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INTRODUCTION

This course is designed for the technician who has a basic understanding of automatic transmissions. This course covers the New Automatic Gearbox (NAG) 1 (version 1) transmission. Basic operation of this transmission is similar to other transmissions; therefore, this training program focuses on the unique operation, diagnosis and repair of the NAG1 transmission.

The information in this publication should be used with the service information when performing repairs. The concepts learned here will help diagnose and repair this transmission.

The NAG1 transmission is an electronically controlled five-speed automatic transmission with a variably engaged torque converter clutch. It is a conventional automatic transmission because it uses hydraulically applied clutches to control three planetary gear sets. The electronic components consist of the Transmission Control Module (TCM), Shift Lever Assembly (SLA), an internally mounted valve body with switches, solenoids and sensors, and inputs from other vehicle systems.

Electronic transmission control provides for more precise adaptation of pressures to corresponding conditions and to the engine output during shifting which results in enhanced shift quality.

Electronic control also offers the advantage of a flexible adaptation to various vehicles and engines. Some of the advantages are:

- Reduced fuel consumption
- Improved shift comfort
- Favorable step-up through gear ranges
- Increased reliability and service life
- Lower maintenance
STUDENT LEARNING OBJECTIVES

Upon successful completion of this course, you will be able to:

- Identify the transmission by decoding the ID tag.
- Identify the proper transmission fluid, service intervals and procedures.
- Identify transmission architecture and major subassemblies.
- Demonstrate transmission powerflow.
- Identify the valve body components.
- Identify hydraulic flow and solenoid actuation necessary to achieve all gear ratios.
- Identify all levels of pressure regulation inside the transmission and understand EMCC/TCC operation.
- Perform the necessary electrical related diagnostic scan tool activities to identify all direct and indirect TCM inputs and outputs.
- Perform the scan tool shift adaptation procedure.
ACRONYMS

The acronyms listed here are used in this course.

- **ABS** Anti-lock Braking System
- **ATF** Automatic Transmission Fluid
- **B1** B1 Brake Clutch
- **B2** B2 Brake Clutch
- **B3** B3 Brake Clutch
- **BTSI** Brake/Transmission Shift Interlock
- **BUX** Built Up for Export
- **CAB** Controller Anti-lock Brake
- **CAN** Controller Area Network (Bus), Chassis CAN
- **CAN-B** Body CAN bus
- **CAN-C** Engine and Diagnostic CAN bus
- **C+** C+ CAN Circuit I.D.
- **C–** C– CAN Circuit I.D.
- **CGW** Central Gateway
- **CKD** Complete Knock Down (e.g. Import to China)
- **DMM** Digital Multi-Meter
- **DTC** Diagnostic Trouble Code
- **ECM** Engine Control Module (Diesel Engine Controller)
- **EGS52** Electronic Gearbox System (Version 52)
- **EGS53** Electronic Gearbox System (Version 53)
- **EMCC** Electronically Modulated Converter Clutch
- **ESM** Electronic Shifter Module
- **ESP** Electronic Stability Program
- **ETC** Electronic Throttle Control
- **F1** F1 Overrunning Clutch
- **F2** F2 Overrunning Clutch
- **ITP** Indiana Transmission Plant
- **K** Kinetic
- **K1** K1 Input Clutch
VEHICLE BODY CODES

The NAG1 Transmission can be found in the following vehicle body codes:

- KA  Nitro
- KK  Liberty
- XK  Commander
- XH  Commander BUX
- LE  300/Magnum BUX
- LX  300/Magnum
- L2  300/Magnum CKD
- LC  Challenger
- VA/VB  Sprinter
- W2  Grand Cherokee CKD
- WK  Grand Cherokee
- WH  Grand Cherokee BUX
- ZH/ZB  Crossfire
The New Automatic Gearbox - Version 1 (NAG1) automatic transmission is an electronically controlled, five-speed transmission equipped with a variably engaged torque converter clutch. As with most automatic transmissions, the NAG1 transmission uses hydraulically applied clutches to control the planetary gear train.
The NAG1 automatic transmission uses three planetary gear sets to transmit torque in five forward ratios. Fifth gear is an overdrive range. The planetary gear set is actuated by application of hydraulic clutches (B1, K1, K2, B3, K3 and B2) via shift valves and electric solenoids in the valve body. The NAG1 also uses two overrunning clutches (F1 and F2). The Transmission Control Module (TCM) electronically actuates the solenoids. The electronic control system enables application of fluid pressures for adaptation to the current operating conditions such as vehicle speed and engine output during a shift phase, thus providing quality shifts.

The system performs its functions based on continuous sensor and switch feedback information. In addition, the TCM receives information from the engine management, body control and chassis control systems over the CAN bus.

Figure 2  NAG1 Automatic Transmission (4x4 Shown)
The TCM controls fluid pressures to the operating clutches during the shift phase by looking at two input speed sensors (N3 and N2) (calculated input shaft speed) and ABS wheel speed sensors (calculated output shaft speed) along with other various inputs. TCM control provides quality transmission shifting. Having more precise control over the hydraulic system provides the advantage of flexible adaptation to various vehicle and engine combinations.

The NAG1 automatic transmission provides:

- Five forward gear ratios
- Adaptive mode
- Close ratios (1st through 5th)
- Lengthy fluid change intervals (some older models are fill-for-life)
- Two reverse ratios (some applications)

![NAG1 Automatic Transmission Clutch Orientation](image)

Figure 3  NAG1 Automatic Transmission Clutch Orientation
## TRANSMISSION MODEL DESIGNATION AND APPLICATION

The following illustration provides an example explanation of the NAG1 transmission model designation.

### Figure 4  Model Designation Breakdown (LX,LE,L2,WK,WH,XK,XH,KA,KK)

<table>
<thead>
<tr>
<th>W</th>
<th>Hydraulic Torque Converter</th>
<th>A or J</th>
<th>A = U.S.-Built*  J = German-Built</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Number of Forward Gears</td>
<td>580, 400, 380 or 330</td>
<td>Maximum Engine Input Torque (N•m)</td>
</tr>
</tbody>
</table>

### Figure 5  Model Designation Explanation (Sprinter/Crossfire)

<table>
<thead>
<tr>
<th>722.</th>
<th>Automatic Transmission for Passenger Cars</th>
<th>81</th>
<th>Version of Transmission for Vehicle Application Matched to Engine (Digits Vary with Application)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.</td>
<td>Sales Designation (W5AXXX)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
TRANSMISSION/VEHICLE APPLICATION

The NAG1 family of five-speed automatic transmissions includes the W5A580, the W5J400, the W5A380 and the W5A330 versions. The acronym NAG comes from the German phrase for ‘new automatic gearbox.’ The “1” refers to the first version of the transmission.

Table 1  NAG1 Transmission/Vehicle Application

<table>
<thead>
<tr>
<th>Transmission</th>
<th>Vehicle Application</th>
<th>Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>W5A330 (722.6.XX)</td>
<td>3.2L ZH</td>
<td>2004-2006</td>
</tr>
<tr>
<td></td>
<td>3.2L ZB</td>
<td>2007-2008</td>
</tr>
<tr>
<td>W5A380 (722.6.XX)</td>
<td>2.7L VA</td>
<td>2003-2006</td>
</tr>
<tr>
<td></td>
<td>3.0L VB</td>
<td>2007-2009</td>
</tr>
<tr>
<td></td>
<td>3.5L VB</td>
<td></td>
</tr>
<tr>
<td>W5J400</td>
<td>2.7L WG</td>
<td>2003-2004</td>
</tr>
<tr>
<td></td>
<td>3.0L WH</td>
<td>2005-2009</td>
</tr>
<tr>
<td></td>
<td>3.0L WK</td>
<td>2007-2009</td>
</tr>
<tr>
<td></td>
<td>3.0L XH</td>
<td>2006-2009</td>
</tr>
<tr>
<td></td>
<td>3.0L LX/LE</td>
<td></td>
</tr>
<tr>
<td>W5A580</td>
<td>3.5L LX RWD</td>
<td>2005-2007</td>
</tr>
<tr>
<td></td>
<td>3.7L WK/WH</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.5L LX AWD</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.5L LX Police/LE/L2 (RWD)</td>
<td>2005-2009</td>
</tr>
<tr>
<td></td>
<td>5.7L LX/LE/L2</td>
<td>2005-2009</td>
</tr>
<tr>
<td></td>
<td>3.7L W2</td>
<td>2006-2009</td>
</tr>
<tr>
<td></td>
<td>3.7L XK</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6.1L LX</td>
<td>2006-2009</td>
</tr>
<tr>
<td></td>
<td>6.1L WK/WH</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4.0L KA</td>
<td>2007-2009</td>
</tr>
<tr>
<td></td>
<td>2.8L KK</td>
<td>2008-2009</td>
</tr>
<tr>
<td></td>
<td>5.7L LC</td>
<td>2009</td>
</tr>
</tbody>
</table>
## Gear Ratios

Table 2 NAG1 Gear Ratios

<table>
<thead>
<tr>
<th>GEAR RANGE</th>
<th>RATIO (W5A580, W5J400 AND W5A380)</th>
<th>RATIO (W5A330)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st</td>
<td>3.59</td>
<td>3.95</td>
</tr>
<tr>
<td>2nd</td>
<td>2.19</td>
<td>2.423</td>
</tr>
<tr>
<td>3rd</td>
<td>1.41</td>
<td>1.486</td>
</tr>
<tr>
<td>4th</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>5th</td>
<td>0.83</td>
<td>0.833</td>
</tr>
<tr>
<td>Reverse 1</td>
<td>3.16</td>
<td>3.147</td>
</tr>
<tr>
<td>Reverse 2</td>
<td>1.93</td>
<td>1.93</td>
</tr>
<tr>
<td>(XK/WK in 4x4 LO &amp; Crossfire Winter Mode)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
TRANSMISSION IDENTIFICATION

With the exception of Sprinter and Crossfire models, the NAG1 Automatic transmission uses two types of identification:

- Barcode Label
- Machined Pin Stamp Pad

The illustration below shows the bar code and pin stamp orientation for a U.S.-Built NAG1 transmission in a Chrysler-built vehicle. This identification arrangement is found on the left (driver's) side of the transmission, just above the oil pan rail.

![Diagram of transmission identification](image)

<table>
<thead>
<tr>
<th></th>
<th>Transmission Bar Code Identification Label</th>
<th>Pin Stamp Pad</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

Figure 6 Transmission Identification (U.S.-Built Transmission / Chrysler-Built Vehicle)
The graphic below shows the bar code and pin stamp orientation for a German-built NAG1 transmission in a Chrysler-built vehicle. This identification arrangement is found on the left (driver's) side of the transmission, just above the oil pan rail.

<table>
<thead>
<tr>
<th></th>
<th>Transmission Bar Code Identification Label</th>
<th>2</th>
<th>Pin Stamp Pad</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Transmission Bar Code Identification Label</td>
<td>2</td>
<td>Pin Stamp Pad</td>
</tr>
</tbody>
</table>

Figure 7  Transmission Identification (German-Built Transmission / Chrysler-Built Vehicle)
The graphic below shows the pin stamp location for a German-built NAG1 transmission in a Sprinter/Crossfire vehicle. This identification pad is found on the left (driver's) side of the transmission, just above the oil pan rail.

**Figure 8** Transmission Identification (German-Built Transmission in Sprinter/Crossfire Vehicle)
### Barcode Label Breakdown

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Traceability</td>
<td>7</td>
<td>Build Sequence</td>
</tr>
<tr>
<td>2</td>
<td>Supplier Code</td>
<td>8</td>
<td>Last Three Part Number Digits</td>
</tr>
<tr>
<td>3</td>
<td>Component Code</td>
<td>9</td>
<td>Revision Level</td>
</tr>
<tr>
<td>4</td>
<td>Build Day (Julian Date)</td>
<td>10</td>
<td>Transmission Part Number</td>
</tr>
<tr>
<td>5</td>
<td>Build Year</td>
<td>11</td>
<td>Part Number Prefix</td>
</tr>
<tr>
<td>6</td>
<td>Line/Shift Code</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 9  Bar Code Label Breakdown (All vehicles except Sprinter/Crossfire)
PIN Stamp Breakdown

The upper row on the transmission ID designates the Mercedes-Benz (MB) part number. The middle row indicates that it is an automatic transmission (722), the sales designation (6), and the version (85).

<table>
<thead>
<tr>
<th>1</th>
<th>Part Number</th>
<th>4</th>
<th>Automatic Transmission for Cars</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Model Designation</td>
<td>5</td>
<td>Sales Designation</td>
</tr>
<tr>
<td>3</td>
<td>Production Code</td>
<td>6</td>
<td>Version: Vehicle Application Matched to Engine</td>
</tr>
</tbody>
</table>

Figure 10  Transmission ID Pad Data (German-Built Transmission)
SHIFT LEVER ASSEMBLY (SLA) & TRANSMISSION RANGES

All NAG1-equipped vehicles use a four-position shifter assembly to control transmission function. The floor-mounted Shift Lever Assembly (SLA) is mechanically connected to the transmission by a shift cable attached to the park lock mechanism and the manual valve in the valve body. As part of the assembly, the electronic shifter module, designated as the ESM, sends shift lever position status over the CAN bus to the TCM.

The NAG1 four-position SLA allows the driver to manually select:

- Park
- Reverse
- Neutral
- Drive
- ERS/Autostick™
A Winter/Standard (W/S) switch is incorporated into the shift lever assembly on Crossfire vehicles. With the W/S switch in the “S” position, lower gear ratios are provided in first and reverse gears. With the W/S switch in the “W” position, a higher ratio is provided in Reverse gear, and 2nd gear is used for launch.

Figure 12  NAG1 Four-Position Shifter (Crossfire Shown)
A four-position column gearshift lever is available on LX 'Police' vehicles. The column shifter option is convenient for Police and Municipal vehicles that require console-mounted equipment and accessories.
ELECTRONIC RANGE SELECT & AUTOSTICK™

The Electronic Range Select and Autostick features provide manual control of transmission shift points and top gear limits. This allows the driver to tailor transmission operation for performance, utility, and efficiency.

Electronic Range Select (ERS)

Electronic Range Select (ERS) is a feature available on all NAG1-equipped vehicles, except for SRT8, 5.7L Charger, Challenger, and 300C "Heritage" applications. ERS allows manual control of the transmission’s top gear limit. For example, selecting ERS 3rd gear (‘3’ displayed in cluster) provides the following operation:

- The transmission launches in 1st gear
- The transmission upshifts to 2nd when appropriate, following the normal shift schedule
- The transmission upshifts to 3rd when appropriate, again following the normal shift schedule.

As vehicle speed and engine RPM increase, the transmission will not upshift from 3rd to 4th as long as the ERS 3rd gear is selected. 3rd gear is the selected top gear limit. No further automatic upshifting takes place.
Autostick™

Autostick™ is a driver-interactive feature that is available in NAG1-equipped SRT8 and 5.7L hemi-equipped Dodge & Jeep vehicles. Autostick™ is a performance feature that allows manual control of transmission upshift and downshift points. At any time during transmission operation, enabling Autostick™ gives control of transmission shift points to the driver. For example, selecting Autostick™ 3rd gear at road speed (‘3’ displayed in cluster) provides the following operation:

- The transmission will upshift or downshift to 3rd (if mechanically safe)
- The transmission will stay in 3rd gear and not upshift until commanded by the driver, or a high rpm is attained and a forced upshift occurs.
- The transmission will automatically downshift if left in 3rd and the vehicle is brought to a crawl or stop.

With the vehicle standing still, and in gear, selecting Autostick™ 3rd gear (or higher) will not put the transmission in that range. 2nd gear is the highest selectable gear from a standing start.

**Note:** Autostick™ & ERS function may vary slightly depending on vehicle application and calibration differences.
Enabling and Operating ERS/Autostick™:

- With the shift lever in 'D', bump the shift lever to the left (─) to activate. The transmission will usually downshift one gear, and current transmission gear will be displayed.
- With a left or right motion, bump the shift lever to select the desired gear, or top gear limit.
  
  (OR)

- Police Models: Press the 'Autostick On/Off' button at the end of the shift lever once. Then operate the rocker switch up (+) and down (─) to control the top gear limit. **Note: Police models have ERS function, not Autostick as printed on the shift lever.**

Disabling ERS/Autostick:

- With the shift lever in ‘D’, bump and hold (for one second) the shift lever to the right (+)
  
  (OR)

- Police Models: Press the 'Autostick On/Off' button at the end of the shift lever once.
  
  (OR)

- Take the shift lever out of the ‘D’ range. **It is not recommended to take the shift lever out of the ‘D’ range when the vehicle is moving.**

ERS/Autostick™ Application

The following table identifies the current application of the ERS and Autostick features.

<table>
<thead>
<tr>
<th>ERS</th>
<th>Autostick</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.8L KA/KK</td>
<td>5.7L Charger</td>
</tr>
<tr>
<td>3.0L LX</td>
<td>5.7L Challenger</td>
</tr>
<tr>
<td>3.0L WK/XK</td>
<td>5.7L 300C “Heritage” Edition</td>
</tr>
<tr>
<td>3.5L LX</td>
<td>6.1L LX</td>
</tr>
<tr>
<td>3.7L WK/XK</td>
<td>6.1L WK</td>
</tr>
<tr>
<td>4.0L KA</td>
<td>3.2L ZB/ZH</td>
</tr>
<tr>
<td>5.7L 300C Standard</td>
<td></td>
</tr>
<tr>
<td>5.7L Magnum</td>
<td></td>
</tr>
<tr>
<td>5.7L LX Police</td>
<td></td>
</tr>
<tr>
<td>3.0/3.5L VA/VB</td>
<td></td>
</tr>
</tbody>
</table>
Brake/Transmission Shift Interlock (BTSI) System

The Brake/Transmission Shift Interlock system combines functions which, in addition to the parking brake, help prevent the vehicle from moving off unintentionally. The brake/transmission shift interlock system includes the following functions:

- **Locking the selector lever in park** - the selector lever lock function only allows shifting out of park when the ignition switch has been turned to position 2 and the brake pedal is pressed.

- **Locking the park detent in the transmission** - the vehicle is secured mechanically by blocking the parking gear. In the event of mechanical or electrical problems, manual release out of park is possible (BTSI Override).

The shifter interlock electronically locks the selector lever in position P. The selector lever remains locked in park when the brake is not operated and the ESM control module is not supplied with ignition switch voltage.

With the ignition switch in position 2, the ESM control module actuates the shifter interlock solenoid when the brake pedal is operated and when selector lever position P is detected. The shifter interlock solenoid unlocks the selector lever and enables a shift out of park.

**Reverse Block**

The shifter incorporates the park/reverse lockout mechanism and solenoid to prevent movement of the shift lever from neutral into reverse or park above 10 km/h (6.2 mph). Park/reverse lock out is controlled by the Electronic Shifter Module (ESM).

---

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Electronic Shift Module (ESM)</td>
</tr>
<tr>
<td>2</td>
<td>ESP Control Module</td>
</tr>
<tr>
<td>3</td>
<td>Shifter Interlock Solenoid</td>
</tr>
</tbody>
</table>

Figure 17  BTSI Interlock (VB Sprinter Shown)
Ignition Switch Interlock

- **Locking the ignition switch** - to ensure that after parking the vehicle the selector lever is shifted into park, the ignition key can only be turned towards position 0 and be removed from the Ignition Cylinder or Central Gateway Module (CGW) in this position.

The mechanical system of the ignition switch interlock connects the selector lever with the Ignition cylinder or CGW module. The system prevents the ignition key from being removed when the shift lever is not in park. When the parking lock is not engaged (selector lever position D, R, or N), the blocking slide blocks the blocking cam. The compression spring only pulls the blocking slide away from the blocking cam in selector lever position P. The ignition key can now be turned into position 0 and removed.

![Diagram of Ignition Switch Interlock](image)

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Locking Valve</td>
</tr>
<tr>
<td>2</td>
<td>Ignition Adapter Housing</td>
</tr>
<tr>
<td>3</td>
<td>Compression Spring</td>
</tr>
</tbody>
</table>

Figure 18 Ignition Switch Interlock (VB Sprinter Shown)
BTSI Override

In the event of an electrical problem, the shift lever can be moved out of park with the key in the UNLOCK or RUN positions and the mechanical release pushed.

LX/LE/L2 Models:

The BTSI override is accessed by removing the cubby bin rubber mat to the right of the shifter gate.

2005-2007 LX/LE/L2 model BTSI overrides are actuated by pressing the pink override lever with a finger. Pressing the lever allows the shifter and transmission to be taken out of PARK.

Figure 19 BTSI Override (2005-2007 LX w/o WINFOBIK Shown)
2008 and later LX/LE/L2 model BTSI overrides require cubby bin rubber mat removal, and the use of a screwdriver or blunt object as shown below. Again, pushing the lever allows the shifter and transmission to be taken out of PARK.

Figure 20  BTSI Override (2008 and later LX w/WINFOBIK Shown)
WK/WH/XK/XH and LC Models:

2008 and later WK/WH/XK/XH and LC model BTSI overrides require removal of a small cover to the right of the shift lever 'D' range. With the cover removed, inserting a screwdriver or blunt object as shown below allows the shift lever to be moved out of the PARK range.

Figure 21  BTSI Override (WK w/WINFOBIK Shown)
VA/VB Models:
To operate the BTSI override, insert a screwdriver (or blunt object) into the provision (with spring loaded door).

- On VA Sprinter models, it is found just below the “−D+” symbol on the SLA. Remove the trim bezel to gain access to the override button. Press the override lever to move the shift lever and transmission out of PARK.
- On VB Sprinter models, it is found below the shift lever assembly in the plastic cover as shown below. Remove the cover and insert a blunt object to actuate the lever.

![Figure 22 BTSI Override (VA Sprinter Shown)](image)

<table>
<thead>
<tr>
<th>1</th>
<th>Blunt Object in Notch</th>
<th>2</th>
<th>Shift Lever Assembly</th>
</tr>
</thead>
</table>

Figure 22 BTSI Override (VA Sprinter Shown)

![Figure 23 BTSI Override Access Hole (VB Sprinter Shown)](image)

Figure 23 BTSI Override Access Hole (VB Sprinter Shown)
TRANSMISSION FLUID

Transmission fluid serves a number of purposes including application of hydraulics, lubrication, cooling, cleaning and seal conditioning. Transmission shift quality, heat dissipation and Transmission Control Module (TCM) calibration all determine the type of transmission fluid that is used. Transmission fluids are similar but have different characteristics such as viscosity and the additives in the fluid, which is why there are different fluids depending on application. Drain and refill the transmission fluid at the recommended service intervals.

Fluid Type

Mopar® ATF+4 Automatic Transmission Fluid is the recommended transmission fluid when servicing the NAG1 transmission used in domestic version transmissions. Using ATF+4 ensures optimum transmission performance. The prescribed fluid level must be maintained.

Mopar® Crossfire & Sprinter Fluid must be used in Sprinter, Crossfire and Mercedes Benz versions of the NAG1 transmission. The transmission is calibrated to use this unique fluid, rather than ATF+4.

| 1  | ATF+4 (LX/LE, WK/WH, XK/XH, KA) |
| 2  | Crossfire/Sprinter Fluid (VA/VB, ZH/ZB) |

Figure 24  Figure 117  NAG1 Transmission Fluid Usage
Note: Chrysler does not approve the addition of any type or kind of additives to the transmission. An exception to this is the use of special dyes to aid in detecting fluid leaks.

Note: ATF+4 must always be used in vehicles that were originally filled with ATF+4.

Caution: Mopar Crossfire/Sprinter automatic transmission fluid must be used when servicing the NAG1 transmission in the Crossfire and Sprinter models. These transmissions are specifically calibrated to use this fluid, and the use of ATF+4 in these applications will result in shift quality and torque converter clutch concerns.

Table 4 Transmission Fluid Application

<table>
<thead>
<tr>
<th>TRANSMISSION FLUID USAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fluid</td>
</tr>
<tr>
<td>ATF+4</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Crossfire/Sprinter</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

Note: Refer to Service Bulletin 21-014-07 for automatic transmission fluid usage in the Chrysler vehicle line-up.

Note: Refer to Service Bulletin 26-003-07 for Chrysler’s vehicle-wide fluid flushing policies, which address aftermarket flushing machines and the use of chemicals. This bulletin does not address transmission cooler flushing.
Service Fluid Level Indicator

Most domestic vehicles equipped with the NAG1 transmission do not have a production fluid level indicator, or ‘dipstick.’ These vehicles retain the transmission fill tube; however, they are capped to prevent debris intrusion. Checking fluid on these vehicles requires the use of the Miller 9336 or 8863B Service Fluid Level Indicator. These indicator ‘dipsticks’ contain a measurement scale in 10mm metric graduations, and are designed to be used with the StarScan/StarMobile for temperature-based fluid level compensation.

Figure 25  Tool 9336 Service Transmission Fluid Level Indicator

Note:  When using service indicators 8863B and 9336 to check fluid level, it is normal for the tool to stop or bottom out with a length of indicator still hanging out of the fill tube.

CAUTION:  When checking fluid level with the 8863B service indicator, do not apply additional force when the tool stops in the transmission. Also, do not use the 9336 in Sprinter/Crossfire models. In either case, the tool may wedge and jam, requiring oil pan removal to dislodge.
Checking fluid on Sprinter and Crossfire vehicles requires the use of the 8863B Service Fluid Level Indicator. This indicator tip does not bottom on the sump pan - instead it pilots into a bore built into the plastic lead frame.

---

Chrysler uses two types of fill tube caps for applications that don’t use a fluid level indicator. Fill tube caps on German transmissions use a cap with a retaining pin (1). The second design used on domestic applications uses a ‘screw-on’ cap (2).
Fluid Level Checking

Chrysler recommends checking the automatic transmission fluid only in the event of the following:

- Transmission fluid leak
- Transmission shift quality concern
- Transmission slippage

The chart below shows the target fluid level throughout the range of normal operating temperature. This chart is only an example, and the correct chart should be used from the Service Information for the vehicle you are checking.

Using the StarScan/StarMobile tool, check the NAG1 transmission fluid as follows:

1. Start and run engine.
2. Place foot on the brake and set parking brake. Place transmission gear selector in either Reverse or Drive range*.
3. Monitor and record transmission fluid temperature while in Reverse or Drive - fluid can only be checked between 70º and 200ºF.
4. When temperature is recorded return transmission shift lever to PARK.
5. Remove the fill tube cap, and using the appropriate service fluid level indicator (Miller 8863B or 9336), check the oil level.
6. Compare the indicator reading to the fill graph above and adjust if/as necessary.
7. Install fill tube cap.

*NOTE: The transmission oil temperature must be checked with the vehicle in reverse or drive. If it is checked in any other gear, the scan tool will display the value for the engine coolant temperature instead of the transmission oil temperature, leading to a wrong oil level reading.
One common cause for transmission problems is incorrect fluid level. With a low fluid level, air is drawn into the transmission hydraulic system, which can cause erratic shifting and slipping, particularly when going around corners, accelerating or stopping. A high fluid level can cause foaming, aerated fluid and the same problems as a low fluid condition. In addition, the introduction of air into the fluid results in severe and rapid oxidation of the transmission fluid.

By design, ATF+4 has properties that keep particles in suspension longer than most conventional fluids. As a result, it is normal for ATF+4 to appear darker than usual. Because of its chemical composition, the fluid also has a unique odor that sets it apart from conventional fluids. **When checking fluid level of transmissions filled with ATF+4, it is important to know that fluid color and odor are not indicators of fluid condition. Dark fluid or fluid with questionable odor do not warrant a fluid change.**
**Oil Level Control**

Oil level control reduces power losses and prevents oil from escaping from the transmission housing at high oil temperatures. As transmission oil level rises due to the normal increase in operating temperature, the oil forces a float on the valve body to rise against and close an opening in the housing that leads to the gear train cavity. The oil level control float closes the opening between the oil pan (sump) and the planetary gear train cavity so that the gear sets do not become overfilled and churn in the oil. This prevents oil from contacting the rotating gear train which would cause aeration (oil foaming).

The oil in the sump expands around the outside of the cavity. Cast drain ports in the gear train cavity area allow for excess oil return to the sump (oil pan).

---

**Figure 29** Sump Oil Level Control Float
Transmission Fluid & Filter Change

Additionally, Chrysler recommends changing the automatic transmission fluid and filter at specific intervals. The correct fluid change intervals are in the Maintenance Schedules, which are found in one of two places:

- Service Information
- Owner’s Manual

Upon refilling the transmission, verify the proper fluid level using the StarScan/StarMobile and fluid indicator 8863B or 9336.

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Oil Filter</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>Oil Pan Gasket</td>
<td>5</td>
</tr>
<tr>
<td>3</td>
<td>Oil Pan</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9</td>
</tr>
</tbody>
</table>

† = Sprinter Only

Figure 30 Transmission Oil and Filter Change
TRANSMISSION OIL LEAK DIAGNOSIS

Bell Housing and Torque Converter Leak Points
Possible sources of leaks at the bell housing are:

- If the converter is wet, it is likely a weld seam joint around the outside diameter or hub weld leak.
- Oil pump leaks can be at the front seal.
- Leak at the 13-pin connector.

Transmission Case Leak Detection Using Dye
Begin with a thorough visual inspection of the transmission, particularly at the area of the suspected leak. If a fluid leak source is not readily identifiable, use the following steps listed below:

1. Do not clean or degrease the transmission at this time because some solvents can cause rubber to swell, temporarily stopping the leak.

2. Add a Mopar®-approved dye to the transmission fluid. Lift the drive wheels off the ground, start the engine and let the engine idle to rotate the driveshaft. Allow the engine to idle for 15 minutes. Check the transmission dipstick to make sure the dye is thoroughly mixed as indicated with a bright yellow color under a black light.

3. Using a black light, inspect the entire transmission for fluorescent dye, particularly at the suspected area of the oil leak. Look for the dye in the oil. If the oil leak is found and identified, repair as necessary.

4. If dye is not observed, drive the vehicle at various speeds for approximately 24 km (15 miles), and repeat the inspection.
FLUID AND FILTER ANALYSIS

During transmission failure analysis, the oil pan and filter provide key information that should be examined very carefully. As the oil pan is being drained, collect a portion of the fluid for analysis.

- Does the fluid show any signs of contamination or additives?
- Does the fluid show any signs of aeration?

After the oil pan is removed, inspect the oil filter for the following:

- Is the oil filter neck cracked or improperly installed? Cracks in the plastic housing and neck or a poor fit between the seal and the neck can allow air to enter the oil pump and aerate the fluid.
- Is the filter contaminated with debris?
  1. If the debris appears to contain friction material, it is likely from the clutch discs.
  2. If the debris appears to contain metal, it is likely from the thrust plates or steel from the roller or thrust bearings.
  3. If the debris appears to contain rubber/Teflon, it is likely originating in the valve body or clutch piston seals.

Careful examination of the pan and filter can reveal clues to conditions that the transmission is experiencing that the Diagnostic Scan Tool might not indicate. Debris, contamination or aeration can all cause insufficient oil pressure in the transmission leading to premature transmission failure.

For Mopar ATF+4 or Mopar Crossfire/Sprinter oil, a pure brown or black coloring had neither an influence to the coefficient of friction nor to any other characteristics of the oil. The color of the oil is not an indicator of fluid condition.

When the oil has graphite-mud type abrasions in it, or there are 1 mm or larger chips in the oil pan, mechanical damage has occurred in the transmission. Based on the complaint, replace the corresponding components or the transmission as necessary. When a repair is possible, the transmission, oil cooler and lines must be cleaned and flushed and the oil and filter replaced.
THE NAG1 AUTOMATIC TRANSMISSION IS AN ELECTRONICALLY CONTROLLED FIVE-SPEED WITH A VARIABLE SLIP RATE CLUTCH IN THE TORQUE CONVERTER. THREE PLANETARY GEAR SETS CAN PROVIDE THE FIVE FORWARD SPEEDS PLUS UP TO TWO REVERSE SPEEDS, DEPENDING ON APPLICATION.

THE GEARS ARE ACTUATED BY A COMBINATION OF ELECTRICAL AND HYDRAULIC COMPONENTS. THE GEAR RANGES ARE SHIFTED BY AN APPROPRIATE COMBINATION OF THREE MULTI-DISC HOLDING CLUTCHES, THREE MULTI-DISC DRIVING CLUTCHES AND TWO SPRAG-TYPE OVERRUNNING CLUTCHES.

![Figure 31 NAG1 Clutches](image_url)

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>B1 Brake</td>
</tr>
<tr>
<td>2</td>
<td>K1 Clutch</td>
</tr>
<tr>
<td>3</td>
<td>K2 Clutch</td>
</tr>
<tr>
<td>4</td>
<td>B3 Brake</td>
</tr>
<tr>
<td>5</td>
<td>K3 Clutch</td>
</tr>
<tr>
<td>6</td>
<td>B2 Brake</td>
</tr>
<tr>
<td>7</td>
<td>F2 Overrunning Clutch</td>
</tr>
<tr>
<td>8</td>
<td>F1 Overrunning Clutch</td>
</tr>
</tbody>
</table>
TORQUE CONVERTER

The NAG1 torque converter is a conventional torque converter using typical converter components:

- Impeller
- Turbine
- Stator
- Torque Converter Clutch

The torque converter clutch (TCC) consists of a clutch and piston that provides a mechanical link between the impeller and turbine. It is unique in construction with the use of a multi-disc clutch assembly. The TCC is hydraulically operated and electronically controlled. When pressure is applied to the front of the TCC piston, TCC engagement is obtained. The NAG1 torque converter clutch is never fully engaged.

The hub of the torque converter housing drives the transmission oil pump at engine speed.

Caution: The torque converter must be replaced if a transmission failure resulted in large amounts of metal or friction contamination in the fluid.
PLANETARY GEAR TRAIN

Torque power flow is transmitted through an input shaft, an output shaft, a sun gear shaft and three integrated planetary gear sets. The higher torque capacity versions of the NAG1 transmission are equipped with four pinion carriers in the planetary gear sets. The front and rear planetary carriers on lower torque-rated transmissions are equipped with only three pinions each.

The input shaft and K2 input clutch assembly rests inside the K1 clutch and integral front planetary gear set. A thrust bearing isolates the two assemblies. The front planetary annulus gear is the primary input to the transmission and is part of the K2 input clutch assembly.

**The front annulus is welded to the input shaft/K2 assembly - therefore when the input shaft is driven, the front annulus is rotating as well.**

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>K1 Inner Disc Carrier with Integrated Front Planetary Carrier</td>
</tr>
<tr>
<td>2</td>
<td>Thrust Bearing</td>
</tr>
<tr>
<td>3</td>
<td>Input Shaft with Front Annulus and K2 Clutch Assembly</td>
</tr>
</tbody>
</table>

Figure 33  Input Shaft and Front Gear Set
The output shaft is integral with the center planetary pinion carrier and as its name implies, is the output of the transmission. The K3 clutch is located on the output shaft and the remaining center and rear planetary gear set components. The output shaft uses several Teflon seals to isolate lubrication and clutch apply ports.

The P2 (center) carrier is welded to the output shaft. Therefore, when the carrier rotates, the output shaft also rotates carrying torque out of the transmission.

---

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Torlon Seal Rings</td>
</tr>
<tr>
<td>2</td>
<td>Output Shaft and Center Planetary Carrier</td>
</tr>
<tr>
<td>3</td>
<td>Needle Bearing</td>
</tr>
<tr>
<td>4</td>
<td>Thrust Washer</td>
</tr>
<tr>
<td>5</td>
<td>Rear Planetary Carrier and Center Annulus</td>
</tr>
<tr>
<td>6</td>
<td>Center Sun Gear/Hollow Shaft, Rear Sun Gear and F2 Overrunning Clutch</td>
</tr>
<tr>
<td>7</td>
<td>K3 Clutch Assembly</td>
</tr>
<tr>
<td>8</td>
<td>Thrust Washer</td>
</tr>
<tr>
<td>9</td>
<td>Thrust Bearing</td>
</tr>
<tr>
<td>10</td>
<td>Shim</td>
</tr>
<tr>
<td>11</td>
<td>Snap Ring</td>
</tr>
</tbody>
</table>

Figure 34  Output Shaft with Center and Rear Planetary Gear Sets
DRIVING CLUTCHES
The input clutch assemblies are used to drive the planetary gear set components by connecting them to a rotating component, such as an input shaft or another planetary member.

The NAG1 transmission employs three input driving clutch assemblies:
- K1 clutch
- K2 clutch
- K3 clutch

K1 Clutch
The K1 clutch and retainer is located in the front of the transmission behind the B1 brake assembly. The K1 clutch is a multi-disc clutch pack housed in a retainer that is splined to both the B1 brake and P1 (front) carrier.

The K1 clutch retainer also houses the F1 ORC and P1 (front) sun gear.

When applied (2nd, 3rd, 4th and R²), the K1 clutch locks the front sun gear to the front carrier.

![Diagram of K1 Clutch](image)

<table>
<thead>
<tr>
<th></th>
<th>Part Description</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>K1 Clutch Hub/Front Sun Gear Shell</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>Front Planetary Carrier</td>
<td>4</td>
</tr>
</tbody>
</table>

Figure 35  K1 Clutch
K2 Clutch

The K2 clutch assembly is found at the end of the input shaft behind the K1 clutch assembly. The K2 clutch is a multi-disc clutch assembly that is splined to the center annulus/rear carrier assembly.

*When applied (3rd, 4th, 5th), the K2 clutch connects input shaft rotational torque to the center annulus/rear carrier assembly.*
K3 Clutch

The K3 clutch is the most rearward driving clutch in the NAG1 case. The K3 is a multi-disc clutch pack that is splined to the P2 (center) sun gear, P3 (rear) sun gear. When applied (1st, 2nd, 4th, 5th, R, R²), the K3 clutch locks the P3 (rear) sun gear to the P2 (center) sun gear. The K3 also hydraulically backs up the F2 one-way clutch.

| 1 | Center Sun Gear | 3 | K3 Clutch |
| 2 | Rear Sun Gear | | |

Figure 37  K3 Clutch
HOLDING (BRAKE) CLUTCHES

Holding (brake) clutch assemblies used in the NAG1 transmission are all friction clutches anchored to the transmission case. Brake clutch assemblies are used to hold and prevent rotation of specific components of the three planetary gear sets to transmit drive torque.

B1 Brake

The B1 Brake is mounted on the torque converter housing toward the front of the transmission.

When applied (1st, 5th, N, R¹), the B1 clutch holds the front sun gear to the case. The B1 clutch also hydraulically backs up the F1 one-way clutch.

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>B1 Brake</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>Front Sun Gear Shell</td>
<td>4</td>
</tr>
</tbody>
</table>

Figure 38  B1 Brake
B2 Brake

The B2 brake clutch is the most rearward clutch in the case. The B2 is a multi-disc clutch pack that is splined to the K3 retainer/P2 (center) sun gear assembly.

When applied (1st, 2nd, 3rd), the B2 brake holds the P2 (center) sun gear to the case. Additionally, with the K3 driving clutch applied, the B2 holds the P3 (rear) sun gear.

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>B2 Brake</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>Center and Rear Sun Gear Assembly</td>
<td>4</td>
</tr>
</tbody>
</table>

Figure 39  B2 Brake
B3 Brake

The B3 brake clutch is located in the rear of the case, forward of the B2/B3 piston assembly. The B3 clutch is a multi-disc clutch assembly that is splined to the center annulus/rear carrier.

When applied ($R^1$, $R^2$), the B3 clutch holds the center annulus/rear carrier to the case.

Figure 40  B3 Brake
OVERRUNNING CLUTCHES

The NAG1’s F1 and F2 sprag-type overrunning clutches are incorporated into the transmission to help optimize shift quality.

Overrunning Clutch Basics

The overrunning clutch optimizes individual gear shifts. The clutches lock the individual elements of a planetary gear set together or to the transmission housing in one direction of rotation, causing torque to be transmitted.

When the inner race of the overrunning clutch is locked and the outer race turns counterclockwise, the sprag-type locking elements adopt a diagonal position to allow overrunning. The outer race slides over the sprags with minimal friction. When the rotation of the outer race changes to a clockwise direction, the sprag elements, due to design contour, stand up and lock the outer race and inner race together.

Note: In most transmission applications, one-way clutches are used primarily as holding devices. However, in the case of the NAG1 transmission, the one-way overrunning clutches are used as either driving or holding devices.

![Sprag-Type Overrunning Clutch](image)

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Counterclockwise</td>
</tr>
<tr>
<td>2</td>
<td>Clockwise</td>
</tr>
<tr>
<td>3</td>
<td>Sprag-Type Locking Element</td>
</tr>
<tr>
<td>4</td>
<td>Outer Race</td>
</tr>
<tr>
<td>5</td>
<td>Gear</td>
</tr>
<tr>
<td>6</td>
<td>Cage</td>
</tr>
<tr>
<td>7</td>
<td>Inner Race</td>
</tr>
</tbody>
</table>

Figure 41 Sprag-Type Overrunning Clutch
**F1 Overrunning Clutch**

The F1 overrunning clutch is housed inside the K1 clutch retainer/P1 (front) sun gear assembly. Its inner race consists of a journal machined into the reaction shaft support, which is attached to the case.

**The F1 one-way clutch holds the P1 (front) sun gear to the case in 1st, 5th, and R¹, supporting the function of the B1 brake clutch.**

**Note:** Failure of the F1 clutch will cause a 1-2 shift RPM flare.
F2 Overrunning Clutch

The F2 overrunning clutch is located between the P2 (center) sun gear (hollow shaft) and the P3 (rear) sun gear.

The F2 locks the P3 (rear) sun gear to the P2 (center) sun gear. In this fashion, it is used as a mechanical driving clutch, and supports the function of an applied K3 clutch.

Note: Failure of the F2 clutch will cause a 2-3 shift RPM flare.

| 1 | Center Sun Gear/Hollow Shaft | 5 | Snap Ring |
| 2 | Retaining Ring | 6 | O-Ring (Two Used) |
| 3 | F2 Overrunning Clutch | 7 | Brass End Faces Out (Toward Oil Pump) When Installed |
| 4 | K3 Clutch Inner Disc Carrier (Hub) |

Figure 43  F2 Overrunning Clutch
PARK LOCK SYSTEM

The park lock system prevents the vehicle from rolling by locking the output shaft to the case. Placing the shift lever in the Park position engages the park lock. The park lock assembly consists of a park lock gear, park lock pawl, park rod assembly (incl. bullet and spring) and a guide.

Engaging the park lock moves the bullet between the lock pawl and the guide, forcing the pawl to engage the park lock gear. The park lock assembly is located on the transmission output shaft and locks the shaft to the case.

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Park Lock Gear</td>
</tr>
<tr>
<td>2</td>
<td>Park Lock Pawl</td>
</tr>
<tr>
<td>3</td>
<td>Guide Bushing</td>
</tr>
<tr>
<td>4</td>
<td>Park Lock Interlock Connecting Rod</td>
</tr>
<tr>
<td>5</td>
<td>Park Lock Interlock</td>
</tr>
<tr>
<td>6</td>
<td>Detent Plate</td>
</tr>
<tr>
<td>7</td>
<td>Park Rod Assembly</td>
</tr>
</tbody>
</table>

Figure 44  Park Lock System (Crossfire/Sprinter Shown)
OIL PUMP ASSEMBLY

The oil pump used in the NAG1 transmission is a gear & crescent design. The NAG1 oil pump assembly supplies fluid under pressure to the transmission hydraulic circuits and to the torque converter.

The oil pump is mounted in the transmission converter housing. The converter housing makes up one half of the oil pump housing.

The oil pump can only be serviced by disassembling the transmission. The bolts securing the oil pump to the housing are inside the transmission through the B1 brake assembly.

<table>
<thead>
<tr>
<th></th>
<th>Component Description</th>
<th></th>
<th>Component Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>B1 Brake Retainer Bolt</td>
<td>4</td>
<td>Oil Pump Retaining Bolt</td>
</tr>
<tr>
<td>2</td>
<td>Torque Converter Housing (Typical)</td>
<td>5</td>
<td>B1 Brake (Holding Clutch)</td>
</tr>
<tr>
<td>3</td>
<td>Intermediate Plate</td>
<td>6</td>
<td>Oil Pump Assembly</td>
</tr>
</tbody>
</table>

Figure 45  Oil Pump Assembly
TRANSMISSION CLUTCH APPLICATION & POWER FLOW

NAG1 Clutch Orientation

Figure 46  NAG1 Clutch Layout

Transmission Elements In Use (What’s-on-When)

Table 6  Gear Ratios and Clutch Application

<table>
<thead>
<tr>
<th>GEAR</th>
<th>RATIO</th>
<th>B1</th>
<th>B2</th>
<th>B3</th>
<th>K1</th>
<th>K2</th>
<th>K3</th>
<th>F1</th>
<th>F2</th>
</tr>
</thead>
<tbody>
<tr>
<td>P/N</td>
<td>—</td>
<td>A</td>
<td></td>
<td></td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>R1</td>
<td>3.16</td>
<td>A</td>
<td></td>
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</tr>
<tr>
<td>R2(2)</td>
<td>1.93</td>
<td>A</td>
<td>A</td>
<td></td>
<td>A</td>
<td></td>
<td></td>
<td>A</td>
<td>OR</td>
</tr>
<tr>
<td>1</td>
<td>3.59</td>
<td>A</td>
<td>A</td>
<td></td>
<td></td>
<td></td>
<td>A(1)</td>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>2</td>
<td>2.19</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td></td>
<td></td>
<td>A(1)</td>
<td>OR</td>
<td>H</td>
</tr>
<tr>
<td>3</td>
<td>1.41</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td></td>
<td></td>
<td></td>
<td>OR</td>
<td>OR</td>
</tr>
<tr>
<td>4</td>
<td>1.0</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td></td>
<td></td>
<td>A</td>
<td>OR</td>
<td>OR</td>
</tr>
<tr>
<td>5</td>
<td>0.83</td>
<td>A(1)</td>
<td></td>
<td></td>
<td>A</td>
<td>A</td>
<td></td>
<td></td>
<td>H</td>
</tr>
</tbody>
</table>

(1) Failure of these clutches will result in a loss of engine braking during deceleration.
(2) When in 4x4 Low (if equipped) or Winter Mode (if equipped).
(3) Required for normal reverse ratio.

A = Applied, H = Holding, OR = Overrunning
PARK/NEUTRAL (STANDARD MODE)

- B1 clutch is applied
- K3 clutch is applied
- No power flows to the output shaft
  - B2 is the only clutch required to launch in first gear

<table>
<thead>
<tr>
<th>A1</th>
<th>Front Annulus Gear</th>
<th>C3</th>
<th>Rear Planetary Carrier</th>
</tr>
</thead>
<tbody>
<tr>
<td>A2</td>
<td>Center Annulus Gear</td>
<td>S1</td>
<td>Front Sun Gear</td>
</tr>
<tr>
<td>A3</td>
<td>Rear Annulus Gear</td>
<td>S2</td>
<td>Center Sun Gear</td>
</tr>
<tr>
<td>C1</td>
<td>Front Planetary Carrier</td>
<td>S3</td>
<td>Rear Sun Gear</td>
</tr>
<tr>
<td>C2</td>
<td>Center Planetary Carrier</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 47  Park/Neutral Power Flow
PARK/NEUTRAL (DEFAULT MODE)

- K1 clutch is applied
- K3 clutch is applied
- No power flows to the output shaft
  - **B2 is the only clutch required to launch in ‘default’ second gear**
FIRST GEAR

All three planetary gear sets are used to provide the gear reduction for first gear. Clutches B1, K3 and B2 are applied and the F1 and F2 overrunning clutches are in use during acceleration.

First Gear Powerflow

Front Gear Set

The front annulus gear is driven by the input shaft. The front sun gear is held by the B1 brake. The F1 overrunning clutch assists in holding the front sun gear while accelerating, but is primarily used for clutch overlap during a 1-2 shift. The output of this gear set is the carrier, which drives the rear gear set annulus.

Rear Gear Set

The rear annulus gear is driven by the front planetary carrier. With the K3 clutch applied, locking the rear sun gear to the center sun gear, application of the B2 clutch holds both sun gears to the case. The F2 overrunning clutch assists the K3 clutch in locking the rear sun gear to the center sun gear during acceleration. The output of this gear set is the rear carrier, which drives the center annulus.
Center Gear Set

The center annulus gear is driven by the rear carrier. The center sun gear is held by the B2 brake. **The output of this gear set is the center carrier which is welded to the output shaft.**

1st Gear (Acceleration)

- Input shaft drives front annulus gear
- F1 assists the B1 in holding front sun gear
- F2 assists the K3 clutch in locking center and rear sun gears together
- B2 holds center and rear sun gear to the case

---

**Figure 50** First Gear Schematic

<table>
<thead>
<tr>
<th>Gear</th>
<th>Ratio</th>
<th>B1</th>
<th>B2</th>
<th>B3</th>
<th>K1</th>
<th>K2</th>
<th>K3</th>
<th>F1</th>
<th>F2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3.59</td>
<td>A(1)</td>
<td>A</td>
<td></td>
<td></td>
<td></td>
<td>A(1)</td>
<td>H</td>
<td>H</td>
</tr>
</tbody>
</table>
SECOND GEAR

The front gear set provides direct drive while the rear and center gear sets provide the gear reduction. K1, K3 and B2 clutches are applied and F2 overrunning clutch is in use during acceleration.

Second Gear Powerflow

Front Gear Set

The front annulus gear is driven by the input shaft. The front sun gear and carrier are locked together by the K1 clutch, producing a direct drive ratio. The output of this gear set is the front carrier at input shaft speed.

Rear Gear Set

The rear annulus gear is driven by the front planetary carrier. With the K3 clutch applied, locking the rear sun gear to the center sun gear, application of the B2 clutch holds both sun gears to the case. The F2 overrunning clutch assists the K3 clutch in locking the rear sun gear to the center sun gear during acceleration. The output of this gear set is the rear carrier, which drives the center annulus.
Center Gear Set
The center annulus gear is driven by the rear carrier. The center sun gear is held by the B2 brake. The output of this gear set is the center carrier which is welded to the output shaft.

2nd Gear (Acceleration)
- Input shaft drives front annulus gear
- K1 puts the front gear set in direct
- F2 assists the K3 clutch in locking center and rear sun gears together
- B2 holds center and rear sun gear to the case
THIRD GEAR
The front and rear gear sets are not used to transmit power flow. The center gear set provides gear reduction. Although the K1 clutch is applied, only the K2 and B2 clutches contribute to third gear.

Third Gear Powerflow

Front Gear Set
The front gear set does not contribute to third gear.

Rear Gear Set
The rear gear set does not contribute to third gear.

Center Gear Set
The center annulus gear is driven by the K2 clutch at input shaft speed. The center sun gear is held by the B2 brake. The output of this gear set is the center carrier which is welded to the output shaft.
Third Gear (Acceleration)

- Input shaft drives the front annulus gear
- K2 drives the center annulus gear
- B2 holds the center sun gear
- Rear sun gear overruns (at input speed) on the 52 overrunning clutch

A1  Front Annulus Gear       C3  Rear Planetary Carrier
A2  Center Annulus Gear      S1  Front Sun Gear
A3  Rear Annulus Gear        S2  Center Sun Gear
C1  Front Planetary Carrier  S3  Rear Sun Gear
C2  Center Planetary Carrier

Figure 54  Third Gear Schematic

<table>
<thead>
<tr>
<th>GEAR</th>
<th>RATIO</th>
<th>B1</th>
<th>B2</th>
<th>B3</th>
<th>K1</th>
<th>K2</th>
<th>K3</th>
<th>F1</th>
<th>F2</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>1.41</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>OR</td>
<td>OR</td>
<td></td>
</tr>
</tbody>
</table>
FOURTH GEAR (DIRECT DRIVE)
All three gear sets provide direct drive. K1, K2 and K3 clutches are applied.

Fourth Gear Powerflow

Front Gear Set
The front annulus gear is driven by the input shaft. The front sun gear and carrier are locked together by the K1 clutch, producing a direct drive ratio. **The output of this gear set is the front carrier at input shaft speed.**

Rear Gear Set
The rear annulus gear is driven by the front carrier at input shaft speed. The rear carrier is driven by the K2 clutch at input shaft speed, producing a direct drive ratio. **The output of this gear set is the rear sun gear at input shaft speed.**

Center Gear Set
The center sun gear is driven at input shaft speed by the K3 clutch. The center annulus gear is driven at input shaft speed by the K2 clutch. **The output of this gear set is the carrier (output shaft) at input shaft speed.**
Fourth Gear (Acceleration)

- Input shaft drives the front annulus gear
- K1 puts the front gear set in direct
- K2 drives the center annulus and rear planetary carrier
- K3 locks the center and rear sun gears together

<table>
<thead>
<tr>
<th>Gear</th>
<th>Ratio</th>
<th>B1</th>
<th>B2</th>
<th>B3</th>
<th>K1</th>
<th>K2</th>
<th>K3</th>
<th>F1</th>
<th>F2</th>
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<tbody>
<tr>
<td>4</td>
<td>1.0</td>
<td></td>
<td></td>
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<td>A</td>
<td>A</td>
<td>A</td>
<td>OR</td>
<td>OR</td>
</tr>
</tbody>
</table>
FIFTH GEAR (OVERDRIVE)

The front gear set provides reduction. The rear gear set provides an overdrive, which is slightly decreased by a reduction in the center gear set. B1, K2 and K3 clutches are applied and the F1 overrunning clutch is in use during acceleration.

Fifth Gear Powerflow

Front Gear Set

The front annulus gear is driven by the input shaft. The front sun gear is held by the B1 brake. The F1 overrunning clutch assists in holding the front sun gear while accelerating, but is primarily used for clutch overlap during a 4-5 shift. **The output of this gear set is the carrier, which drives the rear gear set annulus.**

Rear Gear Set

The rear annulus gear is driven by the front carrier at a reduced speed. The rear carrier is driven at input shaft speed by the K2 clutch. **The output of this gear set is the rear sun gear in a ‘super’ overdrive.**
Center Gear Set

The center sun gear is driven by the rear sun gear through the K3 clutch, which is being driven in overdrive. The center annulus gear is driven by the K2 clutch at input shaft speed. With the sun gear driven at overdrive, and the annulus driven at input shaft speed, the output of this gear set is the carrier in reduction, which is still an overdrive ratio compared to input shaft speed.

Fifth Gear (Acceleration)

- Input shaft drives the front annulus gear
- B1 holds the front sun gear, assisted by the F1 one-way clutch.
- K2 drives center annulus and rear planetary carrier
- K3 locks the center sun gear and rear sun gear together

<table>
<thead>
<tr>
<th>A1</th>
<th>Front Annulus Gear</th>
<th>C3</th>
<th>Rear Planetary Carrier</th>
</tr>
</thead>
<tbody>
<tr>
<td>A2</td>
<td>Center Annulus Gear</td>
<td>S1</td>
<td>Front Sun Gear</td>
</tr>
<tr>
<td>A3</td>
<td>Rear Annulus Gear</td>
<td>S2</td>
<td>Center Sun Gear</td>
</tr>
<tr>
<td>C1</td>
<td>Front Planetary Carrier</td>
<td>S3</td>
<td>Rear Sun Gear</td>
</tr>
<tr>
<td>C2</td>
<td>Center Planetary Carrier</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 58 Fifth Gear Schematic

<table>
<thead>
<tr>
<th>GEAR</th>
<th>RATIO</th>
<th>B1</th>
<th>B2</th>
<th>B3</th>
<th>K1</th>
<th>K2</th>
<th>K3</th>
<th>F1</th>
<th>F2</th>
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</thead>
<tbody>
<tr>
<td>5</td>
<td>0.83</td>
<td>A(1)</td>
<td></td>
<td></td>
<td>A</td>
<td>A</td>
<td>H</td>
<td>OR</td>
<td></td>
</tr>
</tbody>
</table>
REVERSE 1 (NORMAL/STANDARD MODE)
All three gear sets are used to achieve normal reverse gear ratio. B1, B3 and K3 clutches are applied and F1 overrunning clutch holds during acceleration.

‘Normal’ Reverse Gear Powerflow

Front Gear Set
The front annulus gear is driven by the input shaft. The front sun gear is held by the B1 brake. The F1 overrunning clutch assists in holding the front sun gear while accelerating. The output of this gear set is the carrier, which drives the rear gear set annulus.

Rear Gear Set
The rear annulus gear is driven by the front carrier. The rear carrier is held by the B3 brake. The output of this gear set is the sun gear in a reverse direction.

Center Gear Set
The center sun gear is driven in reverse by the rear sun gear through the K3 clutch. The center annulus gear is held by the B3 brake. The output of this gear set is the carrier.
‘Normal’ Reverse Acceleration

- Input shaft drives the front annulus gear
- B1 holds the front sun gear, assisted by the F1 one-way
- B3 holds the rear planetary carrier/center annulus gear
- K3 locks the center sun gear and rear sun gear together

![Normal Reverse Gear Schematic](image)

<table>
<thead>
<tr>
<th>GEAR</th>
<th>RATIO</th>
<th>B1</th>
<th>B2</th>
<th>B3</th>
<th>K1</th>
<th>K2</th>
<th>K3</th>
<th>F1</th>
<th>F2</th>
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</thead>
<tbody>
<tr>
<td>R</td>
<td>3.16</td>
<td>A(^{(1,3)})</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>H(^{(3)})</td>
<td>OR</td>
<td></td>
</tr>
</tbody>
</table>
REVERSE 2 (4X4 LO/WINTER MODE/LIMP-IN)

The front gear set provides direct drive while the rear and center gear sets provide the reverse gear ratio for 4X4 LO/winter mode. K1, B3 and K3 clutches are applied.

Reverse 2 Gear Powerflow

Front Gear Set

The front annulus gear is driven by the input shaft. The front sun gear and carrier are locked together by the K1 clutch, producing a direct drive ratio. The output of this gear set is the front carrier at input shaft speed.

Rear Gear Set

The rear annulus gear is driven by the front carrier. The rear carrier is held by the B3 brake. The output of this gear set is the sun gear in a reverse direction.

Center Gear Set

The center sun gear is driven in reverse by the rear sun gear through the K3 clutch. The center annulus gear is held by the B3 brake. The output of this gear set is the carrier.
Reverse 2 Acceleration

- Input shaft drives front annulus gear
- K1 puts the front gear set in direct
- B3 holds the rear planetary carrier/center annulus gear
- K3 locks the center sun gear and rear sun gear together

<table>
<thead>
<tr>
<th>Gear</th>
<th>Ratio</th>
<th>B1</th>
<th>B2</th>
<th>B3</th>
<th>K1</th>
<th>K2</th>
<th>K3</th>
<th>F1</th>
<th>F2</th>
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<tbody>
<tr>
<td>R(2)</td>
<td>1.93</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>OR</td>
<td>OR</td>
<td></td>
</tr>
</tbody>
</table>
Notes: _____________________________________________

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Module 3 Valve Body & Hydraulic Operation

Valve Body

The NAG1 valve body is a conventional electro-hydraulic unit that is located in the transmission sump. In-vehicle valve body removal requires removal of the 13-way harness connector, and the oil pan and filter.

Removal

- Disconnect the transmission harness connector by rotating the bayonet lock of the guide bushing.
- Use a 7mm socket to loosen and remove the guide bushing (#11 & 12 below). Failure to remove the guide bushing will result in damage to the valve body plastic lead frame.
- Remove the oil pan and gasket, draining the fluid into a suitable container.
- Remove the oil filter from the valve body and discard.
- Use a speed wrench while removing the valve body-to-case bolts. This is done to ensure the bolts have not lost the required torque.
- After valve body removal, inspect the seals, gaskets and valve body-to-case surfaces for damage.

<p>| | |</p>
<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Heat Shield</td>
</tr>
<tr>
<td>2</td>
<td>Valve Body Assembly</td>
</tr>
<tr>
<td>3</td>
<td>Valve Body Retaining Bolt</td>
</tr>
<tr>
<td>4</td>
<td>Oil Filter</td>
</tr>
<tr>
<td>5</td>
<td>Oil Pan</td>
</tr>
<tr>
<td>6</td>
<td>Clamping Element</td>
</tr>
<tr>
<td>7</td>
<td>Bolt</td>
</tr>
<tr>
<td>8</td>
<td>Drain Plug (If Equipped)</td>
</tr>
<tr>
<td>9</td>
<td>Drain Plug Gasket (If Equipped)</td>
</tr>
<tr>
<td>10</td>
<td>13-Pin Harness Connector</td>
</tr>
<tr>
<td>11</td>
<td>Guide Bushing Retaining Bolt</td>
</tr>
<tr>
<td>12</td>
<td>Guide Bushing</td>
</tr>
</tbody>
</table>

Figure 63 Valve Body Assembly
Installation Concerns

- Since the guide bushing seals against the housing to prevent oil from leaking, it is important to inspect and replace the guide bushing o-rings as necessary.
- It is important that the oil filter neck is properly installed through filter seal in the valve body. Inspect and replace this seal as necessary.
- It is important to properly torque the valve body-to-case bolts. Improper torque can damage threads, or allow transmission fluid to leak into an adjacent passageway. This may cause the transmission shift quality concerns, or may put the transmission into ‘Limp-In’ mode.
- It is important to properly torque the guide bushing bolt to 22 in. lbs. Over-torquing this bolt will cause valve body/lead frame damage.

Clutch Air Checking

Using controlled regulated air pressure instead of fluid pressure, the clutch pistons can be tested for large leaks by listening for the sound of air escaping past a piston seal if the seal is leaking. By removing the valve body and using the appropriate port, each clutch piston can be actuated. While applying air pressure to the port, the piston moves and compresses the clutch pack. If a seal is leaking, air is heard leaking past the piston. Testing can be done with the transmission in the vehicle or on the work bench.

Perform the following steps when air pressure testing the clutches:

- Remove the transmission oil pan and valve body.
- Install clutch air check plate tool 10007, using valve body-to-case bolts.
- Apply air pressure to the ports one at a time.

Notes: The compressed air supply must be free of all dirt and moisture. Use a pressure of 20 - 30 psi.

- Listen for the clutch to apply (heard as a slight thud sound). If a large amount of air is heard escaping, the transmission must be removed from the vehicle, disassembled and all seals inspected.

Note: Each clutch includes a bleed orifice and so a small amount of air leakage is normal.
Figure 64  NAG Clutch Air Check Tool 10007

Figure 65  Clutch Pressure Ports
**VALVE BODY ASSEMBLY**

The valve body assembly is an electro-hydraulic control device that is responsible for transmission hydraulic function (pressure regulation, lubrication, etc.) as well as the conversion of mechanical operation into electrical signals used by the electronic control system.

Significant features included with this valve body are:

- Three hydraulic spool valve shift groups
- Three electro-hydraulic ‘on/off’ solenoids
- Two variable force solenoids (VFS) for pressure control
- One PWM converter clutch solenoid
- A plastic lead frame for electrical connections

![Figure 66 Valve Body Assembly](image)
Lead Frame

The lead frame connects the electrical signals of the TCM to hydraulic functions (e.g. solenoids). The sensors of the lead frame transmit electrical input signals to the TCM.

The lead frame contains the following components:

- N2 and N3 Speed Sensors
- 13-way harness connector
- Park/Neutral Switch
- Transmission Temperature Sensor
- Conductive paths for solenoids and sensors

<table>
<thead>
<tr>
<th>Component</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>N3 Speed Sensor</td>
<td>1</td>
</tr>
<tr>
<td>N2 Speed Sensor</td>
<td>2</td>
</tr>
<tr>
<td>13-way Connector</td>
<td>3</td>
</tr>
<tr>
<td>Park/Neutral Switch</td>
<td>4</td>
</tr>
<tr>
<td>Transmission Temperature Sensor</td>
<td>5</td>
</tr>
</tbody>
</table>

Figure 67  Lead Frame
Spool Valves & Valve Groups

The NAG1 valve body is typical in that it uses an aluminum casting, spool valves and springs used to control, direct, and regulate hydraulic fluid. The spool valves are arranged into functional groups, known as ‘shift groups.’ The NAG1 valve body employs the following shift groups:

- 1-2/4-5 Shift Group
- 2-3 Shift Group
- 3-4 Shift Group

Additionally, this valve body contains the valves required for:

- Pressure Regulation
- Torque Converter Control

<table>
<thead>
<tr>
<th></th>
<th>Upper Valve Body</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Manual Valve</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>3–4 Holding Pressure Shift Valve</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>3–4 Command Valve</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>3–4 Shift Pressure Shift Valve</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>3–4 Overlap Valve</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>Line Pressure Regulating Valve</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>TC Pressure Limit Valve</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>2–3 Overlap Valve</td>
<td></td>
</tr>
</tbody>
</table>

Figure 68 Upper Valve Body
### Lower Valve Body

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Lower Valve Body</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>1–2/4–5 Command Valve</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>1–2/4–5 Holding Pressure Shift Valve</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>1–2/4–5 Shift Pressure Shift Valve</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>1–2/4–5 Overlap Valve</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Shift Pressure Regulating Valve</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Control Valve Pressure Regulating Valve</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Shift Solenoid Pressure Regulating Valve</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>B2 Brake Shift Valve</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>2–3 Holding Pressure Shift Valve</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>2–3 Command Valve</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>2–3 Shift Pressure Shift Valve</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Torque Converter Clutch Regulating Valve</td>
<td></td>
</tr>
</tbody>
</table>

Figure 69  Lower Valve Body
Valve, Check Ball and Strainers

In addition to spool valves and springs, the NAG1 valve body uses various check balls, valves, and strainers to assist the hydraulic control system. The NAG1 valve body contains:

- Four plastic check balls for clutch control
- Eight steel balls to plug hydraulic circuits.
- Central and TCC strainers for debris control (in lower valve body)
- Modulating pressure and shift pressure regulating strainers (in upper valve body)
- A pressure feed valve (vents B2 counter-apply)

Check balls need to be inspected very carefully for creases or irregularities. It is very important in diagnosis to know which check ball came from which pocket. Slight irregularities on a check ball can cause intermittent problems.

Also, note the positions of the two strainers associated with the solenoids. The strainers are located in the upper half of the valve body.

<table>
<thead>
<tr>
<th></th>
<th>Lower Valve Body Check Ball and Strainer Locations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Steel Check Balls</td>
</tr>
<tr>
<td>2</td>
<td>Central Strainer</td>
</tr>
<tr>
<td>3</td>
<td>Plastic Check Balls</td>
</tr>
</tbody>
</table>

Figure 70  Lower Valve Body Check Ball and Strainer Locations

Note: During reassembly, check balls should only be retained using petroleum jelly or Trans-Jel. DO NOT use inappropriate greases (such as wheel bearing or white lithium grease).
Solenoids

The solenoids are located in the upper valve body connected to the lead frame which provides electrical connection to the 13-pin connector. As mentioned previously, the following solenoids are in use:

- Three electro-hydraulic ‘on/off’ solenoids
  - 1-2/4-5 Solenoid
  - 2-3 Solenoid
  - 3-4 Solenoid
- Two variable force solenoids (VFS) for pressure control
  - P-mod (or Modulating Pressure Solenoid)
  - Shift-mod (or Shift Pressure Regulating Solenoid)
- One pulse-width-modulated (PWM) torque converter clutch solenoid

The on/off and TCC solenoids are sealed to the valve body using O-rings. The solenoid covers are used to prevent shorting across solenoid contacts from conductive transmission debris - these covers are not used on post-2005 transmissions.
A strainer is located under the VFS solenoids to protect them from contamination.

1 | Strainers (VFS Only)

Figure 71A   Solenoid Strainers
Shift (On/Off) Solenoids

The shift solenoids enable or disable transmission shifts by directing fluid to the various groups of shift valves. These shift solenoids are either On or Off. The shift solenoids are on for approximately 1.5 seconds to complete the shift. The three shift solenoids are:

- 1–2/4–5 shift solenoid
- 2–3 shift solenoid
- 3–4 shift solenoid

The solenoids are used to control when shifts occur. Unlike other Chrysler products, these shift solenoids do not directly control the application or release of a clutch. The shift solenoid is turned on to initiate a shift and then, after the shift is completed, the solenoid is turned off. The shift solenoid acts on the end of one of the shift group valves called the Command Valve to initiate a shift. The pressure into and out of the shift solenoids is approximately 345–379 kPa (50–55 psi).

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Shift Solenoid</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>Contact Spring</td>
<td>5</td>
</tr>
<tr>
<td>3</td>
<td>Conductor Track (on Lead Frame)</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0</td>
</tr>
</tbody>
</table>

Figure 72  On/Off Shift Solenoid
**Shift & Line Pressure (VFS) Solenoids**

The shift/line pressure solenoid regulates the shift/line pressure necessary for the changing operating conditions such as engine load and gear range. These solenoids convert a variable current from the TCM into a proportional pressure and are referred to as variable force solenoids.

The shift pressure solenoid changes the pressure applied to the end of the shift pressure regulating valve which changes the amount of pressure required for the engaging clutch and the regulated pressure through the various shift group valves to the disengaging shift element. The line (P-Mod) pressure solenoid regulates the pressure to the line pressure regulating valve and to the three shift overlap valves.

The shift pressure is regulated to between 0–1517 kPa (0–220 psi).

The pressure produced by the shift/line pressure solenoid is approximately 0–827 kPa (0–120 psi).

---

**Figure 73  Shift/Line (Modulating) Pressure VFS Solenoid**
**Torque Converter Clutch (PWM) Solenoid**

The Torque Converter Clutch (TCC) solenoid is Pulse Width Modulated (PWM), which controls the TCC by modulating the TCC control valve. When the TCC control pressure is being modulated, the torque converter clutch is either:

- Unapplied, or
- Partially Applied (Variable between 5% and 95%).

The pressure into the TCC solenoid is approximately 345–379 kPa (50–55 psi). The TCC solenoid modulated (out) pressure to the end of the TCC regulating valve is between 0–359 kPa (0–52 psi).

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>TCC Solenoid</td>
<td>4</td>
<td>Upper Valve Body</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Contact Spring</td>
<td>5</td>
<td>O-Ring</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Conductor Track (On Lead Frame)</td>
<td>0</td>
<td>Solenoid Vent</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Heavy Arrow Indicates No O-Ring</td>
<td></td>
</tr>
</tbody>
</table>

Figure 74  Torque Converter Clutch PWM Solenoid
HYDRAULIC SYSTEM PRESSURES

The NAG1 hydraulic system relies on a gear-and-crescent pump to supply fluid at a volume and pressure high enough for transmission operation. The system is designed with a number of different levels of pressure regulation. These levels of regulation are required to properly operate the various hydraulic components such as the clutches and the torque converter. The following list dictates the NAG1’s various pressure levels:

- Line Pressure
- Modulating Pressure (P-Mod)
- Shift Pressure
- Control Valve Pressure
- Shift Pressure Regulating Pressure
- Shift Solenoid Pressure
- Torque Converter Control/Lubricating Pressure

**Line Pressure - 414–2206 kPa (60–320 psi)**

- Also referred to as ‘operating’ pressure, is the main pressure of the hydraulic system for clutch, lubrication, and fluid coupling supply.
- Is regulated by the valve body’s main regulator valve.
- Is the pressure that all other system pressures are derived from.
- Is load dependent by modulating pressure and also gear dependent by K1 clutch or K2 clutch pressure.
- Is typically highest in first and reverse gears

**Modulating Pressure (P-Mod) - 0–862 kPa (0–125 psi)**

- Is dependent on engine load, and controlled by the TCM by way of the modulating pressure (P-mod) solenoid
- Determines the level of line (operating) pressure by acting on the face of the line pressure regulating valve.
- Determines the pressure regulated at the three shift overlap valves along with shift pressure.

**Shift Pressure (P-Shift) - 0–1517 kPa (0–220 psi)**

- Is controlled by the TCM by way of the shift pressure solenoid (SP VFS)
- Regulates clutch pressure upon application during the shift phase
- Determines the pressure regulated by the regulating valve/overlap together with the modulating pressure at the clutch as it applies.
- Initializes 2nd gear in fail safe (limp-in) mode
Control Valve Pressure - 0-800 kPa (0-125 psi)
- Supplies regulated pressure to the modulating pressure control solenoid (LP VFS)
- Supplies regulated pressure to the shift pressure control solenoid (SP VFS)
- Supplies regulated pressure to the shift solenoid pressure regulating valve

Shift Pressure Regulating Pressure - 0–827 kPa (0–120 psi)
- Originates from control valve pressure, and modulated by the SP VFS.
- Is supplied to the shift pressure regulating valve, which regulates shift pressure

Shift Solenoid Pressure - 345–379 kPa (50–55 psi).
- Originates from control valve pressure
- Supplies regulated pressure to the following:
  - 1–2/4–5 shift solenoid.
  - 2–3 shift solenoid.
  - 3–4 shift solenoid.
  - TCC solenoid that controls converter clutch pressure.
  - 2–3 shift pressure valve.
  - 3–4 shift pressure valve.

Figure 75  Line, Torque Converter, Lubricating, Modulating and Shift Pressures
Torque Converter Control/Lubricating Pressure - 0-690 kPa (0-100 psi)

- Originates as line pressure regulated by the T/C Limit Valve
- Supplies torque converter fill pressure
- Supplies lube and cooling for transmission mechanical parts

Figure 76  TCC Regulating Valve and Torque Converter Pressure Limit Valves
Torque Converter Clutch Off Mode

When the TCC regulating valve is in the unregulated position (without TCC solenoid pressure), a full amount of lubricating oil flows through the TCC regulating valve into the torque converter at a pressure of approximately 414–690 kPa (60–100 psi). The oil leaves the torque converter and passes back through the lockup control valve and then, through the oil cooler and into the transmission for lubrication. Torque converter out pressure is approximately 69–310 kPa (10–45 psi). Lubrication pressure is approximately 35–276 kPa (5–40 psi).

Torque Converter Clutch Modulation

When the lockup control valve is modulated with TCC solenoid pressure, a reduced amount of oil flows to the torque converter through a restricted orifice (for continued torque converter cooling). At the same time, oil flows through an annular gap (passage) of the valve to the cooler instead of through the torque converter.
Transmission Cooler Bypass

Vehicles with a NAG1 transmission use a thermal-style external bypass valve to bypass the transmission cooler. This design differs from the pressure-style in that fluid bypasses the cooler until a certain fluid temperature is reached.

When the transmission fluid is cold, the fluid bypasses the cooler allowing it to be heated faster to operating temperature.

The NAG1 transmission control uses intelligent logic, which does not update or adapt until temperatures >70°C (158°F). Bypassing the cooler by default promotes a quicker transmission warm-up to this temperature. This design also minimizes parasitic losses associated with cold fluid/temperature operation.

When transmission fluid exceeds operating temperature (excessively hot), fluid is sent to the cooler to be cooled.

The thermal bypass starts to open at 70°C (158°F). The valve is fully open at 85°C (185°F).

Additionally, there is a pressure bypass feature. When fluid is hot enough to be sent to the cooler, a spring-loaded bypass feature allows cooler bypass in the event of a plugged or excessively restricted cooler. This prevents transmission lube circuit starvation.

The pressure-based bypass feature activates when a 483 kPa (70 psi) pressure drop across the valve occurs.

Figure 79 Thermal/Pressure Cooler Bypass Valve
SHIFT GROUPS

As mentioned previously, clutch-to-clutch shifting occurs by way of control from a family of valves known as a shift group. The valve body has three of these families, or shift groups:

- 1-2/4-5 Shift Group
- 2-3 Shift Group
- 3-4 Shift Group

A shift group by design controls two clutches and alternates the apply between them. When a shift is commanded, a shift solenoid initiates the application of one shift group to change the clutches applied for the shift. The other two shift groups are in a ‘stationary’ phase (i.e. the clutches they control are maintained).

1–2/4–5 Shift Group (K1/B1 Clutches)

The 1–2/4–5 shift group controls the upshifts and downshifts 1–2/2–1 and 4–5/5–4. This shift group includes:

- 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

2–3 Shift Group (K2/K3 Clutches)

The 2–3 shift group controls the upshift and downshift 2–3/3–2. This shift group includes:

- 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
3–4 Shift Group (K3/B2 Clutches)

The 3–4 shift group controls the upshift and downshift 3–4/4–3. This shift group includes:

- 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
SHIFT PHASE AND SEQUENCE

The shift phase and sequence are similar for all three shift groups. The 1–2/4–5 shift group is used as an example to illustrate the sequence of a shift event.

First-to-Second Shift Sequence (Steady State Drive 1)

- In First Gear steady state, the B1 clutch is hydraulically applied by line pressure through the holding valve.
- The holding valve position is maintained by a hydraulic clamp circuit, fed by the B1 apply circuit.

Figure 80  First Gear Engaged (Steady State D1)
First-to-Second Shift Transition

- The 1–2/4–5 shift solenoid is energized and hydraulic pressure is applied to the end face of the 1–2/4–5 command valve. This moves the command valve (left).
- The command valve moving initiates the venting of the B1 clutch and the filling of the K1 clutch.
  - The B1 clutch circuit is vented through the overlap valve, which dictates how fast or slow the circuit vents to the sump.
  - The K1 clutch circuit is filled from line pressure converted to shift pressure at the shift pressure regulator, which controls the fill rate of the clutch.
- The venting of B1 circuit combined with the filling of K1 shifts the holding valve to the right, maintaining K1 application.

Figure 81  First-to-Second Shift Transition
Second Gear Shifted (Steady State Drive 2)

- The 1–2/4–5 shift solenoid is deenergized and hydraulic pressure is removed from the end face of the 1–2/4–5 command valve. This allows the command valve to return (right).
  - As the command valve shifts right, this allows venting of the pressure built against the shift pressure valve through the holding valve.
- No pressure on the right side of the holding valve allows line pressure to be directed to the K1 clutch.
- Location of the shift pressure valve determines which clutch is filled and which clutch is vented during the next shift sequence.

Figure 82  Second Gear Shifted (Steady State D2)
NEUTRAL-TO-DRIVE ENGAGEMENT

- First gear is achieved by filling the B2 clutch through the manual valve.
  - The B2 clutch can only be applied by releasing hydraulic pressure in the B2 counter-apply piston.
  - This is accomplished by venting the counter-apply circuit when the 3-4 solenoid modulates the B2 shift valve.

Hydraulic Default (Limp-in)

- The 1-2/4-5 solenoid not energized due to a ‘limp-in’ state will leave the K1 clutch applied, resulting in a 2nd gear launch when the manual valve is moved to the drive position.
Figure 83 Neutral-to-Drive Engagement
SHIFT GROUP SHIFT VALVES

Overlap Valve

The overlap valve controls the reduction in pressure of a releasing clutch during a shift phase.

During the shift phase, the pressure in the releasing clutch is regulated by the overlap valve, based on modulating pressure (engine load) and shift pressure supplied to the applying clutch. The overlap valve controlled pressure drop of the releasing clutch is inversely proportional to the shift pressure increase of the applying clutch. The overlap valve provides regulated (controlled) clutch overlap.

Figure 84  Overlap Valve
Command Valve

The command valve shifts the shift group from the stationary phase into the shift phase and back again.

With no pressure at the end of the command valve in the stationary (in gear) phase, line pressure is routed to the currently applied clutch. To begin the shift phase, shift solenoid pressure is applied to the end of the command valve which causes shift pressure from the shift pressure regulating valve to be routed to the clutch to be applied. At the same time, the pressure in the clutch to be released is routed to the overlap valve for timed release of that clutch. When the shift is complete, the command valve returns to its original position when the shift solenoid is turned off. With the command valve in the static position, line pressure is directed to the newly applied clutch.

![Diagram of Command Valve](image)

<table>
<thead>
<tr>
<th></th>
<th>Command Valve</th>
<th></th>
<th>Overlap Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Command Valve</td>
<td>5</td>
<td>Overlap Pressure</td>
</tr>
<tr>
<td>2</td>
<td>Shift Pressure</td>
<td>6</td>
<td>Shift Solenoid Pressure</td>
</tr>
<tr>
<td>3</td>
<td>Line Pressure</td>
<td>7</td>
<td>Engaging Clutch</td>
</tr>
<tr>
<td>4</td>
<td>Disengaging Clutch</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 85  Command Valve
Holding Pressure Shift Valve

The holding pressure shift valve assigns line pressure to a clutch of a shift group. The holding pressure shift valve is shifted by the pressures occurring on the end faces of the valve from the engaging and disengaging clutches, along with the spring at the one end of the valve (initial condition).

The holding pressure shift valve assigns line pressure to the clutch with the higher pressure (taking into consideration the spring force and effective area). The other clutch of the shift group is then depressurized. A shifting of the valve takes place only during the shift phase.

---

**Figure 86  Holding Pressure Shift Valve**

<table>
<thead>
<tr>
<th></th>
<th>Holding Pressure Shift Valve</th>
<th></th>
<th>Line Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Engaging Clutch</td>
<td>4</td>
<td>Return Flow to Sump (Vent)</td>
</tr>
<tr>
<td>2</td>
<td>Disengaging Clutch</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>
**Shift Pressure Shift Valve**

The shift pressure shift valve assigns the shift pressure to the engaging clutch and the pressure regulated by the overlap valve to the disengaging clutch.

Prior to the shift, the shift pressure shift valve is held in place by line pressure on the end face from one of the clutches in the shift group. In the shift phase, valve position is retained by the line pressure acting on the end face of the valve. After the shift is complete, the shift pressure shift valve moves as the line pressure from the command valve is removed.

<table>
<thead>
<tr>
<th>1</th>
<th>Shift Pressure Shift Valve</th>
<th>5</th>
<th>Line Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Overlap Pressure</td>
<td>6</td>
<td>Disengaging Clutch</td>
</tr>
<tr>
<td>3</td>
<td>Shift Pressure</td>
<td>7</td>
<td>Engaging Clutch</td>
</tr>
<tr>
<td>4</td>
<td>Return Flow to Sump (Vent)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 87 Shift Pressure Shift Valve
SHIFT APPLICATION

The following table shows which clutches are in use for a particular gear range. There are always three clutches “on” to maintain a gear (shown in highlighted cells). To shift to a different gear, two of the three clutches are left “on” while the third clutch is turned off and replaced by another clutch to form the next gear. To shift again, the process repeats itself; two clutches are maintained while the third is replaced with another clutch.

The highlighted cells indicate which three clutches are needed for a particular gear and the bold lettering indicates which clutches changed state for a particular shift to occur. When there are transmission shifting problems, the clutch that has been turned On or Off is the likely cause of a shift problem as the next gear range is attempted. This chart, along with adaptation values, can indicate which clutch needs mechanical inspection to solve a shift complaint. The clutch that is turned On is also the one that is being adapted by the TCM.

### Table 7  Shift Application

<table>
<thead>
<tr>
<th>GEAR SHIFT</th>
<th>SOLENOID</th>
<th>B1</th>
<th>B2</th>
<th>B3 REV</th>
<th>K1</th>
<th>K2</th>
<th>K3</th>
<th>F1</th>
<th>F2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1–2 Upshift</td>
<td>1–2/4–5 *On, Off</td>
<td><strong>Turns Off</strong></td>
<td>Stays On</td>
<td>Not Used</td>
<td><strong>Turns On</strong></td>
<td>Stays On</td>
<td><strong>Turns Off</strong></td>
<td>Stays On</td>
<td>OR</td>
</tr>
<tr>
<td>2–3 Upshift</td>
<td>2–3 *On, Off</td>
<td>Stays On</td>
<td>Not Used</td>
<td>Stays On</td>
<td><strong>Turns On</strong></td>
<td><strong>Turns Off</strong></td>
<td>OR</td>
<td>OR</td>
<td></td>
</tr>
<tr>
<td>3–4 Upshift</td>
<td>3–4 *On, Off</td>
<td><strong>Turns Off</strong></td>
<td>Not Used</td>
<td>Stays On</td>
<td>Stays On</td>
<td><strong>Turns On</strong></td>
<td>OR</td>
<td>OR</td>
<td></td>
</tr>
<tr>
<td>4–5 Upshift</td>
<td>1–2/4–5 *On, Off</td>
<td><strong>Turns On</strong></td>
<td>Not Used</td>
<td><strong>Turns Off</strong></td>
<td>Stays On</td>
<td>Stays On</td>
<td>Active</td>
<td>OR</td>
<td></td>
</tr>
<tr>
<td>5–4 Downshift</td>
<td>1–2/4–5 *On, Off</td>
<td><strong>Turns Off</strong></td>
<td>Not Used</td>
<td><strong>Turns On</strong></td>
<td>Stays On</td>
<td>Stays On</td>
<td>OR</td>
<td>OR</td>
<td></td>
</tr>
<tr>
<td>4–3 Downshift</td>
<td>3–4 *On, Off</td>
<td><strong>Turns On</strong></td>
<td>Not Used</td>
<td>Stays On</td>
<td>Stays On</td>
<td><strong>Turns Off</strong></td>
<td>OR</td>
<td>OR</td>
<td></td>
</tr>
<tr>
<td>3–2 Downshift</td>
<td>2–3 *On, Off</td>
<td>Stays On</td>
<td>Not Used</td>
<td>Stays On</td>
<td><strong>Turns Off</strong></td>
<td><strong>Turns On</strong></td>
<td>OR</td>
<td>Active</td>
<td></td>
</tr>
<tr>
<td>2–1 Downshift</td>
<td>1–2/4–5 *On, Off</td>
<td><strong>Turns On</strong></td>
<td>Stays On</td>
<td>Not Used</td>
<td><strong>Turns Off</strong></td>
<td>Stays On</td>
<td>Active</td>
<td>Active</td>
<td></td>
</tr>
</tbody>
</table>

*Momentarily turned On for 1.5 seconds and then turned Off when the shift completes. OR = Overrunning
The TCM determines the current operating conditions of the vehicle and controls shift scheduling for shift quality and driving conditions. The TCM receives operating data from sensors, switches and broadcast messages from other modules over the CAN-C bus.

NOTE: The NAG1 Transmission Control Module is commonly referred to as EGS-52 or EGS-53 in StarScan/StarMobile screens and Service & Diagnostic Information.

The PCM, ESM and anti-lock brake controller broadcast messages over the CAN-C bus for use by the TCM. The TCM uses this information along with other inputs to determine the transmission operating conditions. The TCM:

- Determines the momentary operating conditions of the vehicle.
- Controls all shift scheduling, considering shift quality and driving conditions

The TCM controls shifts using inputs from several sensors that are direct inputs and several indirect inputs. Direct and indirect input information is used to actuate the proper solenoids in the valve body to achieve the desired gear range. The TCM continuously checks for electrical, mechanical and some hydraulic failures. When the TCM detects a failure, it stores a fault code.
The TCM controls the shift solenoids for modulating shift pressures and gear changes. Relative to the torque being transmitted, the required pressures are calculated from engine load conditions, engine rpm, vehicle speed and transmission fluid temperature. The following functions are programmed into the TCM:

- Shift scheduling
- Downshift safety
- Engine management intervention
- Torque converter clutch
- Adaptation
- Drivetrain protection through limp-in mode
  - Permanent limp-in
  - Temporary limp-in

![Diagram of TCM Inputs and Outputs](image-url)

**Figure 89  NAG1 TCM Inputs & Outputs (Typical)**
<table>
<thead>
<tr>
<th>INPUT</th>
<th>OUTPUT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 TCM Control Unit</td>
<td>7 2-3 Shift Solenoid</td>
</tr>
<tr>
<td>2 Modulating Pressure Solenoid</td>
<td>8 RPM Sensor 2 (N2)</td>
</tr>
<tr>
<td>3 Shift Pressure Control Solenoid</td>
<td>9 RPM Sensor 3 (N3)</td>
</tr>
<tr>
<td>4 Torque Converter Lockup Solenoid</td>
<td>10 Park/Neutral Reed Switch</td>
</tr>
<tr>
<td>5 1-2 &amp; 4-5 Shift Solenoid</td>
<td>11 Transmission Oil Temperature Sensor</td>
</tr>
<tr>
<td>6 3-4 Shift Solenoid</td>
<td></td>
</tr>
</tbody>
</table>

Figure 90  TCM Inputs & Outputs (Typical)
**TCM Location**

The NAG1’s TCM is mounted in various positions, depending on the vehicle model. The 300/Charger/Magnum’s (LX) TCM is located to the left of the steering column and accelerator/brake pedal bracket.

![Figure 91 300/Charger/Magnum (LX) TCM Location](image)
The Grand Cherokee and Commander’s (WK/XK) TCM is located to the right of the steering column, and is fastened to the dash panel as shown, covered by foam insulation.

<table>
<thead>
<tr>
<th></th>
<th>Transmission Control Module (TCM)</th>
<th></th>
<th>Dash Panel</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>TCM C1 &amp; C2 Connectors</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 92  Grand Cherokee/Commander (WK/XK) TCM Location 816b6326 & 814ffc6f
The Nitro and Liberty’s (KK/KA) TCM is located to the behind the driver’s knee bolster to the right of the steering column.

Figure 93  Liberty/Nitro (KA/KK) TCM Location
The Crossfire’s (ZB/ZH) TCM is located in the passenger side floor pan next to the radio power amplifier, below the floor mat and carpet.

Figure 94  ZH Crossfire TCM Location (Right Side Floor) 81bce101
The Sprinter’s (VA/VB) TCM is located under the driver’s seat assembly.
**TCM Power & Ground Supply**

Power is supplied to the NAG1 TCM by way of switched battery voltage from the TIPM. When the ignition switch is turned to the RUN or START position, the Transmission Control Relay (TCR) relay energizes, closing contacts that provide B+ to power the TCM. The circuit is protected by a 15A fuse. Additionally, the circuit contains a diode that prevents a reverse biasing of current.

The NAG1 TCM does not use additional power supply circuits (e.g. memory, keep-alive, etc.). As such, the TCM goes to ‘sleep’ when the ignition key is in the OFF/LOCK or ACC position.

The TCM is grounded by a single chassis ground circuit.

When the TCM is powered up by the TCR, it performs a series of self tests, looking for certain faults. If faults are detected, the TCM removes power from the transmission solenoids, preventing their operation and putting the transmission in default or ‘limp-in’ position. If faults are not detected, the TCM supplies power to the solenoids and normal transmission operation is allowed.

---

**Figure 97  NAG1 TCM Power Supply (LX Rear Compartment PDC Shown)**

<table>
<thead>
<tr>
<th></th>
<th>TCM Power Supply Diode</th>
<th></th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>TCM Power Supply Fuse</td>
<td></td>
</tr>
</tbody>
</table>
Note: Use care when removing the Rear Compartment PDC cover on LX applications. The TCM power supply diode can be easily dislodged by the cover upon removal. This will result in a loss of communication with the TCM and put the transmission in ‘limp-in’ mode.

Note: When installing the TCM power supply diode, it is possible to partially install the diode backwards, enough to make electrical contact and blow the TCM fuse.

Figure 98  NAG1 TCM Power Circuits - Typical
TCM Communication

The TCM communicates with the Electronic Shift Module and many other vehicle modules by way of the Powertrain CAN-C Bus. Powertrain CAN-C is a high-speed communication network that allows a higher degree of control capability between various controllers. Critical information is shared between the transmission, engine, Front Control Module (FCM), cluster and ABS controllers, depending on vehicle. The TCM CAN bus inputs used by the NAG1 electronic control system are:

- ABS Wheel Speed Sensors
- Engine Coolant Temperature
- Engine Static Torque
- Driver Input Requested Torque
- Pedal Position
- Demanded Engine Torque (Electronic Stability Program [ESP])
- Engine RPM
- Brake Light Switch
- Cruise Control Off Signal
- Limp-In Mode Message (from PCM on Grand Cherokee and Sprinter)
- Acknowledge Transmission Torque Request
- Shift Lever Position (from ESM)
- Winter/Standard Switch (Crossfire)
- FCM Inputs to TCM
  - Axle Ratio*
  - Transfer Case*
  - Dynamic Tire Circumference*
  - Model Year* (Crossfire/Sprinter only)
  - Country Code* (Crossfire/Sprinter only)
  - Body Style* (Crossfire/Sprinter only)
  - Odometer*
  - Brake Light Switch
  - Kickdown Signal
  - Ignition Switch Status (Key In, Ignition Off Active, Ignition Run, Ignition Start Active)

* = Configuration ‘variant’ info - Informs TCM what vehicle application and options exist so it can adjust transmission operation and shift quality. This information is critical to proper ‘booting’ of TCM.
A 2.5-volt bias (operating voltage) is present on the CAN bus any time the ignition switch is in the RUN position. Both the TCM and the CAB apply this bias voltage which is 2.4–2.6 volts for CAN Bus high (+) and 2.3–2.4 volts for CAN Bus low (−). The CAN bus is used for module data exchange only.

The CAN bus is comprised of two wires with one wire the CAN bus (+) circuit and the other wire the CAN bus (−) circuit. The CAN bus circuits are twisted wires in the harness to reduce the potential of radio frequency and electrical noise interference.
**TCM Control Strategy**

The TCM continuously monitors operating conditions of the vehicle and adjusts transmission shifting for comfortable and economical driving. In the event of certain faults, the TCM activates a control strategy that may switch to 'limp-in' or default operation. The TCM then stores the fault code assigned to the cause for scan tool diagnosis.

**Limp-In Mode**

If the TCM determines there is a non-recoverable condition present that does not allow proper transmission operation, it protects the transmission by placing it into a permanent limp-in mode. When this occurs, the TCM turns off all solenoids as well as the solenoid supply output circuit.

The following conditions are present during limp-in mode:

- The modulating pressure and shift pressure increase to their maximum values.
- The torque converter lock-up clutch is disengaged
- The last gear shifted remains shifted, until the ignition key is cycled.

When the ignition key is cycled, hydraulic pressure is removed from the valves that were maintaining the present gear. Limp-in operation is then defaulted to 2nd gear only, the transmission will not upshift or downshift, and vehicle speed is limited to 56 km/h (35 mph.).

Limp-in mode is retained until the fault is eliminated or the stored fault code is erased.

**Overheat Condition**

In Reverse (R) or Drive (D), transmission fluid temperature is constantly monitored by the TCM. When transmission fluid is outside the normal operating range, the shift schedule is modified to protect the transmission. This modified shift schedule can involve unique shift timing, delayed or removed torque converter application, or putting the transmission into limp-in mode.

**Torque Converter Lockup**

The torque converter lockup clutch minimizes the losses of the torque converter by reducing slip and lowering engine speed. When actuated by the TCM, oil pressure controlled by the torque converter lockup solenoid is directed through the input shaft to the pressure chamber behind the piston. In a situation where this is not occurring properly, the TCM indicates a fault code and the transmission operates in limp-in mode.
The TCM continuously checks for electrical problems, mechanical problems and some hydraulic problems. When a problem is sensed, the TCM stores a Diagnostic Trouble Code (DTC). Some of these codes cause the transmission to go into “Limp-In” or “Default” mode.

The NAG1 transmission defaults in the current gear position if a DTC is detected. Then after a key cycle or if the transmission is placed in Park, the transmission goes into Limp-In Mode, which is mechanical second gear. Some DTCs allow the transmission to resume normal operation (recover) if the detected problem goes away. A Permanent Limp-In DTC recovers when the key is cycled; but if the same DTC is detected for three key cycles, the system does not recover and the DTC must be cleared from the TCM with a scan tool.

After the scan tool is in the transmission portion of the diagnostic program, it constantly monitors the TCM to see if the system is in Limp-In Mode. The scan tool indicates when the transmission is in Limp-In Mode.
<table>
<thead>
<tr>
<th>FAULT CODE</th>
<th>J2012 DTC</th>
<th>A580 DTC</th>
<th>DESCRIPTION OF FAULT</th>
<th>LIMP-IN SET</th>
<th>MIL LIT</th>
<th>TYPE OF FAILURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>P0753</td>
<td>2100</td>
<td>1–2/4–5 Shift Solenoid</td>
<td>Yes (P)</td>
<td>Yes</td>
<td>C, E, S</td>
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<td>3</td>
<td>P0758</td>
<td>2102</td>
<td>2–3 Shift Solenoid</td>
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<td>Yes</td>
<td>C, E, S</td>
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<td>P0763</td>
<td>2104</td>
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<td>6</td>
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<td>10</td>
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<td>11</td>
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<td>19</td>
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<td>2400</td>
<td>CAN Right Rear Wheel Speed Signal Not Valid</td>
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<td>No</td>
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<td>U140B</td>
<td>2401</td>
<td>CAN Left Rear Wheel Speed Signal Not Valid</td>
<td>No</td>
<td>No</td>
<td>C, E, S</td>
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<td>24</td>
<td>U140A</td>
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<td>CAN Right Front Wheel Speed Signal Not Valid</td>
<td>No</td>
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<td>C, E, S</td>
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<td>25</td>
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<td>P0501</td>
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<td>Vehicle Speed Sensor Performance/Rationality</td>
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<td>U1118</td>
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<td>CAN Engine Variant Message Missing</td>
<td>Yes (T)</td>
<td>Yes</td>
<td>C, E</td>
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</table>

* These faults also set code P0613

(P) = Permanent Limp-In
(T) = Temporary Limp-In
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(N) = Loss of Drive

C = Controller
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<td>Yes</td>
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<td>26</td>
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<td>27</td>
<td>U1404</td>
<td>2406</td>
<td>CAN Static Engine Torque Message Not Valid</td>
<td>No</td>
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<td>C, E</td>
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<td>240A</td>
<td>CAN Engine Speed Message Not Valid</td>
<td>No</td>
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<td>C, E, S</td>
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<td>29</td>
<td>U1405</td>
<td>2408</td>
<td>CAN Minimum Engine Torque Message Not Valid</td>
<td>No</td>
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<td>C, E</td>
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<td>30</td>
<td>U0141</td>
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<td>Lost Communication with Central Gateway</td>
<td>No</td>
<td>No</td>
<td>C, E</td>
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<td>31</td>
<td>U1406</td>
<td>2409</td>
<td>CAN Maximum Engine Torque Message Not Valid</td>
<td>No</td>
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<td>32</td>
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<td>2407</td>
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<td>No</td>
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<td>C, E</td>
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<td>33</td>
<td>U1408</td>
<td>2404</td>
<td>CAN ABS Brake Light Switch Message Not Valid</td>
<td>No</td>
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<td>C, E</td>
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<td>34</td>
<td>U0103</td>
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<td>Lost Communication with Electric Gearshift Module</td>
<td>Yes (T)</td>
<td>Yes</td>
<td>C, E</td>
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<td>35</td>
<td>U0155</td>
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<td>Lost Communication with Instrument Panel</td>
<td>No</td>
<td>No</td>
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<td>36</td>
<td>U110B</td>
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<td>CAN Engine Coolant Message Missing</td>
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<td>37</td>
<td>U0002</td>
<td>2300</td>
<td>Bus-Off CAN Controller 1</td>
<td>Yes (T)</td>
<td>Yes</td>
<td>C, E</td>
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<td>U0121</td>
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<td>ABS CAN Messages Missing</td>
<td>Yes (T)</td>
<td>Yes</td>
<td>C, E</td>
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<td>U0100</td>
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<td>C, E</td>
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<td>41</td>
<td>U0114</td>
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<td>Yes (T)</td>
<td>Yes</td>
<td>C, E</td>
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<td>42</td>
<td>U0404</td>
<td>240C</td>
<td>CAN Gearshift Position Message Not Valid</td>
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<td>C, E</td>
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<td>43</td>
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<td>240D</td>
<td>CAN Transfer Case Message Not Valid</td>
<td>Yes (T)</td>
<td>Yes</td>
<td>C, E</td>
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</table>
**NAG1 Operation & Diagnosis**

* These faults also set code P0613

(P) = Permanent Limp-In  
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<tbody>
<tr>
<td>48</td>
<td>P0602</td>
<td>2010</td>
<td>Internal Controller Variant Not Coded</td>
<td>Yes (P)</td>
<td>Yes</td>
<td>C</td>
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<tr>
<td>49</td>
<td>P0219</td>
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<td>Engine Overspeed</td>
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<td>Yes</td>
<td>C, T</td>
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<td>P0723</td>
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<td>Speed Sensor Output Speed (consistence error)</td>
<td>No</td>
<td>Yes</td>
<td>S</td>
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<tr>
<td>50</td>
<td>P0730</td>
<td>2500</td>
<td>Improper Gear Ratio</td>
<td>Yes (N)</td>
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<td>C, E, T</td>
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<td>51</td>
<td>P0731</td>
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<td>Transmission Slipping in First Gear</td>
<td>Yes (C)</td>
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<td>Yes (C)</td>
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<td>Selector Lever (invalid code)</td>
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<td>Torque Reduction Acknowledge Not Correct</td>
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<td>No</td>
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<td>55</td>
<td>P1731</td>
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<td>Incorrect Gear Engaged</td>
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<td>56</td>
<td>P1629*</td>
<td>2013</td>
<td>Solenoid Supply/Watchdog</td>
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**NAG1 Operation & Diagnosis**

* These faults also set code P0613

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<td>C</td>
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<tr>
<td>67</td>
<td>P1639*</td>
<td>2007</td>
<td>Internal Controller CAN 2 RAM Failure</td>
<td>Yes (P)</td>
<td>Yes</td>
<td>C</td>
</tr>
<tr>
<td></td>
<td>P1644</td>
<td></td>
<td>TCU (Invalid variant coding)</td>
<td>Yes</td>
<td>Yes</td>
<td>C</td>
</tr>
<tr>
<td></td>
<td>P0601</td>
<td></td>
<td>TCU (checksum does not exist)</td>
<td>No</td>
<td>No</td>
<td>C</td>
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<tr>
<td></td>
<td>P0606</td>
<td></td>
<td>TCU (CPU Internal)</td>
<td>No</td>
<td>No</td>
<td>C</td>
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<tr>
<td></td>
<td>P0607</td>
<td></td>
<td>TCU (program flow)</td>
<td>No</td>
<td>No</td>
<td>C</td>
</tr>
<tr>
<td>69</td>
<td>P0613</td>
<td></td>
<td>Internal Controller Failure</td>
<td>Yes (P)</td>
<td>Yes</td>
<td>C</td>
</tr>
<tr>
<td></td>
<td>P0614</td>
<td></td>
<td>PCM Incompatible with TCM</td>
<td>Yes</td>
<td>Yes</td>
<td>C</td>
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<tr>
<td>71</td>
<td>P0752</td>
<td>2101</td>
<td>1–2/4–5 Solenoid Circuit</td>
<td>Yes (P)</td>
<td>Yes</td>
<td>C, E, S</td>
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<tr>
<td>72</td>
<td>P0757</td>
<td>2103</td>
<td>2–3 Solenoid Circuit</td>
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<td>C, E, S</td>
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<td>3–4 Solenoid Circuit</td>
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<td>Yes</td>
<td>C, E, S</td>
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<tr>
<td>74</td>
<td>P0710</td>
<td>2221</td>
<td>Temperature Sensor P/N Switch Circuit</td>
<td>No</td>
<td>No</td>
<td>C, E, S</td>
</tr>
<tr>
<td>75</td>
<td>P0714</td>
<td>2222</td>
<td>Temp. Sensor Erratic</td>
<td>No</td>
<td>No</td>
<td>C, E, S</td>
</tr>
<tr>
<td>80</td>
<td>U1508</td>
<td>2333</td>
<td>Electric Gearshift Module Incorrect Message Length</td>
<td>Yes (T)</td>
<td>Yes</td>
<td>C, E</td>
</tr>
<tr>
<td>81</td>
<td>U0415</td>
<td>2330</td>
<td>ABS Controller Incorrect Message Length</td>
<td>Yes (T)</td>
<td>Yes</td>
<td>C, E</td>
</tr>
</tbody>
</table>

**Legend:**
- (P) = Permanent Limp-In
- (T) = Temporary Limp-In
- (C) = Controlled Limp-In
- (N) = Loss of Drive
- C = Controller
- E = Electrical
- S = Sensor/Actuator
- T = Transmission
* These faults also set code P0613

(P) = Permanent Limp-In  
(T) = Temporary Limp-In  
(C) = Controlled Limp-In  
(N) = Loss of Drive  

C = Controller  
E = Electrical  
S = Sensor/Actuator  
T = Transmission

<table>
<thead>
<tr>
<th>FAULT CODE</th>
<th>J2012 DTC</th>
<th>A580 DTC</th>
<th>DESCRIPTION OF FAULT</th>
<th>LIMP-IN SET</th>
<th>MIL LIT</th>
<th>TYPE OF FAILURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>82 U0401</td>
<td>2331</td>
<td></td>
<td>Engine Controller Incorrect Message Length</td>
<td>No</td>
<td>Yes</td>
<td>C, E</td>
</tr>
<tr>
<td>83 U1507</td>
<td>2335</td>
<td></td>
<td>Engine Coolant Temperature Incorrect Message Length</td>
<td>No</td>
<td>No</td>
<td>C, E</td>
</tr>
<tr>
<td>U1509</td>
<td></td>
<td></td>
<td>CAN Engine Variant Message Incorrect Length</td>
<td>Yes</td>
<td>Yes</td>
<td>C, E</td>
</tr>
<tr>
<td>U150A</td>
<td></td>
<td></td>
<td>CAN FCM Variant Message Incorrect Length</td>
<td>Yes</td>
<td>Yes</td>
<td>C, E</td>
</tr>
<tr>
<td>U1601</td>
<td></td>
<td></td>
<td>ECU Application Software Code 1 Missing or Corrupted</td>
<td>No</td>
<td>No</td>
<td>C, E</td>
</tr>
<tr>
<td>84 U0431</td>
<td>2334</td>
<td></td>
<td>Central Gateway Incorrect Message Length</td>
<td>No</td>
<td>No</td>
<td>C, E</td>
</tr>
<tr>
<td>85 U0423</td>
<td>2332</td>
<td></td>
<td>Instrument Panel Incorrect Message Length</td>
<td>No</td>
<td>No</td>
<td>C, E</td>
</tr>
<tr>
<td>86 U0424</td>
<td>2336</td>
<td></td>
<td>A/C Controller Incorrect Message Length</td>
<td>No</td>
<td>No</td>
<td>C, E</td>
</tr>
<tr>
<td>111 U140F</td>
<td></td>
<td></td>
<td>CAN Engine Variant Message Not Valid or Missing</td>
<td>Yes (P)</td>
<td>Yes</td>
<td>C, E</td>
</tr>
<tr>
<td>112 U1410</td>
<td></td>
<td></td>
<td>CAN FCM Variant Message Not Valid or Missing</td>
<td>Yes (P)</td>
<td>Yes</td>
<td>C, E</td>
</tr>
<tr>
<td>U2301</td>
<td></td>
<td></td>
<td>CAN: Bus-off CAN-Controller 2</td>
<td>No</td>
<td>No</td>
<td>C, E</td>
</tr>
</tbody>
</table>
TCM DIRECT INPUTS

Lead Frame

The Lead Frame contains the NAG transmission’s three primary devices that transmit input signals to the TCM:

- Fluid Temperature Sensor
- Input Speed Sensors
- Park/Neutral Switch

Signals to and from these components are transmitted through conducting bars to and from an integral 13-pin connector.

Figure 100 Lead Frame
**Speed Sensors - Input**

The N2 and N3 Input Speed Sensors are Hall Effect sensors used by the TCM to calculate transmission input speed. These speed sensors do not directly read input shaft speed, but calculate it based on the rotation of gear train components. As such, there is no tone wheel on the input shaft.

Two input speed sensors are required because neither drive element is active in all gear ranges and so input shaft speed is a calculated value.

The input speed sensors are mounted on the electro-hydraulic unit and are permanently attached to the lead frame by contact tabs. A leaf spring that rests against the valve body presses the input speed sensors against the inner transmission housing to ensure a precise distance between the input speed sensors and impulse rings on the drive elements.

**Note:** When viewing speed sensor signals with the Scan Tool, it is normal for the N3 speed sensor to display zero (0) RPM any time the B1 clutch is applied (1st, 5th & Reverse).

Additionally, N2 and N3 will read the same speed in 2nd, 3rd, and 4th gears.

![Figure 101 N2 and N3 Input Speed Sensors](image)
Input speed sensor supply voltage is 6 volts. A common supply voltage and common ground circuits are provided to both sensors with a separate output signal from each sensor to the TCM.

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Transmission Valve Body</td>
<td>4</td>
<td>N2 Speed Sensor Signal</td>
</tr>
<tr>
<td>2</td>
<td>TCM</td>
<td>5</td>
<td>N3 Speed Sensor Signal</td>
</tr>
<tr>
<td>3</td>
<td>Sensor Supply (6 Volts)</td>
<td>6</td>
<td>Sensor Ground</td>
</tr>
</tbody>
</table>

Figure 102  N2 and N3 Speed Sensor Circuits
Fluid Temperature Sensor

The temperature of the ATF influences shift timing and the resulting shift quality. The transmission fluid temperature sensor measures the temperature of the transmission fluid and provides an input signal to the TCM. With temperature sensor information, transmission operation and shift scheduling can be optimized in all temperature ranges.

The NAG1’s fluid temperature sensor is located in the Lead Frame as shown below.

Figure 103  Fluid Temperature Sensor Location
The NAG1’s fluid temperature sensor is a Positive Temperature Coefficient (PTC) thermistor. As the fluid temperature rises, the resistance of the sensor rises.

When monitoring sensor circuit voltage, as temperature increases, voltage will increase.

The fluid temperature sensor is connected in series with the Park/Neutral switch. The temperature signal is transmitted to the TCM only when the reed contact of the Park/Neutral switch is closed and the TCM only reads ATF temperature while in gear (reverse and drive). While in park or neutral, the TCM reads engine coolant temperature over the CAN bus.

**Figure 104  Transmission Fluid Temperature Sensor Circuit**
Park/Neutral Switch

The TCM monitors a contact switch wired in series with the fluid temperature sensor to determine Park and Neutral positions. The contact switch is open in Park and Neutral. The TCM senses transmission temperature voltage as high (5v), confirming switch status as open. The TCM then broadcasts a message over the CAN bus to confirm switch status. The engine controller receives this information and allows operation of the starter circuit.

The TCM senses the position of the plunger through the reed-style contact switch.

**Note:** Refer to temperature sensor circuit for electrical operation of the Park/Neutral Switch.

<table>
<thead>
<tr>
<th></th>
<th>Permanent Magnet</th>
<th>3 Plunger</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Reed Contact Switch</td>
<td></td>
</tr>
</tbody>
</table>

Figure 105 Starter Interlock Reed Contact Switch (Cover Removed for Demonstration Purposes)
TCM INDIRECT (BUSSED) INPUTS

Shift Lever Position (from ESM)
Shift lever position originates from four or five optical sensors that are hardwired to the ESM, then are bussed out to the TCM and other modules. Shift lever position is transmitted within 10 milliseconds. A “shifter lever position implausible” message is transmitted after 100 milliseconds if the lever position cannot be recognized and remains unrecognized for the rest of the current “Ignition On” cycle.

Four shift positions P, R, N and D, along with three intermediate positions PR, RN and ND, are recognized by the ESM. Also in position D of the shift lever, a lateral movement (+ for upshift and – for downshift) are recognized for the Autostick or Electronic Range Select (ERS) feature, if equipped.

ABS Wheel Speed
Wheel speed sensors, in addition to being used for ABS functions, are used to calculate transmission output shaft speed. Wheel speed sensor information is an input to the TCM from the anti-lock brake module over the CAN bus.

The anti-lock brake module receives a digital signal from the wheel speed sensors, and broadcasts vehicle speed over the CAN bus. This message is also monitored by the ESM for the reverse/park block feature.

4x4 Low Switch
This input tells the TCM that 4x4 LO has been selected, resulting in the TCM commanding the Reverse 2 gear ratio and a 2nd gear launch.

Figure 106 4x4 Low Switch (WK Shown)
Notes: ___________________________________________________________________________
_________________________________________________________________________________
_________________________________________________________________________________
_________________________________________________________________________________
_________________________________________________________________________________
_________________________________________________________________________________
_________________________________________________________________________________
_________________________________________________________________________________
_________________________________________________________________________________
_________________________________________________________________________________
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TCM DIRECT OUTPUTS

Shift Solenoids
These solenoids control shifts, regulate modulating pressure and regulate shift pressure depending on various changing operating conditions such as engine load and gear changes. The solenoid converts a variable current from the TCM into a proportional pressure. The regulating solenoids have a close tolerance fit that also seals them to the valve body. Each solenoid is provided with a switched B+ supply from the TCM. The TCM controls the ground side of each solenoid to operate the solenoid as necessary.

On/Off Shift Solenoids
The TCM actuates the shift solenoid to open; this guides control pressure to the necessary command valve. The solenoid remains actuated (open) until the shift sequence is complete. When the TCM de-energizes the solenoid or the power supply to the solenoid is interrupted, the command valve pressure drops to zero.

Electrical control of the current flow through the on/off shift solenoids is pulse width modulated, even though the solenoids hydraulically are either On or Off. When switched on, the solenoids are first controlled with a pulse width of 99.6% for the initial rush-in time (approximately 60 milliseconds). After the initial rush-in time, the pulse width is reduced to approximately 25% to 37% during the holding current phase, for the remainder of the solenoid On cycle. Current flow through the on/off solenoids is in the range of 500–1000 mA.

The diagnostic scan tool only indicates when each solenoid is active or not active. During a shift the appropriate solenoid can be seen as active for approximately 1.5 seconds (solenoid On time) during the shift.

Variable Force Solenoids
As mentioned earlier, two VFS solenoids are used to control line pressure and shift pressure. These solenoids are commonly referred to as:

- P-mod (or Modulating Pressure Solenoid)
- Shift-mod (or Shift Pressure Regulating Solenoid)

The variable force solenoids (VFS) vary the amount of current flow based on the continuously changing operating conditions such as load and gear range. The pressure through the solenoid varies and is inversely proportional to the current applied by the TCM.
The current through the variable force solenoid is varied at a frequency of 1000 Hertz. The controlled current rate indicated on the scan tool is between 0–1000 mA with the average somewhere between 200–800 mA. The higher the current flow indicated on the scan tool, the lower the pressure output of the solenoid. The lower the current flow indicated on the scan tool, the higher the pressure output of the solenoid.

Figure 107 TCM Shift Solenoid Circuits
The following table provides an example of the current rate of the VFS and the corresponding hydraulic pressure output. The values are approximate.

Table 9  VFS Current to Pressure Conversion

<table>
<thead>
<tr>
<th>CURRENT IN MILLIAMPS</th>
<th>UPPER PRESSURE LIMIT</th>
<th>LOWER PRESSURE LIMIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>116.0</td>
<td>105.1</td>
</tr>
<tr>
<td>100</td>
<td>113.4</td>
<td>103.2</td>
</tr>
<tr>
<td>200</td>
<td>107.5</td>
<td>98.3</td>
</tr>
<tr>
<td>300</td>
<td>97.6</td>
<td>89.4</td>
</tr>
<tr>
<td>400</td>
<td>83.1</td>
<td>75.9</td>
</tr>
<tr>
<td>500</td>
<td>64.6</td>
<td>58.4</td>
</tr>
<tr>
<td>600</td>
<td>46.1</td>
<td>40.7</td>
</tr>
<tr>
<td>650</td>
<td>36.7</td>
<td>32.3</td>
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<tr>
<td>700</td>
<td>28.1</td>
<td>23.3</td>
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<tr>
<td>800</td>
<td>15.3</td>
<td>9.9</td>
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<tr>
<td>900</td>
<td>8.9</td>
<td>2.6</td>
</tr>
<tr>
<td>1000</td>
<td>6.9</td>
<td>0.3</td>
</tr>
</tbody>
</table>

Note: Since pressures cannot be read on this transmission, this chart is provided as operational reference indicating TCM intent.

**Torque Converter Clutch (TCC) Operation**

The torque converter clutch solenoid controls the operating phases of the torque converter clutch with defined slippage and is normally applied in third, fourth or fifth gear. However, diesel and SRT packages use the TCC clutch in all gears. The following operating phases are possible:

- 5%–95% EMCC
- No EMCC (Off)

**Pulse Width Modulated Torque Converter Clutch Solenoid**

The torque converter clutch (TCC) solenoid is Pulse Width Modulated (PWM) to obtain more precise control over the slip rate of the clutch. The solenoid PWM control current is pulsed many times per second at 1000 Hertz frequency. During the rush-in phase of an On/Off cycle, the control current is 99.9%. During the holding current phase of an On/Off cycle, the current ranges from 500–1000 mA.

The PWM duty cycle of the solenoid varies between 5–95% at a rate of 100 Hertz. Increased duty cycle means more pressure at the end of the TCC control valve and less clutch slip. Reduced duty cycle means less pressure at the end of the TCC control valve and more clutch slip. The TCM monitors engine rpm and transmission input speed to determine the correct PWM of the solenoid to achieve the programmed slip rate of the TCC.
To check a solenoid with the transmission installed in the vehicle, disconnect the 13-pin harness connector from the connector extension guide. Locate the appropriate pin numbers for the suspect solenoid and measure the resistance of the solenoid windings. Also check for a short to ground.

### Table 10 Solenoid Resistance Values

<table>
<thead>
<tr>
<th>SOLENOID</th>
<th>OHMS RESISTANCE 20–23°C (68–73°F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1–2/4–5 Shift (On/Off)</td>
<td>4.0</td>
</tr>
<tr>
<td>2–3 Shift (On/Off)</td>
<td>4.0</td>
</tr>
<tr>
<td>3–4 Shift (On/Off)</td>
<td>4.0</td>
</tr>
<tr>
<td>TC Clutch (Modulating)</td>
<td>2.5</td>
</tr>
<tr>
<td>Shift Pressure Regulating (Variable Force)</td>
<td>5.0</td>
</tr>
<tr>
<td>Line Pressure (Variable Force)</td>
<td>5.0</td>
</tr>
</tbody>
</table>

**ASSEMBLY-ELECTROHYDRAULIC CONTROL UNIT (NAG1)**

<table>
<thead>
<tr>
<th>Pin</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>N3 Speed Signal</td>
</tr>
<tr>
<td>2</td>
<td>Modulation Pressure Control</td>
</tr>
<tr>
<td>3</td>
<td>N2 Speed Signal</td>
</tr>
<tr>
<td>4</td>
<td>P/N Temp Signal</td>
</tr>
<tr>
<td>5</td>
<td>Sensor Supply Voltage</td>
</tr>
<tr>
<td>6</td>
<td>Sensor Supply Voltage</td>
</tr>
<tr>
<td>7</td>
<td>2-3 Shift Solenoid Control</td>
</tr>
<tr>
<td>8</td>
<td>3-4 Shift Solenoid Control</td>
</tr>
<tr>
<td>9</td>
<td>Shift Pressure Solenoid Control</td>
</tr>
<tr>
<td>10</td>
<td>Sensor Ground</td>
</tr>
<tr>
<td>11</td>
<td>TCC Solenoid Control</td>
</tr>
<tr>
<td>12</td>
<td>1-2/4-5 Solenoid Control</td>
</tr>
</tbody>
</table>

135
TCM INDIRECT (BUSSED) OUTPUTS

The following are the output signals the TCM transmits over the CAN bus.

- Current/Actual/Target Gear (TCM to CAB/PCM)
- Requested Engine Torque
- Calculated Output Shaft Speed
- Allow Transmission Torque Request

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CAB</td>
<td>2</td>
<td>PCM</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>CAN Bus (–)</td>
<td>5</td>
<td>TCM</td>
<td>6</td>
</tr>
</tbody>
</table>
NAG1 Operation & Diagnosis

- Torque Converter Status (Open, Closed, Slipping, Open Slipping [5%), Closed Slipping [95%])
- Kickdown
- Transmission Overtemp (to PCM)
- Transmission in Limp-In Mode (to PCM)
- OK to Crank (to PCM)
- Garage Shift In-Progress
- Output Shaft Torque (CAB/EPS Option Only)
- PRNDL Display Request (to FCM and FCM to Cluster, Sprinter is Shifter to Cluster)
- Transmission Fluid Temperature
- PRNDL Status (Signal Not Available)

**Speed Control**

Engine braking is used on deceleration with cruise control engaged to perform downshifts to as low as third gear. Downshifts become effective at an overspeed of approximately 7 km/h (4 mph) from the set speed.

Engine braking is effective up to approximately 125 km/h (78 mph). This prevents a possible over speed of the engine during a downhill engine braking event.

**Engine Management Intervention (Torque Reduction)**

By briefly reducing engine torque during the shifting process, shift time between gears can be reduced and therefore, shift quality is optimized.
ELECTRONIC SHIFTER MODULE (ESM)

The Shift Lever Assembly (SLA) in NAG1-equipped vehicles uses an Electronic Shifter Module (ESM) to process shifter-related inputs, and broadcast outputs for the TCM and other modules to use. The ESM is the central control for driver-initiated shifting on the NAG1, as the standalone Transmission Control Module does not include these functions.

The ESM is critical to TCM and transmission operation, as it performs the following functions:

- Recognizes shift lever position - both ‘in gear’ and transition positions
- Transmits shift lever position across the CAN bus to TCM, PCM, FCM, etc.
- Monitors ERS/Autostick switches - provides requests to TCM via the CAN bus.
- Controls the BTSI/Reverse Block Solenoid
- Provides pass-thru connectivity for park switch (2008-2009 LX & WK WINFOBIK)
- Provides pass-thru connectivity for lamp dimming (2008-2009 LX & WK WINFOBIK)
- Monitors service brake pedal application (via CAN or hardwire)*
- Monitors via hardwire WINFOBIK for BTSI control (2008-2009 LX & WK Only)
- Records and stores ESM-related faults
- Records and stores 'Loss of communication' faults from other modules
- Supports diagnostics over the CAN bus
- Supports reflash with the Scan Tool

*= Except 2008-2009 LX & WK
Shift Lever Assembly (SLA)  2  Electronic Shifter Module (ESM)

Figure 109  Shift Lever Assembly with ESM (LX Shown, KA/KK & '08 WK/XK typical)

Shift Lever Assembly (SLA)  2  Electronic Shifter Module (ESM)

Figure 110  Shift Bezel Assembly with ESM (2005-2007 WK/WH Shown, 2005-2007 XK/XH Similar)
Figure 111  Shift Lever Assembly with ESM (VA Sprinter Shown)
The ESM receives power from the ignition switch in the UNLOCK, RUN and START positions and has a single ground circuit. The ESM communicates through the CAN-C bus transceiver on the CAN-C bus with the TCM and other controllers.

Figure 112  Typical ESM Diagram (2008 WK Shown)
ESM Inputs

The ESM receives the following inputs:

- Shift Lever Position (from internal opticals, hall effects, or potentiometers)
- ERS/Autostick Switch Position
- ERS/Autostick Enable (Police Only)
- Brake switch status from ESP/ABS
- Vehicle speed signal from ESP/ABS
- Ignition switch - from FCM/TIPM/YIPM
- Shifter illumination (from CCN)

Secondary, less important inputs (via CAN-C) to the ESM are:

- Odometer
- VIN message information
- Network Configuration
- Vehicle Configuration Information

Shift Lever Position

Depending on vehicle application, shift lever position is input to the ESM by one of four different sensing technologies:

- Four Optical Sensors (2005-2007 LX)
- Dual Potentiometer (VA/VB, ZH/ZB)

Optical Sensors:

The 2005-2007 LX models use four optical sensors to transmit shift lever position. Each optical sensor has a light beam projected across it. These beams are blocked by a rotor splined to the shift lever.

As the shift lever is moved, one of seven different combinations of blocked and unblocked light beams is provided to the ESM as shift lever position. This shift lever position is broadcast over the CAN-C BUS for the TCM and other modules to use.

These seven positions are: Park, P-R, Reverse, R-N, Neutral, N-D, Drive.
The optical sensors can be viewed in the Scan Tool in the ESM data display. While unlikely, a fault in the optical sensor circuits will result in a skipped or constant gearshift lever position being transmitted, and storing a fault in the ESM.

The ESM is not serviceable separately; an ESM or optical fault requires shift lever assembly replacement.

<table>
<thead>
<tr>
<th>SLP ▼</th>
<th>OPTICAL 1</th>
<th>OPTICAL 2</th>
<th>OPTICAL 3</th>
<th>OPTICAL 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>PARK</td>
<td>OFF</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
</tr>
<tr>
<td>REVERSE</td>
<td>ON</td>
<td>ON</td>
<td>OFF</td>
<td>ON</td>
</tr>
<tr>
<td>NEUTRAL</td>
<td>ON</td>
<td>OFF</td>
<td>ON</td>
<td>ON</td>
</tr>
<tr>
<td>DRIVE</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>OFF</td>
</tr>
</tbody>
</table>
Linear Hall Effect Sensor:


A 5v source is supplied to the sensor. As the shift lever is moved, voltage sensed at the return circuit changes, indicating either actual shift lever position or a transition (in-between) position. This shift lever position is broadcast over the CAN-C bus for the TCM and other modules to use.

The Hall sensor voltage for shift lever position can be viewed in the Scan Tool in the ESM data display. While unlikely, a faulty or bad Hall sensor circuit will be evident by transmitted gear position not changing when the shift lever is moved.

The ESM is not serviceable separately, an ESM or Hall sensor fault requires shift lever assembly replacement.
**PCB Carbon Conductor:**


Shift lever position switch states can be viewed in the Scan Tool in the ESM data display. The following table provides a combination of switch states for each shift lever position.

<table>
<thead>
<tr>
<th>SLP</th>
<th>PCB CONDUCTOR 1</th>
<th>PCB CONDUCTOR 2</th>
<th>PCB CONDUCTOR 3</th>
<th>PCB CONDUCTOR 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>PARK</td>
<td>OFF</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
</tr>
<tr>
<td>REVERSE</td>
<td>ON</td>
<td>OFF</td>
<td>ON</td>
<td>ON</td>
</tr>
<tr>
<td>NEUTRAL</td>
<td>ON</td>
<td>ON</td>
<td>OFF</td>
<td>ON</td>
</tr>
<tr>
<td>DRIVE</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>OFF</td>
</tr>
</tbody>
</table>

**ERS/Autostick Switches:**

Two types of ERS/Autostick circuits are used in NAG1-equipped vehicles:

- Switched Voltage Divider (Resistor) Network
- Separate Upshift/Downshift Circuits

**Switched Voltage Divider (Resistor) Network:**

2008-2009 WK/XK/LX/LC models use a switched voltage divider network to determine ERS/Autostick input.

The ESM constantly monitors the 5V circuit voltage, in which the return voltage is varied by the closing of the ERS/Autostick Up/Down switches. As voltage changes, the ERS/Autostick Up/Down/Static requests are broadcast to the TCM via the CAN bus.

![ERS/Autostick Voltage Divider Network](image-url)
Separate Upshift/Downshift Circuits

ESMs in 2005-2007 LX, and 2007-2009 KA/KK models use a pair of circuits to monitor ERS/Autostick upshift and downshift requests. At rest both circuits are pulled high (5 Volts). When either of the momentary contact switches are closed, the corresponding circuit is pulled low, indicating a driver request to perform that function (transmission upshift or downshift).

The ESM Autostick upshift and downshift requests are broadcast to the TCM via the CAN-C bus, but only when in the DRIVE position. If requests are received out of DRIVE, a DTC is set.

Additionally, if an upshift and downshift request are received at the same time, a fault is stored.

Brake Switch Status [except 2008-2009 LX & WK]

Another input considered primary to the ESM is the brake switch status input. The ESM monitors the CAN bus for brake switch status as transmitted by the ESP module. As a secondary (backup) measure, it relies on the hardwired brake switch input should the ESP not communicate, or should the ESP message be incorrect.

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ESM Outputs

The ESM performs the following outputs:

- BTSI/Reverse Block solenoid control
- Selector lever position
- ERS/Autostick Request
- Pass-thrus for park switch and lamps dimming
- Several outputs for diagnostics

BTSI/Reverse Block

The BTSI/Reverse Block Solenoid is activated based on brake switch status and vehicle speed. As mentioned in the input section, the ESM monitors brake switch status and vehicle speed via CAN as transmitted by the ESP module. As a secondary (backup) measure, the signal is checked at the hardwired brake switch input at the connector.

To shift out of PARK, the ignition switch must be in the RUN position, and the brake pedal must be pressed. If these conditions are met, the solenoid is energized and the blocker is moved allowing the shift lever to be moved out of PARK.

Reverse block prevents the driver from shifting from DRIVE to REVERSE based on vehicle speed. When the solenoid is energized, the driver cannot move the gear shift lever into reverse. The solenoid stays energized until vehicle speed falls below 10 km/h (6.2 mph), AND the shift lever is moved from the DRIVE range (N-D transition code).

With the ignition key in the RUN position, the BTSI/Reverse Block Solenoid is supplied B+ voltage. The solenoid is energized by the ESM with PWM control (50% duty cycle) of the solenoid’s low-side driver. PWM control is used to minimize the generation of heat over great driving distances, and premature failure of a fully applied solenoid.

Figure 119  BTSI/Reverse Block Solenoid (2005-2009 LX, 2008-2009 WK/LC)
On KA/KK models, the BTSI/Reverse Block Solenoid is perpetually grounded, and is energized by the ESM's control of a high-side driver.

![Figure 120 BTSI/Reverse Block Solenoid (2007-2009 KA/KK Models)](image)

On Sprinter and Crossfire models, the TCM acuates the BTSI/Reverse Block Solenoid by way of controlling the low side. B+ voltage is supplied to the solenoid by the ESM.

![Figure 121 BTSI/Reverse Block Solenoid (Sprinter/Crossfire Models)](image)

<table>
<thead>
<tr>
<th></th>
<th>TCM</th>
<th>3</th>
<th>Park/Reverse Interlock Solenoid</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>ESM</td>
<td>4</td>
<td>Reverse Interlock Control</td>
</tr>
</tbody>
</table>

Figure 121 BTSI/Reverse Block Solenoid (Sprinter/Crossfire Models)

Solenoids that are powered by the PDC and actuated by the brake switch’s control of the low side.

Figure 122  BTSI/Reverse Block Solenoid (2005-2007 WK/XK Shown)
MODULE 5 TRANSMISSION ADAPTATION AND REPAIR VERIFICATION

TCM ADAPTATION

TCM adaptation can only occur during typical city/highway driving while the transmission fluid temperature is above 60°C (140°F) and less than 80°C (176°F). See Adaptation Procedure on following pages.

The Adaptation procedure should be performed if any of the following repairs are performed.

- Transmission replacement
- TCM replacement
- Major transmission component replacement or rebuild

To equalize tolerances and wear, an automatic adaptation takes place for:

- Shift time
- Clutch/brake filling time
- Clutch/brake filling pressure

Adaptation data is stored permanently and to some extent, can be diagnosed.

<table>
<thead>
<tr>
<th>Shift Quality Adaptation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fill Time</strong></td>
</tr>
<tr>
<td>Written to memory.</td>
</tr>
<tr>
<td>The time it takes to apply a shift member.</td>
</tr>
<tr>
<td>Needs certain values to adapt.</td>
</tr>
<tr>
<td><strong>Fill Pressure</strong></td>
</tr>
<tr>
<td>Written to memory.</td>
</tr>
<tr>
<td>Pressure adjustment that affects shift quality.</td>
</tr>
<tr>
<td>Needs certain values to adapt.</td>
</tr>
<tr>
<td><strong>Shift Time</strong></td>
</tr>
<tr>
<td>Written to memory.</td>
</tr>
<tr>
<td>Adjusts Shift Time from one gear to the next.</td>
</tr>
<tr>
<td>Needs certain values to adapt.</td>
</tr>
</tbody>
</table>

Table 1 Adaptation

<table>
<thead>
<tr>
<th>Aggressive Driving Adaptation to Shift Points</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Driving Style</strong></td>
</tr>
<tr>
<td>Adaptation not written to memory</td>
</tr>
<tr>
<td>Moves shift point</td>
</tr>
<tr>
<td>Needs certain inputs to adapt</td>
</tr>
<tr>
<td>Occurs every ignition key cycle</td>
</tr>
</tbody>
</table>
SHIFT TIME ADAPTATION (SHIFT OVERLAP, WORKING PRESSURE)

Shift time adaptation is the ability of the TCM to electronically alter the time it takes to go from one gear to another. Shift time is defined as the time it takes to disengage one clutch while another clutch is being engaged.

Shift time adaptation is divided into four categories:

- **Accelerating upshift** is an upshift under a load. For shift time adaptation for the 1–2 upshift to take place, the transmission must shift from first to second in six different engine load ranges versus transmission output speed ranges.

- **Decelerating upshift** is an upshift under no load. A decelerating upshift is a rolling upshift and is accomplished by letting the vehicle roll into the next gear.

- **Accelerating downshift** is a downshift under load, can be initiated by the throttle or the shift selector.

- **Decelerating downshift** is accomplished while coasting. As the speed of the vehicle decreases, the transmission downshifts.

FILL PRESSURE ADAPTATION (APPLY PRESSURE, MODULATING PRESSURE)

Fill pressure adaptation is the ability of the TCM to modify the pressure used to engage the applying clutch/brake. The value of this pressure determines how firm the shift is.

- If too much pressure is used, the shift is harsh.
- If too little pressure is used, the transmission can slip.

The pressure adjustment is needed to compensate for the tolerances of the shift pressure solenoid valve. The amount the solenoid valve opens as well as how quickly the valve can move, has an effect on the pressure. The return spring for the clutch provides a resistance that must be overcome by the pressure for the clutch to apply. These return springs have slightly different build tolerances, which can affect the application pressure and is compensated for by fill pressure adaptation.

FILL TIME ADAPTATION (ENGAGEMENT TIME ADAPTATION)

Fill time is the time it takes to fill the piston cavity and take up any clearances in a clutch or brake. Fill time adaptation is the ability of the TCM to modify the time it takes to fill the applying clutch/brake by applying a preload pressure.
TORQUE CONVERTER CLUTCH ADAPTATION (PRESSURE CONTROL ADAPTATION)

When “Slip Mode” is active from the TCM, the torque converter clutch attempts to control to a calibrated slip value (Engine Speed vs. Transmission Input Speed).

Torque converter clutch (TCC) adaptation is the ability of the TCM to modify the pressure control to the TCC to minimize the measured slip variation from desired slip.

TCC adaptation can only occur during Slip Mode operation, in a constant gear (no shift taking place), and at steady throttle.

DRIVING STYLE ADAPTATION

The shift point is modified in steps based on the information from the inputs. The control module looks at inputs such as:

- Vehicle acceleration and deceleration (calculated by the TCM)
- Rate of change as well as the position of the throttle pedal (fuel injection information from the PCM)
- Lateral acceleration (calculated by the TCM)
- Gear change frequency (how often the shift occurs)

Based on how aggressive a driver drives the vehicle, the TCM moves up the shift speed so that the present gear is held a little longer before the next upshift. If the driving style is still aggressive, the shift point is modified up to ten steps. If the driving returns to normal, then the shift point modification also returns to the base position.

This adaptation has no memory. The adaptation to driving style is nothing more than a shift point modification meant to assist an aggressive driver. The shift points are adjusted for the moment and return to base position as soon as the inputs are controlled in a more rational manner.

Driving style adaptation does not occur when there is an ABS wheel speed sensor fault.
ADAPTATION PROCEDURE

Using the diagnostic scan tool, reset the transmission adaptives to achieve the factory settings for adaptives.

Drive the vehicle until the transmission temperature is in the range of greater than 60°C (140°F) and less than 80°C (176°F).

**Fill Pressure / Fill Time Adaptation**

From a stop, lightly accelerate the vehicle, keeping the engine speed below 1800 rpm, to obtain all forward gear ranges.

*Note: It might be difficult to obtain 5th gear at 1800 rpm. In this case, allow the transmission to shift into 5th gear at a higher rpm and then lower the rpm to 1800.*

After 5th gear is achieved, allow the vehicle to coastdown to a stop using light or no brake pressure. REPEAT 5 TIMES.

**Shift Time Adaptation**

From a stop, moderately accelerate the vehicle at light to moderate throttle values to obtain all forward gears. REPEAT 5 TIMES.

**TCC Pressure Control Adaptation**

While in 3rd, 4th, or 5th constant gear (no shifting), verify using a scan tool that the TCC is in Slip Mode operation. Then hold vehicle speed constant using light pedal for several minutes. If possible, use scan tool to verify TCC Actual Slip is within +/− 20rpm of TCC Desired Slip.

**ADAPTIVE VALUE STORING**

The TCM stores adaptation values every ten minutes. After performing the adaptation procedures, make sure to leave the engine running for at least ten minutes. You can manually store the adaptation values using the 'Store Learned Adaptives' function in TCM/Miscellaneous Options. Repeat the adaptation procedure if shift quality is questionable. If still questionable, verify any transmission repairs.
TRANSMISSION REPAIR VERIFICATION TESTING

As is always with any transmission service requiring component replacement or when the TCM has been replaced, you must verify that the repair is complete and has corrected the initial concern. There should be no DTCs present and the transmission must be shifting properly with no fluid leaks.

After performing a TCM Adaptation, the vehicle must be road tested to perform the NAG1 Transmission Verification Test. The verification test requires the use of the diagnostic scan tool and that the vehicle be driven to perform various shift adaptations.

Preliminary steps before the Repair Verification Test are necessary.

- Reconnect any disconnected components.
- Connect the diagnostic scan tool to the Data Link Connector (DLC).
- Erase any initial DTCs set as a result of the original concern or from testing.
- Start and run the engine until the transmission temperature is above 43°C (110°F). Use the diagnostic scan tool to display transmission temperature and verify the correct temperature.
- Check the transmission fluid level and adjust as necessary. Refer to the appropriate service information for the procedure.
- Perform the adaptation procedure whenever the TCM and/or the transmission have been replaced or major transmission repairs have been performed. If none of these apply, road test the vehicle.
Road Test

Take the vehicle on a road test with the diagnostic scan tool connected to monitor transmission temperature, throttle angle and any DTCs that might occur and to perform the transmission solenoid test. The Road Test consists of the following:

- Make 15 to 20 1–2, 2–3 and 3–4 upshifts.
- Perform the shifts from a standing start to 72 km/h (45 mph) with a constant throttle opening of 20 to 25 degrees (use diagnostic scan tool).
- With speeds below 40 km/h (25 mph), make five to eight wide open throttle kickdown shifts to first gear. Allow at least five seconds each in second gear and third gear between each kickdown shift.
- Perform the Transmission Solenoid Test and check for any DTCs using the diagnostic scan tool.

After the road test verification, if there are any additional DTCs, refer to the appropriate diagnostic test procedures to correct the condition. Clear any DTCs after testing. Perform the road test again for correct repair verification.

With no DTCs and proper and smooth transmission shifting, the repair is complete.
NAG1 Operation & Diagnosis

Drive 4th

Legend:
- Line Pressure (50-95 psi)
- Control Valve Pressure (105-120 psi)
- Shift Valve Pressure (50-95 psi)
- TC In Pressure (50-100 psi)
- TC Out Pressure (10-45 psi)
- Modulating Pressure (0-120 psi)
- Lubrication (5-40 psi)
- Shift Pressure/Control Solenoid Valve (0-120 psi)
- Sump
D4 TO D3 TRANSITION