

## THE ART OF THEORY

# The Strategy of the 722.9 (NAG2)



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Mercedes Benz has introduced the 5<sup>th</sup> generation electronically controlled transmission, called the 722.9 (NAG2). This unit has seven forward speeds, two reverse speeds, and no mechanical one-way clutches.

In 2000, Mercedes launched the 722.9 into their overseas C-class. It didn't reach United States production vehicles until 2005. These units can be found in a variety of models, from the C-class to the S-class.

The fluid for these units is specific to Mercedes — ATF 3353 — and it'll retro to all earlier Mercedes Benz transmissions. Check with your local supplier for fluids that may be equivalent.

The transmission is constructed with an aluminum bellhousing and a magnesium case. The pump plate is made out of aluminum with an elastomer coating. The pump is bolted down using aluminum bolts which should be replaced during every rebuild.

### Sport, Comfort, and Tap Modes

Like most transmissions, the 722.9 is controlled using variable shift programming. This means the customer has the choice of sport or comfort mode. The sport/comfort (S/C) switch is located on the electronic shifter module (ESM), which consists of the shifter lever assembly and all of the components. Each mode employs certain strategies that allow the vehicle to perform differently.

In sport mode the transmission starts in 1<sup>st</sup> gear and shifts normally; the reverse ratio is 3.42:1.

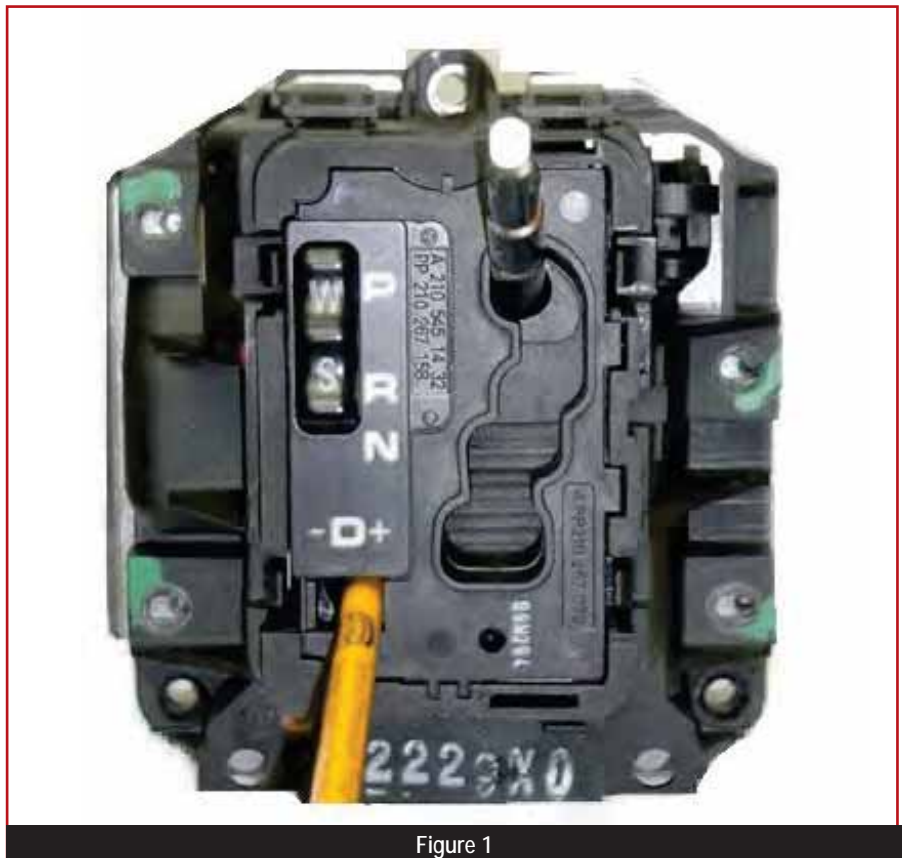
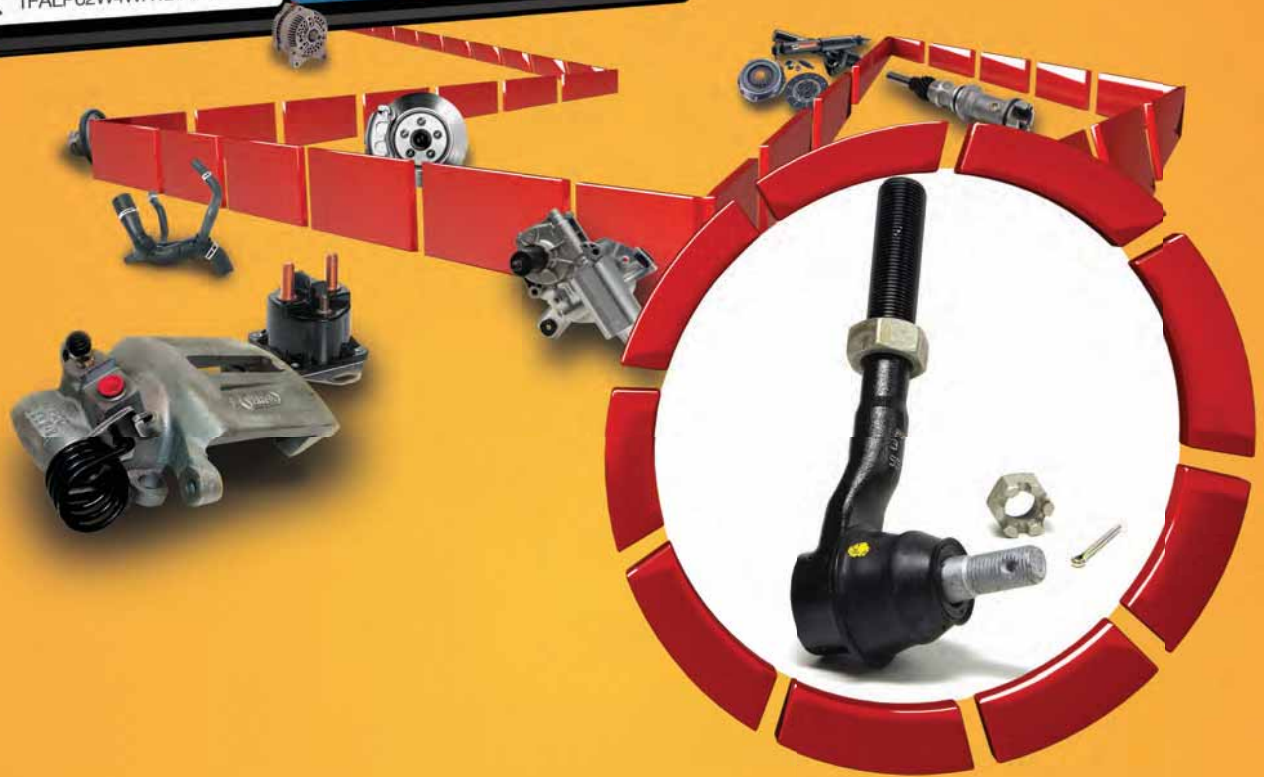


Figure 1

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## The Strategy of the 722.9 (NAG2)

In comfort mode the transmission starts in 2<sup>nd</sup> gear, but will take off in 1<sup>st</sup> if manually selected or acceleration is ¾-to-full throttle. It also exhibits earlier upshifts, later downshifts, and the reverse ratio is 2.22:1.

All upshifts and downshifts are influenced by current driving style and loads, similar to the 722.6. The shift program uses intelligent gear selection when tapped out of D using the “—” (Figure 1). When you tap the shifter into a lower gear, the transmission control module will shift the transmission down one gear from the current ratio.

An example of this is the S500: Driving at 30 MPH in D, tap the “—” button once and the transmission downshifts into 3<sup>rd</sup> gear from 4<sup>th</sup>. Driving at 50 MPH in D, tap the “—” and the transmission downshifts into 5<sup>th</sup> gear from 6<sup>th</sup>. The gear display on the instrument cluster informs the driver of highest gear now available.

In addition to shifting through the gears sequentially, the 722.9 can skip gears while downshifting, as long as only one member in the transmission is released and one member is applied (Figure 2).

## Clutch and Brake Operation

Internally the 722.9 has three, multi-disc clutch elements and four, multi-disc brake elements for holding. There are three planetary gearsets: two simple sets and one Ravigneaux gearset. The clutches are identified as K-1, K-2, and K-3. The brake elements are identified as B-1, B-2, B-3 and B/R.

- K-1 clutch is used in 3<sup>rd</sup>, 4<sup>th</sup>, and 5<sup>th</sup> gears.
- K-2 clutch is used in 4<sup>th</sup>, 5<sup>th</sup>, 6<sup>th</sup> and 7<sup>th</sup> gears.
- K-3 clutch is used in all ranges except 4<sup>th</sup> gear.
- B-1 holds in 2<sup>nd</sup>, 6<sup>th</sup>, and reverse sport mode.
- B-2 holds in 1<sup>st</sup> through 4<sup>th</sup> gears.
- B-3 holds in 1<sup>st</sup> and 7<sup>th</sup> gears, and neutral and reverse comfort mode.
- B/R holds only in the reverse position S/C.

## Electrohydraulic Control Module (ECM)

The 722.9 has its transmission con-

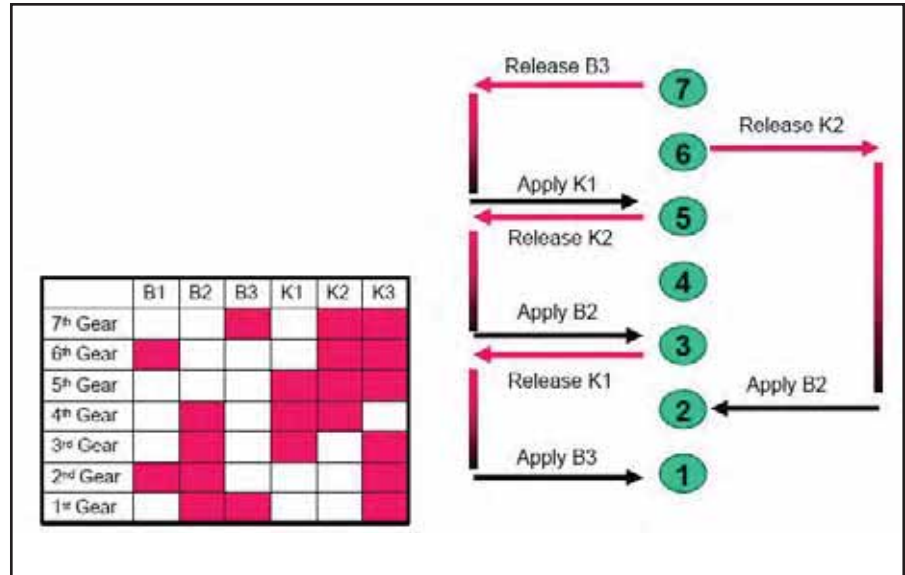


Figure 2

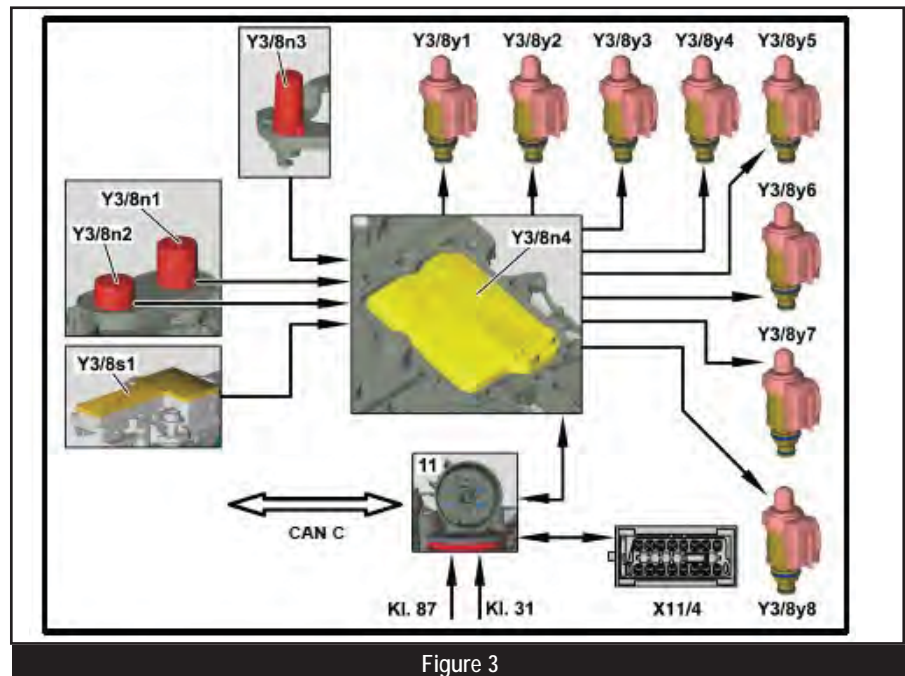


Figure 3

trol module (TCM) on the valve body (Figure 3). Identifying the TCM is probably the most important part of the rebuilding process. The TCM is unique to the transmission, which means when the transmission is assembled at the factory, the valve body is built and programmed specifically for that transmission.

Replacing the TCM or valve body on the 722.9 means you *must* have the TCM programmed for the specific vehicle from the factory. Test values are evaluated and corresponding algorithms are written to the control module's permanent memory. This process ensures that the control module is calibrated to the mechanical and electrical

solenoid valves in that valve body. Once this process is complete, the valve body assembly can be installed in the transmission.

For now, only the factory has this capability. Word on the street says someone is already working on getting this out to the aftermarket.

## TCM Functions

Since the TCM is integrated with the valve body, wiring to the transmission has been greatly reduced. The case connector has only five pins.

Here's what each pin on the transmission connector does:

- Pin 1 — CAN C high
- Pin 2 — CAN C low



A large, circular Raybestos GPZ100 friction plate is the central focus of the advertisement. It is shown in a perspective view, with its outer ring and inner gear-like teeth clearly visible. The plate is a light brown or tan color. The Raybestos logo is at the top, and the GPZ100 model name is prominently displayed in the center. The background is a dark blue gradient.

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Pin 3 — K-Line, used for diagnostics through the data link connector (DLC)

Pin 4 — relay or fused power, depending on the vehicle type

Pin 5 — communication by the SDS (Star Diagnostic Systems) to the CGW (Central Gateway Module) via the CAN D, then to the ECM (Electrohydraulic Control Module) over CAN C

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

The input drum has two plastic strips with magnets attached to it. These magnets enable the turbine and center speed sensors to create signals. The park pawl gear is used for the output speed sensor.

### Solenoid Identification

All of the solenoids are actuated by the transmission control module using variable current. Each solenoid valve has a mesh filter beneath it to prevent contamination. These valves produce increasing pressure with increasing current, or no pressure with no current (normally closed) (Figure 4):

- K-1 clutch solenoid: a normally-closed solenoid; high current equals high pressure and no current no pressure.
- B-2 B/R solenoid: a normally-closed solenoid; high current equals high pressure and no current no pressure.
- B-3 solenoid: a normally-closed solenoid; high current equals high pressure and no current no pressure.
- Lockup: a normally-closed

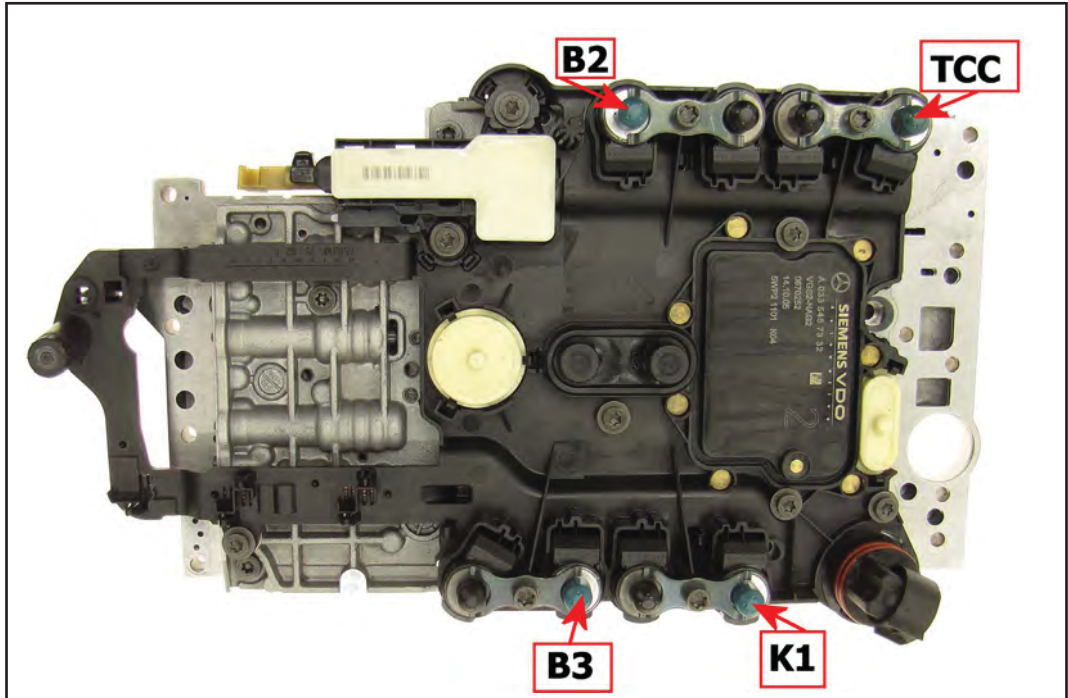


Figure 4

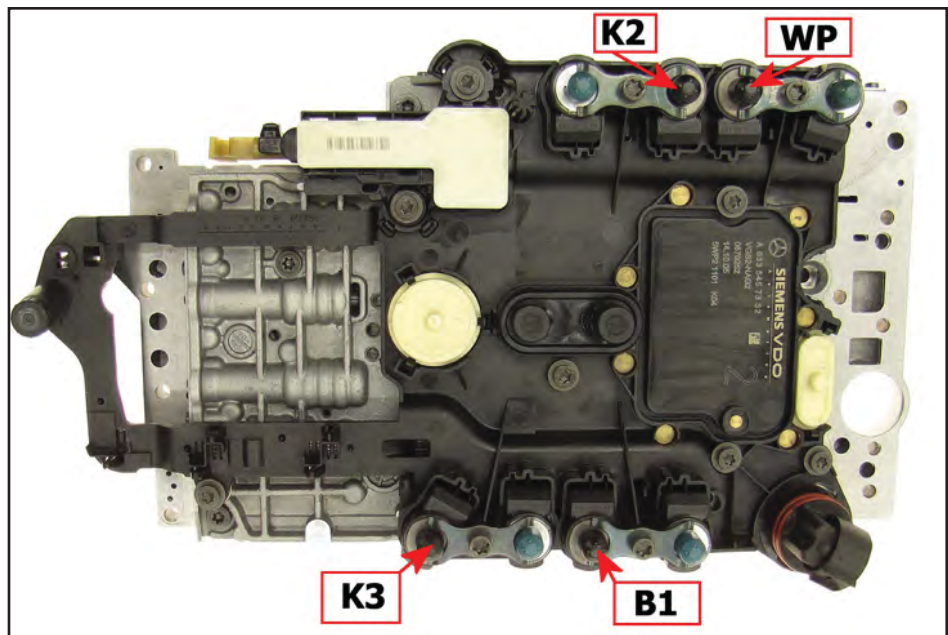


Figure 5

solenoid; high current equals high pressure and no current no pressure.

These next valves are normally open; they produce maximum pressure with no current or no pressure with maximum current (Figure 5):

- Working pressure solenoid: a normally-open solenoid; when there's no current you'll have maximum line pressure and high current will have low pressure.
- K-2 clutch solenoid: a normally-open solenoid; when there's no

current you'll have maximum line pressure and high current will have low pressure.

- K-3 clutch solenoid: a normally-open solenoid; when there's no current you'll have maximum line pressure and high current will have low pressure.
- B-1 solenoid: a normally open-solenoid; when there's no current you'll have maximum line pressure and high current will have low pressure.

The Working Pressure, K-2, K-3,



# MOST WANTED



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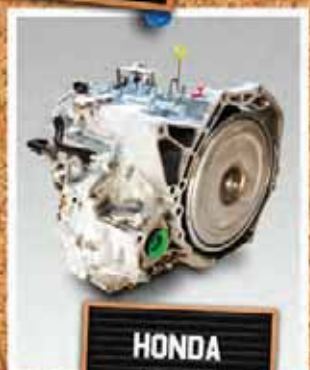
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Figure 6

and B-1 solenoids are responsible for limp home mode (failsafe) when all solenoid valves are de-energized.

## Emergency Function and Limp Mode

In the event of transmission failure, the TCM goes into a failsafe mode. Failsafe for this transmission is 6<sup>th</sup> gear in all forward ranges, plus reverse.

The 722.9 has many different failsafe modes: If a solenoid fails, the clutch that solenoid controls won't function. For example, if the B-3 solenoid fails, the transmission won't go into 1<sup>st</sup>, 7<sup>th</sup>, or reverse in S mode.

If a clutch fails while driving, the transmission remains in the previous gear.

If the TCM fails internally during a driving, all solenoids are switched off. The normally-open solenoids valves allow full working pressure to their respective members, defaulting to 6<sup>th</sup> gear.

If a solenoid, TCM, or clutch fails and the vehicle is brought to a stop and shifted into park, oil pressure from the K-2 solenoid is redirected to the B-2 and B/R circuit. Once this happens,

the emergency operation valves only allow Drive 2 gear in forward gears and reverse.

Some late model 722.9 transmissions use shift-by-wire controls, called Direct Select: There's no mechanical connection through a shifter cable or linkage. An intelligent servo module (ISM) will be attached to the case above the left rear pan rail.

There's an emergency park function to release the transmission from park. This function uses a spare battery under the passenger floor panel to energize the module.

## Control Module Software

Control module software can be loaded using the SDS/DAS (Star Diagnostic Systems/Digital Aid System) (Figure 6) and the appropriate update CD ROM. This process doesn't erase the factory algorithms that were written to the control module during manufacture.

Flashing the control module must be performed:

- after replacing the transmission
- after replacing the electrohydraulic valve body

- to update the control module software to resolve a problem

If the transmission control module is new or the transmission replaced, part of the installation process requires releasing transport protection and personalizing (marrying) the module. Once the transmission control module is married to the vehicle, it won't work correctly in another vehicle (only limp-home mode).

But European and American legislation requires that emission-relevant control modules be codeable with a Software Calibration Number (SCN) to prevent manipulating the software. As of 2004, transmission control modules must incorporate SCN coding. Which means that, as soon as someone creates reprogramming software, we can get after it!

Even though this unit has some unique attributes, it's not all that bad. The more you gain ground on it, the easier it will become. The trick is to learn a little theory before jumping into a rebuild.



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