DSI 6 SPEED AUTO TRANSAXLE

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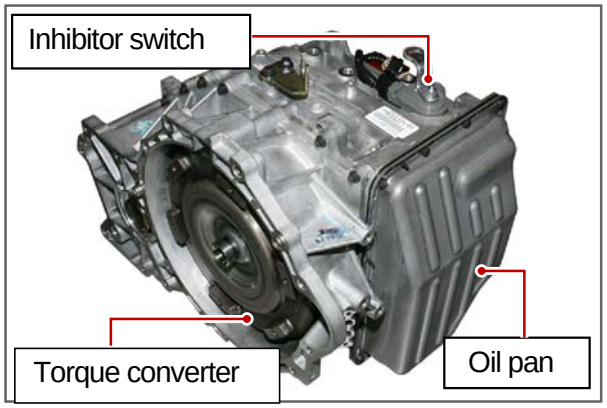
GENERAL INFORMATION

1. GENERAL INFORMATION

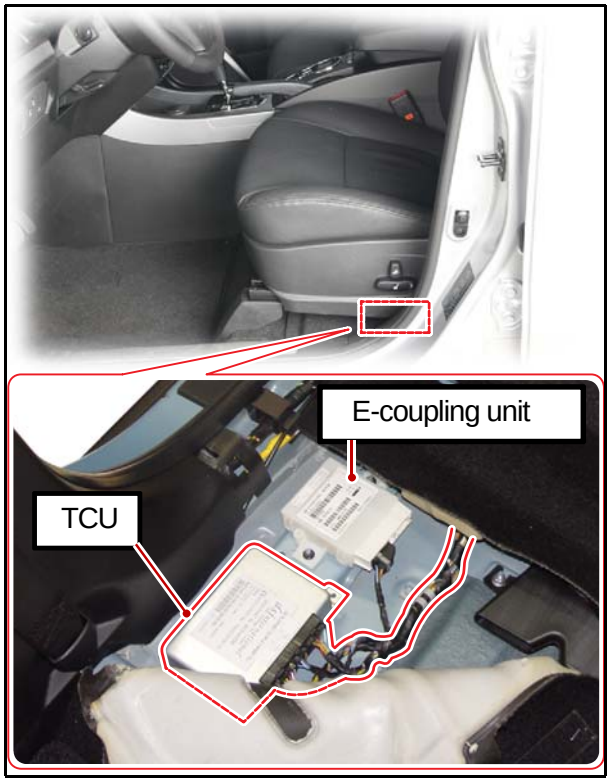


▶ **Automatic transaxle (M11)**

The Model 11 six speed automatic transaxle is available in two variants: four wheel drive and two wheel drive.

- Six forward speeds
- One reverse gear
- A toruqe converter with an integral converter lock-up clutch with slip control capabilities Electronic shift and pressure controls
- A single planetary gear-set
- A double planetary gear-set
- One hydraulically controlled brake bands
- Three multi-plate clutches
- One multi plate brake
- All hydraulic functions are directed by electronic
- solenoids to control:

1) Engagement feel
2) Shift feel
3) Shift scheduling
4) Modulated torque converter clutch applications



▶ **TCU (located under driver's seat)**

TCU is located under the driver's seat and controls the transaxle operations.
TCU is activated and deactivated by the ignition voltage, and connected to the transaxle through pin 26 in connector.
TCU receives and uses the signals from sensors and switches through CAN bus with analog and digital types.

▶ Tip switches on steering wheel

The shiftable gear can be adjusted by pressing the "UP (D+)" or "DOWN(D-)" switch when the gear selector lever is in "M" position.

▶ Meter cluster

This indicator shows the current position of the gear.

▶ Gear selector lever

Shift lock release button

If the selector lever cannot be moved from "P" or "N" position, try to move the lever while pushing down this button with finger. For safety, turn off the engine and depress the brake pedal before the attempt.

Lever positions

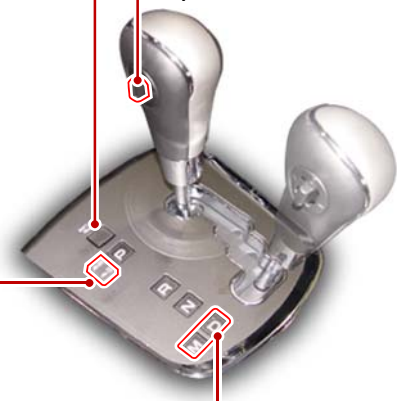
P : Park
R : reverse
N : Neutral
D : Drive

Mode switch

W: Winter mode (pressed "OUT")
S: Standard mode (pressed "IN")
Toggle the mode between winter mode and standard mode by pressing this switch.

Tip switch (manual shift switch)

The shiftable gear can be adjusted by moving this switch to forward and rearward when the gear selector lever is in "M" position.



Selection of Manual/Automatic Shift Function

D: Automatic shift according to the driving condition
M: Manual shift

Modification basis	
Application basis	
Affected VIN	

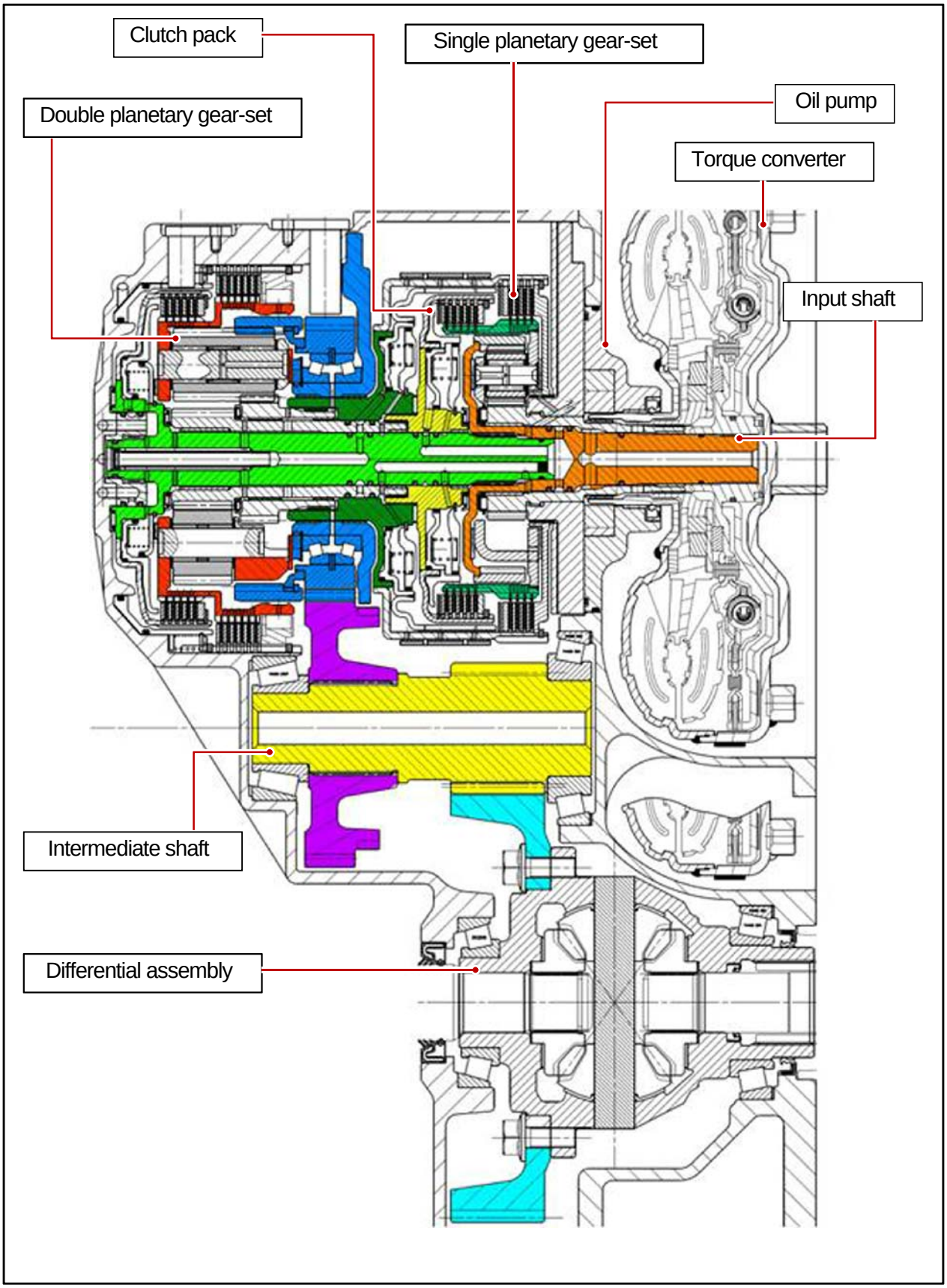
2. SPECIFICATIONS

1) Specifications

Descriptions		Specification
Gear ratio	1st gear	4.156
	2nd gear	2.375
	3rd gear	1.522
	4th gear	1.144
	5th gear	0.859
	6th gear	0.676
	Reverse gear	3.178
Oil	Type	Fuchs TITAN ATF 3292
	Capacity	approx. 7.5 L
	Change interval	EU: Inspect every 20,000 km or 12 months (But, change every 60,000 km under severe condition) General: Inspect every 15,000 km or 12 months (But, change every 60,000 km under severe condition)
Resistance of oil temperature sensor	-20	430.7 to 533.9 kΩ
	0	146.8 to 175.7 kΩ
	20	56.74 to 65.86 kΩ
	100	3.201 to 3.399 kΩ
Inhibitor switch	D	2.686 kΩ ±8%
	N	5.036 kΩ ±8%
	P	8.953 kΩ ±8%
	R	16.786 kΩ ±8%

Type/Weight	M11 6-speed automatic transaxle / approx. 102 kg (including ATF)
TORQUE	400 Nm
Overall length / Center length	367 mm / 205 mm

2) Sectional Diagram



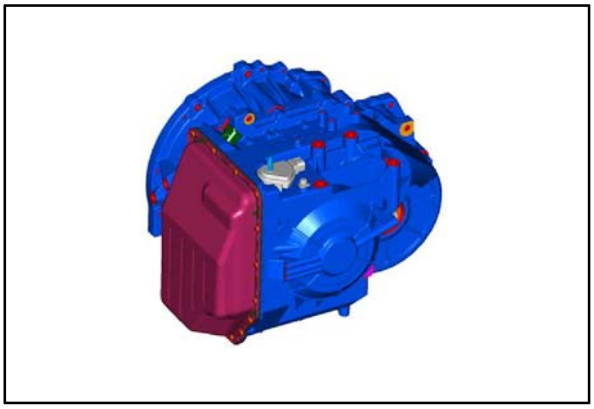
Modification basis	
Application basis	
Affected VIN	

3. TIGHTENING TORQUE

Descriptions		Size x Numbers	Tightening torque (Nm)
Automatic transaxle	Engine side mounting bolt	17 mm X 4	85.0 to 100
	Oil pan and engine side mounting bolt	14 mm X 4	56.0 to 62.0
	Oil filler plug	16 mm	25.0 to 30.0
	Oil drain plug	Hexagon 5 mm	25.0 to 30.0
Valve body	Assembly mounting screw	T30 mm X 9	16.0
	Oil pan bolt	10 mm X 15	7.0 to 8.0
	VBS screw	T30 mm	4.0
	Valve body screw	T30 mm X 25	16.0
Torque converter	Mounting bolt	13 mm X 6	40.0 to 42.0
Cable	Link nut (switch side)	13 mm X 1	13.7 to 19.6
	Link nut (cable side)	12 mm X 1	14.7 to 22.5
	Mounting nut (floor side)	12 mm X 1	17.6 to 21.6
	Mounting nut (dash panel side)	12 mm X 2	17.6 to 21.6
TGS lever	Mounting nut	12 mm X 4	17.6 to 21.6
TCU	Mounting nut	8 mm X 2	5.0 to 6.0
Inhibitor switch	Mounting nut	12 mm X 2	3.9 to 7.8
Transaxle bracket	Left bracket	17 mm X 3	85.0 to 100
	Right bracket	17 mm X 4	85.0 to 100
	Upper bracket	17 mm X 4	85.0 to 100
Oil cooler pipe	Mounting bolt	10 mm X 2	Max.: 13.0
	Bracket mounting bolt	10 mm X 1	13.0

OVERVIEW AND OPERATING PROCESS

1. OVERVIEW



Engine power reaches the transaxle via a torque converter with integral converter lock-up clutch. The six forward gears and one reverse gear are obtained from a single planetary set, followed by a double planetary set. This type of gear-set arrangement is commonly known as Lepelletier type gear-set.
The Model M11 6 speed automatic transaxle is electronically controlled. The control system is comprised of the following components:

- External transaxle control unit (TCU)
- Internal embedded memory module (EMM)
- Input and output speed sensors
- Valve body unit comprised of four ON/OFF solenoid valves and six variable bleed solenoids (VBS)
  Torque converter
-

TCU controls the oil pressure for various internal clutches and bands to select the gear. It also controls the electronic elements, shift pressure and torque converter slip. If the system is defective, TCU provides FMEC (Failure Mode Effect Control) to maintain the functionality of transaxle. This keeps the basic function of transaxle (gear selection) even when there are failure in controls and power supply.

There are selector shaft position sensor (inhibitor switch) and oil temperature sensor in transaxle. In manual mode, TCU receives the information from TGS (Transmission Gear Selector) through PCB (Printed Circuit Board) when driver selects the manual shift mode. TCU communicates with other electric control modules through CAN. In order to ensure a safe driving state and to prevent damage to the automatic transmission, TCU switches to Limp-Home mode in the event of critical faults.

Modification basis	
Application basis	
Affected VIN	

2. FEATURES

1) Advantages

▶ Early Downshift with Hard Braking and Skip Shifts

When heavy braking is detected, the transaxle downshifts early and skips gears to provide increased engine braking to provide gear selection for tip-in.

▶ Gear Hold going Uphill/Downhill

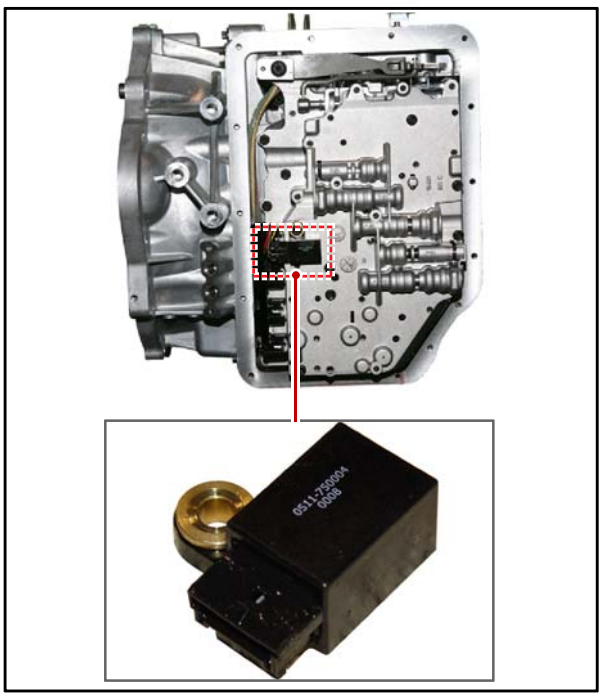
If the accelerator pedal is released when traveling uphill, upshifts are prevented to reduce busyness on grades. If the accelerator pedal is released when traveling downhill, upshifts are prevented to enhance engine braking.

▶ Drive and Reverse Engagement

A soft engagement feature avoids harsh take up of drive when selecting Drive or Reverse. This is achieved by limiting engine speed and engine torque which results in a rapid, but progressive engagement of either Drive or Reverse when moving from the Park or Neutral positions. Drive and Reverse engagements from either Park or Neutral are performed in less than 2.2 seconds. There is no drive engagement prevention strategy implemented on the transaxle system as there is sufficient engine strategy to protect the system. However, reverse engagement is prevented until engine speed is less than 1,400 rpm and the accelerator pedal position is less than 12% and vehicle speed is less than 10 km/h.

▶ Converter Clutch Lock-Up In All Gears

The transaxle features converter clutch lock-up in all gears. This feature provides improved fuel economy and vehicle performance. It also improves transaxle cooling efficiency when towing heavy loads at low speeds, e.g. in city driving or hill terrain.



▶ Embedded Memory Module (EMM)

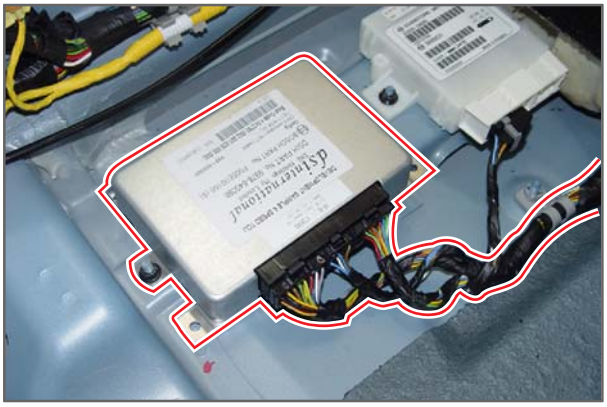
The embedded memory module (EMM) is matched to the transaxle's valve bodies during transaxle assembly to ensure refined shift quality. The EMM is used to store data such as valve body calibration data and valve body serial number. Upon installation, the TCU will download the data from the EMM and utilize this data in the operation of the transaxle.

Modification basis	
Application basis	
Affected VIN	

2) Transaxle Cooling

The transaxle cooling system ensures rapid warm-up and constant operating temperature resulting in reduced fuel consumption and refined shift quality.
It also includes a cooler by-pass within the hydraulic system to allow sufficient lubrication to the transaxle drivetrain in the event of a blockage in the transaxle cooler.

3) Shift Strategy



▶ **Gear Change**

Transaxle gear change is controlled by the TCU. The TCU receives inputs from various engine and vehicle sensors to select shift schedules and to control the shift feel and torque converter clutch (TCC) operation at each gear change.

▶ **Coast down**

Coast down down shifts occur at 0% pedal when the vehicle is coasting down to a stop.

▶ **Torque Demand**

Torque demand down shifts occur (automatically) when the driver demand for torque is greater than the engine can provide at that gear ratio. If applied, the transaxle will disengage the TCC to provide added acceleration.

Modification basis	
Application basis	
Affected VIN	

3. MODES AND FUNCTIONS

1) Mode Switch

▶ **W: Winter mode (pressed "OUT")**

To select the winter mode, press the mode switch. The winter mode indicator (W) in the instrument cluster comes on. To return to standard mode, press the switch again. The indicator goes out. Use this mode to drive off smoothly on an icy and slippery road.

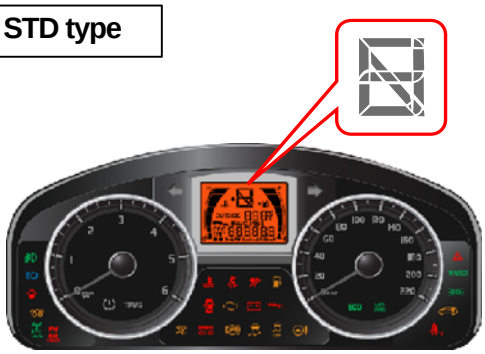
▶ **S: Standard mode (pressed "IN")**

Use the standard mode in normal driving condition.

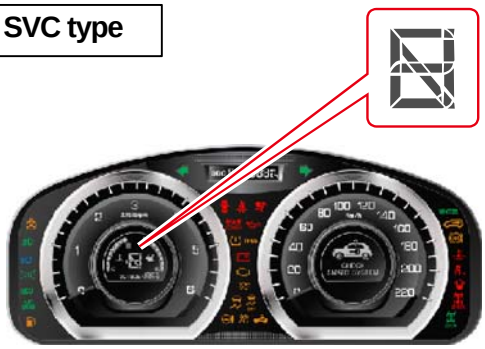
2) M Mode (Manual Mode)

This allows the driver to define the highest possible gear by selecting "+" or "−" on the gear selector when the lever is in the "M" position. When the lever is first moved to the manual "M" position the transaxle will select the lowest possible gear.

STD type



SVC type



▶ 1st Gear State

- The 1st gear state will display on the instrument cluster. Unlike the normal 1st gear, engine braking will be available in this manual 1st state.

▶ 2nd Gear State

- The 2nd gear state will display on the instrument cluster. 2-1 automatic kick-down shifts are available. 2nd gear has engine braking available.

▶ 3rd Gear State

- The 3rd gear state will display on the instrument cluster. 3-2 and 3-1 automatic kick-down shifts are available. 3rd gear has engine braking available.

▶ 4th Gear State

- The 4th gear state will display on the instrument cluster. 4-3 and 4-2 automatic kick-down shifts are available. 4th gear has engine braking available.

▶ 5th Gear State

- The 5th gear state will display on the instrument cluster. 5-4 and 5-3 automatic kick-down shift is available. 5th gear has engine braking available.

▶ 6th Gear State

- The 6th gear state will display on the instrument cluster. 6-5 and 6-4 automatic kick-down shifts are available. 6th gear has engine braking available.

Modification basis	
Application basis	
Affected VIN	

4. LIMP HOME MODE

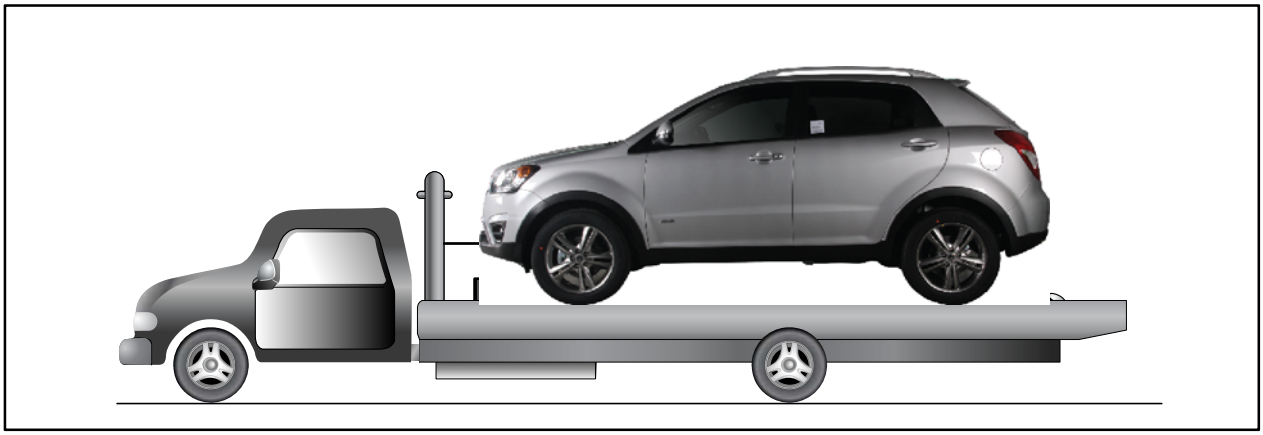
▶ When the transaxle is defective

1. In the event of a system fault, the TCU also provides for failure mode effect control (FMEC) to maintain maximum functional operation of the transaxle.
2. In the event of a total loss of control or electrical power, the basic transaxle functions (Park, Reverse, Neutral and Drive) are retained. The 4th and reverse gear ratios with the torque converter clutch in the unlocked state are the retained gear states the hydraulic system supports without any electrical assistance.
3. The TCU communicates with other vehicle electronic control modules by the controller area network (CAN). If a major fault develops, the transaxle may automatically operate in a "limp home" (failure) mode to enable the vehicle to be driven to an authorized dealer for repair.
4. The TCU also provides for transaxle diagnostics, which meet the requirements of OBD II legislation, monitoring all components which may effect vehicle emissions.

▶ When the transaxle overheats

1. Limp home mode may also be engaged if the battery charge falls below 8V.
2. If the transaxle overheats, the shift patterns will automatically change to enable improved transaxle cooling.
3. During transaxle overheat, the instrument cluster transaxle selector position display and the over temperature condition is indicated by flashing the “W(Winter)” indicator on the instrument cluster until normal transaxle operating temperature is reached.

▶ Towing the automatic transaxle equipped vehicle



CAUTION

- Flat-bed equipment is the best method of moving a disabled vehicle to avoid any damages.
- For AWD vehicle: The vehicle must be towed with a wheel lift and dollies or flatbed equipment with all the wheels off the ground.
  For 2WD vehicles: It is acceptable to tow the vehicle with the rear wheels on the ground without dollies and the front wheels off the ground. When being towed by a commercial towtruck and wheel dollies are not available, the front of the vehicle should be lifted, not the rear.

5. TRANSAXLE ELECTRONIC CONTROL SYSTEM

1) General Information

The transmission control unit (TCU) and its input/output network control the following transmission operations:

- Shift timing
- Line pressure
- Clutch pressure (shift feel)
- Torque converter clutch

also uses these signals when determining transaxle operating strategy. Using all of these input signals, the TCU can determine when the time and conditions are right for a shift, or when to apply or release the torque converter clutch. It will also determine the pressure needed to optimise shift feel. To accomplish this, the TCU operates six variable bleed control solenoids and four on/off solenoids to control transaxle operation.

2) TCU (Transmission Control Unit)

The transaxle control unit (TCU) is mounted under the driver's seat and controls the operation of the transaxle.
The TCU is activated and deactivated by the ignition power supply and is connected to the transaxle link harness by a 26 pin connector. The TCU processes information received from internal sensors and signals received across the CAN bus in analogue and digital forms such as:

- Transaxle input speed
- Transaxle output speed
- Accelerator pedal position
- Gear selector position
- Engine torque
- Engine speed
- Transaxle fluid temperature
- Brake pedal status
- Engine oil temperature
- Engine coolant temperature
- Ambient air temperature
- Barometric pressure

Modification basis	
Application basis	
Affected VIN	

This information is used by the TCU to decide which shift pattern to select and for shift energy management. Electro-hydraulic solenoid valves and variable bleed solenoids control the transaxle gear changes.
Six variable bleed solenoids and four on/off solenoids are used to direct transaxle fluid flow to control the fluid pressure within the three clutches and two bands. Separate pressure regulators are used exclusively for torque converter clutch control and main transaxle line pressure.
The TCU monitors all TCU inputs and outputs to confirm correct system operation. If a fault occurs the TCU is able to perform default action and inform the driver of the problem through the instrument cluster warning lights. Detailed information is available via trouble codes which can be read with the service tool.

3) Shift Map Selection

The driver can manually select between normal (S) and winter modes (W) via the mode switch. Depending on the transaxle temperature, uphill and downhill grades and altitude, shift maps will be selected by the TCU to suit the driving conditions. The following maps are available.

▶ Standard (Normal) Mode

Normal Mode is selected when the lever is in the D position with the mode switch in the normal (S) position and the transaxle is within normal temperature ranges. Shift schedule points are optimised for fuel efficiency and general driving conditions.

▶ Uphill and Downhill Mode

In this mode, depending on the load of the vehicle, adaptive shift maps are selected to progressively adjust the shift points and torque converter lock points.

▶ Altitude Mode

Shift points are automatically adjusted at higher altitudes to compensate for changes in engine torque where the torque produced by the engine is greatly reduced by the effects of reduced barometric pressure and temperature.

▶ Winter (W) Mode

When winter mode is selected, starting in second gear is facilitated and the WINTER mode indicator light is switched ON. To prevent wheel spin on slippery surfaces, the transmission will not allow first gear unless manually overridden.

▶ Warm up Schedule

Used typically when transaxle fluid temperature is below 20°C.
The torque converter will not lock-up below 20°C to assist in transaxle warm-up.

▶ Hot Mode

The hot mode is progressively applied between temperatures of 110° ~ 200°C. The torque converter lock-up is increased to prevent heat generation by the torque converter.

Above 110℃	the electrical radiator fans are switch ON
Above 130℃	the engine torque will be reduced and the W light on the instrument cluster will flash
Above 200℃	the transaxle will neutralise until the fluid temperature falls below 200°C as a final protection.

Activation of the hot mode inhibits other transmission performance features including uphill and downhill compensation and altitude compensation. Some degradation in shift feel may be experienced as the torque converter is not unlocked during shifting.

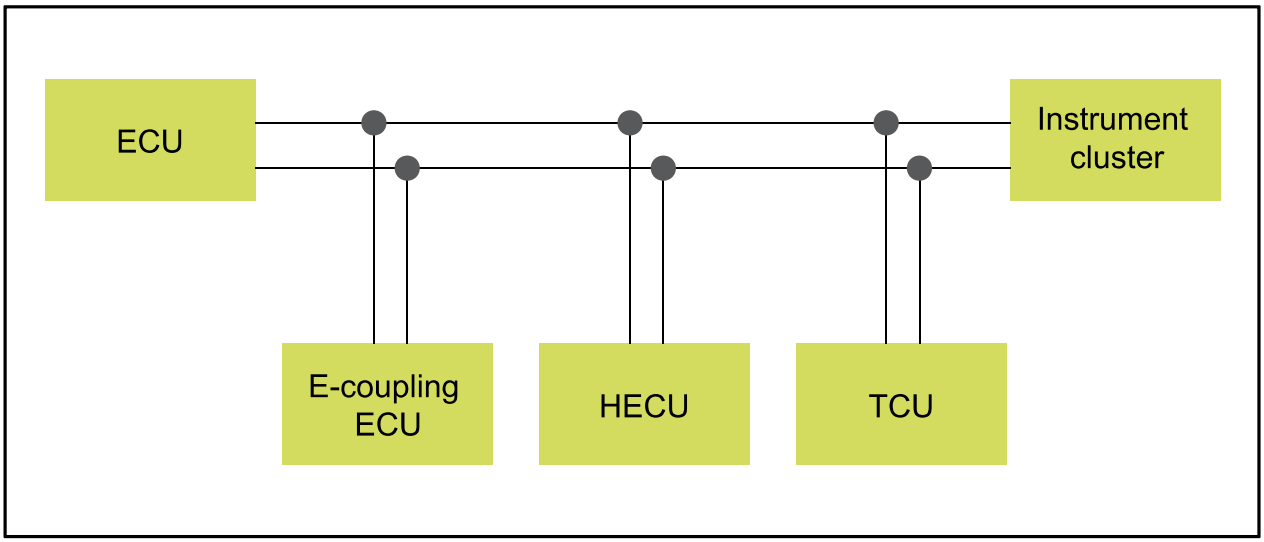
▶ Cruise Control Mode

When cruise control is activated the engine ECU may request the transaxle to downshift under trailing throttle conditions to increase engine braking.

Modification basis	
Application basis	
Affected VIN	

6. CAN NETWORK

▶ **Schematic Diagram of Network Communication**



The TCU sends signals to be used by other vehicle systems via the CAN bus, such as:

- Selector lever position
- Selected gear state
- Manual mode activation
- Output torque
- Transaxle fluid temperature
- Engine torque reduction requests

7. POWER TRANSFER

Power transfer modes are as follow:

- Manual: 1st gear (position M)
- Drive: 1st gear
- Drive: 2nd gear
- Drive: 3rd gear
- Drive: 4th gear - limp home mode
- Drive: 5th gear
- Drive: 6th gear

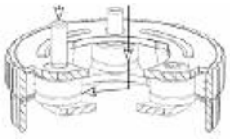
1) Gear Selection and Engagement Element

Gear	Gear ratio	Engagement element (clutch/band)					
		C1	C2	C3	B1	B2	1-2 OWC
M1	4.156		ON			ON	
1st	4.156		ON				ON
2nd	2.375		ON		ON		
3rd	1.522		ON	ON			
4th	1.144	ON	ON				
5th	0.859	ON		ON			
6th	0.676	ON			ON		
Reverse	3.178			ON		ON	

Gear	ON/OFF solenoid valve				Variable bleed solenoid valve (VBS)					
	S1	S2	S3	S4	S5(A)	S6(A)	S7(A)	S8(A)	S9(A)	S10(A)
M1	ON				1	0	1			
1st	ON				1	0			0-1	
2nd	ON			ON	1	0		1	0-1	
3rd	ON		ON		1	0	1		0-1	
4th					0	0			0-1	
5th		ON			0	1	1		0-1	
6th		ON		ON	0	1		1	0-1	
Rev.	ON	ON	ON		1	1	1		0-1	

Modification basis	
Application basis	
Affected VIN	

2) Power Flowing Sequence

Engine →  →  → 

Torque converter

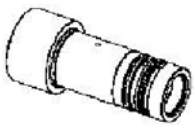
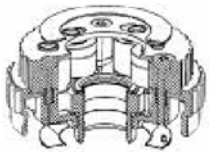
This is a fluid clutch. Transfers the power from engine to transaxle and amplifies the torque.

Input shaft

Transfers the power from torque converter to front planetary gear.

Front planetary gear

Generates the gear ratio and transfers the power.

 →  → 

C2 clutch

Engaged by hydraulic pressure and transfers the power to C1 clutch.

Forwarding sun gear

Transfers the power from torque converter to rear planetary gear.

Rear planetary gear

Generates the gear ratio and transfers the power.

 →  → 

C1 clutch

Engaged by hydraulic pressure and transfers the power to C1 clutch.

Center support

Transfers the power from input shaft to intermediate shaft.

Intermediate shaft assembly

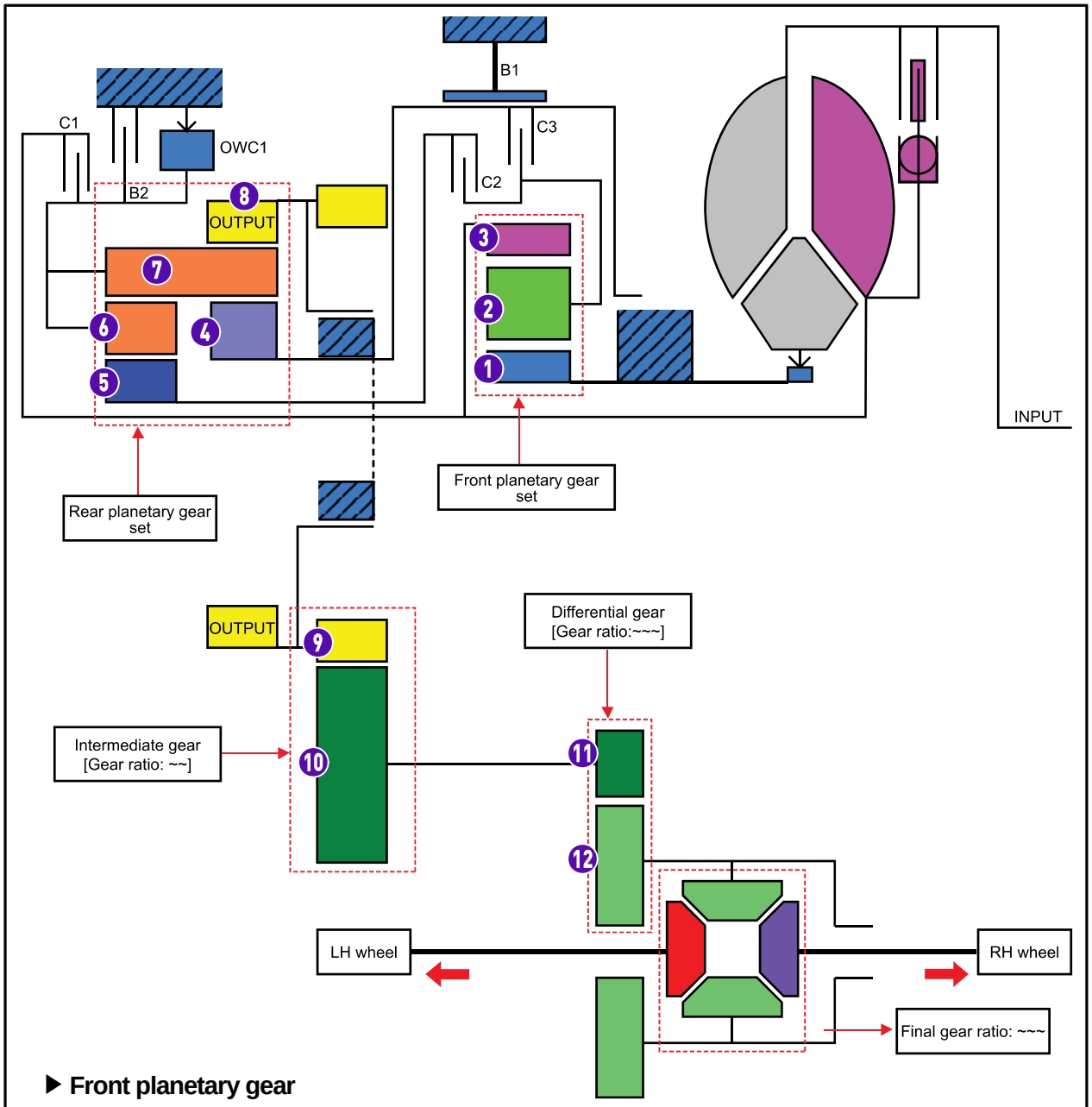
Changes the rotating direction and generates the final reduction rear ratio.

 → Universal joint

inal reduction and differential gear

Generates the final reduction gear ratio and performs the differential function.
Transfers the power to constant velocity shaft.

3) Power Flow



▶ **Front planetary gear**

1. Front sun gear (FSG)
2. Planetary hear pinion (PP)
3. Ring gear (Internal)

▶ **Rear planetary gear**

4. Forward sun gear (FSG)
5. Reverse sun gear (RSG)
6. Short pinion (SPP)
7. Long oinion (LPP)
8. Ring gear (RG)

▶ **Intermediate gear**

9. Drive gear
10. Driven gear

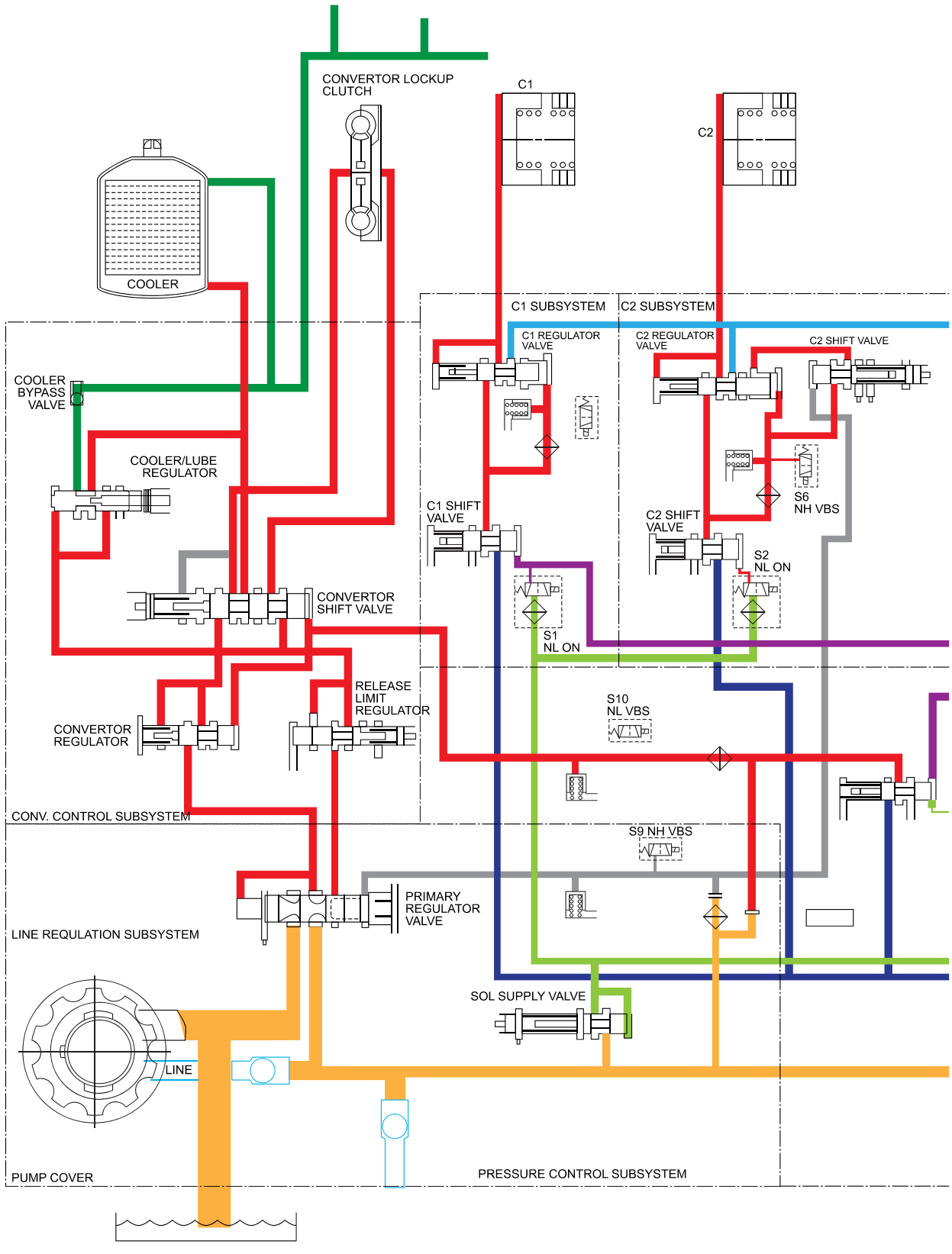
▶ **Differential gear**

11. Pinion
12. Differential

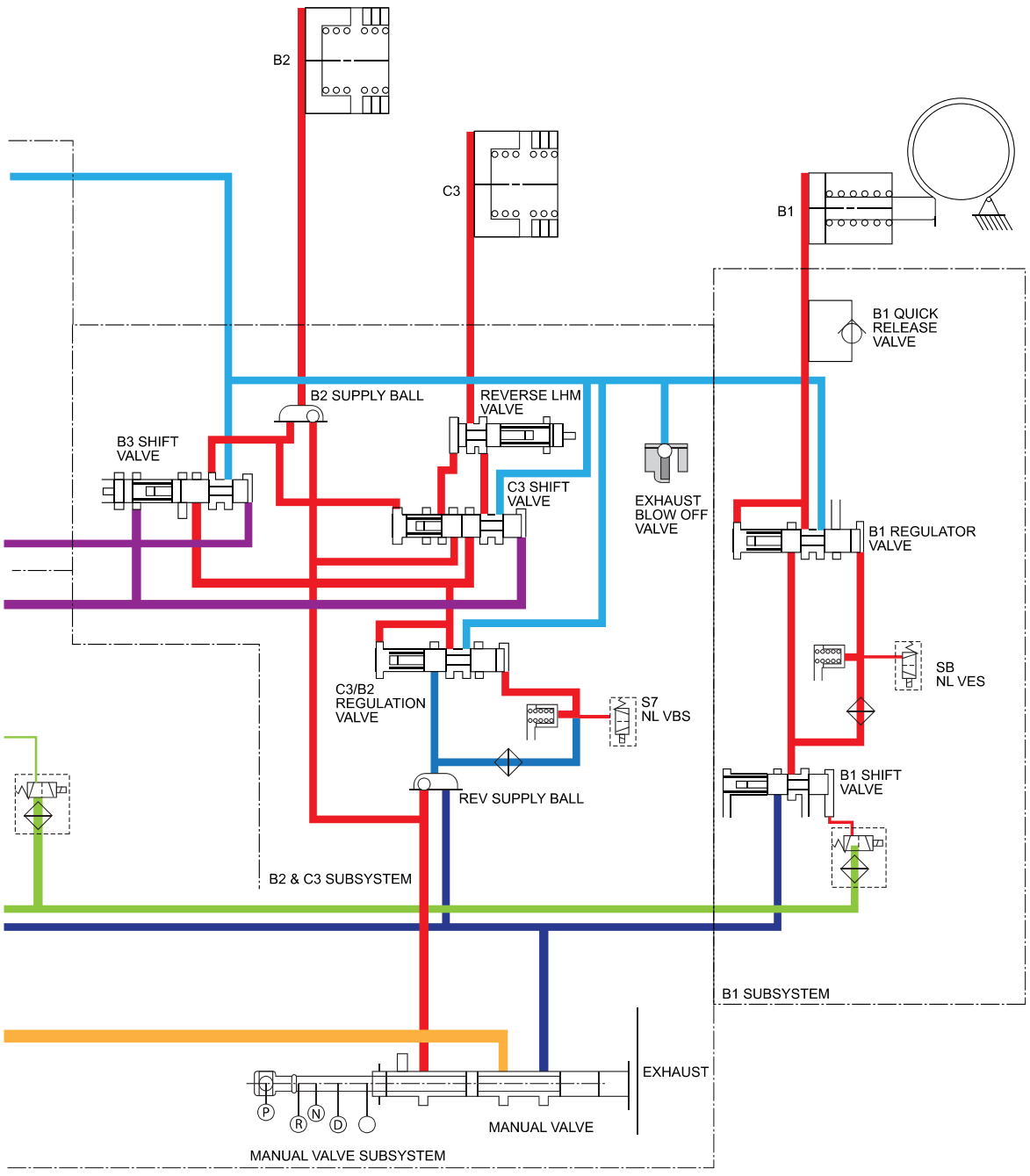
Modification basis	
Application basis	
Affected VIN	

Memo

3) Hydraulic Circuit Diagram



Modification basis	
Application basis	
Affected VIN	



Modification basis	
Application basis	
Affected VIN	

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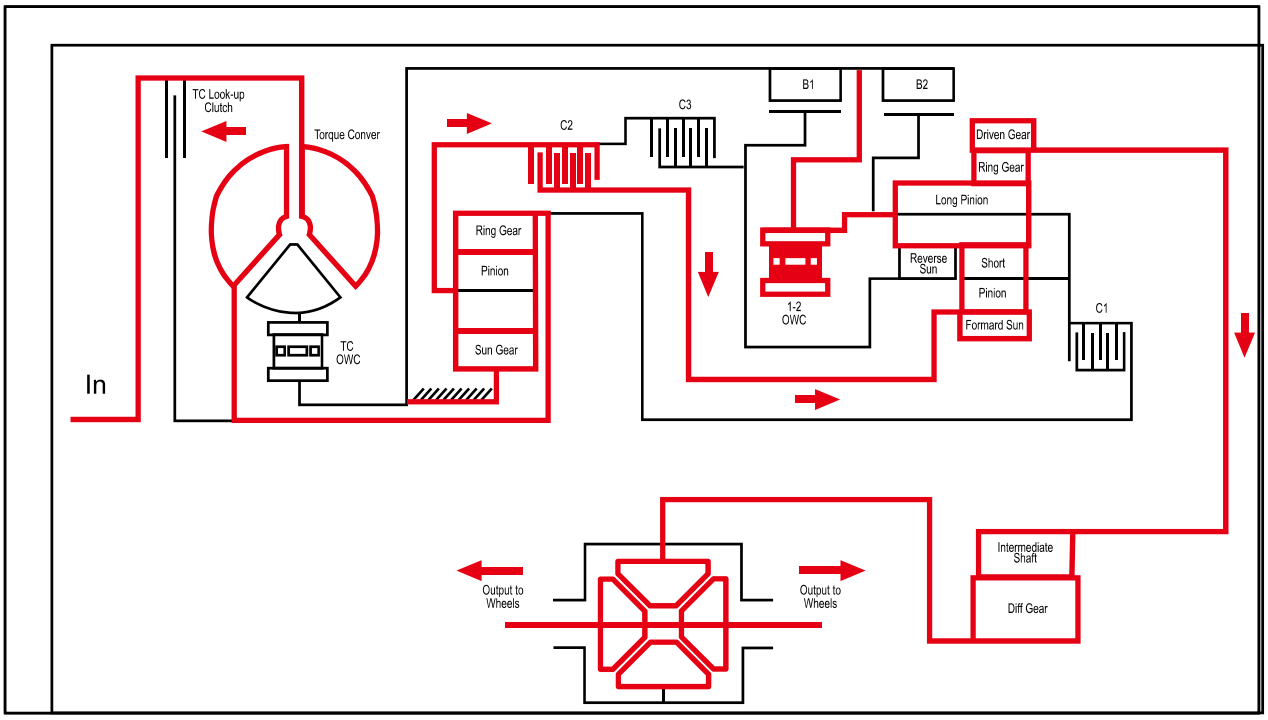
4) Power Transfer in Each Gear

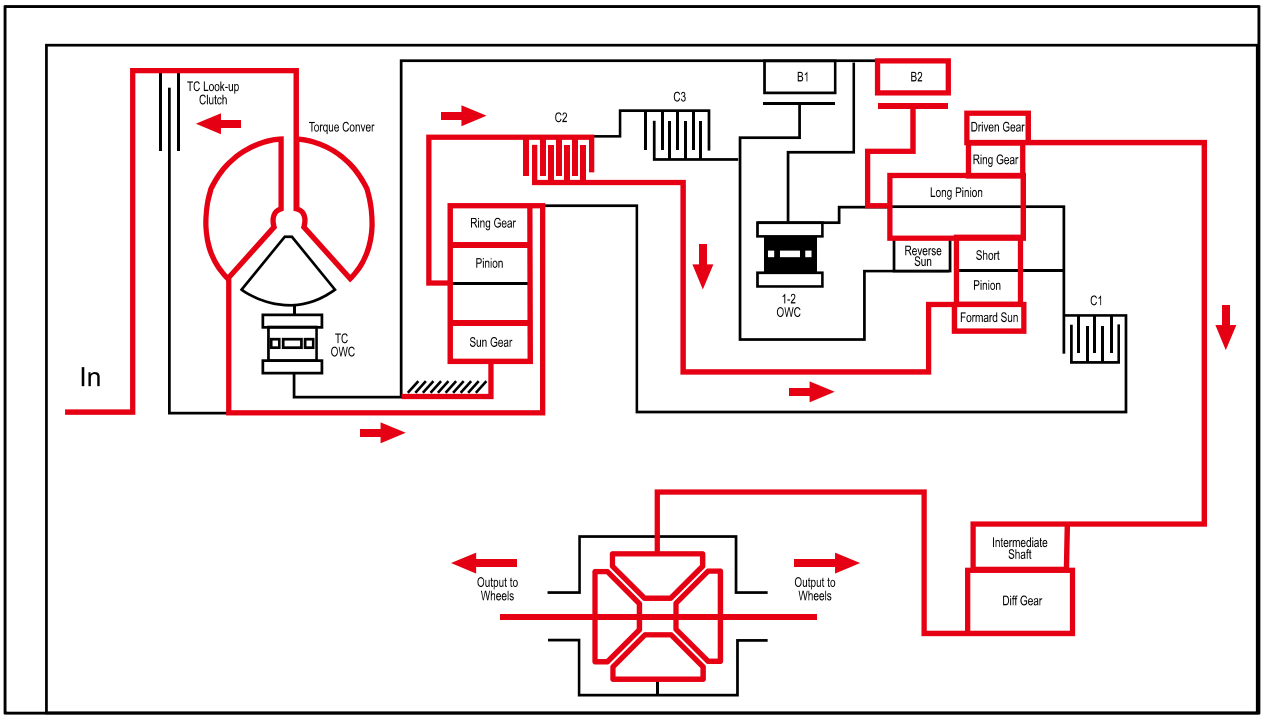
(1) Manual (position M) - 4.156 : 1

▶ **Power flow**



(2) Drive 1st Gear (1st Auto) - 4.156 : 1

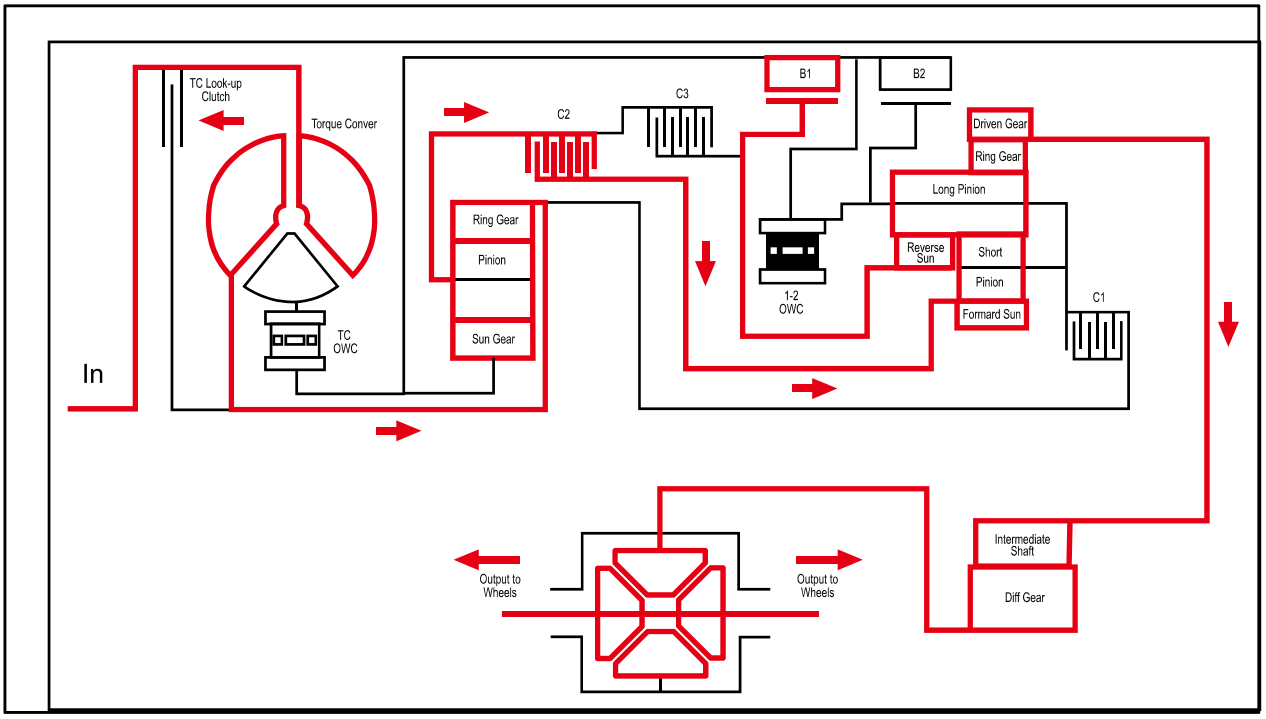
▶ **Power flow**



Modification basis	
Application basis	
Affected VIN	

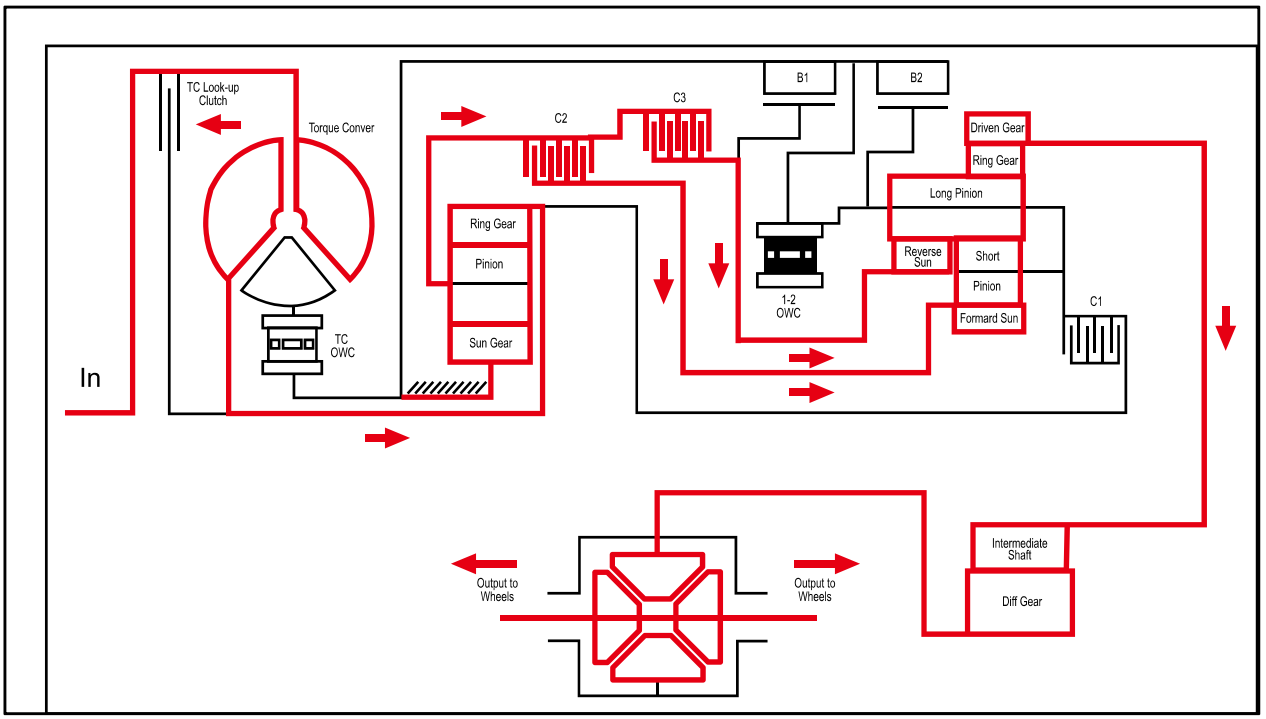
(3) Drive 2nd (2nd Auto) - 2.375 : 1

▶ **Power flow**



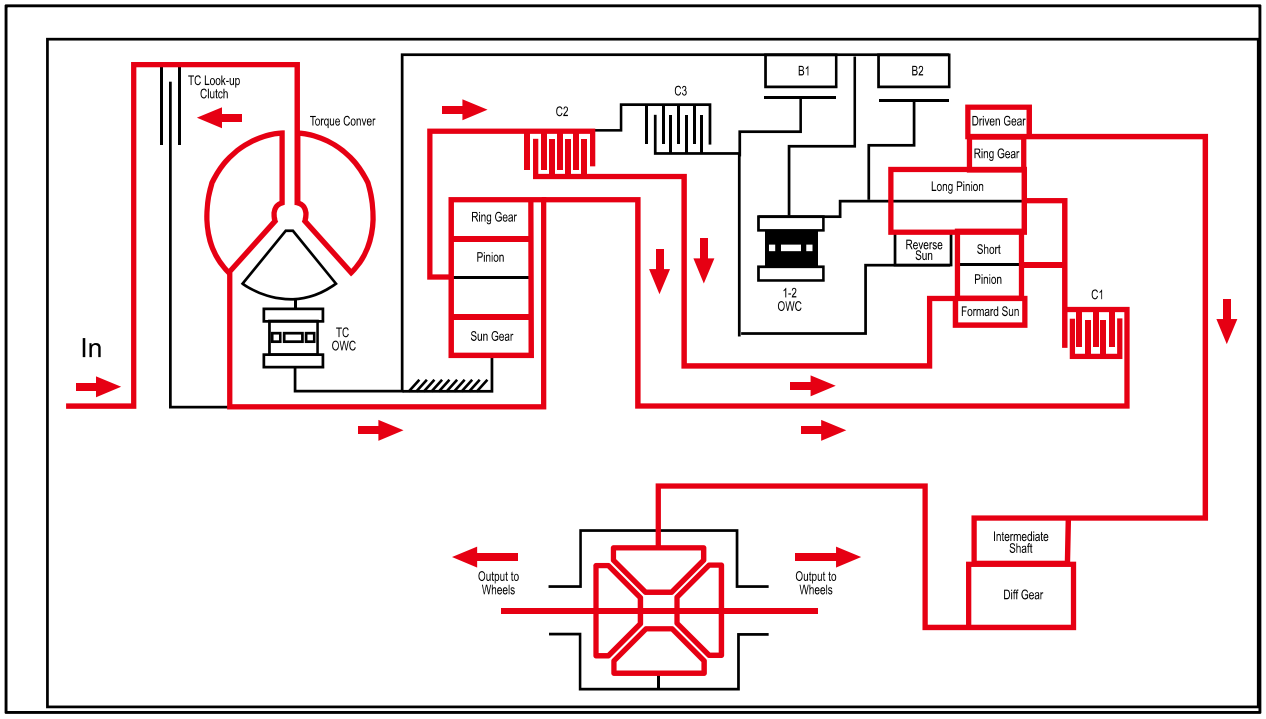
(4) Drive 3rd (3rd Auto) - 1.522 : 1

▶ **Power flow**



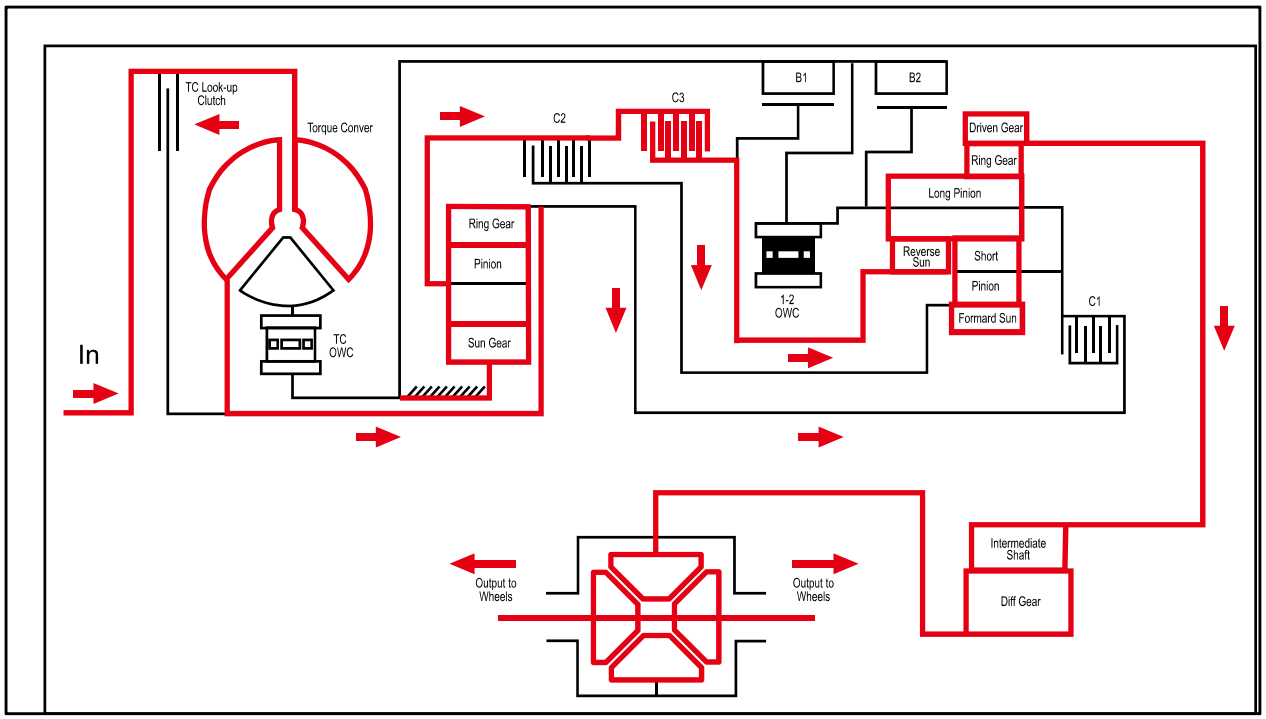
(5) Drive 4th (4th Auto) - 1.144 : 1

▶ **Power flow**



(6) Drive 5th (5th Auto) - 0.859 : 1

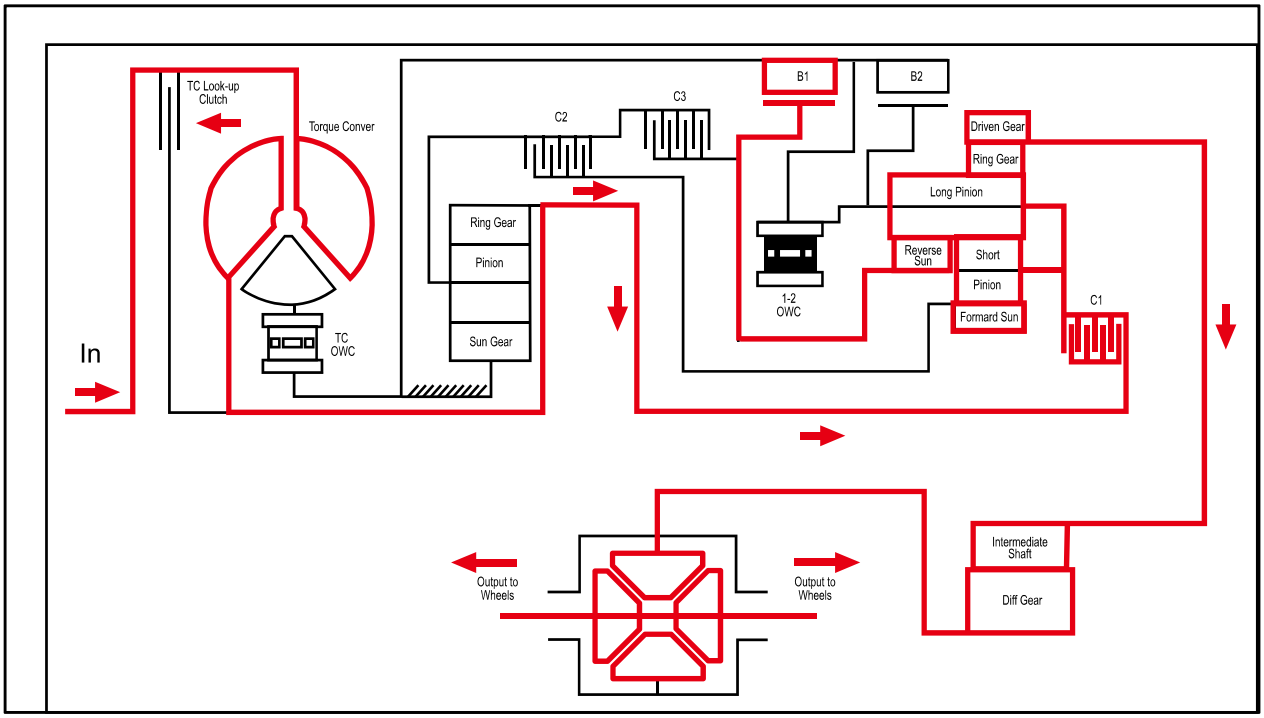
▶ **Power flow**



Modification basis	
Application basis	
Affected VIN	

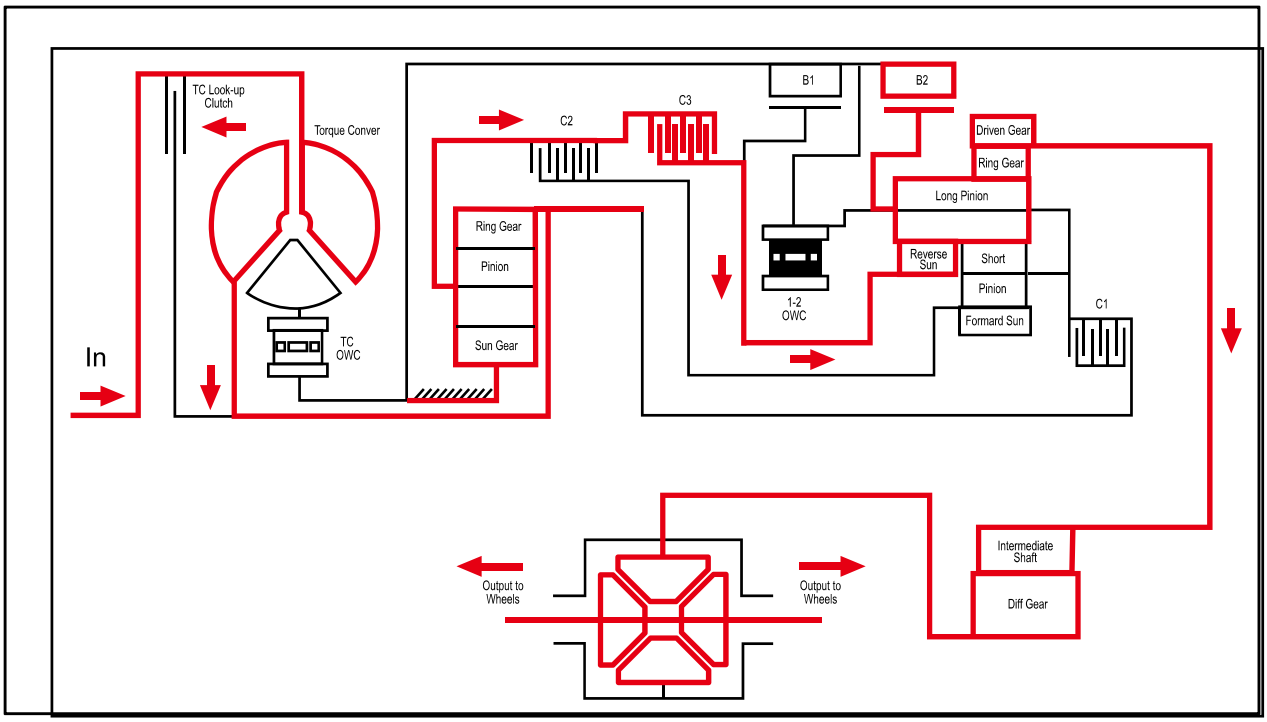
(7) Drive 6th (6th Auto) - 0.676 : 1

▶ **Power flow**



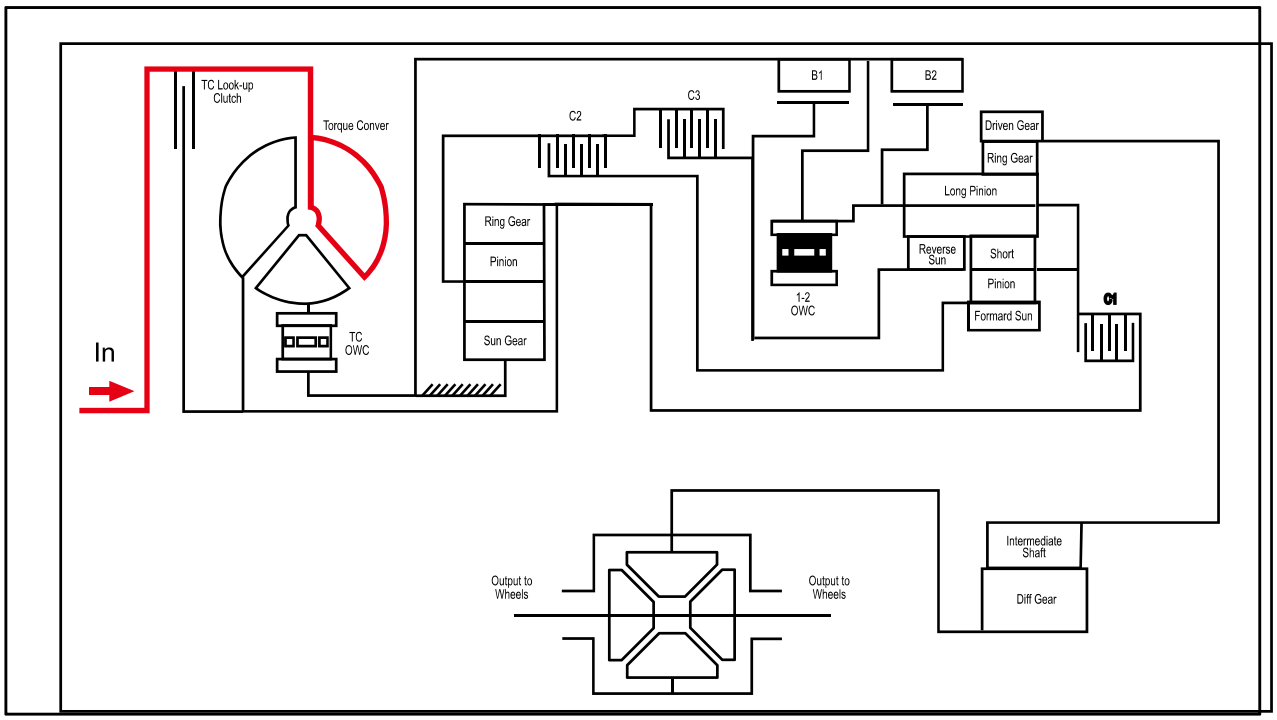
(8) Reverse - 3.178 : 1

▶ **Power flow**



(9) Neutral / Park

▶ Power flow



Modification basis	
Application basis	
Affected VIN	