MERCEDES BENZ 722.6 SHIFT GROUPS

PRINCIPLES OF OPERATION

With the 722.6 being a transmission which shifts from clutch to clutch, proper shift overlap is required for it to be a smooth shifting unit. To accomplish this task, there are a number of components and strategies that merge together which allow for adaptation under various driving conditions. To fully appreciate what it takes to make for correct shift timing and shift feel, it is good to look at and understand these components and strategies independently.

HYDRAULICS

One of the difficulties a transmission technician faces when working with a 722.6 transmission is the lack of any pressure taps. Hydraulic pressures are calculated from input signals such as engine torque, engine speed, accelerator pedal position, cruise control request, wheel speed, traction status, kick-down switch, selector lever signal and the program select switch W/S. If pressure taps were available, there would be, basically 8 different pressure categories as you can see listed in Figure 1 with their respective range specifications which were provided by the Daimler Chrysler Academy of Technical Training.

PRESSURE CIRCUITS	PRESSURE VALUES
LINE PRESSURE	60-320 PSI
MODULATING PRESSURE	0-125 PSI
REGULATED SHIFT PRESSURE	0-120 PSI
SHIFT PRESSURE	0-220 PSI
SOLENOID SHIFT “IN” PRESSURE	50-55 PSI
LINE PRESSURE SOLENOID “IN” PRESSURE	120-125 PSI
TORQUE CONVERTER PRESSURE	0-100 PSI
TCC APPLY PRESSURE	0-118 PSI

Figure 1

SHIFT SOLENOIDS

There are three shift solenoids, the 1-2/4-5 (Y3/6y3), the 2-3 (Y3/6y5) and the 3-4 (Y3/6y4). Just by their very names you can determine their functions. Obviously the 1-2/4-5 solenoid is responsible for the 1-2 and 4-5 up-shift as well as their respective downshifts. Then of course you have the 2-3 solenoid for the 2-3 and 3-2 shift while the 3-4 solenoid handles the 3-4 and 4-3 shift. Each of these 3 solenoids are fed with 50 to 55 psi of pressure called "Solenoid Shift Pressure" which is controlled by the Shift Solenoid “In” Pressure Valve.

PRESSURE SOLENOIDS

There are two pressure control solenoids. One is called the Modulating Pressure Regulating Solenoid (Y3/6y1) and the other is the Shift Pressure Regulating Solenoid (Y3/6y2).

The Modulating PR Solenoid regulates pressure between 0 to 125 psi which influences the Pressure Regulator Valve to increase main line pressure (Working Pressure) from a static 60 psi to as high as 320 psi depending upon torque input. This Modulating PR Solenoid oil also influences the 1-2/4-5, 2-3 and 3-4 shift overlap valves so that the shift overlap of a releasing and applying clutch corresponds to torque input.

PRESSURE SOLENOIDS...*continued*

The Shift Pressure Solenoid regulates pressure between 0 to 120 psi which influences the Shift Pressure Regulator Valve for a controlled clutch apply pressure (Shift Pressure) during a shift transition only. This transitional clutch apply pressure (Shift Pressure) starts from a low 0 psi to as high as 220 psi depending upon torque input.

Both of these solenoids are fed with a maximum of 125 psi from the Line Pressure Solenoid "In" Pressure Valve.

SOLENOID SHIFT CHART

As a reminder for those of you who have read past articles on the unique solenoid shift pattern this unit has, from the solenoid shift chart seen in Figure 2, you will notice that shift solenoids 1-2/4-5, 2-3 and 3-4 are toggled "on-to-off" to make there respective shifts. While in gear they remain in the "off" state. This explains how while driving, whatever the gear the transmission was in at the time the computer system observed a fault, that would be the gear the transmission failsafes to. When the vehicle is brought to a stop and the ignition is cycled, the transmission will remain in second gear.

GEAR SHIFTS	SOLENOID				
	1-2/4-5 ⅄	2-3	3-4 ✶	MOD PC ⌑	SHIFT PC ◎
FIRST	OFF	OFF	OFF	PWM	OFF
1-2 SHIFT	**ON**	OFF	OFF	PWM	PWM
SECOND	OFF	OFF	OFF	PWM	OFF
2-3 SHIFT	OFF	**ON**	OFF	PWM	PWM
THIRD	OFF	OFF	OFF	PWM	OFF
3-4 SHIFT	OFF	OFF	**ON**	PWM	PWM
FOURTH	OFF	OFF	OFF	PWM	OFF
4-5 SHIFT	**ON**	OFF	OFF	PWM	PWM
FIFTH	OFF	OFF	OFF	PWM	OFF

Additional Solenoid Activity Not Shown:

⅄ 1-2/4-5 Solenoid is pulsed during ignition crank.

✶ 3-4 Shift solenoid is pulsed continuously while in Park and during selector lever movement (Garage Shifts).

⌑ a) Pulsed constantly while idling in Park or Neutral at approximately 40% Duty cycle.
b) Voltage observed varied with throttle opening as well as during selector lever movement.

◎ a) Pulsed constantly while idling in Park or Neutral at approximately 33% Duty cycle.
b) Voltage observed varied with throttle opening during each gear shift only.

NOTE: ***The TCC solenoid is not listed here but is pulsed to apply the converter clutch***

Figure 2

SHIFT GROUPS
By viewing the mechanical, hydraulic and electrical operation of a shift, it can be observed that a specific solenoid and a group of valves cause a clutch application change. This is described as a "Shift Group." A shift group has two phases. The transition from one gear to the next is called a "shift phase." Once the shift is complete and the transmission is in gear it is called the "stationary phase." There are a total of three shift groups with which 5 forward speeds are achieved. In a shift phase, a shift solenoid initiates the application of one group of valves to change the clutches required for that shift. During this time the other two groups remain in the stationary phase.

The three shift groups are as follows:

Shift Group K1/B1 (Gear Changes 1-2/4-5)
This group controls the upshift and downshifts 1-2/2-1 and the 4-5/5-4.

· K1 Clutch
· B1 Brake
· 1-2/4-5 Command Valve
· 1-2/4-5 Holding Pressure Shift Valve
· 1-2/4-5 Shift Pressure Shift Valve
· 1-2/4-5 Overlap Valve
· 1-2/4-5 Shift Solenoid (Y3/6y3)

Shift Group K2/K3 (Gear Change 2-3)
This group controls the upshift and downshift 2-3/3-2.

· K2 Clutch
· K3 Clutch
· 2-3 Command Valve
· 2-3 Holding Pressure Shift Valve
· 2-3 Shift Pressure Shift Valve
· 2-3 Overlap Valve
· 2-3 Shift Solenoid (Y3/6y5)

Shift Group K3/B2 (Gear Change 3-4)
This group controls the upshift and downshift 3-4/4-3.

· K3 Clutch
· B2 Brake
· 3-4 Command Valve
· 3-4 Holding Pressure Shift Valve
· 3-4 Shift Pressure Shift Valve
· 3-4 Overlap Valve
· 3-4 Shift Solenoid (Y3/6y4)

COMPUTER STRATEGY
In the beginning of the article under the heading of "Hydraulics," it mentioned how internal transmission pressures are controlled and calculated from various inputs to the TCM. The TCM utilizes these inputs to perform proper shift timing and shift feel under diverse driving conditions through 4 basic adaptation programs. They are: The Driving Style, Shift Time, Fill Pressure and Fill Time.

DRIVING STYLE ADAPTATION
The Driving Style Adaptation is a program ready to adapt to the driving condition as it happens. The TCM is constantly monitoring vehicle speed and throttle opening as well as the rate of change of the throttle as it opens and closes. It also looks at lateral acceleration which is a term for curve recognition. Basically it monitors wheel speeds to determine when and if the vehicle is in a turn. In addition to these inputs it also monitors the frequency of gear changes. As a result, it can quickly adapt to a shift time and feel appropriate for the present condition. This adaptation is not written to memory. It is known as an adaptation that "lives for the moment."

SHIFT TIME ADAPTATION (Shift Overlap Adaptation)
This strategy focuses on the quality of the up-shifts and downshifts while under load and no load conditions. Shift time adaptation gives the TCM the ability to electronically alter the time it takes to go from one gear to another. In other words, the time it takes to disengage one clutch while applying another. Once the TCM has calculated the type of shift that needs to take place, the TCM utilizes the following two strategies to accomplish the task.

FILL PRESSURE ADAPTATION (Apply Pressure Adaptation)
This strategy gives the TCM the ability to control and modify the pressure used to engage a clutch which results in the type of shift feel that will occur.

FILL TIME ADAPTATION (Preload Pressure Adaptation)
This strategy gives the TCM the ability to control the time it takes to fill a clutch drum bringing the clutch pack to a "0" clearance but not yet applying the clutch. This adaptation compensates for wear of the friction plates.

SCANNER DIAGNOSIS

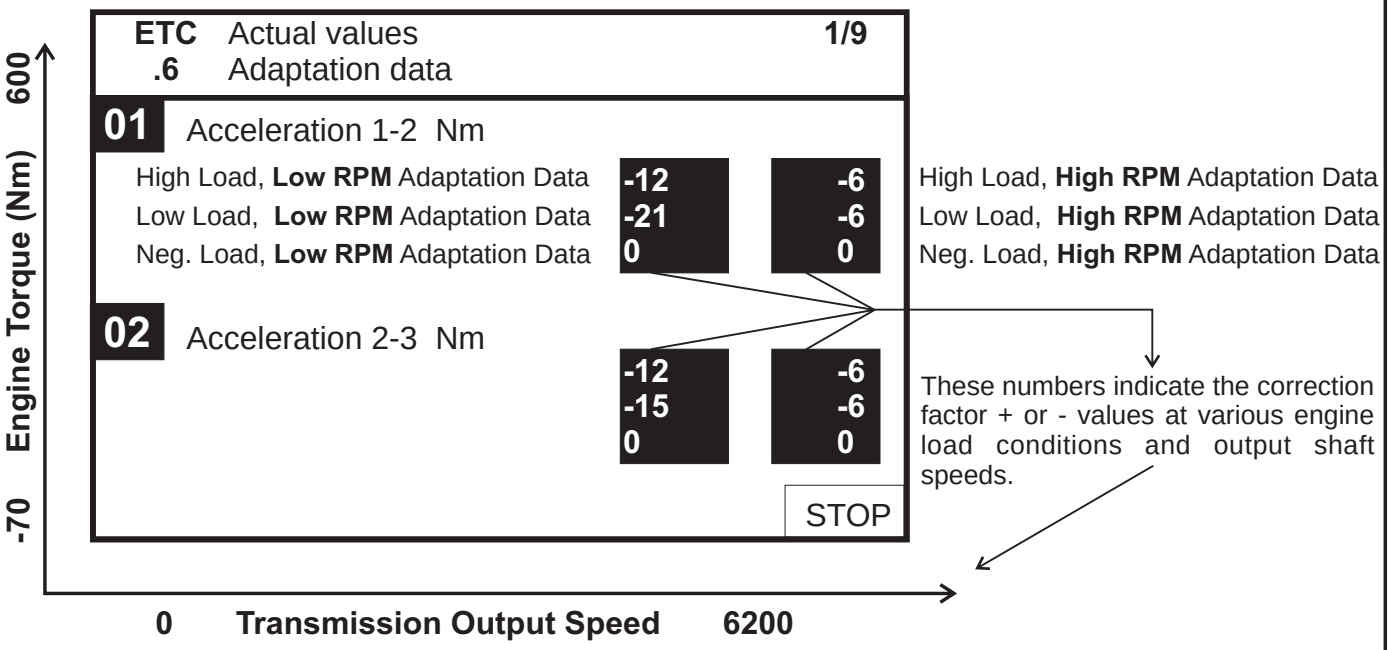
Shift Time Adaptation (Figures 3 & 4)
Specific values are needed to make the Shift Time Adaptation and these values are written to memory enabling the ETC to adapt during the following shift occurrences:

1. Accelerating Up-shift adaptation: Up-shifts that occur under load
2. Deceleration Up-shifts adaptation: Up-shifts that occur under no load
3. Accelerating Down-shifts adaptation: Down-shifts that occur under load
4. Deceleration Down-shifts adaptation: Down-shifts that occur under no load (i.e. coast down shift)

These values are represented in Newton meters (Nm) meaning "Torque." In other words, the strength of the shift. There are no ideal numbers to achieve. For example; if a 1-2 up-shift that occurs under load with an 8 cylinder engine has a 190Nm reading and the shift quality is acceptable, one may consider that the computer is able to handle and overcome the existing clutch clearance or a slight leak in the system without a flare on the shift and possible premature damage to the applying clutch. A 0 number indicates that a clutch pack does not require adaptation or the clutch pack has not yet adapted. However, if an adaptation value is at its maximum value, and the shift is unacceptable, repair work may be required. Additional adaptation cannot be achieved when the following values are reached:

<u>Maximum values in Nm</u>:
8 and 12 cylinder engines have a + or - 210 Nm
6 cylinder engines have a + or - 180 Nm
4 cylinder engines have a + or - 150 Nm

Analyzing Shift Time Adaptation Data as seen on the factory scan tool



Viewing an example of a 1-2 up-shift as seen in a scanner (Figures 3 & 4), the low numbers indicate that a small amount of adaptation was required to optimize the shift. It is the K1 clutch that is applied on the 1-2 up-shift. Therefore, we can conclude that the clutch clearance for the K1 clutch is within specification tolerances. It also indicates that there are no excessive leaks in the circuit as well.

Figure 3

Analyzing Shift Time Adaptation Data as seen on the Snap-on scan tool

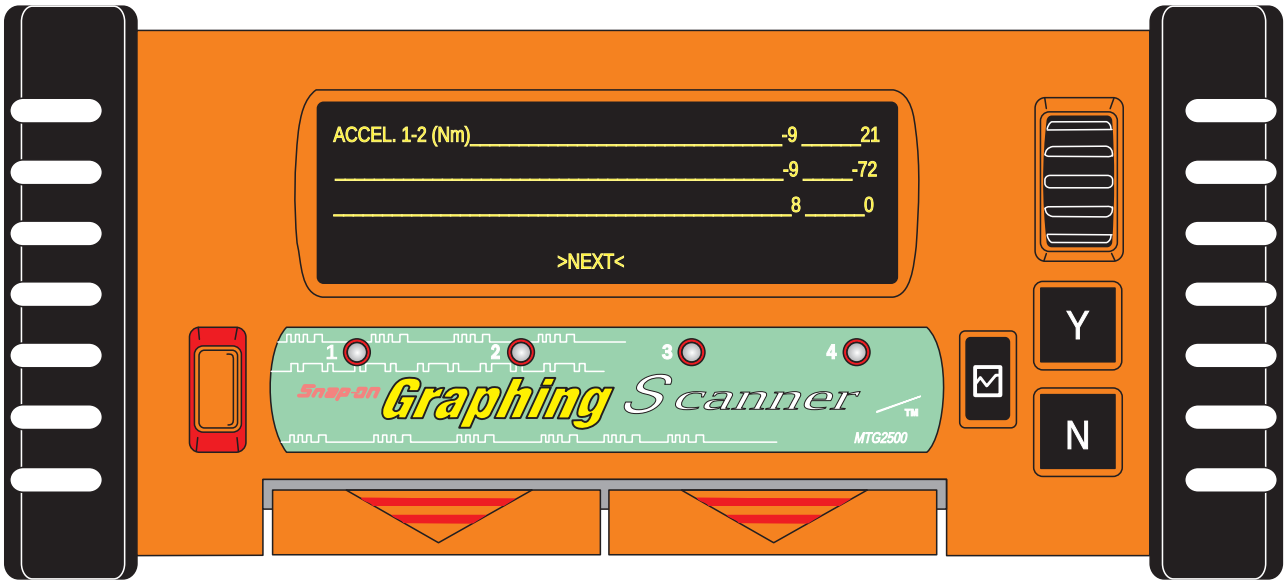


Figure 4

Fill Pressure (Figures 5 & 6)
Fill pressure is measured and presented in millibars (mbar). Higher values indicate that the TCM is increasing fill pressure to produce a firmer shift. Lower values indicate that the TCM is decreasing fill pressure to produce a softer shift. 0 mbar means that either the TCM has not stored an adaptive value, or that the shift member does not require correction. A value at the parameters upper limit, along with poor shift quality, indicates the need for repair.

Analyzing Adaptation for Fill Pressure Data as seen on the factory scan tool

ETC .6	Actual values Adaptation data	
17	Fill pressure 1-2	
	-400 mbar	MAX 1600
18	Fill pressure 2-3	
	-100 mbar	
19	Fill time K1 in 2nd gr.	
	0 Cycle	
20	Fill time K2	
	0 Cycle	
21	Fill time K3	
	0 Cycle	

Figure 5

Analyzing Shift Time Adaptation Data as seen on the Snap-on scan tool

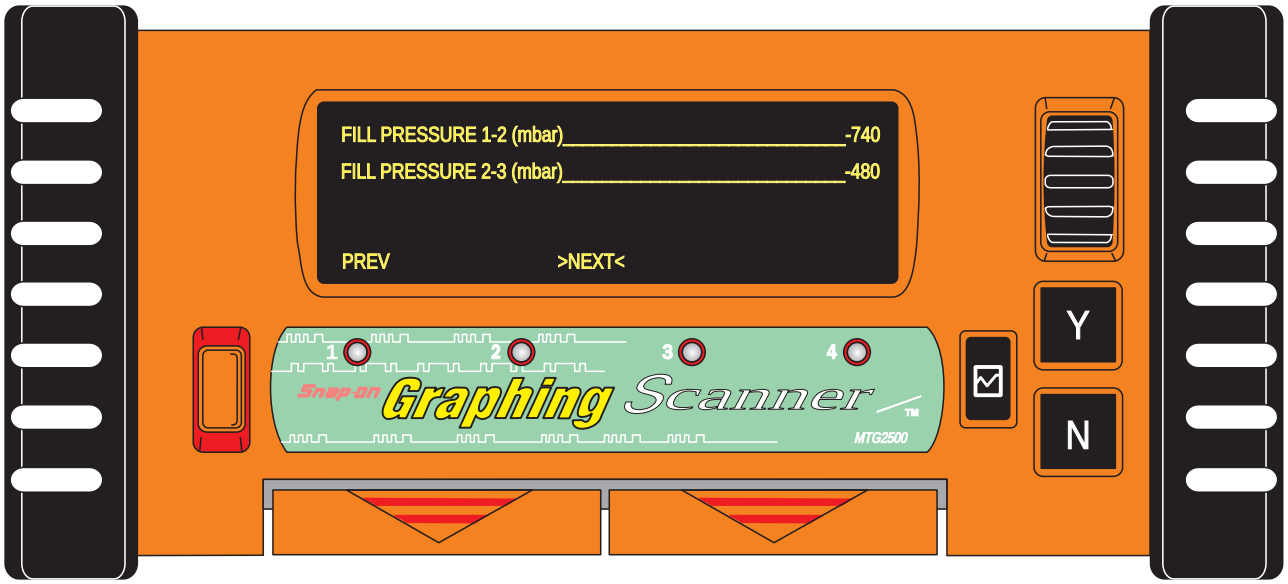


Figure 6

Fill Time (Figures 7 & 8)

Data parameters for Fill Time are displayed in cycles of time. The TCM controls the two pressure solenoids with an amplitude-modulated current. Amplitude means the highest value of a periodically varying quantity. The greater the signal amplitude, or difference between the highs and lows of the signal, the greater the pressure. The TCM can only change signal amplitude once per 20 milliseconds (ms). Each cycle displayed by these data parameters equals one 20-ms period. If the Scanner reports a fill time adaptation of 3 cycles, this means that it took three periods of 20-ms each (60 ms) to alter pressure enough to accomplish the correct application of the shift member. The maximum fill correction time is 15 cycles, or 300 ms. A value of 0 cycles indicates no fill correction was needed.

Analyzing Adaptation for Fill Time Data as seen on the factory scan tool

ETC .6	Actual values Adaptation data		9/9
22	Fill time B1	0 Cycle	
23	Fill time B2	0 Cycle	MAX 15
24	Fill time K1	0 Cycle	

Figure 7

Analyzing Shift Time Adaptation Data as seen on the Snap-on scan tool

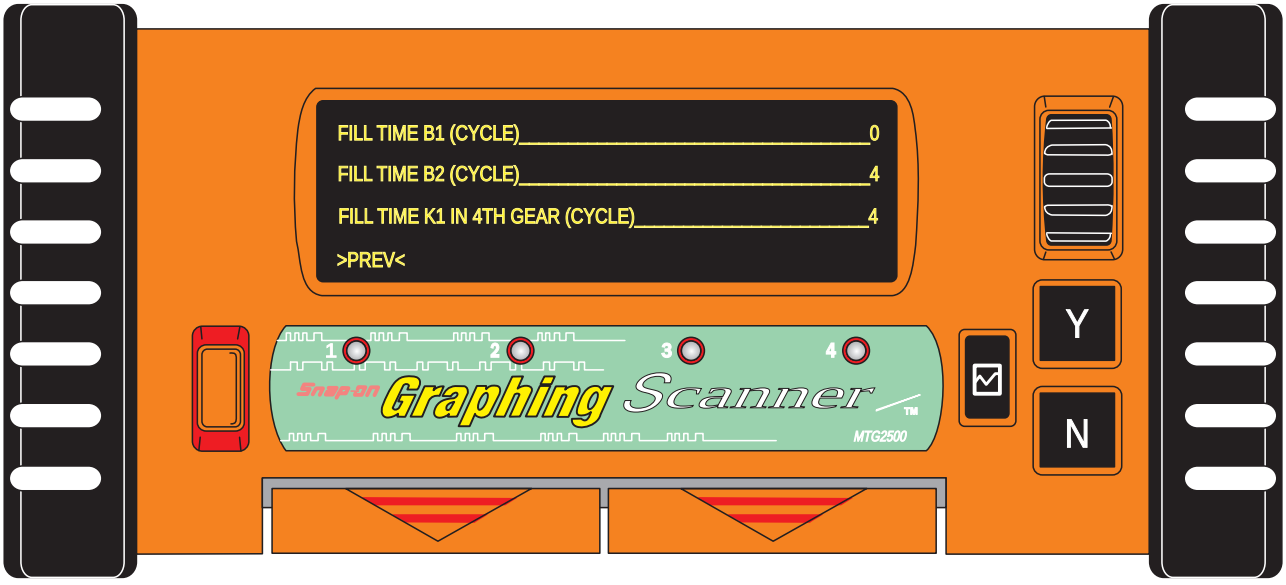
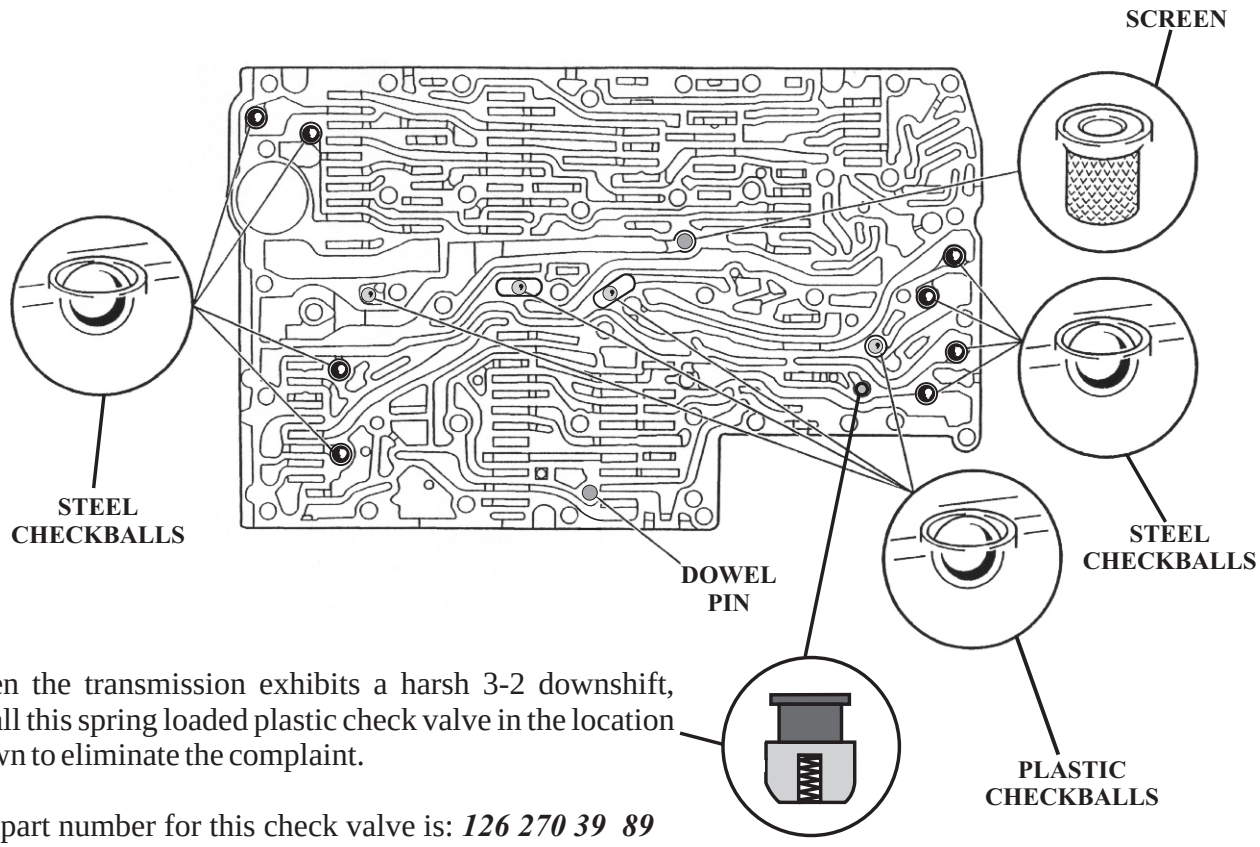


Figure 8

Exhaust Circuits

There is a shift overlap valve in the valve body that controls the decrease in pressing of a releasing clutch. In addition there are check balls which assist in metering the vented pressure (Figure 9).

722.6 VALVE BODY CHECK BALL & SMALL PARTS LOCATIONS



When the transmission exhibits a harsh 3-2 downshift, install this spring loaded plastic check valve in the location shown to eliminate the complaint.

The part number for this check valve is: ***126 270 39 89***

Figure 9

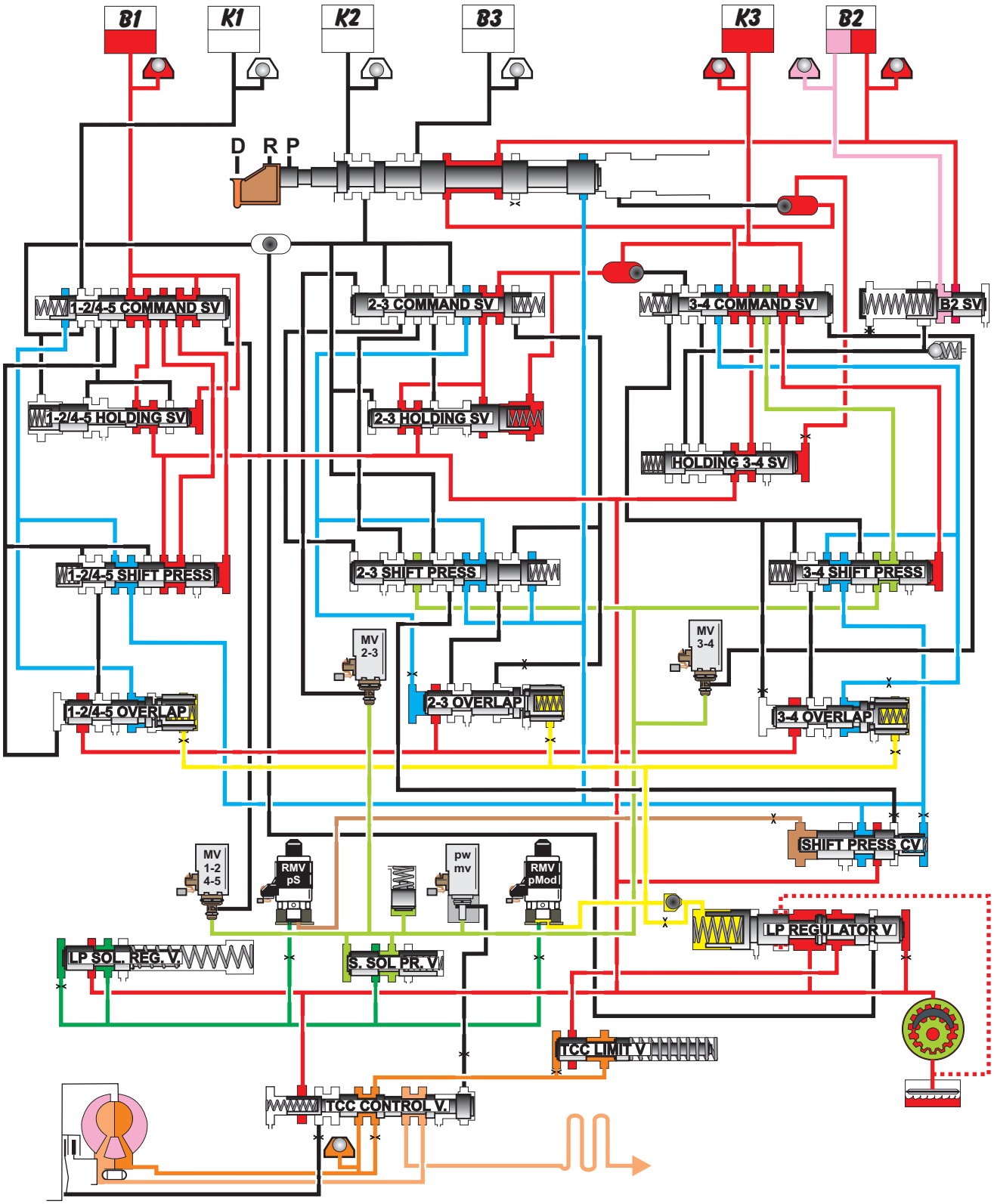

B1
K1
K2
B3
K3
B2
D R P
1-2/4-5 COMMAND SV
2-3 COMMAND SV
3-4 COMMAND SV
B2 SV
1-2/4-5 HOLDING SV
2-3 HOLDING SV
HOLDING 3-4 SV
1-2/4-5 SHIFT PRESS
2-3 SHIFT PRESS
3-4 SHIFT PRESS
MV 2-3
MV 3-4
1-2/4-5 OVERLAP
2-3 OVERLAP
3-4 OVERLAP
SHIFT PRESS CV
MV 1-2 4-5
RMV pS
pw mv
RMV pMod
LP REGULATOR V
LP SOL. REG. V.
S. SOL PR. V.
TCC LIMIT V
TCC CONTROL V.
Drive First Gear
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Figure 10