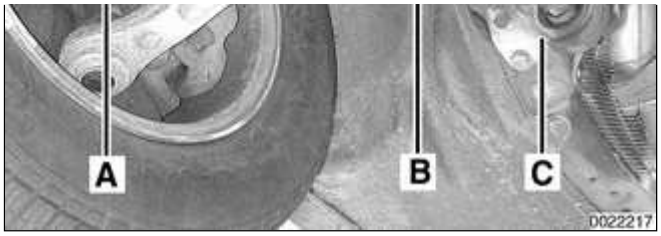


- Each front strut assembly includes a tubular strut housing with an integrated shock absorber and a large coil spring. The upper strut mount includes a coil spring seat and strut bearing. A rubber bump stop limits suspension travel. The steering arm clamps the lower end of the strut assembly. The strut assembly pivots between the upper strut mount bearing and a ball joint on the control arm.

  The front suspension is designed with minimum positive steering offset. This geometry contributes to stability when traction is unequal from side to side.

Front suspension, rear wheel drive cars

The control arms are constructed of forged aluminum. This design lowers the overall weight of the car and reduces the amount of unsprung mass. By reducing unsprung mass, softer, more comfortable springs can be used and accurate handling is maintained.

The three point mounting of each L-shaped control arm precisely controls the front-to-rear and side-to-side position of the strut, while the flexibility of the joints and mounts also allows the movement necessary for suspension travel. The control arm mounting points

are designed with anti-dive geometry. This design reduces the normal tendency for the front of the vehicle to dive under hard braking.

Control arm position is fixed, with no adjustment provisions on the control arms for altering front wheel alignment.

A stabilizer bar mounted to both strut housings helps to reduce body roll when cornering.

Front suspension, all wheel drive

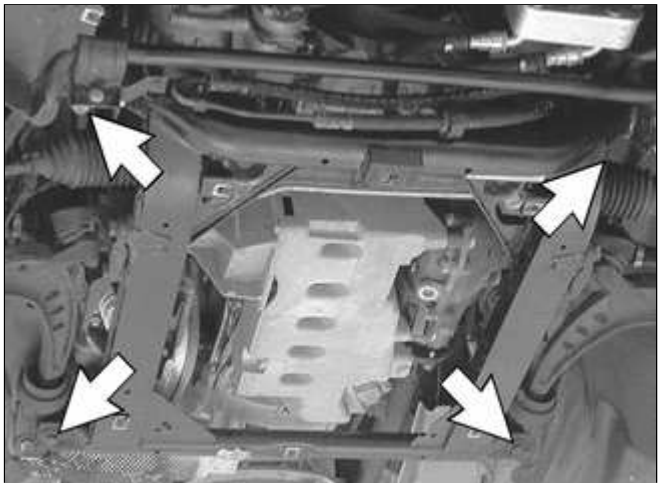
For model year 2001, the E46 Sedan and Sport Wagon are offered with optional all wheel drive. The all wheel drive models are known as 325xi or 330xi.

Note:

The internal BMW designation of these models is E46/16.

The all wheel drive system adds approx. 100 kg (220 lbs.) to the weight of the car. Weight distribution is largely unaffected at 52.7% front, 47.3% rear.

The front suspension for all wheel drive vehicles has been redesigned to provide clearance for the front axle differential and drive shafts. All suspension components are constructed of steel.



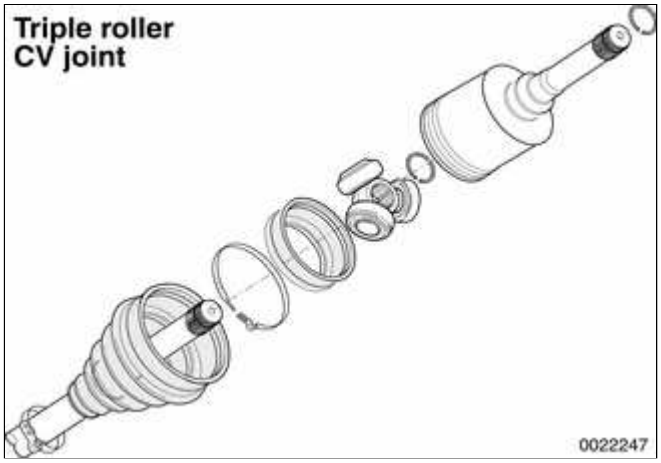
The front subframe consists of two square frame sections welded to two tubes to form a box structure. Four bolts (**arrows**) attach it to the undercarriage of the vehicle.

The steel control arms, smaller than the aluminum arms used on rear wheel drive models, attach at the rear to the subframe. The control arm inner ball joints are bolted to the subframe. The hydraulic engine mounts are different

from the rear wheel drive version and have also been relocated to provide front axle clearance.

The front stabilizer bar has been increased in diameter to accommodate the additional weight. See ⇒ Table a.

The struts are shorter than the rear wheel drive version. Reinforcement plates have been added between the strut upper mounting and the strut towers to prevent sheet metal deformation when traveling on poor road surfaces. The spring travel of the E46 all wheel drive is approximately 20 mm (3/4 in.) less than the rear wheel drive version. The shorter front axle spring travel is due to the limited angle of deflection of the front axle shafts.



Each front drive axle shaft has a conventional constant velocity (CV) joint at the outboard end and a triple roller bearing CV joint at the inboard end. The right inner joint shaft is supported by a bearing pedestal bolted to the oil pan. The shaft extends through the engine oil pan into the front differential.

The front axle differential, bolted to the left side of the engine oil pan, is driven by a 40 mm (1.57 in.) single piece driveshaft. Universal joints are located at both ends of the driveshaft.

The sport suspension option is not available for all wheel drive models.

Steering

The variable-assist power steering system consists of an engine-driven hydraulic pump, a rack-and-pinion type steering gear, and connecting linkage to the road wheels. E46 models utilize an engine-speed dependent variable effort steering system. At low speeds, maximum power assist is provided to

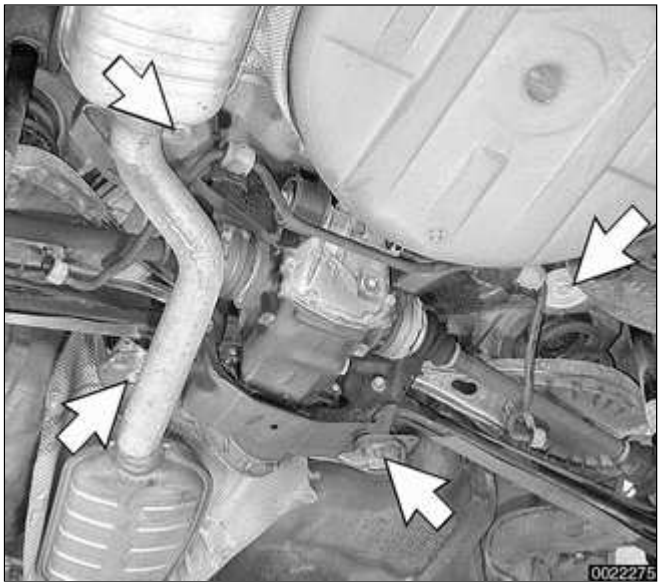
ease parking and city driving. At high speeds, assist is reduced to ensure stability.

The steering linkage connects the rack-and-pinion unit through tie rods to the steering arms. The tie rod ends allow the wheels to pivot and react to suspension travel.

On all wheel drive models, the rack and pinion steering is constructed with a larger diameter piston than the rear wheel drive version. This is necessary to counter the additional drag of the all wheel drive system and the wider standard wheels and tires.

The lower steering column in all wheel drive models connects to the steering rack via a universal joint, whereas there is flexible ("guibo") joint on the rear wheel drive models. The turning radius of the all wheel drive vehicle is 35.8 feet, 1.4 feet greater than the rear wheel drive vehicle.

Rear suspension



The rear suspension subframe (final drive carrier) is the main mounting point for the differential housing and rear suspension components. It is bolted to the vehicle undercarriage using four large rubber bushings (**arrows**).

Trailing arms locate the rear wheels and anchor the springs, shock absorbers and stabilizer bar. Drive axles with constant-velocity (CV) joints at both ends transfer power from the differential to the road wheels. The differential is mounted to the subframe through rubber mounts and bushings to help isolate drivetrain noise and vibration.

In all wheel drive models, the rear suspension and the rear differential have

the same layout as the rear wheel drive version.

The rear suspension travel of the E46 all wheel drive is approx. 17 mm (0.67 in.) less than the rear wheel drive version. The reason for the reduced travel in the rear is to prevent excessive body roll as a result of the higher body profile.

The rear stabilizer bar diameter has been increased to accommodate the additional vehicle weight. See ⇒ Table a.

Table a. E46 stabilizer bars

Model	Front diameter	Rear diameter
Rear wheel drive	23.0 mm (0.906 in.)	18 mm (0.709 in.)
All wheel drive	23.5 mm (0.925 in.)	20 mm (0.787 in.)
Sport suspension (n/a on awd)	24.0 mm (0.945 in.)	19 mm (0.748 in.)

Brakes

E46 cars are equipped with power disc brakes with integral antilock brakes (ABS). The parking brake is a dual-drum system integrated with the rear brake rotors.

Power assist is provided by a vacuum booster when the engine is running. The brake pedal pushrod is connected directly to the master cylinder, so failure of the vacuum booster does not normally result in total brake failure.

Each disc brake uses a caliper with a single hydraulic cylinder. Brake pads in the left front and right rear contain wear sensors. When the pads need replacement, the sensors illuminate a

light on the dashboard.

Tires and wheels

Tire size is critical to the proper operation of the anti-lock brake system and traction control system. Several different styles of wheels in 15, 16, and 17 inch diameters are available from an authorized BMW dealer.

On all wheel drive cars, standard wheel size is 17x 7.0 to ensure there is enough room for the front axles and brakes. Tire size is 205/50 R17.

Tire and rim size applications are listed in ⇒ Table b. Rim and tire sizes.

Note:

Aftermarket wheels should be selected with care. Improperly fitted wheels can contact and damage suspension, brake or body components and may adversely affect vehicle stability.

Table b. Rim and tire sizes

Model	Standard		Option	
	Rim size	Tire size	Rim size	Tire size
323i	15 x 6.5	195/65R 15	16 x 7	205/55R 16
323Ci 325i/Ci 328i	16 x 7	205/55R 16	17 x 8	225/45R 17
328Ci	16 x 7	205/55R 16	17 x 7.5/8.5	225/45R 17 245/45R 17
330i/Ci	17 x 7	205/50R 17	17 x 7.5/8.5	225/45R 17 245/45R 17
325xi 330xi	17 x 7	205/50R 17		

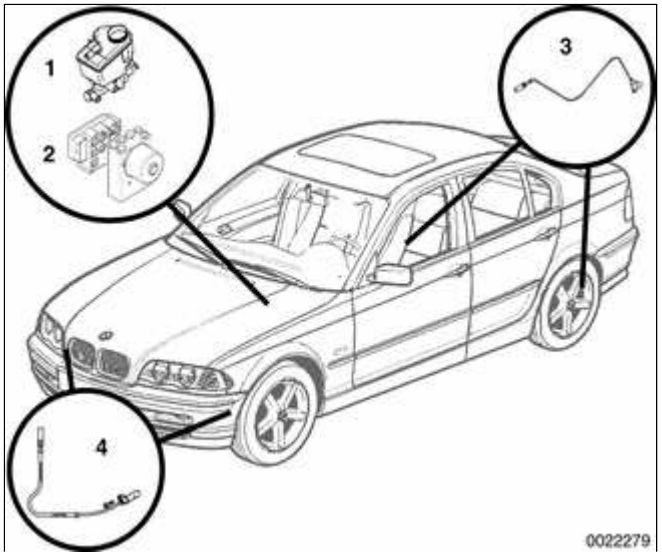
Electronic Brake and Stability Control Systems

All E46 vehicles are equipped with an Antilock Braking System (ABS). Early production models featured ABS with Automatic Stability Control (ABS/ASC). Later models came equipped with ABS and Dynamic Stability Control (ABS/DSC). DSC builds upon the existing ABS/ASC system to provide electronic control of drive and braking systems to insure vehicle stability.

This manual will refer to these systems as ABS. ASC or DSC will be specified when necessary. See the accompanying illustrations for individual system identification.

E46 Electronic braking and stability control systems

ASC



1999 - 2000 Automatic Stability Control Teves MK 20 ASC

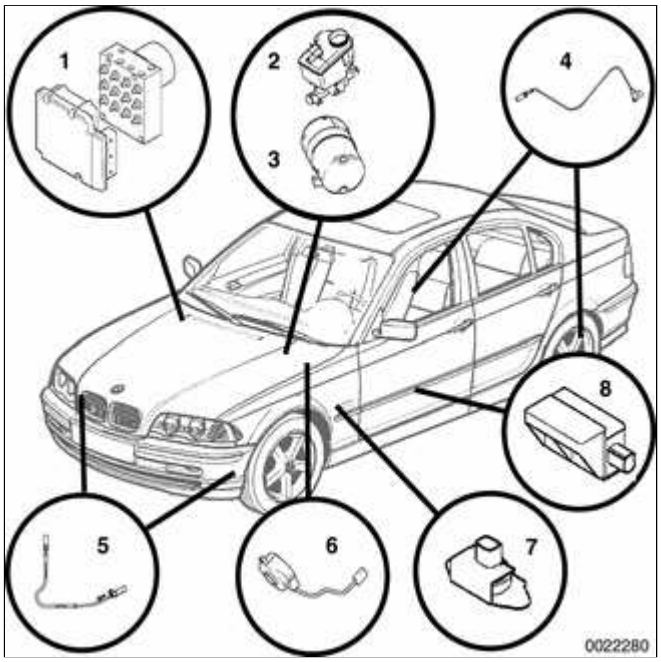
1 - Brake master cylinder and fluid reservoir, left rear of engine compartment

2 - ASC control module and hydraulic unit, left rear of engine compartment under master cylinder

3 - Rear wheel speed sensor, at each rear wheel hub

4 - Front wheel speed sensor, at each front steering arm

DSC



- 1999 - 2000 Dynamic Stability Control Teves MK 20 DSC

1 - DSC control module and hydraulic unit, right rear of engine compartment

2 - Brake fluid reservoir, master cylinder and DSC brake pressure sensors, left rear of engine compartment

3 - DSC precharge pump, left rear of engine compartment, under brake master cylinder

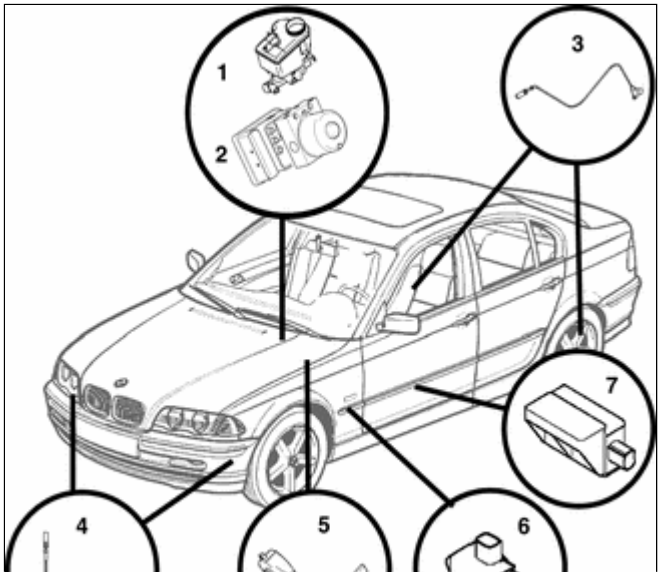
4 - Rear wheel speed sensor, at each rear wheel hub

5 - Front wheel speed sensor, at each front steering arm

6 - Steering angle sensor, at base of upper steering column

7 - Lateral acceleration sensor, behind driver's kickpanel

8 - Rotational acceleration (yaw) sensor, under driver's seat, underneath rug

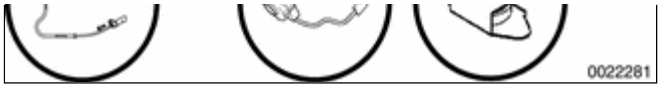


- 2001 rear wheel drive Dynamic Stability Control Teves MK 60 DSC

1 - Brake fluid reservoir and master cylinder, left rear of engine compartment

2 - DSC control module and hydraulic unit, left rear of engine compartment, under brake master cylinder

3 - Rear wheel speed sensor, at each rear wheel hub



4 - Front wheel speed sensor, at each front steering arm

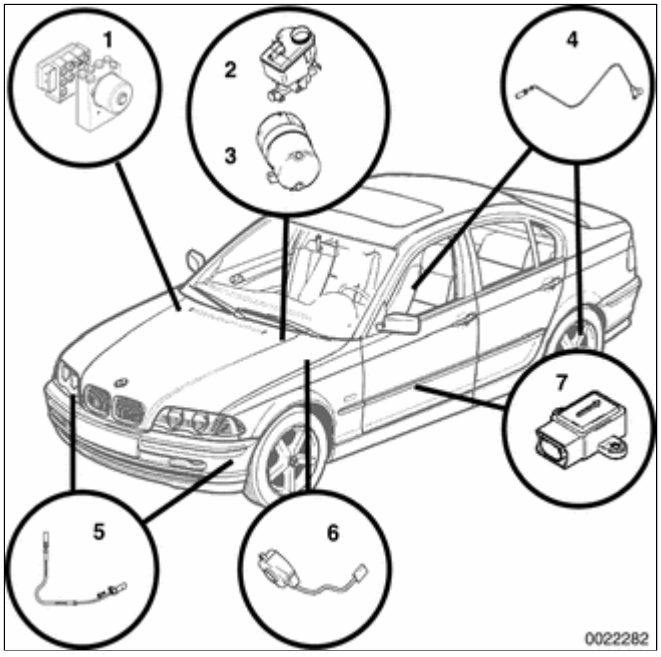
5 - Steering angle sensor, at base of upper steering column

6 - Lateral acceleration sensor, behind driver's kickpanel

7 - Rotational acceleration (yaw) sensor, under driver's seat, underneath rug

Note:

There is no precharge pump in this system.



2001 all wheel drive Dynamic Stability Control Bosch DSC III 5.7

1 - DSC control module, hydraulic unit and DSC brake pressure sensor, right rear of engine compartment

2 - Brake fluid reservoir and master cylinder, left rear of engine compartment

3 - DSC precharge pump, left rear of engine compartment, under brake master cylinder

4 - Rear wheel speed sensor, at each rear wheel hub

5 - Front wheel speed sensor, at each front steering arm

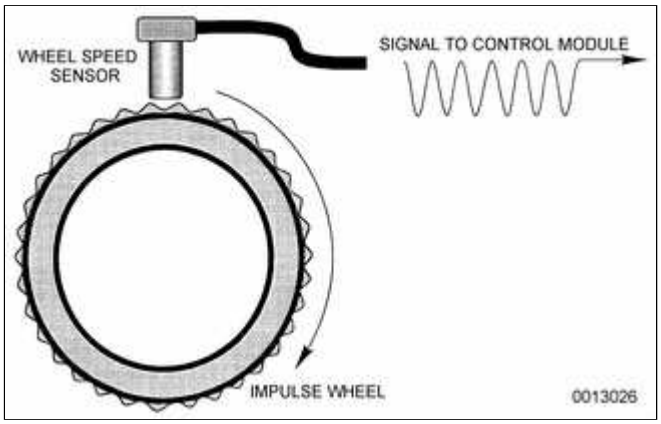
6 - Steering angle sensor, at base of upper steering column

7 - Lateral acceleration sensor and rotational acceleration (yaw) sensor, under driver's seat, underneath rug

ABS system description

The electronically controlled ABS maintains vehicle stability and control during emergency braking by preventing wheel lock-up. ABS provides optimum deceleration and stability during adverse conditions. It automatically adjusts brake system hydraulic pressure at each wheel to prevent wheel lock-up.

The system's main components are the wheel speed (pulse) sensors, the ABS/ASC or ABS/DSC control module, and the hydraulic control unit.



The wheel speed sensors continuously send wheel speed signals to the control module. The control module compares these signals to determine, in fractions of a second, whether any of the wheels are about to lock. If any wheel is nearing a lock-up condition, the module signals the hydraulic unit to maintain or reduce pressure at the appropriate wheel(s). Pressure is modulated by electrically-operated solenoid valves in the hydraulic unit.

Automatic Stability Control (ASC)

The Automatic Stability Control (ASC) system works in conjunction with the Antilock Brake System (ABS) and the engine management system to enhance vehicle control. The main function of the ASC system is to maintain the rolling contact between the tires and the road surface under all driving conditions. This is achieved through exact application and management of braking and drivetrain forces.

Note:

The traction control system referred to as ASC (Automatic Stability Control)

may also be referred to as ASC+T (Automatic Stability Control+Traction).

The ASC system improves traction by electronically applying the rear brakes when the rear drive wheels are spinning at a faster rate than the front wheels. The combined ABS/ASC control module, operating through the ABS hydraulic control unit, modulates braking force at the rear wheels.

In addition, ASC will deactivate individual fuel injectors and override the motor driven throttle to reduce engine torque and maintain vehicle traction. Because the throttle is controlled electronically the driver cannot increase the engine power output during ASC intervention regardless of how far the accelerator pedal is pushed.

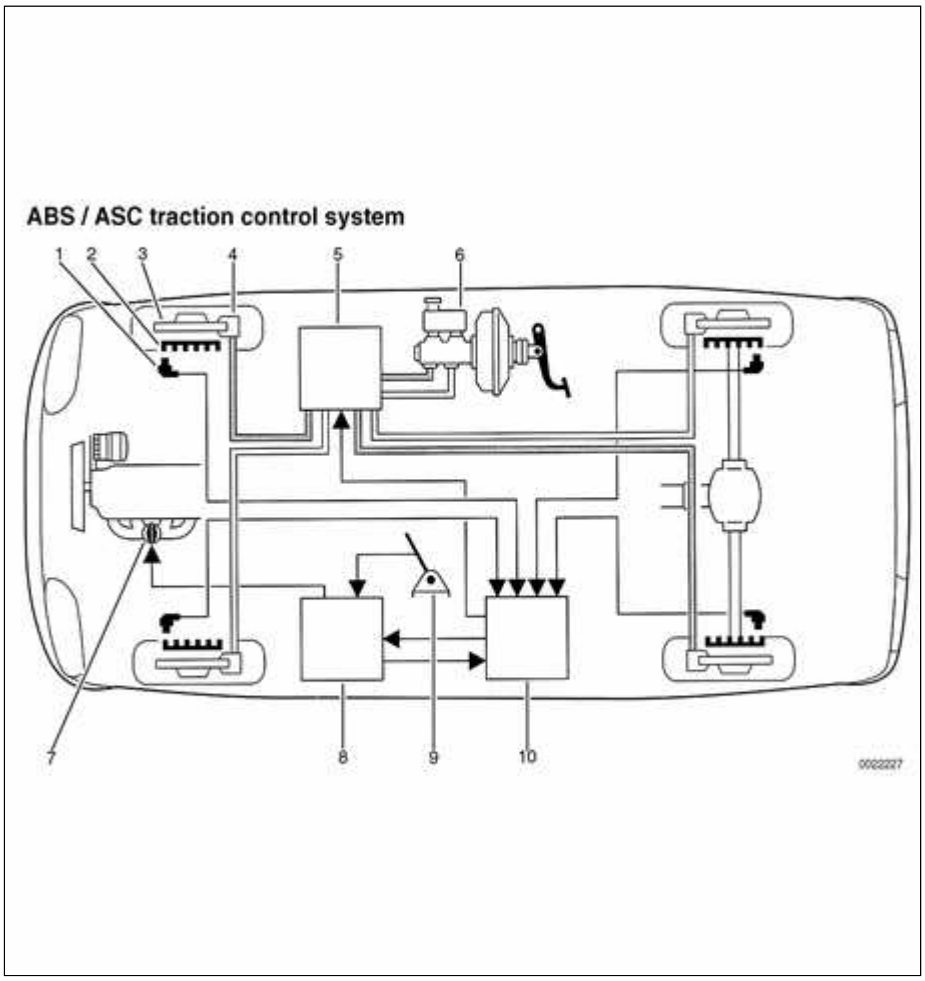
The components that comprise the ASC system also function to replace the limited slip differential available in previous models. Even with the ASC system turned off, if the ASC control module senses a difference in wheel speed (one wheel spinning) the control module will apply modulated braking force to the slipping wheel until traction is regained, but will not override fuel injection function.

Traction control also comes into operation during deceleration. Decelerating on snowy or icy road surfaces can lead to rear wheel slip. If a rear wheel starts to drag or lock up, the ASC system can limit the problem by adjusting throttle, fuel injection and ignition timing.

- A switch on the center console is used to toggle the ASC on or off.

The ASC system is designed to be maintenance free. There are no adjustments that can be made. Repair and troubleshooting of the ASC system

requires special test equipment and knowledge and should be performed only by an authorized BMW dealer. ⇒ Table c. ASC indicator lamp function lists the conditions indicated by the ASC indicator light in the instrument cluster.



ABS/ASC traction control system

1 - Wheel speed sensor

2 - Wheel speed pulse wheel

3 - Brake disk

4 - Brake caliper

5 - ABS/ASC hydraulic unit

6 - Brake master cylinder

7 - Throttle valve

8 - Engine control module

9 - Accelerator pedal

10 - ABS/ASC control module

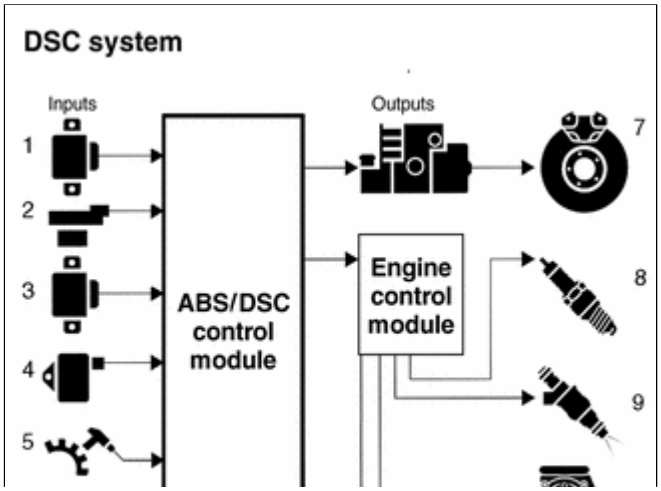
Table c. ASC indicator lamp function

Indicator lamp	Condition	Action / Use
Light on	Normal ASC start-up	Automatic ASC self-test

Indicator lamp	Condition	Action / Use
Light off	ASC monitoring mode	Automatic ASC operation
Press ASC button, light comes on	ASC off (disabled)	Rocking the car to get out of snow or other loose surface Driving with snow chains
Press ASC button, light goes out	ASC monitoring mode	Automatic ASC operation
Light flashes	ASC active mode	Normal ASC operation as it controls wheel speed
Light stays on after start up or comes on while driving	Defect in ASC	Consult BMW dealer for diagnosis/repair (vehicle operation remains normal)

Dynamic Stability Control (DSC)

Dynamic Stability Control (DSC), standard in 2000 and later E46 models, utilizes many principles and components of the ASC traction control system. DSC is active throughout the driving experience, unlike ASC which is only active during acceleration and braking. DSC helps stabilize the vehicle in cornering and avoidance maneuvers by adjusting engine controls such as throttle, ignition, fuel injection and the application of brake pressure to the wheels individually.



The DSC control module uses various inputs to determine vehicle instability during braking, cornering, or reduced traction situations. Based upon these inputs the ABS/DSC control module sends outputs to the engine control module and the ABS/DSC hydraulic unit to activate torque reduction protocols and braking intervention.

Inputs

1 - Lateral acceleration sensor

2 - Steering angle sensor

3 - Rotational rate (yaw) sensor

4 - Brake pressure sensor

5 - ABS wheel speed sensors

6 - Engine control module

Outputs

7 - ABS/DSC hydraulic system

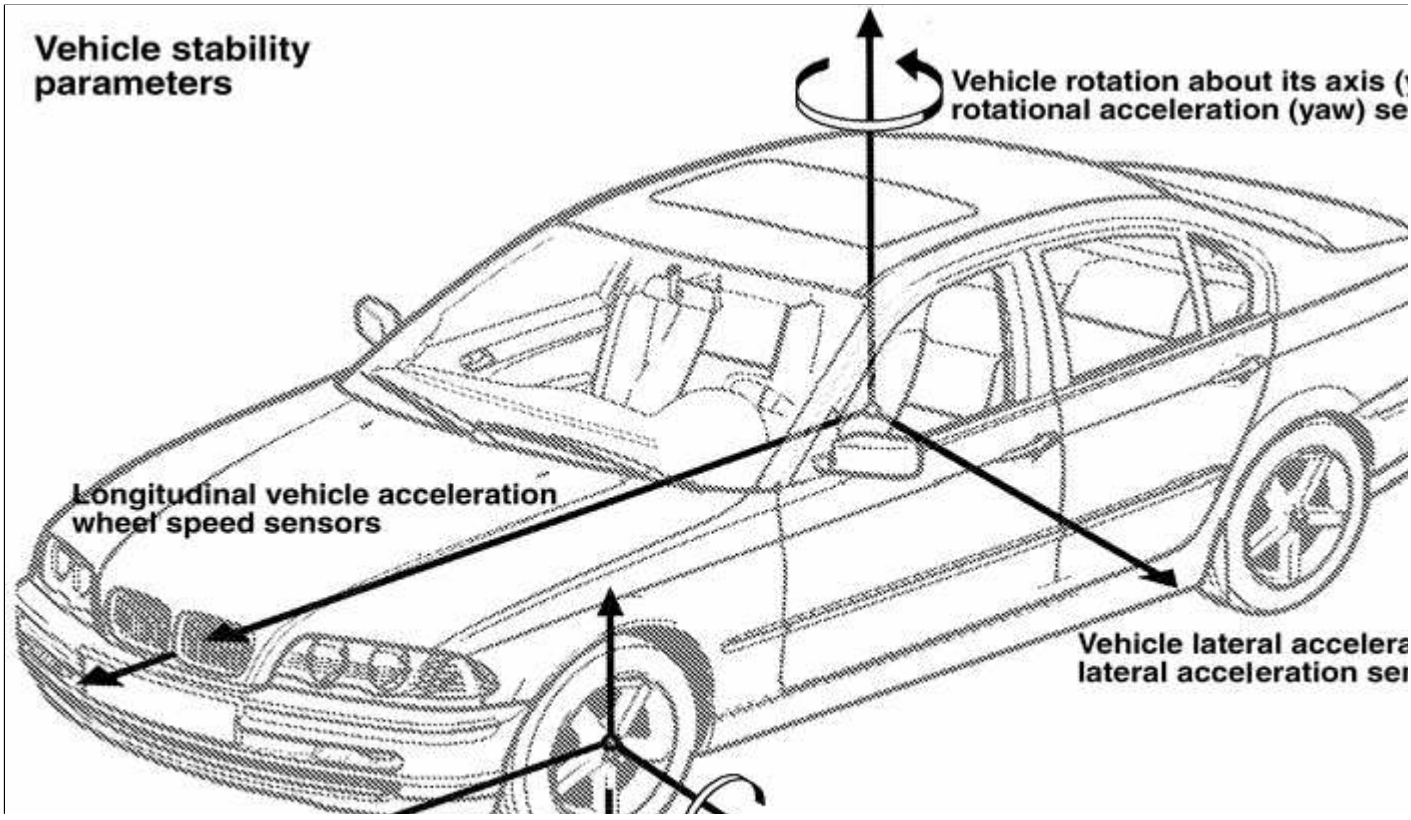
8 - Ignition (spark)

9 - Fuel injection

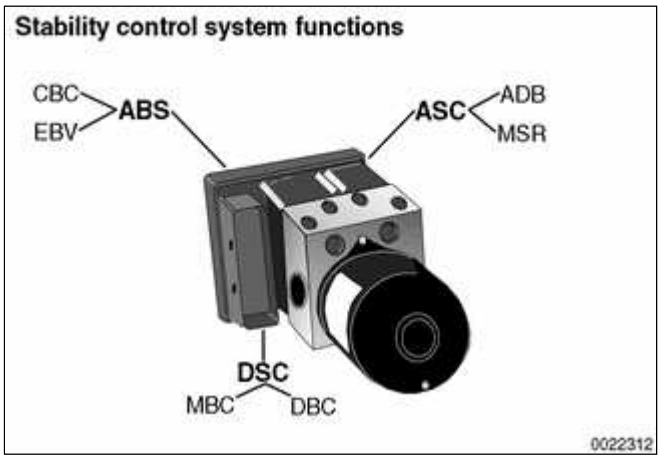
10 - Throttle valve

The DSC system can be toggled on and off by a switch mounted on the center console. Turning off the DSC system does not disable ABS or ASC functions.

Vehicle stability parameters



System functions



Each of the electronic braking and stability control systems include sub-systems which use the hydraulic unit/control module and sensors to carry out additional system functions. The foundation of the stability control systems is Antilock Braking System (ABS) with the following basic functions:

- Cornering brake control (CBC)
- Electronic brake proportioning (EBV)

The Teves MK 20 ASC system functions as a basic ABS system, but adds additional system functions:

- Brake intervention (ADB)
- Drag torque reduction (MSR)

All of the dynamic stability control systems are based on the ABS/ASC system, but add DSC system functions

- Dynamic brake control (DBC)
- Maximum brake control (MBC)

Cornering brake control (CBC)

Cornering brake control reduces brake pressure build up on the inside rear

wheel brake circuit during cornering if activation threshold values are exceeded.

Electronic brake proportioning (EBV)

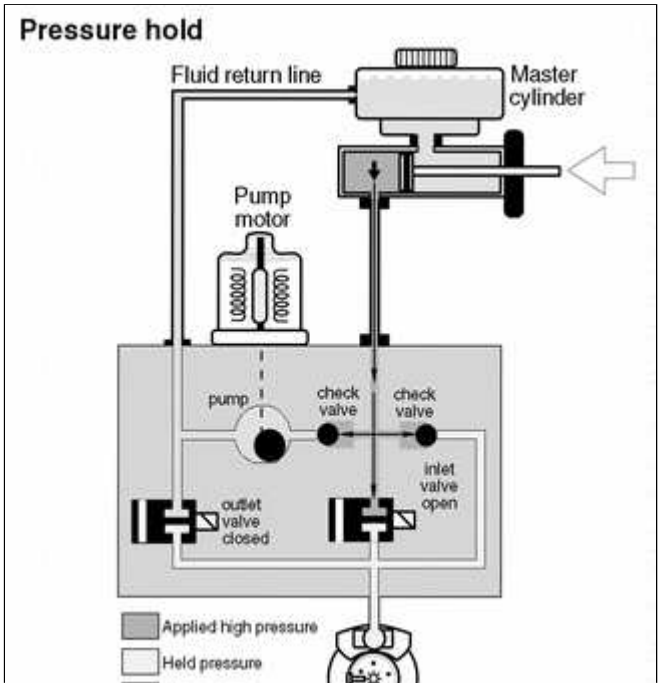
Electronic brake proportioning adjusts braking force to the rear wheels based upon the vehicle's loading, front to rear, to maximize the vehicle's braking power.

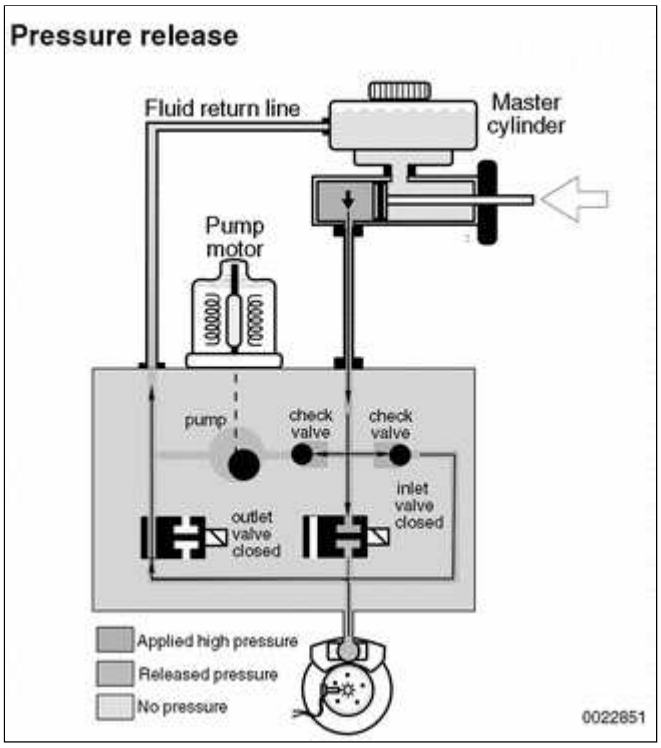
Using wheel speed sensors, the control module compares individual wheel deceleration rates as the brakes are applied. If the difference in wheel speeds exceeds the programmed threshold values, EBV is activated. EBV activation modulates inlet valves to the rear wheels to regulate braking force.

Brake intervention (ADB)

Brake intervention is applied to the individual drive wheel which is losing traction by activating the rear brake calipers in three phases:

- Pressure build
- Pressure hold





- Pressure release

When intervention is necessary:

- The changeover valve in the hydraulic unit energizes and closes inlet valves for the two front wheels and the rear wheel with traction.
- The rear brake circuit intake valve is energized and opened to rear wheel without traction.
- Return/pressure pump is activated and draws in brake fluid from the master cylinder and delivers pressurized brake fluid to wheel without traction.
- Pressure hold and pressure release cycles are run by cycling inlet and outlet valve to rear brake caliper without traction.

Drive torque reduction

In low traction conditions, the ABS control module request is sent to the engine control module (ECM) via the CAN-bus. The ECM accomplishes torque reduction by implementing the following measures:

- Reducing throttle opening angle
- Retarding ignition
- Cutting off individual cylinder fuel injectors

Drag torque reduction (MSR)

During deceleration and engine braking conditions engine drag torque can cause the rear wheels of a vehicle to lock on low traction surfaces, especially in high speed, low gear driving. This can lead to loss of traction in the rear. When drive wheel speed is slower than front wheel speed the ECM will suspend vehicle coasting by increasing throttle opening angle and engine torque.

Dynamic brake control (DBC)

The DBC function provides increased braking pressure, up to ABS threshold, during emergency braking situations. The DSC control unit will implement DBC function when brake pressure builds rapidly with application of the brake pedal.

DBC triggering conditions:

- Brake light switch on
- Brake pressure in master cylinder above ABS threshold
- Brake pressure build up speed above threshold
- Vehicle road speed above 3 mph
- Pressure sensor self test completed and sensors OK
- Vehicle travelling forward
- Not all wheels in ABS regulation range

When DBC function is activated, braking pressure will increase at all wheels up to the ABS regulation point. DBC will continue until the driver releases the brake pedal, brake pressure drops, or the vehicle slows to under 3 mph.

Maximum brake control (MBC)

Maximum brake control is designed to assist in stability control by increasing rear brake pressure when the front wheels are under ABS regulation. MBC intervention is triggered when the brakes are applied too slowly to reach DBC threshold.

MBC triggering conditions:

- Both front wheels in ABS regulation
- Vehicle speed above 3 mph
- DBC and pressure sensor self test completed and OK
- Vehicle travelling forward
- Rear wheels not under ABS regulation

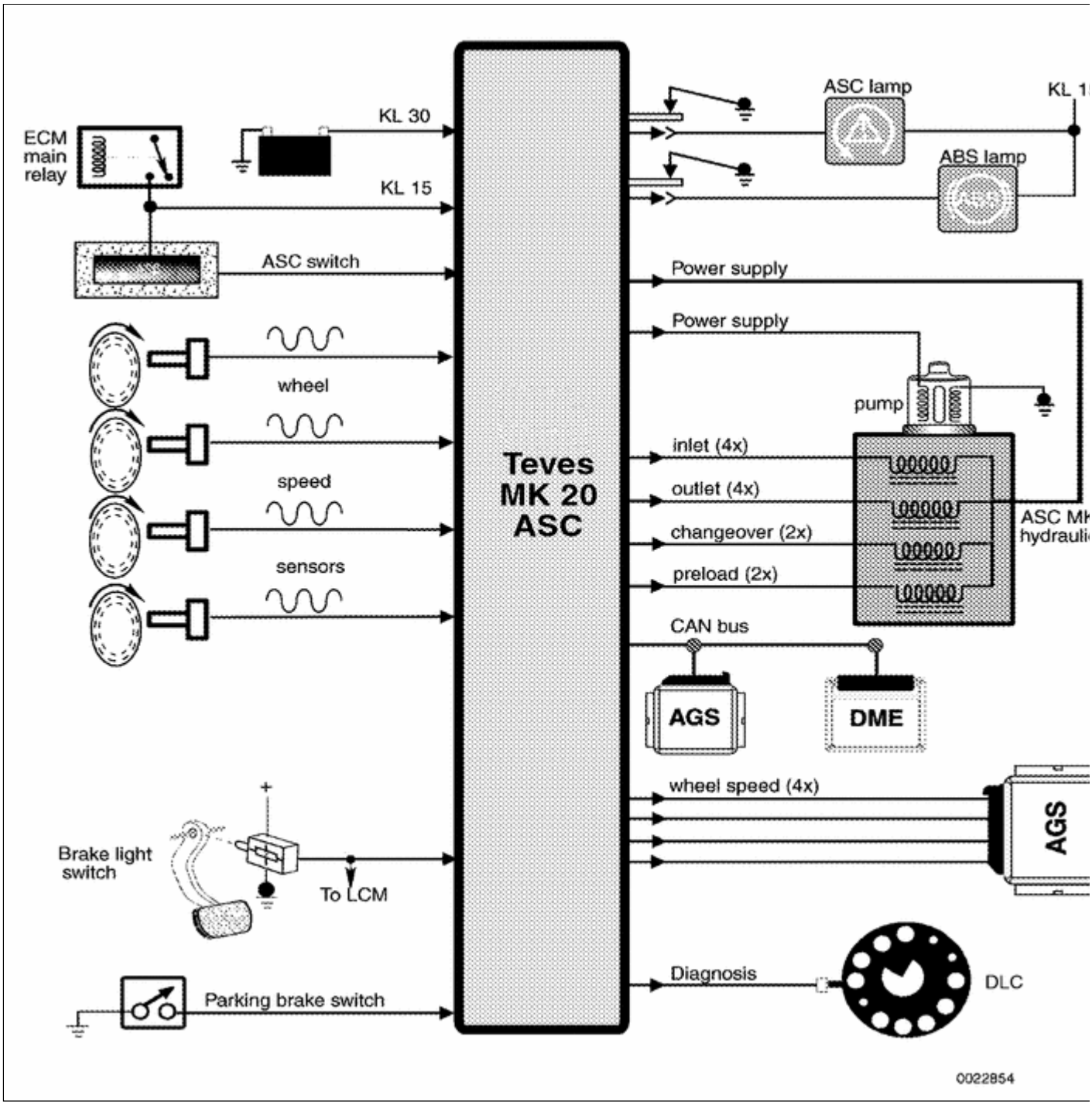
MBC will activate the return pump to increase rear wheel pressure build up. The function will be terminated under the following conditions:

- Front wheels drop out of ABS regulation
- Driver releases brake pedal
- Brake pressure falls below

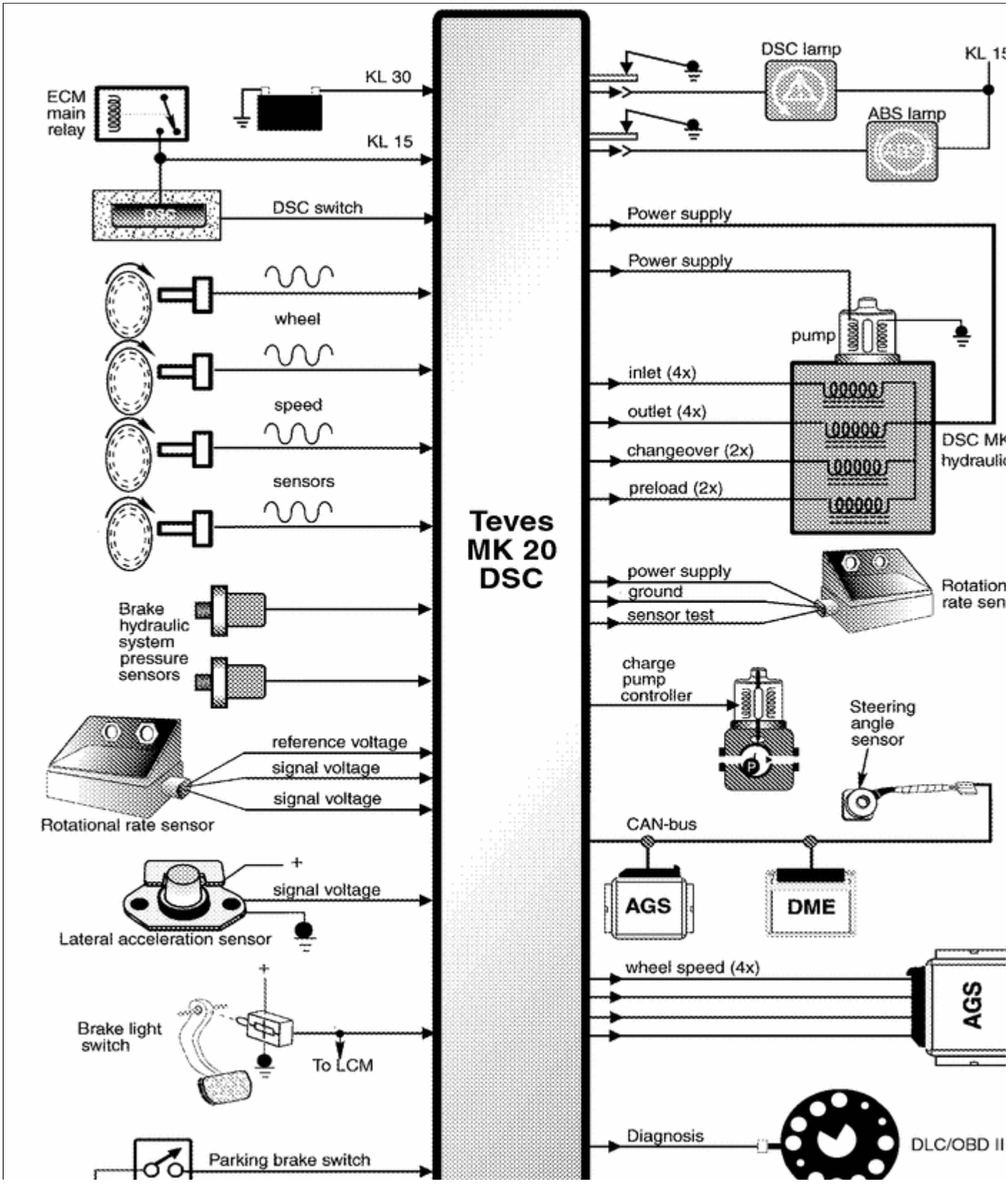
threshold

- Vehicle road speed drops below 3 mph

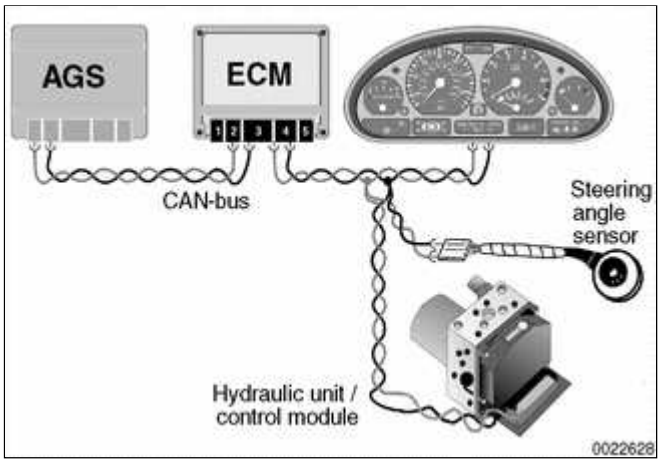
Teves MK 20 ASC diagram



Teves MK 20 DSC Diagram



Vehicle network



The hydraulic unit/control module communicates with some sensors and many other control modules over the CAN-bus. The CAN-bus is a system of wiring that functions like a computer network, allowing different components to communicate over the same data line, at the same time, by varying electronic signals.

Component communication dialogs take place between multiple control units and sensors over the CAN-bus:

- Engine control module (ECM) provides current engine torque to ABS control module.
- ABS control module provides wheel speed sensor signals (vehicle speed) to other modules
- ABS control module signals ECM to increase/reduce torque, ECM adjusts motor driven throttle (MDK/EDK)
- ABS control module commands transmission control module (AGS) to suppress shifts during ASC/DSC regulation
- DSC receives yaw, lateral acceleration & steering angle sensor information
- ABS control module receives signal

from ASC/DSC switch on dash.

- ABS control module signals turn instrument cluster warning lamps on during ASC/DSC regulation.

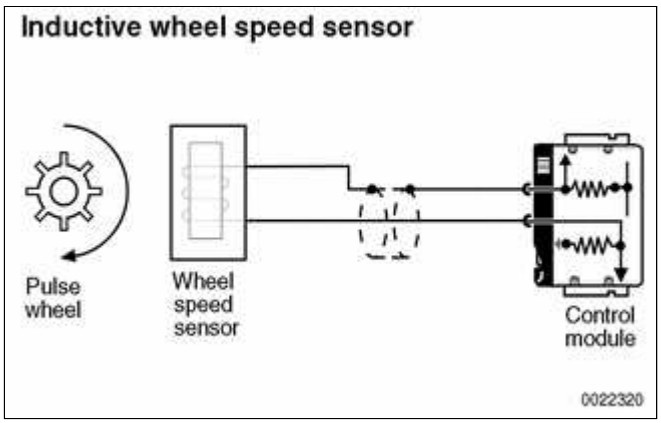
Hydraulic unit/control module

The hydraulic unit is mounted in conjunction with the control module. While the hydraulic unit and control module function as one unit, they are replaceable individually. All ABS/ASC or ABS/DSC processing functions are performed by the control module. The control module is linked to the vehicle's engine control module (ECM) and transmission control module (AGS) (if applicable) by the CAN-bus network.

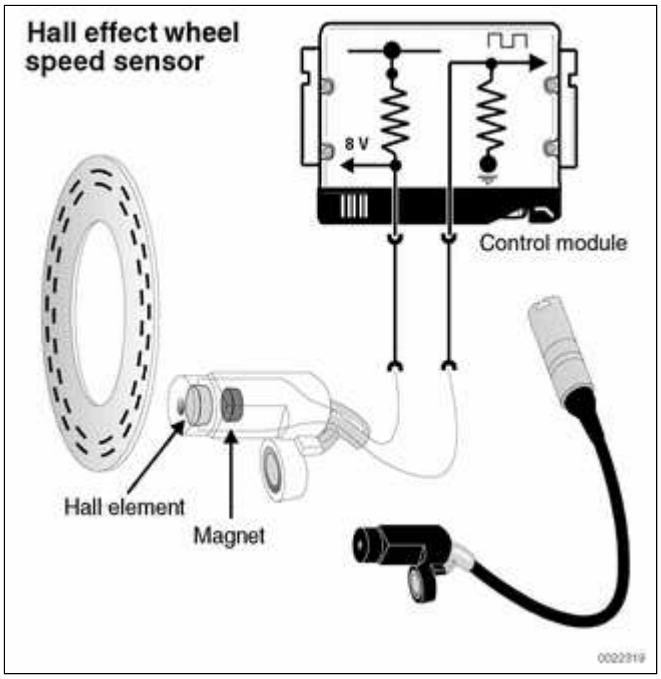
Wheel speed sensors

Wheel speed sensors are a crucial component in every ABS system. Control modules use these sensor inputs to determine overall vehicle speed and individual wheel speed for both ABS braking and stability control functions.

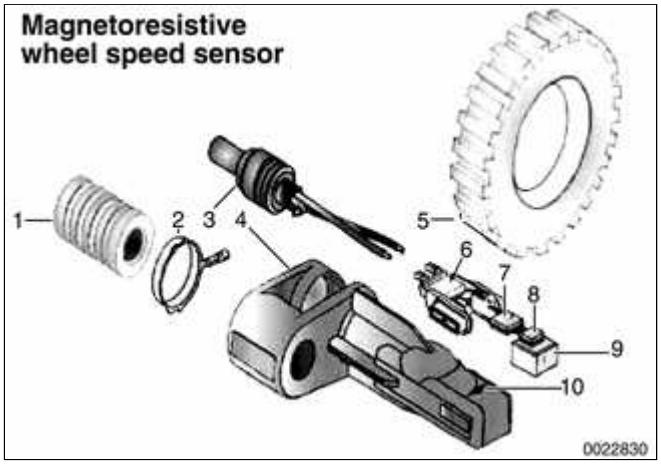
Three different types of wheel speed sensor are used in the E46 electronic braking and stability control systems:



- 1999 - 2000 Teves MK 20 ASC / DSC: Inductive



- 2001 Bosch DSC III 5.7: Hall effect



- 2001 Teves MK 60 DSC: Magnetoresistive

1 - Fastening element

2 - Ground contact

3 - Sensor wiring

4 - Sensor housing

5 - Metal pulse wheel

6 - Sensor element support

7 - Evaluation module

8 - Sensor element

9 - Magnet

10 - Pick-up surface

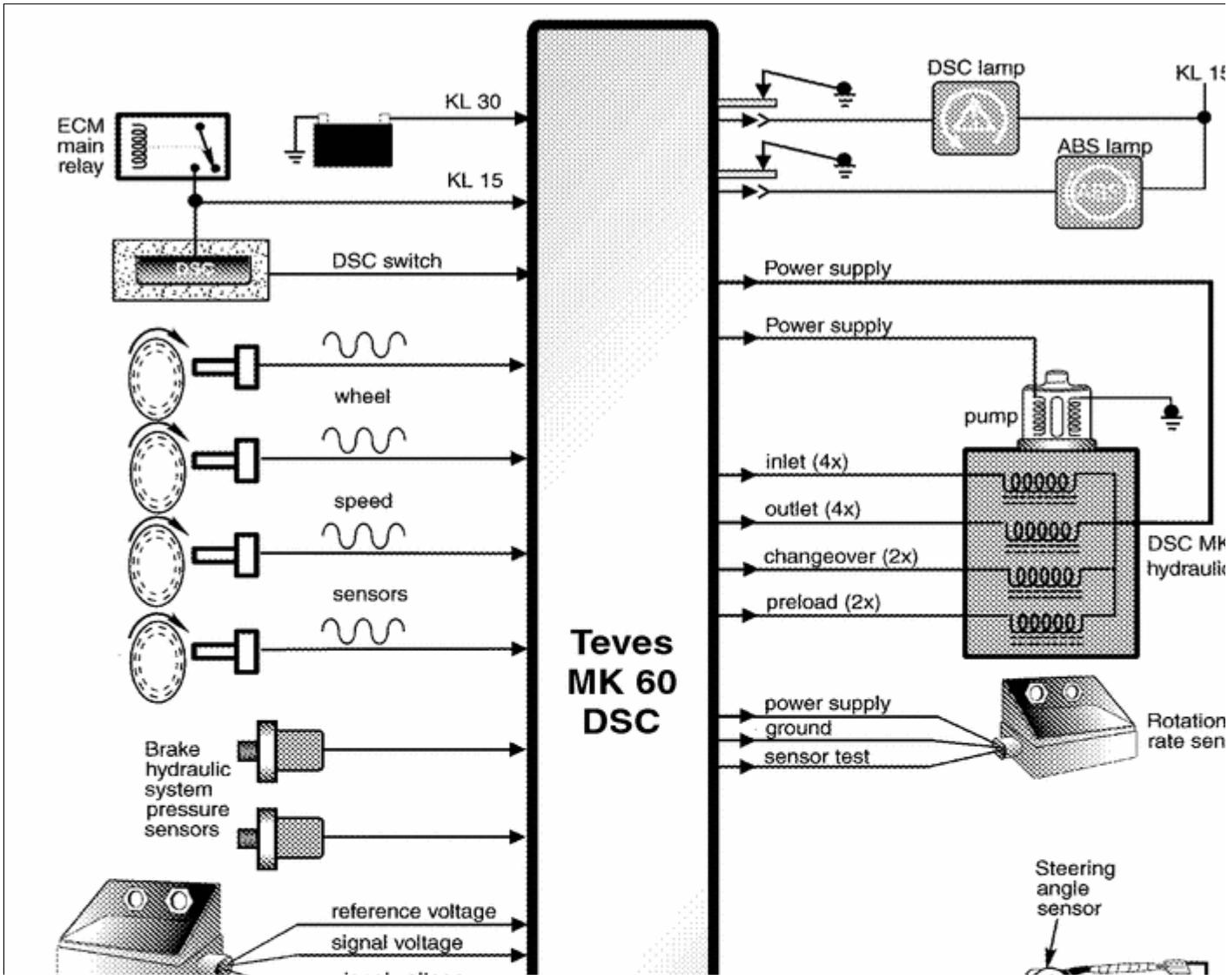
CAUTION!

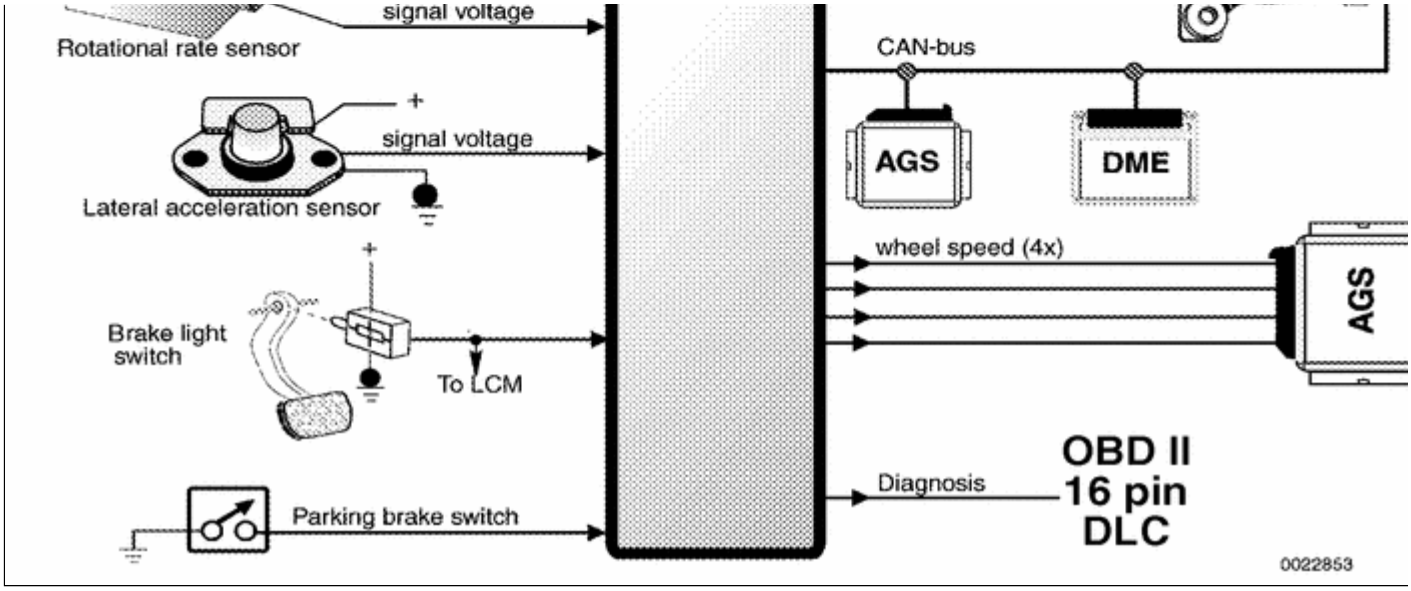
The magnetoresistive and the Hall effect sensor for the rear wheel are physically interchangeable. However, the electronic properties are not the same and they must not be interchanged.

DSC lateral acceleration sensor

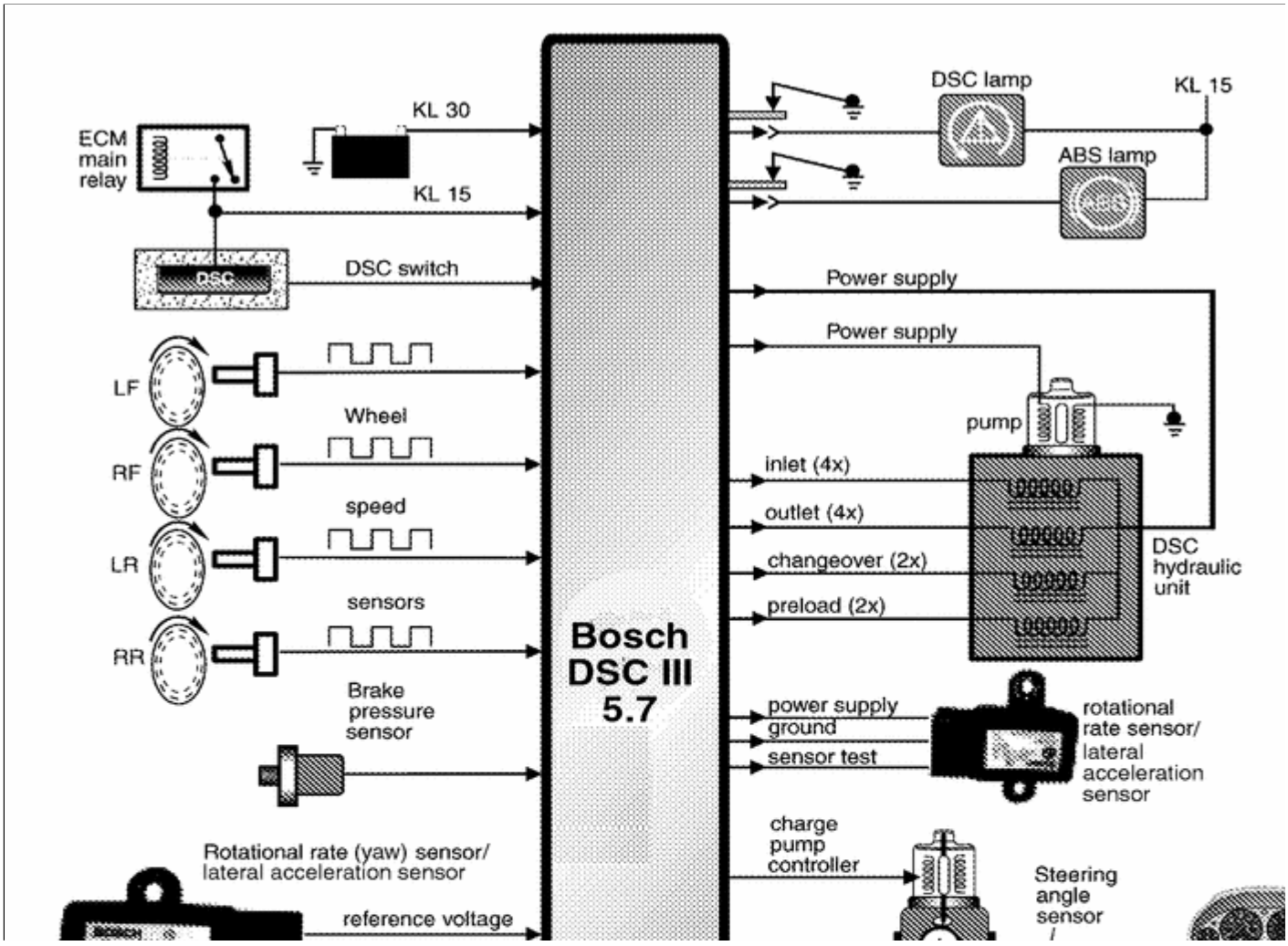
The lateral acceleration sensor provides the DSC control module with an input signal based on the degree of lateral acceleration (g forces) that the vehicle experiences. Based on a 5 volt reference voltage, the sensor will return an output voltage that ranges between 0.5 and 4.5 volts to the DSC control module, with 1.8 volts as a standing voltage. This input, along with other DSC inputs, determines the amount of DSC regulation needed to maintain vehicle stability.

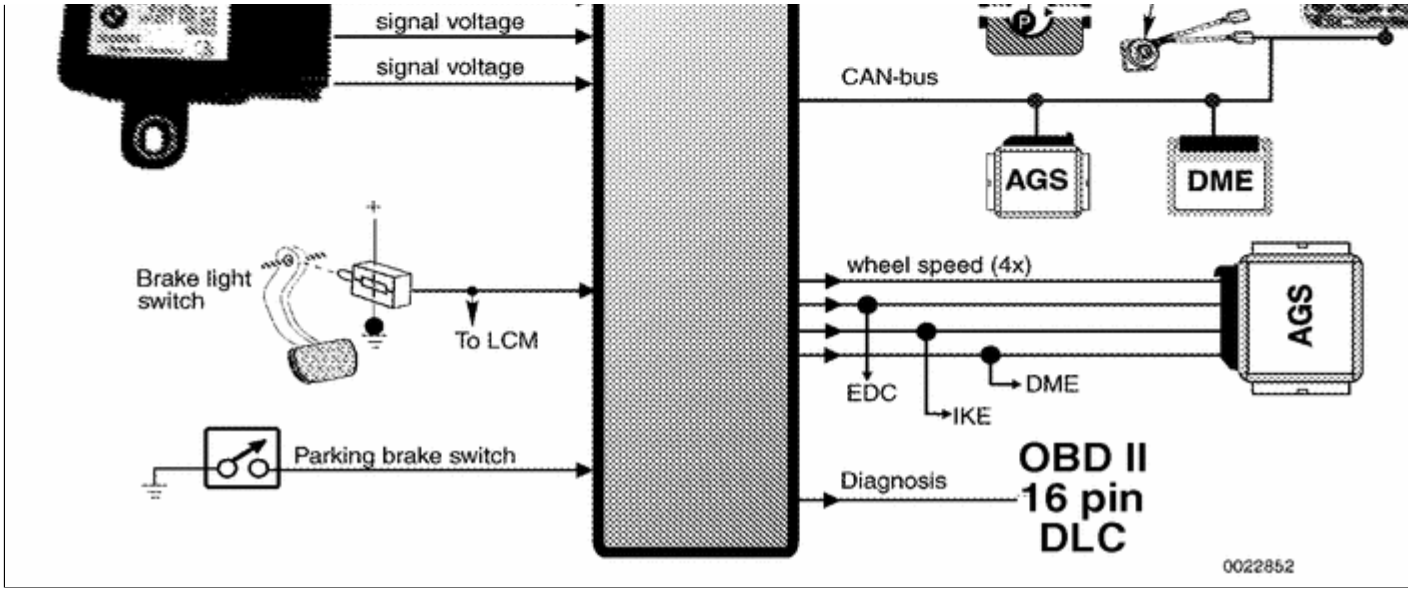
Teves MK 60 DSC diagram



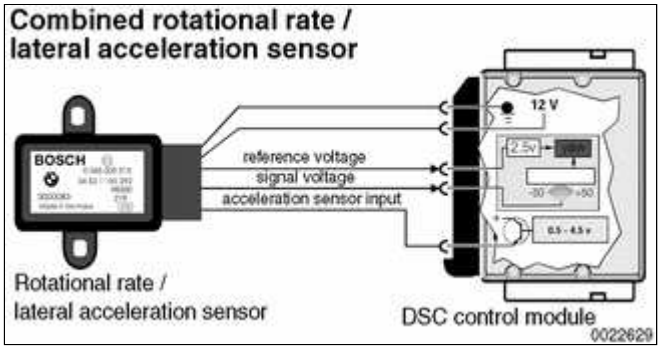


Bosch DSC III 5.7 diagram



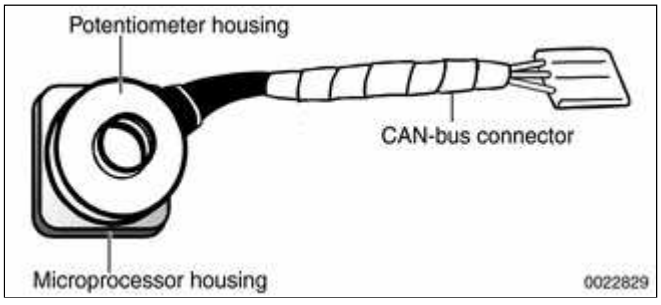


DSC rotational rate (yaw) sensor



The rotational rate sensor provides a analog voltage signal to the DSC control module to indicate the rotational speed (yaw) of the vehicle on its vertical axis. The control module supplies a 5 volt reference voltage to the sensor. The sensor returns a voltage between 0.25 and 4.65 volts based on the amount of yaw. If the vehicle's yaw exceeds preset parameters, the DSC control module will activate a DSC regulation cycle to increase vehicle stability while cornering. In case of failure the sensor will send a constant voltage to the DSC control unit.

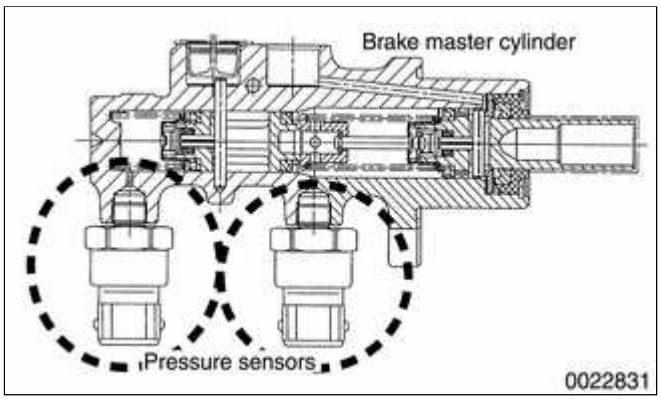
DSC steering angle sensor



Using two potentiometers, the steering angle sensor determines the steering angle and the rate of steering change. The sensor processes the two potentiometer outputs and provides a digital signal to the DSC control unit via the vehicle's CAN-bus network. Sensor recalibration is required after steering

angle sensor replacement or repairs to the steering column. This recalibration is performed using either the DIS or MoDiC BMW scan tools.

DSC pressure sensor



- The DSC pressure sensor(s) provides the ABS/DSC control module an analog voltage signal in proportion to brake pressure in the master cylinder.

The DSC MK 20 and MK 60 systems use two switches installed at the brake master cylinder.

The Bosch DSC III 5.7 system uses one switch installed at the DSC hydraulic unit.

DSC precharge pump

The DSC precharge pump is used in the Teves MK 20 DSC and Bosch DSC III 5.7 systems (1999 - 2000 DSC and 2001 all wheel drive equipped vehicles).

The DSC precharge pump provides the hydraulic unit with the necessary supply of hydraulic brake fluid. When the DSC system is activated, the precharge pump delivers brake fluid from the reservoir to the hydraulic unit at 10 bar (150 psi).

Switches and indicators

ASC/DSC control button

- The control button is used to deactivate the stability control functions of either the ASC system or the DSC system.

Brake light switch

The brake light switch input signal is used by the control module to determine which stability control routine is necessary. The control module will interrupt Automatic Stability Control (ASC) functions if the brake pedal is depressed during ASC operation. On vehicles equipped with DSC, DSC operation is not cancelled during braking situations.

Note:

Bosch DSC III 5.7 control module compares input from the brake light switch with pressure sensor value. The pressure sensor must not detect more than 5 bar when the brake light switch is not actuated.

Parking brake switch

The switch for the parking brake warning lamp is used to signal the control module if the parking brake is engaged. This signal is used in stability control system logic to cancel system functions.

Brake fluid level switch

The reed-type brake fluid level switch monitors the level of brake fluid available in the brake fluid reservoir. When an adequate amount of fluid is present, the switch completes a ground circuit for the

control module. When fluid level is too low, the circuit is broken and the ASC/DSC functions are turned off. Normal braking and ABS remains unaffected.

Warning lamps

Braking and stability control warning lights

1 - ASC/DSC warning light. Illuminates solidly when ASC/DSC system has been turned off, or blinks when ASC/DSC system is activate.

2 - Brake warning light. Indicates when the parking brake is engaged, or when brake system hydraulic fluid level is low.

3 - Antilock brake system (ABS) warning light. Indicates that the ABS system has been deactivated, or when there is an ABS system malfunction.

4 - Brake pad wear warning light. Indicates worn brake pads.

WARNING!

If the brake warning lamp, ABS warning lamp, and ASC/DSC warning lamp are all illuminated at the same time, there is an ABS and stability control system failure. Do not drive vehicle without diagnosing the problem.

Troubleshooting

Stable handling and ride comfort both depend on the integrity of the suspension and steering components. Any symptom of instability or imprecise road feel may be caused by worn or damaged suspension components.

When troubleshooting suspension and steering problems, also consider the condition of tires, wheels and their alignment. Tire wear and incorrect inflation pressures can dramatically affect handling. Subtle irregularities in wheel alignment angles also affect stability. Mixing different types or sizes of tires, particularly on the same axle, can affect alignment and may unbalance a car's handling.

⇒ Table d. Suspension and steering troubleshootinglists the symptoms of common suspension and steering problems and their probable causes, and suggests corrective actions. Bold type indicates the repair groups where applicable test and repair procedures can be found.

Table d. Suspension and steering troubleshooting

Symptom	Probable cause	Repairs
Breaking away while braking	Worn struts or shock absorbers	Replace struts or shock absorbers. ⇒ 310, ⇒ 330
Car pulls to one side, wanders	Incorrect tire pressure	Check and correct tire pressures. ⇒ 020
	Incorrect wheel alignment	Check and adjust wheel alignment. ⇒ 320
	Faulty brakes (pulls only when braking)	Check for sticking/damaged front caliper. ⇒ 340
Front end or rear end	Worn struts or shock absorbers	Replace struts or shock absorbers. ⇒ 310, ⇒ 330

Symptom	Probable cause	Repairs
vibration or shimmy		
	Worn suspension bushings (control arm or trailing arm)	Replace worn bushings. ⇒ 310, ⇒ 330
	Worn front suspension ball joints (control arm, steering arm or steering tie-rod end)	Replace worn ball joints. ⇒ 310
	Unbalanced or bent wheels/tires Loose wheel lug bolts	Balance tires. Check tires for uneven wear patterns. Check wheels for damage. .
	Loose wheel lug bolts	Tighten lug bolts to proper torque.
Poor handling, poor directional stability	Rear control arm or rear subframe bushings worn or damaged	Replace rear suspension bushings as necessary. ⇒ 330
	Rear alignment incorrect	Check and adjust wheel alignment. ⇒ 320
Poor stability, repeated bouncing after bumps, suspension bottoms out easily	Worn struts or shock absorbers	Replace struts or shock absorbers. ⇒ 310, ⇒ 330
Rear end hop with hard braking	Rear trailing arm busing worn or damaged	Replace trailing arm bushing. ⇒ 330
Steering heavy, poor return-to-center	Worn upper strut mounts	Replace strut mounts. ⇒ 310
	Incorrect tire pressure	Check and correct tire pressures. ⇒ 020
	steering system faulty	Check power steering fluid level. ⇒ 320
Steering loose, imprecise	Incorrect tire pressure	Check and correct tire pressures. ⇒ 020
	Loose steering rack mounting bolt(s)	Inspect and tighten bolts. ⇒ 320
	Worn tie rod end(s)	Replace tie rod(s) and align wheels. ⇒ 320
	Faulty front wheel bearing	Replace wheel bearing. ⇒ 310
	Worn or damaged steering rack	Adjust or replace steering rack. ⇒ 320 .
	Worn tires	Replace tires.

Symptom	Probable cause	Repairs
Suspension noise, especially over bumps (drumming, rattling)	Worn front upper strut mounts	Replace upper strut mounts. ⇒ 310
	Worn suspension bushings (control arm or trailing arm)	Replace worn bushings. ⇒ 310, ⇒ 330
	Worn stabilizer bar rubber mounts	Replace stabilizer bar rubber mounts. ⇒ 310 , ⇒ 330
	Loose suspension subframe	Check subframe for damage. Tighten mounting bolts.
Tail skid when braking	Rear trailing arm front bushing worn or damaged	Replace trailing arm bushing. ⇒ 330
Tire flat spots	Worn struts or shock absorbers	Replace struts or shock absorbers. ⇒ 310 , ⇒ 330
Uneven ride height	Incorrect coil springs	Measure ride height. ⇒ 300
	Bent or damaged suspension components	Inspect, repair/replace as necessary. ⇒ 310 , ⇒ 330
	Sagging coil springs	Replace springs as necessary. ⇒ 310 , ⇒ 330
Unsteady in curves, self-steering, poor rear end stability	Rear subframe bushings worn or damaged	Replace rear suspension bushings as necessary. ⇒ 330
	Differential bushings worn or damaged	Replace rear suspension bushings as necessary. ⇒ 330
	Rear shock absorbers worn	Replace rear shock absorbers. ⇒ 330
Wheel noise, continuous growling, may be more noticeable when turning	Worn wheel bearing	Replace wheel bearing. ⇒ 310 , ⇒ 330
Wheel-hop on normal road surface	Worn struts or shock absorbers	Replace struts or shock absorbers. ⇒ 310 , ⇒ 330

ABS troubleshooting

ABS is designed to be maintenance free. There are no adjustments that can be made to the system. Repair and

troubleshooting of major ABS components requires special test equipment and knowledge and should be performed by an authorized BMW dealer.

ABS is self-tested by the control module each time the car is started. Once the test is complete, the ABS dashboard warning light turns off. If the light remains lit or comes on at any time during driving, a system fault has occurred and ABS is electronically disabled. The conventional braking system remains fully functioning.

When a system or component failure occurs in the electronic braking and stability control systems, either the brake warning light, ABS warning light, or the ASC / DSC warning light will illuminate.Troubleshooting and diagnosis for the electronic braking and stability control systems must be made using an electronic scan tool.

Brake bleeding functions, as well as component coding and initialization must be completed using BMW scan tools DIS or MoDiC.

ABS system inspection

A visual inspection of the ABS system components may help to locate system faults. If no visual faults can be found and the ABS light remains on, have the system diagnosed by an authorized BMW dealer.

Carefully inspect the entire ABS wiring harness, particularly the pulse sensor harnesses and connectors near each wheel. Look for chafing or damage due to incorrectly routed wires.

Carefully remove the wheel speed sensors. Clean the sensor tips. Inspect toothed wheel on wheel hub. Check for

missing, clogged or corroded teeth, or other damage that could alter the clearance between the sensor tip and toothed wheel.

Ride height

Ride height measurement (**A**) at either axle is taken from center of wheel arch to bottom of wheel rim.

If the ride height is outside the specification listed, new springs should be installed. Be sure to have the old spring code number on hand when ordering new spring.

⇒ Table e. Front ride height specifications (measurement A) lists front suspension ride height specifications, ⇒ Table f. Rear ride height specifications (measurement A) lists rear suspension ride height specifications. These specifications apply to a car in a normally loaded position. When checking ride height or installing suspension components that require the car to be "normally loaded," load the car as follows:

Normal loaded position	
Each front seat	68 Kg (150 lbs)
Rear seat (center)	68 Kg (150 lbs)
Trunk	21 Kg (46 lbs)
Fuel tank	full

Table e. Front ride height specifications (measurement A)

Wheel size	Standard suspension	Sport suspension	Rough road suspension	All wheel drive suspension
15 inch	576 mm (22.67 in.)	561 mm (22.08 in.)	593 mm (23.35 in.)	

Wheel size	Standard suspension	Sport suspension	Rough road suspension	All wheel drive suspension
16 inch	589 mm (23.19 in.)	574 mm (22.59 in.)	606 mm (23.86 in.)	606 mm (23.85 in.)
17 inch	604 mm (23.77 in.)	589 mm (23.19 in.)	621 mm (24.44 in.)	621 mm (24.44 in.)
18 inch	617 mm (24.29 in.)	602 mm (23.71 in.)	634 mm (24.96 in.)	634 mm (24.96 in.)
Maximum variation between sides: 10 mm (0.4 in)				
Maximum deviation from specifications: 10 mm (0.4 in)				

Table f. Rear ride height specifications (measurement A)

Wheel size	Standard suspension	Sport suspension	Rough road suspension	All wheel drive suspension
15 inch	542 mm (21.33 in.)	526 mm (20.70 in.)	562 mm (22.12 in.)	
16 inch	555 mm (21.85 in.)	539 mm (21.22 in).	575 mm (22.64 in.)	572 mm (22.52 in.)
17 inch	570 mm (22.44 in.)	554 mm (21.81 in.)	590 mm (23.22 in).	587 mm (23.11 in.)
18 inch	583 mm (22.95 in.)	567 mm (22.32 in.)	603 mm (23.74 in.)	600 mm (23.62 in.)
Maximum variation between sides: 10 mm (0.4 in)				
Maximum deviation from specifications: 10 mm (0.4 in)				

General

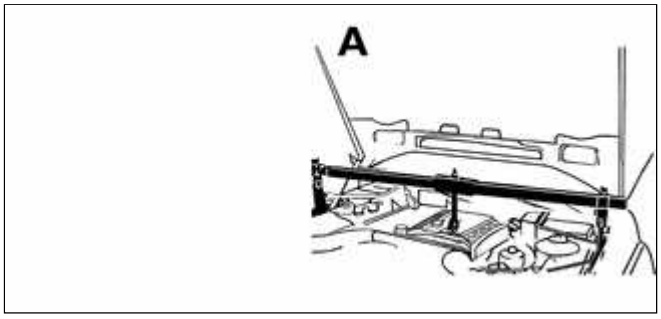
This repair group covers the repair and replacement of components that make up the front suspension of E46 cars.

See ⇒ 300 Suspension, Steering and Brakes-General for a description of the front suspension and components, as well as specification for setting ride height.

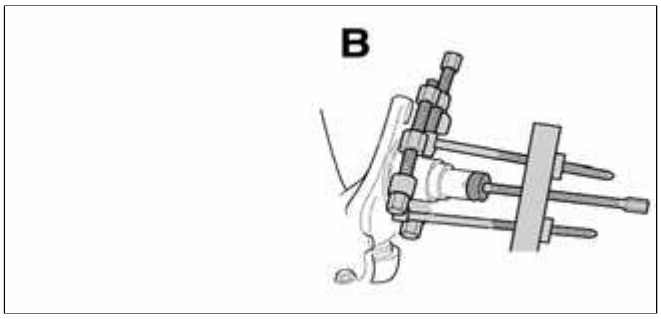
Special tools

Special service tools are required for most of the work described in this repair group. In addition to the tools depicted in the illustrations, a variety of press tools are necessary for control arm bushing replacement.

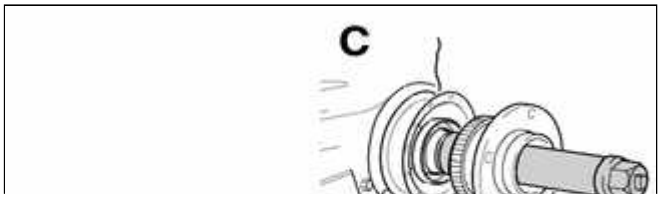
Read the procedures through before beginning any job.



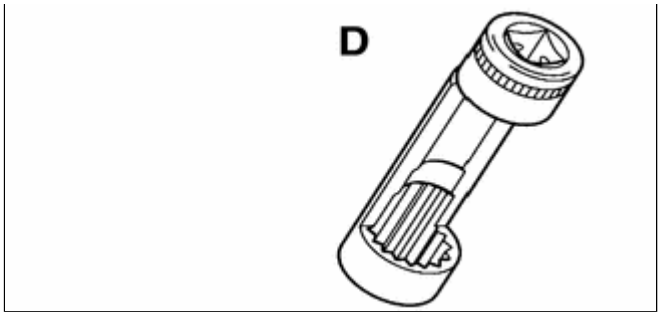
- Engine support bracket BMW 00 0 200/00 0 205



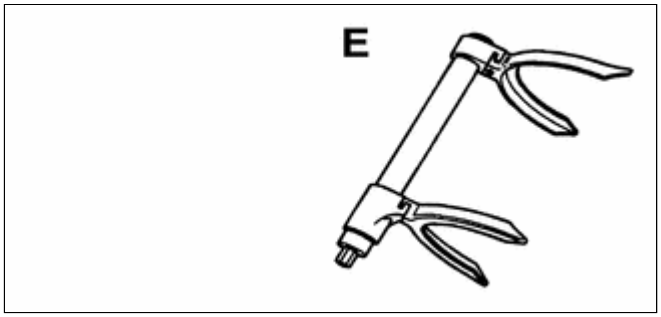
- Bearing puller BMW 00 7 500/31 2 106



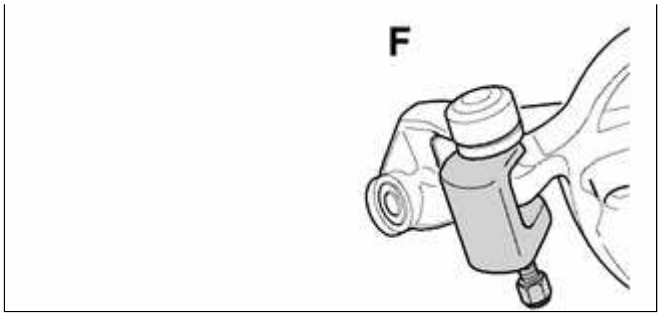
- Wheel bearing installation tool BMW 31 2 110



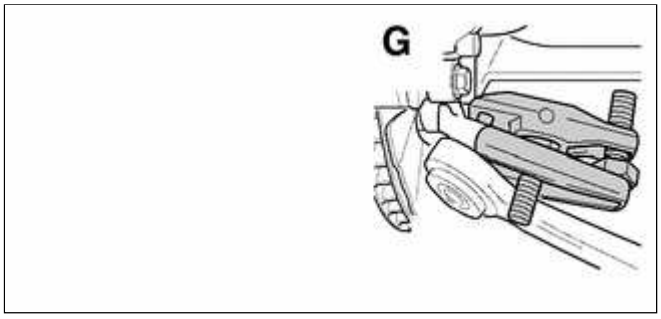
- Upper strut nut removal socket BMW 31 2 210



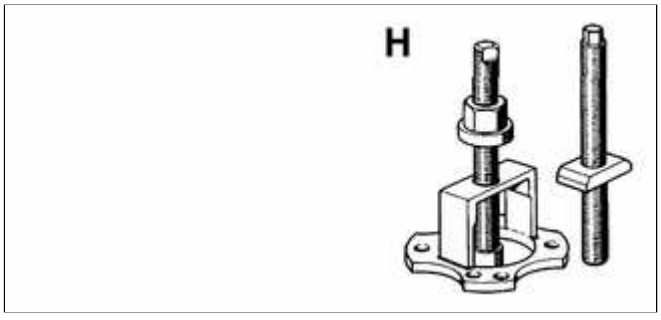
- Front coil spring compressor BMW 31 3 120



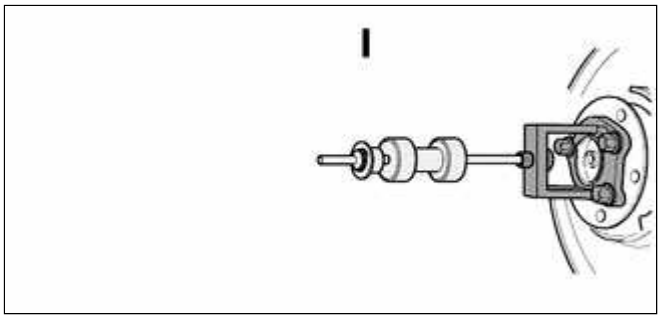
- Ball joint puller (all wheel drive BMW 32 2 040



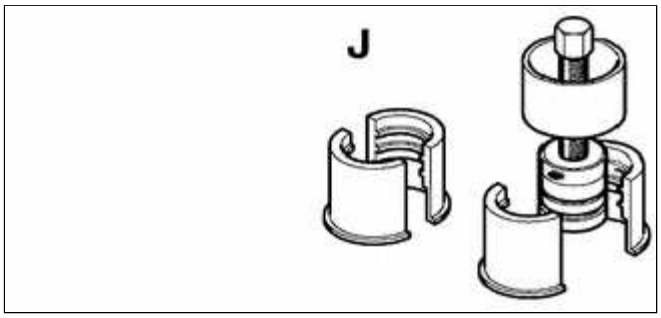
- Ball joint puller BMW 32 3 090



- Outer CV joint removal tool BMW 33 2 111/116/117



- Slide hammer with adapter BMW 33 4 201/202/203 33 2 116



- Inner bearing race puller set BMW 33 4 400

Front suspension construction

Some front suspension components are constructed of weight saving materials. For example, the control arms (in rear wheel drive models) are forged aluminum. This allows for weight reduction in the car, as well as a lower unsprung mass for better handling. However, the aluminum construction prevents removal or replacement of the pressed-in ball joints.

WARNING!

- ***Physical safety could be impaired if procedures described here are undertaken without the proper service tools and equipment. Be sure to have the right tools on hand before beginning any job.***

- ***Do not reuse self-locking nuts or bolts. They are designed to be used only once and may fail if reused. Always replace***

self-locking fasteners any time they are loosened or removed.

- ***Do not install bolts and nuts coated with undercoating wax, as the correct tightening torque cannot be assured. Always clean the threads with solvent before installation, or install new parts.***

- ***Do not attempt to weld or straighten any suspension components. Replace damaged parts.***

CAUTION!

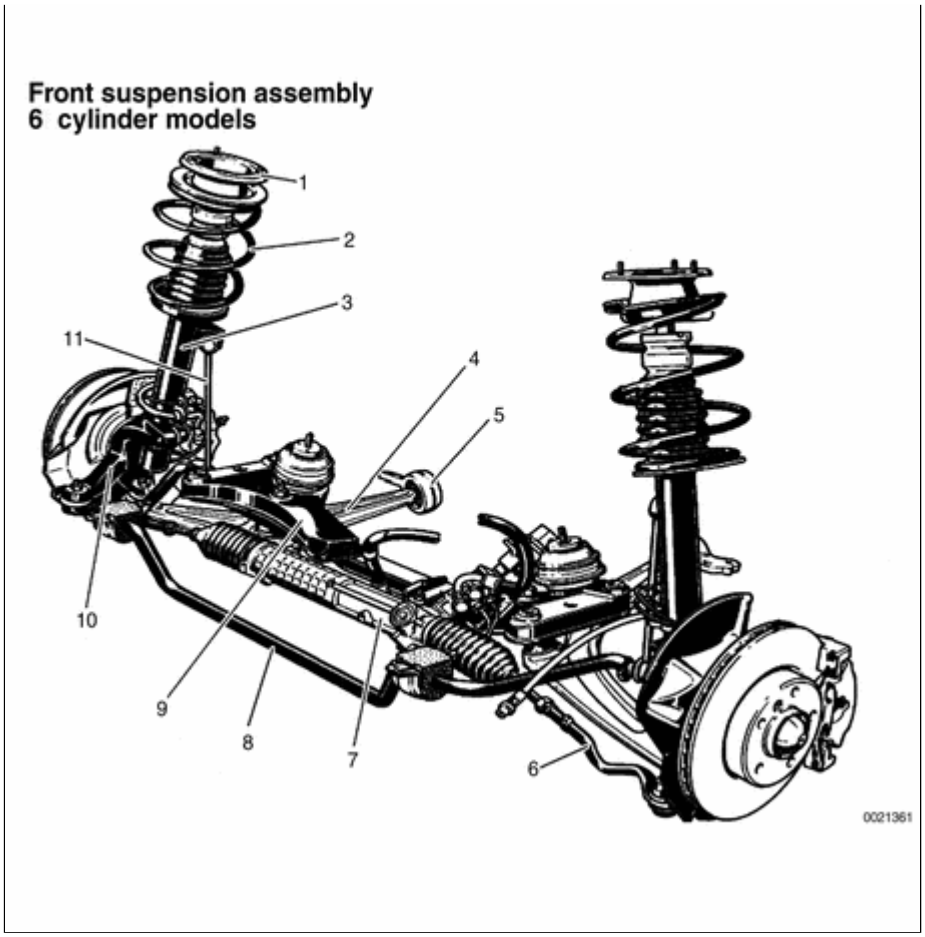
- ***Due to the aluminum construction of the control arms, great care must be taken when working on and around the front suspension:***

- ***When replacing any damaged front end components, always check the condition of the control arms***

- ***Do not clean control arms with wire brushes made of brass or iron. Only use brushes made of stainless steel.***

- ***Do not expose control arms to temperatures exceeding 80°C (176°F); sparks created by grinding; battery acid or other highly corrosive materials; or steel welding splashes.***

Front suspension



assembly (6 cylinder models)

1 - Upper strut mount

2 - Coil spring

3 - Strut assembly

4 - Control arm

5 - Control arm bushing and mount

6 - Tie rod

7 - Steering rack

8 - Front stabilizer bar

9 - Front suspension subframe

10 - Steering arm

11 - Stabilizer bar link

Shock Absorbers and Springs

Note:

Setting the ride height is covered in ⇒ 300 Suspension, Steering and Brakes-General.

The front suspension shock absorbers in E46 cars are McPherson struts. The strut is a major component of the suspension and supports the spring. Most strut assembly components are available as replacement parts. Struts and/or springs should always be replaced in pairs.

Front strut, upper strut mount or spring replacement is a two-step procedure:

- Removal of strut assembly from vehicle
- Disassembly and replacement of components on workbench

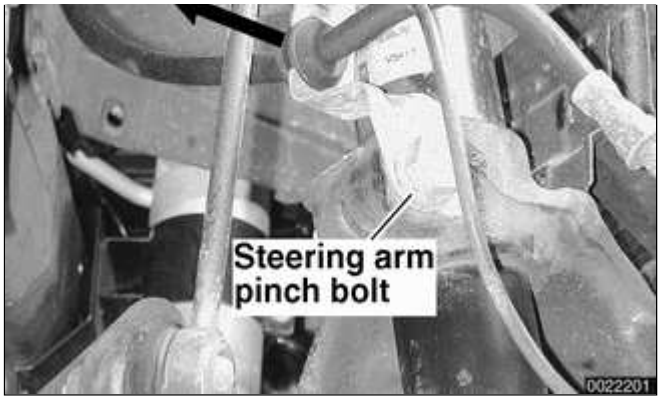
Strut assembly, removing and installing

- Raise car and remove front wheel.

WARNING!

Make sure that the car is firmly supported on jack stands designed for the purpose. Place the jack stands beneath a structural chassis point. Do not place jack stands under suspension parts.

- Pull brake fluid hose and ABS sensor wire harness off bracket at steering arm pinch bolt.



Note:

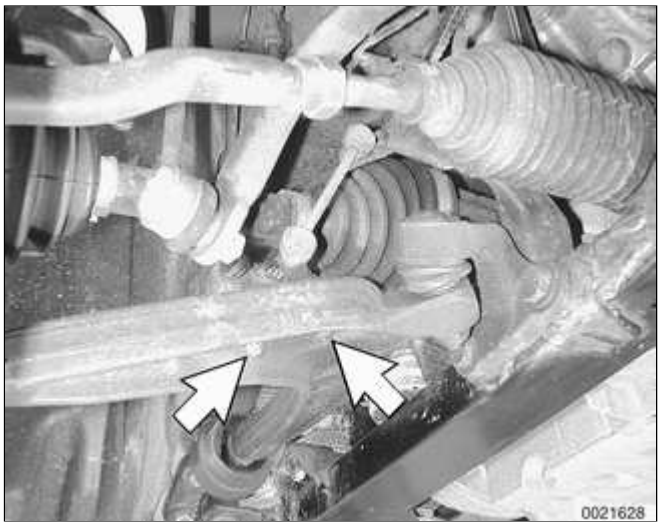
Right side shown is in illustration. Left side bracket also holds brake pad wear sensor wire.

- Unbolt brake caliper assembly, keeping brake hose connected. Suspend brake caliper from chassis using stiff wire. See ⇒ 340 Brakes.

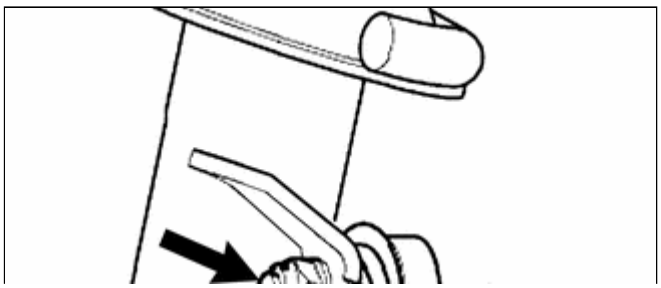
- Remove ABS wheel speed sensor mounting bolt (**arrow**). Slide sensor out of steering arm and lay aside.

Note:

Rear wheel drive vehicle shown in illustration.



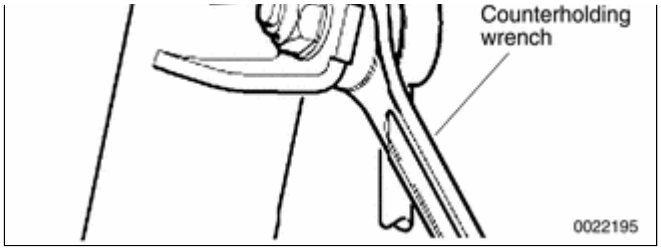
- On cars equipped with xenon headlights: Remove headlight vertical aim sensor link bracket mounting nuts (**arrows**) from right control arm.



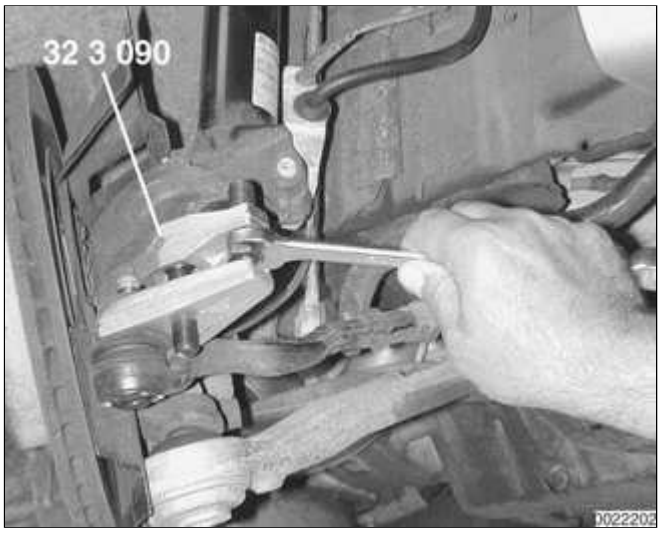
- Loosen and remove stabilizer bar link mounting nut (**arrow**) from strut. Detach link from strut housing.

Note:

Use a thin wrench to counterhold shaft

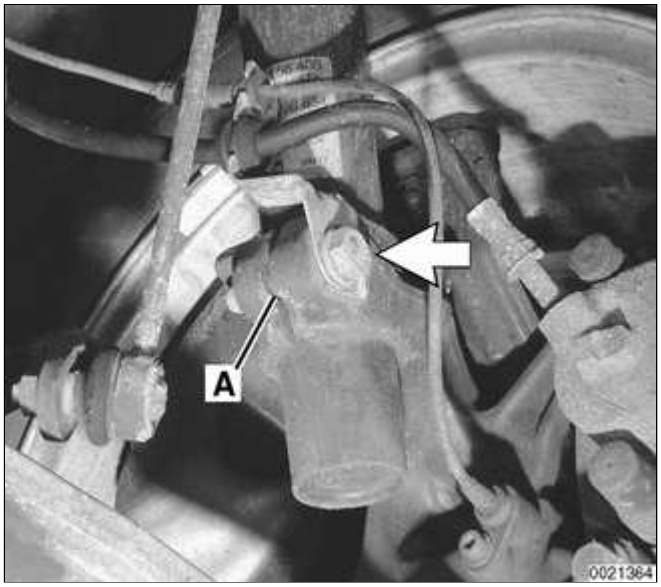


of stabilizer bar link ball joint while removing mounting nut.

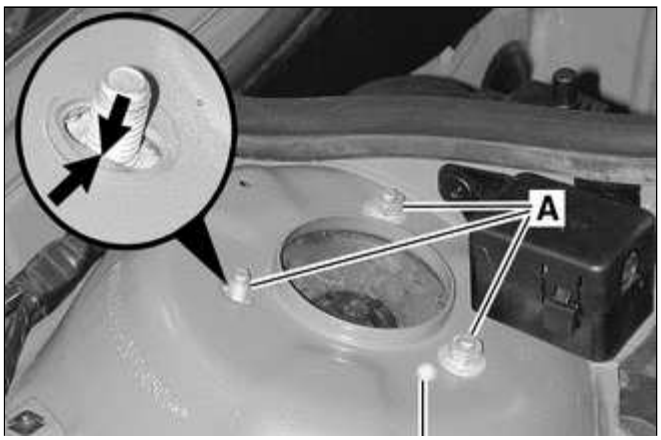


- Remove tie rod outer end nut. Use BMW special tool 32 3 090 or equivalent to press tie rod end off steering arm.

  - Remove lower ball joint nut. Use BMW special tool 32 3 090 or equivalent to separate steering arm from control arm.



- Support steering arm from below. Loosen pinch bolt (**arrow**) at top of steering arm. Spread clamping collar at slot **A**, if necessary, to slide steering arm off strut assembly.



- Support strut assembly from below.

  - Working in engine compartment at strut tower, remove three strut mounting nuts (**A**) on strut tower.

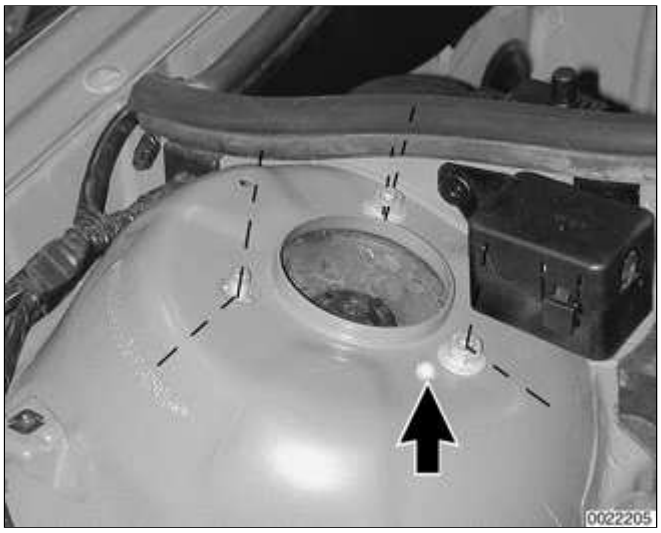
  - If factory alignment locating pin (**B**) is missing, be sure to mark location of strut mounting studs in

strut tower slots (**arrows**).

CAUTION!

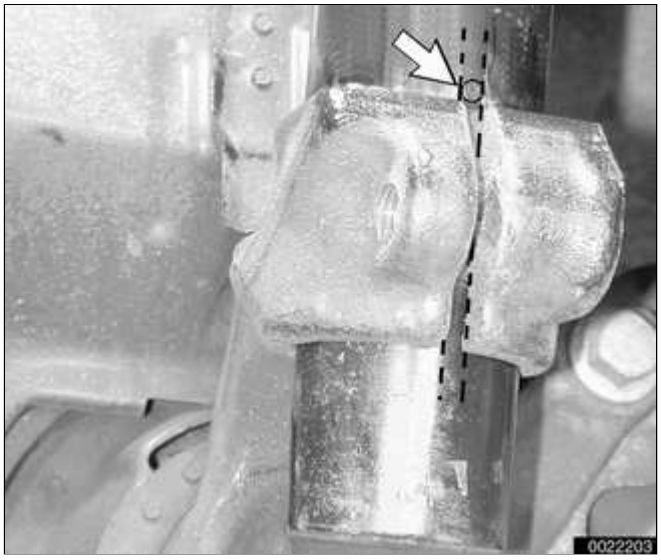
Do not remove center strut retaining nut.

- Lower strut assembly from car.



When installing strut assembly into car:

- Make sure locating pin (**arrow**) of strut bearing is positioned correctly in strut tower.
- If factory alignment locating pin is missing, make sure three upper mounting studs are positioned correctly in slotted holes according to marks made previously.

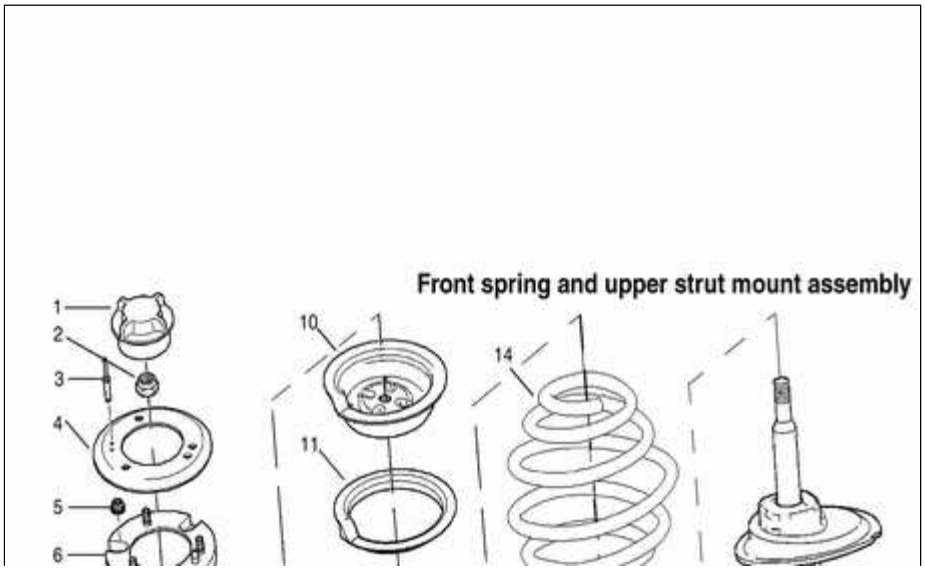


When installing steering arm to strut assembly, insert positioning pin (**arrow**) of strut into slot of steering arm clamping collar. To ensure proper alignment specifications, slide steering arm up on strut until stop is reached.

- Remainder of installation is reverse of removal.
- Be sure to use new self-locking nuts and bolts.
- Use new steering arm mounting bolts, or clean bolts and use Loctite® 270 or equivalent thread-locking compound.
- When attaching stabilizer link to strut, use a thin wrench to counterhold hold link ball joint while tightening nut.

- Have car professionally aligned when job is complete.

Tightening torques	
Brake caliper to steering arm	110 Nm (81 ft-lb)
Road wheel to hub	100 ± 10 Nm (74 ± 7 ft-lb)
Stabilizer bar link to strut	59 Nm (44 ft-lb)
Steering tie rod to steering arm	65 Nm (48 ft-lb)
Steering arm to control arm	65 Nm (48 ft-lb)
Steering arm pinch bolt at strut housing	81 Nm (60 ft-lb)
Strut assembly to strut tower (self-locking nuts)	24 Nm (18 ft-lb)
Upper strut mount to strut tower, self-locking M8 flanged nut:	
18 mm flange	24 Nm (18 ft-lb)
21 mm flange	34 Nm (25 ft-lb)

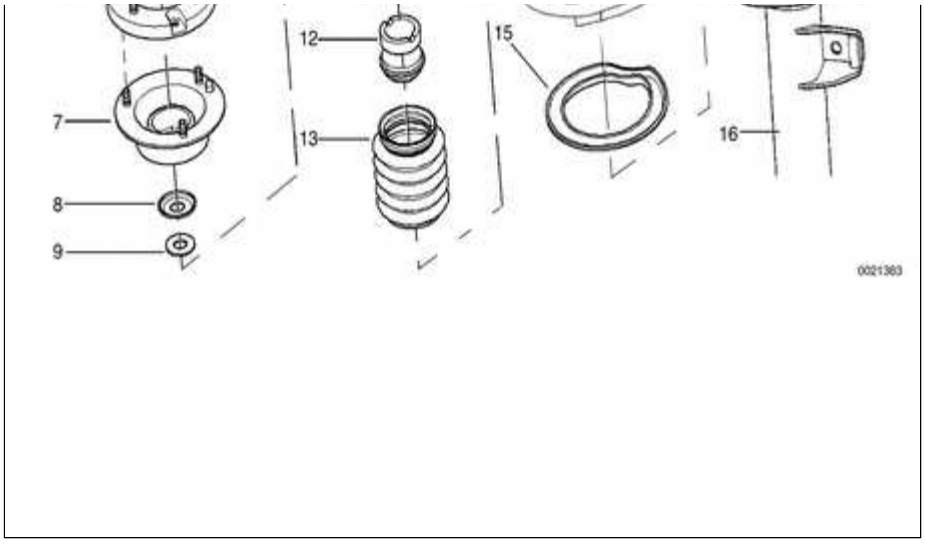


Front spring and upper strut mount assembly

1 - Cap

2 - Upper strut self locking nut M14

- tighten to 64 Nm (47 ft-lb)



3 - **Rivet (all wheel drive or rough road package only)**

4 - **Strut bearing reinforcement (all wheel drive or rough road package only)**

5 - **Self locking flanged nut M8**

- tighten to:
- 24 Nm (18 ft-lb) (18 mm flange)
- 34 Nm (25 ft-lb) (21 mm flange)

6 - **Spacer plate (all wheel drive or rough road package only)**

7 - **Upper strut bearing**

8 - **Sealing ring**

9 - **Flat washer**

10 - **Upper spring seat**

11 - **Upper spring pad**

12 - **Rubber stop**

13 - **Dust seal**

14 - **Spring**

15 - **Lower spring**

pad

16 - Strut

Strut assembly, disassembling and assembling

Replacing the strut, upper strut mount or spring requires that the strut assembly first be removed from the car and disassembled. For a guide to parts used during component replacement, see the accompanying diagram.

- Remove strut assembly as described earlier. Place in shop vice, or support securely.

- Using spring compressor, compress spring until spring force on upper mount is relieved.

WARNING!

- ***Do not attempt to disassemble the struts without a spring compressor designed specifically for this job.***

- ***Make sure the spring compressor grabs the spring fully and securely before compressing it.***

- Pry protective cover off top of strut assembly. Use BMW special tool 31 2 210 or equivalent socket to remove strut top (center) nut. Counterhold strut shaft using 6 mm Allen wrench.

- Remove upper strut bearing and

related components.

- Replace strut, upper strut mount or spring, as needed.

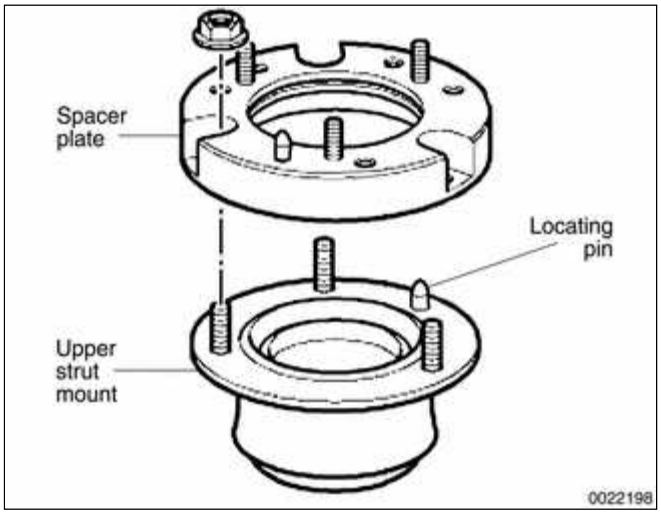
Note:

Springs and/or struts should always be replaced in pairs.

- Be sure that replacement struts are marked with the same code as the ones being removed.

Note:

Aftermarket struts are not marked.

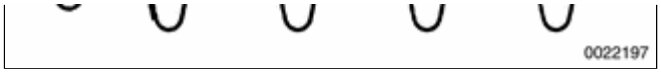


- Vehicles with "rough road" package are equipped with a spacer plate above the upper strut mount. Make sure the strut mount locating pin fits in the corresponding bore of the spacer plate.

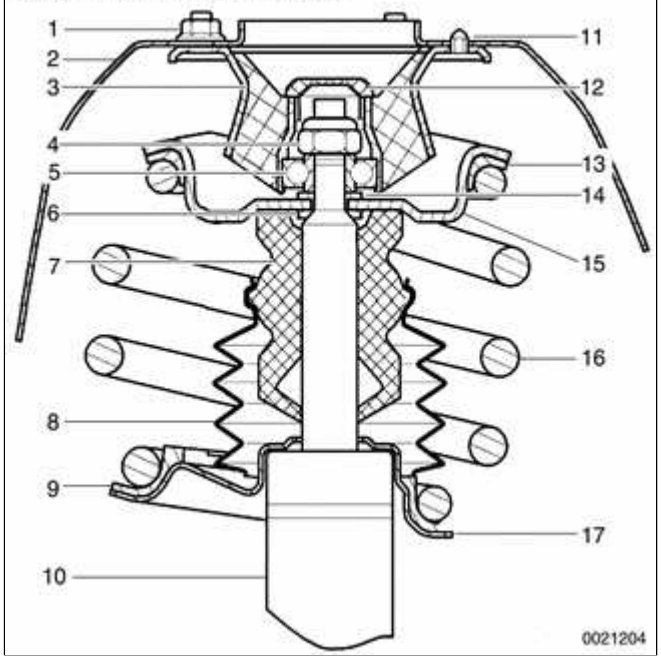
Note:

If there is no locating bore in the strut tower for the pin in the replacement upper strut mount to fit, drive out the pin before installing the new mount.

- Replace springs in pairs only. The part number (**A**) is stamped near the large end of the spring.



Front strut top mount assembly (rear wheel drive models)



Assembly is reverse of disassembly, noting the following:

- Line up slot in spring pad with corresponding slot in lower spring seat.
- Use a new upper strut self locking nut. Tighten nut fully before releasing spring compressor.
- Be sure upper spring pad is correctly installed to upper spring seat and spring end is correctly seated in upper and lower spring seats.
- Release spring compressor carefully and evenly, allowing spring to expand slowly.
- Have car professionally aligned when job is complete.

1 - Self locking nut M8 -tighten to: 24 Nm (18 ft-lb) (18 mm flange) 34 Nm (25 ft-lb) (21 mm flange)

2 - Strut tower

3 - Upper strut mount

4 - Upper strut self locking nut M14 -tighten to 64 Nm (47 ft-lb)

5 - Upper strut bearing

6 - Sealing ring

7 - Rubber bump-stop

8 - Dust shield

9 - Lower spring pad

10 - Strut housing

11 - Locating pin

12 - Protective cap

13 - Upper spring pad

14 - Washer

15 - Upper spring seat

16 - Spring

17 - Lower spring seat

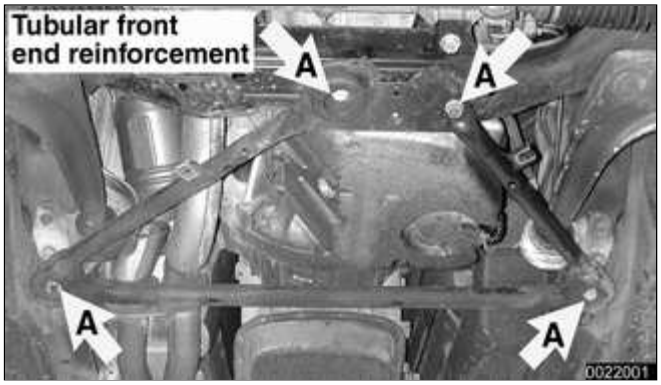
Tightening torque	
Upper strut mount to strut shaft M14 self-locking nut	64 Nm (47 ft-lb)

Front End Reinforcement

In rear wheel drive models, a front end reinforcement is bolted to the rear of the subframe and attached to the frame rails.

CAUTION!

Do not drive vehicle without the front end reinforcement in place. Damage to the front suspension may result.



The tubular front end reinforcement is installed with 4 bolts (**A**) in the following cars:

- Rear wheel drive Sedan and Sport Wagon models manufactured until production date 12/2000.
- Coupe models manufactured until production date 11/1999.

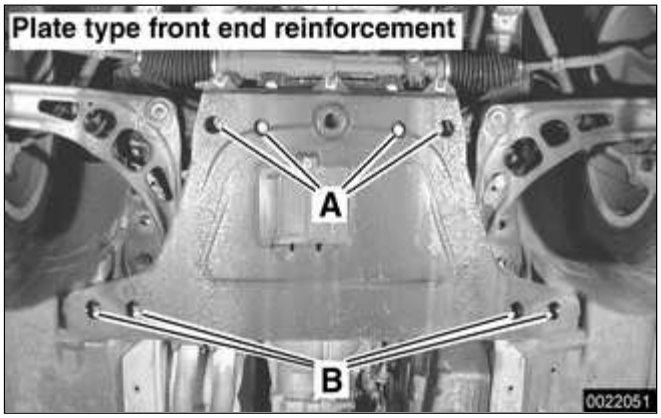
- The aluminum plate type front end reinforcement is installed in the following cars:

- All Convertible models
- Coupe models manufactured from production date 11/1999.
- Rear wheel drive Sedan and Sport Wagon models manufactured from production date 12/2000.

CAUTION!

After 2/2001, the front reinforcement plate was produced with larger cast depressions to accommodate the

larger (66 mm) front control arm bushings. The difference in the early production and later plates can only be discerned by removing the plate.



➢ In order to safely use an early production plate in a car with larger bushings, insert appropriate sized washers between frame rails and reinforcement plate at bolts **B**.

- When reinstalling front end reinforcement:

♦ Replace mounting bolts.

♦ Torque bolts in 2 stages, as shown below. Use BMW special tool 00 9 120 or equivalent torque angle protractor.

Tightening torque	
Front end reinforcement to front subframe or body frame rails: M10 bolt (**A**or **B**) (always replace)	
Stage 1	59 Nm (43 ft-lb)
Stage 2	torque angle 90° + 30°

Front Subframe

The front subframe provides rigid mounting points for the engine, suspension, and steering components. The subframe is not normally subject to wear and should only be replaced if structurally damaged.

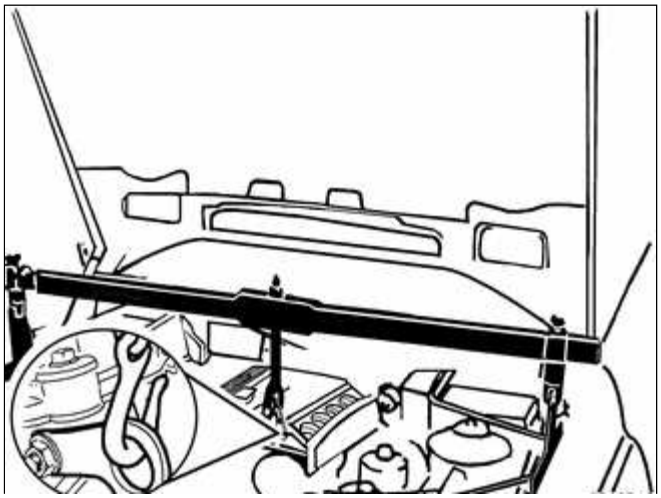
Rear wheel drive and all wheel drive models differ significantly in the design of the front subframe.

Removing the front subframe requires engine lifting equipment to support the weight of the engine from above so that the subframe can be removed from below.

CAUTION!

Removal or replacement of the subframe may affect suspension and steering geometry, including front wheel alignment. Make appropriate matching marks during removal and have the front end aligned once repairs are complete.

Front subframe, removing and installing (rear wheel drive models)



- Using engine support equipment, raise engine until weight of engine is supported.

  - Raise car and remove front wheels.

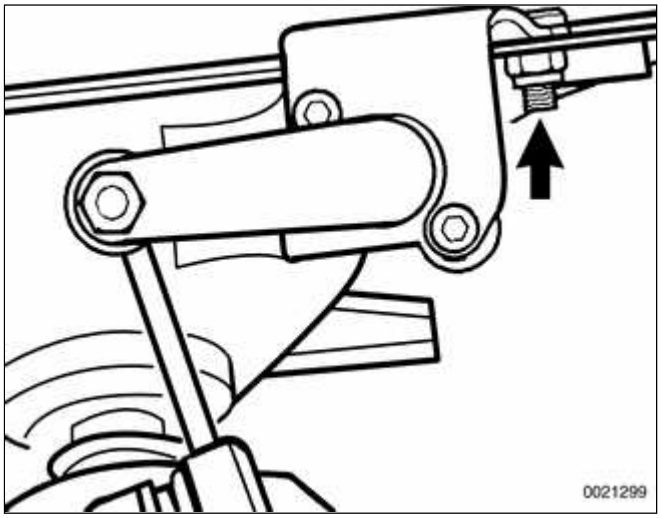
WARNING!

Make sure that the car is firmly supported on jack stands designed for the purpose. Place the jack

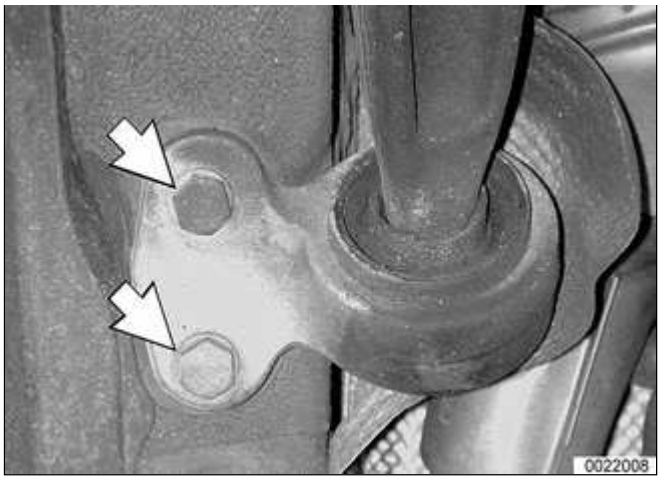
stands beneath a structural chassis point. Do not place jack stands under suspension parts.

- Remove splash shield under engine compartment.

- Remove front end reinforcement. See ⇒ Front End Reinforcement earlier in this group.

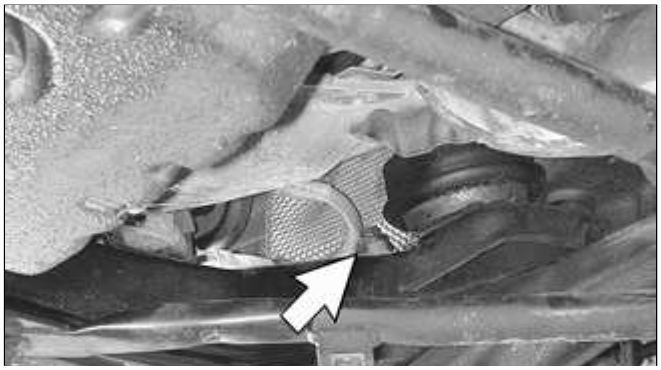


➢ On cars equipped with xenon headlights: Remove front ride level sensor mounting fastener (**arrow**) and lay sensor aside.



➢ Remove right front control arm bracket bolts (**arrows**) from frame rail.

- Repeat for left side.

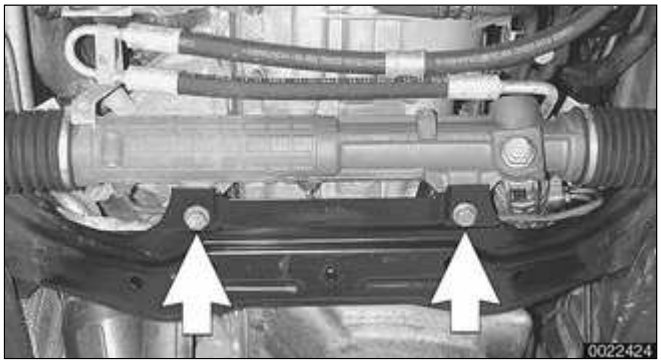


➢ Remove right inner control arm ball joint mounting nut (**arrow**) at subframe.

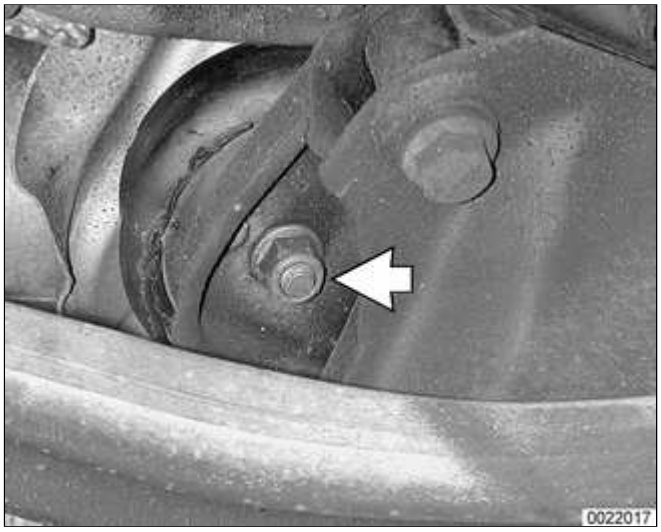
- Drive ball joint shaft out of subframe using soft hammer.

- Push control arm aside.

- Repeat for left side.

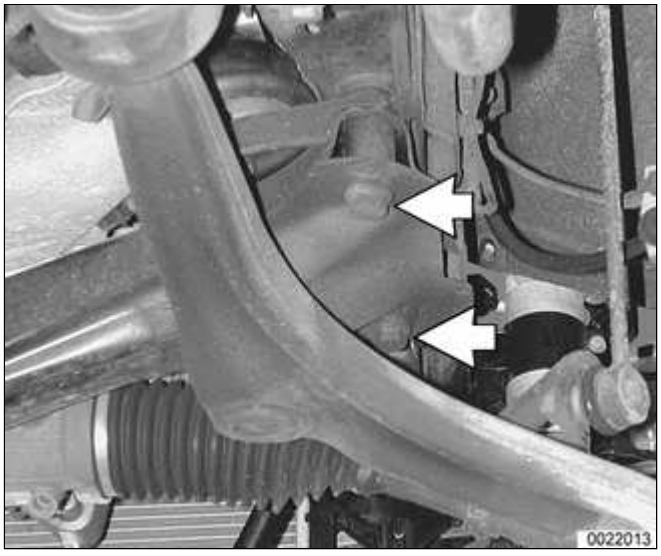


- Remove steering rack mounting bolts (**arrows**) at front of subframe. Suspend rack out of the way with stiff wire.



- Remove right lower engine mount fastener (**arrow**).

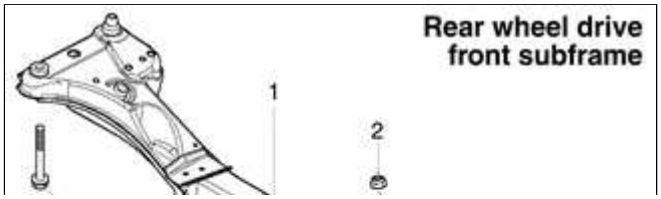
  - Repeat on left side



- Support suspension subframe from below using appropriate jacking equipment. Remove subframe mounting bolts (**arrows**). Remove subframe.

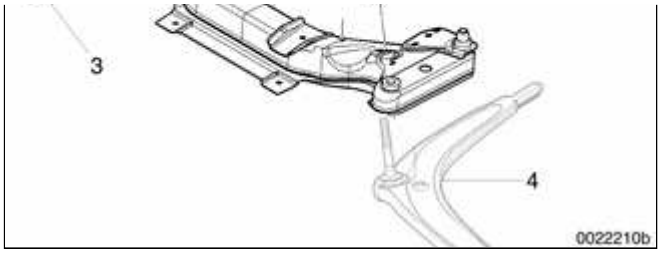
  Note:

  Right side is shown in photo. Left is similar.



- Installation is reverse of removal, noting the following:

  - Make sure all bolts, bolt holes,



and mating surfaces are clean to ensure proper tightening and alignment. Use new self-locking nuts or bolts, where applicable.

- Lower engine onto engine mounts, allowing it to settle fully before tightening engine mount bolts.

- When the job is completed, have front end professionally aligned.

1 - Front subframe

2 - inner ball joint nut -tighten to 90 Nm (66 ft-lb)

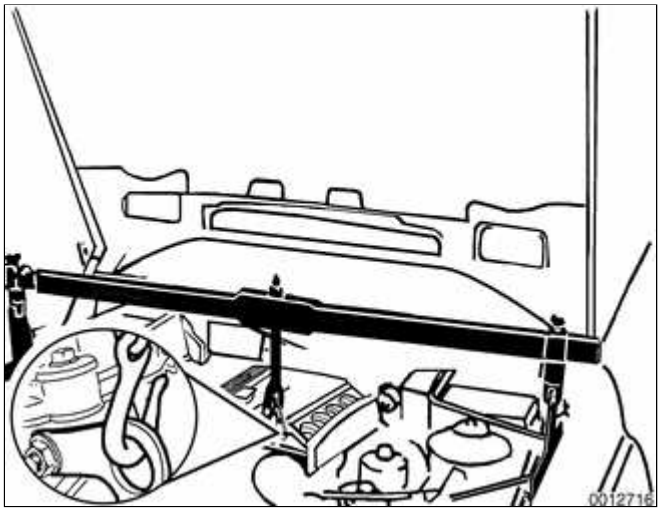
3 - Subframe mounting bolt (See torque table.)

4 - Control arm

Tightening torques	
Control arm ball joint to subframe M14 self-locking nut (always replace)	90 Nm (66 ft-lb)
Control arm bushing carrier to body M10 bolt (always replace)	59 Nm (43 ft-lb)
Front end reinforcement to front subframe or body frame rails: M10 bolt (always replace)	
Stage 1	59 Nm (43 ft-lb)
Stage 2	torque angle 90° + 30°
Steering rack to subframe (M10 bolt)	42 Nm (31 ft-lb)
Subframe to body	
M12-8.8 bolts	77 Nm (57 ft-lb)

Tightening torques	
M12-10.9 bolts	110 Nm (81 ft-lb)
M12-12.9 bolts	105 Nm (77 ft-lb)

Front subframe, removing and installing (all wheel drive models)



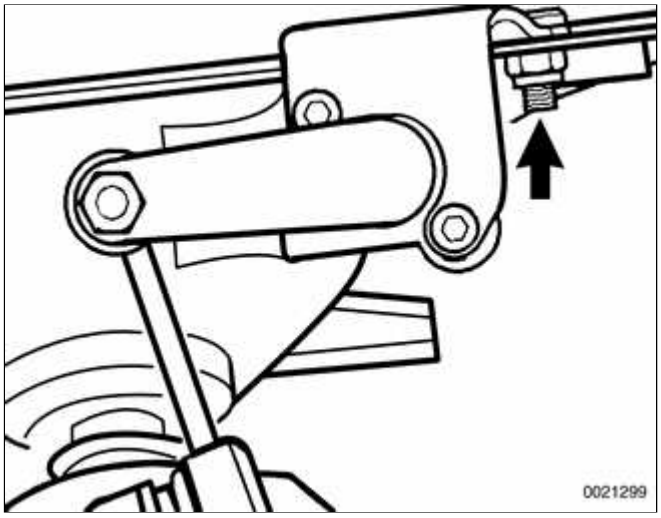
- Using engine support equipment, raise engine until weight of engine is supported.

  - Raise car and remove front wheels.

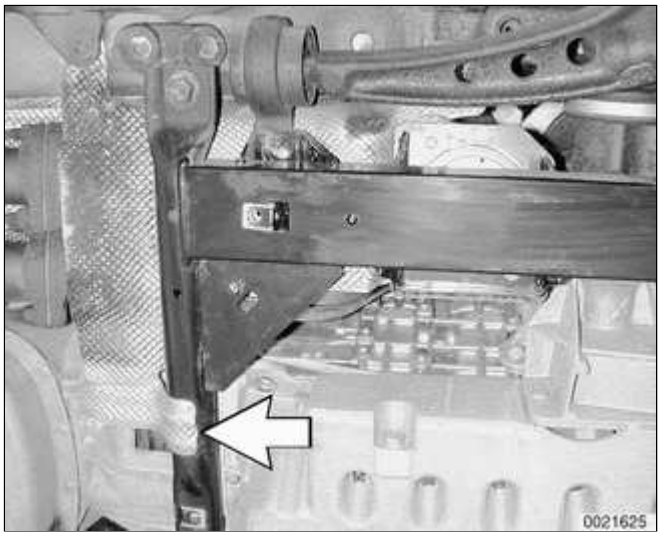
WARNING!

Make sure that the car is firmly supported on jack stands designed for the purpose. Place the jack stands beneath a structural chassis point. Do not place jack stands under suspension parts.

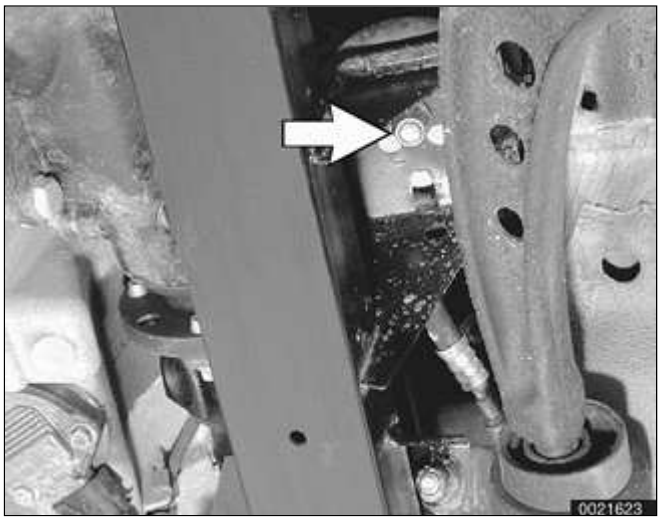
  - Remove splash shield under engine compartment.



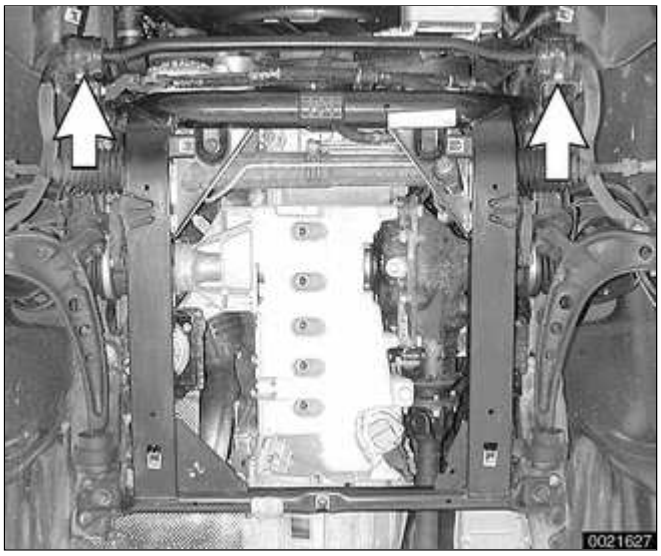
- On cars equipped with xenon headlights: Remove front ride level sensor mounting fastener (**arrow**) and lay sensor aside.



- Working at rear right corner of front subframe, unhook heatshield from subframe (**arrow**).



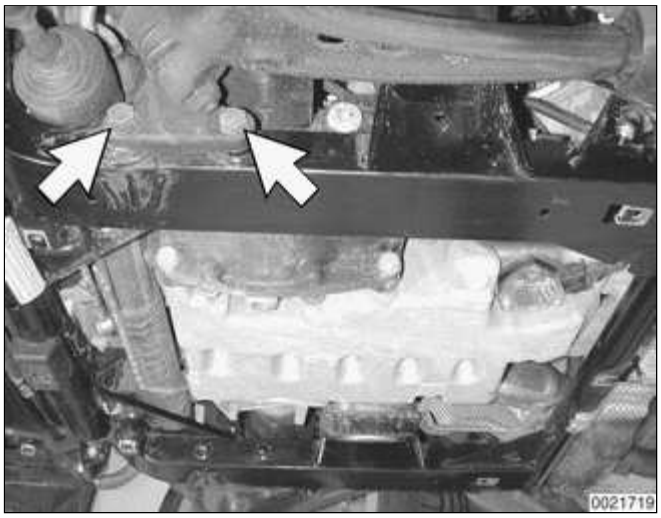
- Remove left engine mount fastener (**arrow**).
  - Repeat for right side.
  - Working at right front of subframe, detach power steering lines.



- Remove stabilizer bar anchor fasteners (**arrows**) from front corners of subframe. Suspend stabilizer bar from chassis using stiff wire.

- Working at left rear corner of subframe, remove control arm rear bracket mounting bolts (**arrows**).

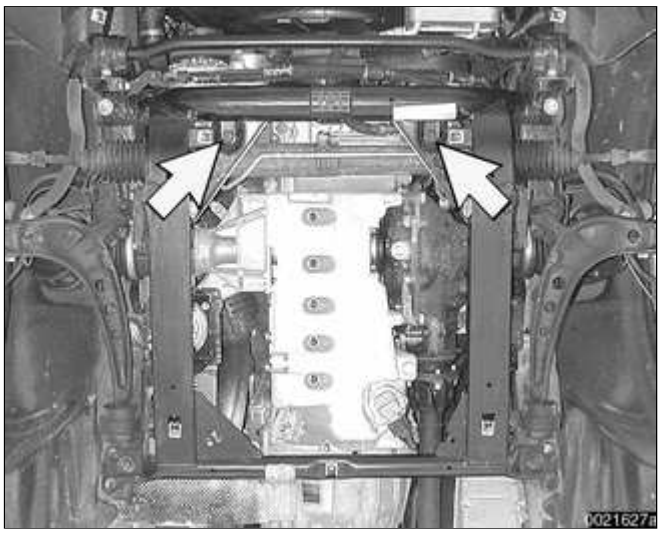
- Repeat for right side.



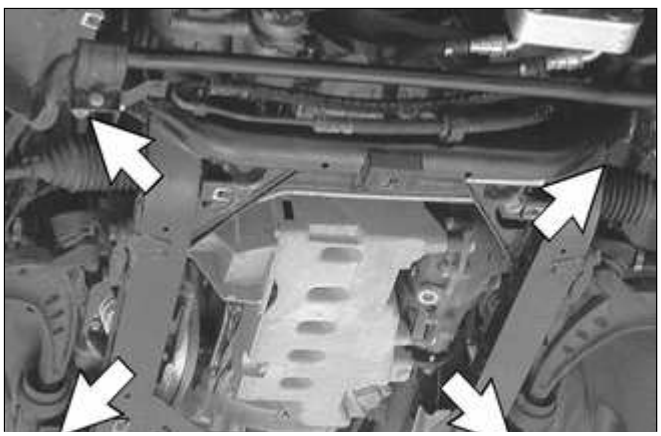
- Working at left side of subframe, remove inner control arm ball joint mounting bracket bolts (**arrows**) from subframe. Hang control arm using stiff wire.

WARNING!

Do not allow the control arm to hang from the outer (steering arm) ball joint. This can damage the ball joint.



- Working underneath subframe, remove steering rack mounting bolts (**arrows**). Suspend rack with stiff wire.



- Support subframe from below. Remove subframe mounting bolts (**arrows**).

  - Slowly lower subframe, making sure heat shields, wiring harnesses and other underbody components are clear during removal.