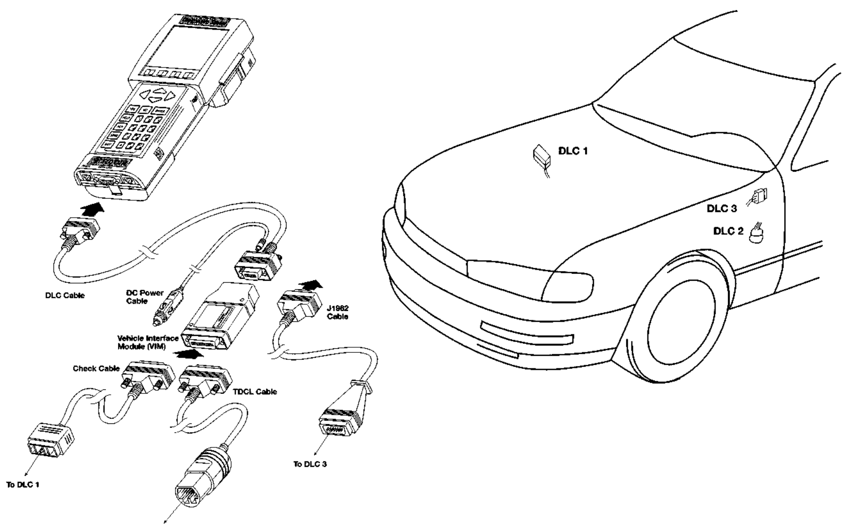
WORKSHEET 5 (On-Car)
Diagnostic Trouble Codes

Vehicle	Year/Prod. Date	Engine	Transmission

In this worksheet, you will practice the use of the Toyota Diagnostic Tester to access ECT diagnostic codes.

Tools and Equipment

- Vehicle Repair Manual
- Diagnostic Tester (TOY220036)
- Resistor "Bug" tool



T273f233

Section 1

Reading Diagnostic Codes

1. Disconnect the temperature sensor in the engine compartment.

2. Attach the DLC cable to the hand held tester and then attach the appropriate connector cable (DLC1, DLC2 or DLC3) to the DLC cable.

3. Attach the connector cable to the vehicle's diagnostic connector.

4. Turn the ignition switch to ON, power up the diagnostic tester and select ENTER and select Normal Mode.

5. At the main menu select Enhanced OBD II and press enter.

6. At the OBD II MENU select Trouble Data and then Codes/Freeze.

7. Record the codes and components/circuits that appear on the tester screen.

____

8. Observe the bottom of the screen for access to "Freeze Data." Press ENTER.

9. What information is displayed and how can this assist in your diagnosis?

____

____

10. Reconnect the temperature sensor.

Section 2

Clearing codes

1. Reconnect the shift solenoid connectors and confirm the repair.
2. Select TROUBLE DATA from the ENHANCED OBD II menu.
3. Select CLEAR CODES from the TROUBLE DATA MENU.
4. Press the YES key to clear Trouble Codes.
5. Describe the recommended procedure to verify a system repair?

____

____

____

WORKSHEET 6 (On-Car)
Diagnostic Tester Sensor Check

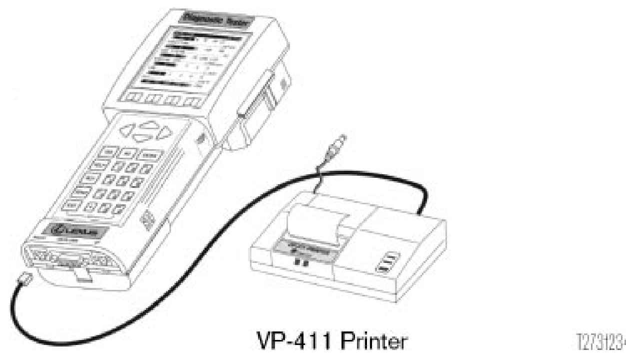
Vehicle	Year/Prod. Date	Engine	Transmission

Worksheet Objective

In this worksheet, you will practice the use of the Toyota Diagnostic Tester to monitor signal data, observe charted signals, and print 5 sensor/output signals.

Tools and Equipment

- Vehicle Repair Manual
- Diagnostic Tester (TOY220036)
- Vetronics Printer



Section 1

Auto Trans Sensor Check Procedure

1. Attach the DLC cable to the hand held tester and attach the DLC3 connector cable to the DLC cable.
2. Attach the connector cable to the vehicle's DLC3 connector.
3. Attach VP-411 printer to the Diagnostic Tester.
4. Turn the ignition switch to ON and power up the unit and select ENTER.
5. At the main menu select enhanced OBD II and press enter.
6. At the Mode Selection screen select NORMAL MODE.
7. At the Enhanced OBD II MENU select CURRENT DATA and then select DATA LIST.
8. From the SELECT DATA select ATM.

Throttle Pos	PNP Switch	Stop Light Switch	O/D Cut Switch 2	Reverse	2nd	low
OK / NG	OK / NG	OK / NG	OK / NG	OK / NG	OK / NG	OK / NG

9. Operate each of the switches in the chart below and circle it's condition

Engine Speed	Coolant Temp	Vehicle Speed	Shift	Lock-up Solenoid
mph	deg.F	mph	1st 2nd 3rd OD	OK / NG

10. Drive the vehicle while the passenger observes the screen. Record information in the second row of the chart below.

11. If the Overdrive Cut Switch reading remains OFF regardless of the switch position, what is the likely cause?

____

12. In the example above, what symptom/s would be noted?

____

13. If the engine temp remained at 284°F, what malfunction is indicated?

____

Section 2

Line Graph Mode

1. Press F4 to select LINE GRAPH mode.
2. Press * and YES until Throttle Position is displayed.
3. Press the down arrow once to highlight the second line.
4. Press * and YES until Shift is displayed.
5. Drive the vehicle up to 35 mph and press the accelerator to achieve a downshift.
6. Press # and SEND simultaneously to print.
8. Paste the printout in the box at right.

Section 3

Manual Snapshot

1. Press EXIT to return to Current Data Menu.
2. Select MANUAL SNAPSHOT from the User Data Menu.
3. Use down arrow to highlight USER DATA then press ENTER.
4. Use up/down arrows to highlight the following sensors and press YES to select them. When finished press the ENTER key:
    a. Calculated Load (CALC LOAD).
    b. Engine Speed.
    c. Throttle Position.
    d. Vehicle Speed.
    e. Shift.
5. Use the left and right arrow keys to select the 100 time scale.
6. Use the up and down arrow keys to highlight the second line.
7. Press * and YES simultaneously until SHIFT appears.
8. Drive the vehicle and note the calculated load and shift lines.
9. Press ENTER to trigger the snapshot when the test emits a second “beep”.
10. Press YES when prompted to save the snapshot data.

Section 4

Replay Snapshot

1. To replay snapshot press EXIT and then press 4 from the CURRENT DATA menu.
2. Press the up and down arrow to highlight the stored snapshot and press ENTER.
3. Press the left arrow key until the time reads -10 sec.
3. Press # and SEND simultaneously to print the selected user list. Paste the print below.
4. Press F4 for Line Graph Mode and highlight parameters you wish to graph.
5. Print the Line Graph for step 4 and paste it below.

Section 5

Strip Chart Mode

1. Go to the CURRENT DATA MENU and press 6 to select USER LIST.
2. Press F6 to select the STRIP CHART MODE.
3. Press # and F8 to start the strip chart.
4. Drive the vehicle while the strip chart prints making two stop and start sequences upshifting to O/D each time.
5. Press # and F9 to stop the strip chart.
6. Paste the strip chart on the back of this page.

Notes

WORKSHEET 7 (On-Car)
Diagnostic Active Tests

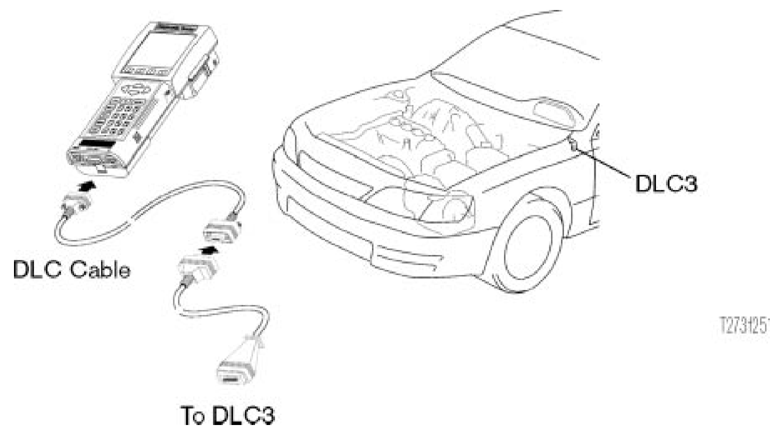
Vehicle	Year/Prod. Date	Engine	Transmission

Worksheet Objective

In this worksheet, you will practice the use of the Toyota Diagnostic Tester to perform active test of the automatic transmission.

Tools and Equipment

Vehicle Repair Manual
Diagnostic Tester (TOY220036)



Procedure:

1. Attach the DLC cable to the hand held tester and attach the DLC3 connector cable.
2. Attach the connector cable to the vehicle's DLC3 connector.
3. Power up the unit and select ENTER.
4. At the main menu select enhanced OBD II and press enter.
5. At the Mode Selection screen select NORMAL MODE.
6. At the Enhanced OBD II MENU select TEST DATA.
7. From the TEST DATA MENU select ACTIVE TEST.
8. From the SELECT DATA screen toggle down to SHIFT and press the ENTER button.
   a. Copy the screen warning statement.

   ____

9. Press the ENTER key.
10. Use the Left and Right arrows to upshift and downshift the transmission.
11. Place the shift selector in Drive position. Using the right arrow key, upshift the transmission to O/D.
12. Press the left arrow to downshift to 3rd gear and stop the vehicle. With the transmission in 3rd gear, accelerate to 35 mph.

a. Refer to the Diagnostics chapter of the repair manual for Auto Trans Code P0753 to determine which solenoid would have to fail to cause the transmission to start-out in 3rd gear?

____

____

b. How might a customer describe the vehicle’s operation?

____

13. A vehicle shifts from first into O/D. The vehicle will downshift to first gear under heavy acceleration below 20 mph. During the active test with the diagnostic tester the transmission shifts from 1st to 2nd to 3rd and O/D.

a. What components and parts have we determined to operate properly by using the active test?

____

b. What is the most likely cause of the problem?

____

14. Return to the Active Test menu and select “Lock-up.”

a. Copy the screen warning statement:

____

15. Press the ENTER key.

16. Press the Left and Right Arrow keys to apply and release the lock-up clutch.

17. Observe the lock-up solenoid on the data list for operational change.

14. What additional method could be used to verify lock-up operation?

____

WORKSHEET 8 (On-Car)
Oscilloscope Function

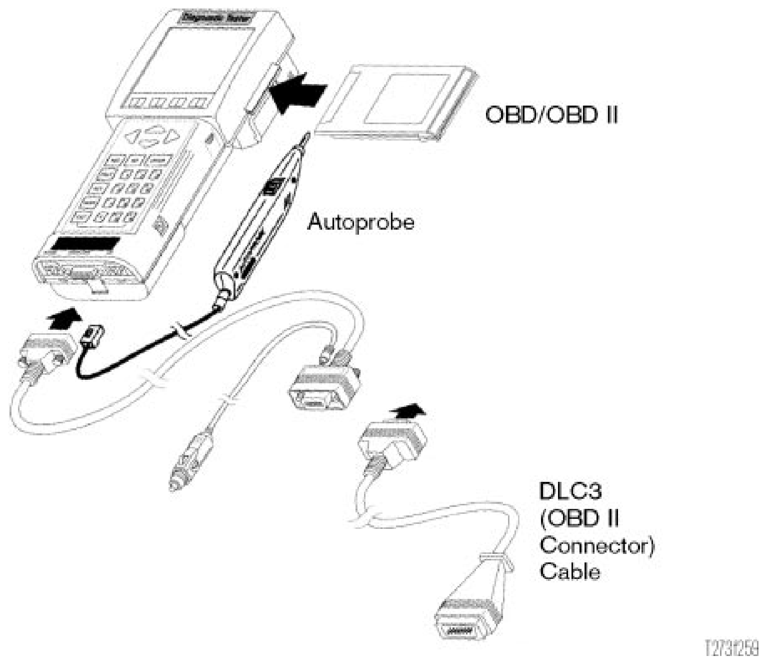
Vehicle	Year/Prod. Date	Engine	Transmission

Technician Objective

In this worksheet, you will practice the use of the Toyota Diagnostic Tester to perform the oscilloscope function on an automatic transmission. The oscilloscope function of the Diagnostic Toolset enables a technician to display voltage signals from the Autoprobe for real-time analysis.

Tools and Equipment

- Vehicle Repair Manual
- Diagnostic Tester (TOY220036)
- Autoprobe attachment



Section 1

Procedure

1. Attach the autoprobe cable to the Instrument Port (I/P) and attach the DLC3 connector cable to the DLC cable.

2. Power up the unit and press ENTER.

3. Select DIAGNOSIS from the application menu and press ENTER.

4. At the Function Select Menu select AUTOPROBE and press ENTER.

5. At the Autoprobe Menu select OSCILLOSCOPE and press ENTER.

6. Note the current settings in the top status line of the screen.

Section 2

Display configuration adjustment

1. Hold the auto probe tip with you hand and Press 1 on the diagnostic tester and press the up and down arrows.

   What happens to the scope pattern when the time is changed?

   ____

2. Press 2 on the Diagnostic Tester and press the up and down arrows.

   What happens when you change the volt scale?

   ____

3. Press 3 on the Diagnostic Tester and press the up and down arrows.

   What happens when you change the start point of the voltage trace?

   ____

4. Press 4 on the Diagnostic Tester and press the up and down arrows.

   What happens when you change the ground point of the voltage trace?

   ____

   ____

5. Press 5 on the Diagnostic Tester.

   What happens to the voltage trace?

   ____

6. Press 6 on the Diagnostic Tester several times while observing the upper right corner of the screen.

   What are the letter designations and what do they mean?

   ____

7. Press 7 on the Diagnostic Tester and release the probe.

   What happens to the voltage trace?

   ____

8. Press 0 on the Diagnostic Tester and then press 5.

   What is the waveform options?

   ____

9. Save the voltage trace that was frozen in step 7.

Section 3

Monitor speed sensor with Oscilloscope

1. Using the Autoprobe and an EWD, locate and backprobe the Vehicle Speed Sensor wire at the ECM.

   What is the advantage of backprobing at the ECM rather than the sensor?

   ____

2. Start the vehicle and drive it at a constant speed. (Or lift the drive wheels off the floor)

   Hold the vehicle speed at 15 to 20 mph and adjust the voltage and time to best fit the trace to the screen.

   Does the trace remain steady at a constant speed?

   ____

3. Adjust the trigger level by pressing the up and down arrow keys. What happens?

   ____

4. Press 7 on the Diagnostic Tester. What happens to the voltage trace?

   ____

5. Describe the procedure to save the displayed voltage trace.

   ____

6. What is the benefit of the oscilloscope function with the diagnosis of a problem in the VSS circuit?

   ____

7. Recall the first image saved on page 2 and record the file number below.

   ____

8. Delete both saved files. How do you know whether the file has been erased?

   ____

Notes

WORKSHEET 9 (On-Car)
Position/Mode Switches and Circuits

Vehicle	Year/Prod. Date	Engine	Transmission

Technician Objectives

With this worksheet, you will learn to test position/mode circuits using the required tools and equipment, retrieve and apply the needed service information, retrieve and interpret service data information.

Tools and Equipment

- Vehicle Repair Manual
- Vehicle EWD
- Diagnostic Tester
- Hand Tool Set

Section 1

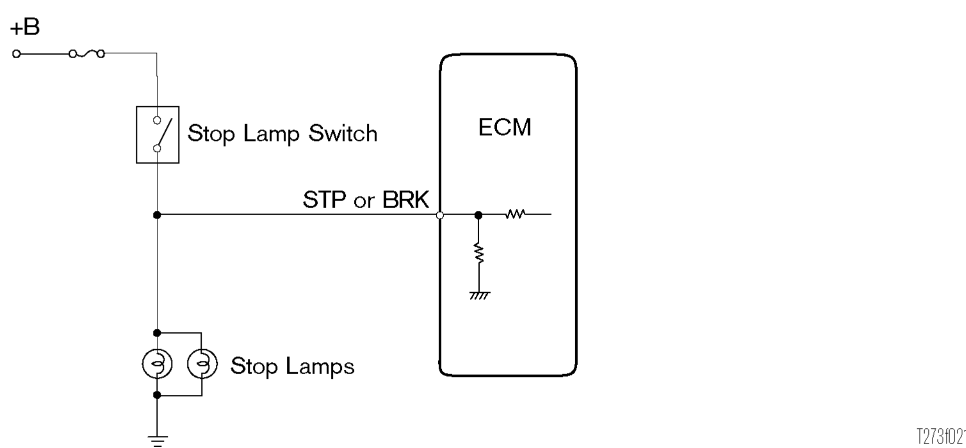
The ECM needs to know the position of a component or when a circuit is being activated. A switch connected to the ECM is often used. The switch can be electrically connected to the ECM in two fundamental ways:

- switch is located between the Battery and ECM.
- switch is located between the ECM and Ground.

Section 2

Switch Between Battery and ECM

1. When the switch is located between the battery and ECM, the switch controls the voltage to the ECM. A very common example is the Stop Lamp Switch. When the driver steps on the brake, the switch closes completing the circuit. The ECM detects battery voltage and “knows” the vehicle is braking.



2. Connect the Diagnostic Tester to DLC3, scroll to Stop Light Switch and observe the reading. ____________

3. Step on the brake and note the change. ____________

4. Using the appropriate EWD and/or RM, locate the STP terminal.

   STP Connector no. ____________ Pin no. ____________ Wire Color ____________ .

5. Connect the positive (+) lead of the DVOM to the STP terminal, the negative (-) lead to ground. Switch the DVOM to DC Volts.

   Note the voltage reading. ____________

6. Step on the brake, and note the voltage reading. ____________

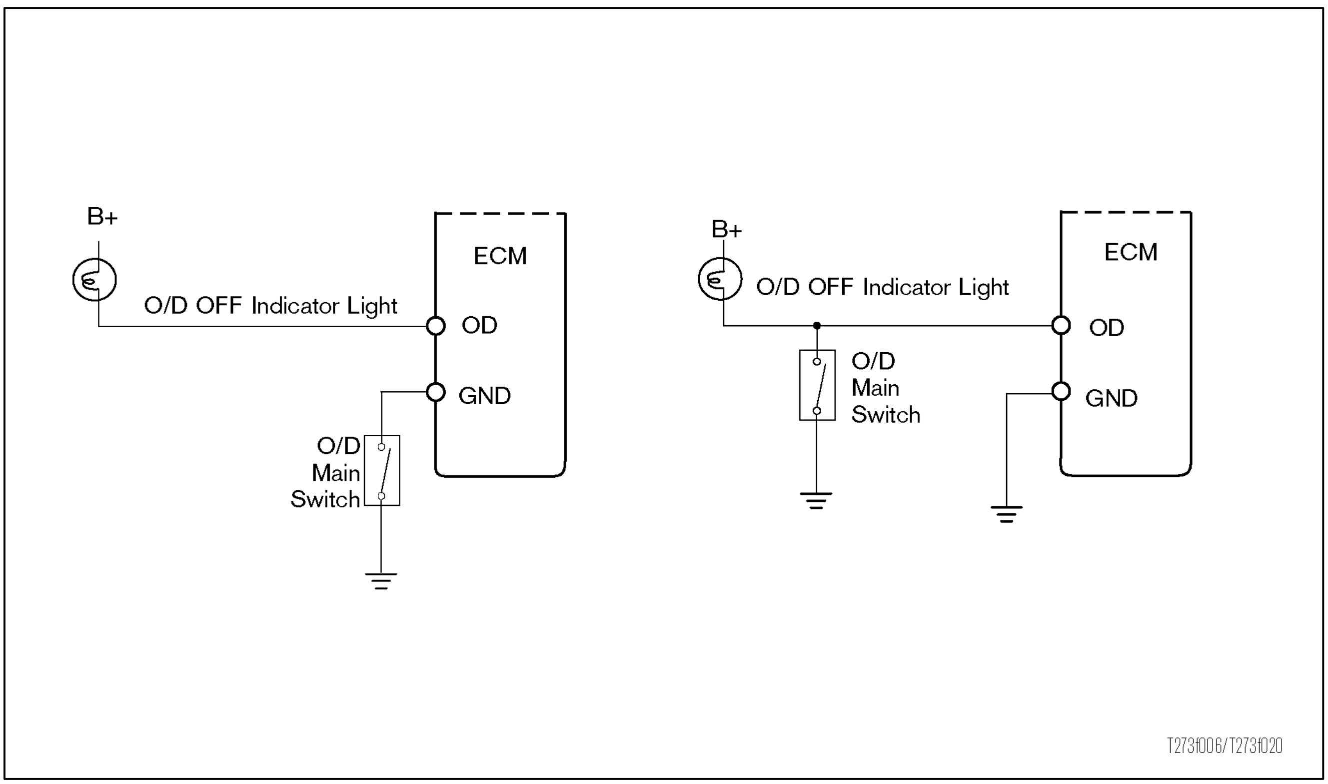
7. Compare the Diagnostic Tester reading to the DVOM reading with brake On/Off and record the results in the chart.

	VOLTAGE AT ECM	**Diagnostic Tester shows**
Brake Off		
Brake On		

Section 3

Switch Between Battery and Ground

1. When the switch is located between the ECM and Ground, the switch controls the ground circuit. An example is the Overdrive (O/D) Main Switch. (If O/D is unavailable, select another vehicle),



2. Connect the Diagnostic Tester to DLC3, scroll to O/D Switch, and observe the reading.

3. Locate the Overdrive (O/D) Main Switch terminal.

   STP Connector no. __________ Pin no. __________ Wire Color __________ .

4. Predict the voltage at the Overdrive (O/D) main switch terminal with the Light off: ______ On: ______

5. Connect the positive (+) lead of the DVOM to the O/D main switch terminal, the negative (-) lead to ground. Switch the DVOM to DC Volts. Toggle the switch between on and off and record your findings in the chart.

O/D SWITCH	"O/D OFF" LIGHT	VOLTAGE AT ECM	DIAG. TESTER SHOWS
O/D Switch Off	ON		
O/D Switch On	OFF		

Section 4

Switch Position

As a rule, the EWD shows the switch in it's natural, at rest position. Most switches connected to the ECM are normally open switches, regardless if they are on the power or ground side.

The stop light switch is a normally open switch. The switch closes when the brake pedal is stepped on.

From the EWD, locate the switches connected to the ECM. Identify if they are:

- power side/ground side switched.
- normally open/close switches.

Fill in the chart blanks:

SWITCH SIDE	POWER/GROUND	NORMALLY OPEN/CLOSED	VOLTAGE SIGNAL AT REST	VOLTAGE WHEN ACTIVATED
Stop Light				
O/D Cancel				
Drive Pattern Select Switch				
Park Neutral Sw				

Notes

WORKSHEET 10 (On-Car)
Temperature Sensors

Vehicle	Year/Prod. Date	Engine	Transmission

Technician Objectives

With this worksheet, you will learn to test temperature sensors and circuits using the required tools and equipment, retrieve and apply the needed service information, retrieve and interpret service data information.

Tools and Equipment

- Vehicle Repair Manual
- Vehicle EWD
- Diagnostic Tester
- Hand Tool Set
- Vehicle at room temperature

Section 1

Engine Coolant Temperature (ECT) and Transmission Fluid Temperature Operation

(If your vehicle does not have an ATF temperature sensor ignore that portion of the worksheet)

1. Connect the Diagnostic Tester and go to the Data List. Observe and record the ATF and ECT temperature. Do they match?

   ECT: __________ ○F ATF: __________ ○F

2. Using the Repair Manual/EWD locate the THW and E2 terminals.

   THW Connector No. __________ Pin No. __________ Wire color __________.

   E2 Connector No. __________ Pin No. __________ Wire color __________.

3. Connect the positive (+) lead of the DVOM to the THW terminal and the negative (-) lead to terminal E2. With the ignition key in the on position, record the voltage.

   ____

Questions 4-8 apply to vehicles with ATF temperature sensor only.

4. Using the Repair Manual/EWD locate the ATF temperature sensor terminal.

   THO Connector No. __________ Pin No. __________ Wire color __________.

5. Move only the positive (+) lead of the DVOM to the temperature sensor terminal and record the voltage.

   ____

6. Turn the Ignition key off.

7. Disconnect the ATF temp sensor at the sensor. Using the test lead connector and DVOM, measure the resistance of the sensor. Does it match the Repair Manual chart?

    ____

8. Reconnect the temp sensor.

Section 2

Make sure the Parking Brake is securely set and exhaust hose is connected. Connect the positive (+) lead of the DVOM to the THW terminal and the negative (-) lead to terminal E2. Start the engine, and observe the ECT reading on the Diagnostic Tester and the DVOM voltage reading. Plot the temperature and voltage on the chart.

Temp. ○F	80	90	100	110	120	130	140	150	160	170	180
Volts											

Complete the following:

1. As the engine gets warmer, the ECT voltage signa ____________________________________

2. As the engine gets warmer, ECT resistance ____

3. Note the difference in voltage every 10○ (F). What happened to the change in voltage signal the last 40○F

    ____

4. Shut the engine off, then turn the ignition key on. What should happen to ECT voltage signal after several minutes?

    ____

5. Does the DVOM and Diagnostic Tester confirm your prediction? ____________________________

Section 3

The following exercises will help you understand the Repair Manual diagnostic procedures.

Create an Open Circuit Fault

1. Disconnect the ATF temp sensor (or ECT) at the sensor, and record the temperature and circuit voltage at the ECM.

    ECT: __________ ○F ATF: __________ ○F Voltage: __________ V

Create a Short Circuit Fault

1. At the sensor connector, use a wire to connect the two terminals together and record the sensor temperature reading and voltage.

    ECT: __________ ○F ATF: __________ ○F Voltage: __________ V

2. At the sensor connector, ground the TH_ wire. Is the reading approximately the same? ______________

3. What DTC is triggered? ____

Repair Manual Logic

1. A customer vehicle comes in with DTC P0115, the Diagnostic Tester reads -40○F. You would look for what type of circuit fault?

   ____

2. What step would you take next?

   ____

Section 4

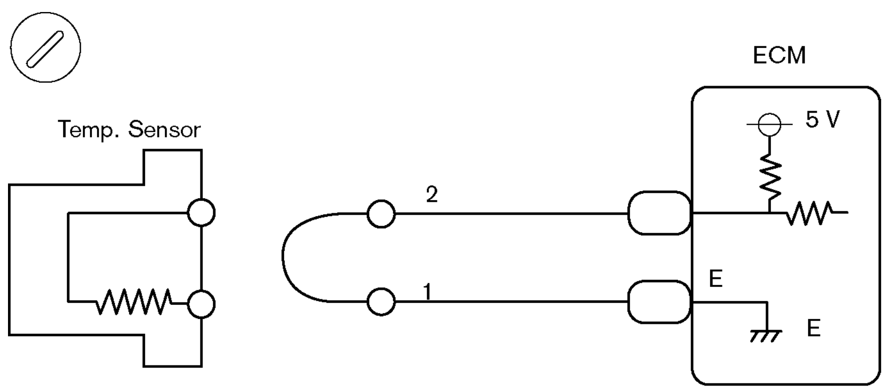
Solving Open Circuit Faults

1. An open ECT sensor will read what temperature on the; DT ____________ DVOM ____________. The following step determines if the fault is with the ECT sensor or the circuit.

   A jumper wire is inserted at the sensor connector. This creates a short circuit and the temperature should go high (hot). If it does:

   What must be good? ______________________________

   What must be at fault? ______________________________

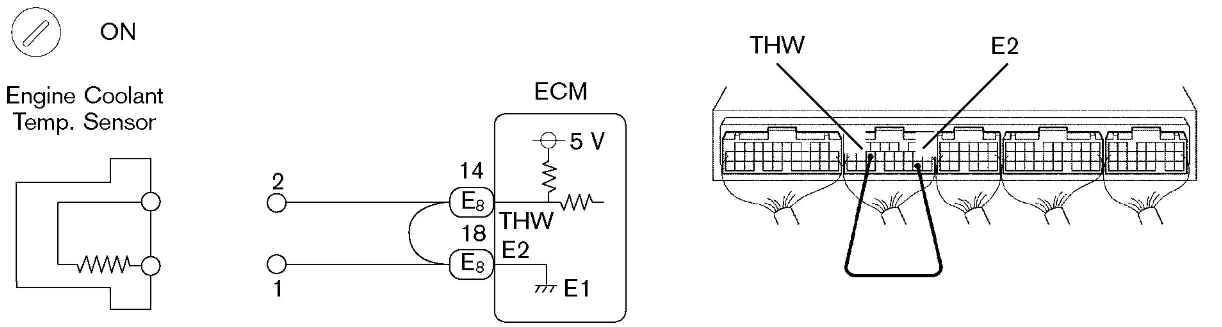


T273f042

If the temperature did not go high (hot), then the problem is with

____

2. Next, determine if the problem is with the circuit or the ECM.



T273f043/T273f044

With a jumper wire between the THW and E2 terminals at the ECM, temperature should go high. If it does, the problem is

____

If it does not go high it is either the

____

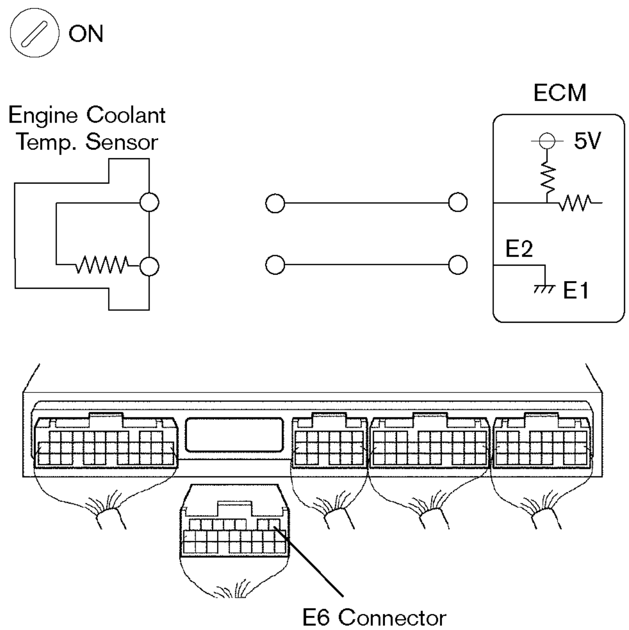
Solving Shorted Circuit Faults

1. A shorted ECT temperature sensor will read what temperature on the; DT ________ DVOM ________

   Disconnecting the temperature sensor creates an open circuit and the temperature should go extremely low (cold). If it does, ________________ must have been shorted to ground.

   If not, the problem must be with the

   ________________ or ________________



T273f045/T273f046

   With the connector at the ECM disconnected, temperature should go low (cold). If it does, the fault is

   ____

   If it does not, the problem is with

   ____

Notes

WORKSHEET 11 (On-Car)
Position Sensors

Vehicle	Year/Prod. Date	Engine	Transmission

Technician Objectives

With this worksheet, you will learn to test position sensors and circuits using the required tools and equipment, retrieve and apply the needed service information, retrieve and interpret service data information.

Tools and Equipment

- Vehicle Repair Manual
- Vehicle EWD
- Diagnostic Tester
- Hand Tool Set with DVOM
- Vehicle at room temperature
- Pencil
- Jumper leads with alligator clips

Section 1

The ECM needs to know the position of the throttle position switch.

1. Use a pencil to draw a dark line approximately 1/4" wide at the bottom of this page. Connect the jumper leads to VC and E2 at the bottom of the page and to VC and E2 of the ECM. Attach the DVOM ground lead to vehicle ground and the positive (+) lead to VC at the bottom of the page. Turning the ignition key on, the DVOM should read 5V. Now slowly move the positive (+) lead towards E2 and note the DVOM reading. What happened to the voltage as the lead moved closer to E2?

   ____

2. The strength of the voltage signal is how the ECM determines the position of the component.

3. Remove the jumper wires from the ECM.

4. With the Diagnostic Tester connected to the vehicle, turn the ignition switch to ON and note the throttle position. Slowly depress the throttle and note the change on the Diagnostic Tester.

5. Connect a DVOM between the VTA and E2 terminals. Slowly depress the throttle and note the voltage on the DVOM. Did the voltage increase with throttle opening?

   ____

Just like the beginning exercise you did, the ECM measures position by the strength of the voltage signal.

The ECM sends 5 volts to the TPS on the VC wire. Voltage is then divided between the signal wire (VTA) and ground (E2). The closer the signal arm moves to the supply voltage, the higher the voltage signal.

VC	E2

Section 2

Repair Manual Checks

The following explanations describe common diagnostic procedures found in the Repair Manual on throttle position sensors. You may find discrepancies with the order in the RM.

Diagnostic Tester

1. Compare throttle position to the Diagnostic Tester data at closed throttle and WOT.

2. Do the readings match specifications? ______________

Check Voltage Between Terminal VC of the TPS and Body Ground.

1. Disconnect the TPS connector and measure the voltage at the VC terminal. It should be about 5 volts. If you get this reading it confirms that the wire is good and ECM is providing the correct voltage. If not, the problem may be with the circuit or ECM.

2. With the TPS disconnected, what did the DT read? ______________

Check Voltage Between Terminals VC and E2 of ECM Connector.

1. If you did not measure 5 volts at the VC terminal at the TPS connector, this test confirms if the ECM is putting out the necessary supply voltage.

2. If you get 5 volts at the ECM connector, the problem is in the

   ____

3. If you did not get 5 volts, the ECM is at fault.

Inspect Throttle Position Sensor

On some models, you will find TPS checks in the Throttle Body “On-Vehicle” Inspection in the SF Section.

1. With DVOM measure the resistance of the TPS at the specified terminal locations. What terminals are used?

   ____

2. Does the TPS meet specifications?

   ____

Section 3

Check voltage between terminals VTA and E2 of ECM connector. This test is the same as in the exercise you did above. This test is to determine if the circuit or the ECM is at fault. If voltage readings are within specifications, the ECM may be at fault. (Intermittent problems in the circuit or TPS may also be the problem). If voltage readings are not in spec., there may be an open or short in the harness and connector between ECM and TPS on the VTA or E2 line.

1. If the VTA line were shorted to ground, what would the voltage reading at the ECM be?

   ____

2. If the VTA line were open, what would the voltage reading at the ECM be?

   ____

3. What test(s) can be made to determine the difference?

   ____

4. If the E2 line were open, VTA voltage at the ECM will be approximately?

   ____

Notes

WORKSHEET 12 (On Car)
Speed Sensors

Vehicle	Year/Prod. Date	Engine	Transmission

Technician Objectives

With this worksheet, you will learn to test speed sensors using the required tools and equipment, retrieve and apply the needed service information, retrieve and interpret service data information.

Tools and Equipment

- Vehicle Repair Manual
- Vehicle EWD
- Diagnostic Tester
- DVOM
- Hand Tool Set

Section 1

The ECM needs to know the speed of many components such as the engine speed, vehicle speed, transmission component speed, etc.

Vehicle Speed Sensor

1. Connect the Diagnostic Tester Autoprobe and DVOM to the Vehicle speed sensor circuit at the ECM.

   Connector no. __________ Pin no. __________ Wire Color _________________________

2. Set the Diagnostic Tester to the oscilloscope/autoprobe function, refer to Repair Manual for settings. Connect DVOM and set to AC volts, Hz.

3. Start the engine and drive the vehicle at 15 and 37 mph; draw or print the waveform for both vehicle speeds.

15 mph ____________ Hz

37 mph ____________ Hz

Input Turbine or Counter Gear Speed Sensor

1. The ECM compares the input turbine speed sensor with the No. 2 speed sensor to detect shift timing and control engine torque and hydraulic pressure.

2. Connect the Diagnostic Tester Autoprobe and DVOM to the Input Turbine speed sensor signal.

   Connector no. __________ Pin no. __________ Wire Color _________________________

3. Set the diagnostic tester to the oscilloscope/autoprobe function. Set the DVOM to AC volts, Hz.

4. Start the engine with the transmission in P or N and observe the DT and DVOM.

5. With the transmission in P or N, does the DT display a waveform? Why?.

   ____

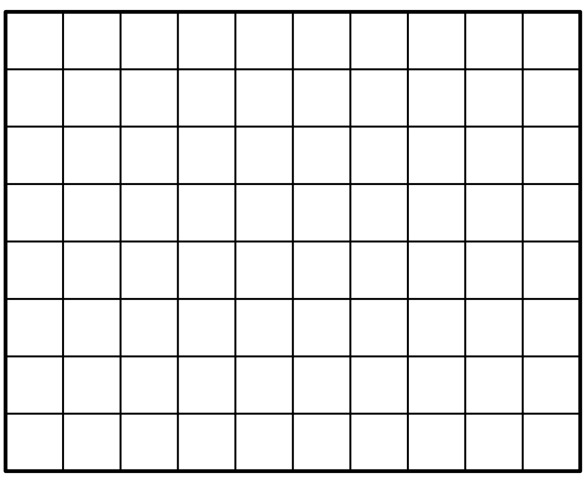
   ____

6. With the gear selector in Drive and the brakes applied, what happens to the waveform?

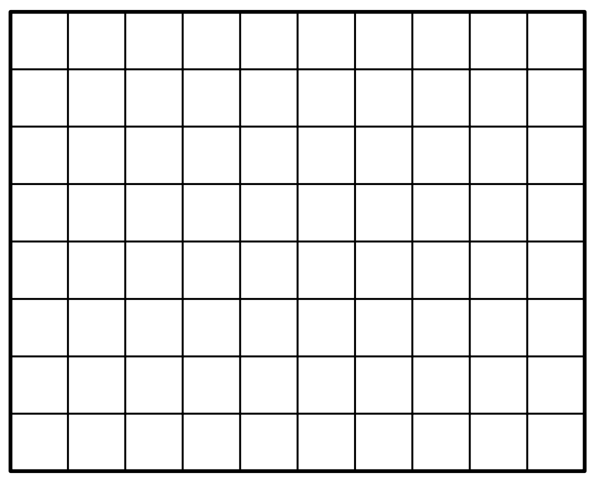
   ____

7. Drive the vehicle at 15 and 37 mph in 3rd gear and draw or print the waveform at the two speeds.

15 mph ____________ Hz



37 mph ____________ Hz



WORKSHEET 13 (On-Car)
Linear Solenoids for Line Pressure and Shifting Controls

Vehicle	Year/Prod. Date	Engine	Transmission

Technician Objectives

With this worksheet, you will learn to test the linear solenoid circuits using the required tools and equipment, retrieve and apply the needed service information, retrieve and interpret service data information.

Tools and Equipment

- Vehicle Repair Manual
- Vehicle EWD
- Diagnostic Tester
- DVOM
- Hand Tool Set
- Vetronix Printer (optional)
- U-series Shift Solenoids
- Power Amplifier (optional)

Section 1

1. Setup the Diagnostic Tester, go to Data List. Connect the DVOM to SLT-terminal. List ECM terminal.
   Connector no. __________ Pin no. __________ Wire Color __________________________

2. Start the engine and note SLT percentage and voltage at idle speed.
   DT: _______________ DVOM: _______________

3. With engine warmed up increase engine RPM to 2500. What happened to SLT percentage and voltage?
   DT: _______________ DVOM: _______________

Section 2

1. Connect the Diagnostic Tester Autoprobe and DVOM to the SLT- circuit at the ECM.
2. Set the Diagnostic Tester to the Oscilloscope/Autoprobe function.
3. Start the engine and place the gear selector in Drive. Set the parking brake and while applying the service brake, observe the oscilloscope at IDLE and at 1500 rpm. Draw or print the waveform at both engine speeds.

Idle

1500 RPM

4. How does the waveform compare to the example in the repair manual? Explain any differences.

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Section 3

Using the **Repair Manual**, U-series shift solenoids, and power amplifier provided, check solenoid resistance.

1. Using a DVOM, measure the resistance between terminals 1 and 2 of the solenoid connector.

2. Does the solenoid meet specifications?

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3. Using a jumper wire and light bulb, check for solenoid operation.

4. What is the wattage of the bulb recommended in the repair manual?

   SL1 and SL2 ____________________

   SLT ____________________

5. What is the purpose of the bulb placed in series with the solenoid?

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6. If the SLT solenoid resistance and operation check out ok, verify circuit continuity and check the circuit for a short to ground.

7. Identify the wire color, connector and pin location for the SLT solenoid at the ECM connector.

   SLT Connector no.__________ Pin no. _______ Wire Color ______________________

8. Describe how the SLT circuit is checked for continuity and an open circuit.

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9. If the SLT solenoid operates properly with the jumper wire and bulb, and the harness has continuity and is not shorted to ground, what is the likely fault?

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