TABLE OF CONTENTS

Subject **Page**

RUNNING GEAR

Model: E46 M3
Production Date: 01/2001

Objectives of the Module

After completing this module, you will be able to:

- Identify which suspension components are modified for the E46 M3.
- Explain what is unique about the Front Strut Upper Mount.
- Describe the operation of the M-differential Lock.

E46 M3 Running Gear and Suspension

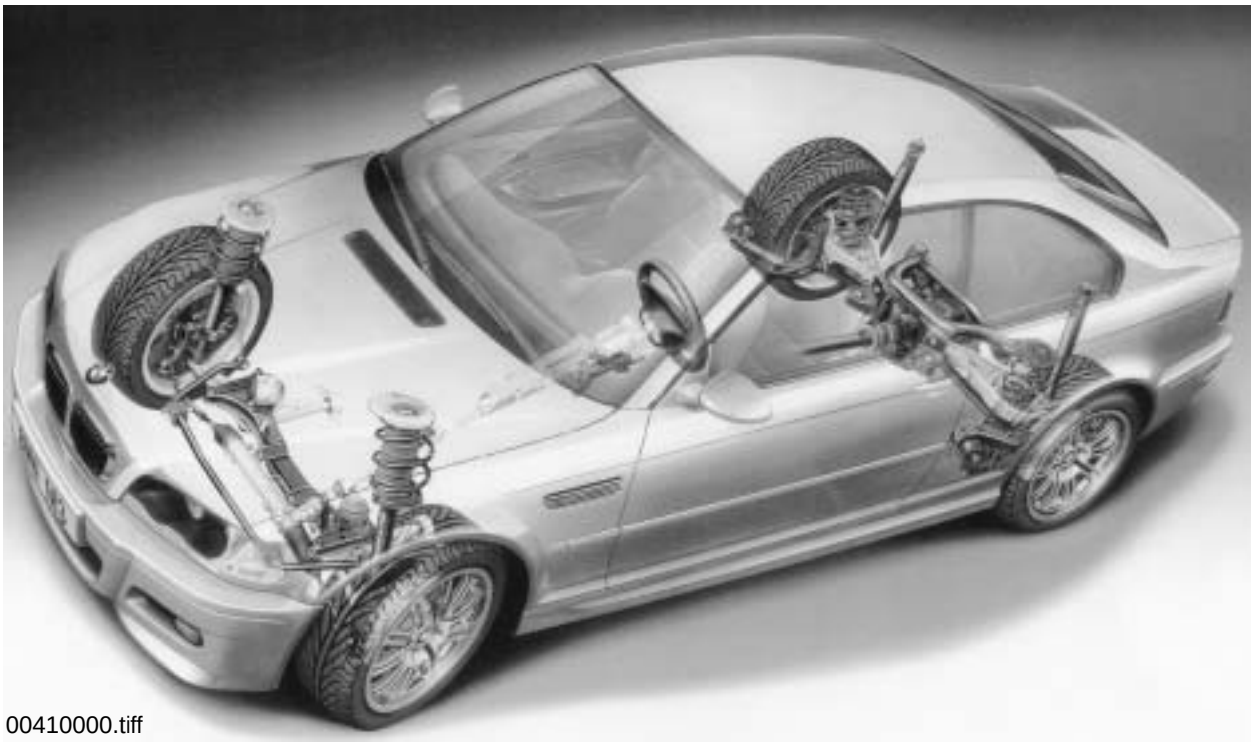
Purpose of the System

A requirement in the development of the running gear for the E46 M3 was: "The running gear must be faster than the engine". The exceptional running gear and suspension of the E46/2 as well as the outstanding running gear of the M3 predecessor served as the basis for the E46 M3.

The combination of a very rigid 3 Series coupe body, lightweight aluminum axle components, 50/50 weight distribution and rear-wheel drive are ideal prerequisites for pure driving pleasure with the BMW E46 M3.

The development objectives of E46 M3 were to further improve the sports car handling characteristics as compared to the predecessor while retaining the outstanding driveability for everyday use.

In addition, by using the variable M-differential lock together with DSC III, it has been possible to avoid the restrictions in winter operation normally associated with sports cars.



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System Components

Front Axle: The front axle of the E46 M3 is designed as a single-joint spring strut front axle. The basic characteristics of the axle resemble those of the M3 predecessor.

The special feature of the E46 M3 front axle is the rigid link of the running gear components to the body.

The E46 M3 “specific” modified components are:

- Front axle mount
- Aluminum control arm frame
- Aluminum thrust zone
- Larger track width (1508 mm)
- Stabilizer bar
- Steering (track rod length changed)
- Steering knuckle
- Wheel bearings
- Front axle carrier
- Modified elastokinematics (rubber mounts and joints)

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Mount: The spring and damper are insulated from each other. This arrangement improves the feel of the road surface conditions through the steering wheel.

Additional damping (rubber) has been inserted between the spring and damper mounting.

The geometric layout (offset center) of the front axle mount makes it possible to increase the caster angle.

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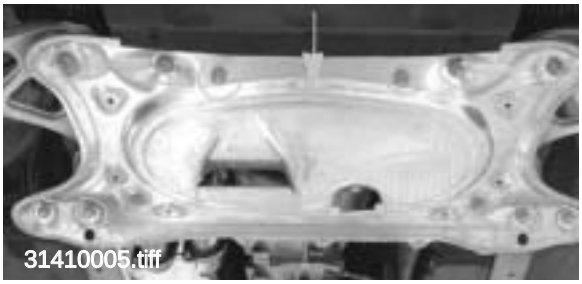
The offset mount center can be seen at the right.

A locating bolt (arrow) can be removed and the upper mount bolt holes in the strut tower are slotted to allow the mount to be re-positioned *for minimum camber adjustment.*

Thrust Zone: The rigid connection of the suspension components to the body is further assisted by the transversely rigid thrust zone.

The thrust zone is made of aluminum and is bolted to the control arm joints, front axle carrier and the rear control arm mounts.



Aluminum Control Arm: The forged aluminum control arm of the E46 M3 front axle is a specific development of BMW M.

Compared to the control arm of the E36 M3, the weight has been reduced by 40%. Its design incorporates specific deformation characteristics.

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Suspension and Damping: The spring rate of the front springs on the E46 M3 has been increased as compared to the E46/2.

The shock absorbers are twin-tube gas pressure dampers. The connection of the stabilizer support is new.

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Stabilizer Bar: The front stabilizer bar is 26 mm in diameter. The stabilizer links have been adopted from the E46/2.

Wheel Carriers and Wheel Bearings: The wheel carriers on the M3 front axle are specific. The mount for the brake caliper has been modified compared to the E46/2. The wheel bearings have been modified for higher loads. A drive pin for the brake disc is located on the wheel hub.

Steering: The steering on the M3 is designed as a power-assisted rack and pinion steering system.

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The steering pump produces a maximum pressure of 120 bar and has a delivery capacity of 11 L/min. The total gear ratio is 15.4 : 1. The steering has no hydraulic limit stops.

The turning circle is 11.0 m
The track circle is 10.6 m

The outer track rods of the rack and pinion steering are specific. They have been modified for the larger track width.

E46 M3 Rear Axle: The concept of the M3 rear axle originates from the E46/2. The characteristics of the central link axle has been adopted and modified from the E36 M3.

The track width of 1525 mm was achieved by modifying the rear rim offset.

The rear axle carrier was modified for accepting the differential and a modified rear stabilizer bar.

The lower control arm was adopted from the E46/2. To improve the wheel control, the outer joint is designed as a ball joint.

The upper control arm is aluminum. In order to improve the wheel control, the outer mount (as on the E36 M3) is designed as a ball joint.

The Semi-trailing arm is specific, the mounts on the body have been adopted from the E46/2. The linkage points of the control arms have been modified to increase the driving stability of the rear axle. The wheel bearing are the same as the E36 M3.

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Rear Axle Carrier with V-Strut: The rear axle carrier has been modified for the E46 M3. The rear body mounts have been specially modified to M3 requirements.

The mounting points for the rear axle differential are new (2 rear, 1 front). The stabilizer bar mounting is new.

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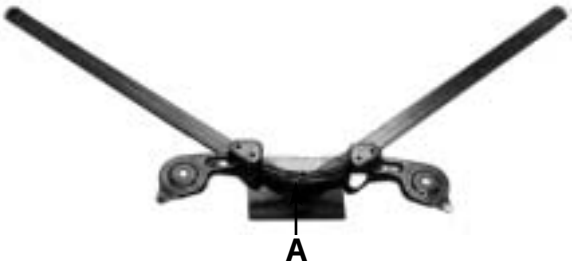
The V-strut is bolted to the body and rear axle assembly for additional rear axle reinforcement.

A reinforcement plate (A) is integrated in the V-strut. The plate deflects air flow towards the rear axle differential cover.



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Suspension and Damping: The suspension and damping components have been tuned in line with sport characteristics.

The coil (barrel) springs on the rear axle are progressive rate. The tuning is M3-specific.

The shock absorbers are designed as twin tube gas pressure dampers. Compared to the E46/2, the diameter of the piston rod and the piston have been increased (piston 32mm, piston rod 15mm).

The auxiliary cushion on the rear axle shock absorber is new. It differs from the standard auxiliary cushion by an additional groove and the black coloring.

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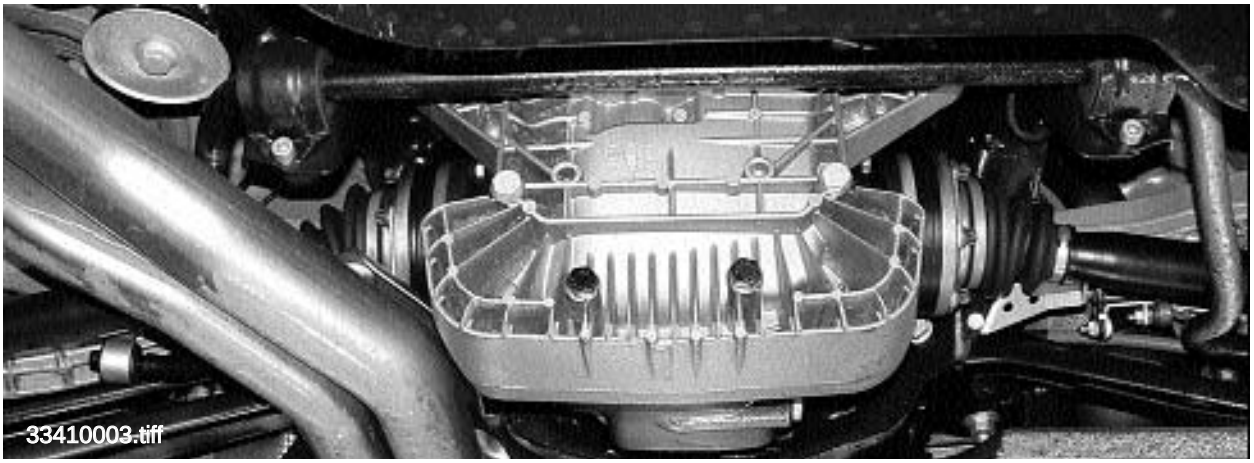
Stabilizer Bar: The rear axle stabilizer bar is specific. The diameter is 21.5 mm. The mounting on the rear axle carrier has been modified for the E46 M3.

E46 Rear Axle Differential: The rear axle differential is developed specifically for the E46 M3. The rear axle differential is designated “210” (ring gear diameter in mm).

The mounting points of the rear axle carrier for the differential have been modified compared to the E46/2.

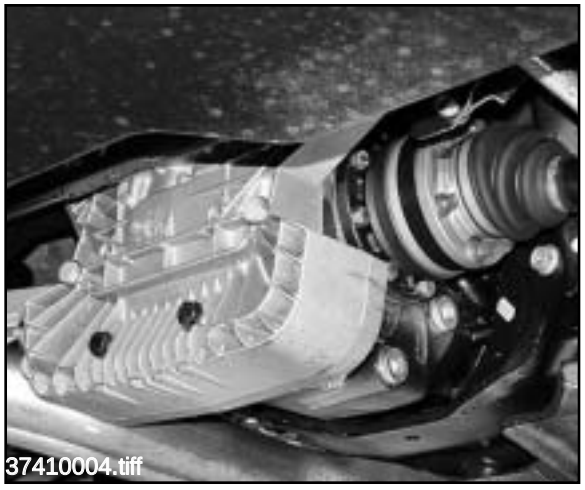
The rear axle differential is bolted to the rear axle carrier at two mounting points on the rear axle differential casing.

The rear axle carrier is connected to the body at the same points as the E46/2. For all BMW vehicles, this mounting arrangement is known as double-flexible rear axle mounting.



The housing of the rear axle differential is E46 M3 specific. The cover of the rear axle differential is made of pressure die cast aluminum. Special arranged cooling fins reduce the temperature of the oil in the differential.

The technical innovations of the variable M-differential lock developed by BMW M in cooperation with GKN Viscodrive GmbH is fitted in the E46 M3.



Variable M-differential Lock

To date, torque-sensing limited slip differentials with a constant basic locking torque have been used in M vehicles. The differential lock value for current M vehicles is 25%. However, if traction is very low, e.g. on snow, the advantages with this differential lock concept are limited due to the restricted support torque.

A variable differential lock is used for the first time in the E46 M3. Compared to the conventional torque-sensing differential lock, the variable M-differential lock is capable of providing traction advantages even under these extreme conditions.

When there is a speed difference between both wheels, a shear pump located on the ring gear side generates a pressure. A working piston transmits this controlled pressure on the basis of the differential speed of the drive wheels to the multi-disc clutches so that the drive torque is transmitted to the wheel with the most “grip”.

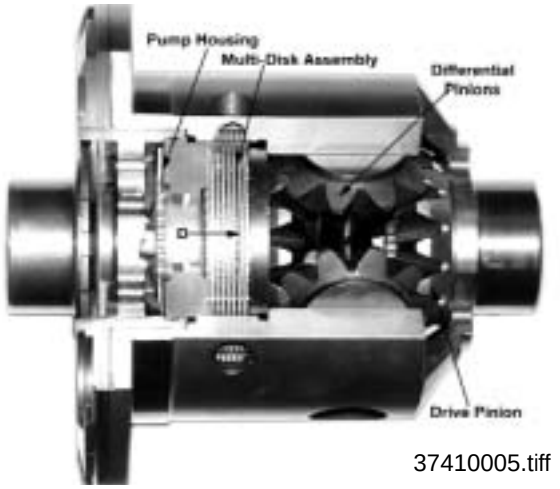
The pump pressure and locking power increase as the speed difference between the two wheels increase. If the differential speed between both wheels decreases, the pump pressure is also reduced and the locking power diminishes.

The Pump Unit: The pump unit is sealed (cannot be dismantled) and is filled with approx. 46 grams of high viscosity silicone oil.

As a result of the speed difference between the drive wheels, shear forces occur in the silicone oil in the pump unit between a channel filled with silicone oil and a pump disc located above it.

These shear forces generate a pressure that is dependent on the differential speed of the drive pinions.

The pressure is built up by a piston (max. 38 bar) that presses the multi-disc clutches together achieving a variable differential lock effect dependent on the differential speed.



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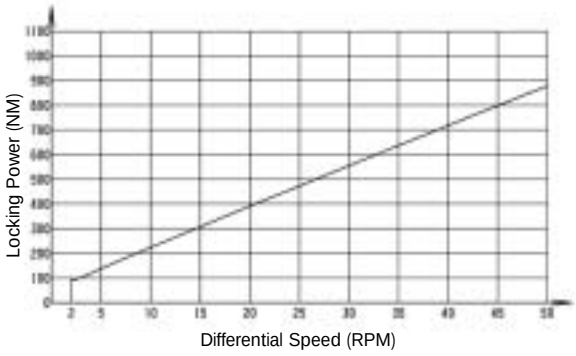

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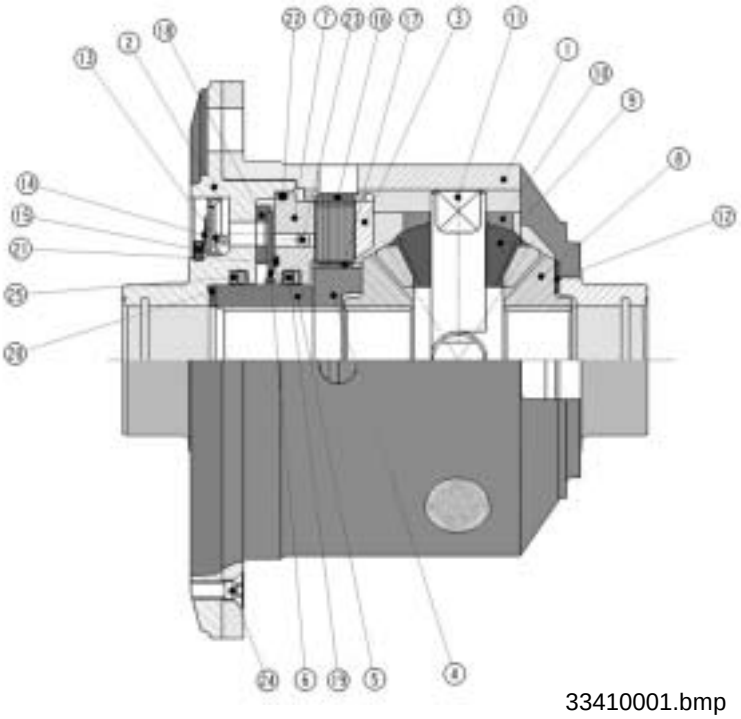
Description
1. Differential Case
2. Differential Cover
3. Differential Ring
4. Inner Disc Carrier
5. Displacement Disk Carrier
6. Displacement Disk
7. Pistons
8. Drive Pinion
9. Differential Bevel Pinion
10. Ball Disk
11. Differential Axle
12. Thrust Washer
13. Differential Piston
14. Disc Spring
15. Retaining Ring
16. Outer Friction Disc
17. Inner Friction Disc
18. Control Disc
19. Four-Lip Ring
20. Thrust Washer
21. O-Ring
22. O-Ring
23. Ball
24. Countersunk Screw
25. Support Ring



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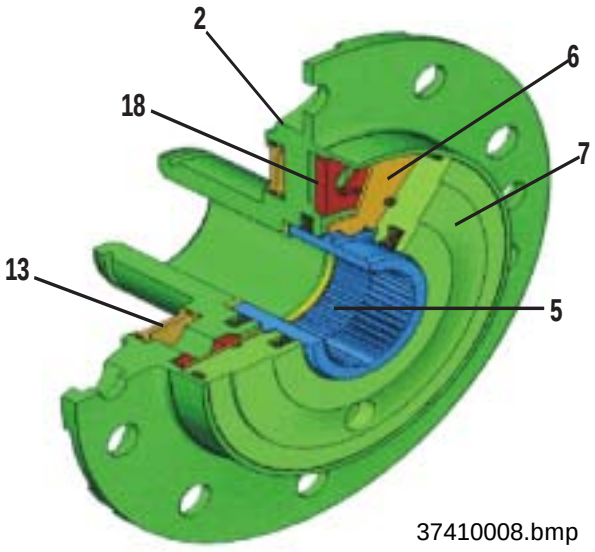
Sectional view of a shear pump unit is shown on the right.



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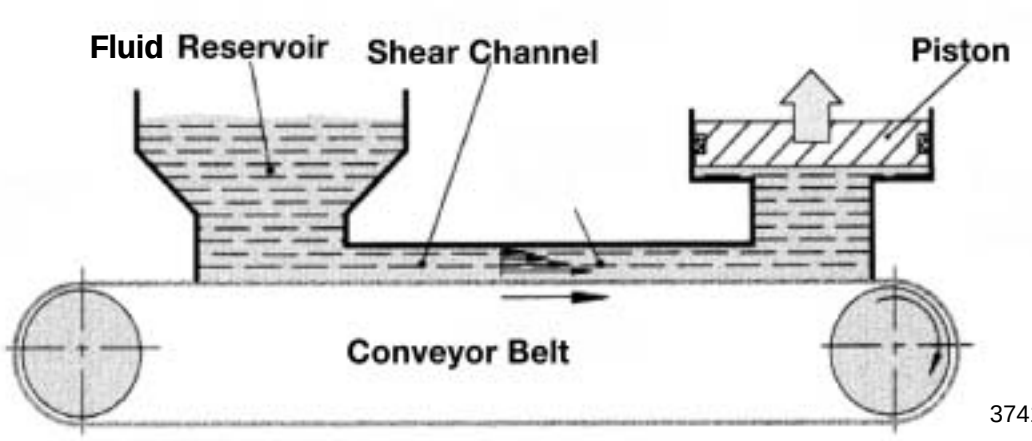
Principle of Operation

The conveyor belt model illustrates the functional principle of the shear pump. As the conveyor belt moves, the viscous friction in the laterally sealed shear channel conveys the fluid in the direction of movement.



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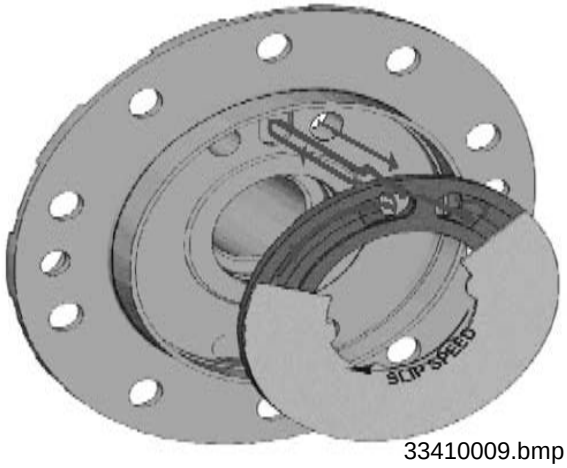
By transferring the operation principle to a rotary system, the conveyor belt becomes a displacement disc driven by the Hub. The shear channel is then a circular groove in the control disk. The control disk is located in the pump housing.

Transfer ports that are connected to outlet holes in the pump housing are provided at the ends of the shear channel.

Silicone oil is conveyed through the outlet holes from the equalization chamber (fluid reservoir) into the pressure chamber. Piston exerts a pressure on the friction discs.

The arrows shown to the right represent the flow of silicone oil between the displacement disc and the control disc. The silicone oil is transferred from the reservoir on the outside of the pump housing to the pressure chamber between displacement discs and the piston.

The arrangement of the pump elements and specific routing of the silicone oil in a gap between the piston and displacement disc ensures the pressure generated acts on the piston.



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E46 M3 Brakes: The E46 M3 is equipped with high performance brakes including floating calipers.

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Front brake discs:

- 325 mm diameter
- 28 mm thick

Rear brake discs:

- 328 mm diameter
- 20 mm thick

The tandem (dual circuit) brake master cylinder is 2-stage.

The brake booster is a twin chamber (9”/10") vacuum assisted unit.

E46 M3 Wheels and Tires: 18" high performance tires were specially developed for the E46 M3.

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The sizes are 225/45 ZR 18 on the front and 255/40 ZR 18 on the rear.

The newly styled 18" light alloy wheels for the E46 M3 are 8" wide on the front and 9" wide on the rear.

The extended hump (EH) of the wheels prevent the tire from slipping into the dropped center of the wheel in the event of pressure loss.

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M-mobility System with RDW: The tire pressure warning system (RDW) is integrated in the Dynamic Stability Control (DSC III).

It triggers a warning when the tire inflation pressure has a loss of approx. 50%.

With the second generation M-mobility System (MMS), holes of up to 6 mm diameter can be sealed.

Dynamic Stability Control: One of the aims in the development of the E46 M3 was to improve traction and winter driving characteristics.

The E46 M3 uses the Teves MK 20 El DSC III system from the E46 production vehicle.

With software adaptation and logic expansion, the system is tuned to the variable M-differential lock.

Review Questions

1. What is unique about the Front Strut Upper Mount? _____
   _____
   _____

2. List the suspension components that are modified for the M3:

_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

3. Concerning the M-differential Lock, what is the purpose of the Shear Pump?
   _____
   _____
   _____

4. What increases the Shear Pump Pressure?
   _____

5. How does “EH” affect a tire with low air pressure? _____
   _____