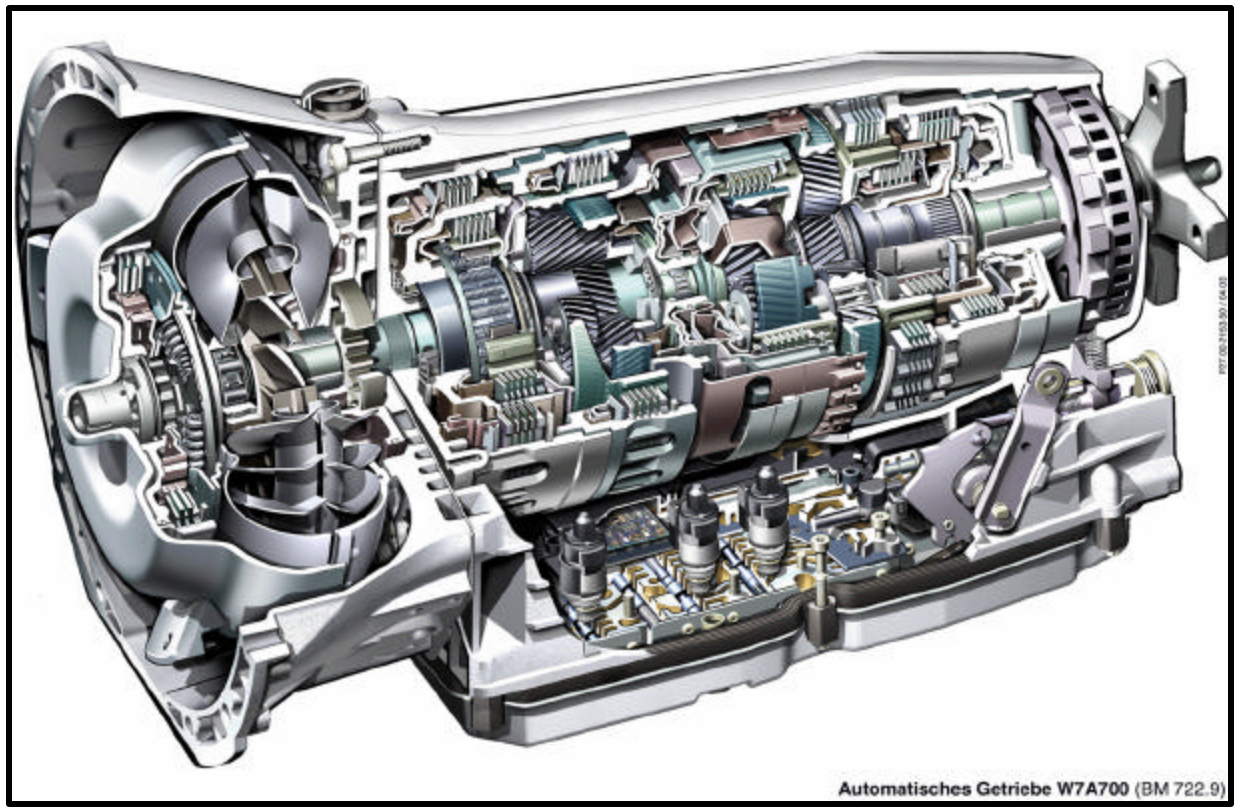
Mercedes-Benz

Automatic Transmission 722.9



Fifth Generation of Mercedes-Benz Automatic Transmission

286 HO 722.9 (Cookson,I)
06-25-04

These technical training materials are current as of the date noted on the materials, and may be revised or updated without notice. Always check for revised or updated information.

To help avoid personal injury to you or others, and to avoid damage to the vehicle on which you are working, you must always refer to the latest Mercedes-Benz Technical Publication and follow all pertinent instructions when testing, diagnosing or making repair. Illustrations and descriptions in this training reference are based on preliminary information and may not correspond to the final US version vehicles. Refer to the official introduction manual and WIS when available.

WIS document numbers shown apply to WIS Version USA/CDN at date of writing.

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Features

- Electronically controlled automatic gearbox
- Seven forward and two reverse speeds
- Transmission control module is:
  - integrated into valve body assembly
  - ‘flash’ capable
- Torque converter operates in open or slip mode in all seven forward speeds
- Gear ratios achieved with four multi-disc brakes and three multi-disc clutches (no free-wheeling units)
- 3 planetary gear sets: 2 simple & 1 Ravigneaux

Advantages

- Shift comfort / driving pleasure increased through improved control of gear changes :
  - Shorter computer reaction time by 0.1 second
  - Downshifts shortened by up to 0.2 second
  - Coasting downshifts shortened by 0.4 – 2.5 seconds
  - 37 to 74 mph acceleration times shortened by 23 - 28% (depending on model)

- Fuel consumption reduced by up to 4%

- Noise levels reduced, due to lower engine speed in 5^{th}, 6^{th} & 7^{th} gear at constant vehicle speed

- Flexible adaptation to vehicle and engine

Transmission Applications

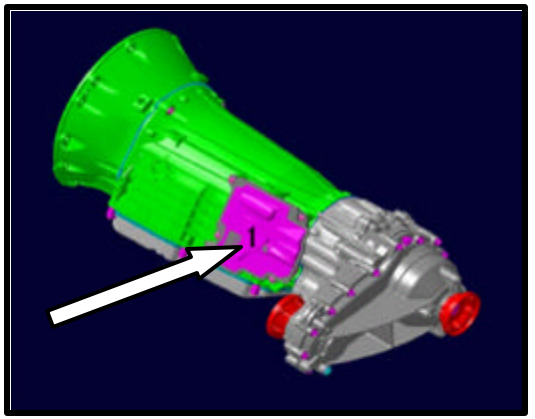
- Currently only 1 size of 722.9 will be produced:
  - W7A 700

  (a smaller version (W7A 400) was to be introduced, currently postponed until further notice)
- Transmission is also referred to as:
  - NAG 2 (Neues Automatische Getriebe 2)
    (New Automatic Gearbox 2)
  - or 7G-Tronic
- First installed on select non 4MATIC MY 2004 vehicles fitted with normally aspirated M113 engine (S430, S500, CL500, E500, SL500)
- 722.6 transmission (NAG 1 or NAG V) will continue to be built until approx 2012 and installed in:
  - 4 cyl models
  - Maybach
  - M275 vehicles
  - Select other manufacturer's vehicles under contract agreement

Transmission Application

- 722.9 transmission will be offered in the future:
  - as an option in new SLK (R171 - 09/04)
  - standard equipment for new M Class (W164 - 2005)
  - standard equipment for new R Class (W251 - 2005)
  - standard equipment for new G Class (X164 - 2006)
  - standard equipment on CLS 350 / 500 (late 2004)
  - standard equipment on E350 (late 2004)

- 722.9 for W164 / W251 / X164 will be equipped with shift by wire (no shift rod). Instead an electric control module is fitted to operate shift control valve and monitor position via a positioning sensor.



- End of production or outgoing models are unlikely to receive the 722.9 transmission (W163, R170, V463)

Shift Program (Customer's Perspective)

- Basic shift program can be varied (same as 722.6), using S/C button on Electronic Shifter Module (ESM)

"S" (Sport): First gear start
Normal shift points
Reverse gear 1 (-3.416:1)

"C" (Comfort): Second gear start
Earlier up-shifts and later downshifts
Reverse gear 2 (-2.231:1)

Note: Transmission will start in first gear if any of the following apply:
- 1st gear manually selected
- engine cold (catalytic converter warm-up)
- ¾ to full throttle applied from stationary start

- Shift into Optimal Gear (SOG) software as known from previous models
- Up-shifts and downshifts are influenced based on the current driving style and loads (similar to 722.6)
- Shift interlock performed by Electronic Shifter Module (ESM) as before

Shift Program (Customer's Perspective)

- Shift program incorporates "intelligent" gear selection when tapped out of 'D' using the '-' button.
  - when shifter is tapped into a lower gear, transmission control module will shift one gear down from the current gear engaged

e.g. S500 driving at 30 mph in 'D' ➔ tap '-' transmission shifts into 3rd gear from 4th
S500 driving at 50 mph in 'D' ➔ tap '-' transmission shifts into 5th gear from 6th

The gear display in the Instrument Cluster informs the driver of highest gear now available.

- If transmission has a defective shift engagement or component, a limp-home mode will be activated (discussed later), ensuring that in almost all cases the vehicle can still be driven at reduced speed to home or workshop.

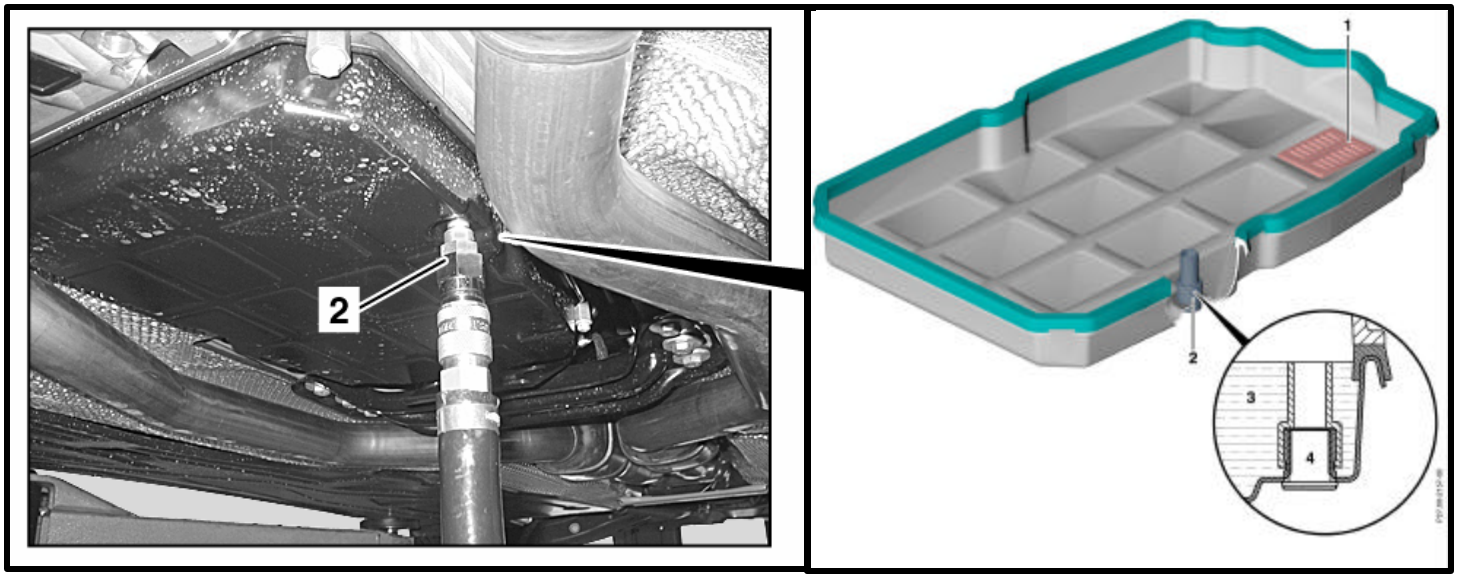
Transmission Fluid

- Requires a newly developed transmission fluid (ATF 3353) with the following properties:
  - Higher friction consistency
  - Higher thermal stability
  - Improved temperature behavior
- Oil suppliers are Shell & Fuchs Europe
- Only use this approved fluid:
  - Currently a 1 liter bottle is available

    (MB part number A001 989 45 03 10)
- No scheduled maintenance
- Can also be used in 722.3 / .4 / .5 / .6

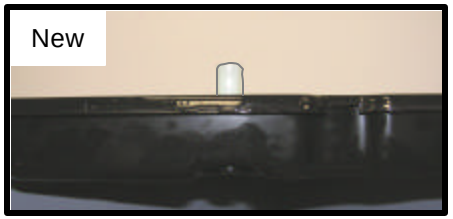
Transmission Fluid Level

- No dipstick or dipstick tube
- Fluid level checked using overflow method
- Oil pan has overflow pipe clipped onto pan, above drain plug
- Fluid level must be checked at specified transmission fluid temperature
- Special filling station used to add fluid through drain plug



Transmission Fluid Level

- Oil pan has been optimized and can be identified by its part number (220 270 09 12) and design
- Overflow pipe length was increased and can be identified by its white color
- Pan design and overflow pipe change has resulted in an increase of fluid quantity by 0.2 liter
- If oil pan is removed during repairs, ensure new optimized pan is installed (Refer to DTB P-B-27.00/39)



Changes compared to old pan.

Pan depth: +3mm
Overflow pipe: +13.5mm

Towing of Vehicle Note

- If vehicle cannot be driven due to complete transmission failure, vehicle should preferably be transported using a flat bed trailer or transporter.

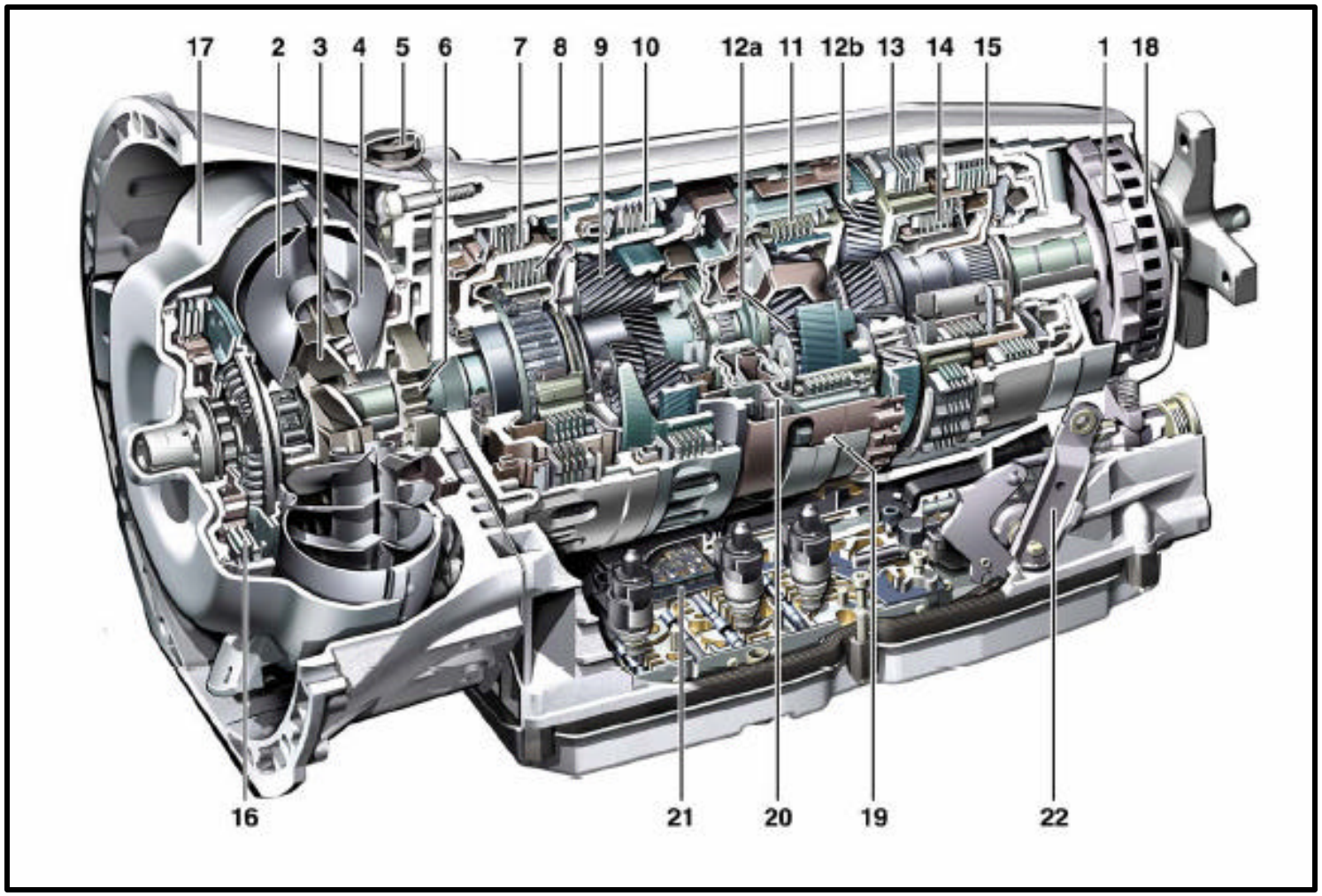
- Alternatively vehicle can be towed with drive axle lifted

- If this is not possible then vehicle can be towed (preferable with a tow bar rather than a rope) under the following conditions / limitations:

    1. Turn key to position 2
    2. Selector lever to position ‘N’
    3. Max. towing speed 31 mph
    4. Max. towing distance 31 miles

Note: If towing speed or distance is exceeded, then further transmission damage can occur.

Major Components



Major Components Legend

1. Park pawl gear
2. Turbine wheel
3. Stator
4. Impeller
5. Transmission housing ventilation
6. Oil pump
7. B1 multi-disk brake
8. K1 multi-disk clutch
9. Ravigneaux gear set
10. B3 multi-disk brake
11. K2 multi-disk clutch

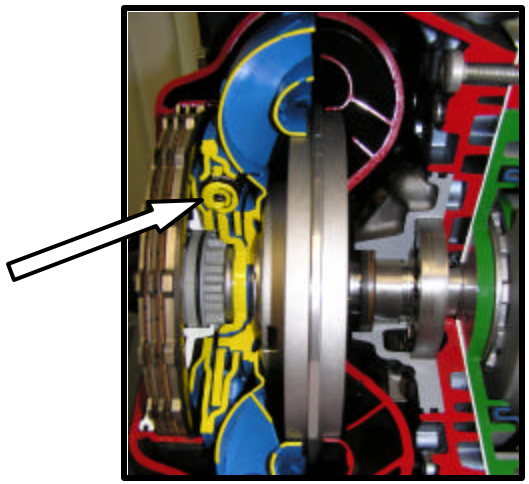
12a. Front simple planetary gear set
(Also referred to as center gear set)

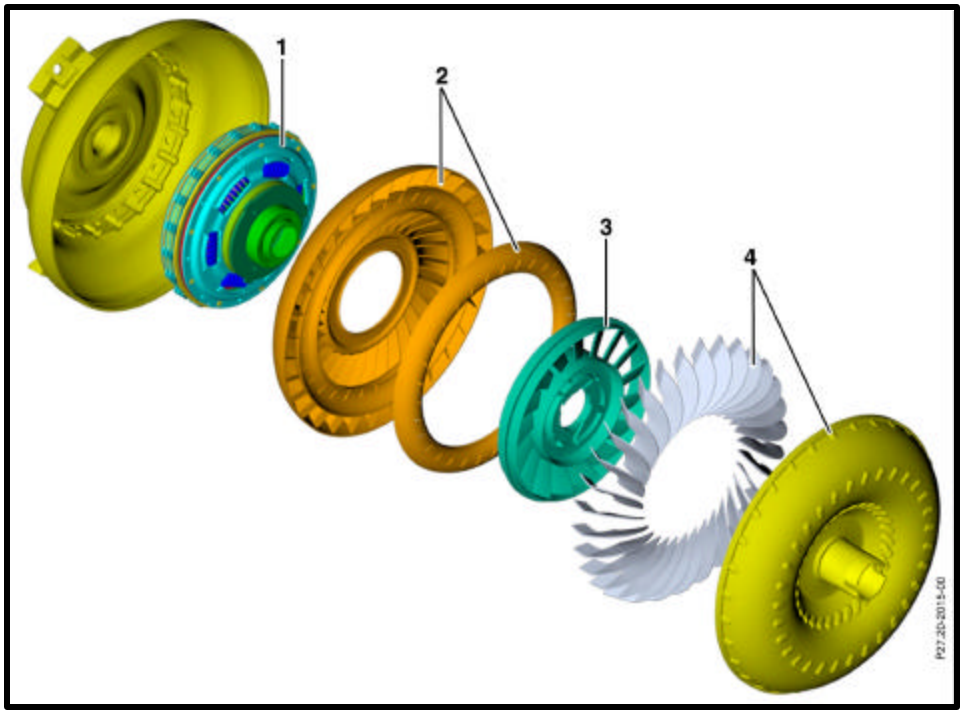
12b. Rear simple planetary gear set

13. BR multi-disk brake
14. K3 multi-disk clutch
15. B2 multi-disk brake
16. Torque converter lockup clutch
17. Torque converter housing
18. Exciter ring for speed measurement (Output speed)
19. Ring magnet for speed measurement (Internal speed)
20. Ring magnet for speed measurement (Turbine speed)
21. Electro hydraulic control unit
22. Range selector lever

Torque Converter

- Same as used in some 722.6
- Holds ~ 4 liters of fluid
- Lock-up clutch can be activated in all 7 forward gears
- Incorporates damper springs in lock-up clutch to reduce vibrations

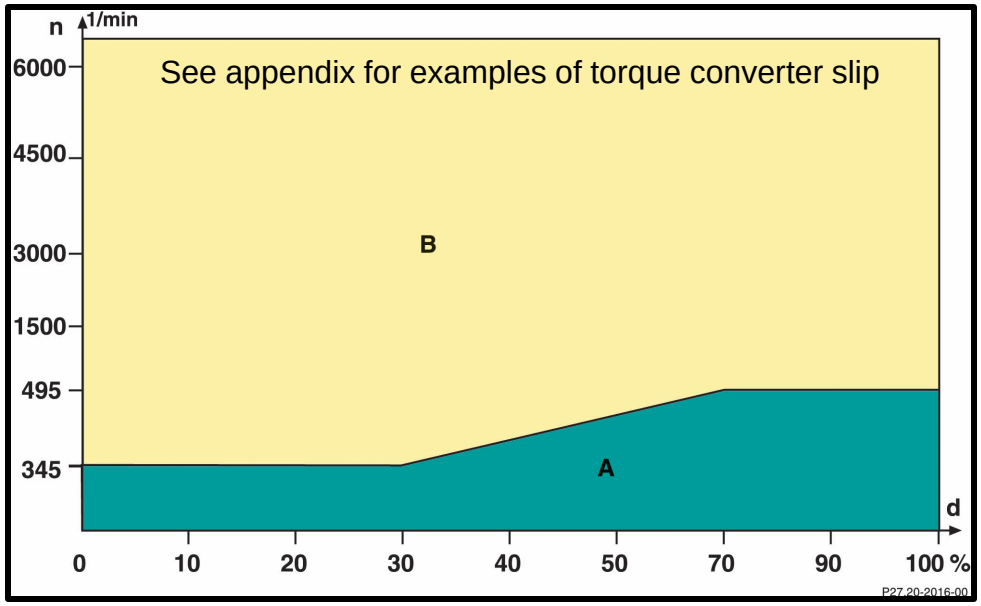




1. Lock-up clutch with torsional damper springs
2. Turbine wheel
3. Stator
4. Impeller

Torque Converter

- Lock-up torque converter is never fully locked
- Converter is open in 1st and 2nd gear if throttle and output shaft speed are in ‘zone A’
- Converter is slip-controlled in all 7 forward gears if throttle and output shaft speed are in ‘zone B’
- Oil supply pressure to converter is varied depending on the amount of slippage
  - open = high oil flow
  - slipping = reduced oil flow
- Lock-up clutch will be switched off and lower gear selected if oil temperature is too high (>140°C - DTC 2226)



A = Open
B = Slipping

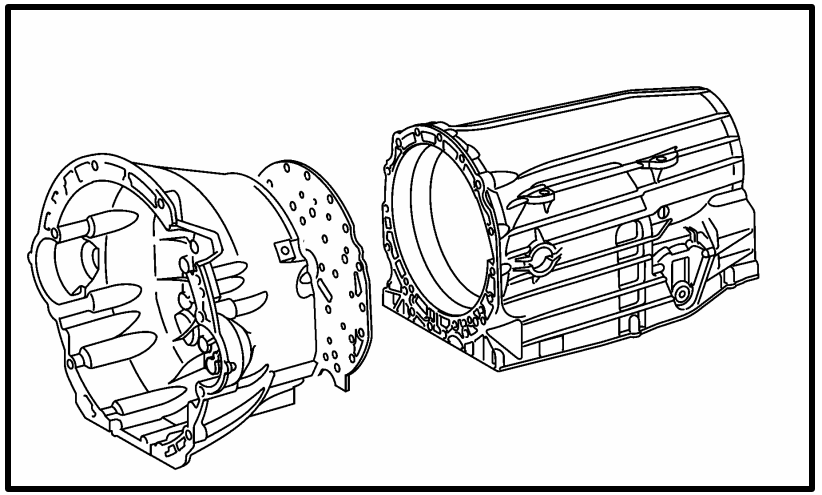
n = output shaft speed
d = throttle valve opening

Transmission Housing

- Converter housing is die-cast aluminum

- Transmission housing is die-cast magnesium
  (weight reduction of 2.5 kg compared to aluminum)

- Requires aluminum bolts due to:
  - steel bolts having a different expansion rate
  - corrosion concerns with steel bolts

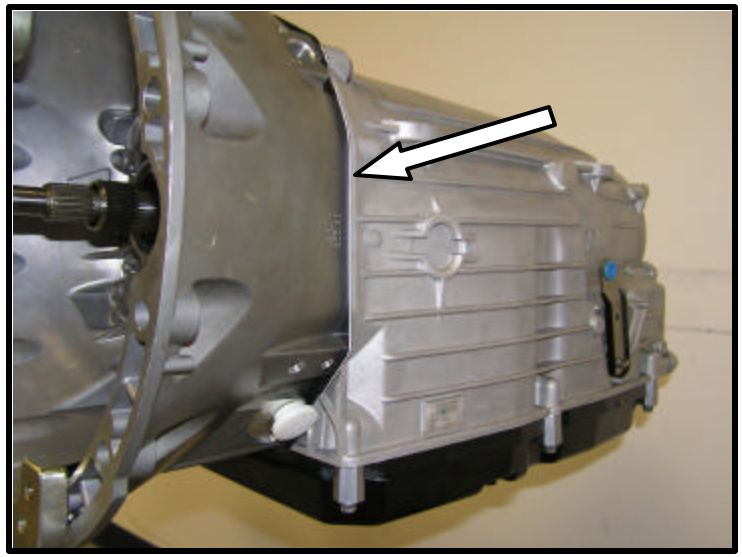


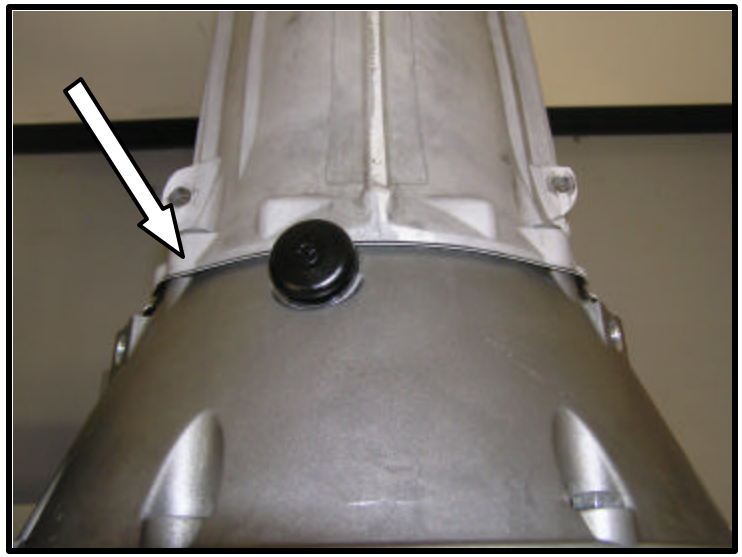
- Aluminum bolts must be replaced if removed!
  - No power tools
  - Adhere to tightening torques & angle

- Thread repair to magnesium case is permissible

Transmission Housing

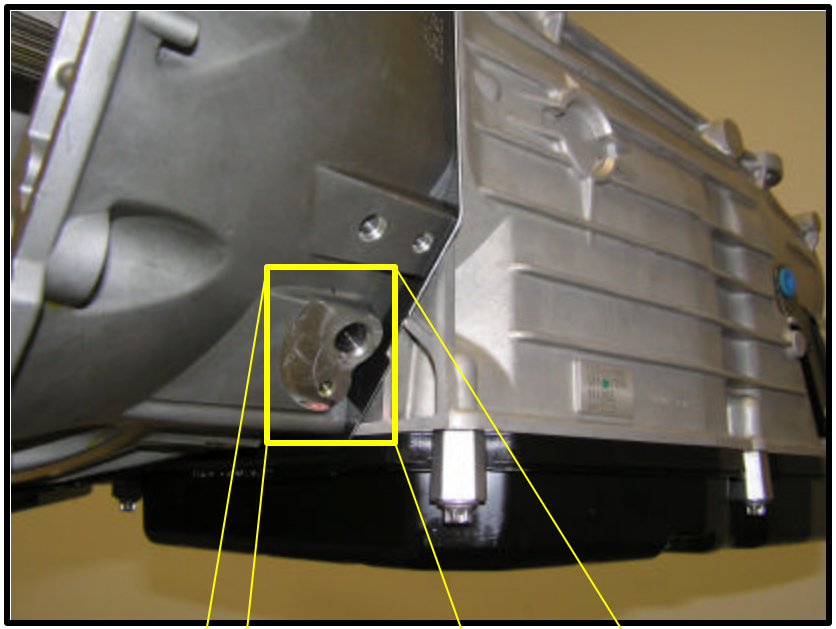
- Intermediate panel or gasket is made from an aluminum sheet coated with elastomer
- Gasket can be reused
- Gasket extends out beyond the sealing surfaces to provide a water guard / channel to direct water away from the transmission housing
- Gasket ‘lip’ faces forward
- Any standing water (especially water containing salt) will corrode magnesium housing over time
  (e.g. 8 weeks is enough time for salt water to damage housing)

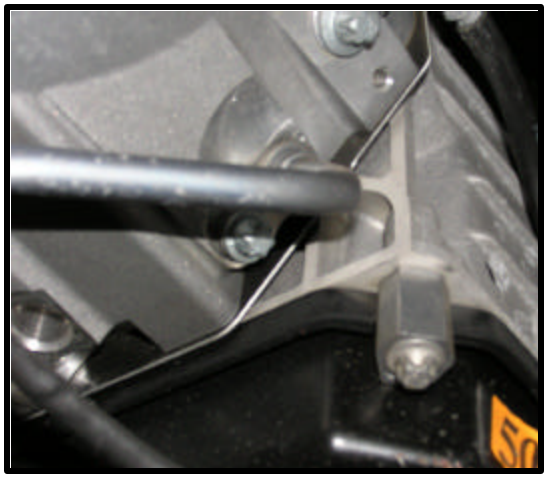


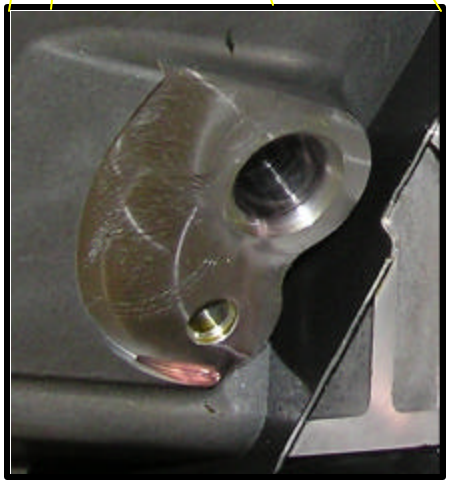


Oil Cooler Lines

- Transmission oil cooler connections do not have threads for banjo fitting
- Cooler lines are sealed with rubber ‘O’ rings
- Oil cooler lines are pushed into connection and secured with retaining bolt





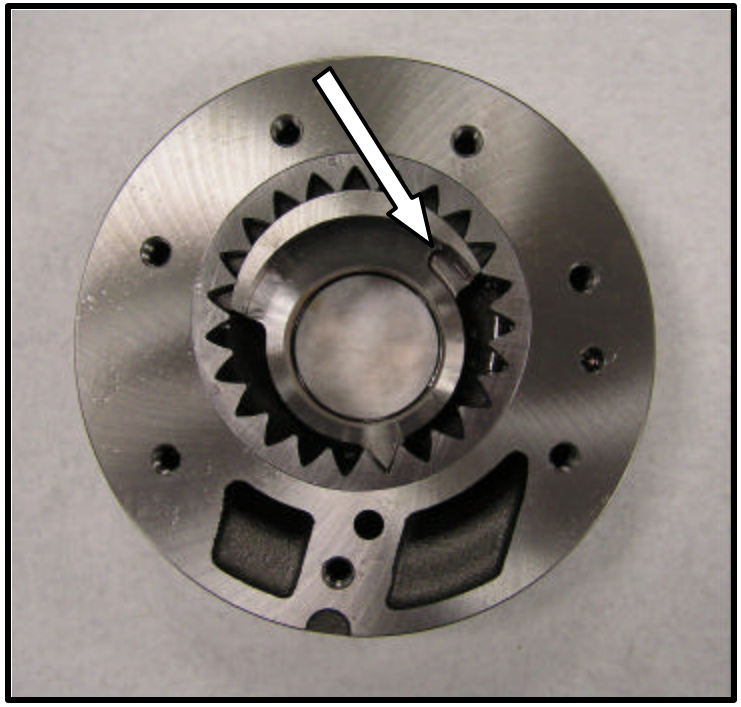


Oil Pump

- Crescent type pump
  (same design as 722.6)

- Task: Provides necessary oil supply
  for cooling, lubrication &
  hydraulic operations

- Suction side of pump has a recess
  to help reduce oil intake noise
  under certain conditions
  (expected to be phased in on 722.6
  as well)



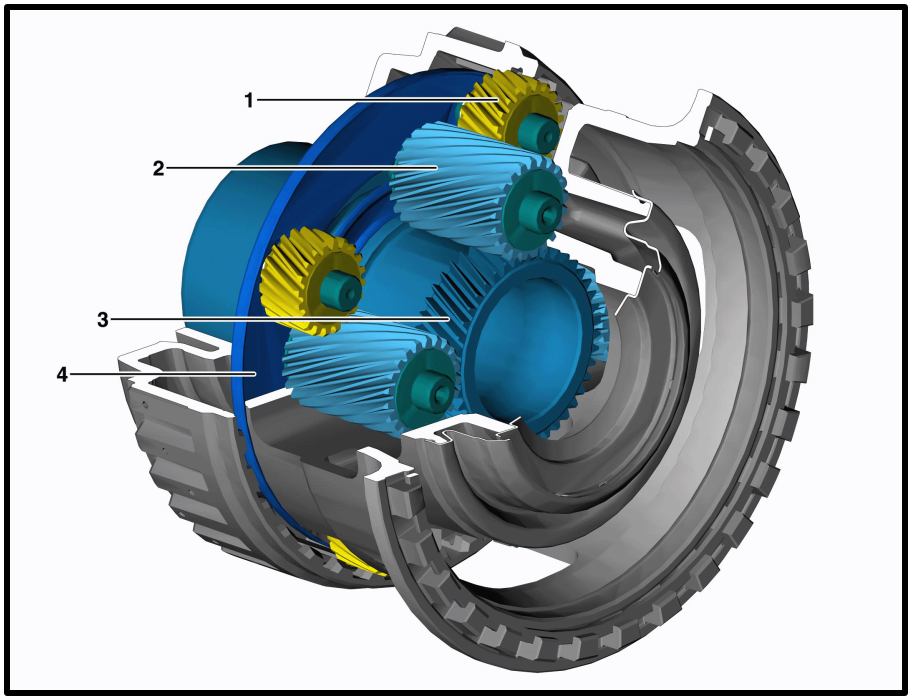
Location: Front of transmission

- In the near future the pump housing and gears may be made out of aluminum thereby cutting weight and improving the pump's performance at high temperatures

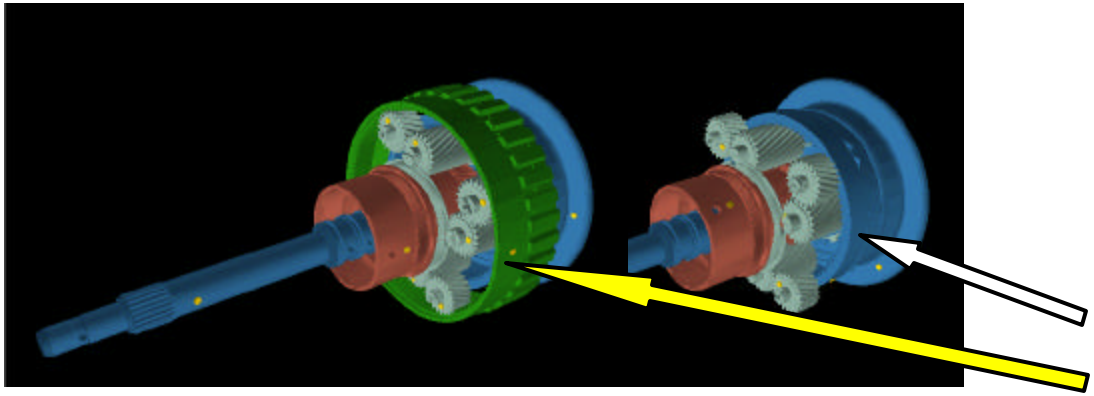
Ravigneaux Gear Set

Advantages:

- Combines 2 simple planetary gear sets into one unit
- Increases gear ratios available compared to simple planetary gear set (has 2 ring gears)
- Compact construction



1. Short planetary gear
   (running on larger ring gear)
2. Long planetary gear
   (running on smaller ring gear)
3. Sun gear
4. Planetary gear carrier

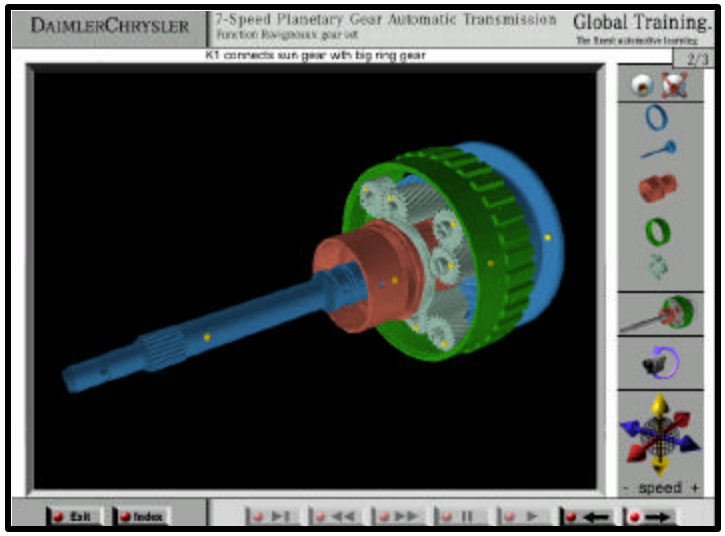


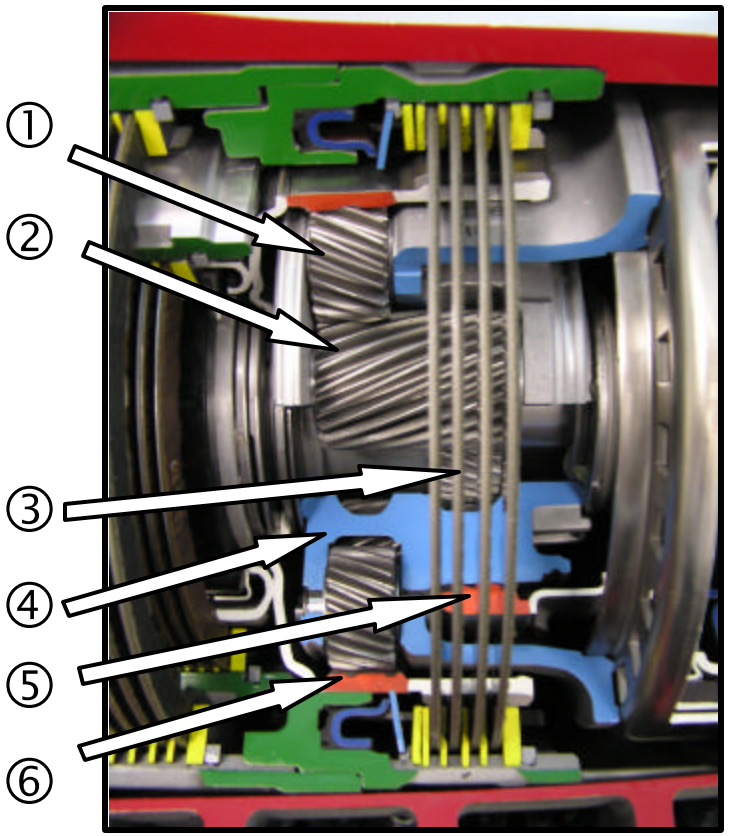
Small ring gear

Large ring gear

Ravigneaux Gear Set

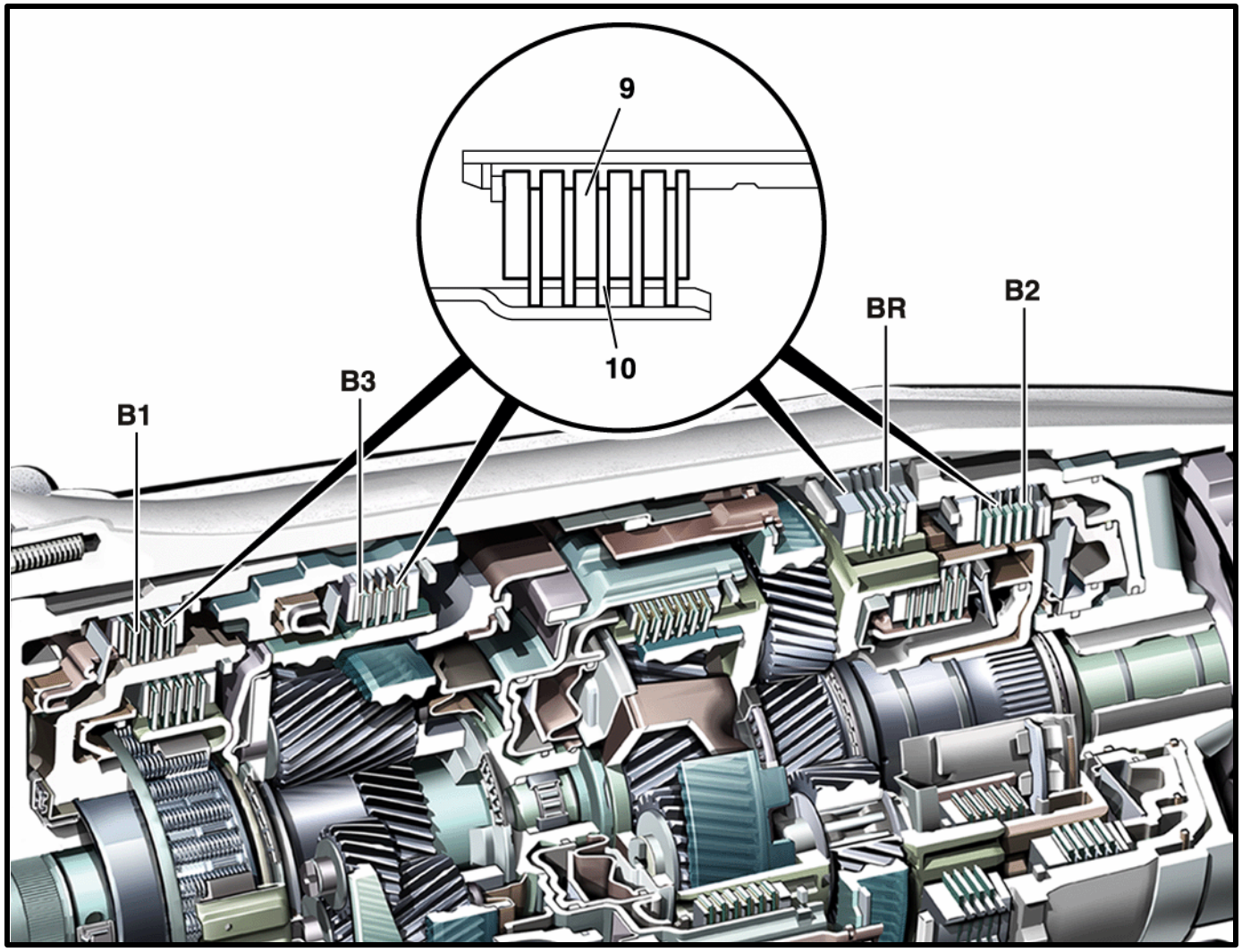
- Drive from torque converter turbine comes into gear set via small ring gear
- Long planetary gear transfers drive via sun gear or short planetary gear depending upon applied member





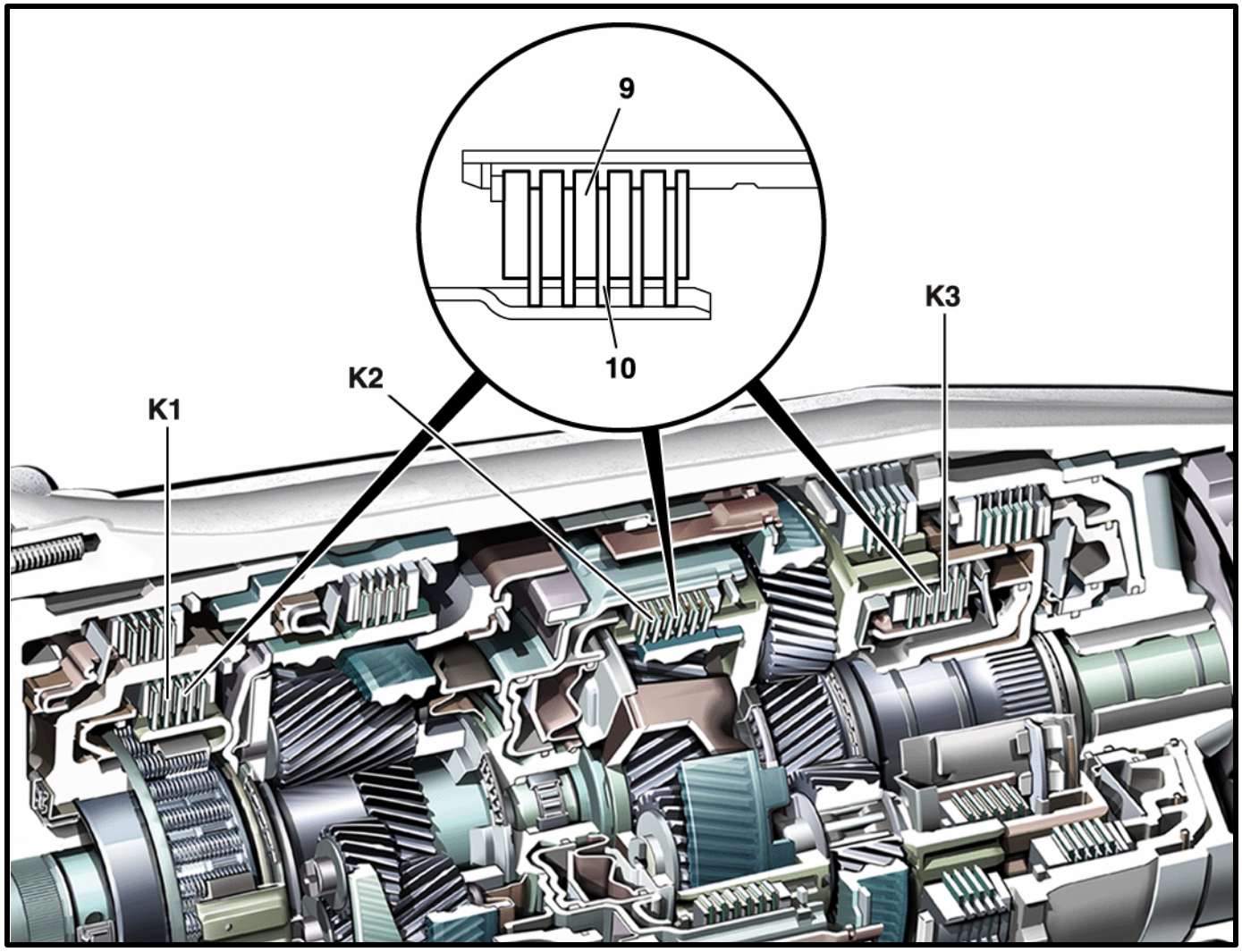
1. Short planetary gear (running on larger ring gear)
2. Long planetary gear (running on smaller ring gear)
3. Sun gear
4. Planetary gear carrier
5. Small ring gear
6. Large ring gear

Multi-disk Brakes



Note: B1 & B3 multi-disk brakes use single-sided plates

Multi-disk Clutches



Note: All multi-disk clutches use single-sided plates

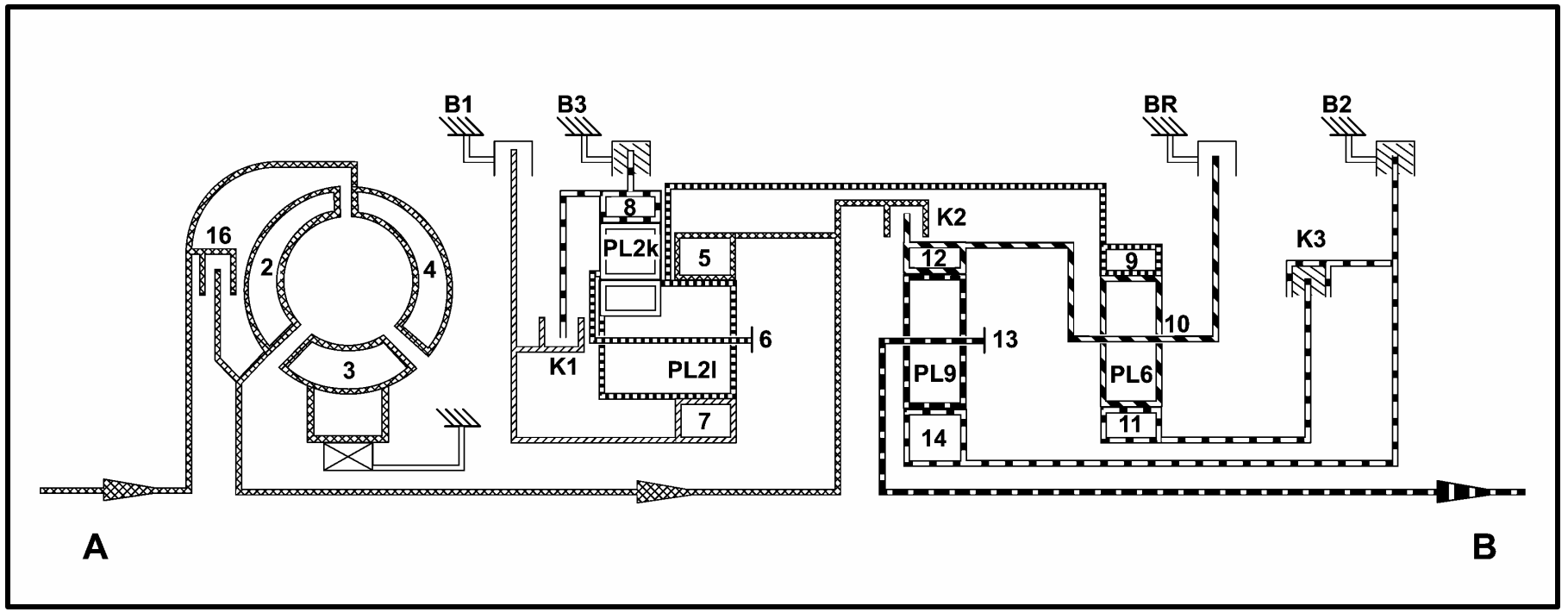
Shift Application Chart

Gear	Gear ratio W7A 700	B1	B2	B3	BR	K1	K2	K3
1	4.377		●	●				●
2	2.859	●	●					●
3	1.921		●			●		●
4	1.368		●			●	●	
5	1.000					●	●	●
6	0.820	●					●	●
7	0.728			●			●	●
N (1)				●				●
R (1)	-3.416			●	●			●
R (2)	-2.231	●			●			●

(1) = S mode (2) = C mode

- 2 shift members are already applied when transmission is in ‘N’, only one shift member needs to be applied when a drive gear is selected.
- A gear change is performed by applying a shift member while disengaging another shift member.

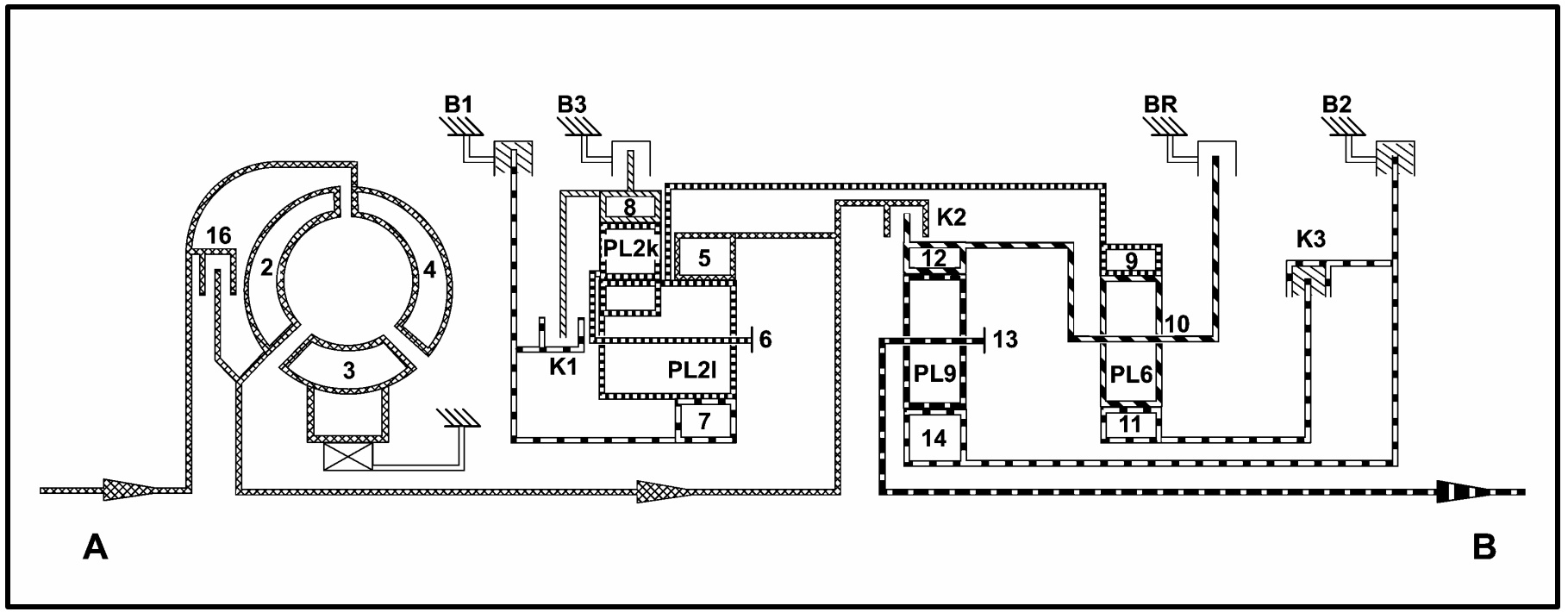
Power Flow 1st Gear



2 Turbine wheel
3 Stator
4 Impeller
5 Small internal-geared wheel
6 Dual planet carrier
7 Sun gear
8 Large internal-geared wheel
9 Internal-geared wheel
10 Planet carrier
11 Sun gear *12 Internal-geared wheel*
13 Planet carrier
14 Sun gear
16 Torque converter lockup clutch

A Input
B Output
BR Multi-disk brake BR
B1 Multiple-disc brake B1
B2 Multiple-disc brake B2
B3 Multiple-disk brake B3
K1 Multi-disk clutch K1
K2 Multi-disk clutch K2
K3 Multi-disk clutch K3
PL2k Short planet gears
PL2l Long planet gears
PL6 Planet gears
PL9 Planet gears

Power Flow 2nd Gear



2 Turbine wheel
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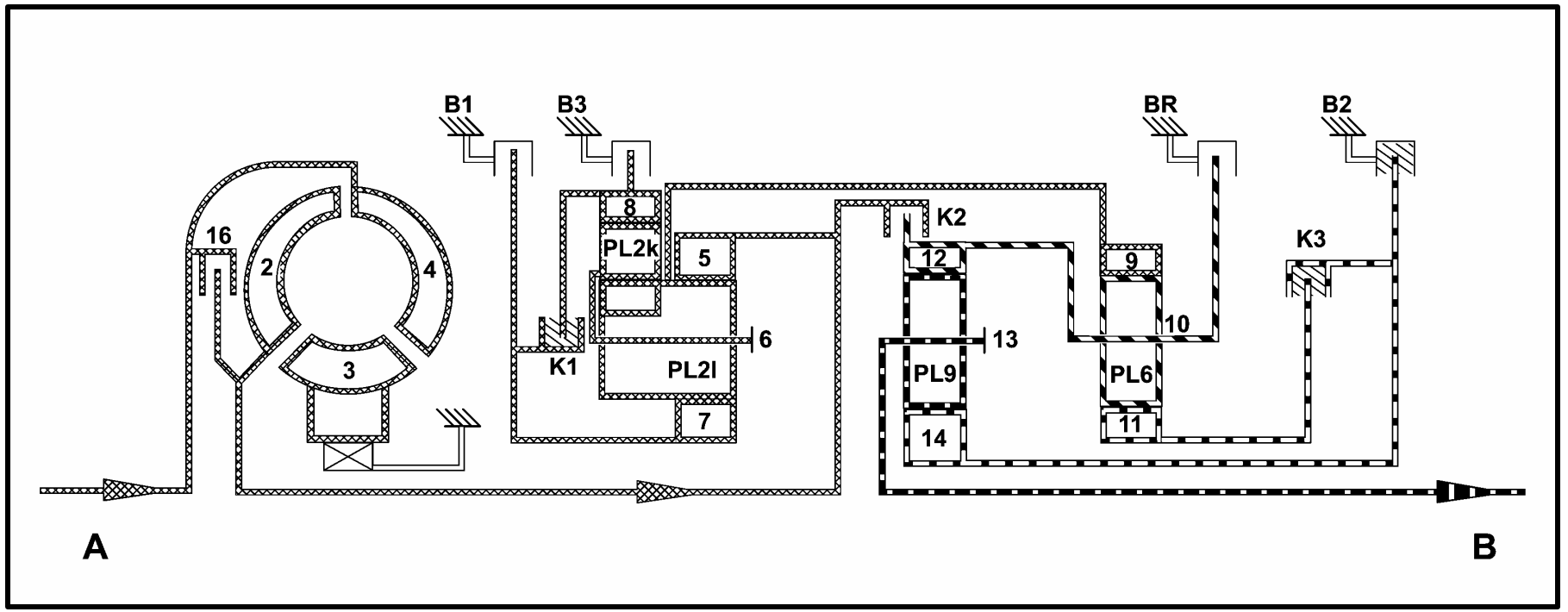
4 Impeller
5 Small internal-geared wheel
6 Dual planet carrier
7 Sun gear
8 Large internal-geared wheel
9 Internal-geared wheel
10 Planet carrier
11 Sun gear *12 Internal-geared wheel*
13 Planet carrier
14 Sun gear
16 Torque converter lockup clutch

A Input
B Output
BR Multi-disk brake BR
B1 Multiple-disc brake B1
B2 Multiple-disc brake B2
B3 Multiple-disk brake B3
K1 Multi-disk clutch K1
K2 Multi-disk clutch K2
K3 Multi-disk clutch K3
PL2k Short planet gears
PL2l Long planet gears
PL6 Planet gears
PL9 Planet gears

Power Flow 3rd Gear

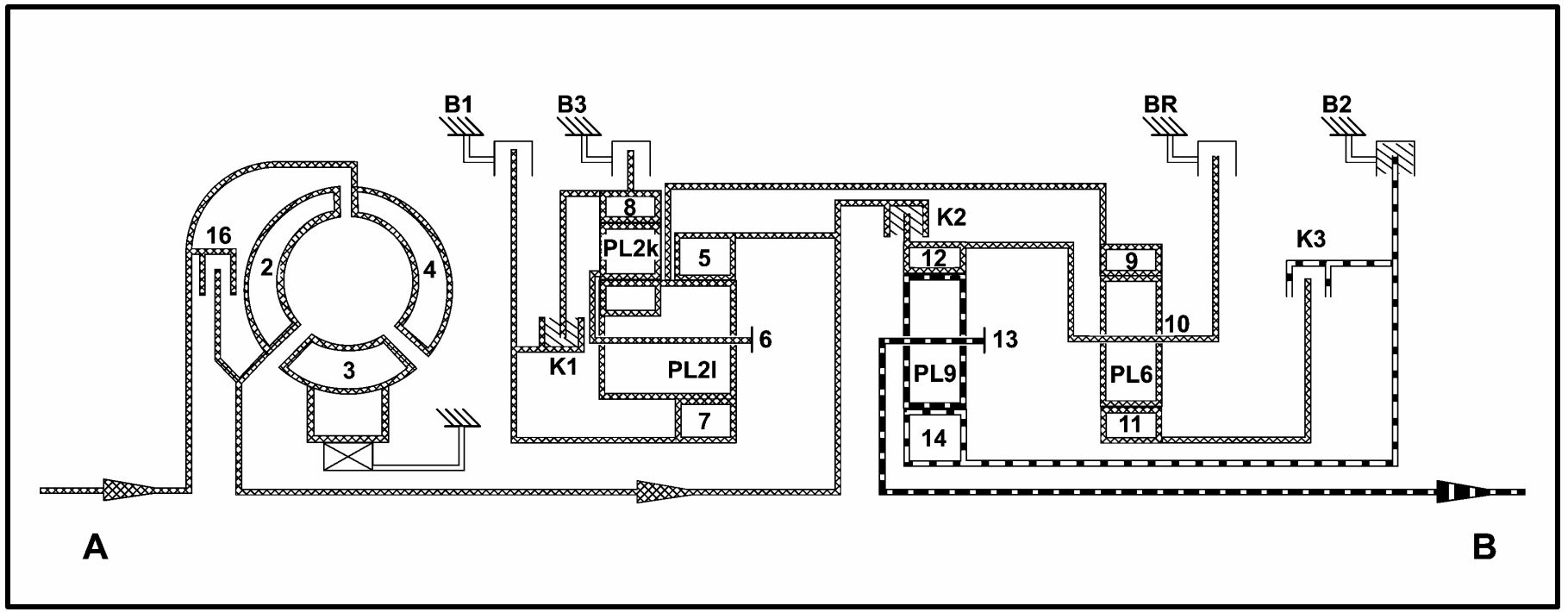


2 Turbine wheel
3 Stator
4 Impeller
5 Small internal-geared wheel
6 Dual planet carrier
7 Sun gear
8 Large internal-geared wheel
9 Internal-geared wheel
10 Planet carrier
11 Sun gear *12 Internal-geared wheel*
13 Planet carrier
14 Sun gear
16 Torque converter lockup clutch

A Input
B Output
BR Multi-disk brake BR
B1 Multiple-disc brake B1
B2 Multiple-disc brake B2
B3 Multiple-disk brake B3
K1 Multi-disk clutch K1
K2 Multi-disk clutch K2
K3 Multi-disk clutch K3
PL2k Short planet gears
PL2l Long planet gears
PL6 Planet gears
PL9 Planet gears

Note:
In 3rd gear the Ravigneaux gear set is locked as one. If a gear noise is being diagnosed and it goes away when in 3rd gear, then check front gear set.

Power Flow 4th Gear

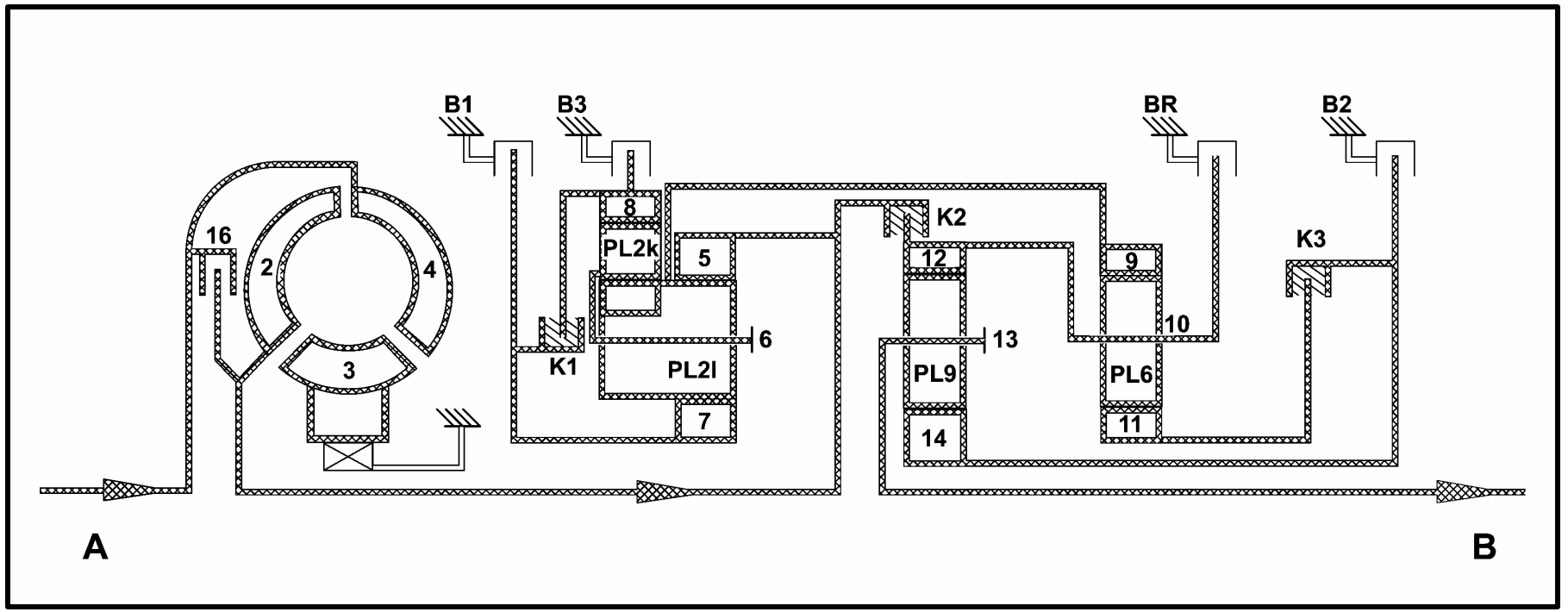


2 Turbine wheel
3 Stator
4 Impeller
5 Small internal-geared wheel
6 Dual planet carrier
7 Sun gear
8 Large internal-geared wheel
9 Internal-geared wheel
10 Planet carrier
11 Sun gear *12 Internal-geared wheel*
13 Planet carrier
14 Sun gear
16 Torque converter lockup clutch

A Input
B Output
BR Multi-disk brake BR
B1 Multiple-disc brake B1
B2 Multiple-disc brake B2
B3 Multiple-disk brake B3
K1 Multi-disk clutch K1
K2 Multi-disk clutch K2
K3 Multi-disk clutch K3
PL2k Short planet gears
PL2l Long planet gears
PL6 Planet gears
PL9 Planet gears

Note:
In 4th gear the Ravigneaux and rear gear sets are locked as one. If a gear noise is being diagnosed and it only goes away when in 4th gear, then check rear gear set.

Power Flow 5th Gear

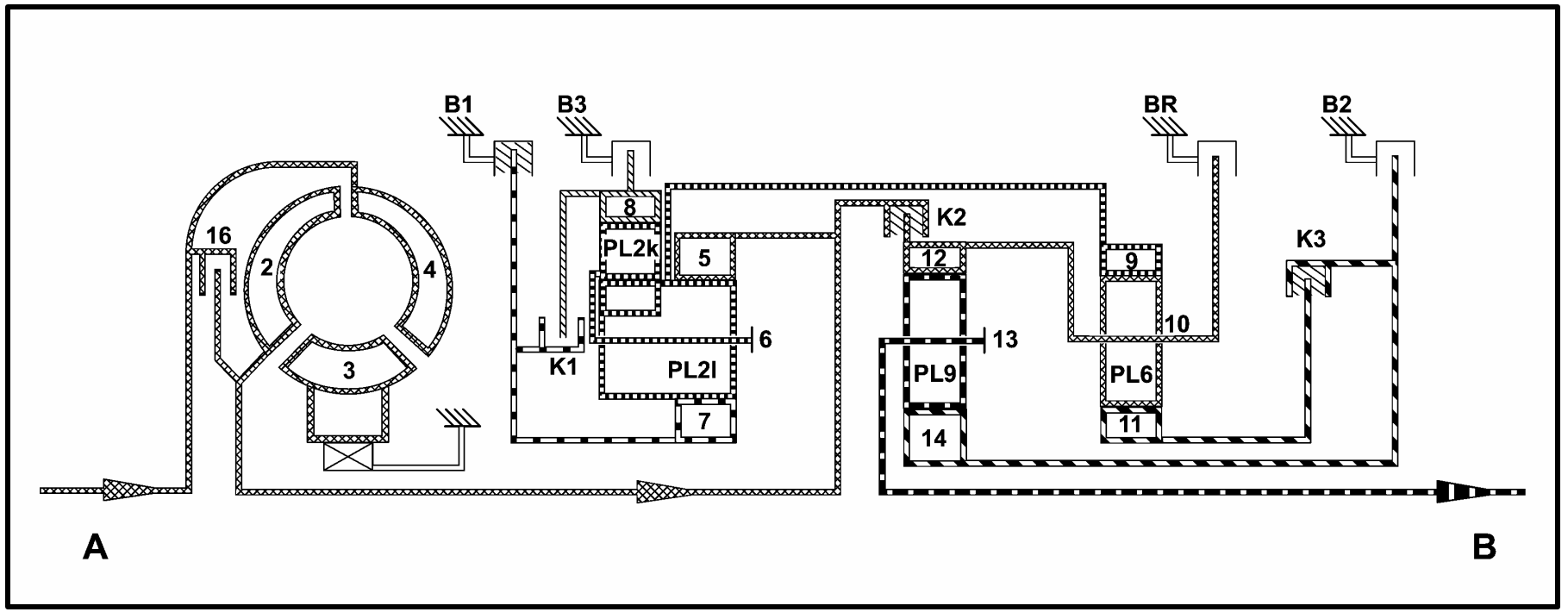


2 Turbine wheel
3 Stator
4 Impeller
5 Small internal-geared wheel
6 Dual planet carrier
7 Sun gear
8 Large internal-geared wheel
9 Internal-geared wheel
10 Planet carrier
11 Sun gear
12 Internal-geared wheel
13 Planet carrier
14 Sun gear
16 Torque converter lockup clutch

A Input
B Output
BR Multi-disk brake BR
B1 Multiple-disc brake B1
B2 Multiple-disc brake B2
B3 Multiple-disk brake B3
K1 Multi-disk clutch K1
K2 Multi-disk clutch K2
K3 Multi-disk clutch K3
PL2k Short planet gears
PL2l Long planet gears
PL6 Planet gears
PL9 Planet gears

Note:
In 5rd gear, all gear sets are locked as one. If a gear noise is being diagnosed and it only goes away when in 5th gear, then check center gear set.

Power Flow 6th Gear



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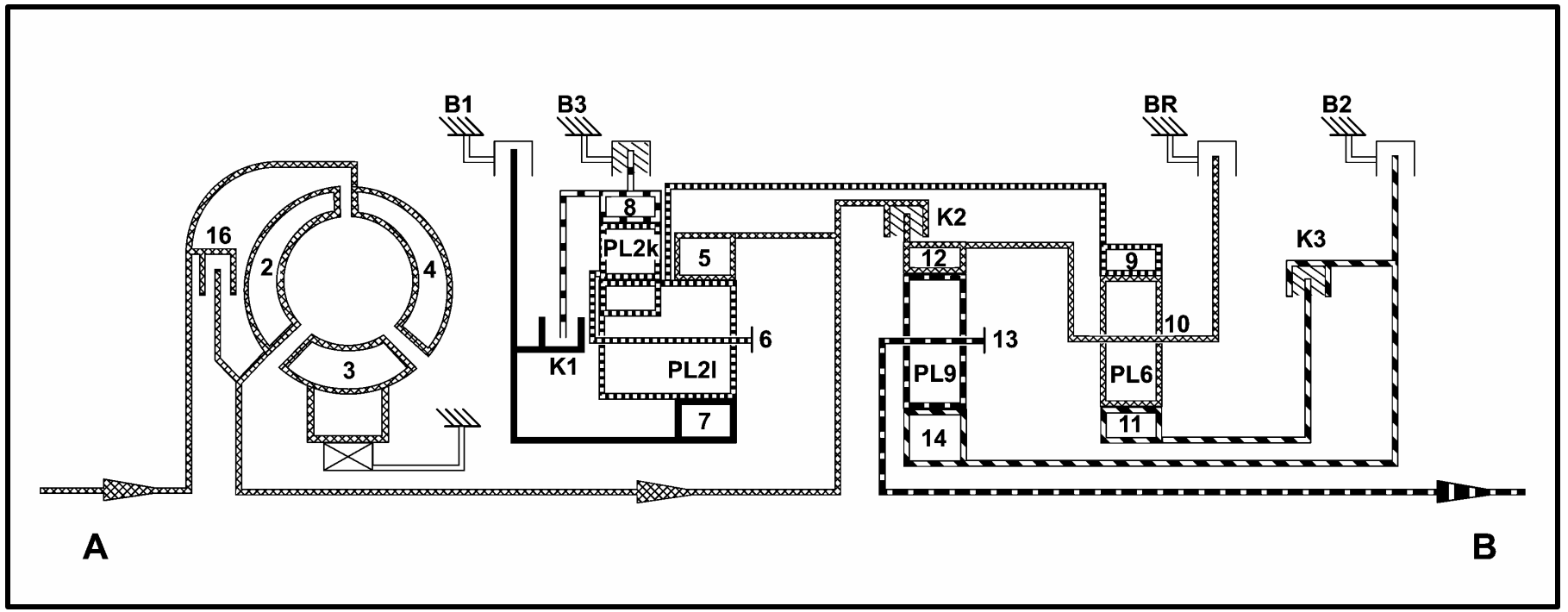
7 Sun gear
8 Large internal-geared wheel
9 Internal-geared wheel
10 Planet carrier
11 Sun gear *12 Internal-geared wheel*
13 Planet carrier
14 Sun gear
16 Torque converter lockup clutch

A Input
B Output
BR Multi-disk brake BR
B1 Multiple-disc brake B1
B2 Multiple-disc brake B2
B3 Multiple-disk brake B3
K1 Multi-disk clutch K1
K2 Multi-disk clutch K2
K3 Multi-disk clutch K3
PL2k Short planet gears
PL2l Long planet gears
PL6 Planet gears
PL9 Planet gears

Power Flow 7th Gear



2 Turbine wheel
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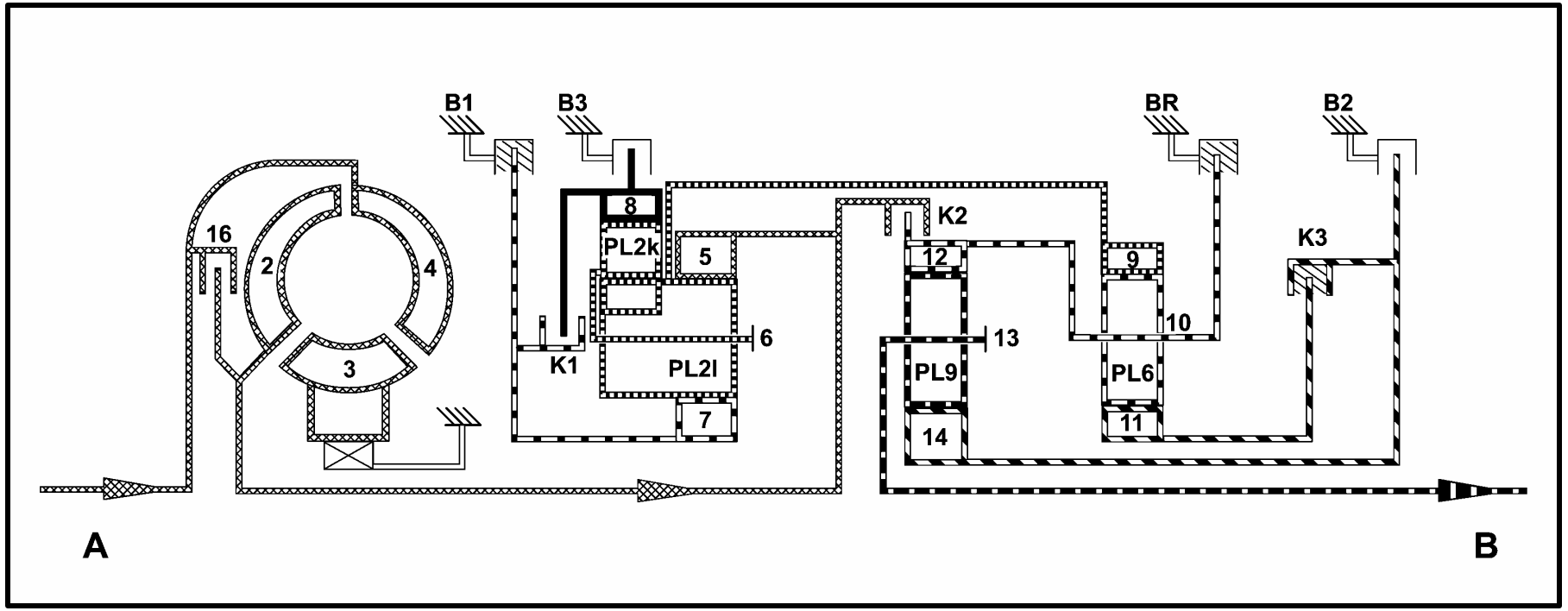
4 Impeller
5 Small internal-geared wheel
6 Dual planet carrier
7 Sun gear
8 Large internal-geared wheel
9 Internal-geared wheel
10 Planet carrier
11 Sun gear *12 Internal-geared wheel*
13 Planet carrier
14 Sun gear
16 Torque converter lockup clutch

A Input
B Output
BR Multi-disk brake BR
B1 Multiple-disc brake B1
B2 Multiple-disc brake B2
B3 Multiple-disk brake B3
K1 Multi-disk clutch K1
K2 Multi-disk clutch K2
K3 Multi-disk clutch K3
PL2k Short planet gears
PL2l Long planet gears
PL6 Planet gears
PL9 Planet gears

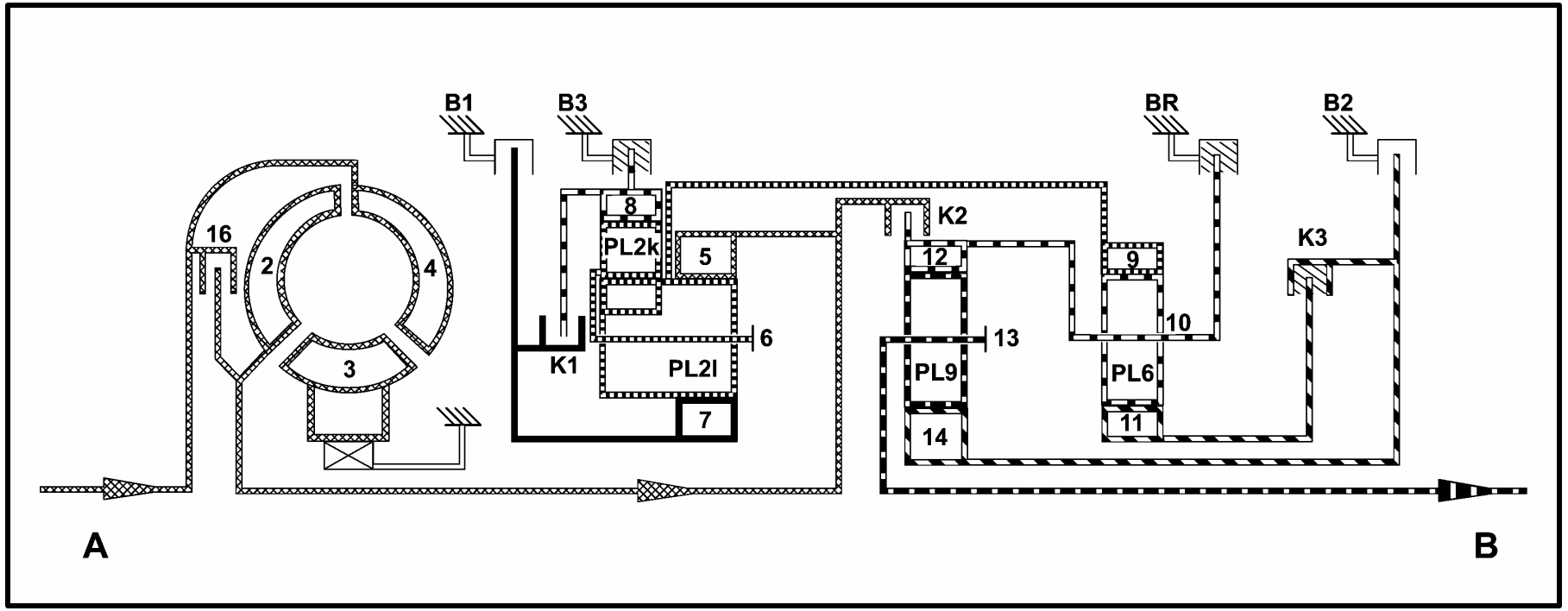
Power Flow Reverse Gear in ‘S’ Mode



2 Turbine wheel
3 Stator
4 Impeller
5 Small internal-geared wheel
6 Dual planet carrier
7 Sun gear
8 Large internal-geared wheel
9 Internal-geared wheel
10 Planet carrier
11 Sun gear *12 Internal-geared wheel*
13 Planet carrier
14 Sun gear
16 Torque converter lockup clutch

A Input
B Output
BR Multi-disk brake BR
B1 Multiple-disc brake B1
B2 Multiple-disc brake B2
B3 Multiple-disk brake B3
K1 Multi-disk clutch K1
K2 Multi-disk clutch K2
K3 Multi-disk clutch K3
PL2k Short planet gears
PL2l Long planet gears
PL6 Planet gears
PL9 Planet gears

Power Flow Reverse Gear in ‘C’ Mode



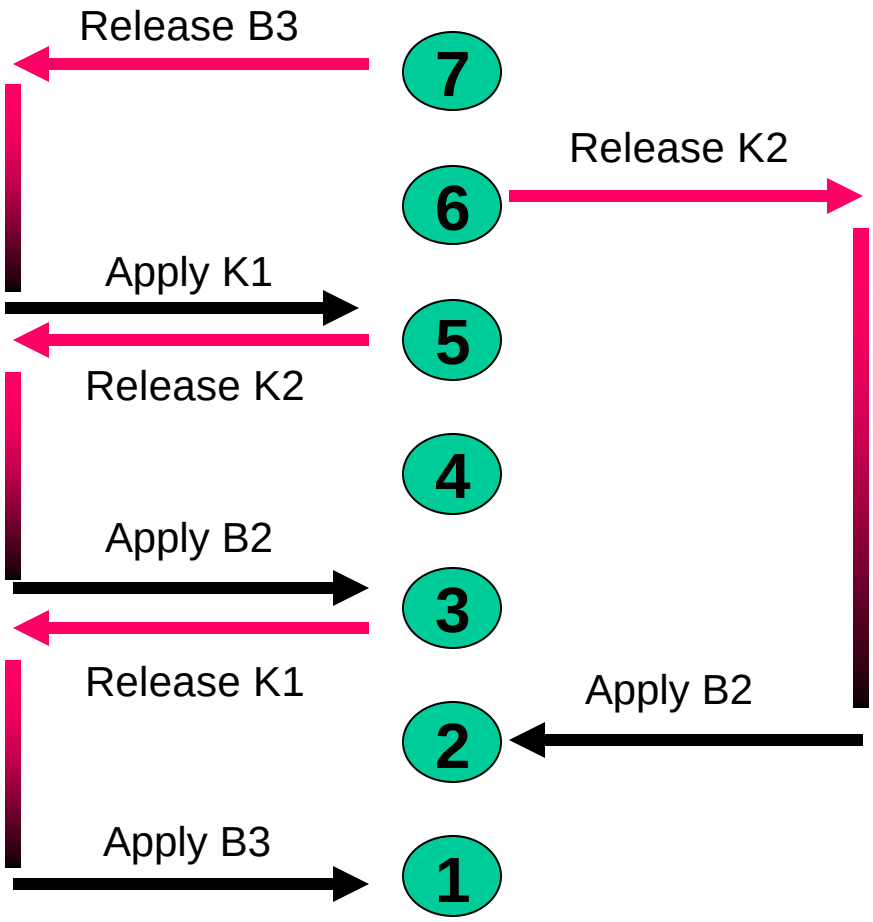
2 Turbine wheel
3 Stator
4 Impeller
5 Small internal-geared wheel
6 Dual planet carrier
7 Sun gear
8 Large internal-geared wheel
9 Internal-geared wheel
10 Planet carrier
11 Sun gear *12 Internal-geared wheel*
13 Planet carrier
14 Sun gear
16 Torque converter lockup clutch

A Input
B Output
BR Multi-disk brake BR
B1 Multiple-disc brake B1
B2 Multiple-disc brake B2
B3 Multiple-disk brake B3
K1 Multi-disk clutch K1
K2 Multi-disk clutch K2
K3 Multi-disk clutch K3
PL2k Short planet gears
PL2l Long planet gears
PL6 Planet gears
PL9 Planet gears

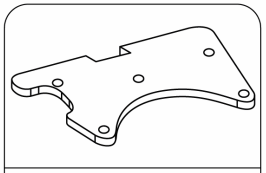
Shift Sequences

In addition to sequentially shifting through gears, the 722.9 can downshift skipping gears, providing that only one member is released and one member is applied.

	B1	B2	B3	K1	K2	K3
7th Gear			■		■	■
6th Gear	■				■	■
5th Gear				■	■	■
4th Gear		■		■	■	
3rd Gear		■		■		■
2nd Gear	■	■				■
1st Gear		■	■			■



Special Tools



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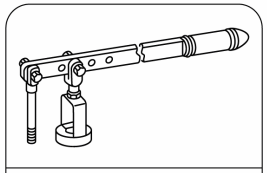

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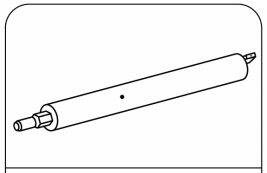

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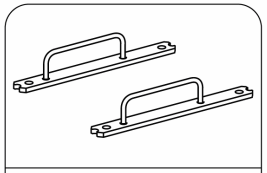

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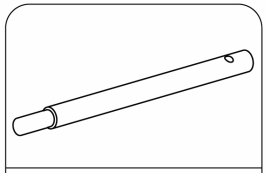

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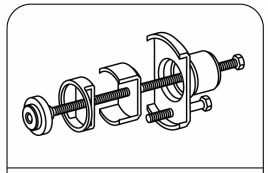

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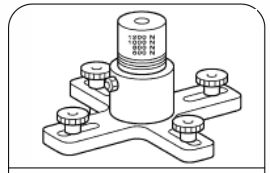

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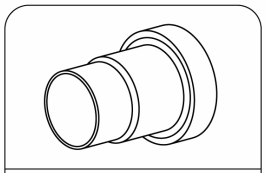

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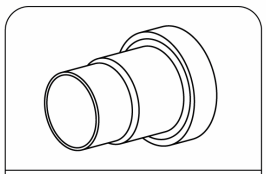

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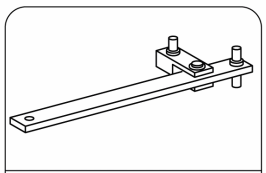

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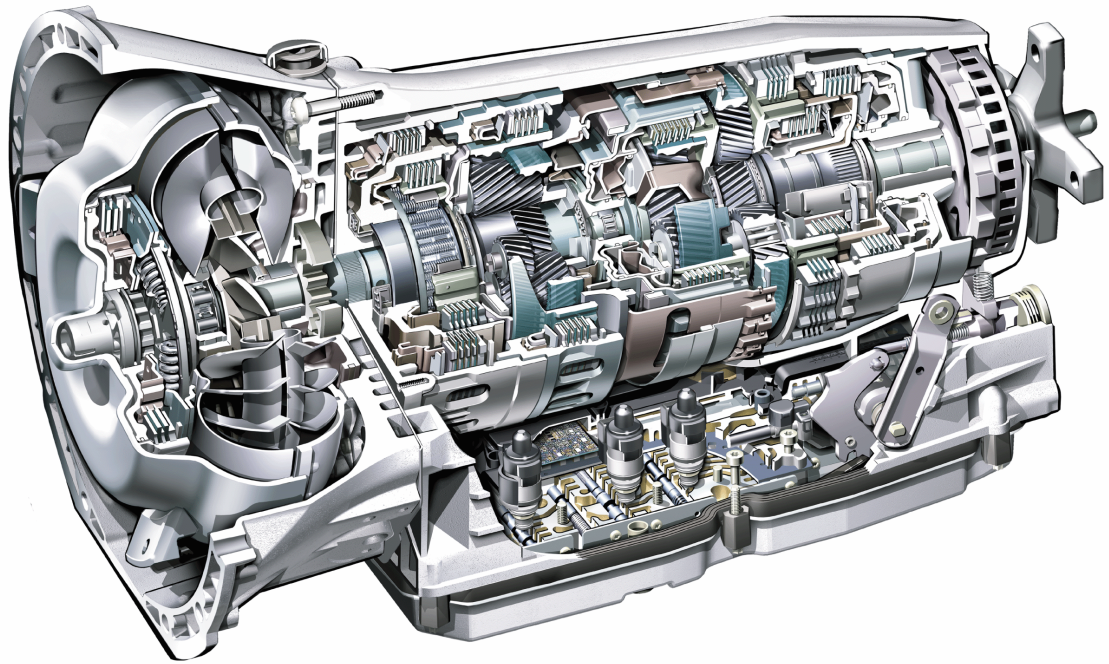

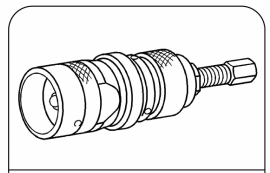

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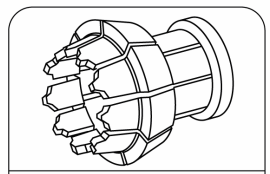

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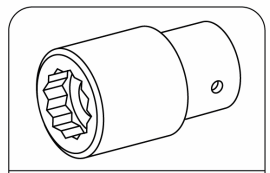

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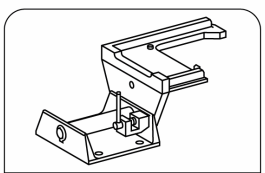

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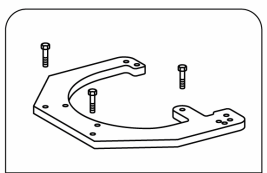

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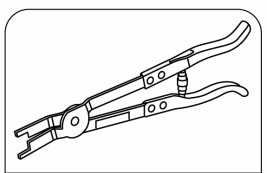

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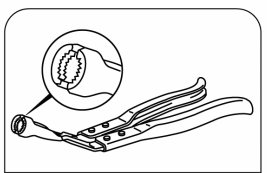

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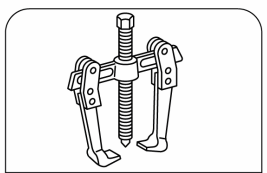

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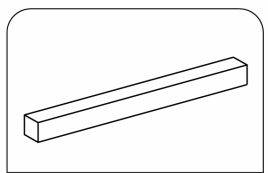

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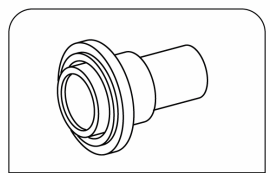

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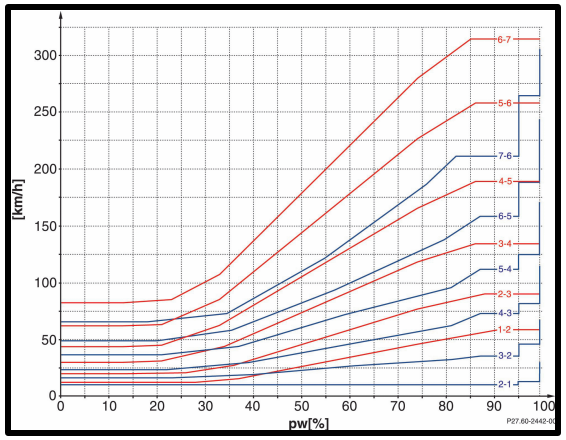
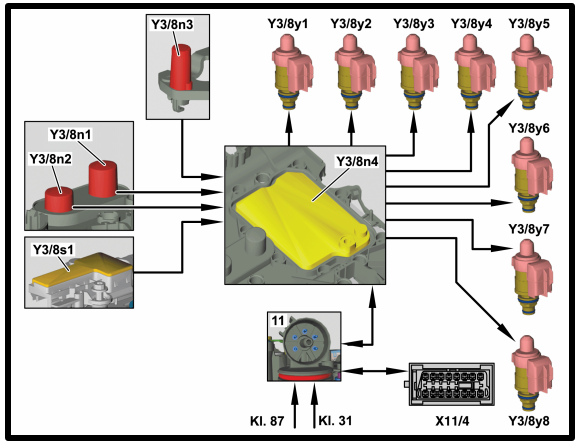
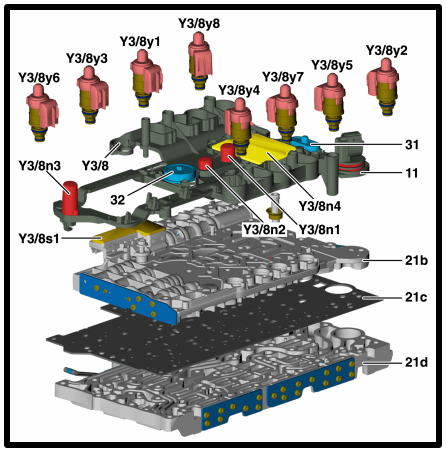
Electrohydraulics

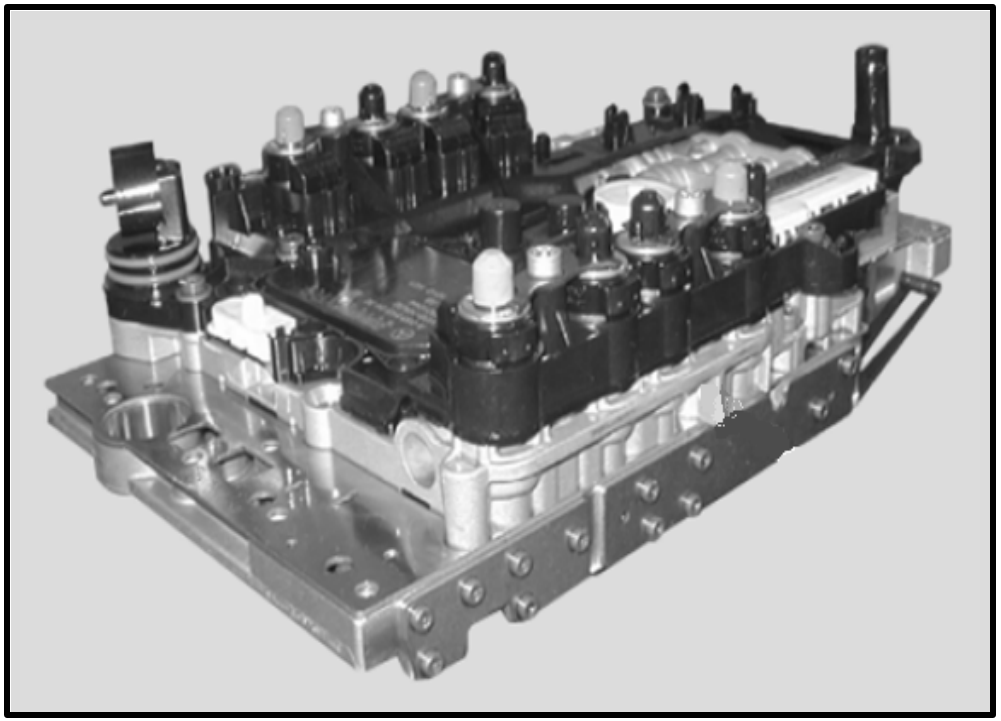






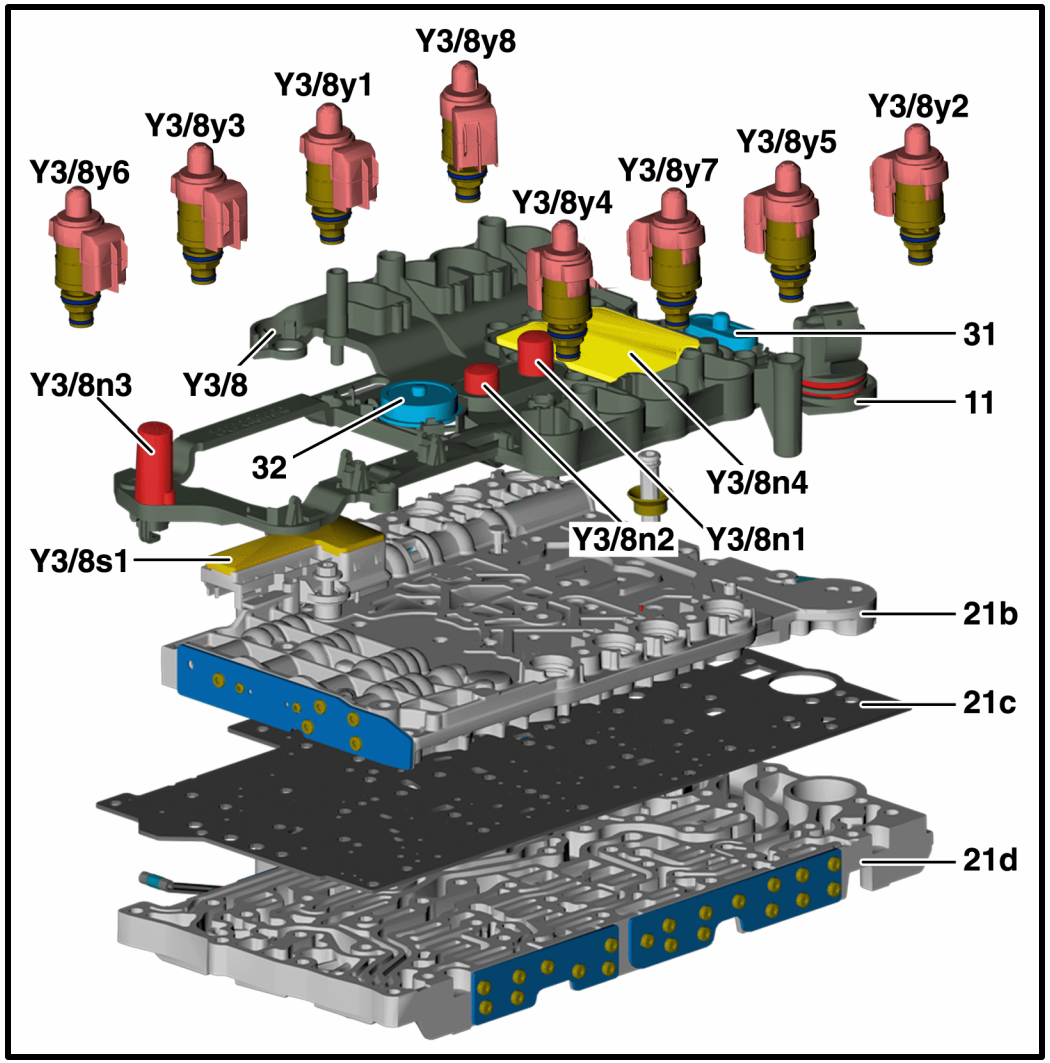
Electrohydraulic Control Module

- Basic principle of controlling hydraulics with electronics, as 722.6
- Transmission control module will adapt shift for optimal quality
- Valve body contains traditional valves, restrictors, selector valve, etc …
- Mounted onto valve body are electrical components that control, monitor and enable the gear shifts
- Assembly comes as one unit
- **Do not** remove or replace any components of this assembly – only replace as a complete unit



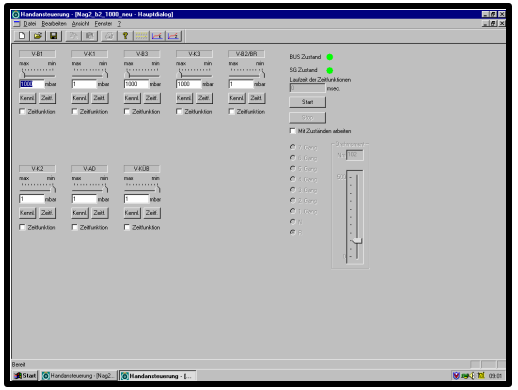
Electrohydraulic Control Module

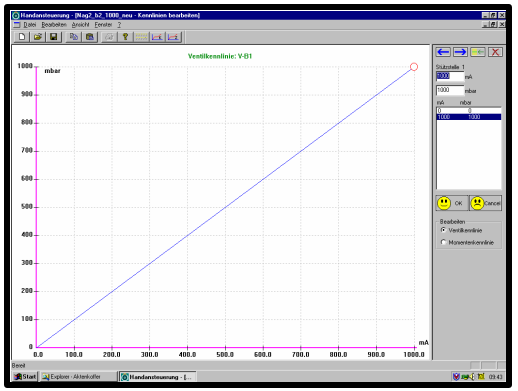
11	Plug connection
21b	Valve body upper
21c	Intermediate panel
21d	Valve body lower / Shift housing
31	Oil control float 1
32	Oil control float 2
Y3/8	Electric control module
Y3/8n1	Turbine rpm sensor
Y3/8n2	Internal rpm sensor
Y3/8n3	Output rpm sensor
Y3/8n4	Transmission control module
Y3/8s1	Selection range sensor
Y3/8y1	Working pressure control solenoid valve
Y3/8y2	K1 clutch control solenoid valve
Y3/8y3	K2 clutch control solenoid valve
Y3/8y4	K3 clutch control solenoid valve
Y3/8y5	B1 brake control solenoid valve
Y3/8y6	B2 brake control solenoid valve
Y3/8y7	B3 brake control solenoid valve
Y3/8y8	Torque converter lockup clutch control solenoid valve

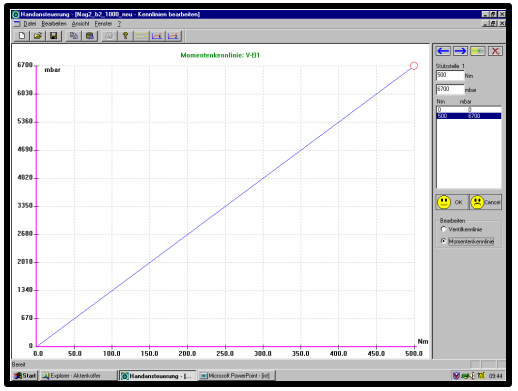


Electrohydraulic Control Module

- Each valve body assembly is individually tested
- Hydraulic pressures and electrical currents are measured by sensors on a computerized test rig
- Test values are evaluated and corresponding algorithms are written to control module's permanent memory
- This process ensures that the control module is calibrated to mechanical and electrical solenoid valves of that valve body
- Once this process is complete, valve body assembly is installed in a transmission

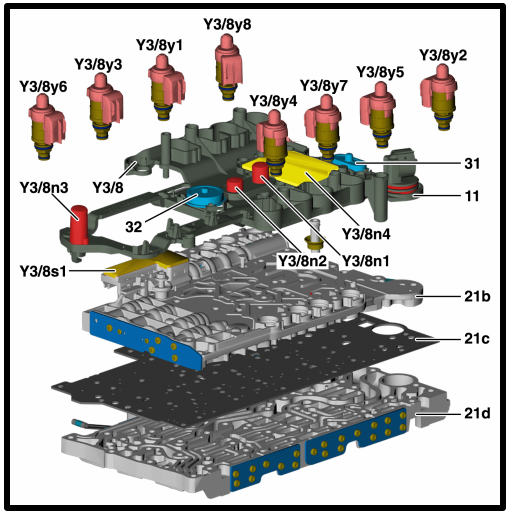


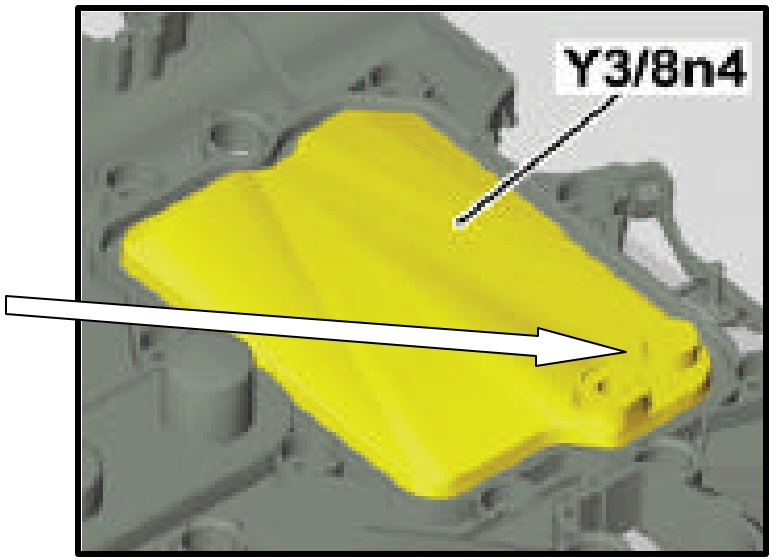




Electric Control Module

- Task:
  - Evaluate various input signals
  - Calculate shift points according to programming
  - Evaluate gear shifts & attempt to adapt
  - Activate eight control solenoid valves





- Mounted directly on valve body
- Incorporates fluid temperature sensor
- Cooled by transmission fluid
- Software can be updated using SDS / DAS (flashable)

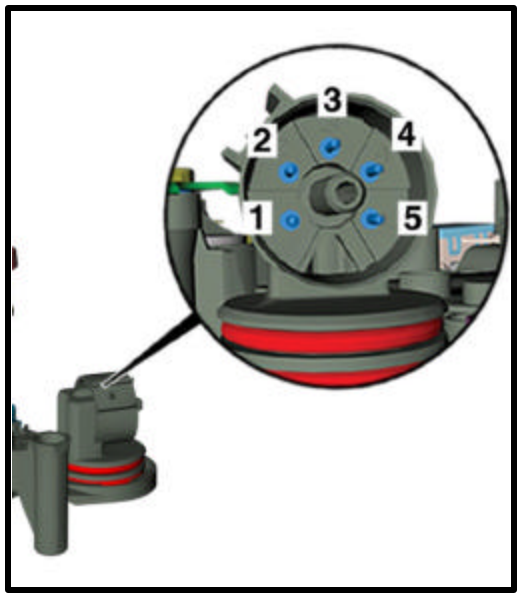
Electric Control Module

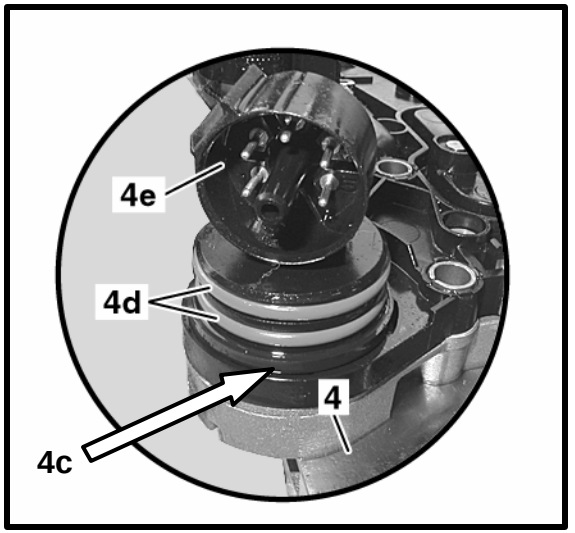
- As the control module is integrated into the valve body, wiring to the transmission has been greatly reduced.

- Electrical plug connector only has 5 pins:
  - 1 = CAN C High
  - 2 = CAN C Low
  - 3 = to Diagnostic X11/4 according to wiring diagram (no known function yet)
  - 4 = circuit 87 (relay & fuse depending on model)
  - 5 = circuit 31

Note: SDS communicates to CGW over CAN D, then to electric control module via CAN C

- Plug connector (4e) is sealed by:
  - 2 round ‘O’ rings (4d) and
  - 1 square ‘O’ ring (4c)





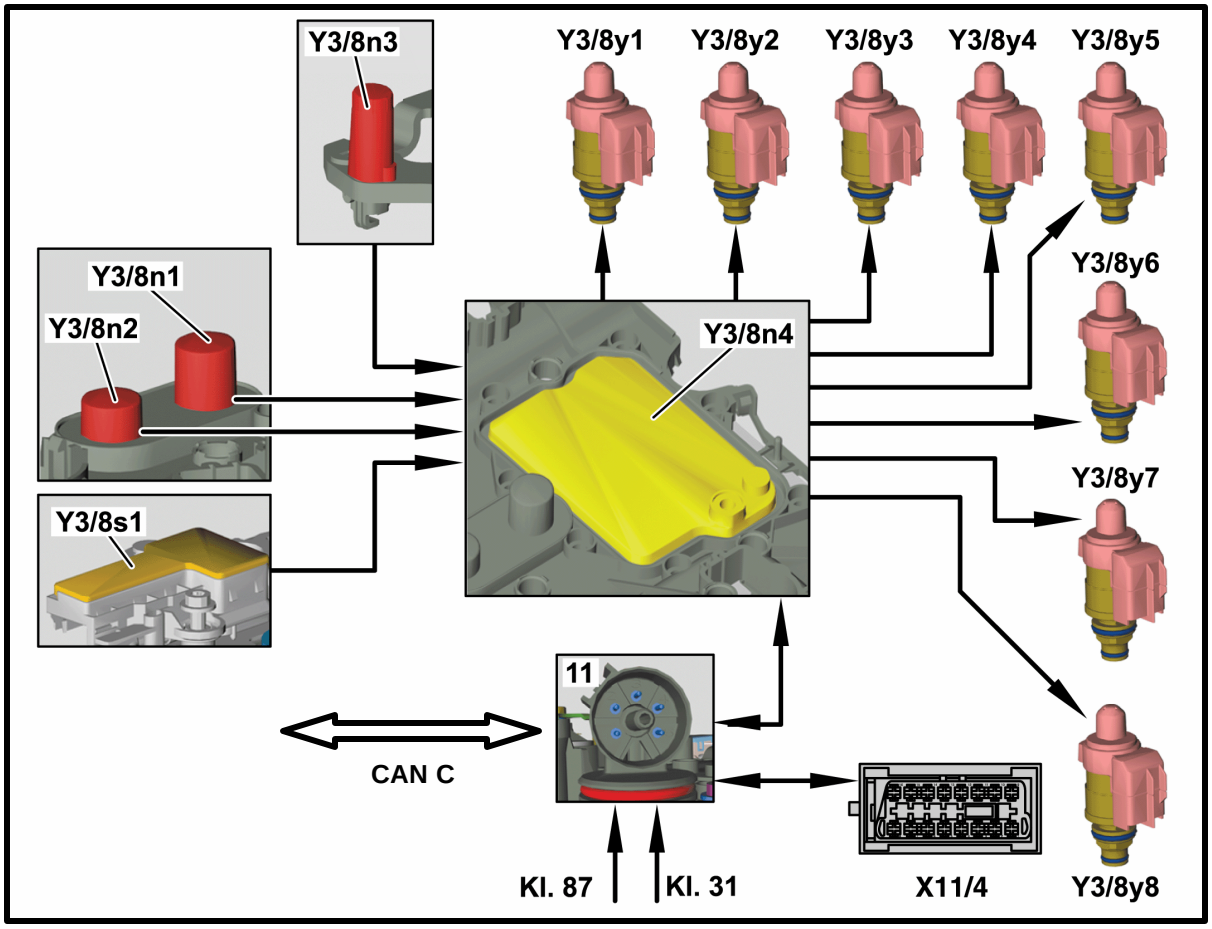
Electric Control Module

Information received over CAN C:

- Engine rpm
- Engine coolant temperature
- Throttle pedal position
- Engine load
- ESP signals
- Cruise control signals (or Distronic)
- ESM (shifter position)

Information received directly:

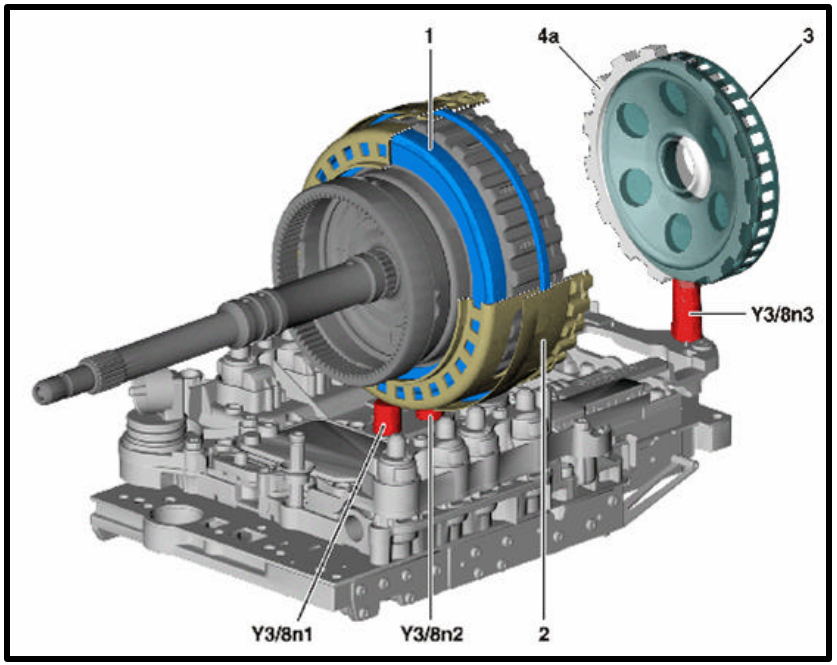
- Speed sensors
- Selector range sensor
- Transmission fluid temperature

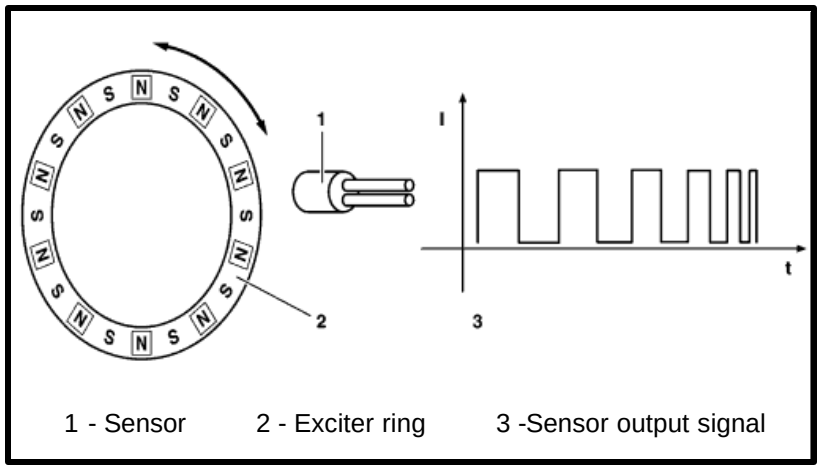


11	Electrical connection	Y3/8n3	Output speed sensor
X11/4	Diagnostic socket	Y3/8n4	Electric control module
Y3/8n1	Input speed sensor	Y3/8s1	Selection range sensor
Y3/8n2	Internal speed sensor	Y3/8y_	Solenoid valve

Speed Sensors (Y3/8n1 & n2)

- Front speed sensor (Y3/8n1) monitors turbine speed (input shaft / small ring gear)
- Center speed sensor (Y3/8n2) monitors Ravigneaux planet carrier speed (ring gear of rear planetary gear set)
- These are active speed sensors
- Permits signal to be read through other non ferrous parts





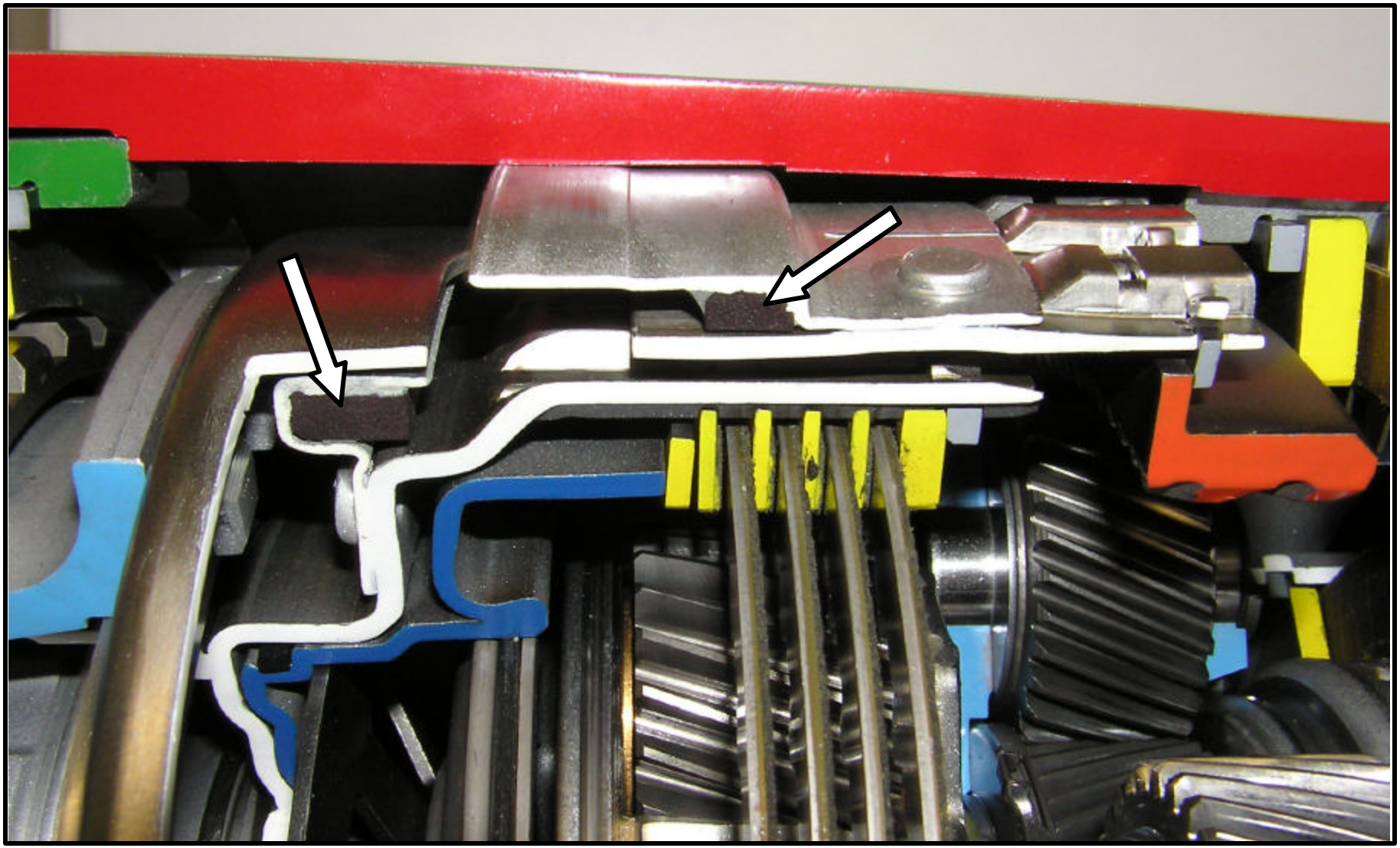
1. Ring magnet
2. Cylinder flange with integrated ring magnet
3. Exciter ring

4a. Park pawl gear

Y3/8n1 Turbine rpm sensor
Y3/8n2 Internal rpm sensor
Y3/8n3 Output rpm sensor

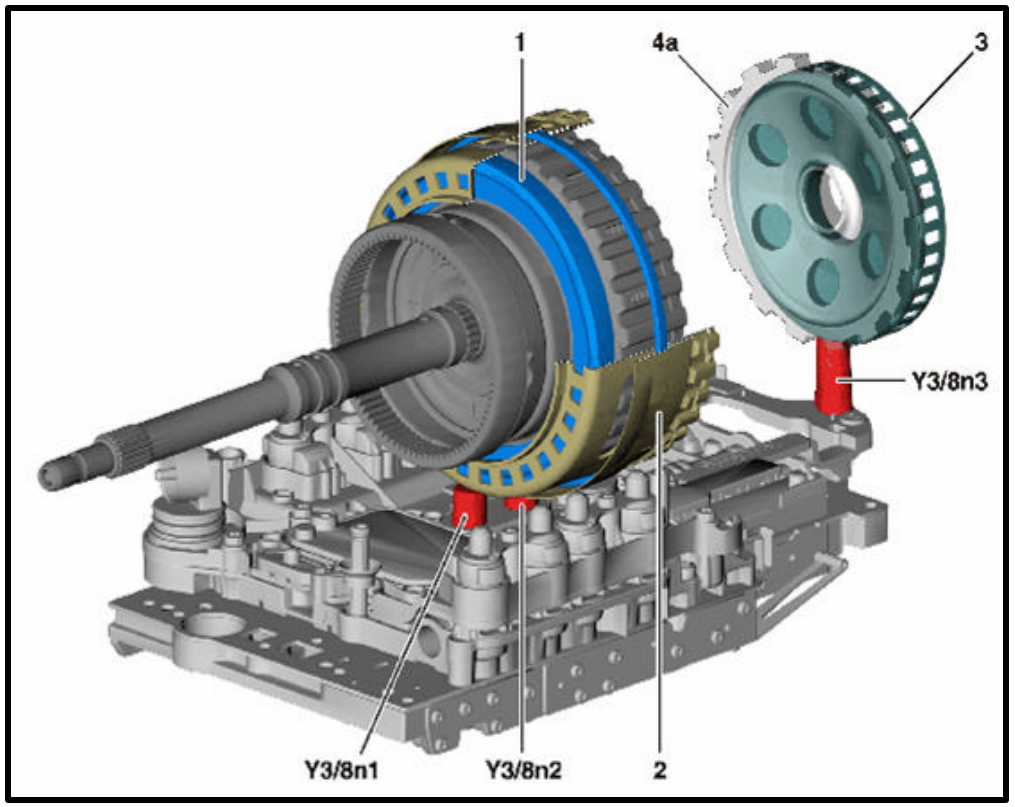
Note: Magnets are molded in plastic ring and secured inside aluminum flanges.

Speed Sensors (Y3/8n1 & n2)



Speed Sensor (Y3/8n3)

- Output speed sensor measures transmission output speed from ring attached to park pawl gear
- Hall effect type sensor
- Replaces wheel speed information previously used to calculate shift points and detect gear slip
- Direct input to electric control module
- Improves reaction time to speed changes



1. Ring magnet
2. Cylinder flange with integrated ring magnet
3. Exciter ring

4a. Park pawl gear

Y3/8n1 Turbine rpm sensor
Y3/8n2 Internal rpm sensor
Y3/8n3 Output rpm sensor

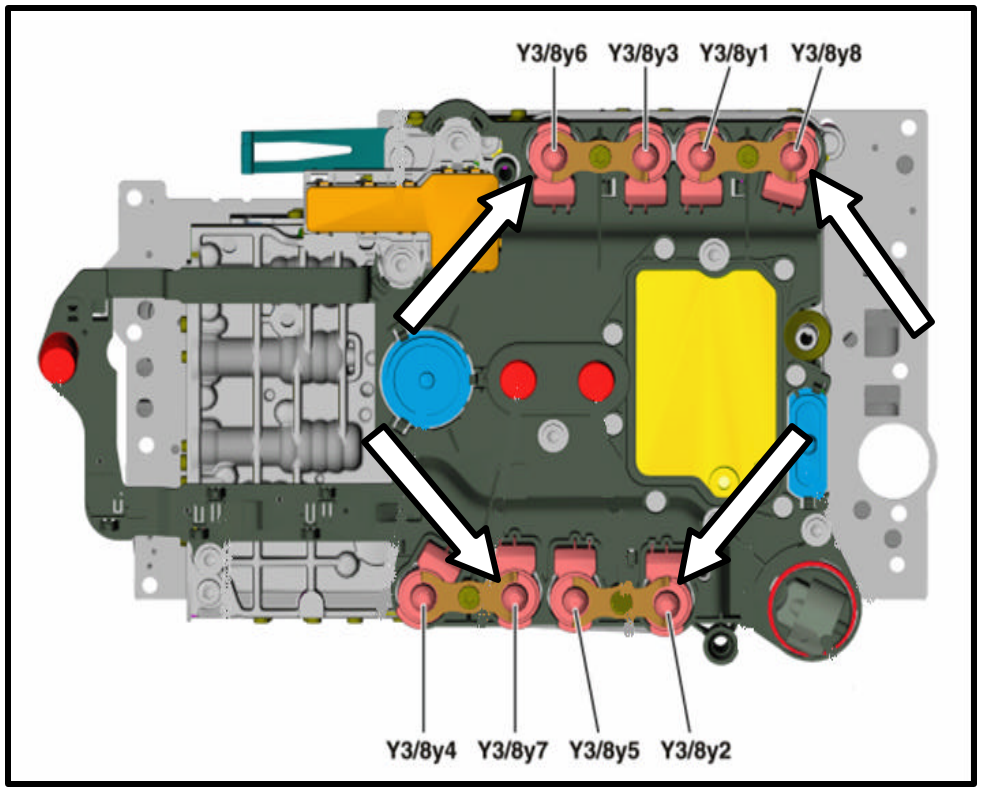
Solenoid Valves

- Actuated by transmission control module using variable current

- Each solenoid valve has a mesh filter beneath it

- The following valves produce increasing pressure with increasing current or no pressure with no current (normally closed):

  - K1 clutch valve (Y3/8y2)
  - B2 brake valve (Y3/8y6)
  - B3 brake valve (Y3/8y7)
  - Torque converter lockup clutch valve (Y3/8y8)

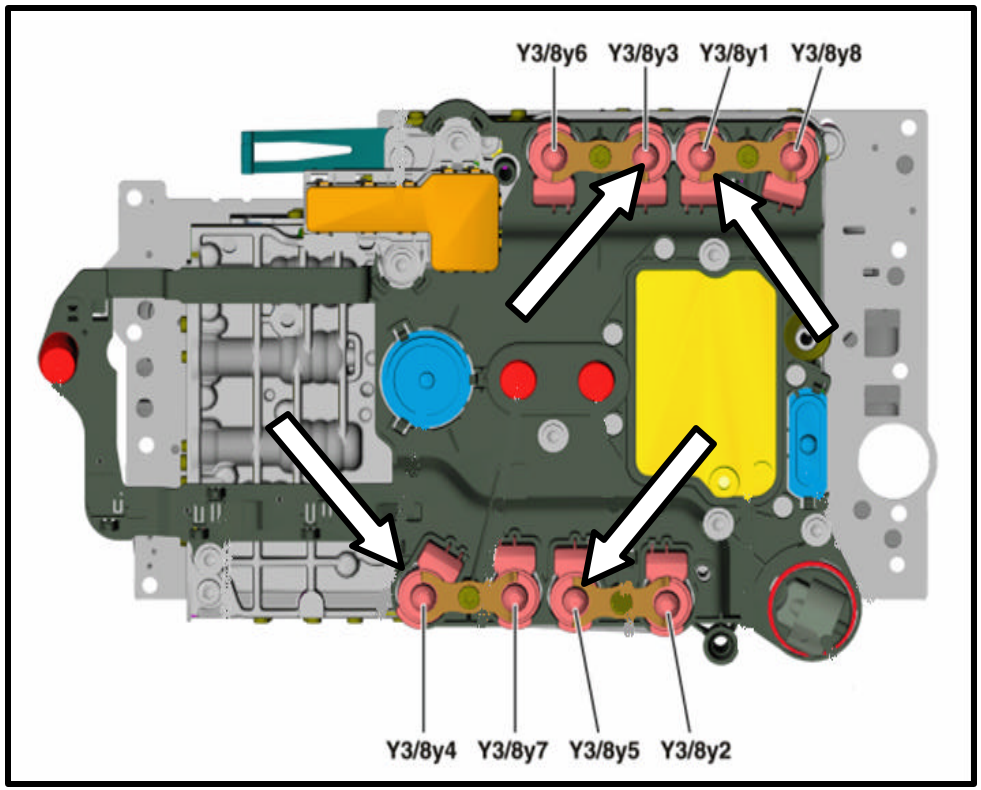


Solenoid Valves

- The following valves produce max. pressure with no current or no pressure with max. current (normally open):

  - Working pressure valve (Y3/8y1)
  - K2 clutch valve (Y3/8y3)
  - K3 clutch valve (Y3/8y4)
  - B1 brake valve (Y3/8y5)

- These valves are responsible for limp-home mode when all valves are de-energized



Shift Members & Solenoid Valve State

Shift Member		B1	B2 *	B3	BR *	K1	K2	K3
Shift Valve		Y3/8y5	Y3/8y6	Y3/8y7	Y3/8y6	Y3/8y2	Y3/8y3	Y3/8y4
Valve State		Pressure / Current	Pressure / Current	Pressure / Current	Pressure / Current	Pressure / Current	Pressure / Current	Pressure / Current
Gear	Ratio	◣	◢	◢		◢	◣	◣
1	4.377	C=Max / P=0	**X** / C=V / P=V	**X** / C=V / P=V		C=0 / P=0	C=Max / P=0	**X** / C=V / P=V
2	2.859	**X** / C=V / P=V	**X** / C=V / P=V	C=0 / P=0		C=0 / P=0	C=Max / P=0	**X** / C=V / P=V
3	1.921	C=Max / P=0	**X** / C=V / P=V	C=0 / P=0		**X** / C=V / P=V	C=Max / P=0	**X** / C=V / P=V
4	1.368	C=Max / P=0	**X** / C=V / P=V	C=0 / P=0		**X** / C=V / P=V	**X** / C=V / P=V	C=Max / P=0
5	1	C=Max / P=0	C=0 / P=0	C=0 / P=0		**X** / C=V / P=V	**X** / C=V / P=V	**X** / C=V / P=V
6	0.82	**X** / C=V / P=V	C=0 / P=0	C=0 / P=0		C=0 / P=0	**X** / C=V / P=V	**X** / C=V / P=V
7	0.728	C=Max / P=0	C=0 / P=0	**X** / C=V / P=V		C=0 / P=0	**X** / C=V / P=V	**X** / C=V / P=V
N (1)		C=Max / P=0	C=0 / P=0	**X** / C=V / P=V	C=0 / P=0	C=0 / P=0	C=Max / P=0	**X** / C=V / P=V
N (2)		**X** / C=V / P=V	C=0 / P=0	C=0 / P=0	C=0 / P=0	C=0 / P=0	C=Max / P=0	**X** / C=V / P=V
R (1)	-3.416	C=Max / P=0	see BR	**X** / C=V / P=V	**X** / C=V / P=V	C=0 / P=0	C=Max / P=0	**X** / C=V / P=V
R (2)	-2.231	**X** / C=V / P=V	see BR	C=0 / P=0	**X** / C=V / P=V	C=0 / P=0	C=Max / P=0	**X** / C=V / P=V

X = Shift member applied C = Current applied to solenoid valve P = Pressure from solenoid valve to shift member (0 = zero / V = variable / Max = maximum)

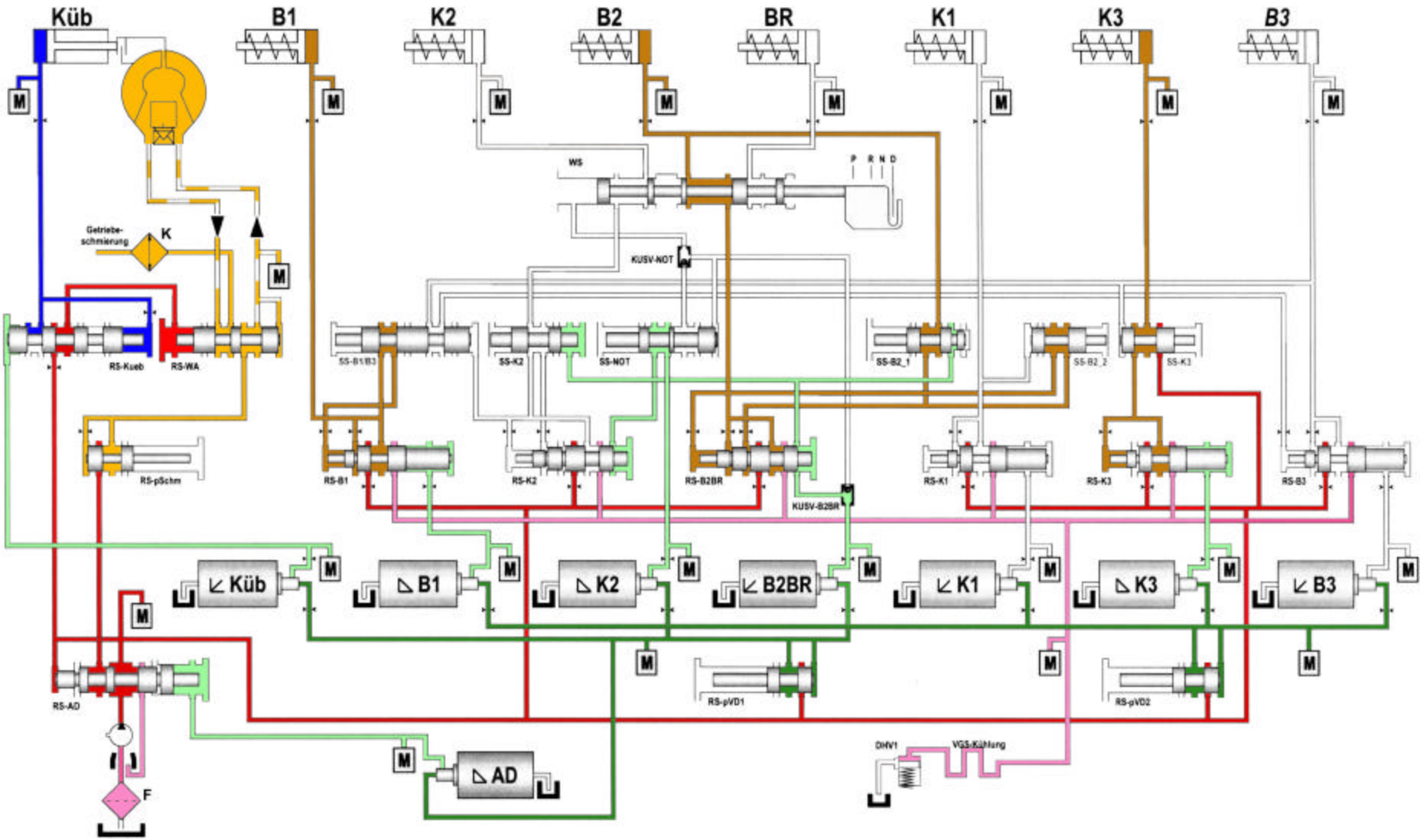
* B2 and BR share the same solenoid valve, the oil is directed to a different member via the selector shift valve.

◢ No current = no pressure
◣ No current = max. pressure

(1) = S mode
(2) = C mode

If transmission enters emergency mode while driving, all solenoid valves are switched off. Trans will shift into 6th gear.
? This is because the solenoid valves for B1, K2 & K3 deliver max pressure with no current applied.
? After engaging P position, then D position; only 2nd and R gear is available.

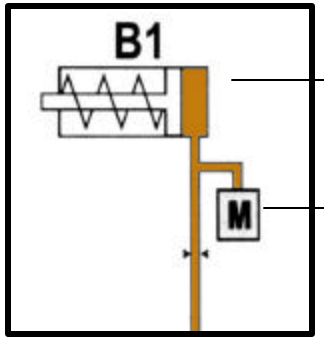
Hydraulic Diagram (Shown in 2nd Gear)



Preliminary hydraulic diagram

Legend

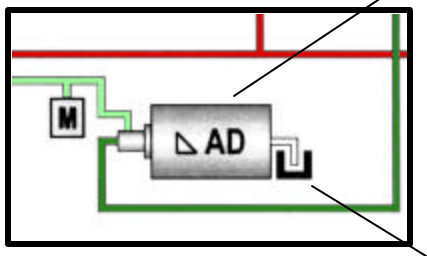
Acronym	Translated description
DHV1	Pressure hold valve
F	ATF Filter
Getriebeschmierung	Transmission lubrication
K	ATF radiator
Küb	Torque converter lock-up clutch
KUSV-B2BR	Switchover valve B2 and BR
KUSV-NOT	Limp home switchover valve
M	Messuring point for the hydraulic pressures (Factory only - sealed off with steel balls)
RS-AD	Regulation valve - Working pressure
RS-B1	Regulation valve - B 1 brakes
RS-B2/BR	Regulation valve - B2 and BR brakes
RS-B3	Regulation valve - B3
RS-K1	Regulation valve - K1
RS-K2	Regulation valve - K2
RS-K3	Regulation valve - K3
RS-Kueb	Regulation valve - TC lock-up clutch
RS-pSchm	Regulation valve - Lubrication pressure
RS-pVD1	Regulation valve - Valve supply pressure 1
RS-pVD2	Regulation valve - Valve supply pressure 2
RS-WA	Regulation valve - converter inlet pressure
SS-B1/B3	Shift valve - B1 and B3 brakes
SS-B2_1	Shift valve - B2_1
SS-B2_2	Shift valve - B2_2
SS-K2	Shift valve - K2
SS-K3	Shift valve - K3
SS-NOT	Shift valve – Limp home
VGS-Kühlung	Returning ATF cools lower surface of the ETC
WS	Selection range valve



Shift member:
B_ brake
K_ clutch

Measuring point

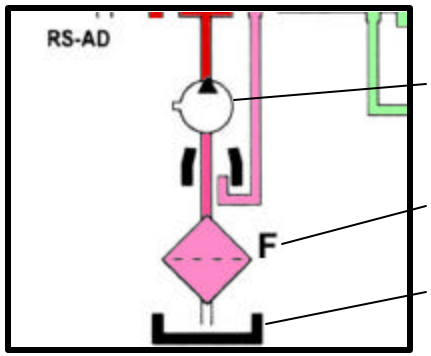
Solenoid valve:



Normally open

Normally closed

Return to oil pan



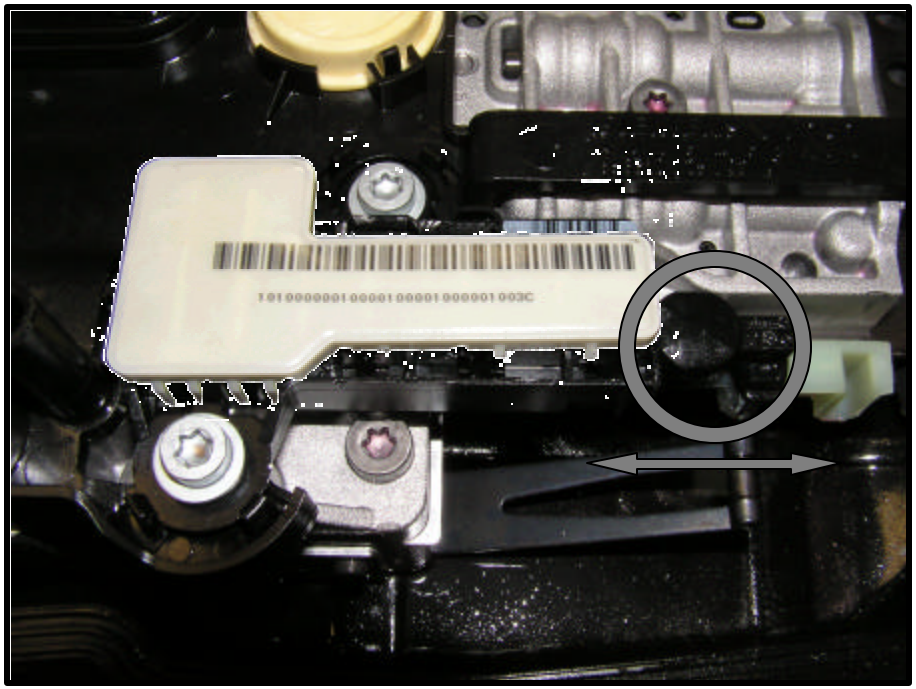
Oil pump

Filter

Oil pan

Selection Range Sensor (Y38s1)

- Soldered onto ribbon cable of electric control module
- Cannot be replaced separately
- Records position of selection range lever
- Permanent magnetic Linear Contactless Displacement (PLCD) sensor
- Construction:
  - Soft magnetic core surrounded by a wire coil along its length with an additional coil at each end
  - Permanent magnet on selection range valve, changes magnetic field & output voltage of sensor



** Must be learned in **

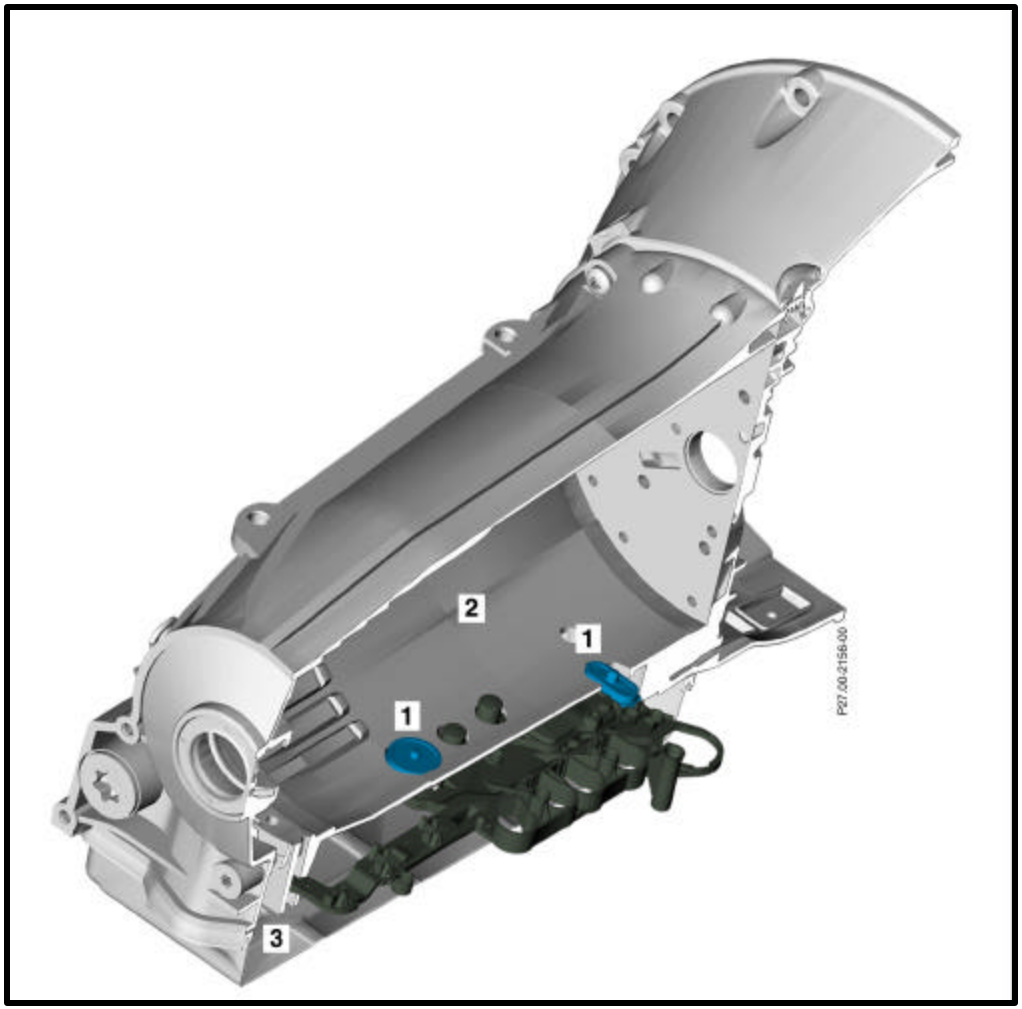
Signal is compared to ESM

If faulty or not learned in = limp-home mode

Fluid Level Control

- Reduces possibility of gear sets running in fluid (causing ATF foaming)

- Two floats are used due to:
  - Transmission 41 mm longer
  - ATF sloshes to the front under sharp decel



1 Fluid level float
2 Transmission case

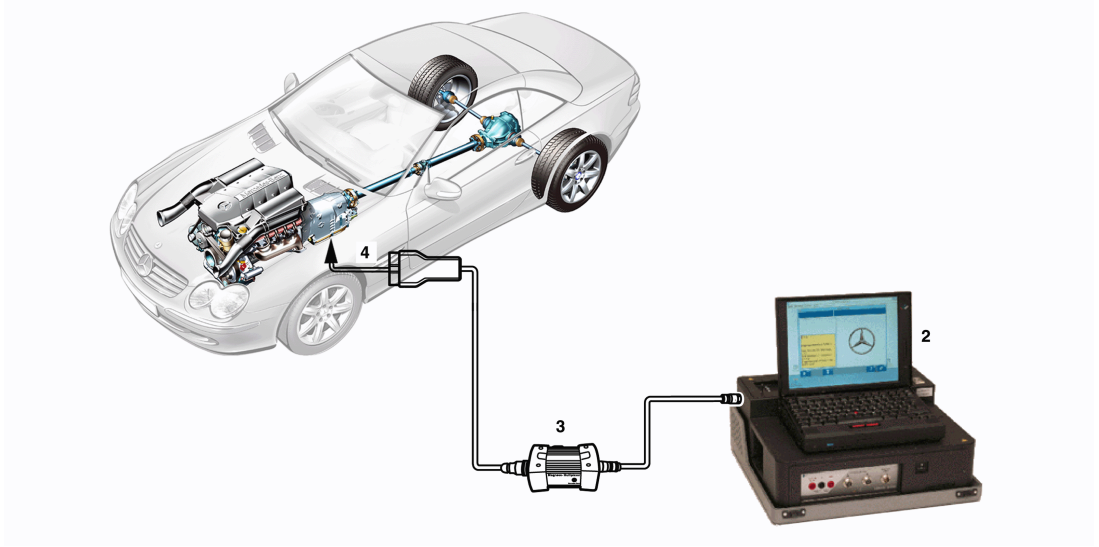
Checks & Diagnosis

Oil Level Check

Limp-home Modes

DTC’s

EDAC



Replacement of Transmission or Control Module

SCN & CVN Coding

Fluid Level

- Can only be checked at a specific fluid temperature (use SDS / DAS)
- Currently there are two different oil pan designs with different fluid temperature and fill specifications:

	Old oil pan design	New oil pan design
WIS doc #:	SI27.00-P-0002A	SI27.00-P-0002B
Initial fill check:	30°C	40°C
Level check:	30 - 35°C	40 - 45°C
Fluid fill total:	9.5 liters	9.7 liters

Fluid fill total = 5.2 / 5.4 transmission + 4.0 torque converter + 0.3 cooler circuit

- In order to fill or top up the transmission the drain plug must be removed and an adapter screwed on
- A special filling station is used to add fluid into transmission via the drain plug
  (Special filling station to arrive at dealers shortly)

ATF Filling Station

- Station consists of:
  - 30 liter ATF reservoir
  - uses compressed air to dispense ATF
  - hand nozzle with delivery controls
  - LCD readout for measured fluid delivery
  - quick-connect fitting to oil pan adapter

- Follow the instructions supplied with the unit for set up & operation

Note:

1. Before attempting to fill station with ATF, remove compressed air supply !!!

2. Before dispensing ATF, bleed hoses up to quick connect fitting

Emergency Function / Limp-home Mode

In the unlikely event of a transmission failure, transmission control module has a variety of different limp-home modes that allow vehicle to be driven home or to the nearest workshop with limited functionality.

- If a shift member solenoid valve is defective, the gear(s) affected is blocked (e.g. Y3/8y7 (B3) defective: no 1st, 7th or Reverse in 'S' mode)

- If a hydraulic fault prevents a gear from engaging then previous engaged gear is retained

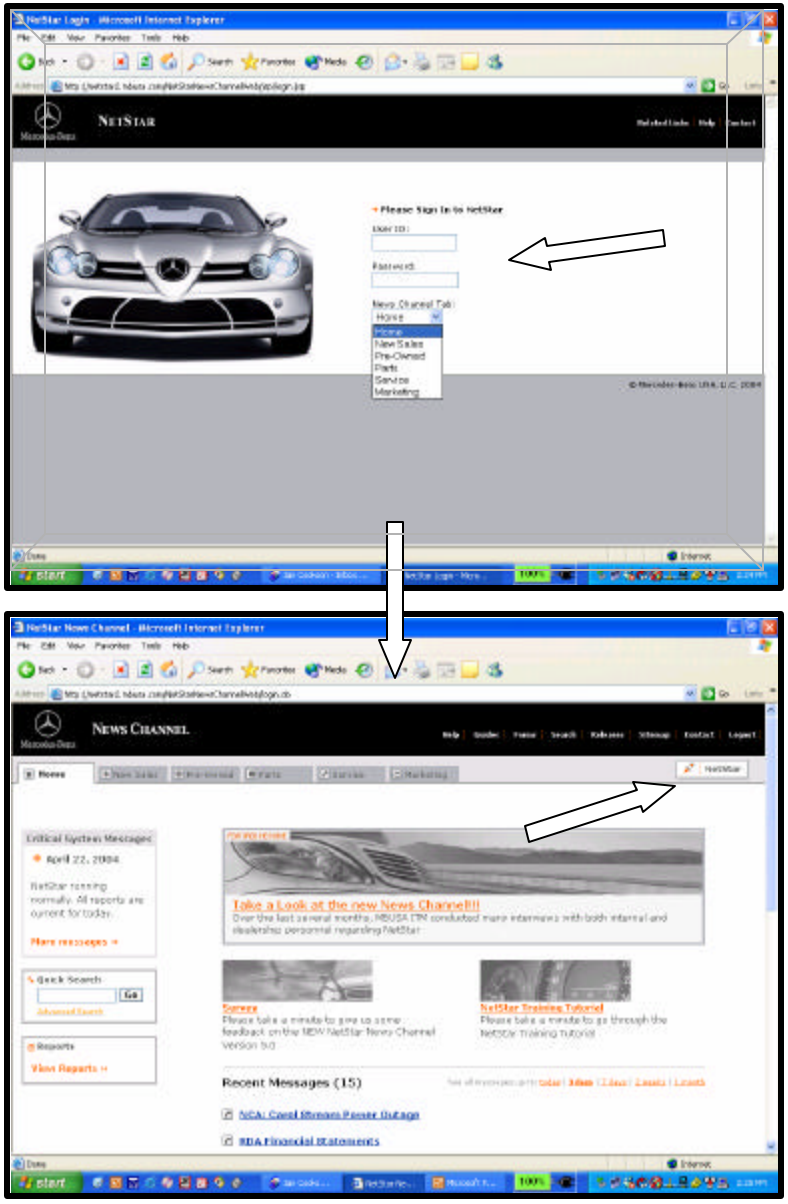
- If a computer fault occurs while driving, all control solenoid valves are switched off. The normally open valves would allow full working pressure to go to the respective members - defaults to 6th gear

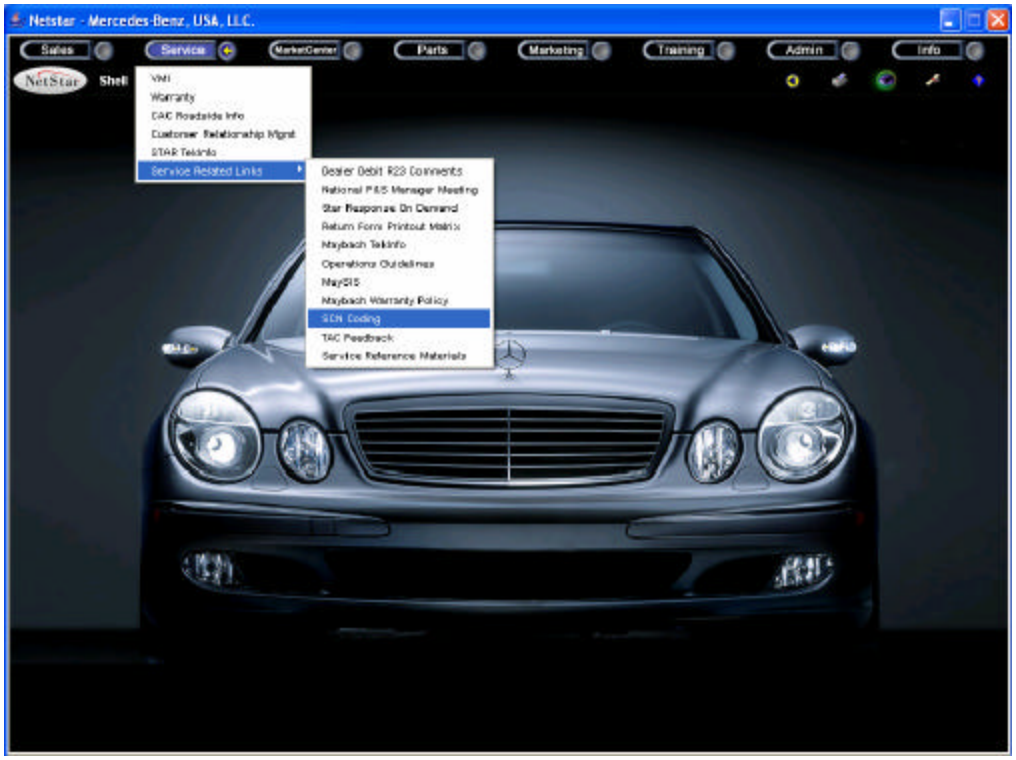
  - After shifting to 'P', oil pressure from K2 solenoid is redirected to B2 / BR solenoid output circuit via emergency operation valves.
  - Oil pressure can now be directed to B2 or BR member using selection range valve 'D' = 2nd 'R' = reverse gear

DTC’s

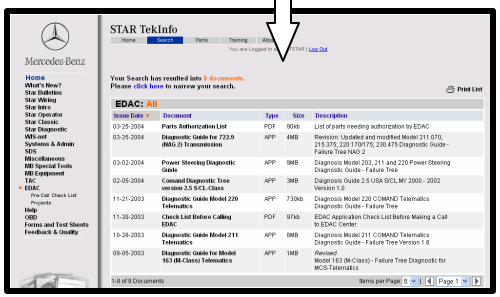
- Transmission control module has over 100 possible fault codes
- These fault codes also have a priority order
- Only a maximum of 16 fault codes can be stored
- If more than 16 fault codes are registered then the 16 fault codes with the highest priority will be stored
- Fault codes can be read out using SDS / DAS and guided tests can be performed after selecting the links
- Additional information about each fault code and diagnostic procedures can also be found at the EDAC failure tree website

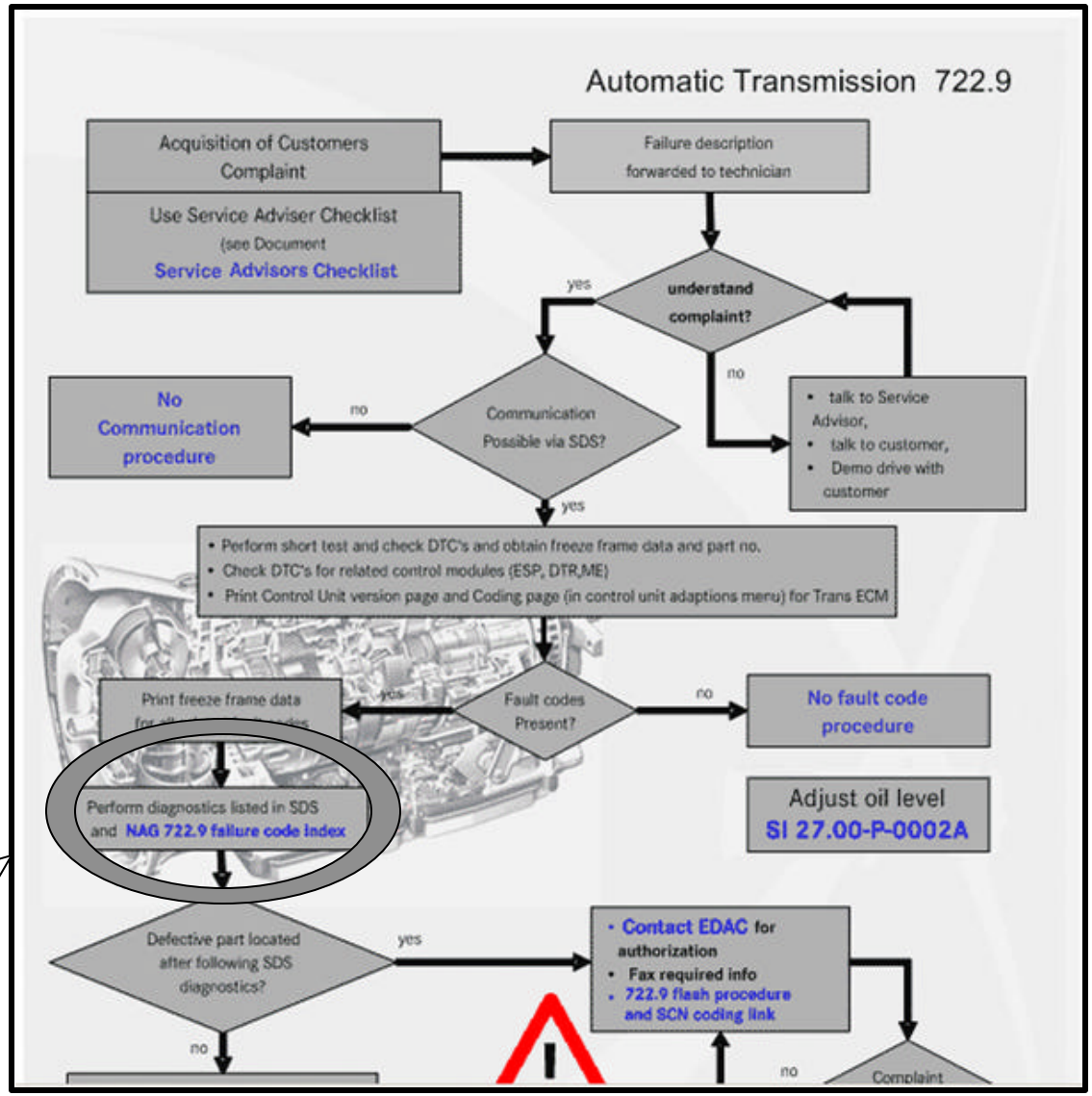
NetStar 2.0 Method





Diagnostics Via EDAC (NetStar 2.0)





Control Module Software

- Control module software can be loaded using SDS / DAS and the appropriate update CD ROM disc (flashing).

- This process does not erase the factory algorithms that were written to the control module during manufacture

- Flashing of the control module would be performed:
  - after replacing transmission
  - after replacing electro-hydraulic valve body
  - to update the control module software to resolve a problem

- If transmission control module is new or transmission is replaced, then part of the installation process would be to release transport protection and personalize (marry) the module

- Once transmission control module is married to the vehicle, it will not work correctly in another vehicle (only limp-home mode)

Control Module Software

- Follow the latest instructions on flashing the software into the transmission control module (DTB / DAS instructions)

- Depending on the scenario some or all of the following will need to be performed after flashing the transmission control module:

  - Determine vehicle data for SCN coding
  - Performing SCN coding
    - as of MY 2005 performing CVN process in addition to SCN
  - Learning the drive authorization system (required with new module)
  - Teach-in of selection range sensor

Tip: Ensure SCN coding is available before programming control module!

Control Module Software

- European & American legislation requires that emission relevant control modules be codable with a Software Calibration Number (SCN) to prevent manipulation of software

- As of MY 2004, transmission control module will incorporate SCN coding

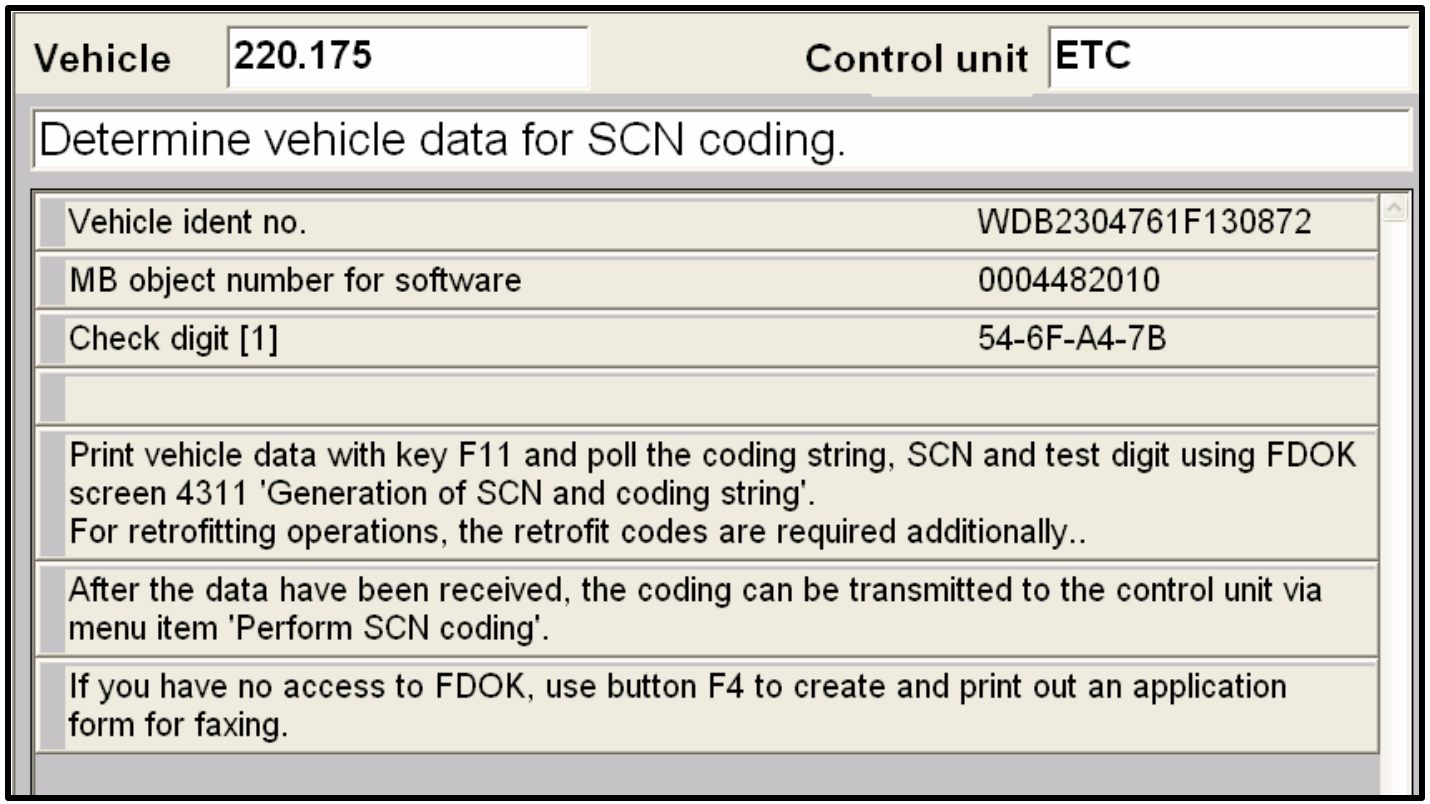
- SCN code will need to be entered using SDS / DAS after every software update

- Failure to enter the SCN code after software update may result in engine not starting

Tip: Ensure SCN coding is available before programming control module!

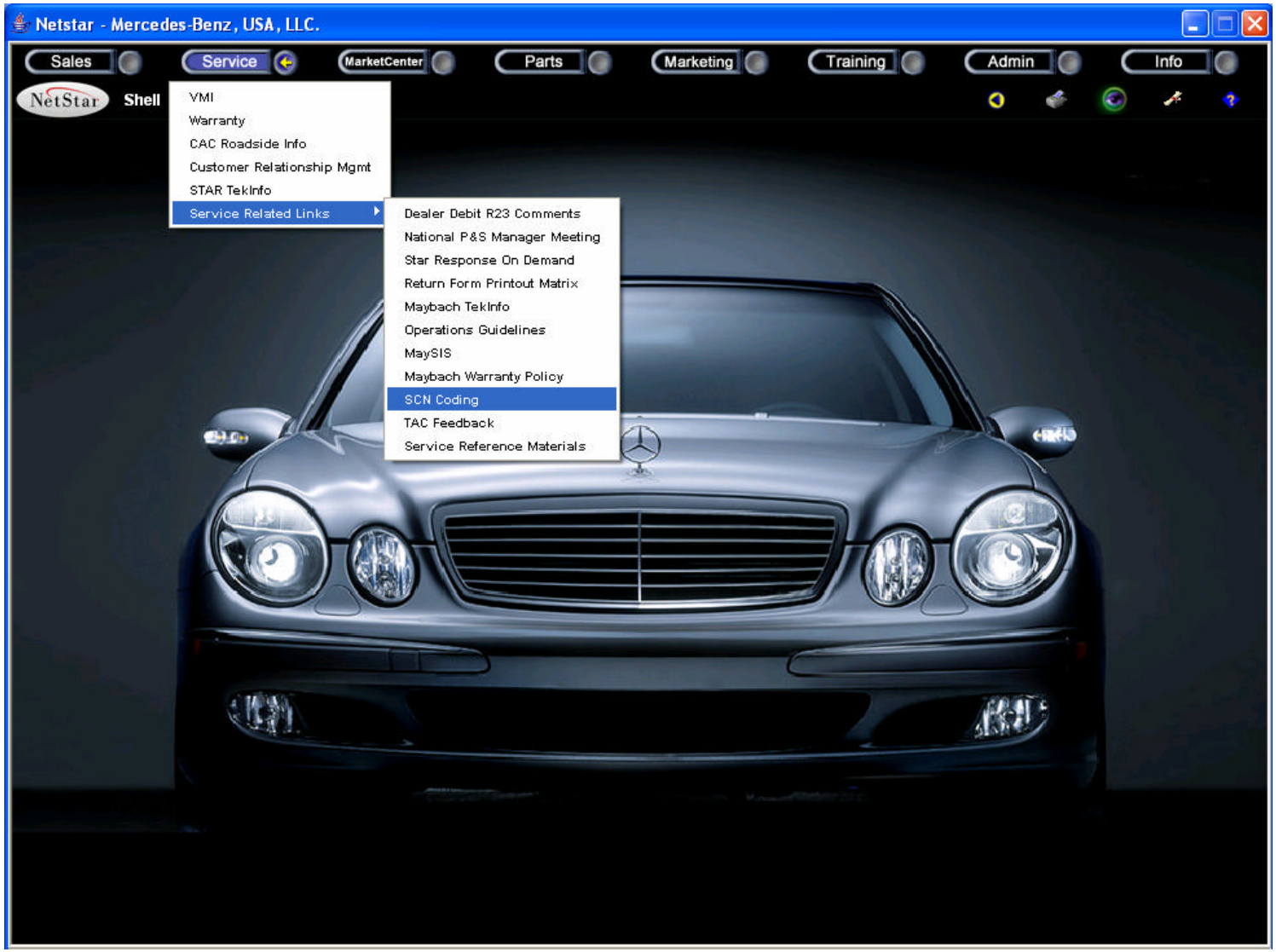
- SCN code for transmission can be obtained using the password protected on-line site, via NetStar

SCN Coding



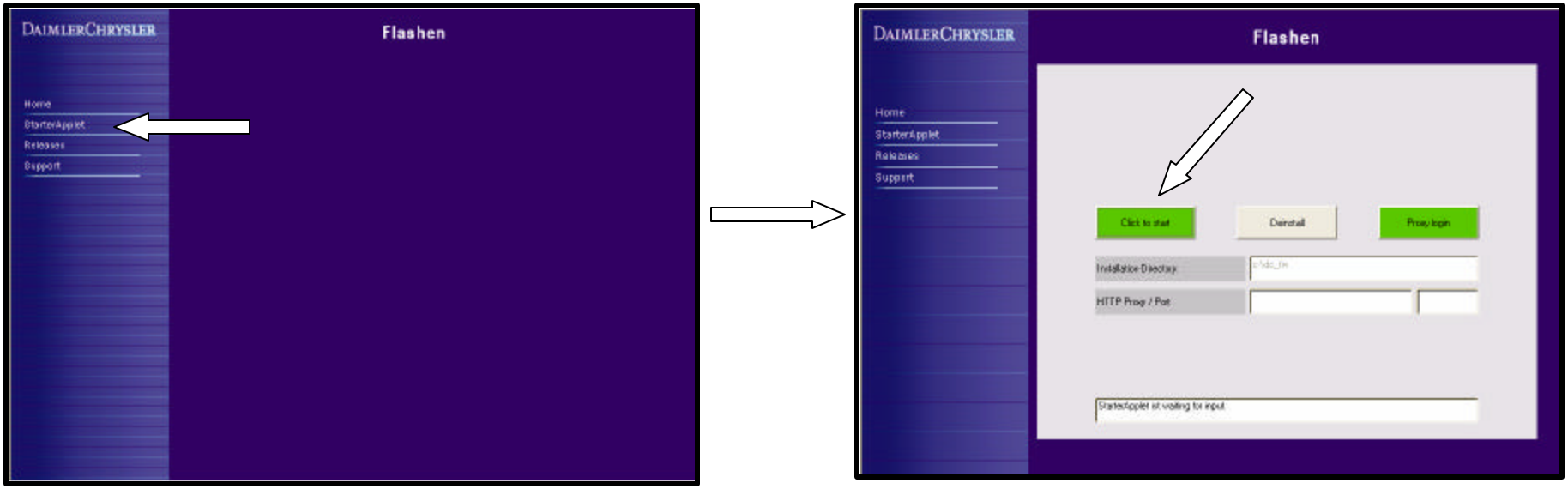
- After installing the software with SDS / DAS, navigate to this screen for the software version in your vehicle to determine SCN code. This information is needed to get the SCN coding
- The last 4 digits of the MB object number changes with the software version
- The example above shows 20 10 software version, the latest software release is _ _ _ _

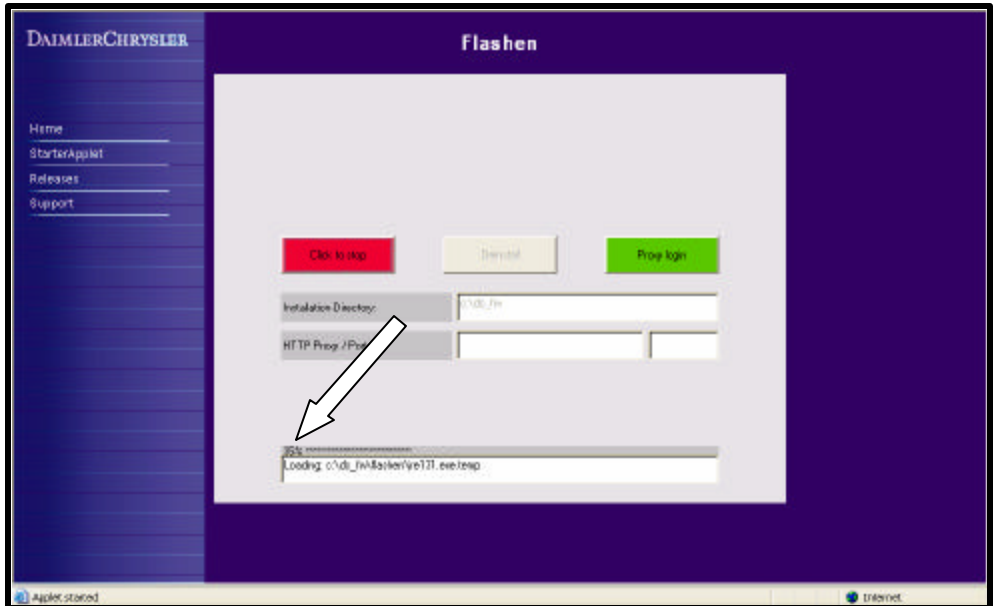
SCN Coding



Process and screens subject to change, for reference only (03/04)

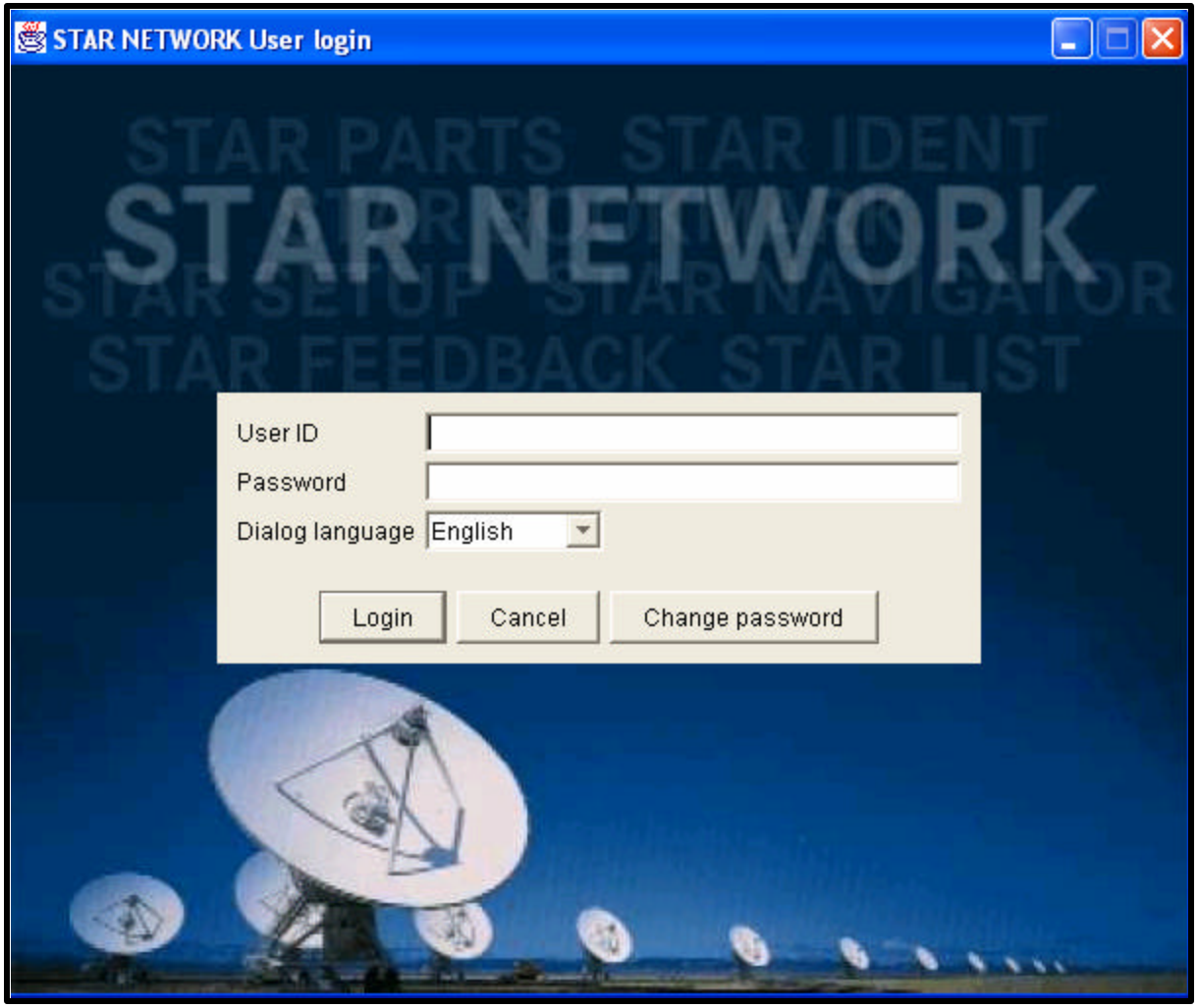
Starting SCN





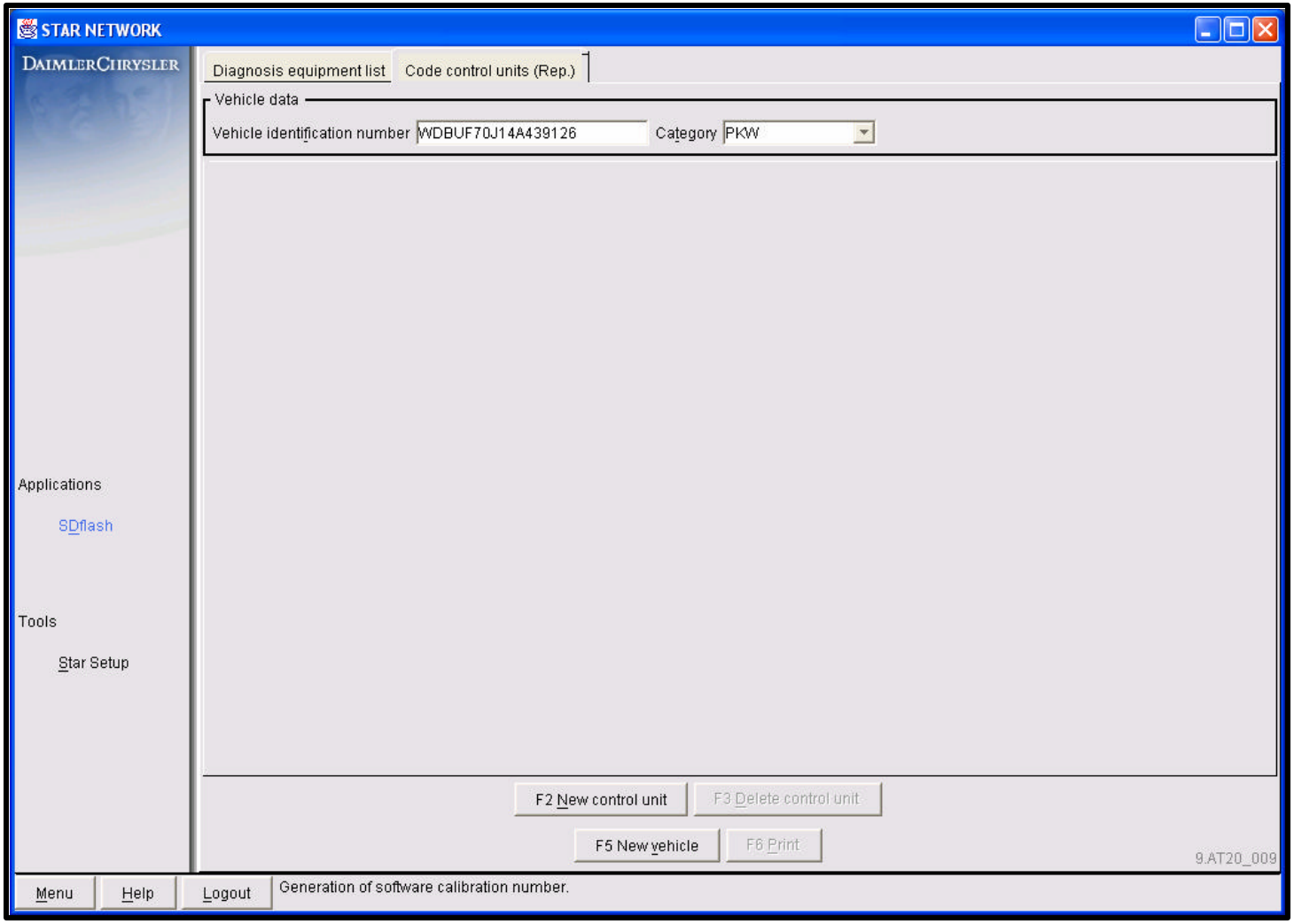
Progress of start-up

Logging In to STAR NETWORK



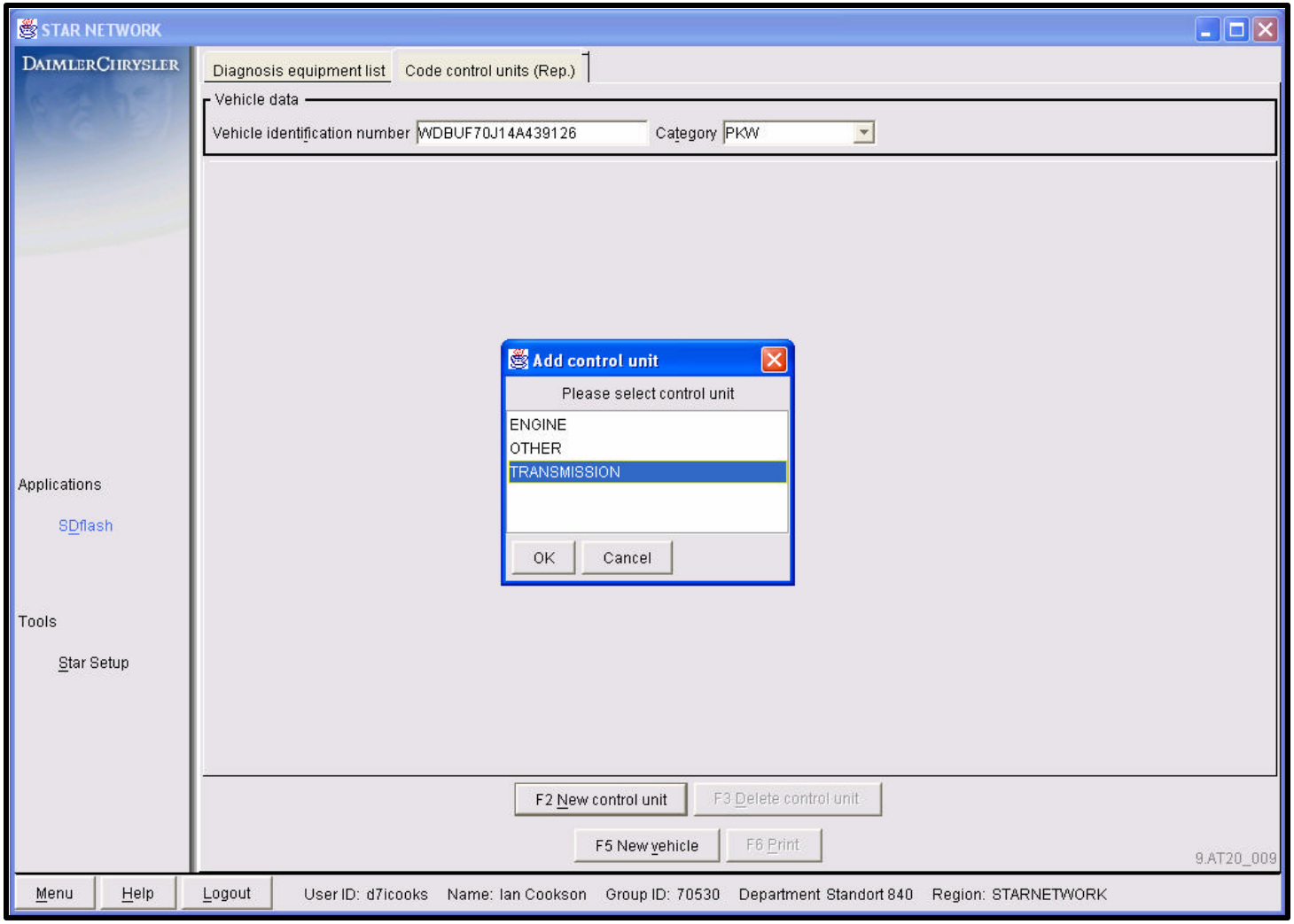
In order to continue you must have already setup a user ID and Password (see S-B-07.61/38d)

STAR NETWORK



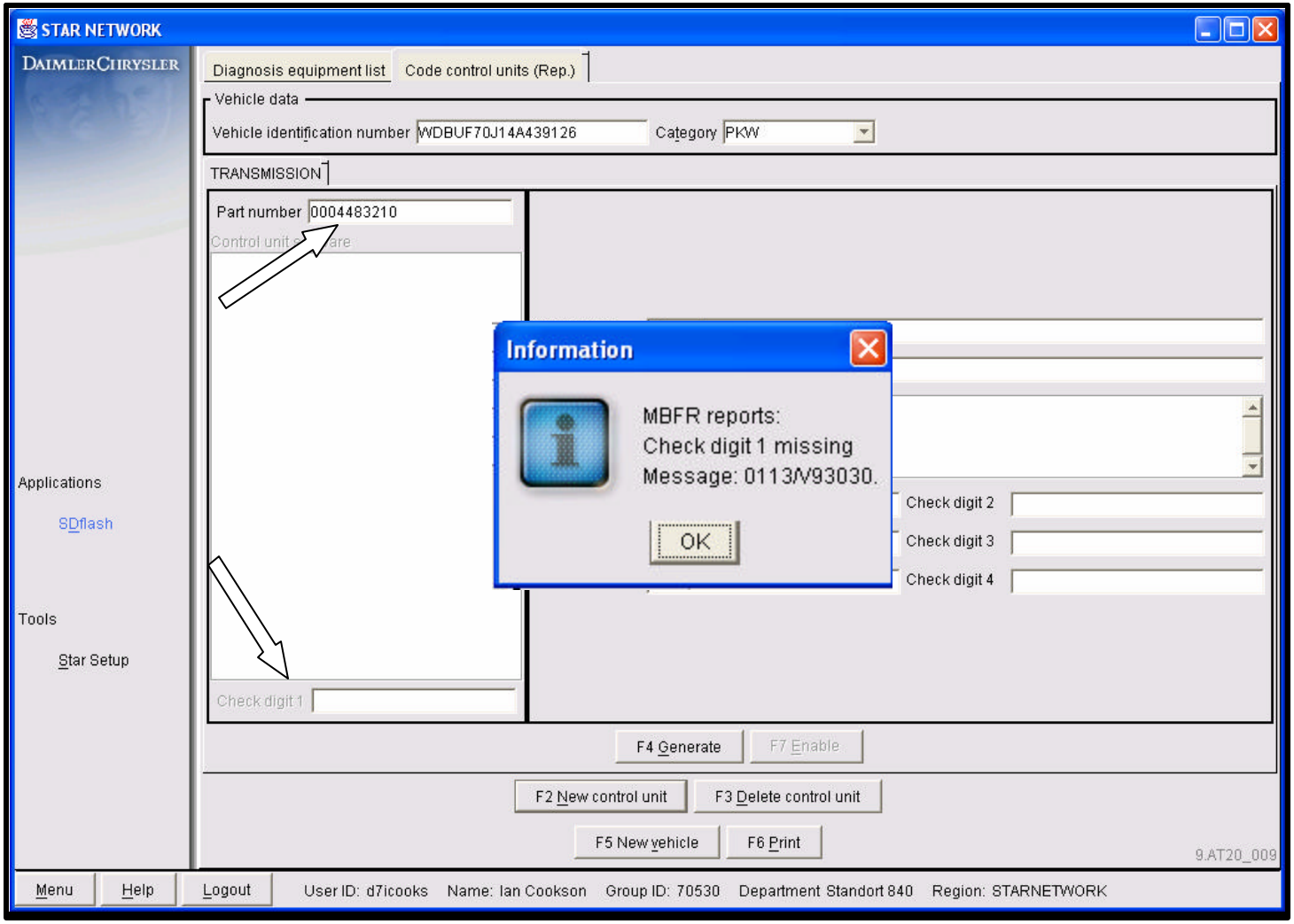
- Select ‘Code control units (rep)’ tab at top of screen
- Enter VIN number and select PKW (passenger vehicles) from category drop down menu
- To continue, press F2 or click new line button

STAR NETWORK



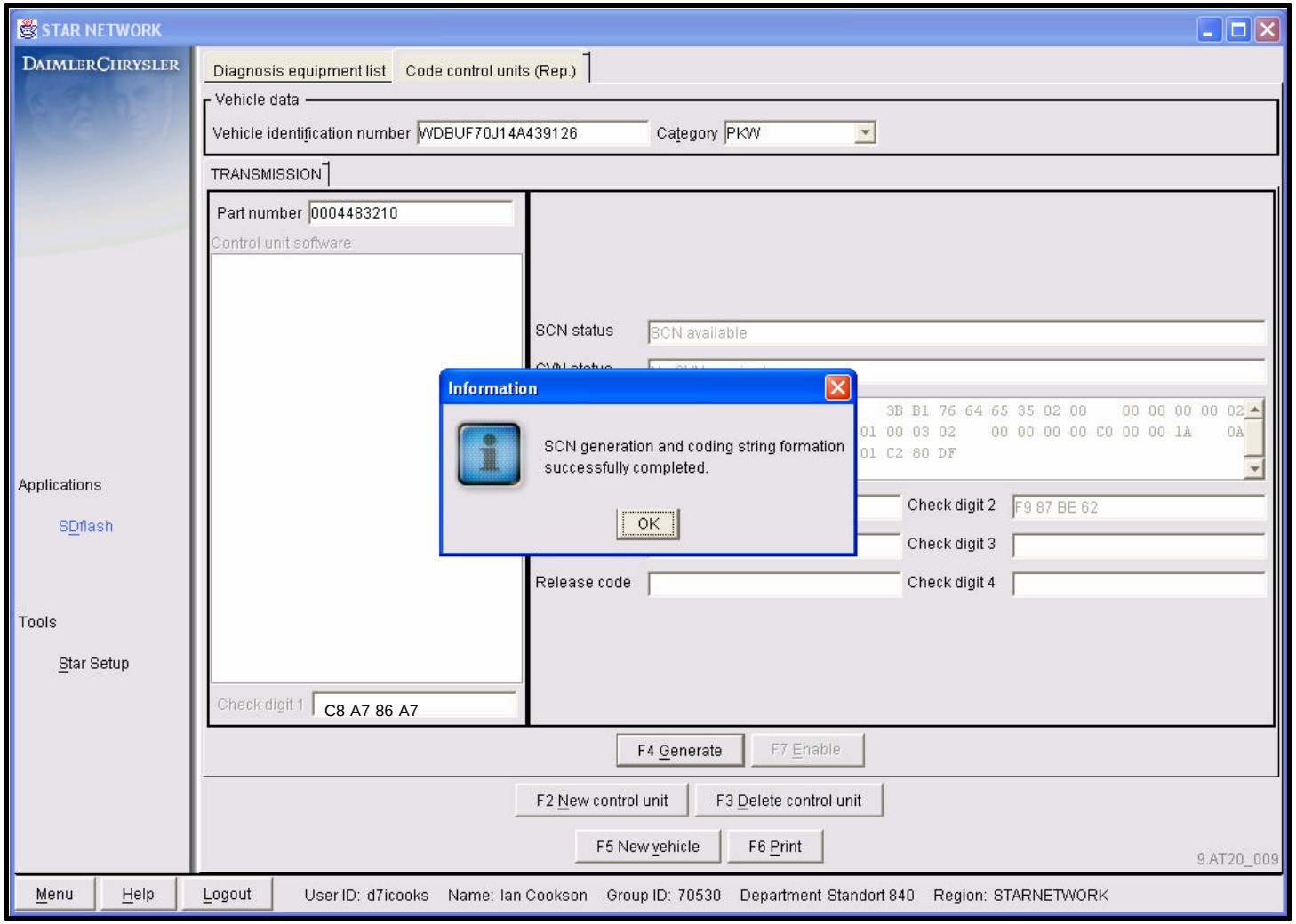
From the pop-up window select the control module you need SCN code for and then press OK

STAR NETWORK



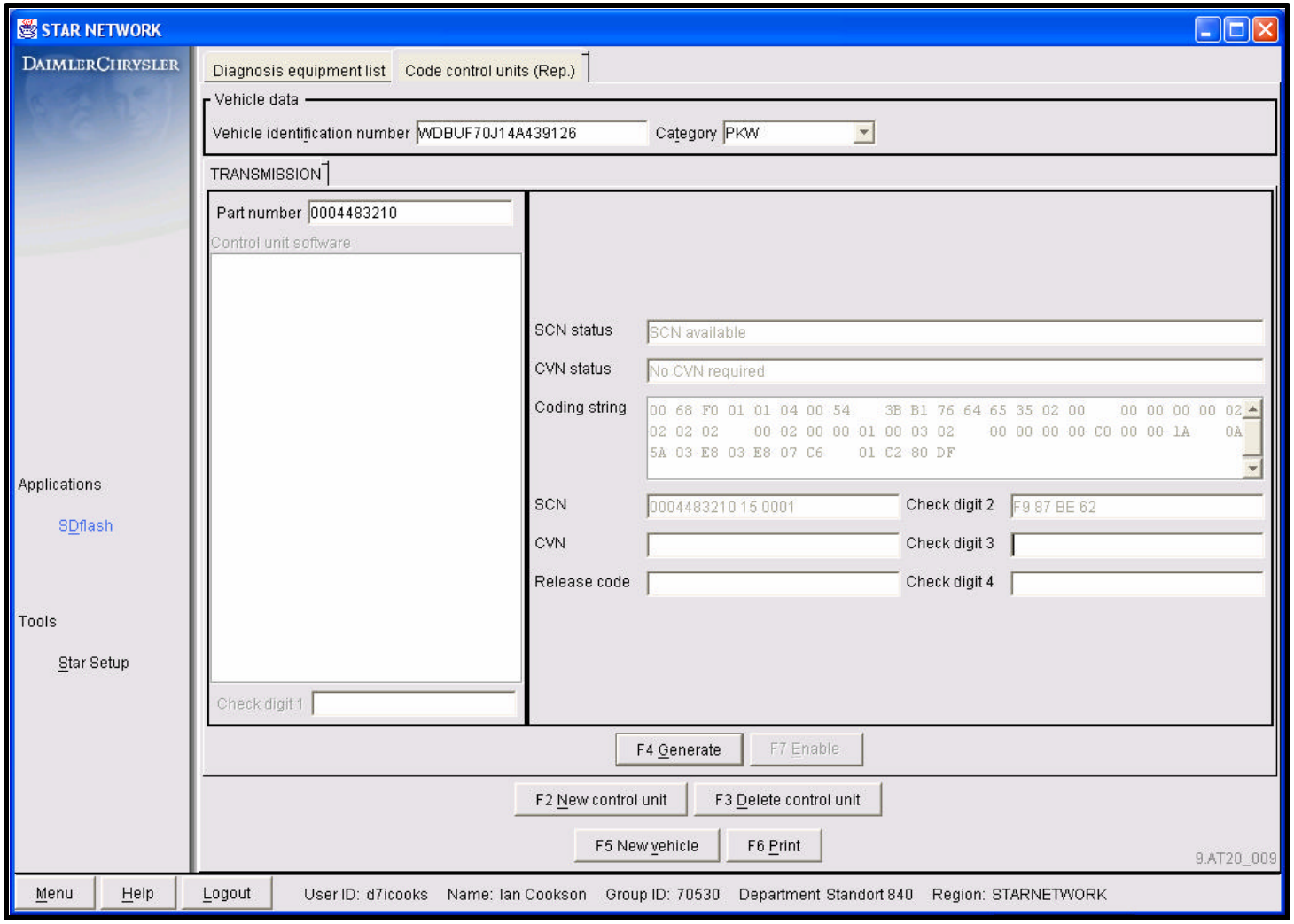
- For transmission SCN code, enter the object number, not the control module number
- As of 06/04 the check digit (1) must be entered, using capital letters / numbers with spaces between pairs of characters, if not an error message will appear

STAR NETWORK



- With the Check digit (1) entered, press F4 or click ‘Generate’ button to generate coding
- A pop-up window will appear informing you of request progress, when completed, click OK

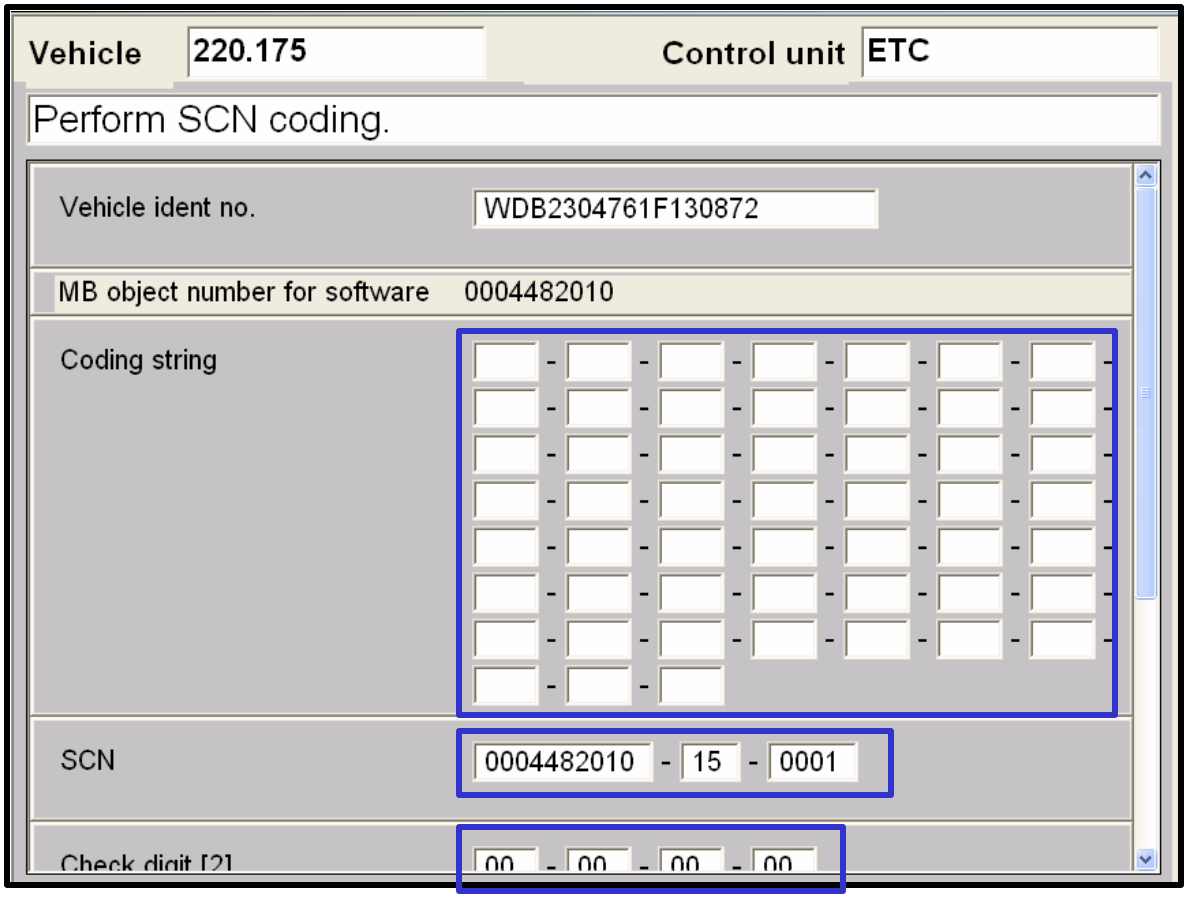
STAR NETWORK



- Transmission SCN code can be seen along with the coding string and check digits
- To print this out press F6 or print button

Entering SCN Coding

- Enter in the coding string:
  - In some cases the last few fields may be left blank
  - If you do not have enough entry fields on DAS screen then check that you have the latest version of DAS
- Enter SCN code
- Enter check digit (2)



- Press F3 to initiate coding of the control module with the data entered
- SDS / DAS checks that the data entered is correct, using the check digit as reference. If correct, coding is transmitted to control module

Entering SCN Coding

- If the SCN code was entered correctly a screen should appear confirming the transfer

- The check digit (2) you entered will not show up here, as it is only used by DAS for checking the data entry was correct and is not transmitted into the control module.

- The following DAS prompts will lead you through the remaining steps:

  - Learning the drive authorization system
  - Initialize transmission control module
  - Release transport protection of transmission control module
  - Teach-in of selection range sensor

- MY 2005 models will continue with the CVN process before the above remaining steps are prompted.

What is CVN?

- CVN stands for Calibration Verification Number
- A process, determines current state of control module memory
- Control module calculates CVN after SCN coding is entered and accepted. Now, it is displayed on the SDS / DAS
- SDS unit will log an entry in a report file listing VIN #, control module type, etc… for that event

  Note: Each time DAS is opened or ME / ETC modules are accessed, the report file will appear informing user that these entries need to be confirmed with FDOK and a release code entered into SDS / DAS to erase the log entry.

- CVN must be sent to FDOK, for verification that the issued software was installed successfully in the vehicle it was intended for.
- Once FDOK receives CVN code, a release code will be generated and sent to the dealer to erase the log entry in SDS for that specific vehicle

CVN

- First vehicles to be affected will be:
  - MY 2005 M Class & C Class

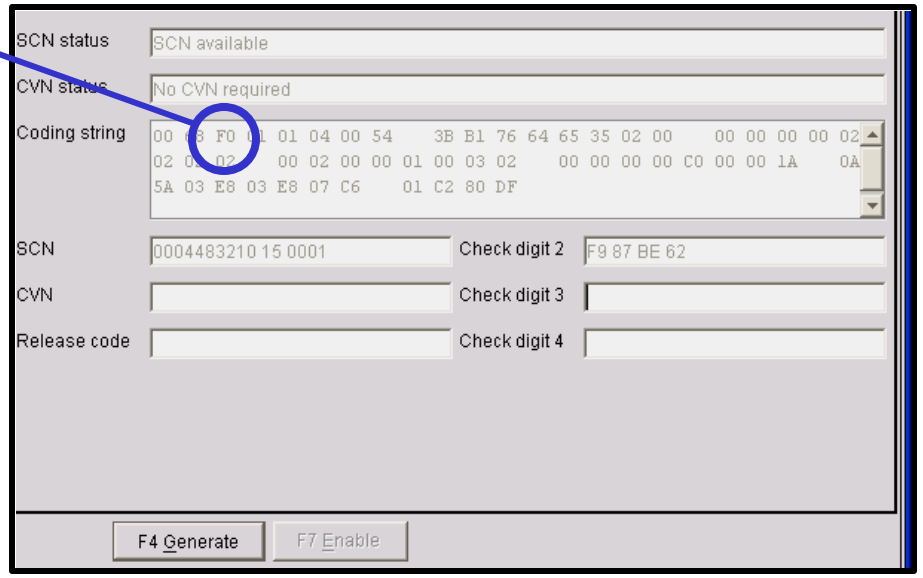
- Followed by other MY 2005 vehicles

  (as CVN is required by California Air Resources Board (CARB) for all US MY 2005 vehicles power train control modules (engine & transmission))

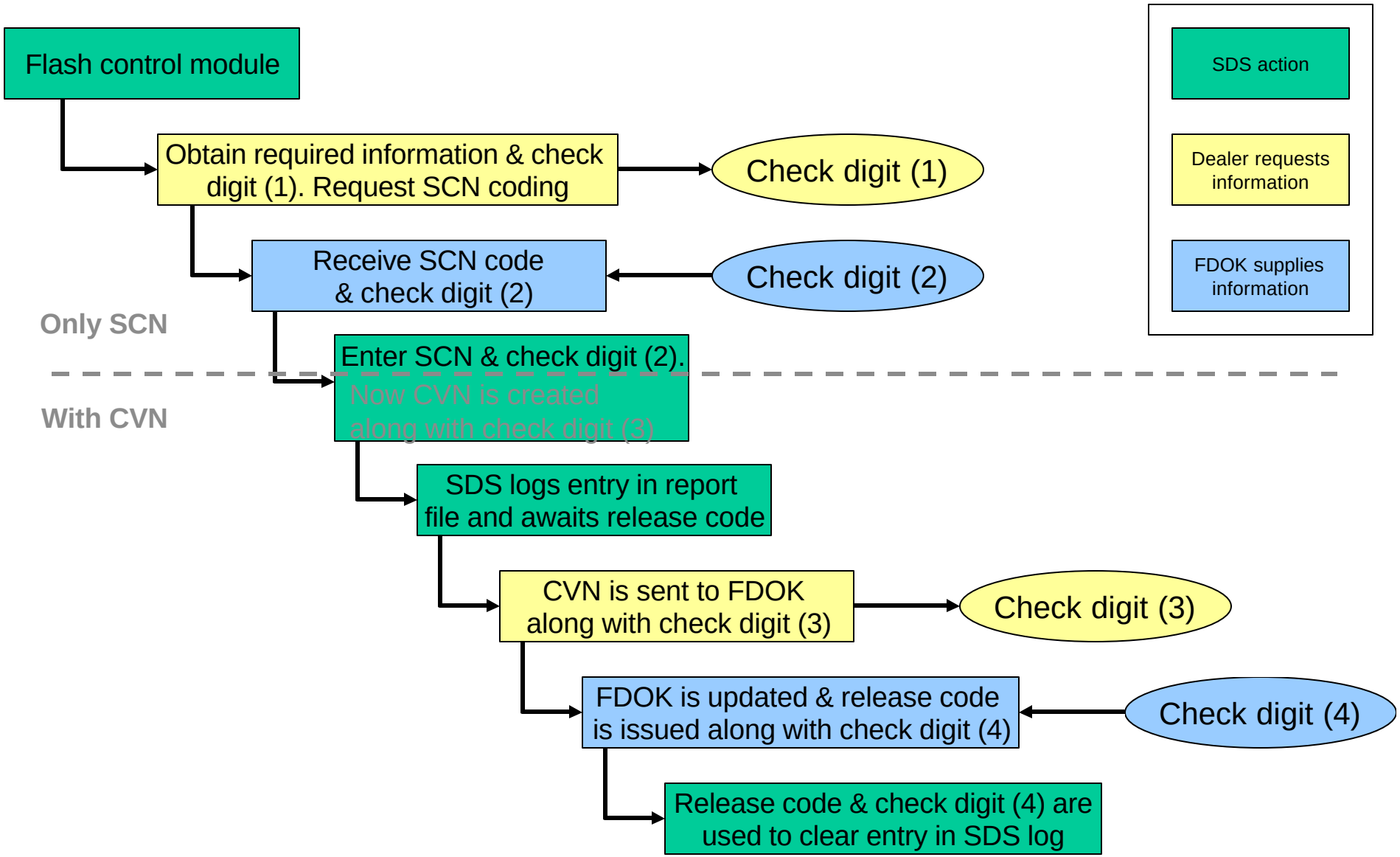
- CVN vehicles can also be determined by the third pair of digits in the coding string: F0 ➔ no CVN F1 ➔ CVN

Fields for:

- CVN
- Check digit (2, 3 & 4)
- Release code
  (use F7 Enable key to generate release code after CVN is entered)



SCN / CVN Recap



Appendix

Torque converter slip values vary tremendously; from stall speed to negative values under deceleration. Computer calculates the optimal slip based on the current conditions.

Here are some examples taken at 45 mph with a MY04 S500.

Note: These figures are only to show examples of slip and should not be used as a guideline for diagnosis

Engine Speed	Turbine Speed	Torque Converter Slip	Output Shaft Speed	Throttle %	Converter state	Current Gear	Driving Condition
1303	1258	45	1533	24	Slipping	6	Cruise
2859	2832	27	1471	53	Slipping	3	½ throttle
4476	4338	138	1520	100	Open ➔ Slipping	2	Kick-down
1169	1270	-101	1524	0	Slipping	6	Deceleration

722.9 Cross Section