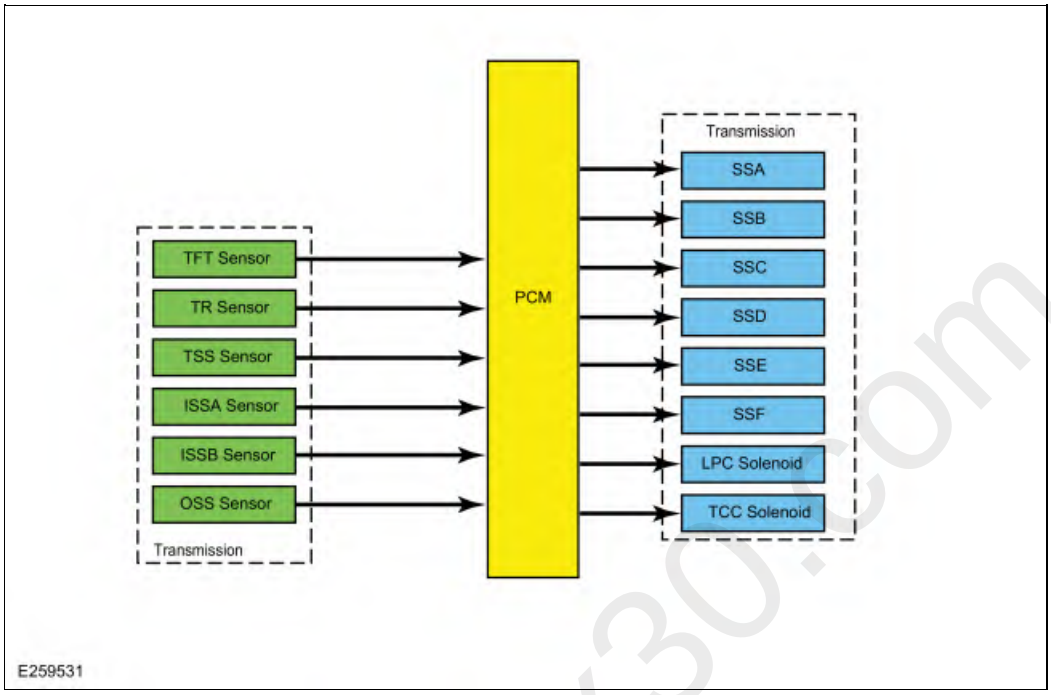
# Transmission Description - System Operation and Component Description

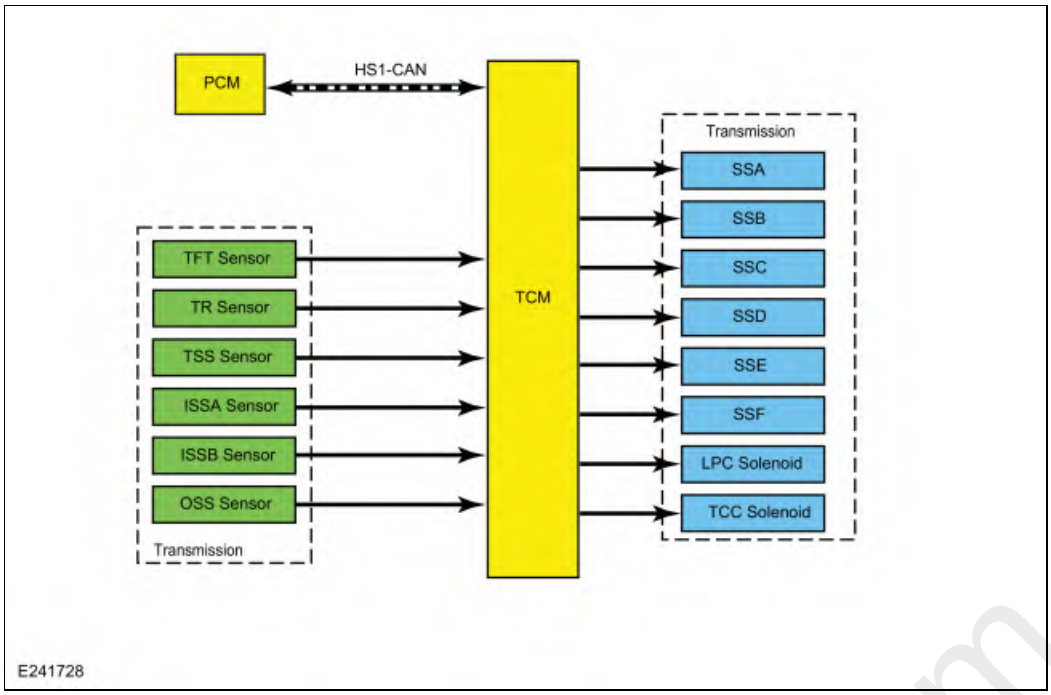
System Diagram

**Vehicles with Gas Engines**




| Item | Description |
|---|---|
| 1 | SSB |
| 2 | SSC |
| 3 | SSD |
| 4 | SSE |
| 5 | SSF |
| 6 | LPC Solenoid |
| 7 | TCC Solenoid |
| 8 | OSS Sensor |
| 9 | ISSB Sensor |
| 10 | ISSA Sensor |
| 11 | TSS Sensor |
| 12 | Transmission |
| 13 | Transmission |
| 14 | PCM |
| 15 | TR Sensor |
| 16 | TFT Sensor |
| 17 | SSA |

**Vehicles with Diesel Engines**




| Item | Description |
|---|---|
| 1 | PCM |
| 2 | SSB |
| 3 | SSC |
| 4 | SSD |
| 5 | SSE |
| 6 | SSF |
| 7 | LPC Solenoid |
| 8 | TCC Solenoid |
| 9 | OSS Sensor |
| 10 | ISSB Sensor |
| 11 | ISSA Sensor |
| 12 | TSS Sensor |
| 13 | Transmission |
| 14 | Transmission |
| 15 | TCM |
| 16 | TR Sensor |
| 17 | TFT Sensor |
| 18 | SSA |

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 10R140 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 10R140 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 10R140 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.

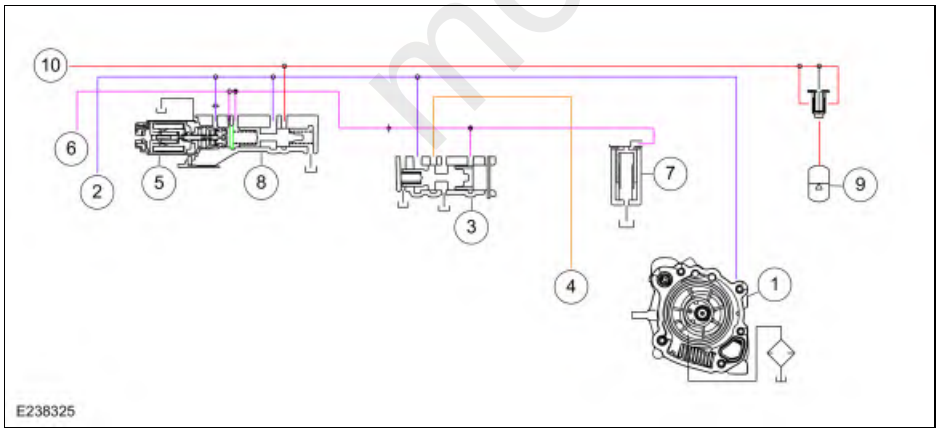
**Drive Modes**

Optimum shift quality is provided in Drive (D) when the Normal Drive Mode is selected. In Manual (M) or when a different Drive Mode is selected, the strategy will provide more aggressive shifts at higher engine speeds. This is **normal** and desired **behavior**.

Component Description

**Hydraulic Circuit**

**Line Pressure Hydraulic Circuit**

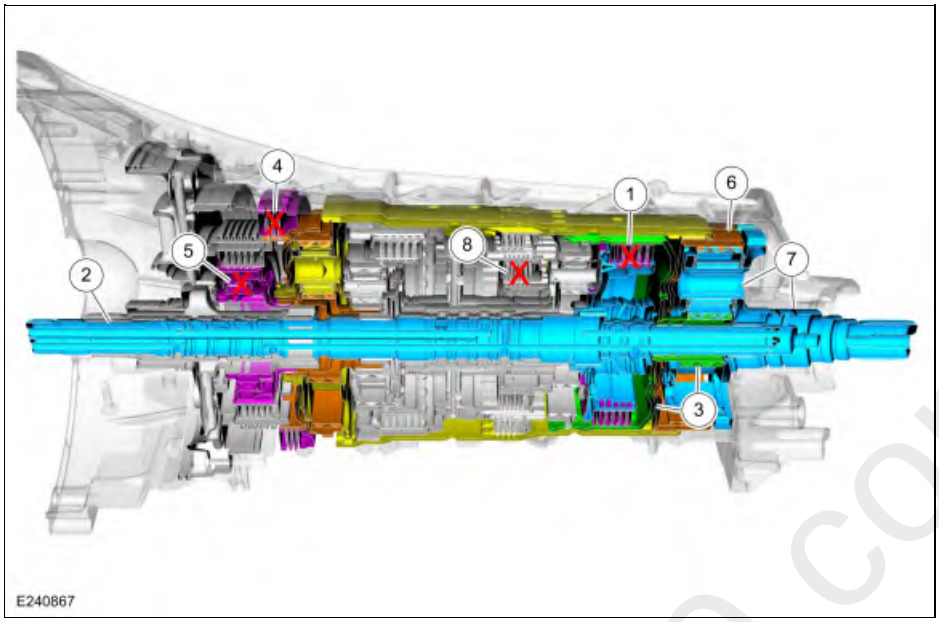



| Item | Description |
|---|---|
| 1 | Mechanical pump |
| 2 | Pump output |
| 3 | Main regulator valve |
| 4 | Pump output decreased |
| 5 | LPC solenoid |
| 6 | LPC pressure |

| | |
|---|---|
| 7 | Isolator valve |
| 8 | Anti-backflow valve |
| 9 | Transmission fluid auxiliary pump |
| 10 | Line pressure |

**Powerflows**

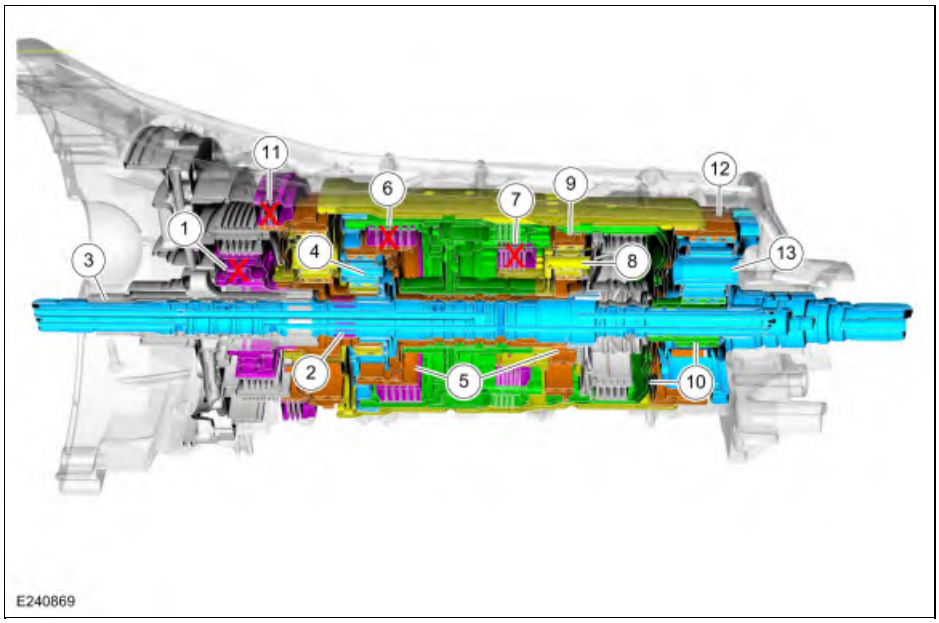
**1st Gear**




| 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**

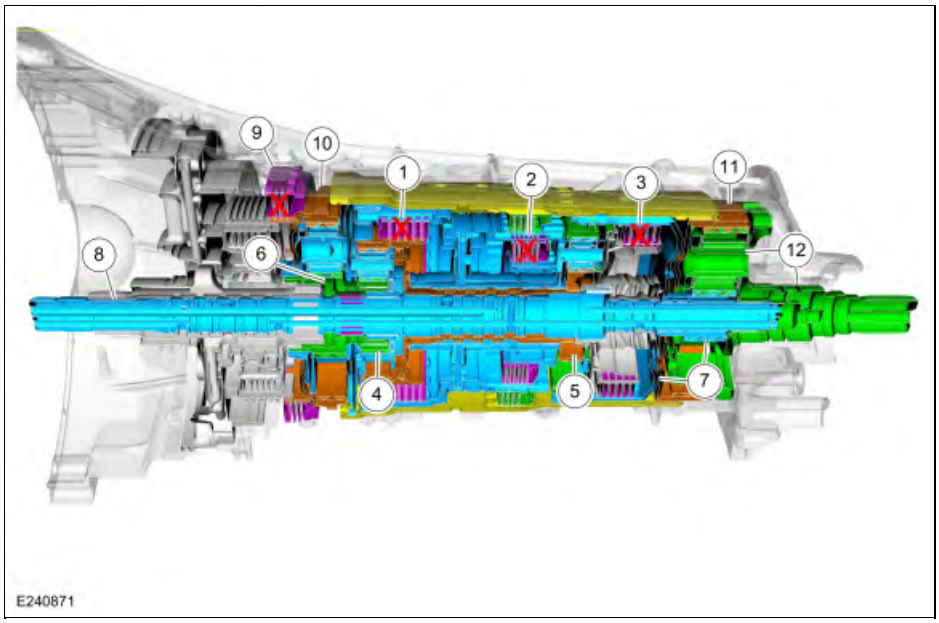



| Item | Description |
|---|---|
| 1 | One-Way Clutch (OWC) |
| 2 | Sun gear No. 2 |
| 3 | Input shaft |
| 4 | Planetary carrier No. 2 |
| 5 | Ring gear No. 2 and sun gear No. 3 |
| 6 | C clutch |
| 7 | D clutch |
| 8 | Planetary carrier No. 3 |
| 9 | Ring gear No. 3 |
| 10 | Shell and sun gear No. 4 |
| 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.

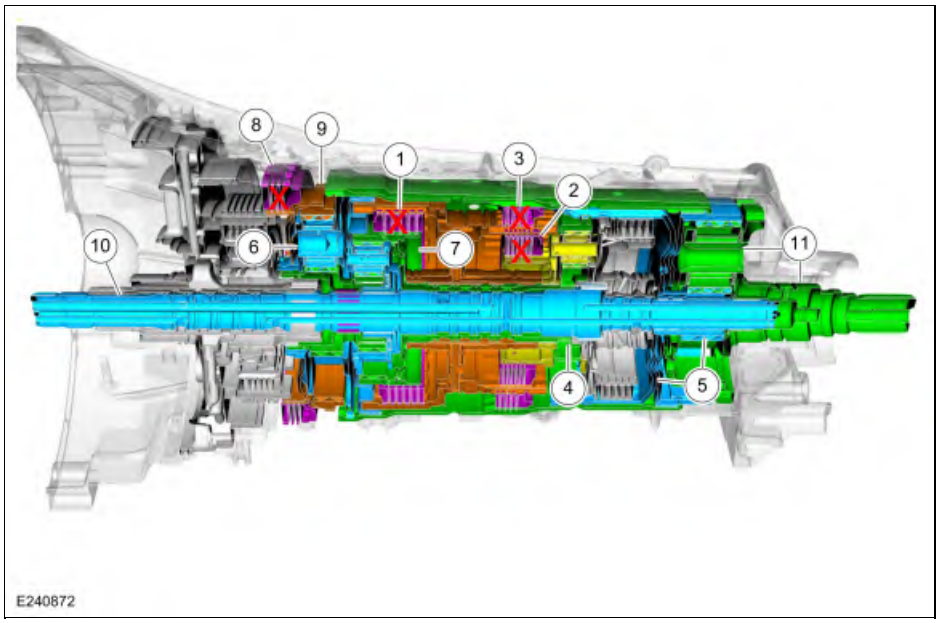
**3rd Gear**




| 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.

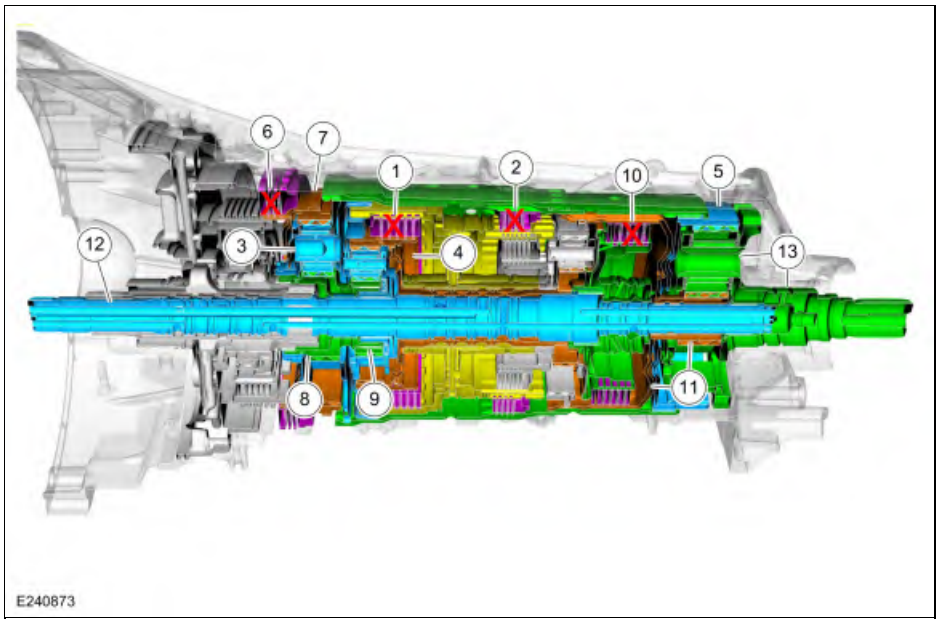
**4th Gear**




| 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**

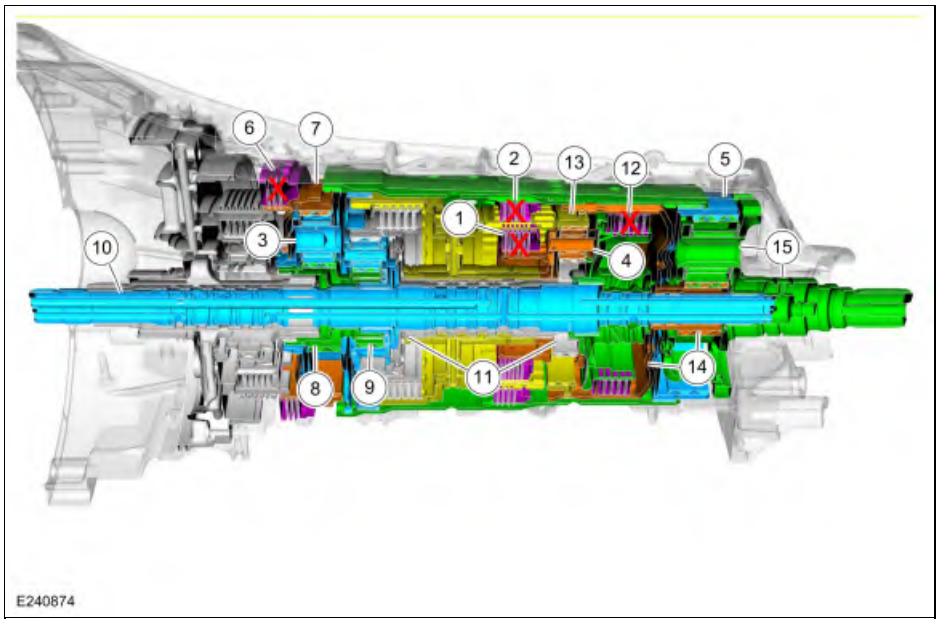



| Item | Description |
|---|---|
| 1 | C clutch |
| 2 | F clutch |
| 3 | Planetary carrier No. 1 |
| 4 | Ring gear No. 2 |
| 5 | Ring gear No. 4 |
| 6 | A clutch |
| 7 | Ring gear No. 1 |
| 8 | Sun gear No. 1 |
| 9 | Sun gear No. 2 |
| 10 | E clutch |
| 11 | Shell and sun gear No. 4 |
| 12 | Input shaft |
| 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.

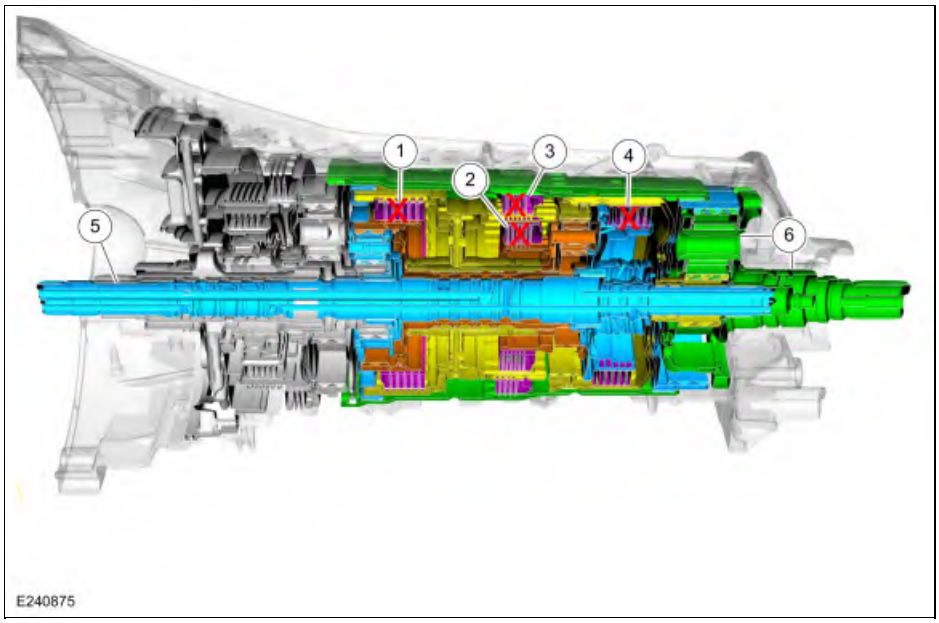
**6th Gear**




| 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.

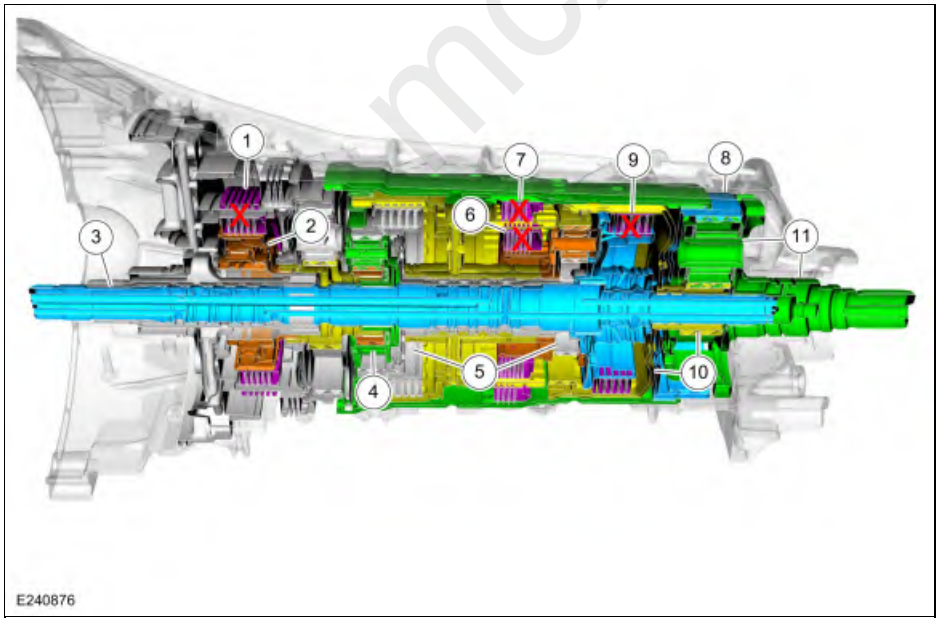
**7th Gear**




| 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**

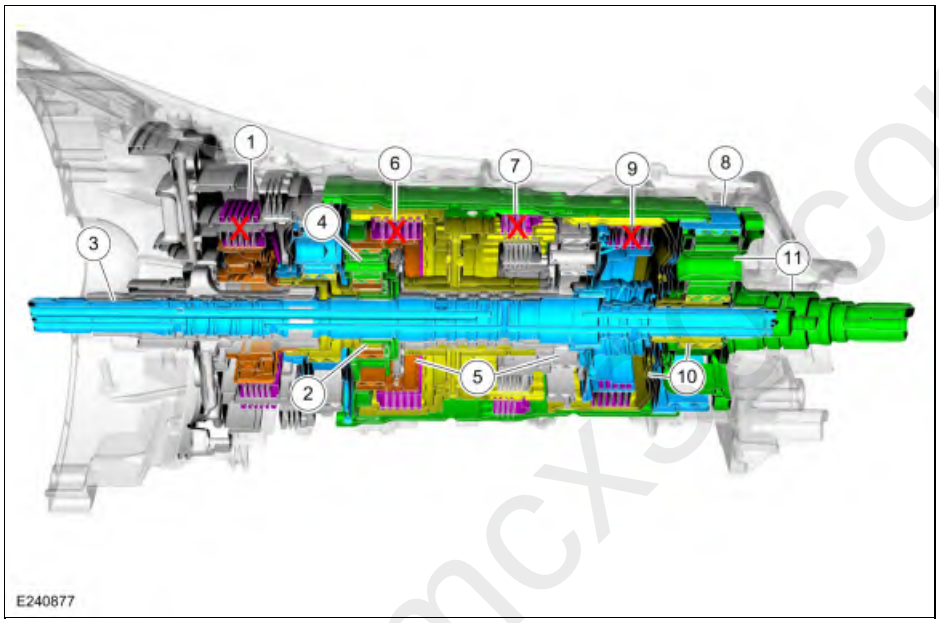



| Item | Description |
|---|---|
| 1 | A clutch |
| 2 | One-Way Clutch (OWC) |

| | |
|---|---|
| 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**

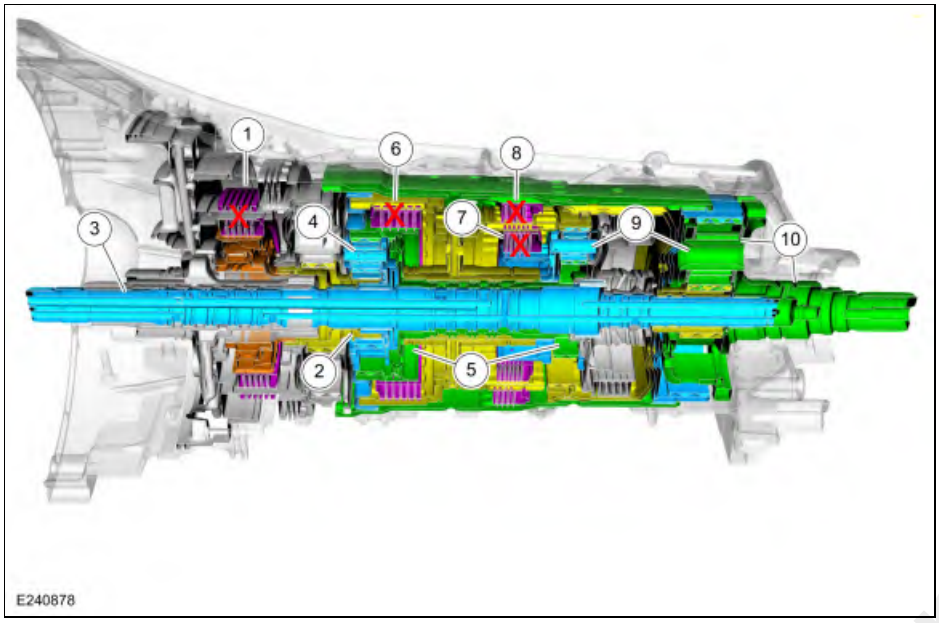



| Item | Description |
|---|---|
| 1 | B clutch |
| 2 | Sun gear No. 2 |
| 3 | Input shaft |
| 4 | Planetary carrier No. 2 |
| 5 | Ring gear No. 2 and sun gear No. 3 |
| 6 | C clutch |
| 7 | F clutch |
| 8 | Ring gear No. 4 |
| 9 | E clutch |
| 10 | Shell and sun gear No. 4 |
| 11 | Output shaft and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

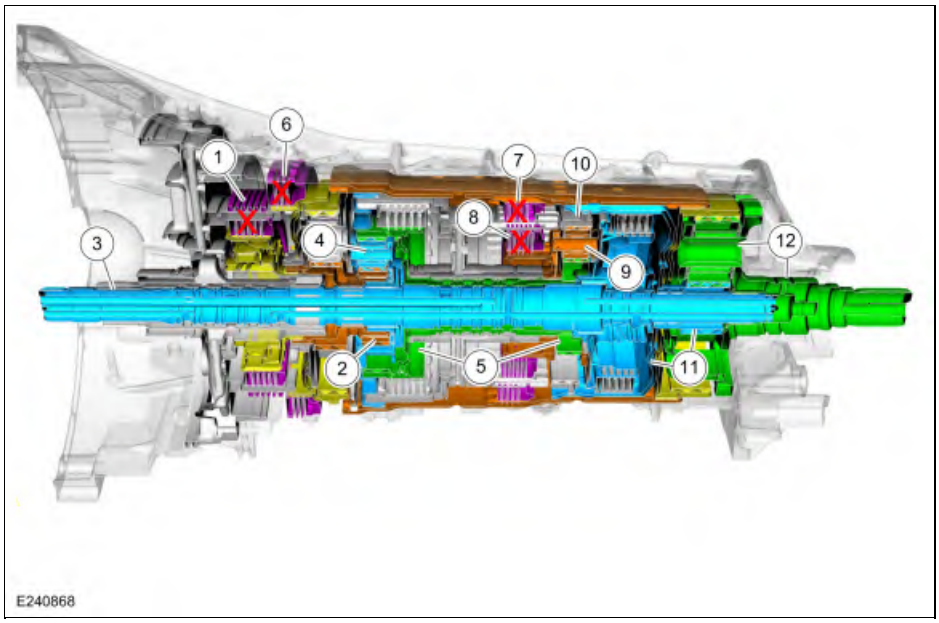



| Item | Description |
|---|---|
| 1 | B clutch |
| 2 | Sun gear No. 2 |
| 3 | Input shaft |
| 4 | Planetary carrier No. 2 |
| 5 | Ring gear No. 2 and sun gear No. 3 |
| 6 | C clutch |
| 7 | D clutch |
| 8 | F clutch |
| 9 | Planetary gear set No. 3 and planetary gear set No. 4 |
| 10 | Output shaft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

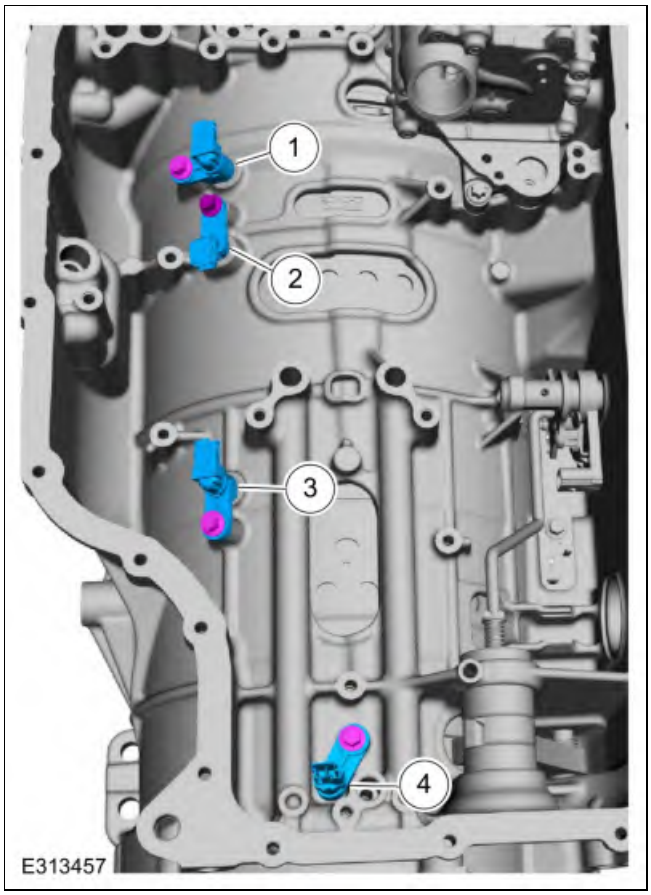



| Item | Description |
|---|---|
| 1 | B clutch |
| 2 | Sun gear No. 2 |
| 3 | Input shaft |
| 4 | Planetary carrier No. 2 |
| 5 | Ring gear No. 2 and sun gear No. 3 |
| 6 | A clutch |
| 7 | F clutch |
| 8 | D clutch |
| 9 | Planetary carrier No. 3 |
| 10 | Ring gear No. 3 |
| 11 | Shell and sun gear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



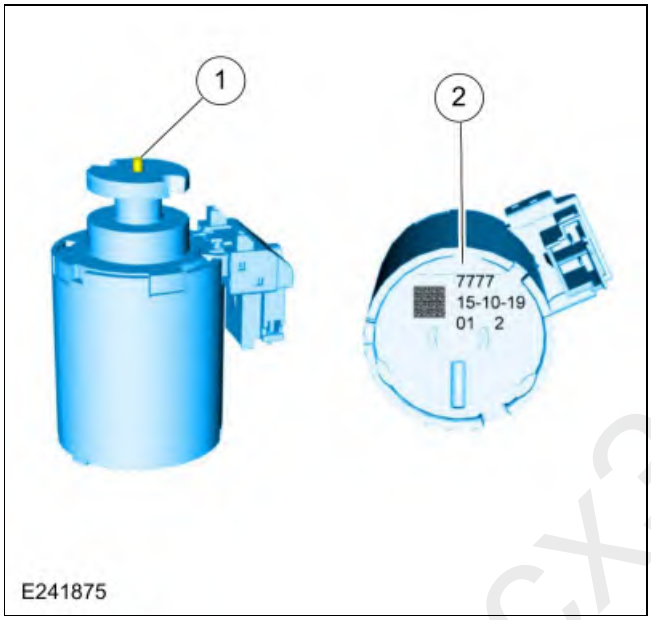

| Item | Description |
|---|---|
| 1 | Intermediate speed sensor A |
| 2 | TSS sensor |
| 3 | Intermediate speed sensor B |
| 4 | OSS sensor |

The PCM for gas engine applications or the TCM for diesel engine applications, controls 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 for gas engine applications or the TCM for diesel engine applications 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 for gas engine applications or the TCM for diesel engine applications provides forward or reverse based on the dual TR sensor inputs. The 10R140 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 10R140 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 for gas engine applications or the TCM for diesel engine applications changes in frequency as the magnetic trigger wheel part of the planetary 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 for gas engine applications or the TCM for diesel engine applications that changes in frequency as the trigger wheel part of the output shaft and planetary 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 for gas engine applications or the TCM for diesel engine applications 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 for gas engine applications or the TCM for diesel engine applications 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. |

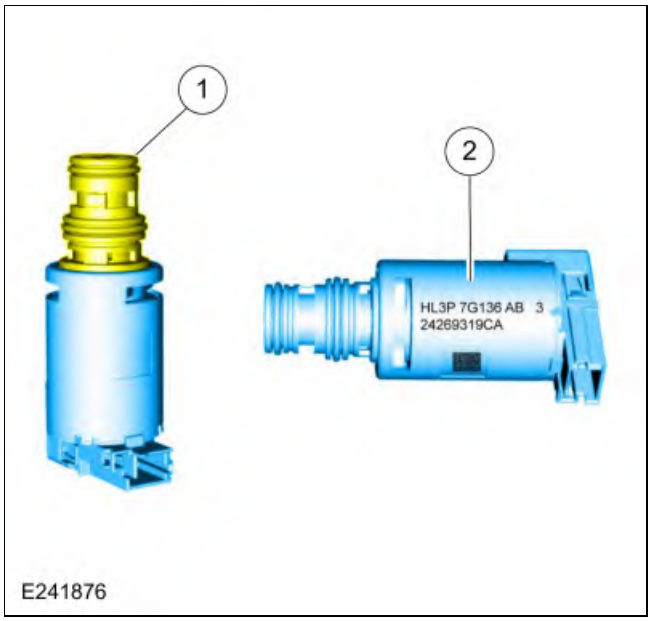
**Shift Solenoids**




| Item | Description |
|---|---|
| 1 | Armature/pin assembly |
| 2 | Part information |

The 10R140 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.

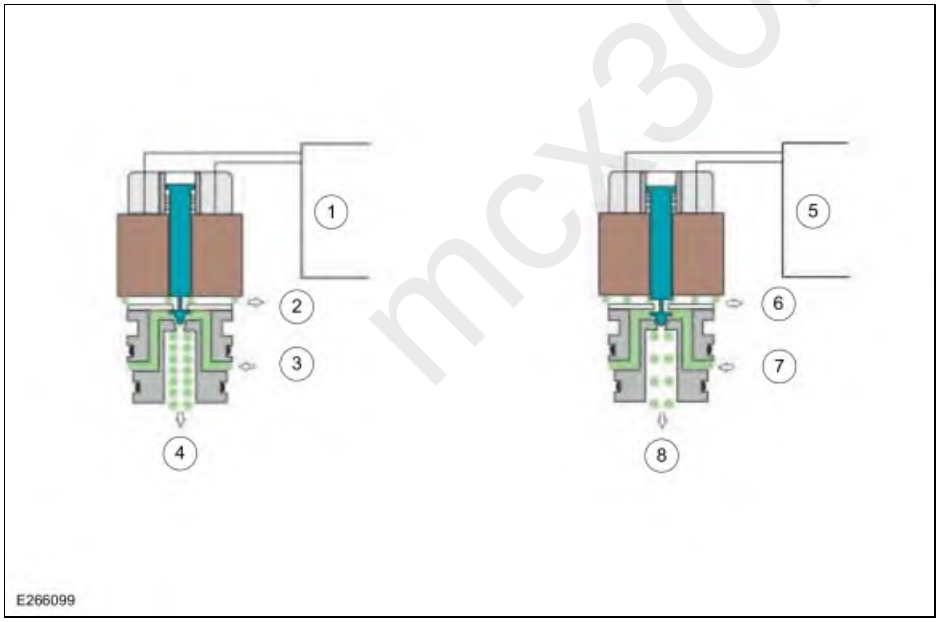
**Line Pressure Control (LPC) Solenoid (Inversely-Proportional (VFS)**




| Item | Description |
|---|---|
| 1 | Solenoid nozzle |
| 2 | Part information |

**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 torque converter hub seal is pressed in to the front support cover.

The front support cover bolt washers seal the bolt heads to the front support cover.

The front support cover seal, seals the cover to the front support.

The front support bolt washers seal the bolt heads to the front support.

The front support seal, seals the cover to the transmission case.

The transmission fluid pan has a reusable press in place gasket.

The transmission PTO cover is a reusable gasket.

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

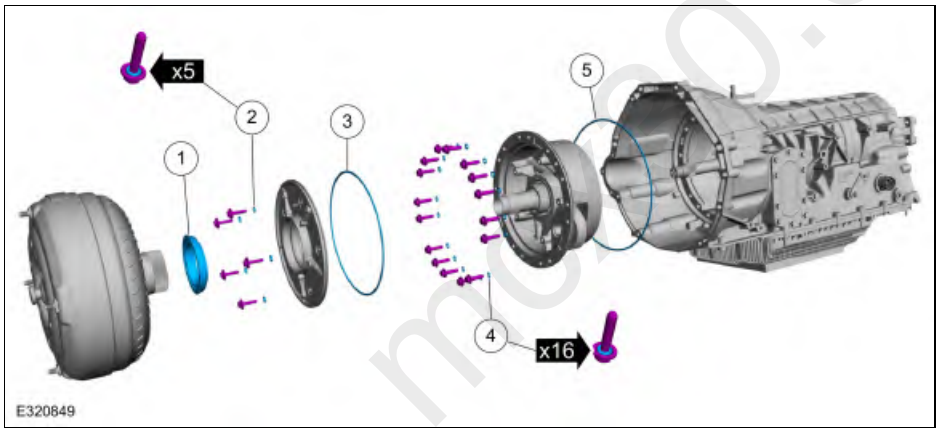
The manual control shaft has a lip seal that is pressed in the transmission case.

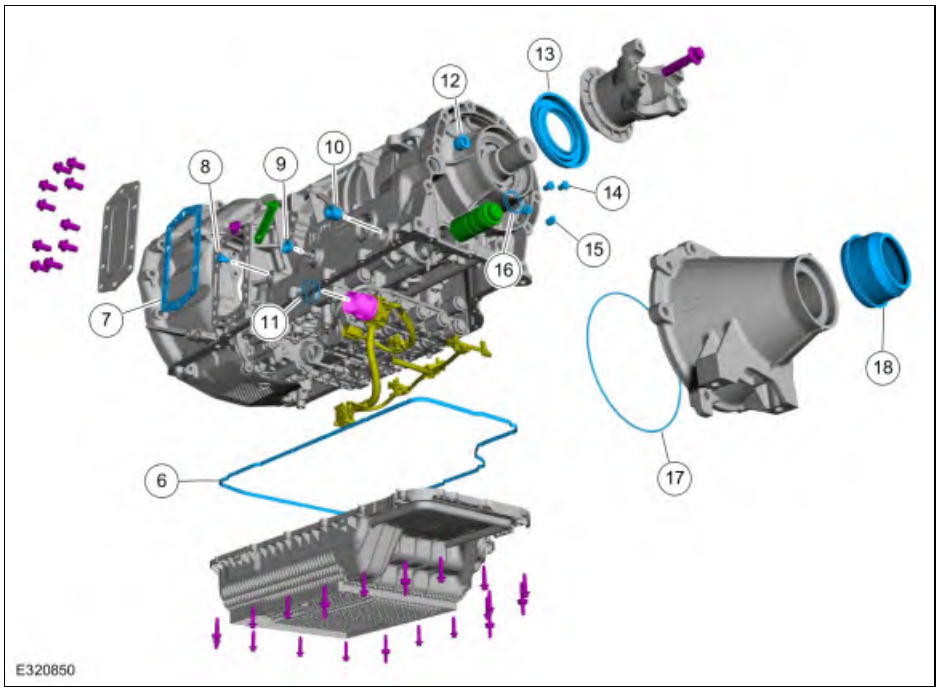
The park pawl actuator sleeve has 2 O-ring seals that seal to the transmission case.

The output shaft uses a seal that is pressed in to the transmission case or the extension housing on slip yoke applications.

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

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






| Item | Description |
|---|---|
| 1 | Torque converter hub seal |
| 2 | Front support cover bolt washers |
| 3 | Front support cover seal |
| 4 | Front support bolt washers |
| 5 | Front support-to-case seal |
| 6 | Transmission fluid pan gasket |
| 7 | PTO cover gasket |
| 8 | Line pressure tap plug |
| 9 | Manual control shaft seal |
| 10 | Transmission fluid fill plug |
| 11 | Internal wiring harness connector O-rings (2 required) |
| 12 | Park pawl shaft plug |
| 13 | Output shaft seal |
| 14 | Transmission case plugs (10 mm) (quantity model dependent) |
| 15 | Transmission case plugs (12 mm) (2 required) |
| 16 | Park pawl actuator rod sleeve seals (2 required) |
| 17 | Extension housing seal (slip yoke application) |
| 18 | Output shaft seal (slip yoke application) |