Reference Manual

XDRIVE DYNAMICS

Technical Training

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E53 AWD and DSC III

Subject — Page

Initial Print Date: 12/03 Revision Date:

E53 AWD & DSC III

Model: E53

Production: From 9/00 to 9/03

OBJECTIVES

After completion of this module you will be able to:

- Understand transfer case design
- Understand ADB/DSC lll features

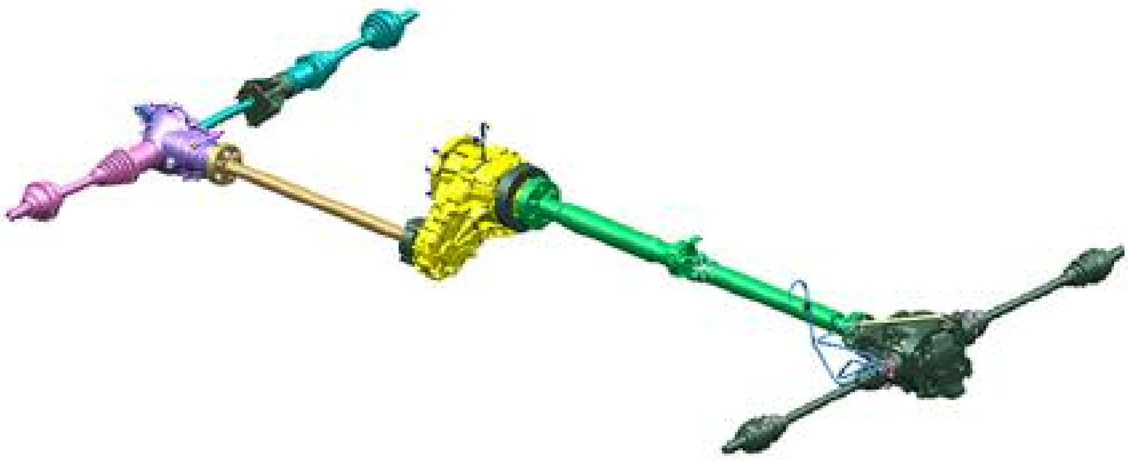
E53 AWD

Drivetrain

The transfer case, driveshafts, final drives and half shafts make up the drivetrain assembly.

The transfer case is always mounted in the same position on the X5. This applies to other markets and future models that will utilize different transmissions for different engine configurations. With these models, the transmission tail shafts will be modified to match up with the transfer case.

The rear driveshaft is a two piece unit using a center bearing, while the front drive shaft is a single piece that is splined to the transfer case and bolted to the front differential.



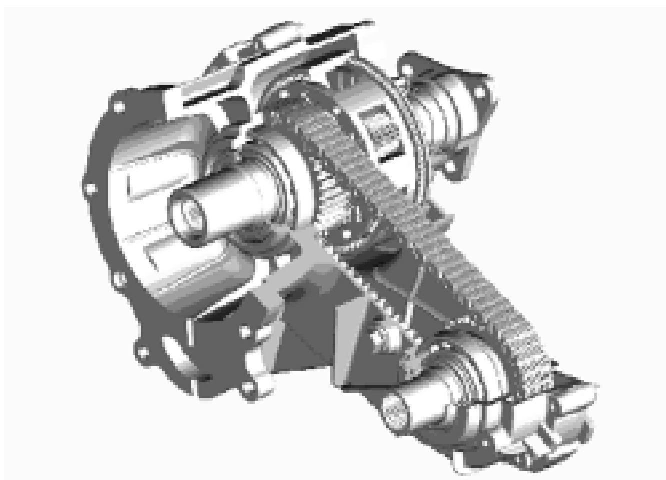
The breather vents for both differentials and the transfer case are mounted higher up on the chassis to prevent water from entering if the vehicle is driven off road through water. The front breather passes up into the engine compartment and is mounted under the left side ignition coil cover. The rear breather passes along the under side of the body and is mounted behind the left side wheel arch cover. The breather vent for the transfer case is mounted up high in the driveshaft tunnel.

Drivetrain-Transfer Case

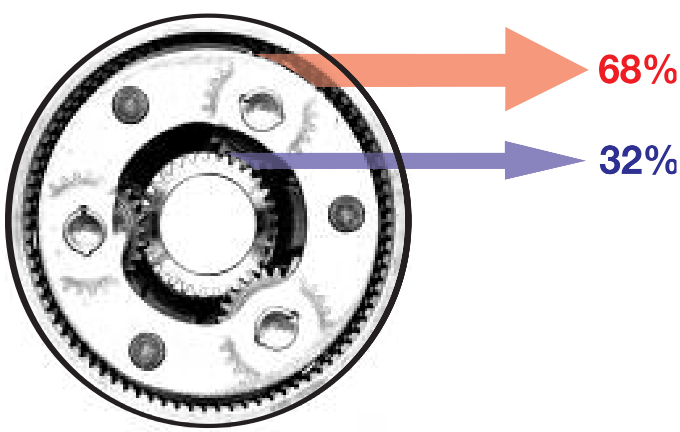
The transfer case is manufactured by New Process Gear Division of New Venture Gear Company. It is identified as model NV 125.

It incorporates a planetary gear set and chain to provide the torque split and all wheel drive. The output torque of the transmission is applied to the planetary carrier of the gear set. The rear drive shaft is connected to the annulus gear and the front drive shaft is connected to the sun gear through the chain drive.

As the output shaft of the transmission turns, the planetary carrier rotates, causing the planetary gears to drive the sun gear and annulus gear.



A torque split of 68% rear/ 32% front is provided through the gearing of the planetary set.



E53 DSC III

Features

Note: This section only describes the new DSC features that are associated with the AWD system. All other Bosch DSC 5.7 features remain unchanged.

Hill Decent Control (HDC)

Hill Decent Control (HDC) is designed for off road use to automatically slow the vehicle and maintain a steady speed on steep gradients. This function allows the driver to focus on steering and controlling the vehicle without having to use the brakes to slow the vehicle.

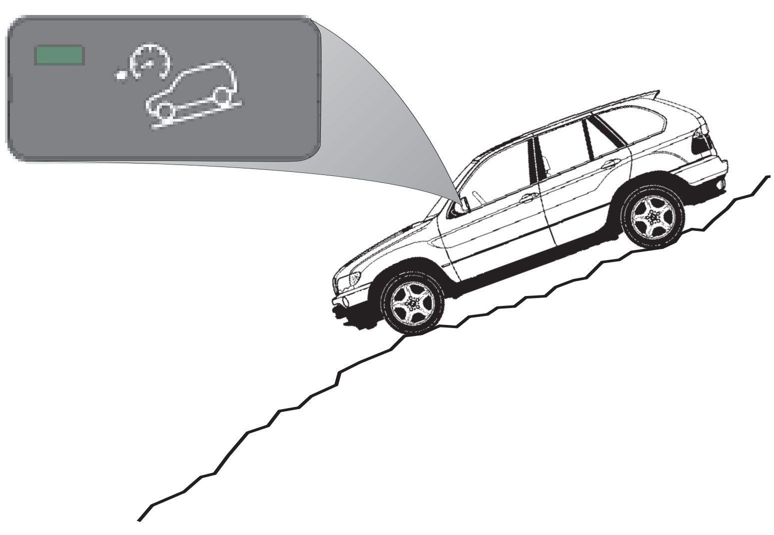
HDC is activated manually through the push button switch located in the center switch panel located in the console. When activated, the vehicle's speed is held to approximately 5 MPH by the DSC system pulsing the brakes to maintain the speed.

The following conditions must be met before the HDC will activate:

- Push button pressed - LED "ON"
- Vehicle speed: < 25 MPH
- Accelerator pedal pressed <15%
- Downhill driving recognized

Downhill is recognized from the vehicle's speed and engine load from the engine control module. The accelerator pedal and engine load signals are passed over the CAN bus to the DSC control module.

The HDC switch can be pressed at speeds < 37MPH and the LED will come on to indicate standby mode. However the system will not activate until the vehicle's speed is below 25.



The driver can accelerate with HDC active up to approximately 20% engine load. The HDC will stop regulating as long as the driver is requesting a speed increase. If the vehicle's speed is > 37 MPH, the HDC function is automatically switched OFF.

Automatic Differential Brake (ADB)

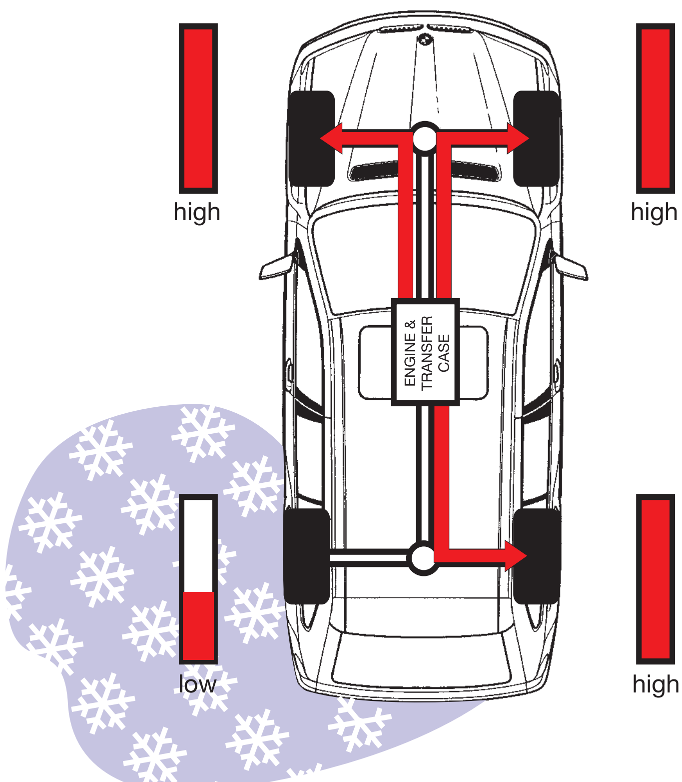
On dry pavement with no wheel slip, the vehicle's driving torque is split 68% rear and 32% front through the planetary gear differential transfer case.

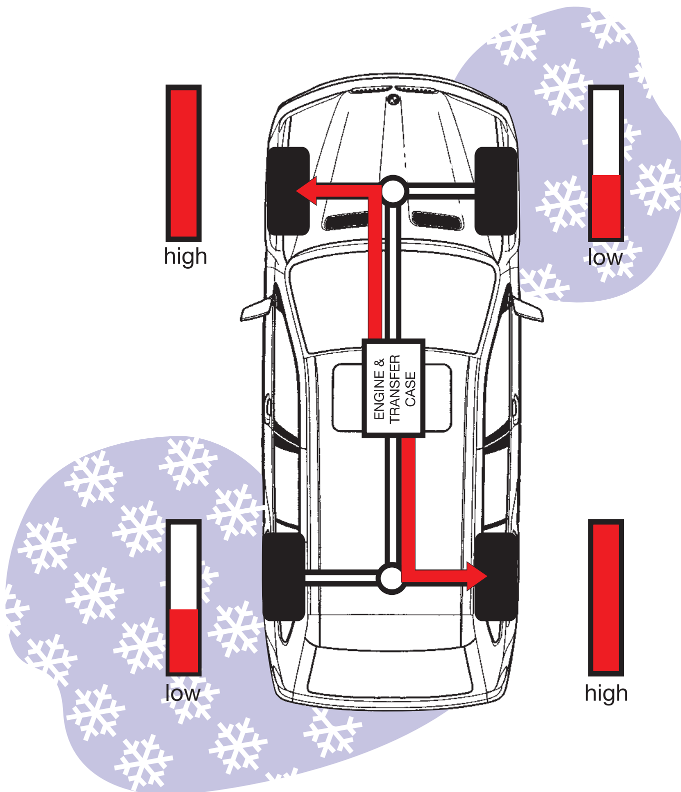
If one or more wheels spin or slip, the DSC will activate a regulation process and the brakes on the effected wheel(s) will be pulsed. The driving torque will be distributed through the differential to the remaining wheels with a good coefficient of friction

The driving torque will be applied through the differential as follows:

- Three wheels - with one wheel spinning.
- On two diagonal wheels with two wheels spinning on different axles.
- One axle only with two wheels spinning on the same axle.

Once the spin or slip is under control, the drive torque will again be applied to all wheels.

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TRANSFER
CASE
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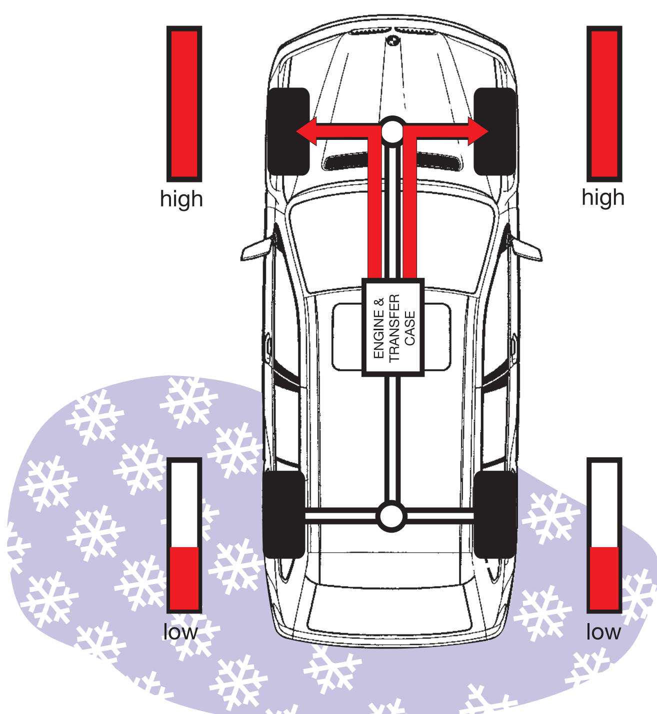
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Traction Control

The traction control feature of the DSC III on the X5 cannot be switched OFF with the DSC switch. Pressing the button will only switch off the dynamic stability control function of the DSC.

The traction control feature is needed at all times to provide anti-spin control especially when driving the vehicle off road. The DSC warning lamp in the instrument cluster will still come on when the system is switched off manually or there is a fault in the system.

Off road traction control or HDC regulation places an additional load on the brakes. To prevent overheating of the brakes and rotors, the temperature of the rotors is calculated over time from the road speed and amount of brake application. If the temperature of one or more rotors goes above 600o C, the traction control or HDC function for that wheel will be cancelled temporarily. Once the temperature of the rotor goes below 500o C, the traction application will be re-activated.

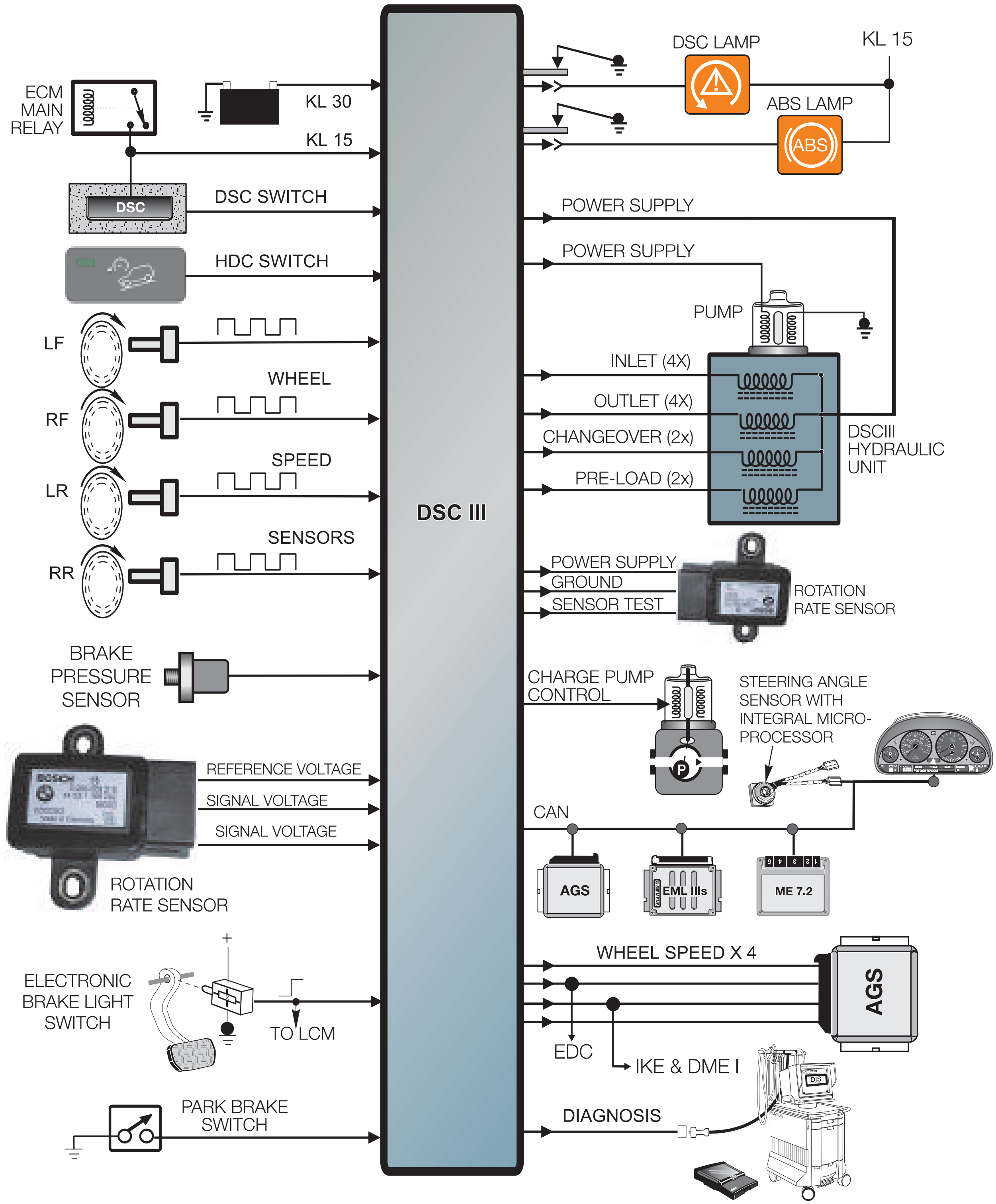
The normal braking function (including ABS) is always active at any temperatures.

Off-Road ABS Control Module Programming

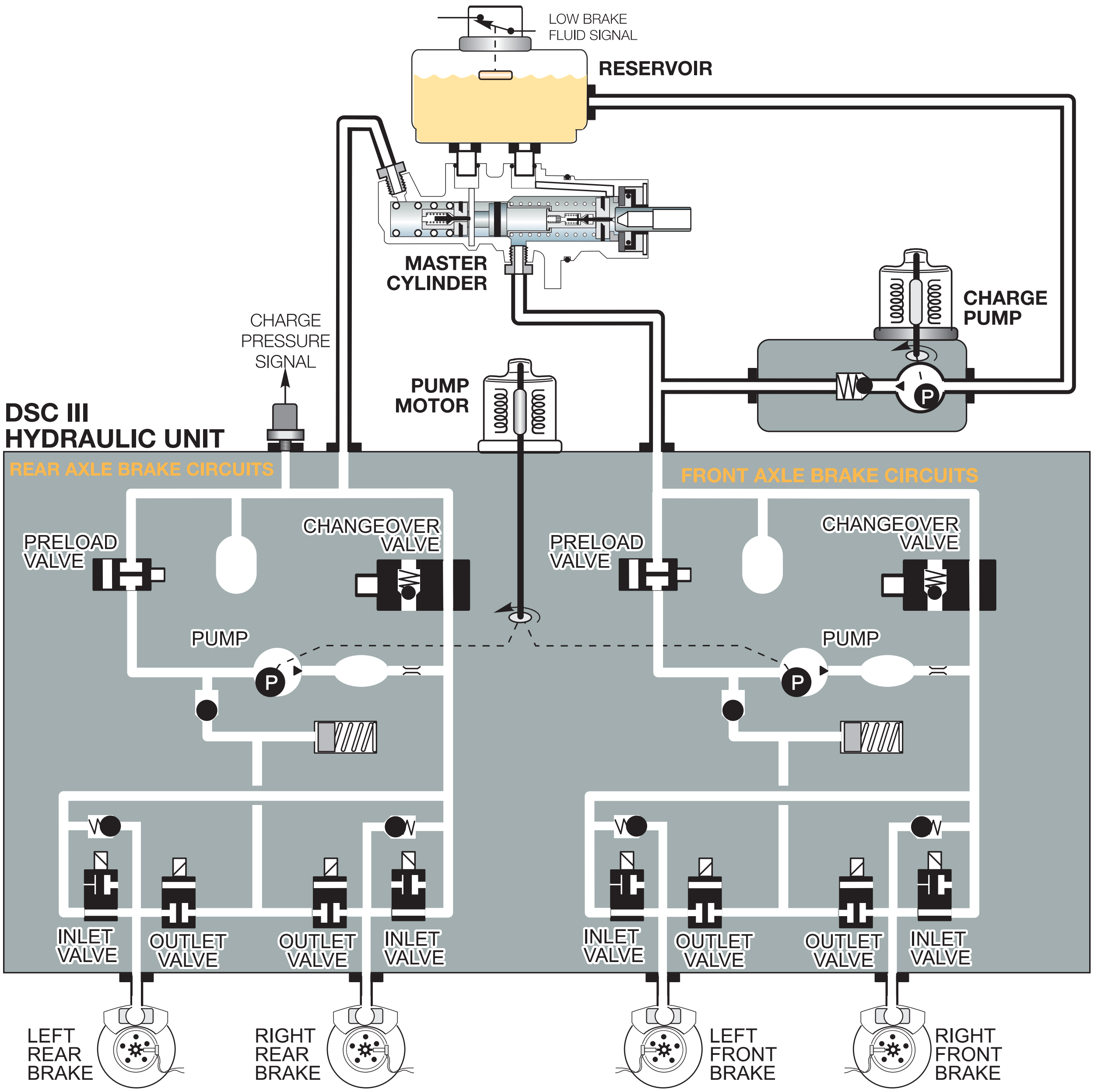
The programming for ABS regulation have changed to allow a higher threshold for ABS regulation when driving off-road in loose gravel or dirt. A locked wheel is more effective in slowing or stopping the vehicle because of the wedge that is built up in front of the tire.

The programming in the DSC control module allows one or both front wheel(s) to lock up to a speed of 12 MPH as long as the vehicle is traveling straight ahead. If the DSC control module receives a signal from the steering angle sensor indicating a turn, ABS regulation will activate to prevent the lock and allow the vehicle to be steered.

DSC III Components/IPO



DSC III Hydraulic Unit



Components

Control Module Hydraulic Unit

The control module is integrated into the hydraulic unit as one compact unit. This reduces the size and wiring required for DSC operation. Additionally the motor relay and valve relay have been replaced by solid state final stages in the control module.
The hydraulic unit continues to use:

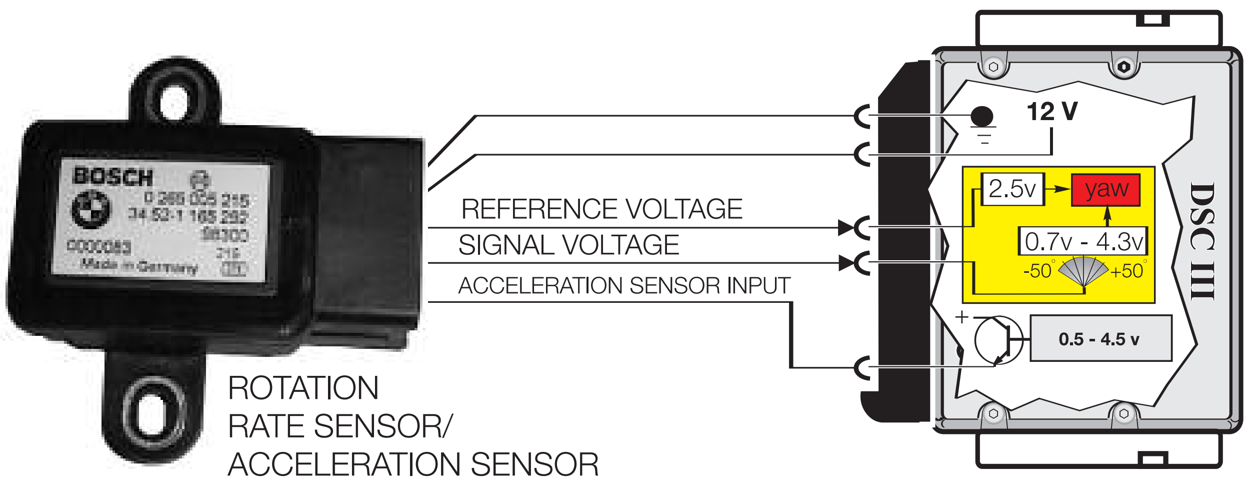
- Two pre-charge solenoid valves
- Two changeover solenoid valves
- Four intake solenoid valves
- Four outlet solenoid valves
- One return pump

Rotation Rate/Transverse Acceleration Sensor

Located under the center console behind the MRS III control module, the rotation rate and transverse acceleration sensor provides two inputs to the DSC control module. The sensor is isolated from body/chassis vibrations through its rubber mounting.

For rotational speed, the sensor produces a reference signal of 2.5 volts and a linear voltage signal from 0.7 to 4.3 volts. This linear voltage input signal is used by the DSC control module as the degree of rotational rate (yaw).

The sensor also produces a linear voltage signal for the lateral acceleration (G-force) that ranges from 0.5 to 4.5 volts. The DSC control module uses this input to determine the side forces acting on the vehicle for DSC regulation.



Location of the Rotation Rate/Transverse Acceleration Sensor under the center console

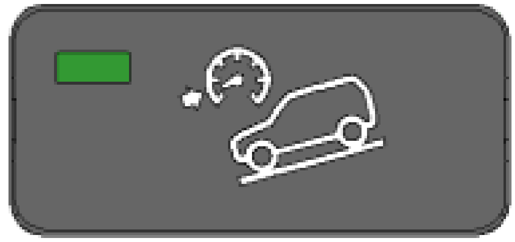
Brake Pressure Sensor

A brake pressure sensor is installed in the hydraulic unit to determine the degree of pressure build-up for Dynamic Brake Control. It is installed in the front axle brake circuit.

The sensor receives its power supply from the DSC control module and produces a linear voltage input signal ranging from 0.5 to 4.5 volts depending on how hard the brakes are applied.

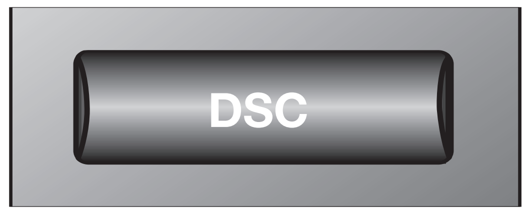
DSC III Components

HDC Switch



The hill decent control function is activated by pressing the HDC switch located in the center console. The LED will come on steady when the function is in standby and flash when HDC is regulating

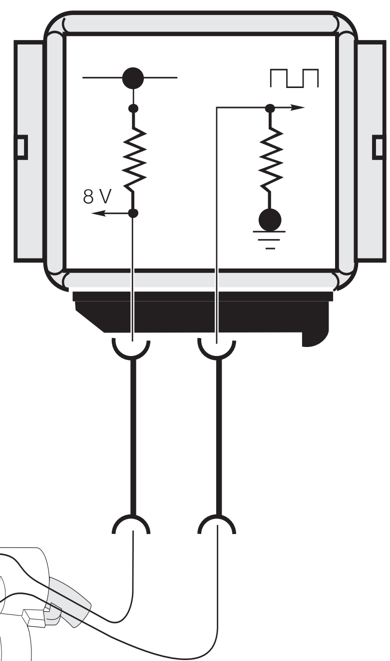
DSC Switch

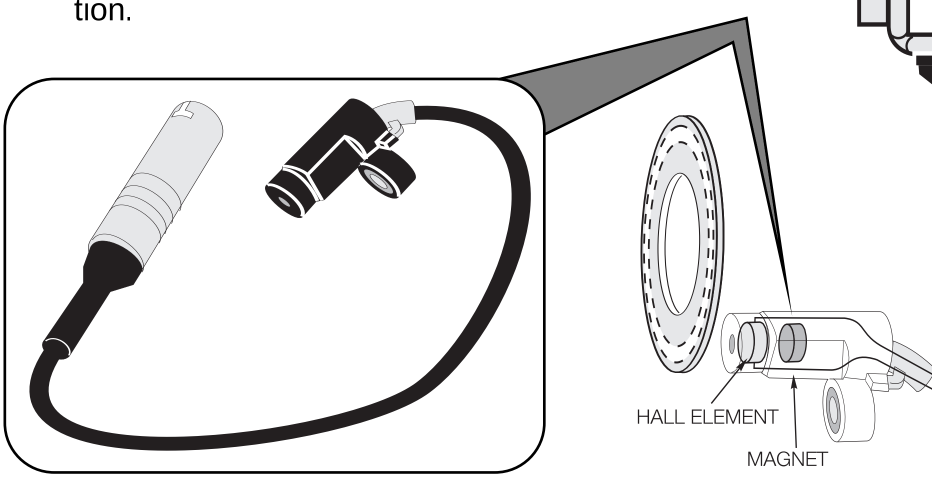


The system is active whenever the ignition is switched on. When pressed, the switch provides a momentary 12 volt signal to the DSC III control module to switch the system off (DSC indicator in cluster illuminated.) When pressed again, the system switches back on (DSC Indicator in cluster goes off.)

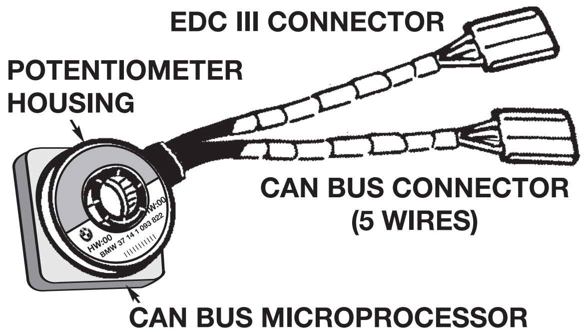
Wheel Speed Sensors

- 2 wire Hall Effect Sensor - “Square wave generator”.
- 48 pulse incremental wheel incorporated in wheel bearing cover for contaminant protection. 48 pulses = one complete wheel revolution.
- Stabilized 8 volt power supply to hall element on one wire, ground path for sensor through second wire back to control module. Signal is generated by the pulse wheel affecting voltage flow through hall element creating a low of .75 and a high of 2.5 volts.
- Sensors identical to DSC II and ASC V systems.
- Sensors provide immediate vehicle speed recognition.





Steering Angle Sensor



The Steering angle sensor is mounted at the bottom of the steering spindle (in front of the flex coupling).

The sensor is equipped with a processor and is directly linked to the CAN bus to communicate with the DSC III module.

The sensor still utilizes two potentiometers to determine the steering angle and the rate of steering. These are the raw signals the CAN Bus microprocessor utilizes to create the steering angle signal for broadcast on the CAN bus.

The sensor requires calibration after repairs to the steering or suspension system (found in DIS Service Functions). Once the calibration is completed the sensor now also sends an identification number over the CAN bus to the DSC III module. The ID provides confirmation in the DSC module that the steering angle sensor is properly calibrated.

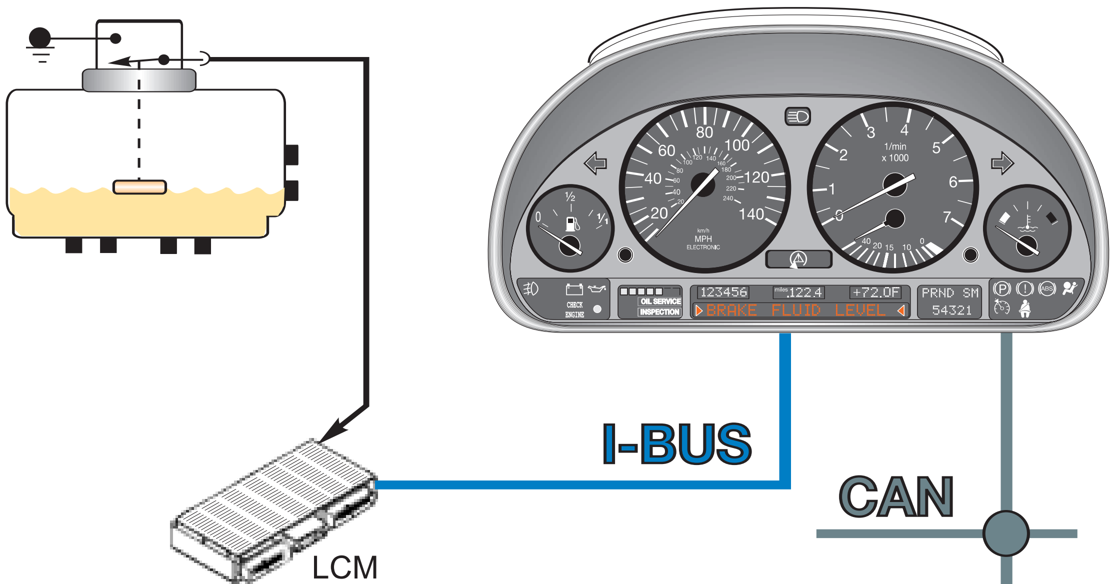
If the ID differs due to component swapping it will not be possible to enter the DSC system for diagnosis. The DIS will request that the steering angle sensor be recalibrated using the service functions. Once complete a new ID number is generated and the DSC III control module and Steering angle sensor are properly mated.

The DSC III logic checks the plausibility of the steering angle sensor against the other DSC III inputs (front wheel speeds, rotation and lateral acceleration sensors). If battery voltage is interrupted, the current steering wheel rotation is recalculated by the DSC module evaluating the front wheel speeds.

Replacement steering angle sensors must be ZCS coded when installed in the vehicle prior to the calibration procedure.

Notes:

Brake Fluid Level Warning Switch



A new fluid level switch is incorporated into the reservoir cap.

- With sufficient fluid level the reed contact is closed.
- When level drops below allowable limits, switch opens.

Since the normal position is closed, this circuit is monitored for shorts to + and ground.

The LCM constantly monitors the input. If the ground signal is momentary, the LCM signals the Instrument cluster of the condition. The instrument cluster then informs the DSC III control module over the CAN bus. If the signal is received just prior to the activation of the charge pump, the charge pump activation is delayed.

If the signal is present for more then 25 seconds, the LCM issues two I BUS message for the Instrument Cluster:

1. Post “Brake Fluid Level” in the Matrix display
2. Notify the DSC III via CAN that the Fluid level has been low for more than 25 seconds.

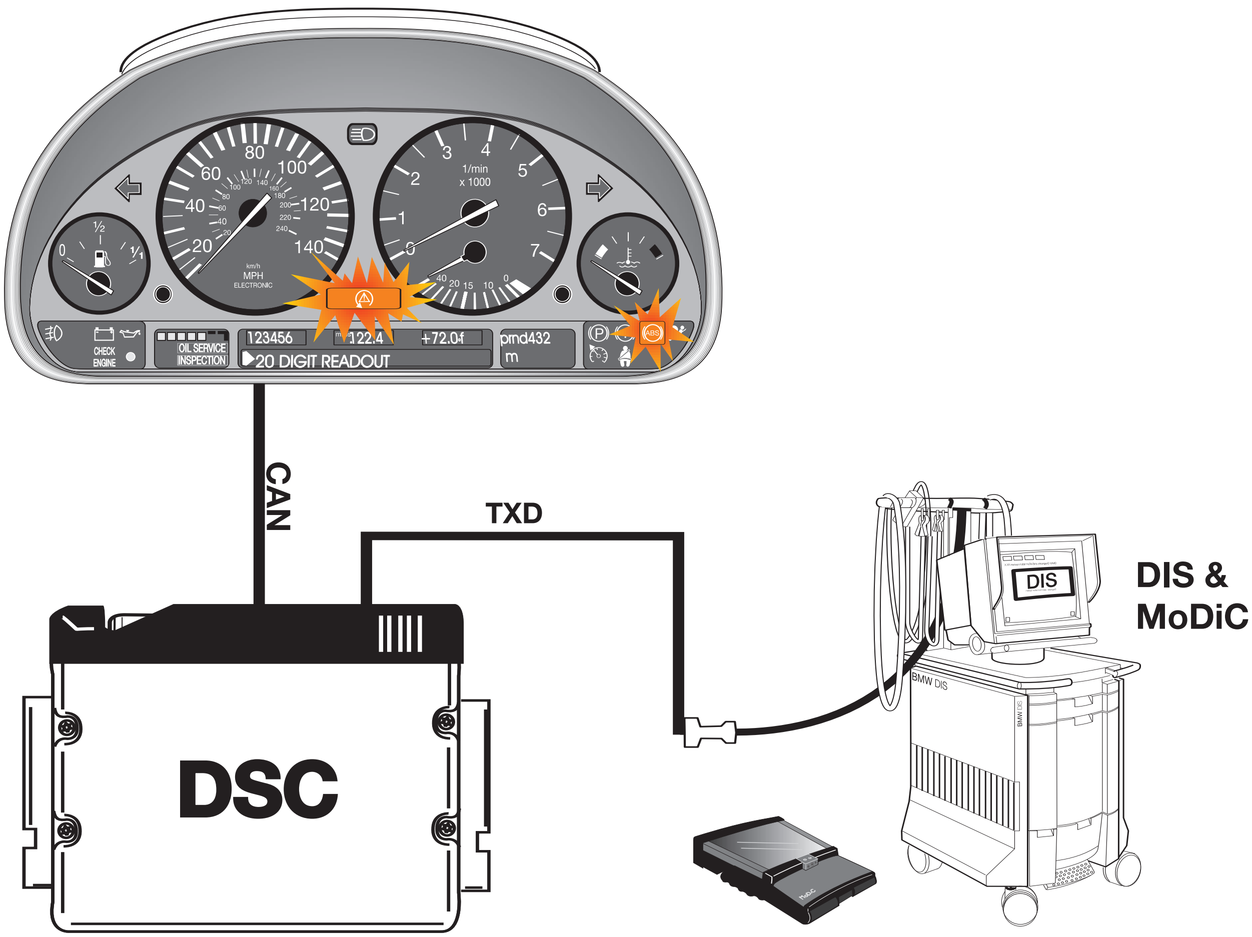
The DSC III control module immediately switches DSC III functions off and continuously illuminates the DSC indicator in the cluster.

Diagnosis

Diagnosis and troubleshooting of the DSC III system is carried out using the DIS Tester or MoDiC. The DSC control module performs a self check every time the ignition is switched on. The warning lamps for DSC and ABS will remain on during the self check.

Any faults with the system will cause the lamps to remain on when the engine is started. Faults that only effect the DSC operation will cause the DSC warning lamp to remain on, however ABS can still function.

If the battery has been disconnected, the DSC warning lamp will remain on until the vehicle receives road speed signals front the front wheel speed sensors and the steering angle sensor can calculate the direction of travel.



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E83/53 xDrive with DSC8

Initial Print Date: 10/03 Revision Date:

E83/53 xDrive with DSC8

Model: E83/ E53 MU (Model Update)

Production: E83 - Start of Production MY 2004
E53 MU - 9/03

OBJECTIVES

After completion of this module you will be able to:

- Familiarize yourself with DSC8 features
- Explain the xDrive mechanical operation
- Describe the xDrive power flow
- Identify the coding resistor and understand its purpose
- Diagnose the VGSG control of the multi-disc clutch
- Perform an “on vehicle” test to verify xDrive function
- Explain the Oil change procedure found in Service Functions

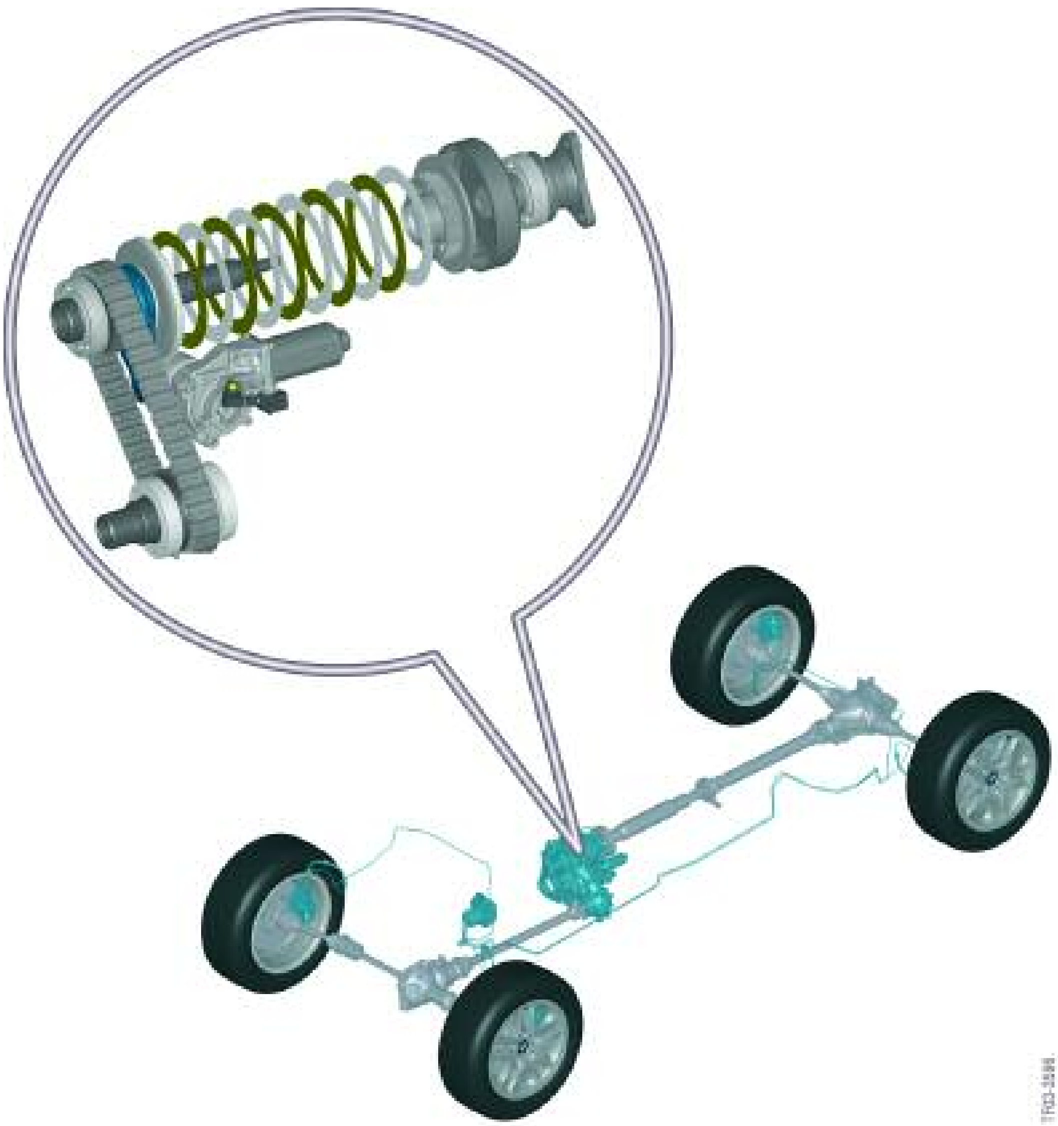
Purpose of the System

xDrive

The innovative xDrive four-wheel drive is a system that controls and regulates the distribution of driving torque to the front and rear axles. The measured variables of DSC are used by xDrive but are also influenced by modified handling performance.

The multi-disc clutch is the heart of the xDrive. By using the controlled multi-disc clutch, it is possible to resolve the conflict between traction and handling performance.

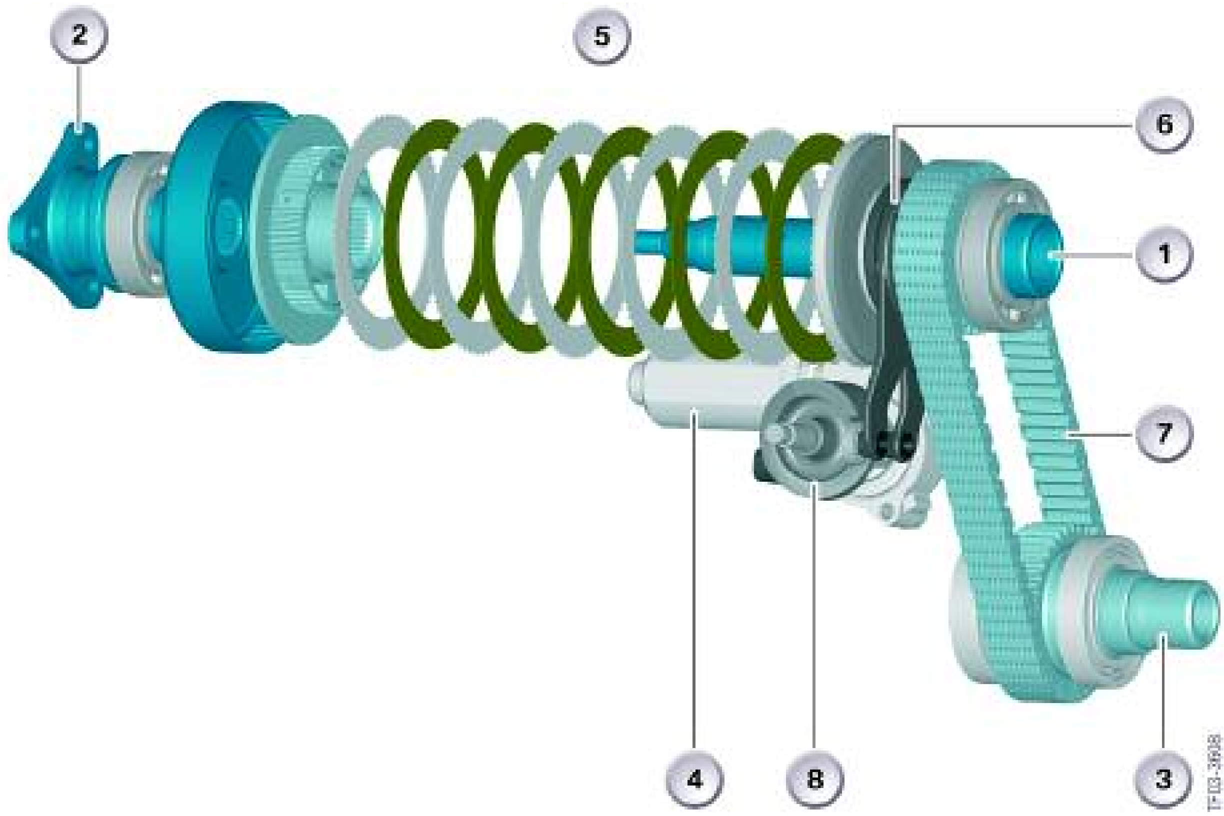
This is achieved through the fact that torque distribution is not determined by a fixed gear ratio in the xDrive as was the case in the previous systems. Instead, the distribution of driving torque is dependent on the locking torque of the controlled multi-disc clutch in the transfer case and on the transferable torque to the front and rear axles.



xDrive - System Components

ATC 400 / ATC 500 Transfer Case

The ATC 400 is installed in the E83 and the ATC 500 in the E53 MU. They differ in that the ATC 500 is splined to the front propeller shaft and the ATC 400 uses a four bolt flange. In addition, there is one more disc in the multi-disc clutch of the ATC 500 and the distance between the input shaft and the output shaft to the front axle is 19 mm greater than in the ATC 400.



1. Input from manual / automatic transmission
2. Output to rear axle prop. shaft
3. Output to front axle prop. shaft
4. Servomotor
5. Clutch discs
6. Adjusting levers with ball ramp
7. Chain
8. Disc cam

The flange illustration of the ATC transfer case is the same for automatic and manual transmissions.

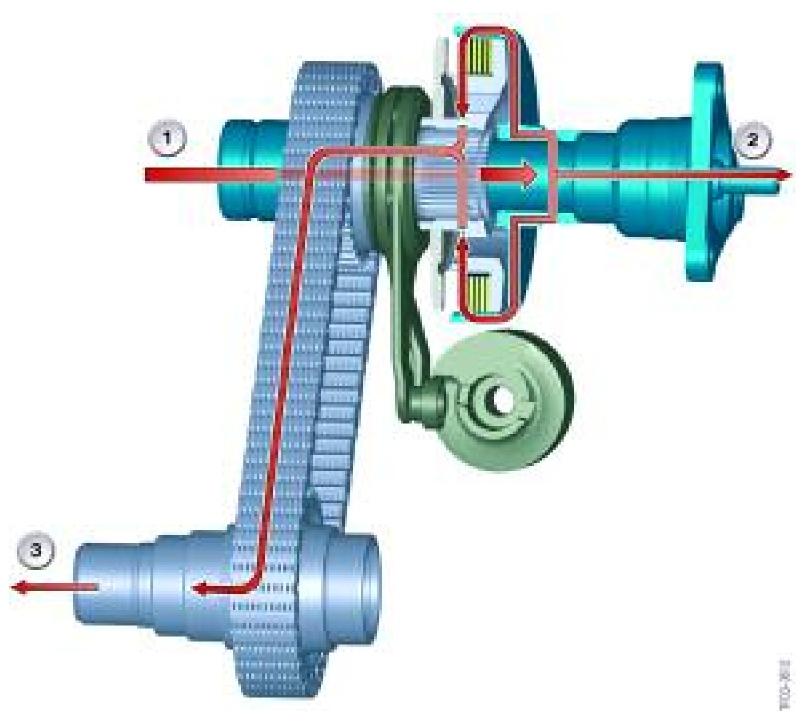
Power Flow

When the multi-disc clutch in the transfer case is disengaged, no driving torque is transmitted to the front axle. All of the driving torque is then distributed to the rear axle. This is because the input shaft (1) is splined providing a permanent connection to the rear axle propeller shaft output flange (2). The multi-disc clutch couples the rear axle propeller shaft output flange to the front propeller shaft output (3).

The driving torque on the front axle is increased or decreased by regulating the locking pressure of the multi-disc clutch, providing a stepless coupling of the front axle to the drivetrain. This depends on driving situations and road conditions. When the multi-disc clutch is fully engaged, the front and rear axles turn at the same speed.

Driving torque distribution (front/rear) is based on available traction at each axle. For example, when traction is identical on the front and rear axles and a driver accelerates from a stop in first gear at full throttle, the rear axle is capable of sustaining greater driving torque as the vehicle weight shifts from the front to the rear.

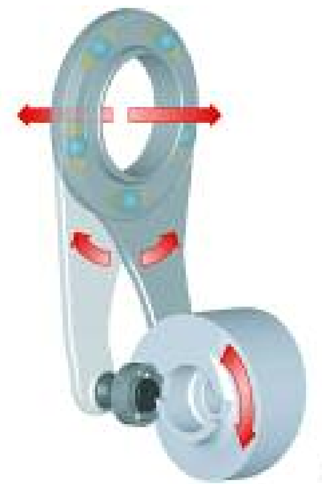
Another example is when the front axle is on a high traction surface and the rear axle is on ice. In this case, virtually 100% of the available driving torque is transmitted to the front axle. Based on available traction, virtually no driving torque can be supported by the rear axle . Obviously, when more driving torque is transmitted to the front axle, driving torque on the rear axle is proportionally reduced due to lack of traction.



1. Input from transmission 2. Rear propeller shaft output 3. Front propeller shaft output

Note:
On a vehicle equipped with an automatic transmission, when driving onto brake analyzers, move the selector lever to the "N" position . On a vehicle equipped with a manual transmission, do not press the accelerator pedal once on the brake analyzer. This keeps the transfer case clutch open and the vehicle cannot be pulled off the analyzer.

Adjusting Levers



When the disc cam is rotated, it forces the adjusting levers apart.

The ball ramps create a precision axial movement which compresses and increases pressure on the multi-disc clutch.

This is completely variable up to a full lock.

Servomotor with Motor Position Sensor

The servomotor with worm gear are powered to rotate the disc cam.

The servomotor is a permanent magnet (1) DC motor which contains a Hall sensor (2) to detect the position and the adjusting speed of the motor shaft.

This is proportional to the degree of multi-disc clutch engagement.

Coding Resistor

1. Disc cam
2. Electric motor
3. Coding resistor
4. Worm gear

Because of mechanical tolerances in production, the characteristic curve of the multi-disc clutch locking torque varies slightly.

Once the actual locking torque has been measured on the clutch test bench, a resistor is attached to the servomotor; the resistor's value is a reference to the locking torque characteristic.

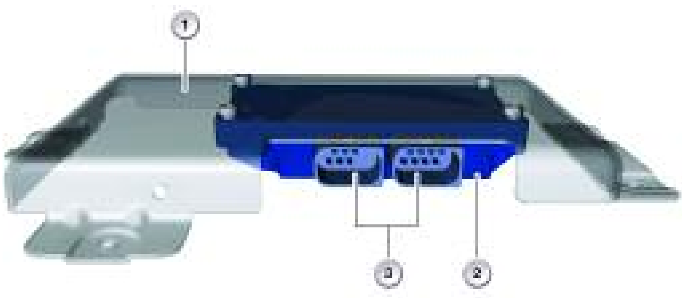
Each time the engine is started, the transfer case control unit measures the resistance value once and the optimum program map for the transfer case fitted is selected.

Transfer Case Electronic Control Unit

The transfer case control unit (VGSG) is on CAN-bus.

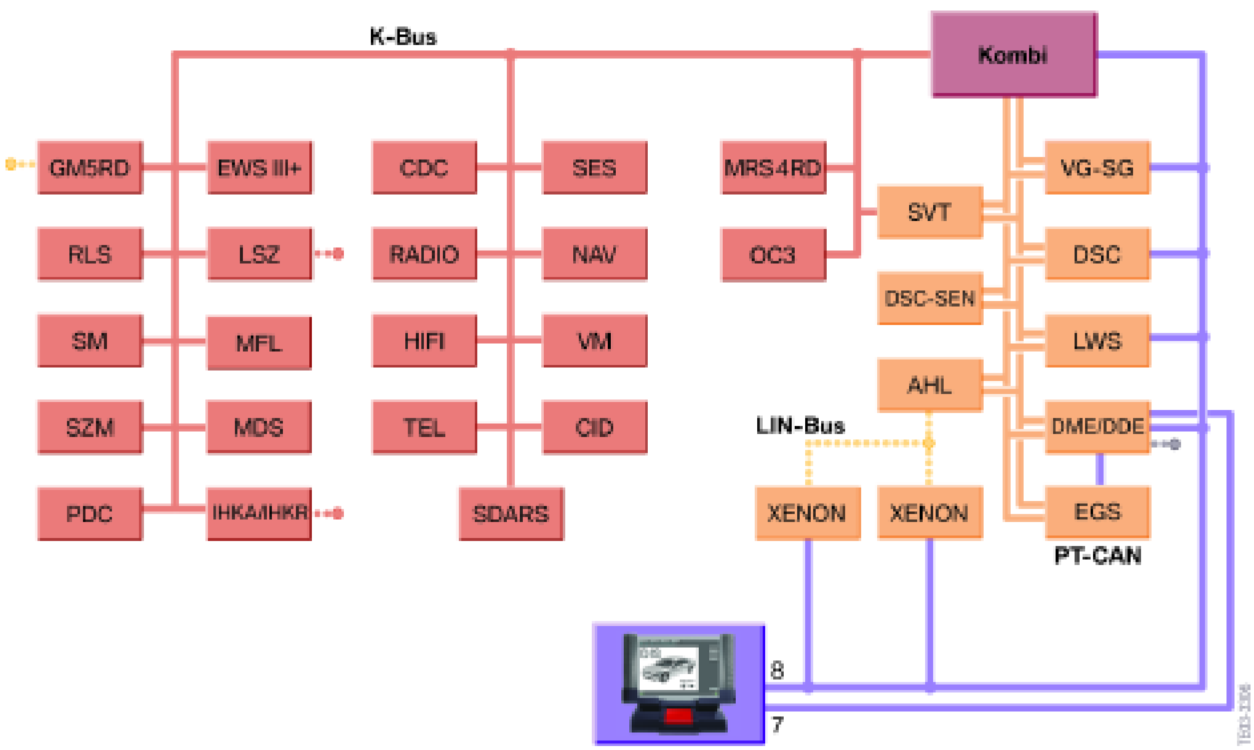
Depending on the vehicle, the module is installed in the following location:

- E60/61 - under the rug foward of the passenger's front seat
- E83 (X3) - under the rear floor panel of the cargo compartment trim
- E53 (X5) - under the rear bench on the left side



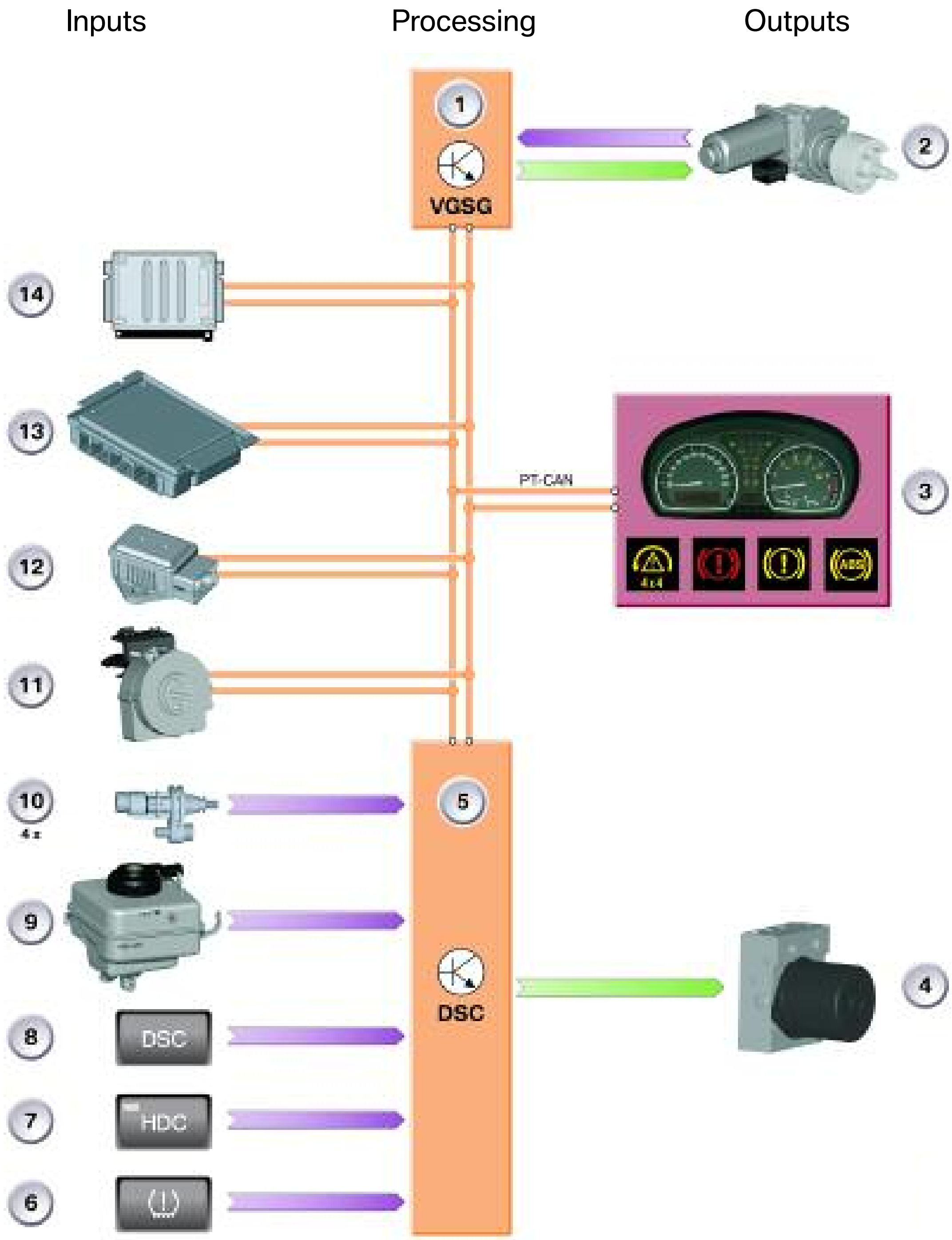
Index	Explanation
1	Kick guard
2	Transfer case control unit
3	Connector

E83 Bus Overview



The transfer case control unit (VGSG) is on the PT-CAN Bus. VGSG shares information with DSC for overall xDrive control and has diagnostic communication via the OBD connector .

E83 IPO



1. Transfer case control unit
2. Transfer case clutch servomotor
3. Instrument cluster
4. DSC hydraulic modulator
5. DSC control unit
6. RDW button
7. HDC button
8. DSC button
9. Brake fluid level
10. Wheel speed sensor
11. Steering angle sensor
12. Yaw/transverse acceleration sensors
13. EGS
14. ECM (DME)

xDrive - Principle of Operation

xDrive

The transfer case control unit (VGSG) regulates the locking pressure of the multi-disc clutch in the transfer case. The transfer case control unit receives information on the required clutch locking pressure from the DSC control unit. The processing, control and electronics required for this are integrated in the transfer case control unit. This information is converted and output as a corresponding rotary motion of the servomotor.

In order to position the servomotor and compensate for wear, a reference run is carried out each time the ignition is switched off. The servomotor position is determined by a Hall sensor integrated in the servomotor. During the reference run, the clutch is engaged and disengaged completely (once). While the clutch is actuated, the current consumption is measured for the servomotor position. This allows the VGSG to determine the beginning and end of the clutch actuating procedure.

A clutch and oil wear calculation is also processed and stored in the VGSG. It increases the locking pressure as necessary in order to reduce friction.

In the event of DSC failure, the VGSG incorporates a fallback level (strategy) for activating the transfer case clutch in order to maintain the four-wheel drive function.

TCC

Regulation of the transfer case clutch (TCC) locking pressure allows stepless coupling of the front axle to the drivetrain. The driving torque on the front axle can be increased or decreased depending on the driving situation and road conditions. Obviously, when more driving torque is transmitted to the front axle, driving torque on the rear axle is proportionally reduced due to lack of traction.

The advantages of variable distribution of driving torque to the front and rear axles are:

- Optimum utilization of the cornering and longitudinal wheel forces on the front and rear axles.
- DSC brake interventions only become necessary at a significantly later stage, an increase in comfort refinement.
- Compared with an “open” differential transfer case and DSC, xDrive significantly improves driving torque distribution when traction on the front and rear axles is notably different.

The DSC control unit influences control of the transfer case clutch. Even when DSC is deactivated, TCC remains active for the purpose of maximum traction and driving dynamics.

Permanent four-wheel drive is only completely deactivated in three control situations:

- During very tight cornering with low engine torque to allow speed compensation between the front and rear axles (e.g. parking)
- At speeds > 180 km/h
- When the vehicle dramatically understeers

The transfer case clutch control logic is described in three main modules:

- Pre-control
- Traction control / driving dynamics control
- Tire tolerance logic

Pre-control

The pre-control logic (shared from DSC) reflects the driver's command and is calculated based on:

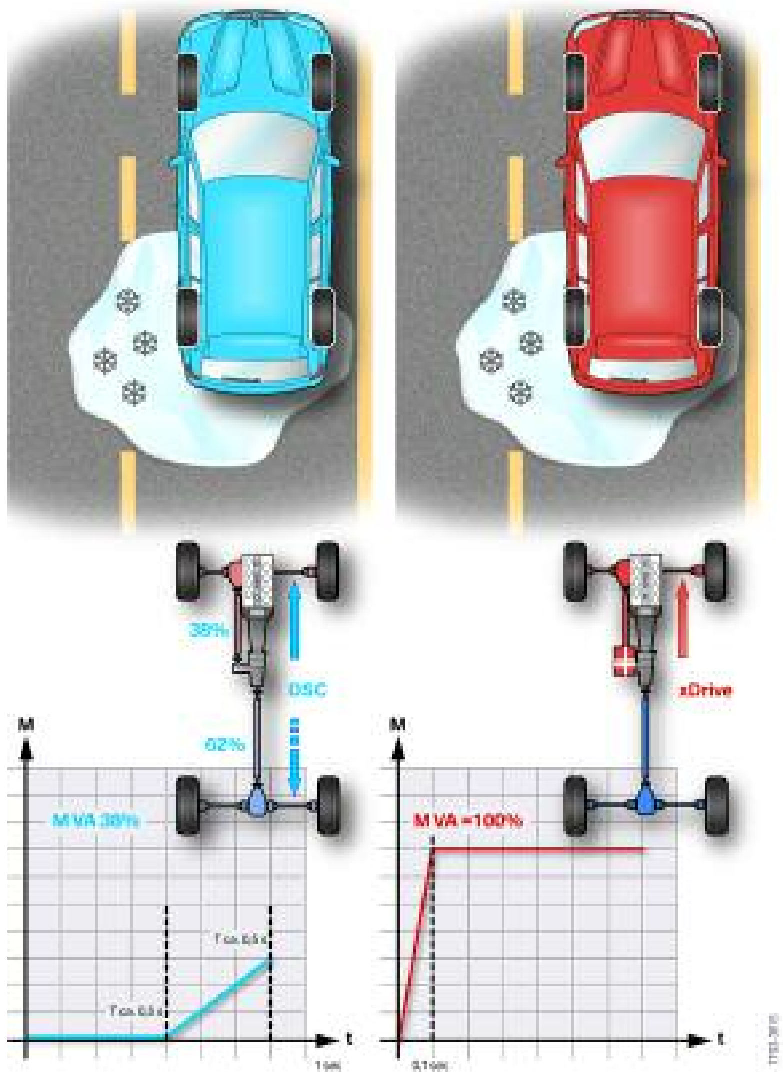
- Accelerator pedal value
- Engine torque
- Engine rpm
- Vehicle speed
- Gear
- Steering angle

In normal driving, the clutch is operated with minimum slip so that permanent four-wheel drive with a driving torque distribution of 40% on the front axle and 60% on the rear axle is available.

Even when the traction for the front and rear axles is dramatically different, the pre-control ensures that the system responds very quickly, as can be seen in graphic on the following page.

Notes:

“Open” Transfer Case   vs   xDrive



M = Driving torque   M VA = Driving torque on front axle   t = Time

In the case of the open transfer case, the brake is applied after slip is detected on the rear axle. This takes approximately one half of a second in reaction time. 62% of the driving torque is supported on the two rear brake discs and only 38% of the driving torque can be transferred to the front axle. In other words, wheel slip must be sensed first before driving torque is transferred through the transfer case by applying the rear wheel brakes.

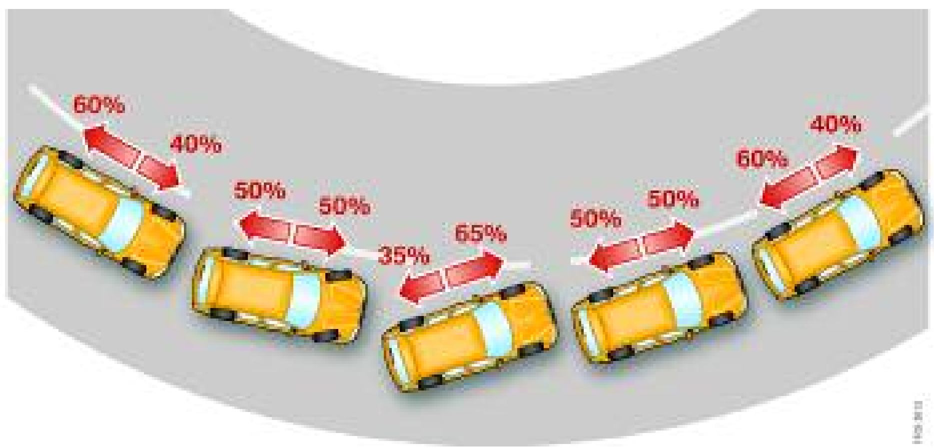
In contrast to an “open” transfer case (differential), the xDrive does not require brake intervention on the rear axle because no slip can occur (permanent through connection). The transfer case clutch is engaging the front axle as the vehicle is accelerating. This takes significantly less time (approx. one/tenth of a second).

Traction Control / Driving Dynamics Control

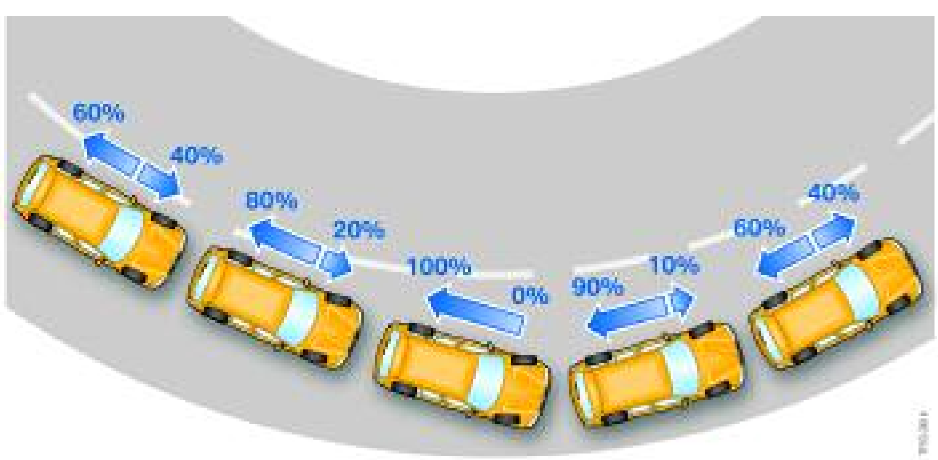
Traction control monitors the slip conditions on the front and rear axles. The wheel speeds, yaw rate and transversal acceleration serve as the input signals.

The function of traction control/driving dynamics control is to achieve optimum traction and to keep the vehicle stable.

As seen in the following graphic, in the event of an oversteer tendency, the transfer case clutch is completely engaged and the maximum supportable driving torque on the front axle is transmitted. This helps to "pull' the front of the vehicle until stability is achieved.



In the event of an understeer tendency, the clutch can be fully disengaged if necessary. In this example, the front axle is separated from the drivetrain and the driving torque can only be transmitted to the rear axle. This helps to "push" the rear of the vehicle until stability is achieved.



Tire Tolerance Logic
The tire tolerance logic detects different tread circumferences on the front and rear axles. This occurs when:

- Mixed tires are used
- Space saving spare tire is installed
- Tires are used that have been worn down to different levels

Normally, tire circumference deviations result in drivetrain torque bias (unwanted variations).

The tire circumference can fluctuate up to 1% or more as a result of mixed tires or wear. The tire tolerance logic decides depending on the driver's command and driving situation whether the slip is to occur in the transfer case clutch or at the contact area between tire and road.

If the slip is permitted in the transfer case clutch, the locking pressure set by the pre-control is reduced in order to keep the work loss low. In the driving dynamic control situation, the clutch is locked slightly more than normal, the four wheel drive is always guaranteed when required.

For maximum xDrive performance, tires (and wheels) of the same diameter should be installed on the vehicle.

Notes:

Workshop Exercise - xDrive Transfer Case

With the Instructor's assistance, perform the following:

1. *Disassemble xDrive transfer case. Familiarize yourself with the mechanical operation.* ____________________

2. *What are the differences between the ATC 400 and the ATC 500?*

   ____

   ____

   ____

3. *The multi-disc clutch (when engaged) locks what two components together?*

   ____

   ____

4. *What is the purpose of the adjusting levers and the cam disc?* __________

   ____

   ____

5. *Visually identify the coding resistor, why is it necessary?* __________

   ____

6. *When the E83 is placed on a brake analyzer (or dyno), what procedure <u>must</u> be followed for:*

   Manual Transmission ____________________

   Automatic Transmission ____________________

7. *The VGSG regulates the* ____________________

   and receives information on the required locking pressure from the __________

8. *When the multi-disc clutch is not engaged, the E83 will always be driven by* _____

   ____

   Why? ____________________

   ____

Workshop Exercise - xDrive on Vehicle

With the Instructor's assistance, perform the following:

1. *With the E83 placed securely on a vehicle lift and all 4 wheels off of the ground, start the engine and place the vehicle in a forward gear.*

   Manual Transmission: release clutch pedal and observe which wheels are being driven______________. Now press down on the accelerator pedal (slightly), what do you observe or feel?______________________________

   ____

   Automatic Transmission: release brake pedal and observe which wheels are being driven______________. Now press down on the accelerator pedal (slightly), what do you observe or feel?______________________________

   ____

   Based on your observations, explain why this occurs:______________________

   ____

   ____

2. *Apply the parking brake (completely). Start the engine and place the vehicle in a forward gear.*

   Manual Transmission: release clutch pedal, what do you observe?____________

   ____

   Automatic Transmission: release brake pedal and press down on the accelerator pedal (slightly), what do you observe?______________________________

   ____

   Based on your observations, explain why this occurs:______________________

   ____

   ____

3. *Is DSC braking application required to transfer drive torque from the rear output to the front output?______________________________________*

4. *DSC braking application takes place to provide:__________________________*

   ____

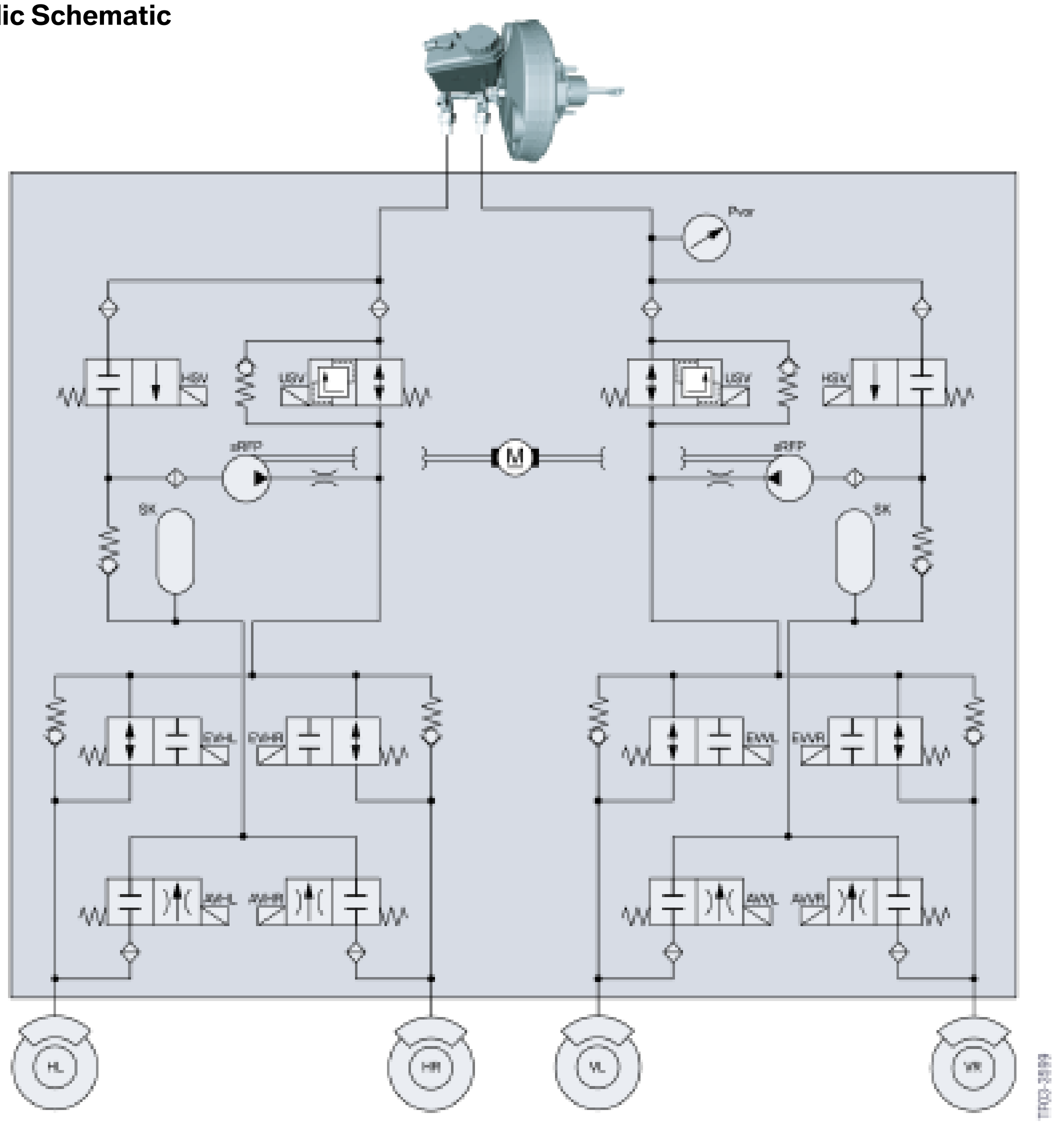
   ____

xDrive / DSC - System Components

The xDrive / DSC system consists essentially of those components from the familiar DSC8. The controllable multi-disc clutch in the transfer case is a new feature.

- DSC8 module
- Transfer case electronic control unit (VGSG)
- Yaw and transversal acceleration sensors
- Wheel speed sensors
- Pressure sensor
- Steering angle sensor
- Brake fluid warning switch
- Brake light switch
- DSC button
- Transfer case motor position sensor
- Coding resistor
- Transfer case servomotor

Hydraulic Schematic



DSC Module

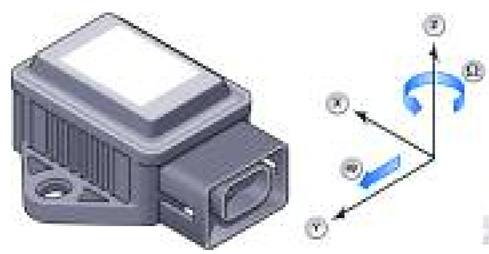
The DSC module located in the engine compartment consists primarily of the following three components:

- Surface mounted control unit
- Valve block with integrated pressure sensor
- Pump motor

It is the same design as the DSC8 module which was introduced at BMW with the E60.

Yaw and Transversal Acceleration Sensors

The sensor (assembly) in the E83 and the E53 MU is located on the transmission tunnel at the rear.



X Longitudinal vehicle axis
Y Transversal vehicle axis
Z Vertical vehicle axis
ay Transversal acceleration
Ω Yaw

Wheel Speed Sensors

The active wheel speed sensors require a supply voltage for operation and output a signal of non speed dependent constant amplitude.

1. Sensor ring (ferromagnetic wheel bearing seal carrier)
2. Sensor IC with Hall elements
3. Sensor housing

The xDrive uses wheel speed sensors with an integrated evaluation circuit. The output signal is transmitted with the pulse width modulation (PWM).

The rising signal edge is used to determine road speed; the pulse width contains additional information on the direction of rotation, standstill detection, installation position detection and air gap reserve to the sensor ring. Direction of rotation detection is by the internal Hall sensor signals (like E65).

xDrive / DSC System - Principle of Operation

As featured in earlier DSC modules, the DSC8 mounted control unit also features two microprocessors. The surface mounted control unit also incorporates two semiconductor relays:

- One for the pump motor
- One for the solenoid valves

When a speed of 6 km/h (4mph) is exceeded, an electronic self-test is started which the pump motor and all the solenoid valves are briefly activated. When the brake light switch is activated simultaneously at that speed (for example: two footed drivers), the self-test is carried out at 15 km/h. Checking of the wheel speed signals is started at 2.75 km/h.

In the xDrive, the DSC also assumes the function of calculating the locking pressure for the multi-disc clutch in the transfer case. The locking pressure is set based on the driver's command and regulated as required depending on the driving situation.

The locking pressure produces the distribution of driving torque to the front and rear axles. The DSC sends the required locking pressure request to the VGSG via the PT-CAN Bus.

In turn, the VGSG signals the locking pressure actually set depending on:

- Transfer case fluid temperature (calculation based on locking pressures)
- Electric motor loads
- Multi-disc clutch loads

System Functions

The xDrive / DSC system comprises the following functions (same as E60 or E53 except for *):

DSC:

- ABS Antilock Braking System
- ASC-X Automatic Stability Control X *
- DSC Dynamic Stability Control
- EBV Electronic brake-force distribution
- DBC Dynamic Brake Control
- CBC Cornering Brake Control
- MSR Engine drag-torque control
- HDC Hill Descent Control
- ADB-X Automatic Differential Brake *

xDrive:

- TCC Transfer Case Control (previously covered)

ASC-X / ADB-X

Unlike regular road vehicles, SAVs are also meant to demonstrate satisfactory handling characteristics and appropriate traction on unconventional roads. In order to provide optimum propulsion with sufficient cornering stability on both normal roads and other road surfaces, Automatic Stability Control X (ASC-X) contains a detection function to distinguish between them.

When off-road terrain is detected, wheel slip threshold is increased to provide sufficient traction force with the increased levels of traction loss.

ASC-X is supplemented by the Automatic Differential Brake (ADB-X) function, which applies the brakes to the wheels per axle, for side to side torque transfer. For example, when a wheel is spinning on one side (up to the slip setpoint), the brakes are applied to that wheel and the driving torque is transferred through the axle differential to the wheel with the higher traction. This provides superb capabilities when there are diagonal traction losses (ie. left front/right rear).

ADB-X remains active when DSC is deactivated. Furthermore, ADB-X can develop full capability because the engine power is not reduced, even during extreme four wheel drive operation. Only that wheel which has a low traction receives the brake application.

The brake disc can overheat with excessive ADB-X intervention with DSC deactivated. In this situation, the operation is discontinued at a disc temperature of approx. 700 °C and is resumed when this temperature drops below approx. 400 °C. This is a calculation performed by the DSC control unit based on brake application time, pressure, wheel speed, etc.

Limp Home Operation

In order to maintain the four wheel drive function for as long as possible even in the event of important sensor signal failures or failure of the DSC control unit, a limp home control is integrated in the transfer case control unit. This control operates in redundancy to the transfer case clutch control in the DSC control unit. The limp home control contains only two control functions, precontrol and traction-slip control.

The wheel speed signals are very important to traction/slip control. Engine signals, steering angle and yaw are used predominantly for precontrol. If individual sensor signals fail, substitute values are calculated and the relevant functions operated with extended control thresholds.

This strategy is continued until useful four wheel drive control is no longer possible. In this event, the driver is alerted by the DSC/xDrive lamp coming on in the instrument cluster and also by an acoustic warning signal (gong).

Faulted wheel speed signals on the rear axle are calculated by driving or engine speed (remember, the rear wheels are always driven). If the front wheel speed signals fail, the values of the rear axle are adopted. Wheel speeds also substitute for a faulty steering angle signal.

Warning Indicator Lamps

The warning indicator lamps for the xDrive / DSC are found in the instrument cluster as shown on the right.

The warning indicator lamps and acoustic signals (gong) are assigned to the xDrive / DSC system states of malfunction described below.

DSC deactivated — no gong

DSC faulty (ABS only)
or
VGSG faulty — with gong

Complete DSC failure
or
Complete DSC failure and VGSG failure — with gong

Workshop Hints

CAUTION!!!

On a vehicle equipped with an automatic transmission, when driving onto brake analyzers, move the selector lever to the “N” position . On a vehicle equipped with a manual transmission, do not press the accelerator pedal once on the brake analyzer. This keeps the transfer case clutch open and the vehicle cannot be pulled off the analyzer.

Towing: Use only a flatbed carrier for all xDrive vehicles!

Transfer Case Oil and Monitoring

Please refer to BMW Operating Fluids for the required transfer case oil and specifications for the correct amount.

Oil Monitoring is performed by the VTG control module to determine when a service (change) is due. The VTG calculates transfer case and clutch wear based on the amount of slip, engagement pressure (torque), speed and mileage.

This calculation accounts for normal “dry” road driving, “adverse” road driving and “other” road extreme driving. Depending on individual vehicle use - driving styles and driving conditions, the transfer case oil service interval will vary.

When a service is due, this will be indicated by a Fault Code and additional details are available using the DISplus/ GT1. Service functions provide directions on changing the transfer case oil and updating the VTG control module with the necessary reset and adaption procedure. This is extremely important for CBS.

Diagnosis

Diagnosis is available for fault repairs and service procedures using the DSIplus/GT1. When the tire tolerance logic is active, it can be read out in the fault memory.

Programming (flashing)

Both the transfer case control unit (VTG) and the DSC control unit are programmable and the new control unit(s) must be programmed when replaced. The wear values stored in the VTG control module (to be replaced) must be transferred to the replacement VTG.

Workshop Exercise - VTG Inputs/Signals

1. *Using the DISplus/GT1, perform an automatic vehicle determination and locate the transfer case (transmission) control.*
2. *For the vehicle you are using, list the power supply sources and locations (power distribution, fuse box, etc.):* ______________________

____

____

3. *What are the connector and pin numbers for the Coding (classification) Resistor? Connector:* ____________ *Pins:* ____________
4. *Disconnect the harness connector at the VTG and perform a resistance measurement of the Coding Resistor. What is the value?* ____________
5. *With the DISplus/GT1, access VTG - "Diagnosis Control unit functions". Select Diagnosis requests, Control module - Battery voltage to transfer case and Coding status. What values are displayed?* ____________ ____________

Additional Information:

6. *With the DISplus/GT1, access VTG - "Diagnosis Control unit functions". Select Diagnosis requests, Transmission, Transmission integrator 1 and Transmission integrator 2. Select Display.*

   These are kW hours of wear on the transfer case calculated by the VTG control module (based on wear factors, refer to page 22).

   Now select Clutch, Plate integrator 1, 2 and 3. Select Display.

   These are kW hours of wear on the multi-disc clutch calculated by the VTG control module (based on wear factors, refer to page 22). These are deleted during a control module reset (oil service procedure).

Notes:

Workshop Exercise - VTG Outputs/Signals

1. *Using the DISplus/GT1, locate the wiring diagram for the transfer case control.*
2. *What are the connector and pin numbers for the servomotor (actuator)?*

   Connector: ________________ Pins: ________________

3. *Disconnect the harness connector at the VTG and perform a resistance measurement of the servomotor "drive motor" (inside the actuator). What is the value? ____________________*
4. *Reconnect the harness, and measure the voltage applied to the drive motor:*

   With key on (KL15) ____________

   Engine started ____________

   Raise vehicle on lift, place in a forward gear and accelerate slightly. ____________

   Set up a scope pattern and repeat the step above, what do you observe?

   ____

   Record the duty cycle (%) while repeating the step above __________________

5. *With the DISplus/GT1, access VTG - "Diagnosis Control unit functions". Select Diagnosis requests, Servomotor, Current consumption, Angle of rotation actual value and Display.*

   Start engine and record readings __________________ __________________

   Place vehicle in a forward gear and accelerate slightly ___________ ___________

   Now select Diagnosis requests, Clutch, Nominal clutch torque, Actual clutch torque and Display.

   Start engine and record readings __________________ __________________

   Place vehicle in a forward gear and accelerate slightly ___________ ___________

6. *With the Diagnostic head connected, ignition "on" (KL15), parking brake "released" and transmission in "neutral", raise the vehicle on the lift.*

   With the DISplus/GT1, access VTG - "Diagnosis Control unit functions". Select Component activation, Servomotor and clutch.

   Turn one front wheel by hand (slowly) and have a colleague select "Activate" while continuing to turn the front wheel steadily. What did you observe?

   ____

   ____

Workshop Exercise - VTG Service/Repairs

1. *Using the DISplus/GT1, locate Service functions for the transfer case (transmission control) VTG.*
2. *What procedures appear in the Components column?*
3. *Select the Oil change service path, what component is "adapted" during this procedure?*
4. *Select the Repair service path, what "selections" are available?*
5. *When you select [3] Replace transfer case, does "Adaption" occur during this procedure?*
6. *When you select [4] Replace VTG control, what values are read out during this procedure?*

   What procedure must be performed with the values?
7. *When you select [5] Enter wear values in new VTG control, what does this procedure prompt you to do?*

   What is provided on screen for you to accomplish this?
8. *Return to the main component selection column and select Complete vehicle, Drive, Transmission control VTG, Transmission oil and Test plan.*

   Does "Adaption" occur during this procedure?

   Is there an on screen indication about the condition of the transfer case oil?

   If yes, what is displayed?

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E60/E61 xDrive with DSC8+

Initial Print Date: 03/05 Revision Date: 04/05

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E60/E61 xDrive with DSC8+

Model: 525xi, 530xi, 530xiT

Production: From April 2005

OBJECTIVES

After completion of this module you will be able to:

- Familiarize yourself with DSC8+ features
- Explain the xDrive mechanical operation
- Describe the xDrive power flow

xDrive with DSC8+

Note: This section only contains changes to xDrive for the E60, 61, 90, 91. Detailed information on xDrive is covered in the E83/E53 xDrive module.

From 04/2005, the BMW 5 Series wagon and sedan (optional) will have all wheel drive capability utilizing the tried and tested all-wheel drive system xDrive of the X3 and X5.

The innovative all-wheel xDrive is a system for controlling and regulating the “infinitely” variable drive torque distribution over the front and rear axle. The xDrive uses the system functions of the DSC to positively influence the vehicle handling by specifically distributing the power in the event of understeer or oversteer.

With the controlled multi-disc clutch in connection with the xDrive it is now possible to resolve the conflict between traction and vehicle handling.

This is been achieved in that the xDrive does not predefine the torque distribution by a fixed transmission ratio as is the case with the previous systems. Instead, distribution of the drive torque is dependent on the clutch lockup torque of the controlled multi-disc clutch in the transfer case and on the transmitted torque at the front and rear axle.

Driver Benefits

In addition to the previous functions, a series of additional safety and comfort functions will now be available to the driver with the introduction of the DSC8+ in the E60/E61.

The expanded DSC8+ functions include:

- Dry braking
- Brake standby
- Automatic soft-stop
- Fading warning and assistance
- Drive-off assistant
- Hill descent control HDC

Besides the outstanding chassis characteristics of the BMW 5 Series, the all wheel drive system offers traction advantages not only on snow and ice but also on unsurfaced roads.

Note: Because many system components and functions and are shared between the xDrive and DSC8+ system, they will be discussed together in this section.

xDrive

The innovative xDrive four-wheel drive is a system that controls and regulates the distribution of driving torque to the front and rear axles. The measured variables of DSC are used by xDrive but are also influenced by modified handling performance.

The multi-disc clutch is the heart of the xDrive. By using the controlled multi-disc clutch, it is possible to resolve the conflict between traction and handling performance.

This is achieved through the fact that torque distribution is not determined by a fixed gear ratio in the xDrive as was the case in the previous systems. Instead, the distribution of driving torque is dependent on the locking torque of the controlled multi-disc clutch in the transfer case and on the transferable torque to the front and rear axles.

DSC8+

The DSC8+ system adds features to the DSC8 system already in use in the E60 sedan and combines features used in other DSC systems (E53/83). Due to the mechanical composition of the xDrive system, the programming for DSC regulation has also been changed.

Present DSC8 functions:

- ABS Anti-lock Braking System
- ADB Automatic Differential Brake
- EBV Electronic Braking Force Distribution
- CBC Cornering Brake Control
- ASC Automatic Stability Control
- DSC Dynamic Stability Control
- DBC Dynamic Brake Control
- MSR Engine Drag Torque Control

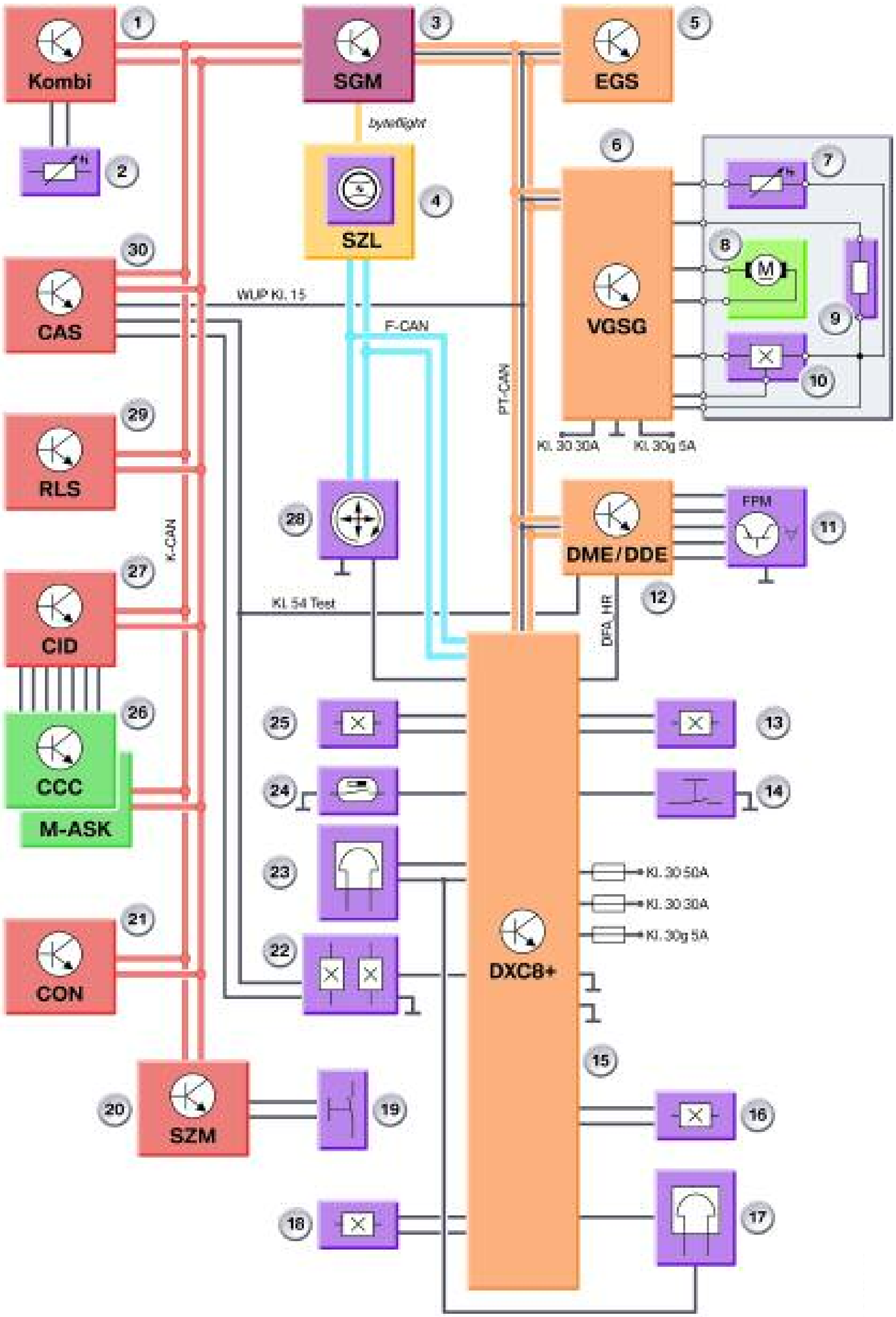
Present DSC functions:

- TCC Transfer Case Control
  (control of multi-disc clutch in transfer case)
- ASC-X Automatic Stability Control X
  (special function for all-wheel drive vehicles)
- ADB-X Automatic Differential Brake X
  (special function for all-wheel drive vehicles)
- HDC Hill Decent Control

New DSC/DSC8+ functions

- Dry braking
- Automatic soft stop
- Drive-off assistant
- Hill descent control HDC
- Brake standby
- Fading assistance
- Trailer stabilization control

System Circuit Diagram



System Circuit Diagram Legend

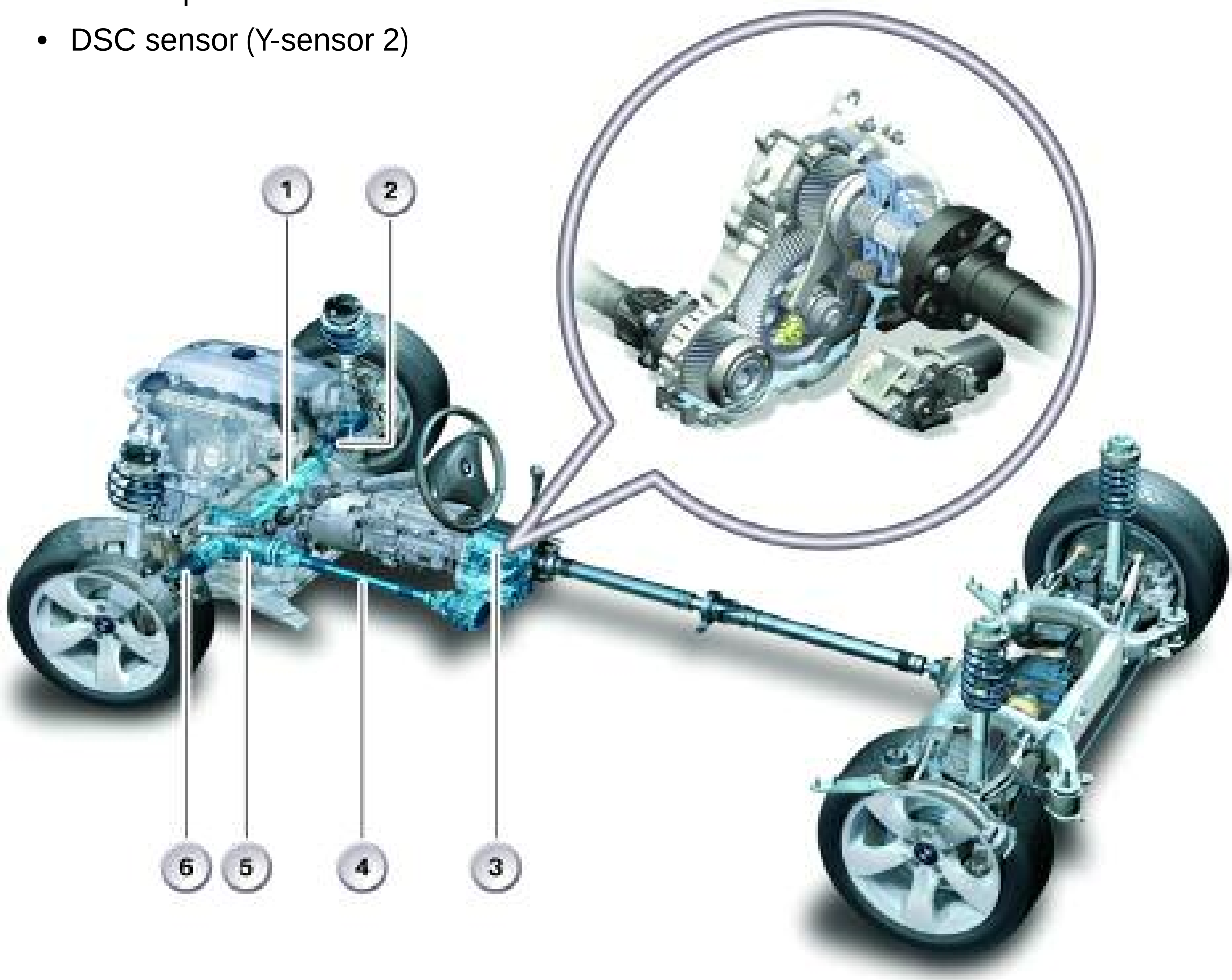
Index	Explanation
1	Instrument cluster
2	Outside temperature sensor
3	Safety and gateway module (SGM)
4	Steering column switch cluster (SZL) with HDC button
5	Electronic transmission control module (EGS)
6	Transfer case control unit (VGSG)
7	Temperature sensor
8	Electronic motor, actuator drive
9	Coding resistor
10	Motor position sensor
11	Accelerator pedal module (FPM) - (not for US)
12	Digital motor electronics (DME) control unit
13	Wheel speed sensor, front right
14	Handbrake switch
15	Dynamic traction control (DSC8+)
16	Wheel speed sensor, rear right
17	Brake wear sensor, rear right
18	Wheel speed sensor, rear left
19	DSC button
20	Center console switching center (SZM)
21	Controller (CON)
22	Brake light switch (BLS)
23	Brake wear sensor, front left
24	Brake fluid level sensor
25	Wheel speed sensor, front left
26	CCC or M-ASK
27	Central information display
28	Yaw rate/longitudinal/transverse acceleration sensor (Y-sensor-2)
29	Rain light sensor (RLS)
30	Car Access System (CAS)

NOTES PAGE

System Components

The xDrive/DSC8+ system is composed of the following major components:

- ATC 300 transfer case
- Adjusting levers
- Servomotor with motor position and temperature sensor
- Coding/classification resistor
- Transfer case control unit
- DSC8+ control unit
- Wheel speed sensor
- DSC sensor (Y-sensor 2)



Index	Explanation	Index	Explanation
1	Oil Pan lead through	4	Propeller shaft to front axle
2	Right drive shaft, front	5	Front axle differential
3	Transfer case	6	Left drive shaft, front

ATC 300 Transfer Case

The transfer case ATC 300 (Active Torque Control) is used on the E60/E61.

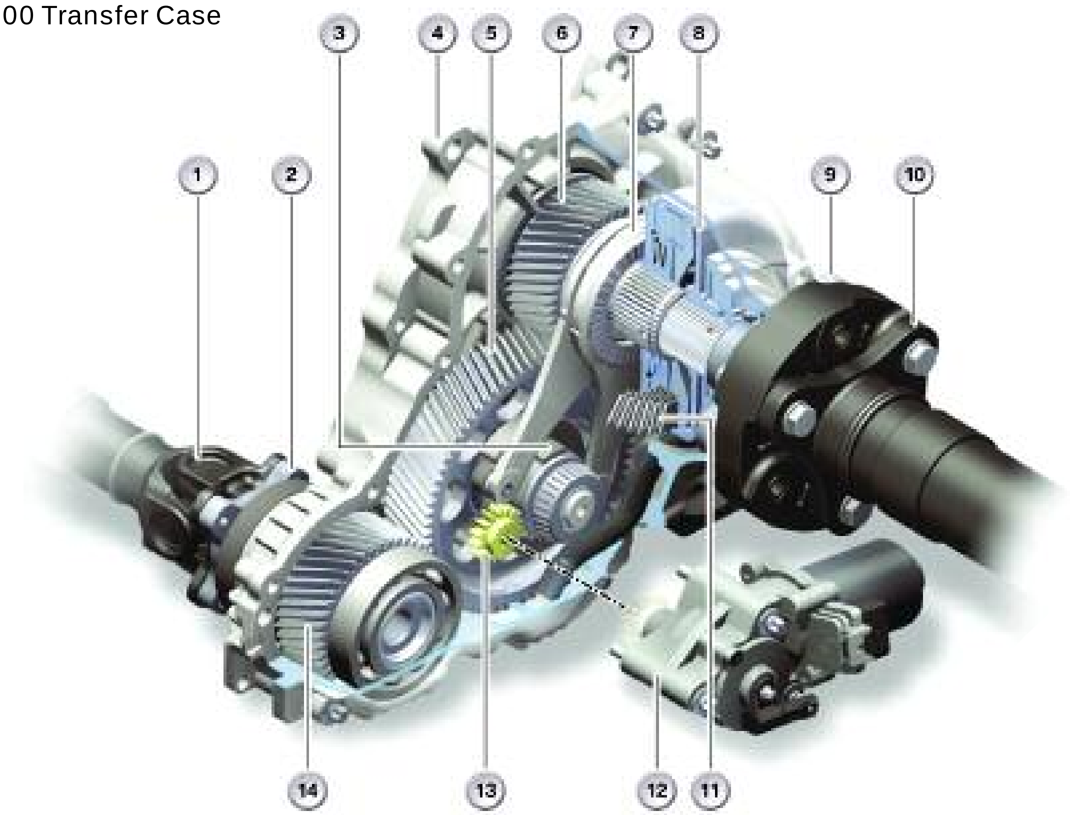
In view of the restricted package space of the transmission tunnel in the BMW 5 Series, it was not possible to adopt the transfer case from the BMW X3 (ACT400) with the same torque rating.

On the BMW 5 Series it was not possible to drive the forward power flow diagonally as is the case on the X3 with a chain, but rather it is necessary to divert it L-shaped with the aid of spur gears (pinions), resulting in a modified design of the transfer case.

The actuator drive and the actuation of the control lever were also modified. The clutch package remains unchanged. The forward connection is provided by a bolted on drive shaft.

The flange of the ATC transfer case is the same for automatic and manual transmissions.

ATC 300 Transfer Case



Index	Explanation	Index	Explanation
1	Propeller shaft to front axle	8	Clutch housing
2	Drive flange to front axle	9	Output flange to rear axle
3	Control cam	10	Propeller shaft to rear axle
4	Transfer case	11	Disc package
5	Idler gear	12	Actuator drive
6	Drive gear	13	Drive pinion
7	Control lever	14	Output gear

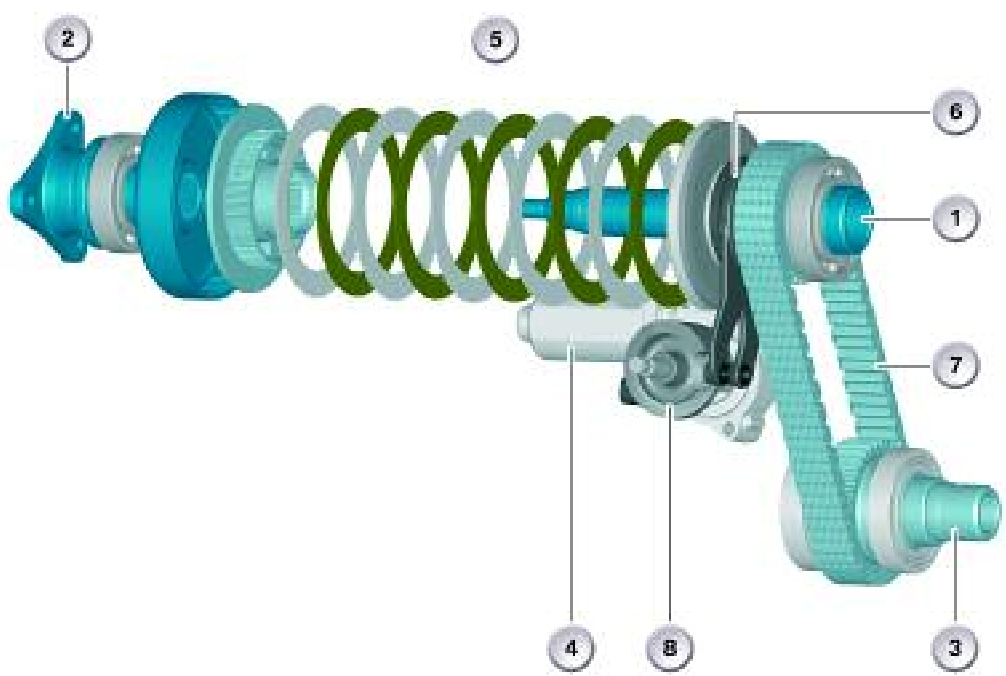
The ATC 300 is installed in the E61 and E60 all wheel drive models. The ATC 400 is installed in the E83 and the ATC 500 in the E53 MU.

The ATC 300 differs from the other transfer cases because it is gear driven not chain driven. The basic functions and operations remain unchanged.

The difference between the transfer cases are:

- ATC 400 & 500 are chain driven vs. ATC 300 which is gear driven
- ATC 300 & 400 uses a four bolt flange to connect to the front propeller shaft vs. ATC 500 which uses a splined connection
- ATC 500 utilizes one more disc in the multi-disc clutch than the ATC 300 & 400
- ATC 500 has 19mm greater length between the input shaft and the output shaft to the front axle than the ATC 400. (the ATC 300 uses gears not a chain)

ATC 500 Transfer Case



Index	Explanation	Index	Explanation
1	Input from manual / automatic transmission	5	Clutch discs
2	Output to rear axle prop. shaft	6	Adjusting levers with ball ramp
3	Output to front axle prop. shaft	7	Chain
4	Servomotor	8	Disc cam

DSC8+ Control Unit

The DSC8+ control unit is installed in the engine compartment essentially consists of three components:

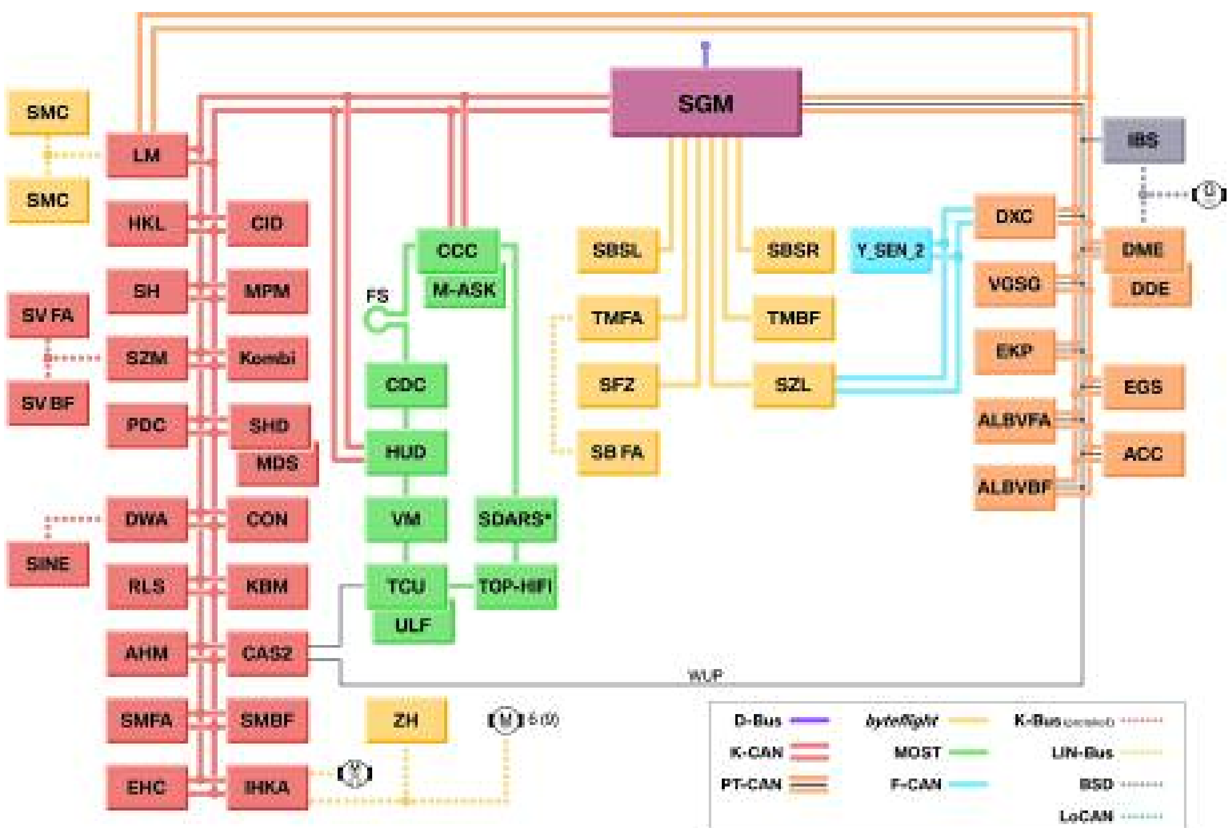
- Add-on control unit
- Valve block with integrated pressure sensors
- Pump motor

The newly developed changeover valves permit even more exact control in the low pressure range, resulting in the following advantages:

- Reduction of control noise
- Improvement in control quality and control comfort
- Improvement in automatic brake intervention by the active/dynamic cruise control ACC/DCC
- Improvement in the control accuracy of the HDC function
- Realization of additional brake functions

Bus Overview

The transfer case control unit (VGSG) is on the PT-CAN. VGSG shares information with DSC for overall xDrive control and has diagnostic communication.



Bus Topology Chart of E61 Sports Wagon (530xiT)

Principles of Operation

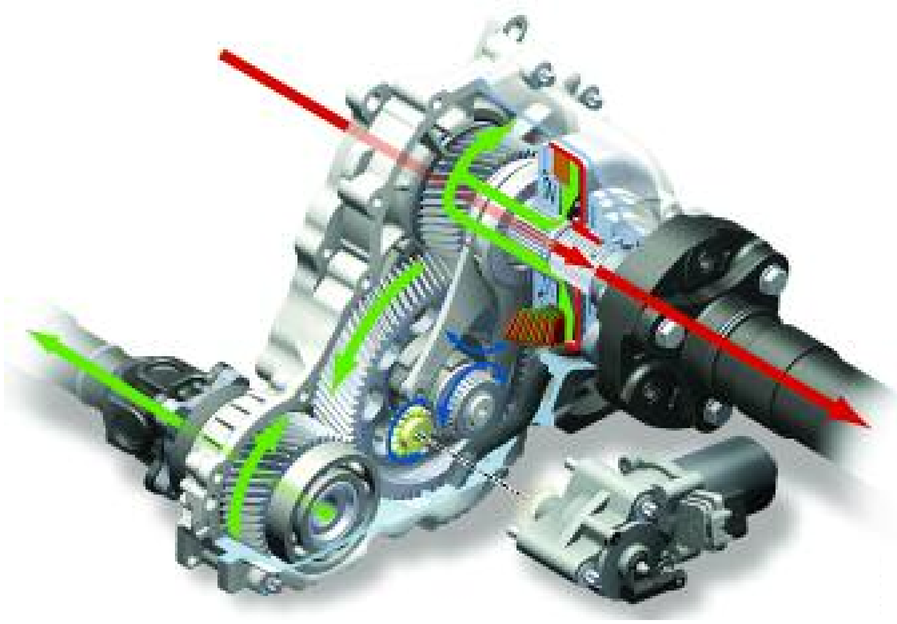
Power Flow

When the multi-disc clutch in the transfer case is disengaged, no driving torque is transmitted to the front axle. All of the driving torque is then distributed to the rear axle. This is because the input shaft (1) is splined providing a permanent connection to the rear axle propeller shaft output flange (2). The multi-disc clutch couples the rear axle propeller shaft output flange to the front propeller shaft output (3).

The driving torque on the front axle is increased or decreased by regulating the locking pressure of the multi-disc clutch, providing a stepless coupling of the front axle to the drivetrain. This depends on driving situations and road conditions. When the multi-disc clutch is fully engaged, the front and rear axles turn at the same speed.

Driving torque distribution (front/rear) is based on available traction at each axle. For example, when traction is identical on the front and rear axles and a driver accelerates from a stop in first gear at full throttle, the rear axle is capable of sustaining greater driving torque as the vehicle weight shifts from the front to the rear.

Another example is when the front axle is on a high traction surface and the rear axle is on ice. In this case, virtually 100% of the available driving torque is transmitted to the front axle. Based on available traction, virtually no driving torque can be supported by the rear axle . Obviously, when more driving torque is transmitted to the front axle, driving torque on the rear axle is proportionally reduced due to lack of traction.



Color	Explanation
Red	Torque from engine to rear axle
Green	Controlled torque to front axle
Dark Blue	Rotation to drive multi-disc clutch

DSC/DSC8+ Control Unit

As in the earlier DSC control units, there are two microprocessors incorporated in the add on DSC8+ control unit. The difference is that in the DSC8 and DSC8+ both processors do not calculate the same algorithms but rather one processor is responsible for performing control and monitoring calculations and checking the plausibility of the wheel speeds.

There are also two semiconductor relays integrated in the DSC8+ control unit, one for the pumpmotor and the other for the solenoid valves.

On exceeding a road speed of 6 km/h, an electronic self-test is started, during which the pump motor and all solenoid valves are briefly actuated. If the brake is operated at a driving speed of 6 km/h, as may be the case with "two-foot drivers", the self-test will be performed at a speed of 15 km/h.

The check of the wheel speed signals is already started at a speed of 2.75 km/h.

In connection with the xDrive, the DSC8+ control unit also undertakes the task of calculating the lockup torque for the multi-disc clutch in the transfer case.

The lockup torque is always optimally set and controlled to suit the corresponding driving situation.

The drive torque distribution over the front and rear axles is based on the lockup torque. The lockup torque to be set is derived from the pilot control and from a higher-ranking traction and vehicle dynamics regulator corresponding to the driving situation.

The DSC8+ control unit sends the data, concerning the lockup torque, on the PT-CAN to the transfer case control unit VGSG.

Conversely, the transfer case control unit signals the lockup torque actually set as well as the load on the transmission fluid, electric motor and multi-disc clutch.

Dynamic Stability Control

DSC8+ offers several new features from April 2005 production vehicles. They are:

- ASC-X / ADB-X
- Hill descent control HDC
- Dry braking
- Brake standby
- Automatic soft stop
- Fading assistance
- Drive-off assistant
- Trailer stabilization control

ASC-X / ADB-X

Unlike regular road vehicles, SAVs are also meant to demonstrate satisfactory handling characteristics and appropriate traction on unconventional roads. In order to provide optimum propulsion with sufficient cornering stability on both normal roads and other road surfaces, Automatic Stability Control X (ASC-X) contains a detection function to distinguish between them.

When off-road terrain is detected, wheel slip threshold is increased to provide sufficient traction force with the increased levels of traction loss.

ASC-X is supplemented by the Automatic Differential Brake (ADB-X) function, which applies the brakes to the wheels per axle, for side to side torque transfer. For example, when a wheel is spinning on one side (up to the slip setpoint), the brakes are applied to that wheel and the driving torque is transferred through the axle differential to the wheel with the higher traction. This provides superb capabilities when there are diagonal traction losses (ie. left front/right rear).

ADB-X remains active when DSC is deactivated. Furthermore, ADB-X can develop full capability because the engine power is not reduced, even during extreme four wheel drive operation. Only that wheel which has a low traction receives the brake application.

The brake disc can overheat with excessive ADB-X intervention with DSC deactivated. In this situation, the operation is discontinued at a disc temperature of approx. 700 ºC and is resumed when this temperature drops below approx. 400 ºC. This is a calculation performed by the DSC control unit based on brake application time, pressure, wheel speed, etc.

Hill Decent Control (HDC)

As on previous all wheel drive vehicles in the BMW line, the E61 all-wheel drive also features the hill descent control facility for safe vehicle operation on steep downhill inclines. The HDC stabilizes the vehicle and prevents the wheels locking. The DSC8+ module controls the build-up of braking pressure at all four wheels so that the vehicle drives downhill at a speed of approx. 7.5 mph (12 km/h).

The HDC function is activated in the central information display via the menu:

Settings => Vehicle settings => HDC

The HDC ON function can be activated by setting a tick in the menu and deactivated by removing the tick.

Furthermore, the HDC ON/OFF function can be selected with one of the two free buttons (asterisk, hash) in the steering wheel button menu.

Menu HDC ON / Active

Dry Braking

The water spray produced in wet conditions coats the brake discs with a water film, causing delayed response of the brakes. In connection with previous systems it was therefore recommended to operate the brakes from time to time.

The dry braking function is dependent on the position of the wiper switch and therefore on the signal of the rain/lights sensor. The brake discs are kept dry by lightly applying the brake pads cyclically as required, this achieving improved braking response in wet conditions.

While doing so, the pressure in the brake system is increased by approx. 1 bar and the brake pads are applied for approx. 1.5 seconds.

Dry braking takes place under following conditions:

- Driving speed > 70 km/h
- Continuous wipe operation in stage 1 or 2

The repeat interval depends on the wiper stage:

- Continuous wipe stage 1 - 200 s
- Continuous wipe stage 2 - 120 s
- Generally 90 s as from 09/2005

This applies only when the driver himself does not apply the brake during this time.

The driver notices no deceleration or noise.

Left disc with water film before dry braking

Right brake disc after dry braking

Brake Standby

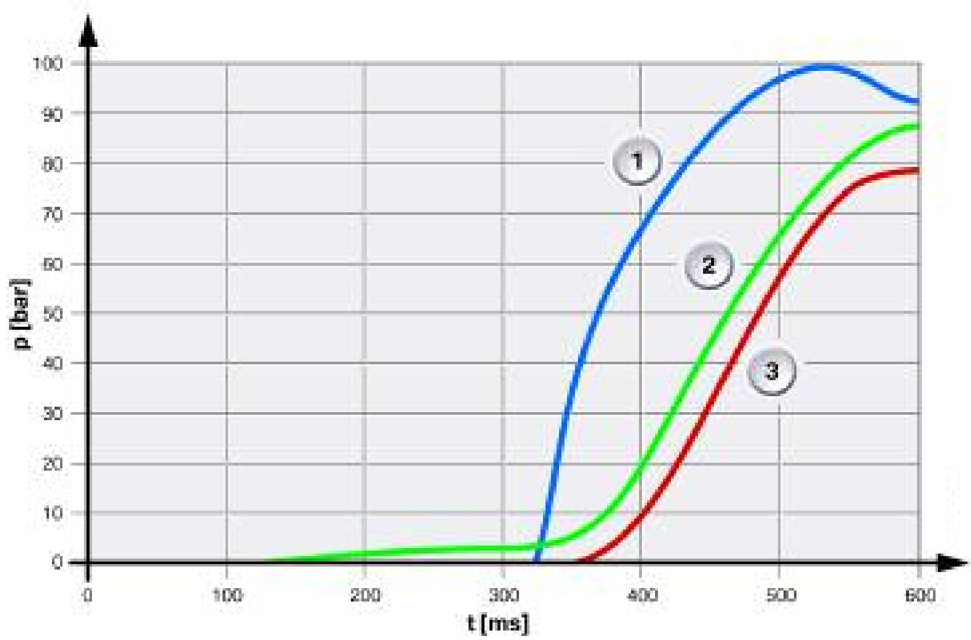
Quick release of the accelerator pedal causes the brake pads to be applied against the brake disc thus reducing the stopping distance (by approx.. 30 cm/100 km/h) during emergency braking. The DSC module builds up slight brake pressure (approx. 2.5 bar) temporarily (approx. 0.5 seconds) in order to eliminate the clearance between the brake pad and brake disc by applying the brake pads.

The brake standby function is activated under following conditions:

- Driving speed > 70 km/h
- Minimum time between brake application 8 s
- The brake standby function is not activated in connection with sudden acceleration (sports driving style).

The DME/DDE control unit makes available the signal indicating quick release of the accelerator pedal via the PT-CAN.

The sensitive driver may perceive a slightly harder brake pedal. No delay or noise is discernible for the driver.



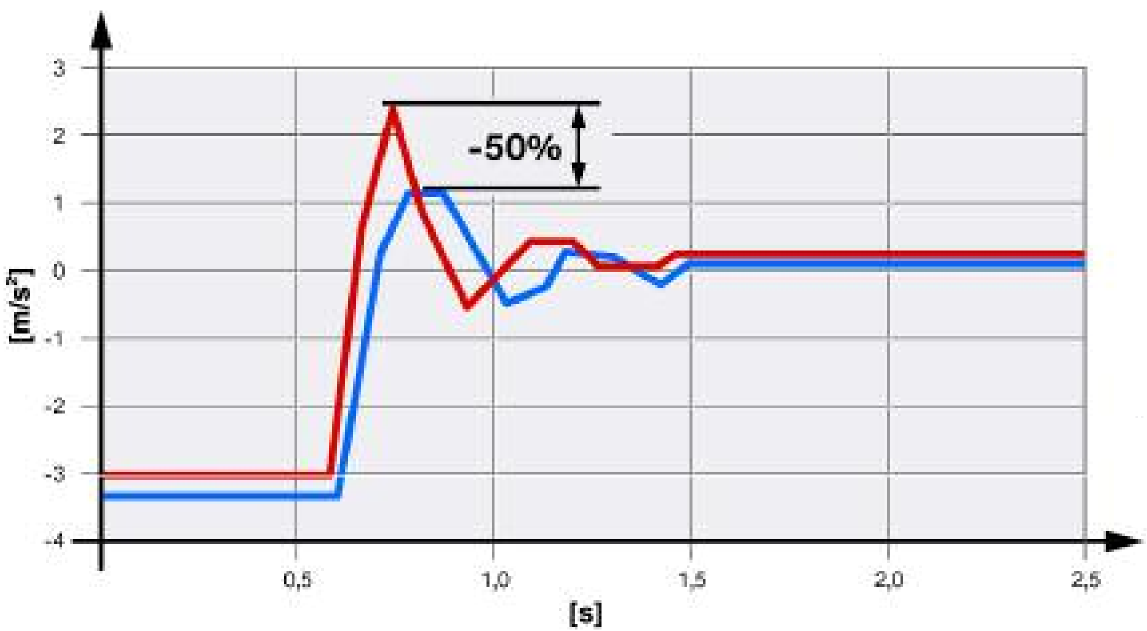
Index	Explanation
P	Braking pressure in Bar
T	Time in milliseconds
1	Pilot pressure applied by driver
2	Braking pressure progression with brake standby
3	Braking pressure progression without brake standby

Automatic Soft Stop

Due to the transition from sliding friction to static friction on the brake disc, a stopping jolt occurs when braking to a standstill where the occupants perceive an increased feeling of deceleration.

When braking lightly (< 25 bar) at constant pressure to bring the vehicle to a halt, the soft stop function automatically reduces the braking pressure at the rear axle just before the vehicle comes to a stop. This consequently reduces the positive acceleration peak perceived by the occupants by approx. 50% while extending the action time.

The speed and standstill status are recognized by way of the wheel speed sensors.



Index	Explanation
m/s2	Deceleration
s	Time in seconds
Red	Deceleration without soft stop
Blue	Deceleration with soft stop
-50%	Reduction of occupant deceleration

Note: This function is inactive at medium to high deceleration or in the event of ABS control in order not to lengthen the stopping distance.

Fading Compensation

High temperatures (> 550°C) can occur at the brake discs when driving downhill over long periods or as the result of extreme multiple braking operations (> 80 bar). These high temperatures cause a change in the coefficient of friction of the brake pads resulting in the braking effect diminishing (fading).

For this purpose, the temperature of the brake disc is calculated by means of a temperature model contained in the DSC8+ software. The braking pressure applied by the driver is measured by the delivery pressure sensor and compared with the current vehicle deceleration (target/actual value).

When the braking effect diminishes, the fading compensation provides assistance for the driver in that pressure is additionally built up by the DSC module.

Brake Disc with Fading

Drive-off Assistant

When negotiating uphill gradients, the drive-off assistant holds the vehicle for a short time (approx. 1.5 s) after releasing the brake so that the vehicle drives off comfortably without the need to use the handbrake. The braking pressure required by the driver to hold the vehicle is maintained automatically in the system.

When driving off, the braking pressure is not reduced before the torque is sufficient for the vehicle to drive off. The holding pressure in the brake system (10 to max. 70 bar) is dependent on the uphill gradient.

Uphill gradients are detected by the DSC sensor with the aid of a longitudinal acceleration sensor.

The function is active both when driving forwards (transmission in Drive) and when reversing (transmission in Reverse) on uphill gradients (up to 50 %).

Drive-off Assistant Function

Service Information

Safety Notice!!! On a vehicle equipped with an automatic transmission, when driving onto brake analyzers, move the selector lever to the “N” position . On a vehicle equipped with a manual transmission, do not release the clutch pedal once on the brake analyzer.

This keeps the transfer case clutch open and the vehicle cannot be pulled off the analyzer.

Towing: Use only a flatbed carrier for all xDrive vehicles!

Oil, Transfer Case, and Clutch Monitoring

Oil

All xDrive transfer cases use Shell Gear oil part number 83 22 0 306 816.

There is no scheduled service for the transfer case oil. Oil Monitoring is performed by the VTG control module to determine when a service (change) is due. The VTG calculates transfer case and clutch wear based on the amount of slip, engagement pressure (torque), speed and mileage.

This calculation accounts for:

- normal “dry” road driving (Integrator 1)
- “adverse” road driving (Integrator 2)
- “other” road extreme driving (Integrator 3)

Depending on individual vehicle use - driving styles and driving conditions, the transfer case oil service interval will vary.

When a service is due, this will be indicated by a Fault Code and additional details are available using the DISplus/ GT1. Service functions provide directions on changing the transfer case oil and updating the VTG control module with the necessary reset and adaption procedure. This is extremely important for CBS.

Transfer Case and Clutch

The transfer case and clutch have separate monitoring characteristics. These values are stored as adaptive values in the VGSG control unit and must be transferred to a new control unit if replaced.

The value for both can be obtained using the diagnostic software under:

Control Unit Functions => VTG => Diagnosis requests => Transmission

Control Unit Functions => VTG => Diagnosis requests => Clutch

Diagnosis

Diagnosis is available for fault repairs and service procedures using the DISplus/GT1.

The test plan for the VGSG contains valuable information on:

- Replacing control unit
- Replacing transfer case
- Transferring adaptation values
  - Automatic
  - Manual
- Reading out adaptation values

Programming (flashing)

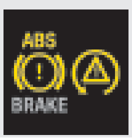
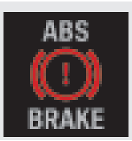
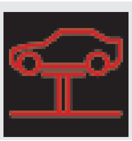
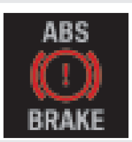
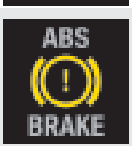
Both the transfer case control unit (VTG) and the DSC control unit are programmable and the new control unit(s) must be programmed when replaced. The wear values stored in the VTG control module (to be replaced) must be transferred to the replacement VTG.

Warning Indicator Lamps

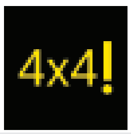
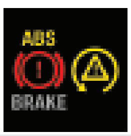
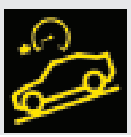
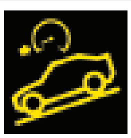
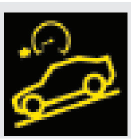
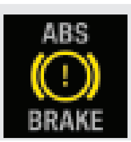
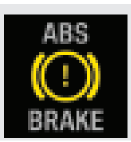
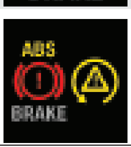
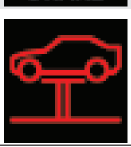
The warning indicator lamps for the xDrive / DSC are found in the instrument cluster as shown on the bottom of this page.

The warning indicator lamps and acoustic signals (gong) are assigned to the xDrive / DSC system states of malfunction described on the next two pages.

Check Control Messages Relating to xDrive / DXC8+

Fixed indicator lamp	Variable indicator lamp	Check control message	Information in central information display
		DSC disabled!	You have disabled DSC. Restricted vehicle stability while accelerating and cornering.
		DTC enabled, DSC restricted!	DTC enabled. Dynamic traction control DTC increases forward propulsion on unpaved surfaces, however, it decreases vehicle stability.
		DSC failed! Drive with moderation	DBC failed. No additional braking assistance from DBC in emergency braking situations. Drive with moderation. Have checked by your BMW dealer as soon as possible.
		DSC failed! Drive with moderation	DSC failed. Restricted vehicle stability while accelerating and cornering. Drive with moderation. Have checked by your BMW dealer as soon as possible.
		Control systems! Drive with moderation	Brake and vehicle control systems failed. Reduced braking and vehicle stability. Avoid abrupt braking where possible. Have checked by nearest BMW dealer.
		Control systems! Drive with moderation	Brake and vehicle control systems failed. Drive with moderation, avoid abrupt braking where possible. Have checked by nearest BMW dealer.
		Brake pads! Replace	The brake pads are worn. Have replaced by nearest BMW dealer.
		Brake fluid! Stop cautiously	Brake fluid level too low. Reduced braking efficiency. Stop cautiously. Contact nearest BMW dealer.
		Brakes too hot! Allow to cool down	Brakes too hot Critical temperature as a result of permanent heavy load. Danger - reduced braking efficiency. Allow brakes to cool down. Stop if necessary.

Check Control Messages Relating to xDrive / DXC8+ (cont'd)

Fixed indicator lamp	Variable indicator lamp	Check control message	Information in central information display
		Brakes overheated! Allow to cool down	Brakes overheated Critical temperature exceeded. Braking efficiency no longer guaranteed. Stop at the next opportunity and allow to cool down substantially.
		4x4 system and DSC failed!	4x4 system and DSC failed! Vehicle stability restricted. Drive with moderation. Have checked by your BMW dealer as soon as possible.
		4x4 system defective! Drive with moderation	4x4 system defective Vehicle stability restricted. Drive with moderation. Have checked by your BMW dealer as soon as possible.
		4x4 system, DSC and ABS failed!	4x4 system, DSC and ABS failed! Vehicle stability restricted. Drive with moderation. Have checked by your BMW dealer as soon as possible.
		4x4 System, DSC, ABS and emergency EBV failed!	4x4 System, DSC, ABS and emergency EBV failed! Vehicle stability restricted. Drive with moderation. Have checked immediately by your BMW dealer.
		HDC enabled!	
		HDC disabled!	HDC disabled. Hill descent control HDC is disabled at speed above 60 km/h (37 mph). System can be re-enabled at speed below 35 km/h (22 mph).
		No HDC control! Drive slower	HDC not possible! Control range ends at 35 km/h (22 mph). To use HDC, reduce speed accordingly.
		HDC currently not available!	HDC not available. Automatic brake intervention interrupted for safety reasons as brakes are overheated. Shift down and drive carefully in order to reduce temperature.
		Drive-off assistant inactive!	Drive-off assistant inactive Caution, vehicle can roll back! Have checked by your BMW dealer at next opportunity.
		Electronics fault! Stop cautiously	Central vehicle electronics failed. Continued journey not possible. Contact nearest BMW dealer.

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E90/E91 xDrive

Initial Print Date: 8/05 Revision Date:

E90/E91 xDrive

Model: 325xi, 325xiT, 330xi

Production: All

OBJECTIVES

After completion of this module you will be able to:

- Familiarize yourself with the changes to the E90/E91 xDrive

Introduction

The new 3 Series Sports Wagon satisfies the standards of style, flexibility and performance - far in excess of sheer driving pleasure. It combines first class driving dynamics with versatile functionality.

It will be introduced in the US as a 325xiT in September 2005. Variants will be available in March 2006.

The technical basis of the E91 is the E90, the 3 Series Sedan, with which the Sports wagon is virtually identical up to the B-pillar. Therefore, what has already been said about the 3 Series Sedan also applies to the Sports Wagon: It is - when compared with the previous model (E46) - stronger and bigger, and the E91 has above all become more functional.

Like the Sedan, the E91 has sporty proportions thanks to its long engine bonnet and a striking swage line rising along the entire side of the car as an expression of powerful dynamics.

The roof line of the Sports Wagon is like a Coupé and the roof spoiler is integrated in these lines. Roof rails are standard.

Drivetrain

Engines

Initially the E91 Sports Wagon will only be offered as a 325xiT with later configurations to follow.

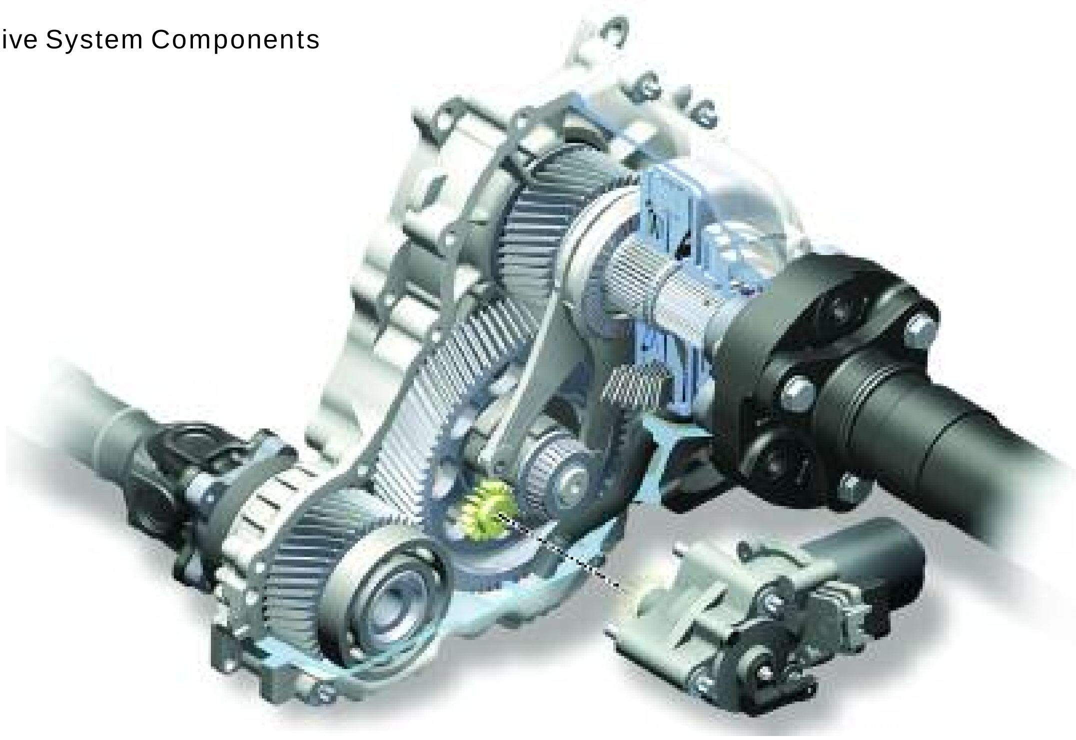
The new BMW N52-generation inline six cylinder engines deliver incomparable agility with more power but less weight and lower fuel consumption. VALVETRONIC and double VANOS are additional features of this engine which, in the E91 as already in the E90, is combined exclusively with 6-speed gearboxes.

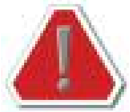
xDrive All-Wheel-Drive System

Initially the E91 Sports Wagon will only be offered in an all wheel drive version. At the same time, the all-wheel-drive system will also be making its debut in the new 3 Series Sedan (September 2005).

The system and function are already familiar from the X3, X5 and 5 Series. Some components such as e.g. the propeller shafts have been geometrically adapted to the altered space conditions in the 3 Series.

xDrive System Components





Towing: Use only a flatbed carrier for all xDrive vehicles!

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Panorama Sunroof

Initial Print Date: 10/03 Revision Date: 8/05

Panorama Sunroof

Model: E83/53/61/91

Production: Start of Production MY 2004

OBJECTIVES

After completion of this module you will be able to:

- Familiarize yourself with the panorama sunroof

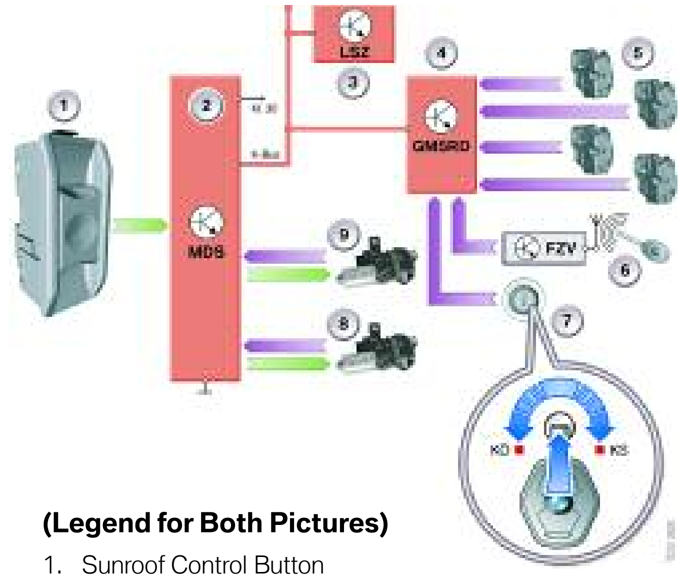
E83/53/61Panorama Glass Sunroof

One of the highlights of the X3 is a fully automatic, two-part panorama glass sunroof with an area of almost one square metre. Its front window section can be fully opened while both window sections can also be tilted rearward. The panorama glass sunroof affords an outstanding view for the rear occupants and, when fully opened, lends the vehicle the impression of being almost a Convertible.

E83/53 System Components

The panorama glass sunroof assembly consists of the following components:

- Panorama Glass Sunroof control unit, MDS
- 2 Drive Motors
- 2 Part floating headliner
- 2 Glass covers
- Power Supply
- K-Bus Interface
- Wind deflector



MDS

The MDS is a further development of the slide/tilt sunroof module fitted to the E 65.

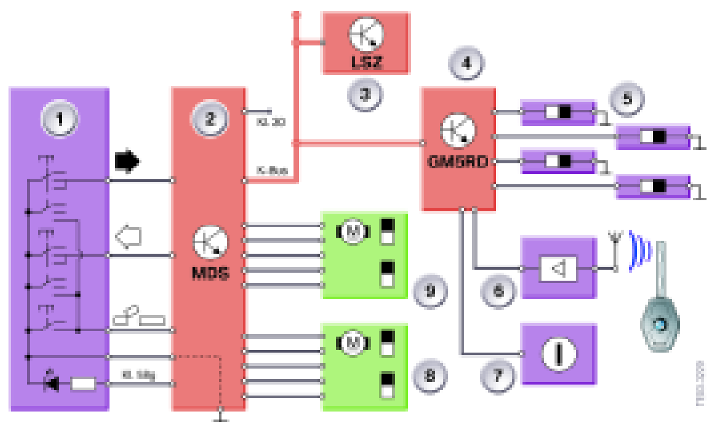
The MDS contains the following components:

- Control Electronics
- K-Bus Interface
- Drive motor Relay
- Hall Sensor Power Supply

The drive motors are connected to the MDS by a 10 pin connector. The remaining components are connected via a 16 pin connector.

(Legend for Both Pictures)

1. Sunroof Control Button
2. MDS
3. LSZ
4. GM5RD
5. Door Contacts
6. FZV
7. Driver's Door Lock
8. Motor
9. Motor



Drive Motors

The motor is a DC motor. The hall sensors are integrated in the motors to detect motor revolutions. These signals are forwarded to the MDS for analysis.

E61 System Components

The panorama glass sunroof assembly consists of the following components:

- Panorama Glass Sunroof control module, MDS
- 2 Drive Motors
- 2 Part floating headliner
- 2 Glass covers
- Wind deflector

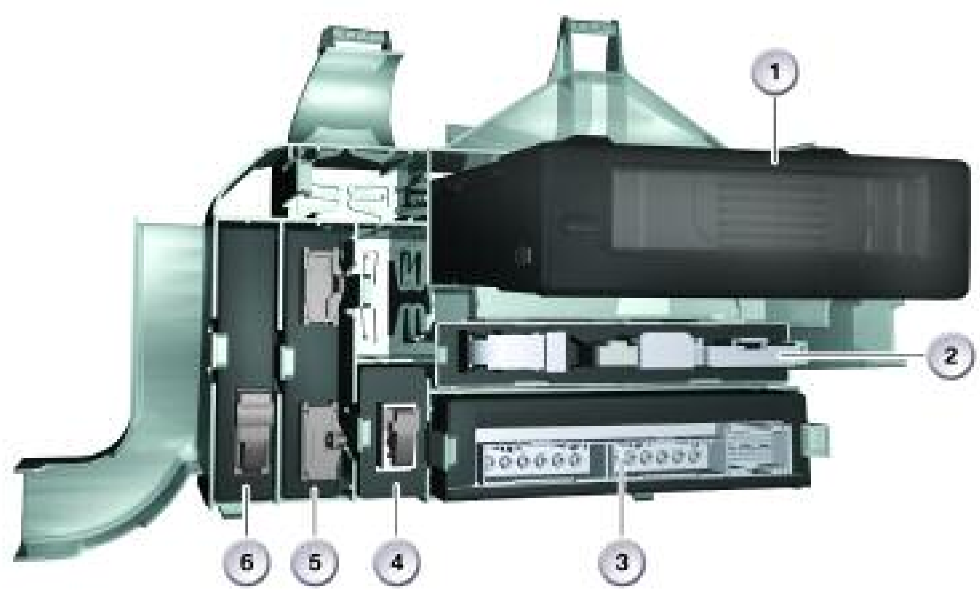
Multi Drive Sunroof Control Module

The MDS contains the following components:

- Control Electronics
- K-CAN Interface
- Drive motor Relay
- Hall Sensor Power Supply

The Multi Drive Sunroof MDS controls and monitors the electric motors and therefore the movement of the panorama glass sunroof.

The MDS is installed on the carrier behind the glove compartment.



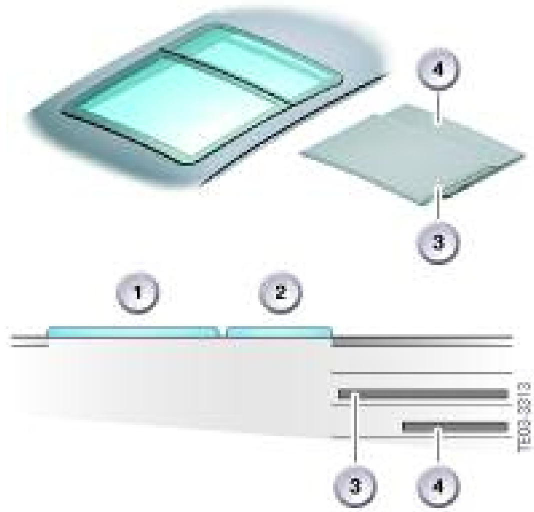
Control units in the carrier behind the glove compartment

Index	Explanation	Index	Explanation
1	CD changer CDC	4	Adaptive headlight AHL
2	Basic body module KBM	5	Multi Drive Sunroof MDS
3	Safety and gateway module SGM (up to 9/05)	6	Comfort Access (9/2005)

Floating Headliner

The floating headliner consists of two parts controlled by a Bowden Cable.

The headliner is interlocked to the function of the glass roofs. The headliner must be opened before the glass sunroof will open. On closing the glass sunroof must be closed before the headliner can be closed.



1. Front glass sunroof
2. Rear glass sunroof
3. Front Floating Headliner
4. Rear Floating Headliner

Glass Covers

Two glass covers are installed in the panorama sunroof. Six. bolts secure the front glass to the frame and four bolts secure the rear glass.

Power Supply and K-Bus Interface

The MDS acts as the power supply module for both the sunroof motor and the headliner motor. Communication with the rest of the car is through the K-Bus. The MDS receives and transmits K-Bus messages.

Wind Deflector

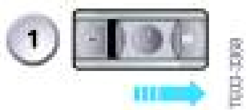
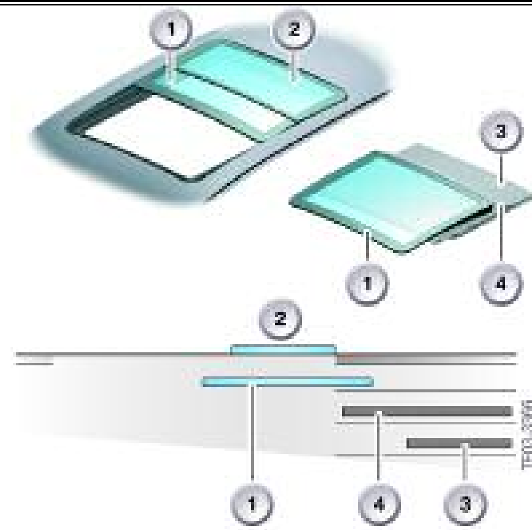
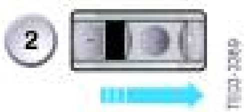
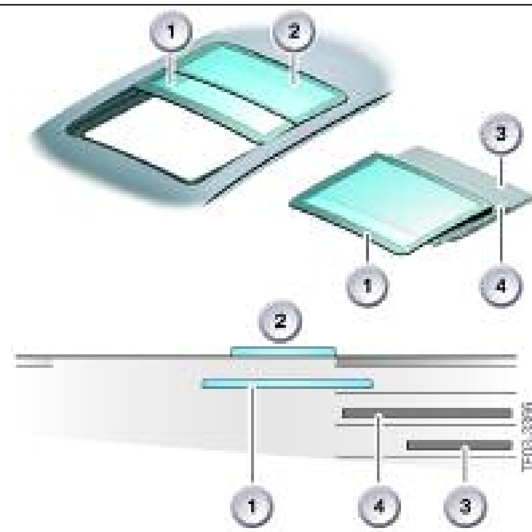
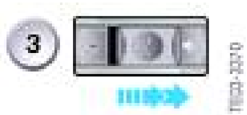
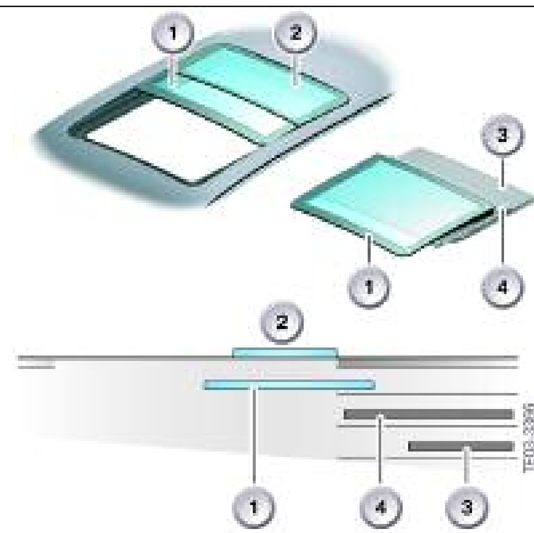
The wind deflector is cable operated by the rear (headliner) motor.

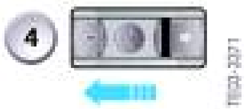
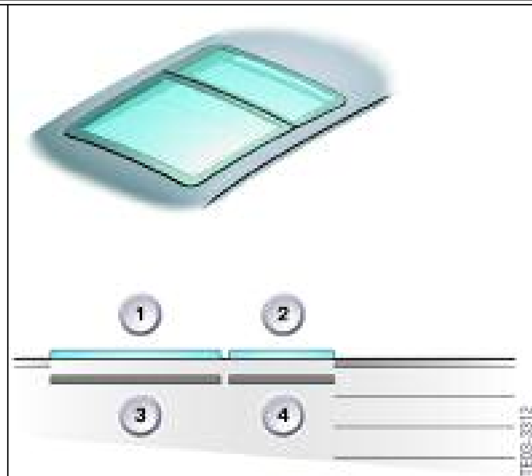
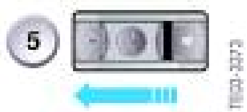
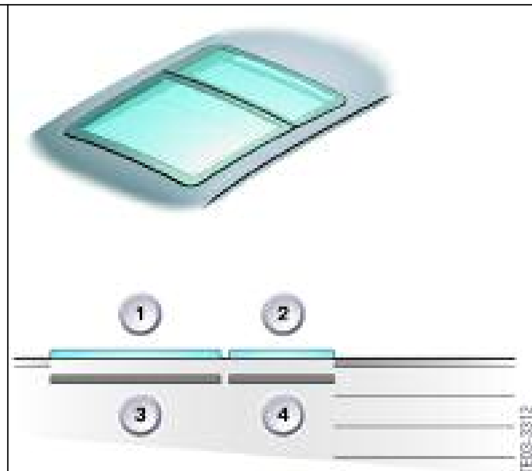
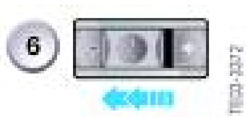
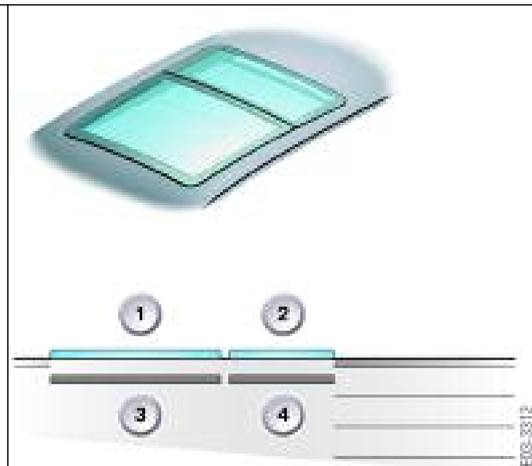
System Operation

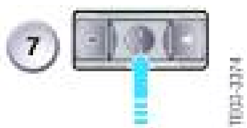
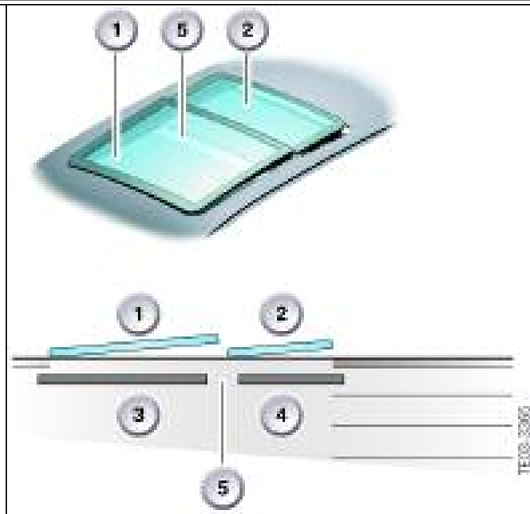
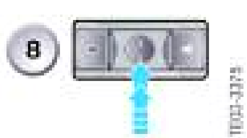
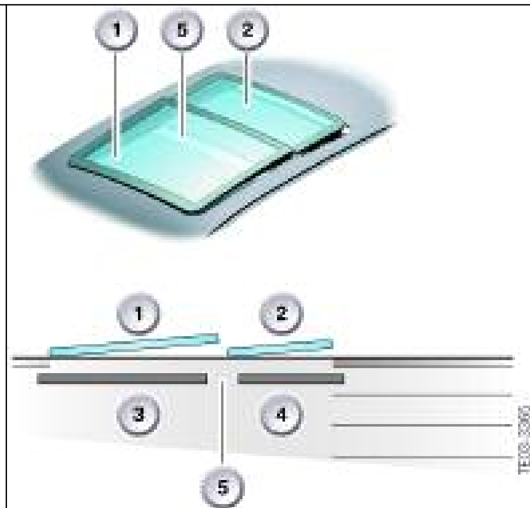
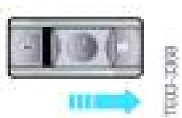
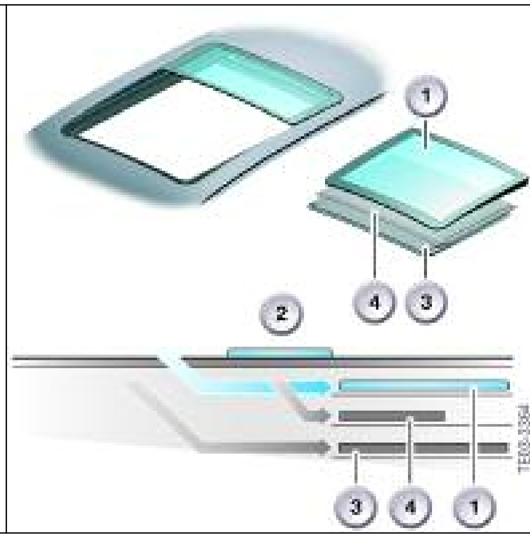
Operation of the panorama sunroof is similar to the conventional slide/tilt sunroof. It functions both as a tilting sunroof and a slide/tilt sunroof. The rear glass only tilts, the front glass slides and tilts. Rear tilt is possible only when the front glass is also tilted.The GM5RD signals the MDS for convenience opening and closing of the panorama glass sunroof.

The panorama glass sunroof is operated as follows:

- Headliner and glass sunroof Closed.
- Headliner closed, front and rear glass in tilt position (Headliner goes to vent position).
- Headliner open, sunroof closed.
- Headliner open, sunroof opened manually.
- Headliner open, sunroof opened to comfort position (Via one touch opening).
- Headliner open, sunroof opened fully (Beyond comfort position).

Control Button	Movement	Panorama Glass Sunroof Positions
 Manual opening of panorama glass sunroof by sliding button to first detente position	Floating headliner of glass tilt sunroof and slide/tilt sunroof are opened until the control button is released.	
 Automatic opening of panorama glass sunroof by sliding the button beyond the pressure point to the second detente position	Panorama glass sunroof is automatically opened to the comfort position.	
 Double-click function Automatic opening of panorama glass sunroof by sliding the button twice beyond the pressure point to the second detente position	Panorama glass sunroof is automatically opened to the comfort position.	

Control Button	Movement	Panorama Glass Sunroof Positions
 Manual closing of panorama glass sunroof by sliding control button in first detente position	Floating headliner or glass tilt and slide/tilt sunroofs are closed until the control button is released	
 Automatic closing of panorama glass sunroof by sliding the button beyond the pressure point to the second detente position	Floating headliner or glass tilt sunroof or slide/tilt sun-roof are fully closed	
 Double-click function Automatic closing of panorama glass sunroof by sliding the button twice beyond the pressure point to the second detente position	Floating headliner and glass tilt sunroof or slide/tilt sunroof are fully closed	

Control Button	Movement	Panorama Glass Sunroof Positions
 Manual opening of panorama glass sunroof by pressing control button to first detente position	Panorama glass sunroof is opened to raised position until the control button is released	
 Double-click function Automatic opening of panorama glass sunroof by pressing the button beyond the pressure point to the second detente position	Panorama glass sunroof is fully opened to raised position and the floating headliner is moved to the vent position.	
 After opening panorama glass sunroof via one touch, the sunroof may be opened fully (rather than the comfort position) by sliding the control button to the first detente and holding.	Front glass of panorama sunroof will move from comfort position to fully open position.	

Floating Headliner

Opening

On opening the front part of the headliner moves over the rear part of the floating headliner. The special feature of the floating headliner is that it can be opened fully without the sunroof being open or tilted.

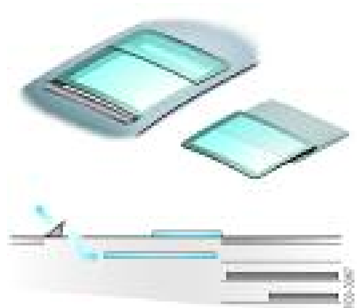
Vent Mode

When the panorama glass sunroof is moved into the tilt position, the floating headliner is moved into the vent position.

The vent position reduces the suction effect at high road speeds.

Wind Deflector

The wind deflector is regulated according to road speed. When the sunroof is opened the wind deflector remains in the down position until road speed is seen by the MDS. Then the wind deflector is placed in the extended position. At roads speeds greater than 140km/h (84mph) it is retracted to an intermediate position. If the road speed drops below 100km/h, the wind deflector is again raised.



Initialization

Initialization must be performed on the panorama glass sunroof anytime the MDS looses positioning of the glass panels or the headliner or if the any component of the sunroof assembly is replaced.

The control button is pressed and held in the position to tilt the sunroof. Initialization begins approximately 15 seconds after pressing the button. The initialization process may take over 2 minutes to perform.

Note: The control button MUST be held in the tilt position during the entire initialization process. Failure to hold the button will result in the initialization procedure to be cancelled.

During initialization the panorama sunroof will operate as follows:

- Both sunroof panels enter tilt position(Headliners enter Vent Mode)
- Both Headliners open
- Both sunroof panels lower
- The front sunroof panel opens then closes
- Both Headliners close

Anti-Trapping Protection

Both the covers and the floating headliners are fitted with anti-trap protection. If the MDS detects something in the path, the appropriate motor is stopped and activated in the reverse direction.

Service Notes

The motors may be replaced individually. An initialization procedure is required after replacing one or both of the motors

The MDS control unit my be replaced separately. The panorama glass sunroof must be recoded and initialized after MDS replacement.

E91 Panorama Sunroof

All E91 Sports Wagons sold in the US will be equipped with a panorama sunroof. The E91 panorama sunroof is an internally operating slide/tilt sunroof with two glass lids and two floating roofliners.

The glass surface area of the E91 sunroof has increased by 140% when compared with the sunroof on the E46 Sports Wagon. This improves the sense of space felt by both the front and the rear passengers.

Panorama Sunroof (E91)

Single Panel Sunroof (E46/3)

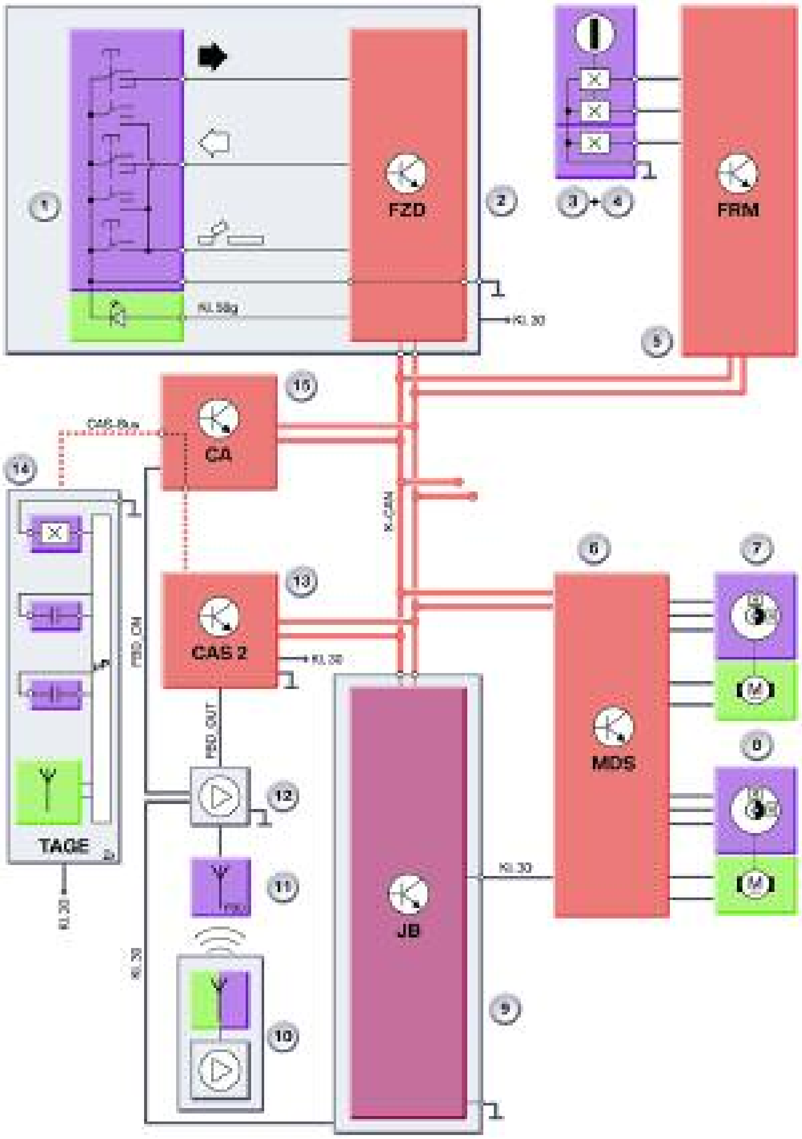
The E91 panorama sunroof is based on that of the E83 with a slight yet significant change. The 50 mm wide ventilation gap on the floating roofliners is at the front and not in the middle as on the E83.

The wind deflector is operated by a mechanism controlled via the floating roofliner motor. This wind deflector is controlled as a function of vehicle speed.

In this way, both lower-frequency drumming (at approx. 70 km/h) and higher-frequency whistling (above 120 km/h) are suppressed.

This is achieved by the net wind deflector, which adopts different heights and therefore counteracts the interference noise.

Panorama Sunroof System Overview



Index	Explanation	Index	Explanation
1	Button for Panorama Glass Sunroof	9	Junction Box Electronics (JBE)
2	Roof Function Center (FZD)	10	Identification Transmitter
3	Lock Cylinder, Driver's Door	11	Rear Window Antenna
4	Door Contact, Driver's Door	12	Remote Control Receiver
5	Footwell Module (FRM)	13	Car Access System 2
6	Multi Drive Sunroof Control Unit (MDS)	14	Electronic Outer Door Handle (TAGE)
7	Motor Panorama Sunroof (glass)	15	Comfort Access
8	Motor Panorama Sunroof (liner/deflector)		

System Components

The panorama sunroof is composed of the following components:

- Glass panels
- Roofliners
- Wind Deflector
- 1 glass panel motor
- 1 headliner/wind deflector motor
- Multi Drive Sunroof (MDS) control unit
- Roof Function Center (FZD) control unit
- Footwell Module (FRM)
- Junction Box (JB)
- Car Access System 2 (CAS2)
- Dynamic Stability Control Unit (DSC)

Individual Components of Panorama Sunroof

Glass Panels / Roofliners

Both glass lids can be removed from the E91 panorama sunroof. The retaining screws must also be released if the lids are adjusted.

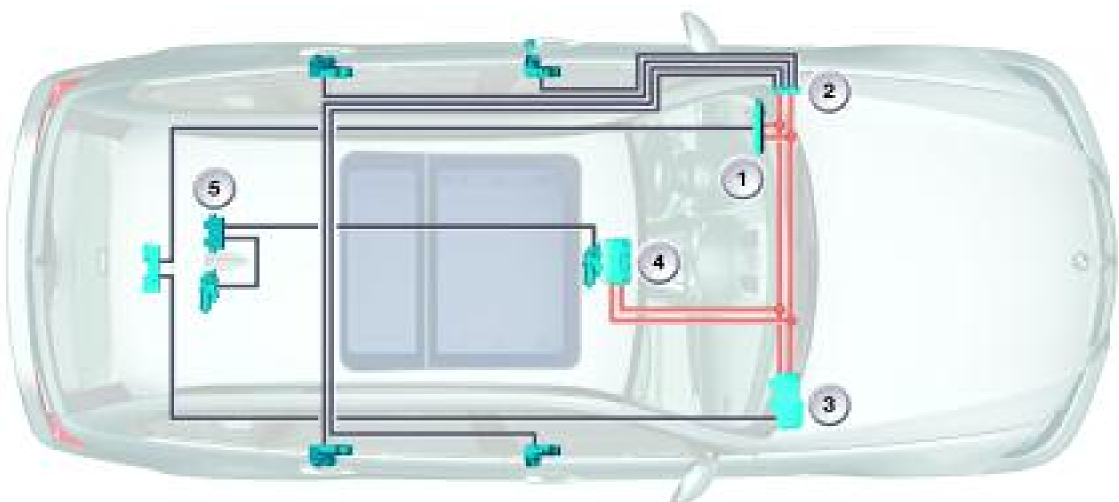
The two floating roofliners can then also be removed. When the panorama sunroof casing is installed, the two electric motors and the wind deflector can still be installed and removed.

Motors

The panorama sunroof uses two motors for operation. One motor is used solely for the operation of the glass panels and the other controls the roofliners and wind deflector.

The motors are identical and thus can be interchanged for diagnostic purposes but should always be left in their original position. This is due to the wear pattern on the motor drive to the bowden/screw cable that drives the sunroof components.

Each motor contains two Hall sensors offset by 90 degrees with respect to each other. Tis enables the MDS control unit to accurately detect rotation, speed of rotation, and direction of rotation. This signal is also used to detect a possible trapping condition.



Electrical Components of Panorama Sunroof

Index	Explanation
1	Car Access System (CAS2)
2	Footwell Module (FRM)
3	Junction Box Electronics (JBE)
4	Roof Function Center (FZD)
5	Multi Drive Sunroof (MDS)

Multi Drive Sunroof (MDS) Control Unit
A separate control unit is installed for the panorama glass sunroof functions. The panorama glass sunroof control unit (multi drive sunroof MDS) controls and monitors the electric motors and thus the movement of the panorama glass sunroof.

The MDS is installed in the headliner behind the panorama glass sunroof. It can be accessed from the rear of the vehicle.

Roof Function Center (FZD) control unit
The FZD is used to receive the sunroof switch status and convert it to a signal that can be transmitted to the MDS control unit over the K-CAN. The roof function center control unit also houses the sunroof switch.

Index	Explanation
1	Interior lighting under transparent trim
2	Ambient lighting
3	Reading light
4	Ambient lighting
5	Reading light
6	Emergency call
7	Handsfree microphone

Roof Function Center Control Unit (FZD)

Footwell Module (FRM)
The FRM transmits the status of the driver's lock cylinder for convenience open/close features.

Junction Box
The JB supplies the MDS control unit power via a KL30g circuit for panorama sunroof motor operation.

Car Access System 2
The CAS2 enables or disables the operation of the panorama sunroof by sending terminal status signals to the MDS control unit via the K-CAN.

Dynamic Stability Control Unit
The DSC control unit is responsible for making the vehicle speed signal available to the MDS control unit for wind deflector operation.

Principles of Operation

The panorama sunroof operation has been almost entirely adapted from the E61 Sports Wagon and X3/X5.

The only difference in operation is that when the sunroof glass panels are placed in the vent mode, the floating headliner does not vent from the middle. Instead the sunroof headliner slides back from the front section similar to conventional single panel sunroofs.

Ventilation Gap E91

Ventilation Gap E61

Notes

Headliner

The headliner of the E91 is totally new due to the changes in the body and the panorama sunroof.

Index	Explanation
1	Roof Function Center (FZD)
2	Roof Handles, (Rear with Coat Hooks)
3	Panorama Sunroof
4	Interior Lights
5	Attachment Mount (Eyelet) for Combination Roller Blind
6	Ultrasonic Interior Movement Detector
7	Sun Visor with Illuminated Vanity Mirror

Workshop Exercise - Panorama Glass Sunroof

The customer has complained of a stained rear sunroof headliner. The sunroof headliner has been received, and now must be replaced. However when the vehicle arrives in the shop, the headliner will not operate.

1. *Check fault memory and list any faults.* ____________________

2. *Is there a Test Plan for this situation?* ____________________
3. *Perform the Test Plan.* ____________________
4. *Which section of the Test Plan best fits this situation?*

5. *From where does the headliner motor receive its power?*

6. *What is the easiest place to check the power supply to the headliner motor?* ____________________

   Check power for visor motor at MDS. ____________________
7. *Is B+ available at the headliner motor?* ____________________
8. *Repair the fault.* ____________________
9. *List the steps necessary to remove the rear headliner.*

10. *List the movement of the sunroof and headliner during initialization.*