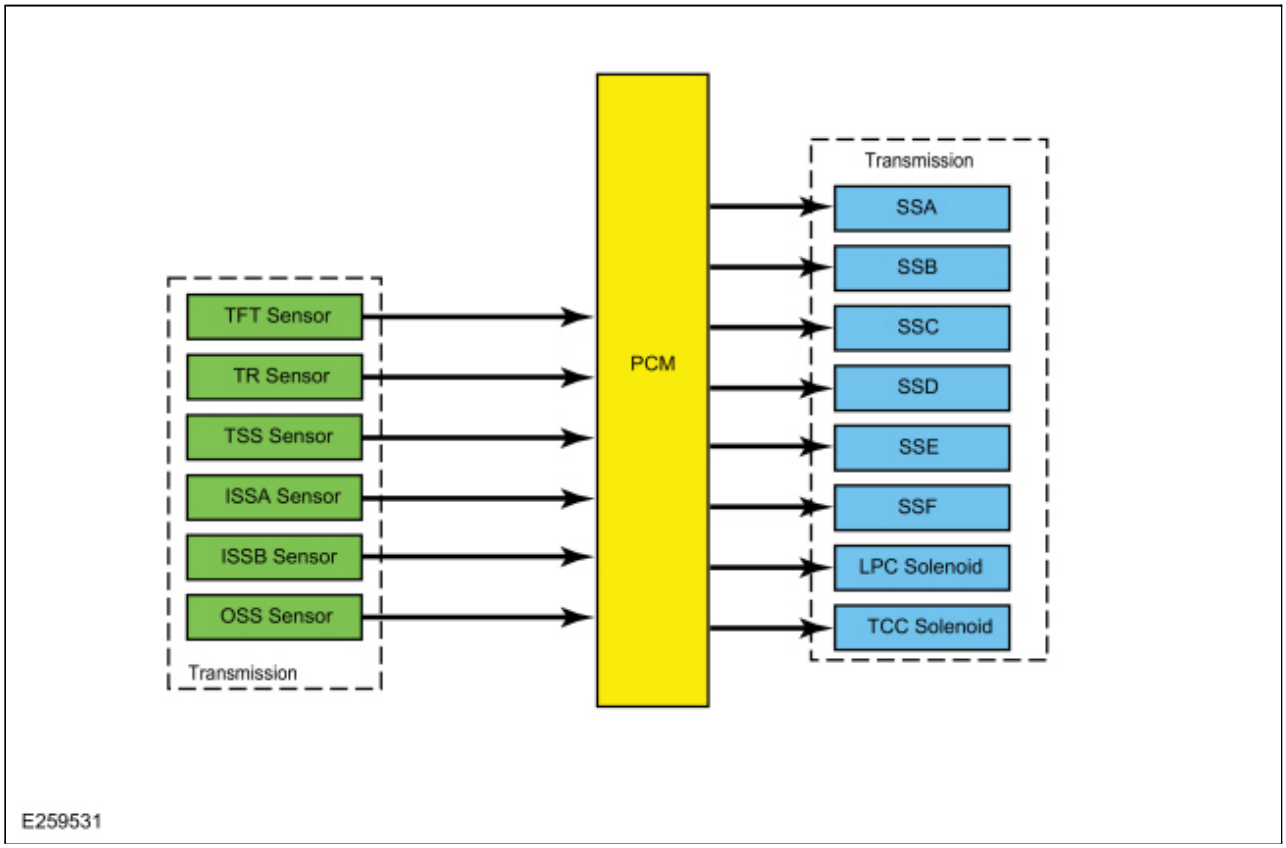
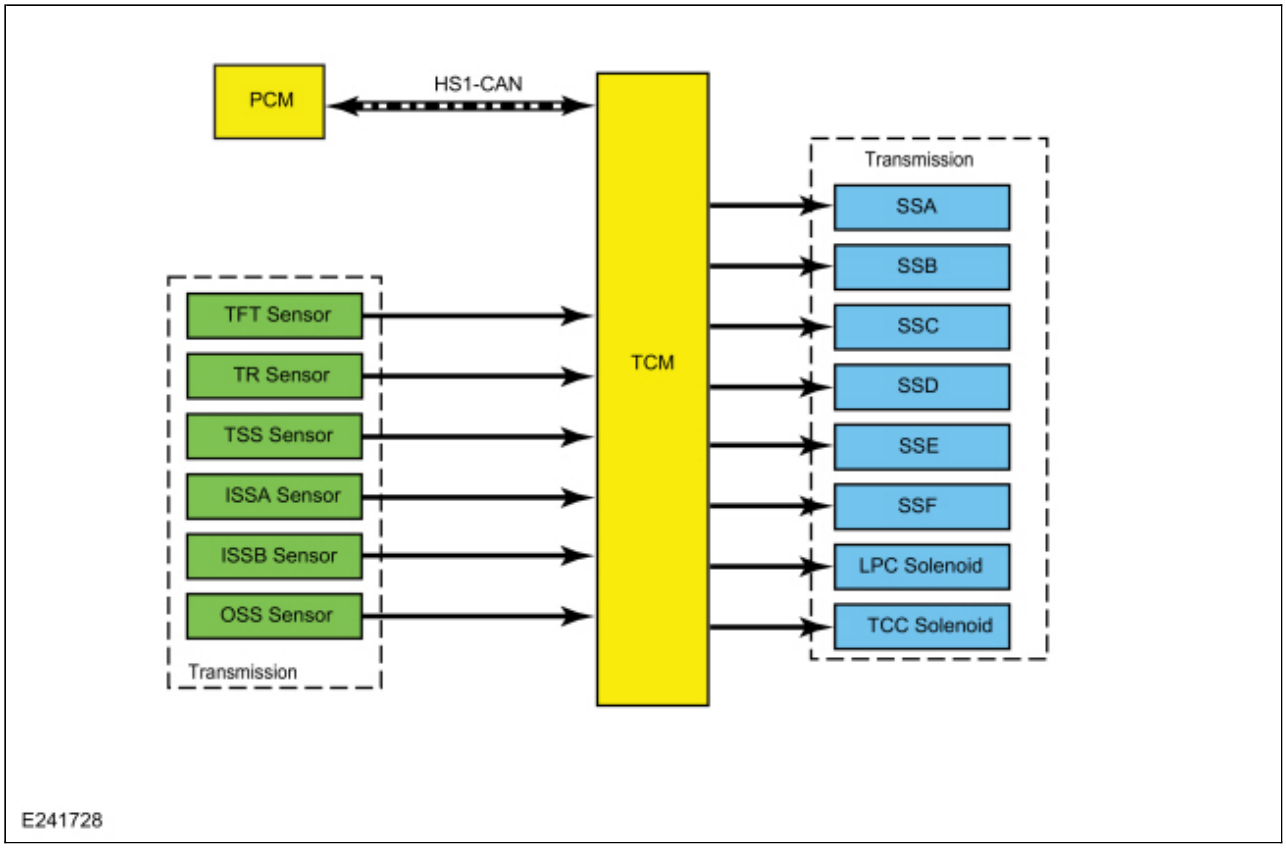
Transmission Description - System Operation and Component Description

System Diagram

2.3L EcoBoost Engines



2.0L TDCi Diesel Engines



Network Message Chart

Broadcast Message	Originating Module	Message Purpose
Engine Speed	TCM	Directly affects shift scheduling, TCC control, line pressure and transmission diagnostics. Indirectly affects shift pressure control.
Engine torque estimate	TCM	Directly affects shift pressure control, TCC control and transmission diagnostics. Indirectly affects shift scheduling and TCC scheduling.
APP	PCM	Directly affects shift scheduling, TCC scheduling and transmission diagnostics. Indirectly affects TCC control and shift control.
Commanded engine torque	PCM	Directly affects shift scheduling, TCC scheduling and transmission diagnostics. Indirectly affects shift control.

System Operation

The 10R80 transmission is a 10-speed, step ratio rear wheel drive transmission that is controlled by a PCM for gas engine applications or a TCM for diesel engine applications. The 10R80 has ten forward speeds, one reverse speed, four planetary gear sets, one mechanical One-Way Clutch or OWC, six friction clutches, an upper valve body, a lower valve body with eight solenoids, and PCM or TCM controlled electronics. The 10R80 utilizes six shift (A-F) solenoids that are linear force solenoids. Unlike previous shift solenoids they are mechanical in nature in that no transmission fluid passes through them. CIDASs use a armature/pin assembly that moves a control valve in the main control valve body to control and apply hydraulic fluid pressure. Each clutch (A-F) is controlled by a corresponding shift solenoid (A-F). These solenoids are directly proportional in that zero current equals zero pressure and maximum current equals maximum pressure. If the power circuit to the transmission solenoids fails open, then all solenoids are failed electrically OFF, none of the clutch packs are able to engage and there is no fail safe operation.

Upshift Gear Sequence

At times the 10-speed transmission may **skip** gears when the vehicle starts from a complete stop. This is **normal** and desired **behavior**.

At part pedal when acceleration is brisk, single step upshifts would result in very frequent shift events (very short time in gear). Double step upshifts results when a longer time is spent in gear.

However, at light pedal or road load, single step upshifts **will** occur. The small 10-speed gear steps allow the engine speed to drop to lower values than it would in the 6-speed transmission; providing for the best fuel economy. In contrast, when the 10-speed transmission is at heavy or max pedal, the small steps keep the engine closer to the horsepower peak for best performance.

Down shift Gear Sequence

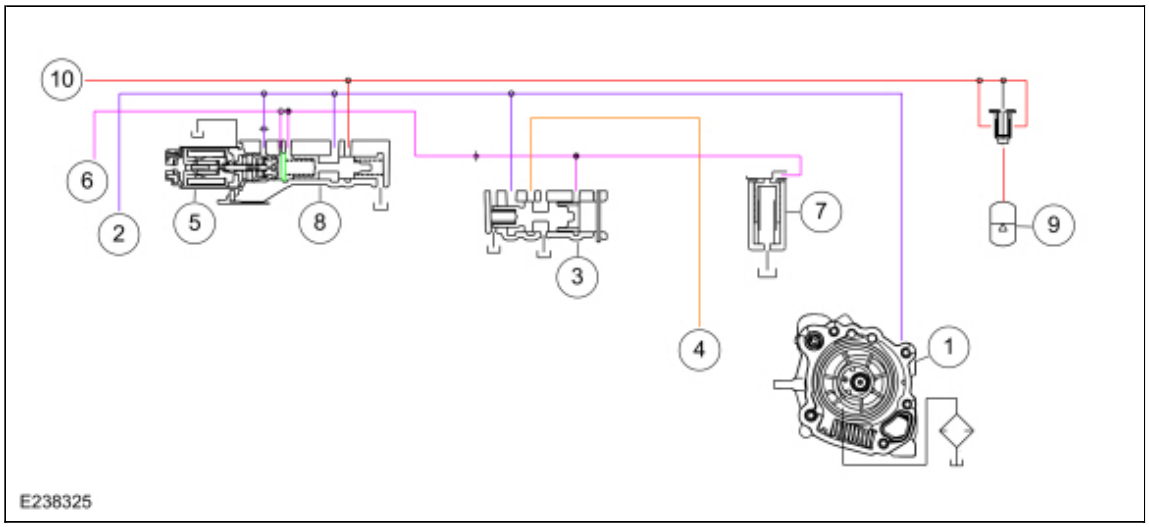
At times the 10-speed transmission may **skip** gears when the vehicle down shifts to a complete stop. This is **normal** and desired **behavior**.

The same **skip** shift strategy that is used for the upshift may be applied during down shift.

Component Description

Hydraulic Circuits

Line Pressure Hydraulic Circuits



Item	Description
1	Mechanical pump
2	Pump output
3	Main regulator valve
4	Pump output decreased
5	LPC solenoid
6	LPC pressure
7	Isolator valve
8	Anti-backflow valve

9	Transmission fluid auxiliary pump (model dependent)
10	Line pressure

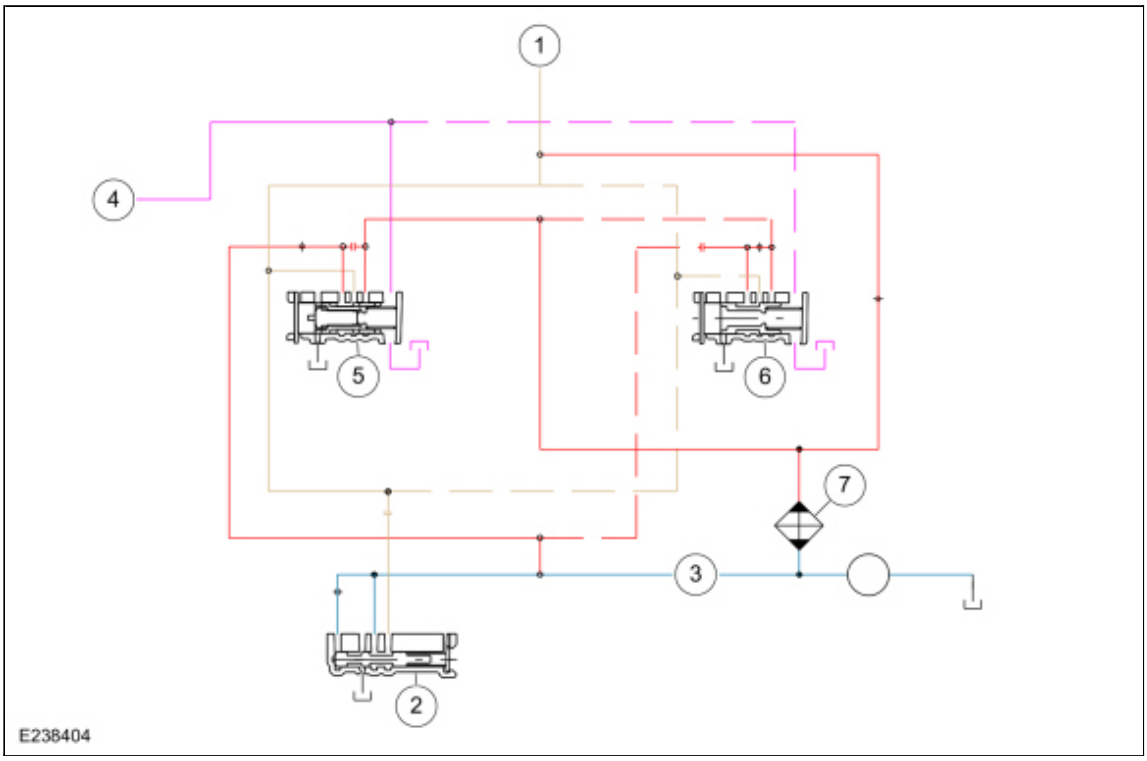
The PCM or TCM controls line pressure with the LPC solenoid. Varying pressure from the LPC solenoid effects shift feel while allowing sufficient pressure for clutch application.

When the engine is running, the pump supplies pressure to the main regulator valve through the pump output circuit. Pressure from the LPC solenoid through the LPC pressure circuit controls the position of the main regulator valve.

The main regulator valve varies pressure in the pump output circuit.

If equipped, the transmission fluid auxiliary pump, an electronic pump is turned on before an engine stop event to maintain line pressure, allowing the transmission to stay engaged during the stop event. This allows quick response on the engine restart because the transmission is already in gear.

Lubrication Hydraulic Circuits



Item	Description
1	Fluid from torque converter
2	Lube control valve
3	Lube fluid circuit
4	Elevated exhaust pressure
5	Thermal bypass valve without active warm up
6	Bypass valve with active warm up

7	Fluid cooler

A small amount of hot fluid from the torque converter is routed through a small orifice in the separator plate to the transmission fluid cooler or transmission fluid warmer/cooler. This fluid purges the cooler or warmer/cooler of air and keeps the cooler or warmer/cooler full of fluid when the vehicle is running.

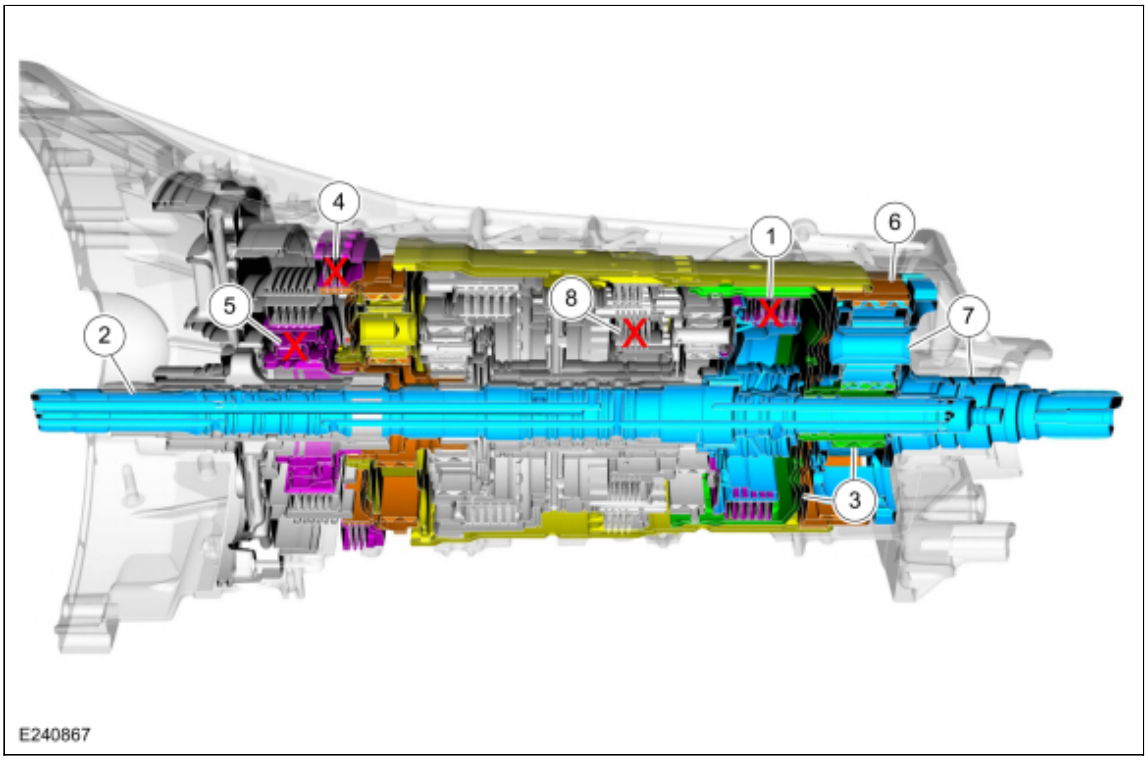
On vehicles without active warm up, most of the hot fluid from the torque converter is routed to the thermal bypass valve. When TFT is below a specified temperature, the thermal bypass valve directs the fluid to the lube circuit. When TFT is above a specified temperature, the thermal bypass valve directs fluid to the transmission fluid cooler. Cold fluid from the transmission fluid cooler is routed to the lube circuit.

On vehicles with active warm up, most of the hot fluid from the torque converter is routed through the bypass valve to the transmission fluid warmer/cooler. Cold fluid from the transmission fluid cooler is routed to the lube circuit.

Fluid in the lube circuit enters the input shaft through the front support assembly and flows through passages in the input shaft and output shaft to provide lubrication for the transmission.

Powerflows

1st Gear

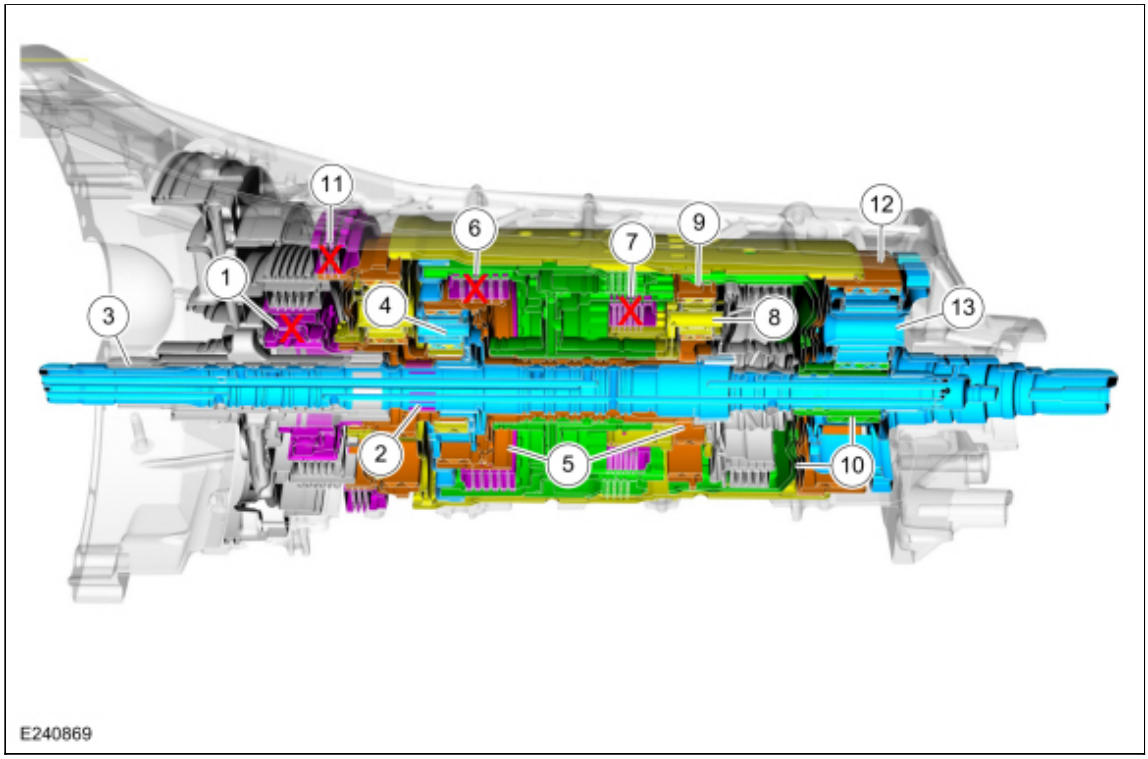


Item	Description
1	E clutch
2	Input shaft
3	Shell and sun gear No. 4

4	A clutch
5	One-Way Clutch (OWC)
6	Ring gear No. 4
7	Output shaft and planetary carrier No. 4
8	D clutch

The E clutch is applied allowing torque to be transferred from the input shaft to the shell and sun gear No. 4. The A clutch and the One-Way Clutch (OWC) are both applied to hold the ring gear No. 4 stationary on acceleration. The shell and sun gear No. 4 drives the pinions of the output shaft and planetary carrier No. 4 in a 4.69 reduction gear ratio. The D clutch is applied to reduce frictional losses from a released clutch, but does not contribute to powerflow.

2nd Gear

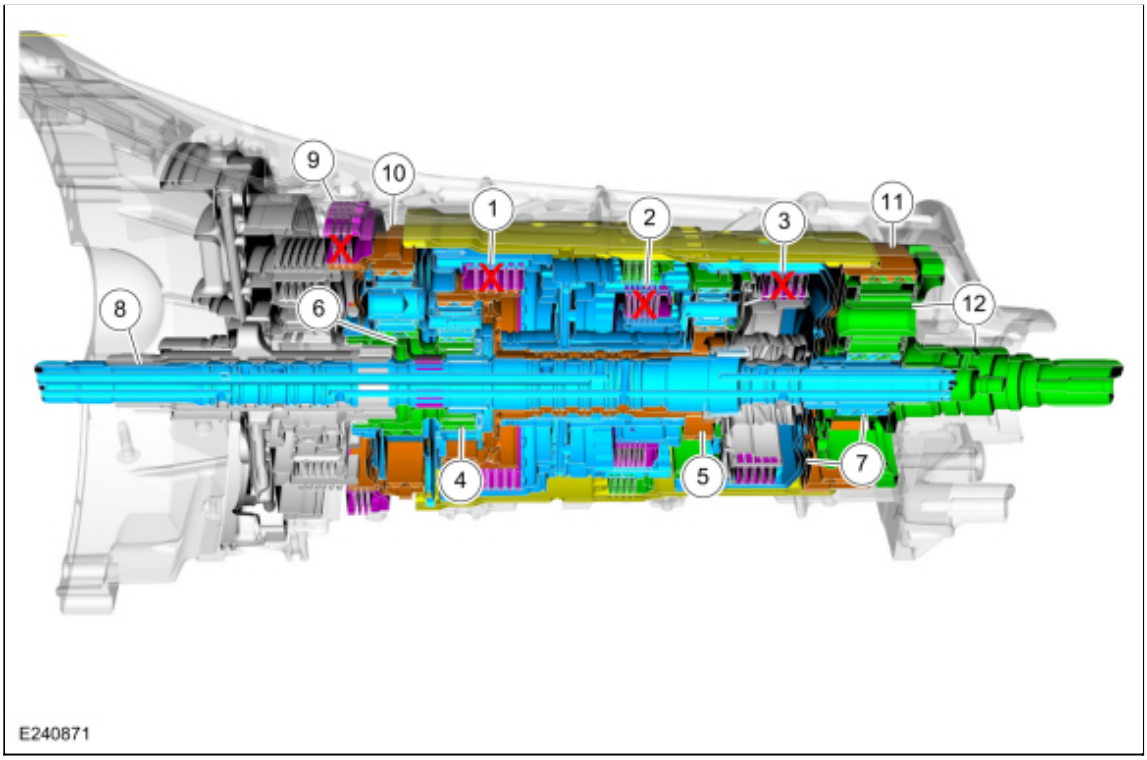


Item	Description
1	One-Way Clutch (OWC)
2	Sun gear No. 2
3	Input shaft
4	Planetary carrier No. 2
5	Ring gear No. 2 and sun gear No. 3
6	C clutch
7	D clutch
8	Planetary carrier No. 3

9	Ring gear No. 3
10	Shell and sun gear No. 4
11	A clutch
12	Ring gear No. 4
13	Output shaft and planetary carrier No. 4

The One-Way Clutch (OWC) holds the sun gear No. 2 stationary on acceleration. The input shaft turns the planetary carrier No. 2 and causes the ring gear No. 2 and sun gear No. 3 to rotate at a 0.63 overdrive ratio. The C clutch and the D clutch are applied allowing torque to be transferred from the ring gear No. 2 to the planetary carrier No. 3 at a 0.63 overdrive gear ratio. The 2 inputs to the 3rd planetary gear set cause the ring gear No. 3 and the planetary carrier No. to rotate at a 0.63 overdrive ratio. The A clutch and the One-Way Clutch (OWC) are both applied to hold the ring gear No. 4 stationary on acceleration. The shell and sun gear No. 4 drives the pinions of the output shaft and planetary carrier No. 4 in a 2.98 reduction gear ratio.

3rd Gear

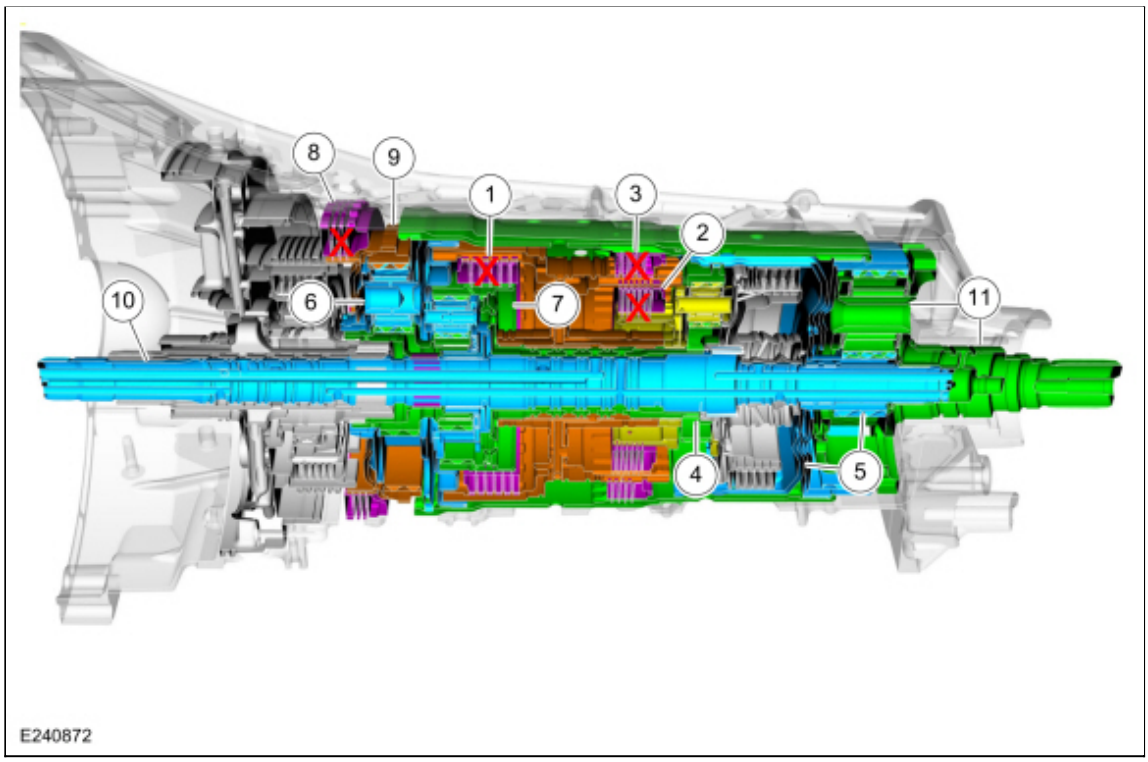


Item	Description
1	C clutch
2	D clutch
3	E clutch
4	Planetary gear set No. 2
5	Planetary gear set No. 3
6	Sun gear No. 1

7	Shell and sun gear No. 4
8	Input shaft
9	A clutch
10	Ring gear No. 1
11	Ring gear No. 4
12	Output shaft and planetary carrier No. 4

The C clutch, D clutch, and the E clutch are applied to provide multiple inputs at the same speed to the 2nd and 3rd planetary gears sets. These inputs effectively lock the 2nd and 3rd planetary gears sets and cause sun gear No. 1 and the shell and sun gear No. 4 to rotate at a 1:1 ratio with the input shaft. The A clutch is holding the ring gear No. 1 stationary causing the planetary carrier No. 1 and the ring gear No. 4 to rotate at a 3.11 reduction ratio. The 2 inputs to the 4th planetary gear set cause the output shaft and planetary carrier No. 4 to rotate at a 2.15 ratio.

4th Gear

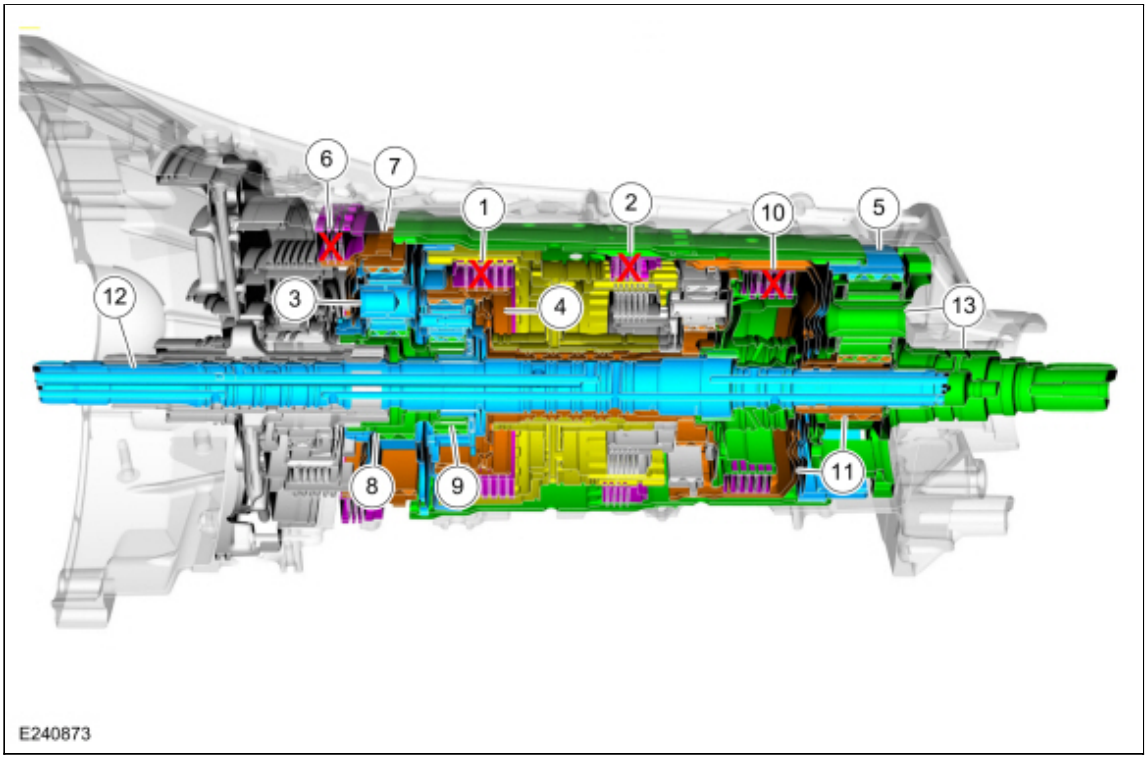


Item	Description
1	C clutch
2	D clutch
3	F clutch
4	Planetary gear set No. 3
5	Planetary gear set No. 4
6	Planetary carrier No. 1

7	Ring gear No. 2
8	A clutch
9	Ring gear No. 1
10	Input shaft
11	Output shaft and planetary carrier No. 4

The C clutch, D clutch, and F clutch are applied effectively locking the 3rd and 4th planetary gear sets, the planetary carrier No. 1, and the ring gear No. 2 together. The A clutch is holding the ring gear No. 1. The 2 inputs to the planetary gear set No. 1 cause the sun gear No. 1 and the sun gear No. 2 to rotate at a 0.56 overdrive ratio. The input shaft turns the planetary carrier No. 2 and causes the ring gear No. 2 and the 4th planetary gear set to rotate at a 1.77 ratio.

5th Gear

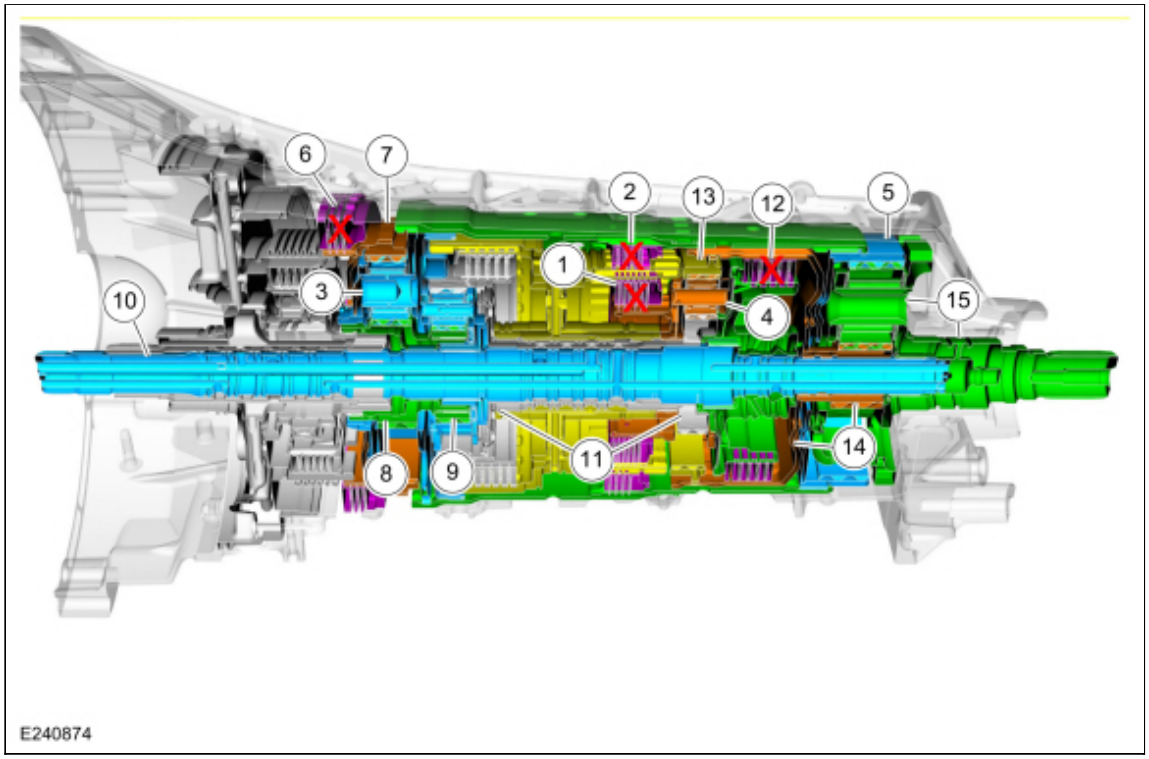


Item	Description
1	C clutch
2	F clutch
3	Planetary carrier No. 1
4	Ring gear No. 2
5	Ring gear No. 4
6	A clutch
7	Ring gear No. 1
8	Sun gear No. 1

9	Sun gear No. 2
10	E clutch
11	Shell and sun gear No. 4
12	Input shaft
13	Output shaft and planetary carrier No. 4

The C clutch and F clutch are applied effectively locking the planetary carrier No. 1, the ring gear No. 2, and ring gear No. 4 together at a 1.77 ratio. The A clutch is holding the ring gear No. 1. The 2 inputs to the planetary gear set No. 1 cause the sun gear No. 1 and the sun gear No. 2 to rotate at a 0.56 overdrive ratio. The E clutch is applied to transfer torque to the sun gear No. 4. The 2 inputs to the 4th planetary gear set cause the output shaft and planetary carrier No. 4 to rotate at a 1.52 ratio.

6th Gear

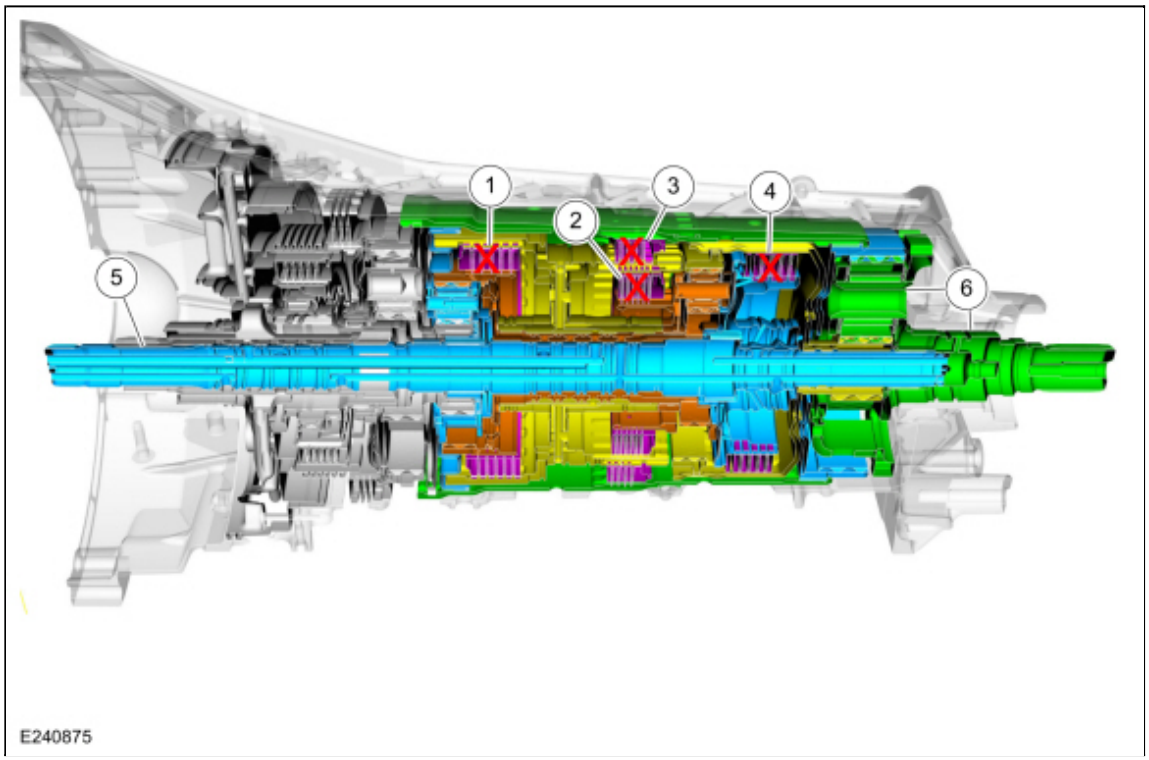


Item	Description
1	D clutch
2	F clutch
3	Planetary carrier No. 1
4	Planetary carrier No. 3
5	Ring gear No. 4
6	A clutch
7	Ring gear No. 1
8	Sun gear No. 1

9	Sun gear No. 2
10	Input shaft
11	Ring gear No. 2 and sun gear No. 3
12	E clutch
13	Ring gear No. 3
14	Shell and sun gear No. 4
15	Output shaft and planetary carrier No. 4

The D clutch and F clutch are applied effectively locking the planetary carrier No. 1, the planetary carrier No. 3, and the ring gear No. 4 together. The A clutch is holding the ring gear No. 1. The 2 inputs to the planetary gear set No. 1 cause the sun gear No. 1 and the sun gear No. 2 to rotate at a 0.44 overdrive ratio. The input shaft turns the planetary carrier No. 2 and causes the ring gear No. 2 and sun gear No. 3 to rotate at a 3.58 ratio. The E clutch is applied to transfer torque from the input shaft to the ring gear No. 3 and the shell and sun gear No. 4. The 2 inputs to the 3rd planetary gear set cause the planetary carrier No. 3 and ring gear No. 4 to rotate at a 1.38 ratio. The 2 inputs to the 4th planetary gear set cause the output shaft and planetary carrier No. 4 to rotate at a 1.28 ratio.

7th Gear

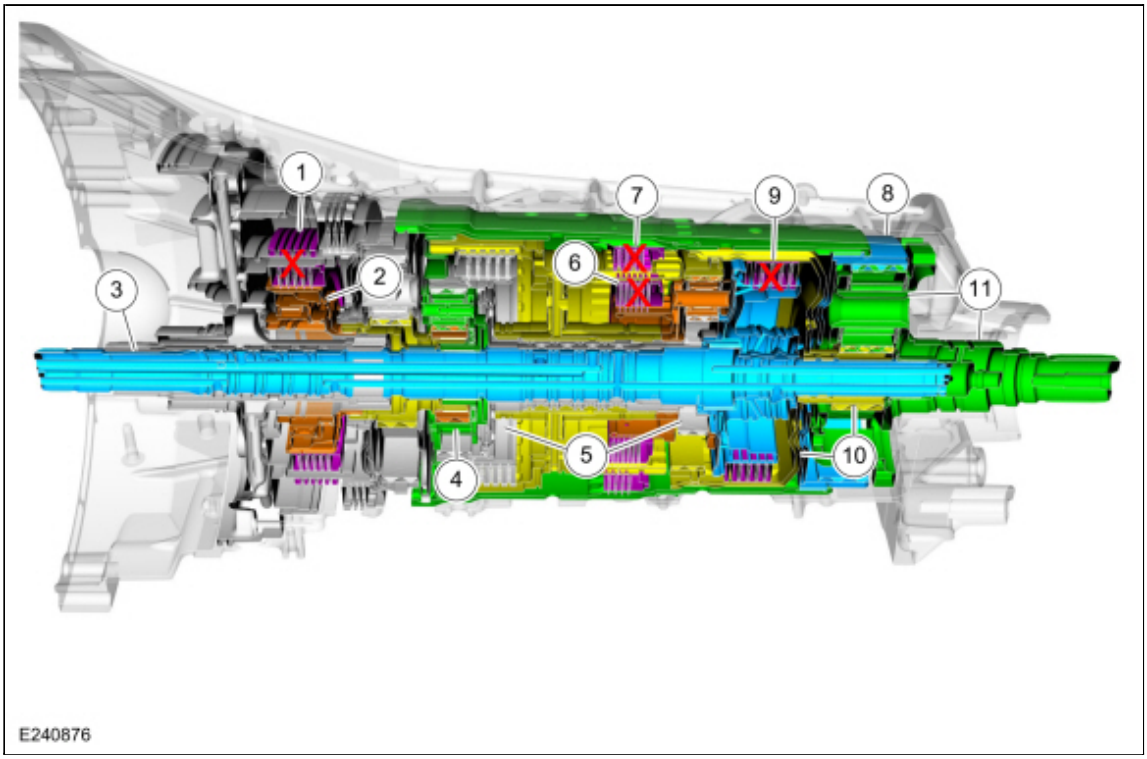


Item	Description
1	C clutch
2	D clutch
3	F clutch
4	E clutch

5	Input shaft
6	Output shaft and planetary carrier No. 4

The C clutch, D clutch, F clutch and the E clutch are applied to provide multiple inputs at the same speed to all four planetary gears sets. These inputs effectively lock all four planetary gears sets causing the output shaft and planetary carrier No. 4 to rotate at a 1:1 ratio with the input shaft.

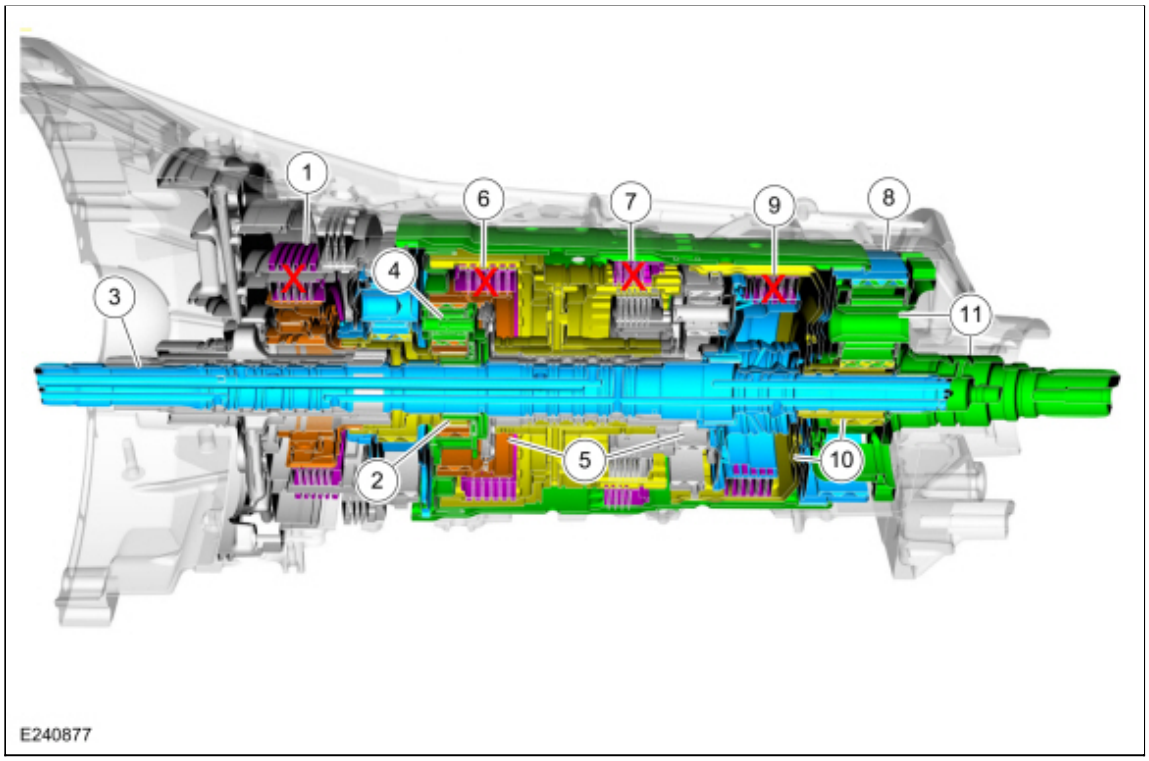
8th Gear



Item	Description
1	A clutch
2	One-Way Clutch (OWC)
3	Input shaft
4	Sun gear No. 2
5	Ring gear No. 2 and sun gear No. 3
6	D clutch
7	F clutch
8	Ring gear No. 4
9	E clutch
10	Shell and sun gear No. 4
11	Output shaft and planetary carrier No. 4

The B clutch is holding the sun gear No. 2 stationary. The input shaft turns the planetary carrier No. 2 and causes the ring gear No. 2 and sun gear No. 3 to rotate at a 0.63 overdrive ratio. The D clutch and F clutch are applied allowing torque to be transferred from the planetary No. 3 to the ring gear No. 4 at a 0.82 overdrive gear ratio. The E clutch is applied allowing torque to be transferred from the input shaft to the shell and sun gear No. 4 at a 1:1 ratio. The 2 inputs to the 4th planetary gear set cause the output shaft and planetary carrier No. 4 to rotate at a 0.85 ratio.

9th Gear

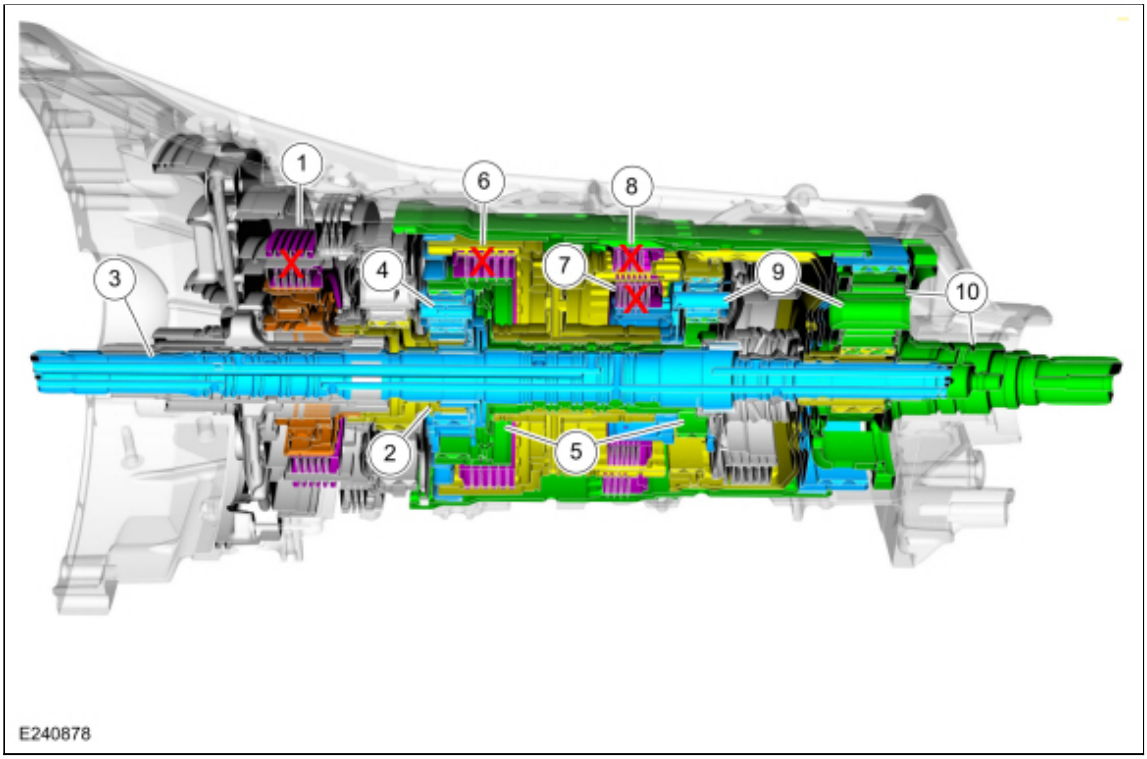


Item	Description
1	B clutch
2	Sun gear No. 2
3	Input shaft
4	Planetary carrier No. 2
5	Ring gear No. 2 and sun gear No. 3
6	C clutch
7	F clutch
8	Ring gear No. 4
9	E clutch
10	Shell and sun gear No. 4
11	Output shaft and planetary carrier No. 4

The B clutch is holding the sun gear No. 2 stationary. The input shaft turns the planetary carrier No. 2 and causes the ring gear No. 2 to rotate. The C clutch and F clutch are applied allowing torque to be transferred

from the ring gear No. 2 to the ring gear No. 4 at a 0.63 overdrive gear ratio. The E clutch is applied allowing torque to be transferred from the input shaft to the shell and sun gear No. 4 at 1:1 ratio. The 2 inputs to the 4th planetary gear set cause the output shaft and planetary carrier No. 4 to rotate at a 0.69 ratio.

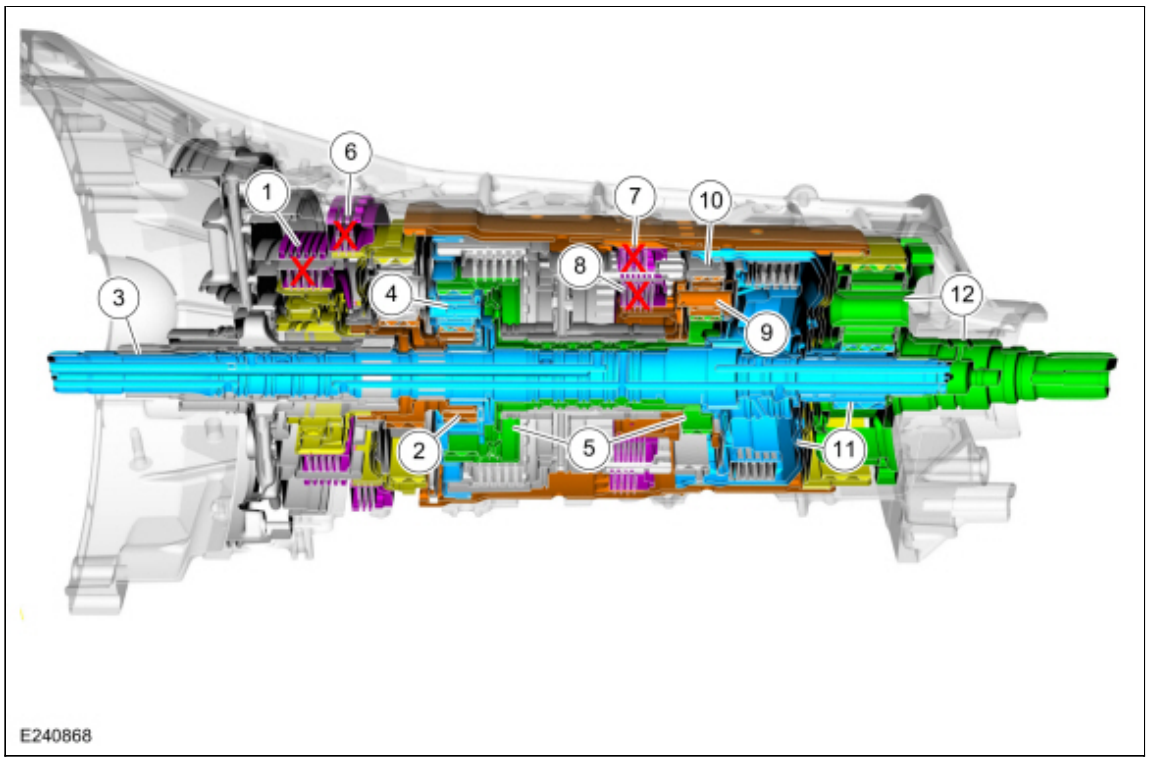
10th Gear



Item	Description
1	B clutch
2	Sun gear No. 2
3	Input shaft
4	Planetary carrier No. 2
5	Ring gear No. 2 and sun gear No. 3
6	C clutch
7	D clutch
8	F clutch
9	Planetary gear set No. 3 and planetary gear set No. 4
10	Output shaft and planetary carrier No. 4

The B clutch is holding the sun gear No. 2 stationary. The input shaft turns the planetary carrier No. 2 and causes the ring gear No. 2 and sun gear No. 3 to rotate. The C clutch, D clutch, and the F clutch are applied to provide torque input from the ring gear No. 2 at an overdrive ratio of 0.56. This torque input effectively locks the 3rd and 4th planetary gears sets causing the output shaft and planetary carrier No. 4 to rotate at a 0.64 ratio.

Reverse

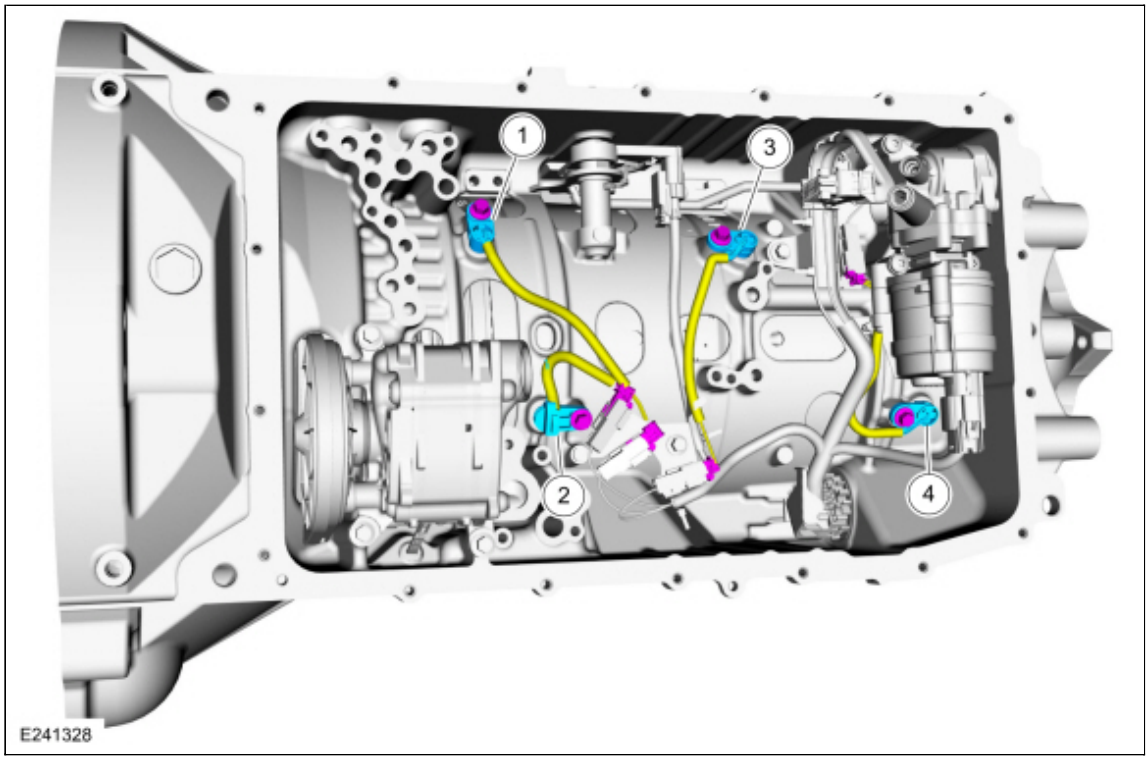


Item	Description
1	B clutch
2	Sun gear No. 2
3	Input shaft
4	Planetary carrier No. 2
5	Ring gear No. 2 and sun gear No. 3
6	A clutch
7	F clutch
8	D clutch
9	Planetary carrier No. 3
10	Ring gear No. 3
11	Shell and sun gear No. 4
12	Output shaft and planetary carrier No. 4

The B clutch is applied to hold the sun gear No. 2 stationary. The input shaft turns the planetary carrier No. 2 and causes the ring gear No. 2 and the sun gear No. 3 to rotate at a 0.63 overdrive ratio. The A clutch, F clutch, and the D clutchs are applied to hold the planetary carrier No. 3 stationary. The 2 inputs to the 3rd planetary gearset cause the ring gear No. 3 and the planetary carrier No. 4 to rotate at a 1.03 ratio in the reverse direction. The A clutch and F clutch are applied to hold the ring gear No. 4 stationary. The 2 inputs to the 4th planetary gearset cause the output shaft and planetary carrier No. 4 to rotate at a 4.85 reduction ratio in the reverse direction.

Component Description

Transmission Sensors



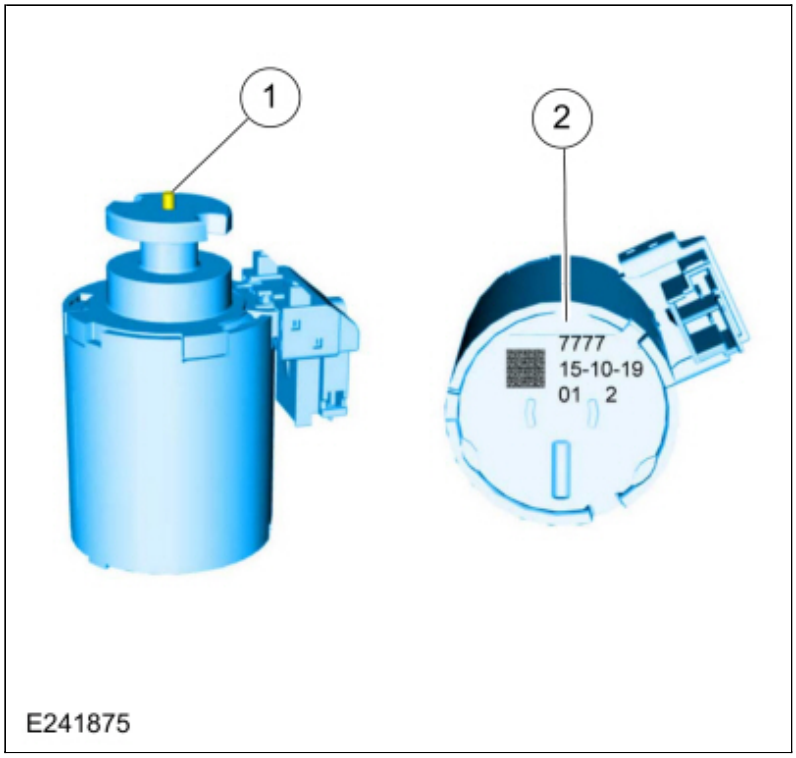
Item	Description
1	Intermediate speed sensor A
2	TSS sensor
3	Intermediate speed sensor B
4	OSS sensor

The PCM for gas engine applications or a TCM for diesel engine applications control the electronic functions of this transmission. The PCM or TCM receives input signals from engine and transmission sensors and uses these inputs to control line pressure, shift time, TCC and shift solenoids.

Item	Description
TFT Sensor	The TFT sensor is located in the transmission main control valve body. It is a temperature-sensitive device called a thermistor. The resistance value of the TFT sensor will vary with temperature change. The PCM or TCM monitors the voltage across the TFT sensor to determine the temperature of the transmission fluid. The PCM or TCM uses this initial signal to determine whether a cold start shift schedule is necessary. The cold start shift schedule allows delayed shifts when the transmission fluid is cold to help warm the transmission fluid. The PCM or TCM also inhibits TCC operation at low transmission fluid temperatures and adjusts line pressure for temperature.
TR Sensor	The TR sensor is composed of a dual set of TR sensors. The manual shifter engages and disengages Park and the shifter position is detected by reading TR sensors A and B. There is

	no manual valve, the PCM or TCM provides forward or reverse based on the dual TR sensor inputs. The 10R80 transmission uses a dual PWM output (at 125 Hz) TR sensors where: TR sensor A increases as the shifter is moved from Park to Sport and TR sensor B decreases as the shifter is moved from Park to Sport, together the sum of the two signals should add up to 100%. The 10R80 transmission mechanical shifter variant is range by wire with mechanical Park. The dual TR sensor's signals are used to determine customer selected range (P, R, N, D, S). PIDs, TR_A_DC and TR_B_DC may be utilized to monitor the TR sensor duty cycles.
TSS Sensor	The TSS sensor is a 2-Wire Hall-effect type sensor that provides a TSS signal to the PCM or TCM that changes in frequency as the magnetic trigger wheel part of the planearty carrier No. 2 varies in speed or direction. The TSS information is compared to engine rpm to determine TSS performance. TSS is also compared to OSS to determine shift quality and clutch performance. The TSS sensor is mounted to the transmission case.
OSS Sensor	The OSS sensor is a 2-Wire Hall-effect type sensor that provides a OSS signal to the PCM or TCM that changes in frequency as the trigger wheel part of the output shaft and planearty carrier No. 4 varies in speed or direction. The OSS is used for shift scheduling. OSS is also compared to TSS to determine shift quality and clutch performance. The OSS sensor is mounted to the transmission case.
Intermediate Speed Sensor A	The intermediate speed sensor A (ISSA), is a 2-Wire Hall-effect type sensor that provides a intermediate speed sensor A (ISSA) signal to the PCM or TCM that changes in frequency as the trigger wheel part of the No. 1 ring gear varies in speed or direction. The intermediate speed sensor A (ISSA) is used to monitor clutch states for transmission fault detection and diagnostics. The intermediate speed sensor A (ISSA) is mounted to the transmission case.
Intermediate Speed Sensor B	The intermediate speed sensor B (ISSB), is a 2-Wire Hall-effect type sensor that provides a intermediate speed sensor B (ISSB) signal to the PCM or TCM that changes in frequency as the trigger wheel part of the clutch and planetary container cylinder varies in speed or direction. The intermediate speed sensor B (ISSB) is used to monitor clutch states for transmission fault detection and diagnostics. The intermediate speed sensor B (ISSB) is mounted to the transmission case.

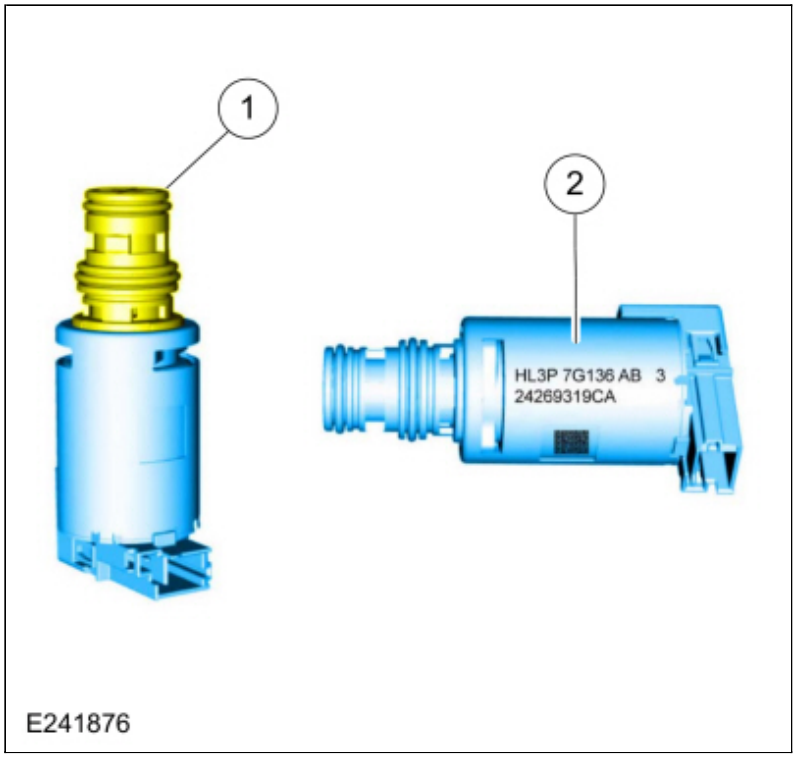
Shift Solenoids



Item	Description
1	Armature/pin assembly
2	Part information

The 10R80 utilizes six shift (A-F) solenoids that are linear force solenoids. Unlike previous shift solenoids they are mechanical in nature in that no transmission fluid passes through them. CIDASs use a armature/pin assembly that moves a control valve in the main control valve body to control and apply hydraulic fluid pressure. Each clutch (A-F) has a corresponding shift solenoid (A-F) that is directly proportional in that zero current equals zero pressure and maximum current equals maximum pressure. Since there is no pressure with zero current if the power is interrupted to the shift solenoids none of the clutch packs are able to engage.

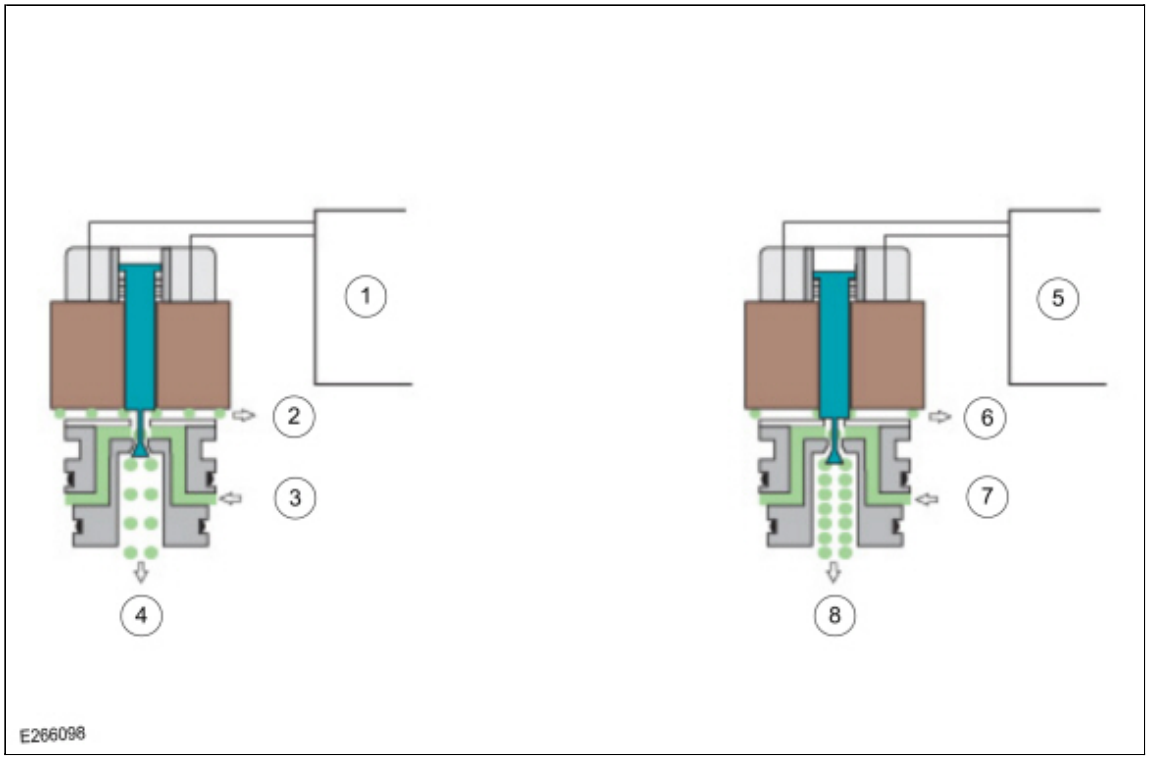
Torque Converter Clutch (TCC) Proportional (VFS) and Line Pressure Control (LPC) Solenoid (Inversely-Proportional (VFS)



Item	Description
1	Solenoid nozzle
2	Part information

Torque Converter Clutch (TCC) Proportional (VFS)

Normally Low Solenoid

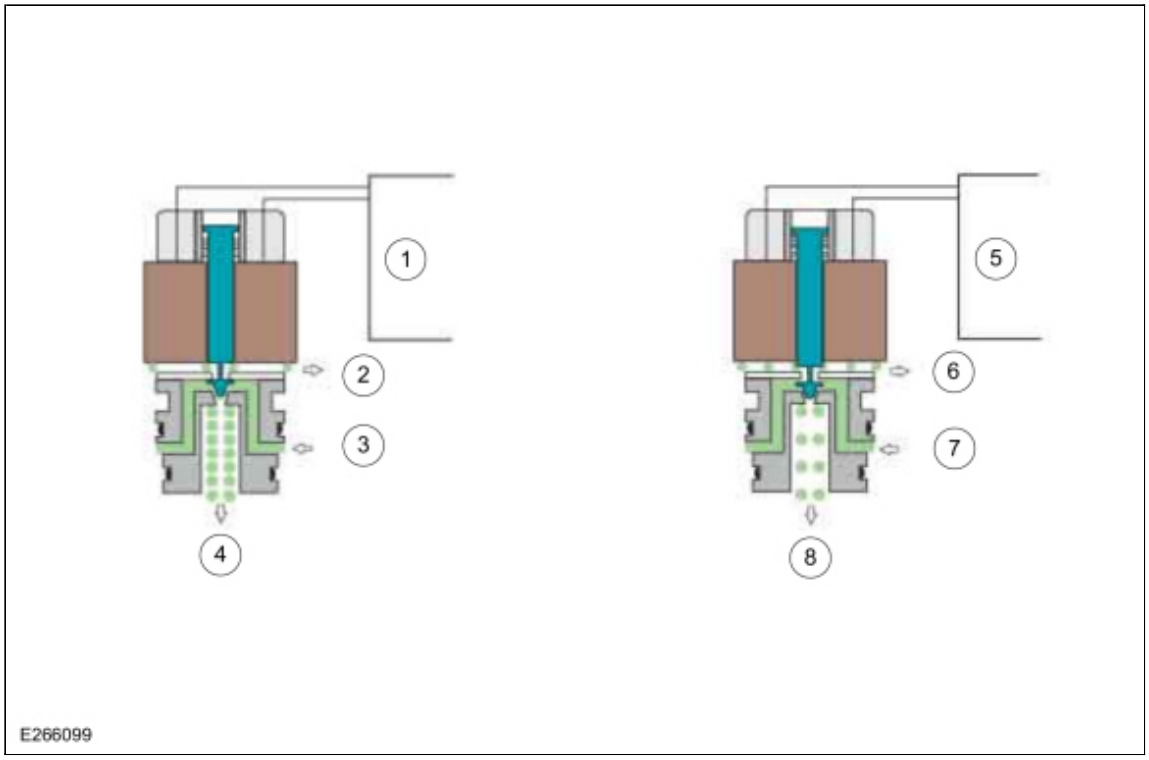


Item	Description
1.	Low Current
2.	High Exhaust
3.	SF Circuit Fluid (Supply)
4.	Low Pressure Output
5.	High Current
6.	Low Exhaust
7.	SF Circuit Fluid (Supply)
8.	High Pressure Output

The TCC solenoid is a variable force solenoid that varies hydraulic pressure by actuating a hydraulic valve. The TCC solenoid uses proportional operation. Normally low solenoids provide hydraulic pressure proportional to supplied current. A normally low solenoid will output very low pressure with low (50 mA) or no current, while it will supply high pressure with high current (850 mA).

Line Pressure Control (LPC) Solenoid (Inversely-Proportional (VFS)

Normally High Solenoid



Item	Description
1.	Low Current
2.	Low Exhaust
3.	SF Circuit Fluid (Supply)
4.	High Pressure Output
5.	High Current
6.	High Exhaust
7.	SF Circuit Fluid (Supply)
8.	Low Pressure Output

The LPC solenoid is a variable force solenoid that varies hydraulic pressure by actuating a hydraulic valve. The LPC solenoid uses inversely proportional operation. Normally high solenoids provide full output of pressure with low or no current (50 mA) and very low pressure with high current (850 mA).

Transmission External Sealing

The front support cover and seal assembly has a bonded rubber seal around the outside that seals to the front support housing. A removable rubber seal on the inside of the front support cover seals the area around the front support cover bolt. A torque converter hub seal is held into the front support cover with a snap ring and is serviced as an assembly.

The front support assembly uses a large rubber seal that seals the support housing to the transmission case.

The transmission fluid cooler tubes use 2 rubber seals with plastic backing rings to seal the tubes to the transmission case.

On the left side of the transmission case, there is a line pressure tap plug.

The manual control shaft has a lip seal that is pressed in the transmission case.

The transmission fluid pan has a reusable gasket.

The output shaft uses a lip-type seal that seals to the transmission case and output shaft nut. The output shaft nut has a bonded rubber O-ring on the inside that seals to the shaft threads.

The large transmission case housing plug provides access to the park pawl shaft and has an O-ring seal.

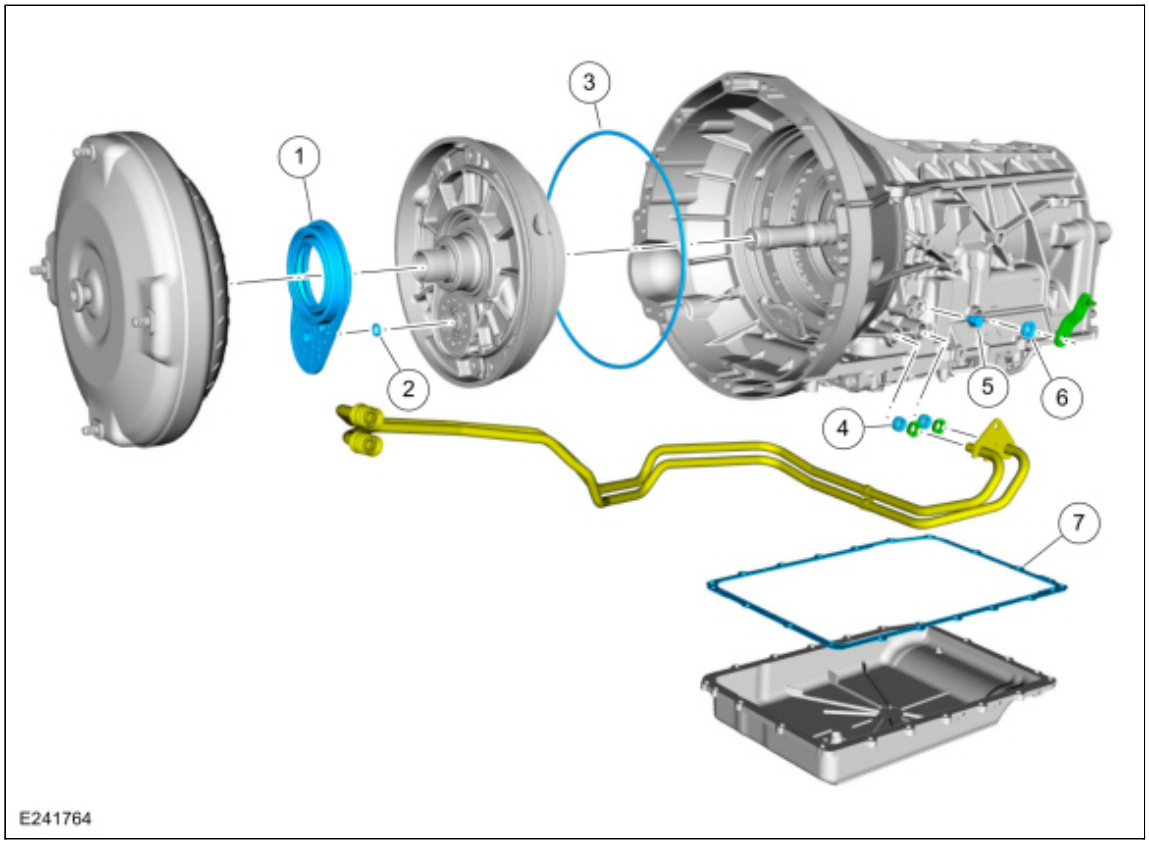
The park pawl actuator sleeve has 2 O-ring seals that seal to the transmission case.

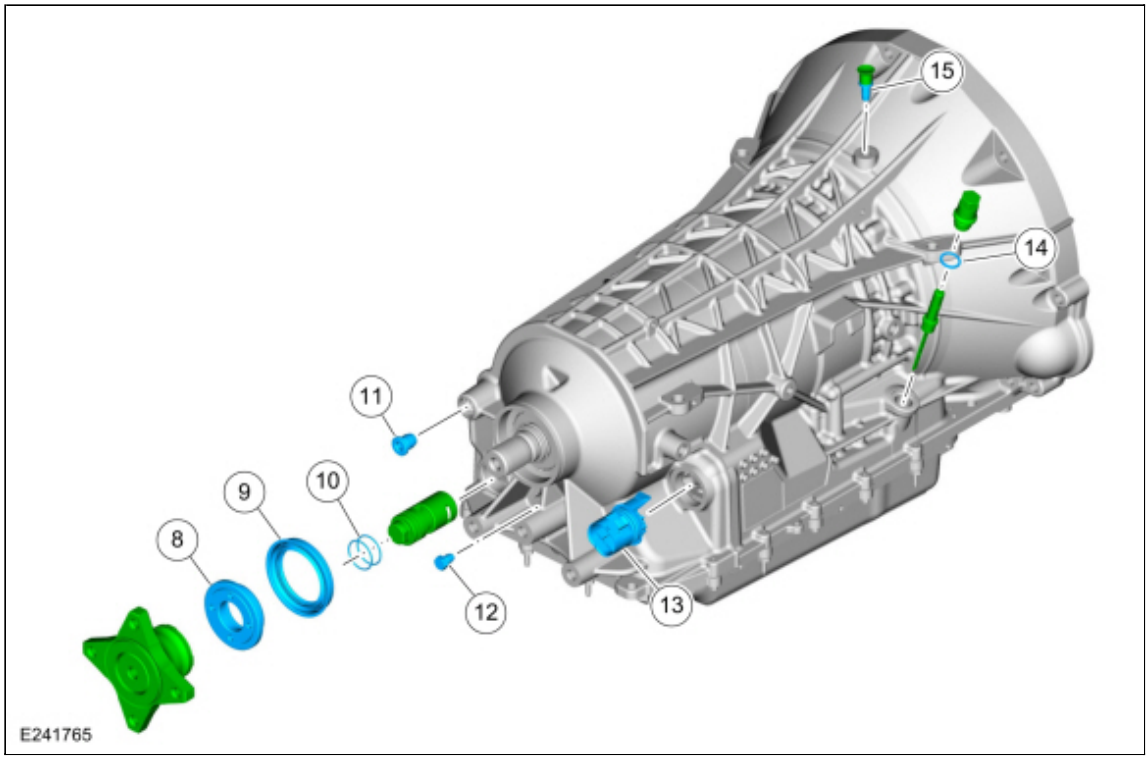
A plug seals the E clutch fluid passage in the rear of the transmission case.

The internal wiring harness bulkhead connector has 2 O-ring seals for the transmission case bore.

The transmission fluid level indicator plug uses an O-ring seal.

The transmission vent tube is pressed into the transmission case.





Item	Description
1	Front support cover and seal assembly
2	Seal part of front support cover and seal assembly
3	Front support-to-case seal
4	Transmission fluid cooler tube seals (2 required)
5	Line pressure tap plug
6	Manual control shaft seal
7	Transmission fluid pan gasket
8	Output shaft nut
9	Output shaft seal
10	Park pawl actuator rod sleeve seals (2 required)
11	Park pawl shaft plug
12	Transmission case plug
13	Internal wiring harness bulkhead connector O-rings
14	Transmission fluid level indicator plug O-ring
15	Transmission vent tube

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