Reference Manual

E53
COMPLETE VEHICLE

Technical Training

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Introduction

The X5 marks BMW's introduction into the luxury "Sports Activity Vehicle (SAV)" niche segment of the Sport Utility Vehicle market. While carrying the designation X5, the vehicle is not based on the 5 Series but it is its own new car-like platform. The X5 is offered with two engine variants:

- The 4.4 liter M62 TU engine equipped with the A5S 440 Z automatic transmission.
- The 3 liter M54 engine with either the GM 5 automatic (A5S360R) or 5 speed manual transmission (S5D280Z).

The X5 incorporates the following features:

- Four wheel independent suspension (BMW tradition)
- Full time - all wheel drive (planetary gear transfer case)
- All road vehicle (ON/OFF road capabilities)
- High ground clearance
- Unitized body and Chassis (car like ride and handling)
- Double pivot front suspension
- "Integral Link" rear suspension with air spring self leveling
- X5 specific traction control system

Two different suspension options are offered (standard and sport) with different springs, shock absorbers and stabilizers.

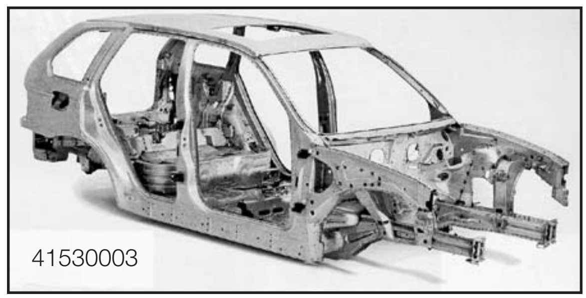
The X5 has 180 mm ground clearance, for both suspensions to allow off road travel. However, the suspension travel is the same as the E39 which allows the X5 to retain a car like feel when driven every day.

Body

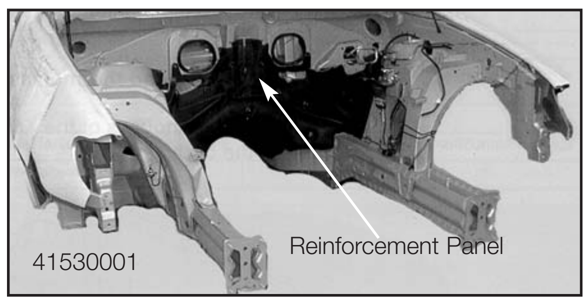
The design of the X5 originated in California at BMW's Design Works. The SAV look was further developed and refined in Munich. Traditional BMW features such as the Kidney grilles, quad headlights, reverse link rear side window trim and typical rear tail light treatment allow the X5 to assume a BMW identity. Yet the unique side and hood treatments as well as the large wheel house openings and high ground clearance set the X5 apart as its own distinctive vehicle.

The design criteria for the X5 was to develop a vehicle with the superb handling and sporty driving characteristics that are typically BMW, yet produce an all wheel drive vehicle that can also be used off-road. This was achieved through the use of independent front suspension and multi-link rear suspension components that are taken from the E38/E39 vehicle design and expanded by the addition of front drive components.

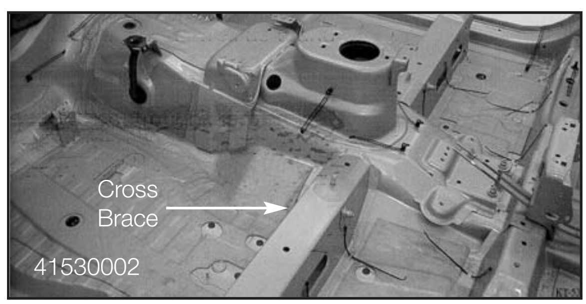
The entire body shell/frame assembly of the X5 is reinforced to ensure optimized body rigidity.



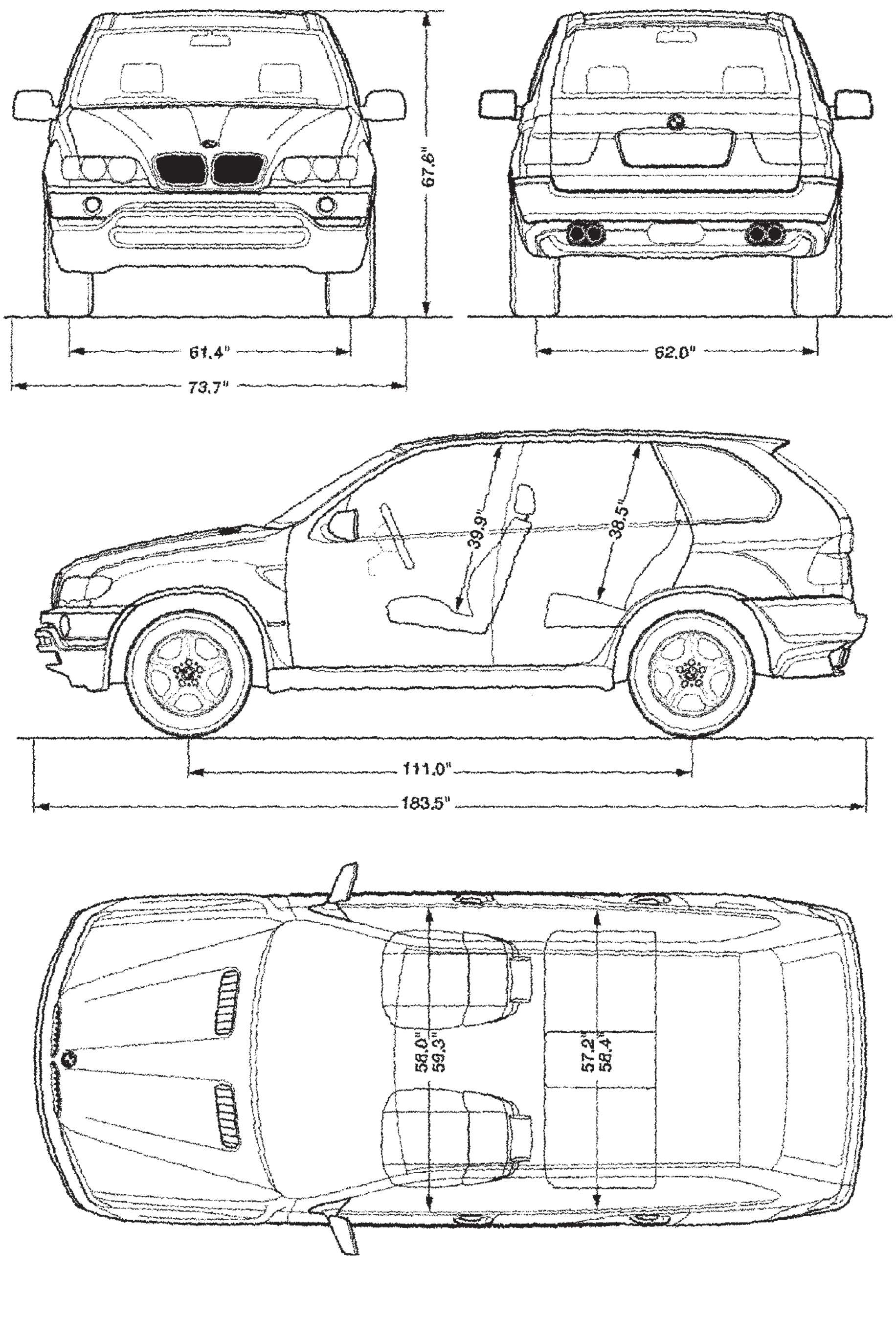
In addition to the cross bracing on the front suspension/engine carrier, an additional panel is installed between the bulkhead and transmission tunnel.



The floor pan of the X5 is reinforced with additional ribbing and cross braces to increase the lateral rigidity. A continuous seat cross brace is connected to the floor pan and side sill for reinforcement.



Specifications



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Specifications

DImensions:			
	X5 3.0i	X5 4.4i	X5 4.6is
Doors	5	5	5
Length	4666 mm	4666 mm	4666mm
Width	1872 mm	1872 mm	1872mm
Height	1717 mm	1717 mm	1717mm

Engine:			
	X5 3.0i	X5 4.4i	X5 4.6is
Designation	M54B30	M62 TU B44	M62 TU B46
Engine Management Syst.	MS 43	ME 7.2	ME 7.2
Horsepower (HP)	225@5900RPM	282@5400RPM	340@5700RPM
Torque	214@3500RPM	324@3600RPM	350@3700
Bore	84mm	92mm	93mm
Stroke	89.6mm	82.7mm	85mm
Compression	10.2:1	10.0:1	10.5:1

Vechicle Weigth withTransmission:			
	X5 3.0i	X5 4.4i	X5 4.6is
Automatic	2015 Kg	2085 Kg	2188 Kg
Manual	1990 Kg	Not Available	Not Available

General			
	X5 3.0i	X5 4.4i	X5 4.6is
Fuel	92I	92I	92I
Drag Coefficient	0.35	0.36	0.38
Payload	610 kg	555 kg	N/A
Roof Load	150 kg	150 kg	150 kg
Gross Weight Manual Trans.	2600 kg	Not Available	N/A
Gross Weight Auto Trans.	2625kg	2650kg	N/A
Cargo Volume	16.1/54.4 cu ft.	16.1/54,4 cu ft.	16.1/54,4 cu ft.
Towed Weight Braked Manual	1600 kg	Not Available	N/A
Towed Weight Braked Automatic	1700 kg	750 kg	N/A
Turning Circle	39.7 ft.	39.7 ft.	39.7 ft.

Hood/Front Grille

The hood on the X5 is distinctive, with two IHKA air intake hood scopes in the center leading down to the traditional BMW twin grilles.

Workshop Hint:
Hood prop tool number 90 88 6 512 170

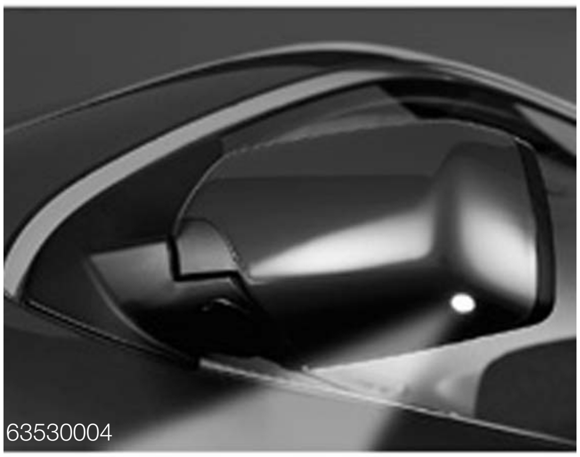
Hood Scoops

The grilles are integrated into the hood with the secondary hood latch springing out from the grille when the hood is opened.

The four round headlights complete the front end with Xenon low beans as an option for the X5. The fog lights as well as the headlight washers are integrated into the bumper.

Doors/Mirrors

The doors on the X5 incorporate side bars which serve as side impact protection without the use of the metal hooks found on the sedans. The mirrors are aero style that includes cascade lighting at the bottom of the mirror for vehicle entry at night. The lights are switched on when the vehicle is unlocked to light the ground around the door. The cascade lighting is optional. Control relay for the cascade lighting is located in the electrical carrier above the glove box.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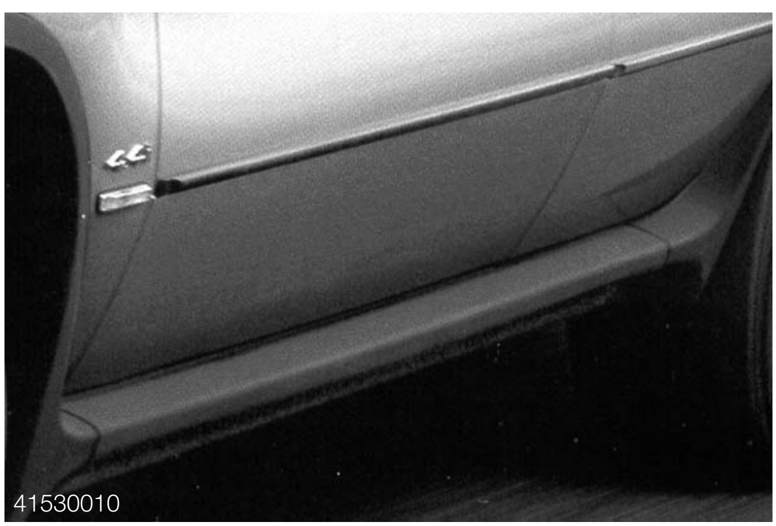
Running boards, integrated into the rocker panels, provide ease of entry on the left and right sides.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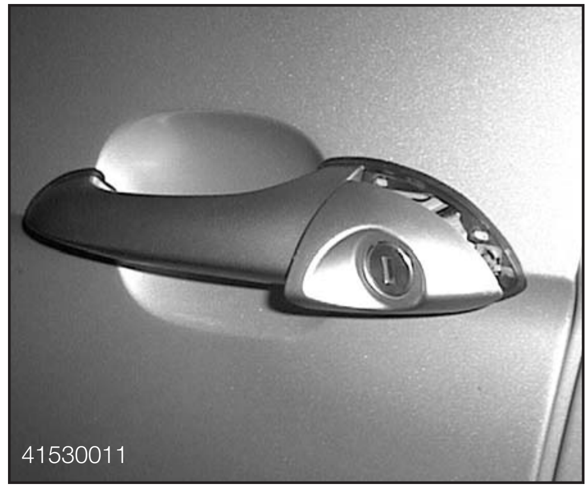
Door Handle

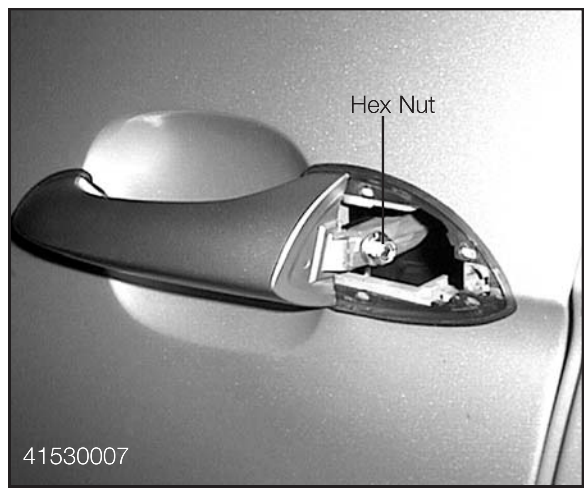
The door handles are similar in design to the E46 and pull out and upward for opening. Removal of the handles is also similar to the E46.

There are no serviceable components on the lock/latch. The assembly must be replaced as a unit.

The lock cylinder is removed by removing the torx screw through the access hole in the door. Once the screw is removed, the lock cylinder can be pushed out of the handle assembly.



The handle is removed by loosening the hex nut holding the handle to the latch mechanism.



The handle is then removed by pulling it out and down to release it from the latch. The handle is turned down to the left to release it from the door latch assembly.

Interior/Seats

The instrument cluster and dashboard layout is similar to other BMW models with all of the controls in easy reach of the driver. The instrument cluster variations (high and base) are taken from the E39 as are all driver information electronic systems.

High Cluster

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Base Cluster

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The center console contains the radio or navigation system and the climate control panel along with the central switch panel (SZM).

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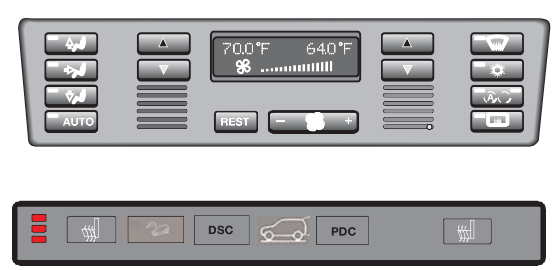

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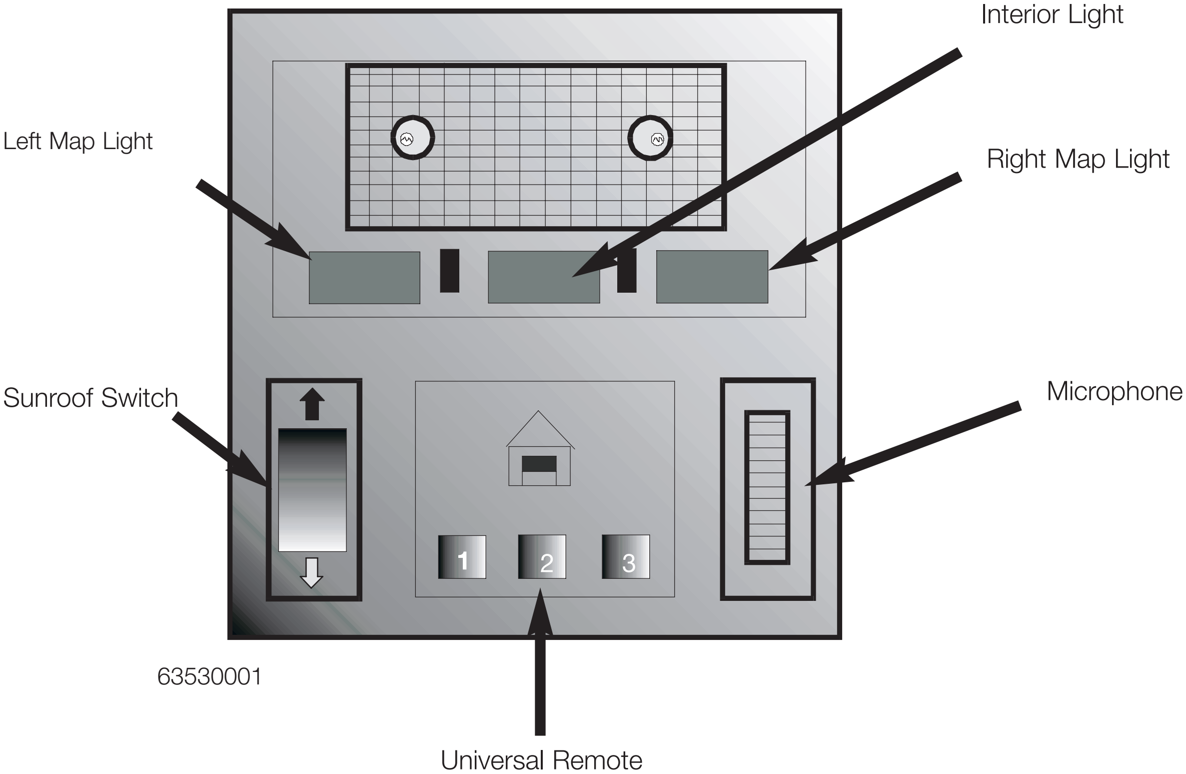
Interior

Located above the windshield in the center is the overhead console that contains the universal remote switch panel, interior lighting/map panel, sunroof switch and grille for the telephone hands-free microphone. The light panel contains a single bulb which is controlled by the ZKE, as well as two map reading lamps. The switch provides a ground signal which the GM recognizes as a request to either turn the interior lights on or off. If the switch is held > 3 seconds, the lights are switched off in the work shop mode as on other models.



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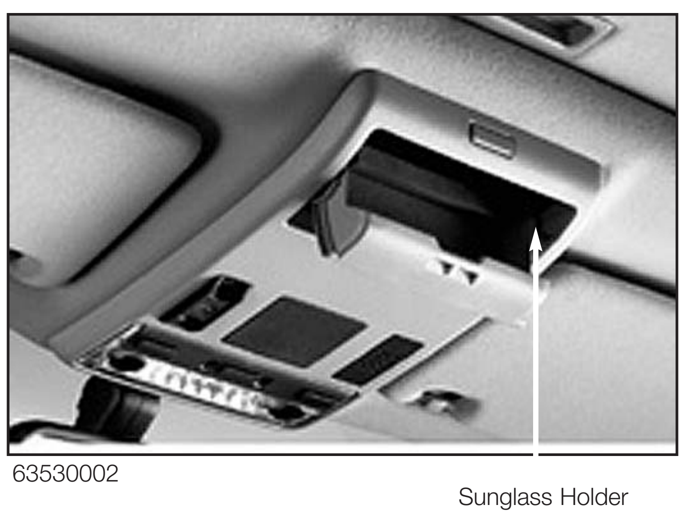
Incorporated into the overhead console, behind the universal remote switch, is a sunglass storage compartment



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Interior/Seats

Two interior seat options (comfort and sport) are available for the X5. The seats are mounted high in the cabin for good visibility and offer 8-way power, memory adjustments with lumber support. The seat/mirror memory control module and switch assembly is located on the side of the driver's seat.

Rear Seats

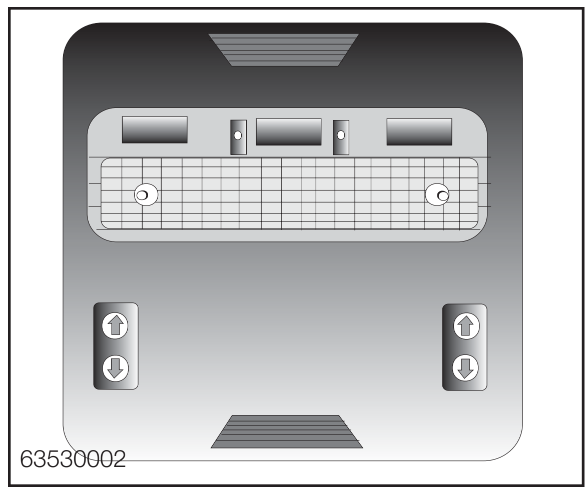
The rear seating area on the X5 offers 1472mm width and 977mm of head room for comfortable seating for the rear passengers. Rear cup holders are installed in the center console below the IHKA outlet grilles which incorporates a separate blower fan for the rear seating area.

The rear seats have a 60/40 split with the fold down center arm rest on the left seat back. The center arm rest also includes the optional folding ski bag.

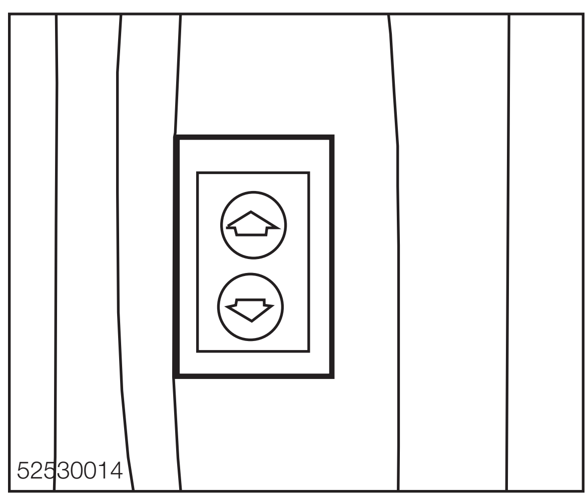
Rear Seat Backrest Adjustment

Electric rear seat backrest adjustment is available on the X5 as optional equipment. Each backrest can be adjusted individually up to 20 degrees. the backrest adjustment option consists of the following:

- Left/Right adjusting motors with gear drive and seat back hooks - located behind the seat backs on the shock towers. The rear seat backs lock into the “D” shaped hooks on the backrest adjustment linkage.



- Left/Right adjusting switches - located in the interior light housing in the head-liner panel.

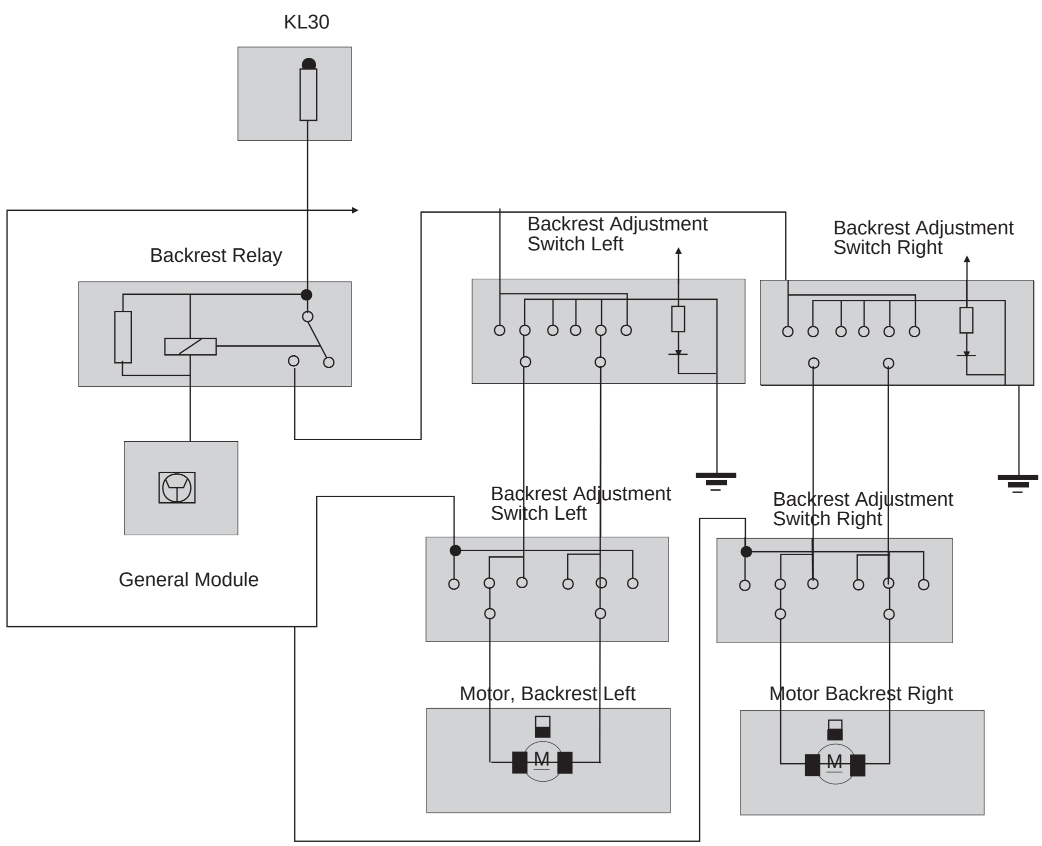


- Left/Right adjusting switches - located in the rear on the left and right sides of the “D” pillar behind the upper tailgate.

System Operation

The seat backs are adjusted from the two different locations as follows:

- The switches in the interior light housing receive operating power through the seat back relay when the ignition is switched on KL 15. The GM controls the operation of the relay and the switches provide the ground.
- The switches in the "D" pillar receive KL 30 and allow seat back adjustment whenever the rear tailgate is opened to gain access to the switches.
- The adjustment motors receive power and ground directly from the switches.



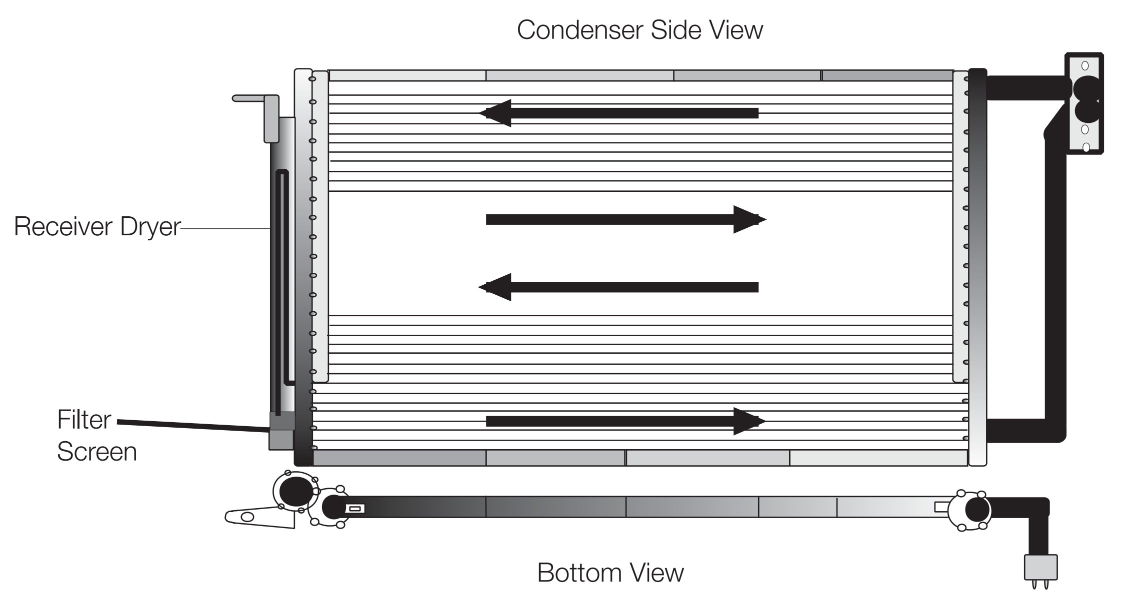
Climate Control Systems (IHKR/IHKA)

Two climate control systems are offered on the X5, the manual IHKR system is standard equipment on the 3 liter X5 and the IHKA system is available as an option. The IHKR is a new system for US production and the IHKA is taken from the E39 vehicles.

Condenser/Receiver Dryer

The X5 incorporates a new design air conditioning condenser/receiver dryer for both the manual (IHKR) and the automatic (IHKA) systems. The dryer cartridge and condenser are one component with the dryer integrated on the left side. The dryer cartridge contains a replaceable filter screen and dryer unit.

The condenser is partitioned which divides the condenser into cooling sections. The hot refrigerant flows across the condenser and into the dryer through inlet holes at the lower 1/3 section of the cooling fins. After the refrigerant passes through the dryer it returns to the evaporator through the outlet hole and bottom 1/3 section of the condenser.



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Climate Control System (IHKR)

The manual system is controlled through the use of bowden cables for air distribution and electronic control for temperature regulation and blower speed. One stepper motor is used for the fresh/recirculated air intake.

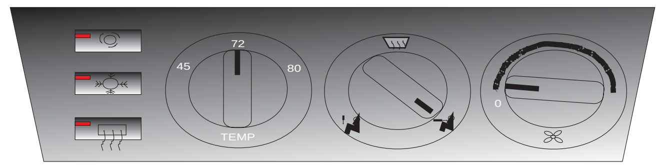
The IHKR incorporates the following features:

- Fresh air intake grilles integrated into the hood - the fresh air passes through the single micro filter installed in the center of front bulkhead.

The air then passes through the air duct, which is bolted to the bulkhead, and enters the heater - A/C unit through the non-return flaps.

IHKR Control Unit

- Integrated control module with operating panel.



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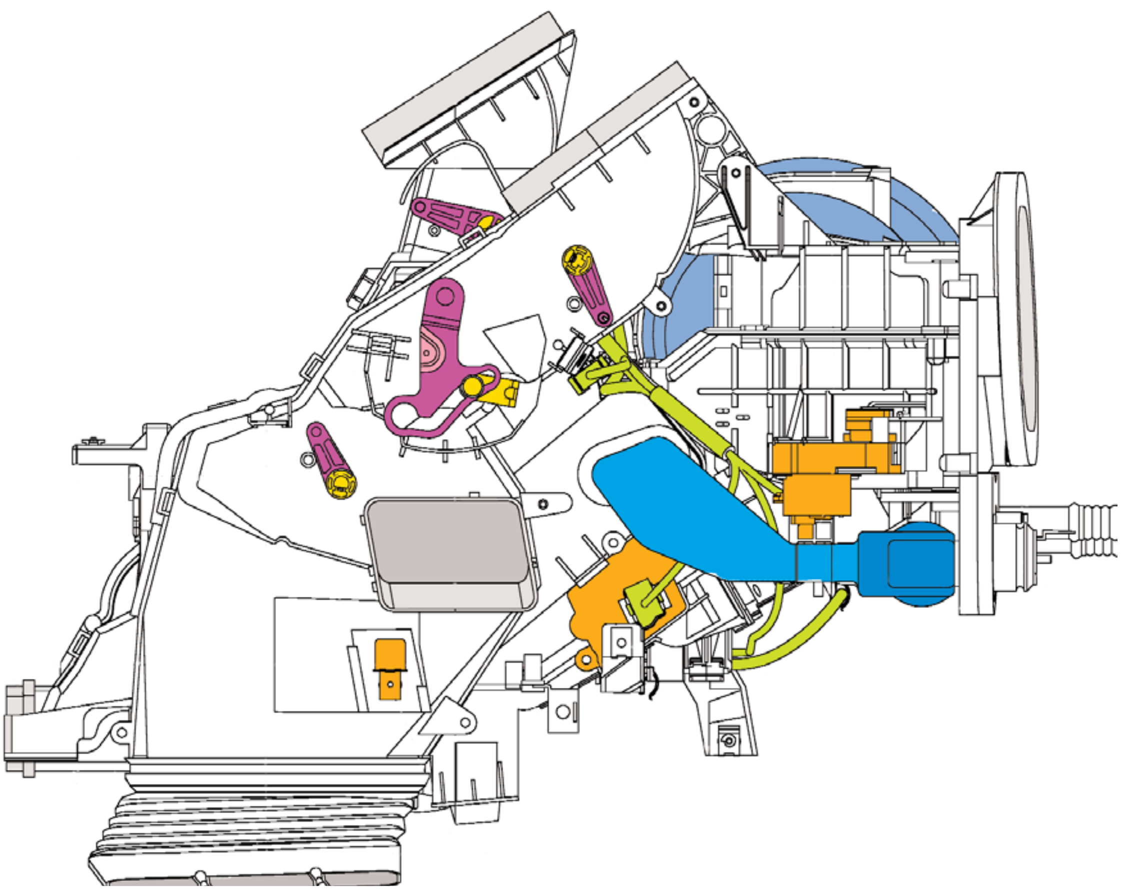
- IHKR heater/air conditioner unit with
  - 1 heat exchanger temperature sensor
  - 1 evaporator temperature sensor
  - 1 footwell temperature sensor
  - Blower motor
  - 1 stepper motor (high speed fresh/rcirc air)



IHKR Operation

IHKR system operation is as follows:

- Temperature Control - The desired interior temperature is set with the rotary knob on the control panel. Control of the interior temperature is carried out electronically by the control module's cycling of the water valve to regulate coolant flow through the heat exchanger.

- Air Distribution - Air distribution is set mechanically through the use of gear linkages and bowden cables. The air can be set for:

  - Footwell or blended between footwell/face vent or footwell and defrost
  - Defrost or blended between footwell/defrost or defrost/face vent
  - Face vent or blended between face vent/footwell or face vent/defrost

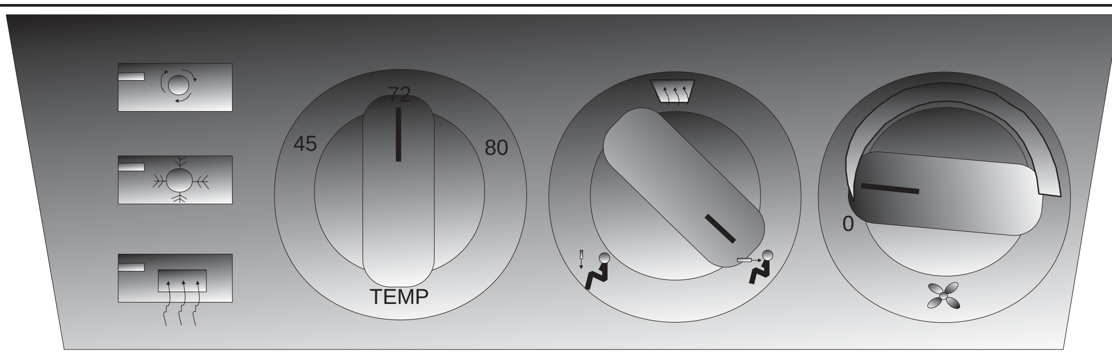
- Blower Control - Blower fan speed is controlled through a final stage with infinitely variable speed control.

  The push buttons on the control panel are used to:

- Switch between fresh air and recirculating air inlet modes

- Request for A/C activation

- Activation of the rear window defogger



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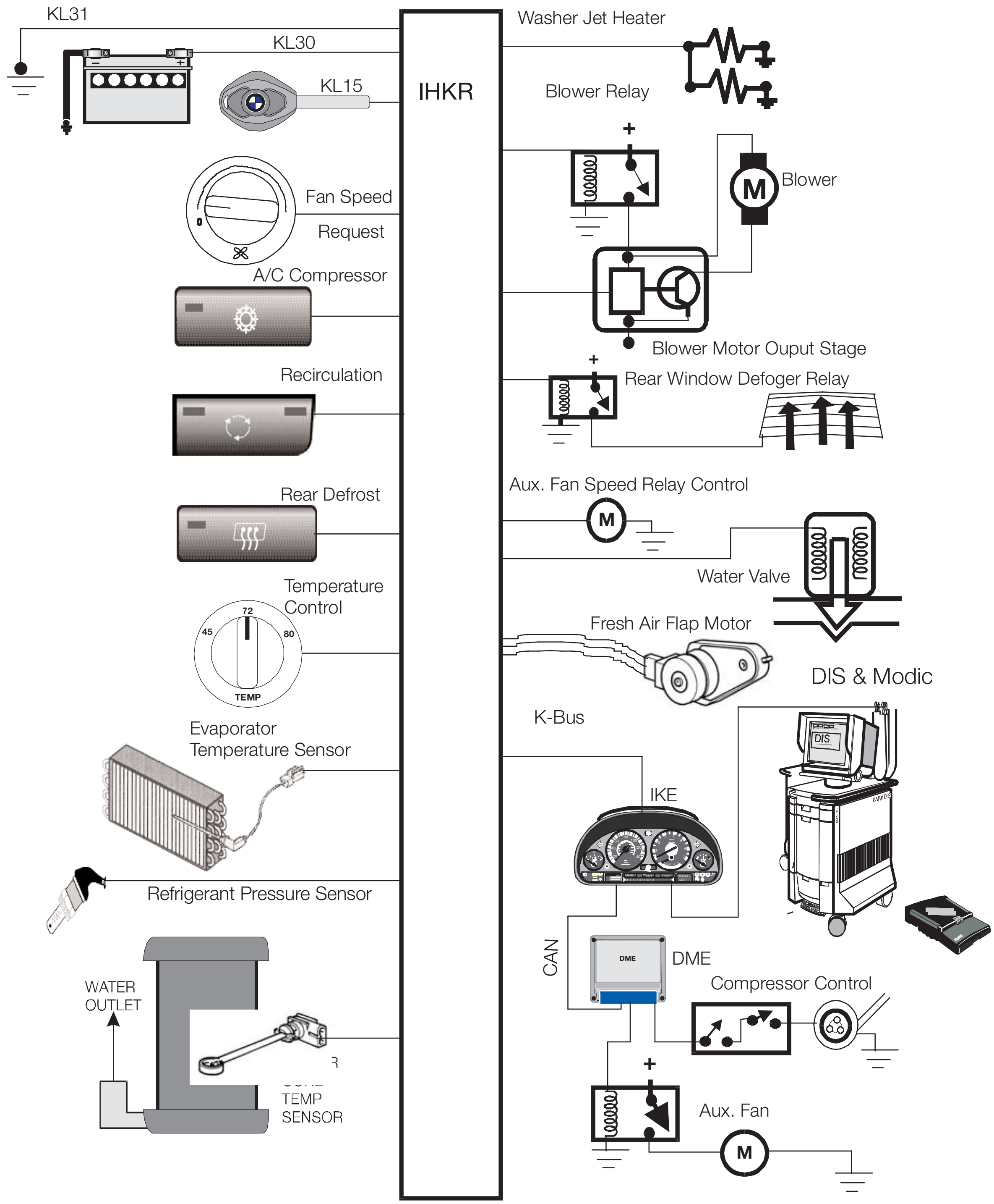
IHKR IPO



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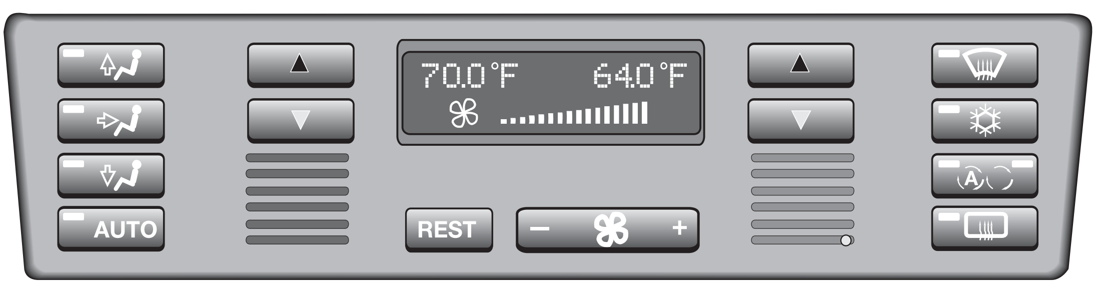
Climate Control System (IHKA)

The IHKA is standard equipment on the X5 with the M62 engine and optional equipment on the M54 version. The IHKA system is taken from the E39 sedan and includes all functions and features of the IHKA currently installed in the E39.

Features of the IHKA system include:

- Integrated control panel/module.
- Separate temperature control for the driver and front passenger.
- Air flap control through the use of bussed stepper motors.
- Automatic Recirculation Control (AUC).
- Recirculation air flap control from the MFL.
- "REST" function for residual heat when vehicle is stopped.
- Service station feature that closes the water valves when stopped to prevent hot water circulating into the heater cores.
- A/C compressor clutch activation through a final stage control.
- Center face vent stratification control through a bowden cable.
- Separate blower motor for rear passenger compartment



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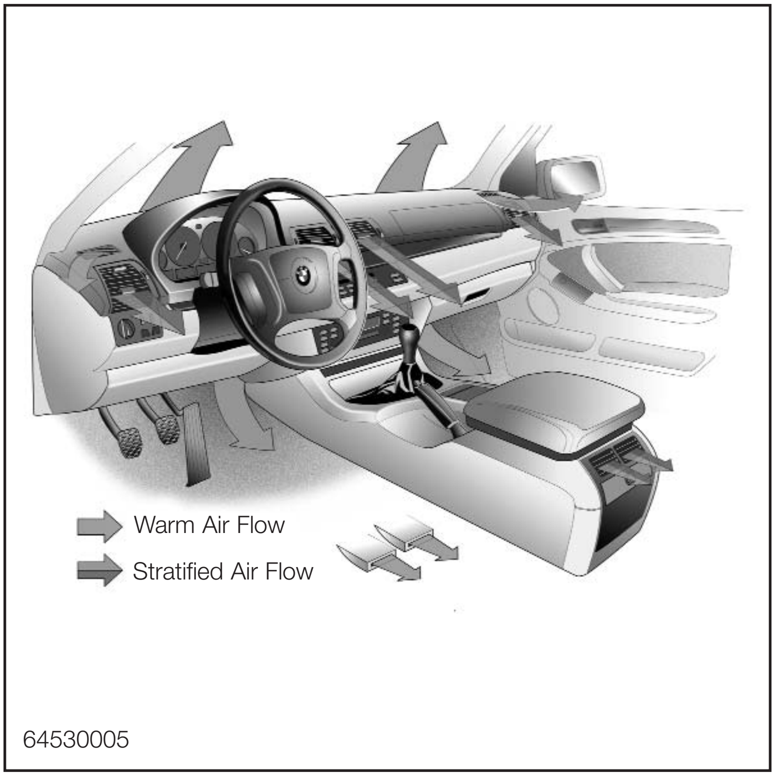
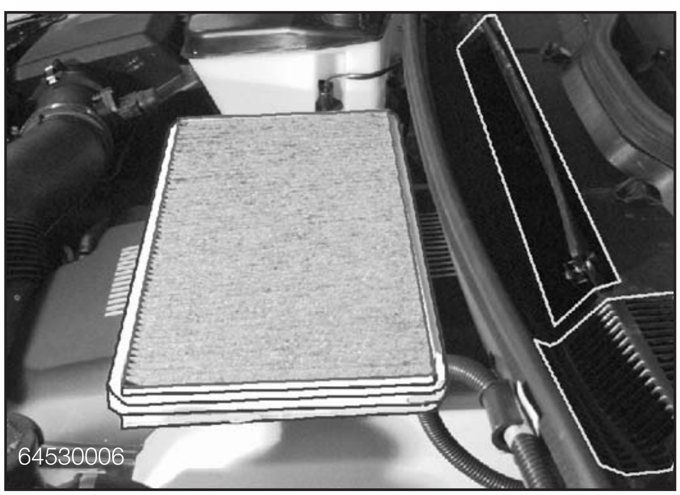
The rear blower motor is located below the center storage box behind the center air outlet grilles. The blower speed control is mounted in the panel below the outlets. Cool or stratified air is available at the center outlets.

IHKA Air Flow

The micro filter for the IHKA system is installed in the engine compartment in the center of the engine bulkhead.





Cargo Area

The cargo area of the X5 offers 450 liters/15.9 cuft of space and has a load capacity of 440 pounds. The retractable, removable cargo cover is standard equipment. Storage compartments are located on the left and right sides in the rear.

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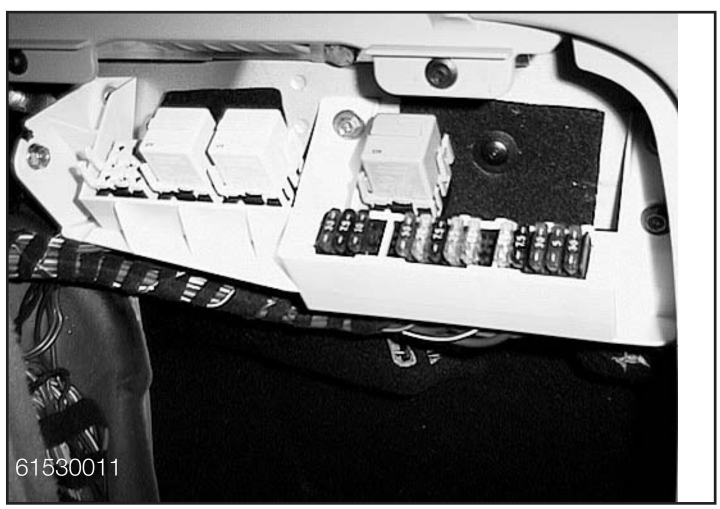
The left side storage compartment contains the NAV computer when installed and the telephone transceiver and CD changer.

The right side storage compartment contains the rear power distribution fuse box as well as the sub-woofer for the stereo system. Mounted in front of the right side storage compartment are two 12 volt accessory power sockets.



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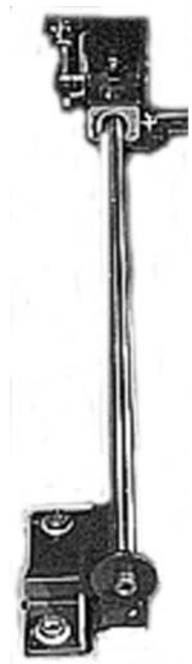
Cargo Area

The sliding load floor is available as an option on the X5. It is mounted through two sliding bushing on two steel rails



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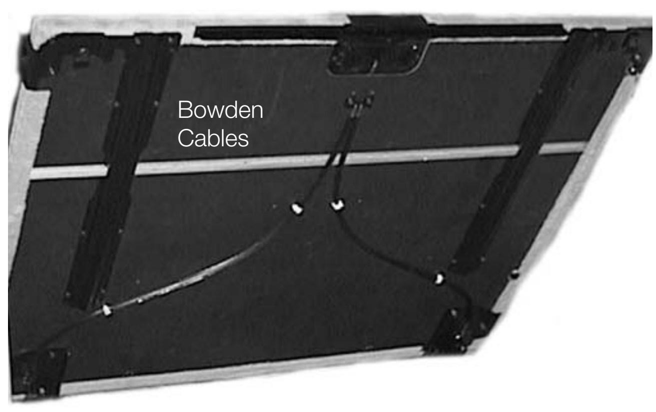
The load floor is held in position by the locking bowden cable mechanism that latches when closed to prevent the floor for sliding while the vehicle is moving. The load floor incorporates a shear point that will cause the floor to collapse upward in a rear collision.



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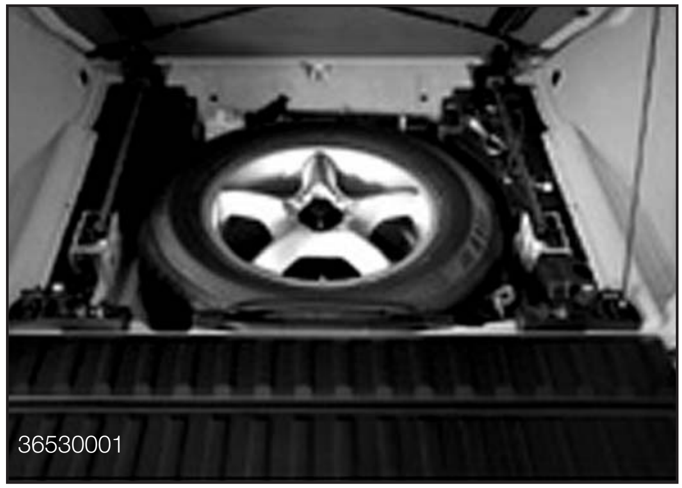
Cargo Area

The full size spare tire is mounted below the load floor with the LVA air supply system for the air springs located beneath the spare.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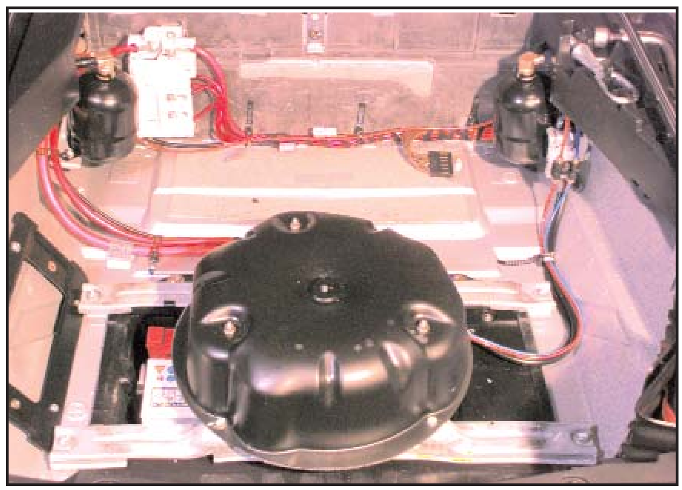
The battery is mounted below the LVA in a molded plastic battery box, along with the EHC control module and the PDC control module. If the optional trailer towing package is installed, the trailer module is also installed in the module carrier.

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Tailgate

The tailgate on the X5 is two sections that open up and down. The upper section has a fixed bonded rear glass that incorporates the rear window wiper and motor assembly. Two gas strut pistons are used on the upper section for opening. An electric actuator is incorporated in the upper section with the micro switch for operation located between the two license plate lights. The actuator locks into the lower tailgate section when closed.

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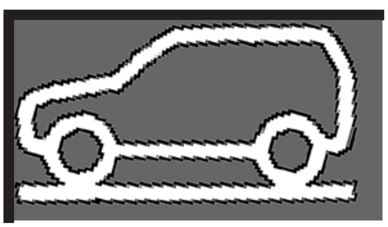


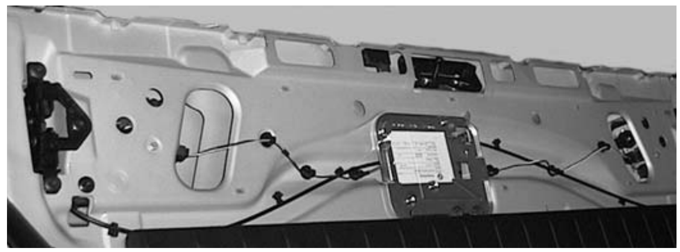
A micro-switch positioned in the center console switch panel is used to open the tail gate from inside the vehicle.

Operation of the upper tail gate is controlled from the GM which locks the operation of the gate when the vehicle speed is over 5 MPH. A dealer installed class three trailer hitch is available as an option with a towing capacity of 6000 pounds.

00530016

Tailgate

The lower tailgate section also uses an electric actuator for its operation. The actuator is positioned in the center of the tailgate and operates two latches though bowden cables. The latches are positioned on the left and right sides of the tailgate. Two springs are used to dampen the operation of the lower tailgate section.



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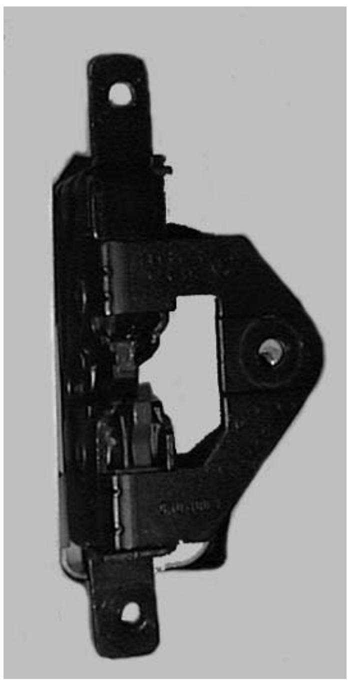

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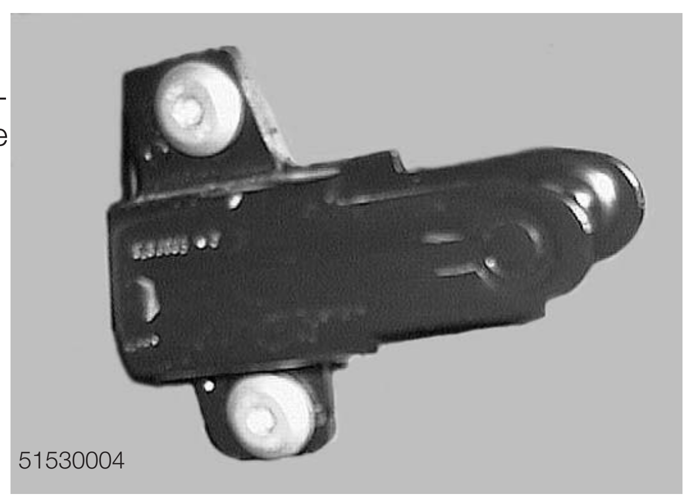
Adjustments of the rear tailgate are carried out at the tailgate body latch on the left and right sides.



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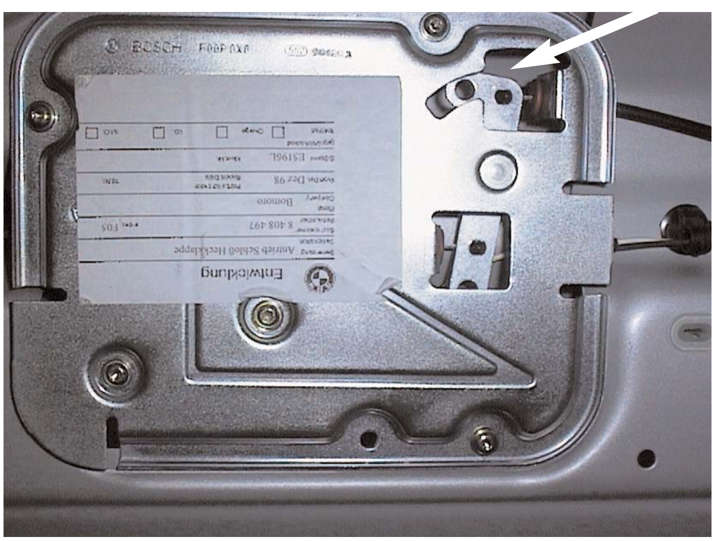
Tailgate (Emergency Opening)

Both sections of the tailgate incorporate emergency release mechanisms for opening the tailgate in the event of electrical or component failures.

The upper tailgate release is a plastic pull tab positioned on the right side of the inner trim cover. Pulling the release tab will mechanically release the upper actuator.

The lower tailgate emergency release is accessed by removing the trim cover on the tailgate section. With the gate closed, only the top section will be able to be loosened. The mechanical release is actuated by inserting a small screwdriver into the opening and pressing the latch to the left.

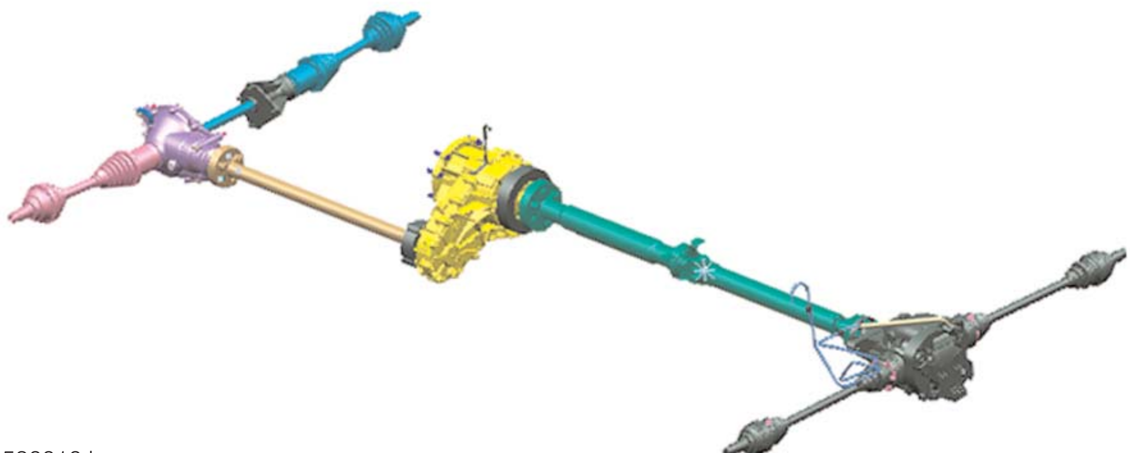
Emergency Release



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.



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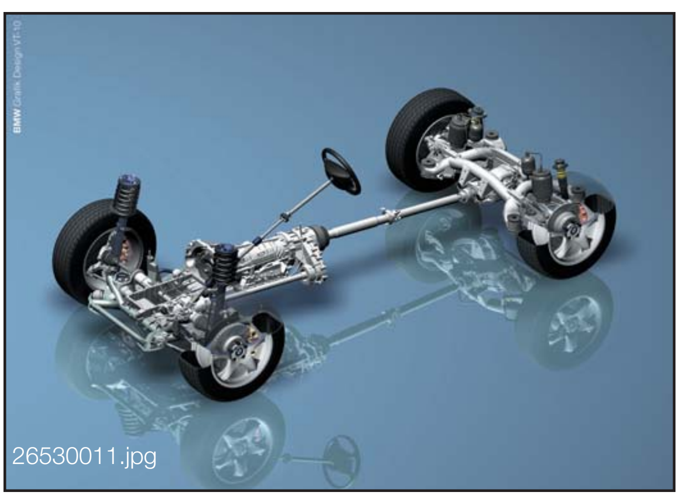
The breather vents for both differentials and the transfer case are mounted higher up on the chassis to prevent water from entering if the vehicle is driven off road through water. The front breather passes up into the engine compartment and is mounted under the left side ignition coil cover. The rear 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.



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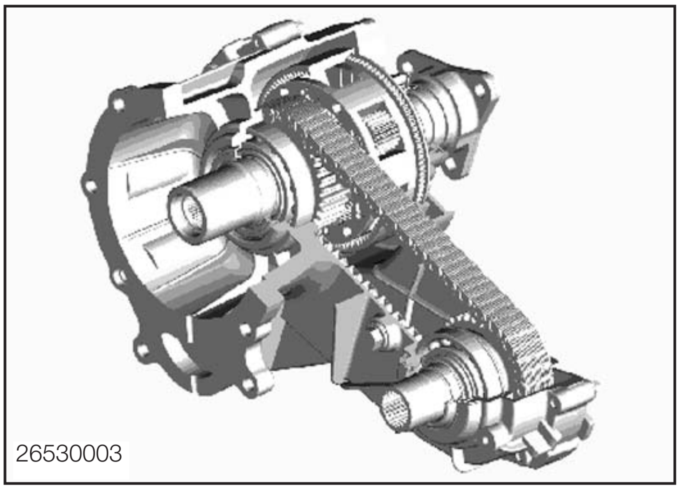
Drivetrain-Transfer Case

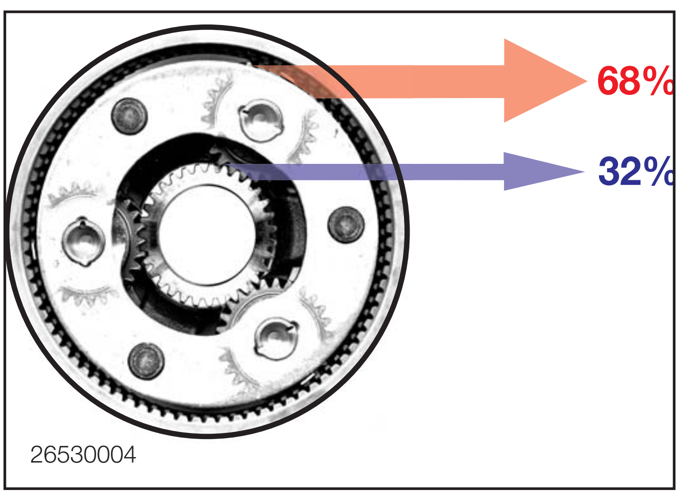
The transfer case is manufactured by New Process Gear Division of New Venture Gear Company. It is identified as model NV 125.

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.



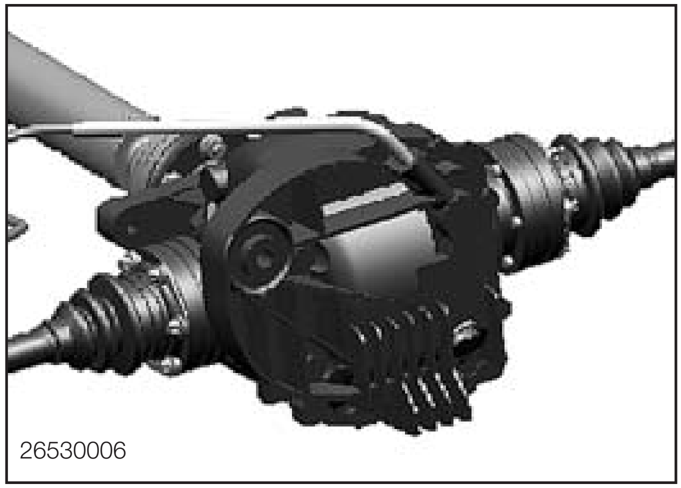
A torque split of 68% rear/ 32% front is provided through the gearing of the planetary set.



Drivetrain-Final Drives

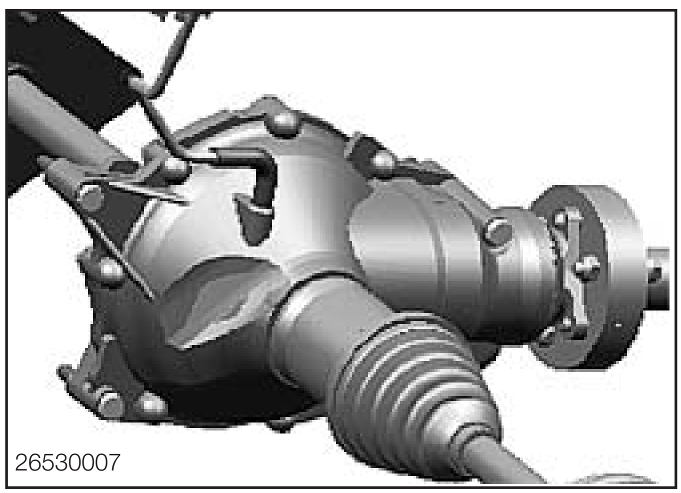
The final drives for the front and rear axles are conventional differentials. The DSC system provides anti-spin/slip control for both the front and rear axles on the X5.

The rear differential is the HAG 188K (compact) unit with a ratio of 3.64 : 1



26530006

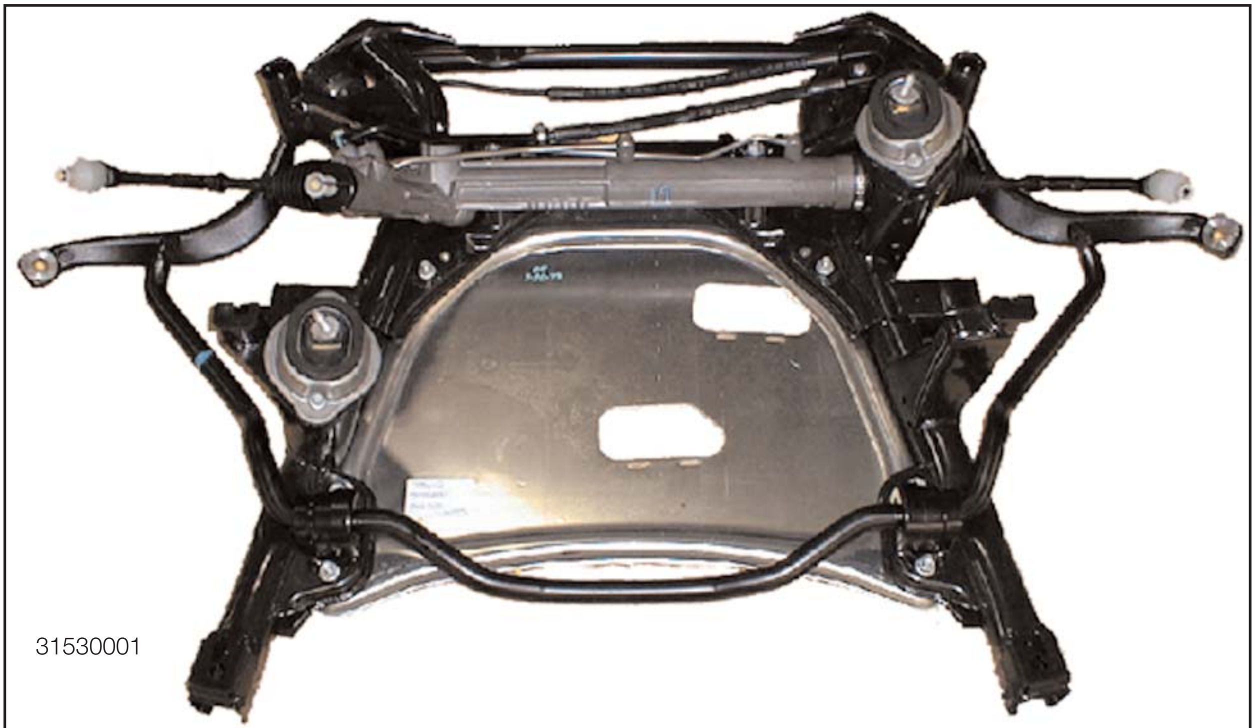
The front differential is the VAG 174 unit with a ratio of 3.64 : 1.



26530007

Front Suspension

The front suspension design is taken from the E38/E39 double pivot system. The components are larger in size and made from all steel for the expected harder use that the X5 suspension will receive. This includes the sub-frame which is also larger in size and supported by two hydraulic mounts for vibration absorbion. The front suspension carrier incorporates an aluminum stiffening plate that is bolted to the carrier. It adds to the front axle kinematics by reducing flex in the front suspension. It also provides protection for the oil pan and front end components when off-road and improves the Cd by providing a smooth surface for air flow under the vehicle.



31530001

Front Axle Technical Data
TRACK: 1576mm
TOE-IN: 18’ +/-10’
CAMBER: -12’ +/- 20’
S.A.I: 12 Degree’s 48 Feet
CASTER: 7 Degree’s 8 Feet

Front Suspension Alignment

The front suspension is adjustable for toe-in and camber. The camber correction is limited to +/- 12 minutes through the elongated slots at the top of the strut towers.

32530000

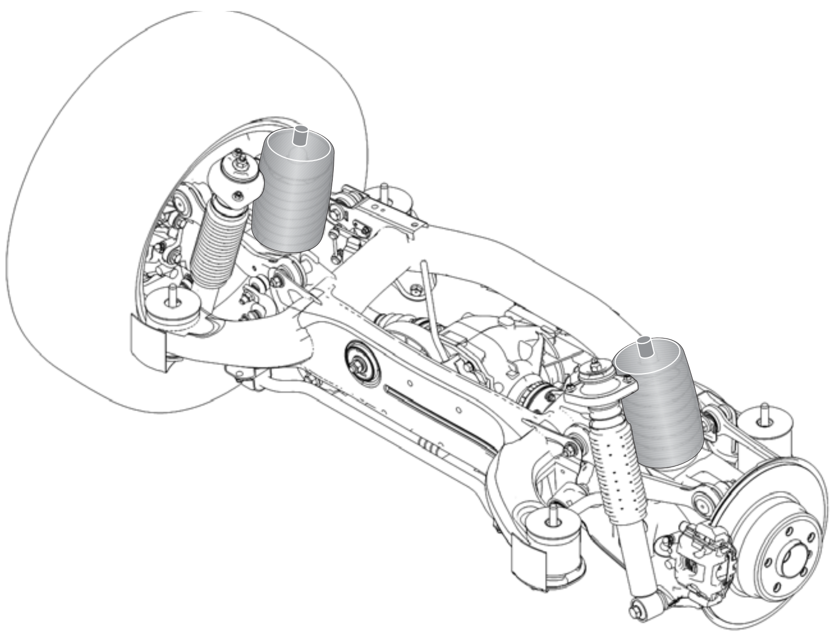
The locating pin at the strut mount is pressed in place and must be pried out for removal in order to make any camber corrections.

32530001

Rear Suspension

The rear suspension is the “intragal” multi-link design taken from the E38/E39 vehicles. Several components AER made from aluminum to erduce the unsprung weight. The X5 with the M62TU engine uses the EHC (air spring) suspension system. The EHC functions the same as the E39 Sport Wagon with only minor differences to the components and layout of the system. The X5 with the M54 engine will use standard springs in the rear with the EHC system as an option. The rear struts on the X5 are mounted to the body instead of the sub-frame.

The rear axle sub-frame is mounted to the body through four bushings (larger than E38) for increased load and comfort. The rear differential is mounted through three rubber bushings two in the front and one hydromount in the rear. The wheel bearings are similar to the E39 but incorporate different seals - designed for off-road use.



Rear Axle Technical Data
Track: 1576mm Toe In: 18 Feet Camber 1 Degree 50 Feet

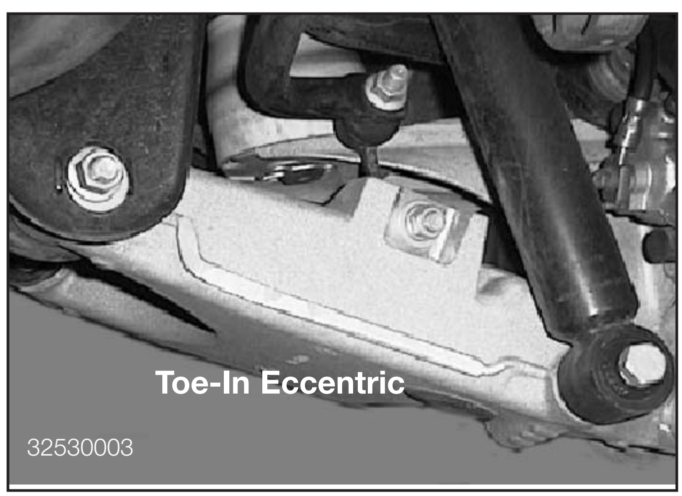
New special tools are available for adjusting the rear suspension due to the limited space.

Rear Suspension Alignment

As with other BMW multi-link suspensions, the X5 rear suspension is adjustable for Camber and Toe-in. Due to the limited space, special tools have been produced for aligning the rear suspension.

The Camber is adjusted through the eccentric bushings at the upper control link arm.

The toe-in is adjusted at the lower control arm mount.

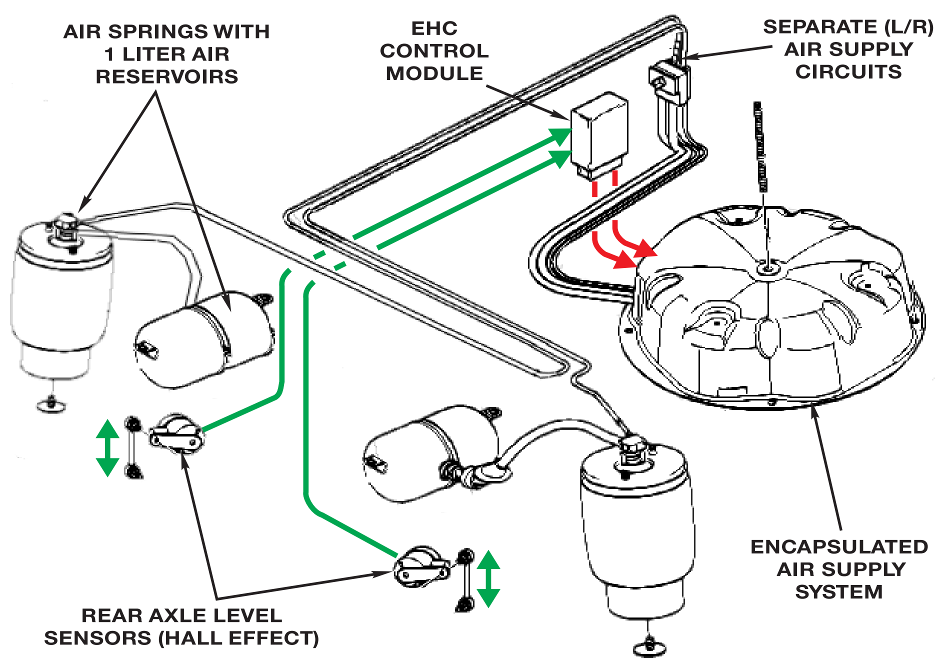


Overview of EHC Control System

The control philosophy of EHC is to "Initiate a control sequence only when necessary". The system offers the following advantages:

- The control system operates independently from the vehicle's engine (no engine driven hydraulic pump system as per previous self leveling systems).
- Individual control of the rear wheels is possible
- An uneven load is identified and compensated for
- Uneven road surfaces are identified and not compensated for
- Automatic control is interrupted when cornering
- The system is diagnosable using the DIS or MoDiC

The air suspension system consists of the following components:



37530000

EHC System Components

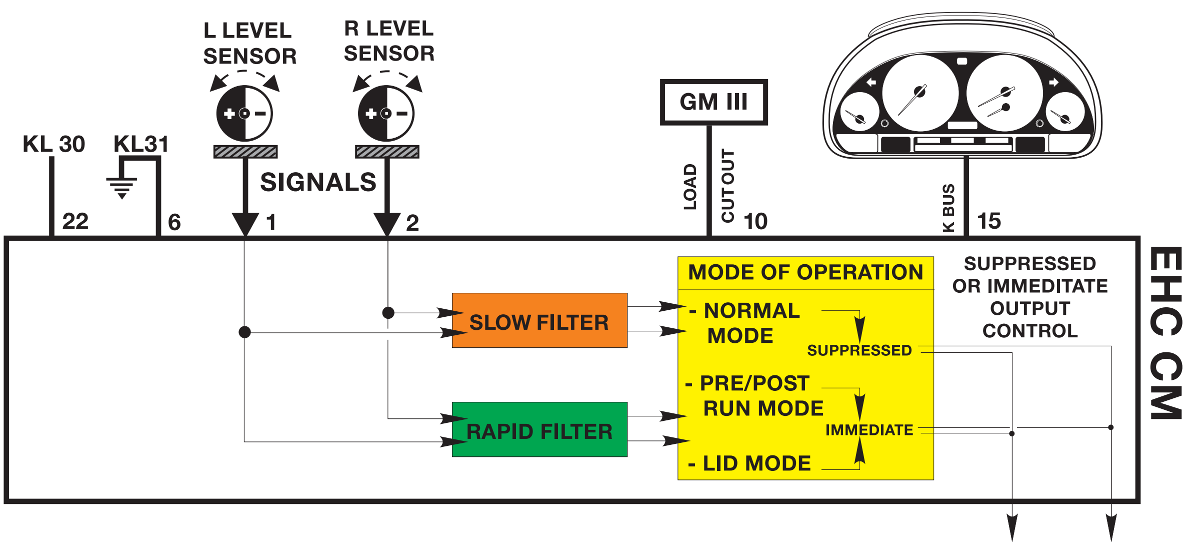
Control Module

The Control Module is mounted in the module carrier box in the luggage compartment on the right side. It contains the processing electronics and final stages for operation of the EHC system.

The control module receives the following inputs for its processing functions:

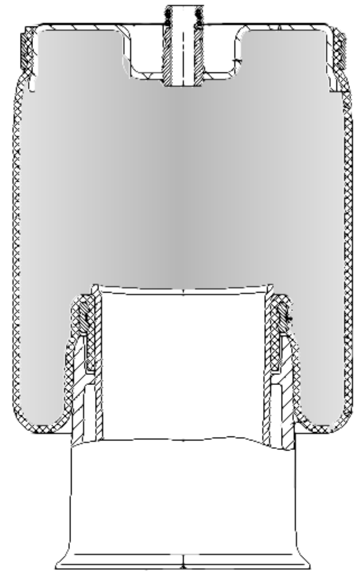
- KL 30 & 31 (Power/Ground)
- KL 15
- Left & Right Ride Height Sensors
- K Bus for;
  - Vehicle speed
  - Engine running
  - Door/tailgate - open/closed

The control module incorporates two filters (slow/rapid) for processing the input signals from the ride height sensors. Depending on the operating mode, either the slow or rapid filter is used to check the need for a regulating sequence.
The slow filter is used during the normal operation mode to prevent normal suspension travel from causing the system to make adjustments.



The rapid filter is used during the pre-run and tailgate (LID) modes to ensure that the suspension is adjusted quickly while the vehicle is being loaded or checked prior to operation.

Air Springs



The air spring is made from a flexible rubber material. It forms an air tight cavity which provides the calculated spring rate required for the sport wagon.

As the spring compresses downward the bottom edge of the rubber material rolls along the vertical surface of the base mount cylinder.

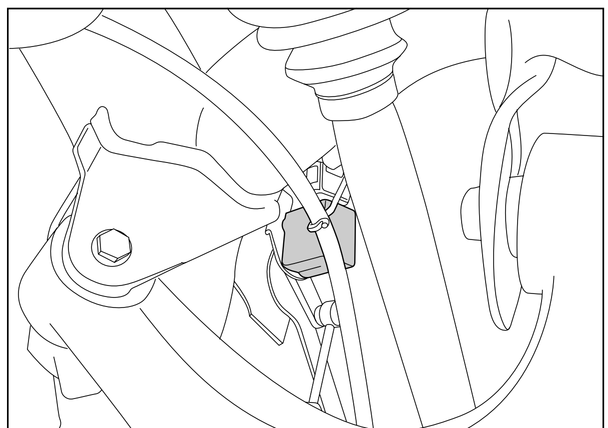
Air is added or removed from the air spring through its top port. The top port of each spring is connected to a reservoir and the air supply pipes. The reservoirs are required to hold additional air due to the compact design of the springs.

Rear Axle Level Sensors

Hall effect sensors are mounted on the left and right sides of the rear suspension for ride height detection. They are pivoted by a coupling rod through the rear axle swing arms.

The hall sensors produce a varying voltage input to the control module as the suspension height changes.

If the vehicle is equipped with Xenon headlights the right side sensor contains an additional sensor for the automatic headlight level adjustment system.

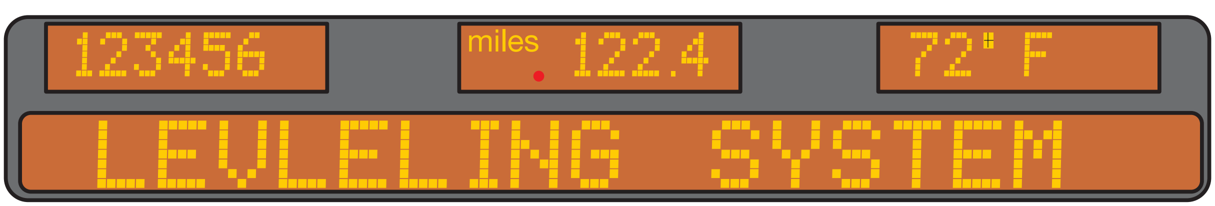


E39 Features 07

Warning Display

If the system is faulted and off-line or set in the transport mode, the following is displayed:

High Cluster: A message is posted in the high cluster matrix display.

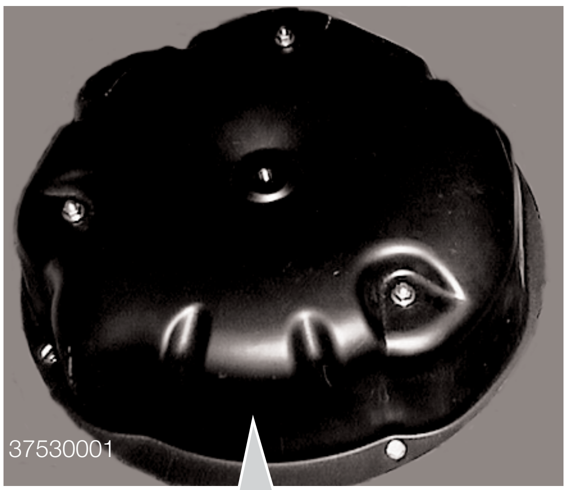


Air Supply System (LVA)

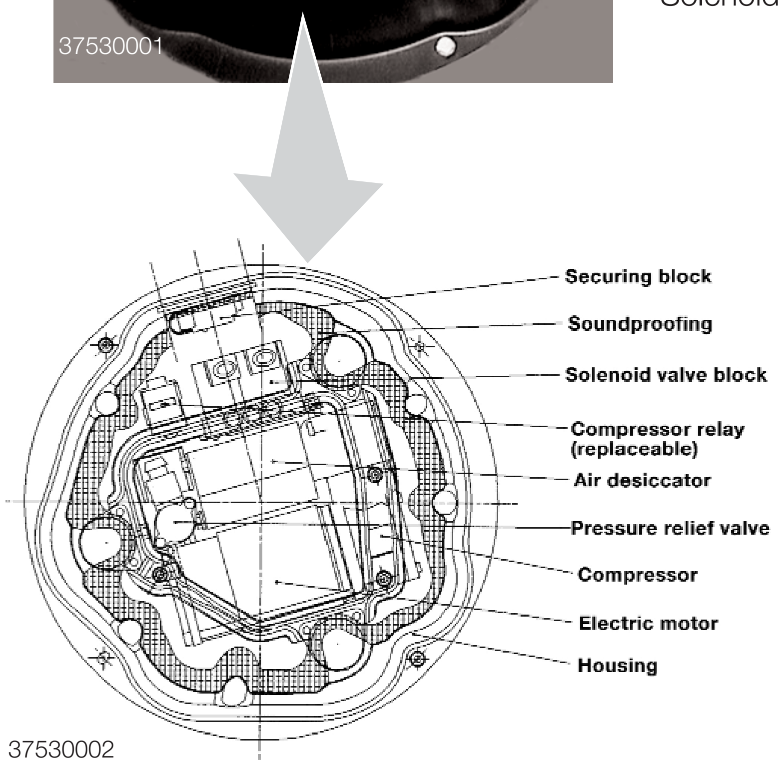
The air supply system is identified as the LVA in the diagnosis program and in the repair manual. It is mounted in the spare tire well compartment. The components are housed in a sound deadening carrier, through rubber bushings, to prevent operating noises from being transmitted through the vehicle's interior.

With the exception of the compressor relay, individual replacement parts for the air supply system are not available. If diagnosis determines a defect in any of the other air system components, complete replacement is necessary.

The air supply system consists of the following components:


37530001

- Compressor assembly with;
  - Piston compressor
  - Electric motor
  - Air dryer (desiccator)
  - Pressure relief solenoid valve
  - Pressure maintenance valve
  - Check valves
- Compressor Relay (Replaceable)
- Solenoid Valve Block (2 - two way valves)



37530002

Air Supply System (LVA) Operation

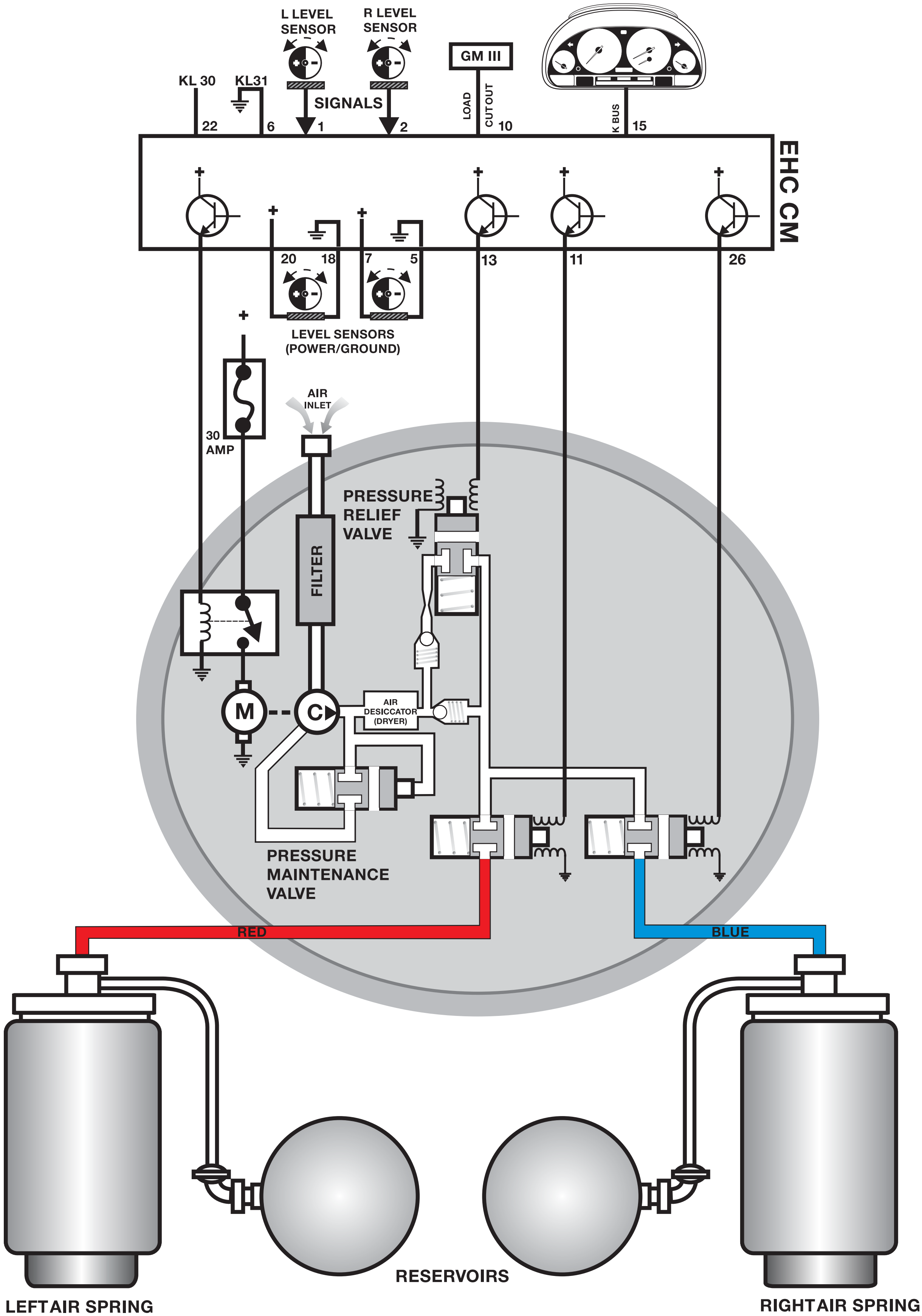
The single stage piston compressor produces a maximum pressure of 13.5 Bar. The compressor is maintenance free - provided it is used in a dust free environment. This includes the compressor's intake air filter.

The compressor is driven by a DC motor that is controlled by the compressor relay through the control module.

When the compressor is activated, the pressure builds up to a working pressure of 11.4 Bar (+0.8/-1.5 Bar). This is controlled through the pressure maintenance valve. The air under pressure is fed through the dryer and check valve to the solenoid valve block for the air springs.

There is one solenoid valve in the valve block for each air strut. This allows the system to compensate for uneven loads in the vehicle and maintain the vehicles ride height at all times.

Pressure is drained through the left or right solenoid valve (energized open) the pressure relief solenoid valve, restricter, check valve and dryer back to the inlet side of the compressor pump.


L LEVEL SENSOR
R LEVEL SENSOR
GM III
KL 30
KL31
SIGNALS
LOAD
CUTOUT
K BUS
22
6
1
2
10
15
EHC CM
20
18
7
5
13
11
26
LEVEL SENSORS (POWER/GROUND)
30 AMP
AIR INLET
FILTER
PRESSURE RELIEF VALVE
M
C
AIR DESICCATOR (DRYER)
PRESSURE MAINTENANCE VALVE
RED
BLUE
RESERVOIRS
LEFT AIR SPRING
RIGHT AIR SPRING

EHC System Operation

A fully functional EHC system is controlled by one of three different modes of operation. The operation mode is selected by the control module based on current conditions provided by the monitored input signals. The main modes of operation are:

- **Pre-Run/Post-Run Mode**
- **Normal Mode**
- **Tailgate Mode**

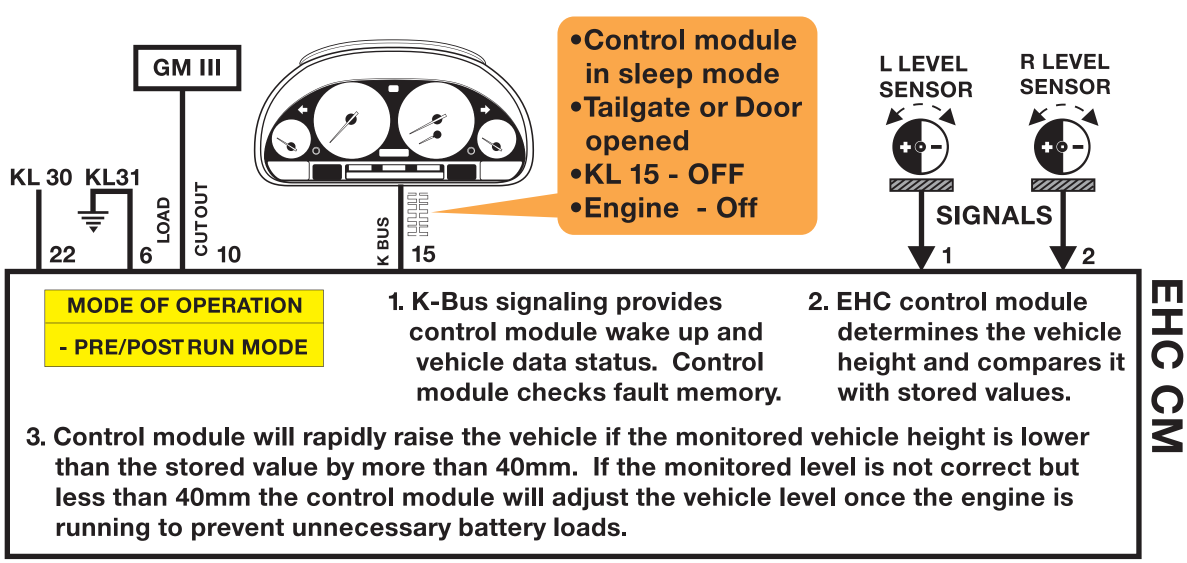
Two special operating modes are also included in the control module programming.

- **New/replacement mode** (pre ZCS encoded). This mode provides basic operation.
- **Transport Mode** - Transport mode is set at the factory and raises the vehicle 30mm to prevent vehicle damage during transportation. It must be deactivated with the DIS/ MoDiC prior to customer delivery.

Pre-Run/Post-Run Mode

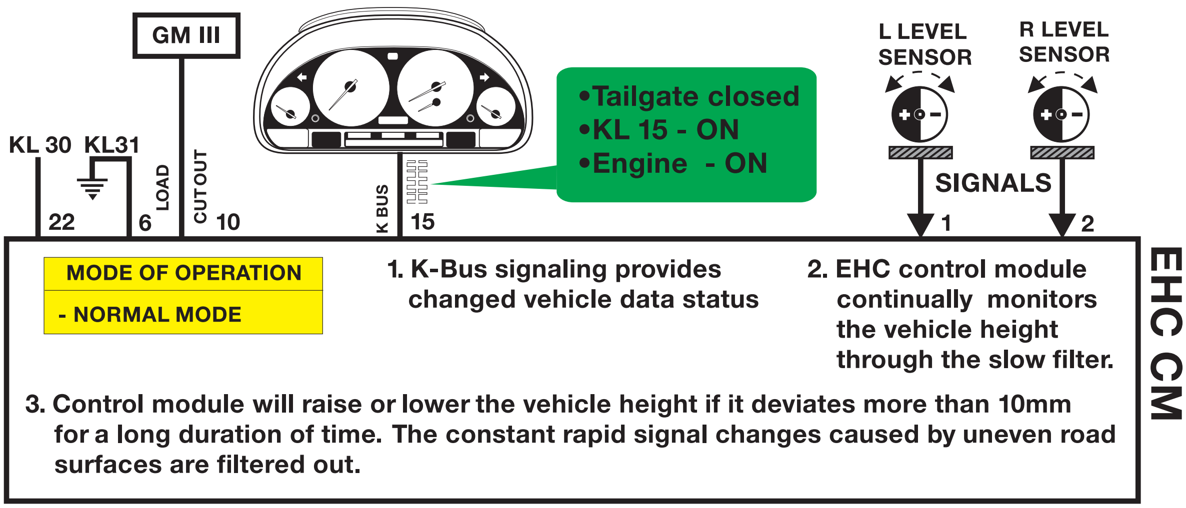
The Pre-Run mode is activated when the vehicle is parked and the control module is in the sleep mode. Opening a door or the tailgate initiates a system wake up and the control module comes on-line.

The control module performs a self-check of the control electronics and sensors. If no fault is found, the system will check the ride height and institute a rapid regulation if the height varies by more than 40mm.



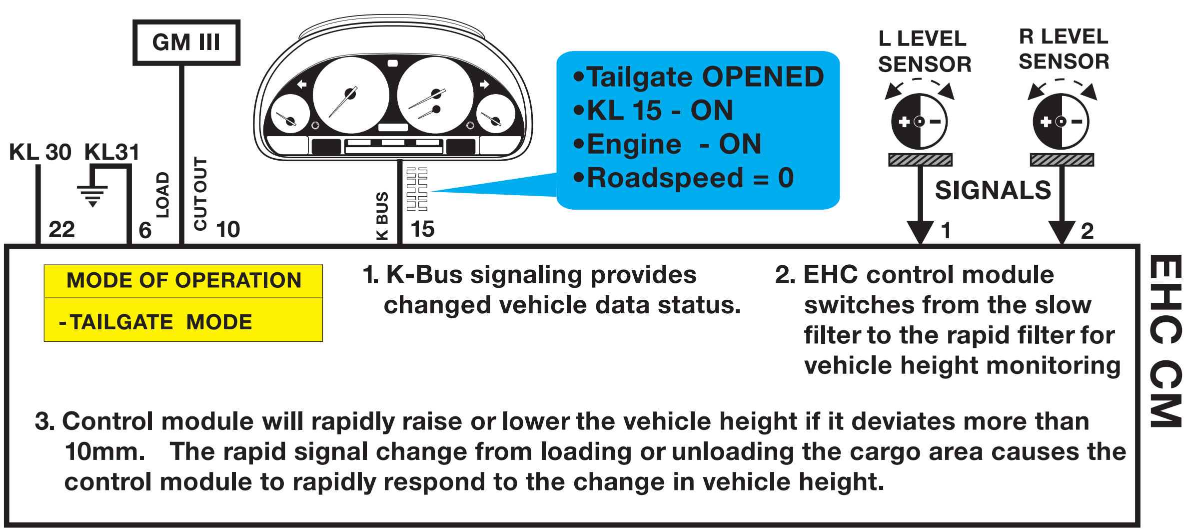
Normal Operation Mode

Once the rear lid is closed, KL 15 switched ON and the engine started, the system switches into the normal operation mode. In the normal mode, the control module will constantly monitor the input signals from the ride height sensors and will activate a correction if the ride height deviates by at least 10mm.



Tailgate Operating Mode

The tailgate operating mode is activated if the gate is opened with KL - 15 On and the engine running. The difference between this mode and the normal operating mode is the response time is rapid instead of slow .



Special Operation Mode

- Assembly Line Mode (New control module)

  The assembly line mode refers to control module manufacturing. New control modules are stored in a deactivated state. The control programming is not active and must first be ZCS encoded.

  After installing a replacement control module, it must be coded using the DIS or MoDiC. The instrument cluster fault display will remain illuminated until the control module is coded.

Control Interrupts

Cornering

To prevent unnecessary suspension adjustments while driving through corners, a “control interrupt” is built into the system. Above 30MPH the control module monitors the left/right ride height sensors for a difference of 30mm. Exceeding this difference will put the system into a control interrupt and no adjustment will take place. The control interrupt last for a duration of 5 minutes.

Vehicle Lifting

The ride height control is interrupted when the vehicle is raised on a lift or with a jack. The system monitors the ride height sensor inputs and when the height limit of 90 mm is exceeded, the control is switched OFF until the vehicle is lowered again.

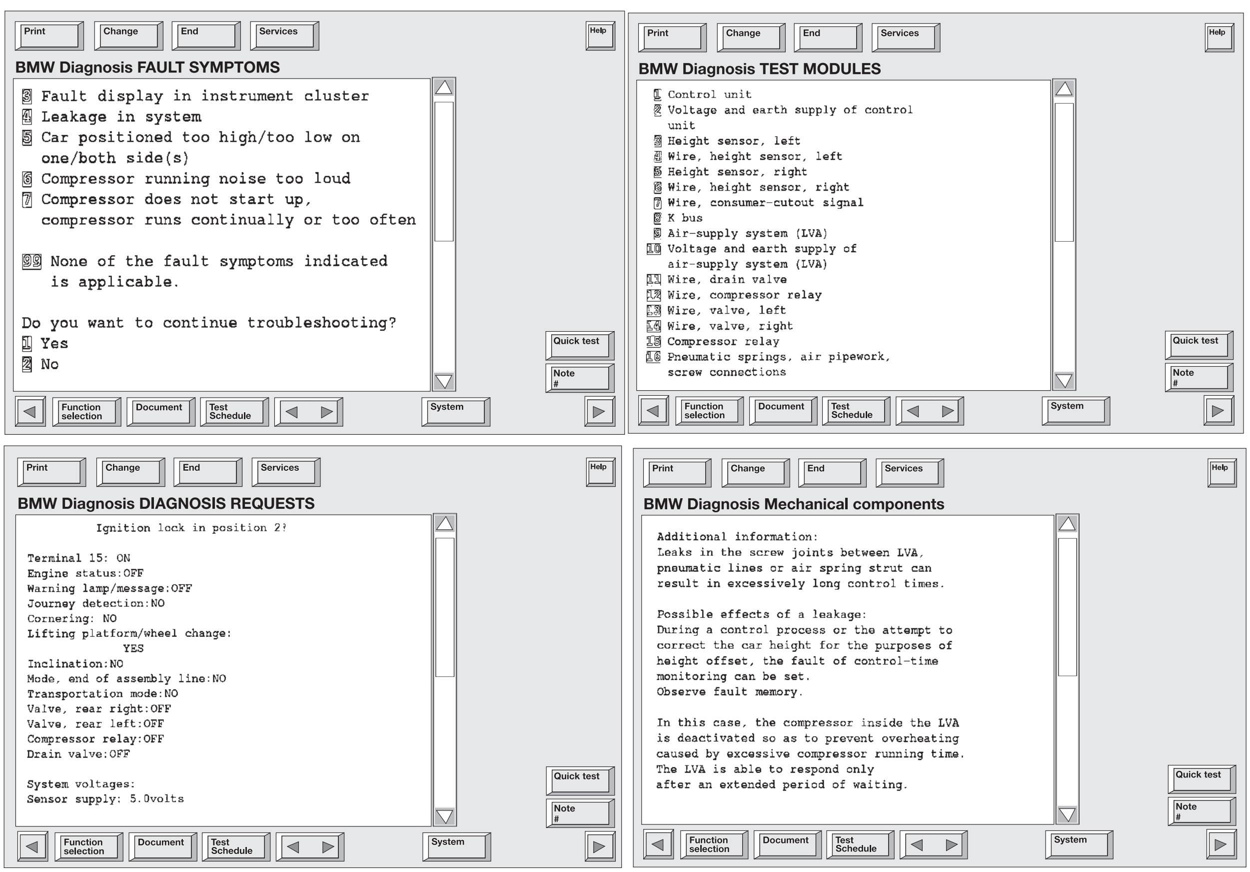
EHC Service Information

Diagnosis / Coding

- The EHC control module is connected to the diagnostic link. The EHC control module activates the fault display in the instrument cluster to alert the operator of the off-line status of the system. The EHC control module stores up to three electrical/electronic faults.

- Diagnosis/troubleshooting of EHC is carried out using the fault symptom troubleshooting program of the MoDiC or DIS. The EHC system has an extensive diagnosis program.

- Replacement control modules are shipped in the factory mode. The control modules must be ZCS encoded using the DIS or MoDiC to activate the operating parameters.



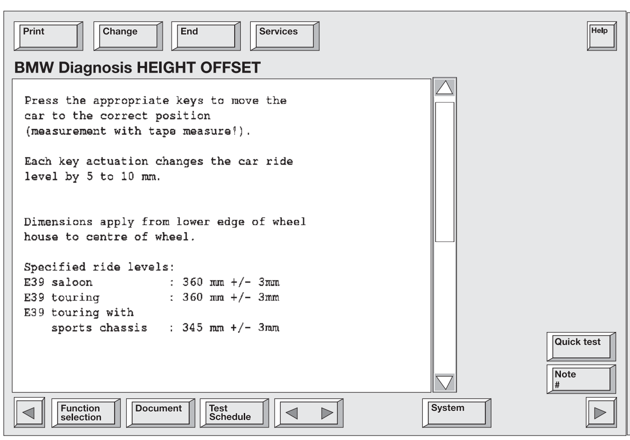
DIS/Modic Service Funnction Program

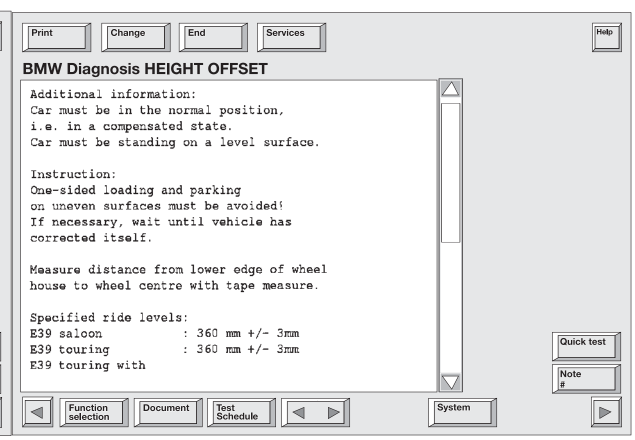
The Service Functions program of the DIS/MoDiC provides the Transport Mode activation/deactivation and Ride Height Offset functions (see next page).

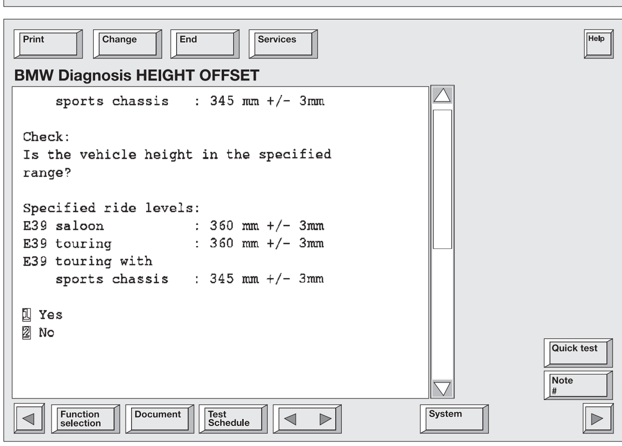
Once the transport mode has been released, or if the system requires left to right side height adjustment, the ride height "OFFSET" must be carried out to ensure that the vehicles suspension has a base ride height level starting point.

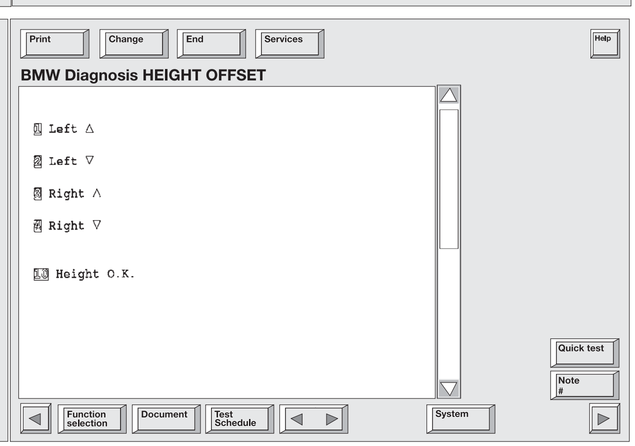
The "HEIGHT OFFSET" is adjusted using the DIS or MoDiC. The procedure is as follows:

- Place the vehicle on a level surface unloaded.
- Access the Height Offset program in the service function menu.
- Measure the base ride height from the lower edge of the wheel housing to the center of the wheel hub.
- Check measured height against the specifications listed
- Use the DIS/MoDiC to correct the ride height if the value differs from the listed specification.









Two Axle Air Suspension

Purpose of the System

The two axle air suspension system (EHC2) offers advantages over the single-axle air suspension with respect to ride comfort and off-road capability.
Lowering the entire body makes it easier to enter, exit, load and unload the vehicle.
The vehicle's off-road capability was improved by providing the possibility for increasing the ground clearance of the body.
The driver can now choose between three different ride levels which can be set with a rocker switch, as required. Automatic ride-height control for payload compensation and automatic inclination compensation continue to be fitted.

Deficits of the old system

The automatic payload compensation facility for the single-axle air suspension did not permit driver control. The driver could not actively control the system to make it easier to enter and exit or load the vehicle.
Ride level was compensated via the rear axle only.

Advantages of the new system

The new system allows the ride-height control system to be controlled actively by the driver.
The twin axle air suspension allows both axles to be lowered evenly and in parallel.
As a result, it is easier for the occupants to enter, exit, load and unload the vehicle.

History

BMW previously supplied ride-height control systems as both optional equipment and, in part, as standard equipment on the 7 Series - E23/E32(not in the US market), 6 Series - E24 (L6/M6) and 5 Series - E28 (M5). On the E39, the load of the complete rear axle was born for the first time by air suspension in combination with the optional ride height control system. The system was controlled automatically under all operation conditions, and there was no possibility for driver intervention on the X5, the rear axle previously had single axle air suspension only. The air supply unit and the control unit were adopted from the E39. The air springs were adapted to the X5.

There is a standard version and a sports version.

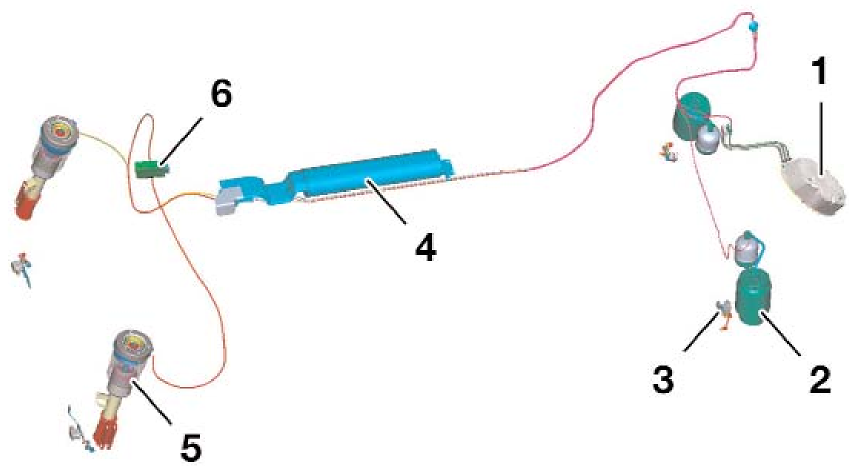
The ride-height control system (EHC) was supplied as standard in combination with the M62 engine and is available as an optional extra in combination with the M54 engine.

EHC2 is optional on both the M62 and M54 versions of the X5 and not available on the 4.6is X5.

System components

The X5 Two Axle Air Suspension System (EHC2) utilizes the air supply unit from EHC mounted in the luggage compartment, with the following components added or modified:

- Air Supply Unit (with redesigned compressor and drier)
- Pressure Accumulator
- Valve Unit
- Ride Height Sensor
- Air Suspension Strut
- Control Unit
- Switch Assembly



1. Air Supply Unit
2. Rear Axle Air Bellows
3. Ride Height Sensors
4. Pressure Accumulator/ Valve Unit
5. Front Axle Air Bellows
6. Control Unit

Pneumatic System of EHC2

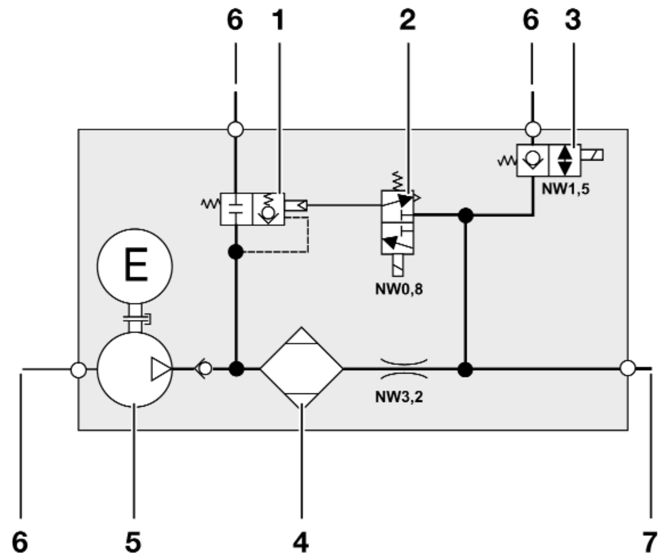
Air Supply Unit

As on vehicles with single axle air suspension, the air supply unit is located in the luggage compartment under the spare wheel. As with the single axle air suspension, the auxiliary tanks for the rear air spring bellows are located in the luggage compartment.

The air supply unit is configured similarly to the single axle air supply unit for the ride-height control system of the E39, which is currently in production.

The functions are implemented by activating a compressor and various valves in the air supply unit and on the air accumulator valve unit.

The maximum pressure of the air supply unit is 21 bar.



1. Pneumatic Drain Valve
2. Electric Pilot Control Valve
3. High Pressure Vent Valve
4. Air Drier
5. Compressor
6. Sintered filter
7. To Pressure Accumulator/Valve Unit

NW Size of opening/tubing in mm.

Air Supply Unit

Pneumatic Drain Valve

The Pneumatic Drain Valve is activated pneumatically by pressure from the control valve. This causes the drain valve to open allowing the pressure supply line to vent to atmosphere. This design allows for large air volumes to be discharged quickly and eliminates the need for a solenoid valve with high current consumption.
The 21 bar pressure limiting valve is integrated in the drain valve.

Electric Pressure Relief Valve

The electrically activated pressure relief valve controls normal system pressure. The control valve performs this function in conjunction with the drain valve.

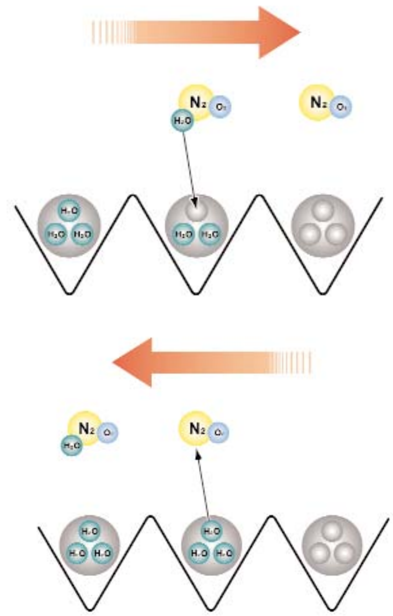
HIgh Pressure Vent Valve

The High Pressure Vent Valve serves as a comfort valve and is used to release system pressure after the accumulator has closed and the compressor is still running. When the high pressure vent valve has opened the compressor can be stopped quietly.

Air Drier

In the air drier, the air which is drawn in passes over a water absorptive filter material in the form of filter nodules which extract moisture from the air. As long as the air contains more moisture than the filter material, the individual nodules absorb and accumulate the moisture. When the air flows back, it is drier than the filter material, with the result that the air is re-humidified and the moisture is discharged into the open air. The maximum water storage capacity of the filter is 30 g.

Compressor with Drier



Top: Air Drying
Bottom: Dissipation of water to air

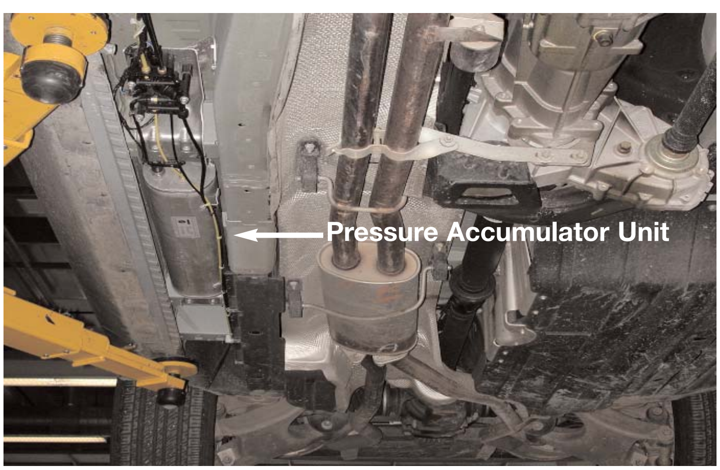
Compressor

Compressor operation is the same as in EHC with the following technical improvements:

- Addition of a temperature sensor (Located on the compressor cylinder head) Temperature sensor switches off the compressor at temperatures above 110^{0}C.
- Extended compressor ON time (180 seconds)
- Redesigned air drier to compensate for additional air volume.

Pressure Accumulator

The twin axle air suspension system now features a pressure accumulator which forms an air accumulator valve unit in combination with the valve. The air accumulator valve unit is located beneath the vehicle floorpan in the right-hand sill area.



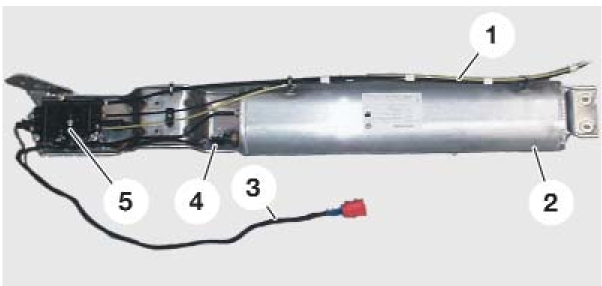
Front

Pressure Accumulator Unit which includes:
Pressure Accumulator
Pressure Sensor
Valve Unit

The pressure accumulator decreases the load on the compressor and significantly reduces the time required for large changes in ride height.

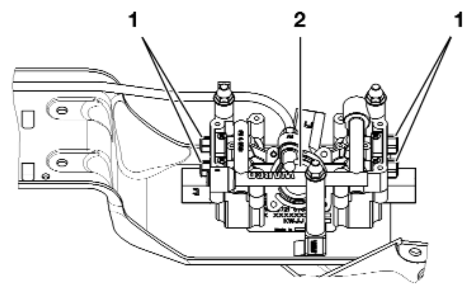
The EHC 2 control module monitors system pressure via a pressure sensor mounted on the accumulator. Normal system pressure is 15.7 +/- 0.7 bar. Minimum system pressure is 9 bar.

The pressure accumulator's charge is sufficient to fill the four suspension struts once from the Access position to the normal position and compensate for vehicle load up to maximum gross weight.



Accumulator/Valve Unit

1. Air Lines
   Yellow-Black Front
   Red-Blue Rear
2. Pressure Accumulator
3. Connecting Cable
4. Pressure Sensor
5. Valve Unit



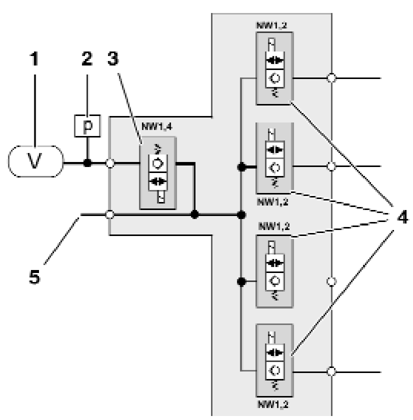
Valve Unit

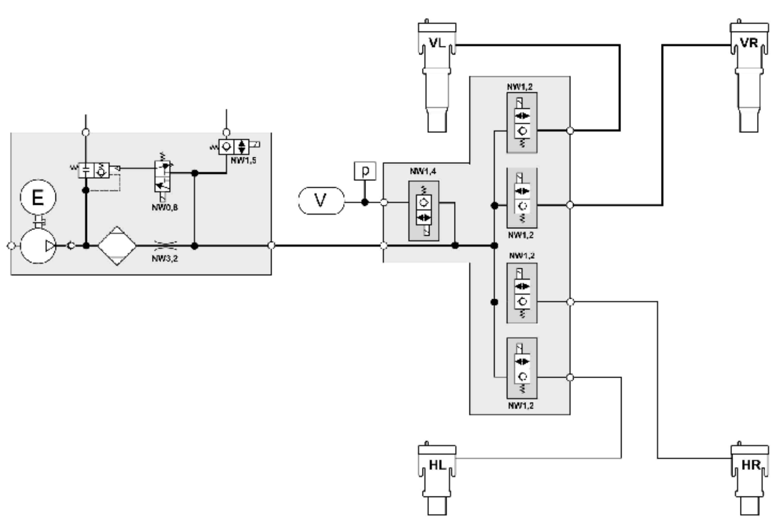
1. Connections for Air Lines
2. Pressure Accumulator valve

Valve Unit

In the valve unit, four bellows valves and the pressure accumulator valve are activated.

The bellows valves and the pressure accumulator valve are solenoid valves which are closed under spring pressure when de-energized.





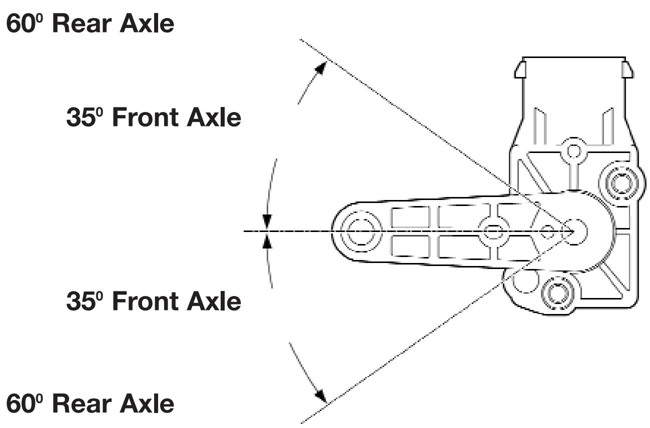
Pneumatic Layout of Control Valve

1. Pressure Accumulator
2. Accumulator Pressure Sensor
3. Pressure Accumulator Valve
4. Bellows Valves
5. From the Air Supply Unit

NW Size of opening/tubing size in mm.

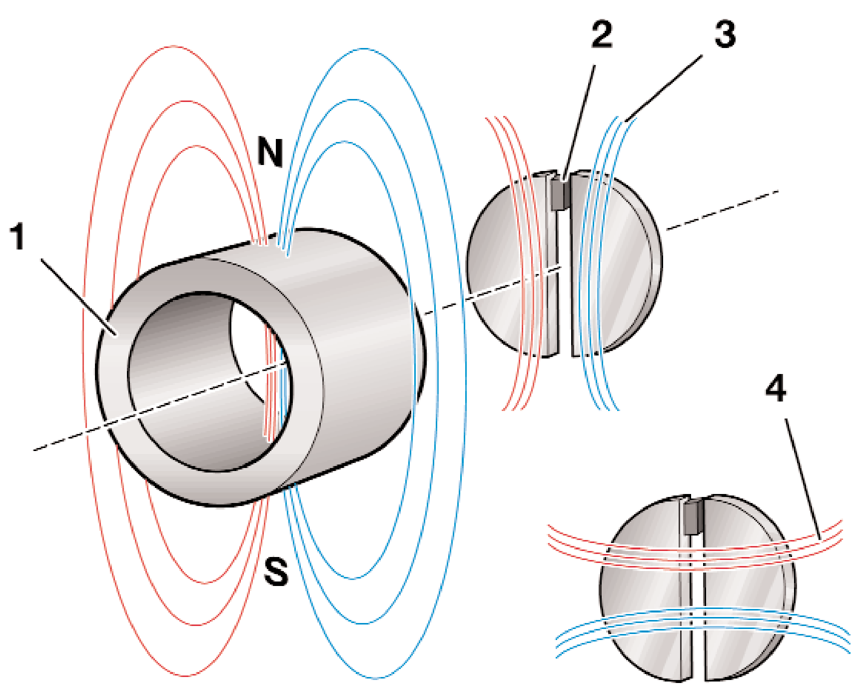
Ride Height Sensor

The control unit obtains information about the ride height of the vehicle via a ride height sensor attached to each of the four wheels.



Ride Height Sensor

The ride height sensor is an angle Hall sensor which is activated by a ring magnet. The ring magnet is polarized vertically from north to south.
The magnetic field line of the ring magnets intersect a Hall cell. The Hall cell is arranged in such a way that only the horizontal components of the field lines are evaluated. This results in different field line strengths at different positions of the ring magnet. The Hall cell measures the field strength of the magnetic flux and converts it into an analog signal with a voltage level between 0.5 and 4.5 V.



Sensor Principle of Operation

1. Ring Magnet
2. Hall Cell
3. Longitudinal magnetic field lines, low voltage 0.5V
4. Transverse magnetic field lines, high voltage 4.5V

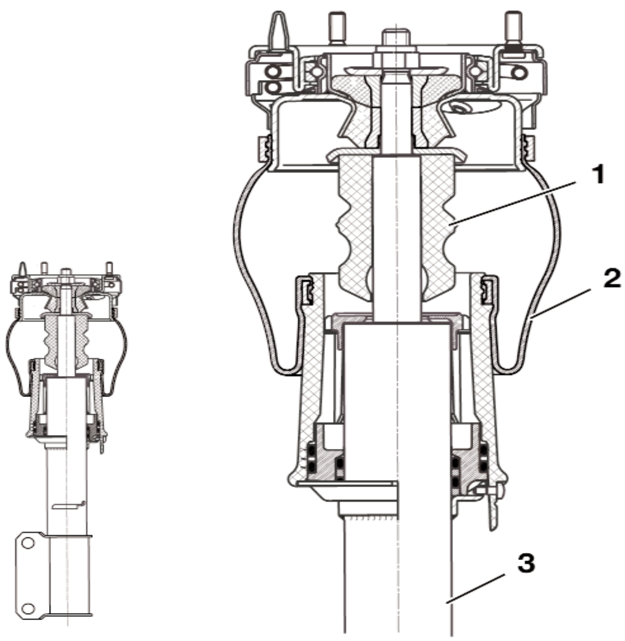
Air Suspension Strut

Rear

Minor modifications were made to the rear axle air springs. The air springs and the dampers are configured separately at the rear axle.

Front

The air suspension replaces the steel suspension at the front axle, i.e. the spring bellows is attached to the damper. The front air suspension strut and the impact absorber form a complete unit.



Air Suspension Strut

1. Auxiliary Spring
2. Air Bellows
3. Damper

Control Unit

The EHC2 Control Unit is located behind the glovebox adjacent to the General Module. The connector is a black 54 pin connector.
Inputs received directly into the control unit are:

Ride Height Level Sensor (X4)
General Module (Load cutout signal)
K Bus Inputs
Compressor Temperature
Up and Down requests from the switch assy.
CAN Bus Inputs
Pressure Sensor

Outputs include:

Air Unit Control (Activation)
LED's for Switch Unit
Pressure Accumulator
Front and Rear Axle Valves
Compressor Relay

Switch Assembly

The dash mounted switch assembly supplies a momentary switched ground to the EHC2 Control Unit requesting a ride height change in the up or down direction. Three LED's provide current ride level selected and target ride level if a request for change has been made. The LED for the current ride height will always be illuminated. The LED for the target ride level will flash until the new ride level is reached.

Notes:

Principle of Operation

Ride Height Control Operations

In addition to the automatic ride-height control system for payload compensation, the driver can set three different vehicle ride heights.

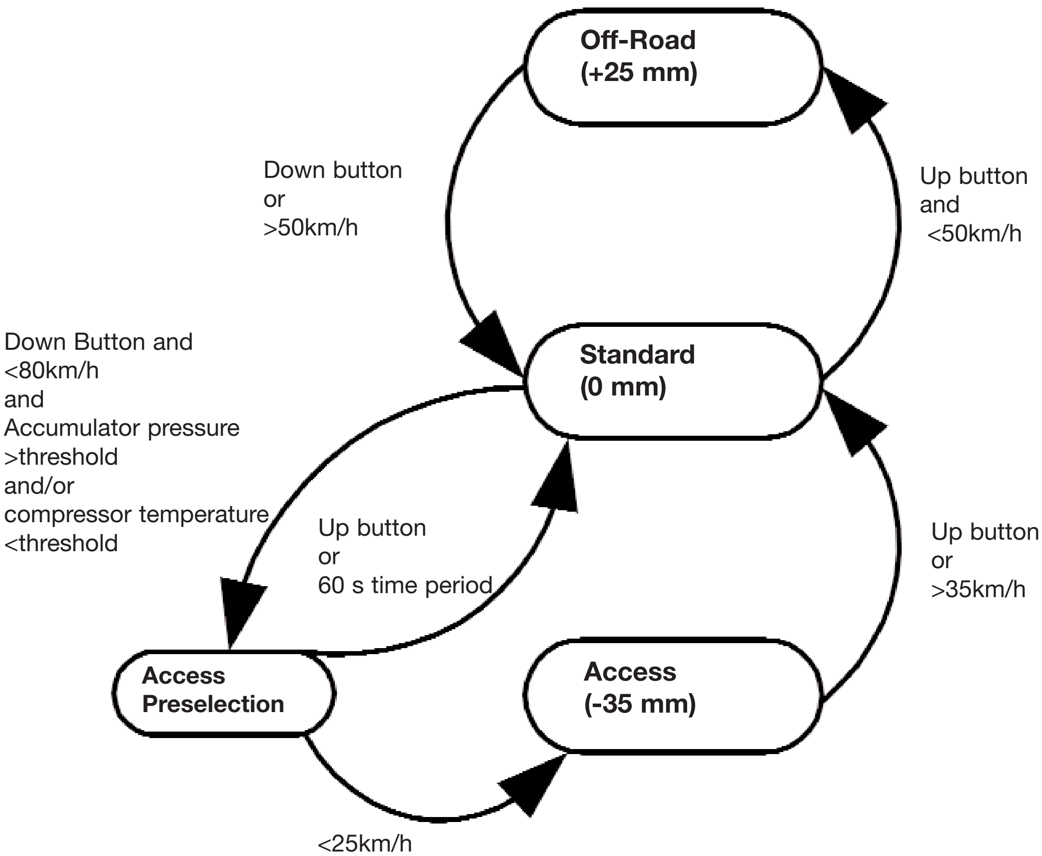
- Off-road (+25 mm), high ground clearance to a max. speed of 50 km/h
- Standard (0 mm), normal ride level
- Access (-35 mm), for entry and exit, loading and unloading to a max. speed of 35 km/h or can be activated in Standard mode at road speeds < 25 km/h

The various heights are selected by scroll rocker. Light emitting diodes indicate the present ride height setting.
Ride height can be adjusted from terminal 15 and with the doors closed. The hood and tailgate may be open.

The system also controls inclination automatically, like the single axle air suspension.

All control operations are executed without stopping at intermediate levels. The vehicle is configured pneumatically in such a way that the front and rear axles can be lowered in parallel in any load situation. Depending on the load situation, either the front axle or the rear axle is slightly quicker. On account of the different control speeds, a difference in height between the two axles is possible during all control operations. If a max. permissible threshold is exceeded, the quicker axle is stopped briefly.

The various levels can be preselected while travelling. Changeover between ride levels is effected at the speed threshold values defined in the control unit. The control unit monitors the change-over.
As soon as the driver sets a new target ride level by pressing a button or when a changeover is initiated automatically by a specific driving condition, the LED for the current ride level remains lit and the LED for the target ride level begins to flash.
When the new level is reached, the LED for the previous level goes out and the LED for the new level reached stays lit permanently.



The various levels can be preselected while travelling. Changeover between ride levels is effected at the speed threshold values defined in the control unit. The control unit monitors the change-over.

As soon as the driver sets a new target ride level by pressing a button or when a change-over is initiated automatically by a specific driving condition, the LED for the current ride level remains lit and the LED for the target ride level begins to flash.

When the new level is reached, the LED for the previous level goes out and the LED for the new level reached stays lit permanently.

If a ride level selection is not allowed, the LED indicating the momentary ride level of the vehicle flashes for 3 seconds.

A special case is preselection of Access levels while travelling. The Access LED flashes and the LED for the original ride level is lit permanently. However, this does not mean that a control operation has already begun. The control operation does not actually begin until the speed threshold which the Access level allows is reached or undershot.

In addition to the LED indicator, the following text messages can
be displayed in the instrument cluster:

- *TRAILER MODE*
  A coupled trailer is identified via the trailer connector. To avoid damaging the trailer and the vehicle, changes of vehicle level are generally avoided. The standard level is "frozen." If the trailer is coupled at a level other than the Standard level, the vehicle ride level is not changed to Standard unless a button is pressed or the speed threshold for automatic change-over is reached. The standard level is then "frozen" until the trailer connector is disconnected.
- *RIDE HEIGHT CONTROL INACTIVE*
  Faults in the system and on the control unit which are only identified by the instrument cluster, e.g. control unit disconnected
- *RIDE HEIGHT CONTROL INACTIVE + MAX. 60 km/h*
  For safety-critical faults (vehicle is too high or at inclination)

Control Modes

Sleep mode

If the vehicle is parked, it enters Sleep mode after 16 minutes. No further control operations are executed. A "watch dog" wakes up the control unit for a few minutes every 6 hours (wakeup mode) in order to compensate for possible inclination of the vehicle. (Vehicle height may only be corrected once as air supply unit only operates with engine running.)

Wake-up

In wake-up mode, the control unit is woken up for a set period of time in order to compensate for possible inclination of the vehicle. Inclination of the vehicle can be caused by large temperature differences or by minor leaks. Adjustments to the front and rear axles ensure that the vehicle is visually level. To minimize power consumption, the vehicle is lowered only. The nominal level of the lowest wheel serves as the nominal level for all other wheels. The lowest nominal level to which the vehicle is lowered is the Access level (-35 mm).
Exception: if the vehicle is parked at Access level, the vehicle is lowered to max. -50 mm in wake-up mode. If the vehicle is parked for a prolonged period of time and there is a leak in the system, further loss of pressure does not produce a change of ride level since the weight of the body is born by the auxiliary suspension and the residual tire pressure.

Advance /Overrun

When the vehicle is woken out of sleep mode by the load-cutout signal (VA), it normally enters advance / overrun mode. Since the engine is not (no longer) running in this mode, however, there are restrictions on the control operations that can be performed in order to conserve the battery. Ride level compensation is restricted to tolerance ranges of 20 mm and 25 mm in the up and down directions respectively. This serves to reduce the frequency of control operations.

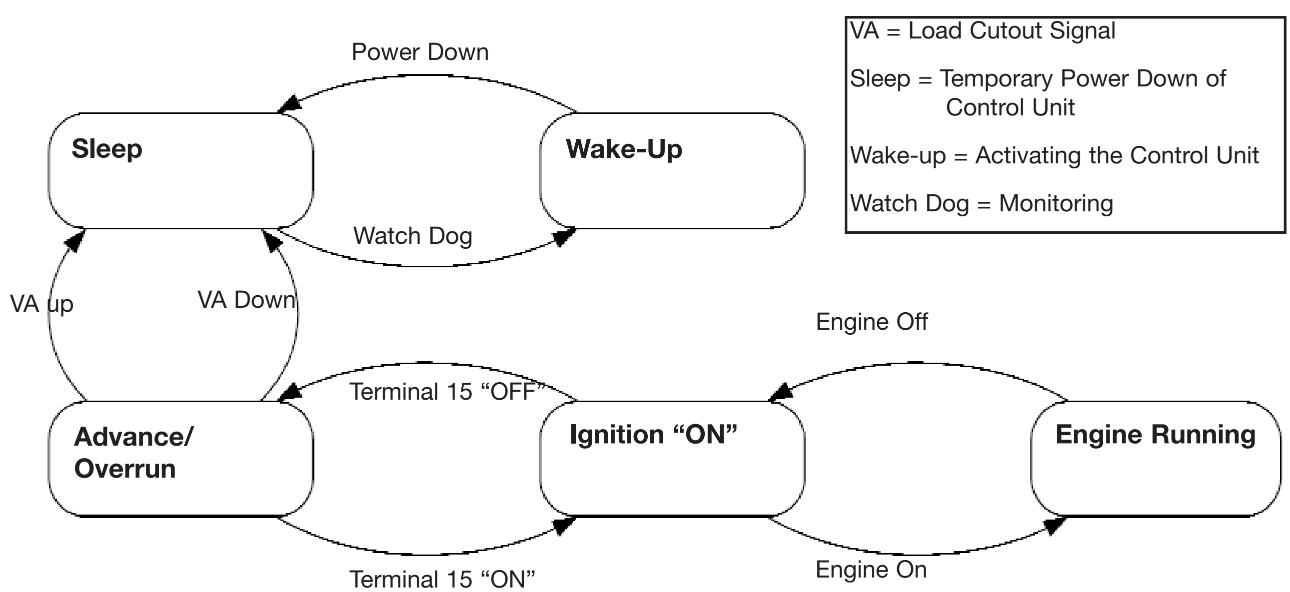
All control operations in advance / overrun mode are executed as long as pressure is available in the accumulator. When the accumulator is empty and the engine is turned off, control operations are directly driven by the compressor. User-activated changes of ride level and filling of the accumulator are not possible.

Terminal 15

As soon as the ignition is turned on (terminal 15), the user is allowed to lower the ride level as required.
However, it is still not possible to raise the ride level or fill the accumulator.
Ride level is compensated outside a narrow tolerance range of 10 mm upwards and 10 mm downwards.

Engine "on"

Ride level compensation, raising and lowering the vehicle's ride height as well as filling the accumulator are permitted when the engine is running. The compressor also starts up during every control operation.
Ride level is still compensated outside the narrow tolerance range of ±10 mm.
As long as the vehicle is stationary, high speed filtered ride level signals are used to detect a change of load. This allows the system to react immediately to changes in ride level.
As soon as the vehicle is travelling, it changes over to low speed filtered ride-level signals. The system no longer reacts to bump movements caused by road surface unevenness. A mean value is formed over a prolonged period of time, i.e. payload is only altered by the progressive emptying of the fuel tank.
The high speed filter is not used until the vehicle is stationary again and a lid is opened. If no lid is opened, the vehicle logically cannot be loaded or unloaded.



Workshop Hints

If a threshold level is exceeded on all 4 wheels when the vehicle is stationary, the control unit assumes that the vehicle has been raised on a workshop platform.
There are three possible reset conditions for workshop platform recognition:

- The original level values are undershot at all four wheels,
- A selection is made by button,
- A speed of >40 km/h is recognized for 3 s.

Vehicle jack
If the lowering speed at a wheel is too low during the lowering operation, the system assumes that the wheel is jacked up. However, the downward velocity must be less than a certain preprogrammed speed threshold. If the system detects a jacked wheel, it stores the height of this wheel.

Car jack recognition is reset when the stored ride height is again undershot. When a travelling speed of 40 km/h is maintained for at least 3 s, another control attempt is performed. The car jack recognition can also be reset by button selection.

Please note that the system also controls ride height in diagnostic mode. For this reason, Belt Mode must be activated before carrying out work on the system or before setting the vehicle ride height.

Belt Mode:
Heights are fixed and are not compensated. If Belt Mode is set, the function LED is off. The text message "ride-height control system inactive" appears in the instrument cluster.

Transport Mode:
The Transport Mode setting is for transportation purposes. When the ignition is turned on, the message "ride-height control system inactive" appears. Heights are increased or decreased depending on ignition key status, e.g. ride height is reduced when the vehicle is lashed to a ship or train and raised when the "Engine on" signal is generated and when the vehicle is transported on a transporter truck.

The correct ride height is set to ± 5 mm via "Activate components." The left and right ride levels are set separately at the rear axle. The ride levels are then set at the front axle. The left and right air springs are adjusted jointly for this purpose.
Following this, the new ride height for the front and rear axles is stored via the "Offset function."

Before replacing components, the system must be depressurized! This is done in the diagnostics via "control unit functions," "Component activation," "Pressure-relieve front axle/rear axle." Repeat the activation procedure 6 times.

If the fabric of the bellows is visible, then the bellows must be replaced.

Upon completion of repair work, the air suspension system of the vehicle raised on the workshop platform must be refilled with air via the diagnostics. The activation procedures must also be repeated 6 times. This prevents the bellows from being folded incorrectly.
The vehicle must with be set down on its wheels when the suspension struts are depressurized!

Important Workshop Hint
Similarly, a defective vehicle with leaky pneumatic system must not be raised on the workshop platform. If depressurized, the bellows would contract under suction forming incorrect folds. These folds could result in malfunctions later on.

Areas on the air bellows which can possibly become leaky are the O-ring at the piston rod and the seal carrier on the roll piston.

The connectors attached to all cables are identical to the connections on the single-axle air suspension. 6 mm cable is used. The tightening torque is 3±1 Nm throughout the system. Special care must be taken when handling breakage-prone plastic parts of air suspension elements.

Upon completion of repair work, Belt mode must be deactivated via the diagnostics. The function LED on the button comes on. No text message appears in the instrument cluster. The system is OK and ready for operation.

Steering

The X5 utilizes a power assisted rack and pinion steering system due to all wheel drive considerations. The power steering pump is a vane cell design.

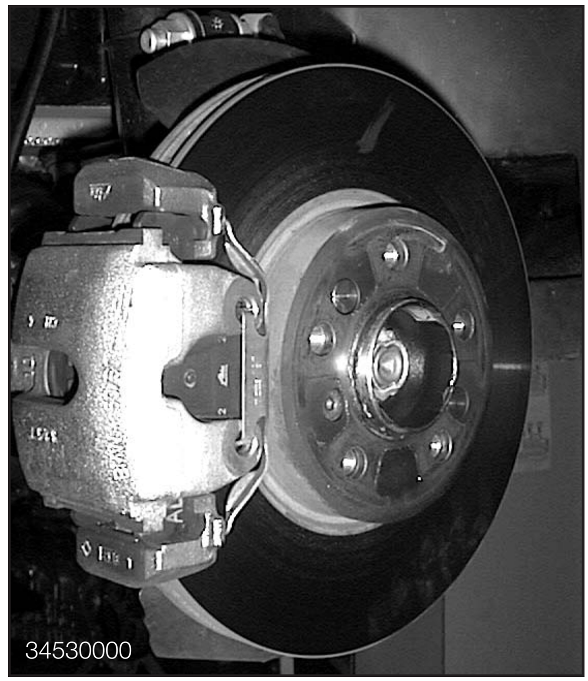
The turning radius of the X5 is 12.2 meters.

The steering column is electrically adjustable for length and height that includes the memory function incorporated into the seat/mirror memory system.

Brakes

The X5 brake system is the dual circuit (black/white) division with Electronic Brake Force distribution (EBV) through DSC control. The system is similar to the E38 with:

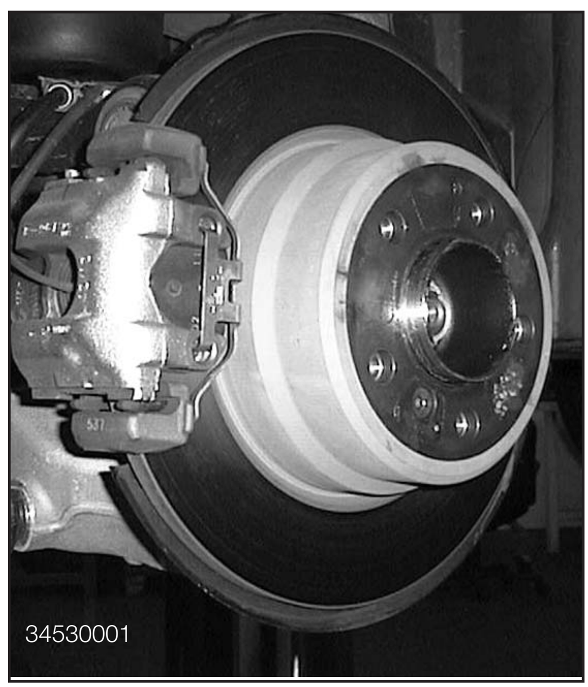
- Vacuum booster with tube jet amplifier
- Tandem master cylinder with two central valves for DSC operation
- Brake fluid reservoir with reed contact
- Vented front rotors/Solid rear
- Single piston calipers
- DSC hydraulic unit with integrated control module
- Pre-load pump for DSC operation



34530000

Front Brakes

Brake Rotor - 332mm diameter - 30 mm thick
Caliper - single piston 60mm diameter
Pads - asbestos free



34530001

Rear Brakes

Brake Rotor - 324mm diameter - 12mm thick
Caliper - single piston 42mm diameter

Wheels and Tires

Light alloy wheels are standard equipment on the X5. The wheels sizes include:

3 Liter version

- Standard Wheel - 7.5J x17 SEH2

- Standard Tires - 235/65R - 17 H rated all season Front and Rear

4.4 Liter version standard suspension

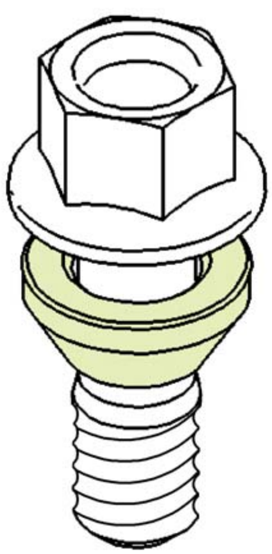
- Standard Wheel - 8.5J x 18 EH2

- Standard Tires - 255/55R - 18 H rated all season Front and Rear

4.4 Liter version sports suspension

- Standard Wheels - 9J x 19 EH2 FRONT
10J x 19 EH2 REAR

- Standard Tires - 255/50R -19 Front/285/45R - 19 Rear V rated

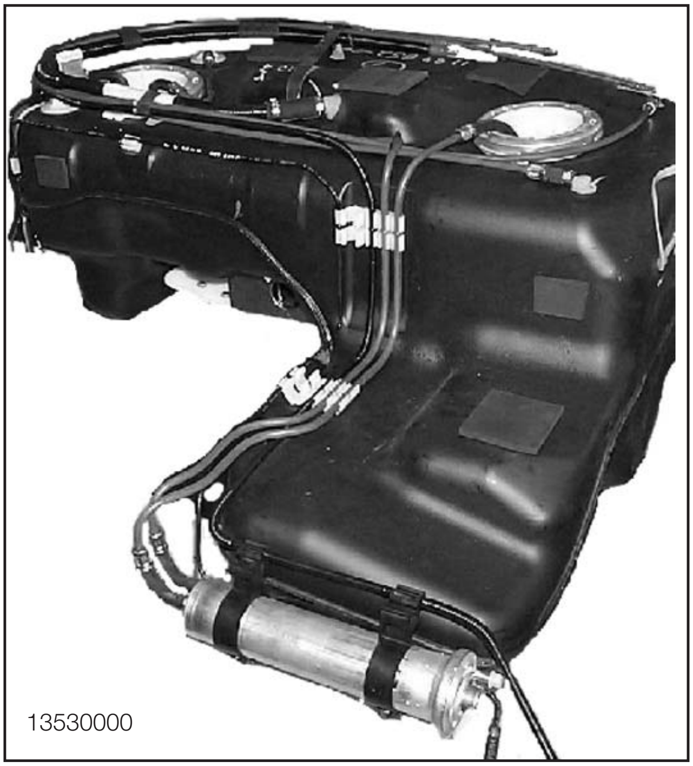


The X5 uses a two piece lug bolt that incorporates a spacer washer and features anti-corrosion coating. The tightening torque on the lug bolts is 130Nm +/- 10Nm. Advantages of using the spacer washer include:

- Longer expansion length for the bolt.
- A better fit to the wheel
- The spacer washer is fixed to the wheel when tightening and the lug bolt turns relative to it.

Fuel System Supply

The fuel tank is constructed from molded plastic and is mounted under the rear seat and extends along the left side of the vehicle. It is the saddle tank design with a siphon jet pump in the right side to transfer fuel to the left side where the fuel pump is mounted.

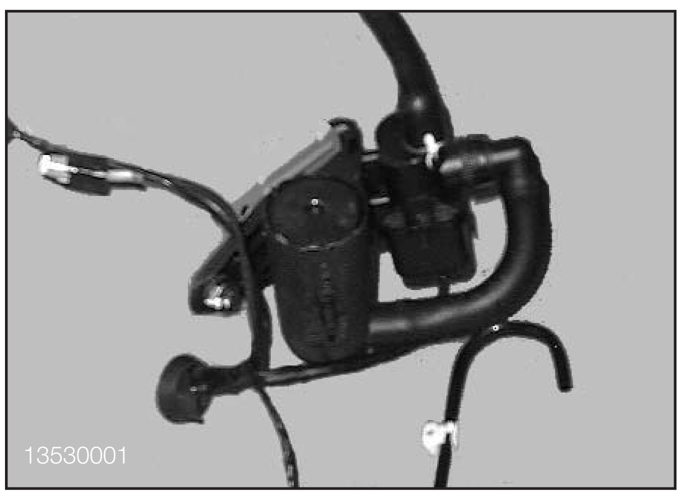


13530000

The fuel filter/pressure regulator is mounted in front of the tank along with the charcoal canister. The components are covered by a plastic plate to protect them when driving off-road.

The liquid/vapor separator is mounted on the right side up in the wheel arch opening next to the filler neck.

The Leak Diagnosis Pump (LDP) is mounted in the left rear side wheel arch opening behind the wheel housing cover. Operation of the LDP will be covered in the engine electronic section of this program.



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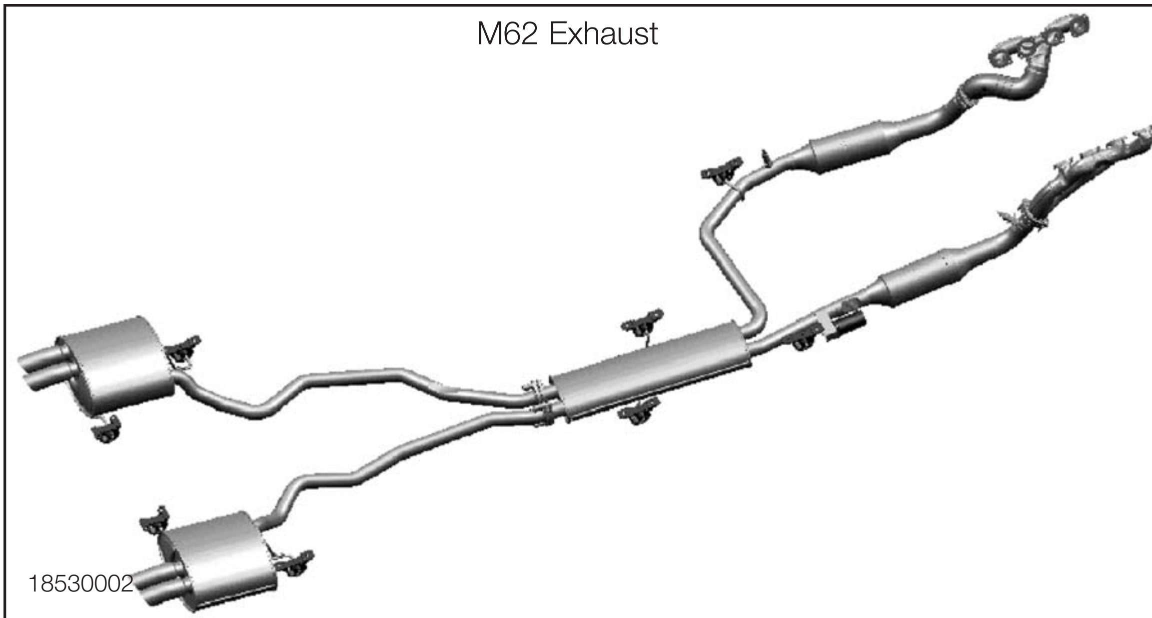
Exhaust System

The exhaust system of the X5 is made from stainless steel and consists of three main pieces after the exhaust manifolds. The front section consists of two monolith catalytic converters with pre and post-oxygen sensors. The two converters converge into one center muffler on the right side of the vehicle.

The two rear sections consists of the tail pipes and main mufflers that are mounted at the rear of the vehicle.

The front and rear exhaust components are bolted together with spring bolts

M62 Exhaust



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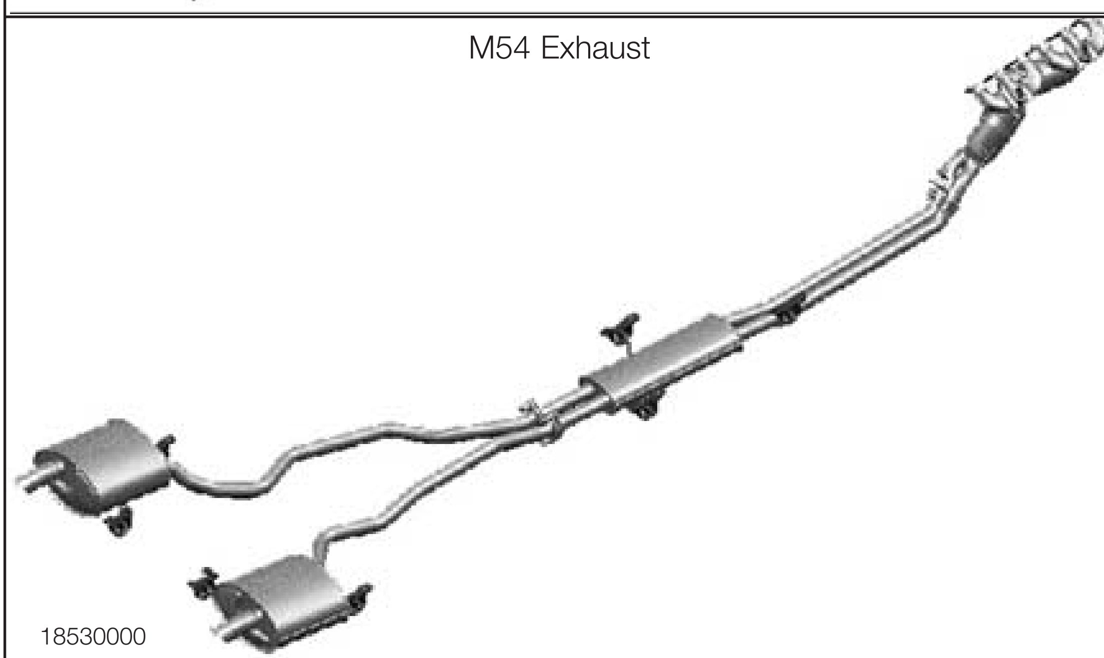
M54 Exhaust



18530000

Power Distribution

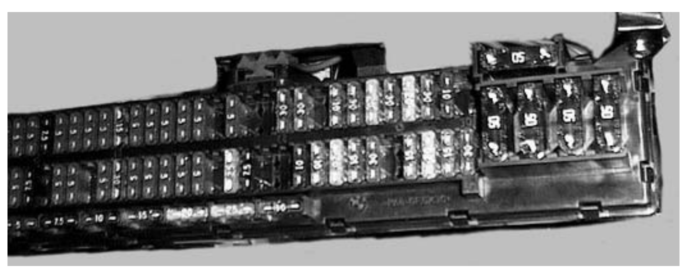
The maintenance free 90 AH battery in the X5 is mounted in the rear below the spare tire and EHC compressor unit. The battery box is formed of molded plastic and the positioning of the battery aids in weight distribution. As with all BMW vehicles, the battery is equipped with the BST on the positive battery cable.


12530012

Power distribution for the vehicle and systems is through two fuse carriers mounted in the right storage compartment in the rear and above the glove box in the front.


61530012

The battery jump/charge point is located in the engine compartment on the left side of the fire wall.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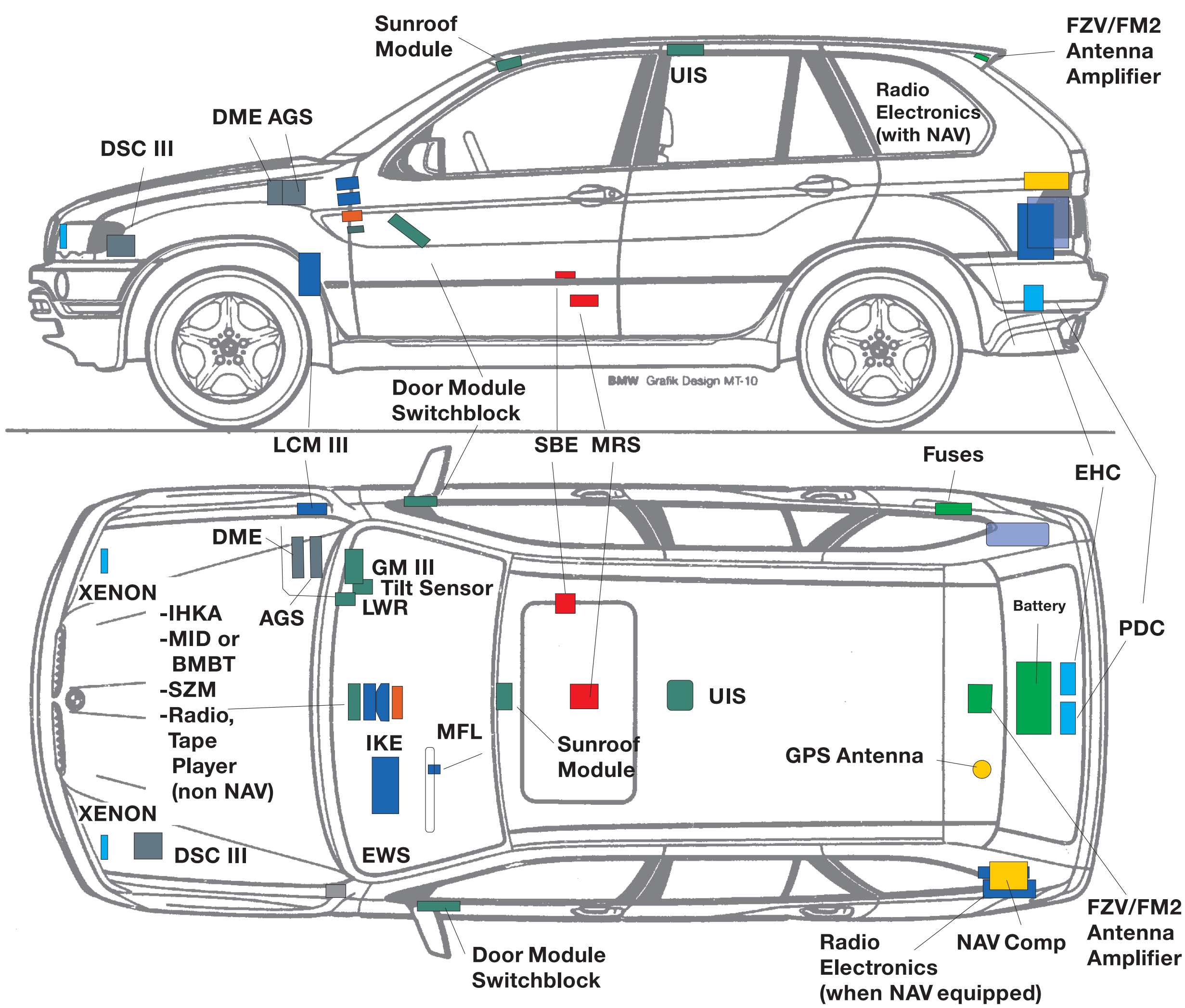
Component Location



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Subject **Page**

DYNAMIC STABILITY CONTROL (DSC III)

DSC FOR THE X5
INTRODUCTION

The X5 is equipped with DSC III for its stability control system. The components are the same as the DSC III system (version 5.7) currently installed in the E38/E39 vehicles. However the software and programming are changed to allow for new functions associated with all wheel drive and off-road use.

New/changed functions of the DSC III include:

- New Hill Decent Control (HDC) function
- New Differential Brake Control (ABD) function
- Changed traction control function
- Changed ABS function

DSC - X5 OVERVIEW

The DSC system for the X5 provides all of the functions and features of the DSC III system currently in the E38/E39 vehicles. these functions/features include:

- Maintaining traction under all driving conditions
- Maintaining the directional Control (Longitudinal Stability)
- Providing Lateral Stability (Correction for oversteer/understeer)
- Providing Corner Braking Control (CBC)
- Providing Dynamic Braking System features of - Dynamic Braking Control and Maximum Braking Control (DBC and MBC)
- Providing Electronic Brake Proportioning (EBV)

TRACTION CONTROL SYSTEM OVERVIEW (ASC)

THEORY OF TRACTION CONTROL

Traction Control Systems are referred to as Automatic Stability Control (ASC), Automatic Stability + Traction Control (ASC+T), Dynamic Stability Control (DSC) or All Season Traction (marketing term). The traction control system has gone through several changes since its introduction in Model Year 1988. While each new version offered new innovations, the principle of traction control remains the same for any of these versions.

The link between the vehicle and its driving environment is established by the frictional contact between the tires and the road surface. The ability to control the vehicle while driving, is lost as a result of excessive wheel spin or slip if either rear tire exceeds its ability to:

- Maintain traction
- Accept side forces to maintain directional control (lateral locating forces)

The primary function of the traction control system is to maintain traction and stability of the vehicle regardless of the road surface condition. This is achieved by reducing the drive torque applied to the rear wheels or pulsing the rear wheel brakes to eliminate wheel slip depending on the version of traction control installed.

The electronics for traction control operation are incorporated in the ABS control module and share many of the same components and sensors. The module determines the speed of the vehicle through a calculated average of the four wheel speed sensor inputs. Wheel slip/spin is then recognized by comparing the speed of the driven wheels to the front wheels.

A critical slip ratio of greater than 5% between the wheels will cause the traction control regulation to begin. This slip ratio is established when the control module detects a wheel speed difference of 2 MPH or higher.

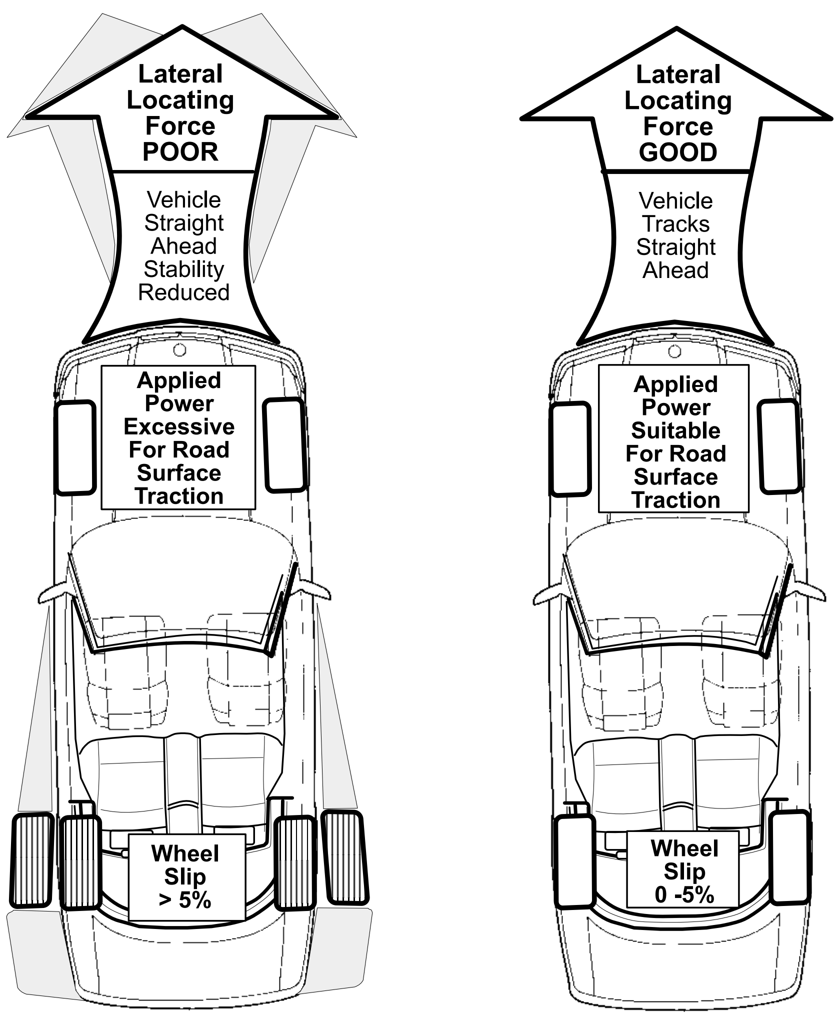
THEORY OF ELECTRONIC CONTROL

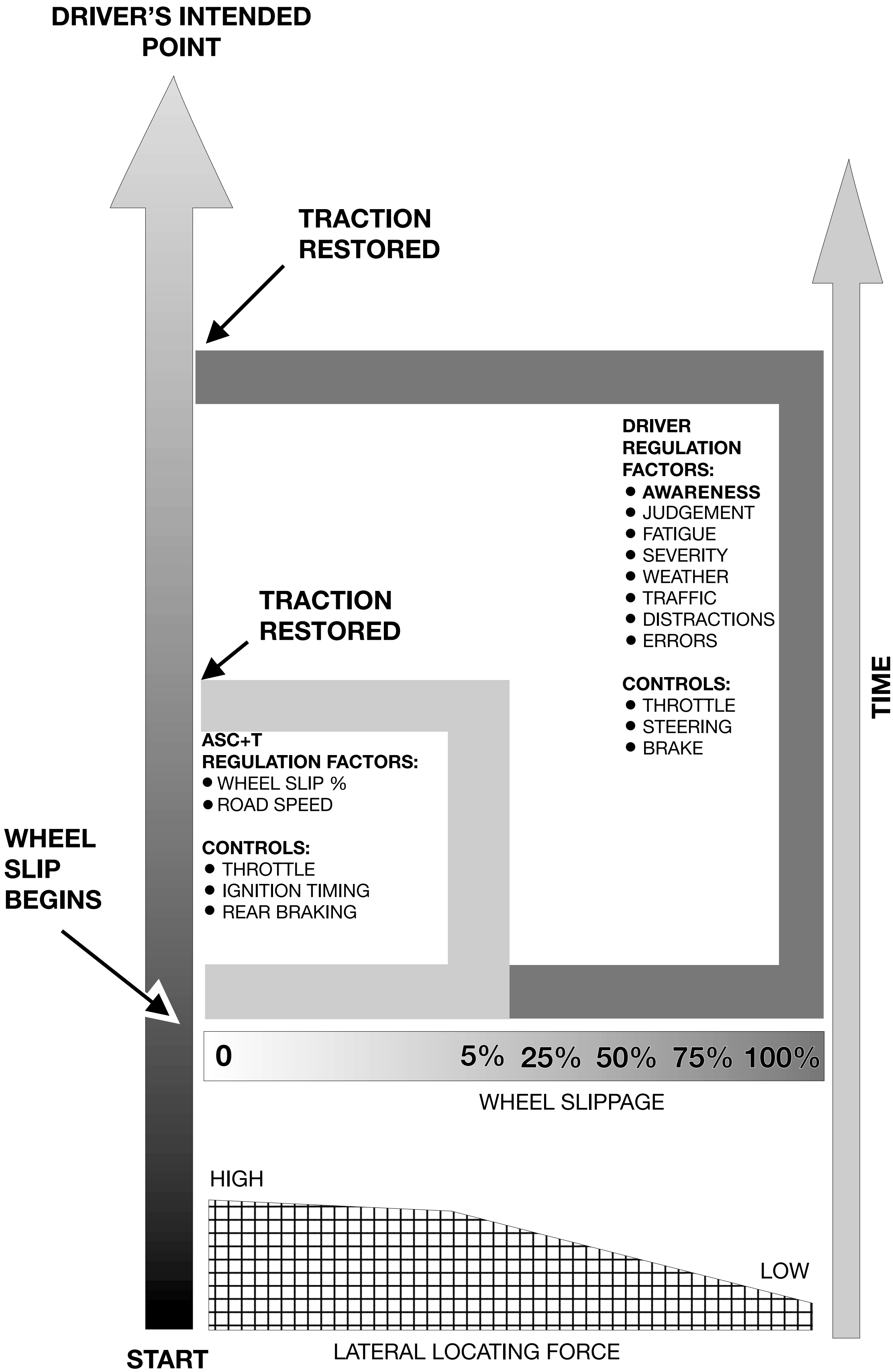
An electronic control system is used because of its ability to react quicker and more precisely than the driver. It backs up the driver's decisions and contributes to active safety, even under extreme driving conditions.

Advantages:

- optimum traction at all speeds
- increased stability by retaining lateral (side to side) locating forces.

NOTE: The system is limited to the extent that no system can overcome the laws of physics.




DRIVER'S INTENDED POINT
TRACTION RESTORED
DRIVER REGULATION FACTORS:
● AWARENESS
● JUDGEMENT
● FATIGUE
● SEVERITY
● WEATHER
● TRAFFIC
● DISTRACTIONS
● ERRORS
CONTROLS:
● THROTTLE
● STEERING
● BRAKE
TRACTION RESTORED
TIME
ASC+T REGULATION FACTORS:
● WHEEL SLIP %
● ROAD SPEED
CONTROLS:
● THROTTLE
● IGNITION TIMING
● REAR BRAKING
WHEEL SLIP BEGINS
0
5% 25% 50% 75% 100%
WHEEL SLIPPAGE
HIGH
LOW
START
LATERAL LOCATING FORCE

DYNAMIC STABILITY CONTROL (DSC II)

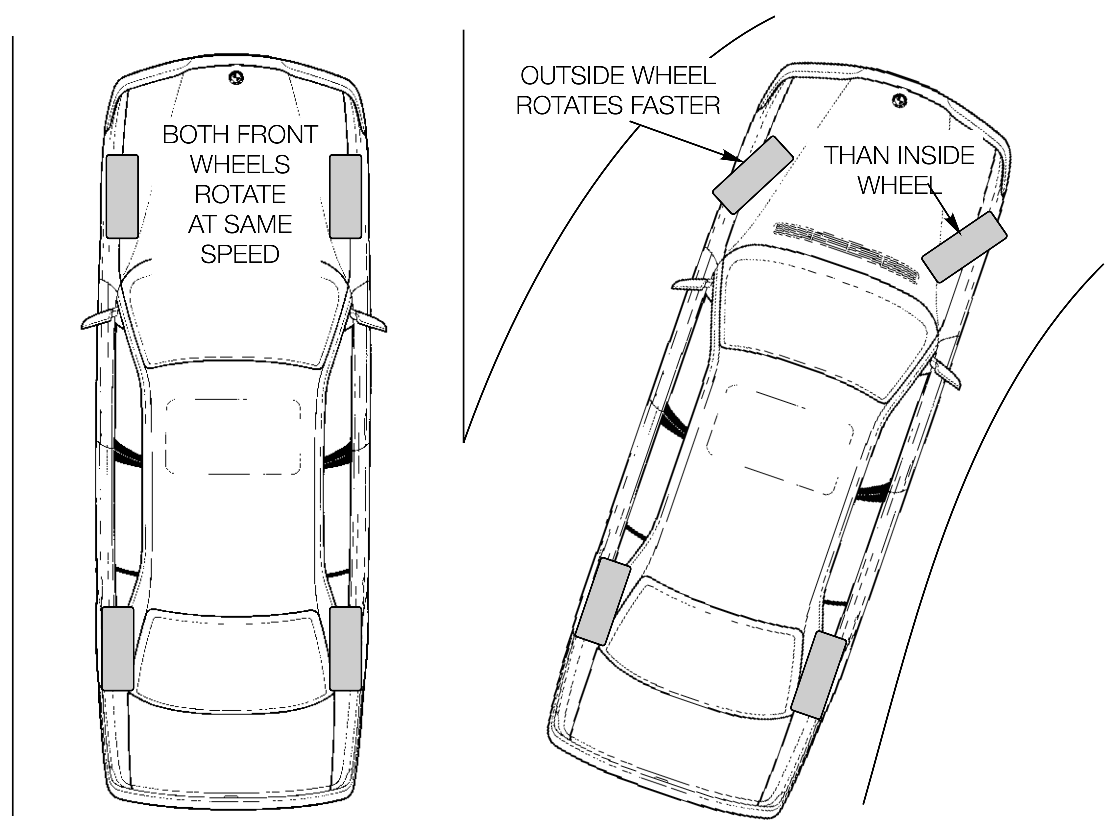
Dynamic Stability Control II (DSC II) is a further development to the ABS/ASC+T5 traction control system. DSC I was introduced in other markets on the E32 and E31 vehicles with the M70 engine.

The DSC system is designed to improve the lateral stability of the vehicle in all driving situations. Whereby ASC+T is primarily designed for longitudinal stability and providing the optimum traction for driving off, DSC adds lateral stability control to the already proven system.

For any given turning angle and speed of the vehicle, there is a set difference between the rotational speeds of the front wheels. If the rotational speeds of the front wheels vary from this set difference, it means the vehicle is understeering or oversteering through the turn. This could lead to an unstable condition and possible loss of control.

The DSC system is designed to monitor this rotational difference and react to any changes or deviations that might possibly occur. The DSC provides ASC control for the vehicle while driving through corners or any time the vehicle is not moving straight ahead.

In essence, the ASC+T5 becomes a Dynamic Stability Control System with this added feature.



DYNAMIC STABILITY CONTROL (DSC III)

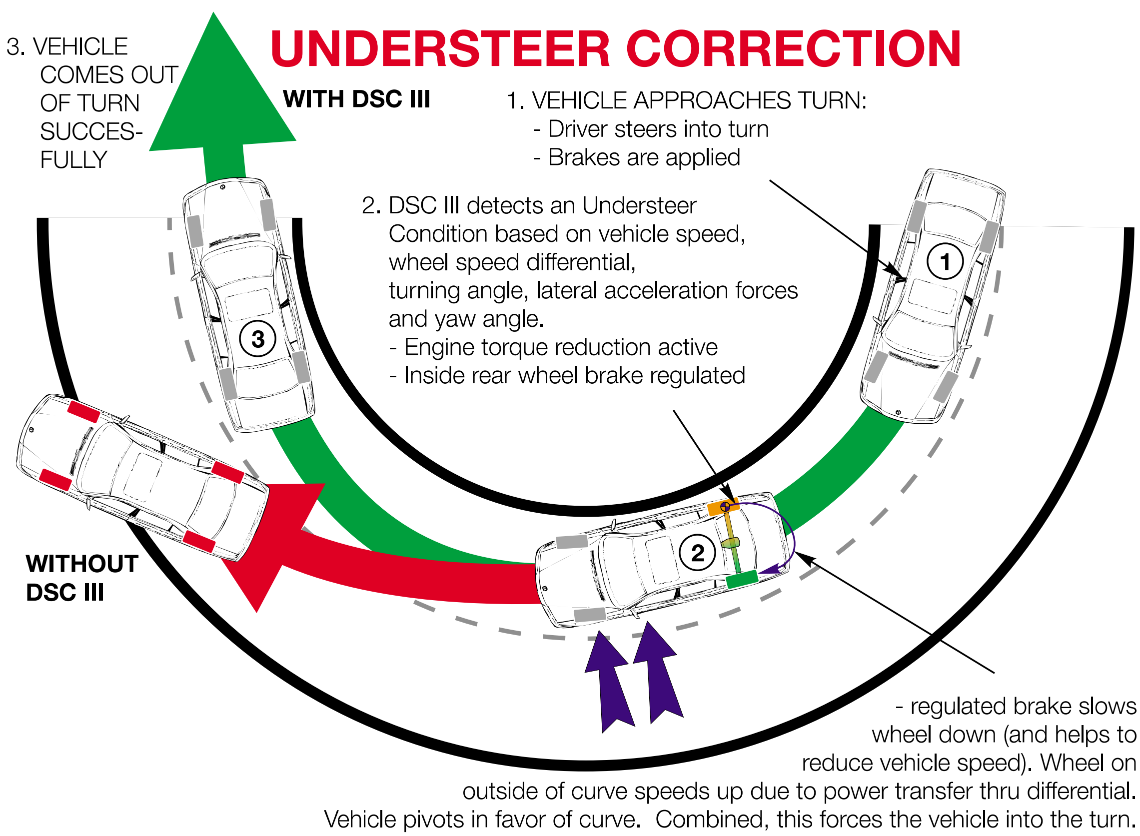
All of the familiar braking and straight line traction control features and system communication carry over from DSC II. Based on select high/select low logic, the DSC III control module selects a vehicle stabilizing strategy based on the specific input signal values it is monitoring at the moment. For all DSC strategies this begins with engine intervention to reduce torque:

- For the 750iL this is handled via CAN communication, DSC III to EML to minimize the throttle angle of the DK motors (750iL). For the 740i/iL and 540iA this is handled by direct DSC III activation of the ADS II throttle housing.

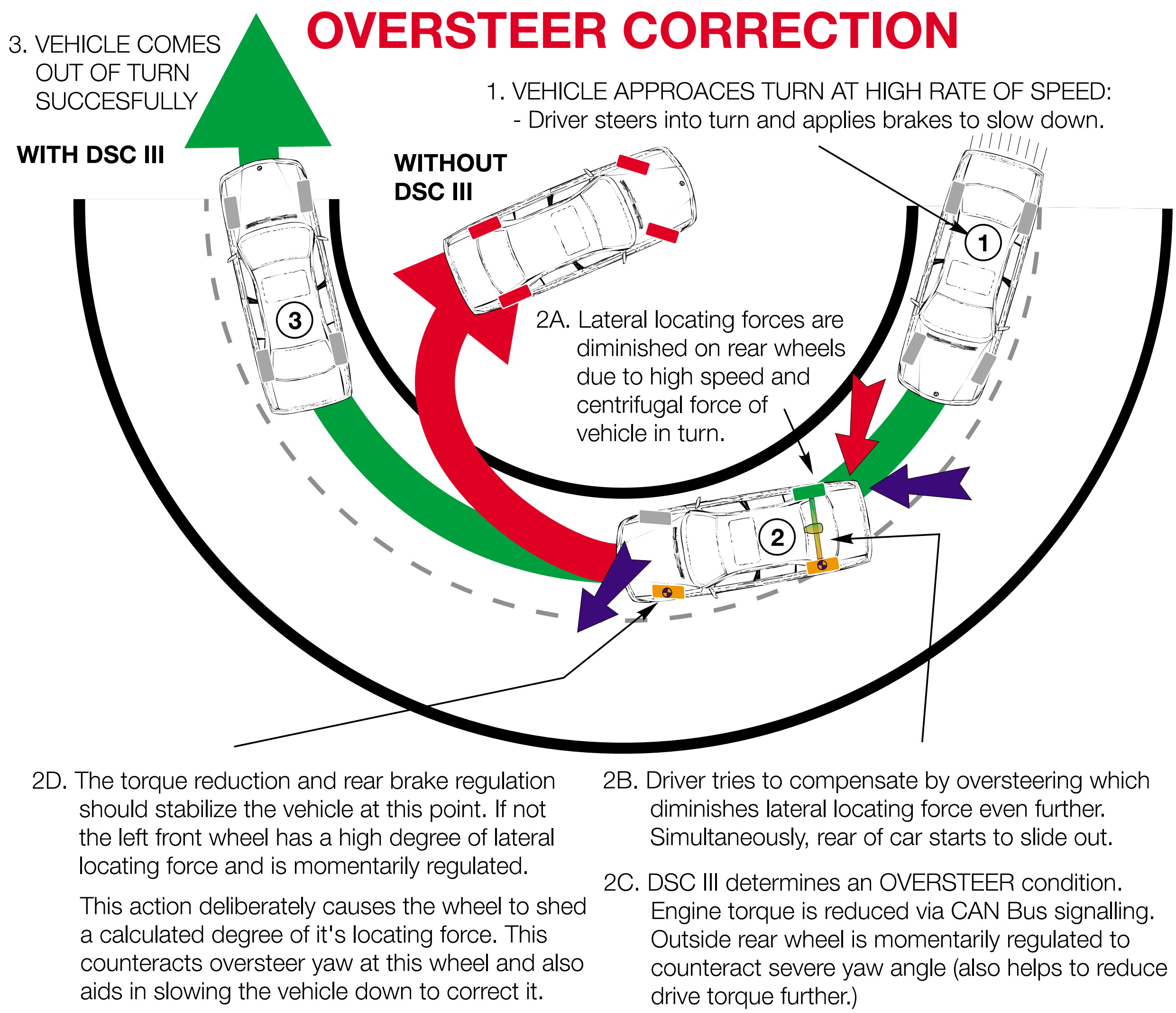
- If additional torque reduction is necessary, DSC III informs DME over CAN to:
  - Retard ignition timing
  - Shut down the fuel injection to individual cylinders

DSC III monitors under/oversteer conditions through the following components:

- The driver's desired steering angle - steering angle signal over CAN bus.
- Vehicle speed and speed differential at front wheels - wheel speed sensors
- Dynamic forces of lateral acceleration and yaw placed on the vehicle. This is possible with two new components which are discussed further on. The results are as follows:



The expanded hydraulic control of individual wheel circuits is apparent when stabilizing a vehicle exhibiting an oversteer condition as follows:



Transmission system intervention also occurs during any ASC/DSC regulating phase. Through CAN bus communication the AGS control module is informed to delay any gear changes during regulation. This prevents any unwanted driveline dynamic changes during DSC regulation.

Though DSC III provides state of the art, electronic correction of undesirable vehicle handling characteristics, it is important to remember vehicle stability is always subject to the physical laws of centrifugal force and extreme road conditions. **Good judgement and common sense on the part of the driver are still required.**

CORNER BRAKING CONTROL (CBC)

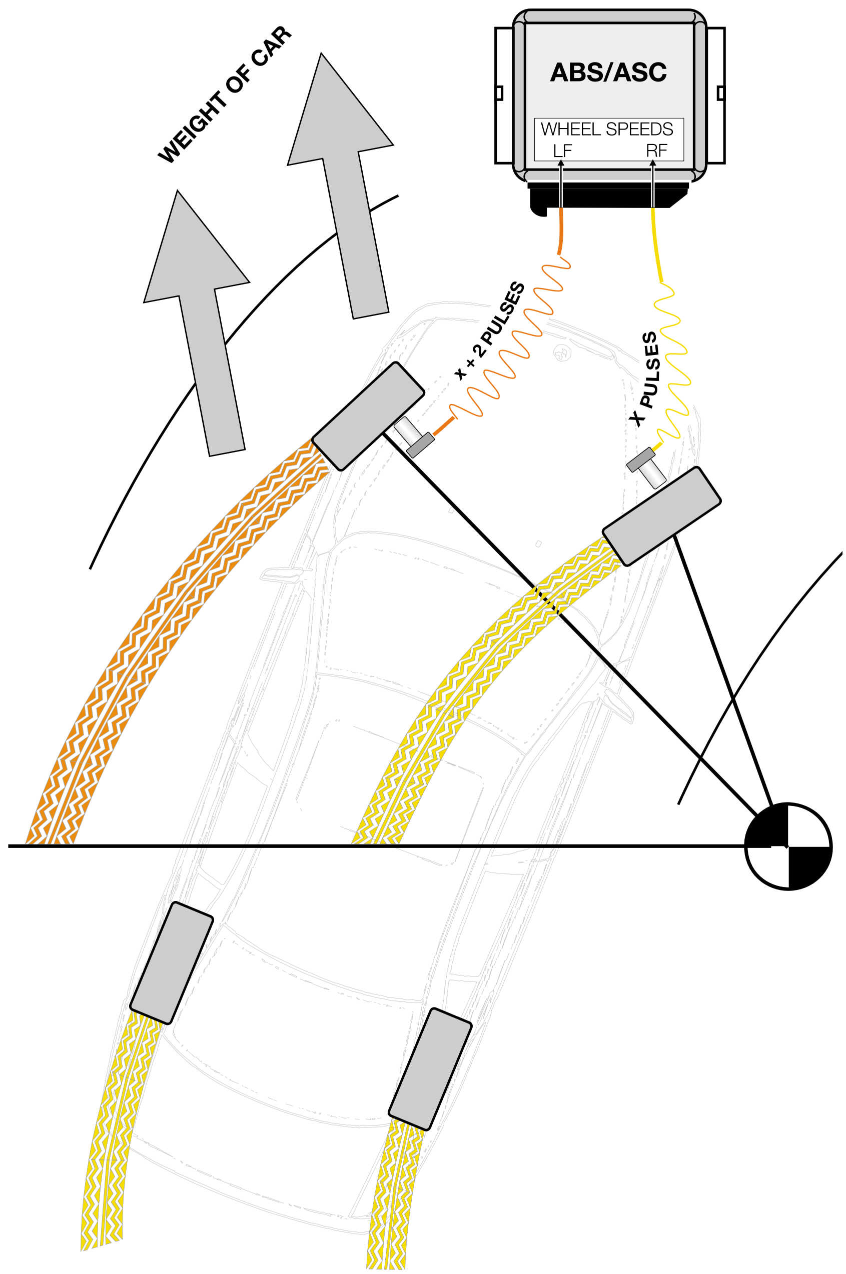
Corner Braking Control (CBC) was an additional feature first added to the ASC/5 system of the E39 at introduction. CBC improves stability control while braking through curves.

As the vehicle enters a curve, the weight of the car shifts to the outside of the curve. With non CBC equipped vehicles if the driver brakes while driving through a curve an equal hydraulic force is applied to each wheel. Though the pressure is equal, the braking effort is unequal at the tire footprint due to the increased weight of the vehicle on the outside curve.

With a CBC equipped system, the feature regulates the apply pressure to the wheels based on the turning angle (curve recognition). When the driver brakes in the same situation, an unequal hydraulic pressure is applied to each side of the vehicle. Though the apply pressure is unequal, the dynamic of the vehicle's weigh transfer compensates for the unequal apply pressure, as a result braking effort is equal at the tire footprint.

The ASC control module monitors the speed signals from all four wheels to determine when this regulation is required.

This is a feature found on vehicles equipped with the Dynamic Stability Control System (DSC), however this ASC/5 system does not incorporate full DSC control.



ELECTRONIC BRAKE PROPORTIONING (EBV)

Electronic brake proportioning allows the DSC system to adjust the braking force to the rear wheels based on the vehicle's loading to maximize the braking force at all wheels.

The DSC control module monitors the wheel speed sensors inputs when the brakes are applied, for activation of this feature. The control module compares the speed at which the front and rear axles are slowing down to determine vehicle loading.

If the rear axle is slowing at a similar rate to the front, it indicates that the vehicle is loaded and more braking force can be applied to the rear calipers to slow and stop the vehicle.

If the decel rate of the rear axle is much less than the front, the vehicle is lightly loaded and less force can be applied to the rear. If the same force were applied, then the vehicle could become unstable.

OPERATION

The values for the decel rate are programmed in the DSC control module. Equal force will be applied to the front and rear axles until the threshold values are exceeded. At this point, the DSC control module will cycle the inlet valves at the rear calipers to reduce the braking force on the rear axle.

DYNAMIC BRAKING SYSTEM

The dynamic braking system is designed to enhance the braking control of the DSC for the driver of the vehicle. The dynamic braking control and maximum braking control are functions that are programmed into the control electronics of the DSC with no additional hardware changes.

DYNAMIC BRAKING CONTROL (DBC)

The DBC function is designed to provide the maximum braking force available during rapid (panic) braking situations. The DSC control module looks at the inputs from the brake pedal switch and the signal from the brake pressure sensor on the master cylinder. The criteria for activation of DBC is how rapidly is the brake pressure built up with the brake pedal depressed. The total criteria required for DBC activation includes:

- Brake switch ON
- Brake pressure build up > threshold value
- Vehicle road speed > 5MPH
- Vehicle not in reverse
- Not all wheels in ABS regulation

If the threshold for DBC activation is achieved, the DSC control module will activate a pressure build up regulation phase through the hydraulic unit. The pressure at all wheels is increased up to the ABS regulation point. This occurs even if the driver does not achieve the ABS regulation point with the pedal.

The rear axle brakes are controlled with select-low regulation and the front axle brakes are controlled individually. ABS regulation will continue until the driver releases the pedal and the pressure in the master cylinder drops below the threshold value stored in the DSC control module.

MAXIMUM BRAKE CONTROL (MBC)

The MBC function is also designed to enhance a driver initiated braking procedure. The MBC will build up the pressure in the rear brake circuit when the front brakes are already in an ABS regulation cycle. The additional braking pressure at the rear wheels will shorten the stopping distance. The following criteria must be met before the DSC control module will activate MBC:

- Both front wheel brakes in ABS regulation
- Vehicle speed > 5 MPH
- Vehicle not in reverse
- DBC and pressure sensor initialization test OK
- Rear wheels not in ABS regulation

DSC NEW FUNCTIONS

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.

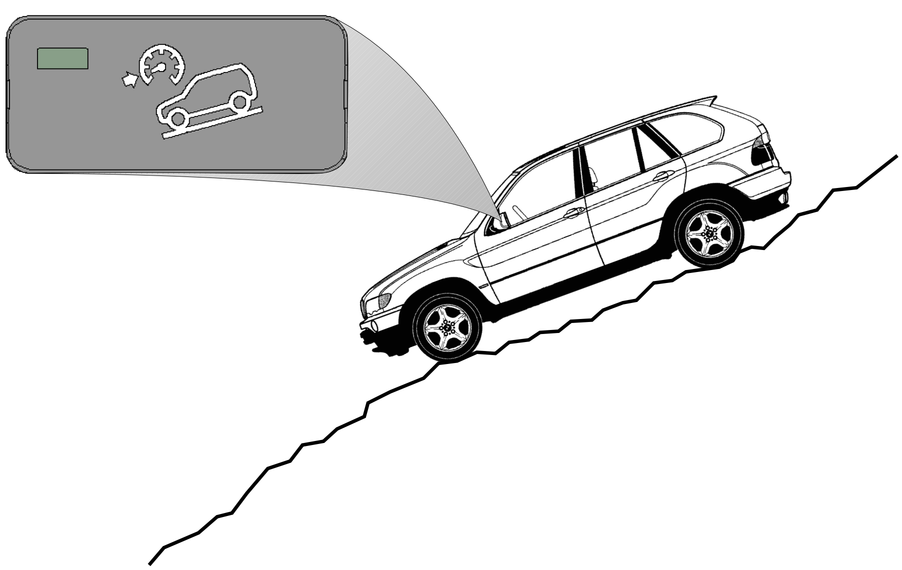
The following conditions must be met before the HDC will activate:

- 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.



DSC - NEW FUNCTIONS

AUTOMATIC DIFFERENTIAL BRAKE (ADB)

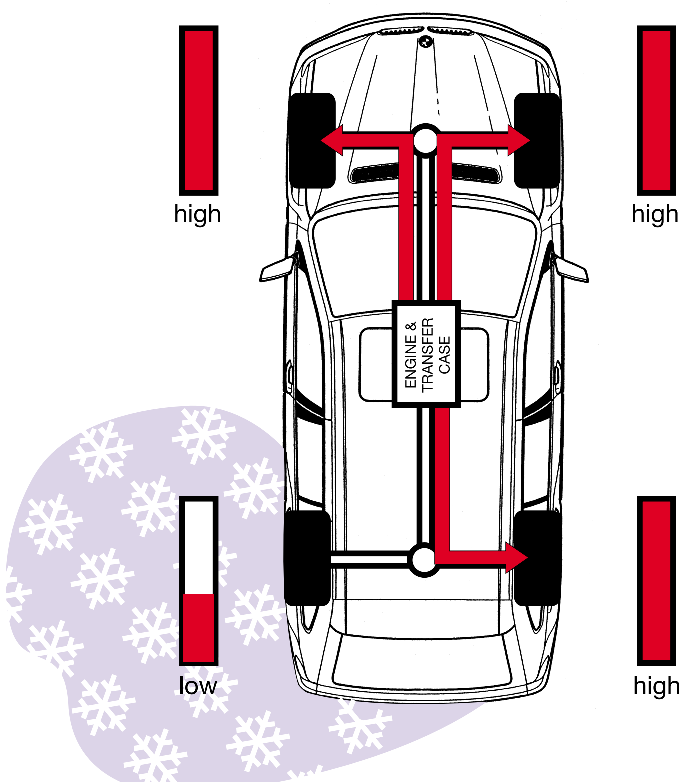
On dry pavement with no wheel slip, the vehicle's driving torque is split 68% rear and 32% front through the planetary gear differential transfer case.

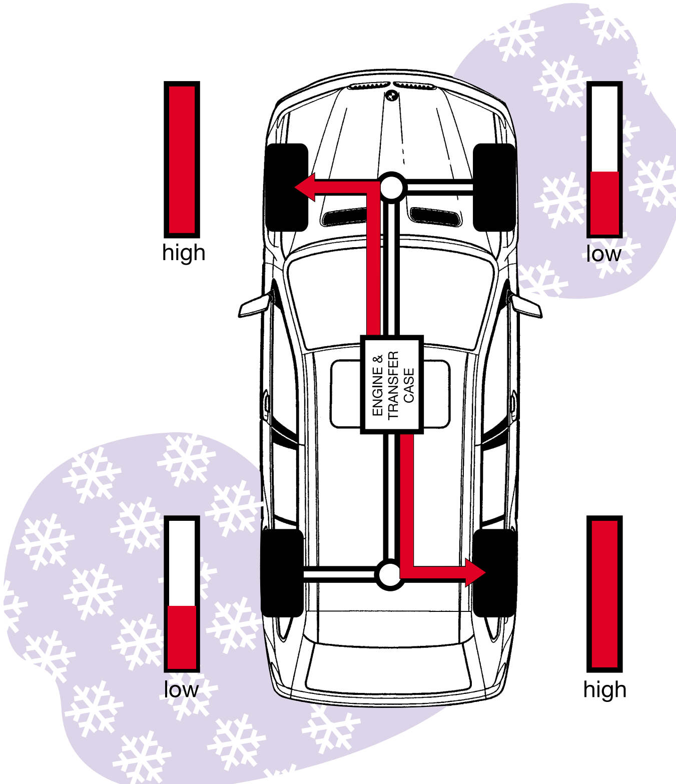
If one or more wheels spin or slip, the DSC will activate a regulation process and the brakes on the effected wheel(s) will be pulsed. The driving torque will be distributed through the differential to the remaining wheels with a good coefficient of friction

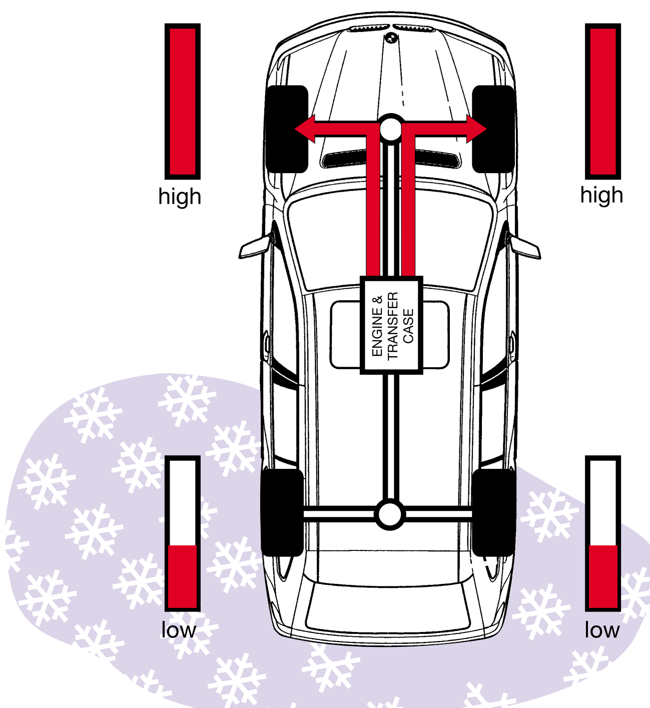
The driving torque will be applied through the differential as follows:

- 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.




high
low
ENGINE &
TRANSFER
CASE
low
high


high
high
ENGINE &
TRANSFER
CASE
low
low

DSC - NEW FEATURE

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 600^{o} C, the traction control or HDC function for that wheel will be cancelled temporarily. Once the temperature of the rotor goes below 500^{o} C, the traction application will be re-activated.

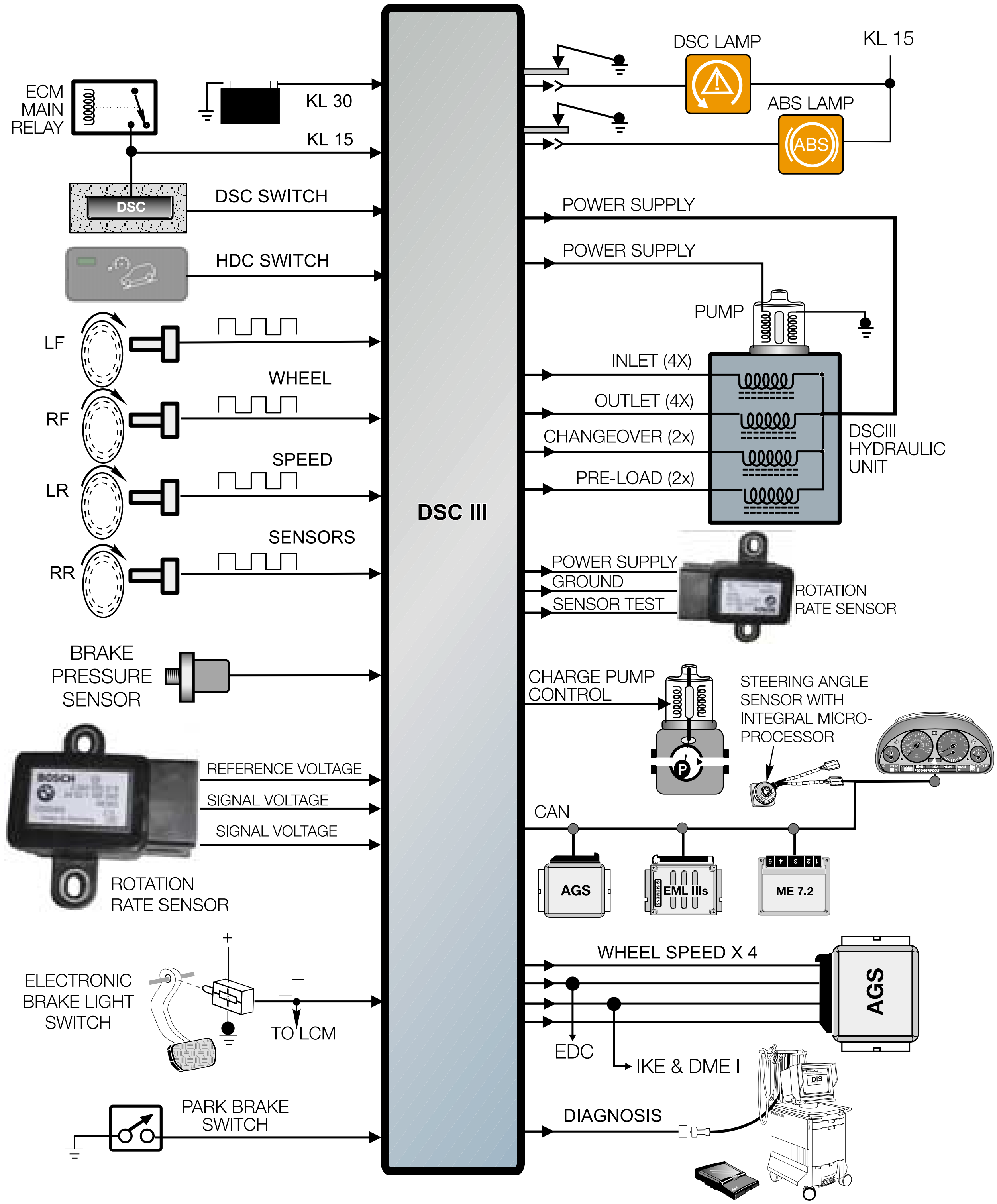
The normal braking function (including ABS) is always active at any temperatures.

DSC - NEW FEATURE

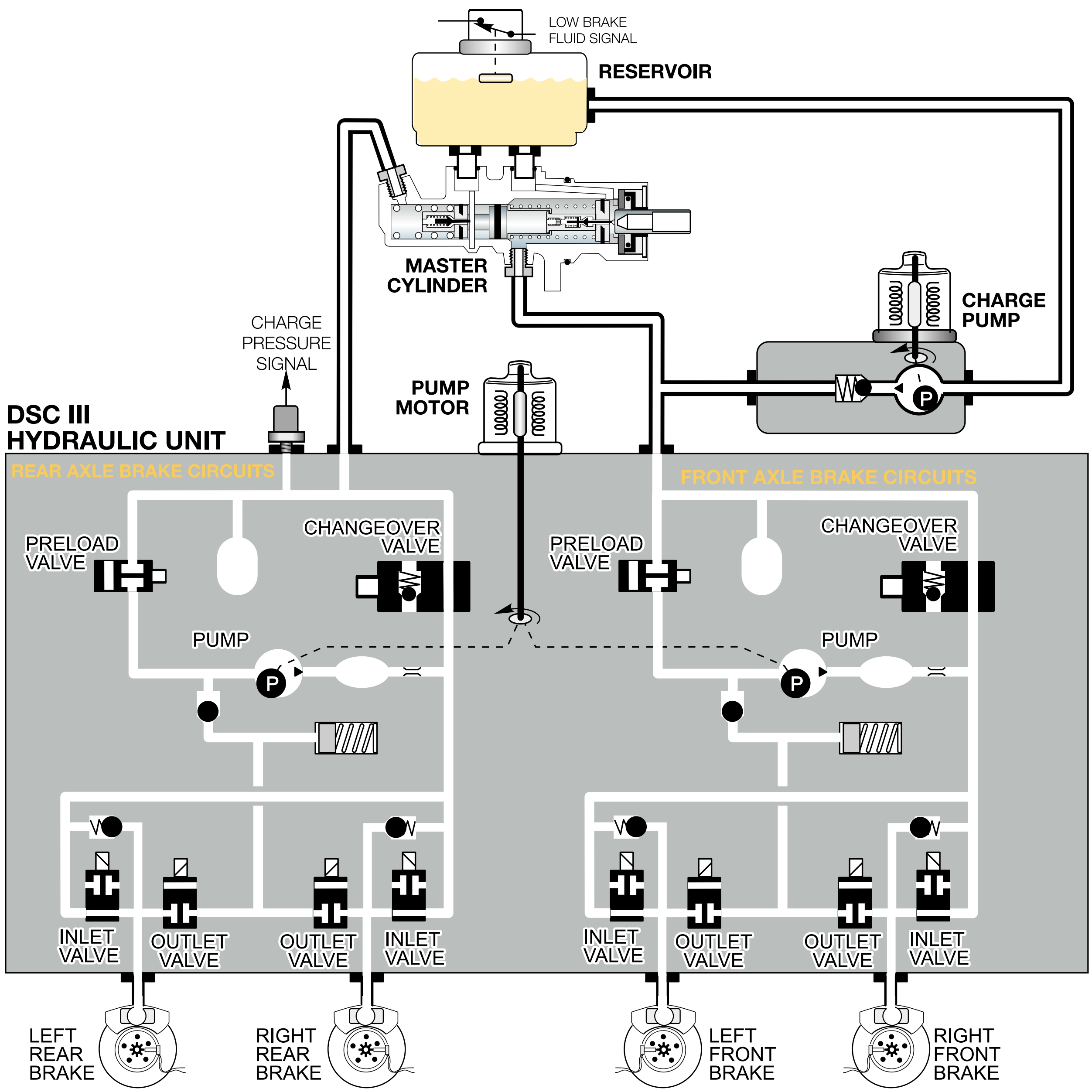
OFF-ROAD ABS Control Module Programming

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.



ECM MAIN RELAY
KL 30
KL 15
DSC
DSC SWITCH
HDC SWITCH
LF
RF
LR
RR
WHEEL
SPEED
SENSORS
BRAKE PRESSURE SENSOR
REFERENCE VOLTAGE
SIGNAL VOLTAGE
SIGNAL VOLTAGE
ROTATION RATE SENSOR
ELECTRONIC BRAKE LIGHT SWITCH
TO LCM
PARK BRAKE SWITCH
DSC III
DSC LAMP
KL 15
ABS LAMP
ABS
POWER SUPPLY
POWER SUPPLY
PUMP
INLET (4X)
OUTLET (4X)
CHANGEOVER (2x)
PRE-LOAD (2x)
DSCIII HYDRAULIC UNIT
POWER SUPPLY
GROUND
SENSOR TEST
ROTATION RATE SENSOR
CHARGE PUMP CONTROL
STEERING ANGLE SENSOR WITH INTEGRAL MICRO-PROCESSOR
CAN
AGS
EML IIIs
ME 7.2
WHEEL SPEED X 4
AGS
EDC
IKE & DME I
DIAGNOSIS
DIS


LOW BRAKE
FLUID SIGNAL
RESERVOIR
MASTER
CYLINDER
CHARGE
PUMP
CHARGE
PRESSURE
SIGNAL
PUMP
MOTOR
DSC III
HYDRAULIC UNIT
REAR AXLE BRAKE CIRCUITS
FRONT AXLE BRAKE CIRCUITS
PRELOAD
VALVE
CHANGEOVER
VALVE
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REAR
BRAKE
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BRAKE
RIGHT
FRONT
BRAKE

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:

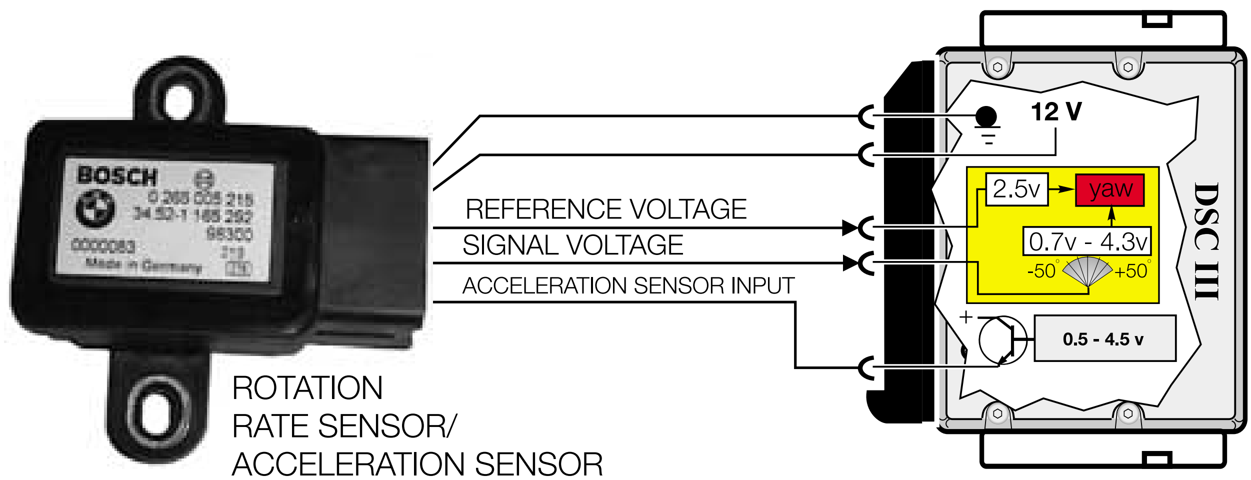
- Two pre-charge solenoid valves
- Two changeover solenoid valves
- Four intake solenoid valves
- Four outlet solenoid valves
- One return pump

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).

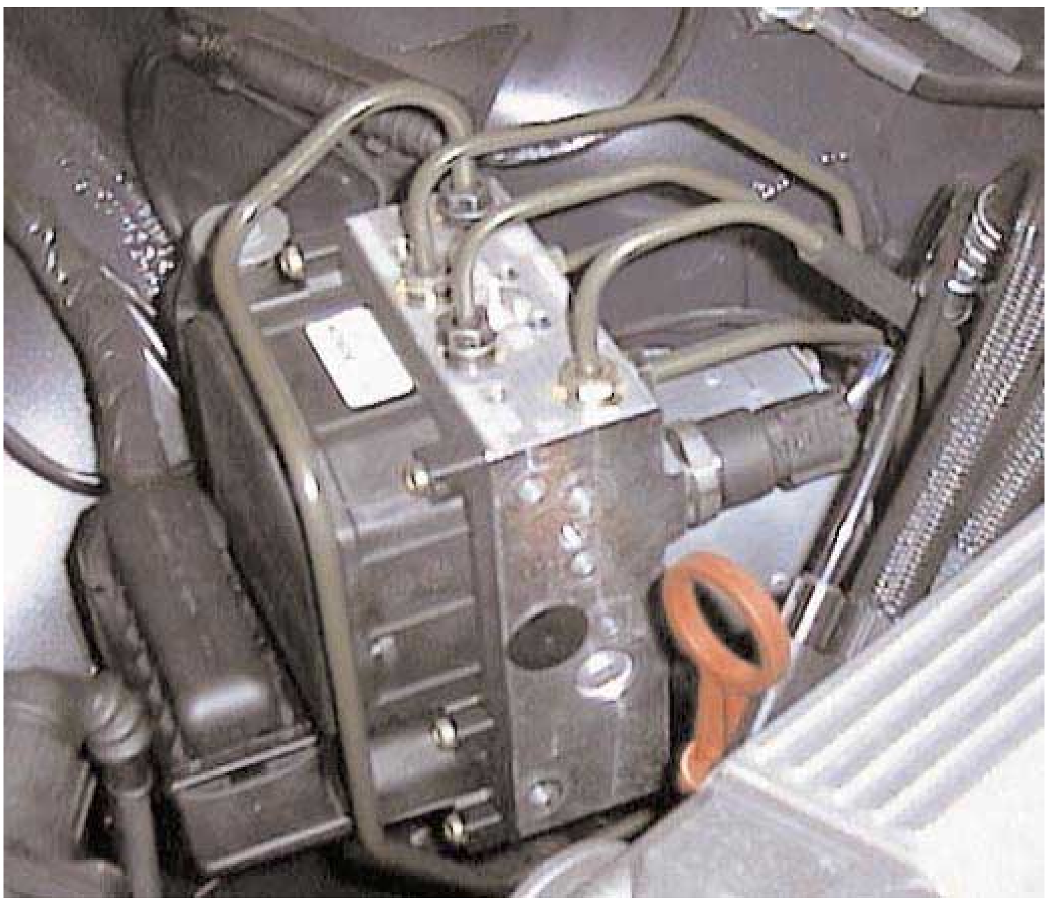
The sensor also produces a linear voltage signal for the lateral acceleration (G-force) that ranges from 0.5 to 4.5 volts. The DSC control module uses this input to determine the side forces acting on the vehicle for DSC regulation.



BRAKE PRESSURE SENSOR

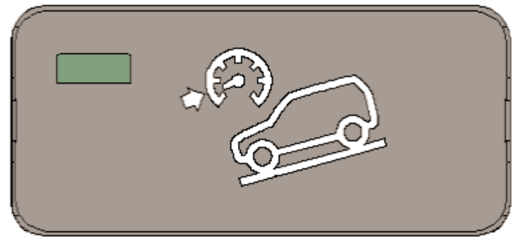
A brake pressure sensor is installed in the hydraulic unit to determine the degree of pressure build-up for Dynamic Brake Control. It is installed in the front axle brake circuit.

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



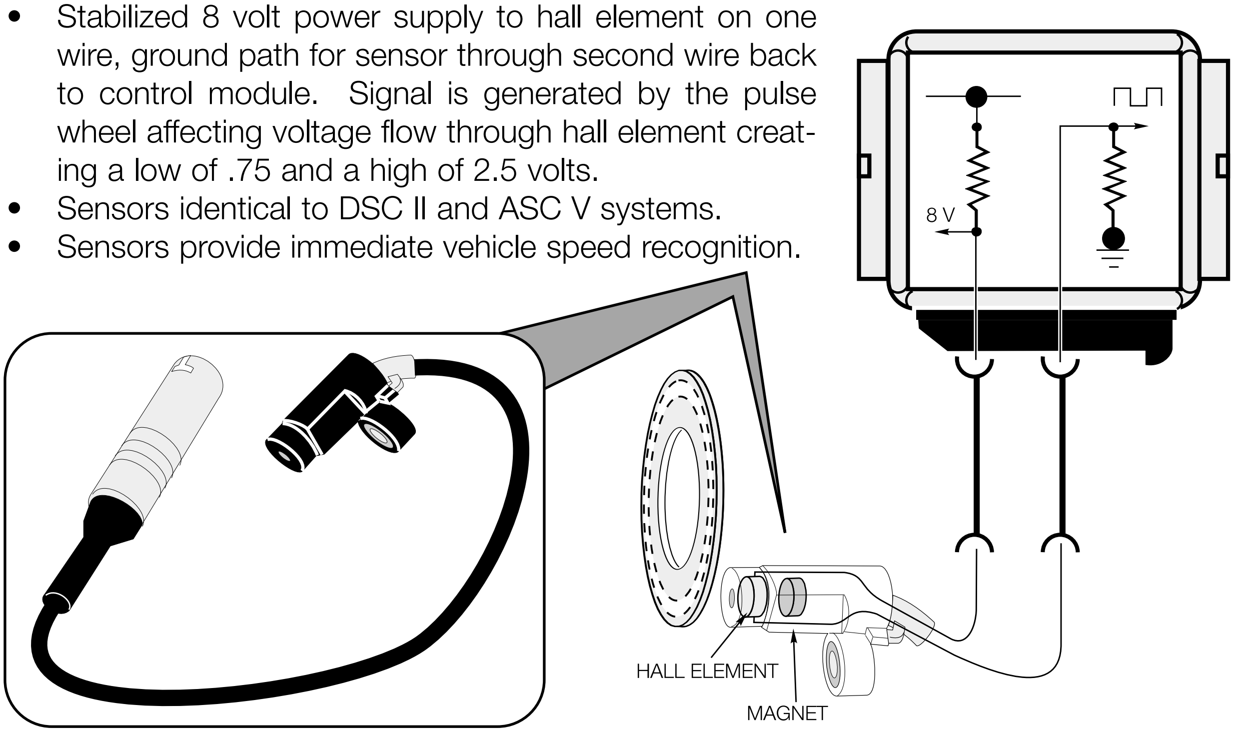
The hill decent control function is activated by pressing the HDC switch located in the center console. The LED will come on steady when the function is in standby and flash when HDC is regulating

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

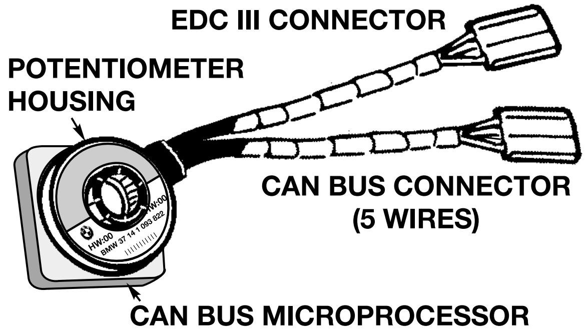
- 2 wire Hall Effect Sensor - “Square wave generator”.
- 48 pulse incremental wheel incorporated in wheel bearing cover for contaminant protection. 48 pulses = one complete wheel revolution.
- Stabilized 8 volt power supply to hall element on one wire, ground path for sensor through second wire back 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.

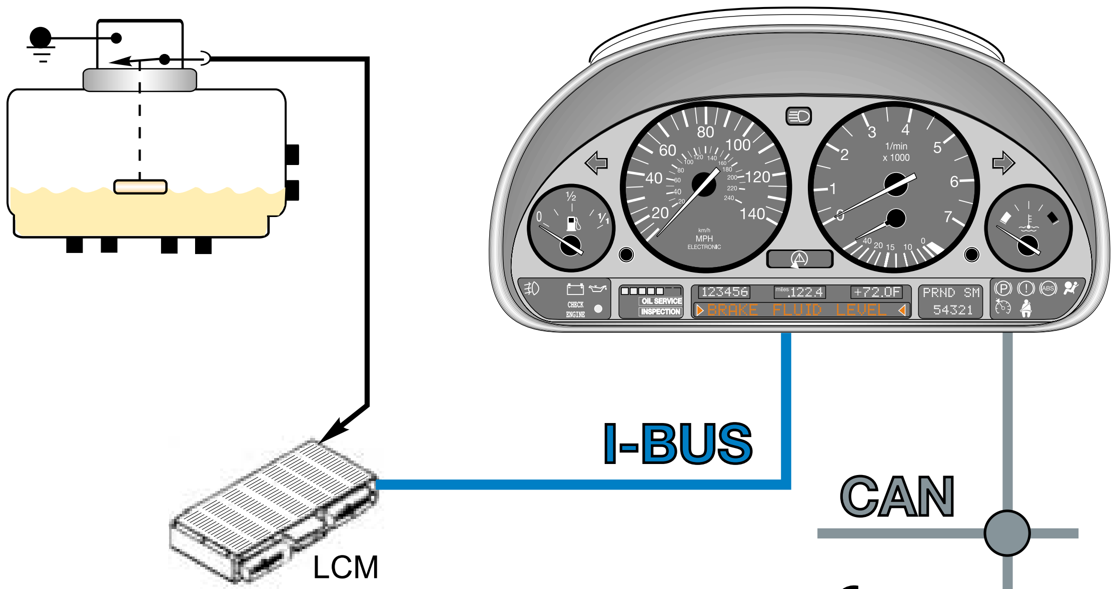
The sensor requires calibration after repairs to the steering or suspension system (found in DIS Service Functions). Once the calibration is completed the sensor now also sends an identification number over the CAN bus to the DSC III module. The ID provides confirmation in the DSC module that the steering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

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.

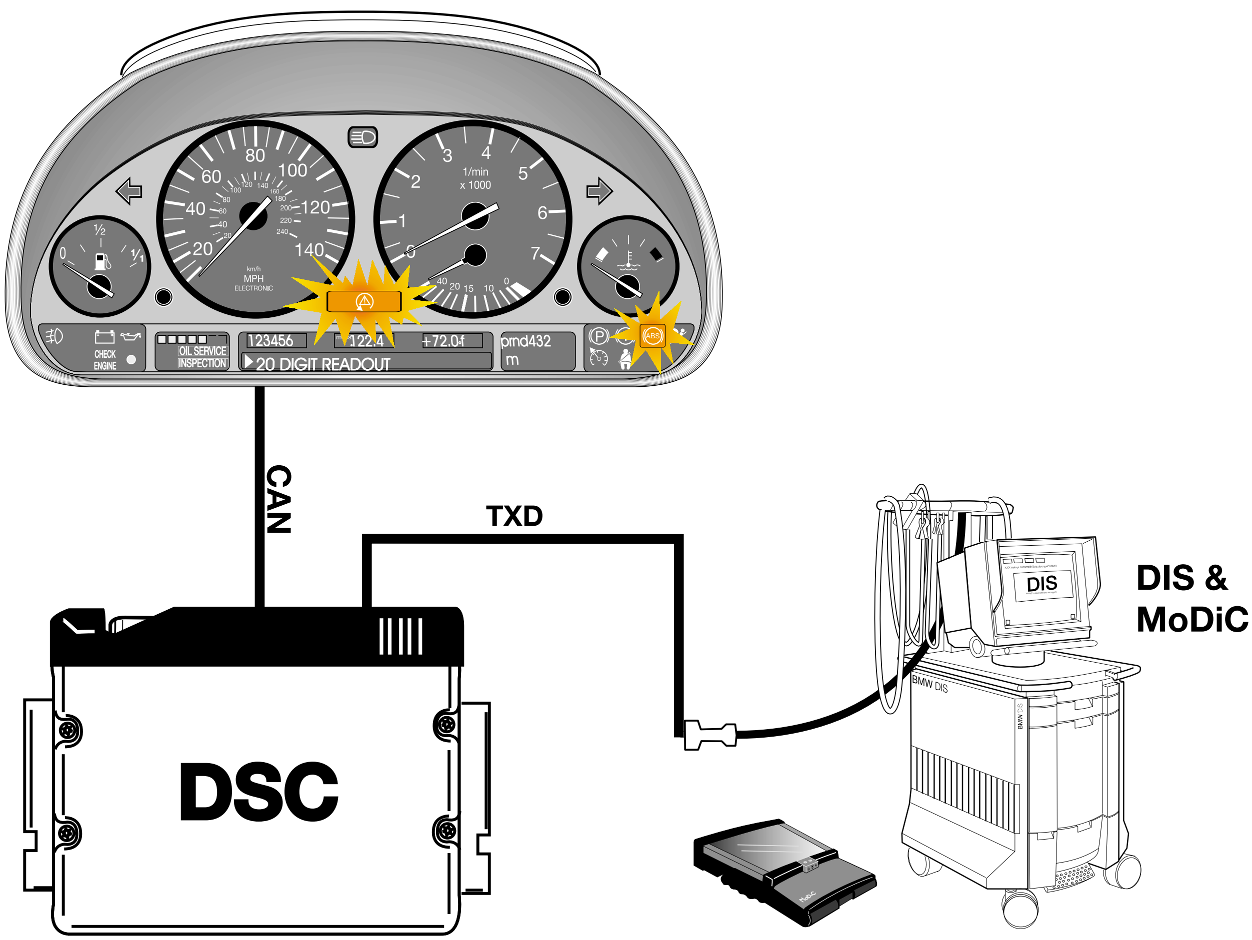


Table of Contents

Subject **Page**

Initial Print Date: 02/2000 Revision Date: 6/2000

M54 ENGINE

Models: E53 X5,
SOP: 3 liter - 4/00

Objectives of the Module:

At the end of this section of the handout, you will be able to:

- Identify the changes to the M54 engines over the M52 TU engine.
- List the design objectives for the M54 engine.

Purpose of the System:

The M54 engine was developed to meet the needs for ULEV compliancy for emission control. The increase in displacement allows the engine to fit the X5 All Roads vehicle while still meeting the demands for power and performance.

INTRODUCTION

The M54 - 6 cylinder engine is being introduced with the 2001 Model Year E53 - X5. The displacement of the new engine for the X5 is 3 liters and the engine will replace the 2.8 liter engine in the E46/Z3 series in 6/2000 and E39 series vehicles in 9/2000.

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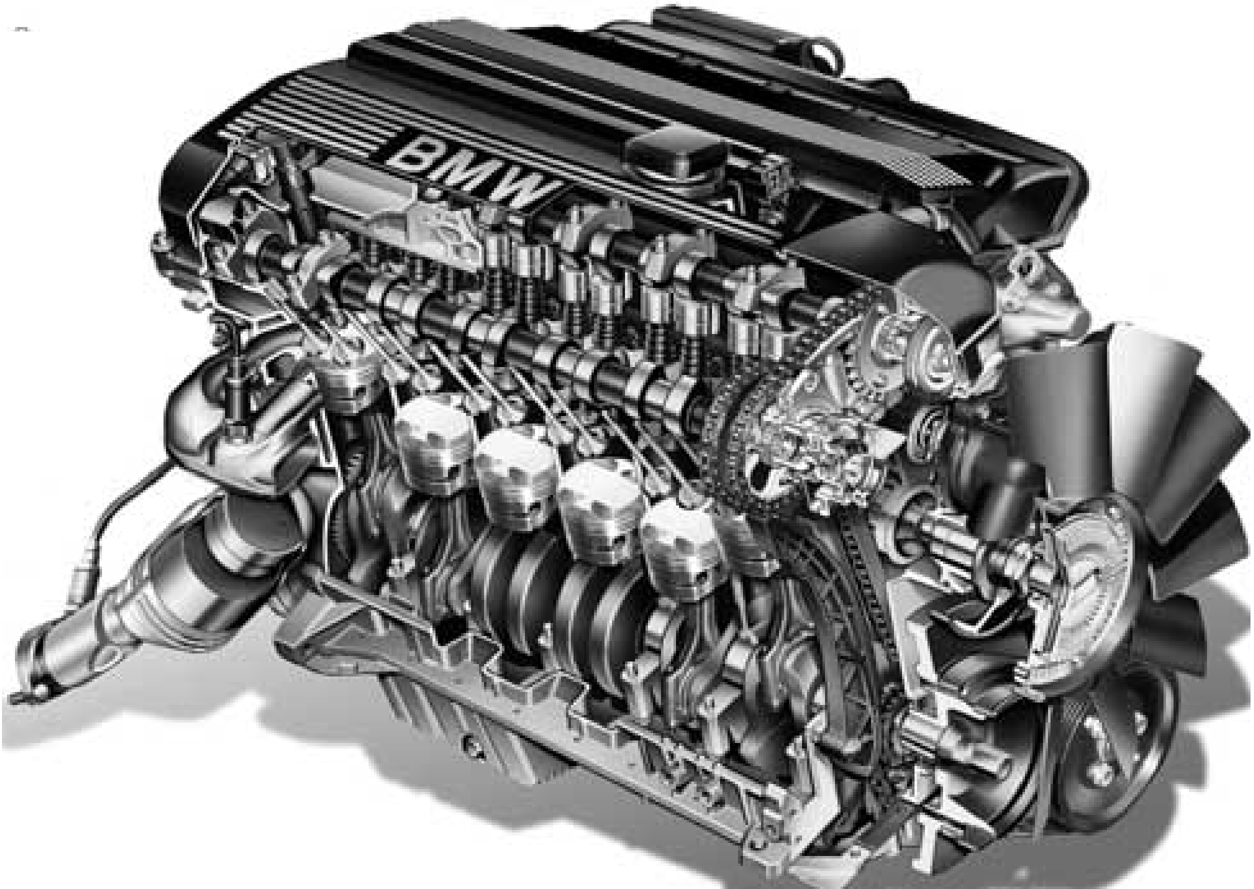
Design objectives for the M54 engine were to provide:

- Lower Emissions
- Maintain Fuel Economy
- Maintain Power and Performance levels

M54 ENGINE



ART-A0021216

	M54B30
HORSE POWER	225@5900RPM
TORQUE	300Nm@3500RPM
BORE	84mm
STROKE	89.6mm
COMPRESSION	10.2:1

M54 ENGINE

Mechanical Changes

In addition to the increased displacement of the M54B30 engine, several mechanical changes were incorporated into the engine for reduced emissions and increased fuel economy. These changes include:

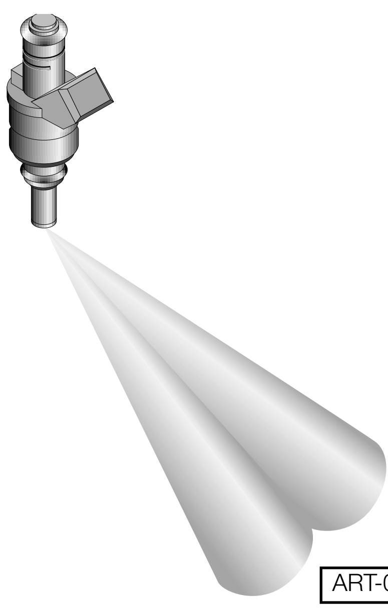
• NEW PISTONS - The piston has a shorter skirt compared to the M52 TU and continues with the graphite coating for friction and emission reducing measures. The piston rings have been modified to reduce friction.

• CRANKSHAFT - The crankshaft for the 3 liter M54 is adopted from the S52B32 - M3 engine.

• CAMSHAFT - The camshaft for the 3 liter M54 is modified with more lift (9.7 mm) and new valve springs to accommodate the increased lift.

• INTAKE MANIFOLD - The intake manifold is modified with shorter ram tubes (20mm shorter on 3 liter. The diameter of the tubes is increased slightly.

• INJECTION VALVES - The diameter of the injection pintle has increased slightly for the increased displacement of the 3 liter engine.


ART-0198U29

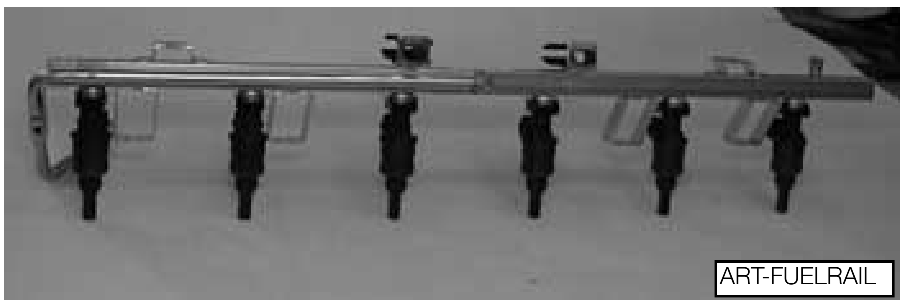

ART-INJECTOR

M54 ENGINE

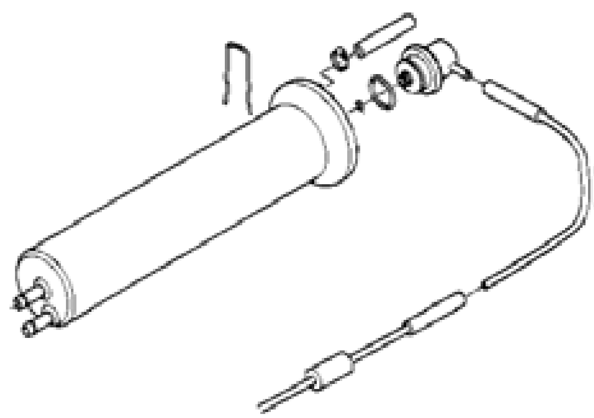
MECHANICAL CHANGES

NON RETURN FUEL RAIL SYSTEM

The M54 engine with MS 43.0 control uses the non return fuel rail system introduced on the M62 TU engine. The system meets running loss compliance without the use of the 3/2-way solenoid valve currently used on the M52 TU engine.

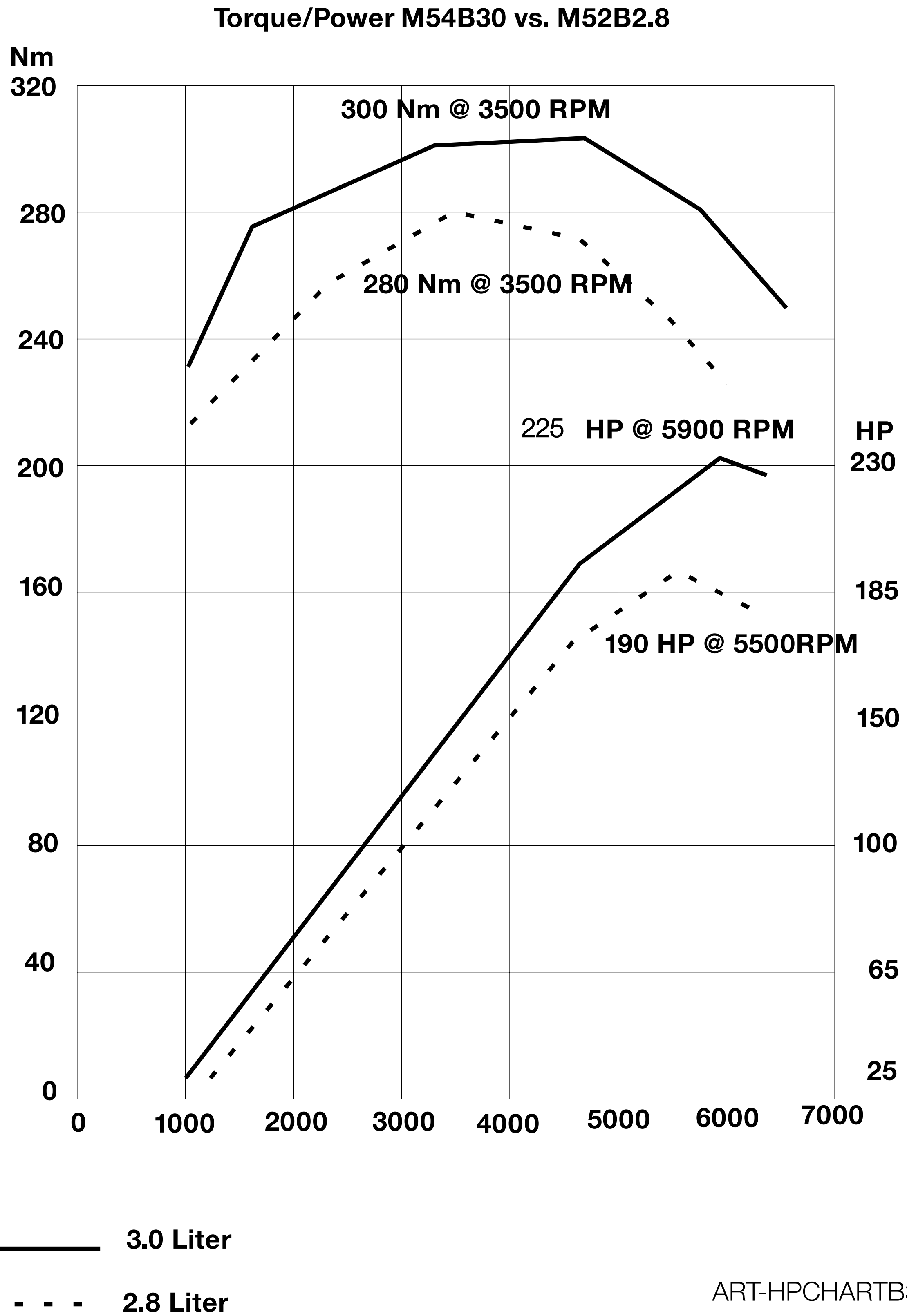


The regulated fuel supply is controlled by the fuel pressure regulator integrated in the fuel filter. The fuel return line is also located on the filter.



The M54 engine uses an Electronic Controlled Throttle Valve (EDK) for intake air control. The idle control valve and turbulence function of the intake manifold carries over from the M52 TU engine.

M54B30 ENGINE



ART-HPCHARTB30.

REVIEW QUESTIONS

1. What is the major reason for the development of the M54 engine?

2. What are the major mechanical changes that were integrated into the3 liter M54 engine?

SIEMENS ENGINE MANAGEMENT SYSTEM

Models: E53 X5

SOP: 3 liter - 4/00

Objectives of the Module:

At the end of this section of the handout you will be able to:

- Identify the changes that have occurred to the MS 43 system compared to the MS 42
- Describe the operation of the new inputs
- Describe the operation of the new outputs
- Discuss which new components/subsystems relate directly to ULEV compliancy

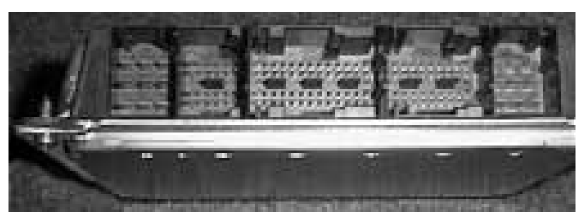
This new generation Siemens system is designated as MS 43.0.

Siemens MS 43.0 is a newly developed engine management system to meet the needs of Ultra Low Emission Vehicle (ULEV) compliancy and continuing with present systems is also OBD II compliant. This system also includes control of the Motor-driven Throttle Valve (EDK).

The ECM uses a pc-board dual-processor control unit in the SKE housing configuration. The MS 43.0 ECM is flash programmable as seen with previous systems.

ECM hardware includes:
Modular plug connectors featuring 5 connectors in the SKE housing with 134 pins.

- Connector 1 = Supply voltages and grounds
- Connector 2 = Peripheral signals (oxygen sensors, CAN, etc.)
- Connector 3 = Engine signals
- Connector 4 = Vehicle signals
- Connector 5 = Ignition signals

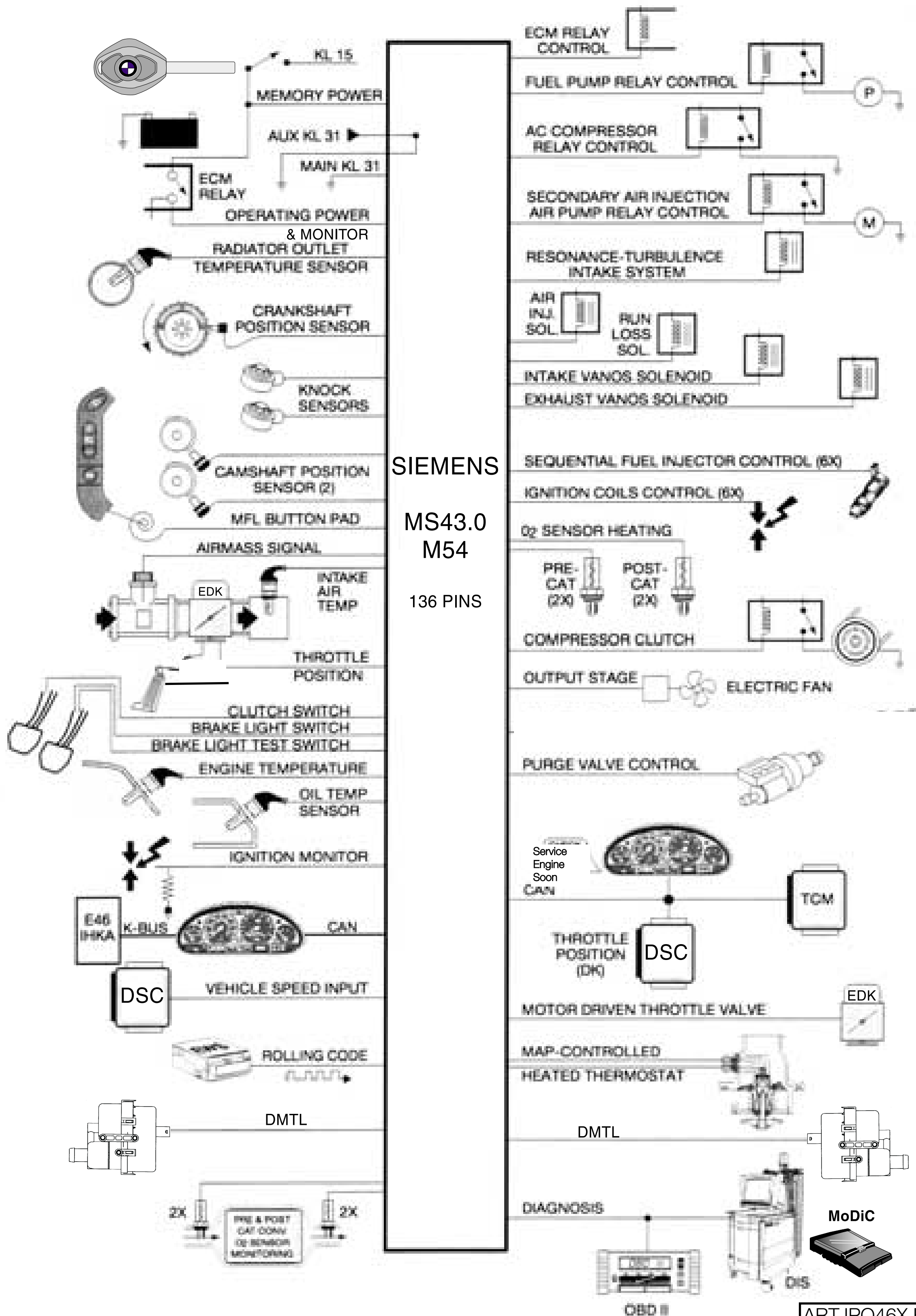


Special features:

- Flash EPROM which is adaptable to several M52 LEV engines and has the capability to be programmed up to 13 times

- Once a control unit is installed and coded to a vehicle it cannot be swapped with another vehicle for diagnosing or replacement (because of EWS 3.3).

SYSTEM OVERVIEW I-P-O



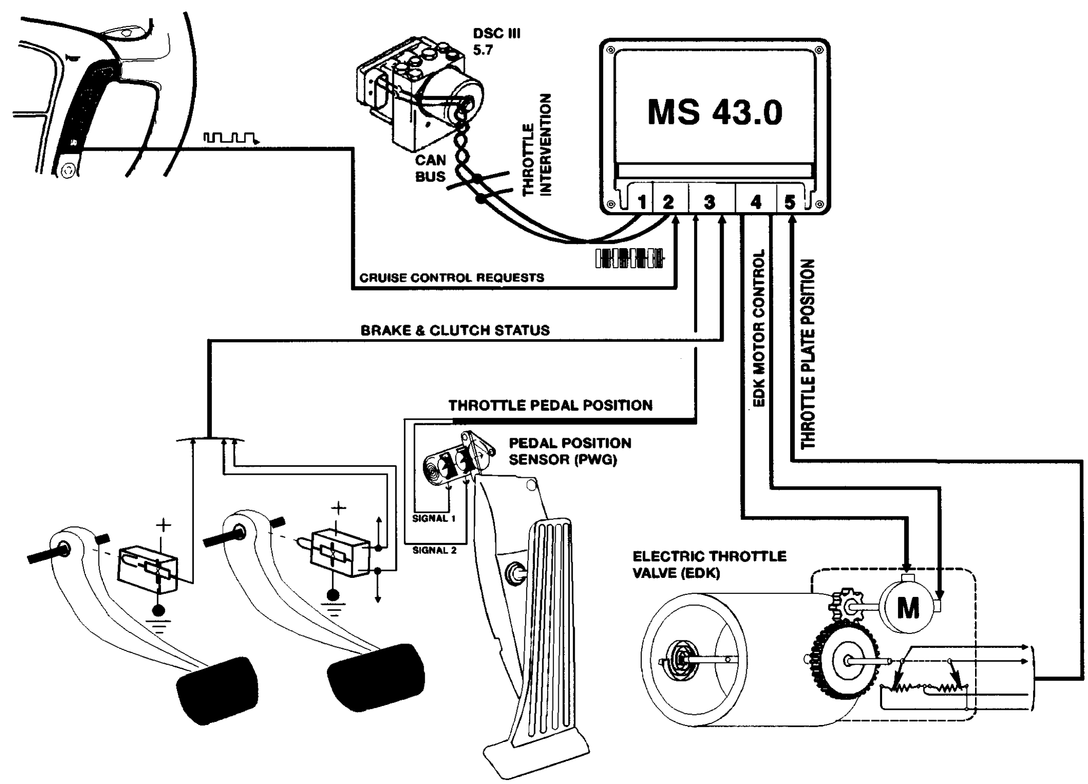
ART-IPO46X.EPS

MS 43 NEW FUNCTIONS

ELECTRONIC THROTTLE SYSTEM - EML

The M54 engine with MS 43 engine control uses an electronic throttle control system adopted from the ME 7.2 system on the M62 engine. The system incorporates an electric throttle valve (EDK) and pedal position sensor (PWG) for engine power control.

The MS 43 control module monitors the PWG input and activates the EDK motor based on the programmed maps for throttle control. The MS 43 module self checks the activation of the EDK via feedback potentiometers motor on the EDK motor.



ART-SCANDIAGRAM

Additional functions of the EML system include:

• Cruise control function
• DSC throttle interventions
• Maximum engine and road speed control

MS 43 NEW FUNCTIONS

ACCELERATOR PEDAL SENSOR

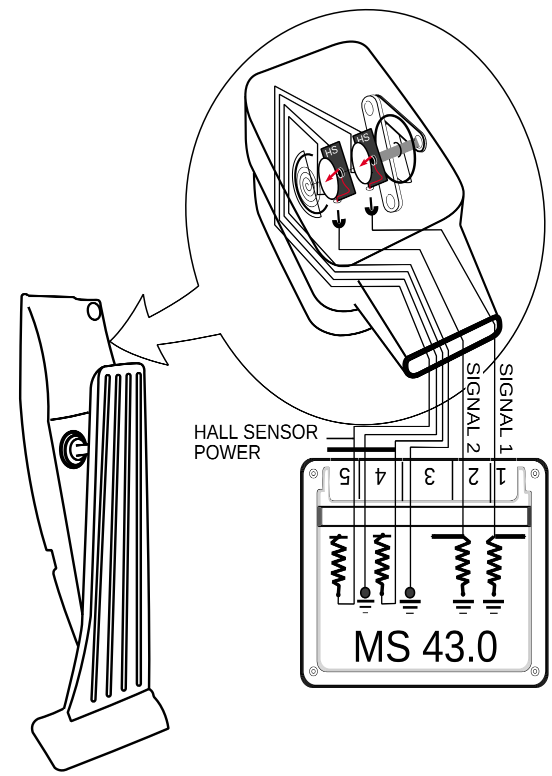
The accelerator pedal sensor is similar to the PWG used on the ME 7.2 system. It is integrated into the accelerator pedal housing. Two hall sensors are used to provide the driver's input request for power.

The hall sensors receive power (5 volts) and ground from the MS 43 control module and produce linear voltage signals as the pedal is pressed from LL to VL.

PWG SENSOR 1 = 0.5 to 4.5 V

PWG SENSOR 2 = 0.5 to 2.0 V

The MS 43 control module uses the signal from sensor 1 as the driver's request and the signal from sensor 2 as plausibility checking.



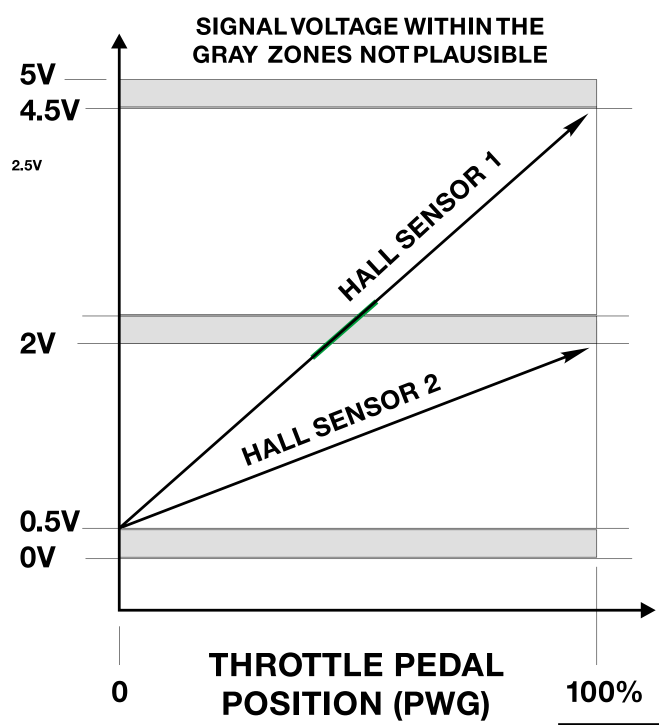
61460015

MS 43 NEW FUNCTIONS

ACCELERATOR PEDAL SENSOR

PWG SIGNAL MONITORING & PWG FAILSAFE OPERATION:

- As a redundant safety feature the PWG provides two separate signals from two integral angle hall sensors (HS #1 and HS #2) representing the driver's request for throttle activation.
- If the monitored PWG signals are not plausible, MS 43.0 will only use the lower of the two signals as the driver's pedal request input providing failsafe operation. Throttle response will be slower and maximum throttle position will be reduced.
- When in PWG failsafe operation, MS 43.0 sets the EDK throttle plate and injection time to idle (LL) whenever the brake pedal is depressed.
- When the system is in PWG failsafe operation, the instrument cluster matrix display will post "Engine Emergency Program" and PWG specific fault(s) will be stored in memory.



E46ICPOT-SIG.

MS 43 NEW FUNCTIONS

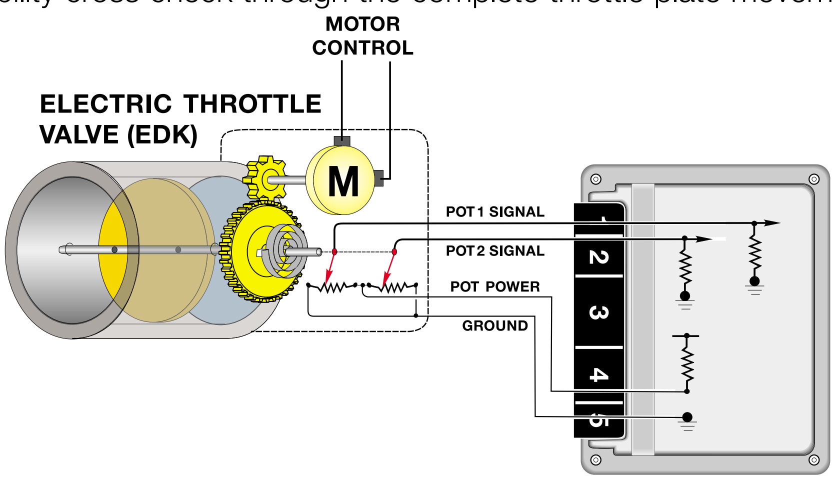
EDK THROTTLE POSITION FEEDBACK SIGNALS

The EDK throttle plate is monitored by two integrated potentiometers. The potentiometers provide linear voltage feedback signals to the control module as the throttle plate is opened and closed.

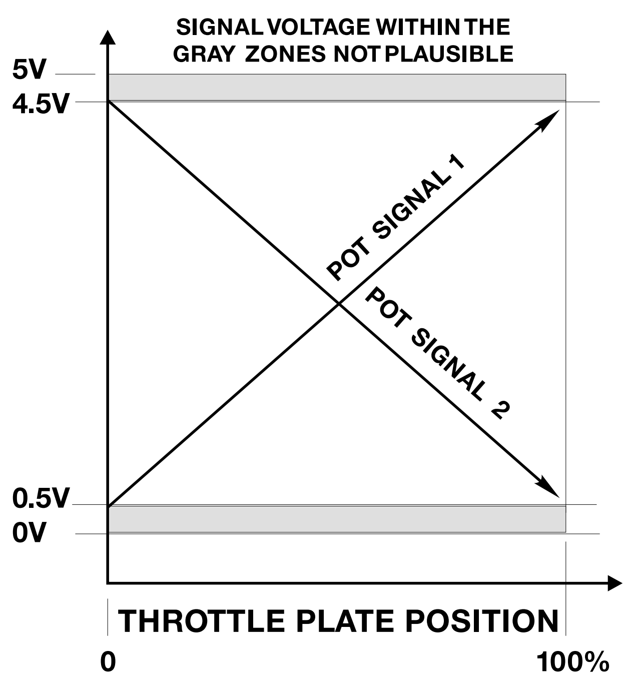
Feedback signal 1 provides a signal from 0.5 V (LL) to 4.5 V (VL).

Feedback signal 2 provides a signal from 4.5 V (LL) to 0.5 V (VL)

Potentiometer signal 1 is the primary feedback signal of throttle plate position and signal 2 is the plausibility cross check through the complete throttle plate movement.



ART-EDK.EPS1



ART-E46ICPWG2.

MS 43 NEW FUNCTIONS

EDK THROTTLE POSITION FEEDBACK SIGNALS

EDK FEEDBACK SIGNAL MONITORING & EDK FAILSAFE OPERATION:

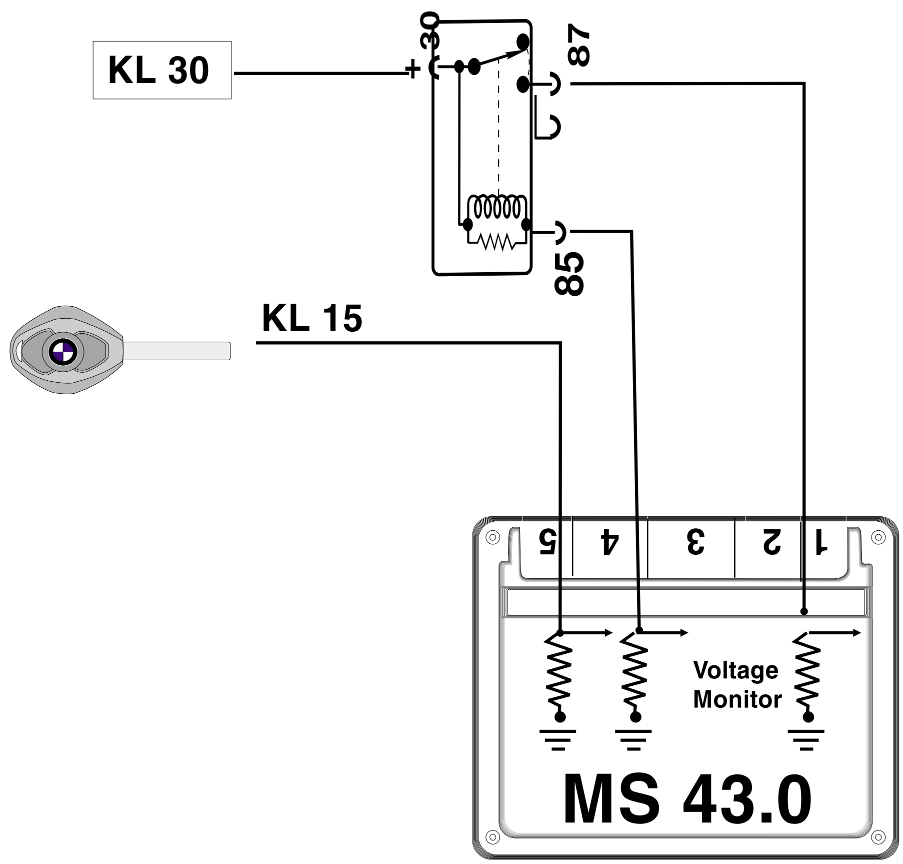
- The EDK provides two separate signals from two integral potentiometers (Pot 1 and Pot 2) representing the exact position of the throttle plate.
- EDK Pot 1 provides the primary throttle plate position feedback. As a redundant safety feature, Pot 2 is continuously cross checked with Pot 1 for signal plausibility.
- If plausibility errors are detected between Pot 1 and Pot 2, MS 43.0 will calculate the inducted engine air mass (from HFM signal) and only utilize the potentiometer signal that closely matches the detected intake air mass.
    - The MS 43.0 uses the air mass signalling as a “virtual potentiometer” (pot 3) for a comparative source to provide failsafe operation.
    - If MS 43.0 cannot calculate a plausible conclusion from the monitored pots (1 or 2 and virtual 3) the EDK motor is switched off and fuel injection cut out is activated (no failsafe operation possible).
- The EDK is continuously monitored during all phases of engine operation. It is also briefly activated when KL 15 is initially switched on as a “pre-flight check” to verify it’s mechanical integrity (no binding, appropriate return spring tension, etc). This is accomplished by monitoring both the motor control amperage and the reaction speed of the EDK feedback potentiometers. If faults are detected the EDK motor is switched off and fuel injection cut off is activated (no failsafe operation possible). The engine does however continue to run extremely rough at idle speed.
- When a replacement EDK is installed, the MS 43.0 adapts to the new component (required amperage draw for motor control, feedback pot tolerance differences, etc). This occurs immediately after the next cycle of KL 15 for approximately 30 seconds. During this period of adaptation, the maximum opening of the throttle plate is 25%.

MS 43 NEW FUNCTIONS

MAIN RELAY MONITOR

The MS 43.0 system incorporates a new monitoring feature for terminal 87 (KL 87) of the main relay. The relay is monitored internally for the voltage level at KL 87. Five seconds after the ignition key is switched on, and the voltage at the KL 15 input is greater than 9 volts, the control module checks the voltage at KL 87.

If the voltage difference between the two terminals is greater than 3 volts, a fault will be stored in the ECM.



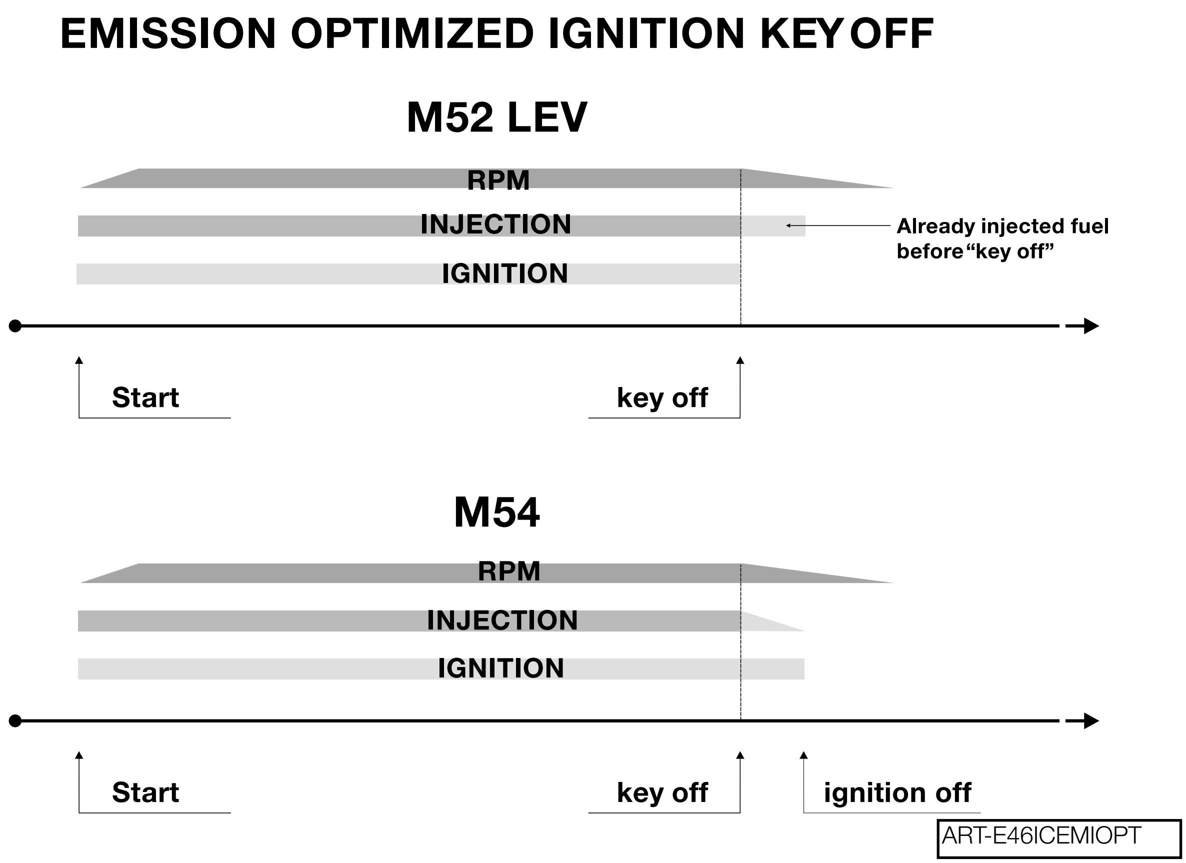
ART-E46ICMS43RELAY

MS 43 NEW FUNCTIONS

EMISSION OPTIMIZED - IGNITION KEY OFF

"Emission Optimized Ignition Key Off" is a programmed feature of the MS 43 control module.
After the ECM detects KL 15 being switched OFF, the ignition stays active for two more individual coil firings. This means that just two cylinders are fired - not two revolutions.

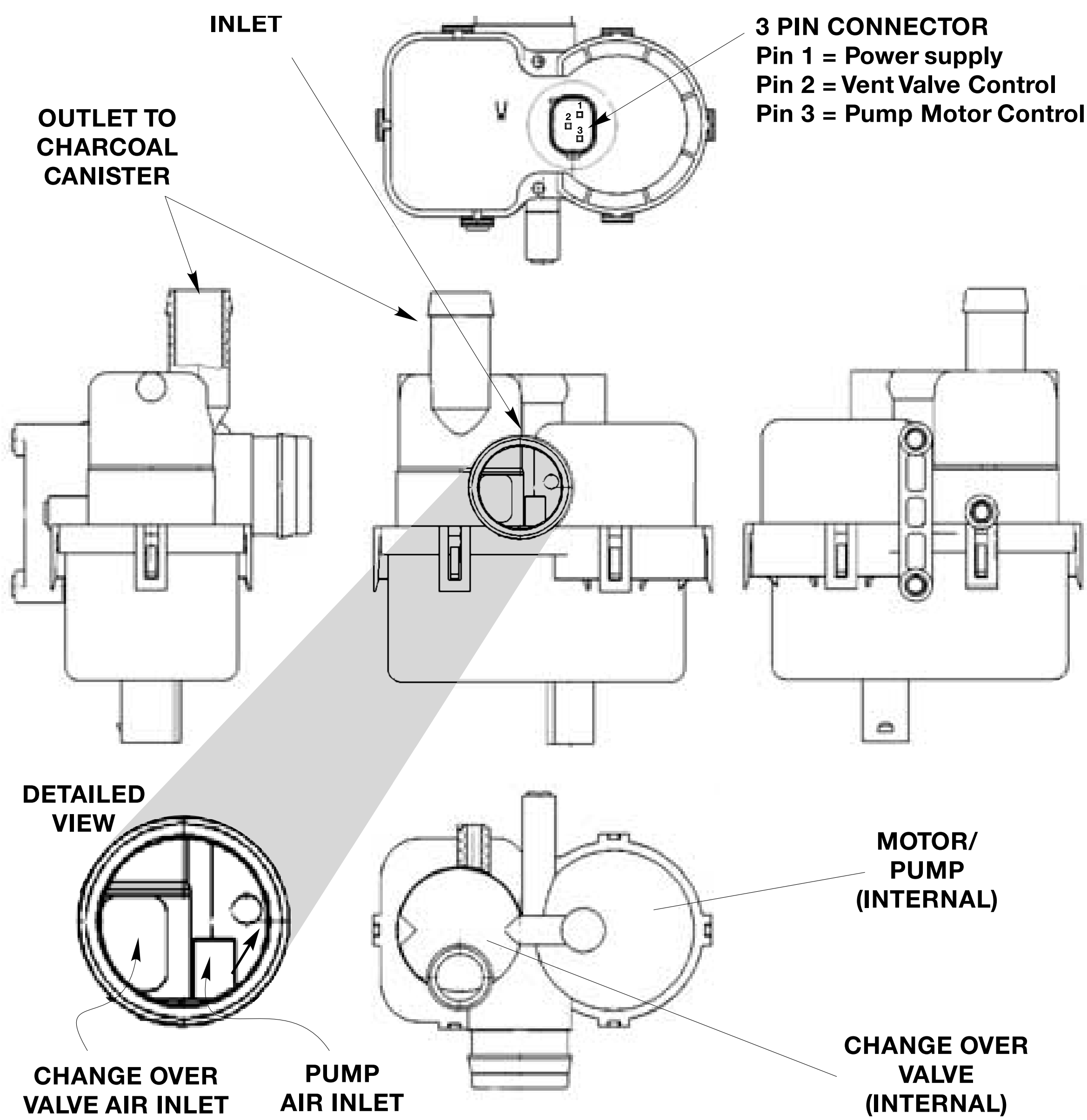
This feature allows residual fuel injected into the cylinders, as the ignition key is switched off, to be burned as the engine runs down.



MS 43 NEW FUNCTIONS

DM-TL (DIAGNOSIS MODULE - TANK LEAKAGE)

The M54 engine with the Siemens MS43.0 engine control system uses the DMTL system for fuel system leakage monitoring. The pump is manufactured by Bosch for use with the Siemen's control system.



DM-TL (DIAGNOSIS MODULE - TANK LEAKAGE)

FUNCTIONAL OVERVIEW:

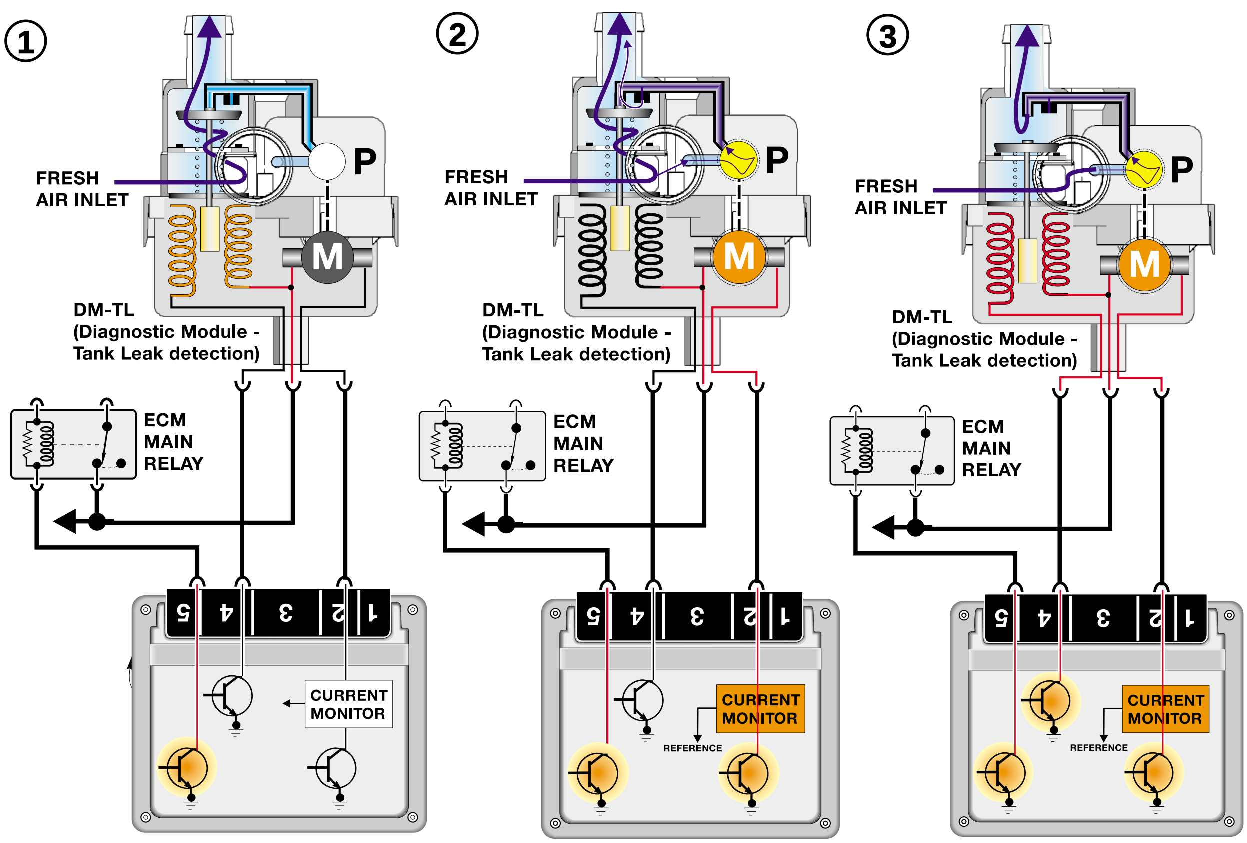
The DM-TL is located in the drivers side rear wheel well in the X5 and next to the charcoal canister on the E46 - M54.

1. In it's inactive state, filtered fresh air enters the evaporative system through the sprung open valve of the DM-TL.

2. When the DME activates the DM-TL for leak testing, it first activates only the pump motor. This pumps air through a restrictor orifice (1.0 or 0.5 mm) which causes the electric motor to draw a specific amperage value. This value is equivalent to the size of the restrictor.

3. The solenoid valve is then energized which seals the evap system and directs the pump output to pressurize the evap system.

The evap system is detected as having a large leak if the amperage value is not realized, a small leak if the same reference amperage is realized or no leak if the amperage value is higher than the reference amperage.

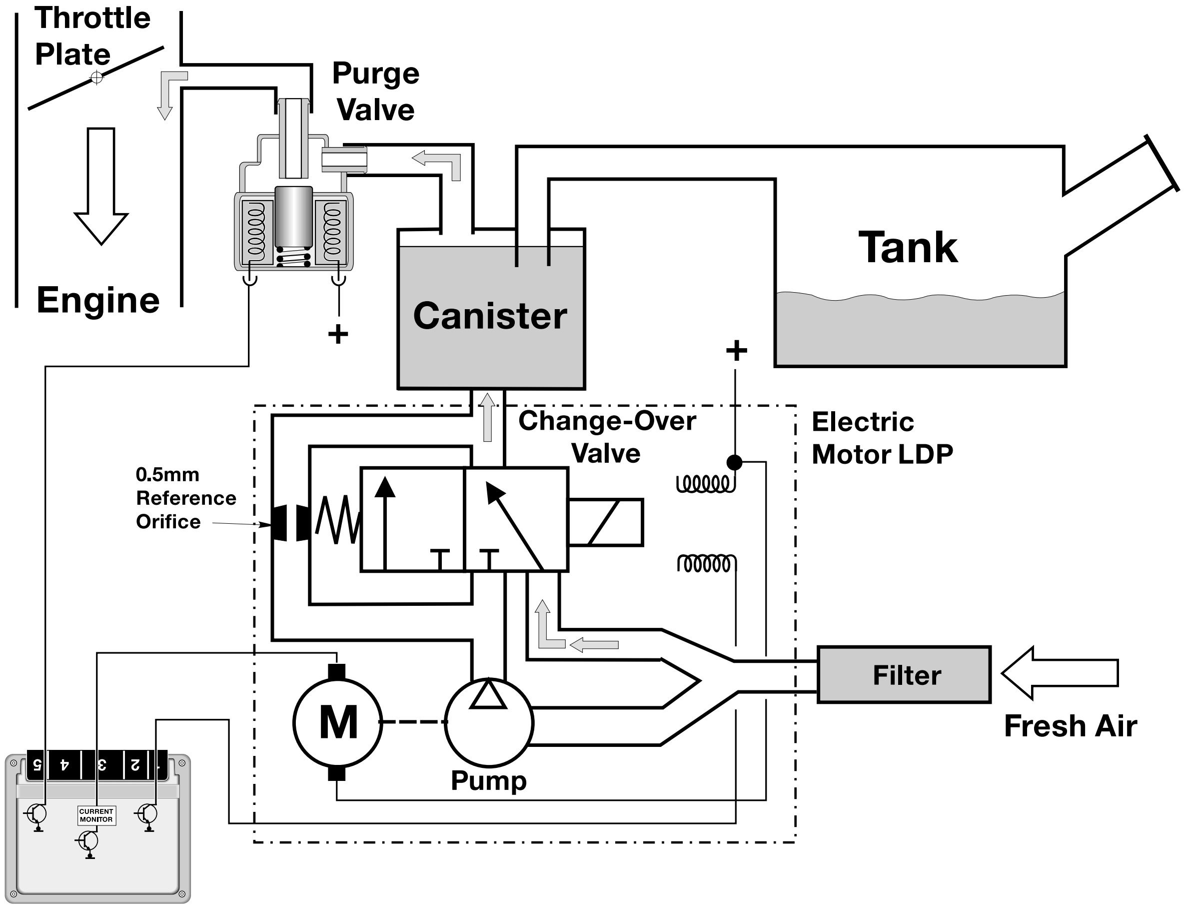


DM-TL (DIAGNOSIS MODULE - TANK LEAKAGE)

FUNCTION

The DC Motor LDP ensures accurate fuel system leak detection for leaks as small as 0.5mm (.020”). The pump contains an integral DC motor which is activated directly by the engine control module. The ECM monitors the pump motor operating current as the measurement for detecting leaks.

The pump also contains an ECM controlled change over valve that is energized closed during a Leak Diagnosis test. The change over valve is open during all other periods of operation allowing the fuel system to “breath” through the inlet filter (similar to the full down stroke of the current vacuum operated LDP).



LEAK DIAGNOSIS TEST PRECONDITIONS

The ECM only initiates a leak diagnosis test every second time the criteria are met. The criteria is as follows:

- Engine **OFF** with ignition switched **OFF**.
- Engine Control Module still in active state or what is known as “follow up mode” (Main Relay energized, control module and DME components online for extended period after key off).
- Prior to Engine/Ignition switch OFF condition, vehicle must have been driven for a minimum of 20 minutes.
- Prior to minimum 20 minute drive, the vehicle must have been OFF for a minimum of 5 hours.
- Fuel Tank Capacity must be between **15 and 85%** (safe approximation between 1/4 - 3/4 of a tank).
- Ambient Air Temperature between **-7°C & 35°C** (20°F & 95°F)
- Altitude **< 2500m** (8,202 feet).
- Battery Voltage between **11.5 and 14.5 Volts**

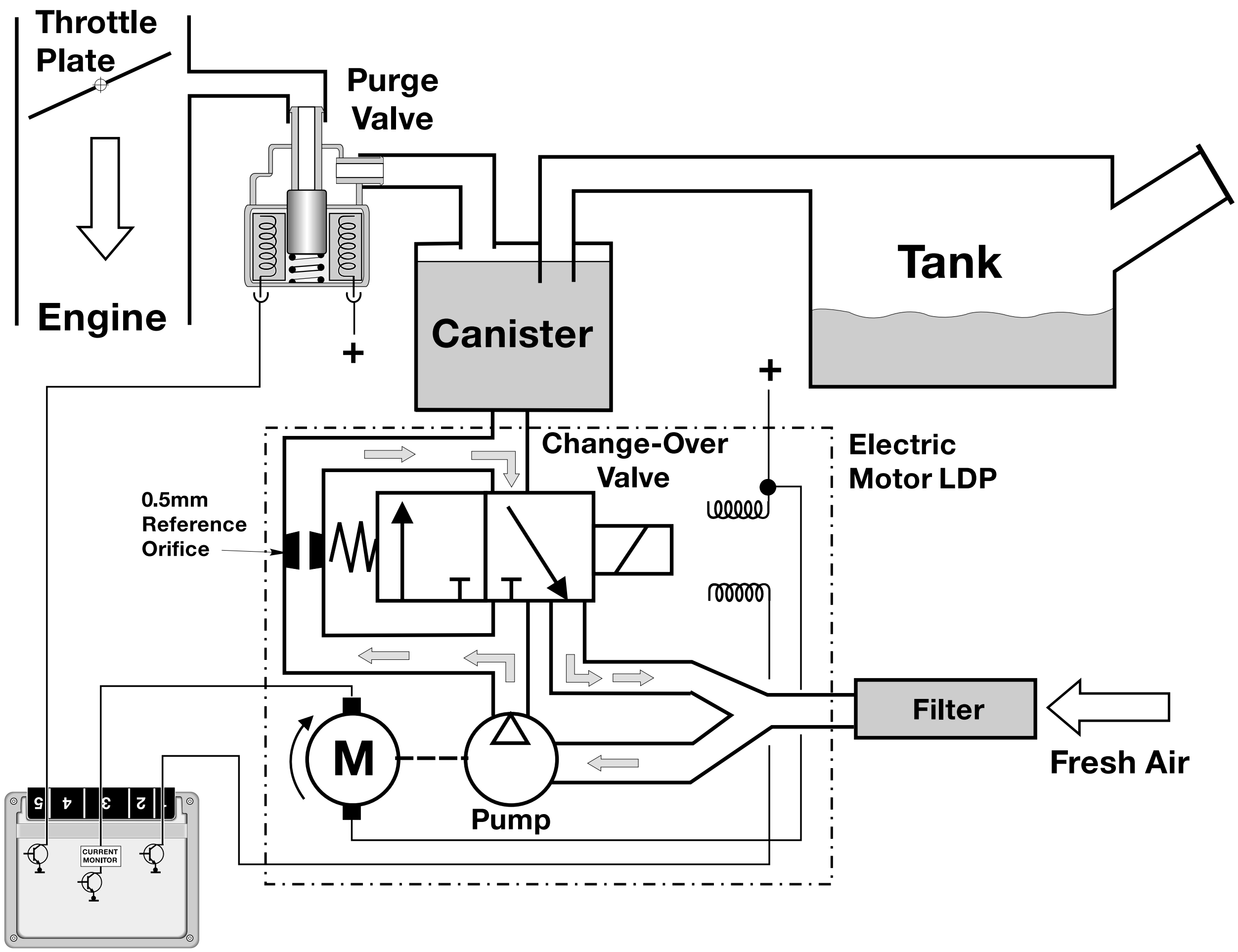
When these criteria are satisfied every second time, the ECM will start the Fuel System Leak Diagnosis Test. The test will typically be carried out once a day i.e. once after driving to work in the morning, when driving home in the evening, the criteria are once again met but the test is not initiated. The following morning, the test will run again.

LEAK DIAGNOSIS TEST

PHASE 1 - REFERENCE MEASUREMENT

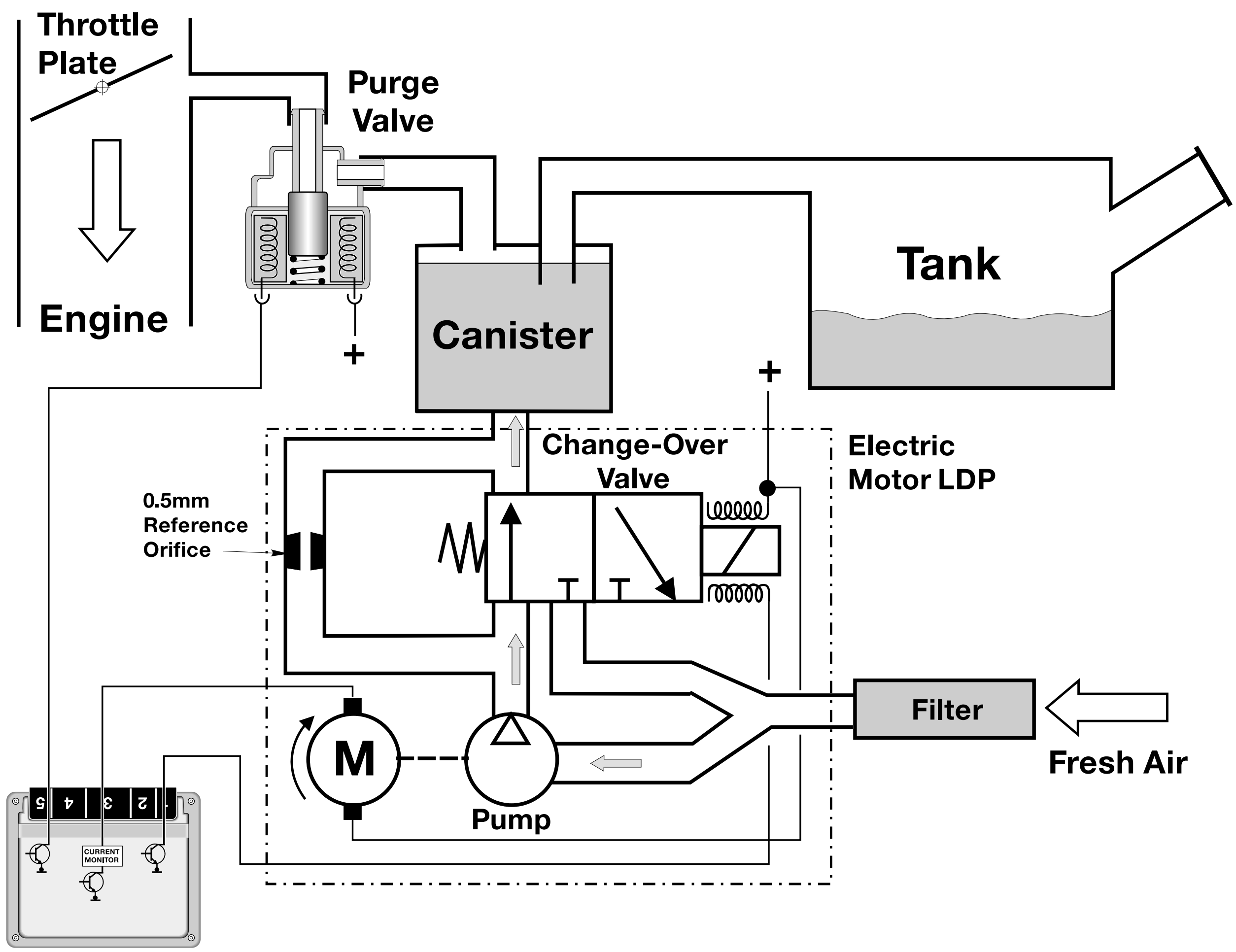
The ECM activates the pump motor. The pump pulls air from the filtered air inlet and passes it through a precise 0.5mm reference orifice in the pump assembly.

The ECM simultaneously monitors the pump motor current flow . The motor current raises quickly and levels off (stabilizes) due to the orifice restriction. The ECM stores the stabilized amperage value in memory. The stored amperage value is the electrical equivalent of a 0.5 mm (0.020”) leak.



PHASE 2 - LEAK DETECTION

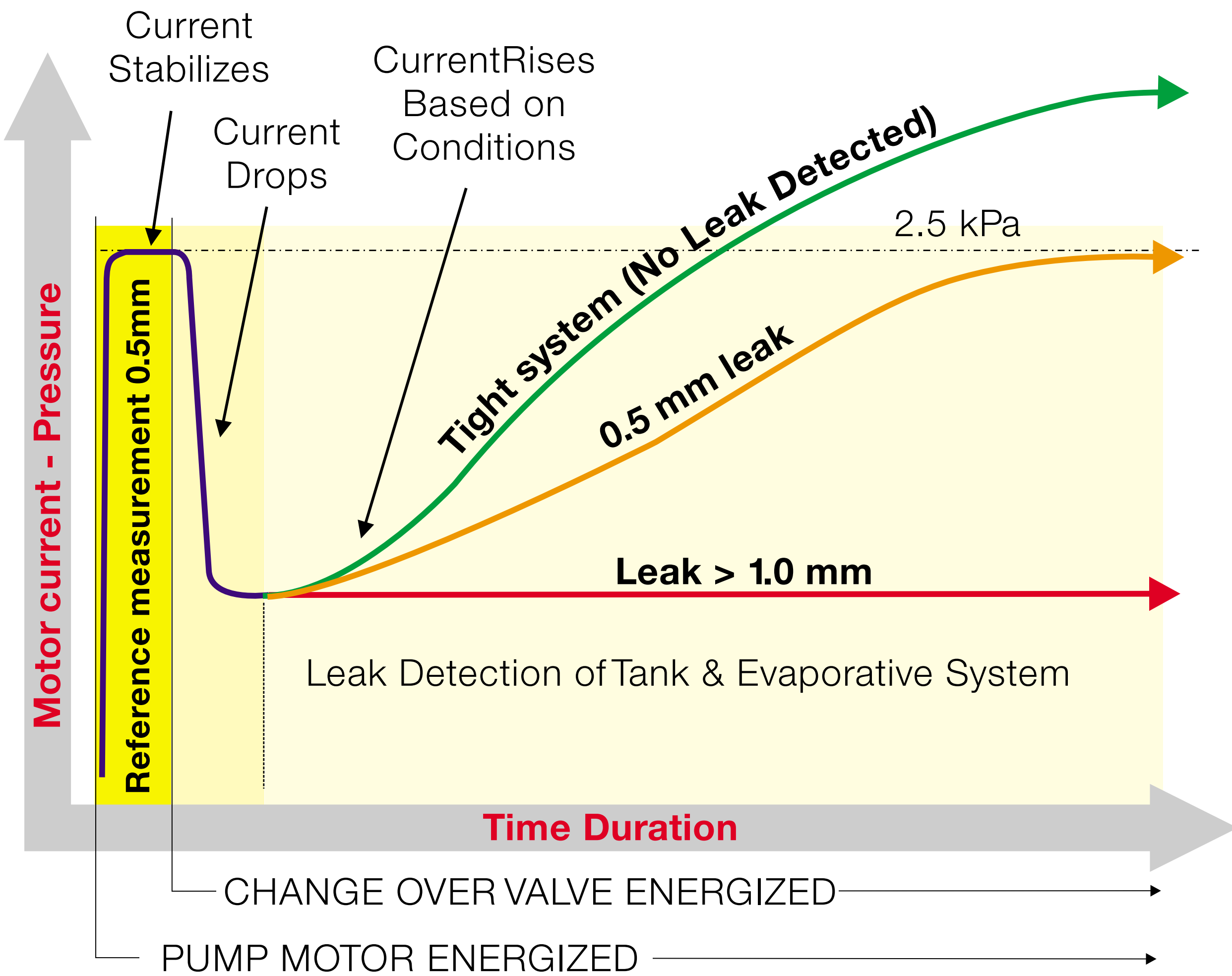
The ECM energizes the Change Over Valve allowing the pressurized air to enter the fuel system through the Charcoal Canister, The ECM monitors the current flow and compares it with the stored reference measurement over a duration of time.



Once the test is concluded, the ECM stops the pump motor and immediately de-energizes the change over valve. This allows the stored pressure to vent thorough the charcoal canister trapping hydrocarbon vapor and venting air to atmosphere through the filter.

TEST RESULTS

The time duration varies between 45 & 270 seconds depending on the resulting leak diagnosis test results (developed tank pressure "amperage" / within a specific time period). However the chart below depicts the logic used to determine fuel system leaks.



MS 43 CARRY OVER FUNCTIONS

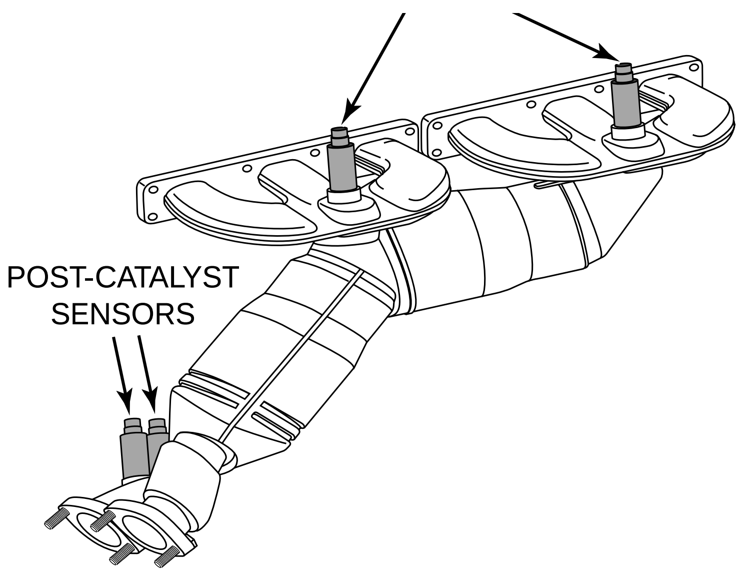
INPUT FUNCTIONS

BOSCH OXYGEN SENSORS

The MS43.0 system uses Bosch LSH 25 oxygen sensors that function basically the same as previously used (in Bosch systems). The voltage range is between 0 - 800 mV.

PRE 02 SENSOR **POST 02 SEN-**
SOR

The location remains the same with the pre-cat sensors are mounted on top of the exhaust manifolds. The catalysts are now integral with the exhaust manifolds (further detailed in the M52 TU engine section).



OXYGEN SENSOR SIGNAL INFLUENCE ON INJECTOR "OPEN" TIME

The ECM monitors the:

- Amplitude of the signal (highest voltage or range sensor is producing)
- Switching time of the signal (how fast from lean to rich)
- Frequency of complete cycles (how many within a period of time)

These characteristics provide info to the ECM that reflect the overall condition of the sensor.

POST CATALYTIC CONVERTER SENSOR SIGNAL

The post catalyst O2 sensors monitor the efficiency of the catalyst as a requirement of OBD II. This signal also provides feedback of the pre-catalyst sensors efficiency and can cause the ECM to "trim" the ms injection time to correct for slight deviations.

- If the catalyst is operating efficiently, most of the remaining oxygen in the exhaust gas is burned (lack of O2 - "constant lean signal").

  The sensor signal fluctuates slightly in the higher end of the voltage scale.

- If the post sensor shows ***excessive fluctuations*** (which echo the scope pattern of the pre sensor), this indicates that the catalytic converter is not functioning correctly and cannot consume the O2 (fault set).

- If the post sensor fluctuations move out of the normal voltage "window", this indicates that the pre sensor is not performing properly due to ***slight*** deterioration. These systems can also "trim" the ms injection time to compensate for this.

The constantly changing oxygen sensor input to the ECM is needed to correct the ms injection time to ensure that the ideal air/fuel ratio is maintained.

CAMSHAFT SENSOR
-INTAKE AND EXHAUST CAMSHAFTS

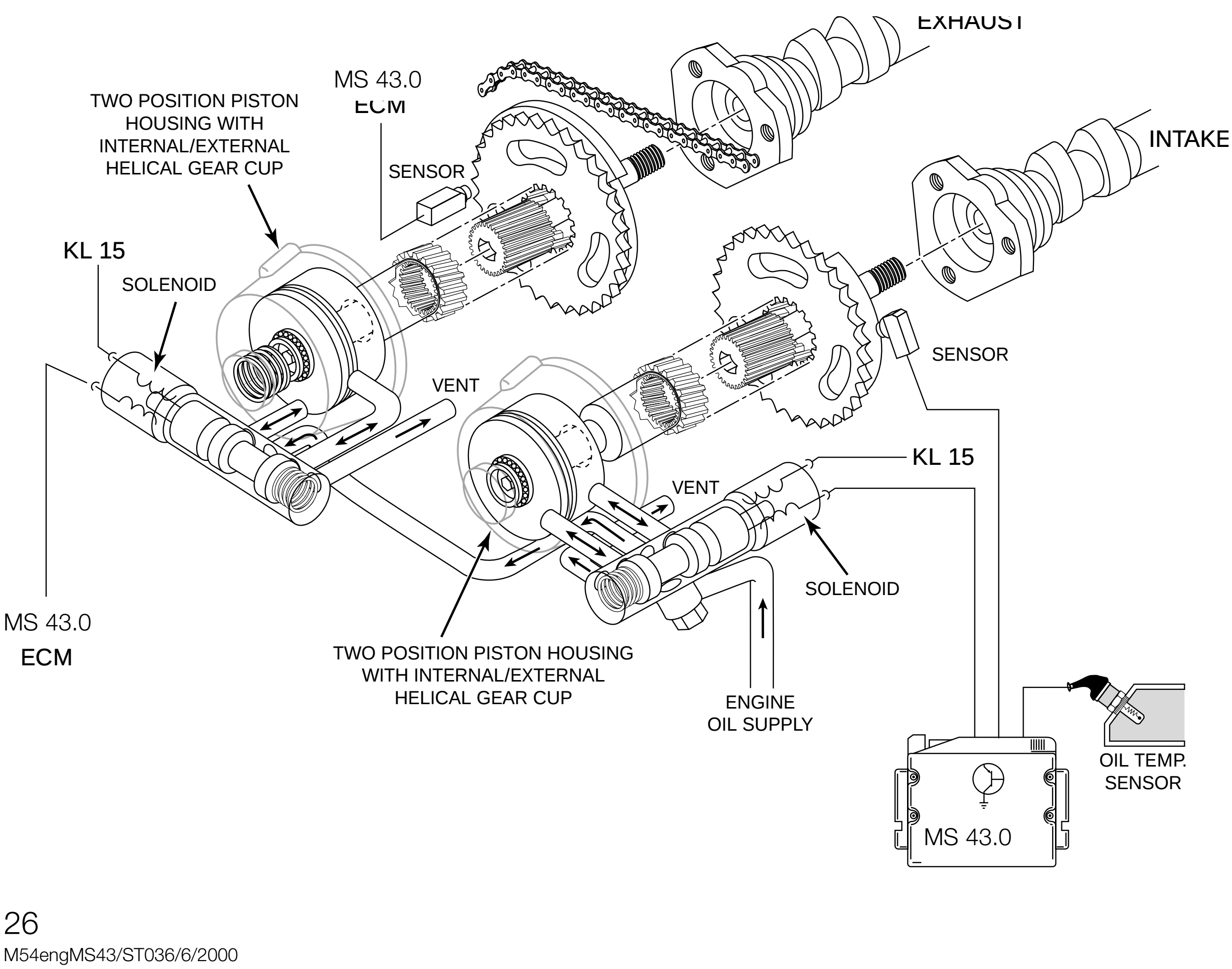
The "static" Hall sensors are used so that the camshaft positions are recognized once ignition is “on” - even before the engine is started.

The function of the intake cam sensor:

- Cylinder bank detection for preliminary injection
- Synchronization
- Engine speed sensor (if crankshaft speed sensor fails)
- Position control of the intake cam (VANOS)

The exhaust cam sensor is used for position control of the exhaust cam (VANOS)

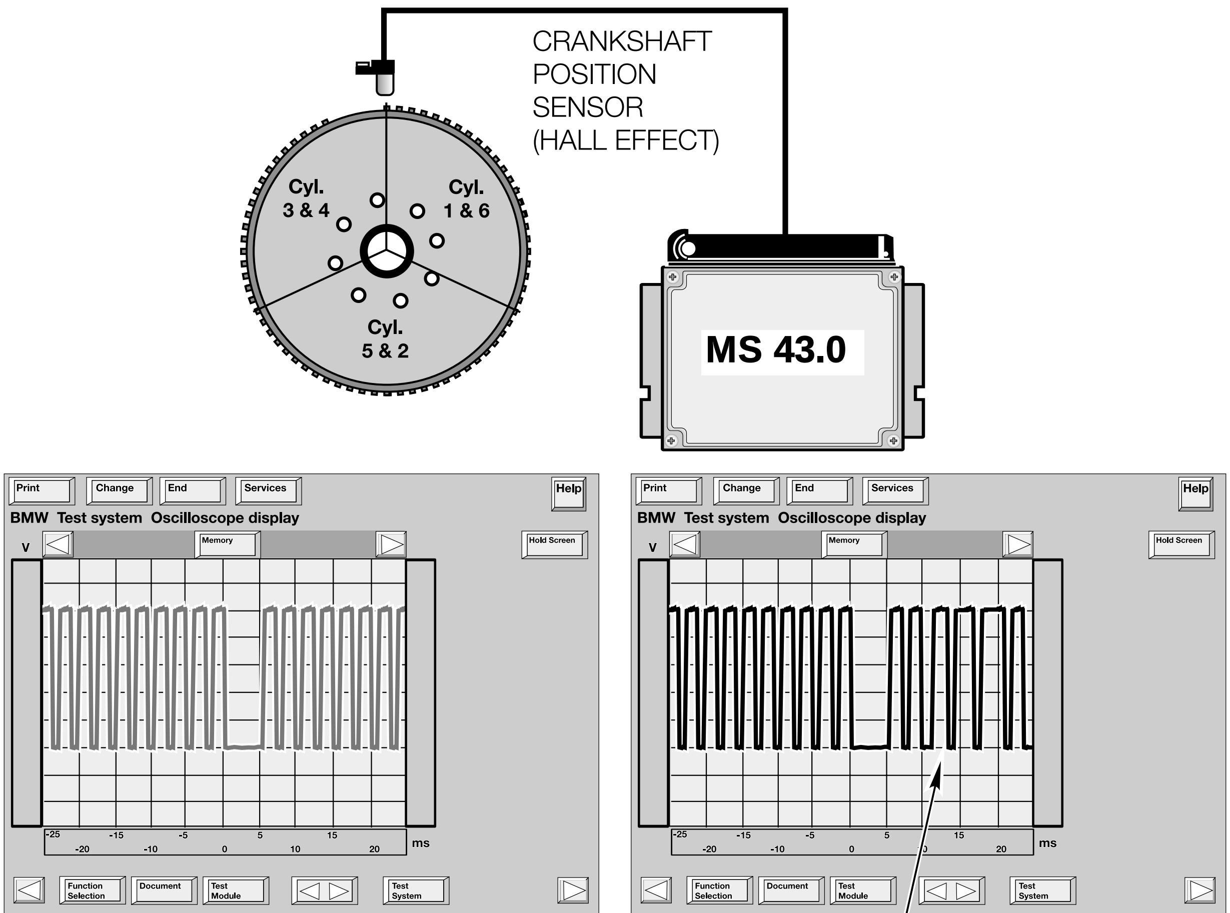
If these sensors fail there are no substitute values, the system will operate in the failsafe mode with no VANOS adjustment. The engine will still operate, but torque reduction will be noticeable.
NOTE: Use caution on repairs as not to bend the impulse wheels



CRANKSHAFT SENSOR

The crankshaft sensor is a dynamic Hall-effect sensor (mounted through the engine block), the signal is sent the moment the crankshaft begins to rotate.

The pulse wheel is mounted directly to the crankshaft as seen on previous models.



SMOOTH RUNNING ENGINE
NOTE SQUARE WAVE

ENGINE MISFIRE DETECTED

MISFIRE DETECTION

As part of the CARB/OBD regulations the engine control module must determine if misfire is occurring and also identify the specific cylinder(s) and the severity of the misfire event, and whether it is emissions relevant or catalyst damaging. In order to accomplish these tasks the control module monitors the crankshaft for acceleration losses during firing segments of each cylinder based on firing order.

Misfire Detection Example: M54 (6 Cyl.) with Siemens System

The misfire/engine roughness calculation is derived from the differences in the period duration (T) of individual increment gear segments. Each segment period consist of an angular range of 120° crank angle that starts 78° before Top Dead Center (TDC).

If the expected period duration is greater than the permissible value a misfire fault for the particular cylinder is stored in the fault memory of the ECM. Depending on the level of misfire rate measured the control unit will illuminate the "Service Engine Soon" light, may cut-off fuel to the particular cylinder and may switch lambda operation to open-loop. All misfire faults are weighted to determine if the misfire is emissions relevant or catalyst damaging.

EMISSIONS RELEVANT:

During an interval of **1000 crankshaft revolutions** the misfire events of all cylinders are added and if the sum is greater than a predetermined value a fault will be set identifying the particular cylinder(s). The “Service Engine Soon” light will be illuminated during and after the second cycle if the fault is again present.

CATALYST DAMAGING:

During an interval of **200 crankshaft revolutions** the misfire events of all cylinders are added and if the sum is greater than a predetermined value a fault will be set identifying the particular cylinders(s). The “Service Engine Soon” lamp:

- On vehicles with a Siemens Control Module (M54 engines) - the lamp will immediately go to a steady illumination since fuel to the injector(s) is removed. Fuel cut-off to the cylinder will resume after several ($\gg$ 7) periods of decel if crankshaft sensor adaptation is successfully completed or the engine is shut-off and restarted.

In each case the number of misfire events permitted is dependent on engine speed, load and temperature map.

The process of misfire detection continues well after the diagnostic drive cycle requirements have been completed. **Misfire detection is an on-going monitoring process** that is only discontinued under certain conditions.

Misfire detection is only disabled under the following conditions:

REQUIREMENTS	STATUS/CONDITION
Engine Speed	< 512 RPM
Engine Load	Varying/Unstable
Throttle Angle	Varying/Unstable
Timing	Timing retard request active (i.e. knock control - ASC, AGS)
Engine Start-up	Up to 5 seconds after start-up
A/C	Up to 0.5 seconds after A/C activation
Decel fuel cut-off	Active
Rough road recognition	Active
ASC Control	Active

OBD II - Misfire Faults

FAILED COMPONENT	POSSIBLE FAULT	MISFIRE EFFECT/LOCATION
Spark plug	electrode gap too small	affected cylinders
	electrodes missing	affected cylinders
	electrodes oil/fuel soaked	affected cylinders
	electrodes oil/feul soaked fouled	
	spark plug ceramic broken	affected cylinders
	oil level too high	most likely more than one cylinder affected
	oil foaming	
	oil level too high, oil/fuel fouled	
	heat range too cold	
	crank case ventilation defective	most likely more than one cylinder affected
Spark plug connector	wet, water or moisture	most likely more than one cylinder affected
	broken	affected cylinders
Ignition Coil	internal defect, arcing	affected cylinders
Connectors ignition	corrosion	one or more cylinders
	pin backed out	one or more cylinders
	plug loose	one or more cylinders
	loose wire from connector	one or more cylinders
Injection Valve	metal filing	on the affected cylinders
	leaking	on the affected cylinders
	carbon fouled	one or more cylinders
	dirty/contaminated	one or more cylinders
Injector connectors	corrosion	one or more cylinders
	pin backed out	one or more cylinders
	plug loose	one or more cylinders
	loose wire from connector	one or more cylinders
Intake manifold leaks	intake plenum, unmetere air leak (i.e. injector seals)	
Intake/Exhaust valve	carbon built up (intake)	most likely more than one cylinder affected
	burnt or damaged	on the affected cylinders
	overrev:intake or exhaust valves leaking (bent)	most likely more than one cylinder affected

FAILED COMPONENT	POSSIBLE FAULT	MISFIRE EFFECT/LOCATION
Camshaft	broken	most likely more than one cylinder affected
Piston	hole in piston crown/piston seized in bore	on the affected cylinders
Hydraulic lash adjusters (HVA)	defective: i.e. oil bore restricted/blocked	on the affected cylinders
	engine oil pressure built up too slow	
Fuel pressure	fuel pump, pressure too low	most likely cyl. 1-3 (front cylinders)
	fuel filter restricted/ blocked	most likely cyl. 1-3 (front cylinders)
	fuel pump, pressure build up too slow after start	most likely cyl. 1-3 (front cylinders)
	leaking fuel feed lines	most likely cyl. 1-3 (front cylinders)
	pressure regulator defective (metal filing)	most likely cyl. 1-3 (front cylinders)
	running loss valve defective	most likely cyl. 1-3 (front cylinders)
	fuel tank empty	most likely cyl. 1-3 (front cylinders)
	siphon jet pump and fuel tank empty	most likely cyl. 1-3 (front cylinders)
	water in fuel tank	most likely more than one cylinder affected
Fuel	high content oxygenated	one or more cylinders
	non anti carbon additives	one or more cylinders
Oxygen sensor	excessive mixture deviation	only the affected bank
Purge sytem	excessive rich mixture due to high ambient temperature	one or more banks
	blocked fuel tank vent inlet	all cylinders
Crank sensor/increment wheel	incorrect input signal for misfire detection	all cylinders
	increment wheel loose	all cylinders
	increment wheel damaged	affected segment
	gap between sensor and increment wheel	affected segment
	fly wheel damaged	
Catalyst damaged	exhaust back pressure on the affected bank	only the afftected bank
DME	final stage igntion/injectors	all cylinder

MASS AIR FLOW SENSOR HFM

The Siemens mass air flow sensor is functionally the same as in the past. The designation 2 Type B simply indicates that it is smaller in design. The mass air meter has a diameter of 85 mm.

MS 43 CARRY OVER FUNCTIONS

OUTPUT FUNCTIONS -VANOS CONTROL

With the double VANOS system, the valve timing is changed on both the intake and the exhaust camshafts.

Double VANOS provides the following benefits:

- Torque increase in the low to mid (1500 - 2000 RPM) range without power loss in the upper RPM range.
- Less incomplete combustion when idling due to less camshaft overlap (also improves idle speed characteristics).
- Internal exhaust gas recirculation (EGR) in the part load range (reduces NOx and post-combustion of residual gasses in the exhaust)
- Rapid catalyst warm up and lower “raw” emissions after cold start.
- Reduction in fuel consumption

Double VANOS consists of the following parts:

- Intake and exhaust camshafts with helical gear insert
- Sprockets with adjustable gears
- VANOS actuators for each camshaft
- 2 three-way solenoid switching valves
- 2 impulse wheels for detecting camshaft position
- 2 camshaft position sensors (Hall effect)

The “initial” timing is set by gear positioning (refer to the Repair Instructions for details) and the chain tensioner. As with the previous VANOS, the hydraulically controlled actuators move the helical geared cups to regulate camshaft timing. The angled teeth of the helical gears cause the pushing movement of the helical cup to be converted into a rotational movement. This rotational movement is added to the turning of the camshafts and cause the camshafts to “advance” or “retard”. The adjustment rate is dependent oil temperature, oil pressure, and engine RPM.

NOTE: With extremely hot oil temperatures Vanos is deactivated (Power loss). If the oil is too thick (wrong viscosity) a fault could be set.

When the engine is started, the camshafts are in the "failsafe" position (deactivated). The intake camshaft is in the RETARDED position - held by oil pressure from the sprung open solenoid. The exhaust camshaft is in the ADVANCED position - held by a preload spring in the actuator and oil pressure from the sprung open solenoid.

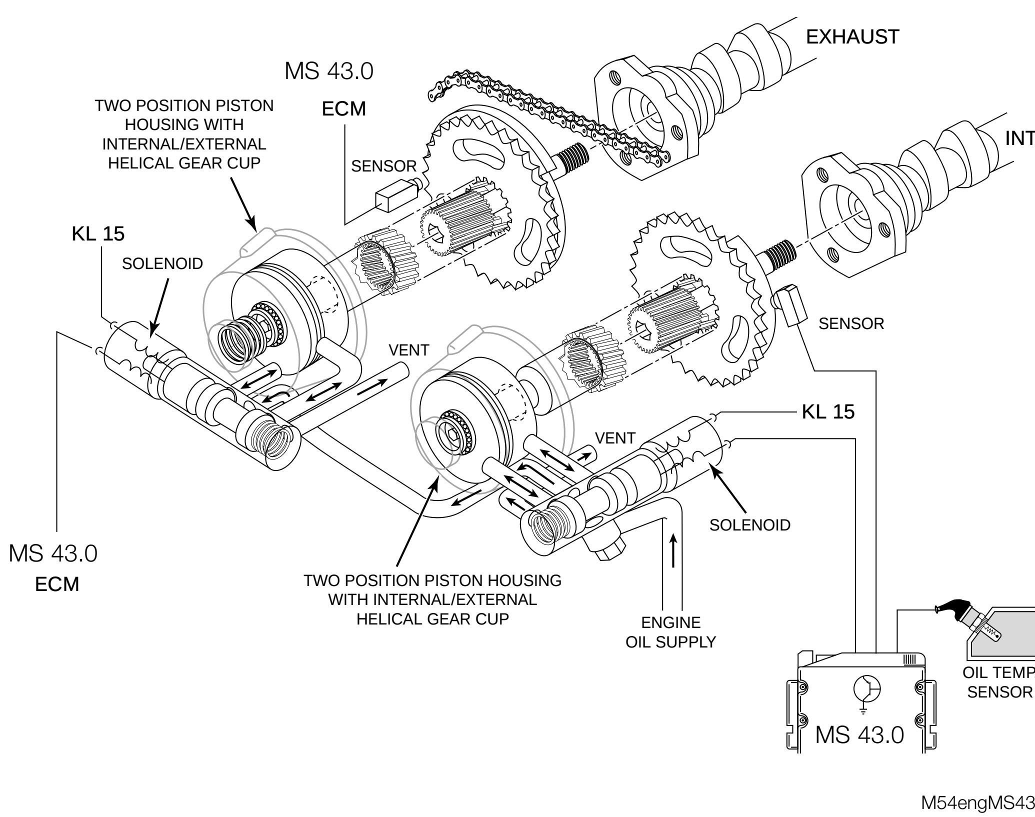
After 50 RPM (2-5 seconds) from engine start, the ECM is monitoring the exact camshaft position.

The ECM positions the camshafts based on engine RPM and the throttle position signal. From that point the camshaft timing will be varied based on intake air and coolant temperatures.

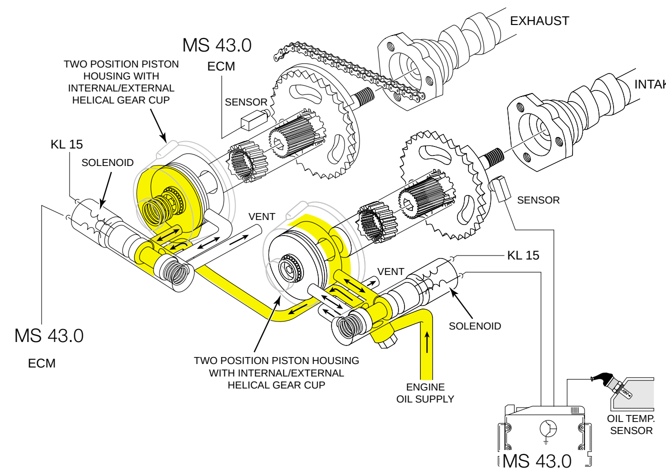
The double VANOS system is "fully variable". When the ECM detects the camshafts are in the optimum positions, the solenoids are modulated (approximately 100-220 Hz) maintaining oil pressure on both sides of the actuators to hold the camshaft timing.

CAUTION: The VANOS <u>MUST</u> be removed and installed exactly as described in the Repair Instructions!

NOTE: If the VANOS camshaft system goes to the failsafe mode (deactivated) there will be a noticeable loss of power. This will be like driving with retarded ignition or starting from a stop in third gear.



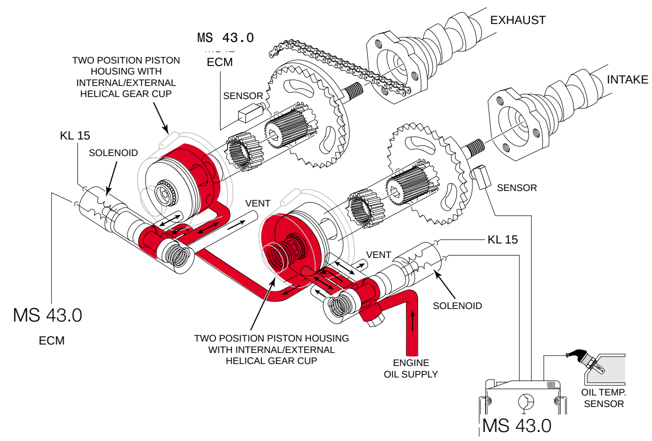
DEACTIVATED



EXHAUST: Advanced piston moved in

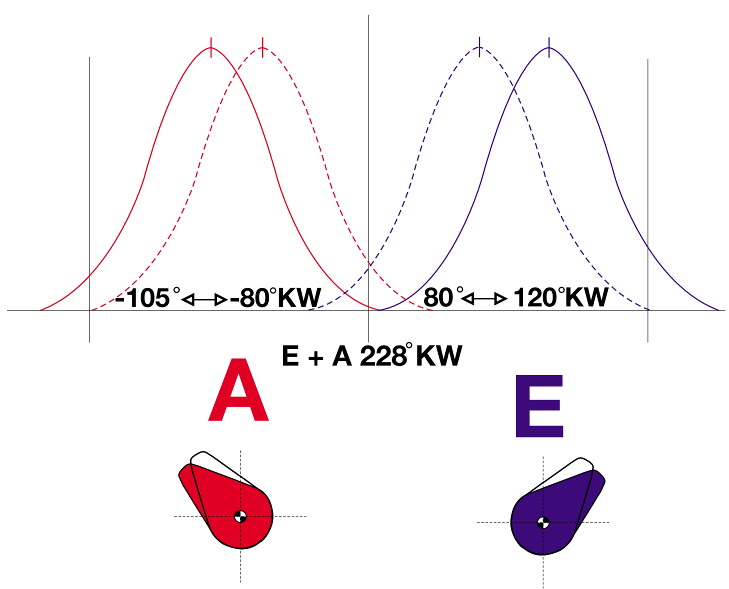
INTAKE: Retard piston moved out

ACTIVATED



EXHAUST: Advanced piston moved out

INTAKE: Retard piston moved in

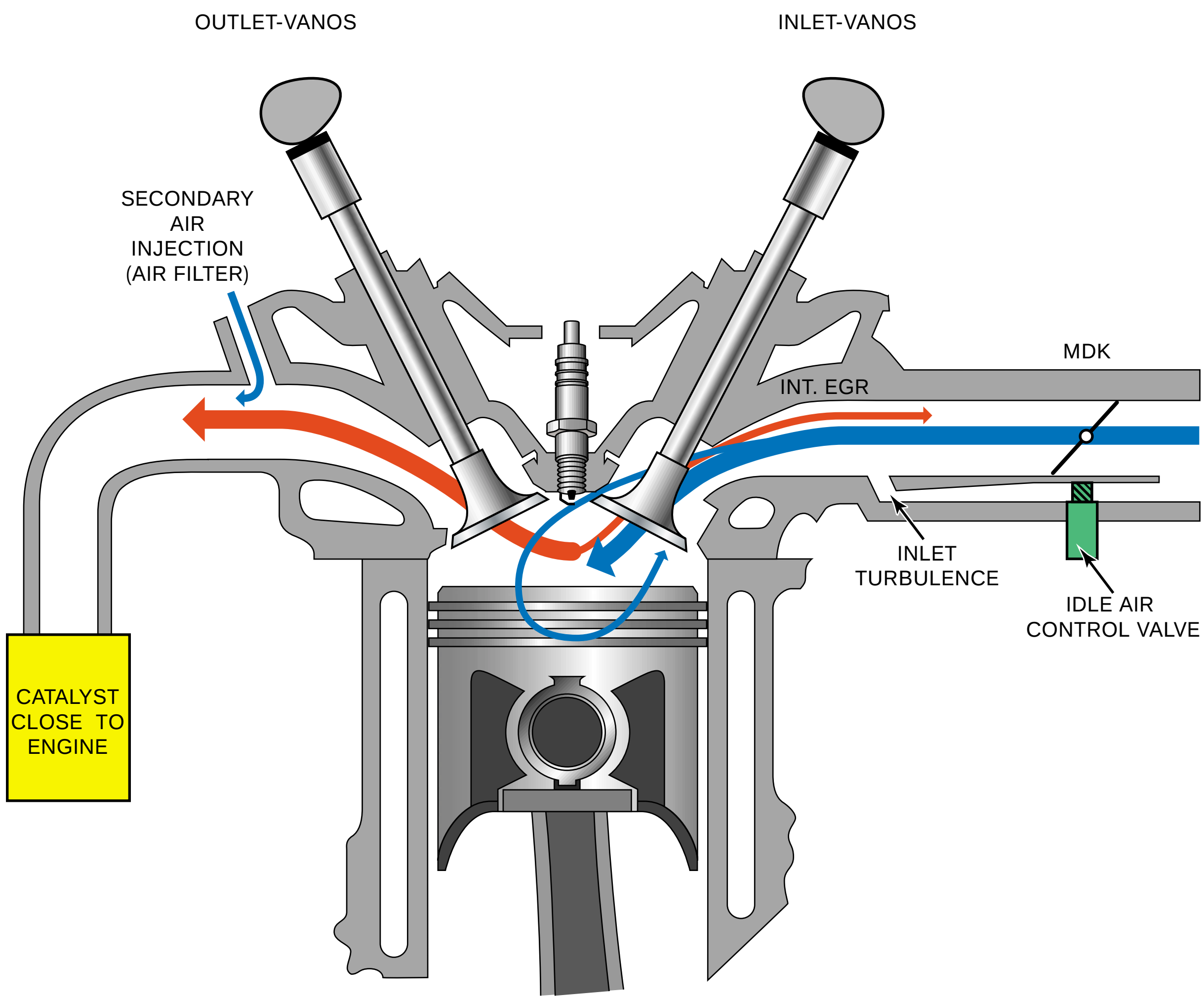


The dual VANOS in conjunction with the variable intake manifold provides an additional emission control feature.

Because of the improved combustion, the camshaft timing is adjusted for more overlap. The increased overlap supports internal exhaust gas recirculation (EGR) which reduces tailpipe emissions and lowers fuel consumption.

During the part load engine range, the intake camshaft overlap opens the intake valve. This allows limited exhaust gas reflow the intake manifold.

The “internal” EGR reduces the cylinder temperature thus lowering NOx. This feature provides EGR without the external hardware as seen on previous systems.



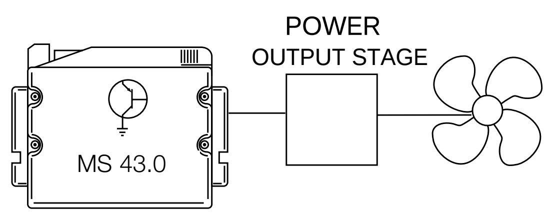
ELECTRIC FAN

The electric cooling fan is now controlled by the ECM. The ECM uses a remote power output final stage (mounted on the fan housing)

The power output stage receives power from a 50 amp fuse (located in glove box above the fuse bracket). The electric fan is controlled by a pulse width modulated signal from the ECM.

The fan is activated based on the ECM calculation (sensing ratio) of:

- Coolant outlet temperature
- Calculated (by the ECM) catalyst temperature
- Vehicle speed
- Battery voltage
- Air Conditioning pressure (calculated by IHKA and sent via the K-Bus to the ECM)



NOTE: If the ECM indicates a fault check the fan for freedom of movement

After the initial test has been performed, the fan is brought up to the specified operating speed. At 10% (sensing ratio) the fan runs at 1/3 speed. At a sensing ratio of between 90-95% the fan is running at maximum speed. Below 10% or above 95% the fan is stationary.

The sensing ratio is suppressed by a hysteresis function, this prevents speed fluctuation. When the A/C is switched on, the electric fan is not immediately activated.

After the engine is switched off, the fan may continue to operate at varying speeds (based on the ECM calculated catalyst temperature). This will cool the radiator down from a heat surge (up to 10 minutes).

SECONDARY AIR INJECTION

This ECM controlled function remains unchanged from the previous Siemens MS system, however there is a hardware change.

The Air Injection Inlet Valve mounts directly to the cylinder head, with a passageway machined through the head. This eliminates the external Air Injection manifold distribution pipes to the exhaust manifolds.

SECONDARY AIR INJECTION MONITORING

In order to reduce HC and CO emissions while the engine is warming up, BMW implemented the use of a Secondary Air Injection System in. Immediately following a cold engine start (-10 - 40°C) fresh air/oxygen is injected directly into the exhaust manifold. By injecting oxygen into the exhaust manifold:

• The warm up time of the catalyst is reduced

• Oxidation of the hydrocarbons is accelerated

The activation period of the air pump can vary depending on engine type and operating conditions.

Conditions for Secondary Air Pump Activation:

REQUIREMENTS	STATUS/CONDITION MS 43.0	STATUS/CONDITION M73
Oxygen sensor	Open Loop	Open Loop
Oxygen sensor heating	Active	Active
Engine coolant temperature	-10 to 40ºC*	-10 to 40ºC* Stage
Engine bad	Predefined Range	Predefined Range
Engine speed	Predefined Range	Predefined Range
Fault Codes	No Secondary Air Faults “currently present”	No Secondary Air Faults “currently present”

*NOTE: Below -10°C the air injection pump is activated only as a preventive measure to blow out any accumulated water vapor that could freeze in the system.

The Secondary Air Injection System is monitored via the use of the pre-catalyst oxygen sensor(s). Once the air pump is active and is air injected into the system the signal at the oxygen sensor will reflect a lean condition. If the oxygen sensor signal does not change within a predefined time a fault will be set and identify the faulty bank(s). If after completing the next cold start and a fault is again present the "Service Engine Soon" light will be illuminated.

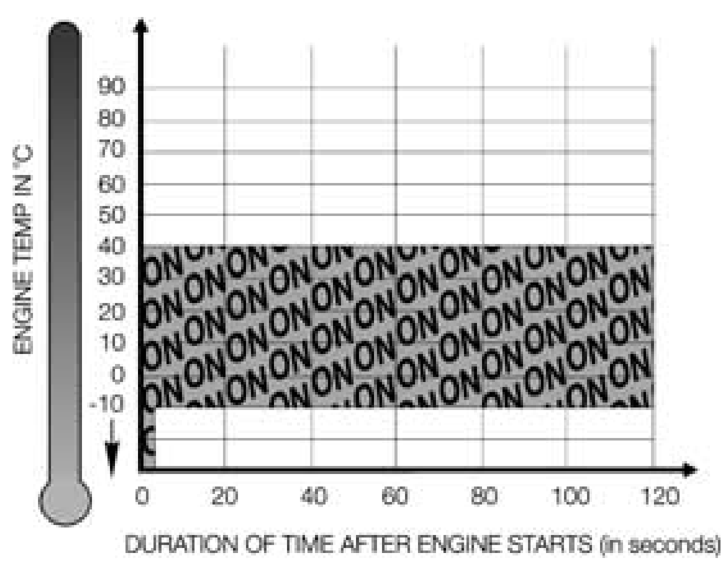
Example: Secondary Air Injection Monitoring (M54-Siemens System)

During a cold start condition air is immediately injected into the exhaust manifold and since the oxygen sensors are in open loop at this time the voltage at the pre catalyst sensor will reflect a lean condition) and will remain at this level while the air pump is in operation. Once the pump is deactivated the voltage will change to a rich condition until the system goes into closed loop operation.

M54 System Operation:
The pump draws air through its own air filter and delivers it to both exhaust manifolds through a non-return (shutoff valve). The non-return valve is used to:

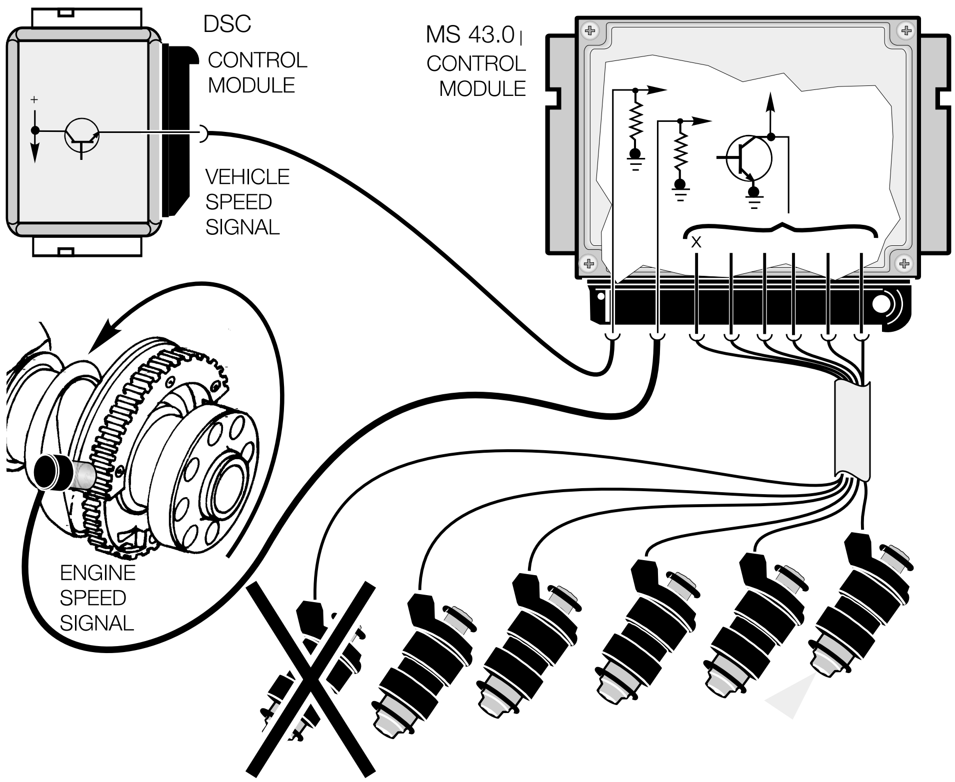
1. Control air injection into the exhaust manifold - A vacuum controlled valve will open the passageway for air to be injected once a vacuum is applied.
2. Prevent possible backfires from traveling up the pipes and damaging the air pump when no vacuum is applied.

The control module activates the vacuum vent valve whenever the air pump is energized. Once the vacuum vent valve is energized a vacuum is applied to the non-return valve which allows air to be injected into the exhaust manifold. A vacuum is retained in the lines, by the use of a check valve, in order to allow the non-return valve to be immediately activated on cold engine start up. When the vacuum/vent valve is not energized, the vacuum to the non-return valve is removed and is vented to atmosphere.



ENGINE/VEHICLE SPEED LIMITATION

For engine/vehicle speed limitation, the ECM will deactivate injection for individual cylinders, allowing a smoother limitation transition. This prevents over-rev when the engine reaches maximum RPM (under acceleration), and limits top vehicle speed (approx. 128 mph).

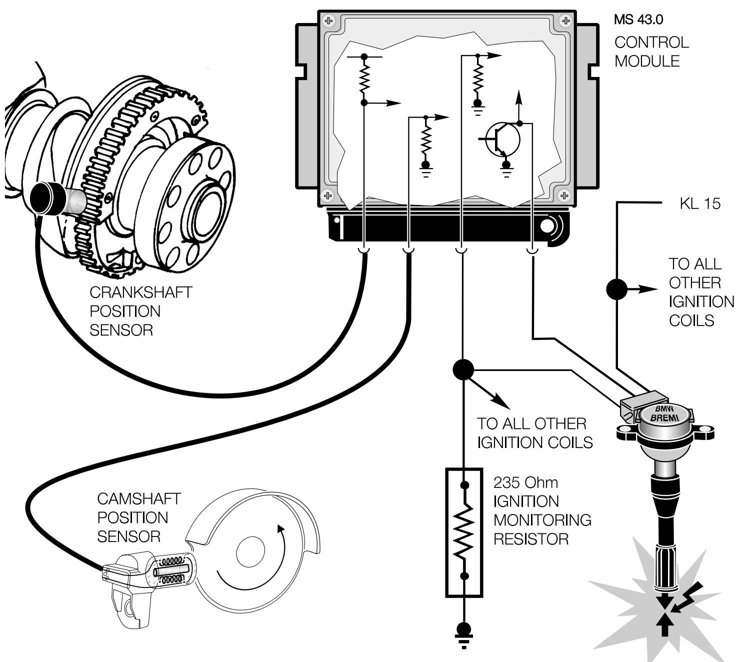


RZV IGNITION SYSTEM

The Siemens MS43.0 system uses a multiple spark ignition function. The purpose of multiple ignition is:

- Provide clean burning during engine start up and while idling (reducing emissions).

- This function helps to keep the spark plugs clean for longer service life (new BMW longlife plugs).



Multiple ignition is active up to an engine speed of approximately 1350 RPM (varied with engine temperature) and up to 20 degrees after TDC.

Multiple ignition is dependent on battery voltage. When the voltage is low, the primary current is also lower and a longer period of time is required to build up the magnetic field in the coil(s).

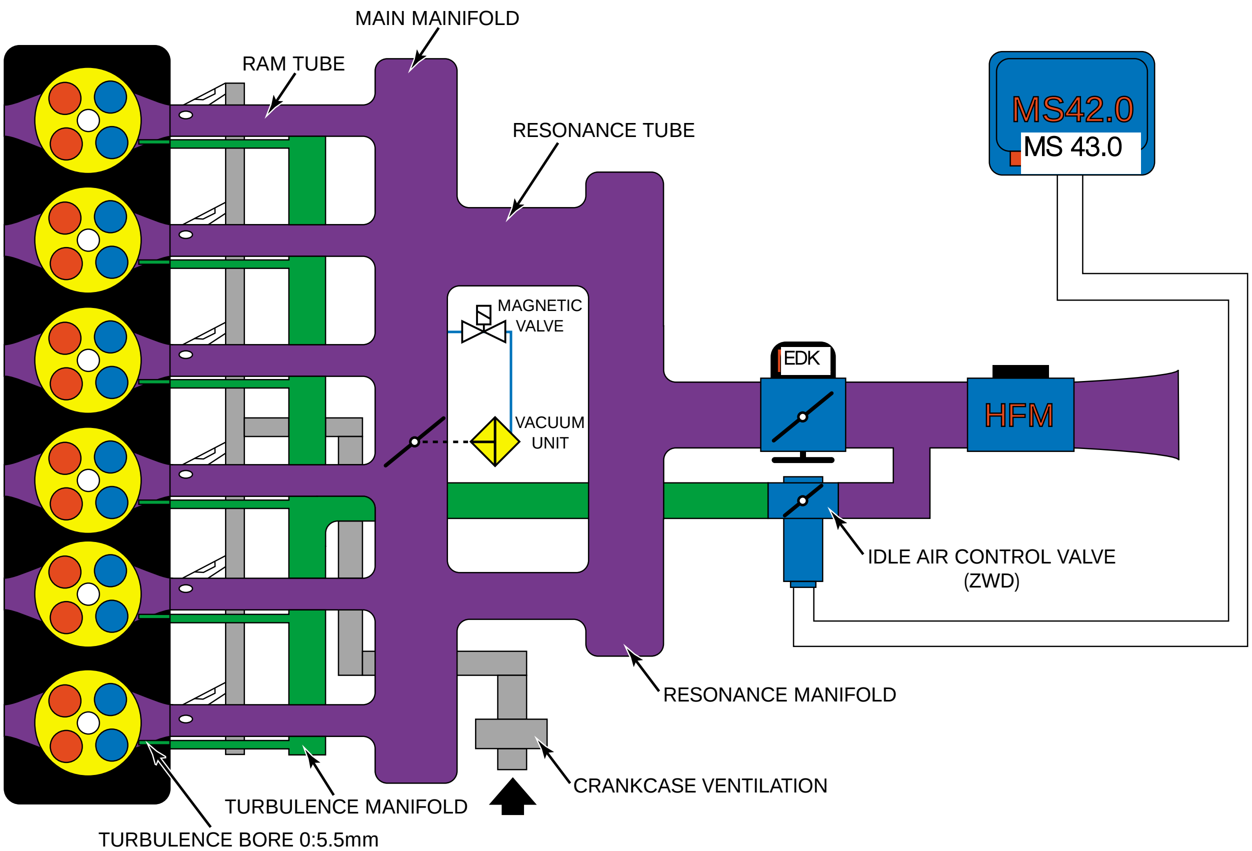
- Low battery voltage = less multiple ignitions
- High battery voltage = more multiple ignitions

The 240 ohm shunt resistor is still used on the MS43.0 system for detecting secondary ignition faults and diagnostic purposes.

RESONANCE/TURBULENCE INTAKE SYSTEM

On the M54, the intake manifold is split into 2 groups of 3 (runners) which increases low end torque. The intake manifold also has separate (internal) turbulence bores which channels air from the idle speed actuator directly to one intake valve of each cylinder (matching bore of 5.5mm in the cylinder head).

Routing the intake air to only one intake valve causes the intake to swirl in the cylinder. Together with the high flow rate of the intake air due to the small intake cross sections, this results in a reduction in fluctuations and more stable combustion.



RESONANCE SYSTEM

The resonance system provides increased engine torque at low RPM, as well as additional power at high RPM. Both of these features are obtained by using a resonance flap (in the intake manifold) controlled by the ECM.

During the low to mid range rpm, the resonance flap is closed. This produces a long/single intake tube for velocity, which increases engine torque.

During mid range to high rpm, the resonance flap is open. This allows the intake air to pull through both resonance tubes, providing the air volume necessary for additional power at the upper RPM range.

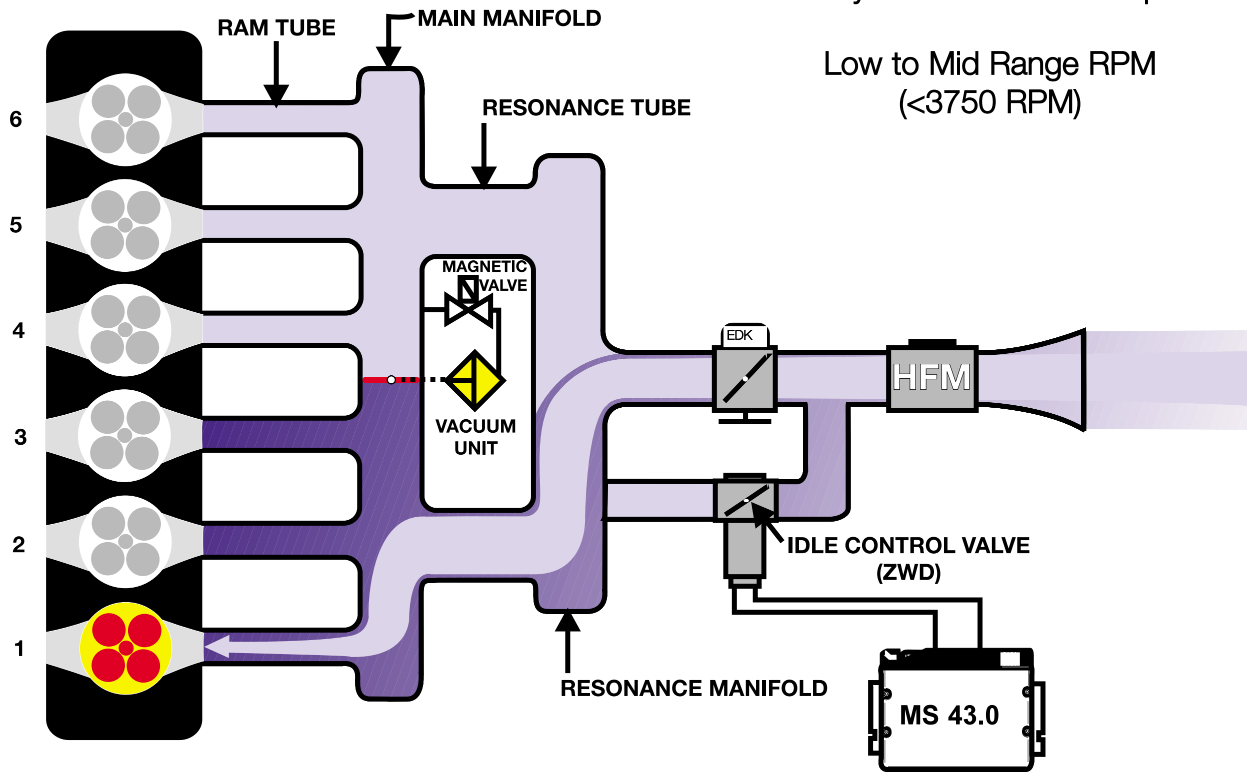
When the flap is closed , this creates another "dynamic" effect. For example, as the intake air is flowing into cylinder #1, the intake valves will close. This creates a "roadblock" for the in rushing air. The air flow will stop and expand back (resonance wave back pulse) with the in rushing air to cylinder #5. The resonance "wave", along with the intake velocity, enhances cylinder filling.

The ECM controls a solenoid valve for resonance flap activation. At speeds below 3750 RPM, the solenoid valve is energized and vacuum supplied from an accumulator closes the resonance flap. This channels the intake air through one resonance tube, but increases the intake velocity.

When the engine speed is greater than 4100 RPM (which varies slightly - temperature influenced), the solenoid is de-energized. The resonance flap is sprung open, allowing flow through both resonance tubes, increasing volume.

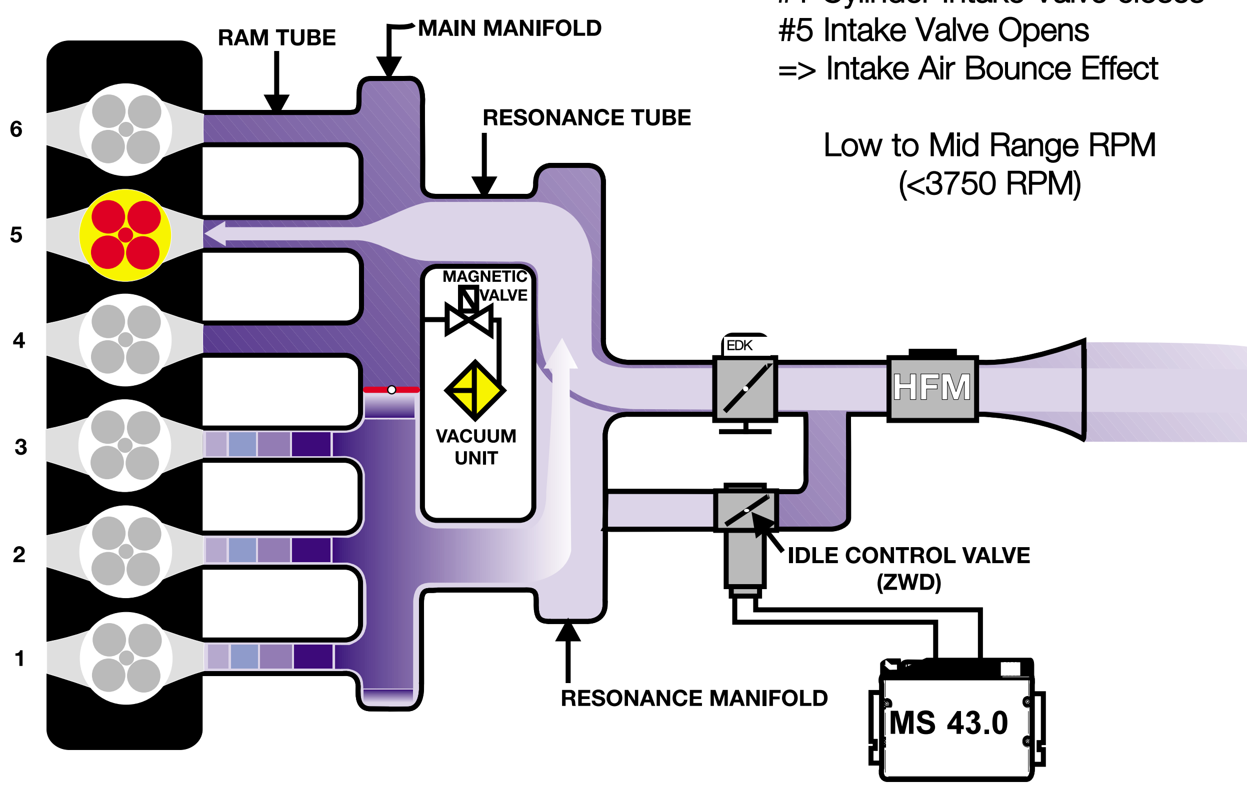
#1 Cylinder Intake Valve open

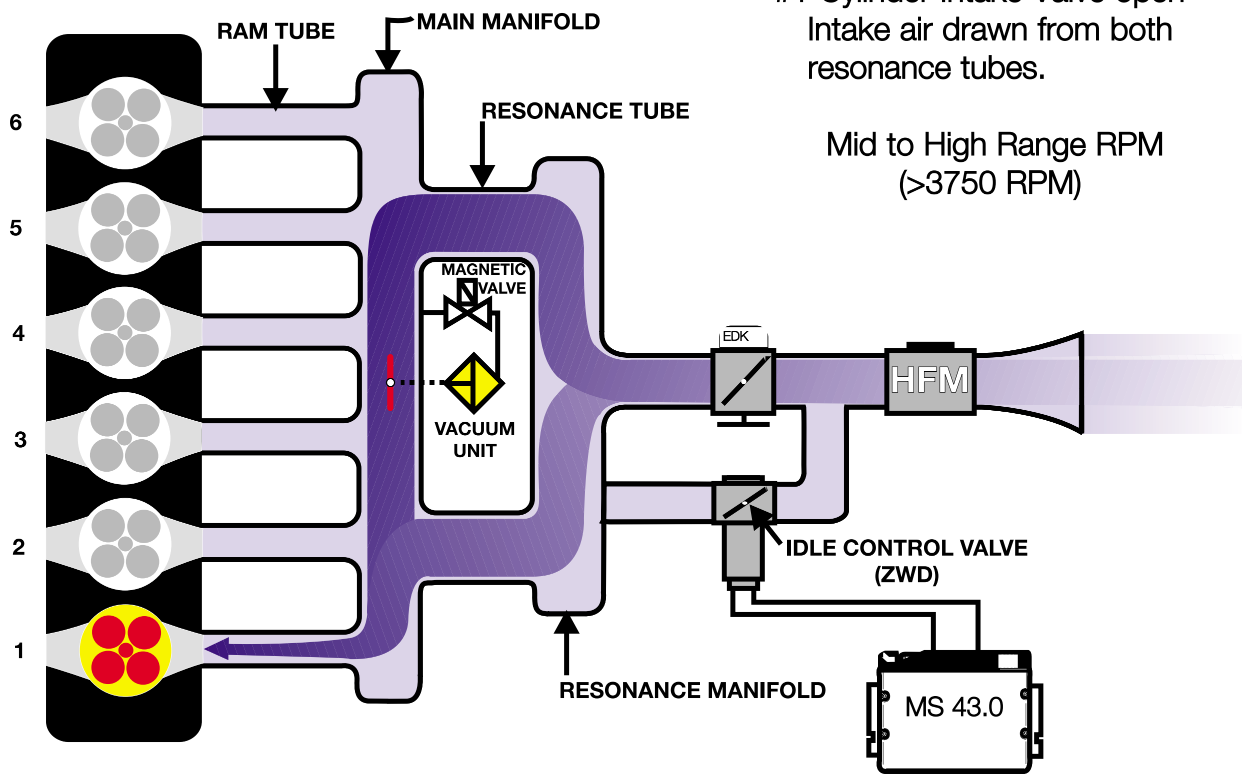
Low to Mid Range RPM
(<3750 RPM)



#1 Cylinder Intake Valve closes
#5 Intake Valve Opens
=> Intake Air Bounce Effect

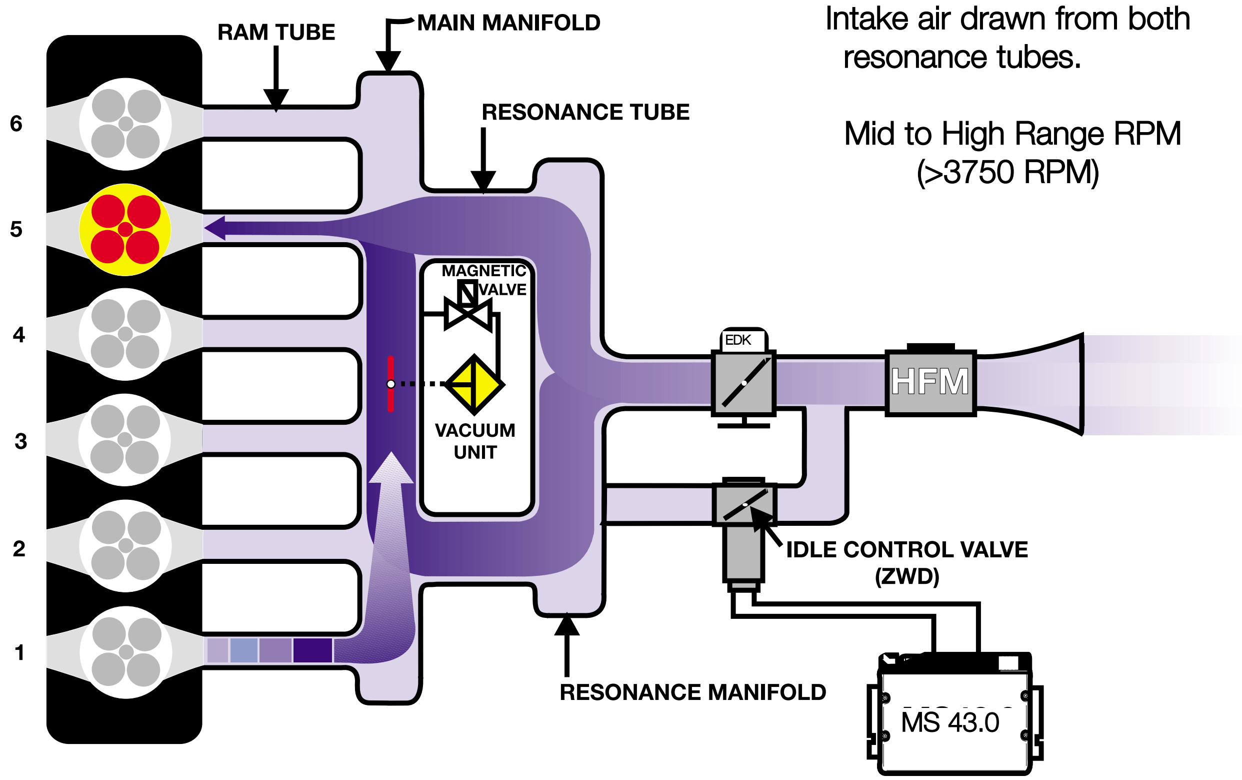
Low to Mid Range RPM
(<3750 RPM)





#1 Cylinder Intake Valve open - Intake air drawn from both resonance tubes.

Mid to High Range RPM (>3750 RPM)



#5 Cylinder Intake Valve open - Intake air drawn from both resonance tubes.

Mid to High Range RPM (>3750 RPM)

IDLE SPEED CONTROL

The ECM determines idle speed by controlling an idle speed actuator (dual winding rotary actuator) ZWD 5.

The basic functions of the idle speed control are:

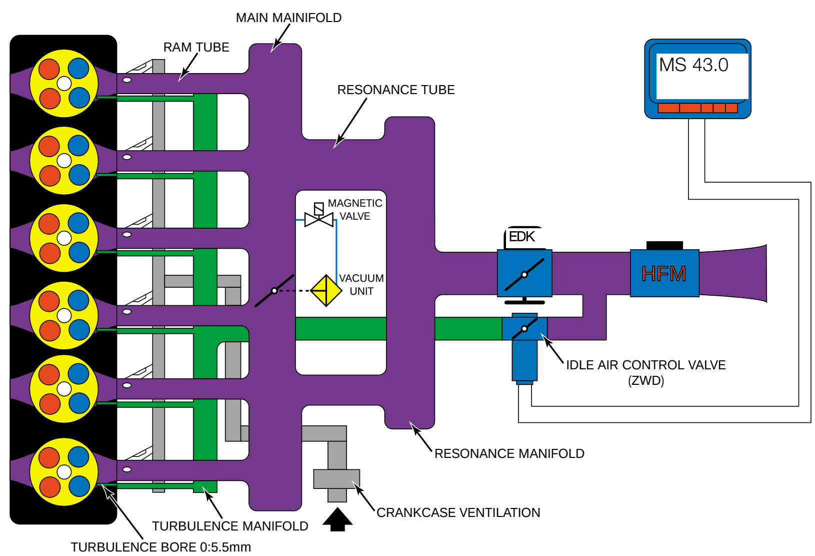
- Control the initial air quantity (at air temperatures <0 C, the EDK is simultaneously opened)

- Variable preset idle based on load and inputs

- Monitor RPM feedback for each preset position

- Lower RPM range intake air flow (even while driving)

- Vacuum limitation



- Smooth out the transition from acceleration to deceleration

Under certain engine operating parameters, the EDK throttle control and the idle speed actuator (ZWD) are operated simultaneously.This includes All idling conditions and the transition from off idle to load.

As the request for load increases, the idle valve will remain open and the EDK will supply any additional air volume required to meet the demand.

Emergency Operation of Idle Speed Actuator:

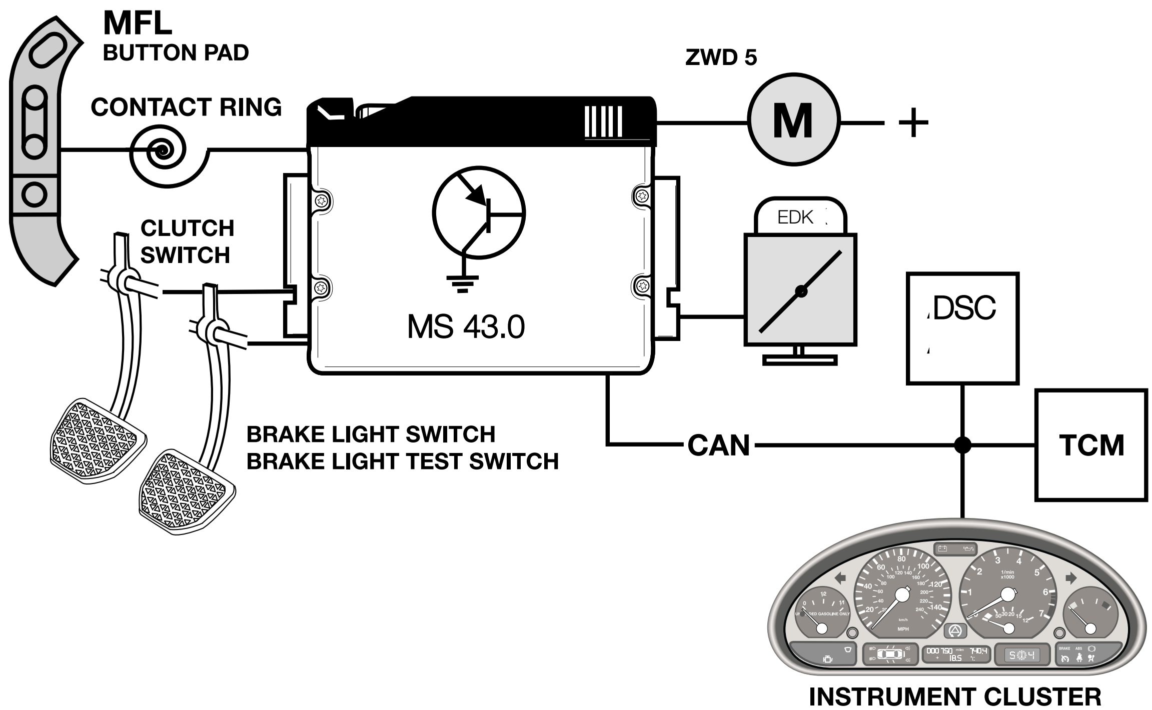
If a fault is detected with the idle speed actuator, the ECM will initiate failsafe measures depending on the effect of the fault (increased air flow or decreased air flow).
If there is a fault in the idle speed actuator/circuit, the EDK will compensate to maintain idle speed. The EML lamp will be illuminated to inform the driver of a fault.

If the fault causes increased air flow (actuator failed open), VANOS and Knock Control are deactivated which noticeably reduces engine performance.

CRUISE CONTROL

Cruise control is integrated into the ECM because of the EDK operation.

Cruise control functions are activated directly by the multifunction steering wheel to the ECM. The individual buttons are digitally encoded in the MFL switch and is input to the ECM over a serial data wire.



The ECM controls vehicle speed by activation of the Electronic Throttle Valve (EDK)

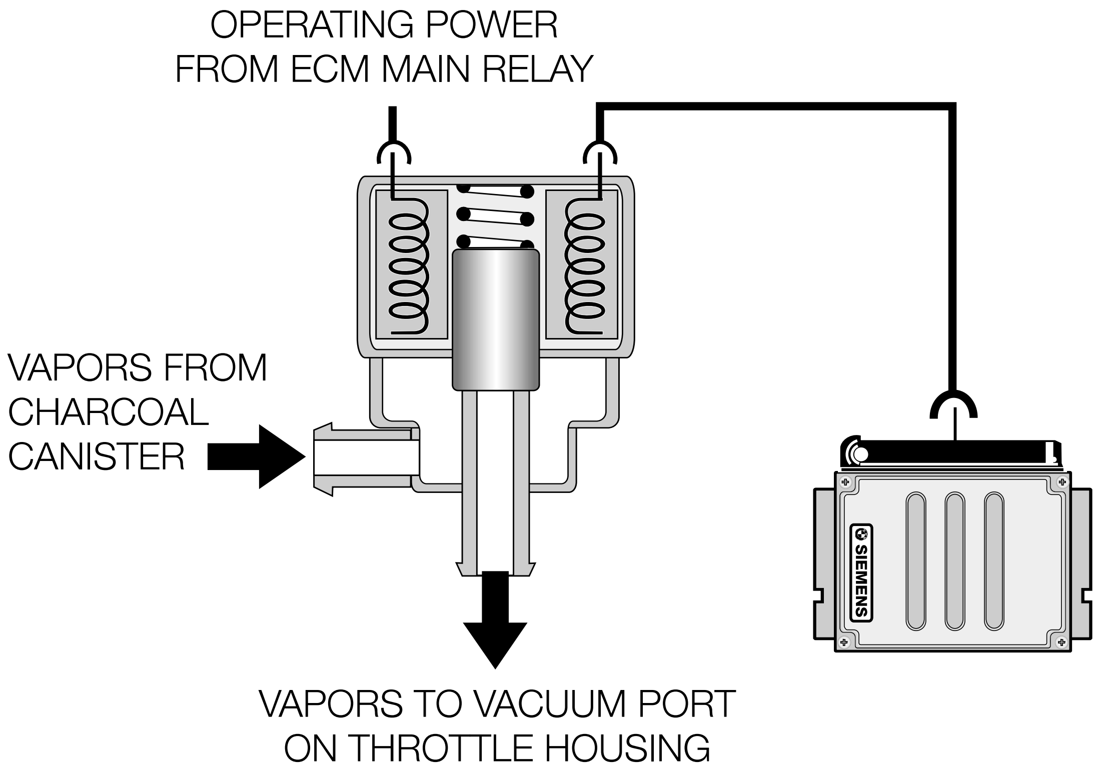
The clutch switch disengages cruise control to prevent over-rev during gear changes.

The brake light switch and the brake light test switch are input to the ECM to disengage cruise control as well as fault recognition during engine operation of the EDK.

Road speed is input to the ECM for cruise control as well as DSC regulation. The vehicle speed signal for normal engine operation is supplied from the DSC module (right rear wheel speed sensor). The road speed signal for cruise control is supplied from the DSC module. This is an average taken from both front wheel speed sensors, supplied via the CAN bus.

PURGE VALVE

The purge valve (TEV) is activated at 10 Hz by the ECM to cycle open, and is sprung closed. The valve is identical to the purge valve used on the Siemens MS 42 system.



REVIEW QUESTIONS

1. List the major changes to the Siemens MS 43.3 system from MS 42:

2. What type of signal does the Hall Sensor - PWG provide to ECM for throttle request?

3. What PWG signal is used if PWG has a plausibility error?

4. What is the purpose of the KL 87 main relay monitor in the ECM?

5. Why is the ignition left ON after KL 15 is switched OFF?

6. Describe the operation of the DM-TL system on MS 43.0.

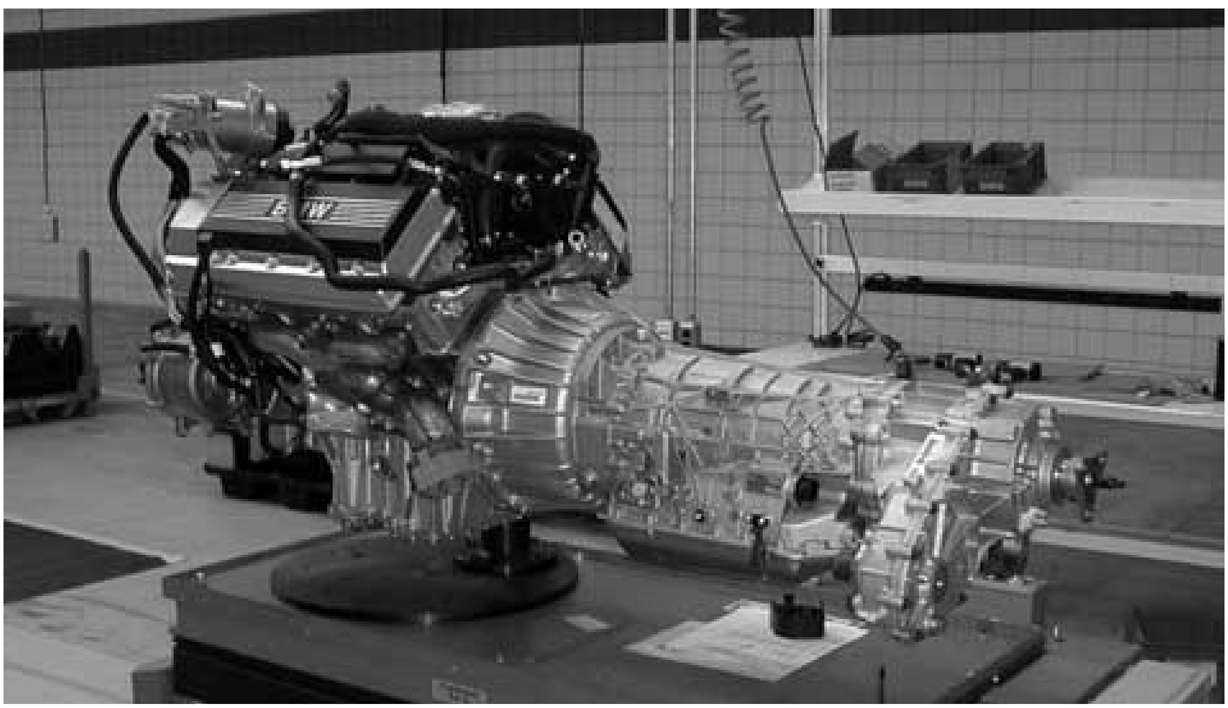
7. Describe the operation of the turbulence - resonance manifold.

TABLE OF CONTENTS

M62TU Engine / ME7.2

The 4.4i X5 is equipped with the M62 TU B44 (4.4 liter) engine. Features of the M62 TU engine include:

- Digital motor Electronics Control ME 7.2.
- Variable positioned intake camshaft VANOS system.
- “EML” Electronic Throttle Control System identified as EDK.
- Compact water cooled generator (F-alternator).
- Thermostat controlled transmission fluid/engine coolant heat exchanger system for automatic transmission equipped vehicles.
- Non Return Fuel Rail (Running Loss Compliance).
- IHKA Auxillary Water Pump.



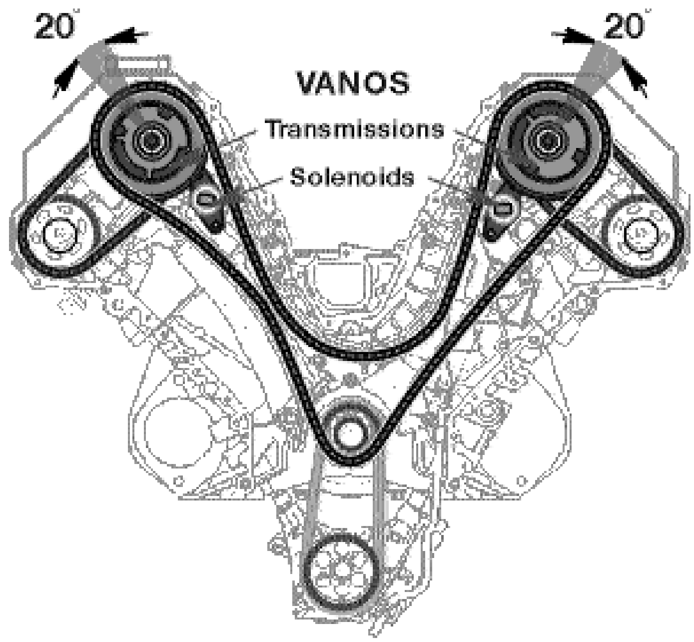
M62 TU VANOS

OVERVIEW

The variable intake valve timing system on the M62 TU continues to be identified as VANOS. This acronym comes from the German words; *VAriable NOckenwellen Steuerung,* which means Variable Camshaft Control.

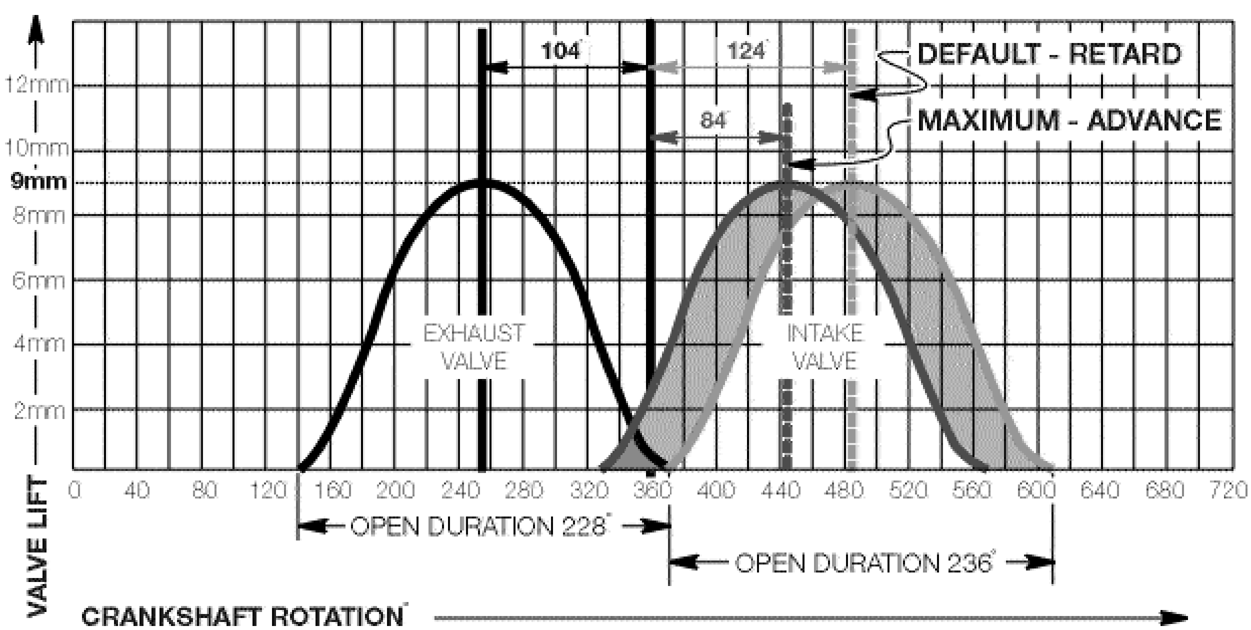
The M62 TU VANOS system is a new variant providing stepless VANOS functionality on each intake camshaft. The system is continuously variable within its range of adjustment providing optimized camshaft positioning for all engine operating conditions.

While the engine is running, both intake camshafts are continuously adjusted to their optimum positions. This enhances engine performance and reduces tailpipe emissions.



Both camshafts are adjusted simultaneously within 20° (maximum) of the camshafts rotational axis.

This equates to a maximum span of 40° crankshaft rotation. The camshaft spread angles for both banks are as follows.



VANOS BENEFITS

The design of a camshaft for a non adjustable valve timing system is limited to the required **overall** performance of the engine.

- An intake camshaft with an **advanced** (early) profile will provide a higher performing power curve at a lower engine speed. But at idle speed the the advanced position will create a large area of intake/exhaust overlap that causes a rough, unstable idle.
- On the other hand, an intake camshaft with a **retarded** (late) profile will provide a very smooth, stable idle but will lack the cylinder filling dynamics needed for performance characteristics at mid range engine speeds.

The ability to **adjust** the valve timing improves the engines power dynamics and reduces tailpipe emissions by optimizing the camshaft angle for all ranges of engine operation. VANOS provides the following benefits:

- Increased torque at lower to mid range engine speeds without a loss of power in the upper range engine speeds.
- Increased fuel economy due to optimized valve timing angles.
- Reduction of exhaust emissions due to optimized valve overlap.
- Smoother idle quality due to optimized valve overlap.

BASIC FUNCTION OF BMW VANOS SYSTEMS

All BMW VANOS systems are operated through electric/hydraulic/mechanical control.

Electric Control: The engine control module is responsible for activating a VANOS solenoid valve based on DME program mapping. The activation parameters are influenced by the following input signals:

- Engine speed
- Load (intake air mass)
- Engine temperature
- Camshaft position
- Oil temperature (MS 42.0 only)

Depending on the specific VANOS system, the solenoid valve is one of two types:

- Basic black/white (on/off) solenoid valve. Found on M50 TU and M52 engines.
- Variable position solenoid valve. Found on the M52 TU and M62 TU engines.

Hydraulic Control: The position of the solenoid valve directs the hydraulic flow of engine oil. The controlled oil flow acts on the mechanical components of VANOS system to position the camshaft.

Mechanical Control: The mechanical components of all VANOS systems operate under the same principle. The controlled hydraulic engine oil flow is directed through advance or retard activation oil ports. Each port exits into a sealed chamber on the opposite sides of a control piston.

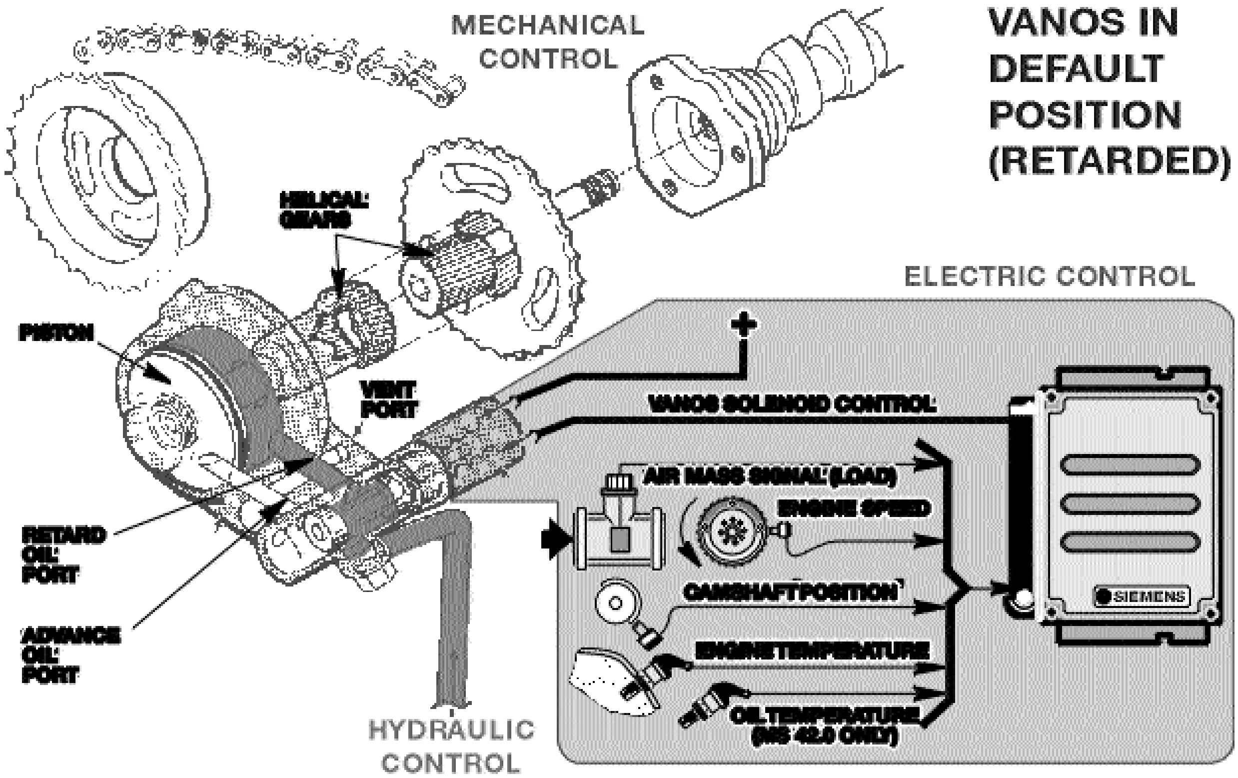
- The control piston on six cylinder engine systems (M50TU, M52 & M52TU) is connected to a separate helical gear cup.
- The control piston on the M62TU VANOS system incorporates the helical gear.

In its default position the oil flow is directed to the rear surface of the piston. This pulls the helical gear forward and maintains the retarded valve timing position.

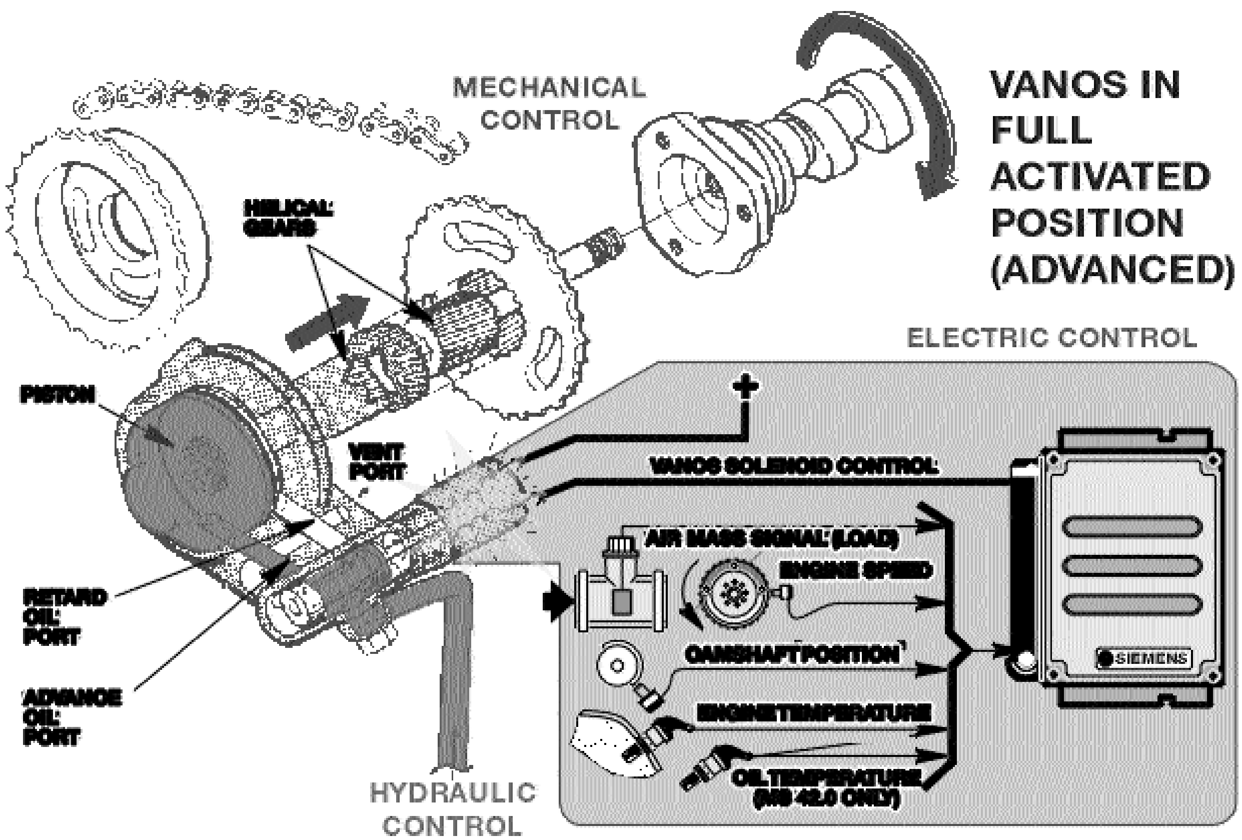
When the oil flow is directed to the front surface of the piston, the oil **pushes** the helical gear in the opposite direction which rotates the matched helical gearing connected to the camshaft.

The angled teeth of the helical gears cause the **pushing** movement to be converted into a **rotational** movement. The rotational movement is added to the turning of the camshaft providing the variable camshaft positioning.

VANOS IN DEFAULT POSITION (RETARDED)



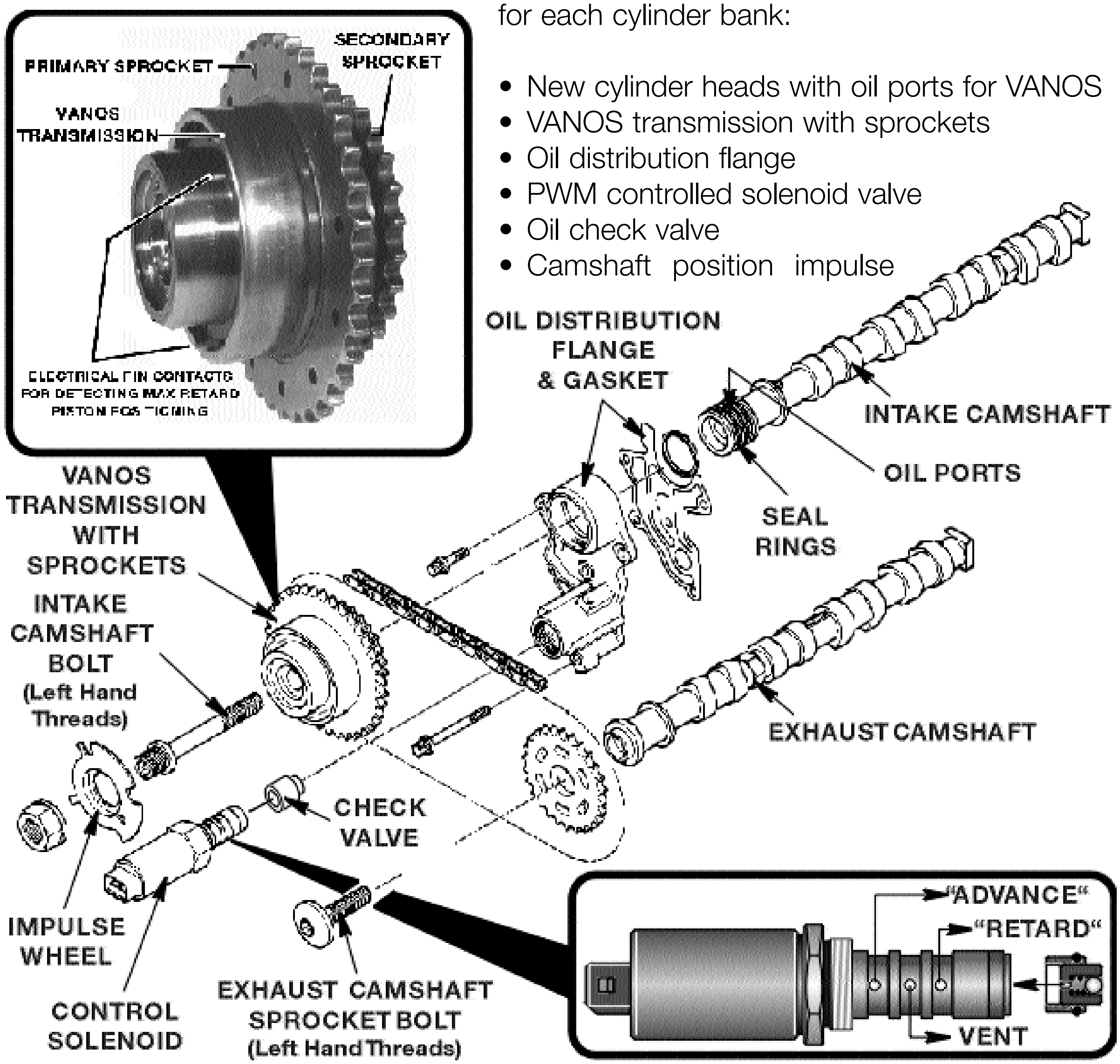
VANOS IN FULL ACTIVATED POSITION (ADVANCED)



M62 TU VANOS COMPONENTS

M62 TU VANOS components include the following for each cylinder bank:

- New cylinder heads with oil ports for VANOS
- VANOS transmission with sprockets
- Oil distribution flange
- PWM controlled solenoid valve
- Oil check valve
- Camshaft position impulse



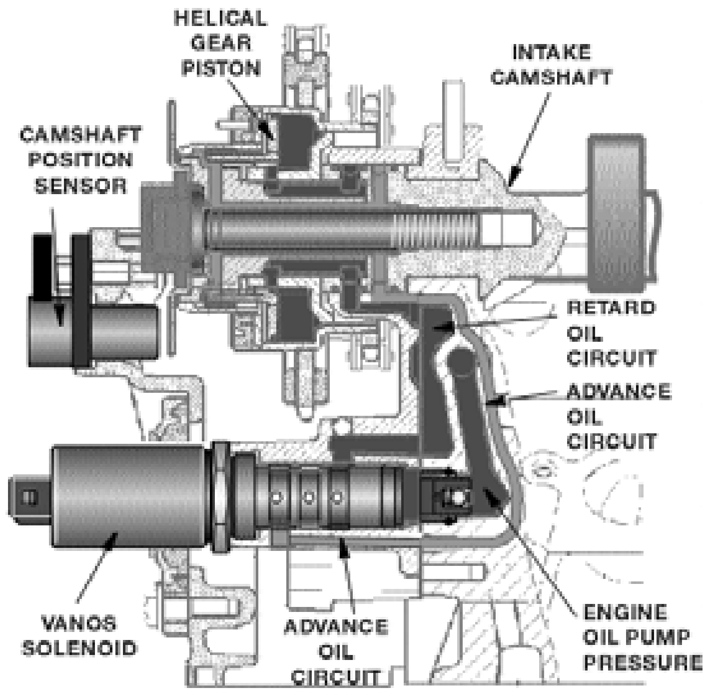
VANOS CONTROL SOLENOID & CHECK VALVE: The VANOS solenoid is a two wire, pulse width modulated, oil pressure control valve. The valve has four ports;

1. Input Supply Port - Engine Oil Pressure
2. Output Retard Port - To rear of piston/helical gear (retarded camshaft position)
3. Output Advance Port - To front of piston/helical gear (advanced camshaft position)
4. Vent - Released oil pressure

A check valve is positioned forward of the solenoid in the cylinder head oil gallery. The check valve maintains an oil supply in the VANOS transmission and oil circuits after the engine is turned off. This prevents the possibility of piston movement (noise) within the VANOS transmission system on the next engine start.

VANOS TRANSMISSION: The primary and secondary timing chain sprockets are integrated with the VANOS transmission. The transmission is a self contained unit.

The controlled adjustment of the camshaft occurs inside the "transmission". Similar in principle to the six cylinder engine VANOS systems, controlled oil pressure moves the piston axially.

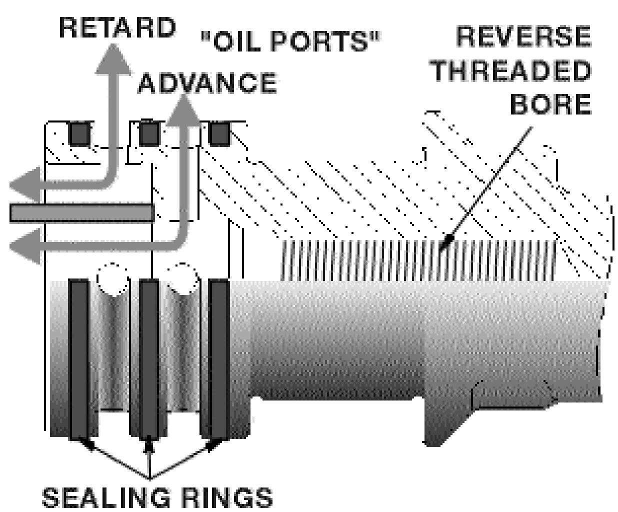


The helical gear cut of the piston acts on the helical gears on the inside surface of the transmission and rotates the camshaft to the specific advanced or retarded angle position.

Three electrical pin contacts are located on the front surface to verify the default maximum retard position using an ohmmeter. This is required during assembly and adjustment. (see service notes further on).

OIL DISTRIBUTION FLANGES: The oil distribution flanges are bolted to the front surface of each cylinder head. They provide a mounting location for the VANOS solenoids as well as the advance-retard oil ports from the solenoids to the intake camshafts.

CAMSHAFTS: Each intake camshaft has two oil ports separated by three sealing rings on their forward ends.



The ports direct pressurized oil from the oil distribution flange to the inner workings of the VANOS transmission.

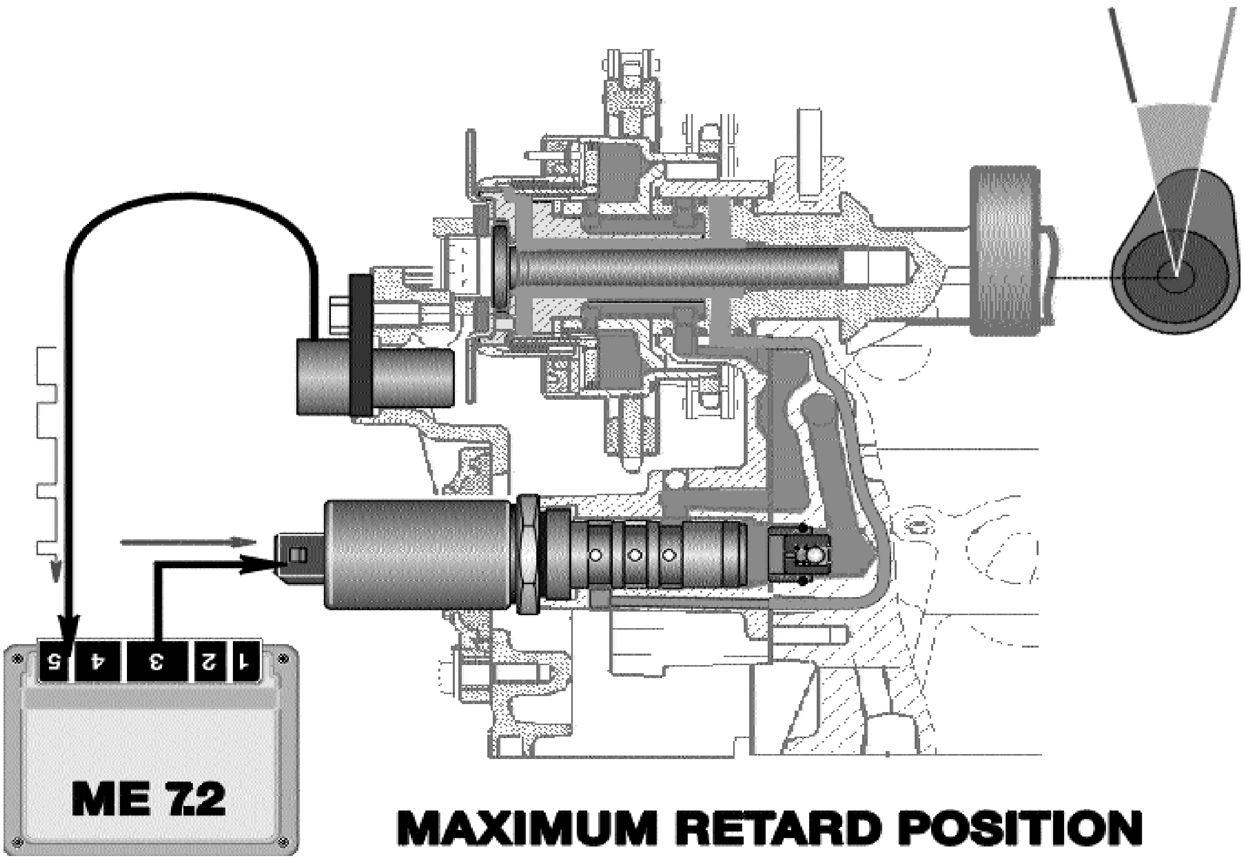
Each camshaft has ***REVERSE*** threaded bores in their centers for the attachment of the timing chain sprockets on the exhaust cams and the VANOS transmissions for each intake camshaft as shown.

CAMSHAFT POSITION IMPULSE WHEELS: The camshaft position impulse wheels provide camshaft position status to the engine control module via the camshaft position sensors. The asymmetrical placement of the sensor wheel pulse plates provides the engine control module with cylinder specific position ID in conjunction with crankshaft position.

M62 TU VANOS CONTROL

As the engine camshafts are rotated by the primary and secondary timing chains, the ME7.2 control module activates the VANOS solenoids via a PWM (pulse width modulated) ground signal based on a program map. The program is influenced by engine speed, load, and engine temperature.

- **Shown below:** In its inactive or default position, the valves direct 100% engine oil pressure flow to achieve max "retard" VANOS positioning

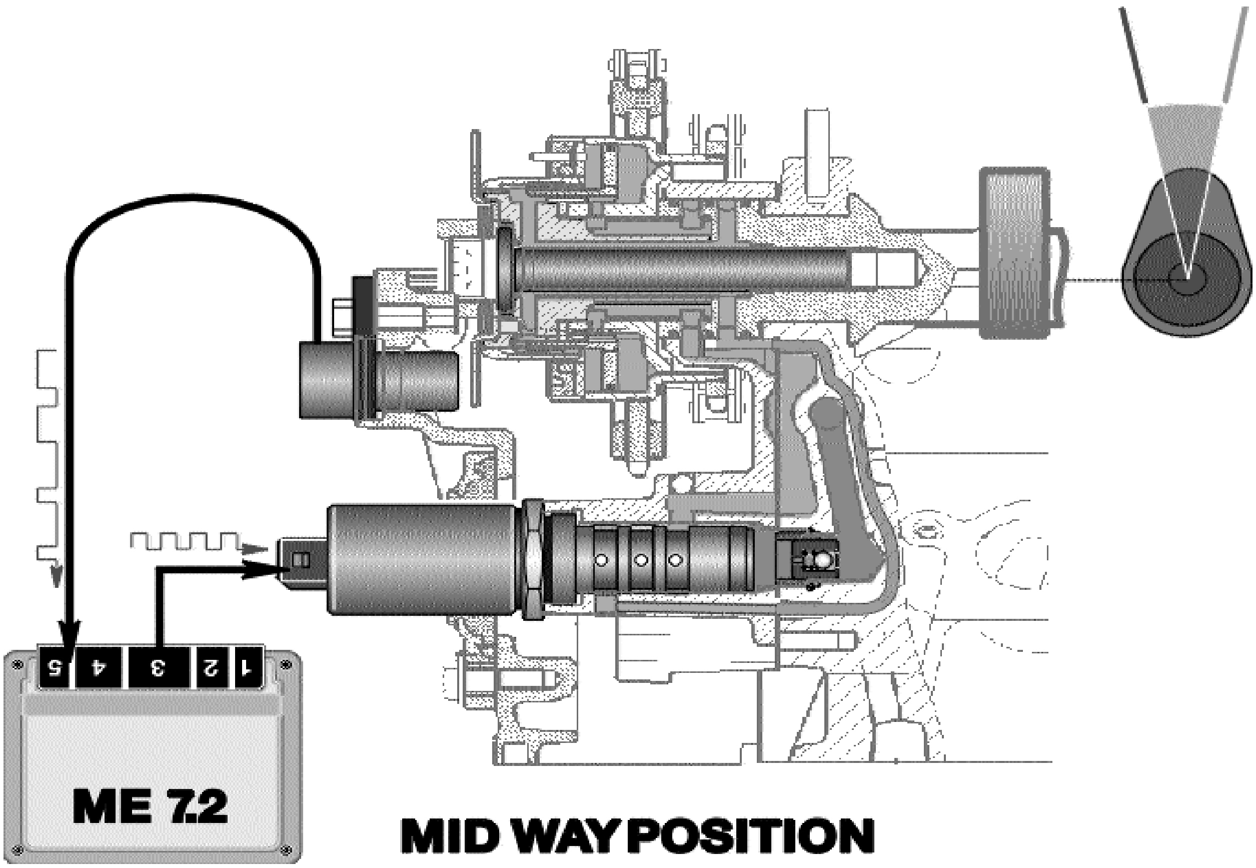


- **Top of next page**: As the Pulse Width Modulation (PWM) increases on the control signal, the valve progressively opens the advance oil port and proportionately closes the retarded oil port.

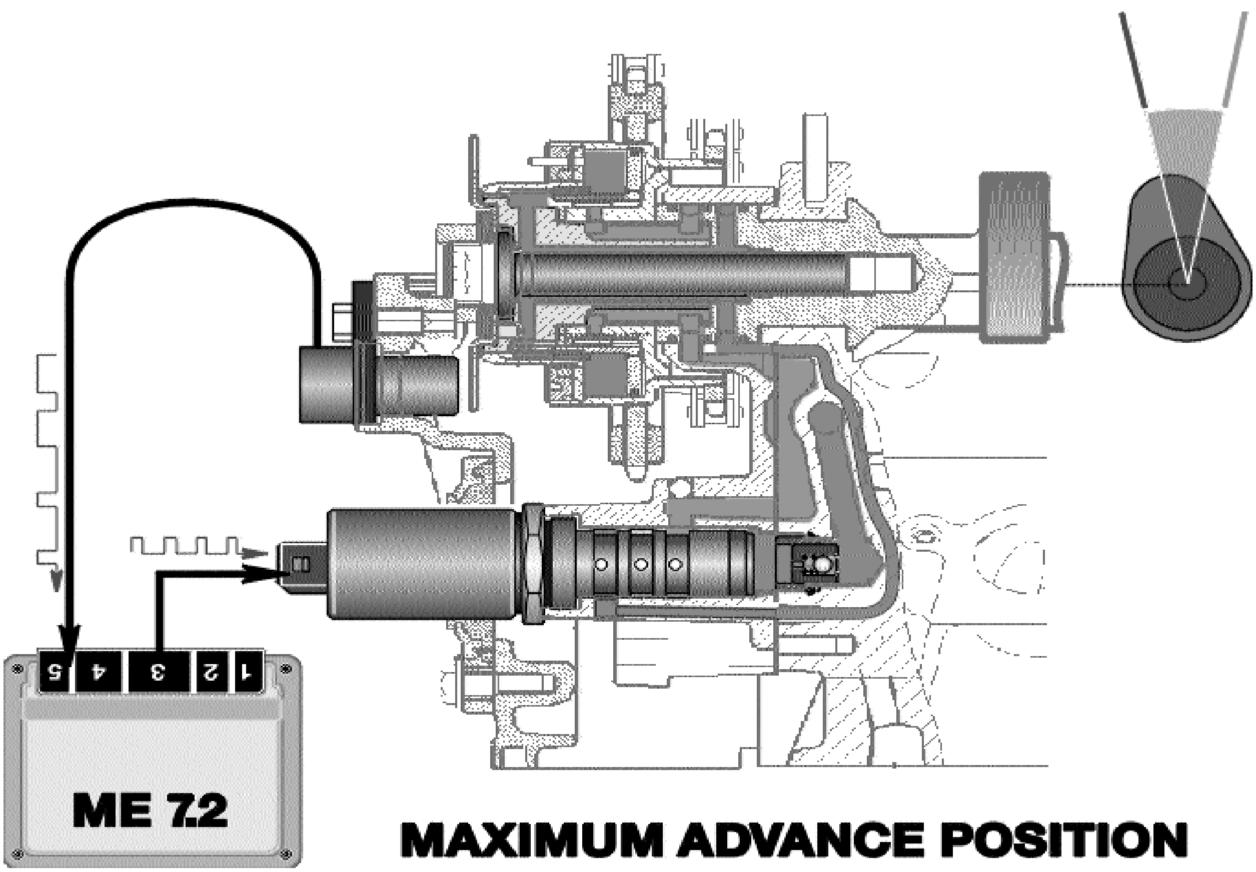
  Oil pressure pushes the piston toward the advance position. Simultaneously the oil pressure on the retarded side (rear) of the piston is decreased and directed to the vent port in the solenoid valve and drains into the cylinder head.

- **Bottom of next page:** At maximum PWM control, 100% oil flow is directed to the front surface of the piston pushing it rearward to maximum advance.

Varying the pulse width (on time) of the solenoids control signals proportionately regulates the oil pressures on each side of the pistons to achieve the desired VANOS advance angle.



MID WAY POSITION



MAXIMUM ADVANCE POSITION

VANOS SERVICE NOTES

VALVE TIMING PROCEDURES

Refer to TIS for complete Valve Timing Procedures. M62 TU valve timing adjustment is similar to the previous non VANOS M62 engine ***with the exception*** of setting the VANOS transmissions to their max retard positions with an ohmmeter and attaching the camshaft gears to each camshaft with single reverse threaded bolts.

- After locking the crankshaft at TDC, the camshaft alignment tools (P/N 90 88 6 112 440) are placed on the square blocks on the rear of the camshafts locking them in place.

- The exhaust camshaft sprockets and VANOS transmission units with timing chains are placed onto their respective camshafts.

- The exhaust camshaft sprockets and VANOS transmissions are secured to the camshafts with their respective single, reverse threaded bolt. Finger tighten only at this point. Install the chain tensioner into the timing chain case and tension the chain.

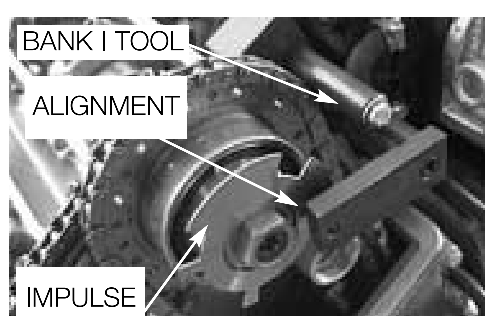
- Connect an ohmmeter across two of the three pin contacts on the front edge of one of the VANOS transmissions. Twist the inner hub of transmission to the left (counter clockwise). Make sure the ohmmeter indicates closed circuit. This verifies that the transmission in the default max retard position.

- Using an open end wrench on the camshaft to hold it in place, torque the VANOS transmission center bolt to specification.

CAMSHAFT IMPULSE WHEEL POSITION TOOLS

The camshaft impulse wheels require a special tool set to position them correctly prior to torquing the retaining nuts.

The impulse wheels are identical for each cylinder bank. The alignment hole in each wheel must align with the tool's alignment pin. Therefore the tools are different and must be used specifically for their bank.



The tool rests on the upper edge of the cylinder head and is held in place by the timing case bolts.

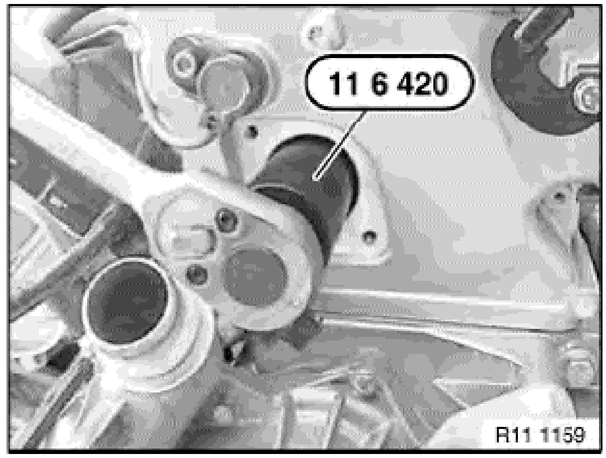
Refer to the TIS repair manual section for complete information.

VANOS SOLENOID REPLACEMENT

Refer to TIS repair manual section for complete solenoid replacement procedures.

The solenoids are threaded into the oil distribution flanges through a small opening in the upper timing case covers.

Special Tool 11 6 420 is required.

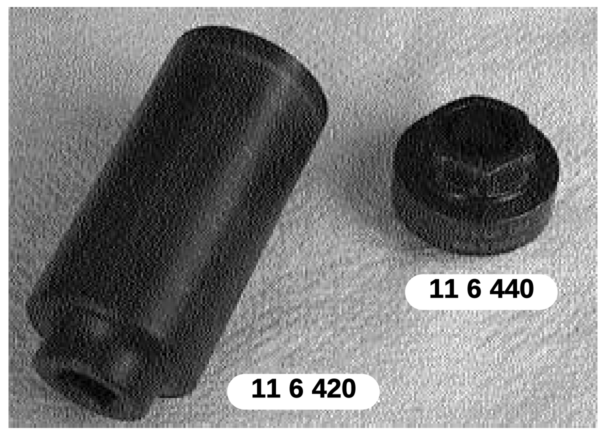


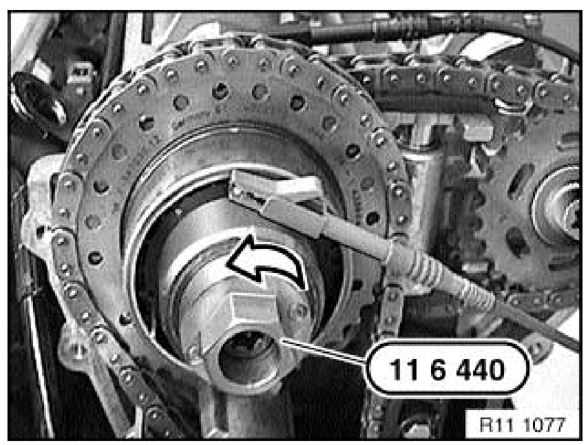
VANOS TRANSMISSION RETARD POSITION SET UP TOOLS

Special Tool 11 6 440 is used to rotate the transmission to the full retard position when checking the piston position with an ohmmeter.

This tool engages the inner hub of the transmission provides an easy method of twisting it to the left for the ohmmeter test.

Refer to SI Bulletin 04 12 98 for additional special tool information.





DIAGNOSIS

The VANOS is fully compatible with the diagnostic software providing specific fault codes and test modules. Additionally, diagnostic requests section provides status of the PWM of the VANOS solenoids and camshaft position feedback via the camshaft position sensors. The Service Functions section of the DIS/MoDiC also provides a VANOS system test.

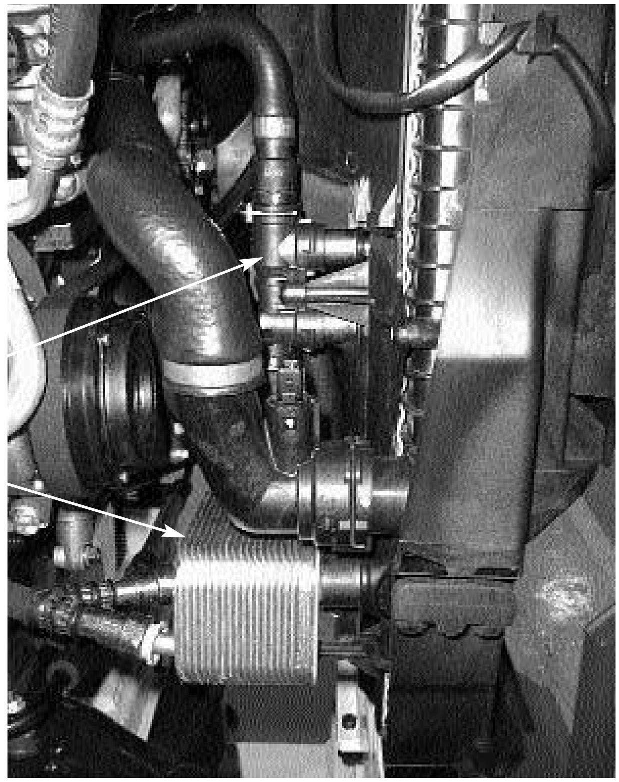
ENGINE COOLING SYSTEM

The cooling system concepts introduced in the 1999 Model year including the automatic transmission heat exchanger and the the water cooled alternator have been retained for the X5.

The component locations have however been changed:

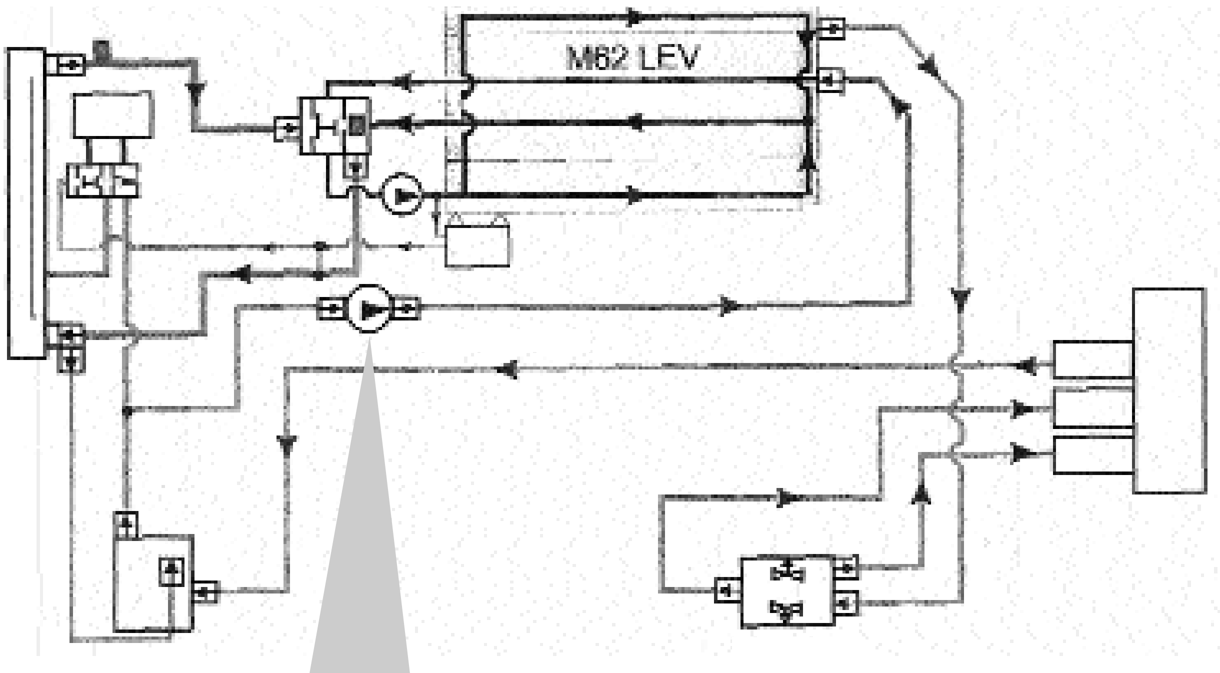
- Thermostat for heat exchanger mounted directly on radiator

- Transmission heat exchanger - right side of radiator.



IHKA SYSTEM AUXILIARY PUMP

The auxiliary water pump for the IHKA is mounted on the left side of the radiator. The function of the pump remains the same as follows:

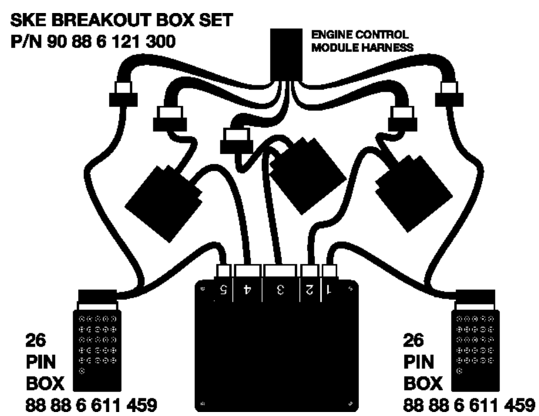


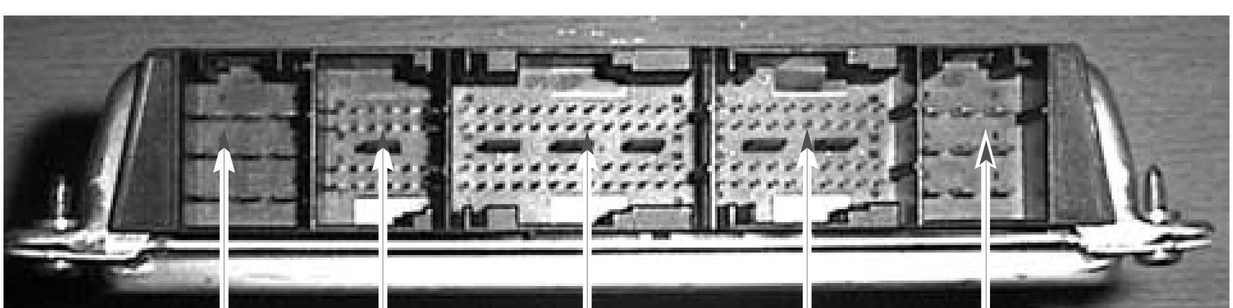
- provide adequate coolant flow for IHKA operation.
- provide coolant circulation for the REST function of IHKA.

DME-ME 7.2 ENGINE MANAGEMENT SYSTEM

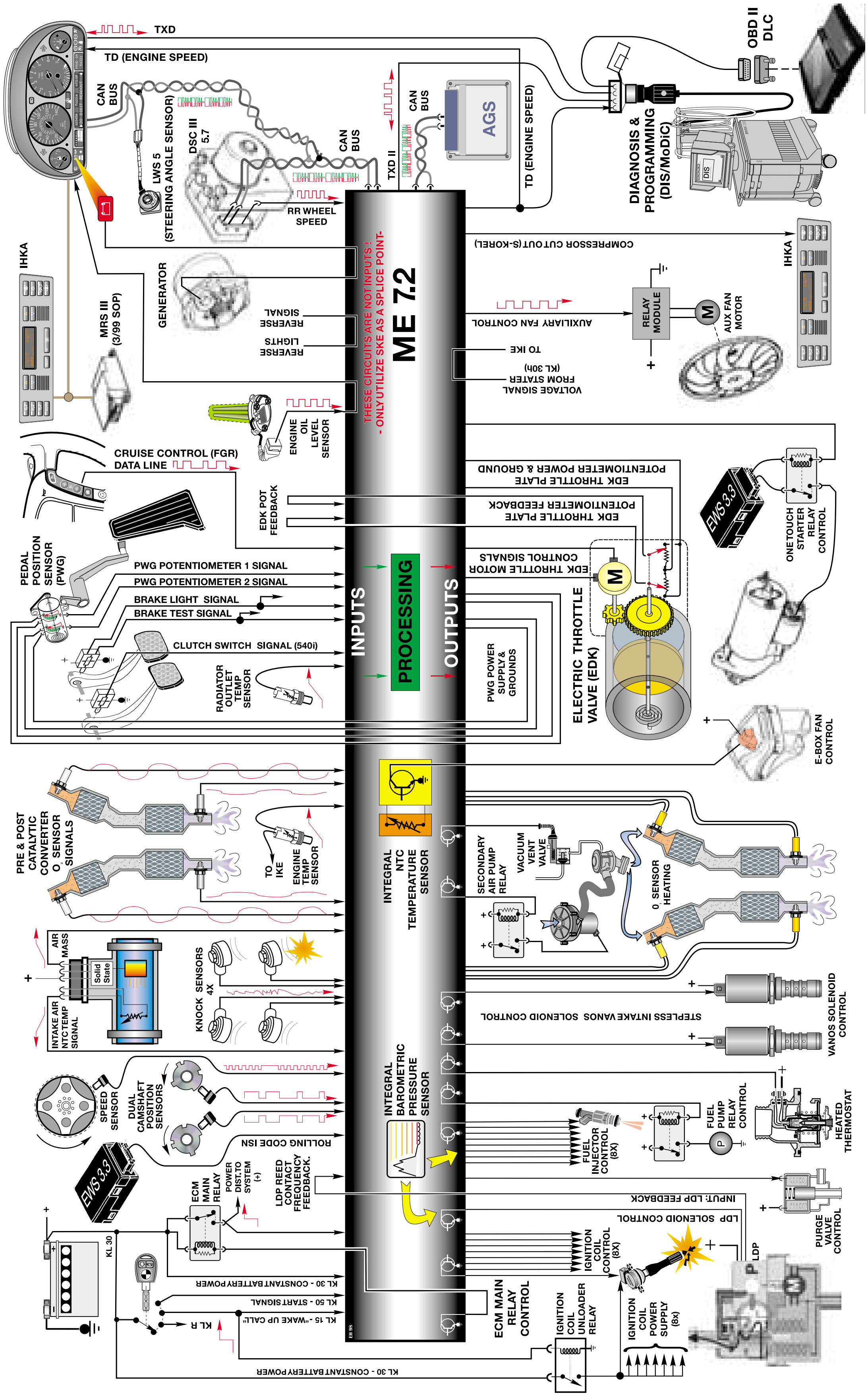
The “ME” designation identifies the system as “M” = Motronic, “E” = EML.

- Manufactured by Bosch to BMW specifications
- 134 pin SKE (standard shell construction) control module located in E box
- Diagnostic communication protocol-KWP2000
- Uses break-out box set (P/N 90 88 6 121 300)
- Integral EML throttle control system
  - monitors an interior installed PWG
  - actuates an electric throttle valve (EDK)
- Integral Cruise control functionality
  - monitors cruise control requests
  - monitors brake pedal and clutch switches
  - carries out throttle control directly via EDK
- Carries out DSC III torque reduction requests.
- VANOS control
- Integrated altitude sensor
- Integrated temp sensor for monitoring E box temperatures
- Control of E-box fan
- One touch engine start control
- Oxygen Sensor heating
- Engine overrev & Max speed limitation
- Active Hall sensor for camshaft position monitoring
- Single speed secondary air injection system
- Electrically heated coolant system thermostat
- Longlife spark plugs
- IHKA Auxiliary Fan control
- ***DM-TL (Diagnostic Module - Tank Leak Diagnosis System)***





1	2	3	4	5
(9 pins)	(24 pins)	(52 pins)	(40 pins)	(9 pins)

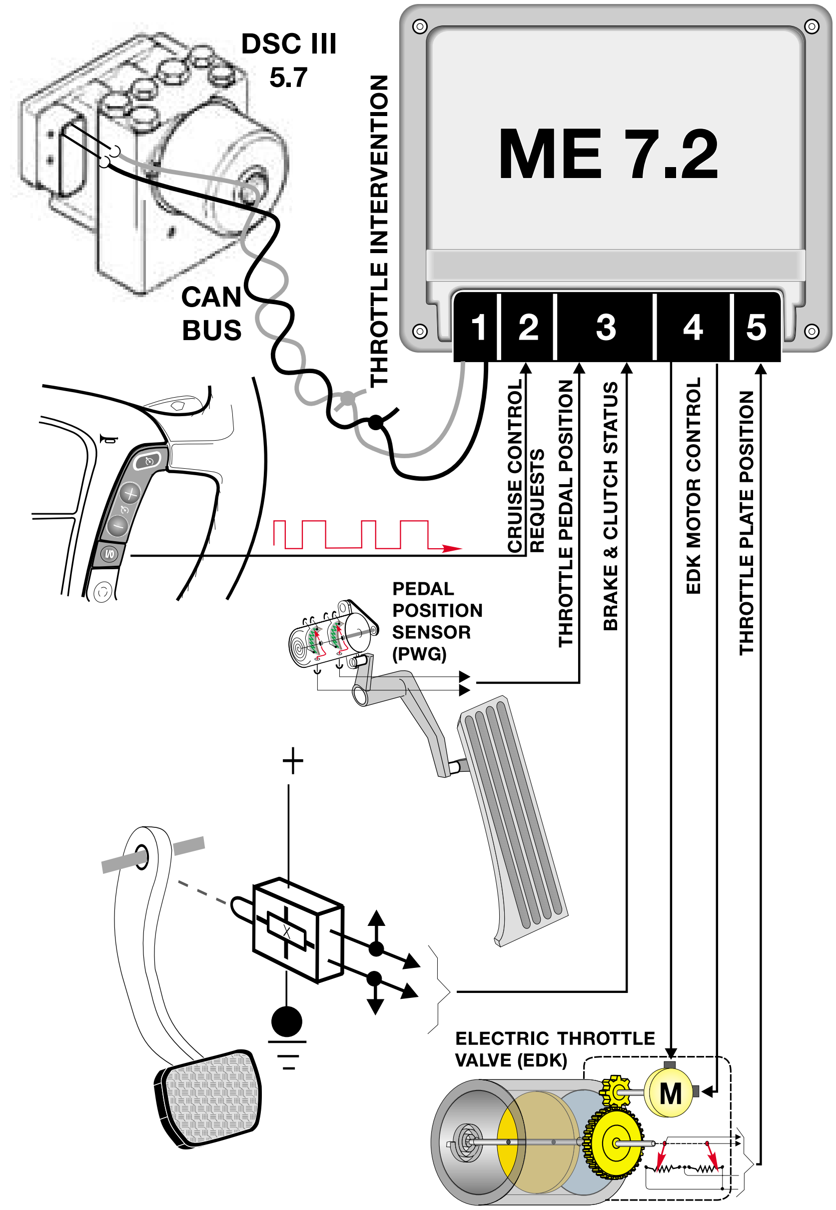


ME 7.2
INPUTS
PROCESSING
OUTPUTS
THESE CIRCUITS ARE NOT INPUTS !
- ONLY UTILIZE SKE AS A SPLICE POINT-
TXD
TD (ENGINE SPEED)
CAN BUS
LWS 5 (STEERING ANGLE SENSOR)
DSC III 5.7
RR WHEEL SPEED
TXD II
AGS
TD (ENGINE SPEED)
DIAGNOSIS & PROGRAMMING (DIS/MoDiC)
OBD II DLC
IHKA
COMPRESSOR CUTOUT (S-KOREL)
GENERATOR
MRS III (3/99 SOP)
REVERSE SIGNAL
REVERSE LIGHTS
AUXILIARY FAN CONTROL
RELAY MODULE
AUX FAN MOTOR
TO IKE
VOLTAGE SIGNAL FROM STATER (KL 30h)
ENGINE OIL LEVEL SENSOR
CRUISE CONTROL (FGR) DATA LINE
EDK THROTTLE PLATE POTENTIOMETER POWER & GROUND
EDK POT FEEDBACK
EDK THROTTLE PLATE POTENTIOMETER FEEDBACK
EWS 3.3
ONE TOUCH STARTER RELAY CONTROL
EDK THROTTLE MOTOR CONTROL SIGNALS
PEDAL POSITION SENSOR (PWG)
PWG POTENTIOMETER 1 SIGNAL
PWG POTENTIOMETER 2 SIGNAL
BRAKE LIGHT SIGNAL
BRAKE TEST SIGNAL
CLUTCH SWITCH SIGNAL (540i)
RADIATOR OUTLET TEMP SENSOR
PWG POWER SUPPLY & GROUNDS
ELECTRIC THROTTLE VALVE (EDK)
E-BOX FAN CONTROL
PRE & POST CATALYTIC CONVERTER O SENSOR SIGNALS
TO IKE
ENGINE TEMP SENSOR
INTEGRAL NTC TEMPERATURE SENSOR
SECONDARY AIR PUMP RELAY
VACUUM VENT VALVE
O SENSOR HEATING
AIR MASS
Solid State
INTAKE AIR NTC TEMP SIGNAL
KNOCK SENSORS 4X
STEPLESS INTAKE VANOS SOLENOID CONTROL
VANOS SOLENOID CONTROL
SPEED SENSOR
DUAL CAMSHAFT POSITION SENSORS
INTEGRAL BAROMETRIC PRESSURE SENSOR
ROLLING CODE ISN
FUEL INJECTOR CONTROL (8X)
FUEL PUMP RELAY CONTROL
HEATED THERMOSTAT
ECM MAIN RELAY
POWER DIST. TO SYSTEM (+)
LDP REED CONTACT FREQUENCY FEEDBACK.
INPUT: LDP FEEDBACK
PURGE VALVE CONTROL
LDP SOLENOID CONTROL
LDP
KL 30
KL 30 - CONSTANT BATTERY POWER
KL 50 - START SIGNAL
KL 15 - "WAKE UP CALL"
KL R
IGNITION COIL CONTROL (8X)
ECM MAIN RELAY CONTROL
IGNITION COIL UNLOADER RELAY
IGNITION COIL POWER SUPPLY (8x)
KL 30 - CONSTANT BATTERY POWER

INTEGRAL ELECTRIC THROTTLE SYSTEM (EML)

FUNCTIONAL DESCRIPTION

When the accelerator pedal is moved, the PWG provides a change in the monitored signals. The ME 7.2 compares the input signal to a programmed map and appropriately activates the EDK motor via proportionally high/low switching circuits. The control module self-checks it's activation of the EDK motor via the EDK feedback potentiometers.



Requirements placed on the Electric Throttle System:

- Regulate the calculated intake air load based on PWG input signals and programmed mapping.
- Control idle air when LL detected with regard to road speed as per previous systems.
- Monitor the driver's input request for cruise control operation.
- Automatically position the EDK for accurate cruise control (FGR) operation.
- Perform all DSC III throttle control interventions.
- Monitor and carryout max engine and road speed cutout.

PWG SIGNAL MONITORING & PWG FAILSAFE OPERATION:

- As a redundant safety feature the PWG provides two separate signals from two integral potentiometers (Pot 1 and Pot 2) representing the driver's request for throttle activation.
- If the monitored PWG potentiometer signals are not plausible, ME 7.2 will only use the lower of the two signals as the driver's pedal request input providing failsafe operation. Throttle response will be slower and maximum throttle position will be reduced.
- When in PWG failsafe operation, ME 7.2 sets the EDK throttle plate and injection time to idle (LL) whenever the brake pedal is depressed.
- When the system is in PWG failsafe operation, the instrument cluster matrix display will post "Engine Emergency Program" and PWG specific fault(s) will be stored in memory.

EDK FEEDBACK SIGNAL MONITORING & EDK FAILSAFE OPERATION:

- The EDK provides two separate signals from two integral potentiometers (Pot 1 and Pot 2) representing the exact position of the throttle plate.
- EDK Pot 1 provides the primary throttle plate position feedback. As a redundant safety feature, Pot 2 is continuously cross checked with Pot 1 for signal plausibility.
- If plausibility errors are detected between Pot 1 and Pot 2, ME 7.2 will calculate the inducted engine air mass (from HFM signal) and only utilize the potentiometer signal that closely matches the detected intake air mass.
    - The ME 7.2 uses the air mass signalling as a "virtual potentiometer" (pot 3) for a comparative source to provide failsafe operation.
    - If ME 7.2 cannot calculate a plausible conclusion from the monitored pots (1 or 2 and virtual 3) the EDK motor is switched off and fuel injection cut out is activated (no failsafe operation possible).
- The EDK is continuously monitored during all phases of engine operation. It is also briefly activated when KL 15 is initially switched on as a "pre-flight check" to verify it's mechanical integrity (no binding, appropriate return spring tension, etc). This is accomplished by monitoring both the motor control amperage and the reaction speed of the EDK feedback potentiometers. If faults are detected the EDK motor is switched off and fuel injection cut off is activated (no failsafe operation possible). The engine does however continue to run extremely rough at idle speed.
- When a replacement EDK is installed, the ME 7.2 adapts to the new component (required amperage draw for motor control, feedback pot tolerance differences, etc). This occurs immediately after the next cycle of KL 15 for approximately 30 seconds. During this period of adaptation, the maximum opening of the throttle plate is 25%.

INPUT SIGNALS/COMPONENTS

CAMSHAFT POSITION SENSORS

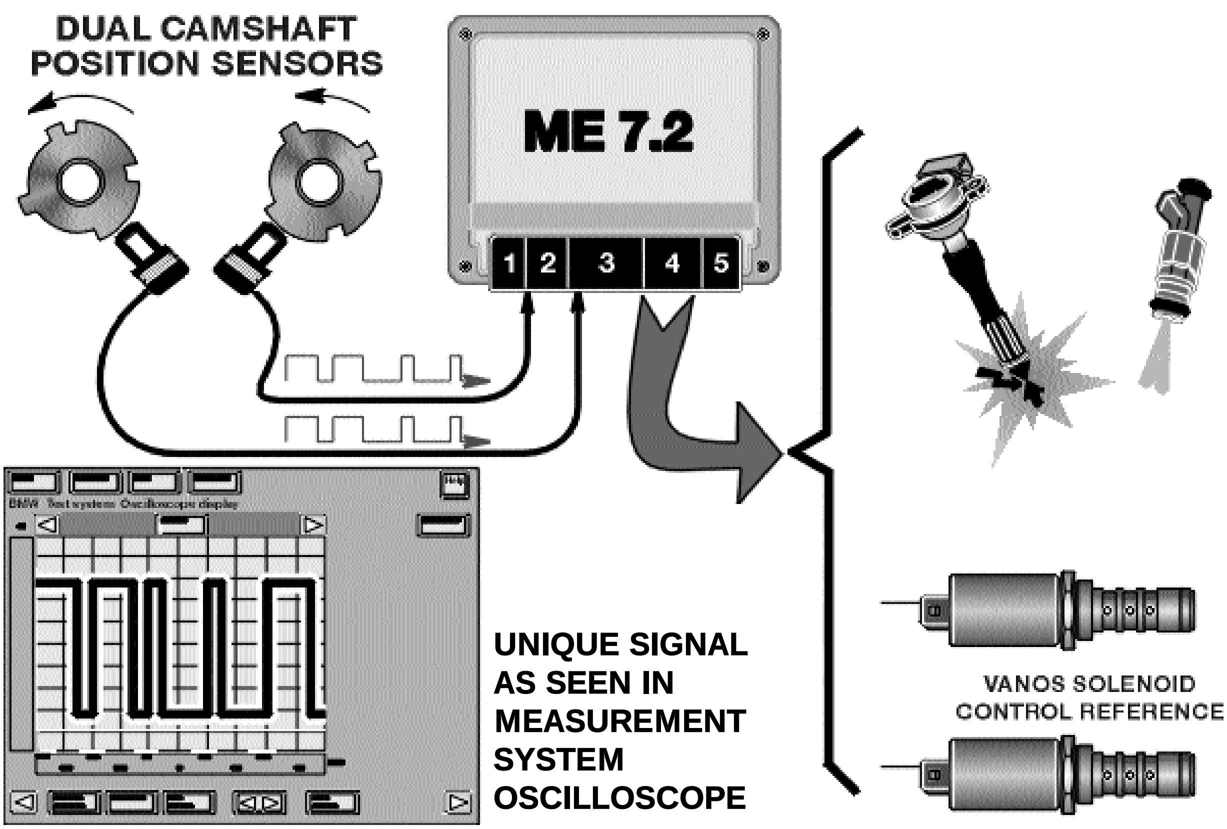
Located on the upper timing case covers, the camshaft position sensors monitor the position of the camshafts to establish start of ignition firing order, set up sequential fuel injection triggering and for accurate camshaft advance-retard (VANOS) timing feedback.

Each intake camshaft's advance-retard angles are adjusted simultaneously yet independently. For this reason ME 7.2 requires a camshaft position sensor on each cylinder bank for accurate feedback to monitor the VANOS controlled camshaft positioning.

The sensors are provided with operating power from the ECM main relay. The sensors produce a unique asymmetrical square-wave signal representative of the impulse wheel shape. The sensors are new in the fact that they are "active" hall effect sensors. Active hall sensors provide:

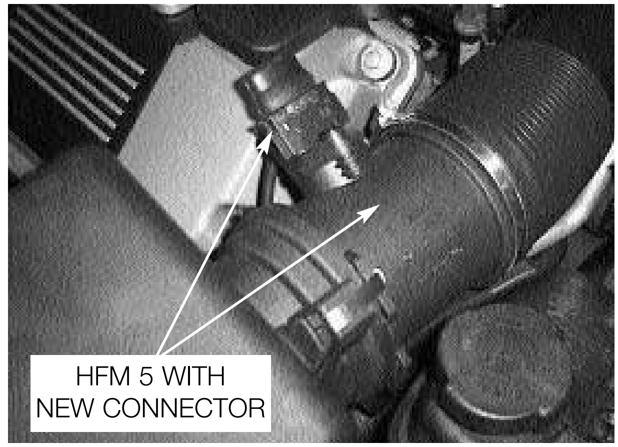
- low signal when a tooth of the camshaft impulse wheel is located in front of the sensor
- high signal when an air gap is present.

The active hall sensors supply a signal representative of camshaft position even before the engine is running. The ME 7.2 determines an approximate location of the camshafts positions prior to engine start up optimizing cold start injection (reduced emissions.)

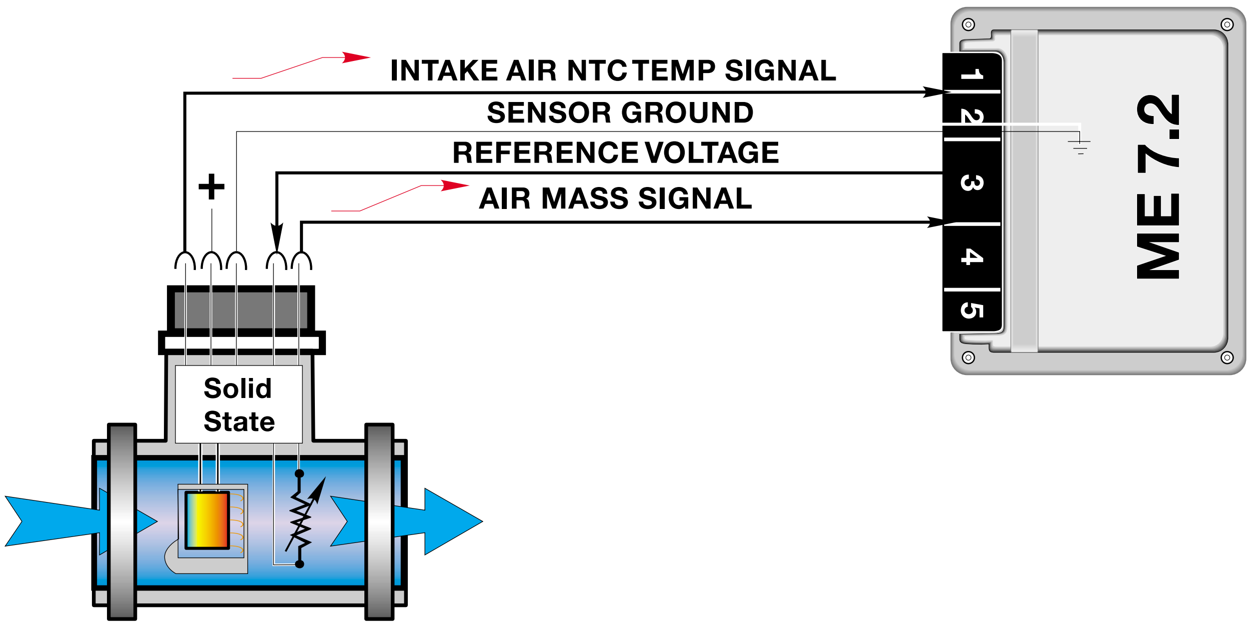


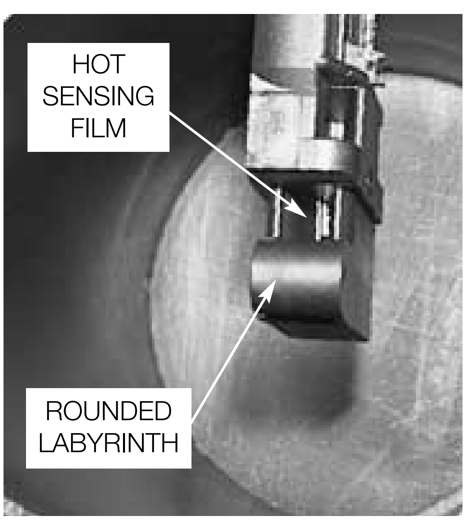
HOT FILM AIR MASS SENSOR (HFM 5)

The M62 TU is equipped with a new Hot Film Air Mass Sensor identified as HFM 5. It is a combined air mass/intake air temperature sensor. The separate intake air temperature sensor is no longer used on the M62 TU.



The HFM 5 is provided with operating power from the ECM main relay. Based on calculated intake air mass, the HFM 5 generates a varying voltage between 0.5 and 4.5 volts as an input signal to the ME 7.2





An additional improvement of the HFM 5 is that the hot film element is not openly suspended in the center bore of the sensor as with previous HFMs. It is shrouded by a round fronted plastic labyrinth which isolates it from intake air charge pulsations.

This feature allows the HFM to monitor and calculate the intake air volume with more accuracy. This feature adds further correction for calculating fuel injection “on” time (ti) which reduces emissions further.

INTEGRATED AMBIENT BAROMETRIC PRESSURE SENSOR

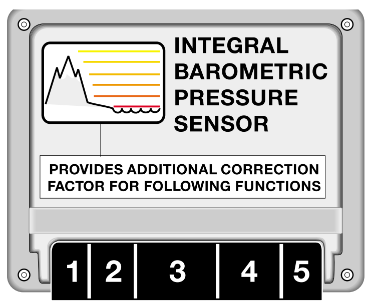
The ME 7.2 Control Module contains an integral ambient barometric pressure sensor. The sensor is part of the SKE and is not serviceable. The internal sensor is supplied with 5 volts. In return it provides a linear voltage of approx. 2.4 to 4.5 volts representative of barometric pressure (altitude).

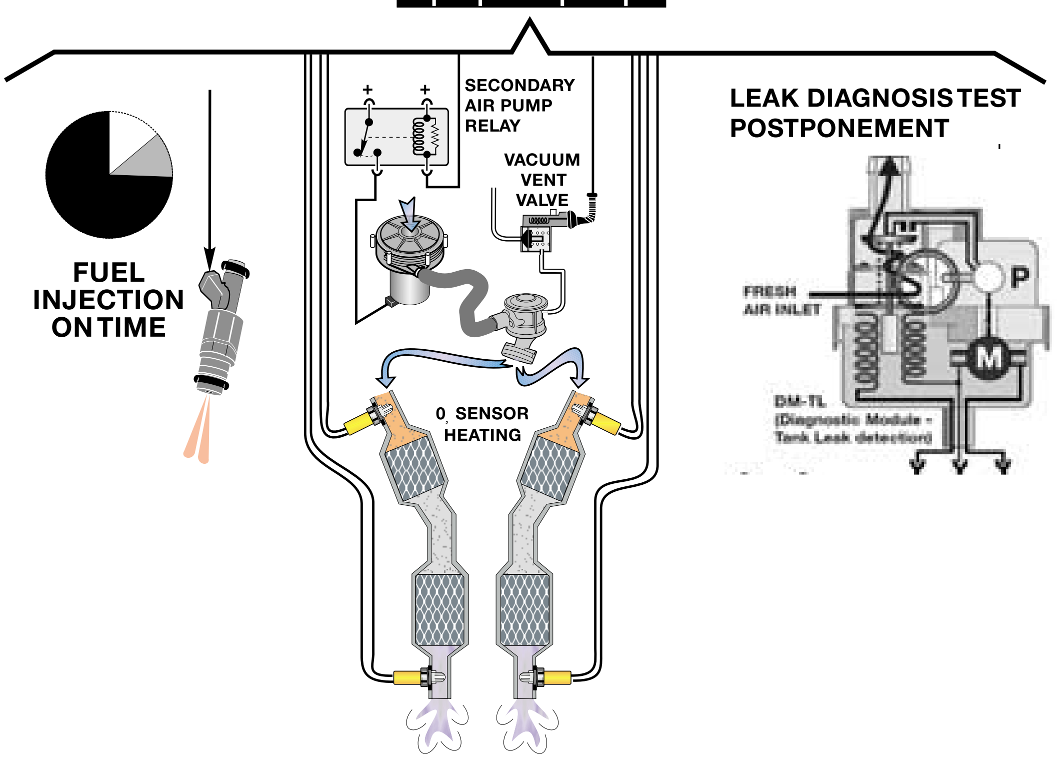
The ME 7.2 monitors barometric pressure for the following reasons:

- The barometric pressure signal along with calculated air mass provides an additional correction factor to further refine injection “on” time.

- Provides a base value to calculate the air mass being injected into the exhaust system by the secondary air injection system. This correction factor alters the secondary air injection “on” time, optimizing the necessary air flow into the exhaust system.

- Recognition of altitude above the accepted criteria postponing DM-TL activation for evaporative emission leak diagnosis.

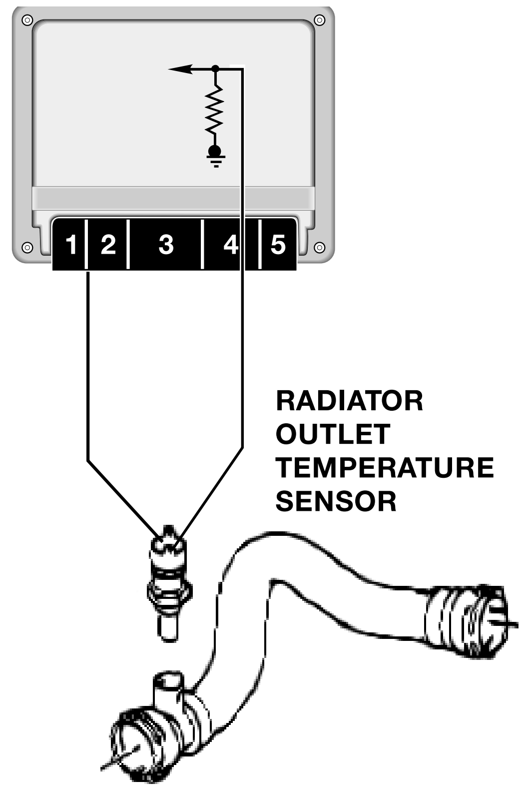




RADIATOR OUTLET TEMP SENSOR

First seen on the MS 42.0 control system, the ME 7.2 uses an additional water temperature sensor located on the radiator outlet.

ME 7.2 requires this signal to monitor the water temperature leaving the radiator for precise activation of the IHKA auxiliary fan.

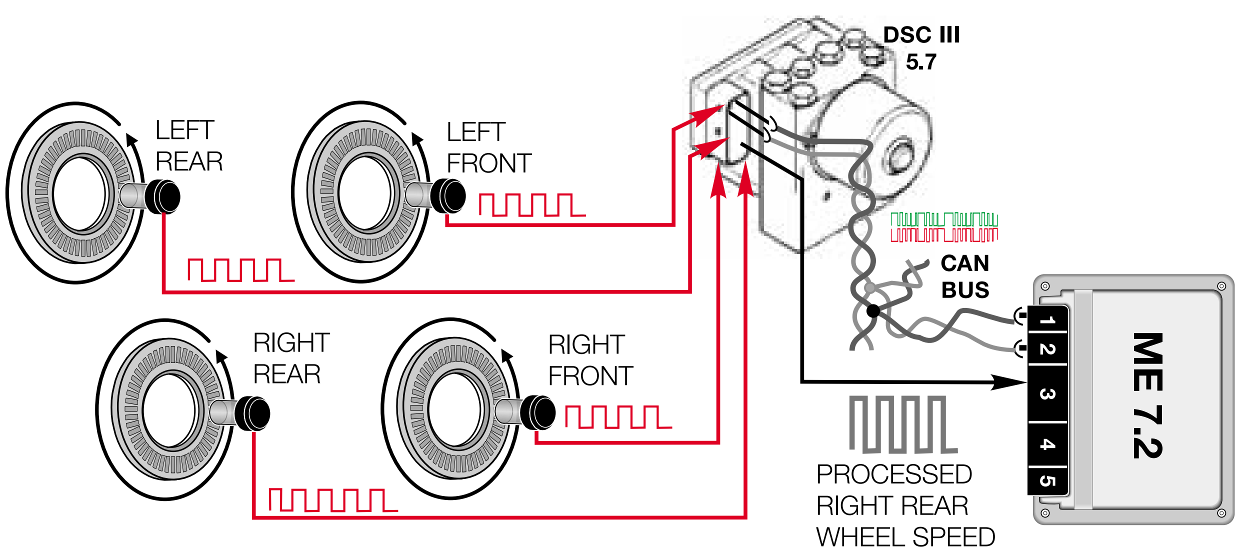


DSC III - ROAD SPEED SIGNAL

ME 7.2 receives the road speed signal directly from the DSC III control module for maximum vehicle speed management. The DSC control module provides a processed output of the right rear wheel speed sensor as a digital square wave signal. The frequency of the signal is proportional to the speed of the vehicle (48 pulses per one revolution of the wheel).

The cruise control function (FGR) of the ME 7.2 also monitors vehicle speed from the redundant vehicle speed CAN bus signal. The CAN bus speed signal is provided by the DSC III control module and based on the combined average of both front wheel speed signals.

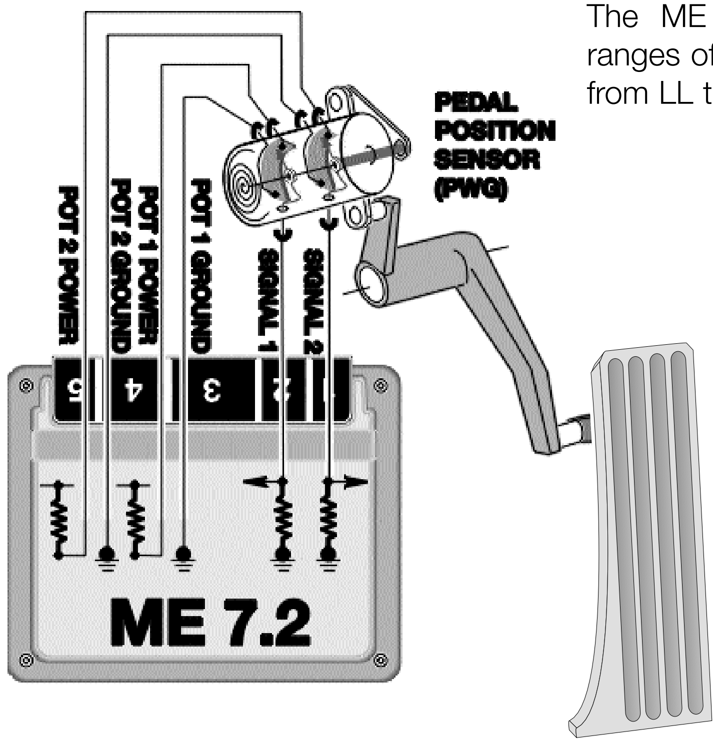
Additionally, ME 7.2 monitors all four wheel speed signals via CAN bus signalling to detect abrupt fluctuations in vehicle speed signals for the purpose of detecting rough road surfaces. This is continuously monitored as part of the OBD II emission requirements providing a correction factor for misfire detection plausibility. Earlier systems only monitored the right rear speed signal input from DSC.



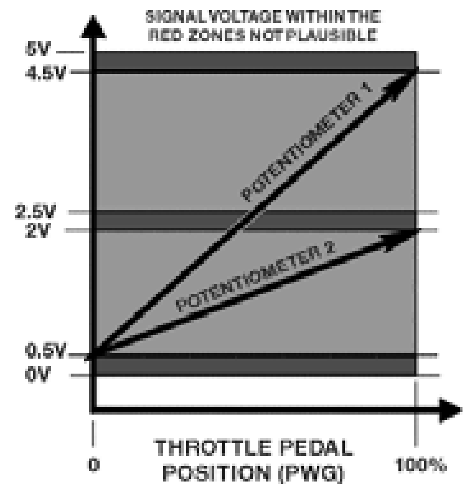
ACCELERATOR PEDAL SENSOR (PWG)

The driver's application of the accelerator pedal is monitored by a PWG sensor in the driver's footwell as with previous non-bowden cable EML systems.

The PWG provides two separate variable voltage signals to the ME 7.2 control module for determining the request for operating the Electric Throttle Valve (EDK) as well as providing a kickdown request with automatic transmission vehicles.



The ME 7.2 monitors the changing signal ranges of both circuits as the pedal is pressed from LL to VL.



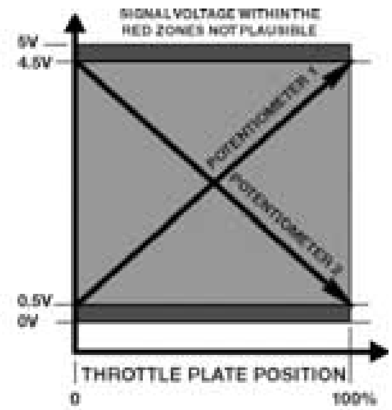
- In vehicles equipped with an automatic transmission (A5S 440Z), the ME 7.2 recognizes the max pedal value (4.5V) as a kickdown request and signals the AGS via CAN bus.

PWG SIGNAL MONITORING & PWG FAILSAFE OPERATION:

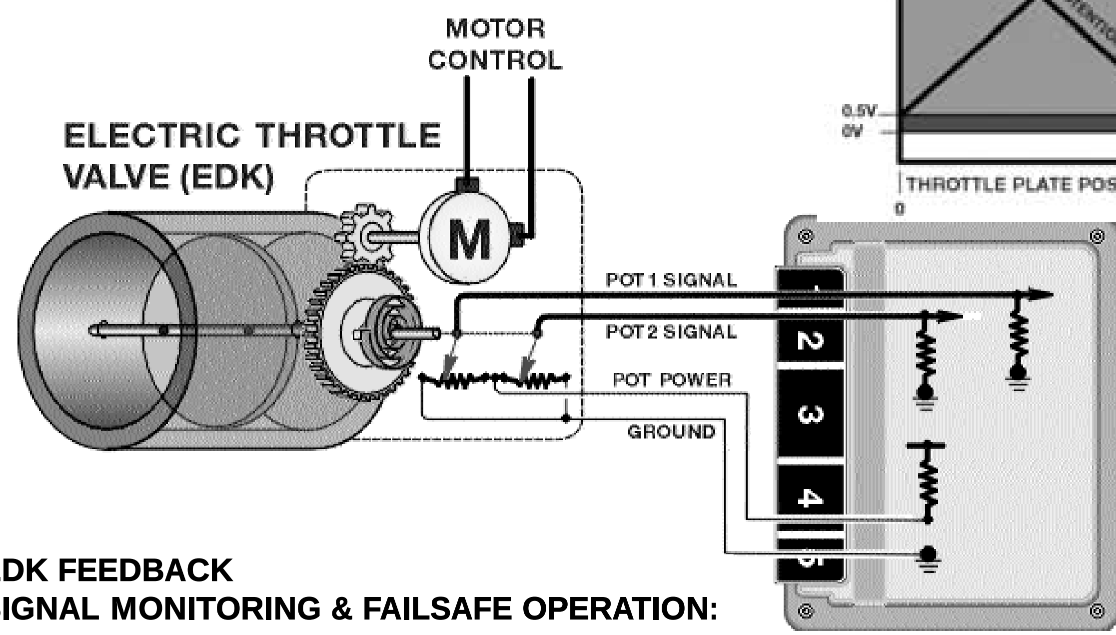
- If the monitored PWG potentiometer signals are not plausible, ME 7.2 will only use the lower of the two signals as the driver’s pedal request input providing failsafe operation. Throttle response will be slower and maximum throttle position will be reduced.
- When in PWG failsafe operation, ME 7.2 sets the EDK throttle plate and injection time to idle (LL) whenever the brake pedal is depressed.
- When the system is in PWG failsafe operation, the instrument cluster matrix display will post “Engine Emergency Program” and PWG specific fault(s) will be stored in memory.

EDK THROTTLE POSITION FEEDBACK SIGNALS

The EDK throttle plate position is monitored by two integrated potentiometers. The potentiometers provide DC voltage feedback signals as input to the ME 7.2 for throttle and idle control functions.



Potentiometer signal 1 is the primary signal, Potentiometer signal 2 is used as a plausibility cross-check through the total range of throttle plate movement.



EDK FEEDBACK
SIGNAL MONITORING & FAILSAFE OPERATION:

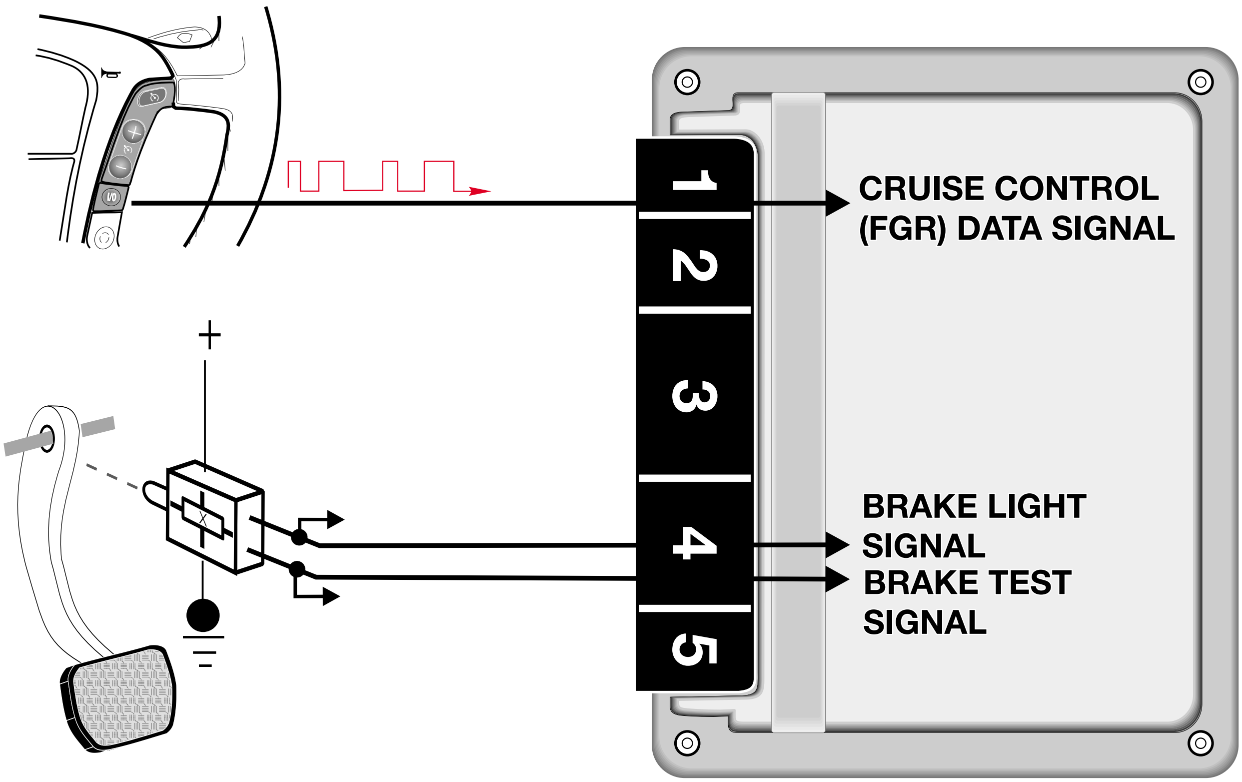
- If plausibility errors are detected between Pot 1 and Pot 2, ME 7.2 will calculate the inducted engine air mass (from HFM signal) and only utilize the potentiometer signal that closely matches the detected intake air mass.
  - The ME 7.2 uses the air mass signalling as a “virtual potentiometer” (pot 3) for a comparative source to provide failsafe operation.
  - If ME 7.2 cannot calculate a plausible conclusion from the monitored pots (1 or 2 and virtual 3) the EDK motor is switched off and fuel injection cut out is activated (no failsafe operation possible).
- The EDK is continuously monitored during all phases of engine operation. It is also briefly activated when KL 15 is initially switched on as a “pre-flight check” to verify it’s mechanical integrity (no binding, appropriate return spring tension) by monitoring the motor control amperage and the reaction speed of the EDK feedback potentiometers.

  If faults are detected the EDK motor is switched off and fuel injection cut off is activated (no failsafe operation possible). The engine does however continue to run extremely rough at idle speed.

MFL CRUISE CONTROL DATA SIGNAL

The ME 7.2 control module provides the FGR cruise control function. Throttle activation is provided by ME 7.2 automatic control of the EDK and monitoring of the throttle plate position feedback potentiometer signals.

All of the familiar driver requested cruise control function requests are provided to the ME 7.2 control module via the MFL control module on a single FGR data signal wire.



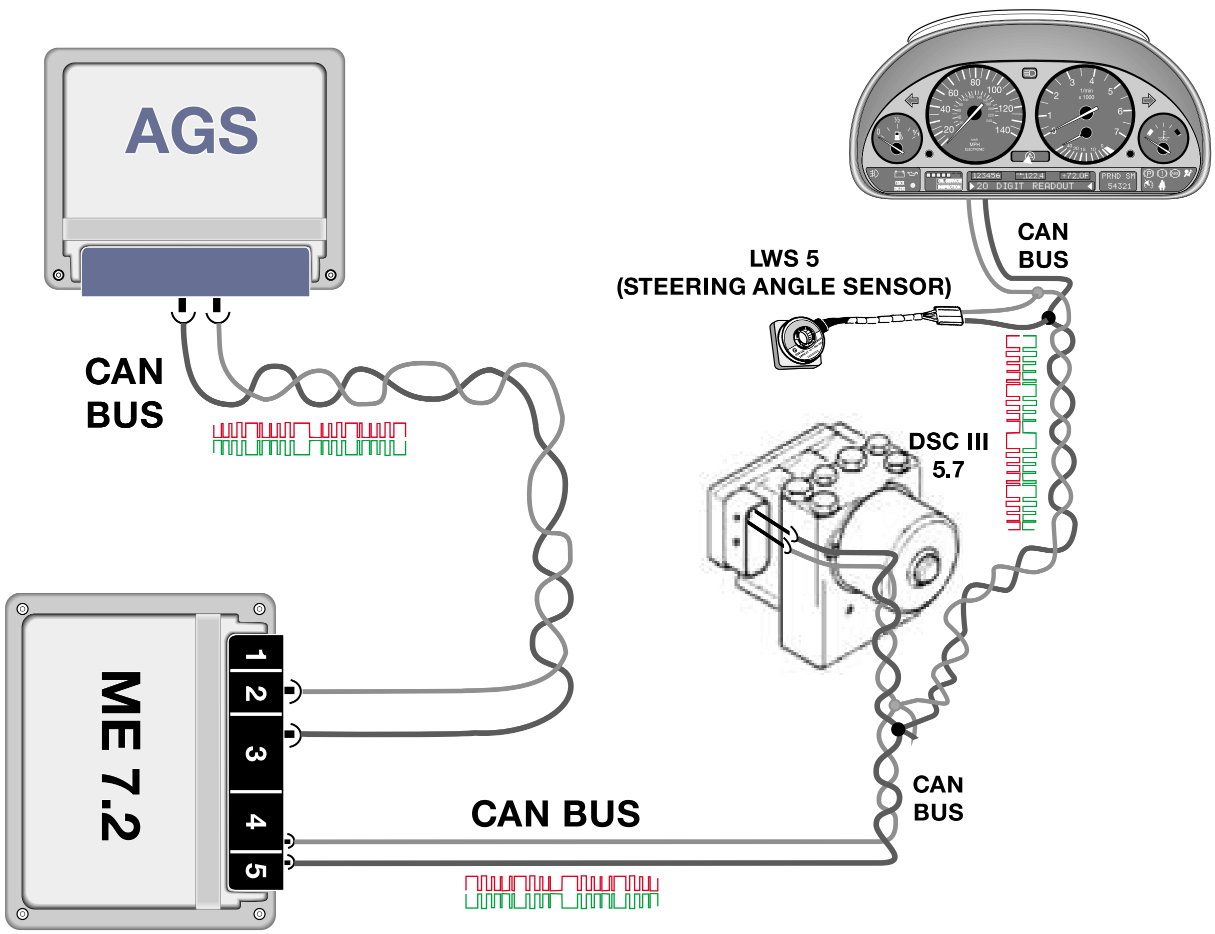
BRAKE LIGHT SWITCH

The Electronic Brake Switch (Hall effect) provides brake pedal position status to the ME 7.2. The control module monitors both the brake light and a separate brake light test switch circuits for plausibility.

When the brake pedal is pressed the brake light segment of the switch provides a ground signal. Simultaneously, the brake light test switch (located in the same housing) provides a high signal.

CAN BUS

- The CAN bus consists entirely of a twisted pair wire set. This configuration eliminates the need for a ground shield.
- The Engine Control Module has two CAN bus communication ports, one dedicated to AGS and the other for the balance of the vehicle's CAN bus control modules.
- This configuration improves the reliability of CAN bus signalling. If an open occurs in one area, the other control systems can still communicate on either side of the open.
- However, signals not reaching their intended recipients will cause CAN bus faults to be stored in the affected systems.

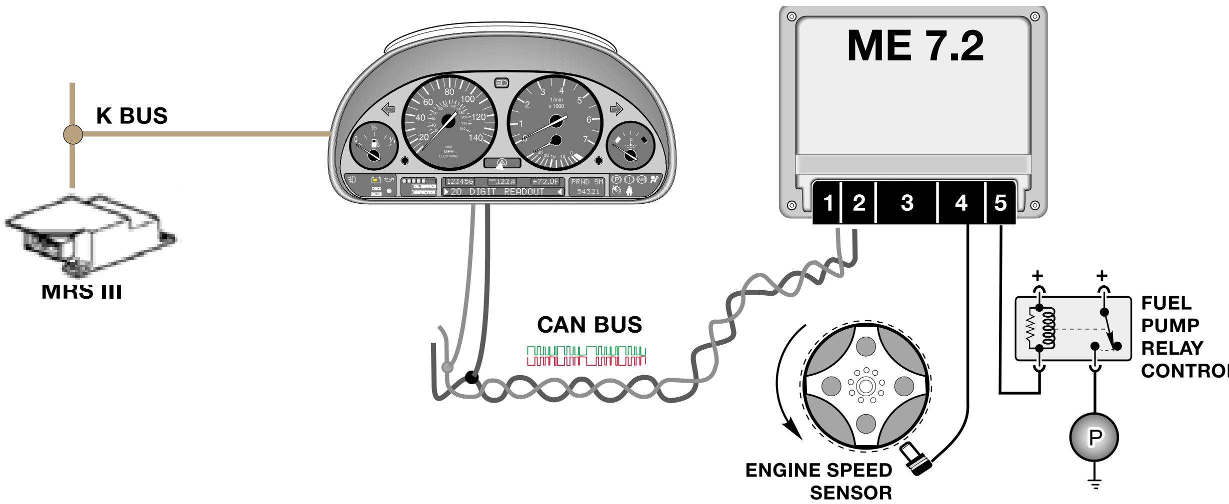


OUTPUT CONTROL FUNCTIONS

FUEL PUMP RELAY CONTROL

ME 7.2 controls the fuel pump relay as with previous systems with regard to engine speed input for continual activation of the relay.

The ME 7.2 will switch off the fuel pump relay when an airbag is activated as an additional safety function. The signal is passed from the MRS III control module to the ME 7.2 over the CAN line

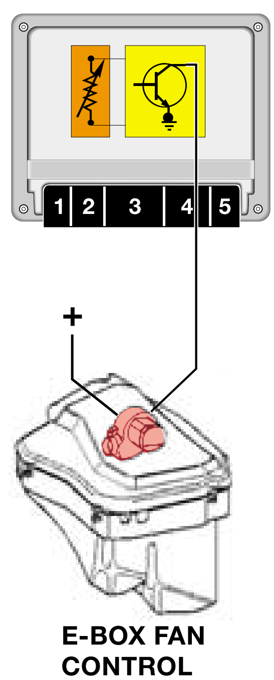


E BOX FAN CONTROL

The E Box fan is controlled by ME 7.2. The control module contains an integral NTC temperature sensor for the purpose of monitoring the E box temperature and activating the fan.

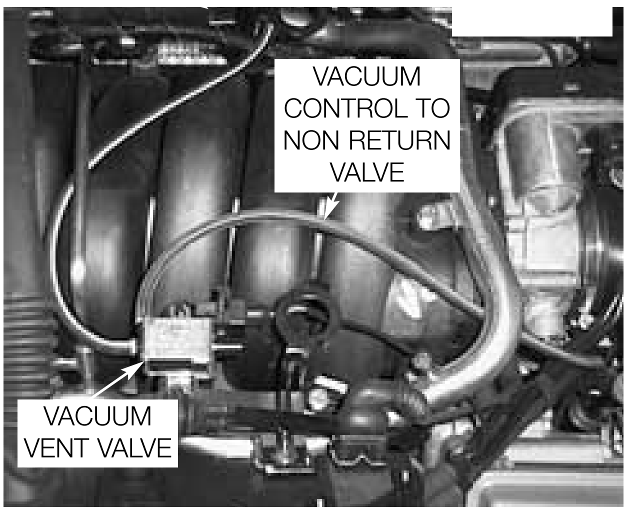
When the temperature in the E-Box exceeds predetermined values, ME 7.2 provides a switched ground for the E Box fan to cool the E box located control modules.

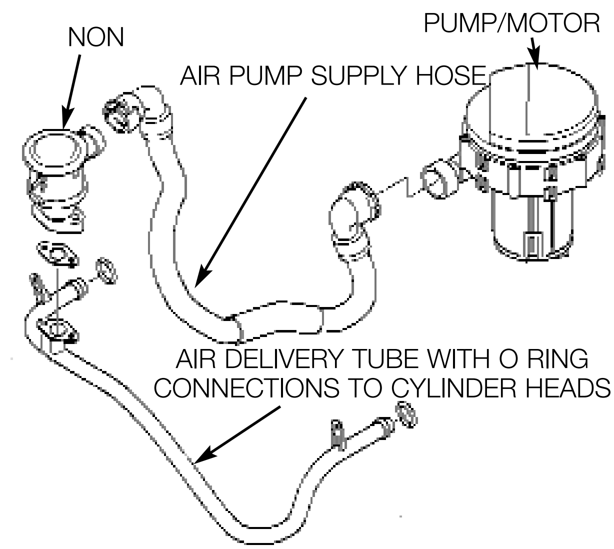
With every engine start-up, ME 7.2 briefly activates the fan ensuring continued fan motor operation for the service life of the vehicle.   This feature is intended to prevent fan motor "lock up" from lack of use due to pitting or corrosion over time.



SECONDARY AIR INJECTION

Secondary air injections required to pre-heat the catalytic converters for OBD II compliance. The system consists of the same components as previous systems with V8 specific locations.



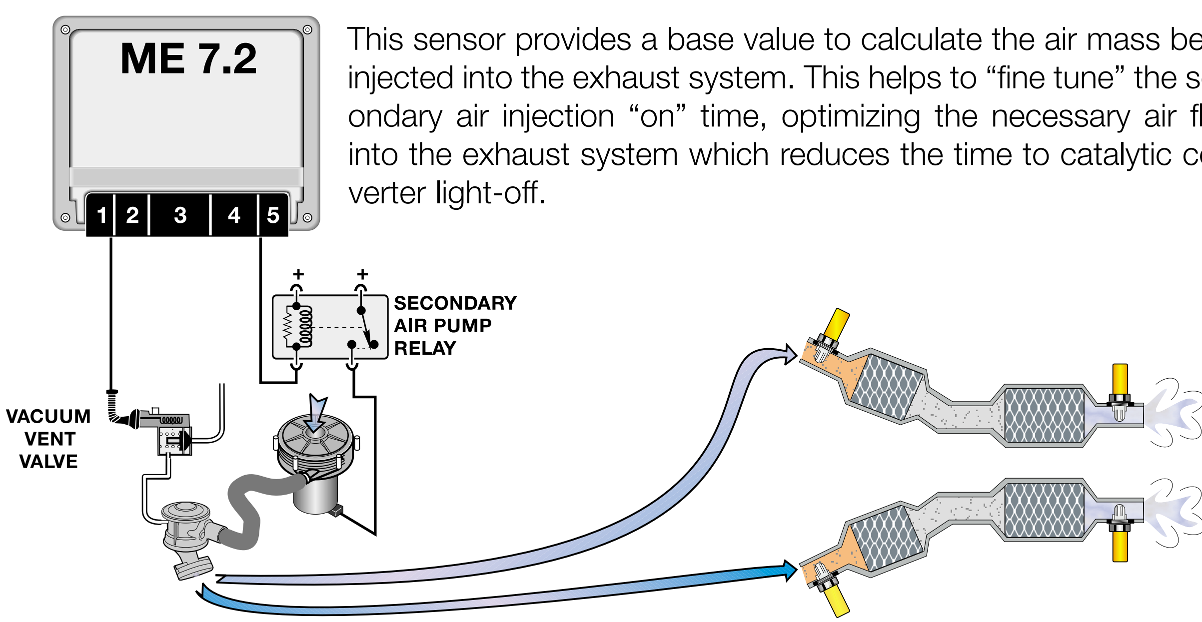


The DME ME7.2 control unit controls the vacuum vent valve and the secondary air injection pump relay separately but simultaneously.

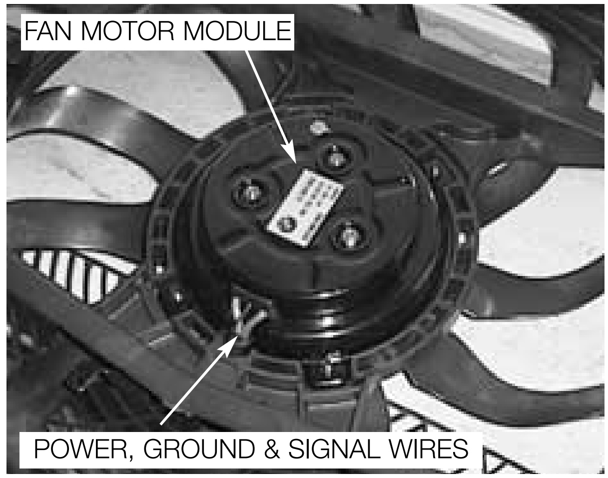
The secondary air pump operates at a start temperature of between 10°C and 40°C. It continues to operate for a max. of 2 minutes at idle speed.

ME 7.2 contributes an additional correction factor for secondary air "on" time with the additional input from the integral ambient barometric pressure sensor.

This sensor provides a base value to calculate the air mass being injected into the exhaust system. This helps to "fine tune" the secondary air injection "on" time, optimizing the necessary air flow into the exhaust system which reduces the time to catalytic converter light-off.



AUXILIARY FAN CONTROL



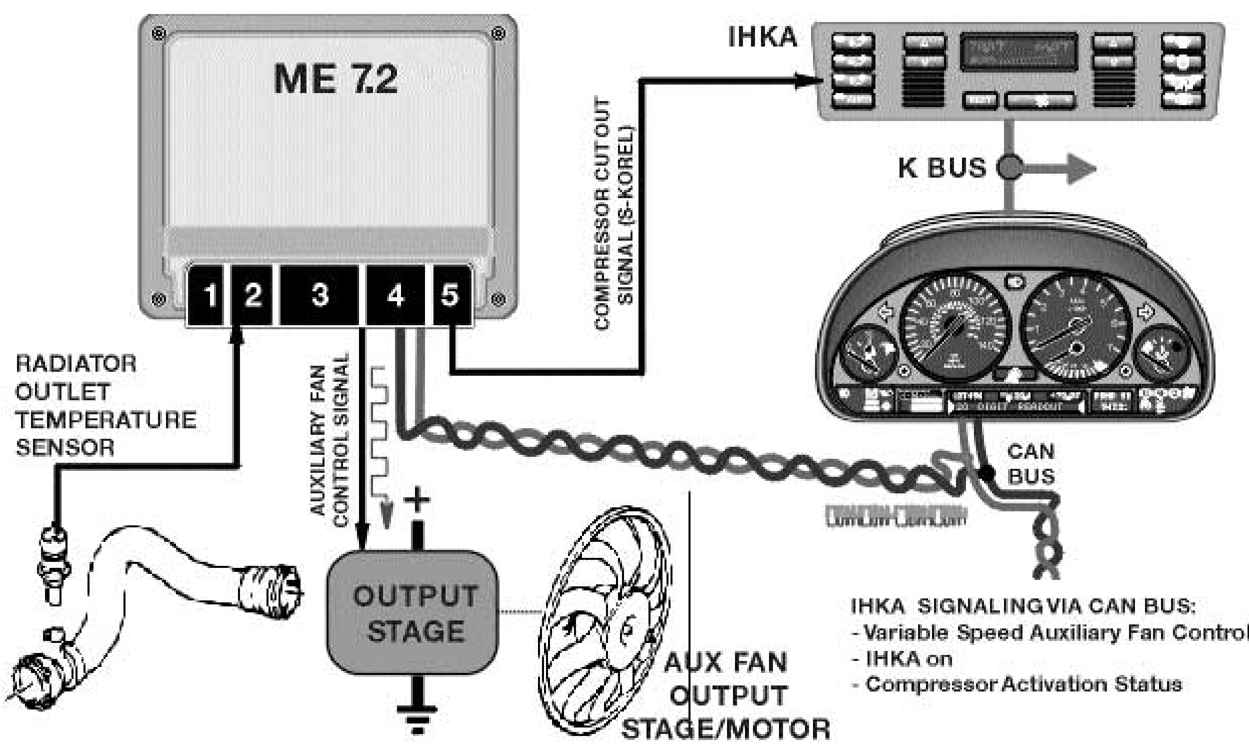
The Auxiliary Fan motor incorporates an output final stage that activates the fan motor at variable speeds.

The auxiliary fan is controlled by ME 7.2. The motor output stage receives power and ground and activates the motor based on a PWM signal (10 - 100 Hz) received from the ME 7.2.

Similar to the aux fan in the E46 with MS 42.0 control, the fan is activated based on the following factors:

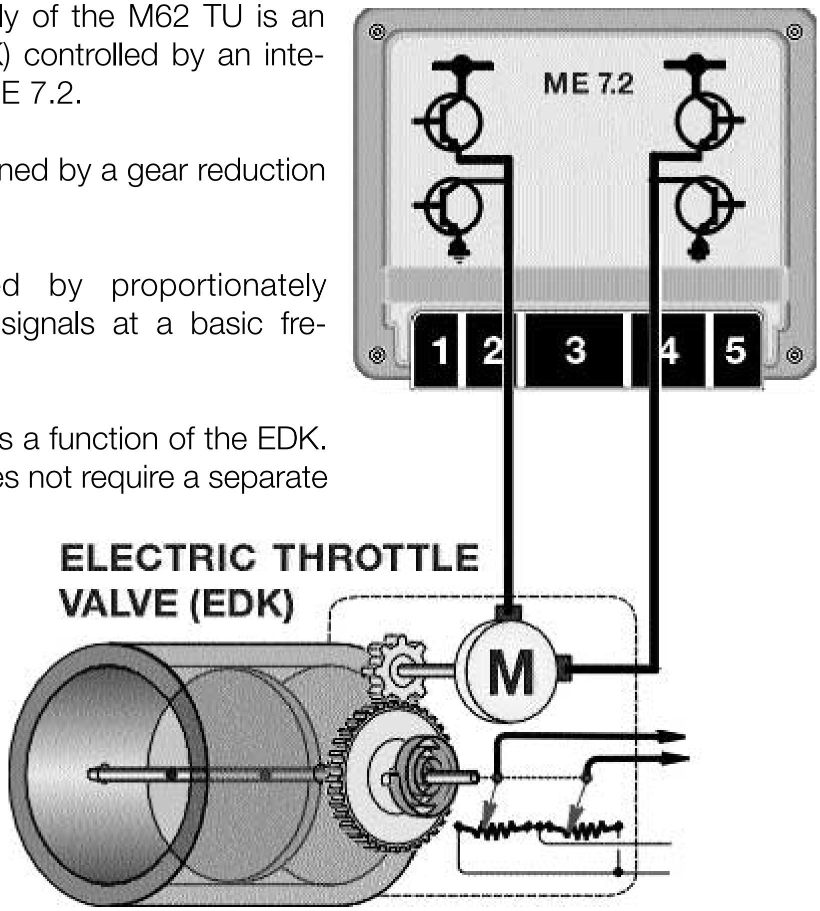
- Radiator outlet temperature sensor input exceeds a preset temperature.
- IHKA signalling via the K and CAN bus based on calculated refrigerant pressures.
- Vehicle speed
- Battery voltage level

When the over temperature light in the instrument cluster is on (120°C) the fan is run in the overrun function. This signal is provided to the DME via the CAN bus. When this occurs the fan is run at a frequency of 10 Hz.



ELECTRIC THROTTLE VALVE (EDK) CONTROL

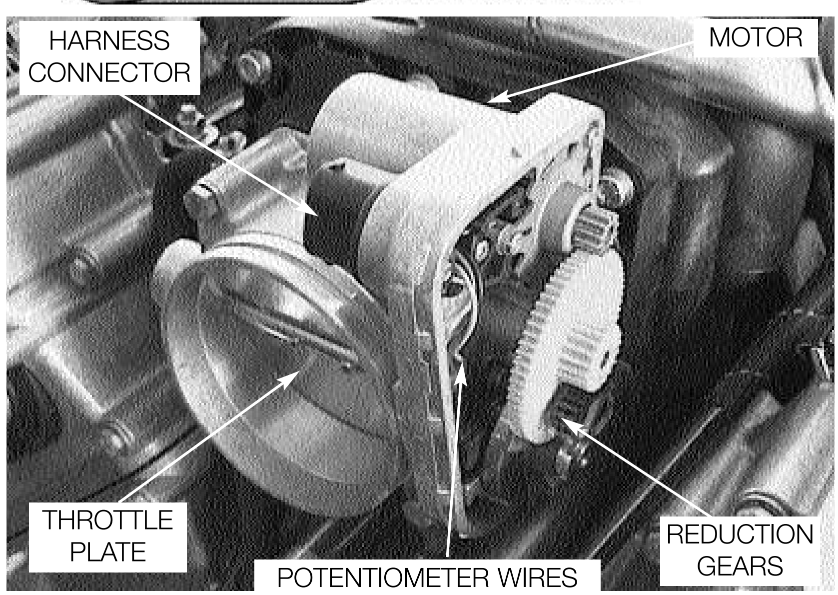
- The throttle valve assembly of the M62 TU is an electric throttle valve (EDK) controlled by an integral EML function of the ME 7.2.
- The throttle plate is positioned by a gear reduction DC motor drive.
- The motor is controlled by proportionately switched high/low PWM signals at a basic frequency of 2000 Hz.
- Engine idle speed control is a function of the EDK. Therefore, the M62 TU does not require a separate idle control valve.



EDK ADAPTATION PROCEDURE:

When a replacement EDK is installed the adaptation values of the previous EDK must be cleared from the ME 7.2 control module.

1. From the Service Function Menu of the DIS/MoDiC, clear adaptation values.
2. Switch the ignition OFF for 10 seconds.
3. Switch the ignition ON (KL 15). At approximately 30 seconds the EDK is briefly activated allowing the ME 7.2 to “electrically learn” the new component.



This procedure is also necessary after replacing an ME 7.2 control module. However, the adaptation values do not require clearing since they have not yet been established.

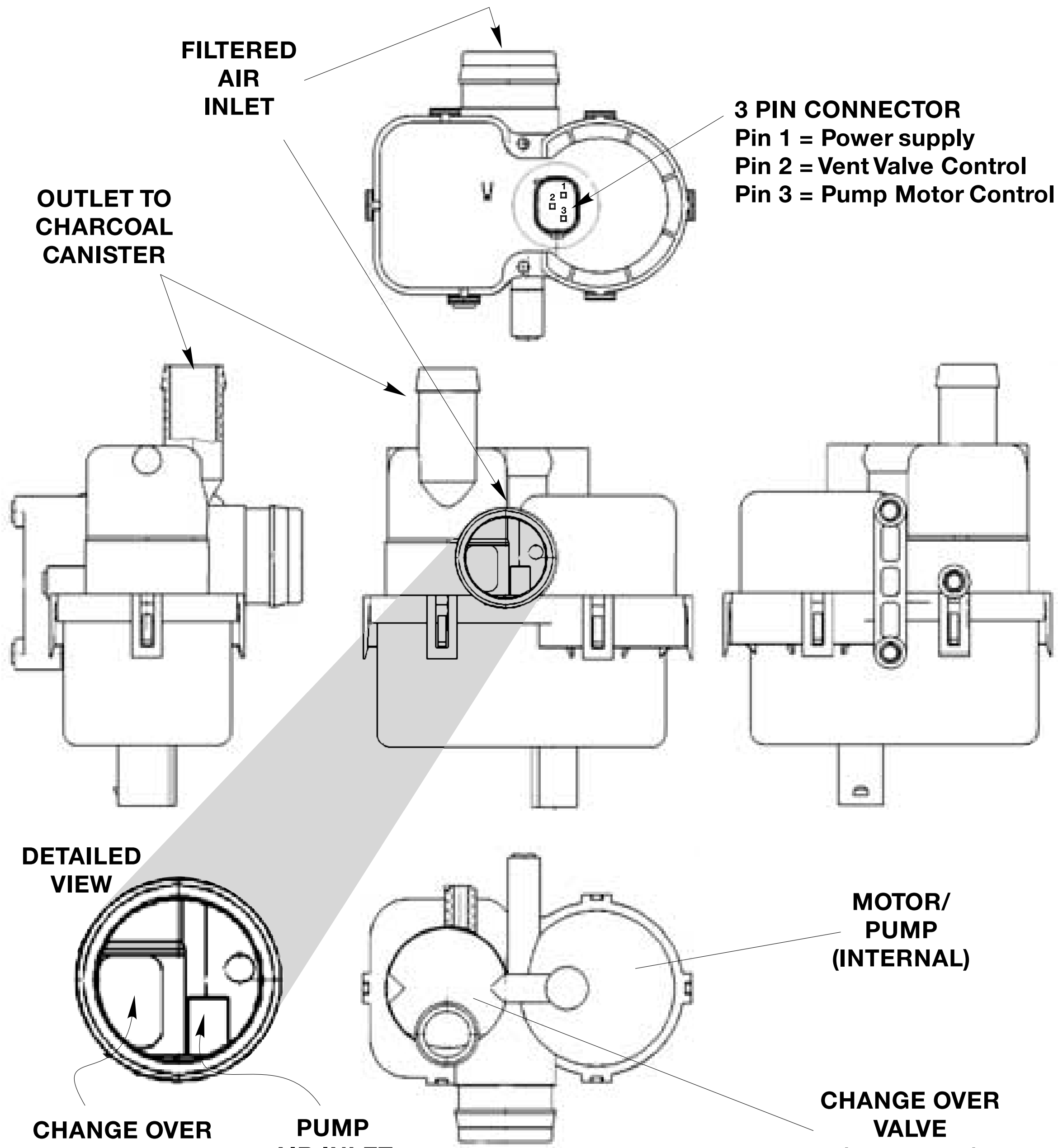
DM-TL (DIAGNOSIS MODULE - TANK LEAKAGE)

INTRODUCTION

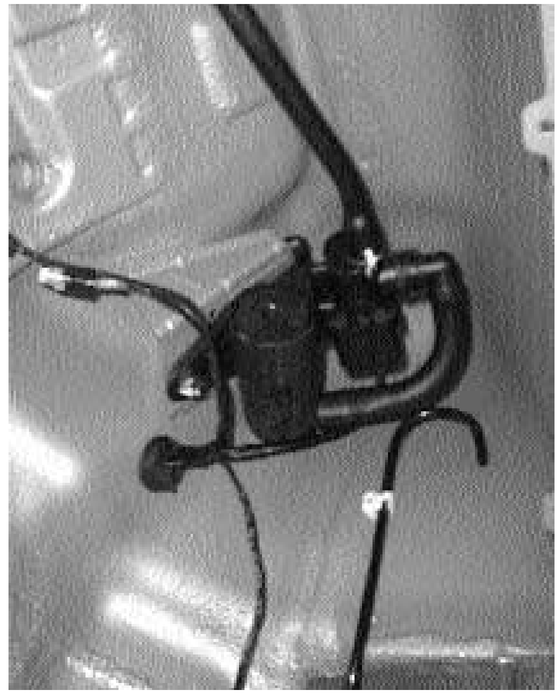
A new Fuel System Leak Diagnosis Pump is equipped on the X5. The pump will eventually replace the current vacuum LDP on all vehicles.

The pump is manufactured by Bosch to BMW specifications.

- Bosch ECMs identify the electrical function of the pump as DM-TL.



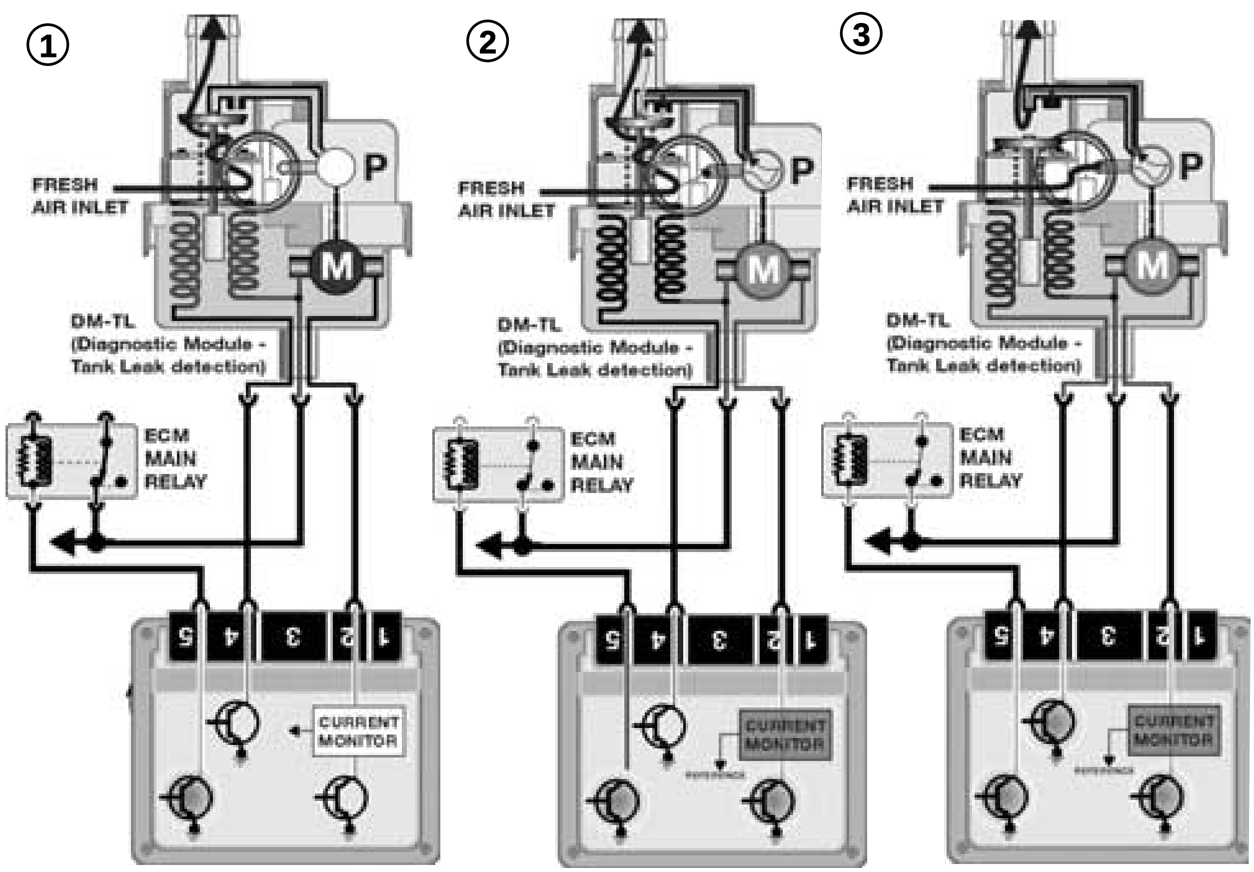
Functional Overview:



The DM-TL is located in the drivers side rear wheel well in the X5.

1. In it's inactive state, filtered fresh air enters the evaporative system through the sprung open valve of the DM-TL.
2. When the DME activates the DM-TL for leak testing, it first activates only the pump motor. This pumps air through a restricter orifice (1.0 or 0.5 mm) which causes the electric motor to draw a specific amperage value. This value is equivalent to the size of the restricter.
3. The solenoid valve is then energized which seals the evap system and directs the pump output to pressurize the evap system.

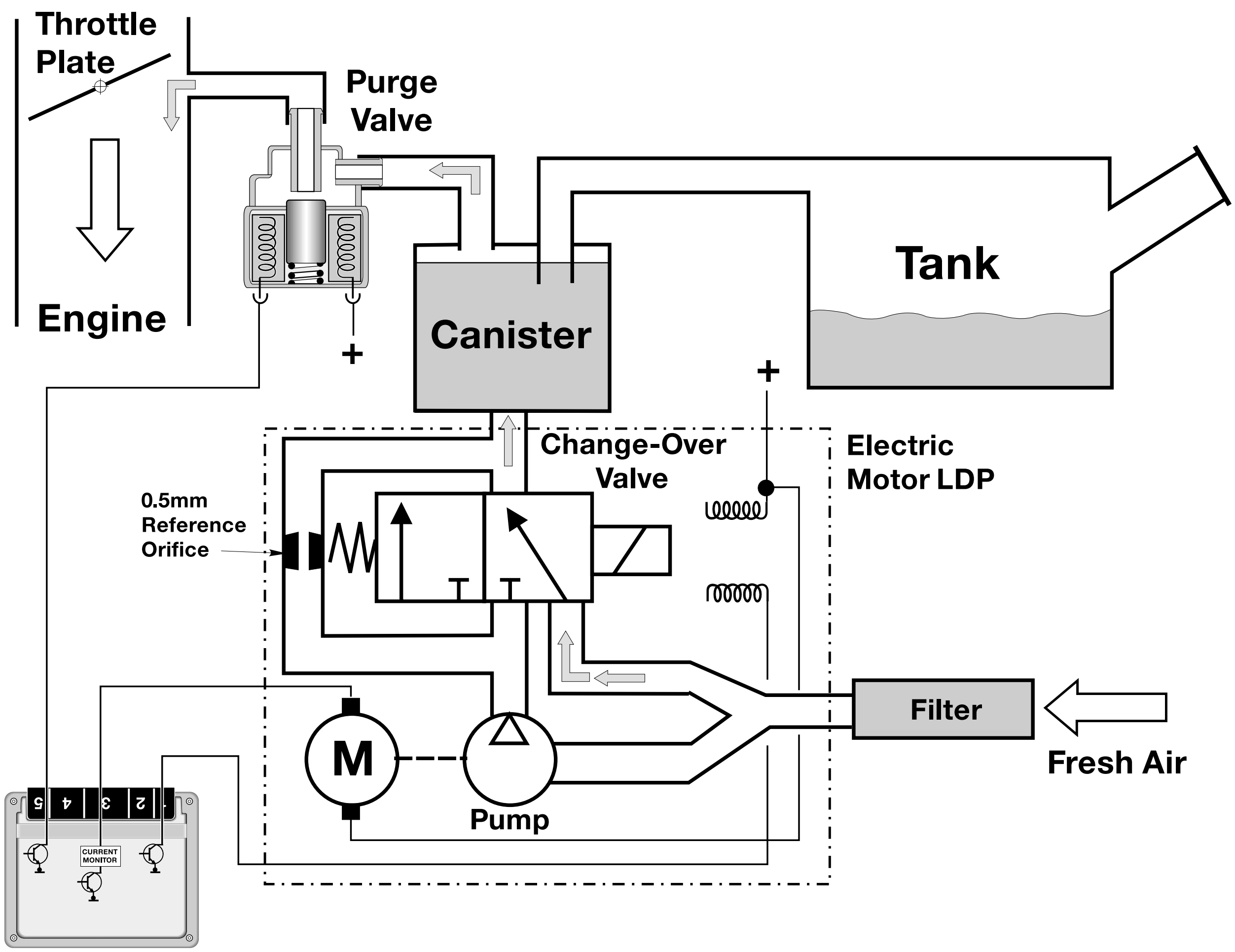
The evap system is detected as having a large leak if the amperage value is not realized, a small leak if the same reference amperage is realized or no leak if the amperage value is



FUNCTION

The DC Motor LDP ensures accurate fuel system leak detection for leaks as small as 0.5mm (.020”). The pump contains an integral DC motor which is activated directly by the engine control module. The ECM monitors the pump motor operating current as the measurement for detecting leaks.

The pump also contains an ECM controlled change over valve that is energized closed during a Leak Diagnosis test. The change over valve is open during all other periods of operation allowing the fuel system to “breath” through the inlet filter (similar to the full down stroke of the current vacuum operated LDP).



DC MOTOR LDP INACTIVE -- NORMAL PURGE VALVE OPERATION

In it’s inactive state the pump motor and the change over valve of the DC Motor LDP are not energized. When purge valve operation occurs filtered air enters the fuel system compensating for engine vacuum drawing on the hydrocarbon vapors stored in the charcoal canister.

LEAK DIAGNOSIS TEST PRECONDITIONS

The DME only initiates a leak diagnosis test every second time the criteria are met. The criteria is as follows:

- Engine **OFF** with ignition switched **OFF**.
- Engine Control Module still in active state or what is known as “follow up mode” (Main Relay energized, control module and DME components online for extended period after key off).
- Prior to Engine/Ignition switch OFF condition, vehicle must have been driven for a minimum of 20 minutes.
- Prior to minimum 20 minute drive, the vehicle must have been OFF for a minimum of 5 hours.
- Fuel Tank Capacity must be between **15 and 85%** (safe approximation between 1/4 - 3/4 of a tank).
- Ambient Air Temperature between **-7°C & 35°C** (20°F & 95°F)
- Altitude **< 2500m** (8,202 feet).
- Battery Voltage between **11.5 and 14.5 Volts**

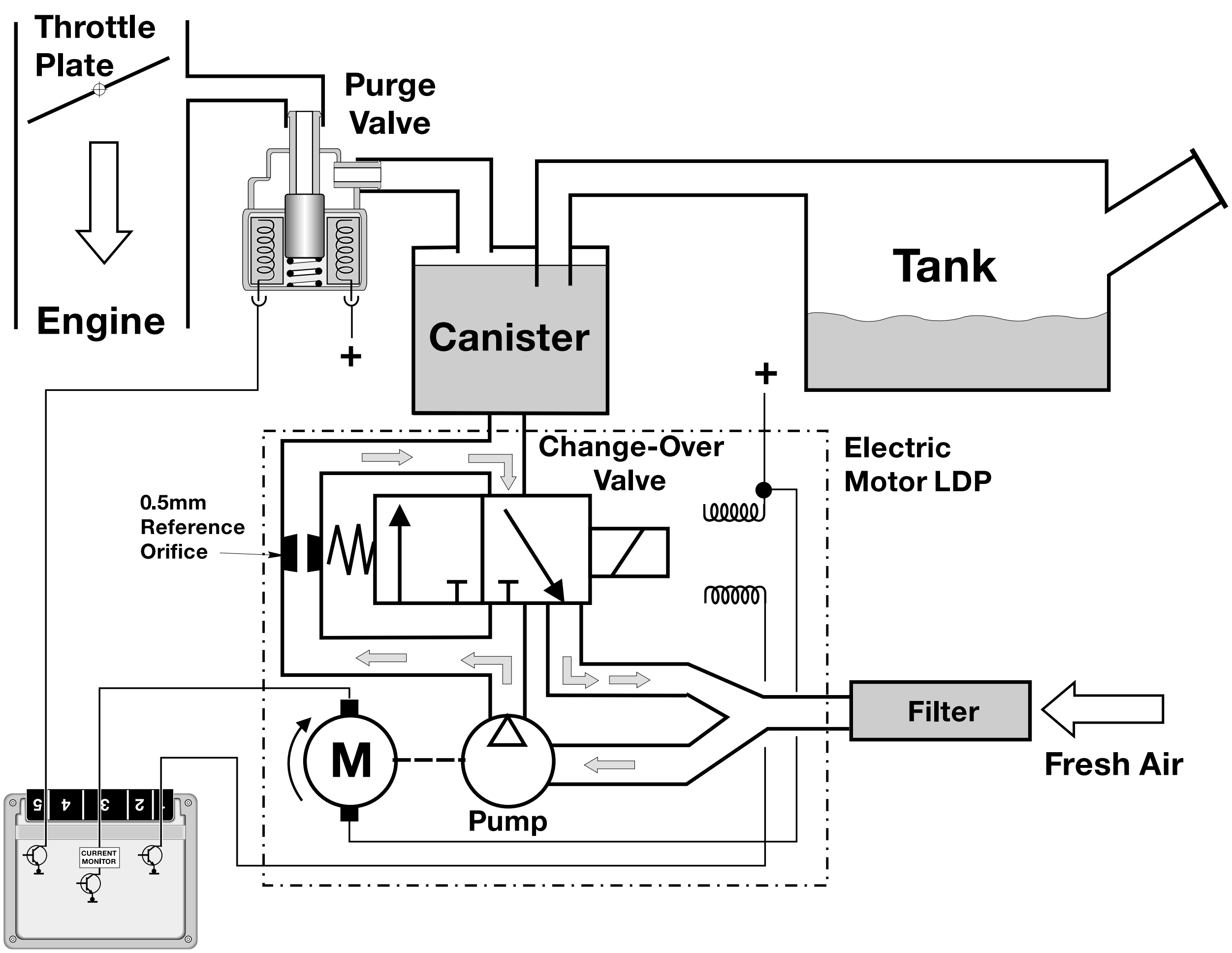
When these criteria are satisfied every second time, the ECM will start the Fuel System Leak Diagnosis Test. The test will typically be carried out once a day i.e. once after driving to work in the morning, when driving home in the evening, the criteria are once again met but the test is not initiated. The following morning, the test will run again.

LEAK DIAGNOSIS TEST

PHASE 1 - REFERENCE MEASUREMENT

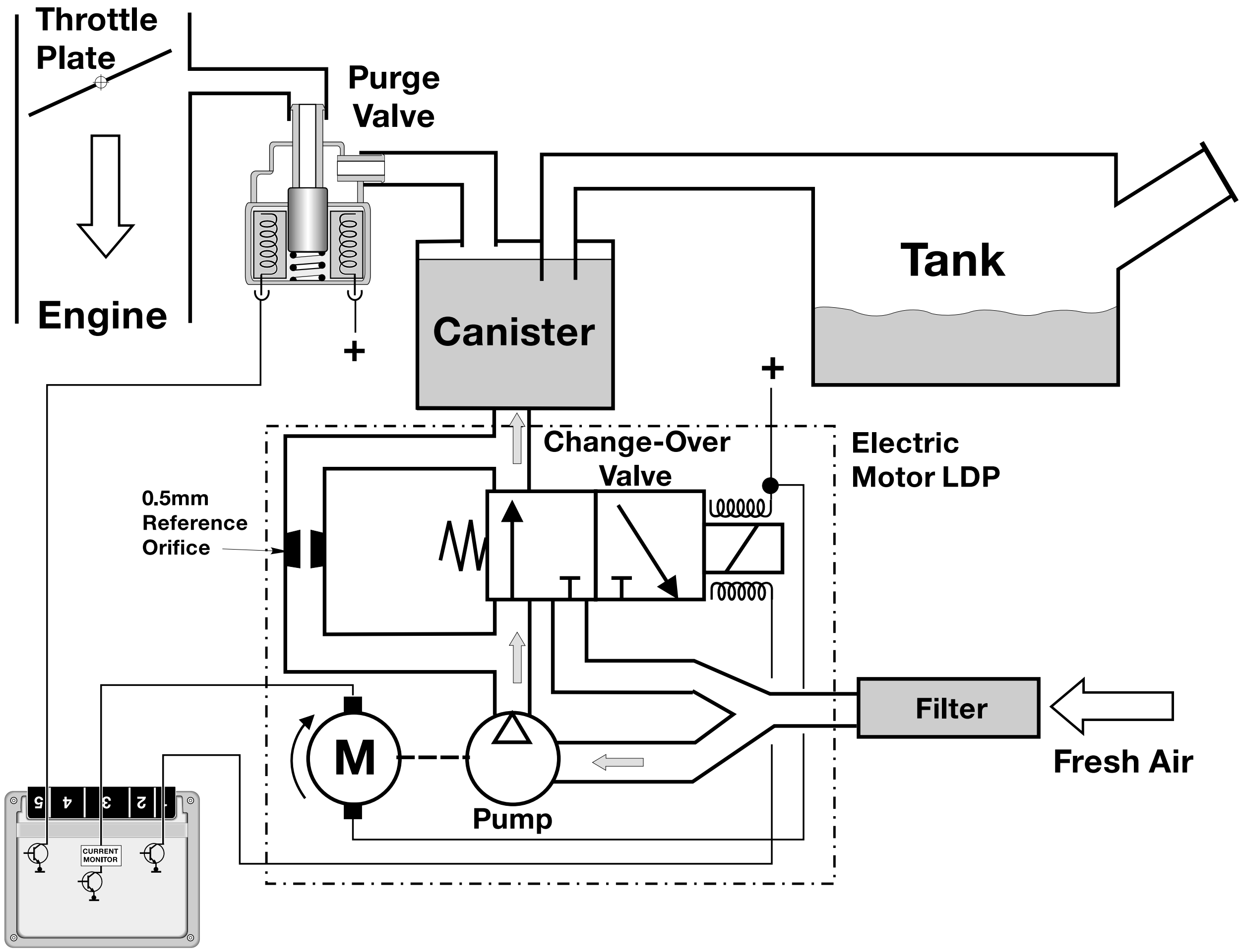
The ECM activates the pump motor. The pump pulls air from the filtered air inlet and passes it through a precise 0.5mm reference orifice in the pump assembly.

The ECM simultaneously monitors the pump motor current flow . The motor current raises quickly and levels off (stabilizes) due to the orifice restriction. The ECM stores the stabilized amperage value in memory. The stored amperage value is the electrical equivalent of a 0.5 mm (0.020”) leak.



PHASE 2 - LEAK DETECTION

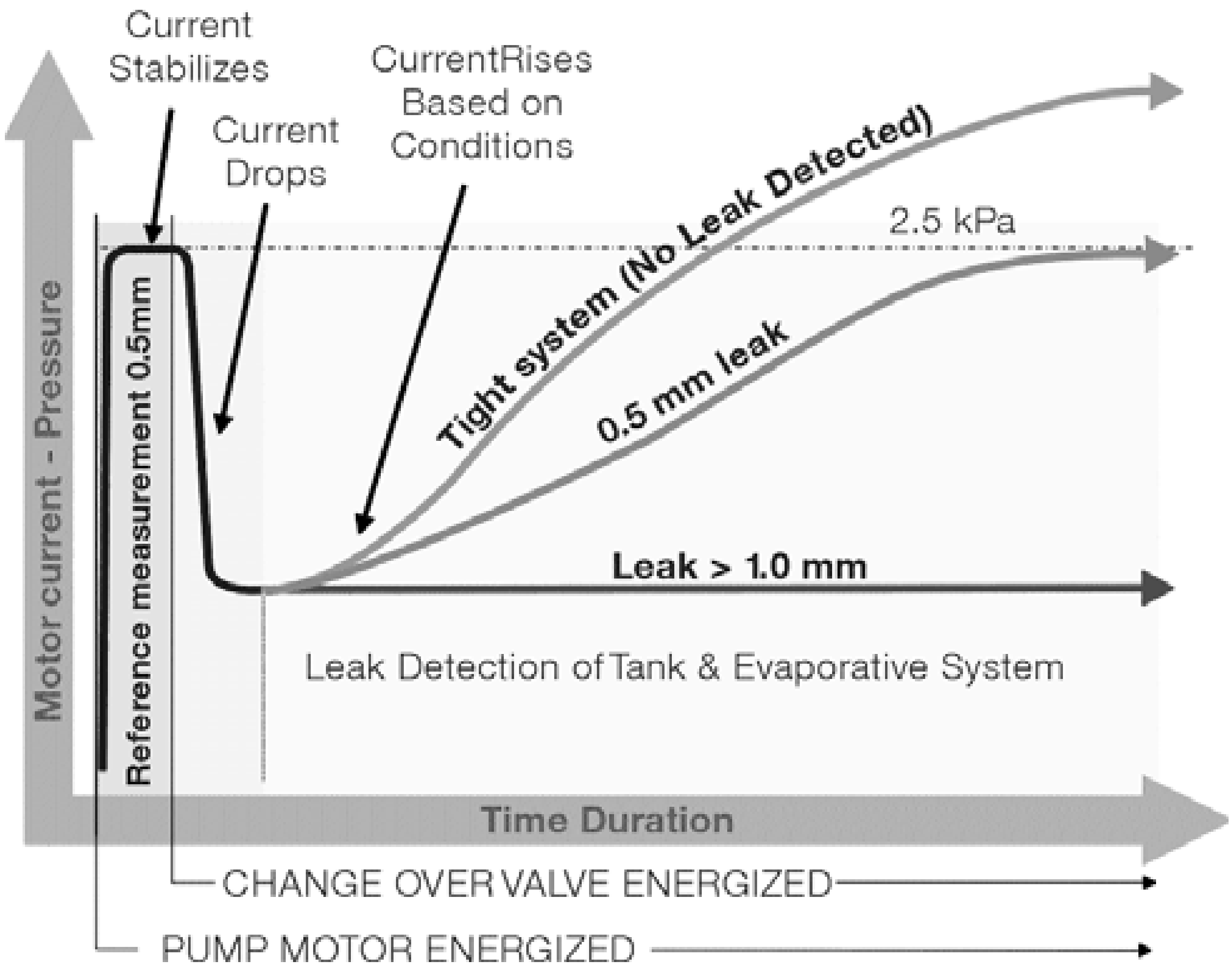
The ECM energizes the Change Over Valve allowing the pressurized air to enter the fuel system through the Charcoal Canister, The ECM monitors the current flow and compares it with the stored reference measurement over a duration of time.



Once the test is concluded, the ECM stops the pump motor and immediately de-energizes the change over valve. This allows the stored pressure to vent thorough the charcoal canister trapping hydrocarbon vapor and venting air to atmosphere through the filter.

TEST RESULTS

The time duration varies between 45 & 270 seconds depending on the resulting leak diagnosis test results (developed tank pressure “amperage” / within a specific time period). However the chart below depicts the logic used to determine fuel system leaks.



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X5 4.6is

Subject **Page**

X5 4.6is

The X5 4.6is is an additional model added to the X5 family of SAV's. The 4.6is receives model code FB93/0266 and is available start of production 10/01.

Features added to the 4.6is versus the 4.4:

- Increased Engine Displacement/Horsepower
- Increased Transmission Capacity
- Upgraded Brakes
- Additional Standard Features
- Special/Limited Exterior Colors
- New Interior Textures

Engine

The engine for X5 4.6is is a M62 with increased displacement and horsepower.

	M62 4.6is	**M62 4.4**
Displacement (cm^3)	4619	4398
Bore (mm)	93.0	92.0
Stroke (mm)	85.0	82.7
Compression Ratio	10.5:1	10.0:1
Maximum Horsepower@RPM	340 @ 5700	290 @ 5400
Maximum Torque (NM)@RPM	475 @ 3700	440 @ 3600
Engine Management System	ME7.2	ME7.2
Emission Compliancy	LEV	LEV
Performance 0-60 mph	6.2 Seconds	7.4 Seconds

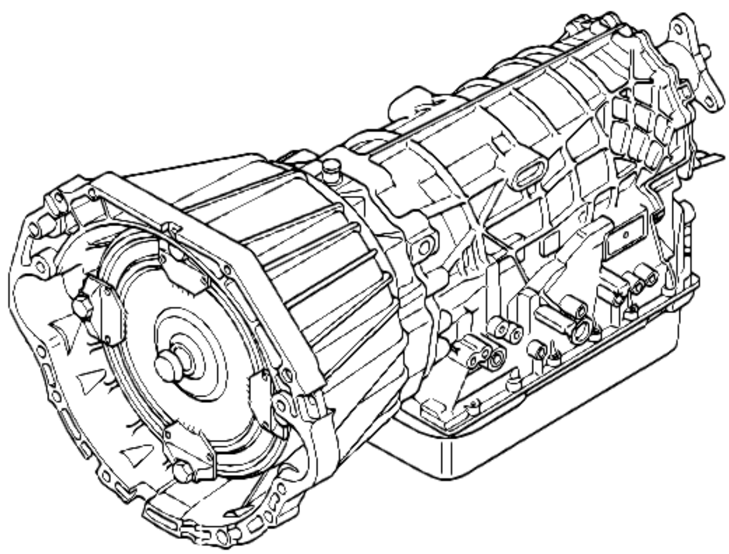
Diagnostics of the 4.6is are carried out in the same manner as the X5 4.4.

X5 4.6is

Transmission

The X5 4.6is is available only with a ZF A5S 440Z 5-speed automatic transmission which features modified internal components. Many internal components, including the torque convertor have been modified to handle the increased torque and horsepower. The transmission is specific to the X5 4.6is and no other transmission should be substituted.

Programming of the transmission is also changed to better accommodate the vehicle. Transmission management will be by EGS 8.60.2. Transmission diagnostics will be handled in the same manner as other models.



Brakes

Front and rear brakes are upgraded on the X5 4.6is. Brake rotor size is increased from the 13.1 in. front normally found on the X5 4.4 to a size of 14.0 in. on the 4.6is. While rear brake rotor diameter remains the same on the 4.6is at 12.8 in., the thickness of the rotor is increased and the rear rotor is now ventilated similar to the front rotor.

With these changes brake calipers, brake rotors and brake pads for both front and rear are vehicle specific for the X5 4.6 and similar components from other models may not be interchanged.

Additional Standard Features

The following equipment is added to the 4.4 model equipment for the X5 4.6is:

Glass Moonroof	Roller Sun Blinds For Rear Doors
Self Dimming Mirrors	Rear Seat Back Adjustment
Rear Seat Heating	PDC
Rain Sensor	Premium Sound System
CD Changer	Privacy Glass

Colors

Special colors and combinations along with special interior packages are available. Refer to marketing information for current availabilities.

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MULTIPLE RESTRAINT SYSTEM (MRS III)

INTRODUCTION

The X5 is equipped with the Multiple Restraint System (MRS III) which employs the use of "SMART" technology. Smart technology refers to the control module's programming which allows for the deployment of the airbags, in stages, depending on the severity of the impact. Two stage airbags are used for both the driver and front passenger which allows for a softer cushioning effect when the bags are triggered at lighter impacts.

The MRS III system is installed in E38/E39 and E46 Sedan vehicles as of 3/99 production and in E46 Coupes as of 6/99 production.

MRS III control modules are manufactured by either Bosch or Temic. While the functional operation of both modules are the same. The control modules are not interchangeable from a replacement standpoint. Always refer to the EPC parts system to ensure that the proper module is installed in the vehicle.

In addition to the use of two stage airbags for the driver and passenger, the following features are also included in the MRS III system:

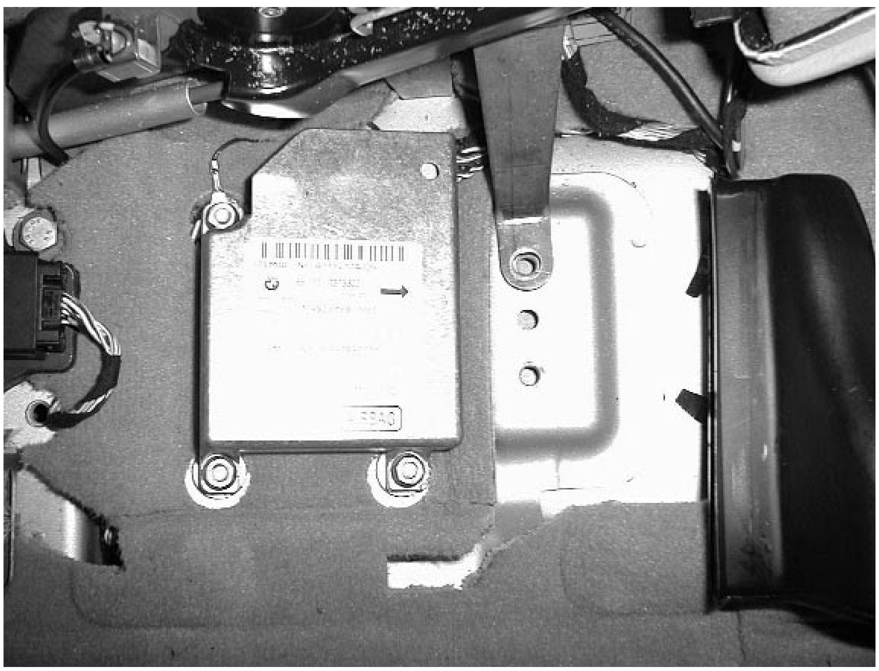
- The MRS III control module is linked to the K-Bus for coding and diagnosis.
- The MRS III includes a fuel pump cut off feature in the event of an airbag deployment.
- Inert gas generators are now used for all air bags and seat belt tensioners.
- The inert gas is a mixture of hydrogen (13.5%) and oxygen (86.5%).

COMPONENTS

MRS III CONTROL MODULE

The control module is mounted in the center console area on the driveshaft tunnel below the center storage box. The X5 will use the TEMIC system that can be recognized by the green 50 pin connector on the module.

The control module contains the processing electronics (Smart Technology) for triggering of all air bags and pyrotechnic devices installed in the vehicle. Two electronic deceleration sensors are installed in the module for crash or impact detection.

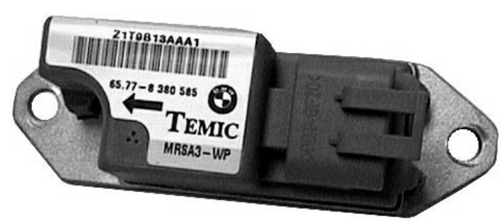


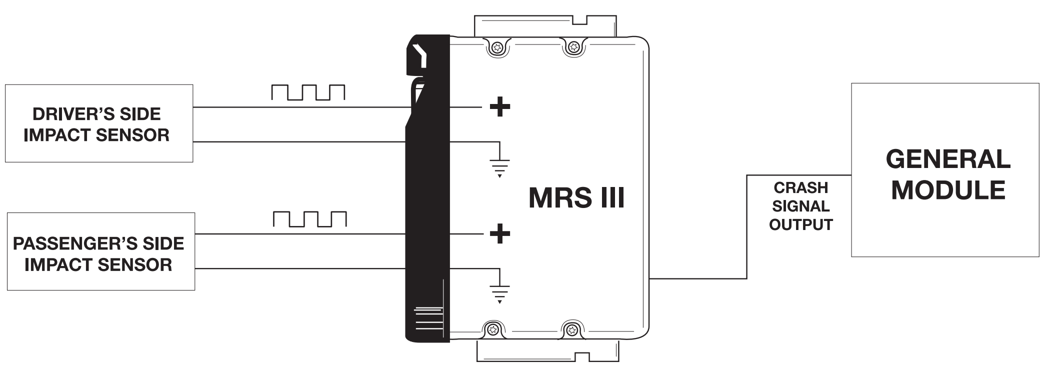
COMPONENTS

SATELLITE SENSORS

The satellite sensors are mounted below the driver's and passenger's front seats on the seat frame. The function of the sensors is to detect the severity of side impacts and signal the MRS III control module, through a pulse modulated signal, in the event of a crash. The control module uses this input signal along with its internal impact sensor signal to determine the deployment of the side/head airbags.

As with the control modules, the satellite sensors are manufacturer specific. The Temic sensors in the X5 have a three wire connector which will not interchange with the Bosch sensors. Only two of the wires are used for the satellite sensor's operation. The signal for deployment of the bags is carried over the power wire of the sensor.



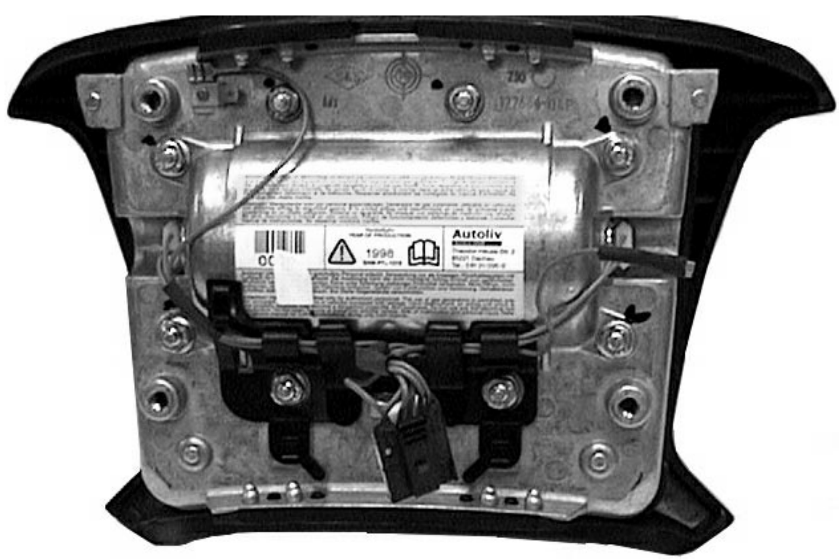


COMPONENTS

DRIVER'S FRONT AIRBAG

With the MRS III system, the driver's front airbag becomes a two stage bag similar to the passenger's front side bag, introduced on the 1999 model E38/E39s. The complete assembly is mounted beneath the cover in the center of the steering wheel as with previous airbags. The assembly now contains the inert gas generator chamber and two ignition stages (ignitors).

The airbag consists of:
- Accumulator/gas generator
- Two ignition capsules
- Propellant gas - 13.5% hydrogen/86.5% oxygen
- 64 liter airbag

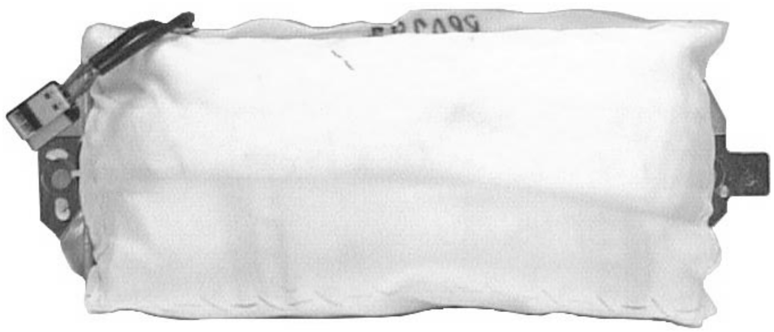


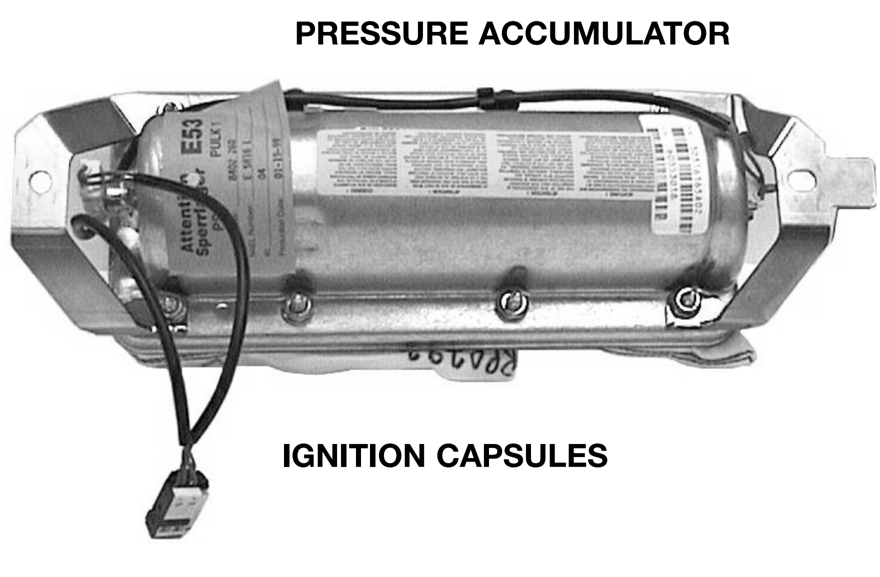
COMPONENTS

PASSENGER'S FRONT AIRBAG

The passenger's front airbag is the same unit as installed on E38/E39 vehicles as of 9/98 production. The passenger's airbag consists of:

- Pressure accumulator/gas generator
- Two ignition capsules - for two stage activation
- Propellant gas of - 13.5% hydrogen/86.5% oxygen
- 105 liter airbag



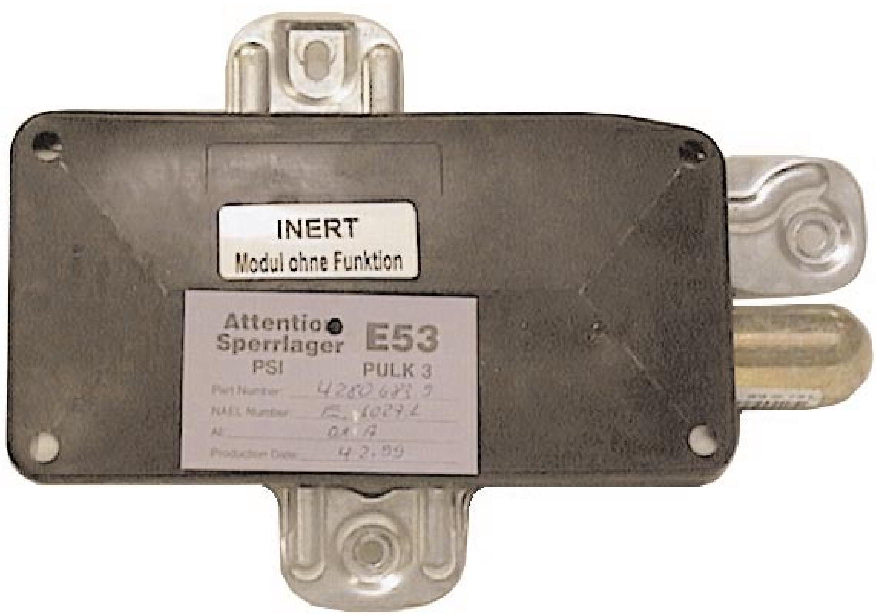


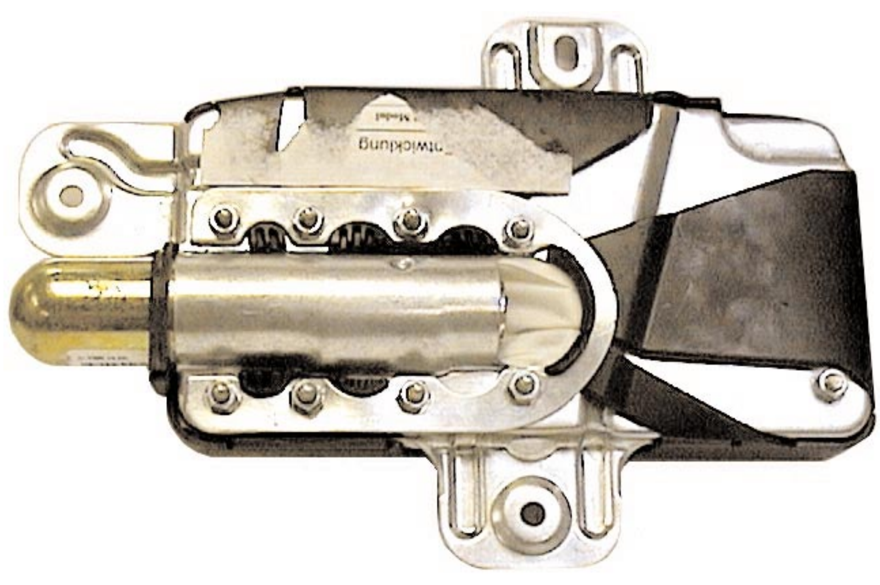
COMPONENTS

SIDE AIRBAGS FRONT/REAR (THORAX)

The side airbags continue to be mounted in the door panels on the front and rear doors. Deployment of the side airbags is dependent on the triggering thresholds programmed in the MRS III control module, based on the inputs from the satellite sensors and internal crash sensor.

The side airbags use the same cold gas inflation method as the driver's and passenger's front bags.

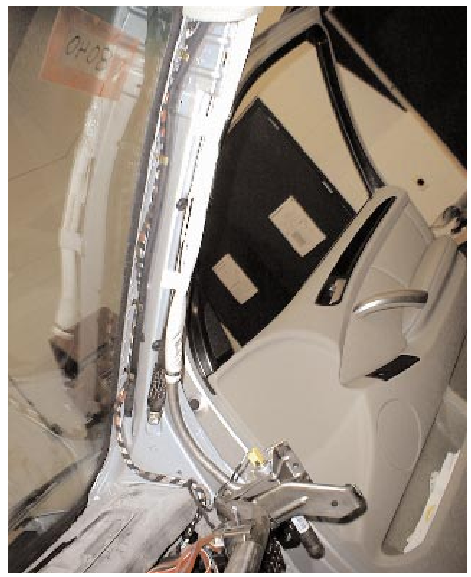




COMPONENTS

HEAD AIRBAG (ITS)

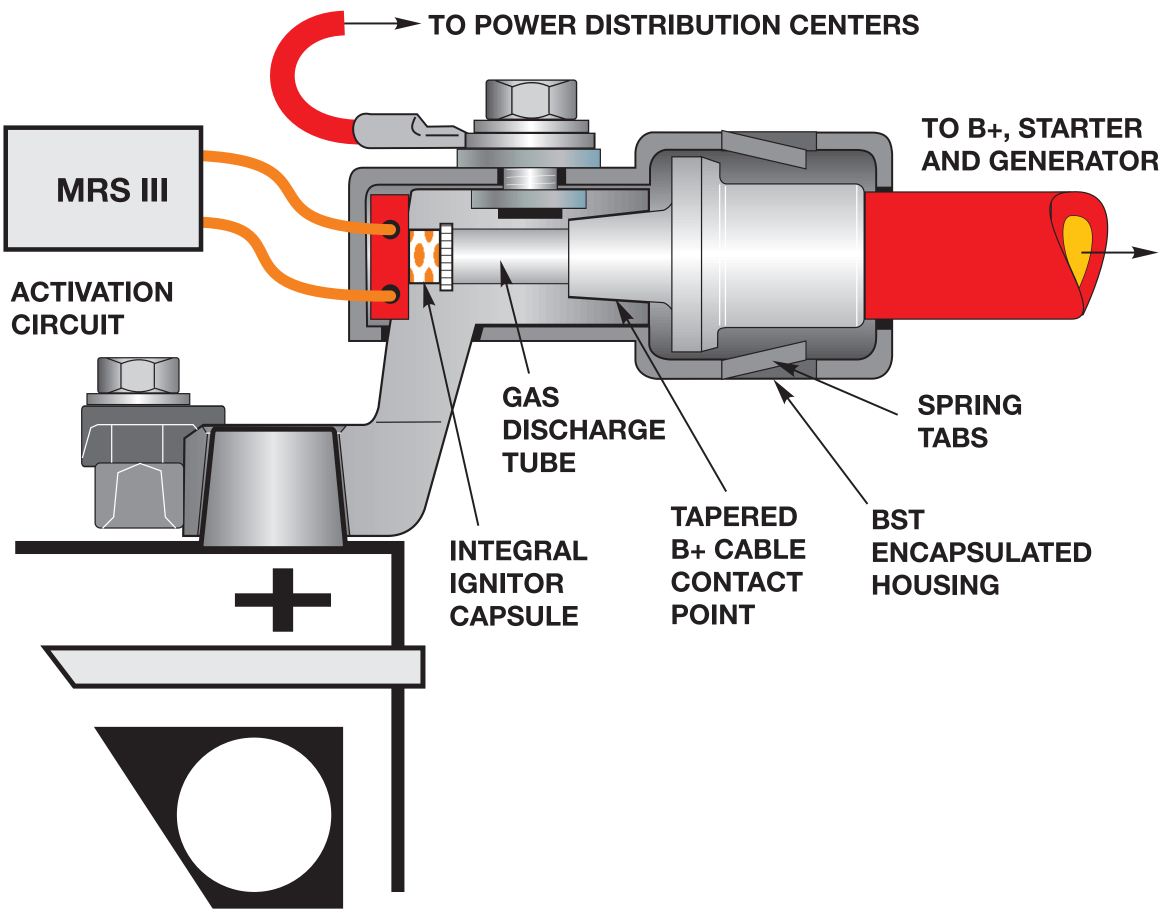
The head airbags are similar to the ITS bags used on the MRS II system. They continue to be mounted from the "A" pillar up along the headliner and are anchored behind the "B" pillar. The ITS bags of the MRS III system are also the cold gas inflation type. The head airbags are always triggered with the side (Thorax) bags.



COMPONENTS

BATTERY SAFETY TERMINAL (BST)

As with previous systems, the BST is used to disconnect the battery's "B+" connection to the engine compartment in the event of an airbag deployment. The safety measure helps prevents the possibility of a short circuit causing a fire.

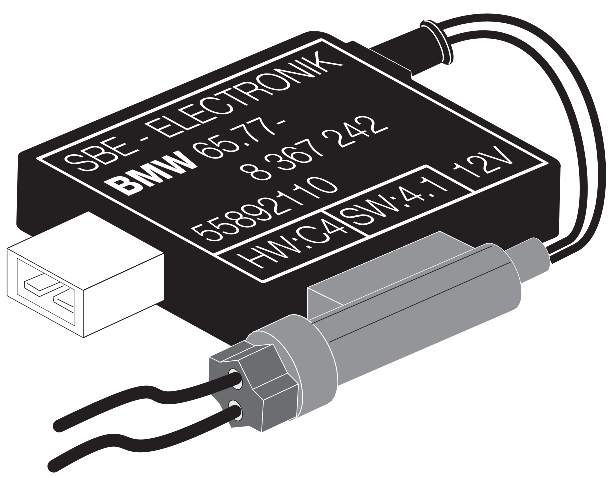


COMPONENTS

SEAT BELT TENSIONERS

The seat belt tensioners are a new design and also make use of the inert gas for triggering. The MRS III control module will deploy the seat belt tensioners based on the programmed parameters during impact.

SEAT OCCUPANCY SENSOR (SBE)



The SBE continues to be used as an input to the MRS III control module for detection of a front seat passenger. The module uses the input to determine seat belt tensioner and/or front airbag deployment.

MRS III OPERATION

As with previous systems, the triggering thresholds are programmed in the MRS III control module. These thresholds are determined by BMW through crash and vehicle testing during the design and development of the vehicle. These thresholds will vary depending on the vehicle size and design.

There are several different thresholds for airbag and safety restraint deployment including;

- Belt pre-tensioner threshold for activation of the seat belt tensioners.
- Airbag threshold #1 - the first level of activation for the two stage front airbags, always deployed first when the front triggering threshold is reached.
- Airbag threshold #2 - the second level of the two stage front airbags, can be deployed simultaneously or after a time delay, depending on the severity of the impact.
- Rear crash threshold - for activation of the seatbelt tensioners with a rear impact.
- Battery safety terminal threshold - for activation of the BST with airbag deployment.
- Side airbag/ITS threshold - for deployment of the side and thorax airbags.

MRS III OPERATION

TRIGGERING THRESHOLDS - TWO STAGE AIRBAGS

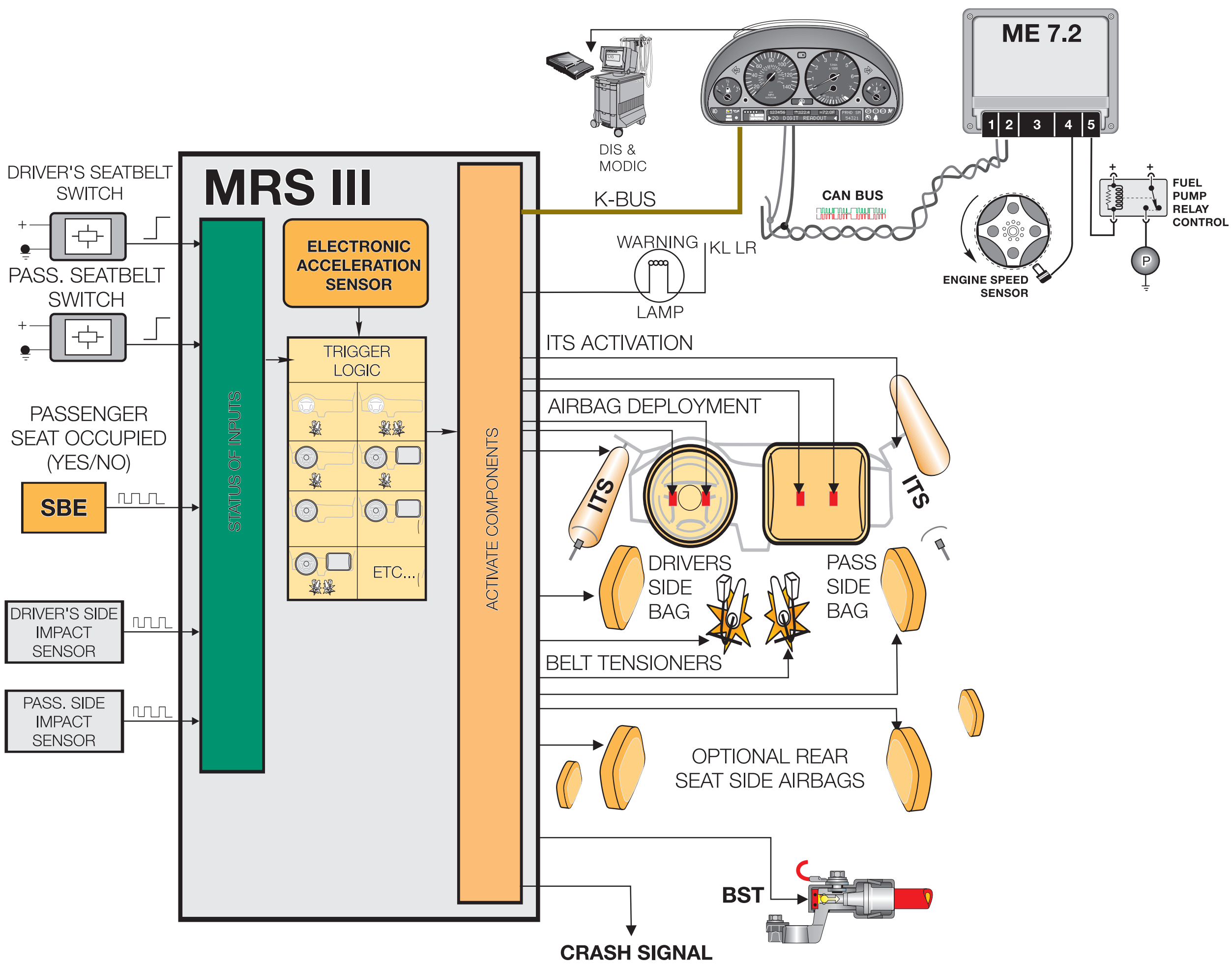
The programming of the MRS III includes four triggering thresholds for the two stage front airbags. The triggering of the front airbags is also dependent on whether the seat belts are connected and if the front passenger seat is occupied. The triggering thresholds for the two stage airbags are as follows:

THRESHOLD	NO-SEATBELT	BELTED
1	Ignition Stage 1	No Activation
2	Ignition Stage 1 & 2 with Time Delay	Ignition Stage 1
3	Ignition Stage 1 & 2 with Time Delay	Ignition Stage 1 & 2 with Time Delay
4	Ignition Stage 1 & 2 Simultaneoulsy	Ignition Stage 1 & 2 Simultaneously

If the signal from the SBE is defective on triggering, the MRS III will deploy as if the seat is occupied.

If the signal from the seat belt contacts are defective, the MRS III will deploy as if the belts were not buckled.

MRS III I-P-O



ME 7.2
1 2 3 4 5
DIS & MODIC
DRIVER'S SEATBELT SWITCH
MRS III
K-BUS
CAN BUS
FUEL PUMP RELAY CONTROL
ENGINE SPEED SENSOR
P
WARNING LAMP
KL LR
ELECTRONIC ACCELERATION SENSOR
PASS. SEATBELT SWITCH
TRIGGER LOGIC
ITS ACTIVATION
PASSENGER SEAT OCCUPIED (YES/NO)
SBE
STATUS OF INPUTS
ACTIVATE COMPONENTS
AIRBAG DEPLOYMENT
ITS
ITS
ETC...
DRIVERS SIDE BAG
PASS SIDE BAG
DRIVER'S SIDE IMPACT SENSOR
BELT TENSIONERS
PASS. SIDE IMPACT SENSOR
OPTIONAL REAR SEAT SIDE AIRBAGS
BST
CRASH SIGNAL

TRIGGERING THRESHOLDS

SIDE AIRBAGS/ITS

The triggering thresholds for the side airbags/ITS is dependent on the signals from the satellite sensors and the crash sensor in the MRS III control module. The triggering thresholds are independent of the belt tensioners.

BELT TENSIONER

The triggering of the belt tensioners is dependent on the signal from the seat belt contact and the severity of the impact as detected by the control module.

BATTERY SAFETY TERMINAL

The BST will deploy in a frontal impact at threshold 2 or greater. The threshold for BST activation with a side impact is programmed separately in the side deployment criteria. The BST will also be deployed when the rear impact threshold is exceeded.

FUEL PUMP SHUT-DOWN

New to the MRS III system is the link via the K-Bus/CAN Bus to the Engine Control Module for deactivation of the fuel pump. The MRS III will signal the DME over the K-Bus through the instrument cluster and CAN Bus to shut off the fuel pump in the event that any crash threshold is exceeded.

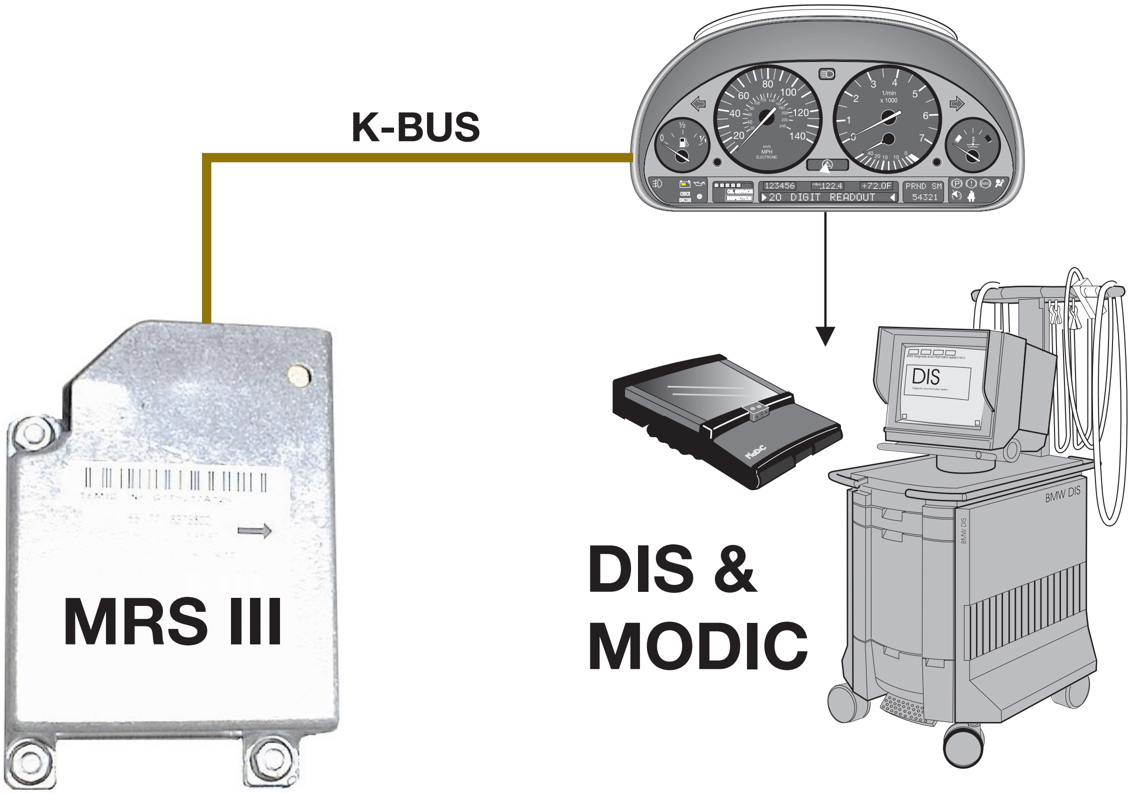
DIAGNOSIS

Diagnosis and troubleshooting of the MRS III system is fault driven and can be accessed using the DIS Tester or MoDiC. The control module performs a self test of the system every time the ignition is switched on (this includes the satellite sensors and seat occupancy sensor). Any faults with the system will cause the warning lamp in the instrument cluster to remain illuminated after the engine is started.

Installation of a new or replacement control module requires ZCS coding also using the DIS or MoDiC.

When servicing or replacing any MRS III components, always follow precautionary measures outlined in the repair manual of TIS. this includes disconnecting the battery prior to any repair or maintenance work being performed.

All airbag components are part number specific by model and require verification in the EPC to ensure the correct component is being installed.



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Introduction

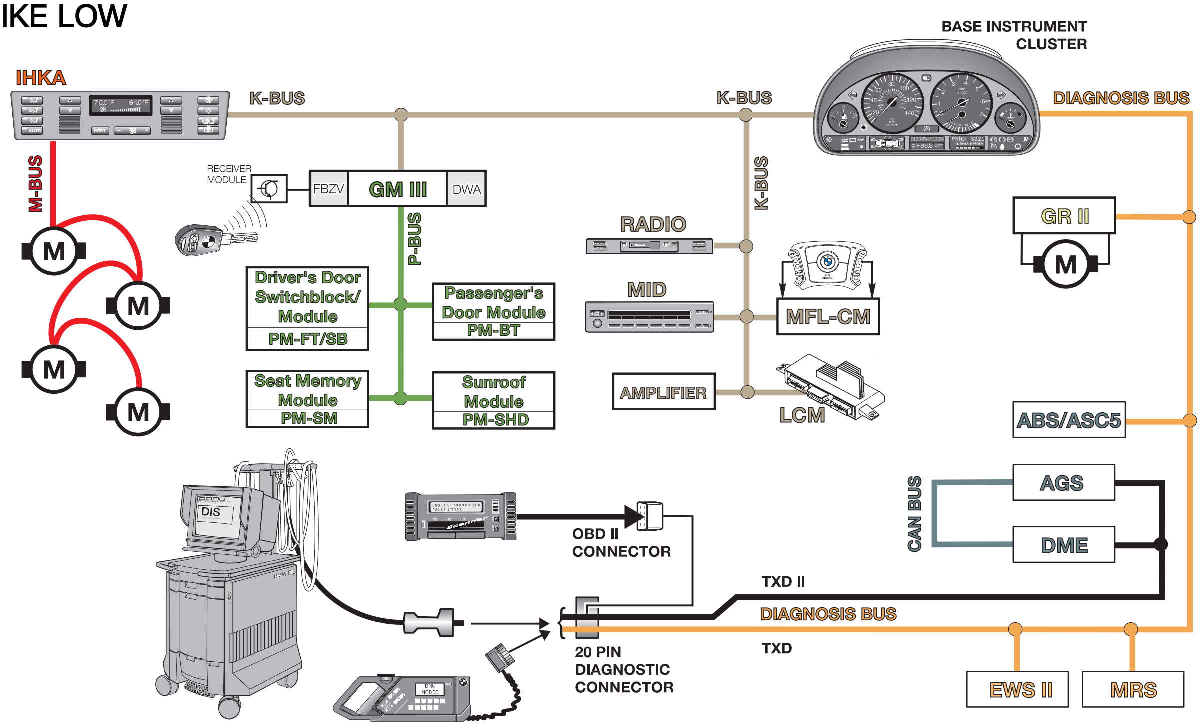
Depending on the model and equipment installed, the X5 is equipped with either the high version E38/E39 or the base version Instrument Cluster - Driver information systems. The wiring harness is similar to the E38/E39 systems with minor changes made for functional changes with control modules.

The X5 continues to make use of multi-information bus communication systems. They offer the advantages of:

- A high level of reliability
- Reduction in the size of the harnesses
- Multiple utilization of sensor and signal inputs
- Expanded functions through increased data flow
- Flexibility in configuring the systems
- Reduction in cost
- Expanded diagnostic capabilities

The CAN bus link to the Instrument Cluster provides expanded communication for all vehicle functions to share engine/drivetrain data with the body electrical systems. The cluster is an important link in the system, and vital information is updated faster to the control modules.

IKE LOW



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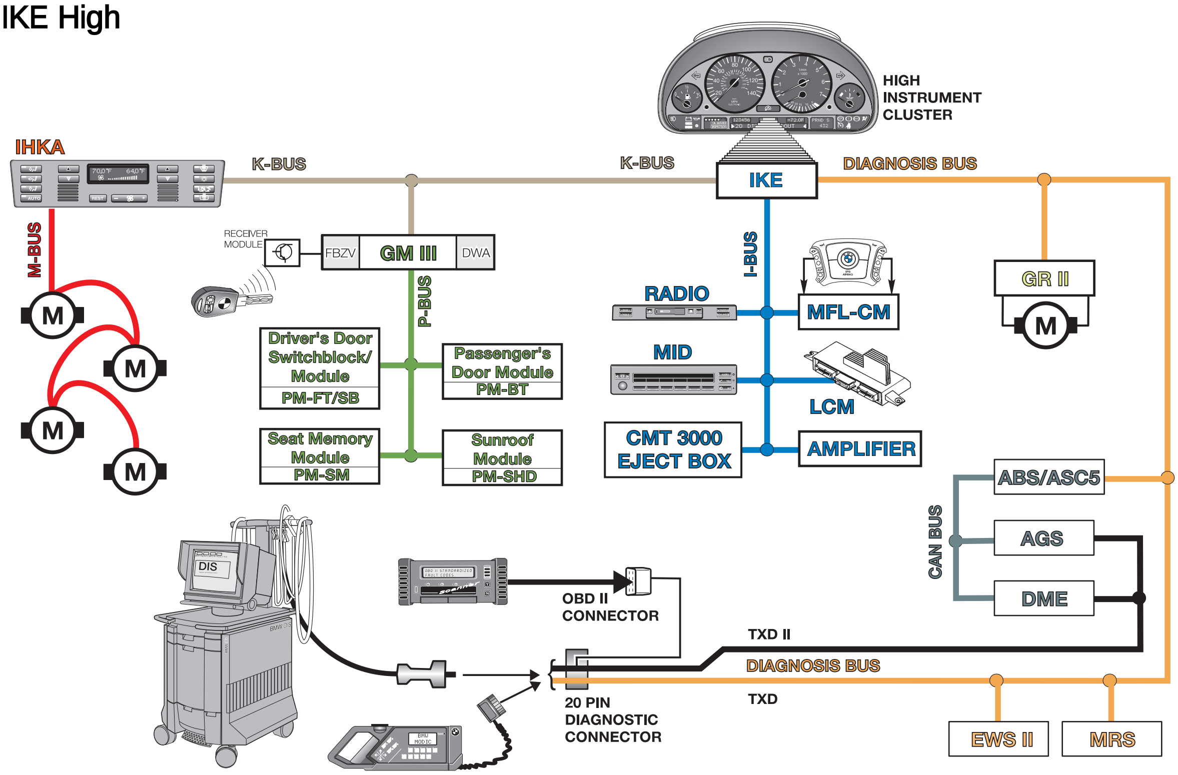
IKE High



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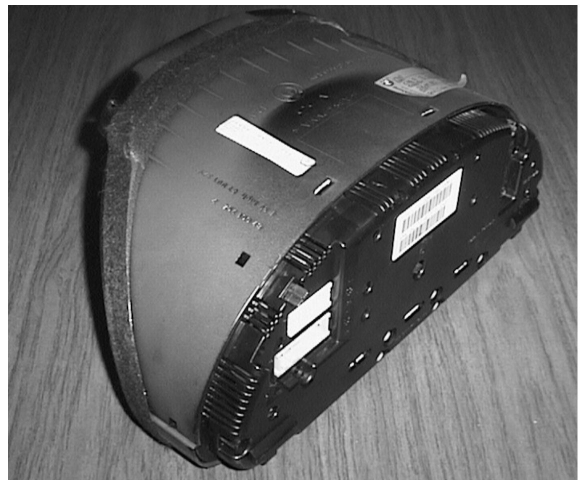
High Instrument Cluster (IKE)

The IKE corresponds to the E38/E39 system. It consists of the integrated control electronics and the Display Unit. The IKE is the data gateway for the I, K and CAN Busses. The IKE is also the gateway for diagnostic messages that are sent to and from the DIS tester and all of the modules on both the “I” and “K” busses.



The “CHECK ENGINE” light nomenclature has been changed to “SERVICE ENGINE SOON”.

Redundant data storage for the total mileage and service interval indicator is stored in the LCM III.

All gauge functions, warning lamp indicators and the matrix display are the same as in the E38. The needle of the coolant temperature gauge is centered if coolant temperature is between 75° C - 115° C.

The fuel economy indicator returns to its starting point when road speed is reduced to 5 MPH and doesn’t move again until road speed is above 8 MPH. Certain indicator/warning lights are illuminated momentarily when KL15 is switched on as a pre-drive check. The indicators will switch off after 2 seconds or within 1 second after the engine starts.

Base Instrument Cluster

The base instrument cluster consists of five analog gauges. The processing electronics and drivers for the gauges are contained in the cluster. The five gauges include:

- Fuel Gauge
- Speedometer
- Tachometer
- Fuel Economy Gauge
- Coolant Temperature

62530004

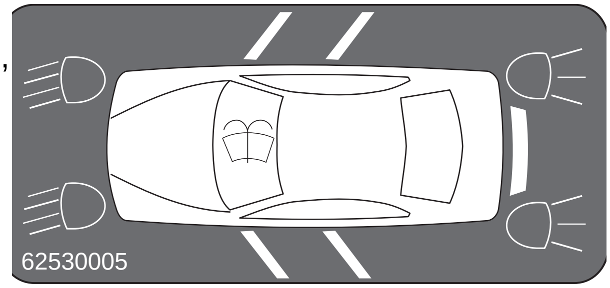
Three Liquid Crystal Display blocks are provided for the:

- Check Control Display - pictogram
- Mileage, Outside Temperature and BC Display
- Transmission Range and SI Display

Warning lamps and indicators are positioned to the left and right of the display blocks. The number of warning lamps is greater on the base cluster for the display of several check control warnings. All of the warning lamps and indicators are LEDs and not replaceable. Critical warning lamps use two LEDs for a safety margin.

The **LEFT DISPLAY BLOCK** contains a pictogram for various check control warnings. LEDs within the display will illuminate for:

- Lighting failures for headlight (low beam), taillight and brake lights.
- Open doors or trunk
- Low washer fluid



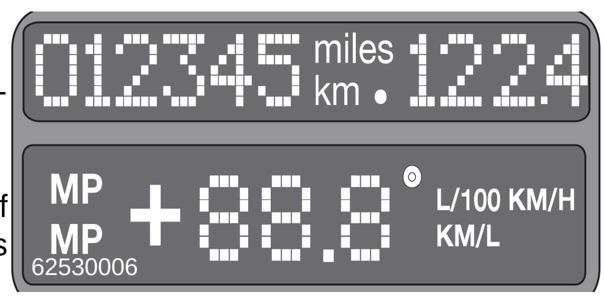
Additional circuits monitored by check control include the engine oil level and transmission emergency program. These warnings are indicated by lamps positioned in both indicator display areas on the left and right sides on the bottom of the instrument cluster.

Due to the ability to illuminate multiple warning LEDs, there is no priority displays for the pictogram check control. If multiple faults exist, each corresponding LED will illuminate.

The LED will remain illuminated as long as the fault exists. The only exception is the washer fluid which will go out 60 seconds after KL 15 is switched ON.

All check control and lamp control circuits are monitored by the Light Check Module (LCM). When failures or faults exist, the messages are passed to the cluster for display over the K-Bus.

The **MIDDLE BLOCK** contains the displays for the Total Mileage, Trip Mileage and Board Computer.



The total mileage is stored in non-volatile memories in the cluster EEPROM and the LCM.

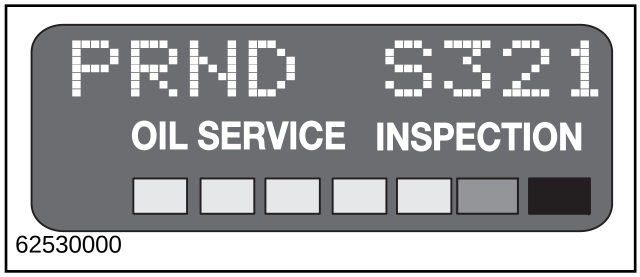
The mileage can be displayed with the key off for 25 seconds if the mileage reset button is pressed.

Board Computer information can be displayed by pressing the turn signal lever.

NOTE: The outside temperature is displayed automatically every time the key is switched ON.

The **RIGHT BLOCK** contains the displays for the automatic transmission driving range and the Service Interval Indicator III. The display of the Service Indicator on the E39 is the same as previous systems.

The processor for the intervals is located in the cluster electronics. However, the processing method for determining interval times has changed. The E39 uses the new Service Interval III system. Interval times are based on fuel consumption instead of mileage and starts. This system was introduced on the 1996 E38 - 750iL and is now being phased into the other models.



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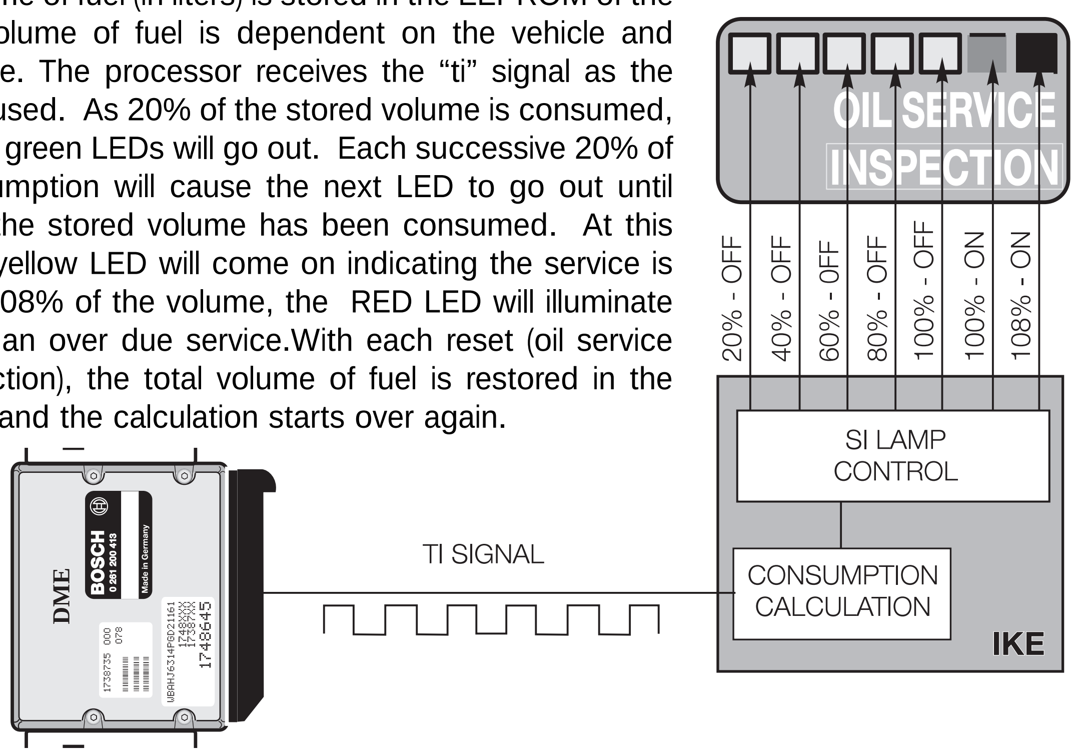
Using fuel consumption offers several advantages over the previous method for determining oil service.

- First, the processing electronics are less involved in that only one value is needed for the processing.
- Second, the use of fuel consumption is a more accurate method of determining engine load and the need for service.
- Third, resetting of the indicator before the scheduled time will not effect the time to the next service.

A set volume of fuel (in liters) is stored in the EEPROM of the SI. The volume of fuel is dependent on the vehicle and engine size. The processor receives the "ti" signal as the vehicle is used. As 20% of the stored volume is consumed, one of the green LEDs will go out. Each successive 20% of fuel consumption will cause the next LED to go out until 100% of the stored volume has been consumed. At this point the yellow LED will come on indicating the service is due. At 108% of the volume, the RED LED will illuminate indicating an over due service.With each reset (oil service ore inspection), the total volume of fuel is restored in the EEPROM and the calculation starts over again.



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DYNAMIC DIGITAL INPUTS

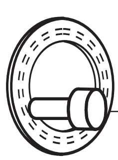
DISTANCE SIGNAL- This input is supplied to the cluster by the DSC control module as a square wave signal. Pulses from the wheel speed sensors are processed by the DSC module to produce this signal.

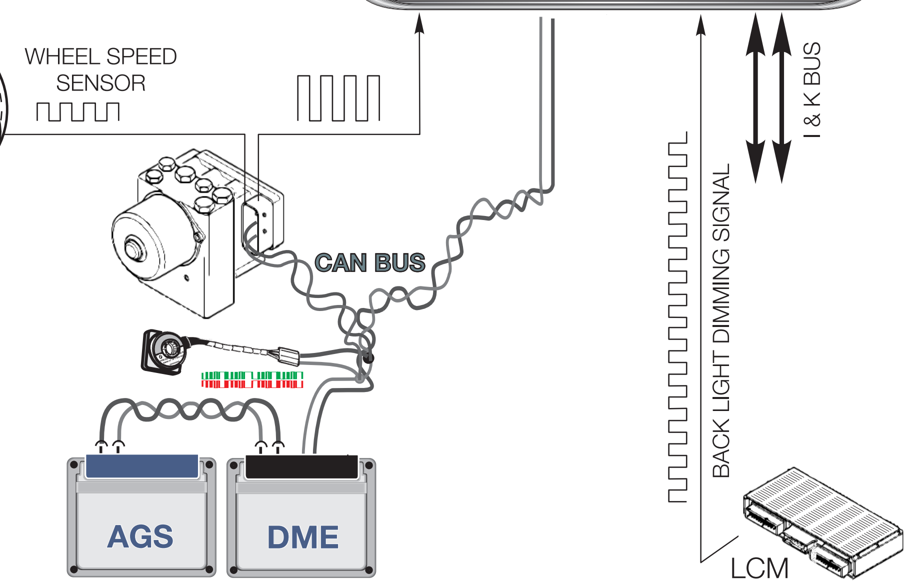
The cluster electronics process the input for the cluster display and pass the signal along, on the I & K busses, as speed signal “A” for other control modules requiring the vehicle speed signal.

CAN BUS SIGNALING - The CAN bus connection to the instrument cluster is found at pins 8, 9 and 10 of the blue 26 pin Elo connector on the back.

The signals transmitted from over the CAN bus to the instrument cluster include:

- Engine temperature
- Engine rpm
- Ti signal (fuel economy indicator)
- Check engine lamp activation
- Transmission range selector position and driving program.





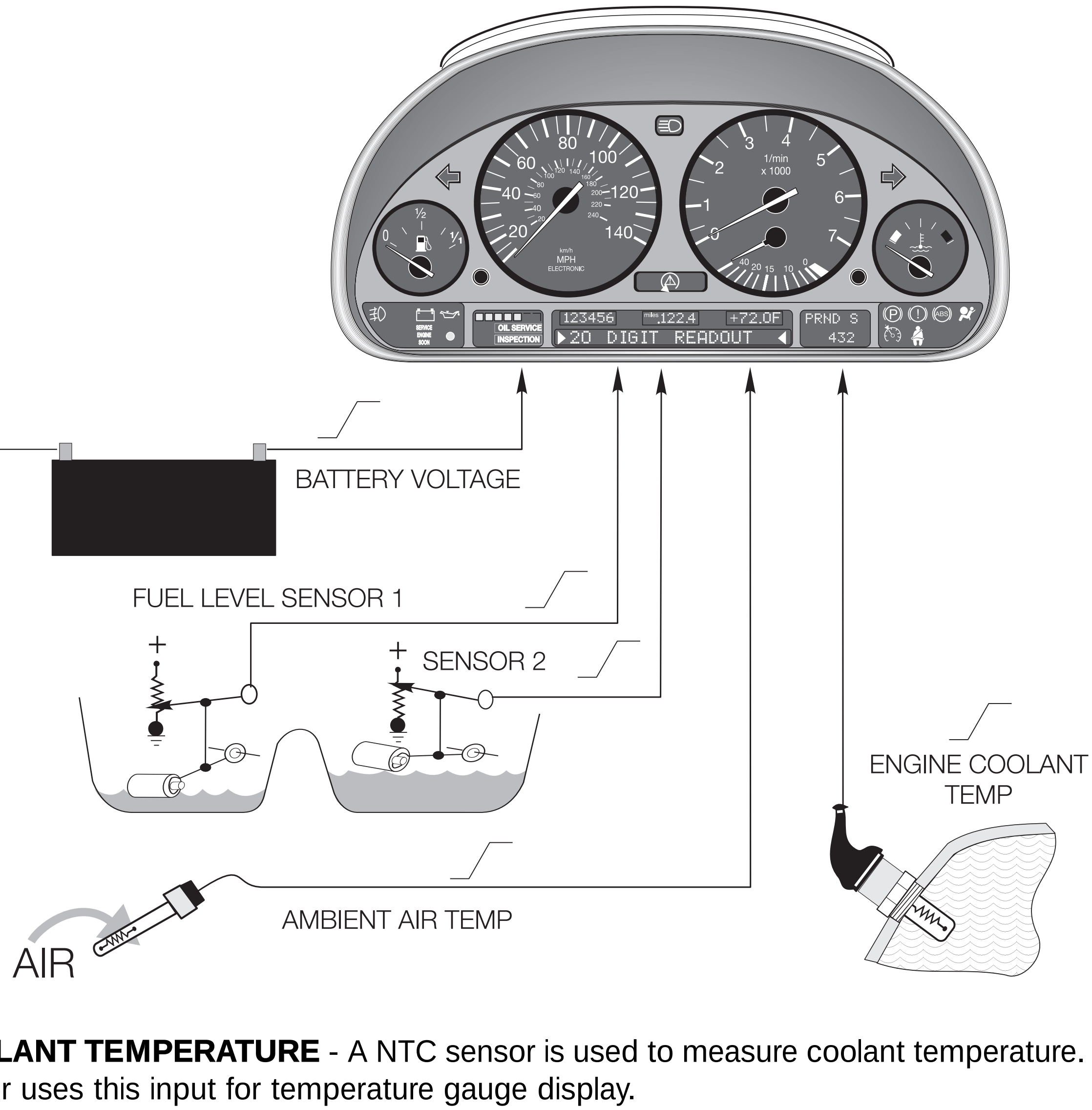
A malfunction with the interface to the instrument cluster could cause the DSC and transmission fail-safe indicators to appear. In addition, the instruments affected by the signals listed above will be inoperative.

DIMMER SIGNAL - This is a pulse-width modulated signal from the LCM. It is used to control the intensity of the back lighting of the instruments and the LCDs when the lights are switched ON. This signal is also output over the “K” Bus.

ANALOG INPUT SIGNALS

BATTERY VOLTAGE - Battery voltage is monitored by the cluster and a fault is stored if the voltage exceeds 16 volts

FUEL TANK LEVEL - Two lever action sensors are wired in parallel to the cluster. The two varying voltage signals are processed by the cluster for fuel gauge and low fuel warning display.



COOLANT TEMPERATURE - A NTC sensor is used to measure coolant temperature. the cluster uses this input for temperature gauge display.

OUTSIDE TEMPERATURE SENSOR - A NTC sensor is used to measure the ambient temperature. The signal is processed by the cluster and passed out over the K Bus to modules requiring this input for processing.

DIGITAL INPUT SIGNALS

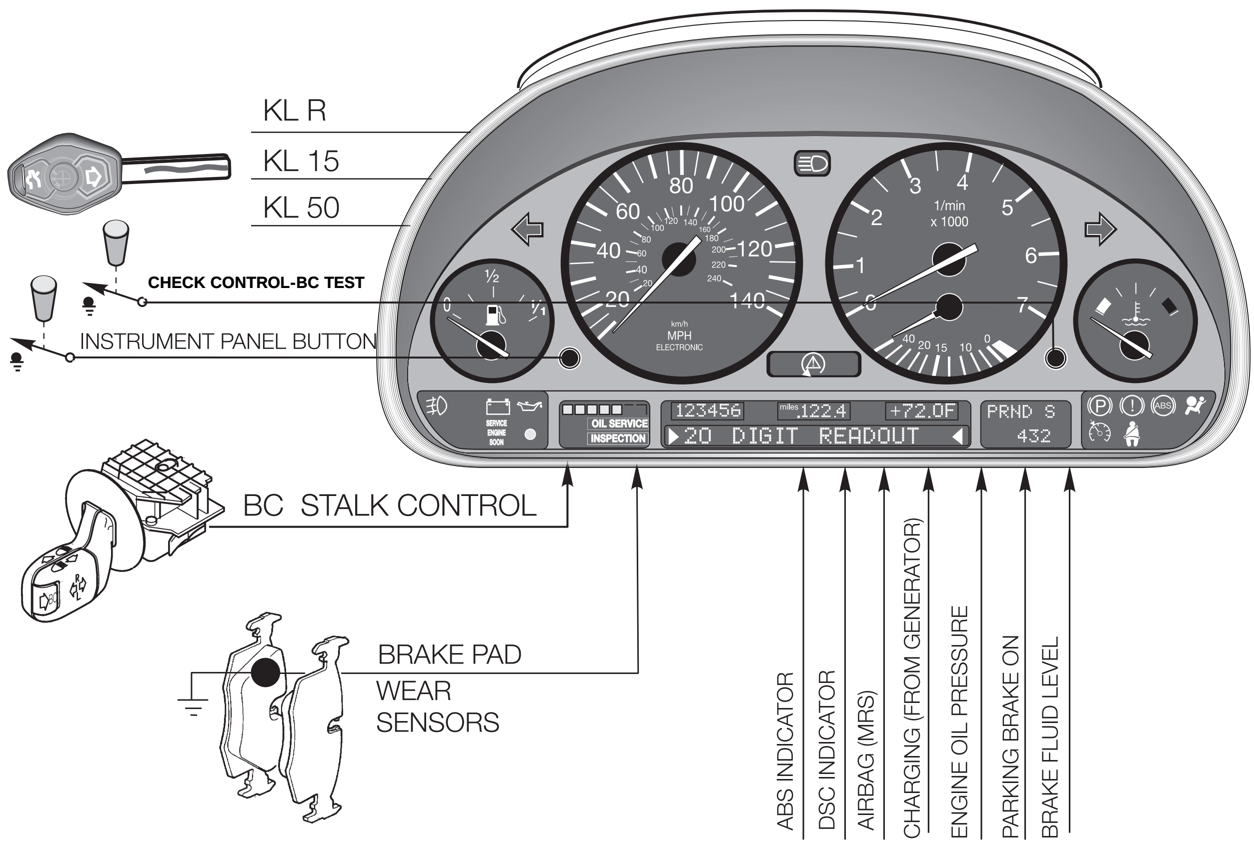
The normal ignition switch terminals (**KL R, KL 15 & KL 50**) are input to thee cluster. Various functions are dependent on ignition switch position.

STEERING COLUMN SWITCH - As with previous systems the turn signal stalk is used to call up BC functions.

BRAKE PAD WEAR SENSORS - The pad sensor inputs are used to illuminate the brake pad warning indicator as in the past.

INSTRUMENT PANEL BUTTON - The reset button is used to reset the trip - odometer as in the past. It will also display the mileage, if pressed with the key switched OFF. This button is also used for the Base BC/instrument cluster test functions outlined on page 15.

INPUTS FOR WARNING LAMPS - Various switches are used to signal the cluster for warning and indicator lamp illumination.

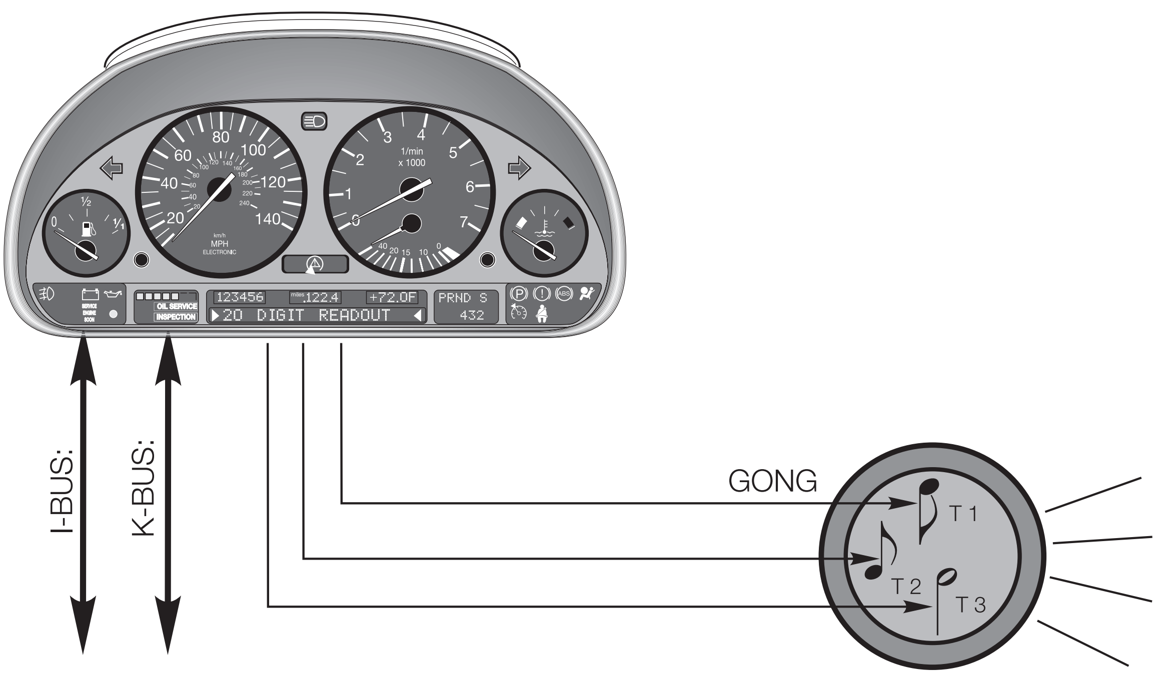


OUTPUT SIGNALS

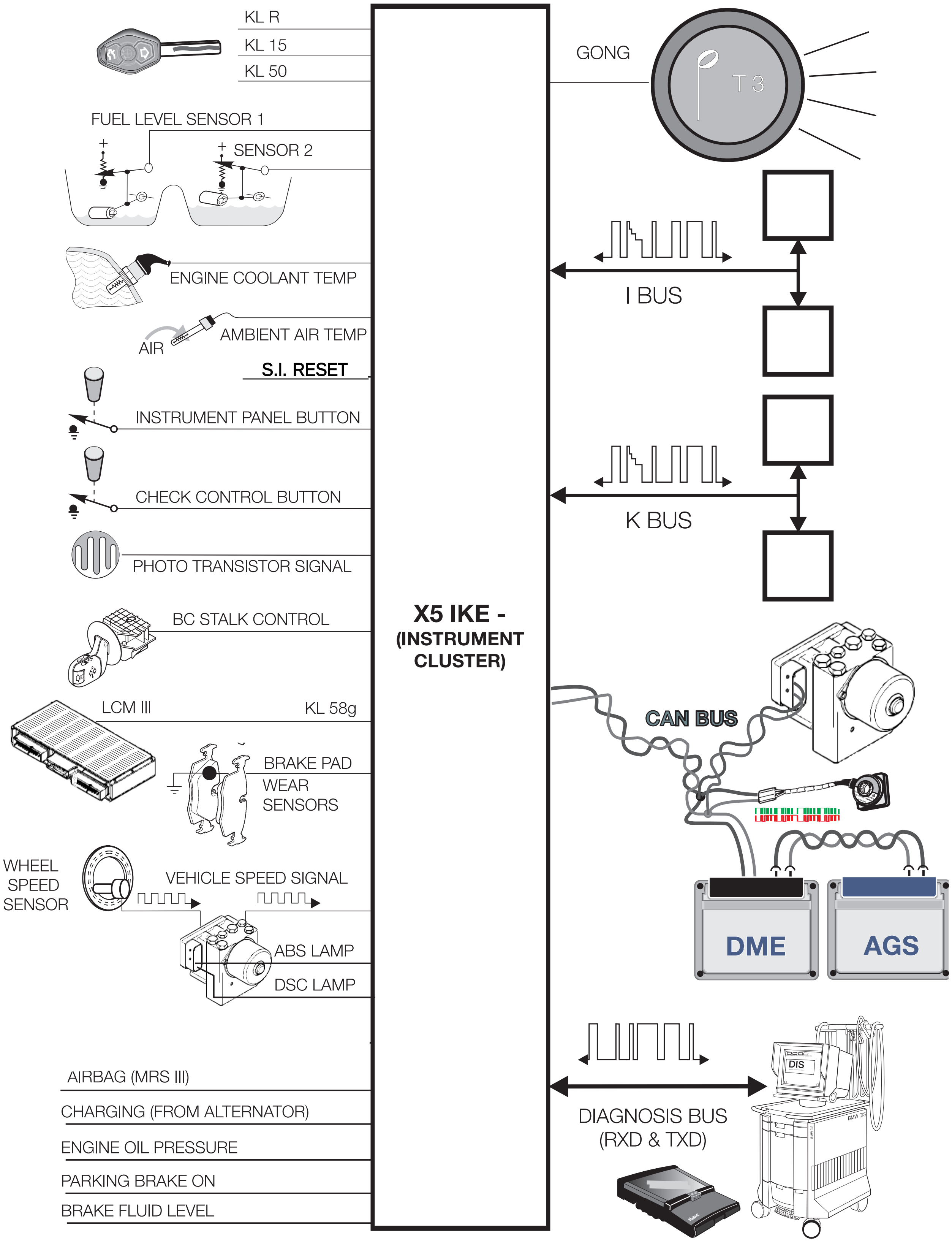
I & K BUS INTERFACE - The K Bus is used to transfer data between the cluster and other modules on the link. The diagnostic interface also passes over the K Bus for troubleshooting with the DIS Tester.

Gong Outputs T 1 , T 2 , T 3

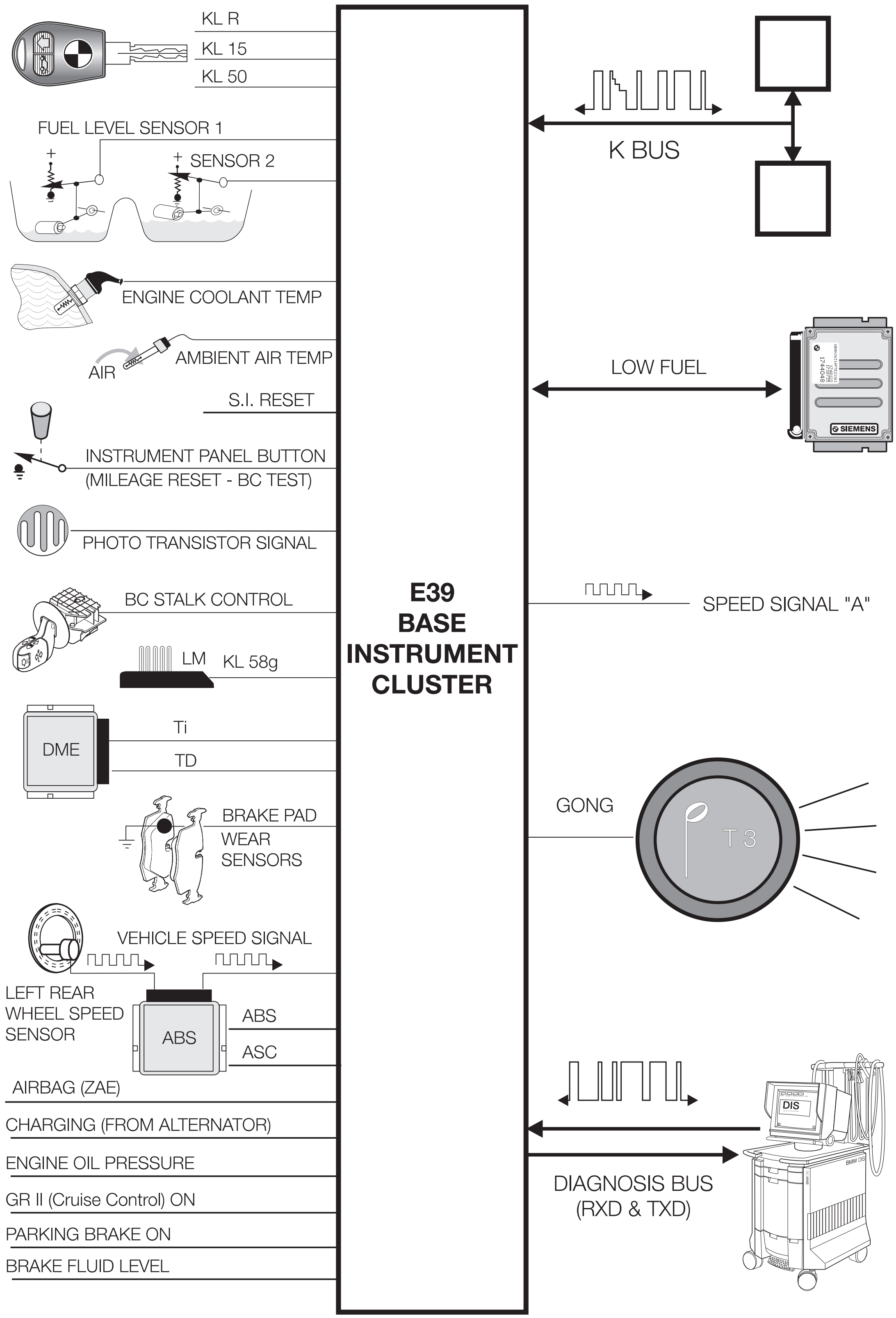
- **T 1 -** Activates memo (hourly reminder)
- **T 2 -** Activates the tone for the freeze warning
- **T 3 -** Activates the tone for check control functions
- **T 1 -T 2 -** Activated simultaneously produces the tone for code and limit functions.



High Instrument Cluster



Base Instrument Cluster

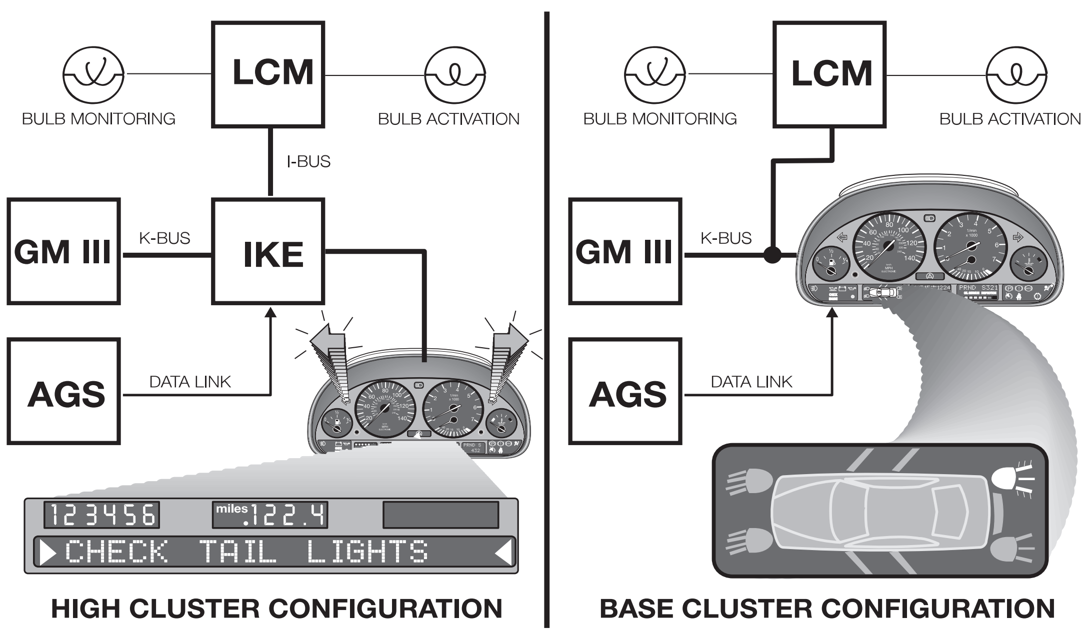


LIGHT CHECK MODULE III (LCM III)

The LCM lll continues to be installed in the right kick panel. The LCM communicates with other modules over the "I" and "K" busses. The module itself has been redesigned with new semi-conductor final stages that produce less heat in operation. This has allowed for the elimination of the protruding heat sink found on the previous LCM.

Functions of the LCM include:

- Monitoring of all check control inputs
- Formation and output of check control messages or signals
- Control of all vehicle external lighting
- Monitoring of all external lighting for operation
- Instrument panel illumination dimming (KL 58g) signal
- Control of instrument cluster indicator lights - for high beam, turn signal and fog light indicators.



For Proper Operation of the check control and lamp control functions, the LCM must be coded with the Central Key (ZCS) if replacement is required.

LAMP CONTROL/MONITORING

Lamp control and monitoring on the X5 follows the E38 in design and function. All exterior lighting is controlled by the LCM. It contains transistor power output stages for activating the lights. This eliminates the need for fuses and relays previously used for this purpose.

The LCM receives the input request for light illumination from the various switches and data inputs from other control modules. The LCM then switches the power output stages ON for lamp activation.

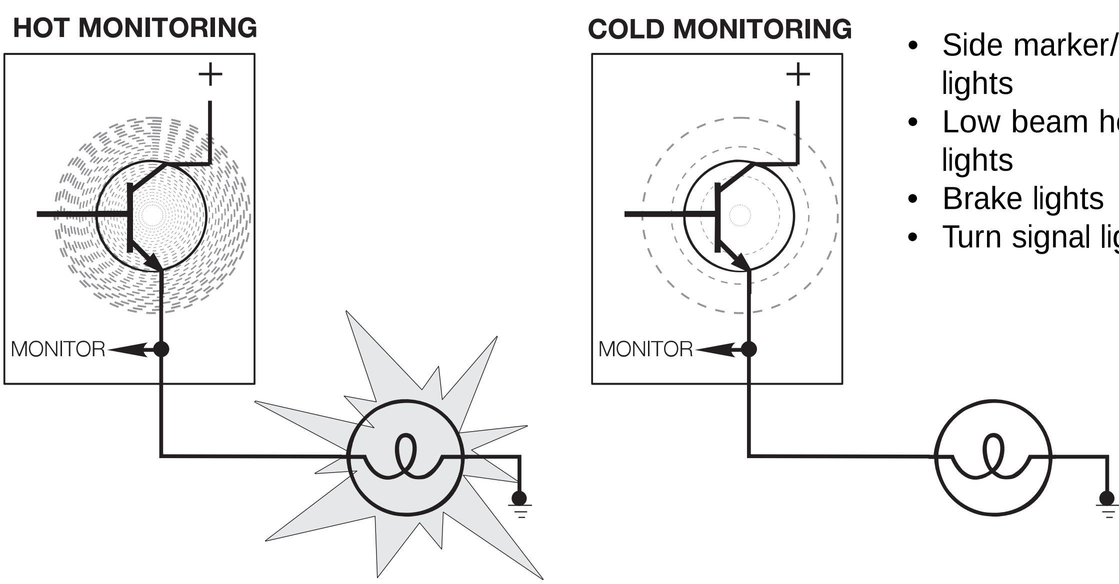
Other control modules that communicate with the LCM include:

- IKE over the I/K bus for turn signal, highbeam and fog lamp indicator illumination.
- The ZKE for crash alarm indication.
- The AGS control module for back up lamp activation.

All exterior lighting is monitored (both hot and cold) by the LCM. When the monitored value exceeds an acceptable level (high or low) the LCM generates and sends the signal to the IKE or base instrument cluster for check control display.

- Hot monitoring takes place from the LCM by monitoring the current flow through the output stages.
- Cold monitoring takes place by the LCM by briefly switching the lights ON and monitoring the current flow through the output stages. This is not enough to cause the lights to illuminate.

For safety purposes, the LCM is designed with emergency functions. A LCM failure will still allow various lamps to function for safety purposes. These lamps include:



- Side marker/tail lights
- Low beam head-lights
- Brake lights
- Turn signal lights

REPLACEMENT LIGHTING

The LCM uses substitute bulbs for various lights if a failure should occur, for example:

Front Parking Lights: If one of the parking lamps should fail, the LCM will illuminate the turn signal bulb on the affected side. The lamp will be dimmed by the LCM so that the intensity is the same as the parking lamp.

Tailights: If one of the taillights should fail, the LCM will switch on the brake lamp on the affected side. The lamp will be dimmed to the intensity of the tail lamp.

OUTPUT VOLTAGE LIMITING FUNCTION

The output voltage applied to the parking and tail lamps is regulated to increase the life of the lamps. If the voltage at the LCM increases over 12,5 volts, the LCM will reduce the voltage to 12 volts.

FOLLOW ME HOME LIGHTING

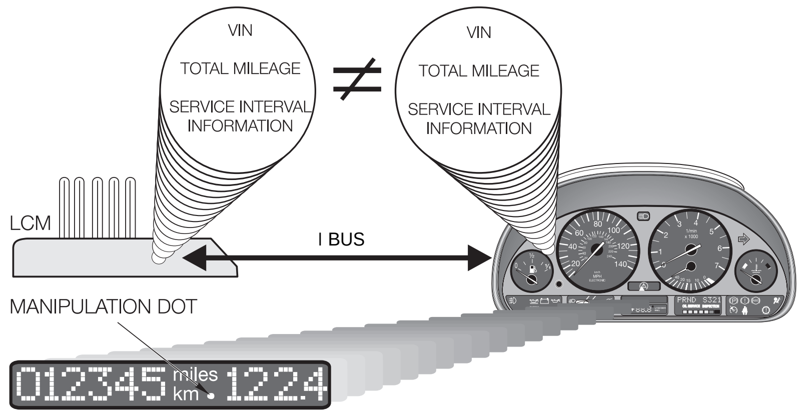
This convenience feature provides lighting for the driver and passengers to leave the vehicle and enter their homes.

The feature is switched "ON" by pulling the headlight flasher switch after the headlights and ignition have been switched OFF. The feature is switched OFF after a coded time delay or by switching the ignition ON.

REDUNDANT DATA STORAGE

The specific information stored redundantly includes:

- Vehicle ID number
- Total mileage
- Service Interval data



The data is stored in the cluster and in the Light Check Module (LCM). The storage of this data follows the redundant storage of the E38. It prevents the loss of total mileage or SI data in the event of a cluster processor failure.

The data is compared each time KL 15 is switched ON. If the data does not match, the manipulation DOT in the mileage display is illuminated.

Because of this redundant storage feature, the following points must be noted:

1. If the vehicle ID number is not the same in both modules, the manipulation DOT is illuminated and no data transfer takes place. All functions of both modules will continue to operate.

2. Data will only be accepted by the cluster from the LCM if the ID numbers match and the cluster mileage is zero.

3. The vehicle ID number is input into the cluster through coding and will only be accepted when the cluster is at zero mileage.

4. The LCM stored mileage can only be overwritten with a higher mileage and is updated every 60 miles.

5. If the mileage differs by more than 120, and the ID numbers are the same, the cluster will continue recording the mileage and set a fault for data transfer.

6. If the I Bus link to the LCM fails, the cluster will continue to record mileage and store a fault for the data link.

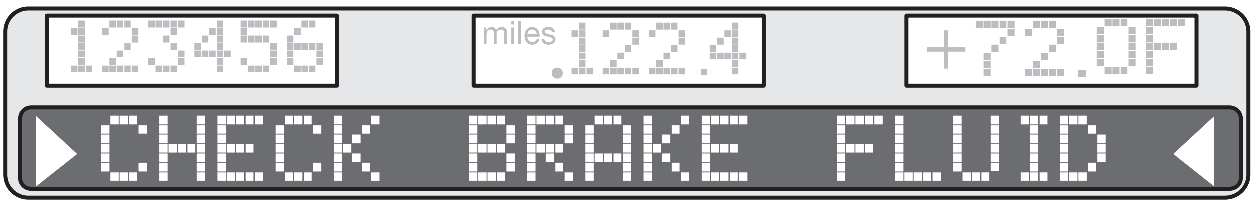
These conditions will only allow new components to be installed for replacement purposes. However, a used component can be installed for testing purposes. If a cluster from another vehicle is used for testing purposes, road testing of the vehicle should be avoided, because the cluster will accumulate mileage.

CHECK CONTROL (High Cluster)

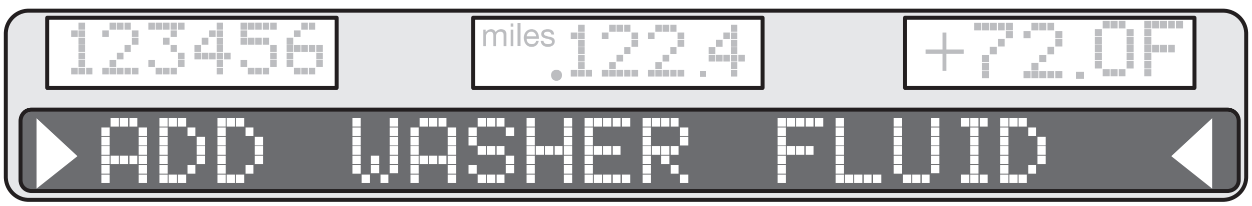
The Check Control system corresponds to that of the E38/E39 in function and operation. The LCM collects and evaluates all check control data inputs from the various switches and sensors. This includes the lamp monitoring function within the same module. The failure or warning messages are formed in the LCD and transmitted to the IKE over the “I” bus for display in the cluster matrix.

The cluster matrix contains a 20 character display field for posting messages. Failures and warnings are prioritized for display following the same criteria as the E38.

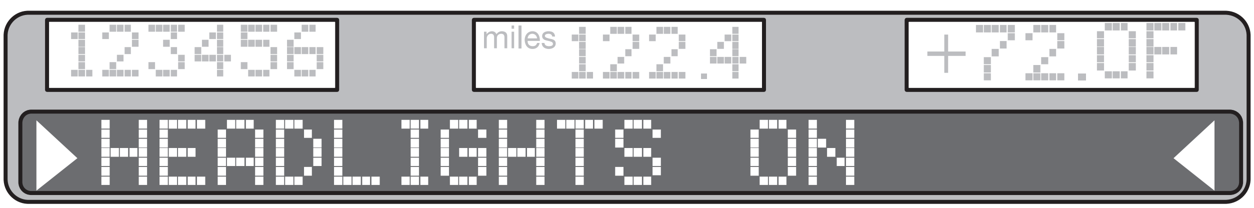
Priority P1 - Critical or important warnings that cannot be canceled with the CC button.



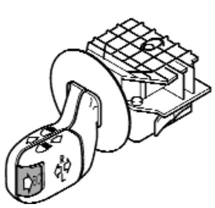
Priority P2 - Messages that are displayed when KL 15 is switched on for a maximum of 23 seconds or when the failure occurs for while driving.



Priority P3 - Messages that are only displayed at the start of or end of a trip.



Special Warnings: These are top priority messages and won’t be overridden when displayed. Seatbelt, ignition key in lock with door open are some of these messages.



The CC button or steering column switch can be used to call up or cancel P2 or P3 messages.

The language of the check control display is set with the central coding key and cannot be changed by the driver.

DISPLAY	GONG	PRTY	SCOPE OF MONITOR
OPERATING CONDITIONS			
Release Parking Brake	G	P1	Warning displayed above 3 MPH
Door open with ignition key in position KL 15		S	Warning displayed when a door is open or opened above 3 MPH.
Trunk Open	G	P2	Warning displayed above 3 MPH when trunk opens or was left open prior to pulling away. Displayed once only.
Stop! Engine oil pressure	G	P1	Warning displayed oil pressure has fallen below safe level.
Coolant Temperature	G	P1	Warning displayed when coolant rises above maximum temperature
Check Brake Lights Check low-beam headlights Check high-beam headlights Check parking lights Check front fog lights Check license plate lights	G	P2	The LCM monitors certain vehicle lights and circuits. When a fault is detected the IKE is notified to post the display.
Check brake pads		P2	Warning issued when brake pad wear limit is reached.
Lights on?	G	P3	Warning displayed when key is in position 0 if driver's door is opened with light switch on.
Ignition key in lock	G	S	Warning is displayed when key is left in ignition switch in position R or 0.
Fasten Seatbelt	G	S	Warning is displayed for a 6 second period after "Ignition on" with seatbelt fastened or not. If seatbelt is fastened the intermittant gong is switched off.
Remote Battery		S	When remote key battery voltage drops below 4.5 volts
FLUID LEVELS			
Check Brake Fluid	G	P1	Warning is displayed when brake fluid is too low.
Check engine oil level		P2	Warning is displayed when the engine oil level is too low.
Check coolant level		P2	Warning is displayed when coolant level is too low. The warning is only posted when the ignition key is first turned on.
Add washer fluid	G	P2	Warning is displayed when washer fluid level is low. This warning is displayed at any time the level becomes low to provide an early warning
NOTE: The fluid level warnings are monitored in 25 second intervals. This time interval prevents false displays from occuring due to bumpy roads, fluid sloshing, etc.			
CONTROL SYSTEM FAULT DISPLAYS			
Emergency transmission operating program	G	P2	If a fault occurs in the AGS control system check control displays the message. The message is orriginated from the AGS CM to IKE over a one way serial data line. From there IKE notifies the LCM over the I Bus.
EEPROM IKE		S	When IKE and LCM data differ (for testing purposes).

MULTI-INFORMATION DISPLAY (MID)

The X5 utilizes the E39 MID for control and display of the radio/tape/CD changer and clock. The MID itself, does not perform any calculations, it is only an input/display device.

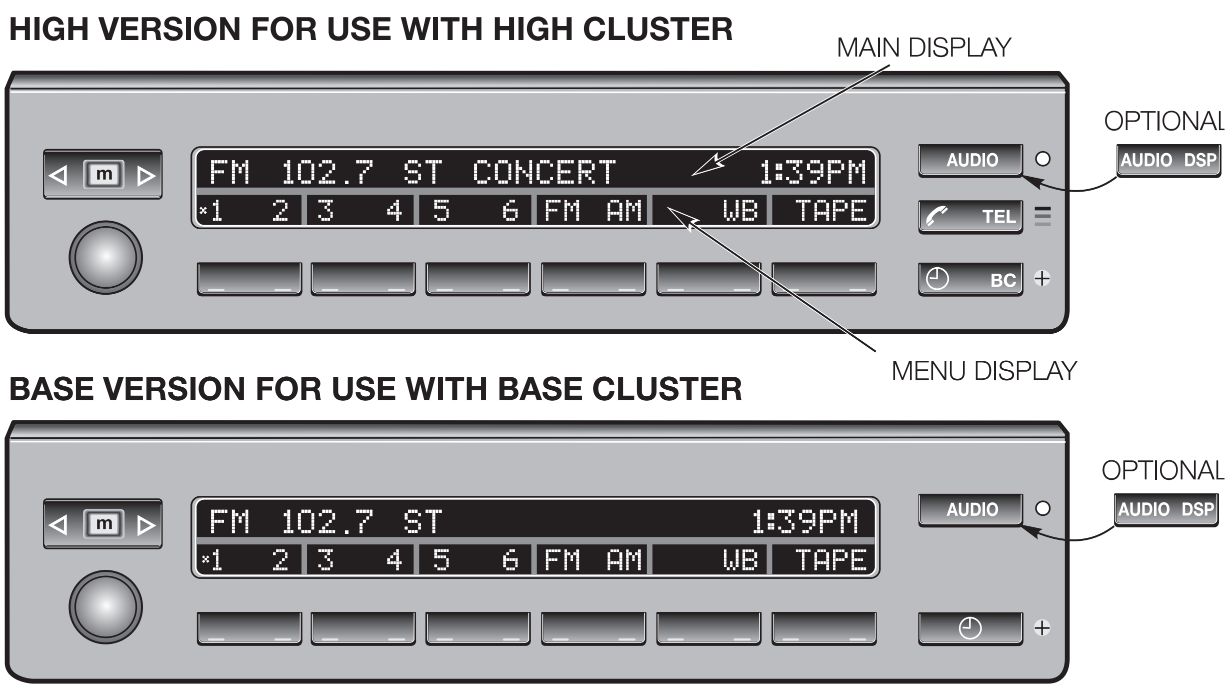
If installed, the Digital Sound Processor (DSP) will also be adjusted and controlled through the MID.

Additionally, with the high version clluster, the MID will also be used as the control and display for the Board computer and telephone.

The MID contains two sets of displays

MAIN DISPLAY - A 32 character display for presentation of primary information.

MENU DISPLAY - 6 small display blocks above each button switch for labeling the switch functions.



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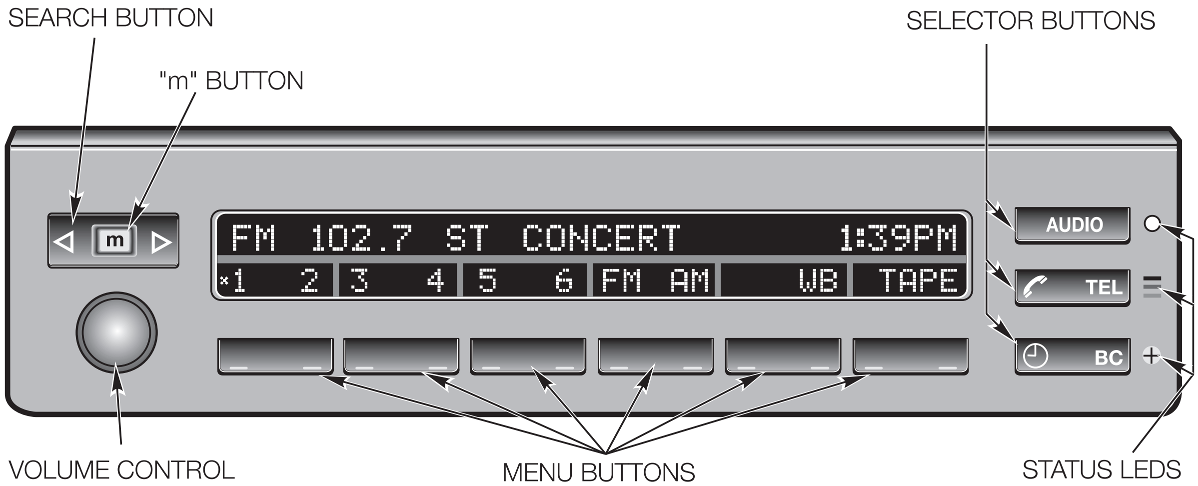
MENU BUTTONS - the buttons are designed as rocker switches having a left and right side contact. The function of each button changes as the different systems are selected.

SELECTOR BUTTONS - These buttons are used to select the desired system to be used:

- **Audio** - calls up the radio/tape/CD control functions for operation and programming.
- **Telephone** - used to program and call up stored telephone numbers.
- **Time/BC** - calls up the clock and BC control functions for programming and display.



SEARCH BUTTON -

- **Radio** - will activate the search for radio stations in either direction
- **Tape** - activates music search in forward or reverse directions.
- **CD** - activates title search up or down the music list.

The integrated “m” button is used to switch over to a “manual” search of the functions listed above. An “m” is posted in the display when in this mode. The “m” button is also used to activate the radio test.

VOLUME CONTROL

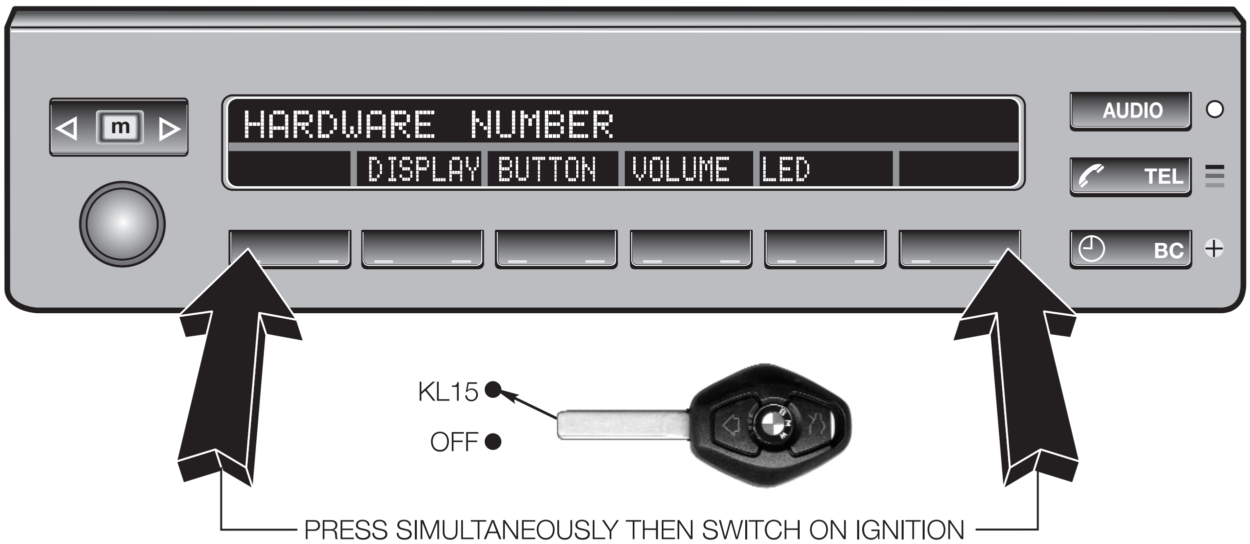
- Push button for ON/OFF control of audio system.
- Rotary knob for volume control on the audio system and telephone hands-free speakers.

STATUS LEDs

- Red, yellow and green LEDs indicate status of telephone operation.
- A red fan symbol indicates the status of the parked car ventilation system’s operation.

MID SELF TEST

Operation of the MID can be checked through the test function sequence on the MID panel. The following items can be checked:



UNIT IDENTIFICATION - The following information appears for approximately 3 seconds when the ignition is switched on

- Hardware number
- Software number
- Variant index

All other test must be started within three seconds, while the identification data is displayed. If not the MID will exit the test mode.

DISPLAY TEST - Activate this test by pressing the display menu button. All elements of the main and menu displays are illuminated with different check patterns.

BUTTON TEST - Start this test by pressing the button test menu button. All buttons on the MID have been assigned an alphabetical letter that will appear when the button is pressed.

VOLUME CONTROL TEST - This test is carried out by pressing the volume menu button and turning the volume knob. Numbers from 01 to 36 appear in the display indicating each step of the knob's rotation.

STATUS LED TEST - Activate this test by pressing the menu button. All status LEDs are illuminated.

MID REMOVAL PROCEDURE

The X5 MID is removed from the center console as follows:

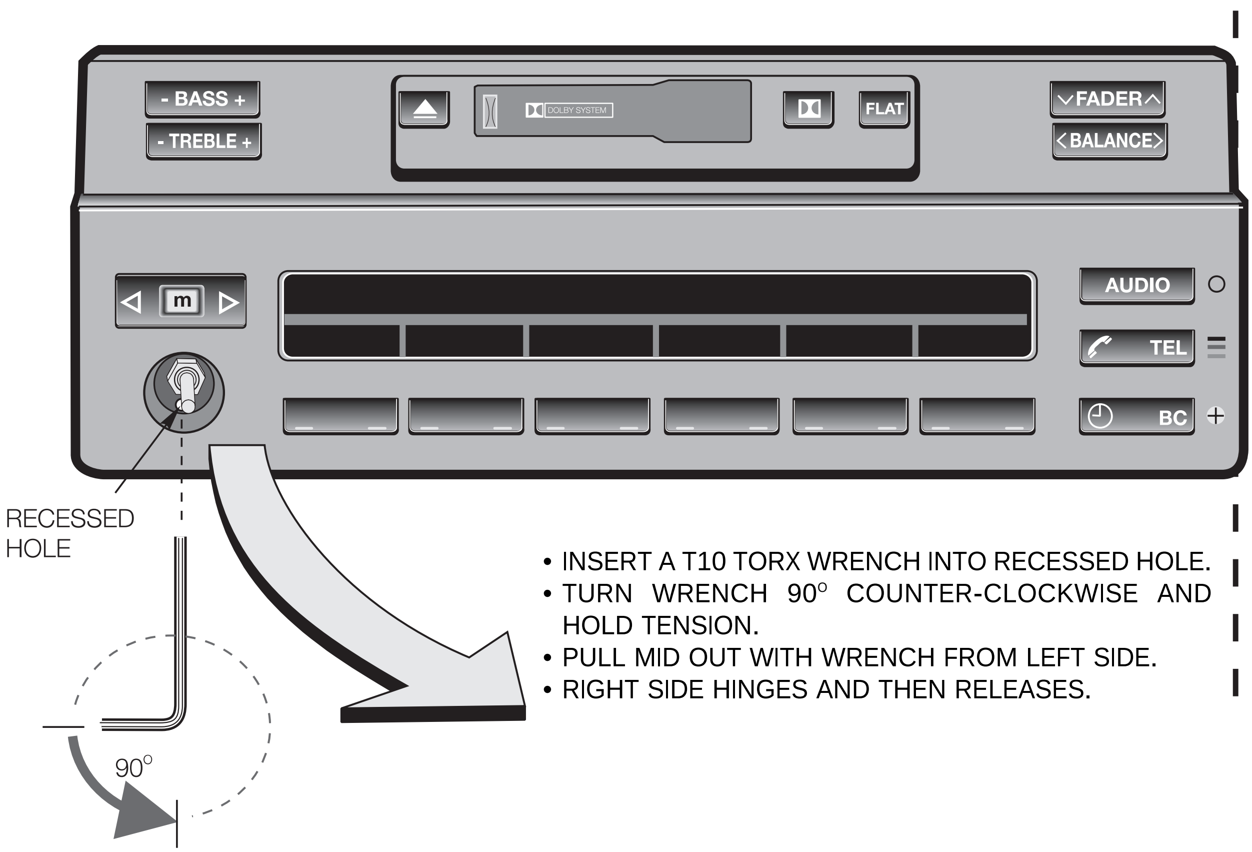
1. Pull the volume knob off the MID.

2. Insert a T10 torx wrench into the recessed hole beneath the volume knob shaft.

3. Turn the wrench 90° to the left until a stop is felt.

4. While maintaining tension on the wrench in the stopped position, use the torx wrench as a pull handle to pull the left side of the MID out of the center console. The right side of the MID acts as a hinge on the center console.

The radio/tape player is removed by turning the 2.5mm allen head bolts to unlatch it from the center console as on previous radios. The radio allen head bolts are visible once the MID is removed.

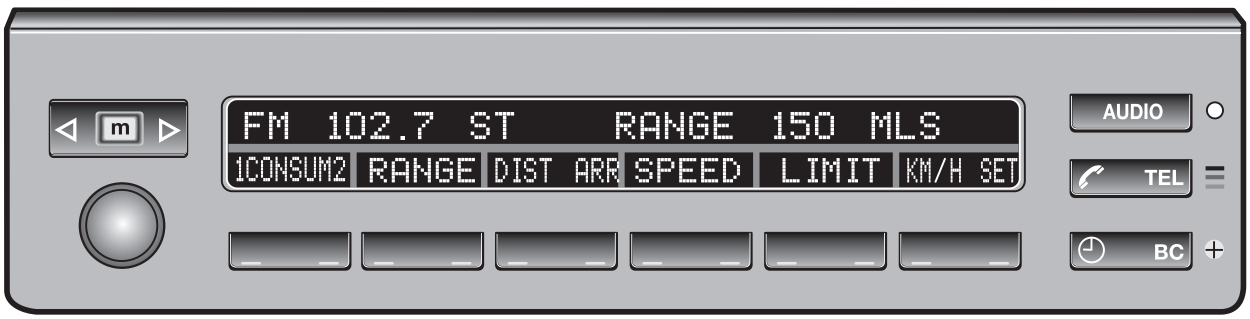


ON BOARD COMPUTER (High Version)

The familiar BC V on board computer functions are carried over to the X5. The BC processing is a function of the IKE and can be displayed in the cluster matrix and the MID or if Nav system equipped, on the BMBT LCD screen.

The following BC functions are available for display:

- Time/Date
- Arrival Time
- Range
- Distance
- Stop Watch
- Average fuel consumption
- Limit
- Average Speed
- Two Timers for programming parked car ventilation



Operation and programming of the BC is carried out with the MID as on the E38.

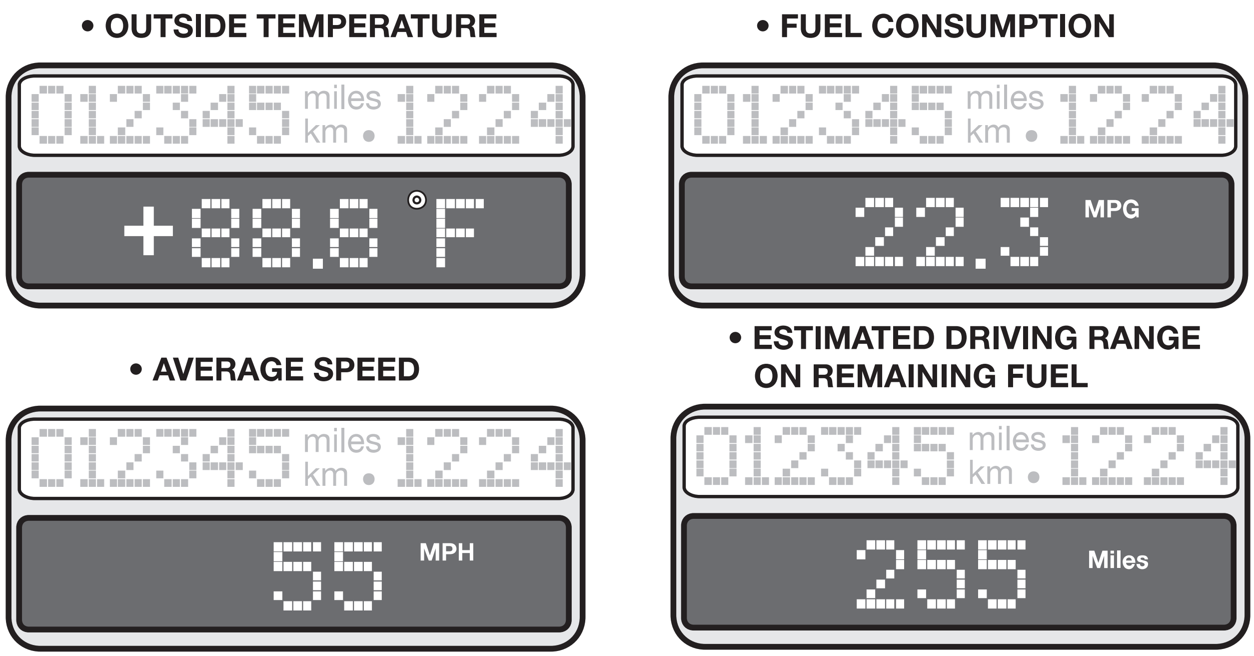
The menu displays change as each function is called up for programming/resetting purposes. this includes the changeover functions for the clock, mileage and MPG displays.

BC functions can be displayed in the cluster matrix by pressing the turn signal lever as in the past.

The cluster displays can be programmed for number of displays and order of appearance.

ON BOARD COMPUTER (Base Version)

The On Board computer information on the base variant cluster can only be displayed in the center matrix. The following information can be displayed:



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When KL R is switched ON, the outside temperature will be displayed. To call up any other function, the turn signal lever must be pressed and released. The other functions are than displayed one after the other. A blank field is provided after the average speed display to allow the driver to switch off the display.

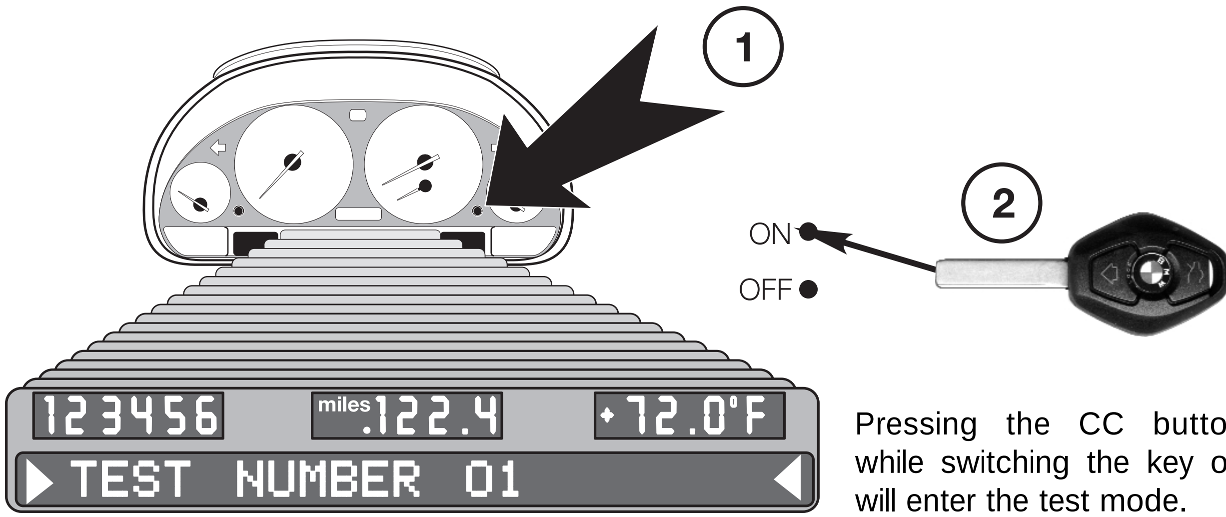
A freeze warning is incorporated in the BC. If the temperature drops below 37^{O}F, the gong will sound and the temperature display will flash in the BC. Pressing the turn signal lever will cancel the display.

The temperature display in the base on board computer can be switched from Fahrenheit to Celsius by pressing the instrument cluster button and holding it while cycling the ignition key. During this procedure, the base instrument cluster also produces a “temperature changeover signal” on the K-bus for the IHKA to switch over the control panel/module to match the display in the instrument cluster. This feature is only available with the base instrument cluster.

Two of the displays “Average Fuel Consumption” and “Average Speed” can be reset to start new calculations. To reset the displays, press and hold the turn signal lever, for longer than one second, when the function is called up. The BC will than start to compute a new aver-

BC TEST FUNCTIONS (High Version)

The BC test functions can be used to check various inputs, outputs, status and functions of the IKE. It follows the BC test functions of the E38 with the test functions being displayed in the cluster matrix. (Reference the IKE handout of the E38 Introduction course).



Pressing the CC button while switching the key on will enter the test mode.

Test # 1,#2 are the only unlocked tests of the test functions. Test #19 is used to unlock the tests as follows:

1. Go to test #1 and display the VIN.
2. Add the last five digits of the VIN and note the total, **EG;** VIN = BG00222. 2+2+2 = 6.
3. Go to test #19. Display reads "Lock ON".
4. Press the reset button "6" times.
5. Press the CC button. The tests are now unlocked.

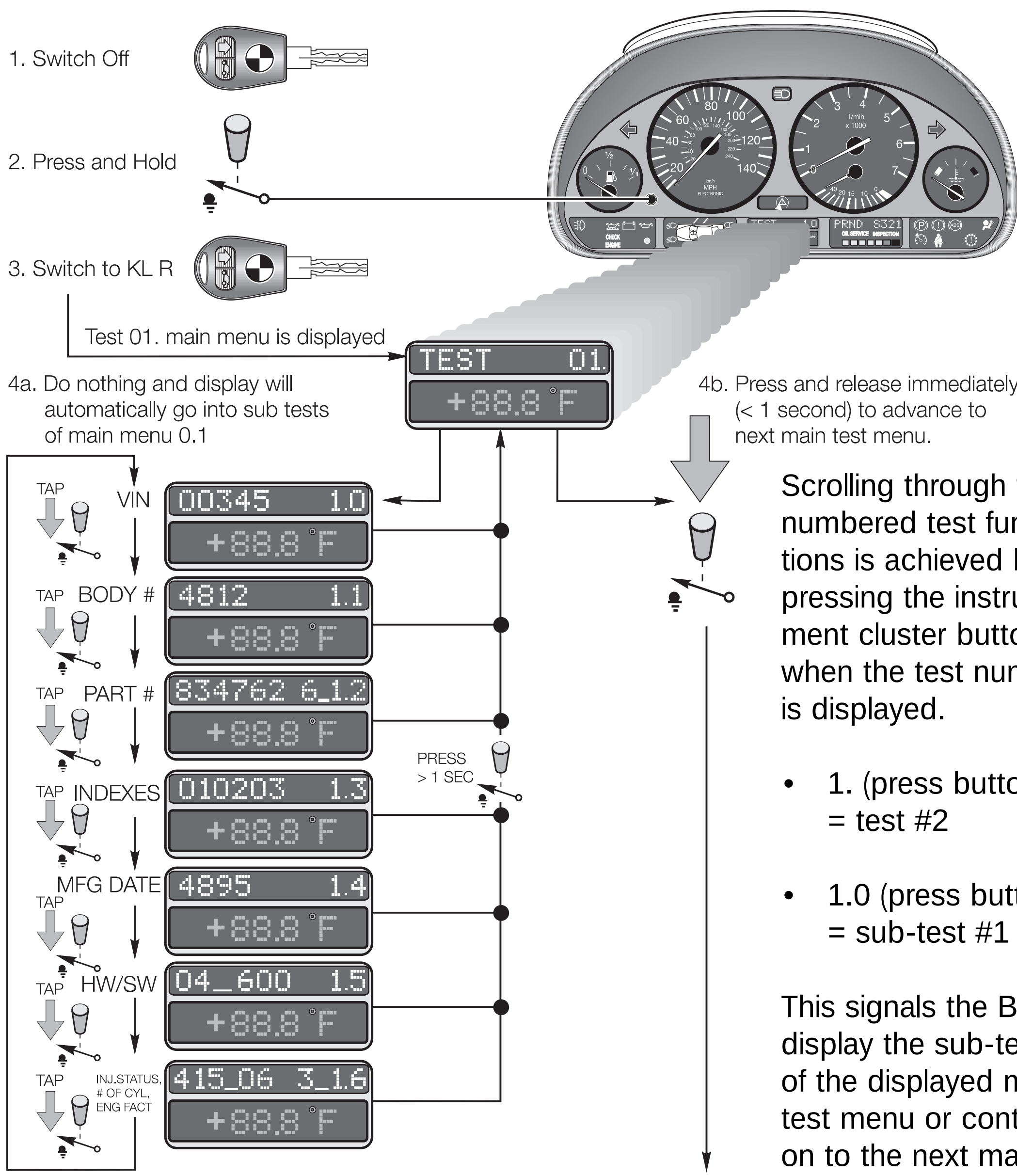
Several test functions have sub-test values that are called up by pressing the reset button while the test is displayed. The test functions available on the BC include:

TEST 01 - Vehicle specific data
TEST 02 - Cluster self test
TEST 03 - SI data
TEST 04 - Fuel Consumption
TEST 05 - Range calculation data
TEST 06 - Fuel tank sensor inputs
TEST 07 - Coolant/RPM inputs
TEST 08 - Road speed input
TEST 09 - Battery Voltage
TEST 10 - Country Code
TEST 11 - Unit Code
TEST 12 - Data for est. arrival time
TEST 13 - GONG Test
TEST 14 - HEX value for fault memory
TEST 15 - Port binary input values
TEST 16 - OEL Temp
TEST 17 - RCC-EMPF.: _ _ _ _ MIN.
TEST 18 - BLANK
TEST 19 - Lock/Unlock
TEST 20 - Correction Factor
TEST 21 - Reset function

BASE BC/INSTRUMENT CLUSTER TEST FUNCTIONS

In addition to the fault memory and diagnostic link, the base instrument cluster contains a series of test functions that can be accessed to check various functions and values. The test functions are displayed in the mileage LCD block. There are a total of 21 test functions. The test functions are similar to those of previous Board computers and contain similar tests.

- Tests 1 & 2 are always unlocked.
- Tests 3 -21 are only accessible after unlocking the test function. Test 19 is the unlock function for accessing the displays.



Scrolling through the numbered test functions is achieved by pressing the instrument cluster button when the test number is displayed.

- 1. (press button) = test #2
- 1.0 (press button) = sub-test #1

This signals the BC to display the sub-tests of the displayed main test menu or continue on to the next main test menu.

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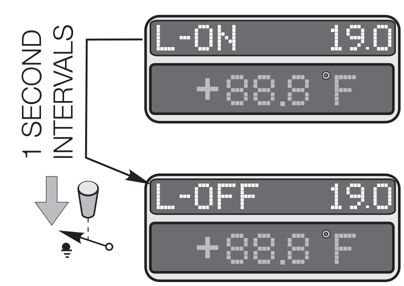
TEST 19. - LOCK/UNLOCK

Sub-Tests
L-ON...
L-OFF   19.0 =



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Display changes from "L-ON" to "L-OFF" every second. To unlock test functions, press the cluster button **immediately** when it changes to "L-OFF".
Tests are automatically locked when exiting test functions.

The test functions of both cluster/BC systems are the same except where noted

TEST NO. 01

The IKE/Cluster module supplies the following data, which appears on the cluster matrix display:

Sub test
base version

1.0 • Vehicle Identification number = FGSTNR: GB11111

1.1 • K value = K: 4739 (high version) - Body Number (low version)

6_1.2 • BMW part number: Bmwtnr. 13809873

1.3 • Encoding, diagnosis and bus index: CI: 01 Di: 01 bi:01

1.4 • Production date: dat: 52/94

1.5 • HW/SW number: hw: 40sw:80

3_1.6 • Injection Status/number of cylinders/engine factor

• Motor: zyl:8
m:6 s:400

• ROM Date: ROM; 23.08.96 (high version)

TEST NO. 02

The following displays and instruments are activated (system test):

- Speedometer, tachometer, coolant temp gauge, fuel gauge.
- LC displays (segment test)
- Indicators and Warning Lights

This test can only be called up with the vehicle at a standstill, engine turned off, with KL R or 15 switched on.

TEST NO. 03

The following SI data can be displayed:

Sub Test
base version

3.0 • Liters

3.2 • Periodic inspection - not for US

• SI km since last reset: si km: 1250

• SI automatic transmission kilometers: SI-GETR - km 23300

TEST NO. 04

Momentary Fuel Consumption is displayed:

Sub Test
base version

4.0 • VBR: 0.0 L100km
4.1 • VBR: 0.0 l/h

TEST NO .05

This function shows the range calculation data:

Sub Test
base version

5.0 • Range at measured fuel consumption: RW-vbr: 19.5 l/100 km
5.1 • Momentary distance to go (km)

TEST NO .06

In this function, the fuel tank volume for the right and left half of the fuel tank and the current total tank volume are shown in the Instrument Cluster matrix display.

This enables the function of the float level sensors to be checked.

Display: tnk 29.5/34.2/63.7L
TNKANZ 60.2L PHASE 1

The first numerical value in line 1 shows the contents of the left half of the fuel tank, the second, the volume of the right half of the tank. The third value is the current total value. If a level sensor is defective, it's value reverts to 0.

Line 2 shows the current average value (displayed value) for the contents of the fuel tank. The numerical value after the word phase refers to the valid computed number.

Phase 1: Regular computing method by way of sensors (both sensors OK).
Phase 2: Calculation in progress from TKVA signal (sensor faulted)
Phase 3: Fuel tank contents cannot be computed, fuel gauge reads 0 (at least one sensor is faulted).

Sub Test
base version

6.0 • Fuel Level averaged
6.1 • Total tank Level Averaged
1_6.2 • Indicated value and tank phase
• 1 = both sensors OK
• 2 = one senosr fault
• 3 = implausible input

TEST NO. 07
Sub Test
base version

- 7.0 • Coolant temperature. ktmp: 076^{O} C (high version)
- 7.1 • Outside Tempeature
- 7.3 • Engine speed: N:5238 u/min (high version)
- 7.4 • Vehicle Speed

TEST NO. 08

• Momentary Road Speed V: 085 KM/H (high version)

Sub Test
base version

- 8.0 • HEX Code - Cluster inputs

TEST NO. 09
Sub Test
base version

- 9.0 • Battery voltage (terminal 30) Ub: 12.5 v

TEST NO. 10

Preset national market codes list. The number is encoded in the IKE/Ckuster module with the central code key

Sub Test
base version

- 10.0 • Display: usa 02

TEST NO 11

The unit code is entered in the EEPROM by the DIS after IKE has been installed and can be read out by means of test function 11.

Sub Test
base version

- 11.0 • Cluster Code

TEST N0. 12

This test function shows the data for computing the vehicle's estimated time of arrival.

- Average speed for calculating arrival time: vank: 029.7 km/h

- Current arrival time: ank: 13.04

Base version - not used

TEST NO. 13

This test function enables the gong to be tested, Display: gong?

- After confirming by pressing the trip odometer reset button, the four audible warning signals are triggered off once in succession.

- Gong T1 (Memo signal) 2.0s
- Gong T2 (Outside temperature) 1.5 s.
- Gongs T1 and T2 (LIMIT/CODE warning) 1.5 s
- Gong T3 (Check Control Gong)

Sub Test
base version
13.0 • Activate gong by pressing button

TEST NO. 14

This function shows the contents of the fault memory in a hexidecimal code.

Display: DIAG: D7 81 033

TEST NO. 15 - 18

Not assigned to any test function.

TEST NO. 19

Procedure for unlocking the BC test functions.

TEST NO. 20

BC consumption value correction factor. This test adjusts the correction factor for the consumption value displayed in the MID. The production line installed value is 1000. The value ranges from 750 to 1250.

To adjust the correction factor press the trip meter reset button once for a reduction of 1. For each press of the reset button the value decreases by 1 until it reaches 750. After 750 the number will reset to 1250 and begin to count down again.

To accept the set correction factor press the CC button.

The consumption correction factor (VK) is calculated from the actual amount of consumed fuel (VBR IST) and the displayed value (VBR ANZ):

VK = (Actual MPG / Displayed MPG) X 1000.

Sub Test
base version

20.0 • "ones" digit correction
20.1 • "tens" digit correction
20.2 • "hundreds" digit correction

TEST NO. 21:

This function resets the software at the IKE. This reset is necessary after replacing for example one of the fuel tank level sensors. Otherwise the damping function in the software will prevent the actual value from being shown only after a long time duration.

Display: reset ?

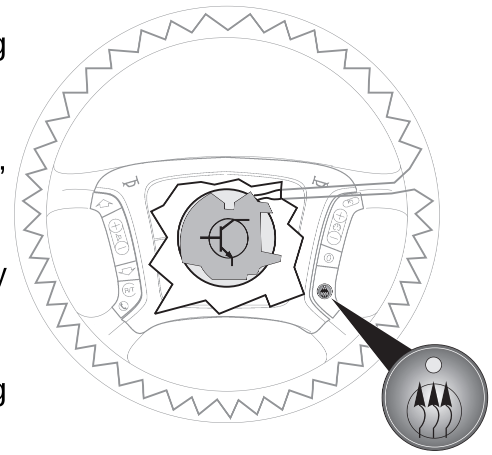
If the test is terminated without a software reset, the ignition switch must be turned back to "0" or the CC button pressed.

Sub Test
base version

21.0 • Reset software

HEATED STEERING WHEEL

The heated steering wheel system consists of the following components:

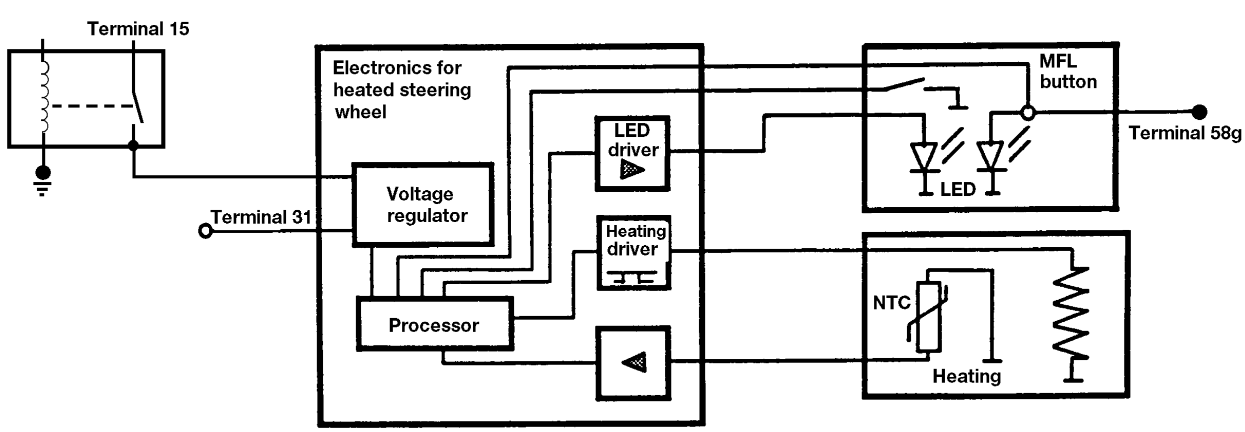


- A heating filament integrated into the steering wheel cover.
- An NTC temperature sensor, in the filament circuit, to regulate the heating current.
- A push button mounted in the right side MFL key pad.
- The control module located behind the air bag assembly.
- Slip ring assembly for the power and ground supply.

OPERATION

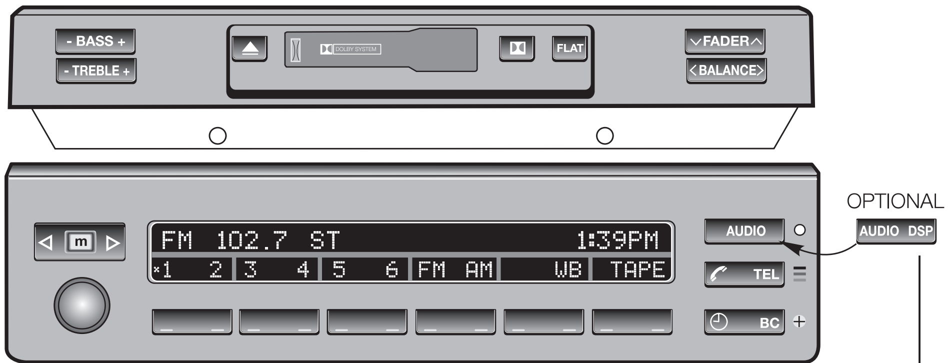
When KL 15 is switched ON, the heated wheel can be switched ON by pressing the button. A green LED illuminates to indicate system operation. Maximum current is supplied and heats the filament to its operating temperature (surface temperature of approximately 90^{O}F). The NTC detects the temperature of the filament and causes the control module to cycle once the wheel is heated. Cycling is carried out with a pulse width modulated signal.

The system is not connected to the diagnostic link, however the control module does monitor operation of the system. If a fault occurs during operation, the system and green LED will switch OFF.



AUDIO SYSTEM

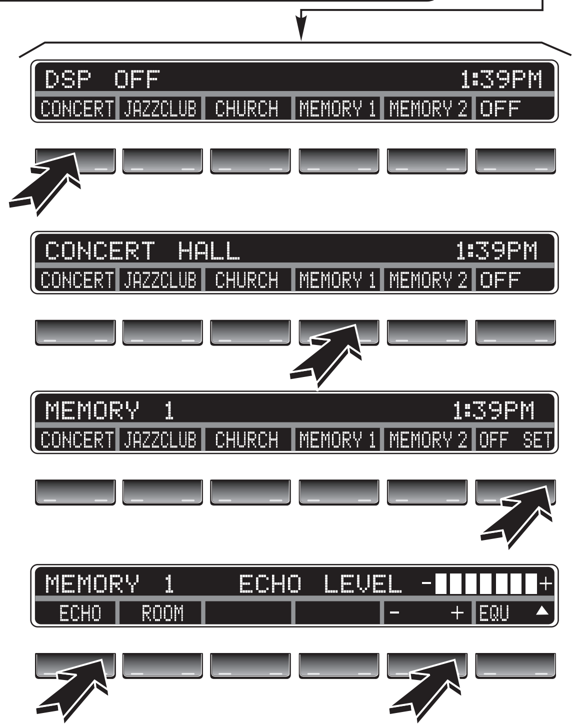
The X5 Audio system consists of:



- **Radio/Tape player** - houses radio electronics, tape player, treble, bass, fader, balance adjustments.

- **MID** - for ON/OFF, volume control, station selection, digital sound processor (DSP) control, etc. If the DSP system is installed, the audio button in the MID has a second position to activate the controls.

  The memory feature of the X5 DSP has two memory positions.



- **Amplifier** - Mounted in the left rear.

  - The standard 200 watt amplifier for the 10 speaker non DSP audio system

  - The optional 12 speaker 440 watt amplifier for the 12 speaker DSP audio system.

- **CD Player** - mounted in left rear if installed.

- **MFL Controls**

RADIO TEST FUNCTION: To activate the test switch the radio on and within 8 seconds press and hold the “m” button for more than 8 seconds. The displayed tests include:

- Radio Serial Number
- Radio Production date
- DSP Recognition (1/0)
- Station signal Strength
- Road speed dependent volume control (GAL 1-4)
- Area Use Control - ECE, US, Canada selections
- AF - Manual or Off (Audio freq.)
- TP-V (Traffic Program Volume)

Adjusting the GAL makes the volume increase more noticeable (4) or less noticeable (1).

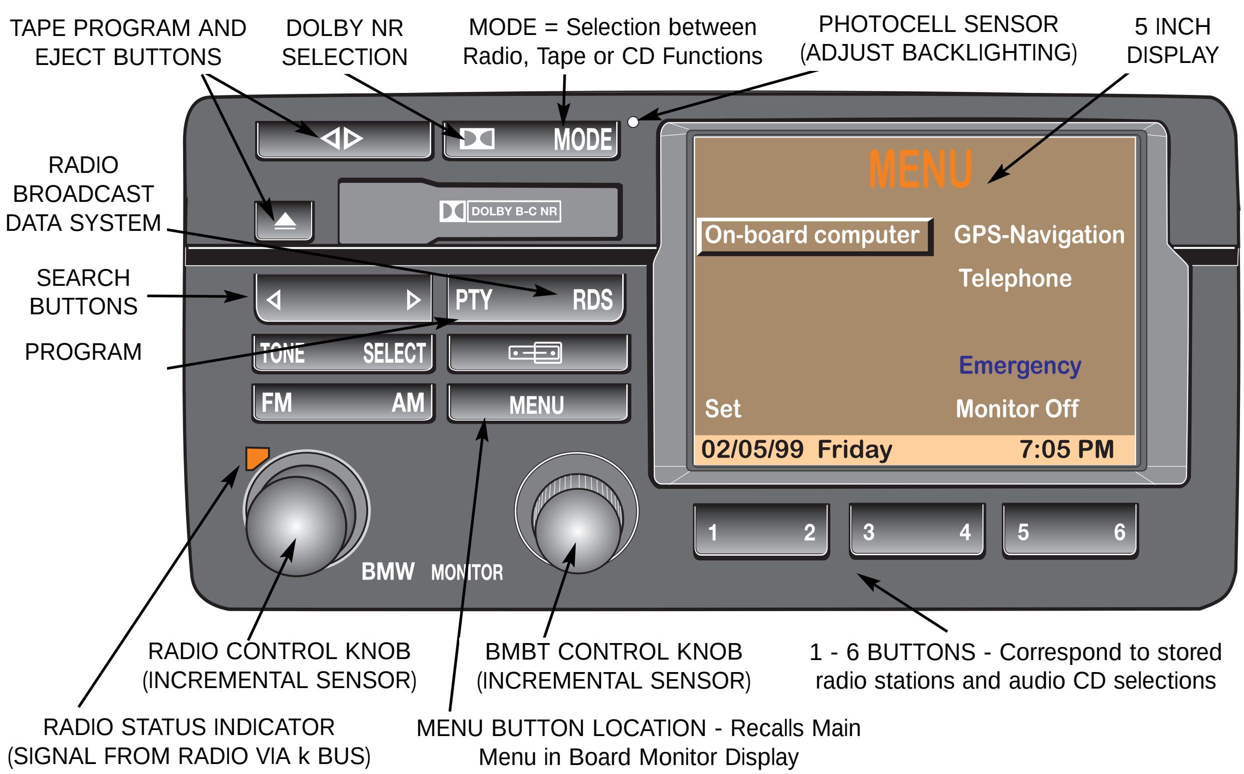
MARK II NAVIGATION SYSTEM

COMPONENT OVERVIEW

The X5 Mark II Navigation System is similar to E38/E39 Mark II. All of the E38/E39 Mark II system components are carried over with the exception of the BMBT:

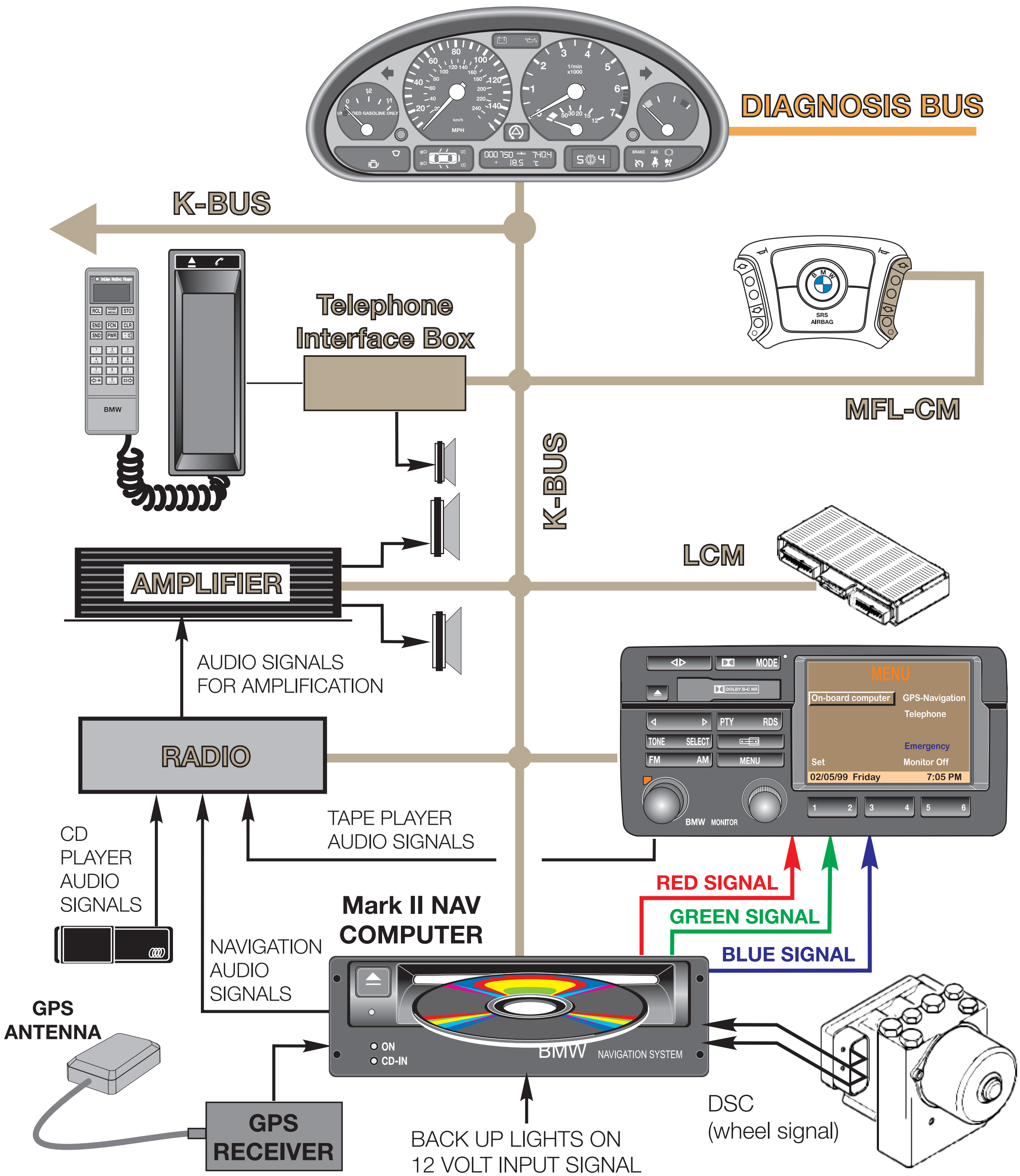
X5 Specific Board Monitor (BMBT):

- 5 inch display (320 X 234 pixel resolution)
- Uses on screen soft keys for telephone send/end functions. E38/E39 uses buttons.
- Control of auxiliary ventilation function
- Provides display and control functions for the Audio System (radio, cassette and CD).
- Provides display and control functions for systems in the menu display.



- **RDS =** Radio Broadcast Data System. In the future, this feature will provide a wide variety of commercial broadcast data as well as traffic and limited weather information as a text display in the radio or Board Monitor display.

- **PTY =** The RDS system also includes the PTY feature whic stands for “Program Type”. PTY indicates the type of music being broadcast. This is helpful for organizing favorite station programming. Complete RDS functionality requires a cooperative effort on the part of the radio stations to provide this service. There are approximately 700 FM Radio Stations in the United States currently transmitting messages via RDS.



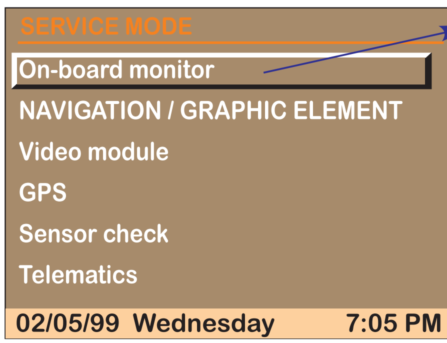
The BMBT communicates with interfacing control modules via the I Bus. As with all previous Original Equipment Navigation Systems, the radio electronics are installed in the trunk. The BMBT sends and receives operation instructions to the radio via bus communication. The Mark II Nav computer continues to provide the RGB output signals to the BMBT for system function display.

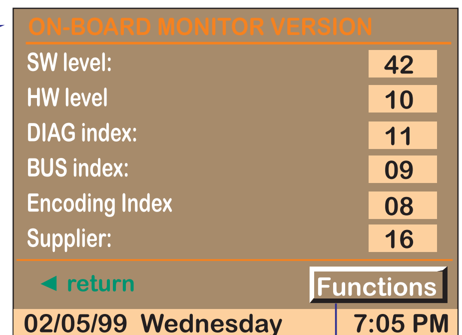
X5 BOARD MONITOR & NAVIGATION SERVICE MODE DISPLAYS

The Mark II system provides a service mode display function. These screens provide system hardware/software identification numbers and status of Board Monitor and Navigation specific functions for use as a diagnostic tool. The screens are accessed as follows:

- From the Main Menu select “Set”.
- Once in the Set function, press and hold the menu button for 8 seconds.
- The next screen to appear is the SERVICE MODE menu.

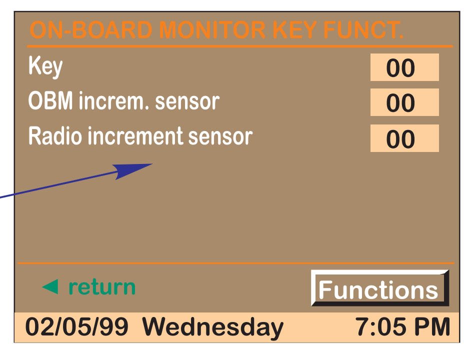
The first accessible function is “On-board monitor”.   Pressing this selection calls up the version screen which provides identification of hardware/ software specific index versions for the installed system.

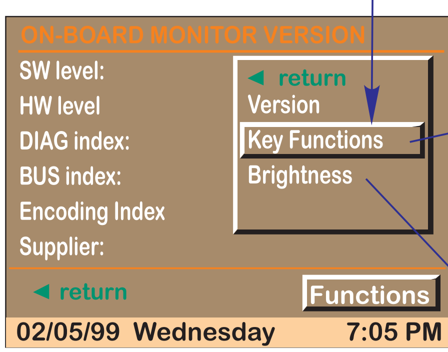




Pressing the functions key at the bottom continues into additional screens including the Key Functions and Brightness controls.

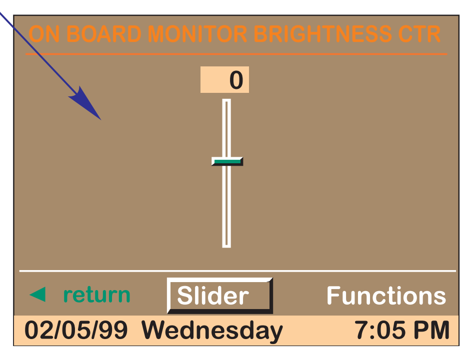
Key Functions tests the key input on the BMBT. Input status (1-25) will display in the window.





If no keys are pressed the status will be displayed as “FF”.

Rotating the left or right rotary knob displays hex code input status.



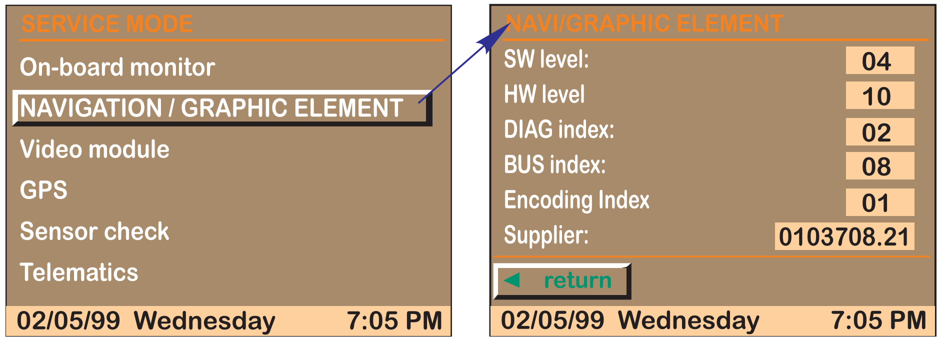
Rotated slowly, the display changes with each increment. The display eventually stops at “1F” in the left rotated direction and “E0” to the right.

The key function test terminates automatically if no keys or knobs are moved after a short duration (“00”).

The brightness control allows the display illumination to be manually adjusted.

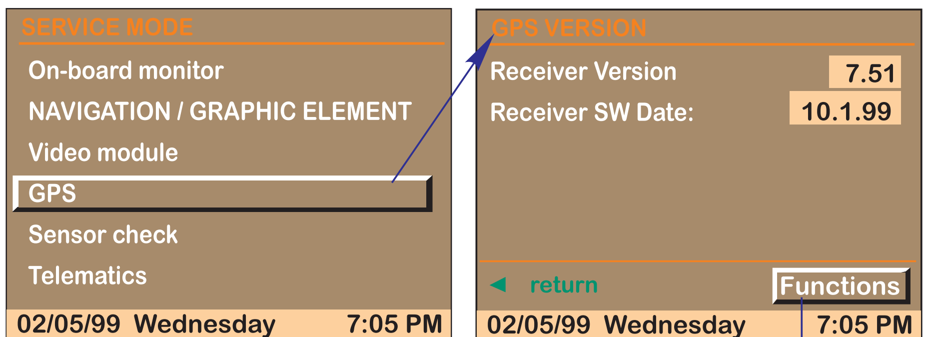
The next accessible function is the NAVI/GRAPHIC ELEMENT.

This screen identifies hardware/ software specific index versions for the installed system.



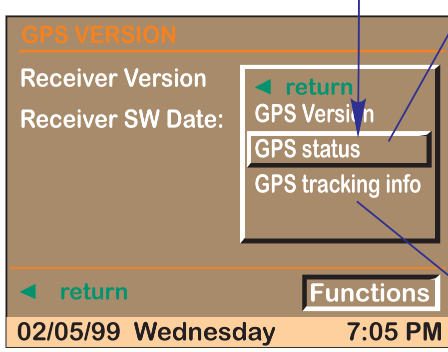
The Video module selection is not functional since the US version Mark II nav system does not utilize the video module.

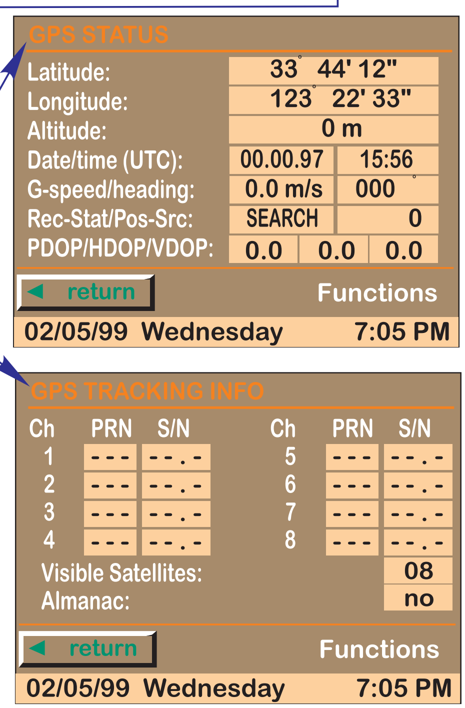
The next available selection from the service mode menu is “GPS”.



This display provides the GPS receiver module hardware version number and date of programmed software.

Pressing the functions button in the lower right corner of this screen provides a sub-selection menu.



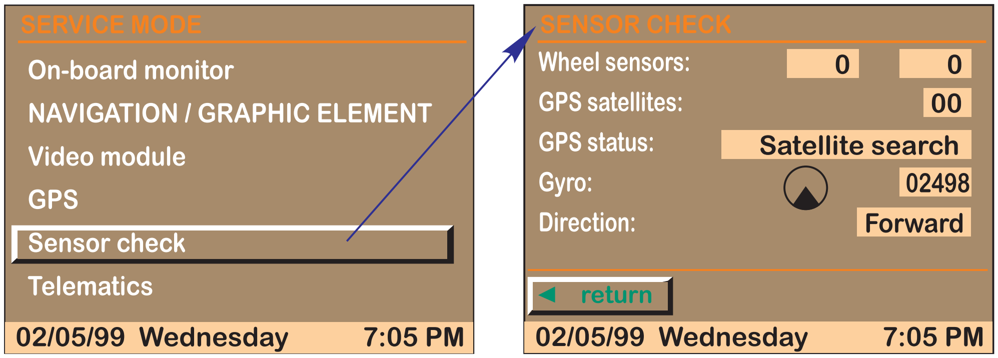


GPS Status provides information on the exact coordinates of the vehicle based on the calculations of the GPS receiver module.

GPS Tracking provides information about the individual satellites currently sending signals to the GPS receiver module. Though interesting, this display provides data which is not usable for BMW service

The next selection available from the SERVICE MODE menu is “Sensor check” which provides:

- Wheel speed input (only one wheel speed signal, displayed).
- Number of satellites detected.



- What mode the GPS receiver module is currently in; (ie: Search)
- The Gyro status provides the millivoltage value the Nav computer is utilizing for the current vehicle position. This area also includes an icon representing what direction the vehicle is heading in.
- The direction status indicates what gear is selected (forward or reverse).

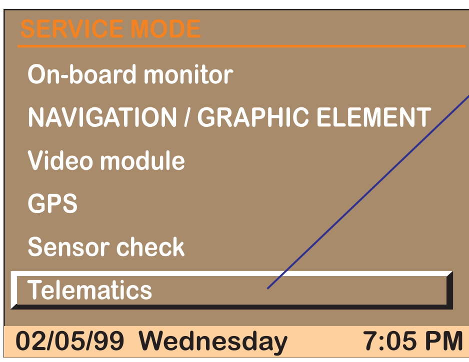
The Sensor check display is intended to be used while test driving the vehicle. Use the legend below to compare with the display status.

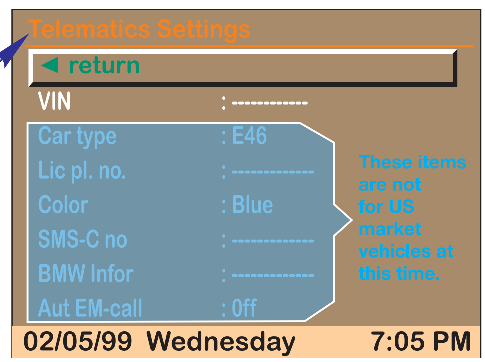
STATUS DISPLAY	WHAT SHOULD BE DISPLAYED	WHAT TO DO IF NOT OK
Wheel Sensors:	As the vehicle is driven, the number should increase with an increase in vehicle speed.	Check fault codes in ASC/DSC system. If necessary carry out wheel speed sensor test.
GPS Satellites:	With unobstructed upward view of sky the display should be > 3	Check for interference of signals to GPS antenna, Check integrity of circuit from GPS receiver module and Nav computer
GPS Status:	“See Legend on next page”	
Gyro:	Direction icon moves with vehicle turning movement. Milli voltage display value should be approx 2500 mV (+/- 400mV) when the vehicle is stationary or driven straight ahead. When the vehicle is turning, the value must rise or fall which indicates the gyro sensor is detecting yaw.	Replace Navigation computer.
Direction:	Reverse is displayed when range selector is in reverse. Forward in any other range.	Check back up light signal input.

GPS Status Text Display	Description
1. “GPS fault”	Problem with GPS system. Swap GPS receiver module and or antenna from know good vehicle after checking GPS status display information described on page 153 .
2. “Reception Interference”	Problem with GPS system. Same as above.
3. “No Almanac”	No Data yet stored from satellites. The GPS almanac is a memory account of received satellite signals. If the vehicle battery has been disconnected or after replacing a GPS receiver module it has an empty memory and requires satellite signals to become functional. After the receiver module receives battery voltage and ground, it must be left outside with an unobstructed sky above with the ignition switched to KL R for approximatly 15 minutes.
4. “Satellite search”	GPS is currently searching for satellite signals.
5. “Satellite contact”	At least one satellite is found
6. “Position known”	Vehicle’s Latitude and Longitude known. Navigation is possible.

The last selection available is the **Telematics** entry display. This replaces the “VIN” selection from the E38/E39 Mark II systems. The only requirement of this entry screen is that the VIN is entered at the VPC when prepped prior to distribution.

This is necessary for the Emergency program if needed when calling the Cross Country Group Roadside Assistance Program.





Additionally, if the vehicle is equipped with a Phase V phone the system will automatically utilize the entered VIN as per E38/E39 Mark II systems.

The VIN is entered at the VPC for all vehicles (with or without a Phase V phone). If the VIN has been incorrectly entered it can be changed by turning and pressing the rotary knob when the correct letter or digit of the last seven character of the VIN is displayed.

The balance of the data displayed below the VIN entry is not currently used in the

TABLE OF CONTENTS

INTRODUCTION

The Central Body Electronics (ZKE III) equipped on the X5 includes the following sub-systems under the total scope of its control:

- Windshield/tailgate wiping/washing, including windshield rain sensor (AIC).
- Interior lighting
- Central locking
- Keyless entry
- Tailgate release
- Power windows/Sunroof
- DWA alarm system
- Mirror - adjustment/memory/heating
- Seat adjustment/memory
- Steering column adjustment/memory
- Consumer cut-off/sleep mode

The following is an overview of new or changed features found on the X5 ZKE III variant.

- Passenger's door module is now incorporated into the passenger's door switchblock module.

- Sunroof module (SHD) located on the K bus.

- The Central Locking system uses a new style door lock actuator with hall effect sensors similar to E46.

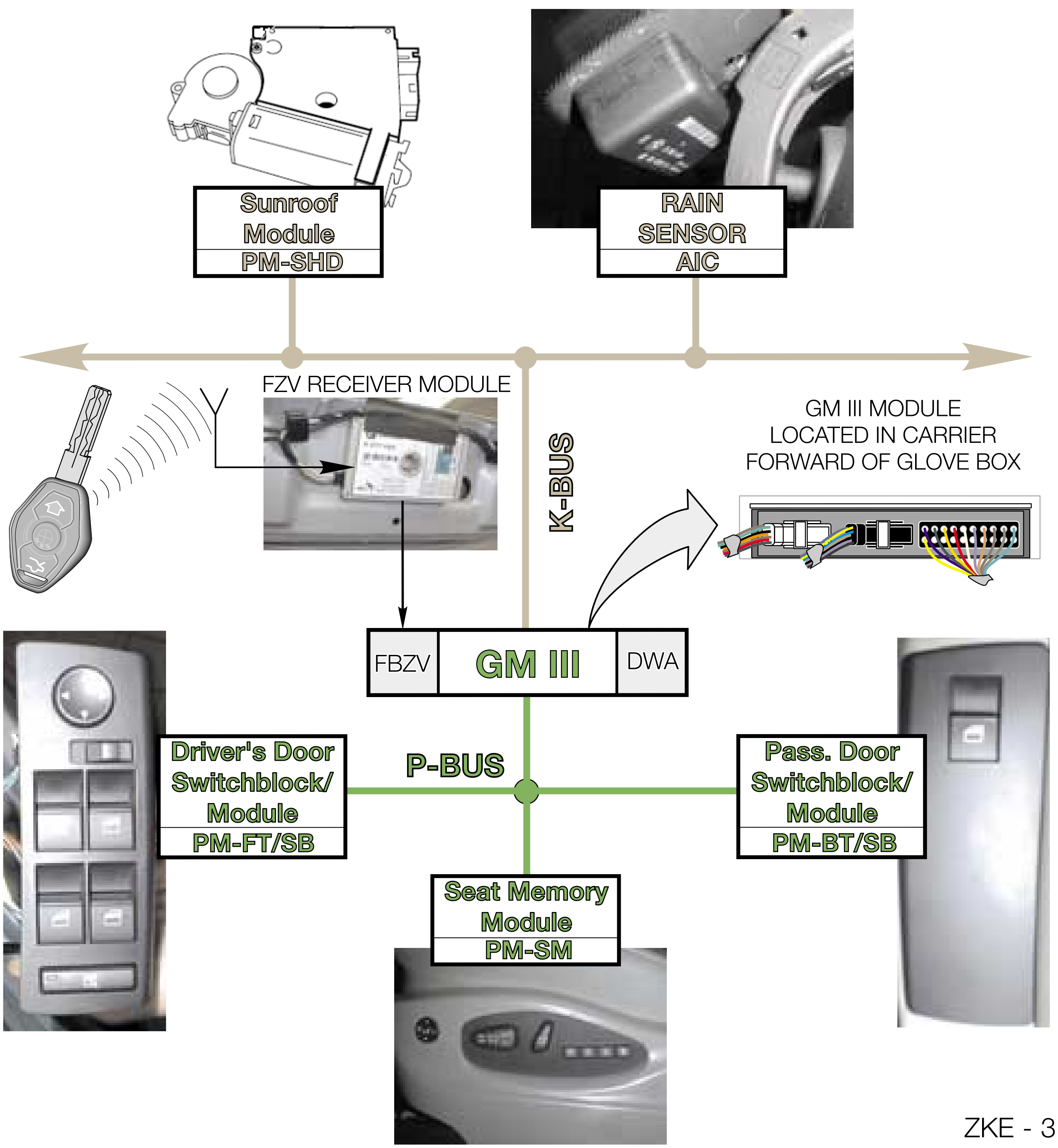
- The GM III is responsible for the Key Memory feature. It provides the added convenience of identifying users of the vehicle. Whenever the vehicle is locked or unlocked via the FZV keyless entry system, a unique key identification signal (key number) is transmitted to the General Module.

  The key identification signal alerts the GM to communicate with other control systems over the K Bus to store (when locked) or reset (when unlocked) certain driver adjustable settings for the driver using the specific key. The GM also resets certain driver adjustable settings that it controls directly.

The X5 ZKE III system continues to be a modular system consisting of the following:

- **General Module III;** main controller for ZKE functions
- **PM - FT/SB;** Driver's door switch block and door module
- **PM - BT/SB;** Passenger's door module
- **PM - SHD;** Sunroof module
- **PM - SM;** Seat/Mirror/ Steering Column memory module
- **AIC;** Rain Sensor

All of these modules communicate over the K-Bus and P-Bus for signaling purposes and diagnosis. The ZKE III continues to utilize power transistors for final stage output control.

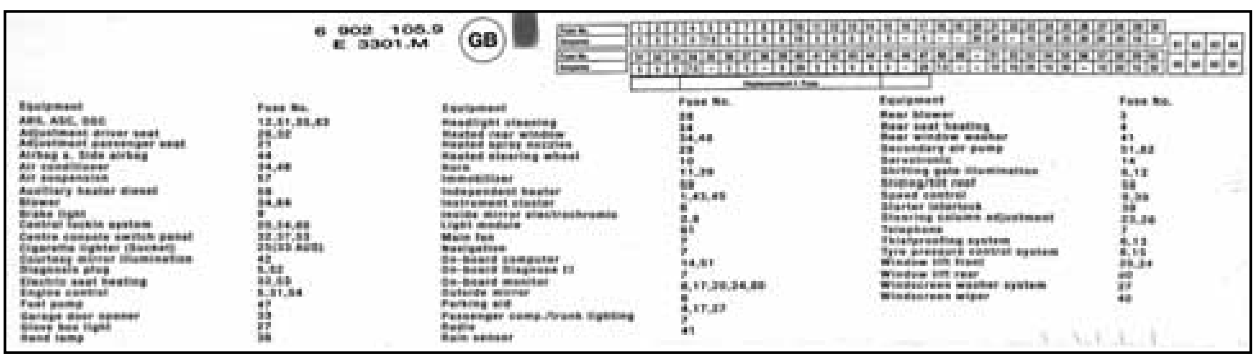


POWER DISTRIBUTION

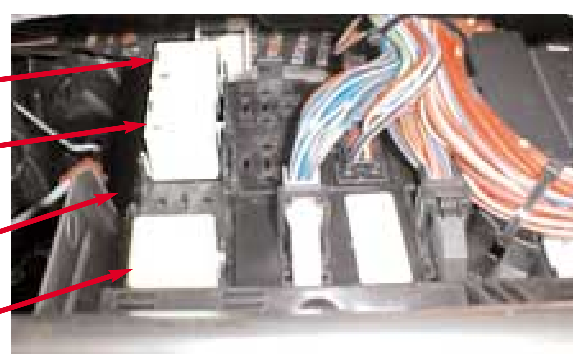
The X5 utilizes a single high amperage fused power distribution center located to the left EHC air reservoir beneath the cargo area floor.

The main fuse box is located inside the glove box above a hinged panel. This places the power distribution close to the main electronics carrier behind the glove box.

The glove box mounted fuse box includes fuses 1 - 64.



Mounted on the top surface of the fuse panel are the following relays:



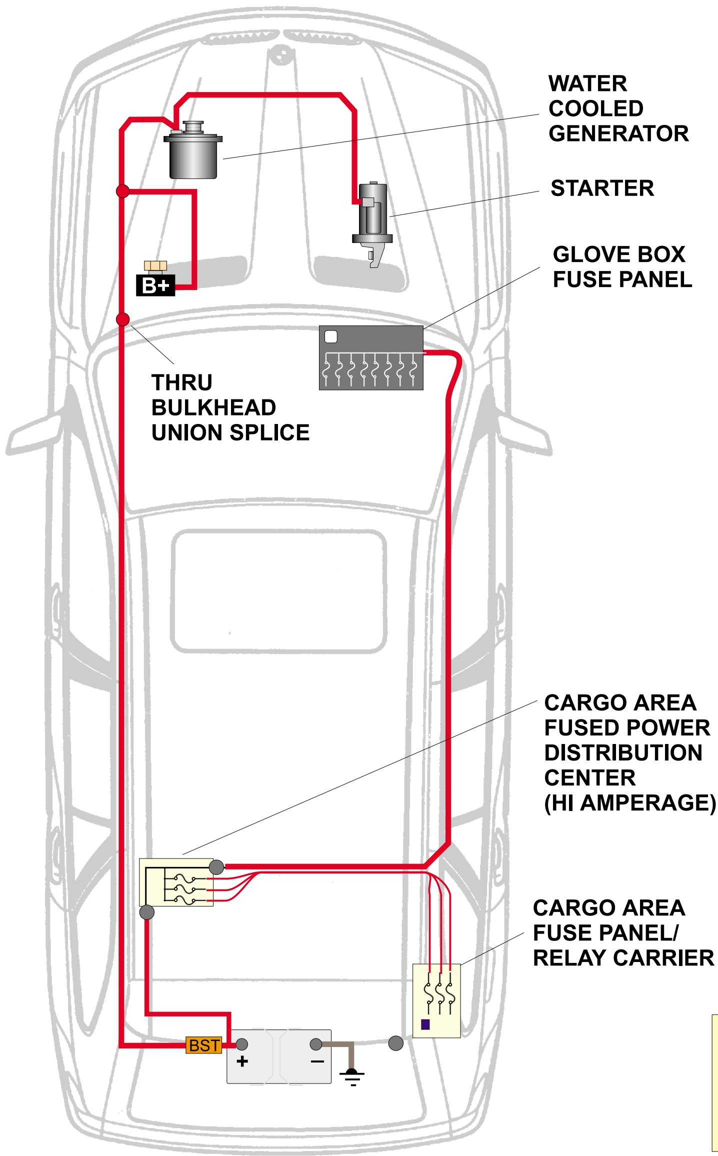
FUEL PUMP

HEATED STEERING WHEEL

VISUAL ENTRY AID RELAY MODULE
(OPTIONAL - REFER TO 1999 MODEL UPDATE)
NOT SHOWN IN THIS PHOTO

HORN

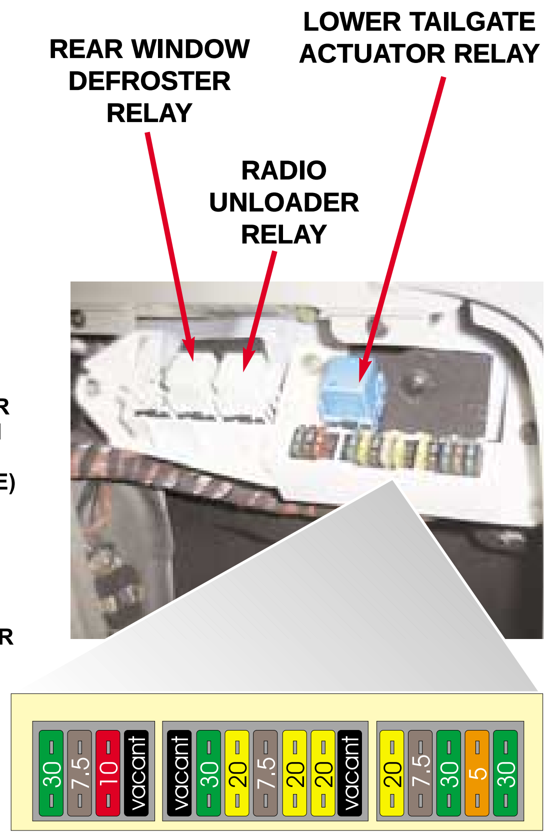
This view shown through passenger side airbag opening in dash panel.



An additional fuse panel is located in an electrical carrier located at the right rear of the cargo area.

The panel contains fuses 72 - 87.

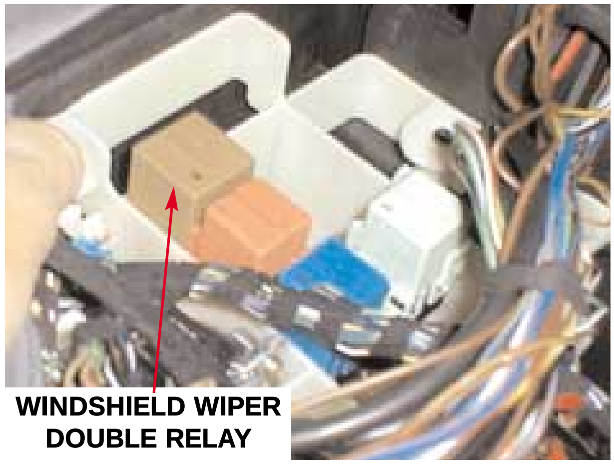
The carrier also contains the following relays



Equipment	Fuse(s)
Air suspension (EHC)	78, 87
Cargo Compartment Power Sockets	83
CD Changer	72
Central Locking in Tailgate	84
Central Locking FZV module	86
Heated Rear Window	85
Nav System	72, 73
On Board Monitor	7, 72, 73
Radio	7, 72, 73
Rear Seat Back Adjustment	77
Rear Washer Pump	81
Telephone	7, 73, 74
Trailer Socket	78

WINDSHIELD WIPING/WASHING

- The GM III controls all of the windshield wiping/washer and headlight washing functions.
- Output control of the wiper motor is through the windshield wiper double contact relay. The relay is located in the engine compartment E-box and is tan in color.
- The system continues to have four wiping stages and four interval wiping speeds. The wiping stage inputs are coded signals through a two wire link with a combination of high/low inputs as on previous systems.



WINDSHIELD WIPER DOUBLE RELAY

- The Windshield Wiping System can also be supplemented with the Rain Sensor system as optional equipment. The Rain Sensor detects rain drops on the windshield and automatically activates the wipers when the stalk switch is in the intermittent position.

Wiper Stalk Switch:

SINGLE: Holding the wiper switch down in the single position provides a ground signal to activate the slow speed circuit providing wiper operation until the switch is released.

INTERMITTENT: The intermittent wiping time inputs are provided by a potentiometer mounted in the wiper stalk switch.

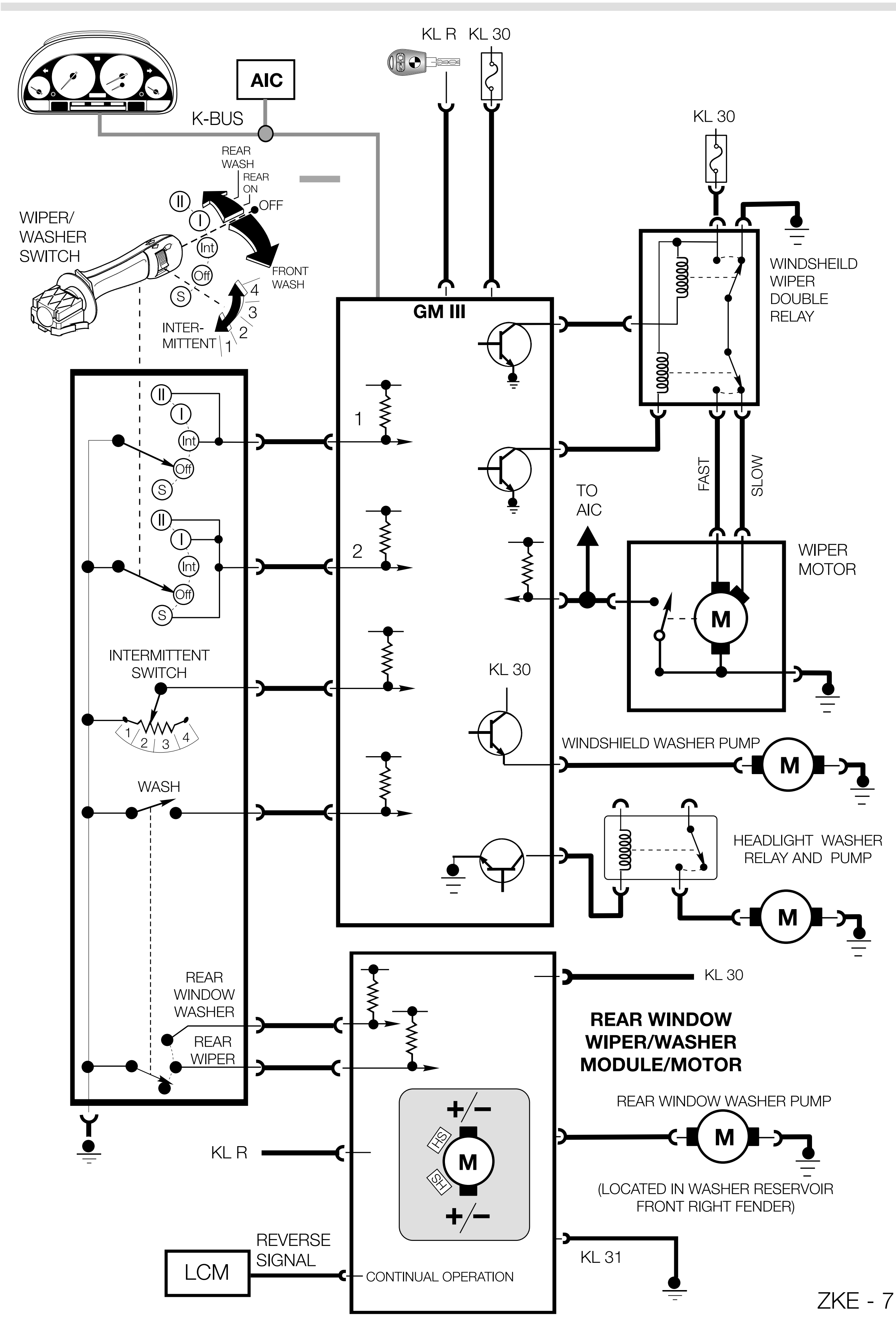
- The intermittent wiping intervals are dependent on the road speed.
- As road speed increases, the wiping interval delay is decreased.

WIPER TIME DELAYS (SECONDS) BASED ON SET POSITIONS 1 - 4

THUMB WHEEL POSITION	VEHICLE SPEED IN MPH					
	< 4	5 - 22	23 - 45	46 - 60	61 - 87	> 87
1	26	19	17	15	15	13
2	17	12	11	10	9	7
3	10	6	6	5	4	3
4	5	3	3	2	2	2

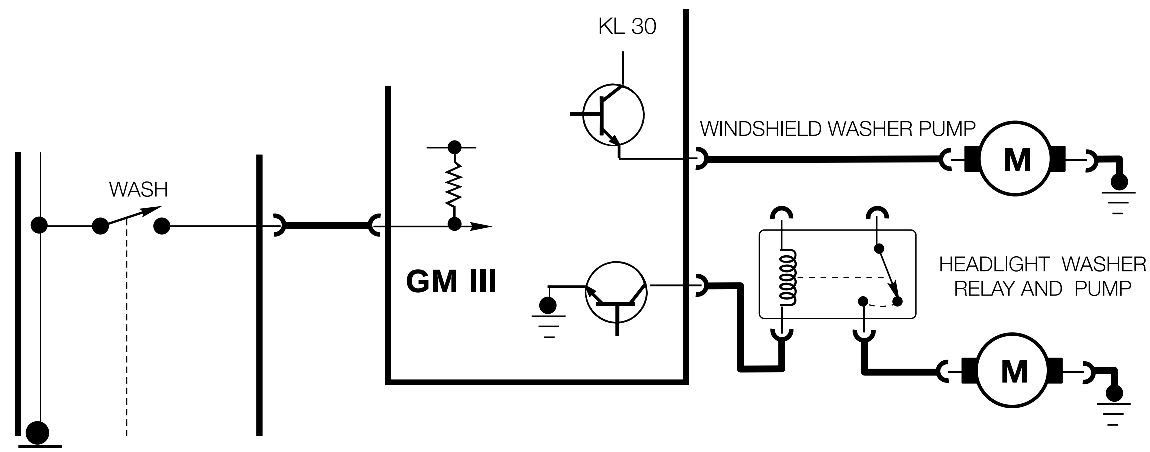
SLOW (I) AND FAST (II): The stage I and stage II wiping speeds are also affected by road speed. The factory encoded settings are the same as previous systems:

- Stage I automatically switches to intermittent when the vehicle is stopped
- Stage II switches to stage I when stopped.


KL R
KL 30
AIC
K-BUS
KL 30
REAR WASH
REAR ON
OFF
WIPER/ WASHER SWITCH
II
I
Int
Off
S
FRONT WASH
4
3
2
1
INTER- MITTENT
GM III
WINDSHEILD WIPER DOUBLE RELAY
FAST
SLOW
TO AIC
WIPER MOTOR
M
INTERMITTENT SWITCH
KL 30
WINDSHIELD WASHER PUMP
WASH
HEADLIGHT WASHER RELAY AND PUMP
KL 30
REAR WINDOW WASHER
REAR WIPER
REAR WINDOW WIPER/WASHER MODULE/MOTOR
REAR WINDOW WASHER PUMP
KL R
HS
SH
+/−
(LOCATED IN WASHER RESERVOIR FRONT RIGHT FENDER)
REVERSE SIGNAL
LCM
CONTINUAL OPERATION
KL 31

WINDSHIELD WASHING:

Pulling the Windshield Wiper Switch rearward closes the "wash" contact providing a switched ground input to the GM. The GM activates the windshield washer pump directly via a power output final stage transistor.



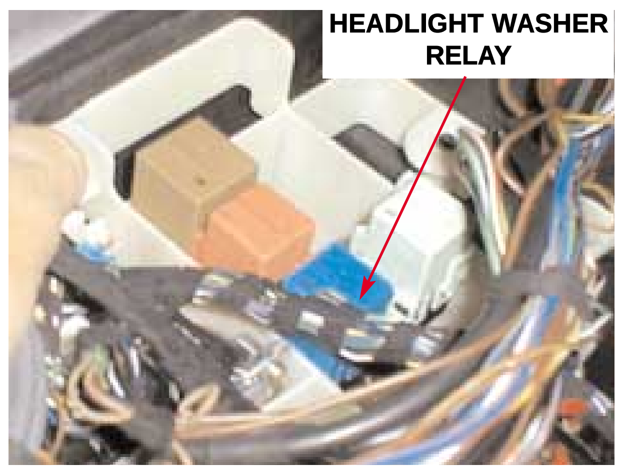
HEADLIGHT WASHING:

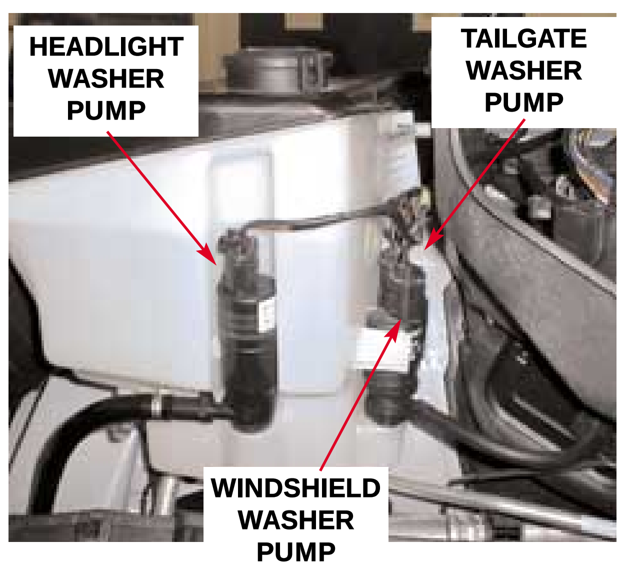
When the headlights are on, the headlight washer pump is activated with the first activation of the windshield washer pump. The GM recognizes headlights on via K bus signalling.

Within the same "on" cycle (ignition key has not been switched off), it is only activated again after five successive windshield washer cycles.

The GM provides a ground on the headlight washer relay control circuit providing pump operation. The relay is located in the e-box.

The X5 uses three separate washer pumps which are all easily accessible on the 5.3 liter washer fluid reservoir located in the engine compartment.





REAR WINDOW WIPER/WASHER SYSTEM

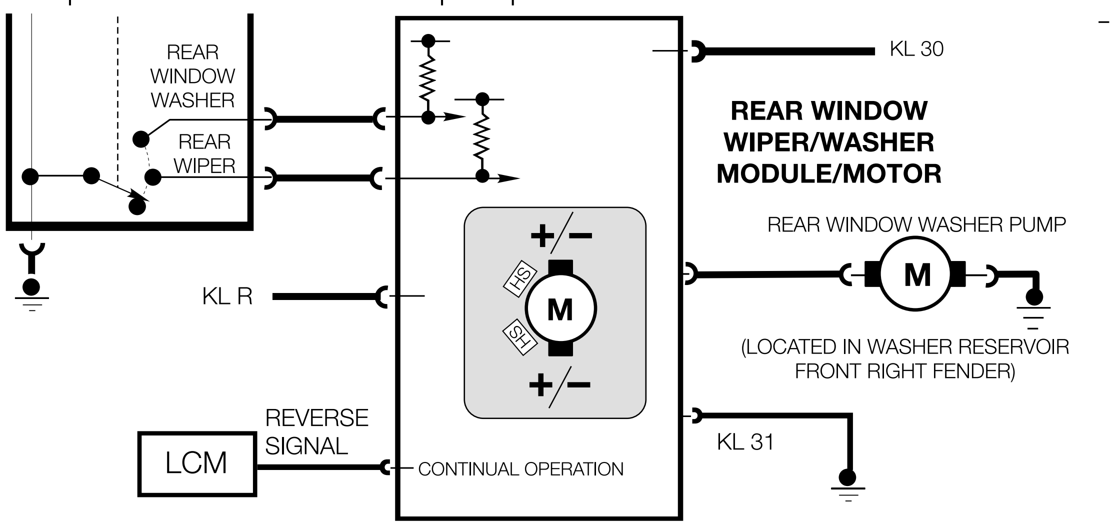
The tailgate window wiper/washer system is included in the scope of ZKE however is not controlled directly by the GM. The control electronics are integrated into the rear wiper motor assembly. It contains two hall sensors, one for monitoring park position and other for the end stop, or to signal reverse direction of the wiper motor.

The rear wiper system is operator controlled through the wiper stalk switch providing the following functions:

- Intermittent rear window wiping
- Programmed rear window wiping interval
- Operation of the rear window washer

Pressing the wiper stalk forward to the first detent activates the rear wiper in the intermittent mode.

The default timed interval is approximately 12 seconds. The full sweep and park positions are recognized by the two hall sensors on the motor gear assembly. If the wiper is switched OFF, the wiper blade will return to the park position.



The programmed wiper interval procedure is identical to the E39 sport wagon; Briefly switch the rear wiper ON/OFF, Wait the desired interval time, Switch the rear wiper ON again. The OFF time will be the programmed interval - up to approx. 30 seconds

Rear window washing is activated by pressing the wiper stalk switch to the full forward position. The washer pump operates followed by two full wiping cycles. The wipers will then switch to the intermittent wiping mode.

When the transmission is shifted into reverse, the wiper will switch to continuous operation until the vehicle is shifted out of reverse. This high signal is provided by the LCM III when it activates the back up lights.

OPTIONAL RAIN SENSOR (AIC)

The Windshield Wiping System will also be available with an optionally equipped Rain Sensor. The Rain Sensor provides added driver convenience and enhances safety by automatically activating the intermittent function of the windshield wipers when water droplets are detected on the windshield.

COMPONENTS:

The rain sensor unit is mounted on the top center area of the interior windshield surface directly behind the rear view mirror. The unit contains:

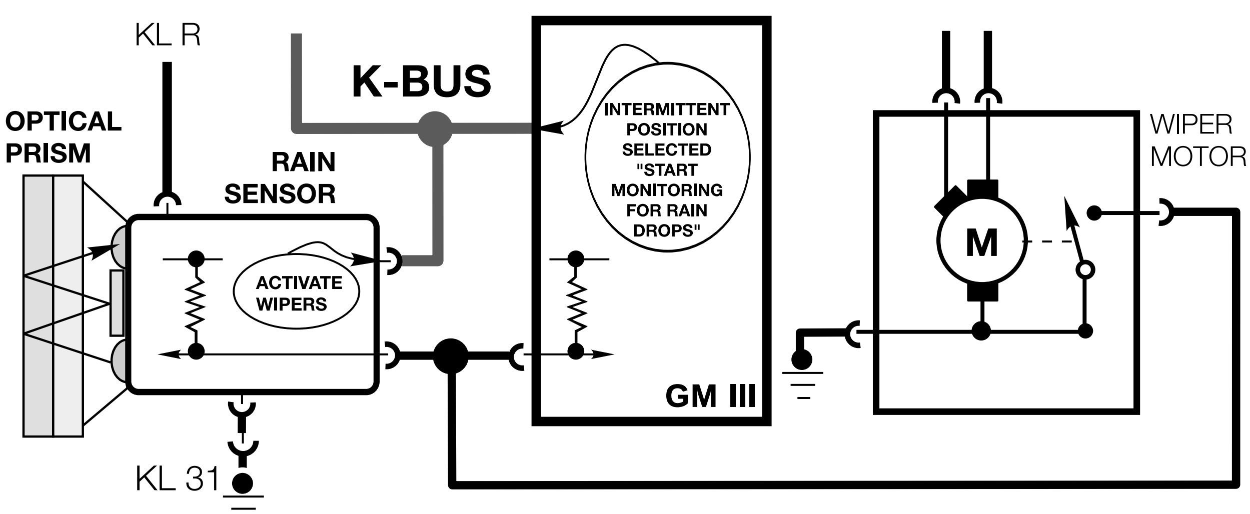
- **Optical Prism Body:** This portion of the unit is permanently fixed to the windshield. It can not be removed and can only be replaced with a replacement windshield.

  The prism body has a reflective surface that faces the back of the windshield. The prism body also acts as the windshield mount for the Rain Sensor Control Module.

- **Rain Sensor Control Module:** The control module incorporates the following;

  - Infra Red Emitter and Detector Diodes
  - Optics heater (prevents condensation from forming on diodes and prism)
  - Optics evaluation and control electronics
  - Photo cell to detect night time driving

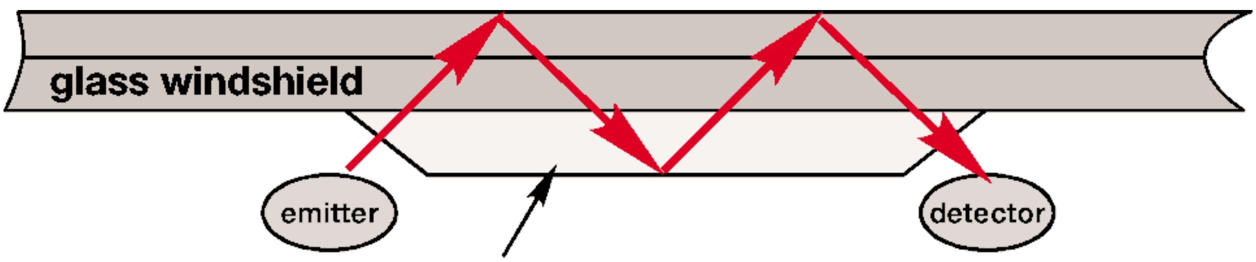
  The control module requires four signals for operation; KL R, KL 31, Windshield Wiper Motor Park Signal Feedback and K Bus interface.



THEORY OF OPERATION:

The optical infra red portion of the sensor operates by the principle of refraction (bending of a light ray). The rain sensor control module activates the emitter diode which sends a beam of infra red light through the windshield on an angle. The set angle is important because it provides the beam with a calculated reflective path back to the detector diode.

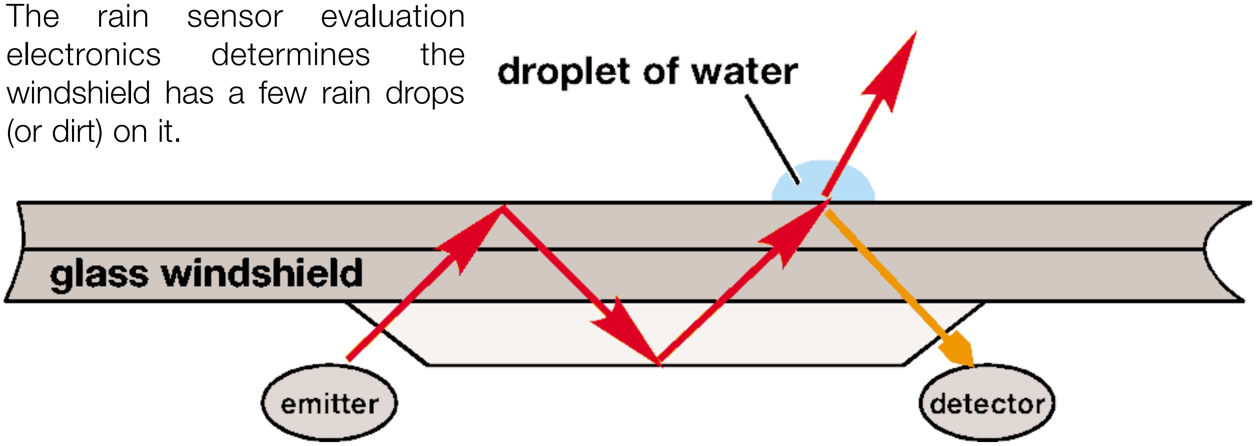
The beam is reflected back into the windshield due to the density difference of the glass compared with the ambient air on the outside surface of the glass. When the windshield is clean (no rain drops, moisture or dirt) the detector diode receives 100% of the infra red light that the was sent by the emitter. With this condition, the rain sensor evaluation electronics determines the windshield is free of rain drops.



RAIN SENSOR PRISM OPTICS

The density of water is closer to that of glass than air. When rain starts to accumulate in the sensor monitoring area, it causes part of the infra red beam to extend past the outside surface of the glass and into the rain drop. When this occurs, the beam is refracted and only part of the beam returns to the detector diode.

The rain sensor evaluation electronics determines the windshield has a few rain drops (or dirt) on it.



The intensity of the returned infra red beam diminishes proportionally with an increase of water droplets. The rain sensor control module generates a signal proportionate to the amount of rain on the windshield and broadcasts it to the GM III via the K bus.

The GM III activates the intermittent wipe cycle if the windshield wiper stalk switch is in the intermittent position. It also adjusts the frequency of wiping the windshield depending on the four position thumb wheel.

RAIN SENSOR FUNCTION:

The rain sensor is online as soon as it receives KL R operating power.

- When the windshield wiper stalk switch is placed in the intermittent position the GM signals the rain sensor control module via the K Bus of the request for intermittent wiping and the position of the knurled wheel (sensitivity).
- As an acknowledgement, the rain sensor sends a command via the K Bus to activate the wiper motor. If more than 12 seconds pass before the GM receives the acknowledgement, the GM concludes the rain sensor has a defect and operates the intermittent wipe function as a system not equipped with a rain sensor. The wiper intermittent cycling is based solely on the knurled wheel setting.
- The rain sensor continuously monitors the windshield for rain accumulation and signals the GM to activate the wipers based on the knurled wheel position and how fast the rain accumulates on the windshield.
- The knurled wheel position signal (1-4) via the K bus informs the rain sensor of the selected level of sensitivity.
  - Position 1 (least sensitive) delays the wiper activation signal.
  - Position 4 (most sensitive) sends the wiper activation signal to the GM sooner.
- When the wiper motor park contacts signal the GM of the wiper arm position, the signal is simultaneously sent to the rain sensor as an indication that the windshield has been cleared of water drops and causes the rain sensor to reset the sensitivity delay timer back to 0.
- If night time driving is detected via the integral photocell, the sensitivity to water droplets is increased causing a shorter delay than day time driving.
- Depending on the intensity of the rain the wipers will be operated continuously as if set in the normal wiper stalk switch position regardless of the knurled wheel setting. For this reason, the vehicle speed signal on the K bus is not utilized on rain sensor equipped wiper systems.
- If the ignition switch is turned off with the wiper switch in the intermittent position, the rain sensor will only become active after the ignition is switched back on and one of the following occurs:
  - The stalk switch is moved from the intermittent position and then back.
  - The knurled wheel setting is adjusted.
  - or the wash function is activated.

  The reasoning behind this switching strategy is to have the driver make a conscious decision to activate the system themselves.

RAIN SENSOR CONTROL MODULE ADAPTATION

The rain sensor control module adapts to the optics system environment as follows:

Windshield Aging: As the vehicle ages the possibility of stone chipping in the rain sensors monitoring area may occur which will cause a loss of light in the optics system.

The control module adapts for loss of light based on the intensity of the detected infra red light with a cleared windshield (wiper motor park signal). Therefore, the rain sensors function is not adversely affected due to windshield aging.

Dirty Windows: The rain sensor adaptation reacts less sensitively to a dirty windshield (dirt, road salt, wax residue) after a completed wipe cycle. A dirty windshield has a film on it that diminishes the ability of the infra red to refract into present water droplets. This causes a delay in the rain sensor detection capabilities which lengthens the time intervals on an intermittent wipe.

SERVICE NOTE FOR VEHICLES EQUIPPED WITH THE RAIN SENSOR:

Make sure the wiper blades are in perfect condition. Only use window cleaner to clean the windows. ***Dirty windows can cause the Rain Sensor control module to set a fault due to the end limits of its adaptation abilities.***

WINDSHIELD WIPER SYSTEM FAILSAFE OPERATION

The GM provides failsafe operation of the wiper system if faults are detected with any of the following input signals:

FUNCTION	FAULTED INPUT DETECTED	FAILSAFE FUNCTION
Intermittent wipe	Short or open circuit of the knurled wheel signal	Delay value for setting 3 used.
Intermittent wipe with Rain Sensor	Faulted Rain Sensor or K Bus Signal corrupt	Normal intermittent wipe implemented
Wiper motor not functional moving	Park contact feedback signal takes longer than 16 seconds	Wiper motor control deactivated for 3 minutes

WINDSHIELD WIPER SYSTEM DIAGNOSIS

The GM monitors the circuits of the wiper potentiometer, wiper motor, double relay, the windshield washer pump and terminal 30.

CENTRAL LOCKING

SYSTEM FEATURES:

- The Central Locking system controls the door locks, tailgate locks and Fuel Filler Flap actuators.

- The familiar single/double locking strategy is maintained from previous systems with a **new style door lock mechanism** combined with dual actuator motors similar to that of the E46 ZKE V system.

- The **automatic locking** feature activates the door lock actuators when a road speed signal of 7.5 MPH is detected via the K-Bus. The factory default encoding of this feature is off, but can be encoded on for individual users with the Key Memory function.

- The Driver's door lock location is the only point outside of the vehicle where the key can mechanically control the central locking system functions. The lock incorporates the familiar overrunning lock cylinder that breaks away and freewheels if an attempt is made to destroy the lock with a screwdriver, dent puller, etc.

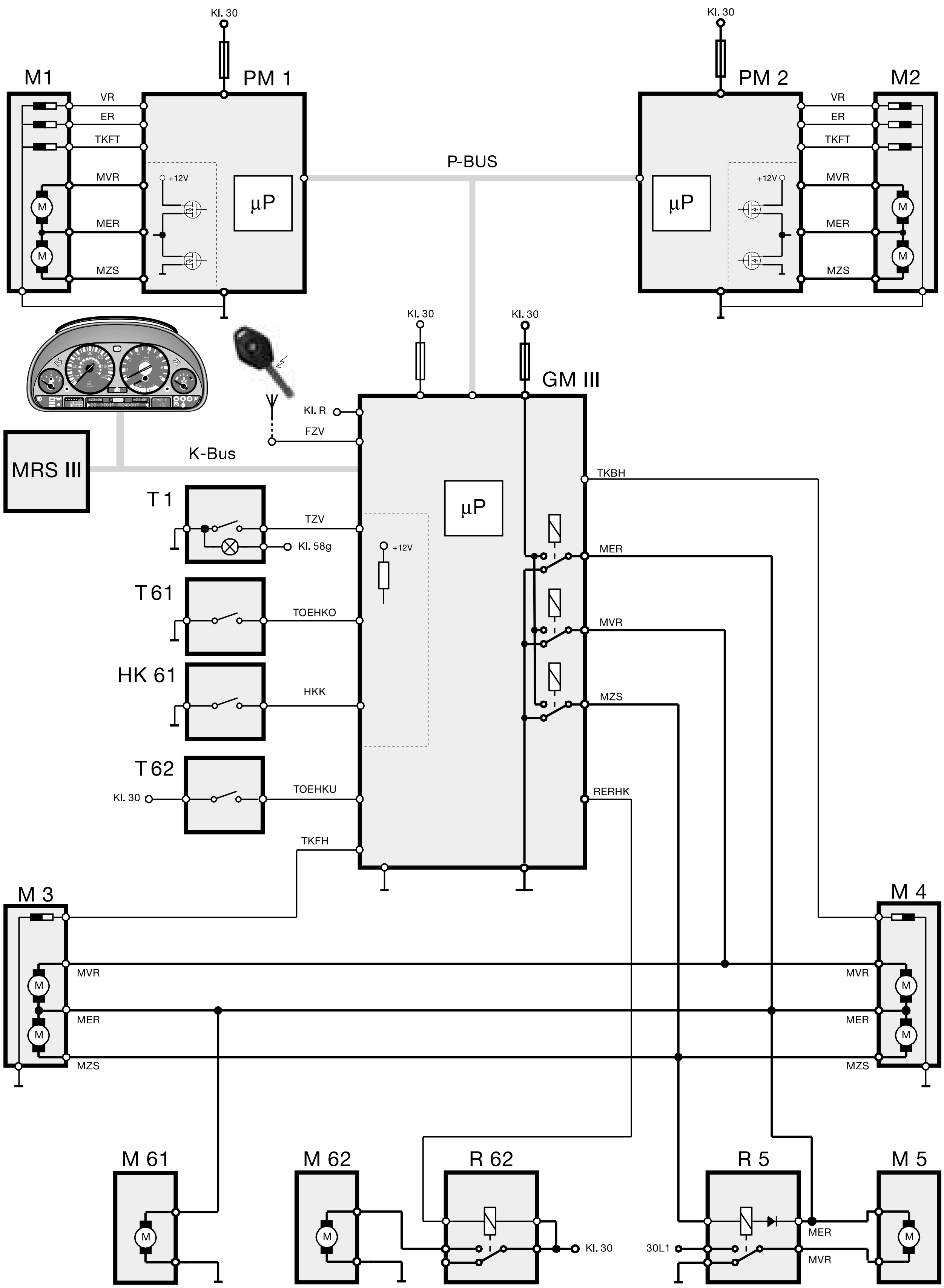
- The selective unlocking feature is maintained. A single unlock request from the driver's door with the key or via the remote transmitter unlocks the driver's door only. A second unlock request unlocks the remaining doors and trunk. This feature can be modified for individual users with the new Key Memory capabilities to activate all lock actuators simultaneously.

- When unlocked, the X5 ***upper*** tailgate can be opened by:

  - the tailgate button in the center console SZM,
  - trunk release switch pad located above the license plate, or
  - the trunk release button on an FZV key.

- With the upper tailgate open, the lower tailgate is then opened by depressing the switch located along it's top edge.

- GM and EWS 3.3 interface via the K bus to monitor double lock status and to initiate double lock override. This feature allows the doors to be opened from the inside if an accepted EWS key is switched on in the ignition when double locked.



Kl. 30
M1
PM 1
VR
ER
TKFT
MVR
MER
MZS
+12V
µP
P-BUS
Kl. 30
PM 2
M2
VR
ER
TKFT
MVR
MER
MZS
+12V
µP
Kl. 30
Kl. 30
GM III
Kl. R
FZV
K-Bus
MRS III
T 1
TZV
Kl. 58g
+12V
µP
TKBH
MER
MVR
MZS
T 61
TOEHKO
HK 61
HKK
T 62
Kl. 30
TOEHKU
RERHK
TKFH
M 3
M 4
MVR
MER
MZS
MVR
MER
MZS
M 61
M 62
R 62
R 5
M 5
Kl. 30
30L1
MER
MVR

DOOR LOCK ACTUATORS

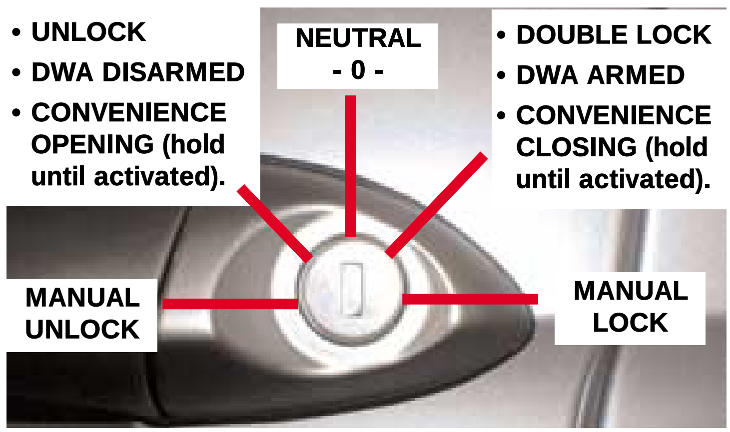
The actuators are sealed, self contained units with no replaceable parts. The door lock actuators use hall effect sensors to provide:

- Door lock key position (driver's door only),
- Door open/closed status.

The driver's door lock provides the following signals to the driver's door switchblock module (PM-FT/SB):

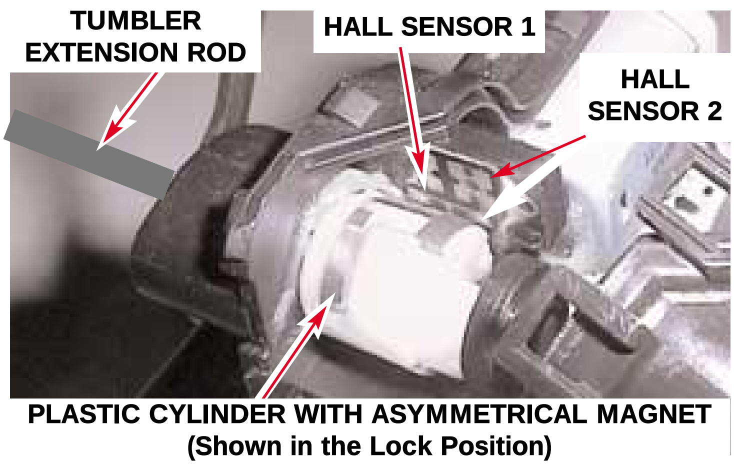
- Lock / Unlock,
- DWA arm/disarm
- Convenience closing and opening signals.

DOOR LOCK POSITION HALL SENSORS



The Drivers door switchblock module monitors these key positions over two wires. The signals are generated by two hall effect sensors (Hall Sensor 1 & 2) located in the actuator.

When the key is turned, a plastic cylinder in the lock actuator is simultaneously rotated by the lock tumbler extension rod.



A magnet is incorporated in the plastic cylinder, which when rotated changes the magnetic influence on the hall sensors.

The presence of a magnet in close proximity to the sensing surface of either hall sensor creates a coded input over the two wires that the GM uses to determine the key position.

- Magnet in front of sensor, current flow through the sensor is <5 mA **(0)**.
- Magnet rotated away from sensor, current flow through the sensor is >12 mA **(1)**.

Hall sensor 1 & 2 are not included in the front passenger door or rear door actuators.

DOOR CONTACT HALL SENSOR

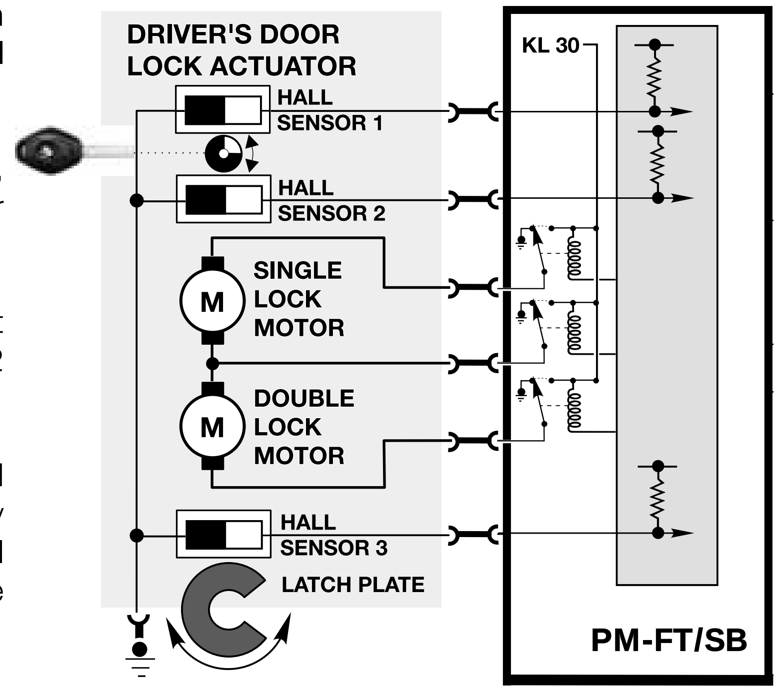
Also included in the driver's door actuator is a third hall effect sensor. This sensor signals the door open/closed status to the driver's door switch block module and to the GM via the P-bus.

The rotary latch plate position activates the door contact hall sensor.

- When the door latch is closed, current flow through the sensor is <5 mA **(0)**.

- When the door is open, current flow through the sensor is >12 mA **(1)**.

The passenger side front door and both rear door lock actuators only include this hall effect sensor (hall sensor 3). Hall sensors 1 & 2 are not required.



ACTUATOR MOTOR CONTROL

There are two motors incorporated in each actuator that provide two separate functions:

- **Single lock/unlock function**. This motor controls the mechanical lock mechanism when the central lock button is pressed to single lock the vehicle. The mechanism is locked at this point but can by opened from the interior by pulling an interior door handle **twice** or by pressing the central lock button again. When single lock function is activated, the fuel filler flap actuator is not locked.

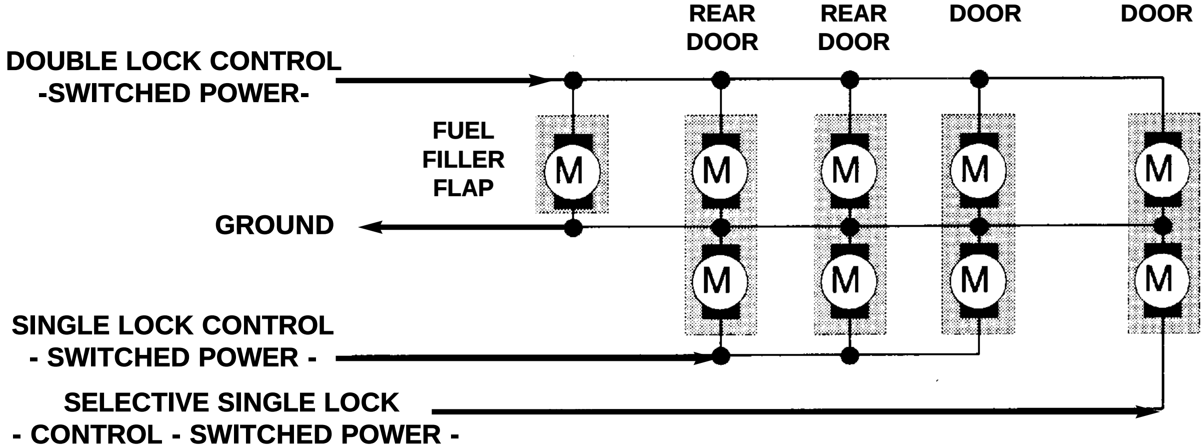
- **Double lock/unlock function**. This motor is activated only when the vehicle is locked from the outside at the driver's door lock with a key or when the GM receives a lock request from the FZV system. In this case the double lock motor is activated simultaneously with the single lock motor. The function of the double lock motor is to mechanically offset an internal rod disabling it from unlocking the vehicle from the interior. This prevents the doors from being unlocked by any means except from an unlock request at the driver's door, the FZV remote key or via central lock button.

- Continuous locking/unlocking will initiate a timed arrest of the locking system. The GM counts each time the locks are actuated. After approximately 12 cycles, the timed arrest is active. The timed arrest is deactivated one actuator cycle for every 8 seconds until the counter is reset to 0. The timed arrest is overridden if a crash signal is received from the MRS III.

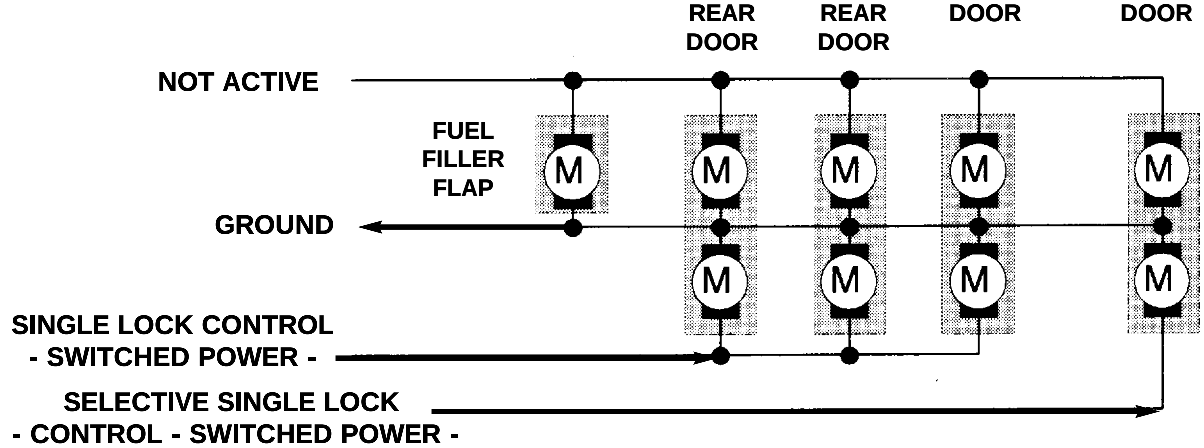
All door lock actuators and the fuel filler flap actuator are controlled directly by the GM via four internal load relays. The drivers door lock actuator has a separate circuit for the selective unlocking feature.

If this feature is disabled by key memory encoding, the driver's door lock actuator selective unlock circuit is activated simultaneously with the balance of the motors during unlock.

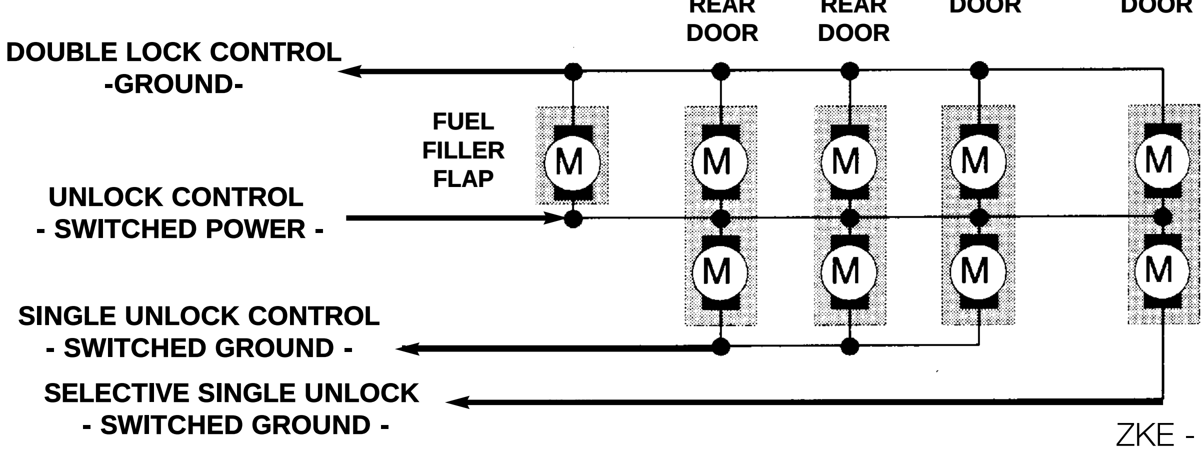
CONTROL DURING DOUBLE LOCK:



CONTROL DURING SINGLE LOCK:



CONTROL DURING SINGLE UNLOCK:

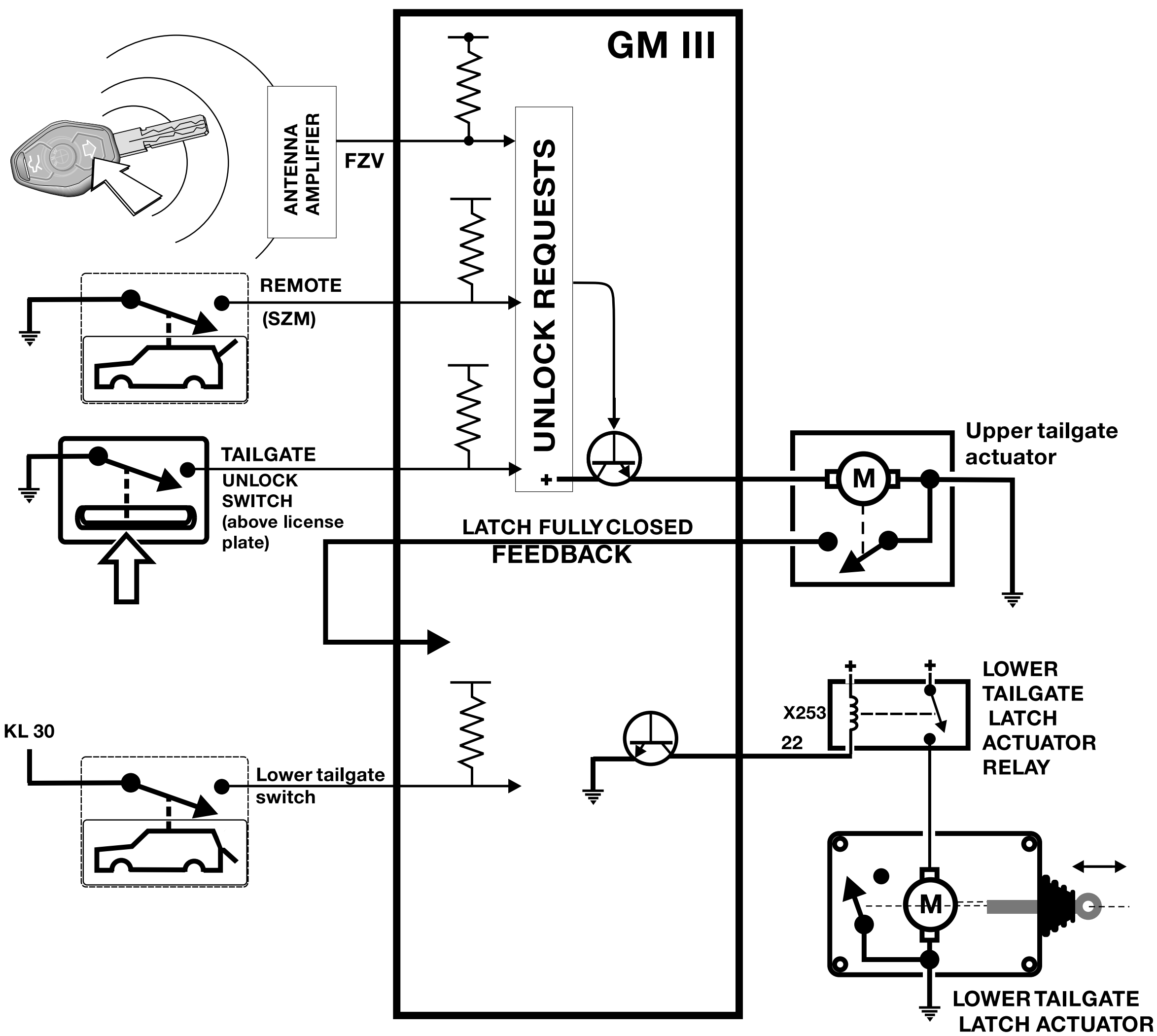


TAILGATE CONTROL

The tailgate can be opened from the following locations:

- Exterior tailgate switch pad above the license plate
- Interior remote tailgate button
- FZV radio key

The remote tailgate button is locked out when the GM detects a vehicle speed signal > 4 MPH via the K-bus. The switch has been incorporated into the SZM.



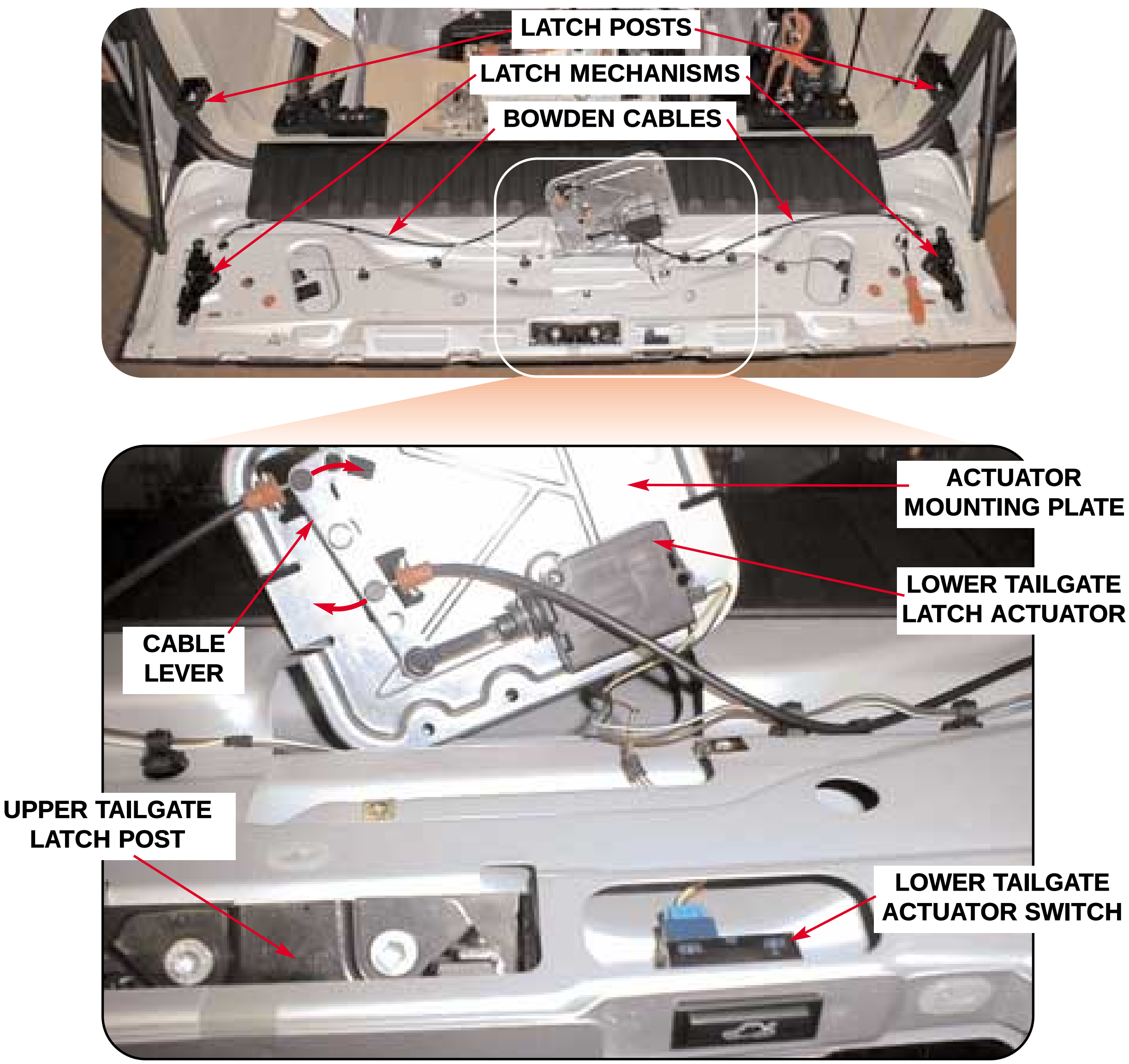
TAILGATE LOCK ACTUATORS

Each tailgate has a separate latching/actuator system. The upper tailgate actuator must first be activated open before the lower tailgate actuator can be operated (program logic).

When closed, the tailgate actuator position switch provides a ground signal to the GM signifying a "closed tailgate". This switch also serves as the tailgate open signal to automatically switch the interior lights on.

The lower tailgate actuator operates a lever which pulls two bowden cables to unlatch the outboard mounted latch mechanisms. The upper and lower latch mechanisms can also be manually unlatched for if electrical malfunction occurs (refer to complete vehicle section).

LOWER TAILGATE COMPONENTS



CENTRAL LOCKING BUTTON

The central lock button in the center console provides a momentary ground input signal to the GM.

- This input initiates a single lock for each door and the trunk.
- The fuel filler flap remains unlocked for refueling purposes.
- If a door is manually opened while centrally locked, the remaining doors stay locked.

The opened door can be re-locked when closed by manually locking or pushing the central button twice. This allows the locks of the remaining doors to be re-synchronized again.

As an additional safety feature, the central lock button input also unlocks a double locked system. Pressing the button returns the system to central lock (single) position, allowing the doors to be opened when the interior door handles are opened twice. This feature was also added to other ZKE systems during the 1999 model year.

CRASH SIGNALLING

The Multiple Restraint System (MRS III) provides a switched signal to the GM in the event of an accident. The signal is an output function of the MRS control module and becomes active when MRS determines a crash has occurred.

When active, the GM unlocks the door lock actuators, switches on the interior lights and signals the LCM III via the K bus to activate the hazard warning flashers.

Once the crash signal is active, the GM will not respond to lock requests from the system until the ignition switch is cycled or a front door is opened.

REMOTE RF (KEYLESS) ENTRY

The X5 keyless entry system's operation is carried over from the E38/E39. However, the FZV key has undergone considerable redesign.

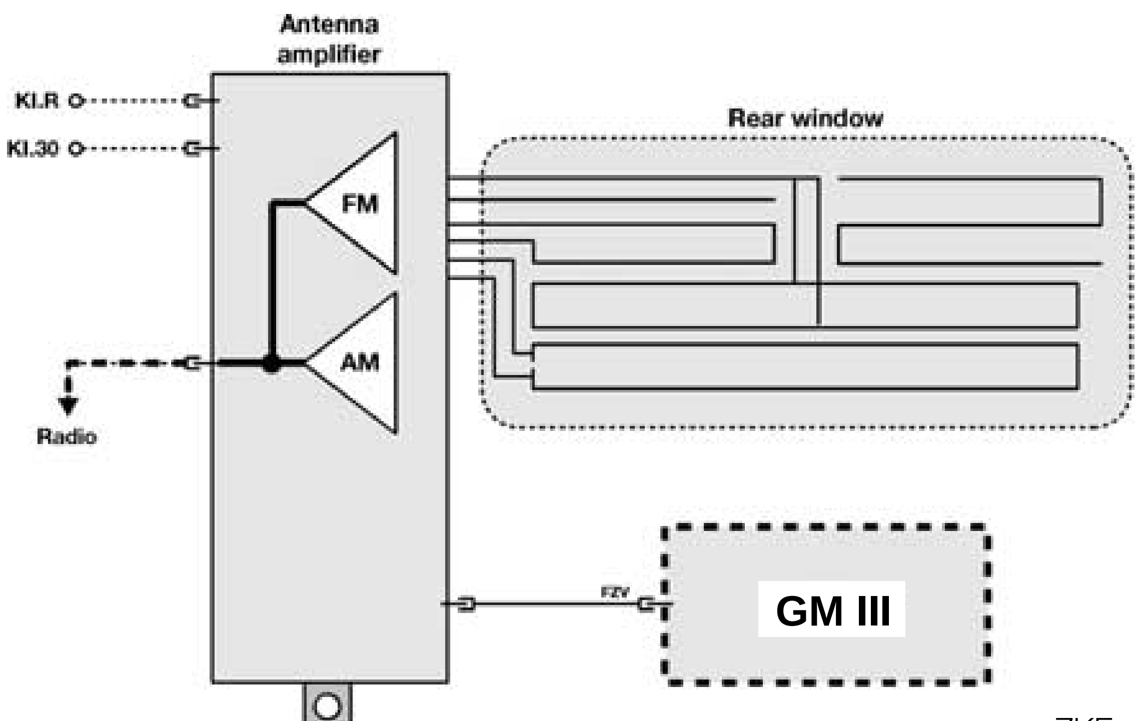
- The remote key receiver is part of the antenna amplifier and is installed in the center of the top section of the tailgate.

  The receiver produces a digital signal based on the transmitter command and sends it to the GM for processing.

  The GM then carries out all remote lock system, window/sunroof convenience closing features and DWA arming/disarming functions.

- The frequency at which the key transmits the radio signal to the antenna amplifier is 315 MHz.

- The system is also used to convey the key identification number being used to lock/unlock the vehicle. This is a requirement of the Key Memory feature covered further on in this manual.



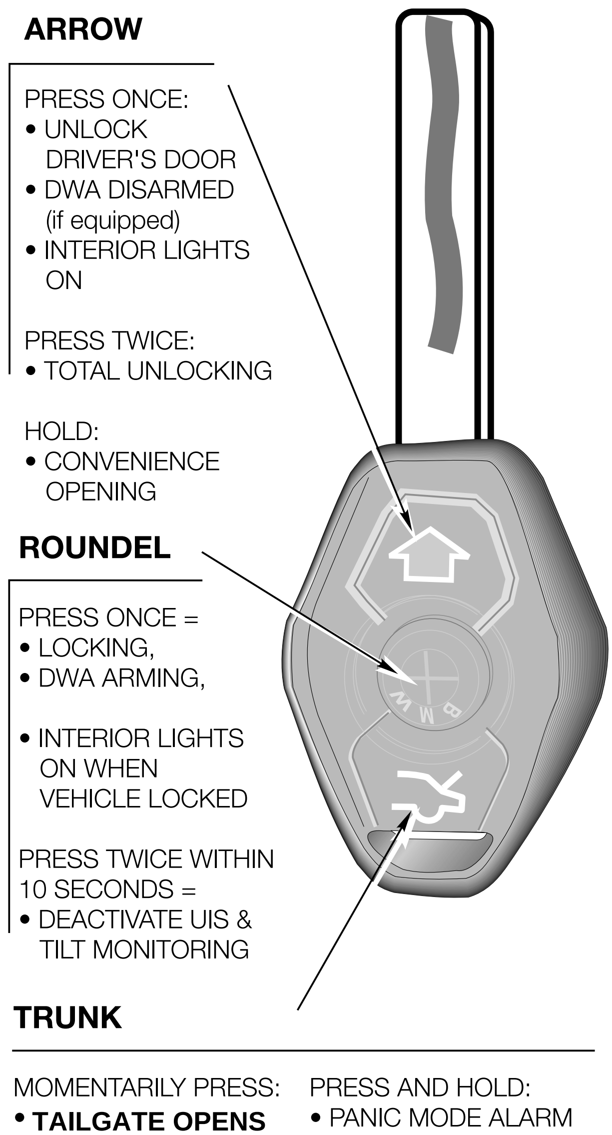
MODEL YEAR 2000 FZV KEY

Visual Changes:

- New appearance with blue and white BMW roundel.
- New button arrangement (larger buttons) with sequential operation (enhanced operating convenience)
- Rechargeable battery replaces replaceable batteries. Charged by EWS ring antenna.
- The key housing is encapsulated and can not be opened.
- The LED has been omitted.
- Key will be used in E46, E38 and E39 vehicles.

Features of the keyless entry system include:

- Up to 4 radio-control keys can be operated in conjunction with one vehicle.
- Locking/unlocking of doors, tailgate, fuel filler lid.
- Selective unlocking of driver's door (as with key in lock)
- Arming/dis-arming of DWA alarm system (if equipped).
- Remote unlocking of the tailgate only.
- Comfort opening of windows and sunroof
- Interior lighting activation (search mode).
- Panic mode alarm activation..
- Automatic correction for up to 1000 erroneous activation signals.
- Low transmitter battery fault code storage in the GM.
- An EEPROM is used to store the key data.
- Keys delivered with a four color label sheet containing four different colored labels for each of the four possible FZV keys.



REMOTE KEY INITIALIZATION

The initialization of the FZV keys is required to establish the Lock/Unlock signal synchronization with the GM. The initialization procedure provides the GM with a key identification number and a "rolling code" for each key. If the initialization is not performed, the GM will not respond to the key signals.

Up to 4 remote keys can be initialized. They must be initialized at the same time. Key initialization is only possible with the vehicle unlocked.

Procedure:

1. Close all doors and have all keys available.

2. Using key number 1, turn the ignition switch to KL R, then switch off within 5 seconds and remove the first key.

3. Within 30 seconds of turning the ignition switch to "off" **Press and hold** the **arrow** button.

4. While holding the arrow button, **press and release** (*"tap"*) **the roundel** button **three times** within 10 seconds.

5. Release both buttons. The GM will immediately lock and unlock the doors signaling a successful initialization.

6. If additional keys need to be initialized repeat steps 3 - 5 within 30 seconds.

7. Switching the ignition to KL R completes the initialization.

SERVICE NOTE: The key memory function of the GM responds to the key identification number of each key. If the keys are not initialized in the same order prior to initialization, the key memory function activated by the keys will not be assigned correctly.

Always initialize the keys in the same order.

FZV KEY RECHARGEABLE BATTERY

From KL R, the battery inside the key head is charged inductively by the EWS ring antenna via a coil antenna integrated in the key. The charging process is controlled by electronic circuitry integrated in the key.

- The service life of a radio-control key used under normal conditions corresponds to the vehicle lifespan.
- If the FZV keys are not used (ie: stored in a drawer), the battery will be discharged after approx. 1.5 years.
- The time required to fully charge a discharged battery is approx. 30 hours.
- The remote control can be operated about 15 times after a charging period of approx. 30 minutes (driving time).

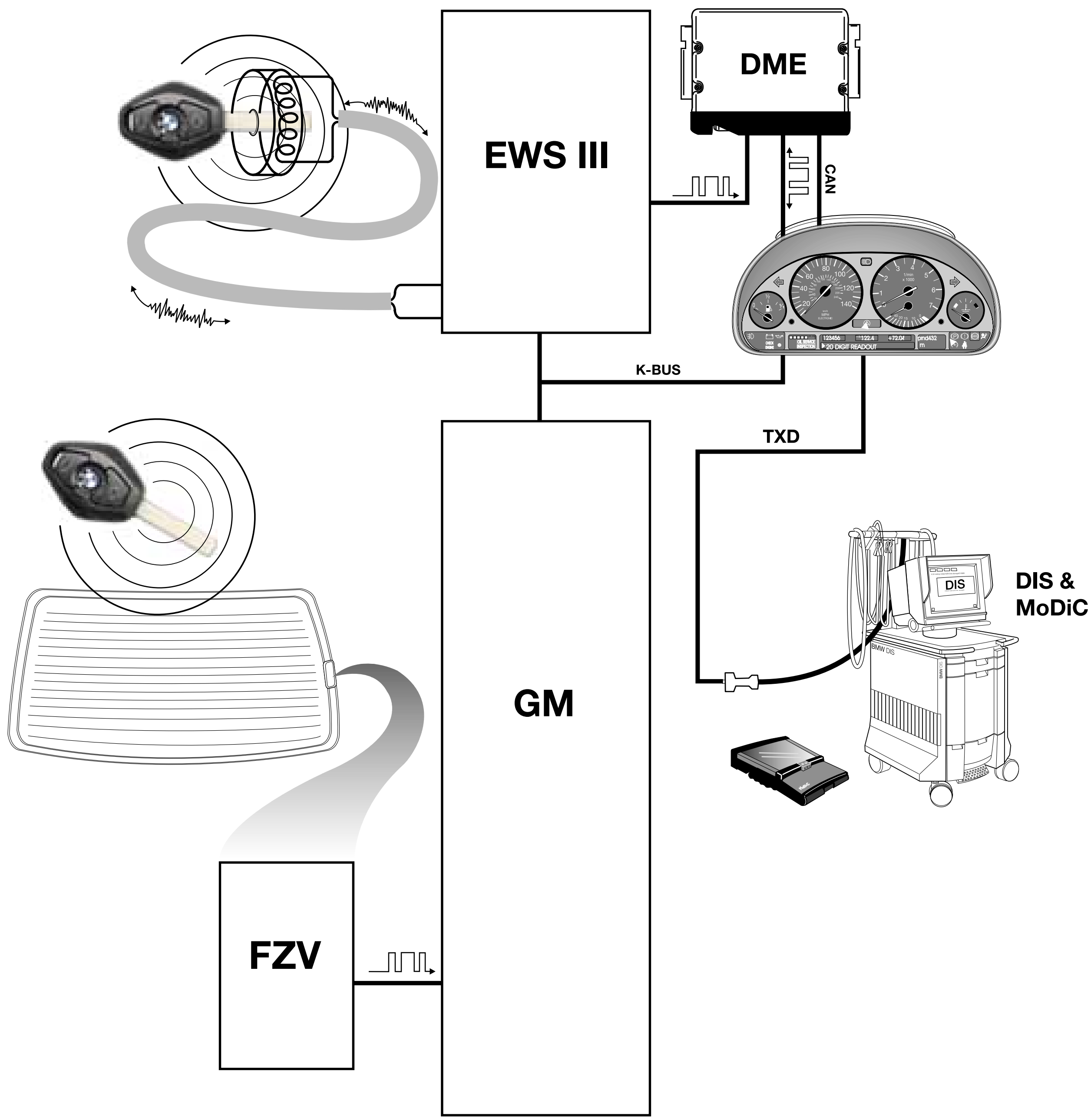
The key data is stored in a transponder chip. The transponder chip is a wireless read and write EEPROM. It is powered via the ring coil at the steering lock. Power is applied electromagnetically when the key is in the ignition switch from KL R.

The power supply is used both for data transfer as well as for charging the battery. This has been made possible by new development of the transponder chip.

As with previous systems, every press of an FZV key also provides the battery charge condition. When the FZV electronics receives a low power condition message three successive times, the GM sets a fault indicating a low battery within a specific key. The LCM is also informed via the bus system and alerts the driver via an instrument cluster matrix message.

If the battery is recharged (used operate car), the fault will be automatically deleted when five successive messages are received indicating a charged battery condition.

The battery has no affect on the EWS III communication function!


DME
EWS III
CAN
K-BUS
TXD
DIS
DIS &
MoDiC
GM
FZV

Car Memory / Key Memory

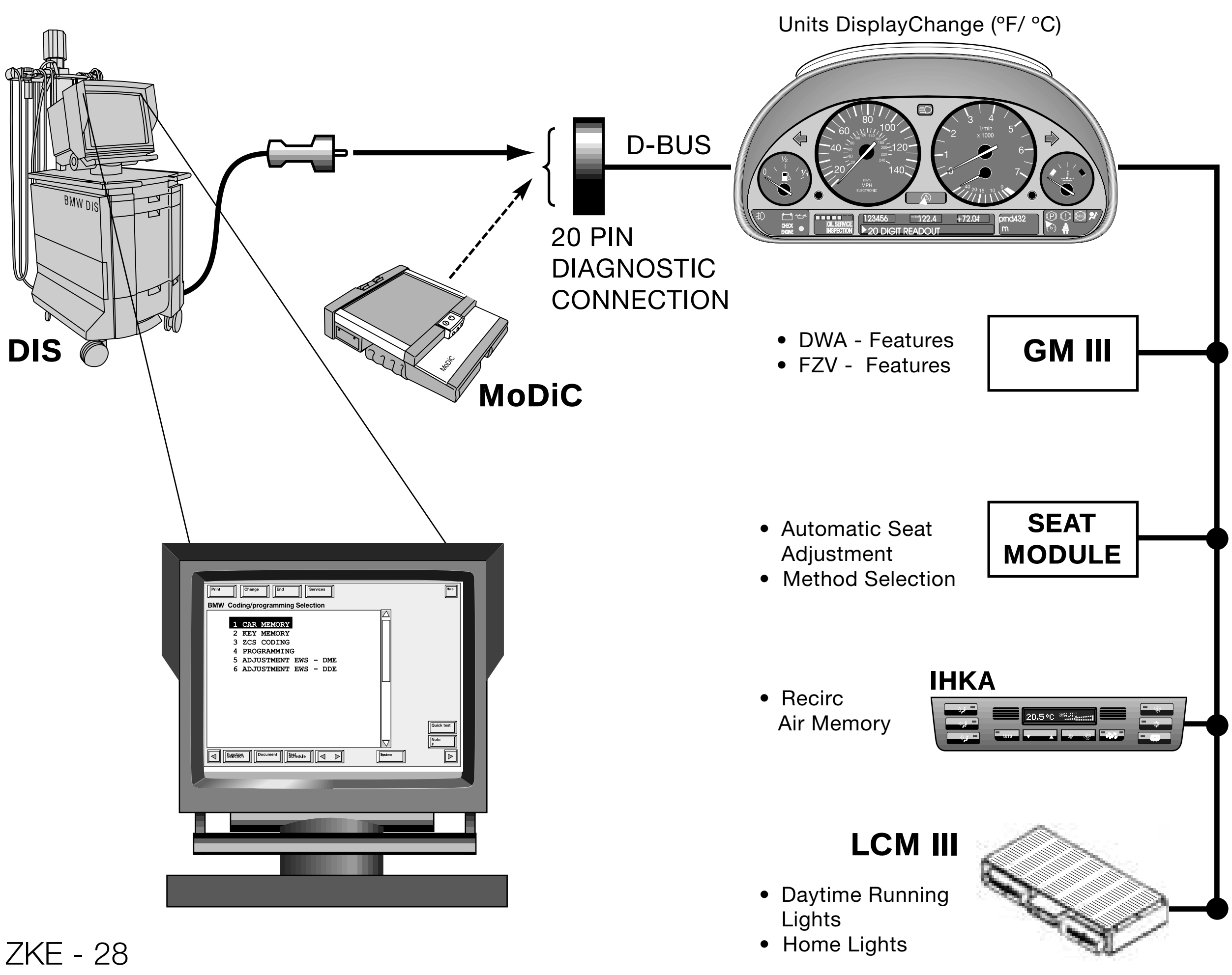
The Car/Key Memory feature provides the flexibility of allowing the owner to customize certain functions of select vehicle systems and automatically identifies users of the vehicle by a key identification signal provided by the remote keyless entry system (FZV).

Car & Key memory is marketed as a combined feature but is actually two separate functions of the select vehicle control systems.

Car Memory: The owner is provided with a list of available system functions that can be customized to their liking. Prior to delivery, the DIS or MoDiC is used to encode the owner's chosen selections into the appropriate control modules.

These choices become a permanent function of the control module and can only be changed by re-encoding with the DIS or MoDiC at a BMW Center.

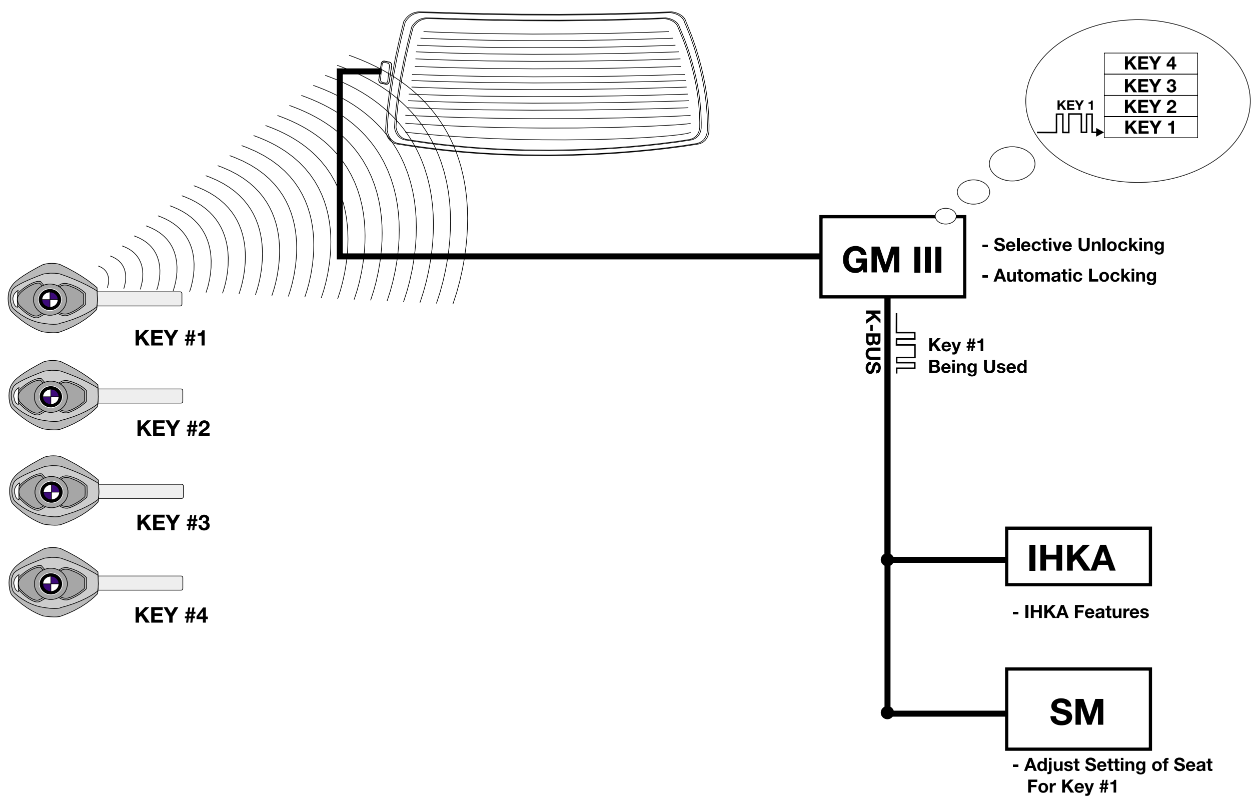
This feature has been available for some time via the ZCS Conversion Feature but has never been fully utilized or officially presented to the vehicle owner as a feature of their vehicle.



Key Memory: This feature provides the added convenience of identifying users of the vehicle whenever a lock or unlocked signal is generated via the individual FZV keys. A maximum of four FZV keys can be used with the Key Memory feature.

Each of the four keys generate a unique key identification signal (key number) that is transmitted simultaneously with the lock/unlock signals to the General Module. ***Key Memory does not respond to Lock/Unlock requests from the drivers door lock.***

Most of the key memory functions require the vehicle be configured using the “KEY MEMORY” function of the DIS or MoDiC. However, there are a few features that store settings automatically without configuration such as IHKA blower speed and temp setting.



The key ID signal alerts the GM V to communicate with select control systems over the K Bus to store (when locked) or reset (when unlocked) certain driver adjustable settings.

There are features that function as both a Car & Key Memory feature.

Example; the Automatic Seat Adjustment feature is encoded as a Car Memory Function with the following possibilities:

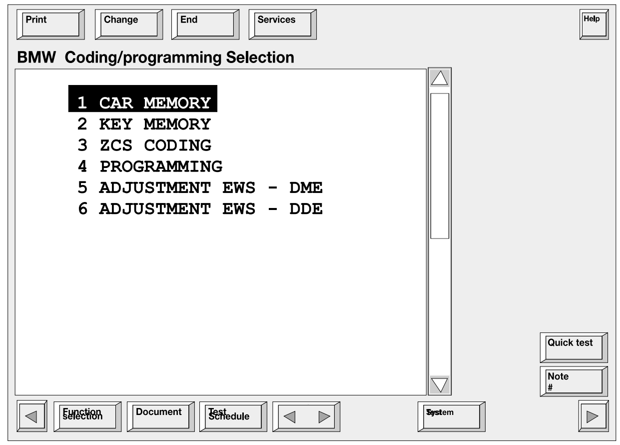
- when unlocking,
- when opening a door after unlocking
- or not active at all.

If active, the seat positions are stored and reactivated by the Key Memory function for individual users of the car.

REQUIRED PRECONDITIONS:

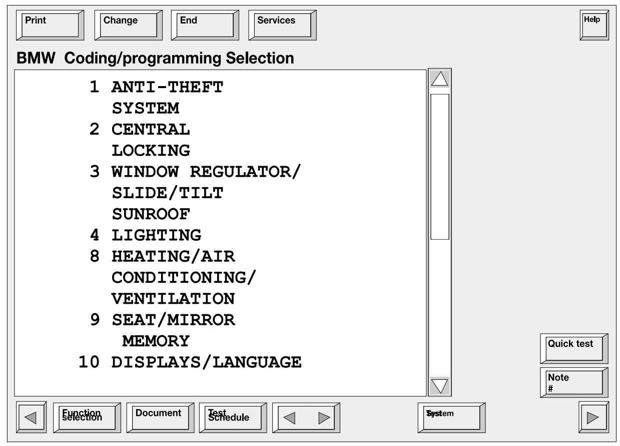
Before configuring Car or Key Memory Functions, connect a battery charger to the vehicle. This will ensure adequate battery voltage during the Car/Key Memory configuration.

If battery voltage drops below 11.8 volts, the procedure will terminate.



Car Memory Configuration procedure:

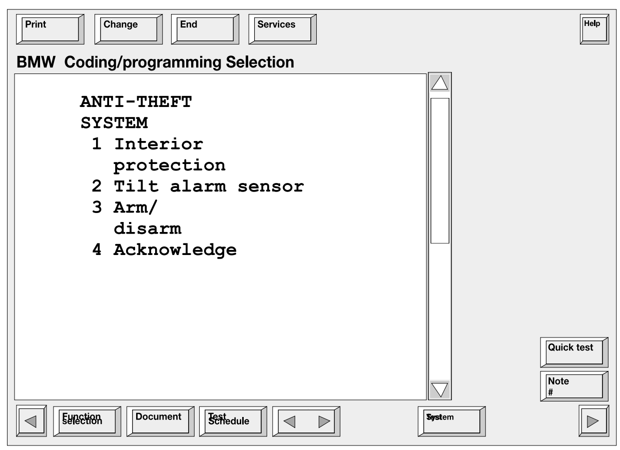
From the Coding/Programming Selection function of the DIS or MoDiC, Select "CAR MEMORY" and proceed by pressing the right arrow.



The system will scan for control systems capable of configuration based on the ZCS in the Instrument Cluster.

After a short wait the system will display a list of detected control systems capable of CAR MEMORY configuration.

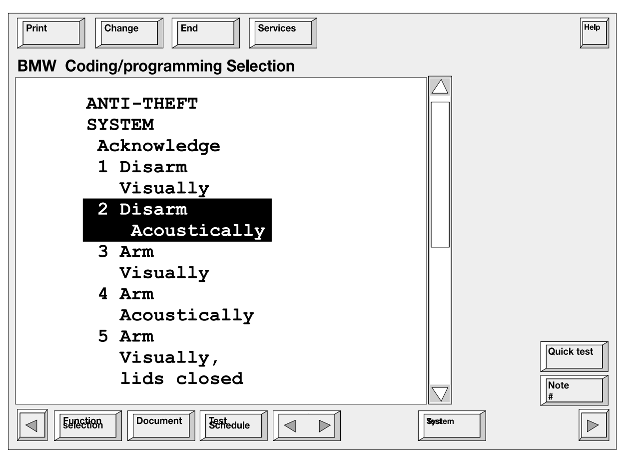
Using the owner's selection list, enter the systems selected for customization.



Example: The owner chooses not to have an acoustic acknowledgment when the DWA is disarmed.

- From the displayed list select "Anti Theft System" and press the continue arrow.

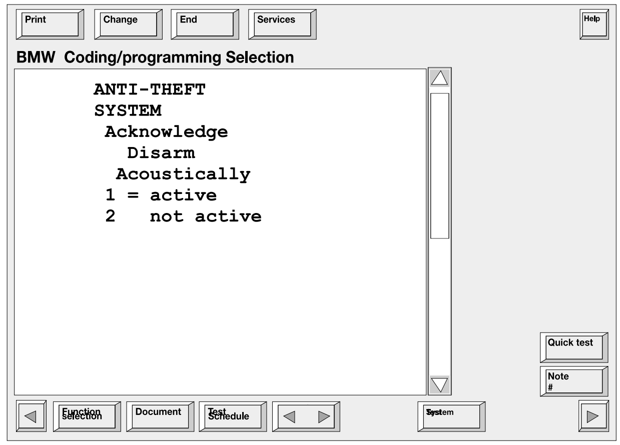
- From the Anti Theft Sub menu, select 4. Acknowledge.



The Acknowledge sub menu provides all possible options for the DWA Acknowledgment.

- Select 2. Disarm Acoustically, and press the continue arrow.

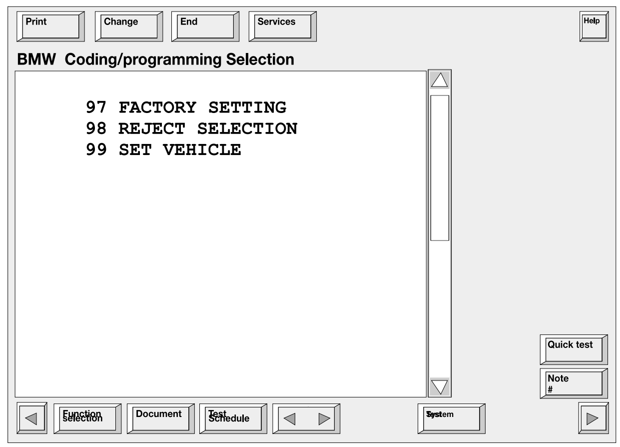
The next displayed screen is the "active/not active" selection.



The blue "=" sign indicates what mode this particular function is set to at the present.

- Select the "not active" function and press the continue arrow.

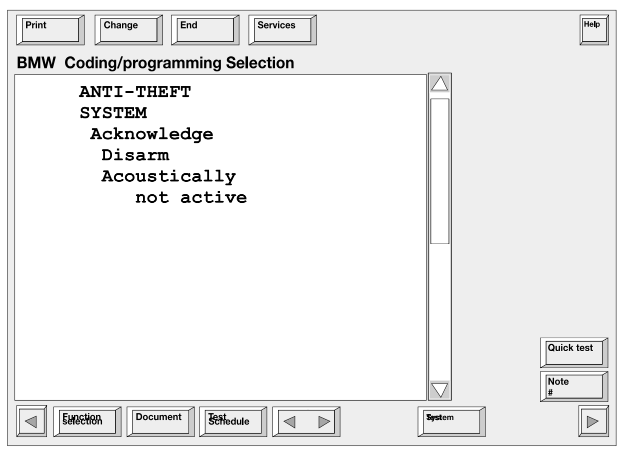
The system will accept the selection and bring the CAR MEMORY main selection menu back in the display.



If additional selections are required, enter into the systems displayed and repeat the steps from above.

- When all of the required CAR MEMORY configuration selections are entered, scroll down to the bottom of the main car memory menu and select 99 SET VEHICLE.

All of the selected configuration changes are now displayed. Check the displayed list against the Owner's selection list making sure all of the choices are entered.



Print this list out and place in the vehicle history file for future reference.

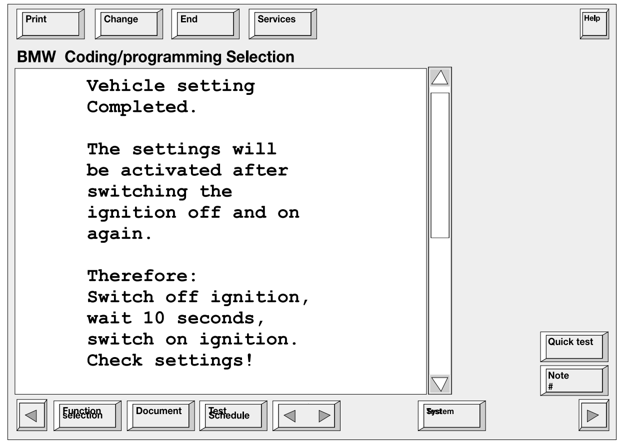
- Press the continue arrow to proceed with the configuration. The display will request that the ignition switch be "switched off and on again". Switch off for a minimum of 10 seconds, then switch back on. Press the "Yes" button to continue.

A bar graph indicating configuration progress is displayed along with the current battery voltage. This portion of the configuration varies in duration based on the total number of configuration selections. Watch the battery voltage level during the configuration. Low battery condition will terminate or possibly incorrectly configure the vehicle.

The display will change indicating the “Vehicle setting completed”. Switch ignition off for 10 seconds and then back on.

Verify the configuration change(s) by activating the new function.

Pressing the Left arrow brings the Main Coding/Programming Menu back in the display.



Key Memory Configuration procedure:

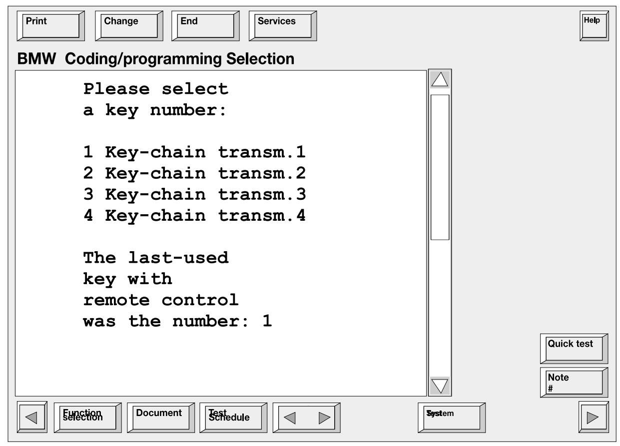
From the Coding/Programming Selection function of the DIS or MoDiC, Select "KEY MEMORY" and proceed by pressing the right arrow.

With the ignition switched on press the right arrow to allow the system to scan for control systems capable of KEY MEMORY configuration.

After a short wait the system will display a key number selection list of the four possible keys. The display also indicates the identification number of the last key used

- Using the owner's selection list, select the key for key memory assignment and press the continue arrow.

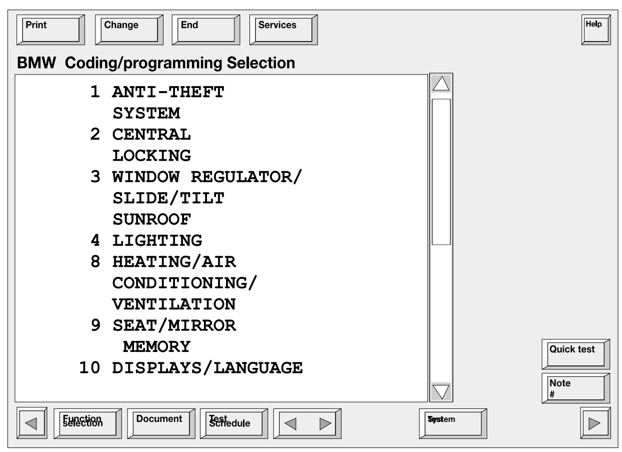
The system will scan for key memory functions for the specific key.



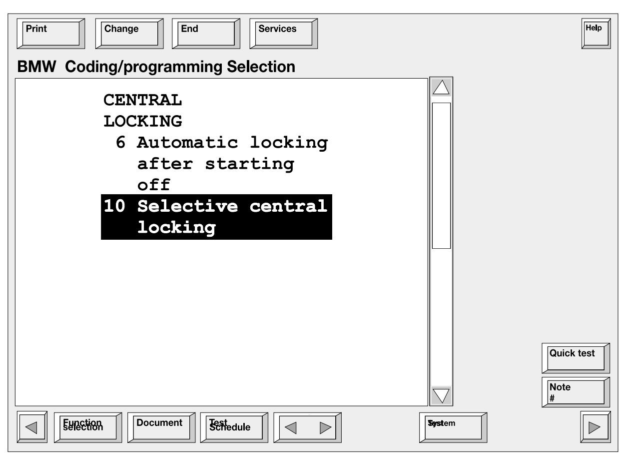
Similar to the CAR MEMORY main menu, the KEY MEMORY main menu provides all of the possible configuration options.

As an example, the owner requires the selective unlocking feature be deactivated.

- Press 2. CENTRAL LOCKING and press the continue arrow.



- From the displayed list select "10 Selective central locking" and press the continue arrow.



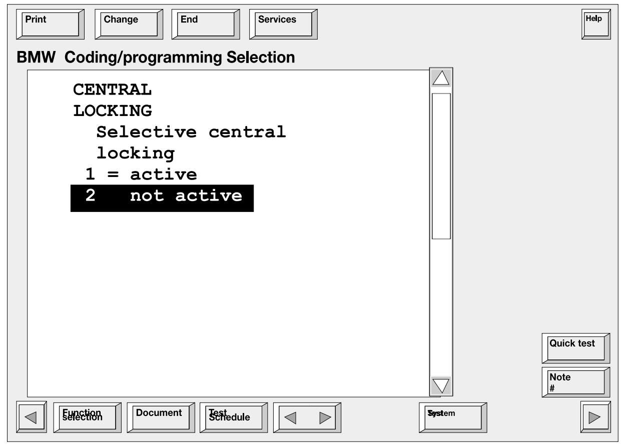
The blue "=" sign indicates what mode this particular function is set to currently.

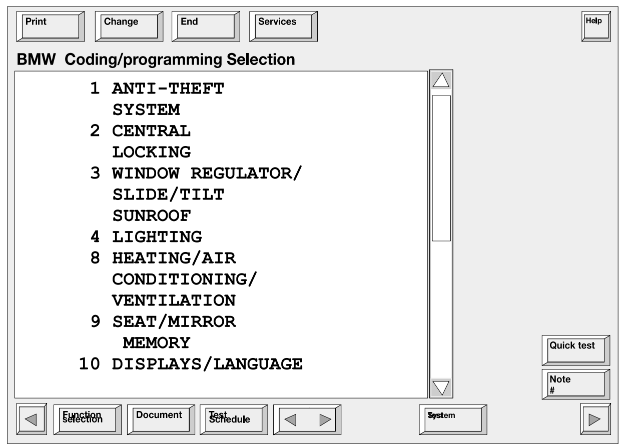
- Select the "not active" function and press the continue arrow.

The system will accept the selection and bring the KEY MEMORY main selection menu back in the display.

If additional selections are required, enter into the systems displayed and repeat the steps from above.

- When all of the required KEY MEMORY configuration selections are entered, select 99 SET VEHICLE.

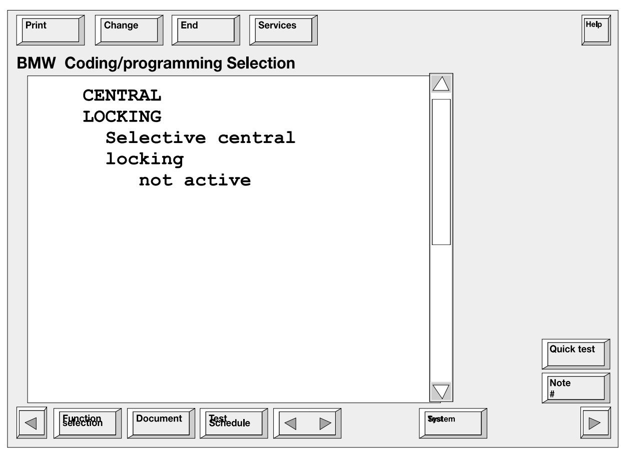




The next screen displays all of the selected configuration changes.

Check the displayed list against the Owner's selection list making sure all of the choices are entered. Print this list out and place in the vehicle history file for future reference if necessary.

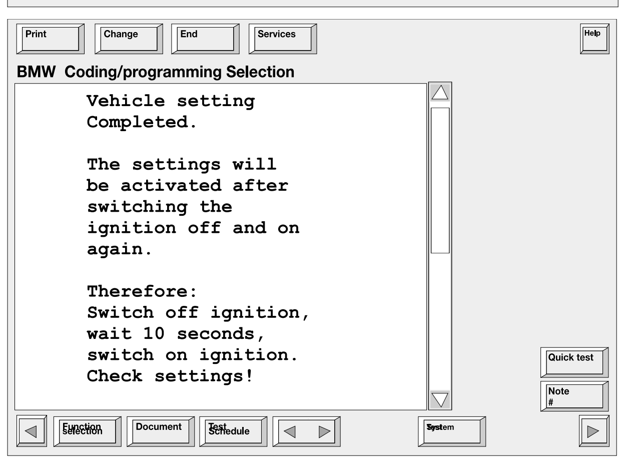
- Press the continue arrow to proceed with the configuration.



The next display will request that the ignition switch be "switched off and on again". Press the "Yes" button to continue.

A bar graph indicating configuration process is displayed along with the current battery voltage.

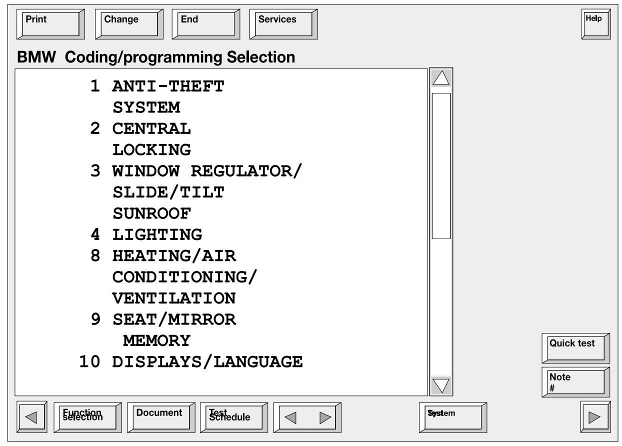
The display will change indicating the "Vehicle setting completed". Turn the ignition switch back off for 10 seconds and then back on. Verify the configuration change(s) by activating the new function.



Also located at the bottom of both the CAR & KEY selection menus are the possible selections:

- 97 FACTORY SETTING - This selection automatically resets the original factory default settings

- 98 REJECT SELECTION - This selection resets the last selected entry to the previous setting.



During the operation of the FACTORY SETTING selection, it is a normal function for the LCM III controlled lights to flash.

Symbols: **=** The equal sign signifies the current mode of function

> The arrow symbol signifies selected changes to be encoded when all selections are completed. This symbol can be seen when returning to a selection menu to check on selected modes of operation prior to "99 Set Vehicle".

✱ The asterisk indicates the factory default encoding function after encoding.

CAR/KEY CONFIGURATION AND THE ZCS CODING CONVERSION FEATURE

The ZCS Coding Conversion feature is still utilized for changing other system functions as in the past. For example: The Language Display Change for the instrument cluster display block is only available using the Coding Conversion feature.

CAR/KEY MEMORY SERVICE CONSIDERATIONS

Replacing Car or Key Memory Configured Control Modules:

If a Car/Key Memory capable control module becomes defective and needs replacement, the specific customized data will be transferred over to the new replacement unit during the ZCS encoding process.

If this is not possible due to extensive control module failure, the owner must be made aware of the situation and requested to provide the options they originally selected. For this reason, it is advantageous to print the selected features as mentioned in the CAR & KEY MEMORY configuration procedures.

FZV Key Initialization Procedure:

Also mentioned in the FZV section of this manual, If FZV keys need re-initializing, make sure they are initialized in the same order. Adhere to the colored label identification system for proper key initialization sequencing.

Technician Awareness:

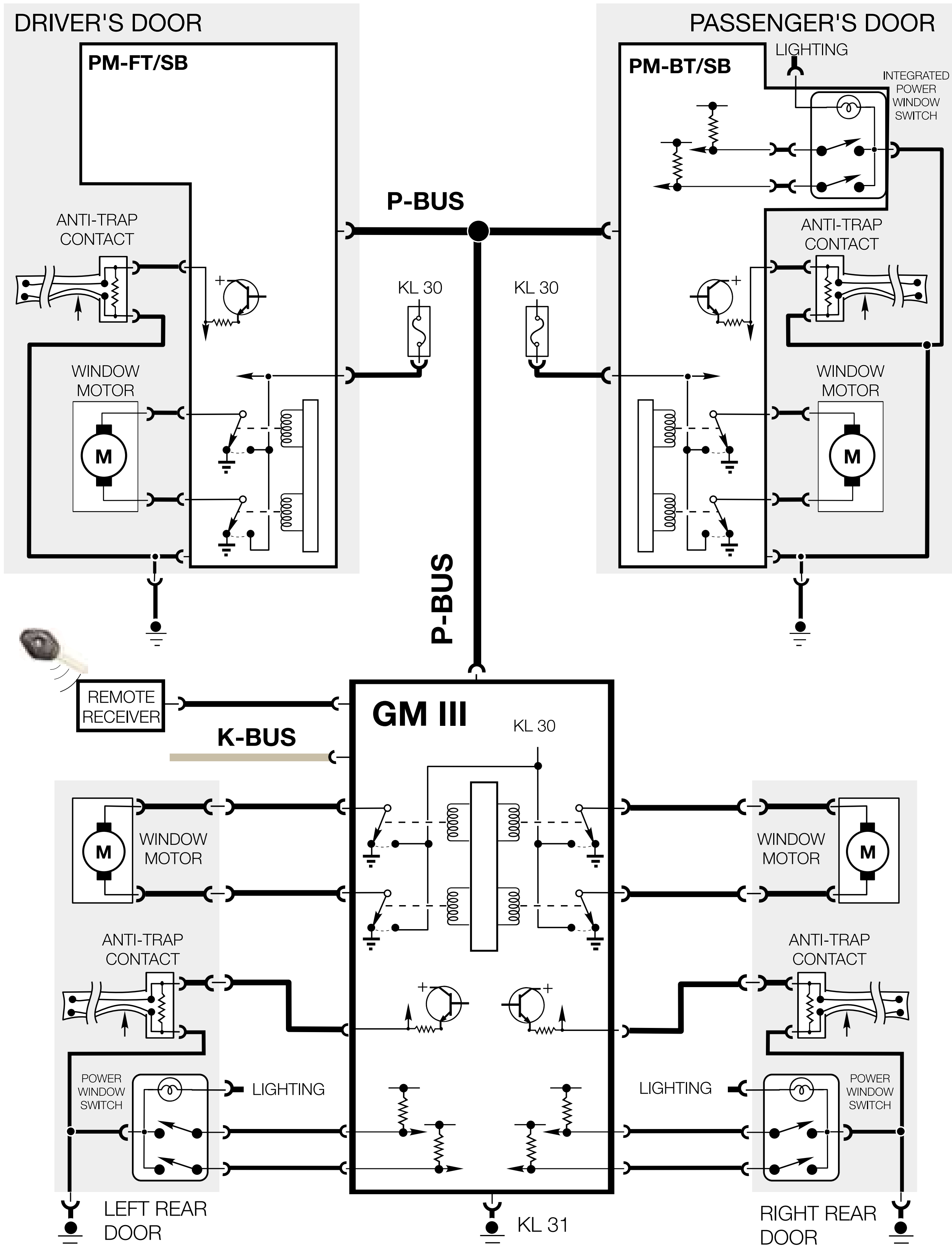
Car Memory/Key Memory Configuration obviously changes the functionality of the systems. Before concluding a specific system is defective, review the Car/Key memory selection for the vehicle you are working on. There may be an owner selected function activated that is not a common selection, causing misunderstanding of the system's function.

When working on a Car/Key Memory capable vehicle, avoid using the FZV keys. Use the driver’s door lock to lock and unlock the vehicle to maintain the owners memorized settings. If settings had to be modified as part of repair procedure, inform service advisor of situation to convey to vehicle owner.

POWER WINDOWS

The power window operation on the E53 is similar to previous systems. Features of the system include:

- Control of the front and rear door window motors is carried out directly by the GM.
- One-touch operation in both directions on all four windows.
- Cable type window regulator used for all windows.
- Anti-trap detection is provided by the pressure sensitive finger guard .
- Push/pull window switches
- The rear window switches located in the rear doors can be deactivated by the pressing child lock out switch in the center console.
- Convenience closing/opening of the windows from the driver's lock cylinder or convenience opening only from the FZV remote key (FZV operation can be owner customized with the Car Memory Function).
- Window operation with the ignition switched off until a door is opened or 16 minutes has elapsed after the key is switched off.
- Window load switching is through relays integral of the GM for rear windows and in the respective door switchblock modules for the front windows. The current draw is monitored for end limit position. The maximum run time for the window motors is limited to 8 seconds. This allows the motors to be switched off if the end limit load sensing fails.


DRIVER'S DOOR
PASSENGER'S DOOR
PM-FT/SB
PM-BT/SB
LIGHTING
INTEGRATED POWER WINDOW SWITCH
P-BUS
ANTI-TRAP CONTACT
ANTI-TRAP CONTACT
KL 30
KL 30
WINDOW MOTOR
M
WINDOW MOTOR
M
P-BUS
REMOTE RECEIVER
GM III
KL 30
K-BUS
WINDOW MOTOR
M
WINDOW MOTOR
M
ANTI-TRAP CONTACT
ANTI-TRAP CONTACT
POWER WINDOW SWITCH
LIGHTING
LIGHTING
POWER WINDOW SWITCH
LEFT REAR DOOR
KL 31
RIGHT REAR DOOR

WINDOW ANTI-TRAP DETECTION

The window anti-trap detection feature is only active in the one touch and convenience close modes of operation. If the window switch is pushed/pulled and held, the Anti-trap feature will not function.

The rubber pressure guard located at the top edge of each door frame consists of two contact strips that close when subjected to pressure. This provides anti-trap detection and signal generation to the GM.

When the contact strip closes, the window immediately (10ms) reverses direction as with previous anti-trap systems. The contact strip does not require that the anti-trap feature be initialized prior to operation.

The pressure sensor finger guard has a resistance of 3.0 KOhm and it is monitored for open circuit. When pressed, the monitored resistance changes to <1KOhm. Faults with the anti-trap system require that the window switch be held to close the window.

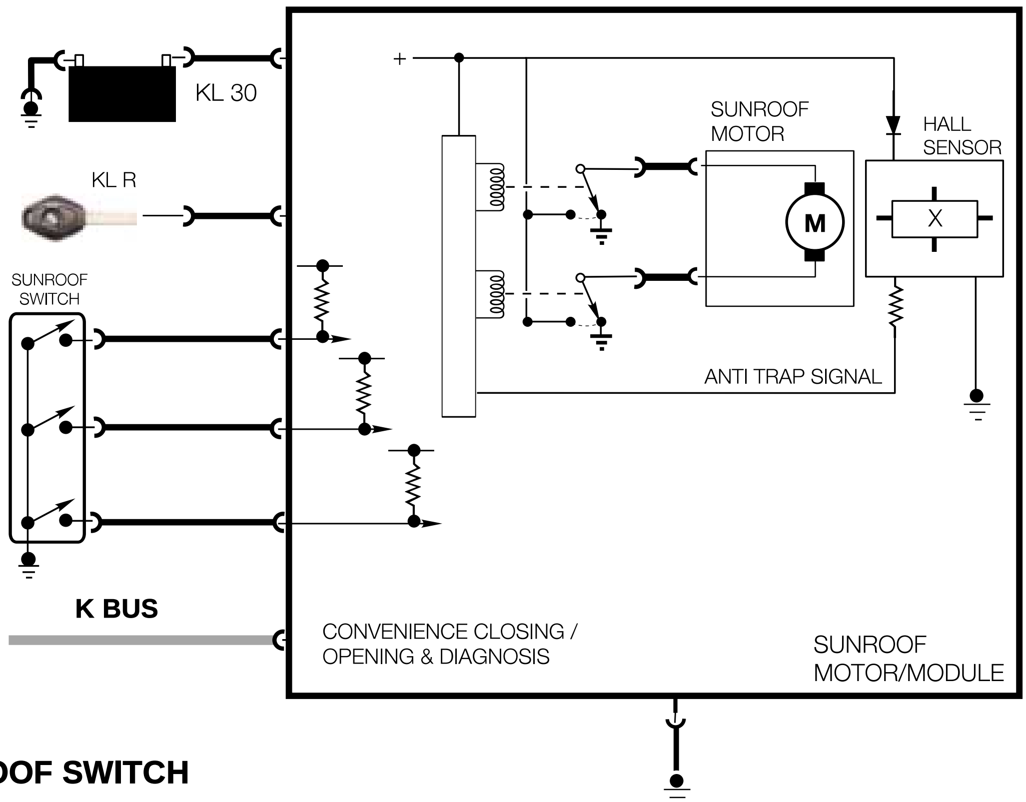
CONVENIENCE OPENING/CLOSING

The GM and Front Door Switchblock Modules provide the convenience open/close feature providing control of the power windows (and sunroof) from outside the vehicle with the key in the driver's door lock. The FZV provides the same function for the opening only.

- The anti-trap feature is active during convenience closing from the driver's door lock.
- The convenience open feature provides outside activation of the windows and sunroof in the same manner.
- If the GM receives a request to operate convenience close or open for more than 110 seconds, the function is deactivated and a fault code is stored.
- The Car Memory Feature can activate and deactivate the Convenience Open Feature from the FZV's control.

SUNROOF

The sunroof is mechanically similar to previous systems. All of the electronic controls and relays are contained in the sunroof module (SHD). The module is connected to the K-Bus for comfort closing/opening, unloader signalling during engine startup, diagnosis and fault memory purposes



SUNROOF SWITCH

Mounted in the sunroof motor trim cover is the sunroof switch. Also similar to previous systems, the switch provides coded ground signals for system operation.

The following switch signals are generated over three wires through coded combinations:

- Rest position
- Slide open request (press and hold switch - first detent of open position)
- Automatic slide open request (press further to second detent and release)
- Tilt open (press and hold)
- Slide close request (press and hold switch - first detent of close direction)
- Automatic slide close request (press further to second detent and release)

SUNROOF MOTOR/MODULE (SHD)

The combined motor module has a 13 pin connector for interfacing the switch, and vehicle harness (power ground and K bus.)

The motor contains two hall effect sensors that monitor the motor shaft rotation providing sunroof panel position.

The hall sensors also provide the end limit cut out function for the SHD once the system is initialized. The SHD counts the pulses and cuts the motor out prior to the detected end run of the sunroof panel.

INITIALIZATION

Initialization is required for the SHD to learn the end positions of the motor's travel. The hall sensors provide pulses for motor rotation, the SHD counts the pulses and determines where the panel is by memorizing the stored pulses.

If the system is not initialized, the sunroof will only operate in the tilt up and slide close positions. Initialize as follows:

- Press and hold the sunroof switch in either the tilt up or slide close positions for 15 seconds.

- The sunroof motor operate momentarily signifying initialization acceptance.

The SHD memorizes the pulses from the hall sensors on the next activation of the motor by driving the panel to its end run positions. The SHD senses an amperage increase and determines the end run position. The counted number of pulses is then used as the basis for calculating the panel position.

ANTI TRAP FEATURE

The anti-trap feature of the sunroof uses a hall sensor to detect obstructions while the sunroof is closing (pulse frequency slowed down) in the automatic close function. The anti-trap feature is shut down prior to full closing (4mm from full closed) to allow the sunroof the seat into the seal.

Additionally, the anti-trap feature is not functional when the switch is held in the manual close position.

SHD SELF DIAGNOSIS

The SHD monitors its operation and stores fault codes if a defect is determined: The SHD monitors the following conditions:

- **SHD motor relays:** The relays are checked for sticking contacts (plausibility) and non functional contacts.

- **Hall effect position sensors:** The SHD must detect a pulse frequency from the hall effect sensor(s) during operation.

- **Sunroof Switch:** The SHD monitors the signal plausibility of the coded signaling from the sunroof switch.

SUNROOF FAULT RESPONSE CHARACTERISTICS

If a fault occurs with any of these functions, the SHD responds as follows:

- Overrides the end run detection.
- Switches the motor off if the relay contacts stick for more than 500 ms.
- Switches the motor off if pulses are not received.

EMERGENCY OPERATION OF SUNROOF

If the sunroof motor does not respond to the switch signals, the hex key in the trunk lid tool kit is used to manually turn the motor shaft drive as on previous systems

INTERIOR LIGHTING

The GM controls the interior lighting automatically with the status change of several monitored inputs. The lighting can also be manually controlled using the interior light switch.

COMPONENTS

DOOR CONTACTS: The door lock actuators contain a hall effect sensor for the purpose of monitoring door open/closed status (hall sensor 3 in the driver's door actuator). The hall effect sensor is located directly behind the rotary latch plate encased in the actuator. The sensor is activated by the rotary latch plate's position. A change in current flow informs the General module when a door is opened or closed.

Front seat interior/map light unit: The overhead front seat interior/map light unit contains a single main interior light. The light is controlled by the GM automatically or by momentarily pressing interior light switch located on the light assembly. The switch provides a momentary ground signal that the GM recognizes as a request to either turn the light on (if off) or turn the light off (if on).

If the switch is held for more than 3 seconds, the GM interprets the continuous ground signal as a request to turn the interior light circuit off for the Workshop Mode as on previous systems. The workshop mode is stored in memory and will not come back on even if the GM is removed from it's power supply and reconnected. The switch must be pressed to turn the lights back on.

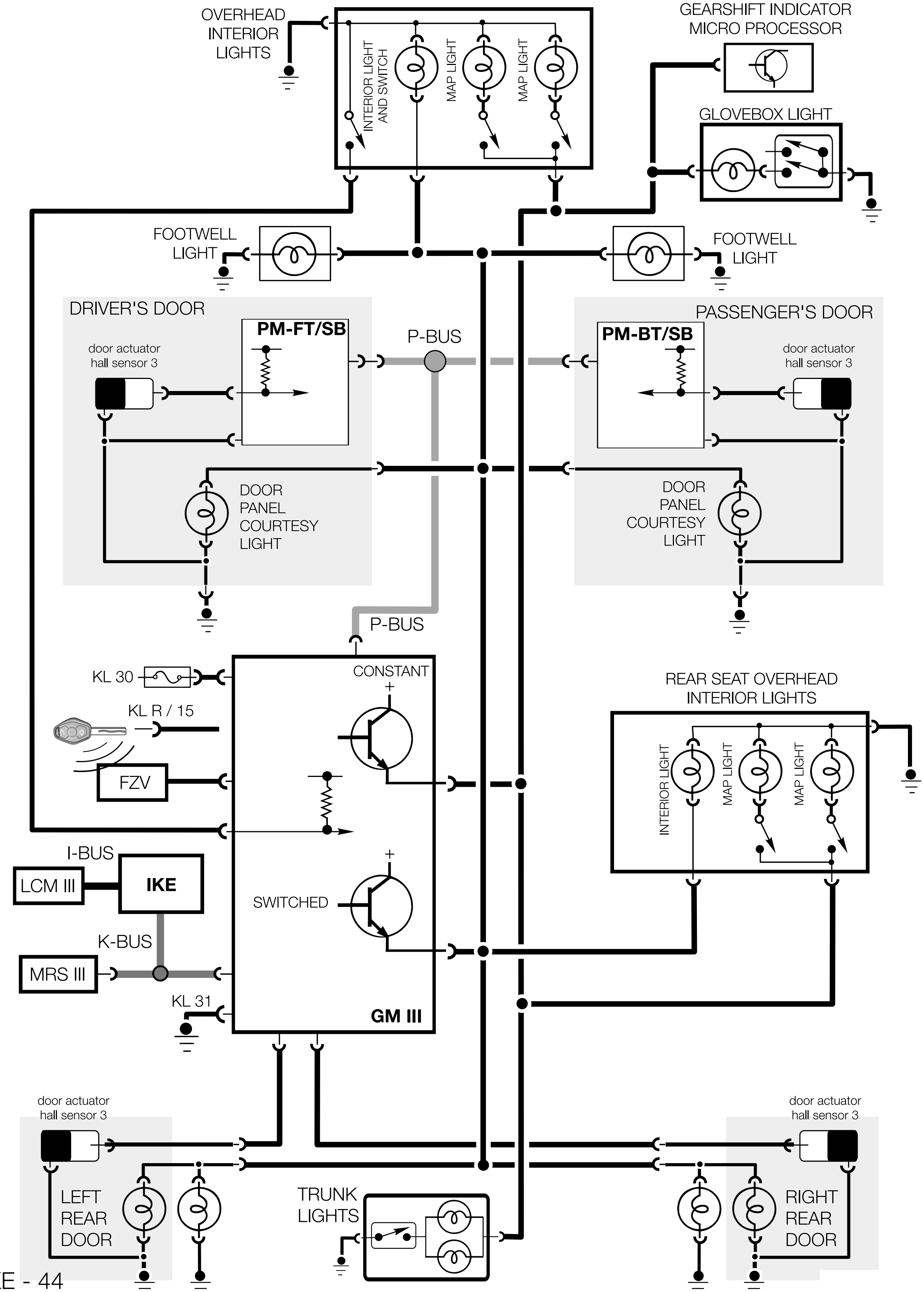
There are two reading/map lights also located in the assembly. Each map light is mechanically controlled by depressing it's corresponding on/off switch. The power supply for the map lights is supplied by the GM through the Consumer Cut Off circuit.

Rear seat interior light unit:

In the center headliner is an additional interior/reading light unit. This unit contains an interior light that is controlled with the front interior light and a mechanically switched reading light on the consumer cut off circuit.

Front footwell lights:

In each front footwell, there is also a courtesy light. These lights are only operated when the GM provides power to the interior lighting circuit.


OVERHEAD
INTERIOR
LIGHTS
INTERIOR LIGHT AND SWITCH
MAP LIGHT
MAP LIGHT
GEARSHIFT INDICATOR
MICRO PROCESSOR
GLOVEBOX LIGHT
FOOTWELL
LIGHT
FOOTWELL
LIGHT
DRIVER'S DOOR
PM-FT/SB
P-BUS
PASSENGER'S DOOR
PM-BT/SB
door actuator
hall sensor 3
door actuator
hall sensor 3
DOOR
PANEL
COURTESY
LIGHT
DOOR
PANEL
COURTESY
LIGHT
P-BUS
KL 30
KL R / 15
FZV
CONSTANT
REAR SEAT OVERHEAD
INTERIOR LIGHTS
INTERIOR LIGHT
MAP LIGHT
MAP LIGHT
I-BUS
LCM III
IKE
SWITCHED
K-BUS
MRS III
KL 31
GM III
door actuator
hall sensor 3
door actuator
hall sensor 3
LEFT
REAR
DOOR
TRUNK
LIGHTS
RIGHT
REAR
DOOR

AUTOMATIC CONTROL FUNCTION

The GM provides 12 volts (linear application providing soft on feature) to the interior lighting circuit when the one of the following input signal statuses change:

- Door contact hall sensor active (door opened)
- An Unlock request from the driver's door key lock hall sensors are received. This only occurs if the ignition switch is off.
- An Unlock request is from the FZV keyless entry system is received via the K bus. This only occurs if the ignition switch is off as well.
- The ignition switch is switched off and the vehicle exterior lights (LCM III) have been on for a minimum of 2 minutes prior. This information is provided to the GM via the K bus.
- Active crash signal from the MRS III control module.
- Lock button of FZV key is pressed with the vehicle is already locked (interior search function).

The GM gradually reduces the full 12 volt power supply (linear reduction providing soft off) until the lights are off when the following input signal statuses change:

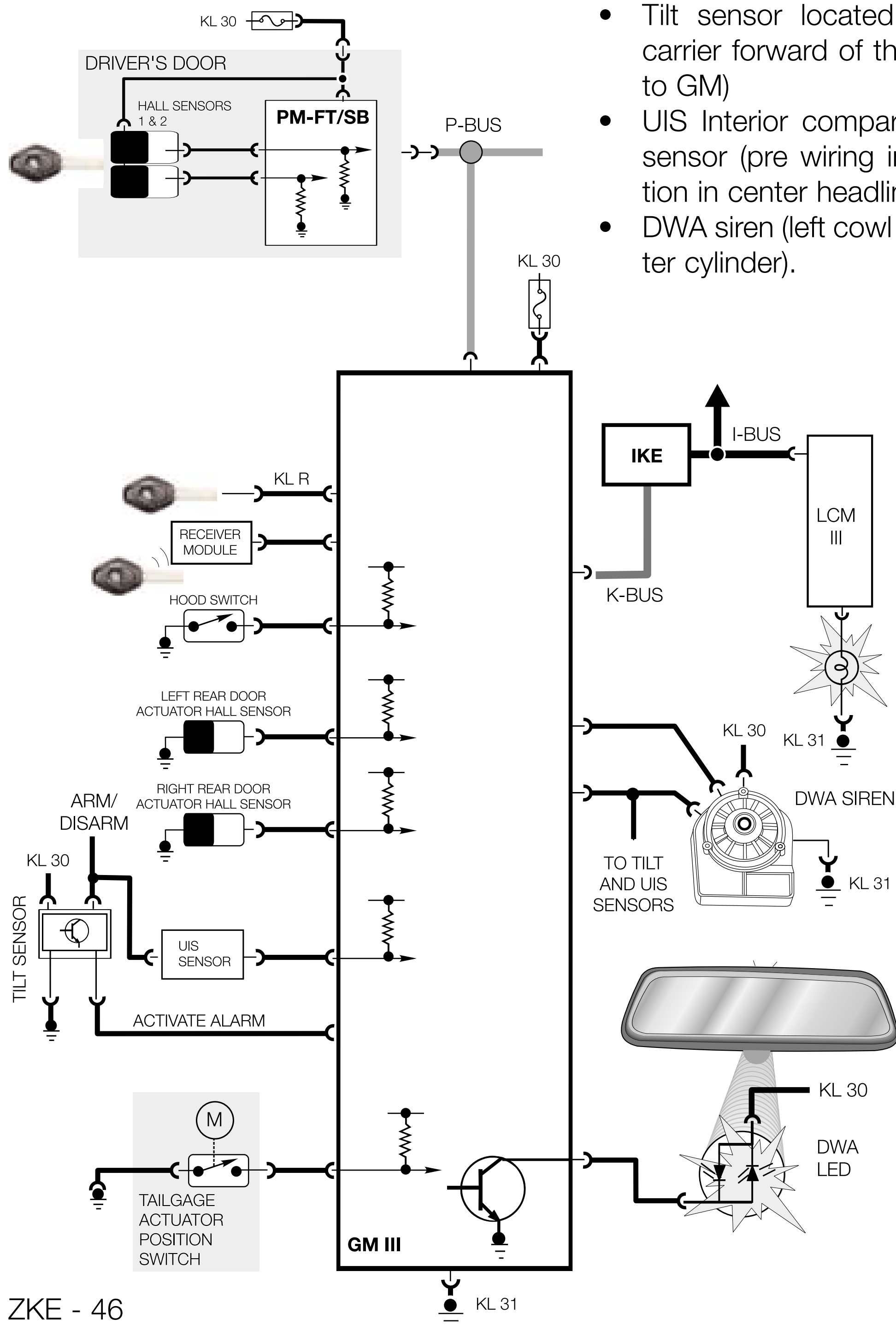
- Immediately after the ignition switch is turned to KL R with the driver's door hall sensor door contact closed.
- When the vehicle is locked (single or double) with the door contacts closed.
- When the vehicle door contacts are closed. The lights remain on for 20 seconds and then go to soft off.
- After the interior search function is activated, the lights will automatically turn off (soft off) after 8 seconds.
- After 16 minutes with a door contact active (open door) and the key off, the lights are switched off (consumer cutoff function).
- The component activation function of the DIS also has the ability to switch the lights.

The Interior lighting output circuit of the GM is approximately 3.5 amps with all lights on.

ANTI-THEFT (DWA) SYSTEM

The GM utilizes the following components to provide the DWA function:

- Door lock hall effect sensor contacts (door open/closed).
- Tailgate lid switch contact (monitored for closed tailgate).
- Hood switch (monitored for closed hood, located under the hood).
- DWA status LED (part of rear view mirror).
- Tilt sensor located in the electrical carrier forward of the glove box (next to GM)
- UIS Interior compartment monitoring sensor (pre wiring in area of installation in center headliner).
- DWA siren (left cowl area next to master cylinder).



COMPONENTS

DOOR CONTACTS

As mentioned in the Central Locking Section, the door lock contact hall effect sensors provide status of door open/closed. The GM will activate the siren if a door open signal becomes active when the DWA is armed.

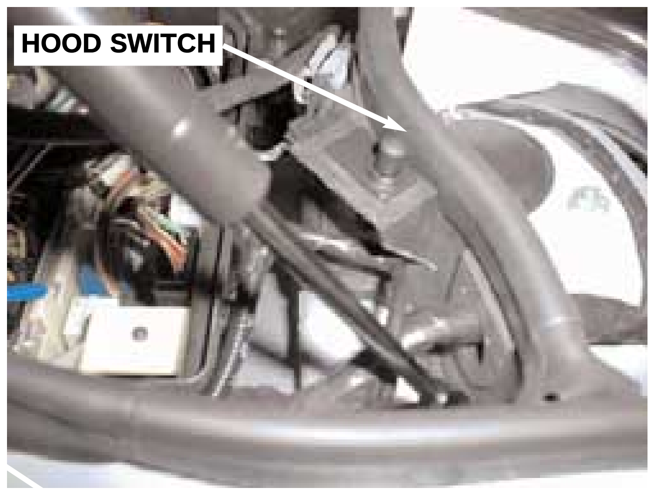
TAILGATE SWITCH CONTACTS

The tailgate switch contact is located in the tailgate lock actuator assembly. When closed, the tailgate contact provides a ground signal to the GM signifying a "closed tailgate". The GM will activate the siren if the tailgate switch contact ground signal opens when the DWA is armed.

HOOD CONTACT SWITCH

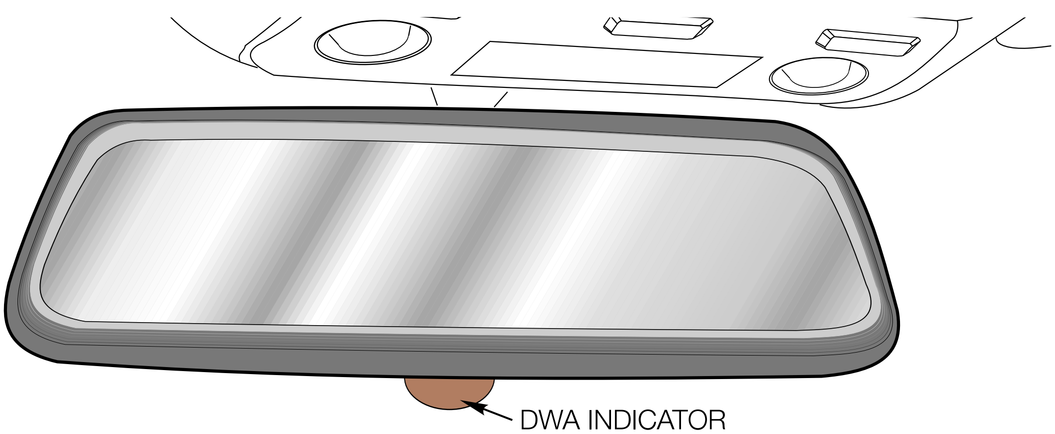
Located on the right side engine compartment, the hood contact switch provides a ground signal to the GM signifying an open hood.

The plunger of this switch can be pulled up past a detent causing the switch contact to open. This feature can be used to simulate a closed hood with the hood open when diagnosing the DWA system.



DWA LED

The LED is provided with constant battery voltage (KL 30). The GM provides a switched ground signal providing the various blinking signals used to convey DWA status to the vehicle operator (covered further on).



TILT SENSOR

Located in the electrical carrier forward of the glove box, the tilt sensor is an electronic sensing device with the sole purpose of monitoring the vehicle's parked angle when DWA is armed.

The sensor requires three signal wires to perform its function:

- KL 30 - Constant battery voltage

- Signal "STDWA"; switched ground input signal provided by the GM indicating DWA armed/disarmed status. The tilt sensor is used as a splice location for the STDWA signal to the Siren and FIS interior protection sensor.

- Signal "NG"; switched ground output signal provided to the GM. The signal is used for two purposes,

  1. As a momentary acknowledgment that the tilt sensor received STDWA and is currently monitoring the vehicle angle.

  2. If the tilt sensor detects a change in the vehicle's angle when DWA is armed, signal NG is switched to inform the GM to activate the siren.

When the tilt sensor receives the STDWA signal from the GM it memorizes the vehicle's parked angle. The angle of the vehicle is monitored by the solid state electronics. Once armed, if the angle changes, the tilt sensor provides a switched ground signal to the GM to activate DWA.

INTERIOR PROTECTION (UIS)

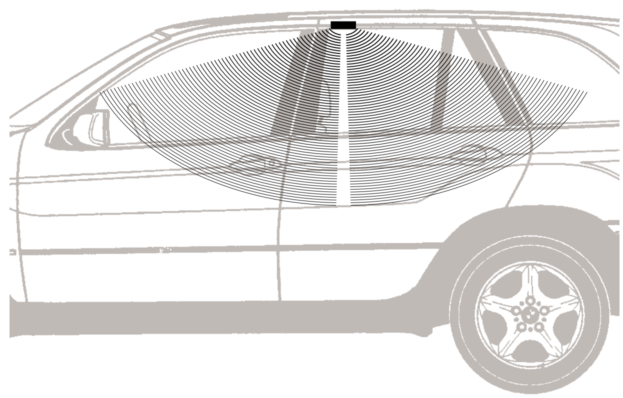
The UIS monitors the vehicle interior for motion through ultrasonic sound waves. The UIS is a combined transmitter and receiver.

The X5 UIS sensor is incorporated into the rear seat interior light trim cover. It is a two piece unit with cable connection to the rear transmitter/receiver.

The UIS and trim panel are clearly identified with arrows indicating forward mounting direction.

Due to the design of the vehicles interior, the sensor is uni-directional and must be installed in the proper direction to ensure proper operation of the system (trim cover ensures directional installation).

Every time the DWA system is armed (signal STDWA), the sensor adapts to what ever objects might be stationary in the interior.



The sensor emits ultra sonic waves in a programmed timed cycle. It receives echos of the emitted waves.

The UIS amplifies the received sound wave signals and compares them with the transmitted waves. The UIS also checks the incoming echos for background hiss (wind noise through a partially open window) and adapts for this.

- If the echos are consistently similar, no movement is detected,
- If the echos are altered, (inconsistent), the UIS determines motion in the interior compartment.

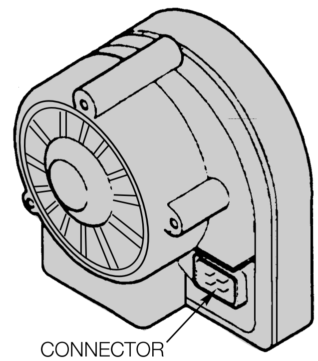
If motion is detected, the UIS changes to a constant cycle and the echo is compared again. If the inconsistency is still present the UIS sends the activate siren signal (INRS) to the GM.

As with the tilt sensor, the UIS is also switched OFF when the vehicle is locked two times within ten seconds. This allows the sensor to be switched OFF for transportation purposes.

ALARM SIREN

The siren is located in the vehicle cowl on the driver's side of the vehicle. This location provides a secure position with loud acoustic output.

The siren contains electronic circuitry for producing the warning tone when the alarm is triggered. The siren also contains a rechargeable battery that is used to power the siren when the alarm is triggered.

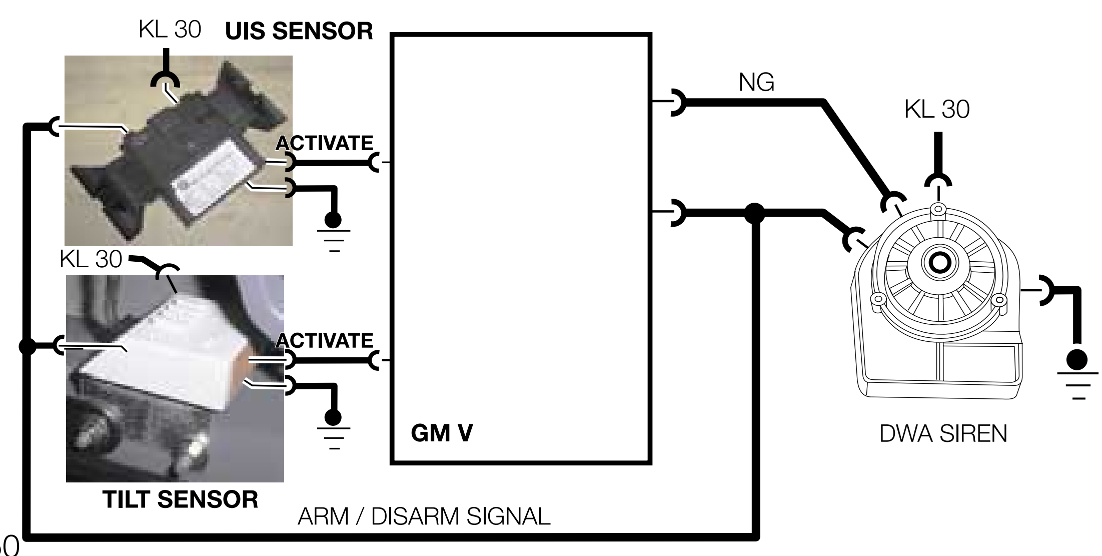


The rechargeable battery will allow the siren to sound if it or the vehicle's battery is dis-connected. The siren battery is recharged, from the vehicle's battery when DWA is not in the armed state.

The siren has four wires connecting it to the system; KL 30, KL 31, Signal STDWA (arm/disarm signal from GM), and Signal NG (activate siren output signal to the GM)

The arm/disarm output signal from the GM (STDWA) is provided to the Tilt sensor, FIS sensor and the siren simultaneously. The arm/disarm signal is a switched ground that signals the components of DWA armed/disarmed status.

The activate siren signal (NG) is high whether DWA is armed or disarmed. If a monitored input activates the alarm, the high signal to the siren is switched to a 50% duty cycle at the GM. The control circuitry in the siren activates the siren driver. If the DWA is armed and the battery is disconnected the siren recognizes the normally high "NG" signal as suddenly going low, the siren is also activated.



DWA ARMING/DISARMING

- The DWA is armed every time the vehicle is locked from the outside with the door lock cylinder or FZV key.

- The LED in the rear view mirror flashes as an acknowledgment along with the exterior lights and a momentary chirp from the siren.

- The GM monitors all required input signals for closed status (door closed, tailgate closed, etc.) The inputs must be in a closed status for a minimum of 3 seconds for the GM to include them as an activation component. If after 3 seconds any input signal not in the closed status is excluded (this is acknowledged by the DWA LED) preventing false alarm activation's.

- If the DWA is armed a second time within 10 seconds, the tilt sensor and interior protection sensor are also excluded as alarm activation components. This function is useful if the vehicle is transported on a train or flat bed truck to prevent false alarm activation's.

- While armed the tailgate can be opened with out the alarm being triggered as follows:

  - If opened with the tailgate remote button via the FZV, the GM prevents the alarm from activating. (This feature is customizable under the Car Memory function).

  - If opened with the key at the tailgate lock cylinder the tailgate key position switch signals the GM and in the same manner prevents the alarm from activating.

    In either case, when the tailgate is returned to the closed position, it is no longer considered as an activation signal.

Panic Mode Operation: When the tailgate button is pressed and held, the GM is signaled to activate the siren for the Panic Mode. The panic mode will function with either an armed or disarmed DWA system.

EMERGENCY DISARMING

Emergency disarming occurs automatically if a key is used to turn the ignition switch on and the EWS III accepts it. The EWS III signals the GM to unlock the doors and deactivate the DWA.

ALARM INDICATION

When the alarm is triggered, the siren will sound for 30 seconds. At the same time the low beam headlights and four way flashers will flash for 5 minutes. The GM signals the the LCM III via the K bus -- I bus to flash the lights.

Following an alarm trigger, the system will reset and trigger again if further tampering is done to the vehicle.

DWA LED STATUS

DWA STATUS	DWA LED CONDITION
Disarmed	OFF
Armed	Continual slow flash
Armed with one or more monitored inputs not in closed position (ie: trunk not fully closed, etc)	Rapid flash for 10 seconds, then continual slow flash.
Alarm activated	Rapid flash for 5 minutes, then continual slow flash.
Rearmed in less then 10 seconds.	ON for 1 second
Disarmed after activated alarm	Rapid flash for 10 seconds, then OFF.

DRIVER'S SEAT MEMORY FUNCTION

As with previous systems, the seat memory feature of the SM stores three seat positions for recall. The positions are stored in a non-volatile memory preventing loss of positions if in case the SM or the battery is disconnected.

The additional buttons on the SM (M) provide activation of recording memory position and (1-2-3) for storing or recalling a specific seat setting.

Storing current seat position:

- Seat in desired position,
- Ignition switch in KL R,
- Press the M button until it illuminates
- Within 7 seconds press the 1,2 or 3 button to store.

The stored position can be recalled at any time by pressing the appropriate memory location button (1-2-3).

MEMORY RECALL MODES OF OPERATION

Depending on current SM input signals via K-Bus, the memory recall operates in two distinctly different modes:

- One-touch mode (TTB),
- or press and hold mode of operation (DTB).

If the following input signal status is current, the SM resets the seat position by a momentary **"one touch"** of the selected memory button.

- Ignition switch off with the driver's door open, or,
- KL R on, door open or closed

If the following input signal status is current, the SM resets the seat position by a continuous **"press and hold"** of the selected memory button.

- Ignition switch off with the driver's door closed
- KL 15 on, door open or closed.

DRIVER’S SEAT MEMORY (CAR Memory Influence)

The PM-SM can be encoded to recall a specific seat position for a vehicle user when the GM signals the SM to automatically recall stored positions separate of the 1-2-3 button selections.

This feature is encoded through the car memory function and activated by the key memory function. The PM-SM will monitor the seat position and store it in another area of it's memory when the vehicle is locked with the remote keyless entry system. The GM sends a request to memorize the seat position and store it for FZV key user 1,2,3 or 4.

If another user of the vehicle changes the seat position the PM-SM restores the memory position the next time the specific key is used to unlock the vehicle.

This feature can be further modified to activate the position recall based on the owner's selected activation scenario, for example: The owner can choose to :

- Disable this feature,
- Initiate memory recall when the unlock signal is initially sent before a door is opened.
- Initiate memory recall when the unlock signal is sent but only when the driver's door is opened.

See Car Memory Key Memory for additional information.

POWER SEAT DIAGNOSIS

The PM-SM communicates with the DIS or MoDiC via the K bus - instrument cluster gateway - to the P-bus. The PM-SM monitors the seat motors and circuits as well as it's internal operation. Any detected faults are stored in the PM-SM fault memory and are called up when diagnosing the system with the Fault Symptom diagnostic plan.

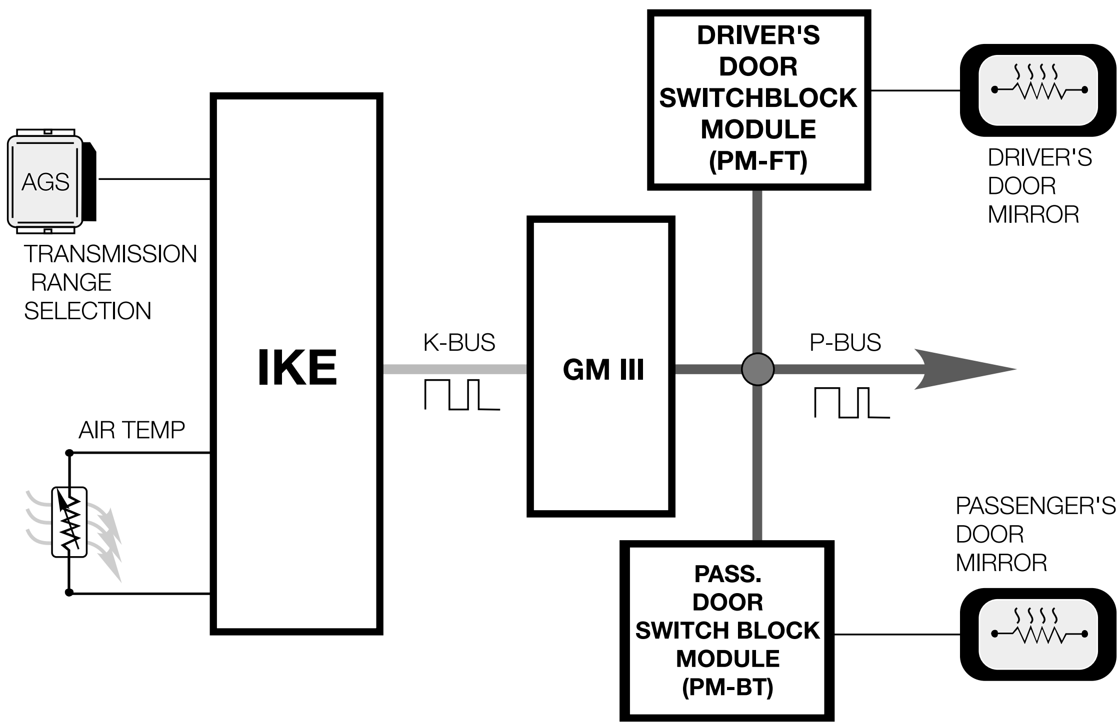
The PM-SM also provides status display to the DIS of its input and output control signals as well as component activation.

MIRROR OPERATION

The output stages and memory storage of mirror positions is handled by the respective door modules. The positioning of the mirrors is signaled from the driver's door switch block/module. The signal passes over the P-Bus to the passenger's door module.

The memory/recall for the driver's mirror comes directly into the door module from the memory switch. The operation for the passenger's side mirror is carried out over the P-Bus from the driver's door module to the passenger's door module.

The memory positions are stored in each respective module. The memory position is recognized by the feedback potentiometers located on each mirror motor.

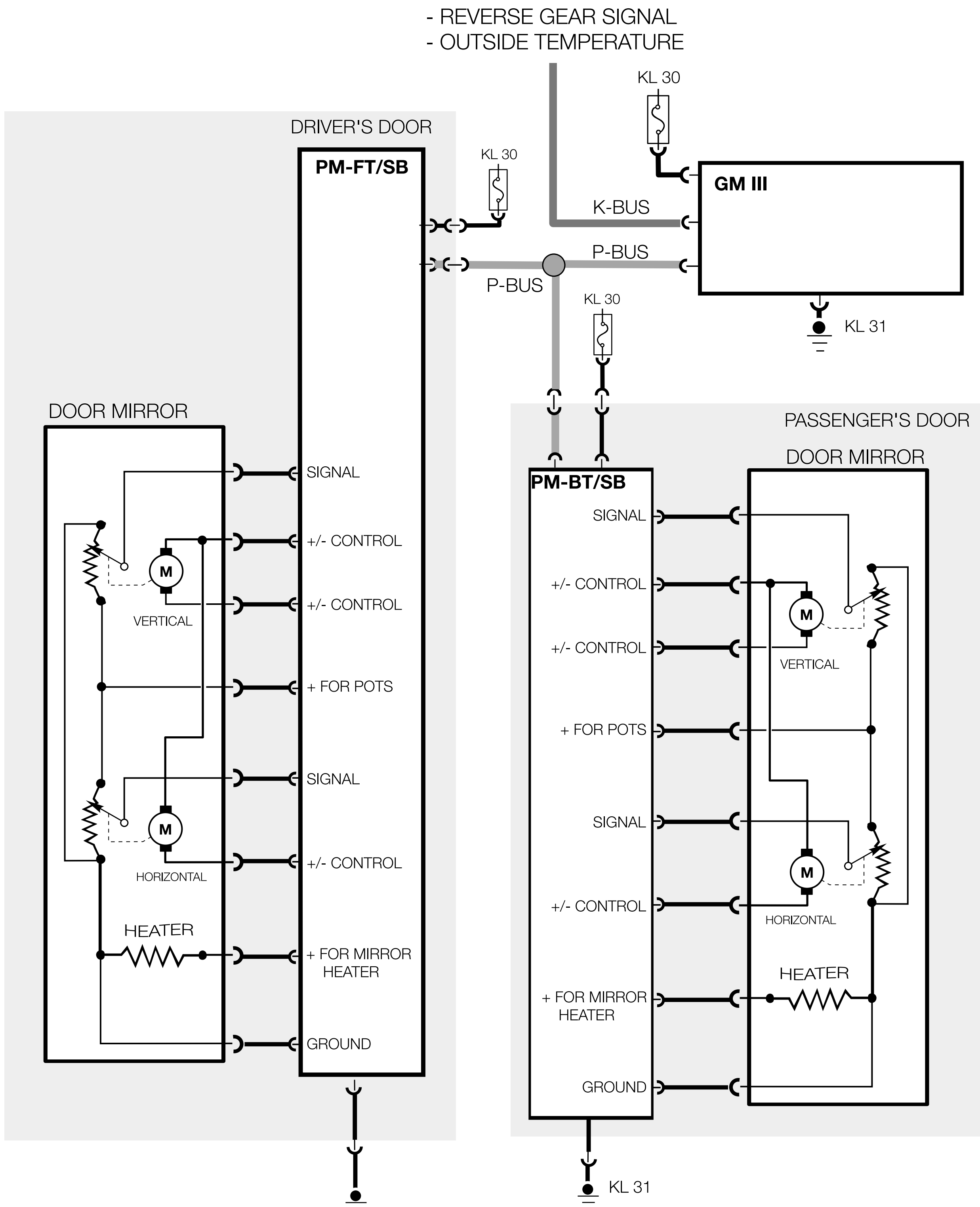


The reverse gear tilt feature for the passenger's mirror is signaled from the GM III, over the P-bus, when reverse is selected and the mirror switch is set for the driver's side.

Mirror heating is controlled by each respective door module. The GM III receives the outside temperature from the IKE and passes it to the door modules. The "ON" time for mirror heating is adjusted based on the outside temperature.

A pulsed heating cycle is used for the mirrors based on the outside temperature.

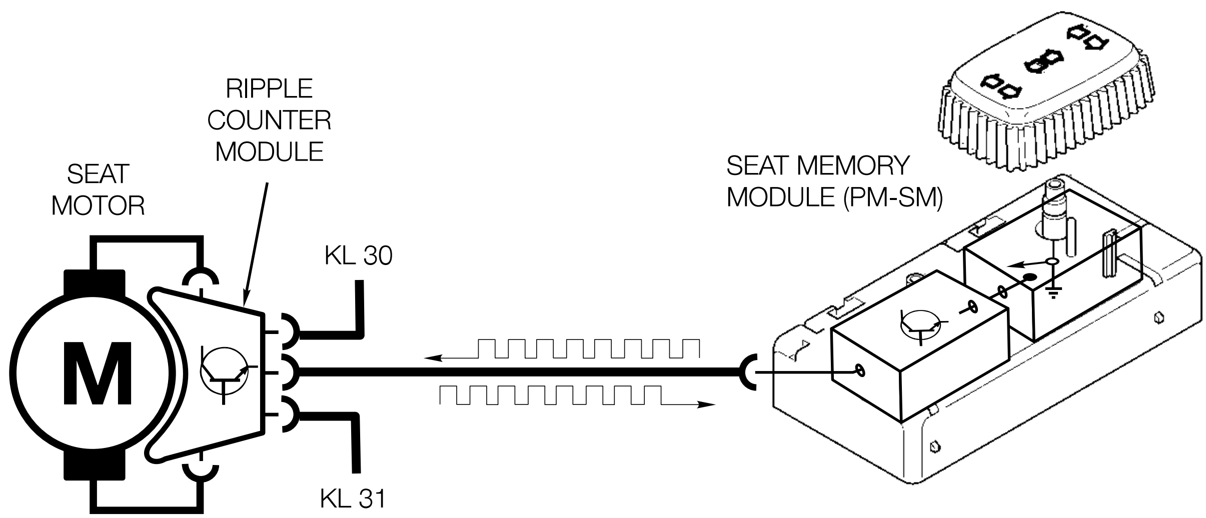
Temperature	<-10^{o}C	-10 to 0^{o}C	0 to 15^{o}C	15 to 25^{o}C	>25^{o}C
ON - duration	100%	75%	50%	25%	5%


- REVERSE GEAR SIGNAL
- OUTSIDE TEMPERATURE
KL 30
DRIVER'S DOOR
PM-FT/SB
KL 30
GM III
K-BUS
P-BUS
P-BUS
KL 30
KL 31
DOOR MIRROR
PASSENGER'S DOOR
DOOR MIRROR
SIGNAL
+/- CONTROL
+/- CONTROL
VERTICAL
+ FOR POTS
SIGNAL
+/- CONTROL
HORIZONTAL
HEATER
+ FOR MIRROR HEATER
GROUND
PM-BT/SB
SIGNAL
+/- CONTROL
+/- CONTROL
VERTICAL
+ FOR POTS
SIGNAL
+/- CONTROL
HORIZONTAL
HEATER
+ FOR MIRROR HEATER
GROUND
KL 31
M
M
M
M

SEAT OPERATION

Each motor for seat adjustment contains a micro-processor (called a Ripple Counter) that receives a digital signal from the seat control module for motor activation. The motors are connected to KL 30 and KL 31 and respond to the signals generated by the seat module when seat movement is requested. The seat adjustment switch provides ground input signals to the module when seat movement is desired. The module processes these input signals and sends output signals to the seat motor processors. The seat motor processors activate the motors and the seat moves to the desired point.

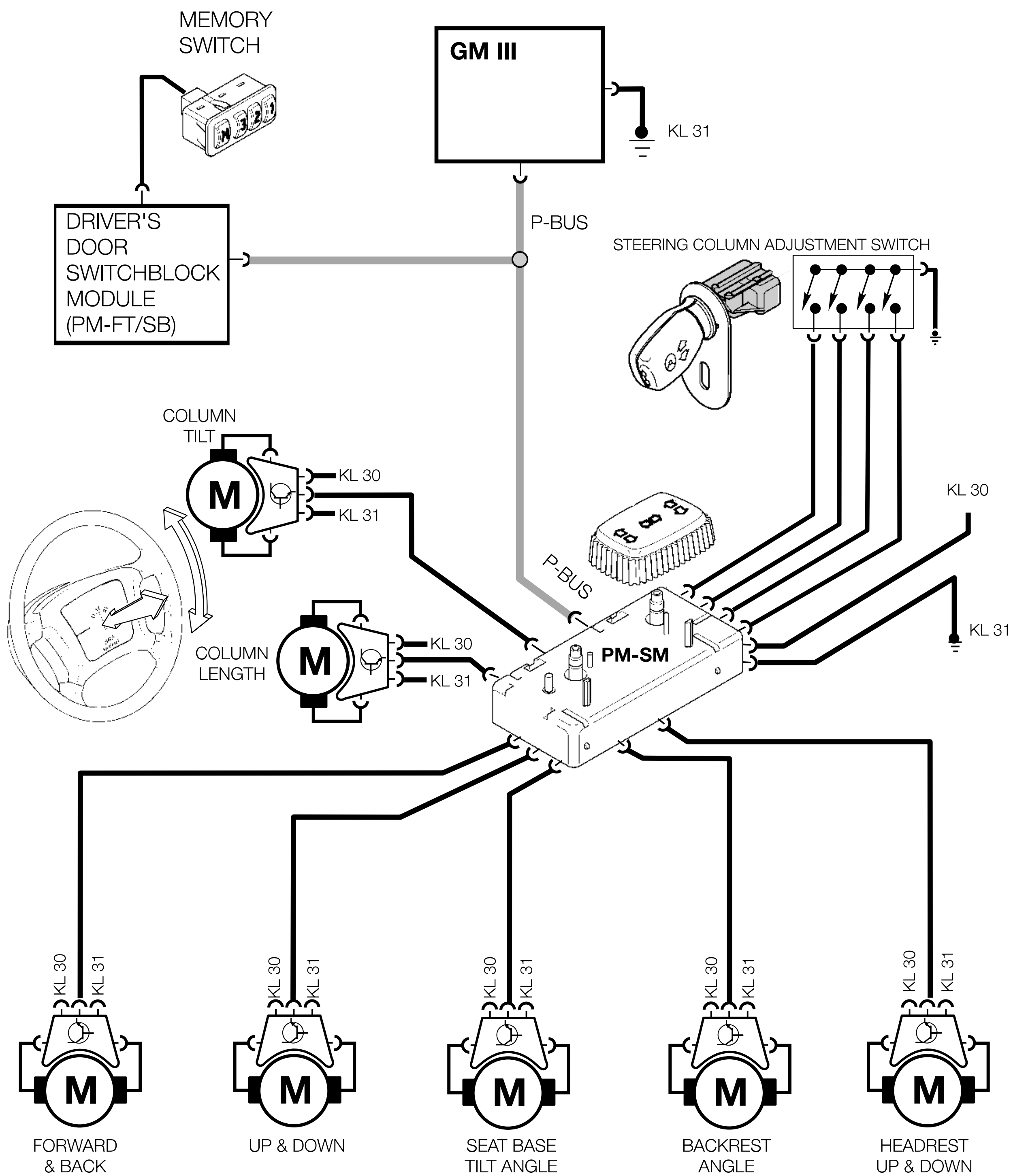
The circuitry of the Ripple Counter detects the motor activation current. As the armature segments of the motor rotate passed the brushes, the current flow rises and falls producing a ripple effect. The peaks of these ripples are counted and stored in the Ripple Counter module. The memory function of the seat module uses this ripple count instead of feedback potentiometers to memorize and recall seat positions.



RIPPLE COUNT RECOGNITION

When the seat is installed and the battery is connected, the ripple counter uses the initial position of the motors as the “Zero Position”. Any movement from this point is counted as “+” or “-” pulses as the motors move in either direction. The pulse position of the motors is stored in the seat module, in an EEPROM, before the ZKE goes into its “Sleep Mode”.

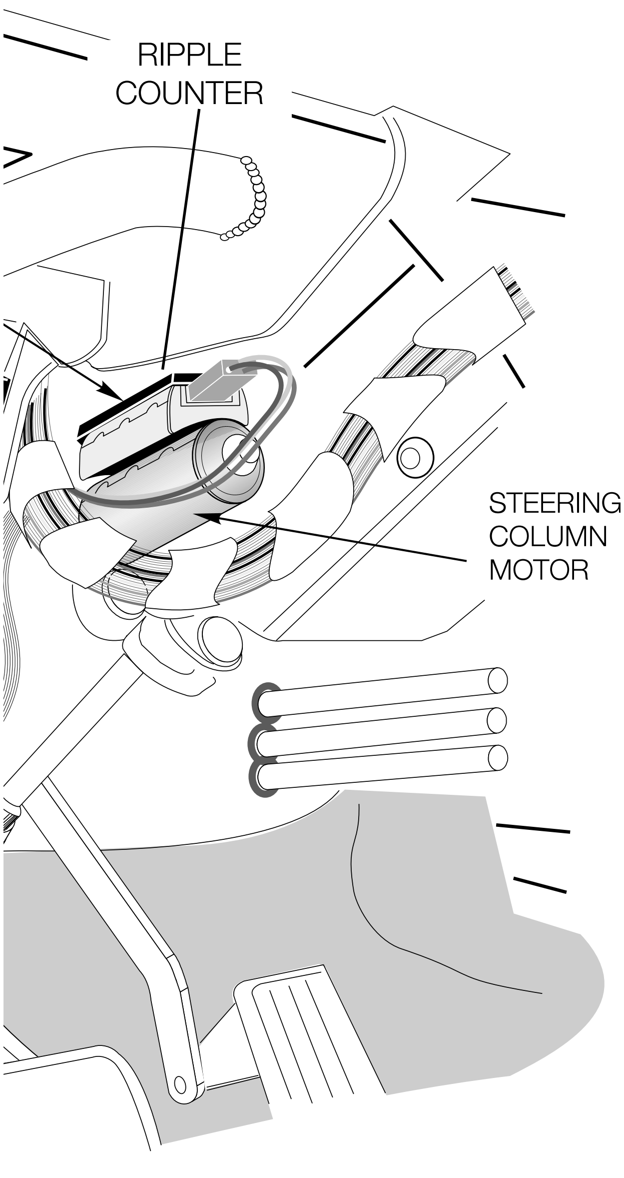
This prevents the position recognition from being lost. If the battery is disconnected before the 16 minute sleep mode activation, the memory positions of the seat will be lost and reprogramming will be required.


MEMORY
SWITCH
GM III
KL 31
P-BUS
DRIVER'S
DOOR
SWITCHBLOCK
MODULE
(PM-FT/SB)
STEERING COLUMN ADJUSTMENT SWITCH
COLUMN
TILT
KL 30
KL 31
KL 30
P-BUS
COLUMN
LENGTH
KL 30
KL 31
PM-SM
KL 31
KL 30
KL 31
FORWARD
& BACK
UP & DOWN
SEAT BASE
TILT ANGLE
BACKREST
ANGLE
HEADREST
UP & DOWN

STEERING COLUMN OPERATION

The adjustable steering column is similar to the E38 in components, mechanical linkages and electrical operation. The steering column adjusting switch is mounted on the left side of the steering column and provides for four directions of column movement.

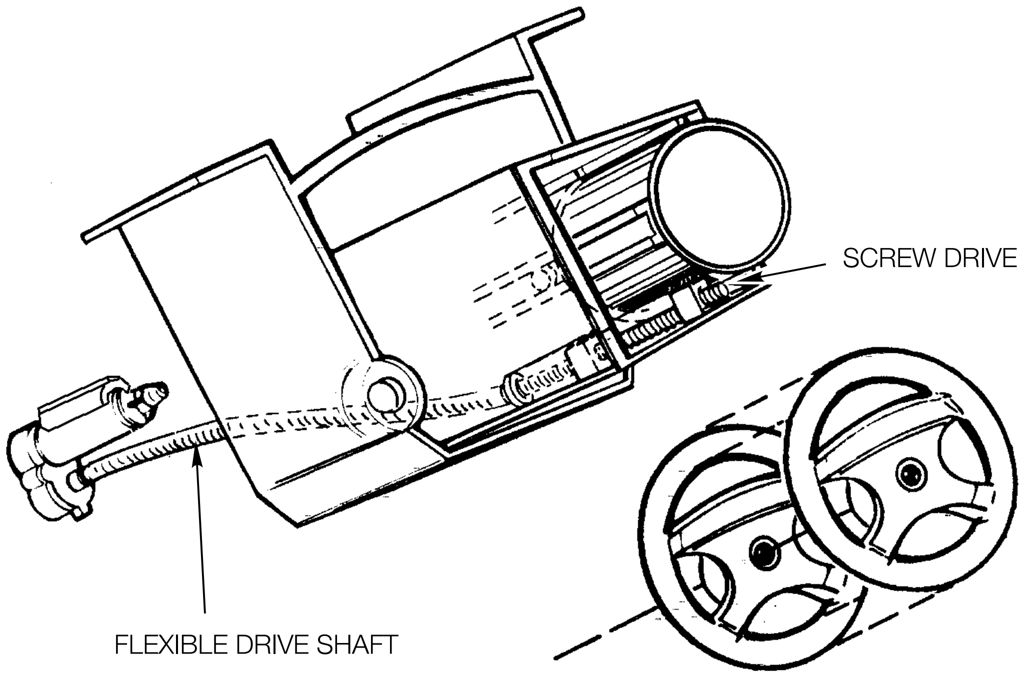
The motors for tilt and length also employ ripple counter modules for motor control and memory recall. The control electronics for the steering column are integrated into the seat module. The steering column switch inputs are processed by the seat module and the output signals are sent to the steering column ripple counter modules for motor activation.



STEERING COLUMN MOTOR DRIVES

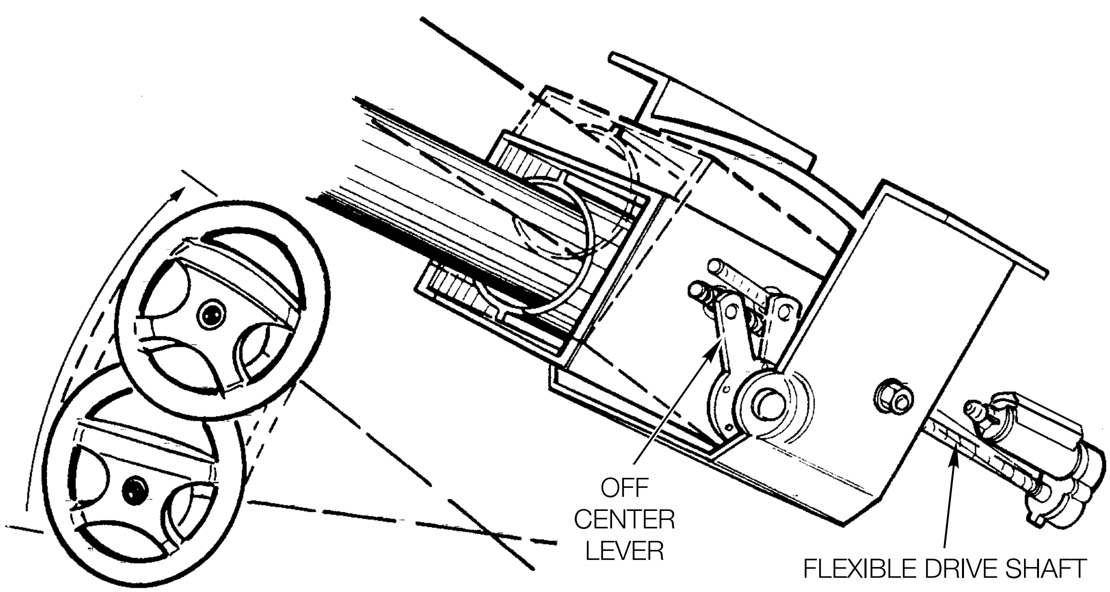
Forward/Back (Telescope)

A flexible drive shaft operates a screw drive which causes a forward/back movement of the steering column.



Up/Down

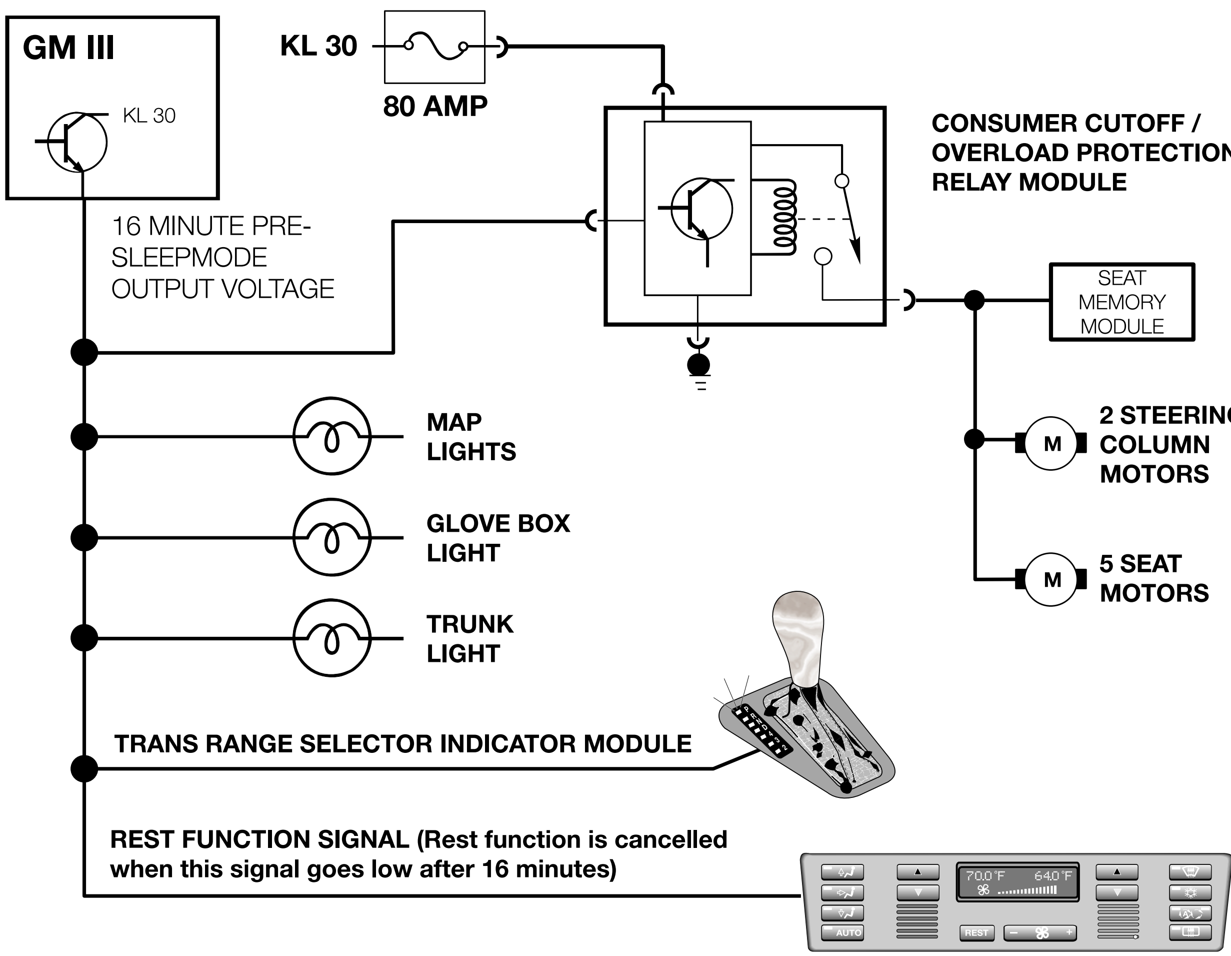
A flexible drive shaft moves an off-center lever causing up/down steering movement.



GENERAL FUNCTIONS OF ZKE III

CONSUMER CUT OFF

The interior lights are connected to the consumer cut out circuit. These consumers are connected to KL 30 and can remain on if one of the control switches are left on. This would prevent the ZKE from going into the sleep mode. However, the consumer cut off will switch Kl 30, to the interior lighting, off after 16 minutes.



OVERLOAD PROTECTION

The seat and steering column motors are provided operating power through the consumer cutoff / overload protection relay module as on the E38. The consumer cutoff signal from the GM signals the relay to maintain operating power to the consumers.

If an overload condition exists, the relay module detects the increase in amperage and opens the relay. The relay module is located in the electrical carrier forward of the glove box.

SLEEP MODE

To lower the constant battery draw when the vehicle is parked, The complete ZKE system will go into the “Sleep Mode” 16 minutes after the ignition has been switched off and no further ZKE function is active.

Approximate X5 Battery draw:

- Ignition switch off = approx 750 mA.
- One minute after = approx. 560 mA.
- After 16 minutes (sleep mode) = approx. 18 mA.

All modules in the ZKE system will go into the sleep mode. The P-Bus remains active, however no data transfer takes place until a wake-up request is received. The general module, door modules or keyless remote module can wake the system up and put the ZKE back on line. The K-Bus is not active in the sleep mode, however the GM III of Remote Entry Module can put the K-Bus back on-line with a wake-up request.

SLEEP MODE CRITERIA: KL R, 15 OFF and no further function activated for 16 minutes.

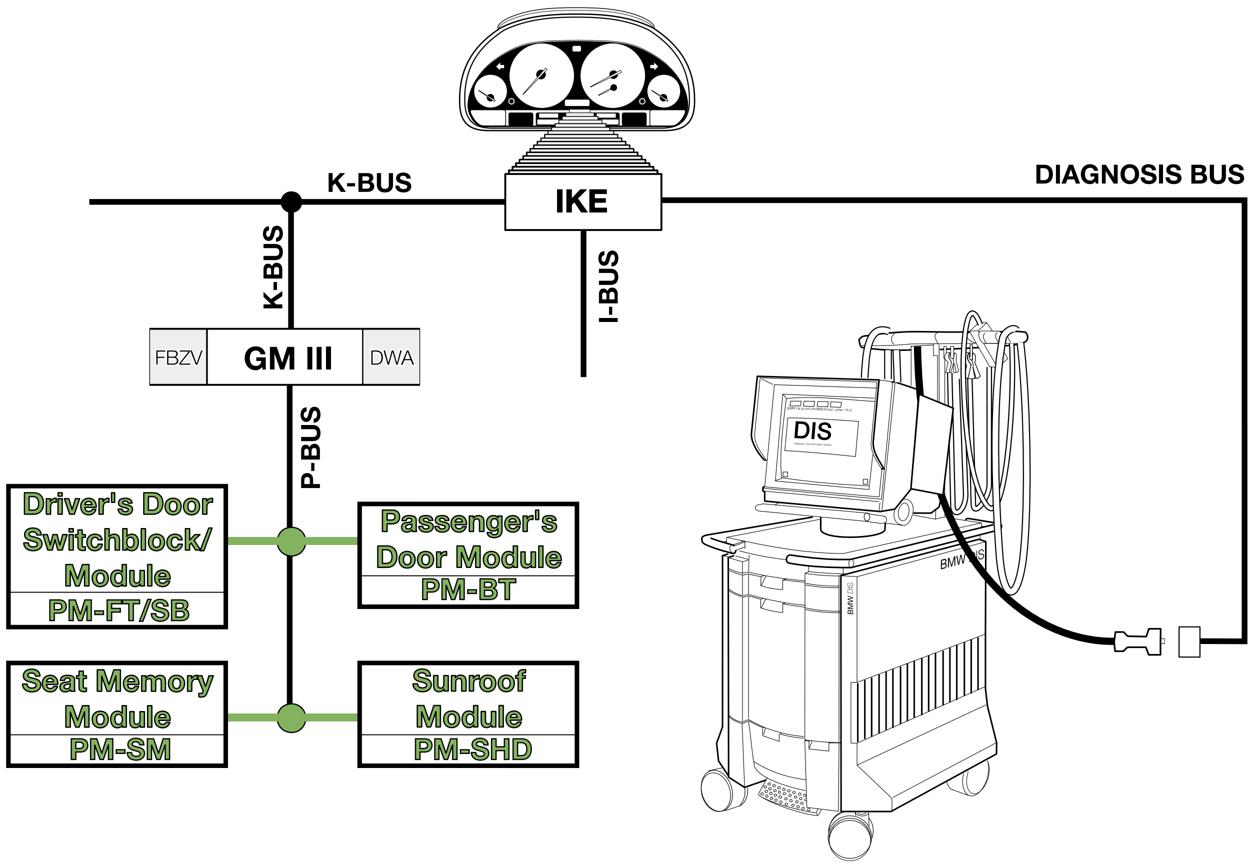
WAKE UP CRITERIA: KL R or 15 “ON” or a change in one of the signal states listed below.

SIGNAL	ACTIVITY	ORIGINATING MODULE
K-BUS	High	General Module
Door jamb switches (possibility of 4)	Low	“
Tailgate lock cylinder microswitch	High	“
Tailgate pushbutton microswitch	Low	“
Interior Tailgate pushbutton microswitch	Low	“
Central locking button	Low	“
Hood microswitch	Low	“
Tailgate microswitch	Low	“
Interior light switch	Low	“
UIS sensor	Low	“
Tilt Alarm sensor	Low	“
FBZV operational signal	High	FBZV Module
Driver’s door lock microswitch - (lock)	High	PM-FT/SB
“ “ “ “ - (unlock)	High	“
Passenger door lock microswitch - (lock)	High	PM-BT
“ “ “ “ - (unlock)	High	“

DIAGNOSIS/TROUBLESHOOTING

The GM III contains an EEPROM fault memory. Faults that occur with any of the sub-systems of the ZKE are stored in the GM III. Diagnosis and troubleshooting is carried out with the DIS tester. The diagnostic link is through the IKE or Instrument cluster over the K bus to the GM.

Additional sub-fault memories are incorporated in all of the peripheral modules. The information stored in these location is used to pin point defective components.



BASIC TROUBLESHOOTING

- Always personally verify the customer complaint.
- Always verify that the complaint is truly a system malfunction.
- Perform a Quick Test to determine if the vehicle systems have logged fault codes.
- Call up the faulted system or appropriate test schedule to verify the correct control module is installed in the car.
- Follow the Diagnostic Information System (DIS) on screen instructions and perform all tests as specified.
- Use the DIS and fault symptom diagnostic procedures as trained.
- Follow the appropriate test module procedures for systems that malfunction but fail to set faults in memory.
- System problems which elude diagnostic procedures must be brought to the attention of BMW of North America, Inc.
- **BMW Technical Assistance Hotline 1-800-472-7222**

Table of Contents

X5 Face Lift

X5 Face Lift

Model: E53

Production: Start of Production MY 2004

OBJECTIVES

After completion of this module you will be able to:

- Recognize the external changes to the X5
- Understand operation of the X-Drive
- Explain mechanical and electrical changes to the X5

X5 Updates

The X5 Face Lift includes both seen and unseen changes. A partial list of the X5 updates is as follows:

- N62 Engine available
- New Engine wiring harness
- New Driveshaft
- Updated emissions for the M54
- 150 Amp generator for the M54
- New wheel designs
- DXC
- New wheel speed sensors
- X Drive transfer case
- RPA
- New Steering Wheel
- New Transmissions
- Bi-Xenon Lights
- Redesigned Tail Lights
- New LCM
- Revised PDC
- New AC compressor
- New Telephone prep
- Redesigned Front End
- Panoramic Sunroof (after 04/04)
- New Colors
- New Interior Trim

Lights

New lighting features for the X5 FL include the following:

- Revised Front Headlights
- Redesigned Taillights

Front Headlights

The front headlights are all new. Both the High and Low beams are now free-form reflectors and no longer use glass lenses. The turn signal now has a clear lens housing, and the parking light uses the optical wave guide technology. Clear rings surround the High and Low beam reflectors.

Out put voltage for the light source module comes from the parking lamp final stage of the LCM IV.

Bi-Xenon

Bi-Xenon lights are optional in the X5 3.0I and standard in the 4.4I Operation is the same as E46.

Taillights

The revised taillights include brake lights, running lights, rear fog lights, reverse and turn signal lights. Similar to the headlights, the lenses have been replaced with a clear lens. Taillight dimensions remain unchanged.

Tail light up to October 2003

Tail light X5 FL

LCM IV

Due to improvements in the LCM, the same LCM unit (IV) may be used for both the halogen and bi-xenon lights.

Check Control Messages

A modified CC message, Check Gas Cap, replaces the old Check Filler Cap.

PDC

Placement of the sensors has changed due to revisions of the front bumpers.

GM3RD

The GM3RD has been Redesigned to accommodate new functions in the X5 FL. While some pin assignments have changed, operation and diagnostics remain the same.
New features of the GM3RD include:

- Revised software and hardware
- Adaptation of HW for Interior Lighting (IB) changes
- Additional Load Deactivation (VA2) to support peripheral control units
- Integration of Soft Close Actuator (SCA)

The primary reason for the redesign of the GM3 was to integrate a new microprocessor. Additionally, other hardware changes were also implemented requiring a new printed circuit board.

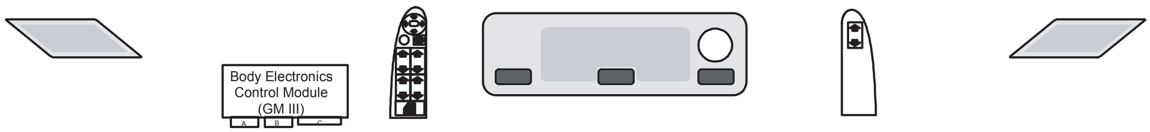
- Semiconductor control of lock activations (not relay)
- Integrated Optical Entry Assist (OEH)
- SCA
- Elimination of heat sink
- Pulse width modulated (PWM) signal for the interior lighting (IB), and reading lights supply line (VA)

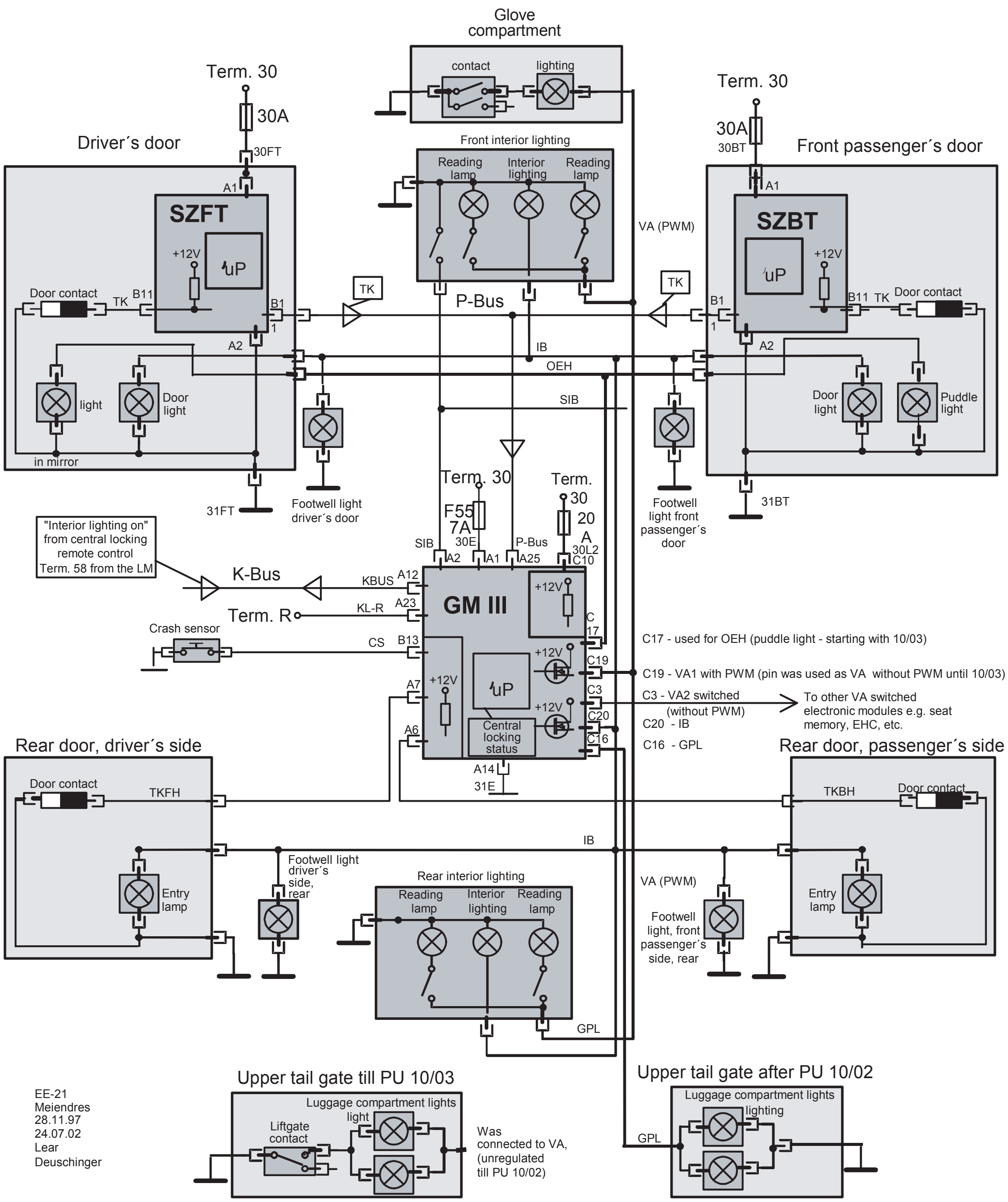
Load Deactivation

Load Deactivation remains the same.

There are now two VA outputs from the GM3RD. VA1 is a PWM signal and VA2 is not PWM.

Interior Lighting Schematic





Softclose Actuator (SCA)

The softclose actuator system for the rear upper hatch is new for the E53 Facelift package. The purpose of the SCA system is to automatically pull the upper lift-gate fully closed once the customer lowers the hatch, and to automatically release the hatch once the opening process is initiated. The controlling function for the SCA is integrated into the GM3.

System Components

- SCA Assembly
  - Locking Pawls
  - Mechanical Components (Gears, springs, etc.)
  - Load Protection Device
  - Motor
  - Hall Sensor system
- Pushbutton Switches
- Relay SCA Open
- Relay SCA Close

SCA Assembly

Prior to this change, a micro-switch located in the upper lift-gate was used to provide the status of the lift-gate to the GM3 body electronics control module. For the 10/03 facelift, the micro-switch has been replaced with Hall Sensors for greater reliability. The hall sensors report the status of the lift-gate to the GM3. The GM3 responds to the status signals and provides the outputs to the relays that control the SCA motor. The GM3 also uses these input signals to control the upper hatch luggage compartment lights and to trigger the DWA anti-theft alarm.

Pushbutton Switches

The upper and lower lift-gates can be opened electrically in the same manner as before by using the respective switches in the upper and lower lift-gate. Additionally, the upper lift-gate can be opened using the center console switch, or the remote key.

The pushbutton switches for the upper lift-gate must be pressed for at least 200 ms in order for an electrical opening of the upper hatch to be initiated.

The SCA motor is not activated if the battery voltage is lower than 9 volts. In a crash situation (crash telegram generated), the lift-gate opening function is blocked for 10 seconds for additional safety.

Relay SCA Open

The GM3 controls the SCA Open relay K112 by applying a ground signal to the relay coil, which switches KL30 voltage to the motor.

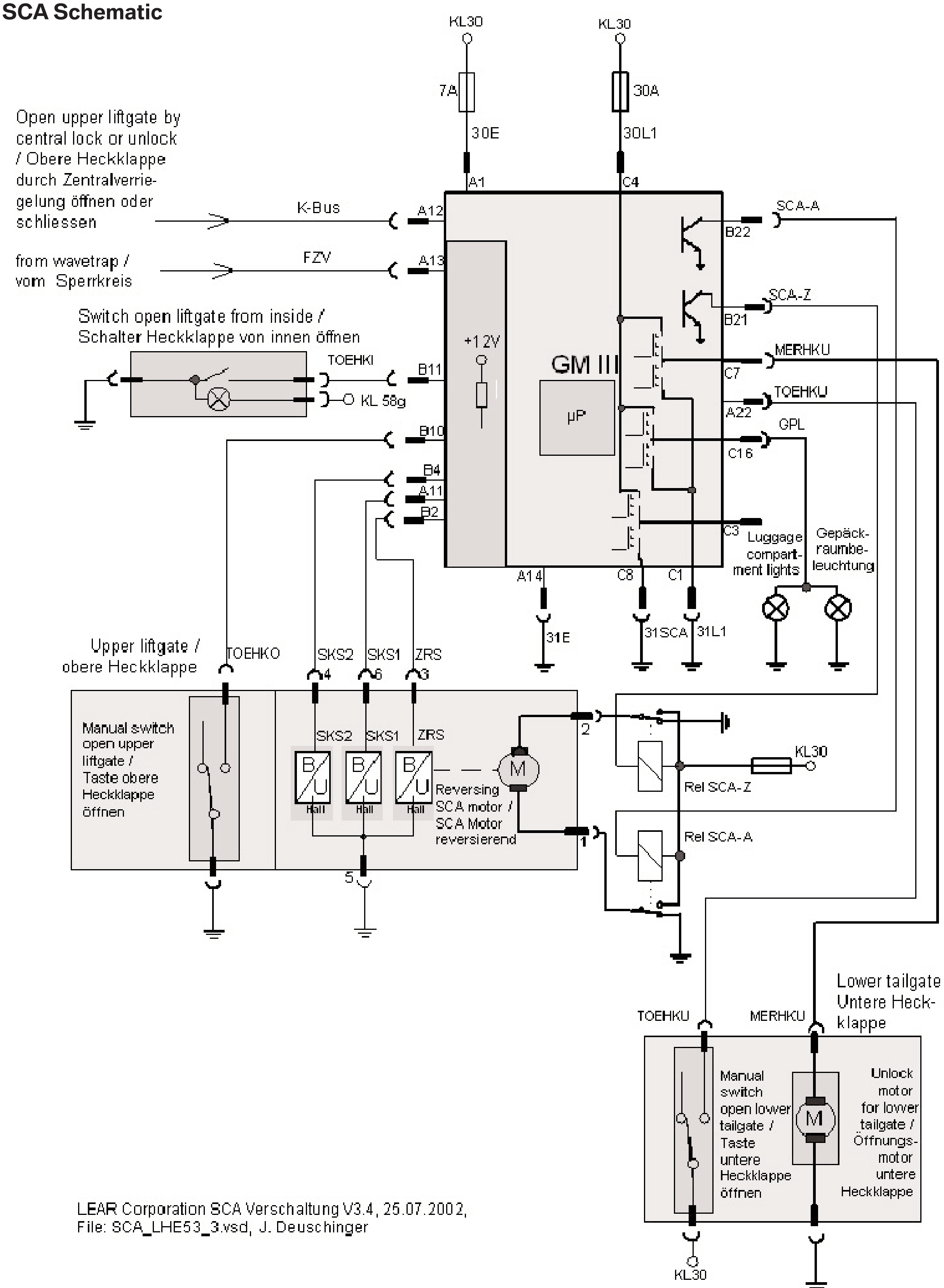
Relay SCA Close

The GM3 controls the SCA Close relay K70 by applying a ground signal to the relay coil,which switches KL30 voltage to the motor pulling the liftgate closed.

SCA Functions

- Disabling of liftgate operation while vehicle is moving
- Disabling of liftgate for 10s following a crash
- Opening of the upper liftgate from the outside/inside electrically via a pushbutton (minimum actuation duration 200 ms) and remote control.
- Opening the lower liftgate via pushbutton on the lower liftgate.
- Dimmed activation and deactivation of the interior lighting and luggage compartment lighting via the body electronics control module.
- The Pawl Sensor is an anti-theft alarm system trigger.
- Activation of the SCA motor in order to automatically close the SCA latch into the primary position after engagement in the secondary position by means of the "pull-closed" function.
- Activation of the SCA motor must occur in order to open the SCA latch when the vehicle is at a standstill.
- Activation of the SCA motor via two relays, activation of the lower liftgate motor and the luggage compartment light directly via the GM3RD

SCA Schematic

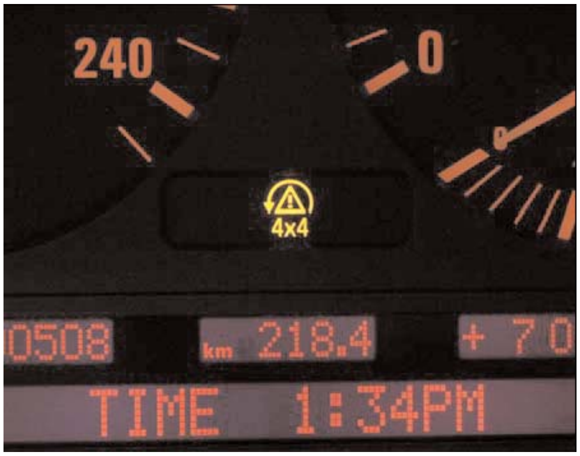


LEAR Corporation SCA Verschaltung V3.4, 25.07.2002,
File: SCA_LHE53_3.vsd, J. Deuschinger

Instrument Cluster

Soft ware and hardware have been updated.

The “Check Gas Cap” CC message and the DCX icon have been added.



MFL

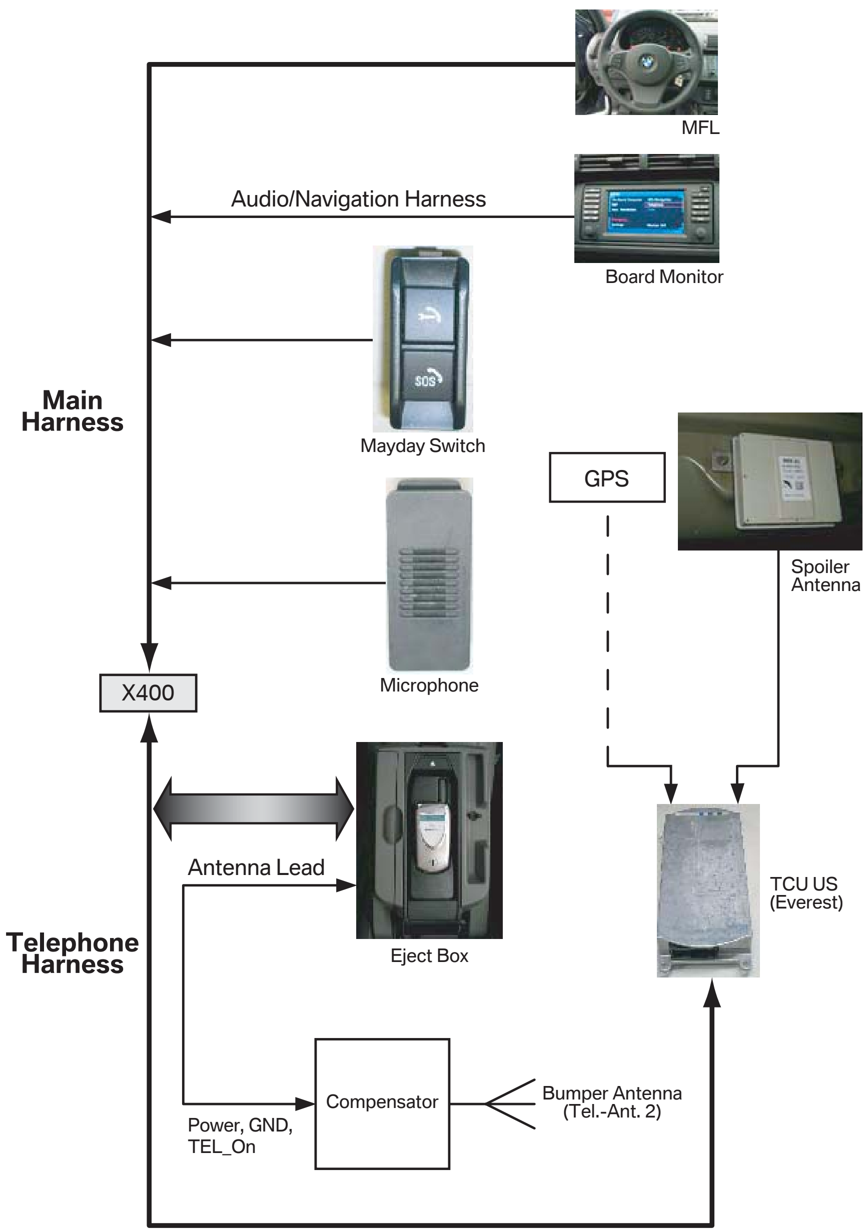
Communication Systems

The Navigation System, Business Radio and DSP Amplifier all have revised software and hardware. While the changes internally may be dramatic, there will no apparent change to the customer.

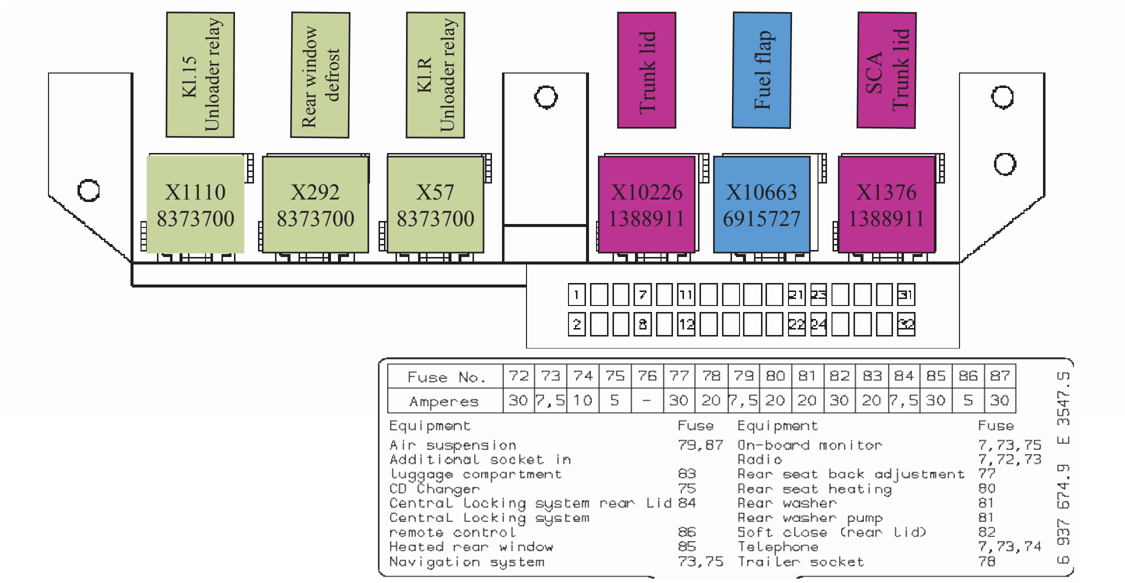
Telephone System

The X5 FL now include a TCU as standard equipment. Operation of the system is the same as E65/E60 equipped with the Everest Platform.

Installation of the eject box, cell phone antenna and compensator will be performed at the dealership.



Fuse and Relay Carrier Layout

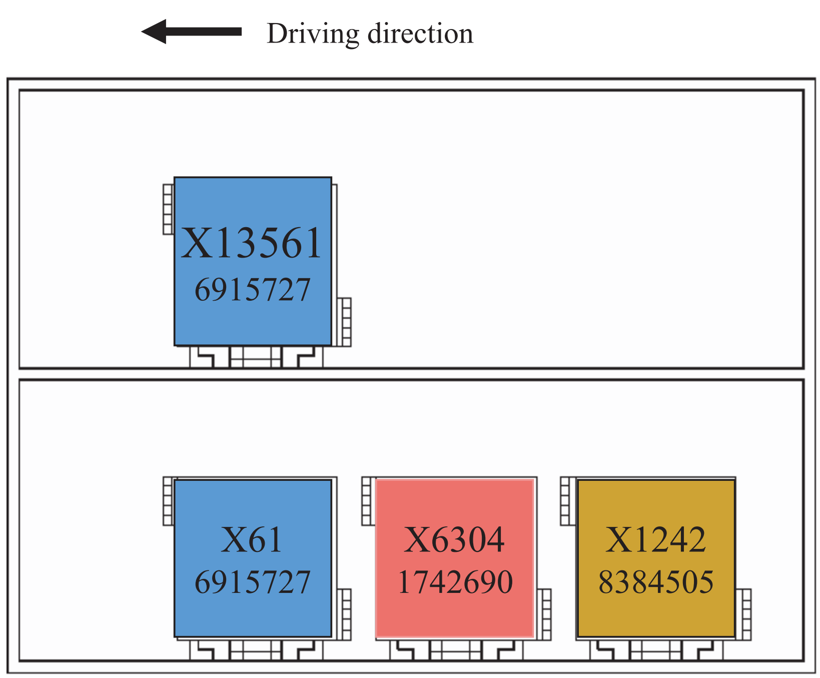


Fuse No.	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87
Amperes	30	7,5	10	5	-	30	20	7,5	20	20	30	20	7,5	30	5	30

Equipment	Fuse	Equipment	Fuse
Air suspension	79,87	On-board monitor	7,73,75
Additional socket in		Radio	7,72,73
luggage compartment	83	Rear seat back adjustment	77
CD Changer	75	Rear seat heating	80
Central Locking system rear Lid	84	Rear washer	81
Central Locking system		Rear washer pump	81
remote control	86	Soft close (rear Lid)	82
Heated rear window	85	Telephone	7,73,74
Navigation system	73,75	Trailer socket	78

Relay Schematic E Box

X 61 High pressure headlight cleaning
X66 KL.50
X1242 wiper module
X6304 secondary air pump



Control Module and Relay Carrier

GM III # 6935890-01
HW 2.5 SW 3.1

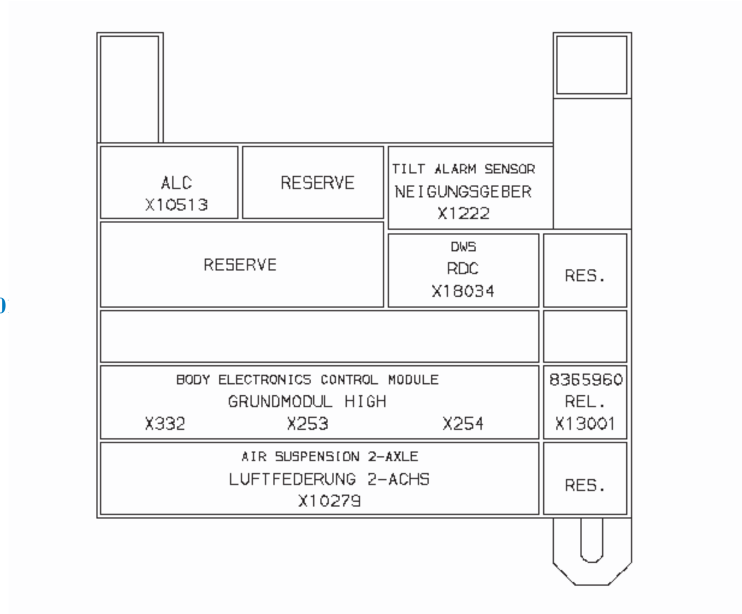
RDC # 6759023-01
HW 2 SW 10
CI 1 DI 2 BI 8

2-axle air suspension # 6758452-01
HW 20 SW 30

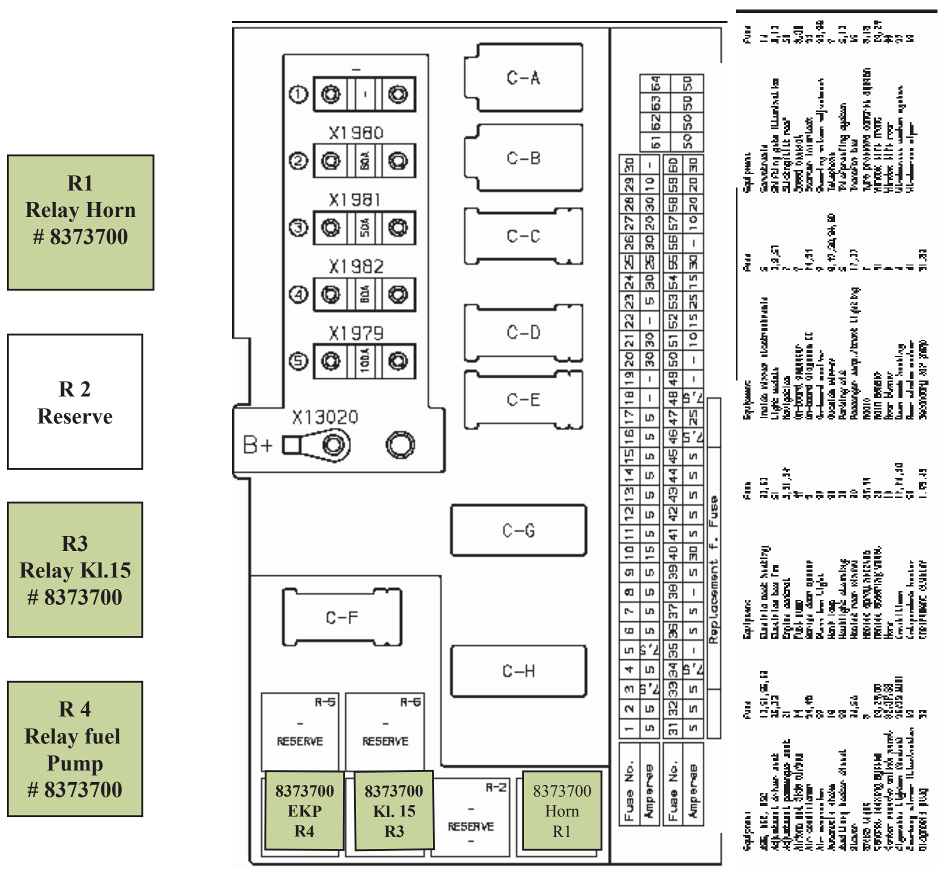
DWA tilt alarm sensor # 6923209-0
HW 04 SW16

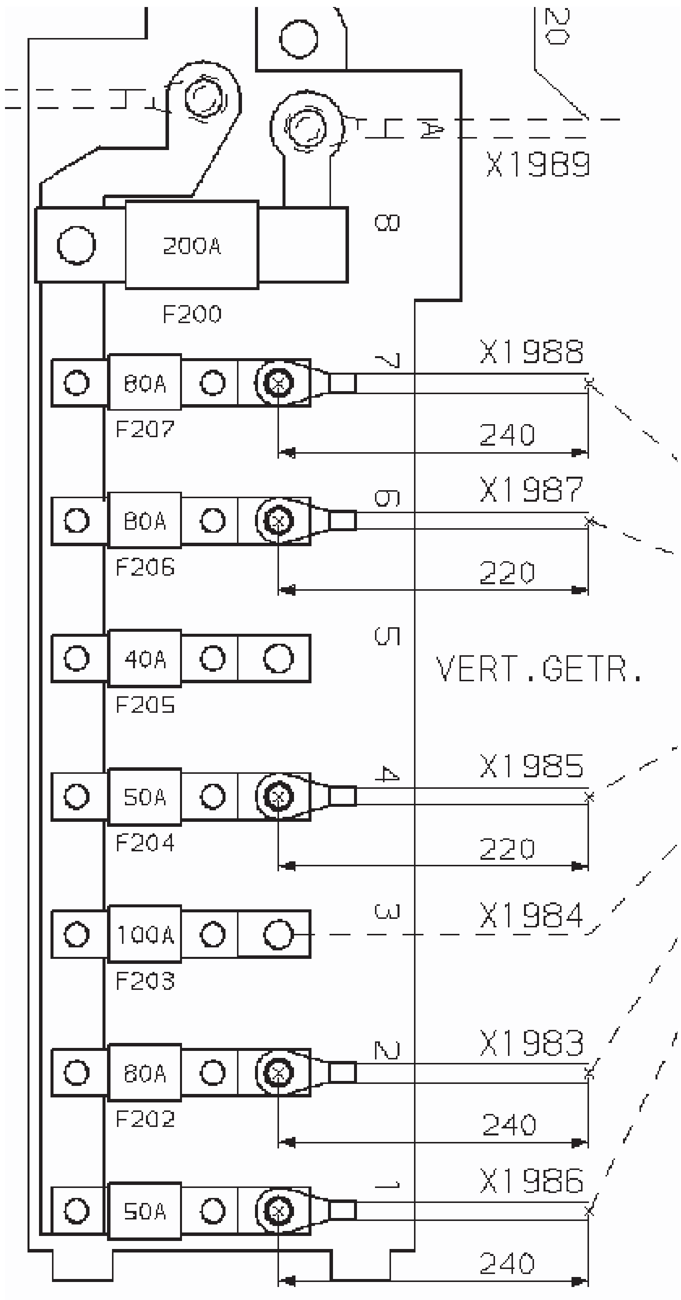
Sleep current relay # 8365960-01

ALC
Part of the 04_2004 package



Power Distribution and Relay Carrier





F 200 >

F 207 >
F 206 >
F 205 > VGSG (Transfer case control) unit

F 204 > relay 2-axle air susp

F 203 >

> F 202 >

> F 201 > trailer module

Components for US Telephone

Oddiments Tray

Spoiler Antenna

TCU

Emergency Call Button

Voice Recognition Jumper

Table of Contents

xDrive / DSC

Initial Print Date: 10/03 Revision Date:

xDrive/DSC

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:

- 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

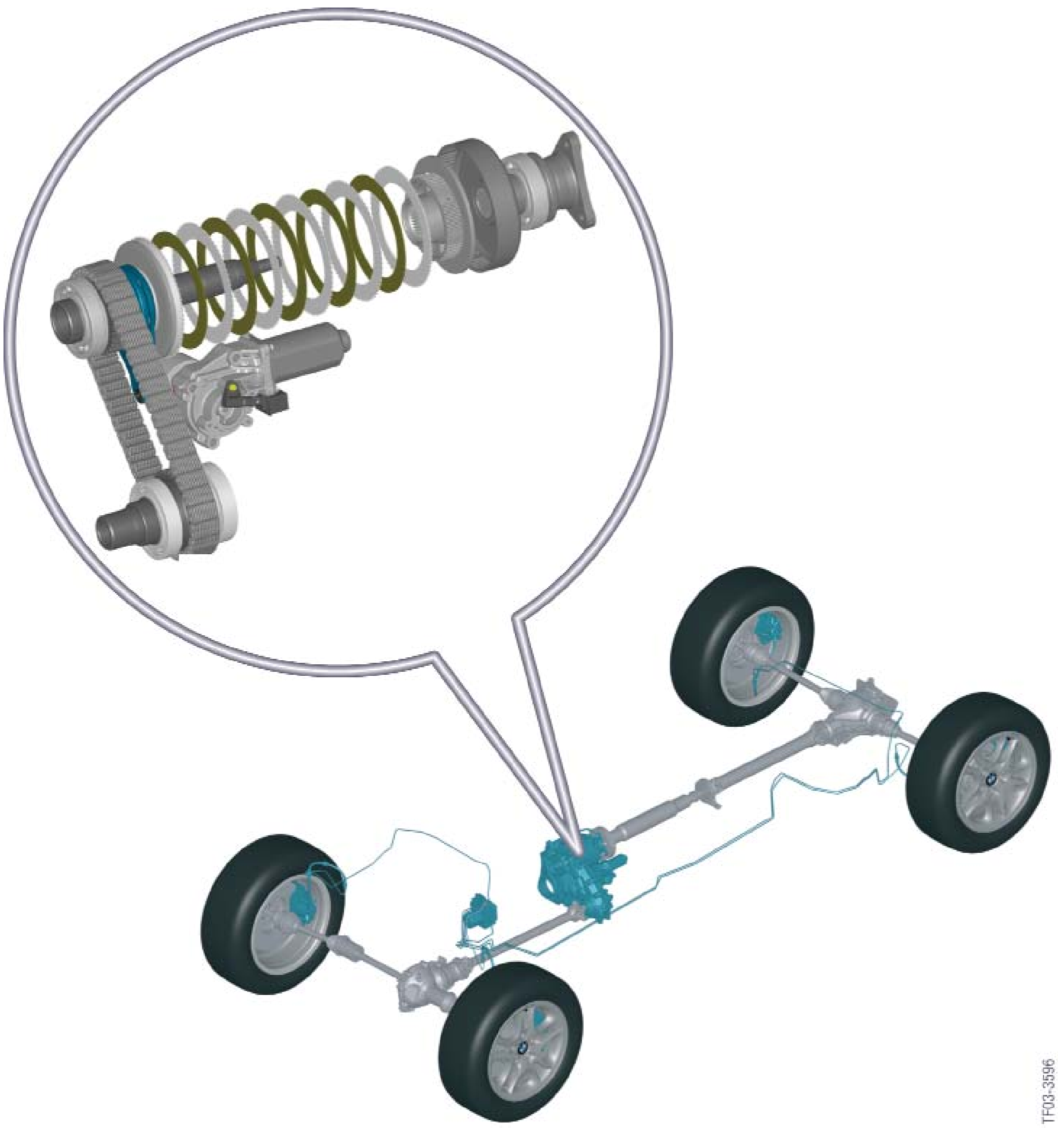
Purpose of the System

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.

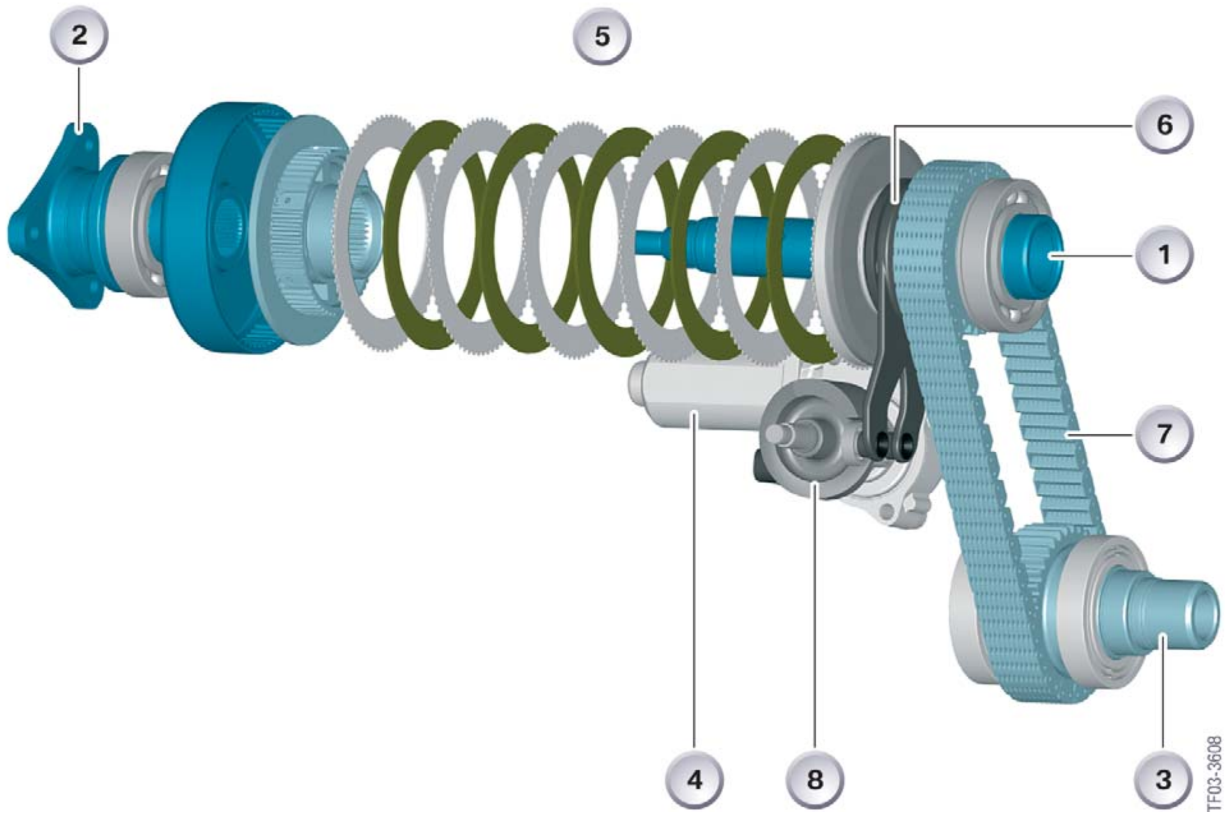
This is achieved through the fact that torque distribution is not determined by a fixed gear ratio in the xDrive as was the case in the previous systems. Instead, the distribution of driving torque is dependent on the locking torque of the controlled multi-disc clutch in the transfer case and on the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

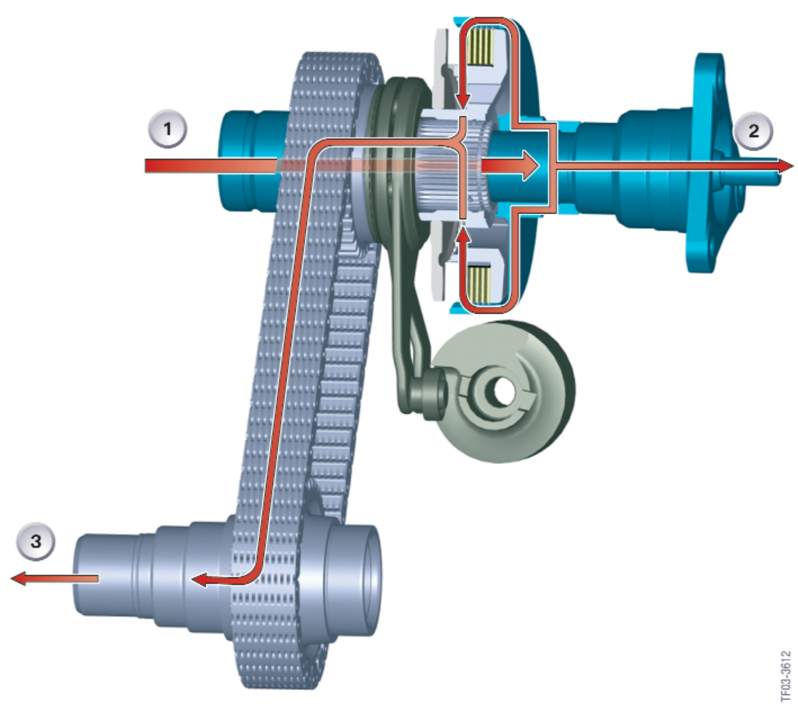
Power Flow

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.

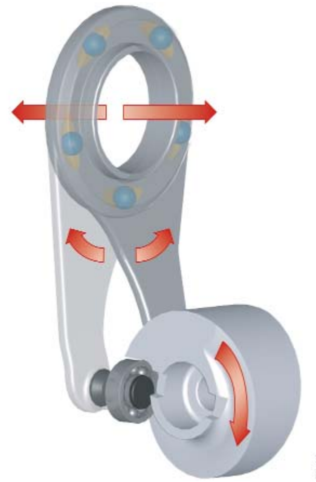
Another example is when the front axle is on a high traction surface and the rear axle is on ice. In this case, virtually 100% of the available driving torque is transmitted to the front axle. Based on available traction, virtually no driving torque can be supported by the rear axle . Obviously, when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

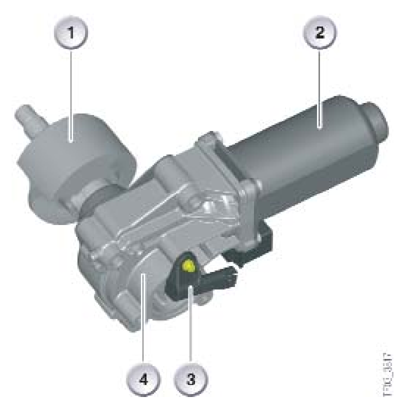
This is proportional to the degree of multi-disc clutch engagement.

Coding Resistor

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.

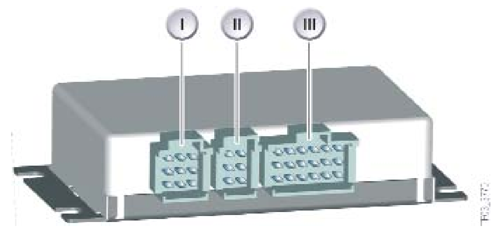


1. Disc cam
2. Electric motor
3. Coding resistor
4. Worm gear

Transfer Case Electronic Control Unit

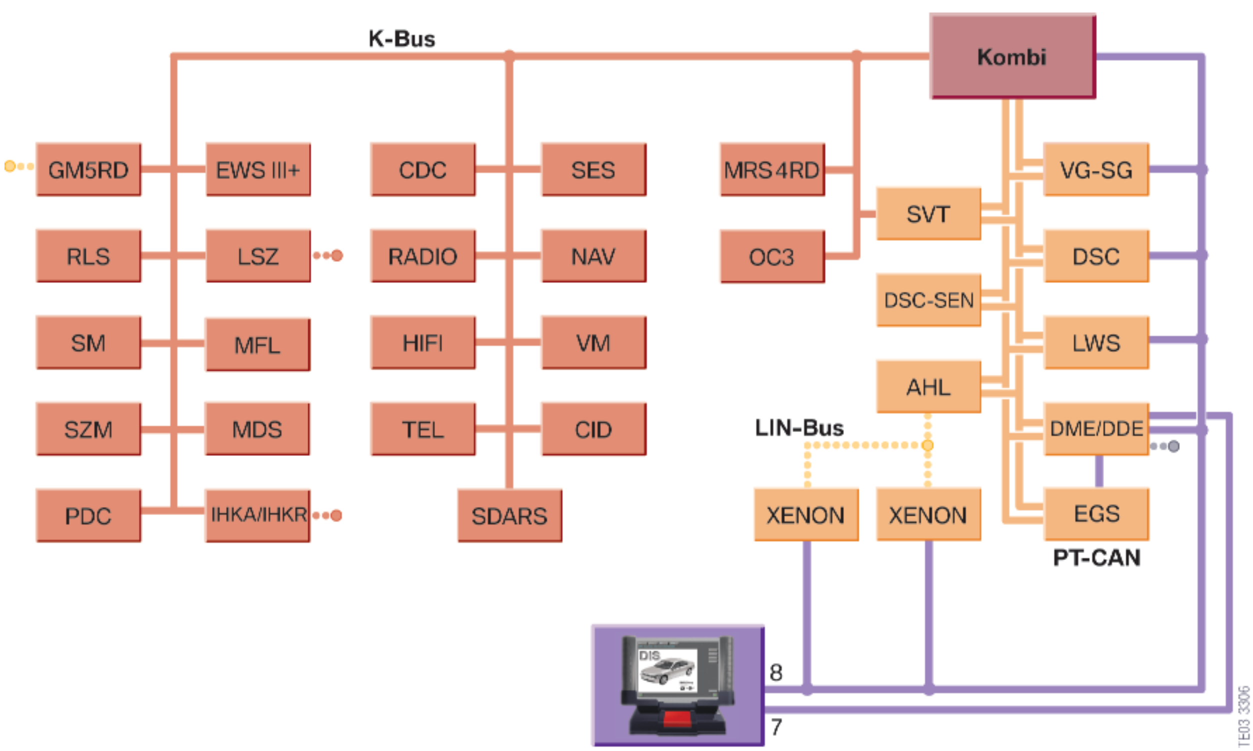
The transfer case control unit (VGSG) is installed in the E83 on the rear floor panel under the luggage compartment trim.

In E53 MU, it is located underneath the rear bench seat on the left.



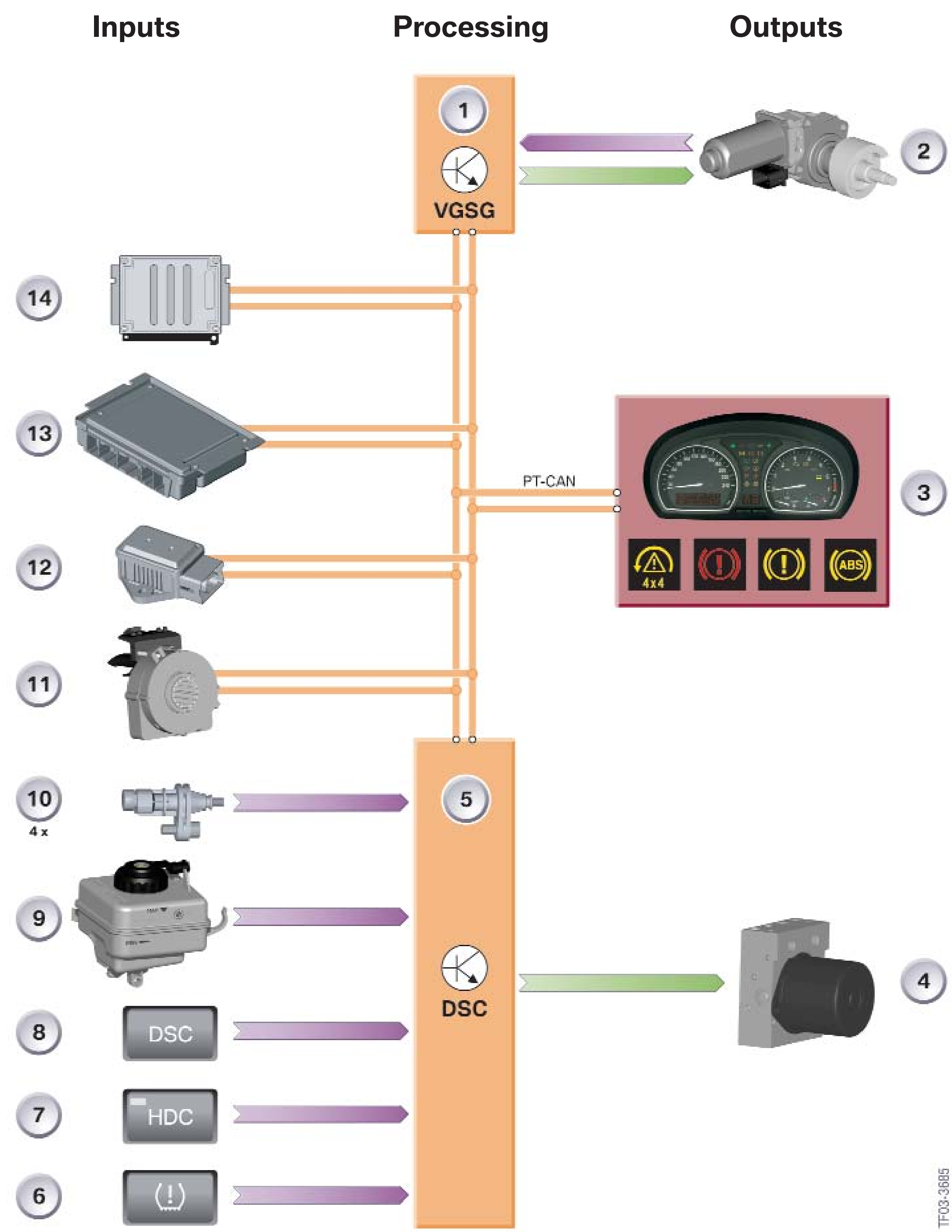
I. 9-pin ELO connector (not used)
II. 6-pin ELO connector
III. 18-pin ELO connector

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 .

Notes:



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:

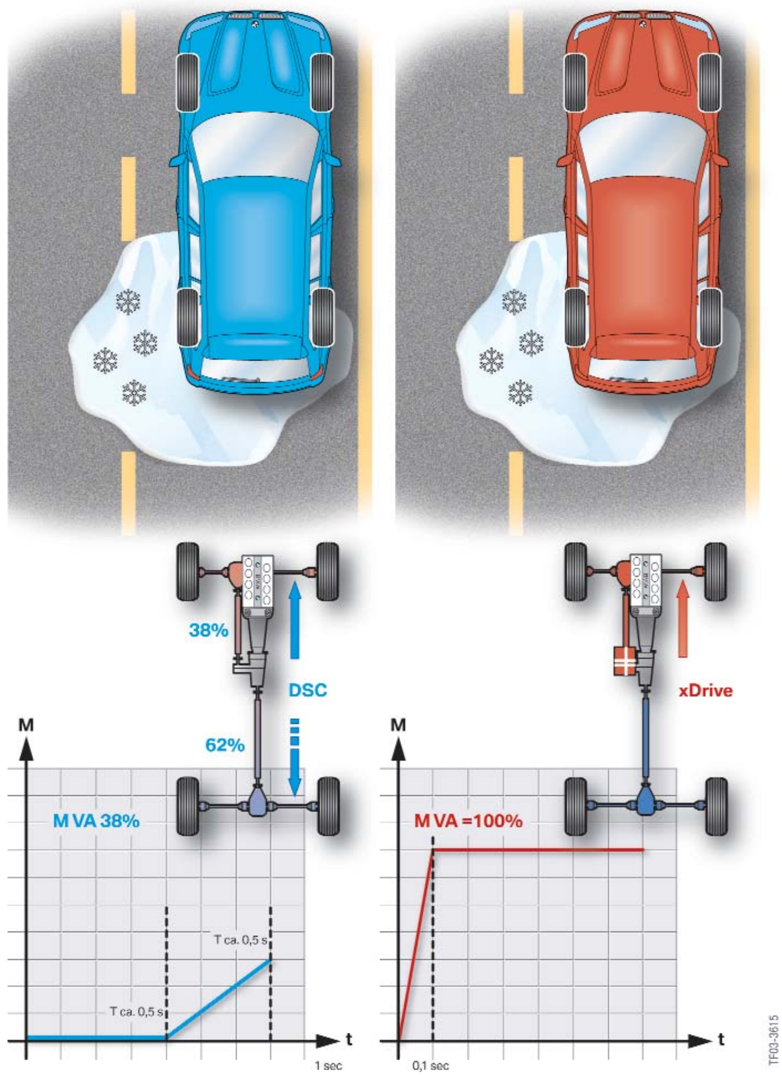
- Accelerator pedal value
- Engine torque
- Engine rpm
- Vehicle speed
- Gear
- Steering angle

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.

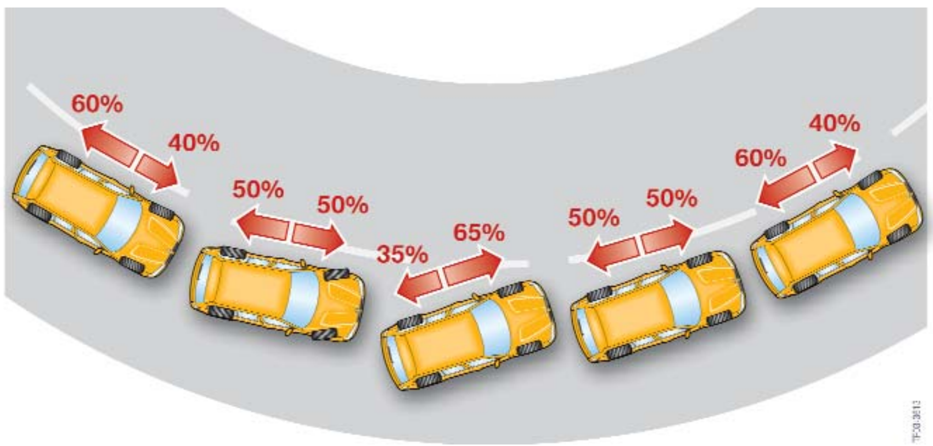
In contrast to an “open” transfer case (differential), the xDrive does not require brake intervention on the rear axle because no slip can occur (permanent through connection). The transfer case clutch is engaging the front axle as the vehicle is accelerating. This takes significantly less time (approx.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

Traction Control / Driving Dynamics Control

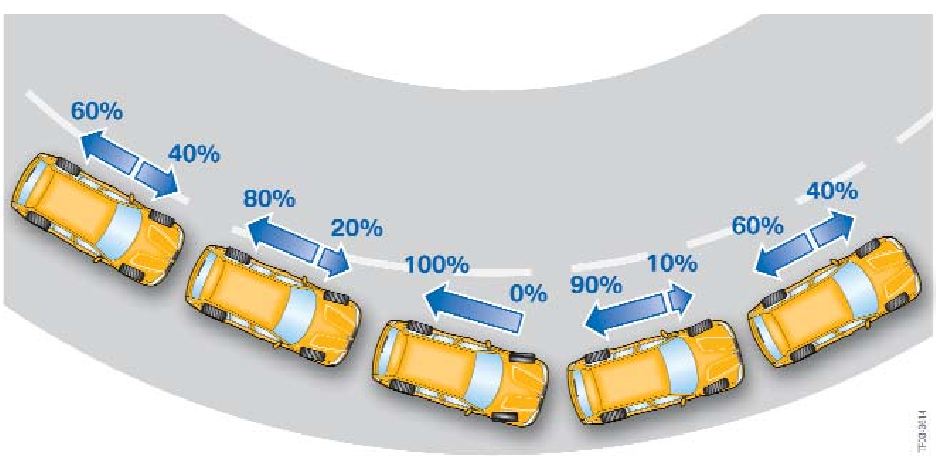
Traction control monitors the slip conditions on the front and rear axles. The wheel speeds, yaw rate and transversal acceleration serve as the input signals.

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:* ________________________

   ____

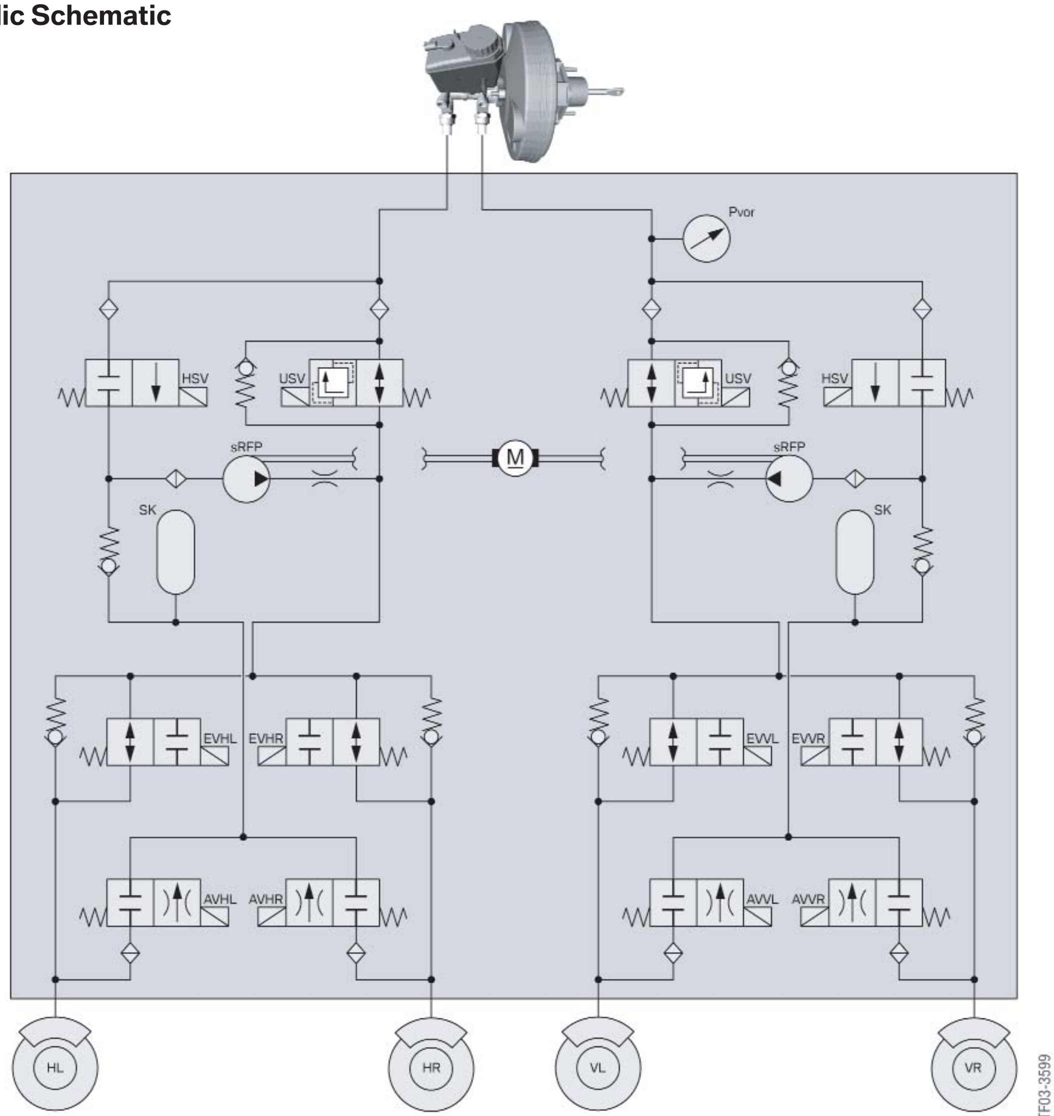
   ____

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

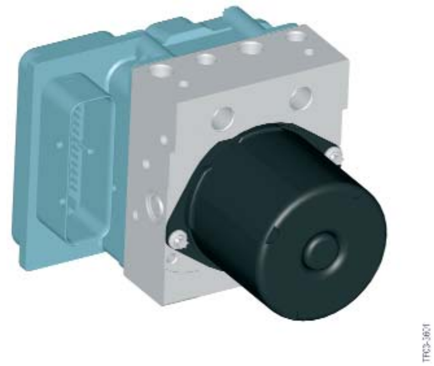
Hydraulic Schematic



DSC Module

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

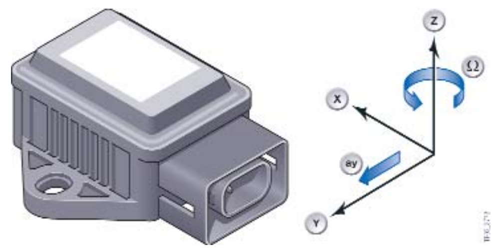
- Surface mounted control unit
- Valve block with integrated pressure sensor
- Pump motor



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

Yaw and Transversal Acceleration Sensors

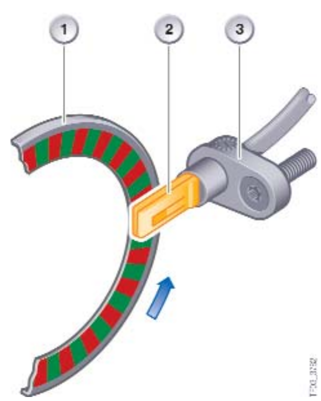
The sensor (assembly) in the E83 and the E53 MU is located on the transmission tunnel at the rear.



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!

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? ____________________

   ____

   ____