Reference Manual

E71
COMPLETE VEHICLE

Technical Training

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E71 Introduction Workbook

Subject **Page**

Initial Print Date: 04/08 Revision Date: 5/08

Introduction

Model: E71

Production: From Start of Production

OBJECTIVES

After completion of this module you will be able to:

- Compare the E70 X5 with the E71 X6
- Describe the new technology used on the E71 X6
- Identify the features of the E71 X6

The All-New X6

"Dynamic Elegance", "The first of its kind", are some of the phrases and accolades that BMW and the media have employed when speaking about the new BMW X6. Just two days after its worldwide debut, the BMW X6 Sports Activity Coupe was named "Best Production Truck" at the Eyes On Design Awards at the North American International Auto Show (NAIAS).

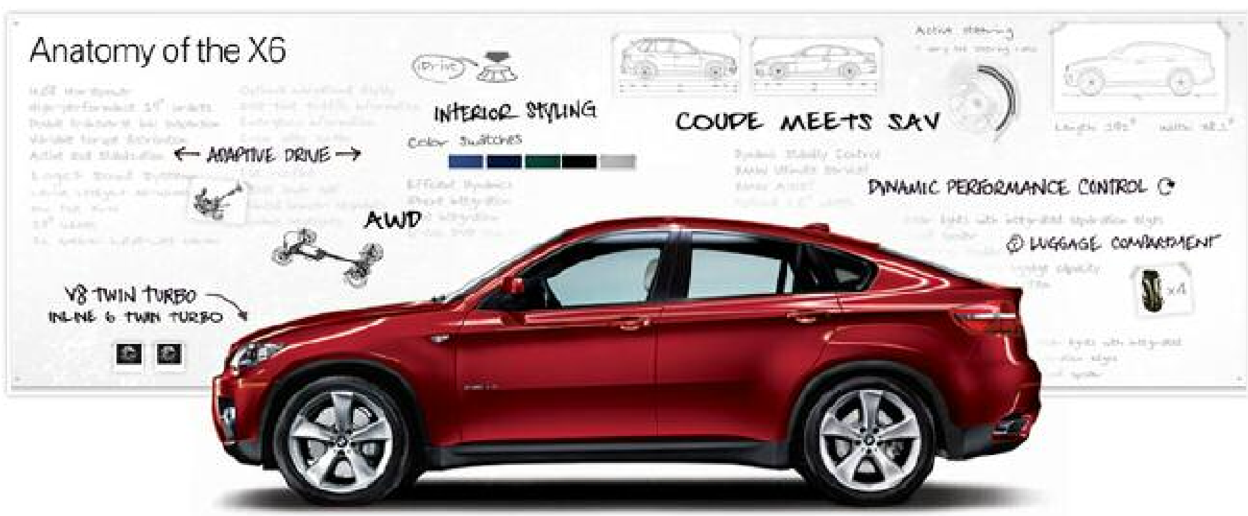
The X6 is a totally new concept due to arrive in the US in March of 2008. BMW has combined the practicality and convenience of the Sport Activity Vehicle (SAV) with the styling and features of a sport coupe. This new concept is being referred to as a (SAC) or Sport Activity Coupe.

The stylish lines of the X6 are combined with a sleek and sporty wide stance which is signature of all BMW coupes. The X6 sloping roofline continues all the way to the newly designed tailgate. The passenger compartment accommodates four occupants in a higher sitting position, while offering all the same options and amenities available on current E70 Vehicles. With the rear split seats lowered, the X6 delivers the largest cargo room in its class.

Built on the E70 platform, the X6 also employs xDrive (BMW all-wheel-drive technology with electronic control for variable distribution of drive power between the front and rear axles), only to be taken to another level with the use of Dynamic Performance Control (DPC).

The typical E70 xDrive system is now coupled with a totally new QMVH differential and a new system referred to as Integrated Chassis Management (ICM) system. This new system allows the distribution of the drive torque from front to rear as well as from left to right at the rear axle. xDrive with QMVH continually adjusts to any driving condition and performs well in all situations.

The X6 will be available in two models, differentiated mainly by their power plant. The xDrive35i will sport the already familiar N54 engine with its 3.0 liter twin turbo, direct injection, 300 hp and 300lb-ft torque six cylinder. The xDrive50i gets the N63, a new 4.4 liter, 400 hp, 450 lb-ft torque V8 engine with direct injection and twin turbochargers (neatly tucked into the engine valley).



Body

The E71 will be launched in early 2008 and will be available in the following models:

- X6 xDrive50i with N63B44O0 engine
- X6 xDrive35i with N54B30O0 engine

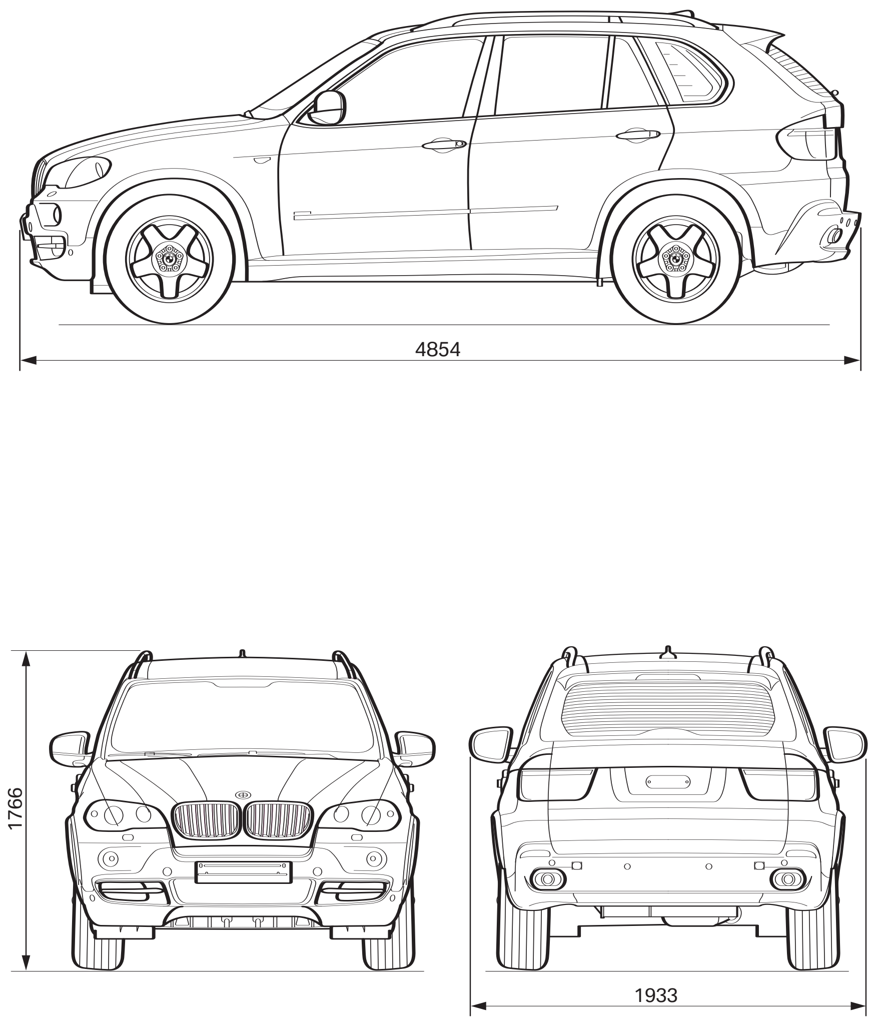
To further reinforce the sports-oriented character of the E71, compared to the E70, the conventional chassis has been set lower by 10 mm.

The ride height has remained the same as on the E70 for the chassis and suspension system with adaptive drive.

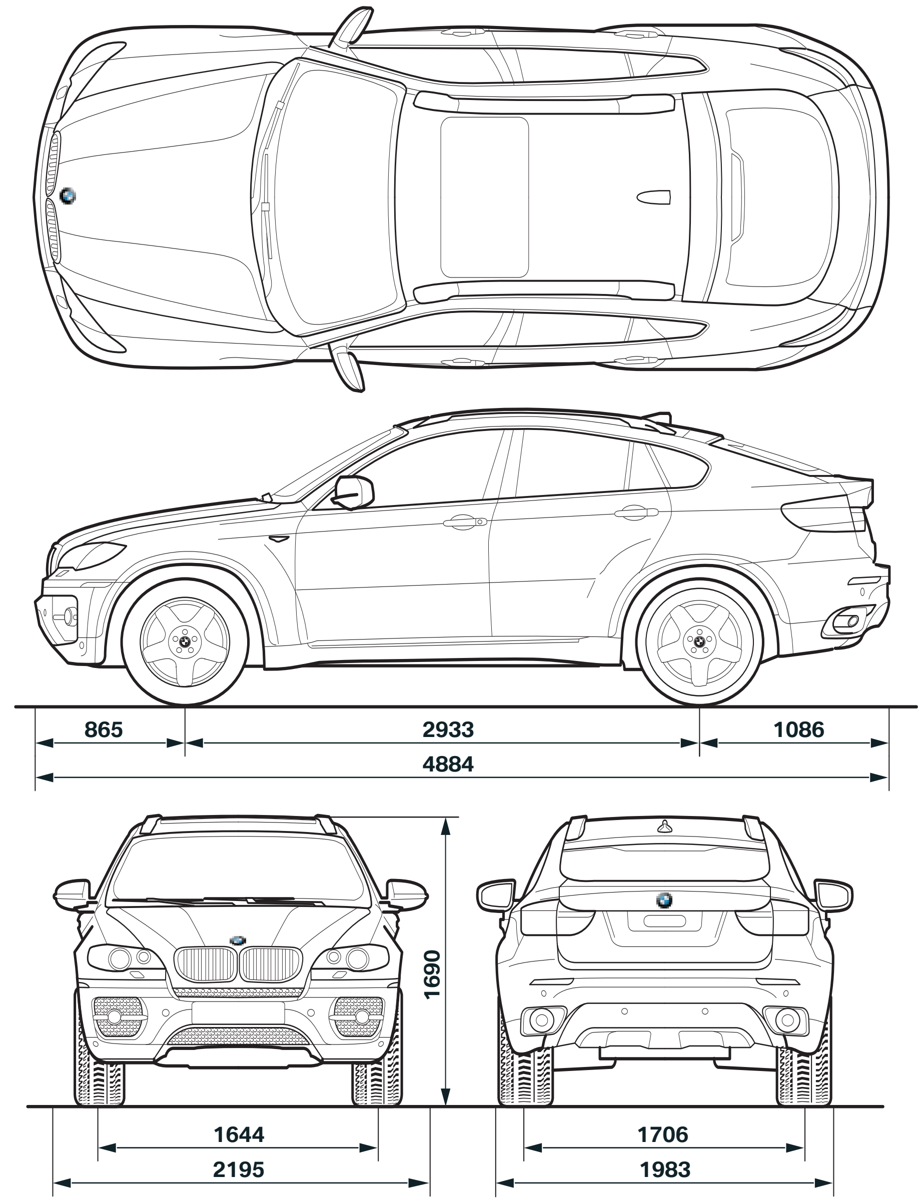
Compared to the E70, the dimensions and weight of the E71 are as follows:

Specification	E71	E70
Unladen weight (kg)	2,145	2,125
Length (mm)	4,884	4,854
Width (mm)	2,195	2,197
Height (mm)	1,690	1,766
Wheelbase (mm)	2,933	2,933
Track width, front (mm)	1,644	1,644
Track width, rear (mm)	1,706	1,650

Technical Comparison (E70 vs E71)



E70 X5 Body Dimensions



E71 X6 Body Dimensions

Bodyshell Construction

- In the E71, demanding functional requirements have been achieved by the consistent implementation of innovative light-weight construction while adopting many components from the E70 sub-frame.
- The E71 features hot-formed BTR materials in tailor rolled blanks (TRB) as well as micro-alloyed dual-phase steels.
- Torsional rigidity is comparable to the E70.

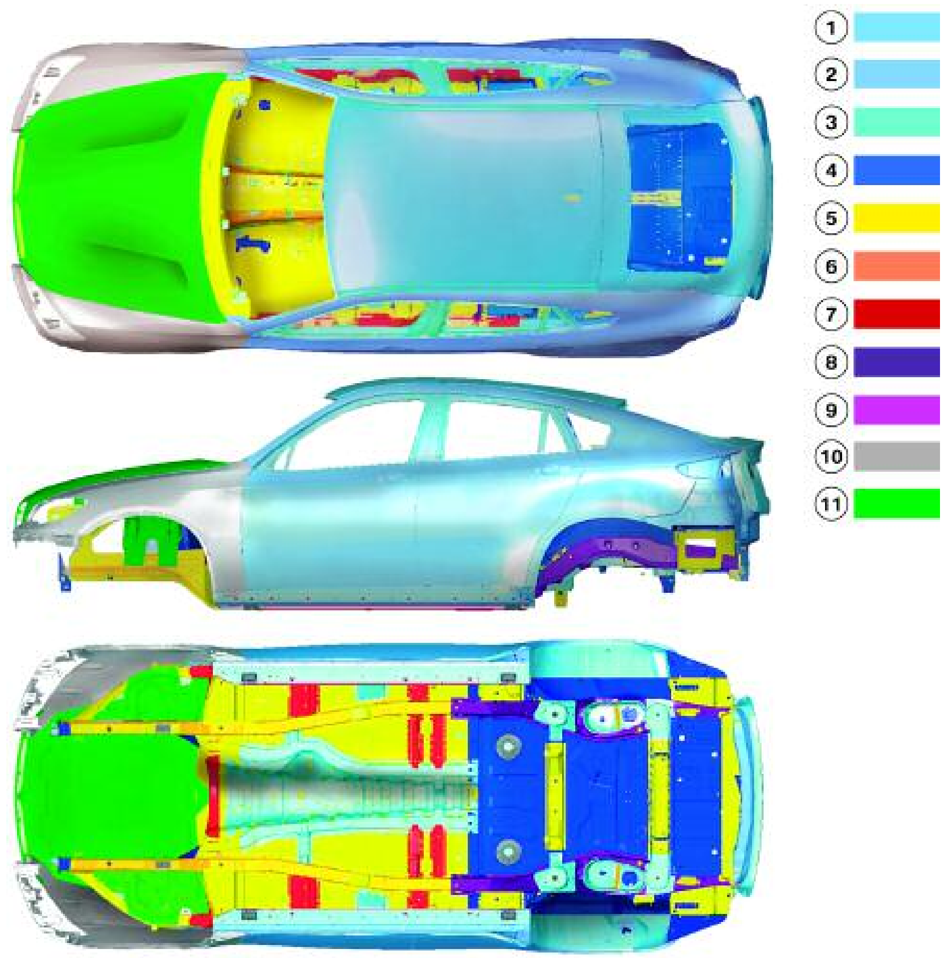
The design layout of the body structure was primarily based on optimum interaction of passive safety measures for the purpose of achieving maximum safety for all vehicle occupants.

A large number of body reinforcements were used in the safety-relevant areas of the front end, B-pillar and rear end while using new steel grades to provide a greater load bearing capacity compared to conventional steel. As a result, impact deformation is kept as low as possible while interacting with the restraint systems to ensure maximum safety for all occupants. Impact energy that occurs during a collision is absorbed by the structure and correspondingly directed along load paths.

The structure of the E71 was designed to conform to the US Lateral Impact New Car Assessment Program (LINCAP) at 64 km/h/40mph with crabbed barrier, to US Insurance Institute for Highway Safety (IIHS) new side impact test at 50 km/h/31mph at 90° as well as to US high speed rear end impact 80 km/h/50mph with 70% offset.

With the aim of providing the highest possible level of occupant protection in connection with the safety passenger compartment, all conceivable situations, going beyond legal requirements, were considered in the simulations.

The body structure remains intact at an impact of up to 15 km/h (lateral 40% offset at front and rear) at an impact angle of 10°.



Index	Explanation	Index	Explanation
1	Other steels	7	CR420X, CR950DL
2	DC04 - DX54D, DX56D	8	HD680C
3	HC180BD - HC180YD	9	22MnB5 (BTR165)
4	HC260BD, HC240LAD	10	Plastic
5	HC300BD	11	AlMg3Mn - AlSi10MgMn, AlMg04, 5Mn04
6	HC380LAD		

Passive Safety

A complex, perfectly coordinated system, consisting of various safety components ensures the greatest possible passenger protection in the event of an accident occurring while reinforcing the concept of "The Ultimate Driving Machine". This system consists of the seat belt, airbag and steering assembly maximizes passenger safety.

The integrated safety electronics has the important task of triggering the right airbag at the right safety level and right time corresponding to the type and severity of collision . The intelligent system does not deploy any airbags that are not required, thus ensuring that they are still available to protect the vehicle occupants in the event of secondary impacts. This system achieves the US Top Safety Picks in the IIHS crash test.

Structure

The greatest possible degree of safety at the lowest possible weight was achieved through intensive co-operation between development engineers and safety experts as part of the development of the E71 body:

- Optimum design layout and utilization of deformation zones for generating intelligent and coordinated vehicle characteristics.
- Extremely rigid passenger compartments.
- High-strength, large volume carrier structures with specific use of high and super high strength steel grades in the front section, roof and side frame as well as in the rear section.
- The implementation of tried-and-tested design elements in frontal impacts with complete or minimum offset for effective transmission and dissipation of forces.
- Minimizing of deformation depth and intrusion speeds during side impacts through reinforced side structures in the B-pillar and sill/rockers, high-strength door reinforcement, sturdy seat cross member and a cross beam in the underbody assembly.
- Even in the event of a severe impact, the passenger compartment effectively safeguards the occupants thanks to the heavily reinforced pillars and roof members.

The energy-absorption characteristics are achieved by maintaining the passenger compartment structure and the successful adaptation of restraint systems.

It was possible to significantly improve the rigidity of the body by using a closed torsion ring around the D-pillar and by optimum node design layout. Another feature used to increase the torsional strength is the load-sharing, wedged tailgate. By applying tension to the hatch between the D-pillars, the hatch shell, with its profiles, increases the rigidity.

E71 Torsion Ring

Pedestrian Protection

This system was adopted from the E70:

- The aluminum hood
- The hood hinges have a disengaging mechanism in the direction of impact
- The brackets for the hood latches collapse
- The plastic side panel module

The bodyshell structure has been lowered and the resulting space filled in with a plastic carrier structure (module carrier) with a plastic fender. This separates the "soft" requirements of design and pedestrian protection from the "hard" requirements of rigidity, stability, high and low-speed crash performance.

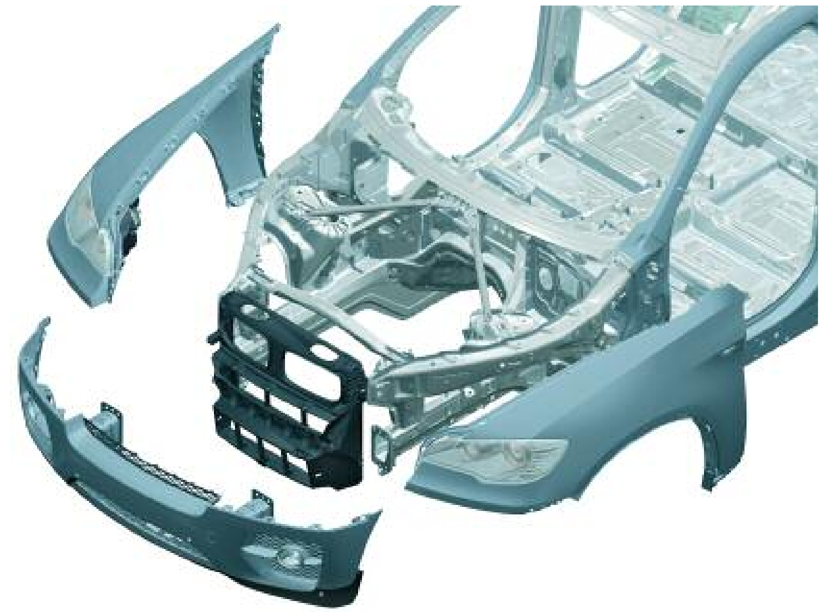
The front lower wheel arch carrier support creates a space which is filled with a plastic module carrier.

E71 Side Panel Module

Front End Design

The fenders are made from a plastic, of the same material as the bumper panels. This makes it possible to use the same painting process (painting temperature should be 85°C/185°F) for both components.

In simulated pedestrian protection tests, a test object (3.5 kg/7.7 lb) is shot against the side panel at a speed of 35-40 km/h or 25mph.



E71 Front Section Components

In most cases, the deformation proved to be reversible (no splintering and no breakage of component, including the paint work). As a passive system, the module carrier of the side panel module effectively contributes to complying with pedestrian protection requirements. With its ribbed structure, the module carrier essentially acts as a spring element.

Interior

Accents and Features

For the purpose of differentiating the top engine models, the BMW X6 exhibits the following design features.

- Badges on front fenders differentiate engine models

  xDrive35i

  xDrive50i
- Sporty coupe appearance
- Chrome trim accentuates windows
- The already expressive kidney is further accentuated and the sports-orientated character of the vehicle is emphasized.
- An E60 style sunroof is used with Panaroma glass sunroof option not available for E71.

Continuous chrome strip in area of 'Hofmeister' kink, no joint as on other models.

Dashboard

The leather-grain surface material of the dashboard is made from an in mould coating (IMC) slush skin with the following properties:

Maximum performance over the entire service life of the vehicle, light resistant, provides protection against scratching and soiling, complies with technical and legal requirements, excellent appearance as well as touch and feel properties.

The leather-coated dashboard option provides optimum appearance and feel. Special non-woven upholstery padding under the leather makes it feel soft and flexible. The leather therefore has ample give when touched. The scent of real leather conveys an air of exclusivity in the vehicle interior.

The seams additionally contribute to the high-grade visual appearance of the dashboard and door shoulder.

Door Trim

- 2-part decor strip for high-quality appearance.
- Leather trim pull handle (available in Nevada leather, Alcantara and Saddle exclusive leather), basic: soft paint; Handle bracket in 2-component technology.
- Ambient lighting in the door handle and in the door pocket (option).
- Recessed handle for driver's door.

The new recessed handle in the driver's door improved ergonomics. While new ambient lighting (option) conveys a better impression of space at night.

Front door trim, front passenger side

Rear door trim

Front Seats

The following seat variants are offered for the E70:

- Fully electric basic seat
- Multifunction seat
- Sports seat

In addition to the functions of the fully electrically operated basic seat, the multifunction seat also has:

- Electric backrest-head adjustment
- Pneumatic lumbar support depth and height adjustment
- Electric head restraint height adjustment
- Luxury head restraint with manual lateral adjustment ("rest head restraint")
- Electric seat back width adjustment
- Electric depth adjustment of the seat
- Memory functions for driver and front passenger

Possible options (driver and front passenger):

- Four-circuit seat heating
- Active seat
- Active seat ventilation including seat heating

Active Seat Ventilation
The improved cushion and cover design and active ventilation of the seats increases the climate and physiological well-being of the passengers.

The system is operated by means of a button on the climate control panel. A blue LCD indicates that the system is active. The setting (3-stage) is shown in the control display.

This option is only available in conjunction with the electrically adjustable front luxury option and the seat heating option for driver and front passenger.

Active seat ventilation is split into the following components:

- Perforated cover in Nevada leather
- Seat heating
- Interlay knitted fabric for optimum air distribution
- Nine axial-flow fans (four in the backrest, five in the seat cushion)

Note: Crash sensitive head restraints are standard equipment.

Rear Seats

The vehicle offers ample knee room in the rear while the range of options makes it possible to individualize. There are two individual sports style seats in the rear, demonstrating the E71's coupe character while creating an exclusive atmosphere. Additional storage space is provided on either side between the rear seats and door trim panel.

Two large drink holders and a storage compartment or alternatively an ashtray and cigarette lighter are integrated in the rear console located between the two individual seats. This unit is closed off by two roller covers, concealing a large, open and divided storage compartment.

Note: The ISOFIX system is accessed through a slit in the seat cover.

Individual Rear Seats

The seats are designed as full foam folding split seats with separate backrest and seat cushion and a torso angle of 26°. The split ratio is 60/40. The backrest is unlocked by means of a handle on the backrest. The integrated head restraints and the individual seats with molded side sections underscore the high-performance coupe character of the rear seat system. The special design layout of the headliner ensures optimum headroom without having to forego a folding center armrest and a ski bag (option).

Rear seat heating (three-stage switch, heating output as on E70); is only in conjunction with front seat heating.

Seat Belt Height Adjustment

In terms of passive safety, due to the geometry of the area surrounding the seats, there is no need for a seat belt height adjustment feature. In the E71, the seat belt system has been ergonomically tailored to the rear passengers while taking the various physical sizes into account. This system complies with stringent passenger safety requirements and corresponding legal stipulations.

Glove Compartment

The E71 glove compartment was inspired by the E70 design. It locks automatically when the vehicle is locked. The volume of the glove box is bigger, as the airbag has been moved closer to the windshield. The new position makes it easier to look into and access stored items.

Both lids are opened by means of a button on the left, next to the glove compartment. This is located under the center grill, integrated into the right side end of the lower accent strip. The lids are coupled with each other; in a way that they automatically move together upwards or downward at the push of a button.

A 6-disc DVD multimedia changer is offered as an option, with CCC cars only. It is located in the glove box and will also be available on the E70. This option allows video media to be played on the front CID providing the vehicle speed is 0 mph.

Glove compartment with optional multimedia changer

Center Storage Compartments

The console storage compartment is located on the center console, the two lids can be opened separately at the push of a button. The buttons are located on the front of the console, each directly to the right or left beneath the lids. The lids may be operated individually. They open automatically with a spring and are closed manually.

Drinks holders and extra storage tray, are located in the front section of the center console, where the compartment tray is covered by sliding roller doors. These meet in the middle and can be opened to the front or back with two small handles. In the front area, there is a storage tray or, optionally, an ashtray with a cigarette lighter. In the rear section there are two large drinks holders.

Knee Pads

Knee pads made from high-quality glass fiber reinforced plastic, characterized by outstanding stability and lightweight construction. The knee pads are coated with leather as standard. The knee pads can be coated with all types of leather depending on the selected leather option. The Alcantara leather combination is considered the exclusive leather option.

Luggage Compartment

- A large luggage compartment volume at 1540 liters compared to large coupe and SUVs.
- Delivers ample functionality.
- Extensive additional storage options.
- Folding luggage compartment cover can be stowed away under luggage compartment floor.
- Stainless steel loading step/sill.
- Storage package with two lashing rails (option).

The design layout and size of the luggage compartment are noteworthy when compared to vehicle of this class.

Due to the run-flat tires standard on this vehicle a spare tire is no longer required. Though a space saver tire is standard equipment in the US.

The luggage compartment floor is opened with the help of gas-pressurized prop piston. The optional storage package includes useful items such as two lashing rails with four adjustable lashing eyes, stowage nets, bag hooks, a light for the storage compartment and a 12 Volt connection in the center console.

The luggage compartment floor is lockable as standard. The luggage compartment cover is easy to remove and install and coated with a high quality textile material. Due to its Z-folding design, the cover can be folded and stored under the luggage compartment floor provided the space-saver wheel option was not ordered.

An fastening system is optionally offered, which is available only together with the storage package. With this option, the luggage compartment can be divided allowing smaller items of luggage to be secured.

The stainless steel loading step/sill gives the vehicle an individual and high quality appearance.

Tailgate

There is two different tailgates options offered on the E71 X6:

- Manual Tailgate with dual height adjustment
- Automatic Tailgate (HKL)

Note: The adjustment can only be performed when the tailgate is in the fully "open up" position.

Manual Tailgate

The system operates with the use of two hydraulic shocks that provide the lifting of the tailgate. To set the maximum tailgate opening height, these hydraulic shocks can be manually adjusted to 2 separate positions. The adjustment is made by rotating the hydraulic shock/covers on the right and left lifting cylinders, which are appropriately, marked 1 and 2.

When set to the #1 position, the tailgate opens up to its low setting. When the #2 position is selected, the tailgate is raised to its maximum setting. To fully open the tailgate when the adjustment is in position (1), the tailgate must be first lowered approximately 12" and then raised all the way up, before position #2 is selected.

Manual Tailgate adjustment on the hydraulic lifting shocks

Position #1 corresponds to the lowest tailgate height setting.

(Lowest Setting)

Position #2 corresponds to the highest tailgate height setting.

(Highest Setting)

Automatic Tailgate (HKL)

In terms of its functionality, the automatic tailgate operation is identical to that of the E70 X5 HKL. It differs only by minor changes made to the mechanical and electrical systems.The automatic tailgate operating system has been adapted to the body of the X6 and only the changes/modifications are outlined.

The tailgate of the E71 X6 is a one-piece component.

Automatic opening of the tailgate may be done by remote control or push button. Closing the tailgate is only possible with the use of the push button. The push button on the inside of the tailgate no longer connects to the junction box but rather directly to the HKL module.

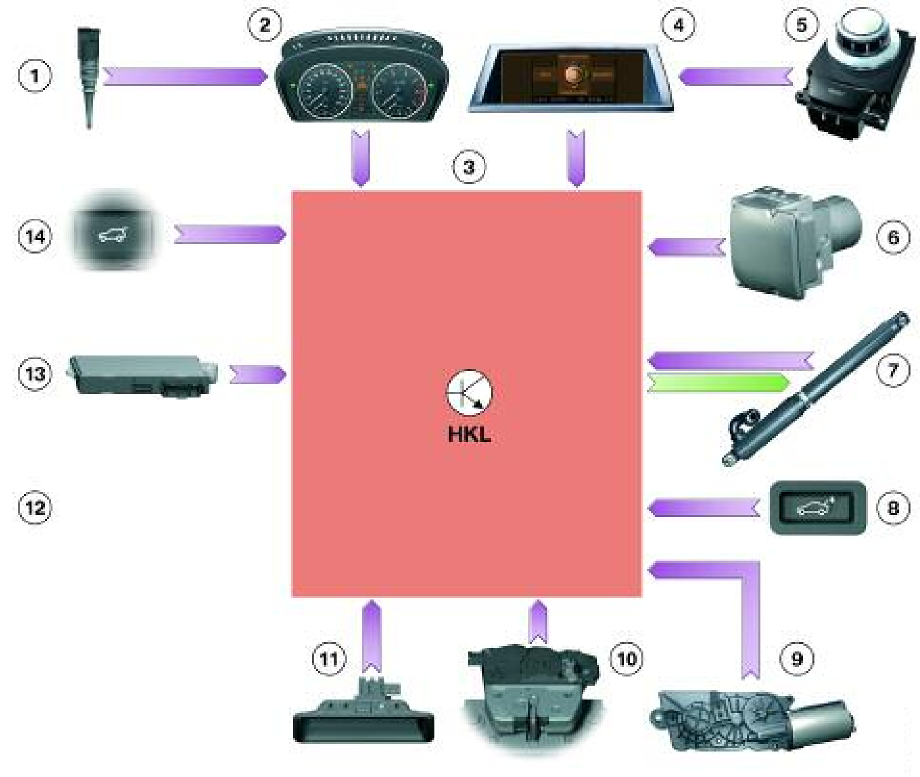
An anti-trap system is provided and integrated into the screw drives units. The HKL monitors position and current of the screw drive units.

Since there is no lower tailgate, there is no need for the lower tailgate contact. The fact that no signal is sent is ignored by the control unit (JB).

Automatic Tailgate Operation

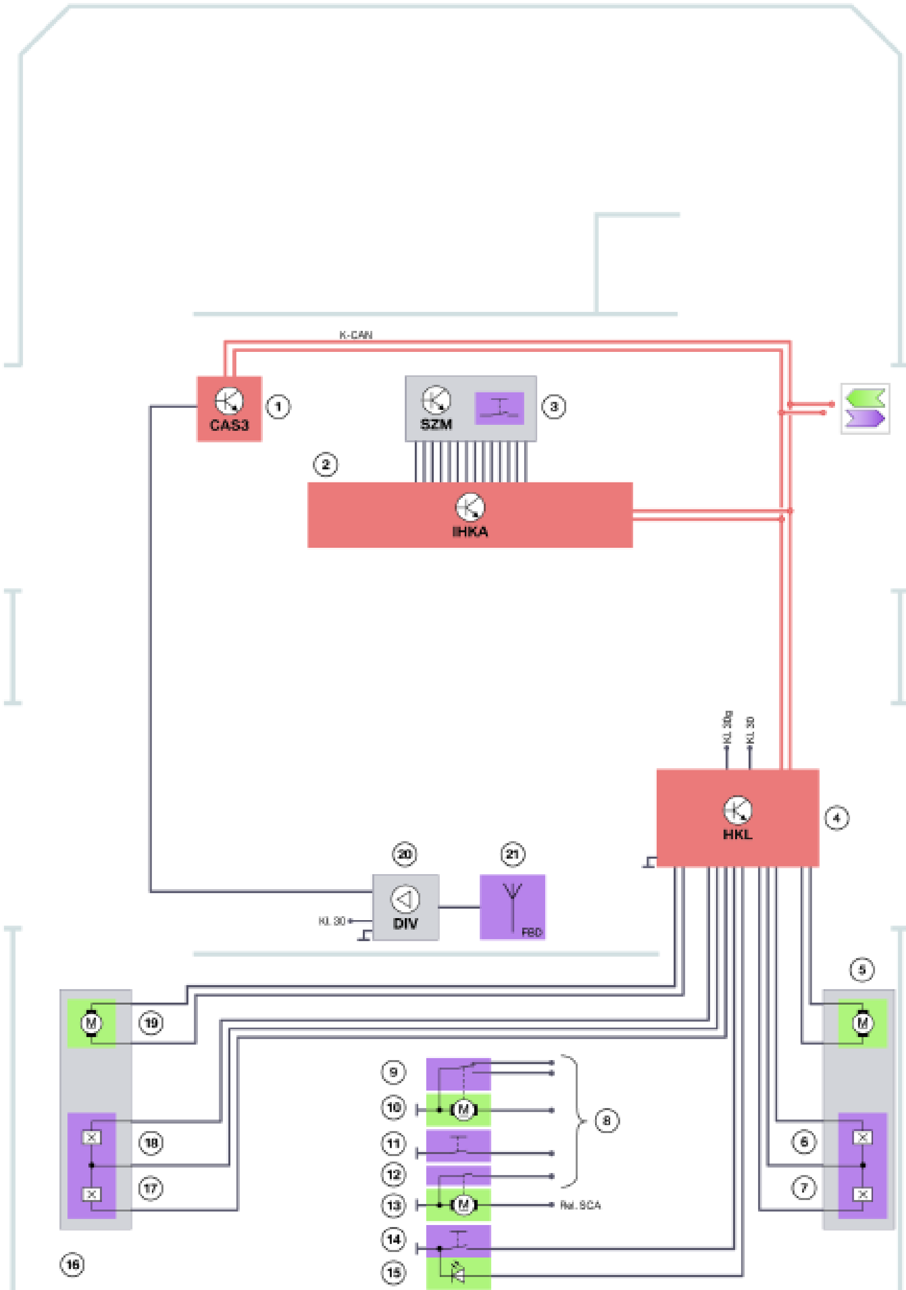
The tailgate lift (3) controls and monitors the opening or closing of the tailgate. This can be triggered by the tailgate push buttons (8, 11 and 14). The controller (5) can be used to adjust the maximum opening angle for the tailgate on Central Information Display (4).

The signals from outside temperature sensor (1) and the vehicle speed (6) are evaluated in the decision as to whether the tailgate may be opened or closed in response to pushing the button.



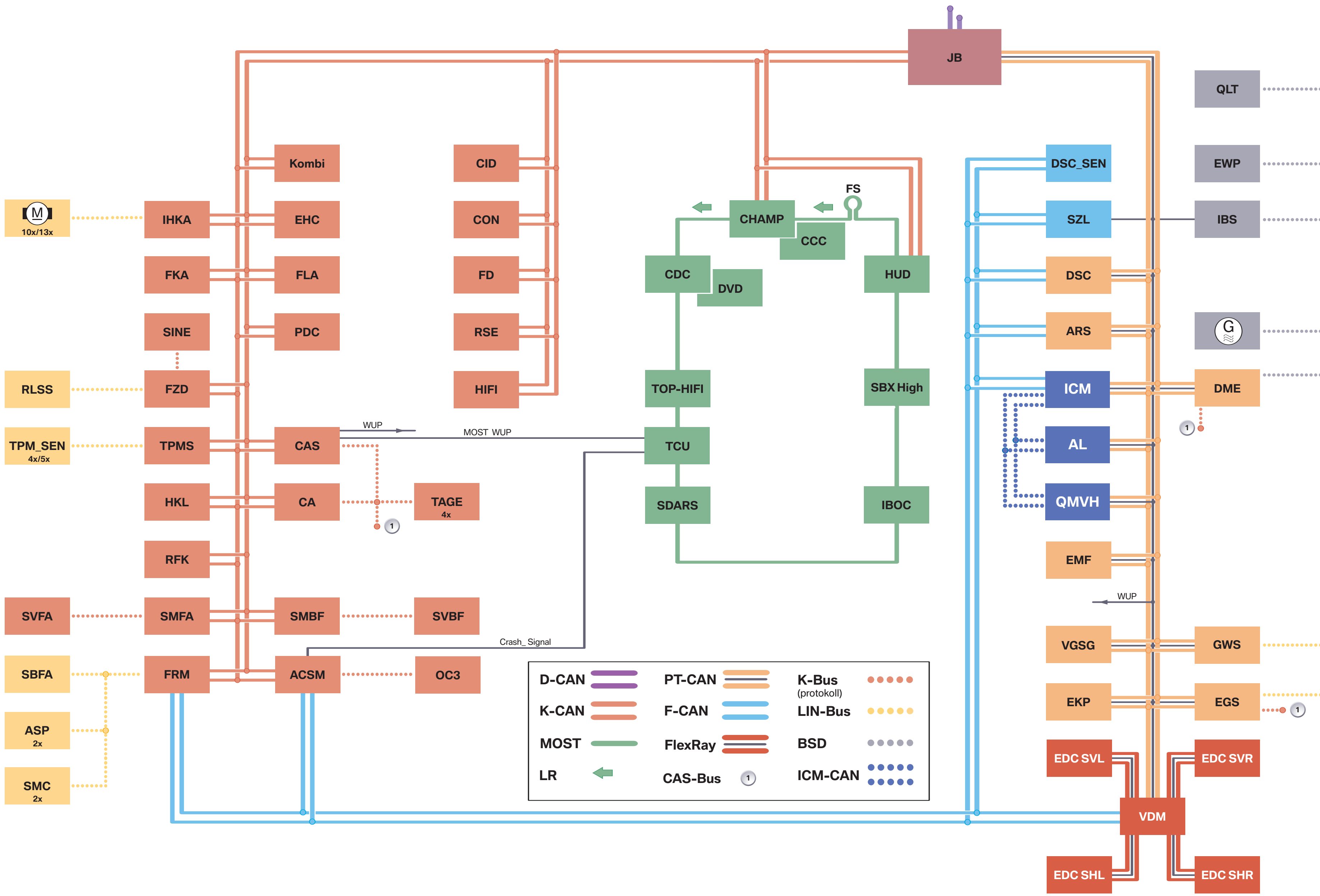
Index	Explanation	Index	Explanation
1	Outside temperature sensor	8	Interior tailgate push button
2	Instrument cluster	9	Drive unit for automatic soft-close function
3	Automatic tailgate operation control unit	10	Tailgate lock
4	Central information display	11	Exterior tailgate push button
5	Controller	12	Not applicable
6	Dynamic stability control	13	Car Access System 3
7	Tailgate screw drive	14	Interior tailgate push button

E71 Automatic Tailgate Operation System Circuit Diagram



Index	Explanation	Index	Explanation
1	Car Access System 3 (CAS3)	14	Interior tailgate push button
2	Integrated automatic heating and air-conditioning system (IHKA)	15	Interior tailgate push button illumination
3	Tailgate push button in the center console switch cluster (SZM)	16	Not applicable
4	Tailgate lift (HKL)	17	Hall sensor, left
5	Spindle drive motor, right	18	Hall sensor, left
6	Hall sensor, right	19	Spindle drive motor, left
7	Hall sensor, right	20	Remote control receiver in diversity module
8	Connections to the junction-box (ECU)	21	Remote control aerial in the rear window
9	Rear hatch contact	K-CAN	Body CAN
10	Upper tailgate lock motor	Kl.30	Terminal 30
11	Exterior tailgate push button	Kl. 30g	Terminal 30 switched
12	Contact for drive of automatic soft-close function	Rel.SCA	Connection to the automatic soft-close relay
13	Automatic soft-close for tailgate		

Bus System Overview



Workshop Exercise - Vehicle Walk Around

Using this training manual, inspect the overall vehicle exterior and answer the questions below:

Fill in the chart below regarding the external body materials.

Body Component	Material
Hood	
Fenders	
Doors	

Fill in the blank below with the correct answer regarding the overall dimensions on the E71:

The overall length the E71 is _______ mm, ___________ than the E70.

The unladen weight of the E71 is ________ kg, ___________ than the E70.

The wheelbase of the E71 is _________ mm, ____________ than the E70.

The overall height of the E71 is _________ mm, __________ than the E70.

Observe the wheels and tires on the E71.

Are run-flat tires standard or optional on the E71?

____

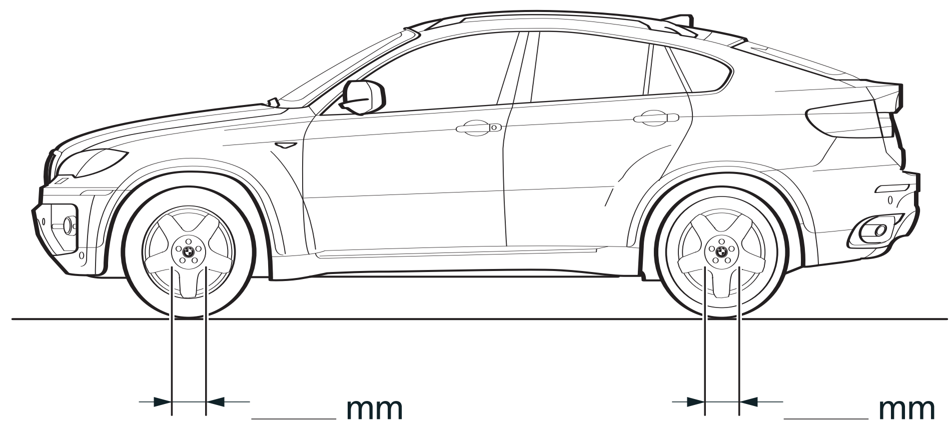
____

What's the obvious difference between the front and rear wheels?

____

____

Measure the front and rear hubs and record your findings below.



What is the purpose of this feature on the E71?

____

____

What precaution must be taken while mounting the available space saver spare tire in these vehicles?

____

____

Will E70 wheels fit on an E71 vehicle properly?

____

____

____

Workshop Exercise - Vehicle Walk Around

Open the tailgate and note its operation.

In comparison to the E70, how does the E71 tailgate differ?

E70 Deck Lid

Locate and note the position/operation of the emergency tailgate release.

Where is the emergency tailgate release located?

What tool, if any, is needed to gain access and operate the emergency tailgate release?

Take note of the tailgate height when fully opened.

Is the maximum opening height of the E71 HKL tailgate adjustable?

How is the maximum opening height of the E71 HKL tailgate adjusted?

E71 Deck Lid

Is there an anti-trap system for the HKL tailgate operation?

Where is the anti-trap device located?

Workshop Exercise - Vehicle Walk Around

Look over the vehicle interior of the E71.

What is the passenger capacity of the E71?

Locate the vehicle tool kit and note contents.

In the tool kit, there is a red “hammer like” tool, what are the two uses for this tool?

1.

2.

How do these procedures differ from the E70?

Find the following components and note locations:

Component	Location
Battery	
DSC control Module	
Spare Tire	
SDARS	
HiFi Amplifier	
TCU	
Fuel Pump Module (EKP)	
ICM Module	
Rear Power Distribution Box	
QMVH Module	
Vertical Dynamics Module (VDM)	
Cooling pump for turbos (N63)	
Cooling pump for intercoolers (N63)	

Workshop Exercise - Vehicle Walk Around

Examine underhood components and note the following items:

- ❑ *Engine Oil Fill*
- ❑ *Dipstick (N54 and N63)* ❑ *Oil Level Sensor(N54 and N63)*
- ❑ *Washer Fluid Fill*
- ❑ *Power Steering Fill*
- ❑ *Brake Fluid Fill (Master Cylinder)*
- ❑ *E-Box Access*
- ❑ *A/C High and Low Pressure Ports*
- ❑ *Microfilter Access*
- ❑ *A/C Ambient (Outside) Temp Sensor*
- ❑ *Air Filter Replacement*
- ❑ *Fender Adjustment Points*
- ❑ *Headlight Bulb Access*
- ❑ *DME Control Module Location*
- ❑ *Battery Junction Locations*
- ❑ *Coolant Reservoir Fill (N54 and N63)*
- ❑ *Coolant Reservoir Fill for intercoolers on N63*

Examine the N63 engine bay and list the components that need to be removed in order to gain access and replace the air filters.

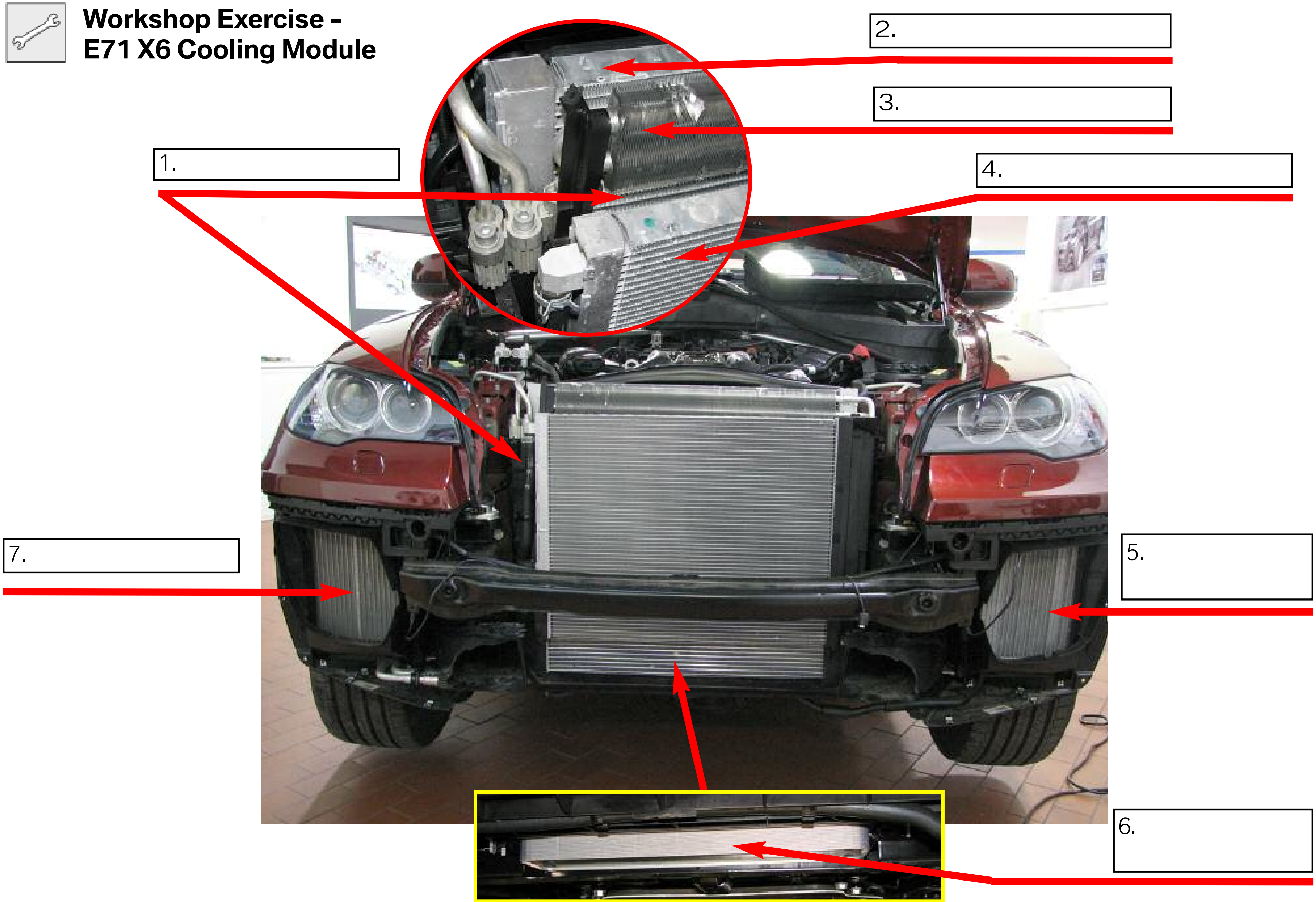
Workshop Exercise - E71 X6 Cooling Module

Remove the bumper cover, cooler module brace struts, plastic grill frame and top radiator cover.

Examine the components of the E71 Cooling module and note their location.

Label each cooler/radiator using the graphics and arrows shown on the next page.

Workshop Exercise - E71 X6 Cooling Module



Workshop Exercise - Walk Around Quiz

1) How is the rear track increased on the E71?
Check the best possible answer.

❑ With the use of the QMVH system

❑ With the use of the rear rim off-set

❑ With the use of wider rear tires

❑ With the use of rear hub spacers

2) How many motors are used in the HKL system?
Check the best possible answer.

❑ Two

❑ Three

❑ Four

3) What signal typically going to the JBE on (early) E70 is no longer used on late E70 and E71 HKL?
Check the best possible answer.

❑ Anti-trap signal

❑ Tailgate open signal

❑ Tailgate closed signal

❑ Lower tailgate contact signal

4) Study the E71 Bus System Overview and list the 3 major changes below, compared to the E70 Bus System?

1.	2.	3.

5) What is the tool in the illustration used for in the E71?
Check the best possible answer.

❑ Emergency open for the tailgate

❑ Emergency Brake and shifter release

❑ Emergency Brake release only

❑ This tool is not used in E71

6) Which statement is ***true*** about the 6 disc multimedia changer?
Check the best possible answer.

❑ It can now play DVD/videos on the front CID.

❑ It now can to play up to 6 DVDs on the rear display.

❑ The driver can now view a video in the front CID while driving.

❑ It now can play DVD/videos on the front CID on Non CCC cars.

7) A Panorama Glass roof is available as an option for the E71.
Check the best possible answer.

❑ TRUE

❑ FALSE

Walk Around Summary

After the vehicle walk around and overview of topics in the section. Check and make sure you can answer the following questions:

- ❑ What are the basic dimensional on the E71?
- ❑ What are the materials used on the hood and fenders etc.?
- ❑ Do you understand the E71 HKL tailgate operation?
- ❑ What are the components/systems involved in the “Pedestrian Protection System?
- ❑ Do you understand the difference between the front and rear wheels on the E71?
- ❑ Do you understand the E71 seat options, functions and configuration?
- ❑ Do you understand the different models offered of the E71?
- ❑ How is the E71 EMF released in the event of an emergency?
- ❑ Can you locate the vehicles fuses (front and rear)?
- ❑ What is new about the 6 disk changer?
- ❑ How is the JB accessed?
- ❑ Can you identify and locate all of the changes to the Bus System?
- ❑ How are the front headlight bulbs accessed?
- ❑ Can you identify and locate the individual coolers that make up the E71 cooling module?

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N63 Engine Workbook

Initial Print Date: 04/08 Revision Date:

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N63 Engine

Model: All with N63 Engine

Production: From Start of Production (2008)

OBJECTIVES

After completion of this module you will be able to:

- Understand engine changes on the N63 as compared to the N62TU
- Understand basic engine assembly and disassembly procedures.
- Understand basic engine service issues

Note: This workbook is intended for classroom instruction only. It is not meant to replace currently available repair instructions. Always refer to the most current version of repair instructions, technical data and torque specifications. Refer to the latest version of TIS.

New BMW 8-Cylinder Technology

As the successor to the N62 engine, the N63 was developed based on the principles of "Efficient Dynamics". Efficient Dynamics combines driving enjoyment with efficiency which, in a new engine, is expressed in increased power output together with reduced fuel consumption.

One of the ways of achieving this objective is through downsizing. This means the same power output is achieved with reduced engine displacement or higher power output at the same engine displacement.

Both objectives apply to the N63 engine. Compared to the N62 engine, the power output has been boosted while decreasing the engine displacement.

In comparison, the N62TU has a displacement of 4.8 liters, while the new N63 engine displaces only 4.4 liters.

This is primarily achieved by technologies that already gave the N54 engine its legendary dynamics and outstanding efficiency: Bi-turbocharging in connection with high precision injection.

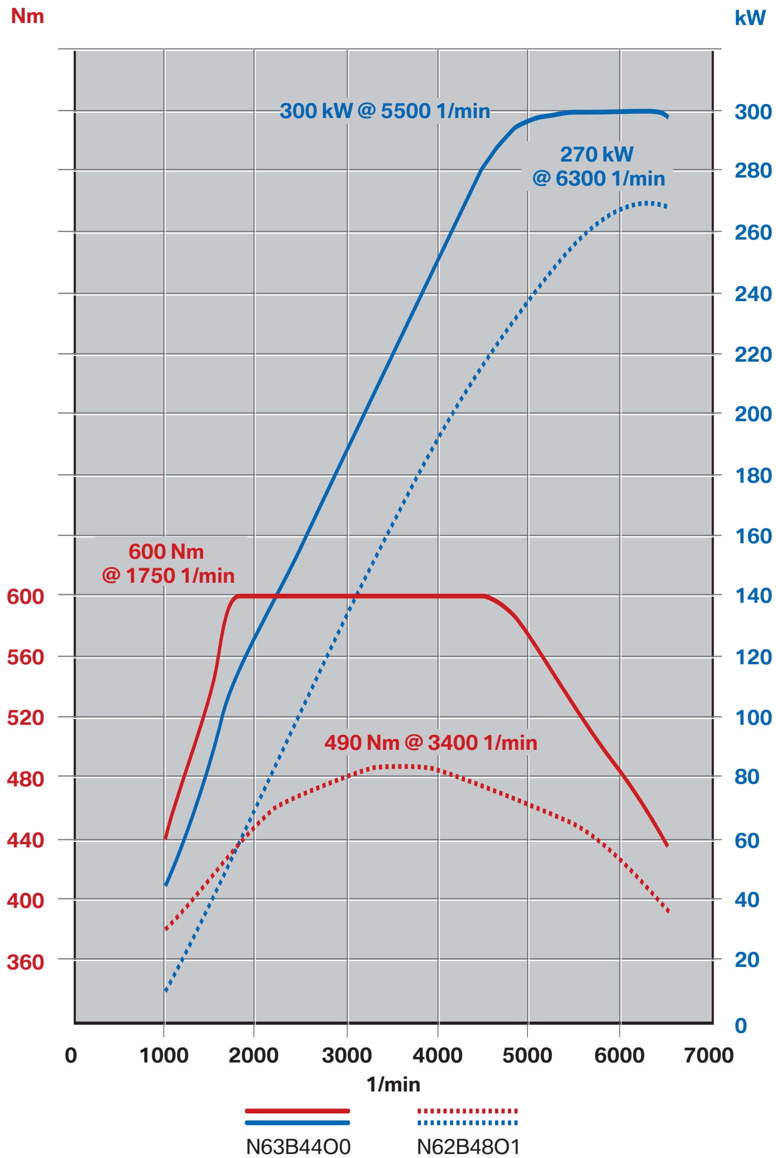
The N63 is the first engine world-wide to feature an optimized package, involving the integration of the turbocharger and the main near-engine catalytic converters in the “v-space”.

With the aim of achieving the demanding performance objectives in connection with optimum package and weight, the exhaust turbochargers and the catalytic converters have been placed in the v-space between the cylinder banks resulting in the intake and exhaust ports changing places.

With short pipe lengths and larger cross sections, this arrangement minimizes the pressure losses on the intake and exhaust side.

Engine Output Chart

Compared to it's predecessor, the N62TU, the new N63 engine is characterized by distinctly higher output. It has an impressive torque curve which not only peaks earlier (at 1750 RPM), but is also very "flat" which is a characteristic of BMW turbocharged engines.



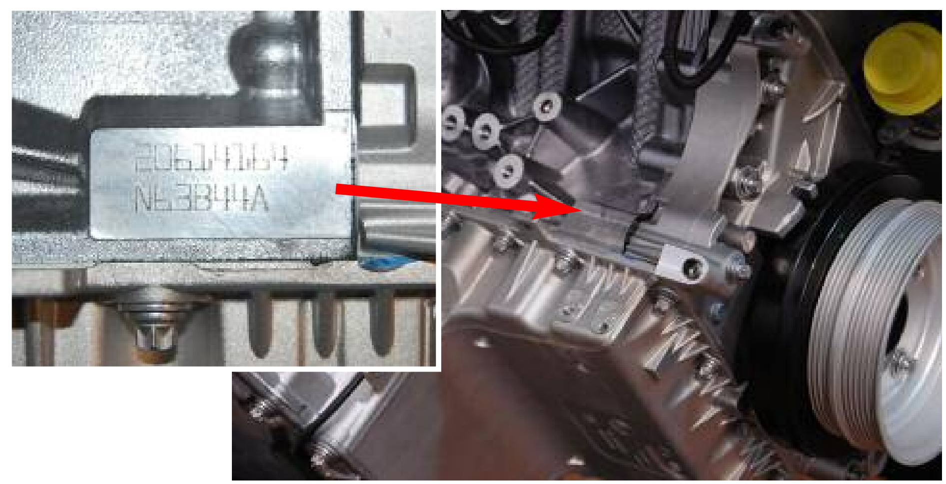
Engine Designations

Officially, the engine designation for the new BMW N63 engine is N63B44O0. The designation is broken down in the following:

Index	Explanation
N	BMW Group "New Generation" engine
6	8-cylinder engine
3	Gasoline, direct-injection
B	Gasoline engine
44	4.4 liter displacement
O	Upper output stage
0	New development

Engine Identification and Serial Number

The engine ID and sequential serial number are located on the passenger side of the engine behind the AC compressor mounting at the front of the crankcase.



Engine Technical Data N62TU vs. N63

Description	Units of Measurement	N62B48O1	N63B44O0
Engine type		V-8	V-8
Displacement	(cm3)	4799	4395
Firing order		1-5-4-8-6-3-7-2	1-5-4-8-6-3-7-2
Stroke	mm	88.3	88.3
Bore	mm	93	89
Power output @ rpm	hp @ rpm	360 @ 6300	400 @ 5500 to 6400
Torque @ rpm	Nm @ rpm	490 @ 3400	600 @ 1750 - 4500
Maximum engine speed	rpm	6500	6500
Power output per liter	kw (hp)	56.26 (75)	68.26 (90)
Compression ratio		10.5 : 1	10.0 : 1
Cylinder spacing	mm	98	98
Valves/cylinder		4	4
Intake valve	mm	35.0	33.0
Exhaust valve	mm	29.0	29.0
Main bearing journal diameter	mm	70	65
Connecting rod journal diameter	mm	54	54
Fuel specification (Octane)	(RON)	98	98
Engine management		ME 9.2.2	MSD85
Emission standard		ULEV II	ULEV II

Overview of Engine Changes

The latest generation of BMW V-8 engines differs from past designs in several areas. Although all of these engines have been derived from the M60 engine from 1993, the N63 engine design is a departure from the original design.

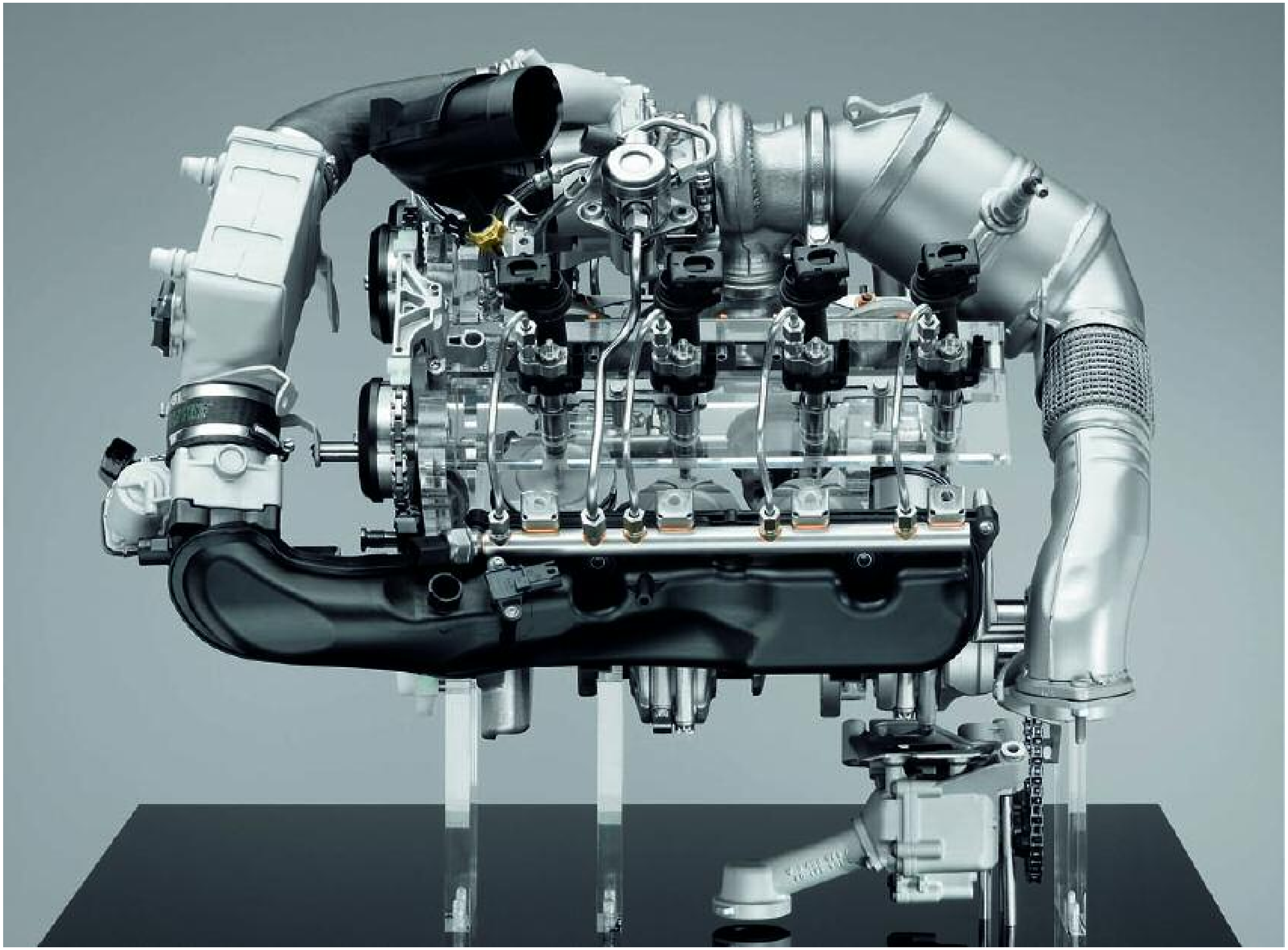
The following chart will point out some of the differences where the N63 is unique and distinct. The information found below outlines the new engine technology as compared to previously known systems. The features are organized by engine system and are divided into the following categories:

- New Development - this is a system or component which has never been used previously on a BMW engine.
- New Design - this is a system or component which has been specifically developed for the N63 engine, but does not represent a technical innovation.
- Technology carried over from N54 - This represents technology already known from the N54 engine and adapted to the N63.

Component/System	New Development	New Design	Technology carried over from N54	Remarks
Engine casing components		X		Engine casing components include the cylinder head, cylinder head cover, crankcase, oil pan.
Crankshaft drive system		X		Crankshaft drive system includes the crankshaft which has reduced weight, while maintaining sufficient strength.
Valve gear		X		The N63 engine uses VANOS, which is carried over from N52. (No VALVETRONIC is used)
Timing gear	X			A new tooth-roller chain is used in the timing gear.

Component/System	New Development	New Design	Technology carried over from N54	Remarks
Belt drive	X			The belt drive uses the ELAST drive belt, but is characterized by a new tensioning system for the AC compressor.
Oil supply		X		A volumetrically controlled oil pump is used for the N63 engine.
Cooling system	X			In addition to a conventional coolant pump, the N63 engine uses an auxiliary electric cooling pump for cooling of the turbochargers. There is also an additional cooling circuit for the water-cooled intercoolers with it's own electric coolant pump and heat exchangers.
Air intake and exhaust systems		X		Due to the arrangement if the turbochargers in the "v-space" and the indirect charge air cooling, the intake and exhaust systems are completely re-configured.
Turbocharging			X	A bi-turbocharging system has been carried over from the N54 engine.
Vacuum system		X		A two-stage vacuum pump similar to that used on the N62TU engine.
Fuel system			X	The HPI injection system from the N54 engine has been adapted to the V-8 (N63).
Engine electrical system		X		The engine management system features a new ECM and there are new oxygen sensors (LSU ADP).

N63 Engine Mechanical



Engine Housing Components

Crankcase

The crankcase of the N63 engine is a new design based on the closed-deck principle with lower-set side walls. It is made of an aluminum alloy (Alusil) with honed cylinder liners. Similar to the N62 engine, a double main bearing bolting with additional side wall mounting is used. There is now no coolant reservoir in this area due to the new arrangement of the turbochargers in the V-space.

Oil Pan

The 2-piece aluminum oil pan accommodates the oil filter housing and the front differential on all wheel drive vehicles. It is also important to note that the engine oil dipstick has been eliminated as on the New Generation 6-cylinder engines. Oil level monitoring is now carried out electronically as in those models.

Cylinder Head Covers

The cylinder head covers are made from aluminum alloy. There are accommodations for the the ignition coils, camshaft sensors and the mounting for the high pressure fuel pump.

Cyclone separators are contained within the cylinder head covers as removable plastic components. There are no crankcase ventilation valves on the N63 engine, but there are externally mounted check valves similar to the N54.

Cylinder Head

The most distinctive new feature on the cylinder head of the N63 engine is the inverse arrangement of the intake and exhaust ports.

At the same time, optimized cross flow through the coolant jacket from the intake to exhaust side has been achieved.

The intake port features a trailing edge for creating more intensive charge movement. The fuel injectors and spark plugs are arranged transversely adjacent to each other in the center of the combustion chamber roof.

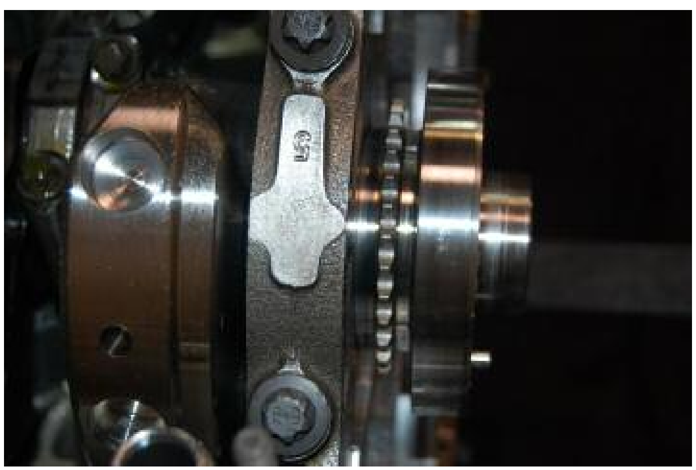
There is now only one non-return valve for the oil circuit integrated in the cylinder head. The two non-return valves that were used for VANOS are now integrated in the VANOS units.

Engine Internal Components

Crankshaft

To reduce weight, the main bearing diameters of the crankshaft have been reduced from 70 mm to 65 mm. The crankshaft is a forged steel unit and contains an integrated sprocket for the oil pump.

The oil pump on the N63 engine is driven by the crankshaft on the flywheel side. The sprocket is built directly into the crankshaft.



Timing Gear

A newly developed tooth-roller chain is used per cylinder bank to drive the camshafts. This chain combines the advantages of a toothtype chain and a roller chain, i.e. high resistance to wear and low running noise.

The chain tensioners, tensioning and slide rails are common parts for both cylinder banks. The oil spray nozzles are integrated in the chain tensioners.

The N63 engine is no longer locked at ignition TDC of the first cylinder but rather at 150° before ignition TDC of the first cylinder.

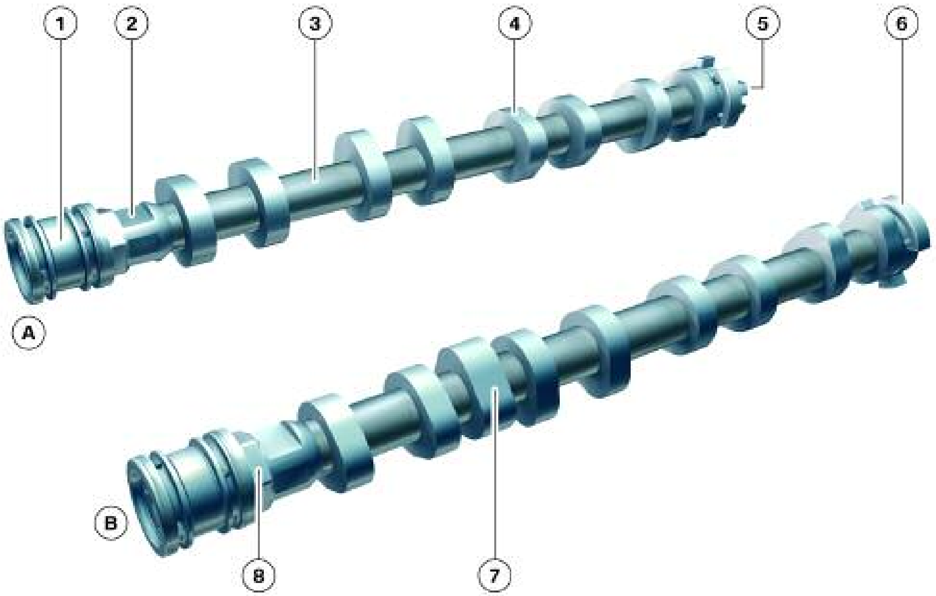
To block off the engine, a special tool is placed on the torsional vibration damper thus forming the reference for the plug mandrel to the crankcase.

Lubrication System

The lubrication system utilizes the same volumetric flow-controlled oil pump as seen on the six-cylinder N52/N54 engine. This type of oil pump offers the same reduction in fuel consumption as on past designs. The main difference on the N63 is that the oil pump is chain driven off of the rear of the engine rather than the front as on previous V-8 engines.

Camshafts

Recent advancements in engine technology have brought about new camshaft designs. Most modern BMW engines use some form of composite camshafts which are assembled from individual components rather than machined from an solid cast iron blank. This technology not only provides a reduction in manufacturing costs, but also a considerable weight savings.



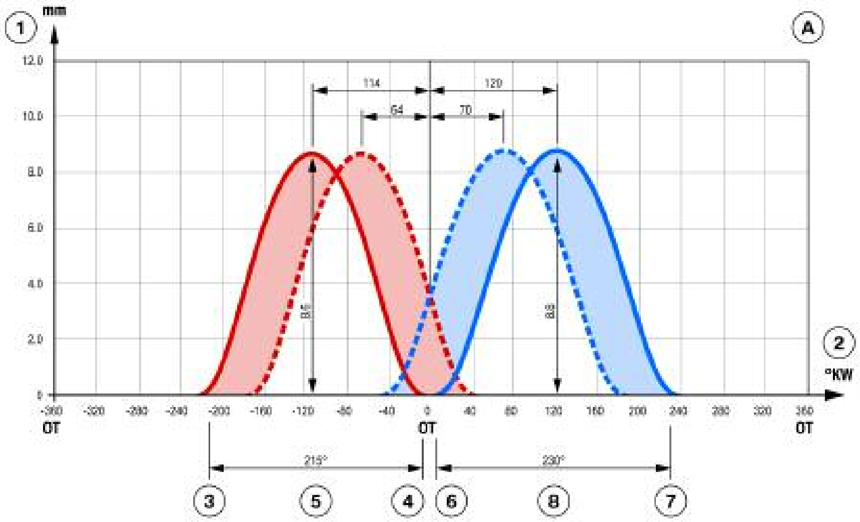
Index	Explanation	Index	Explanation
A	Intake camshaft	4	Cam lobe
B	Exhaust camshaft	5	Output flange for vacuum pump
1	Drive flange	6	Reference for camshaft sensor
2	Flat for special tool	7	3-point lobe for high pressure pump
3	Shaft tube	8	Flats for wrench

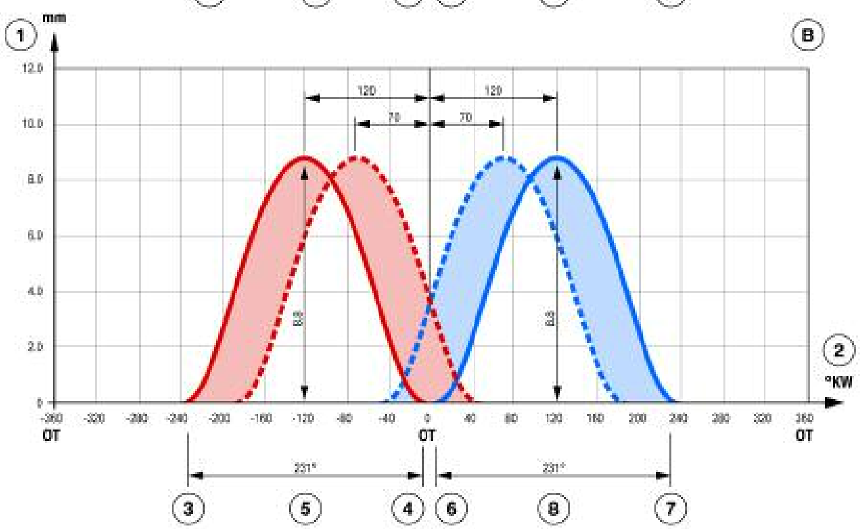
The N63 engine has assembled camshafts of the type as used on the M73 engine. All components are shrink-fitted on to the shaft.

The illustration shows the different components of the camshafts.

The drive flange, the wrench flats and the flats for the special tool are made from one single component. A three-point cam that drives the high pressure pump of the fuel system is additionally mounted on the exhaust camshafts. It is located after the first/fifth cylinder.

Another special feature of the N63 engine is that the exhaust camshafts for cylinders 2, 4, 7 and 8 produce a different valve lift curve than for cylinders 1, 3, 5 and 6. The exhaust valves of cylinders 2, 4, 7 and 8 open later, they have a shorter opening period and a smaller valve lift for even smoother engine operation.





Index	Explanation	Index	Explanation
A	Cylinders 2,4,7 and 8	4	Exhaust valve closes
B	Cylinders 1,3,5 and 6	5	Exhaust valve opening period
1	Valve lift (mm)	6	Intake valve opens
2	Crankshaft angle (degrees)	7	Intake valve closes
3	Exhaust valve opens	8	Intake valve opening period

Infinitely Variable Double VANOS

The charge cycle in the N63 engine is realized with four valves per cylinder, which are driven by two overhead camshafts.

The engine timing can be variably influenced by means of the two infinitely variable VANOS units.

The VANOS units used here have the following timing angles:

- Intake VANOS unit: 50° crankshaft angle
- Exhaust VANOS unit: 50° crankshaft angle

The VANOS units on the N63 engine differ from the VANOS units on the N62 engine. The function is identical but some components have been omitted and the VANOS unit has been optimized.

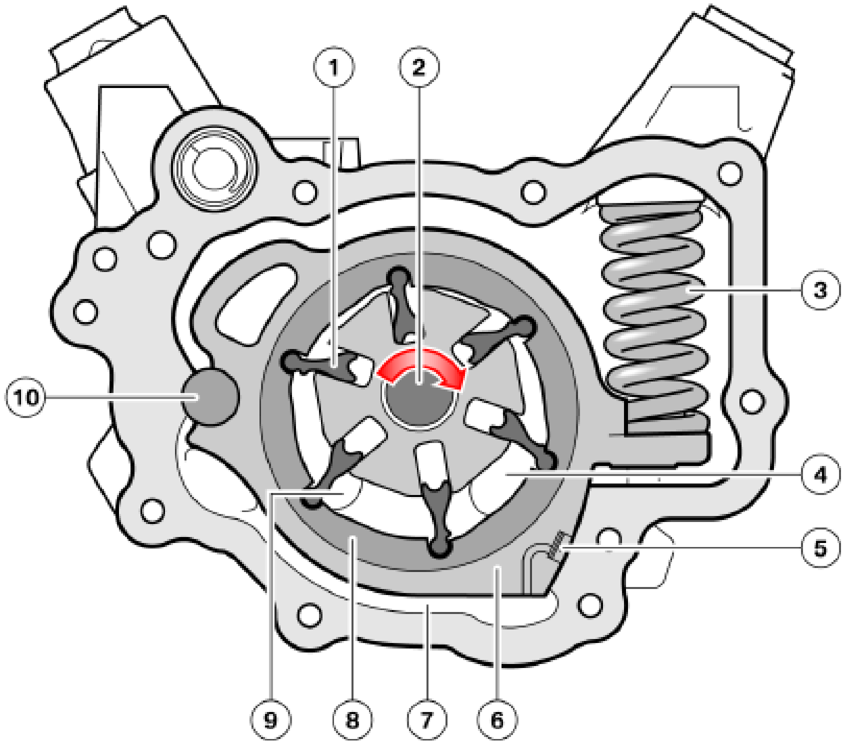
On the N63 engine, the individual vanes of the VANOS unit are no longer individual parts but rather they have been further developed to form an oscillating rotor (as on the N52 engine).

The torsion spring integrated in the N62 VANOS unit is now designed as a coil spring accommodated on the front of the N63 VANOS unit protected by a plastic cover.

Lubrication System

In the same way as the 6-cylinder engines, the N63 engine is now equipped with a volumetric flow controlled oil pump. It is driven by the crankshaft on the flywheel side.

The oil pump is designed as a sliding-vane positive displacement pump with a control system that also operates in the same way as on the 6- cylinder engines.



Index	Explanation	Index	Explanation
1	Vane	6	Slide
2	Pump shaft	7	Oil chamber
3	Compression spring	8	Rotor
4	Intake side	9	Pressure side
5	Sealing strip	10	Pivot pin

The difference is that the oil pressure does not act on the control piston but rather directly on the slide. The oil pressure that acts on the slide is tapped off downstream of the oil filter and cooler, i.e. the pressure prevailing in the system.

Advantage of volumetric flow-controlled oil pump
The oil pump uses a considerable proportion of the engine power output. VANOS requires a large volume of oil for the purpose of adjusting the camshaft angle. On the other hand, VANOS requires no oil flow for retaining the camshaft angle.

Consequently, the oil requirement depends on the extent of the adjustment operations. Conventional oil pumps produce the oil pressure necessary for the largest possible oil flow rate that can occur in the engine. In many operating situations, this represents unnecessary energy consumption through the oil pump and additional wear of the oil.

The volumetric flow-controlled oil pump delivers only as much oil as is necessary under the respective engine operating conditions. No surplus quantities of oil are delivered in low-load operating ranges, thus reducing fuel consumption and oil wear and tear.

Functional principle of volumetric flow-controlled oil pump
The pump is designed as a sliding-vane positive displacement pump. In delivery mode, the pump shaft is positioned off-center in the housing and the vanes are displaced radially during rotation.

As a result, the vanes form chambers of differing volume. The oil is drawn in as the volume increases and, conversely, expelled into the oil channels as the volume decreases.

The oil pressure in the system (downstream of the oil filter and oil cooler) acts on the slide against the force of a compression spring in the control oil chamber. The slide element can rotate about a pivot pin.

The pressure increases in the system when less oil is required by the lubricating system than the pump delivers. As a result, the pressure in the control chamber also increases thus turning the slide so that the pump shaft is located more in the center of the slide, thus reducing the change in volume and therefore the delivered quantity.

If the oil required by the engine increases, for example, VANOS control intervention, the pressure in the lubricating system drops and is therefore also reduced in the control oil chamber.

The compression spring moves the slide such that the pump shaft is off-center, thus increasing the change in volume and therefore the delivered quantity.

Pressure Relief Valve

The pressure relief valve is integrated in the oil pump. Pressure upstream of the filter is applied to the valve which opens at a pressure of approximately 18 bar. When opened, the valve allows surplus oil to flow directly into the oil pan.

Oil Filter

The N63 engine is equipped with the standard full flow oil filter. It is screwed into the oil pan from below. It also features an integrated filter bypass valve. The valve opens when the filter is dirty and ensures that the lubrication points still receive engine oil (albeit unfiltered).

No drain valve is fitted due to its installation position. A drain plug in the oil filter cover makes it possible to drain the oil out of the filter housing before the oil filter cover is opened.

Oil Cooling

The oil is cooled via an oil-to-air heat exchanger. This separate oil cooler is located to the right of the cooling module. A thermostat only allows the oil to flow through the oil cooler when a defined oil temperature has been reached, thus ensuring the engine oil heats up at a rapid rate.

Oil Spray Nozzles

Oil spray nozzles are used at points that cannot be reached by oil channels. On the N63 engine, these are the standard oil spray nozzles for piston crown cooling and the oil spray nozzles for lubricating the timing chain.

Oil spray nozzles for piston crown cooling

The N63 engine has four double oil spray nozzles for cooling the piston crowns. Each oil spray nozzle cools an opposing pair of cylinders.

A piston cooling valve is integrated in the oil spray nozzle. This valve ensures that the oil circuit is not drained via the oil spray nozzles while the engine is not running.

Oil spray nozzles for timing chain lubrication

The oil spray nozzles for lubricating the timing chains are integrated in the chain tensioners of the two cylinder banks. They spray the engine oil directly on to the timing chains. A throttle in the oil spray nozzle limits the oil output.

Chain Tensioner

The N63 engine is equipped with one chain tensioner per cylinder bank. It is a hydraulic chain tensioner that acts on a tensioning rail.

Chain tensioners always act on the no-load side of the chain, i.e. the slack side.

Non-return Valves in Cylinder Head

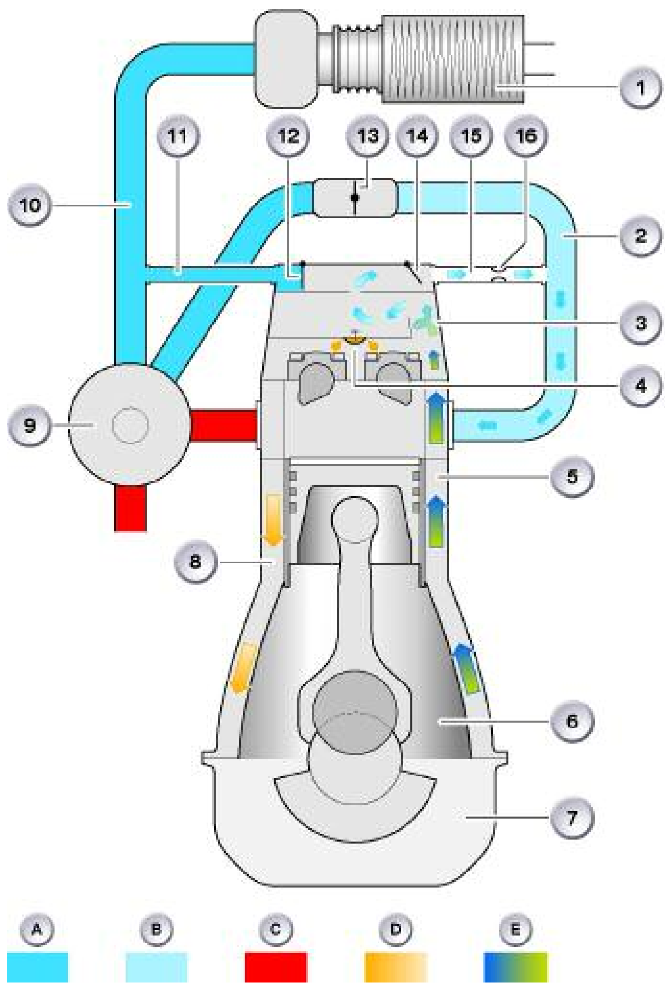
Non-return valves that prevent the oil channels in the cylinder head draining while the engine is not running are normally installed in the cylinder head.

There is only one non-return valve in the cylinder head of the N63 engine. The nonreturn valves for VANOS units are now directly integrated in the solenoid valves.

Crankcase Ventilation System

The crankcase breather on the N63 engine operates in accordance with the same principle as on the N54 engine. In the case of the N63 engine, each cylinder bank has its own crankcase breather.

The crankcase ventilation on the N63 operates in two modes, similar to the N54. One mode is for turbocharged operation and the other is for "naturally aspirated mode" which is usually under deceleration.



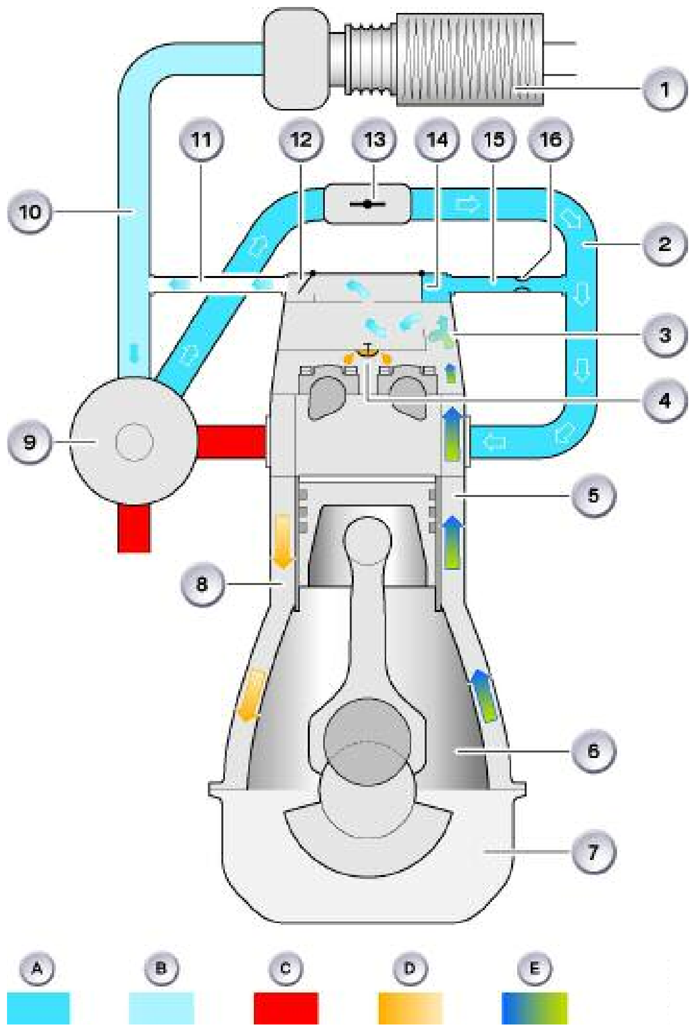
Index	Explanation	Index	Explanation
A	Overpressure	7	Oil sump
B	Vacuum	8	Oil return channel
C	Exhaust gas	9	Exhaust turbocharger
D	Oil	10	Clean air pipe
E	Blow-by gasses	11	Line to clean air pipe
1	Air cleaner	12	Check valve (non-return) to intake
2	Intake manifold	13	Throttle valve
3	Oil separator	14	Check valve to clean air pipe
4	Oil drain	15	Line to intake manifold
5	Ventilation duct	16	Pressure restrictor
6	Crankshaft cavity		

Crankcase breather, naturally-aspirated engine operation
Because of its exhaust-gas turbocharging, in the same way as the N54 engine, the N63 engine is equipped with a special crankcase breather.

The standard function can only be utilized while there is a vacuum in the intake manifold, i.e. in naturally-aspirated engine operation.

As soon as the pressure in the intake manifold is increased by turbocharging, the blow-by gasses can no longer be introduced by way of this route. A non-return valve is incorporated in the channel to the intake manifold to prevent the risk of boost pressure being introduced into the crankcase.

There is a risk, under conditions of high vacuum, that oil can be drawn in through the crankcase breather into the intake manifold. So, this area of the crankcase breather must be provided with a pressure limiting facility.



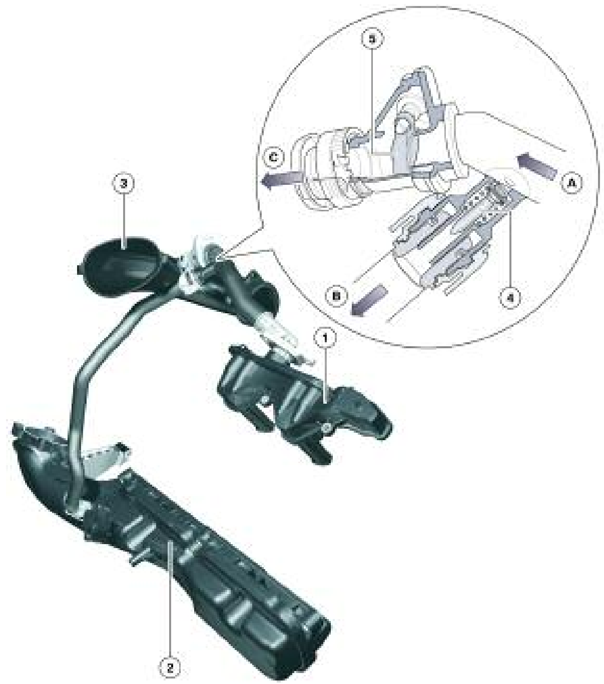
This is realized in the N63 engine with a restrictor, which limits the throughflow and thus also the pressure level in the crankcase breather. As the illustration shows, ventilation takes place during naturally aspirated operation via an external line from the cylinder head cover to the intake manifold.

The throttle for limiting pressure on the N63 is integrated in the non-return valve to the intake manifold.

Crankcase breather, turbocharged operation

In turbocharged mode, the pressure in the intake manifold increases and thus closes the non-return valve. Because there is a vacuum in the clean-air pipe in this operating range, it opens the non-return valve to the clean-air pipe and the blow-by gasses are directed via the turbocharger compressor and the intercooler into the intake manifold.

Check Valves



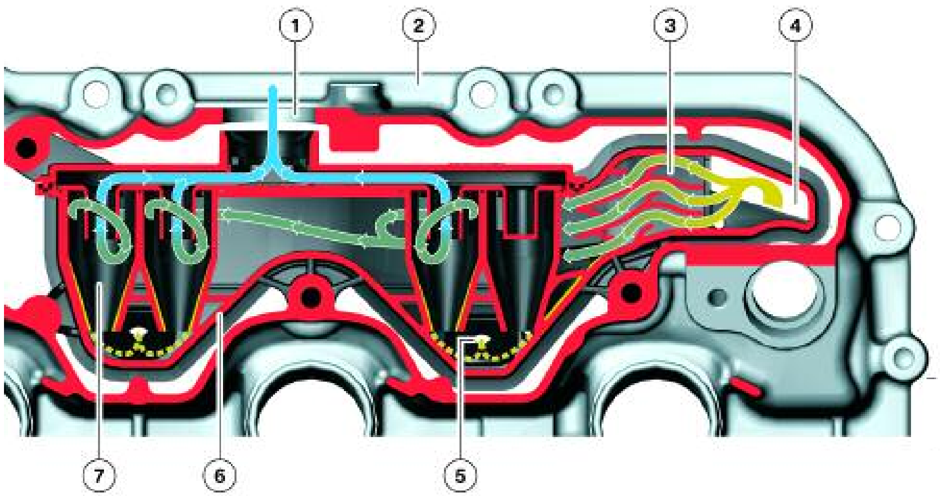
Index	Explanation	Index	Explanation
A	Cleaned blow-by gas	2	Intake manifold
B	Ventilation, naturally aspirated operation	3	Clean-air pipe
C	Ventilation, turbocharged operation	4	Check valve to intake
1	Oil separator	5	Check valve to clean air pipe

Oil Separator

Labyrinth and cyclone oil separators are used on the N63 engine. One labyrinth separator and four cyclone separators are integrated in the oil separator housing of each cylinder bank, however, only three are used at present.

The fourth is reserved for further developments. The oil mist drawn out of crankcase is routed through the labyrinth. This serves as the first oil separation stage as the oil collects on the walls of the labyrinth and flows off. The further flow of blow-by-gas is made to swirl in the cyclones.

As a result of the centrifugal forces, the heavier oil settles on the cyclone walls and from there drips into the oil drain. The lighter blow-by gas is drawn out from the middle of the cyclone.
The cleaned blow-by gas is then fed to the air intake system.



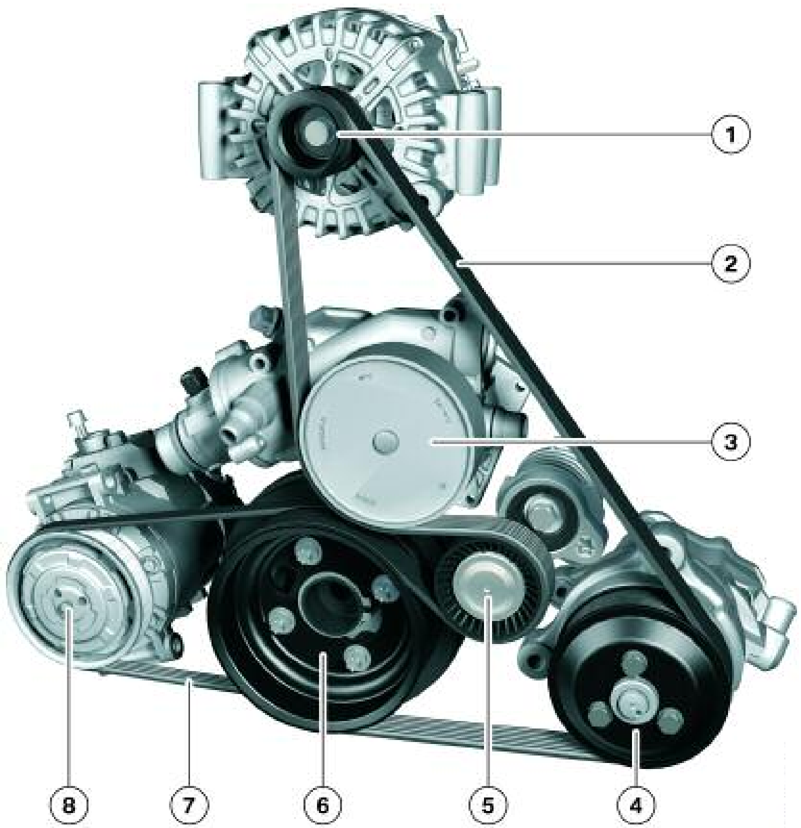
Index	Explanation	Index	Explanation
1	Channel to air intake	5	Oil return
2	Cylinder head cover	6	Oil separator housing
3	Labyrinth	7	Cyclone
4	Ventilation duct from cylinder head		

Note: If the exhaust system produces blue smoke, it is necessary to check whether the engine is also drawing oil into the combustion chamber through the crankcase breather, which suggest that there is a fault in the area of the crankcase breather. A clear sign of a problem is an oiled up clean-air pipe.

Belt Drive

The N63 engine is equipped as standard with a double belt drive. The main belt drive features a mechanical tensioning pulley that provides the necessary tension in the poly-V-belt.

The A/C compressor is driven by a ELAST drive belt which is mounted and tensioned in a new way.

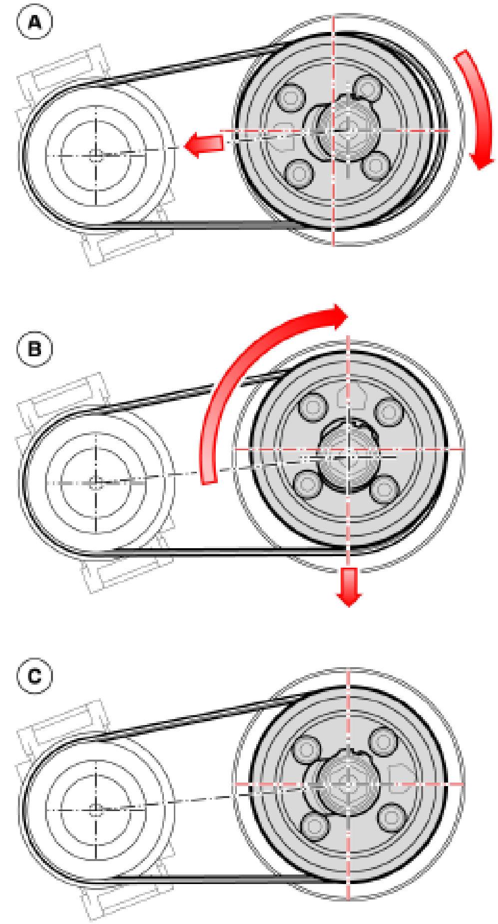


Index	Explanation	Index	Explanation
1	Alternator	5	Tensioning pulley
2	Poly V-belt	6	Torsional vibration damper
3	Coolant pump	7	ELAST belt (AC)
4	Power steering pump	8	A?C Compressor

The belt pulley on the torsional vibration damper can be shifted in a defined position in the direction of the A/C compressor. This makes it possible to easily install the ELAST drive belt without the need for special tools.

This is made possible by an eccentric slot in the belt pulley, which allows the crankshaft to be shifted in radial direction after the four mounting screws holding the belt pulley have been removed. The tension in the ELAST drive belt pulls the belt pulley back into the central position over the crankshaft when the engine is now turned by 180°.

The bolts can then be re-installed to complete the belt change.



Index	Explanation
A	Mounting position for ELAST drive belt
B	Turning torsional vibration damper for tensioning belt
C	Normal position

Classroom Exercise - Review Questions

1. The E71 (N63), is a able to achieve ________________ horsepower at 5500 RPM.

   A. 360 B. 375 C. 400 D. 425

2. The impressive torque output of the N63 engine (610 Nm) is available at ______________________ RPM.

   A. 1250 B. 1750 C. 2250 D. 2500

3. The engine identification plate is located:

   A. Behind the starter
   B. Behind the AC compressor
   C. under the alternator
   D. On the bank 1 cylinder head

4. To reduce weight, the crankshaft main journal diameter has been reduced:

   A. from 80 mm to 75 mm
   B. from 75 mm to 70 mm
   C. from 70 mm to 65 mm
   D. from 65 mm to 60 mm

5. Which of the following statements **BEST** describes the construction of the N63 crankcase?

   A. The crankcase is made from aluminum and uses a “closed deck” design with “Alusil” cylinder bores
   B. The crankcase is made from magnesium and uses a “closed deck” design with “cast iron” cylinder liners
   C. The crankcase is made from aluminum and uses a “open deck” design with “Alusil” cylinder bores
   D. The crankcase is made from aluminum and uses a “closed deck” design with “cast iron” cylinder liners

Classroom Exercise - Review Questions

6. Which of the following statements **BEST** describes the oil pump drive method on the N63?

   A. The oil pump is driven by a gear to gear connection by a gear at the rear of the crankshaft

   B. The oil pump is chain driven off the front of the engine by a sprocket which is integrally cast into the crankshaft

   C. The oil pump is driven by the exhaust camshaft on bank 1

   D. The oil pump is chain driven off the rear of the engine by a sprocket which is integrally cast into the crankshaft

7. The displacement of the N63 is:

   A. 4.0 liters B. 4.4 liters C. 4.8 liters D. 5.0 liters

8. Which of the following **BEST** describes the camshaft manufacturing process?

   A. Presta process

   B. Hydroforming

   C. Cast Iron

   D. None of the above

9. The crankcase ventilation system on the N63 engine uses cyclone separators which are located:

   A. In the intake manifold

   B. In the cylinder head covers

   C. In the fresh air intake to the turbocharger

   D. None of the above

10. What special tool is needed to install the ELAST drive belt on the N63?

    A. 11 1 280 B. 11 2 450 C. 11 3 560 D. None of the above

Workshop Exercise - N63 Engine Disassembly

Remove both intercoolers ,disconnect hose clamps at throttle housing (pic A) and clamps at turbo inlet (pic B) and place intercoolers aside. Also, take note of the mounting bolts, (pic C) there are 3 on each intercooler and they are different lengths.

Remove the coolant pipe, disconnect from water pump housing and cylinder head cover (pic D).

Picture A

Picture B

Picture C

Picture D

What is unique about the intercoolers on the N63?

What sensors are installed on the intercooler housings?

How are the turbocharger kept cool?

Note: This workbook is intended for classroom instruction only. It is not meant to replace currently available repair instructions. Always refer to the most current version of repair instructions, technical data and torque specifications. Refer to the latest version of TIS.

Workshop Exercise - N63 Engine Disassembly

Remove both plastic turbo inlets (pic A) along with the check valves (picture B) for the crankcase ventilation systems (disconnect from cylinder head cover and intake manifold).

Remove alternator (pic C) along with fuel line brackets and low pressure fuel line (pic D) which crosses over between banks. (this includes auxiliary water pump and bracket).

Picture A

Picture B

Picture C

Picture D

Where are the cyclone separators located on the N63?

What is the purpose of the check valves (pic B)?

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Workshop Exercise - N63 Engine Disassembly

Remove top bracket for engine cover (pic A).

Remove pre-catalyst O2 sensors (pic B) and all heat shielding from top of engine and exhaust system (after cat).

Remove cable brackets (pic C) for the post-catalyst O2 sensors.

Remove both catalysts (pic D) with exhaust pipes and put aside (leave post-cat O2 sensors attached to pipe).

Picture A

Picture B

Picture C

Picture D

What special tool is used to remove the pre-catalyst O2 sensors? ______________________

What type of bolts are used to attach the heat shields?

____

____

What is the difference between the pre-catalyst and post catalyst oxygen sensors on the N63?

____

____

____

Workshop Exercise - N63 Engine Disassembly

Remove all ignition coils and spark plugs from both banks and put aside (pic A).

Remove all fuel injectors, high pressure fuel lines, high pressure fuel pump and fuel rails on both banks(pic B).
Note: Be aware when removing high pressure fuel pump, the bolts should be loosened in 1/2 turn increments and alternate sides to prevent internal pump damage.

Remove fuel pump follower (pic C) and set aside (protect follower from damage).

Remove both cylinder head covers (pic D) and set aside.

Picture A

Picture B

Picture C

Picture D

What drives the high pressure fuel pumps? ____________________

What process is used to manufacture make the camshafts? ____________________

____

What special tool is used to remove the fuel injectors? ____________________

What type of tool is needed to remove the spark plugs? ____________________

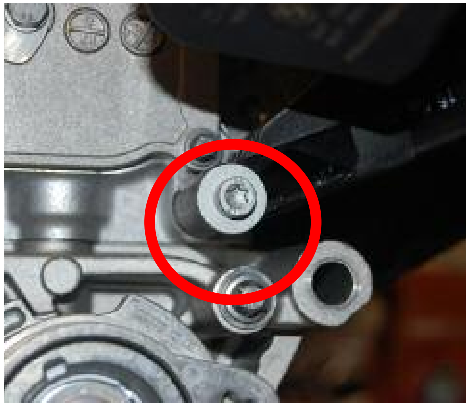
____

Workshop Exercise - N63 Engine Disassembly

Proceed with removal of both intake manifolds (pic A), remove 5 bolts on intake manifolds and the additional bolt (pic B). Remove additional heat shielding at rear of cylinder heads (Pic C - take note of bolt length - one is longer, this is for both sides).

Remove vacuum pump and heat shielding from the cylinder head on bank 1.

Picture A



Picture B

Picture C

Picture D

Since the traditional position of the intake manifolds have now been moved, how does that affect camshaft location?

Where are the knock sensors located and how many knock sensors are used on the N63?

What type of vacuum pump is used?

Workshop Exercise - N63 Engine Disassembly

Once the intake manifolds have been removed, proceed with removal of the turbochargers.

Remove oil feed line to the bank 2 turbocharger (braided line) and disconnect bracket (pic A).

Remove coolant lines from the bank 2 turbocharger (feed & return) (pic B) and retain copper washers (replace when servicing in field).

Disconnect oil return line to the bank 2 turbocharger using Torx socket (T30) with long 1/4 " extension.

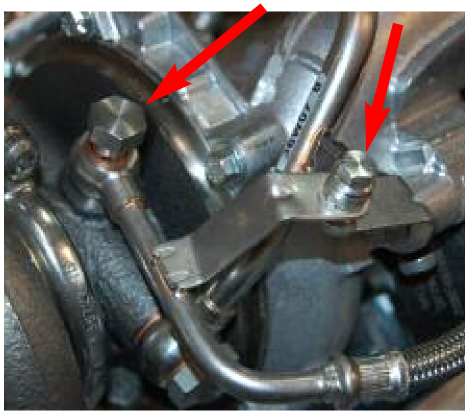
Un-clamp and remove bank 2 turbocharger.

Leave coolant lines attached to bank 1 turbocharger. (you can remove these lines with the bank 1 turbo).

Disconnect oil feed and return lines (pic C) and brackets to the bank 1 turbo.

Remove clamp from bank 1 turbo and remove from engine.

After the turbochargers are removed, proceed by the removing the coolant bleed hoses (pic D).



Picture A

Picture B

Picture C

Picture D

Workshop Exercise - N63 Engine Disassembly

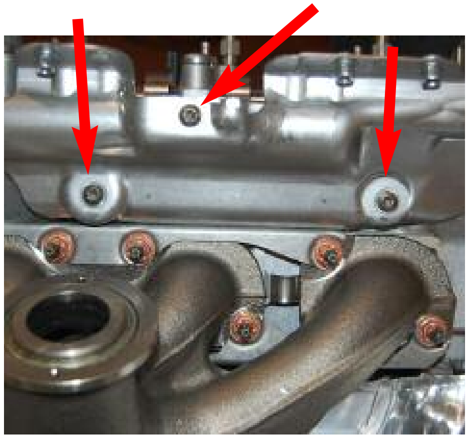
Before removing the exhaust manifolds, remove additional heat shielding at the front of the engine (pic A) as well as the additional shielding on the cylinder heads (pic B) for both banks.

Remove the exhaust manifolds and set aside and remove the exhaust manifold gaskets.

After the exhaust manifold removal is complete, remove the lower heat shield in the valley area (pic C).

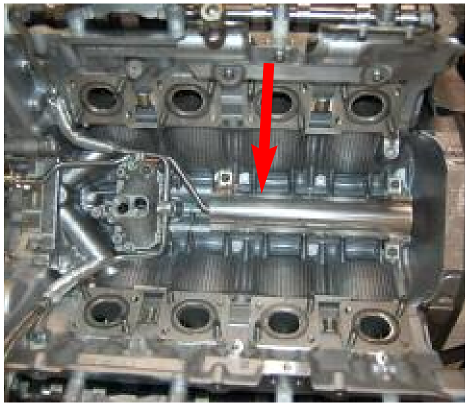
After that step is complete, examine the location of the vacuum reservoir, oil feed lines for turbo and the oil return manifold (pic D).

Picture A



Picture B

Picture C



Picture D

What is the purpose of the component in picture D (arrow)?

What is different about the N63 engine block as compared to the N62/N62TU with regard to the "v-space"?

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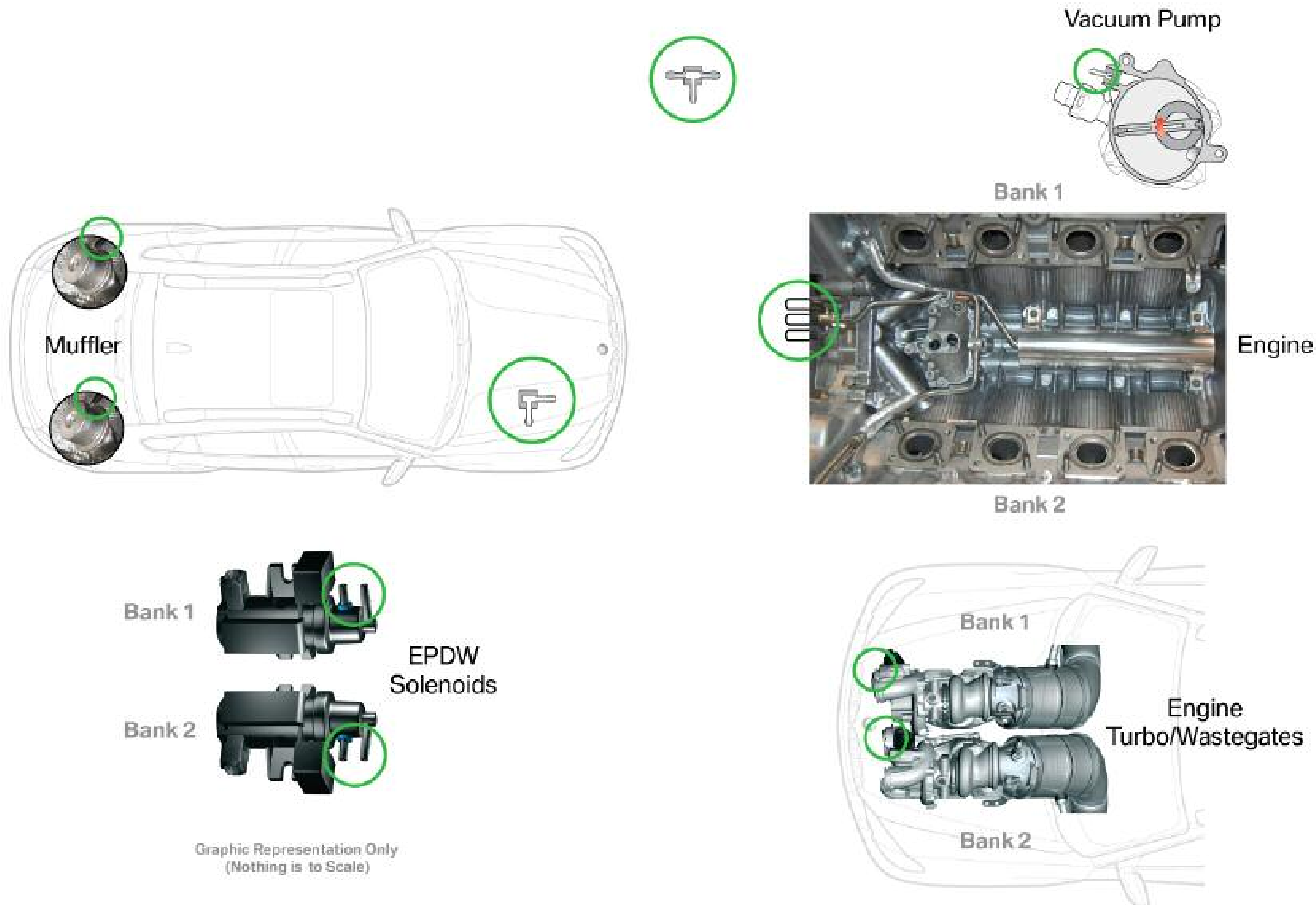
Workshop Exercise - N63 Vacuum Circuit Diagram

Complete chart by drawing in the vacuum lines to the individual components. Using colored markers, for the vacuum hoses between the wastegate and solenoids (EPDW).



Workshop Exercise - N63 Engine Disassembly

Remove water pump and accessory belt pulley by removing bolts and snap ring (pic A).

Remove VANOS solenoids on both cylinder heads (pic B).

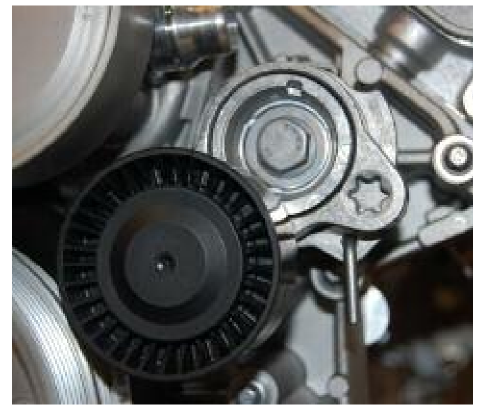
Remove VANOS solenoid adapter plates from the front of the cylinder head (pic C).

Remove accessory belt tensioner (pic D).

Picture A

Picture B

Picture C



Picture D

What is unique about the accessory belt pulley?

Are the VANOS solenoid interchangeable?

Are there any special tools required to release accessory belt tensioner?

Workshop Exercise - N63 Engine Disassembly

Prepare to remove cylinder heads. Rotate engine to the indicated position in the repair instructions (pic A). Keep in mind that the N63, unlike previous BMW engines, is not set up on ignition TDC at #1 cylinder. Actually, when removing the cylinder heads and setting camshaft timing, the engine is locked at 150 degrees BTDC. This arrangement ensures that no pistons are at TDC during cylinder head removal and installation which prevents potential valve damage while servicing.

The first step is to attach special tools as shown in picture B and C (engine should only be rotated clockwise).

Install camshaft locking tools on the bank 2 cylinder head as shown in picture D.

Picture A

Picture B

Picture C

Picture D

What special tools are shown in picture B?

What special tools are shown in picture D?

Workshop Exercise - N63 Engine Disassembly

After installing the camshaft locking tools on the bank 1 cylinder head, remove the lock on the crankshaft hub and rotate the engine slightly counter-clockwise (pic A). This will compress the timing chain tensioner to allow installation of the retaining pin (pic B). If special tool is not available, a 1/8 " pin punch will suffice.

Perform the process for both banks. Remove both timing chain tensioners and set aside.

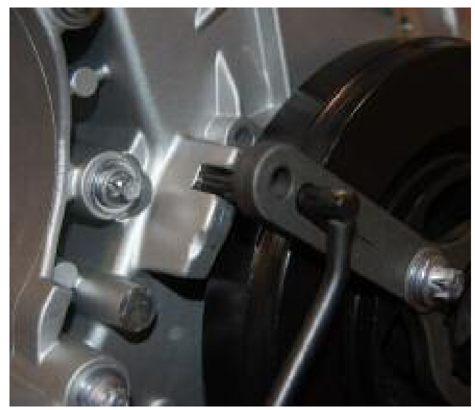
Rotate engine clockwise to re-install crankshaft locking tools (pic C).

Loosen the central retaining bolts for the VANOS units on the intake and exhaust (pic D) . Switch camshaft locking tools to the opposite bank and loosen both VANOS units as well. Also, remove chain guides on both banks (also pic D).

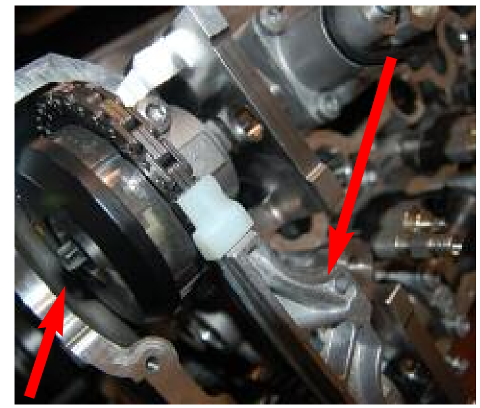
Remove retaining bolts and all VANOS units.

Picture A

Picture B



Picture C



Picture D

Why is the crankshaft locked at 150 degrees BTDC?

Workshop Exercise - N63 Engine Disassembly

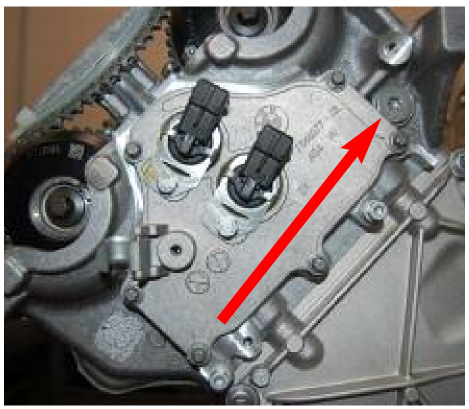
Once the timing chains and VANOS units are removed, the chain guide pins can be removed (both bank (pic A).

Next, remove the cylinder heads. Rotate engine so cylinder head surface is parallel with the floor (pic B).

Proceed with cylinder head removal by removing camshaft locking tools (if installed). Loosen and remove small bolts at the front of the cylinder head in the timing case area (pic C).

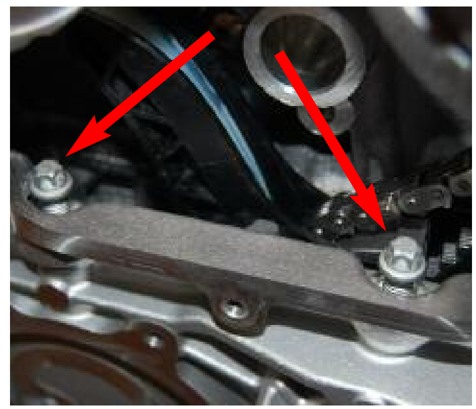
Then , loosen cylinder head bolts by starting at the outside and progressing to the inside in a circular motion (pic D). Secure cylinder head from falling when removing last bolt.

Remove cylinder head and repeat process on bank 2 cylinder head. Set both cylinder heads aside and protect head surface. Some of the valves may protrude and be damaged if the cylinder head is laid flat.



Picture A

Picture B



Picture C

Picture D

Is it necessary to remove the camshafts before removing the cylinder heads?

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Workshop Exercise - N63 Engine Disassembly

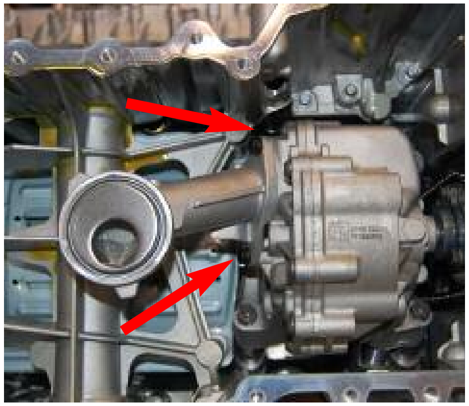
Rotate engine and remove oil pan lower section as well as the oil filter housing (pic A).

Remove oil pump pickup screen and tube (pic B) .

Remove all oil pan bolts in upper section. Note hidden bolts under the oil filter housing. Remove upper oil pan (pic C).

Remove flywheel (flexplate) (pic D).

Picture A



Picture B

Picture C

Picture D

What is different regarding the location of the oil pump?

What is the reason for the re-location of the oil pump?

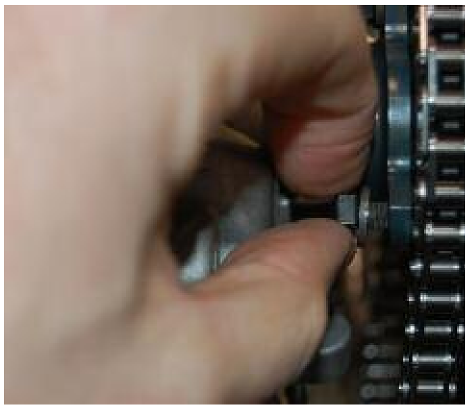
Workshop Exercise - N63 Engine Disassembly

Remove oil pump chain by removing sprocket bolts on oil pump (pic A). Also, remove rear main seal cover.

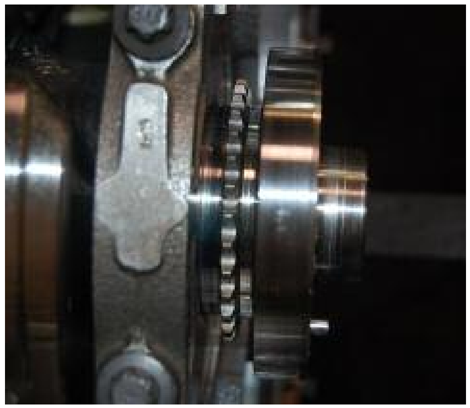
Note additional sprocket cast into rear of crankshaft (pic B).

Remove oil pump attachment bolts and remove oil pump (pic C).

Note location of oil pump chain adjustment during re-installation (pic D).



Picture A



Picture B

Picture C

Picture D

Is the oil pump sprocket on the crankshaft removable?

How is the oil pump chain adjustment carried out?

What is different about the oil pump on the N63?

Workshop Exercise - N63 Engine Disassembly

After removal of the oil pump, proceed with removal of the timing cover. Rotate engine to the upright position.

Using special tool, lock crankshaft and remove central bolt and front crankshaft damper (pic A).

Remove all timing cover bolts and remove timing cover (pic B). Note arrangement of the timing chain guides (pic C).

Remove chain guides and set aside (pic D). Arrange neatly for re-installation.

Picture A

Picture B

Picture C

Picture D

What special tool is used to hold the crankshaft while loosening the central bolt (pic A)?

Are the timing chain guides interchangeable?

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Workshop Exercise - N63 Engine Assembly

Prepare to re-assemble engine.

Install timing chains and guides on engine, pay attention to the arrangement of the chains (pic A).

Install timing cover and ensure gaskets are installed correctly. Also make sure the timing chain does not interfere with cover installation (pic B).

Install timing cover bolts (be aware some bolts are of a different length) (pic C).

Install front crankshaft damper and tighten central bolt using special tools.

Lock engine to the 150 degree BTDC position using special tools (pic D).

Picture A

Picture B

Picture C

Picture D

What is the torque specification for the central bolt? Fill in the chart below:

Initial (jointing torque)	Torque angle (1st)	Torque angle (2nd)	Torque angle (3rd)

Workshop Exercise - N63 Engine Assembly

Prepare to install cylinder heads (engine should be at 150 degrees BTDC w/special tools installed).

Begin by rotating engine so the deck surface on one bank (bank 2) is parallel with the floor (pic A).

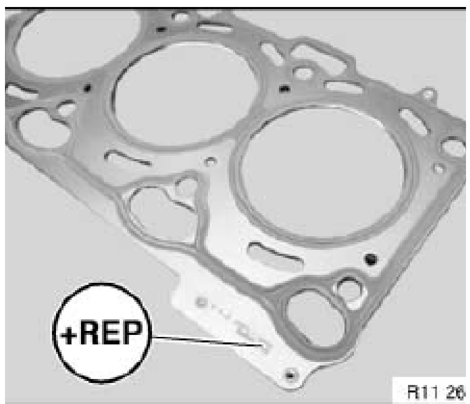
Install head gasket on cylinder block, be aware of markings (pic B).

Install cylinder head while positioning timing chain for installation (pic C).

Install head bolts (w/washers) and tighten in proper order to specification (first jointing torque only - for training engine).

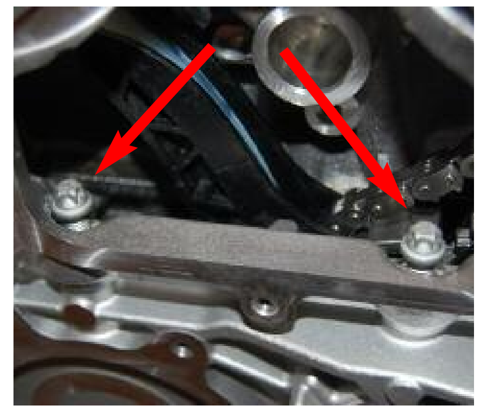
Install and tighten bolts in timing case (pic D).

Picture A



Picture B

Picture C



Picture D

What is the torque specification for the cylinder head bolts? (fill in chart below)

Initial (jointing torque)	Torque angle (1st)	Torque angle (2nd)	Front head bolts (pic D) M8

Workshop Exercise - N63 Engine Assembly

Install the cylinder head for the other bank (repeat previous steps for head installation).

Install VANOS units for intake and exhaust (keep in mind the intake and exhaust positions) Also, install upper chain guide (pic A).

Install central bolts, but do not tighten at this time (pic B).

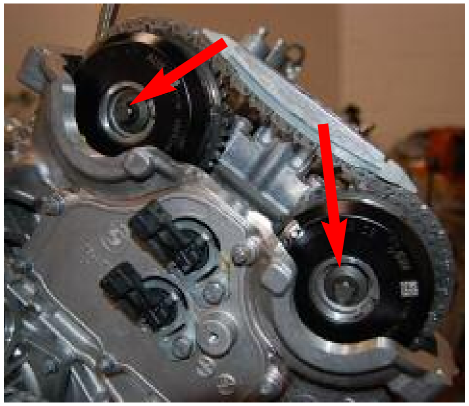
Install camshaft adjusting tools (pic C).

Install the VANOS units for bank 2 as in the above steps. (i.e. follow the same sequence).

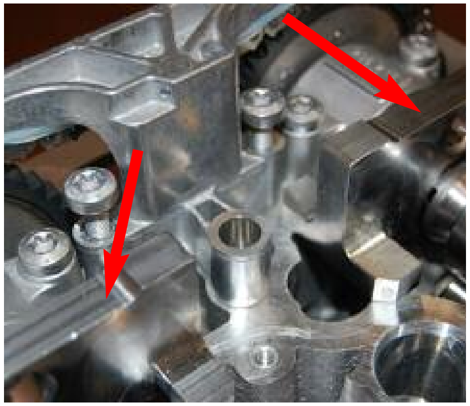
Important - Do not rotate the engine unless all timing mechanisms are in place and the VANOS central bolts are tightened to spec (Risk of bending valves or mis-timing the engine).

Also, install chain guide pins for both banks and tighten (pic D).

Picture A



Picture B



Picture C

Picture D

What are the torque specifications items listed below? (fill in chart below)

Upper chain guide	Chain guide pins

Workshop Exercise - N63 Engine Assembly

Prepare to set the camshaft timing. Start with bank 1.

Install special tools to check camshafts (pic A).

Install timing chain tensioning tool and tighten to 0.6 Nm (pic B).

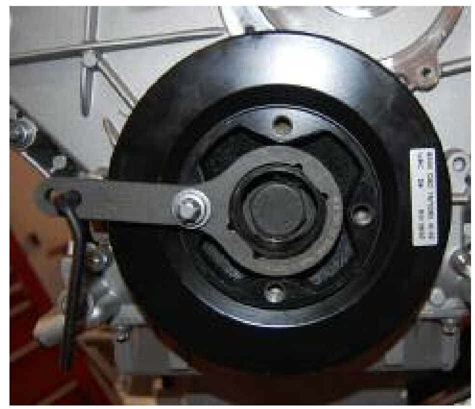
Install crankshaft locking tool (pic C).

Tighten VANOS central bolts (on bank 1) to specification.

Transfer special tools to bank 2 and repeat process (A through B) (pic D).

Picture A

Picture B



Picture C

Picture D

Why is it necessary to torque the tensioning tool to 0.6 Nm?

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Workshop Exercise - N63 Engine Assembly

Re-install the hydraulic timing chain tensioners (with pins installed) on both banks (pic A).

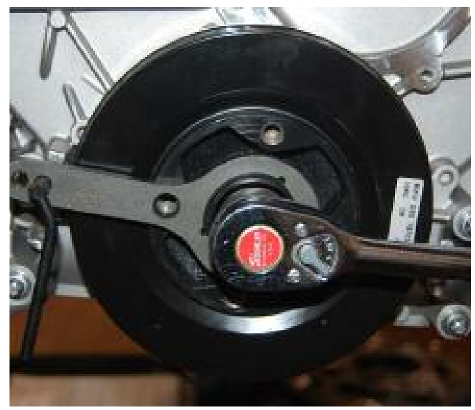
Leave the camshaft locking tools installed and rotate engine counter clockwise slightly while watching the tensioner piston(s). As soon as the tensioner pistons are retracted sufficiently, remove the locking pins on both banks (pic B).

Then, rotate the engine clockwise through 2 rotations (360 degrees X 2) and re-set engine to locked position (pic C) check the camshaft timing . If not OK, re-adjust.

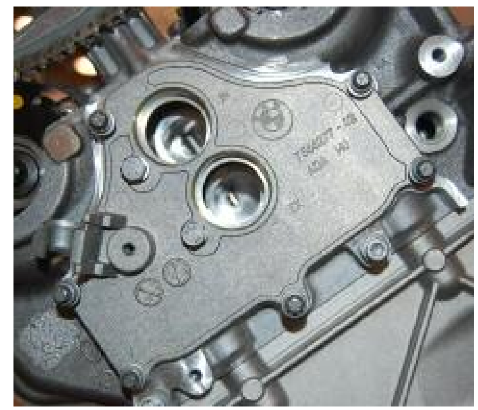
If OK, continue with engine assembly. Install adapter plates for VANOS solenoids (pic D) and install VANOS solenoids on both banks.

Picture A

Picture B



Picture C



Picture D

Fill in the torque specifications for the following items:

Chain tensioner bolts	VANOS solenoid cover	VANOS solenoid bracket

Workshop Exercise - N63 Engine Assembly

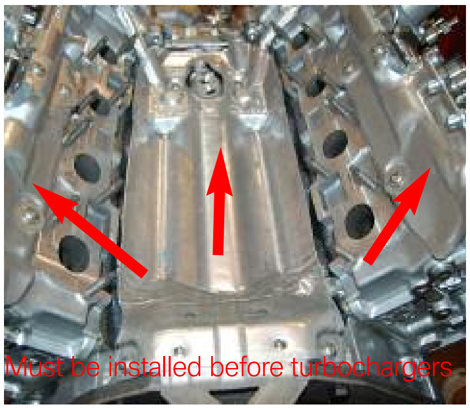
Install water pump, accessory belt tensioner and front pulley.

Install heat shield between cylinder heads and head shields brackets as shown (pic A). (must be installed before turbochargers)

install exhaust manifold gaskets (pic B). Pay attention to gasket installation. (they can be installed incorrectly).

Install exhaust manifolds, with brackets and copper nuts (pic C). Reinstall heat shields on cylinder heads.

Install front heat shield between cylinder heads (pic D) and install coolant bleed hoses between cylinder heads.



Picture A

Picture B

Picture C

Picture D

What special attention should be paid to the copper washer on the oil and coolant lines?

Is it possible to install the exhaust manifold gasket incorrectly?

Workshop Exercise - N63 Engine Assembly

Install turbocharger for bank 1 and tighten oil return line (pic A).

Install clamp at turbocharger to exhaust manifold connection as shown (pic B).

Install all coolant and oil lines to bank 1 turbocharger before installing bank 2 turbocharger (pic C).

Install turbocharger for bank 2 and repeat all steps above including oil and coolant lines (pic D).

Reconnect all vacuum lines to the wastegates for both turbochargers. Be aware, the red vacuum line is for bank 1 and the blue line is for bank 2.

Picture A

Picture B

Picture C

Picture D

Fill in the torque specifications for the following items:

Oil feed lines	Oil return lines	Coolant lines (for turbo)	Clamp to exhaust manifold

Workshop Exercise - N63 Engine Assembly

Once the turbo installation is complete, proceed with the installation of the cylinder head covers. When tightening bolts, be sure to torque in proper sequence (i.e. inside to outside - pic A).

Install all fuel injectors and spark plugs for both banks.

Install high pressure fuel pump for both banks, make sure the camshaft follower is installed first (pic C).

Install low pressure fuel line between the high pressure pumps.

Install alternator and attach hold down brackets for fuel line.

Picture A

Picture B

Picture C

Picture D

What is important to observe when tightening the bolts on the high pressure fuel pump?

Fill in the torque specifications for the following items:

Cylinder head cover	HP Pump	Low pressure fuel lines	Alternator bracket

Workshop Exercise - N63 Engine Assembly

Before proceeding with the high pressure fuel line installation, the intake manifolds must be installed.

Install both intake manifolds and tighten bolts to specification (pic A).

Be sure to install additional bolts (pic B) on both banks (one on each).

Install fuel rails for both banks (pic C).

Install high pressure fuel lines between injectors and fuel rail as well as the lines between the high pressure pump and fuel rail (pic D).

Picture A

Picture B

Picture C

Picture D

Fill in the torque specifications for the following items:

Fuel Lines (injectors)	Fuel lines (rail to HP pump)	Intake manifold

Workshop Exercise - N63 Engine Assembly

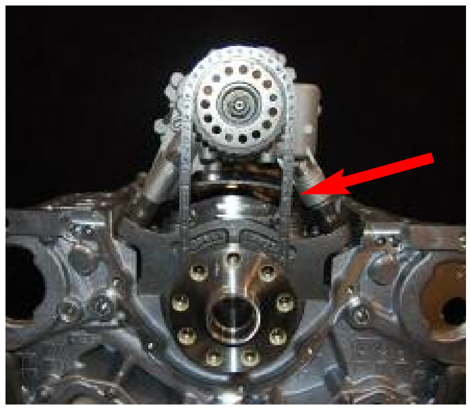
Rotate engine to install oil pump. Make sure both o-rings are installed properly (pic A).

Install oil pump chain and sprocket, adjust oil pump chain deflection if necessary (pic B).

Install rear main seal cover (pic C).

Install flywheel/flexplate (pic D).

Picture A



Picture B

Picture C

Picture D

Fill in the torque specifications for the following items:

Oil pump mounting	Oil pump sprocket	Rear main seal cover	Flywheel

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Workshop Exercise - N63 Engine Assembly

Once the oil pump is installed, proceed with installation of the upper and lower oil pan.

Install upper oil pan using proper bolt tightening sequence (pic A).

Install oil pump pickup (pic B).

Install lower oil pan using proper bolt sequence (pic C).

Install oil filter (pic D).

Picture A

Picture B

Picture C

Picture D

Fill in the torque specifications for the following items:

Oil pan upper	Oil pump pickup	Oil pan lower	Oil filter

Workshop Exercise - N63 Engine Assembly

Rotate engine to the upright position. Prepare to install exhaust manifold/catalytic converter assemblies.

Install heat shields at the rear of the cylinder heads (pic A) for both banks.

Install exhaust manifold/catalytic converter assemblies (pic B). (Pay attention to clamp location)

Install rear heat shields on catalysts first (pic C) and then install all remaining heat shields including upper heat shield (over turbos) .

Install the cable brackets for the post catalyst oxygen sensors (pic D).

Picture A

Picture B

Picture C

Picture D

Fill in the torque specifications for the following items:

Exhaust clamps (pic B)	O2 sensor cable bracket (pic D)

Workshop Exercise - N63 Engine Assembly

Install crankcase ventilation tubes (check valves- pic A) and connect at both ends (cylinder head cover and intake manifold).

Install pre-catalyst oxygen sensors with heat shields (pic B).

Install upper bracket for engine cover (pic C).

Make sure the engine is completely re-assembled. Double-check all hose connections, heat shields etc. (pic D).

Picture A

Picture B

Picture C

Picture D

Fill in the torque specifications for the following items:

Pre-catalyst O2 sensors (pic B)

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Classroom Exercise - Review Questions

1. When removing the cylinder heads on the N63 engine, the engine must be locked at:

   A. 0 degrees (TDC)
   B. 30 degrees ATDC
   C. 150 degrees BTDC
   D. 90 degrees BTDC

2. The cyclone separators for oil separation on the N63 engine are located:

   A. under the intake manifolds
   B. in the cylinder head covers
   C. in the air cleaner housing
   D. in the timing case

3. What special tools is used to remove the O2 sensors?

   A. 11 2 120
   B. 11 9 190
   C. 11 7 020
   D. 11 1 100

4. The vacuum reservoir for the EPDW solenoids and exhaust flaps is located:

   A. under the exhaust manifolds
   B. behind the right front fender
   C. in the E-box
   D. behind the left headlight assembly

5. When setting the camshaft timing on the N63, the timing chain tensioner tool should be tightened to:

   A. 10 Nm
   B. .1 Nm
   C. 6.0 Nm
   D. 0.6 Nm

Classroom Exercise - Review Questions

6. The high pressure fuel pumps for the N63 are driven:

A. by a tandem connection to the vacuum pump
B. by a lobe on the exhaust camshafts
C. by a chain connection to the intake camshafts
D. None of the above

7. When removing the intake manifolds, which of the following components must be removed to access the attaching bolts?

A. the turbochargers
B. the fuel rails
C. the engine mounts
D. the cylinder head covers

8. The intercoolers on the N63 engine each have a sensor. What does this sensor monitor?

A. Coolant temperature for the intercoolers
B. Air charge pressure and temperature
C. Air charge temp only
D. Air charge pressure only

9. What two tools are needed to lock the engine when removing the cylinder heads?

A. 11 2 120 and 11 9 190
B. 11 7 420 and 11 0 200
C. 11 8 570 and 11 9 190
D. 11 3 320 and 11 5 150

10. What special tool is needed to lock the engine to remove the central bolt?

A. 11 8 570
B. 11 8 090
C. 11 8 920
D. 11 9 900

MSD85 Engine Management

Due to the changes brought about with the new N63 engine, the engine management system has been adapted accordingly.

The new system, designated MSD85, works in conjunction with the High Precision Injection (HPI) system which is familiar from the N54 engine.

Engine Control Module

The high level of technology on the N63 engine place high demands on the DME system. The ECM used features a very powerful 150 MHz processor and features a new connector concept.

The connector concept consists of five chambers and functional configuration. This means each chamber is assigned to a specific function group.

The following list outlines the configuration of the chambers in corresponding order:

- Chamber 1 (8 pins): Ignition
- Chamber 2 (59 pins): Engine plug, cylinder bank 1 and several central engine functions
- Chamber 3 (40 pins): Vehicle plug
- Chamber 4 (54 pins): Engine plug, cylinder bank 2 and several central engine functions
- Chamber 5 (16 pins): Fuel injection

An engine plug relates to sensor/actuator connections on the engine while the vehicle plug represents the interface to the vehicle specific components.

The functions of the engine management system are described in the respective systems.

Sensors

Oxygen Sensors

The familiar Bosch LSF4.2 sensors are used as the monitor sensors downstream of the catalytic converter.

The control sensors upstream of the catalytic converter are new. The new LSU ADV sensors are used here for the first time. LSU denotes oxygen sensor universal and ADV advanced. They therefore represent further-developed broadband oxygen sensors.

The new ADV oxygen sensor has an extended measuring range: It starts measuring from Lambda = 0.65. Other advantages of the new sensor include the higher temperature stability, shorter response times of less than 30 milliseconds as well as high signal accuracy.

The fact that the sensor is ready for operation in less than 5 seconds means lower emission values in the engine warm-up phase. Thanks to higher measuring dynamics of the sensor, the air-fuel ratio can be more effectively determined and controlled separately for each cylinder.

This results in a homogeneous exhaust flow that reduces emissions while also having a favorable effect on long-term emission characteristics. The service life of the sensor equals the service life of the vehicle.

Actuators

Electric Fan

As usual, the electric fan has its own electronics module and is controlled dependent on engine speed by a pulse-width modulated signal. The pulse duty factor during normal operation (100 Hz) is converted into a speed signal.

- 7% pulse duty factor wakes the fan electronics
- 11% pulse duty factor equates to 33% of the maximum fan speed
- 93% pulse duty factor equates to the maximum fan speed
- 97% pulse duty factor is a command for self-diagnosis of the fan electronics

To output the fan after-running command, the output frequency of the DME is reduced to 10 Hz during the latching phase (terminal 15 OFF). The fan time and speed are selected based on the pulse duty factor.

A further new feature is that the DME switches the power supply through terminal 30 via a relay.

NOTES PAGE

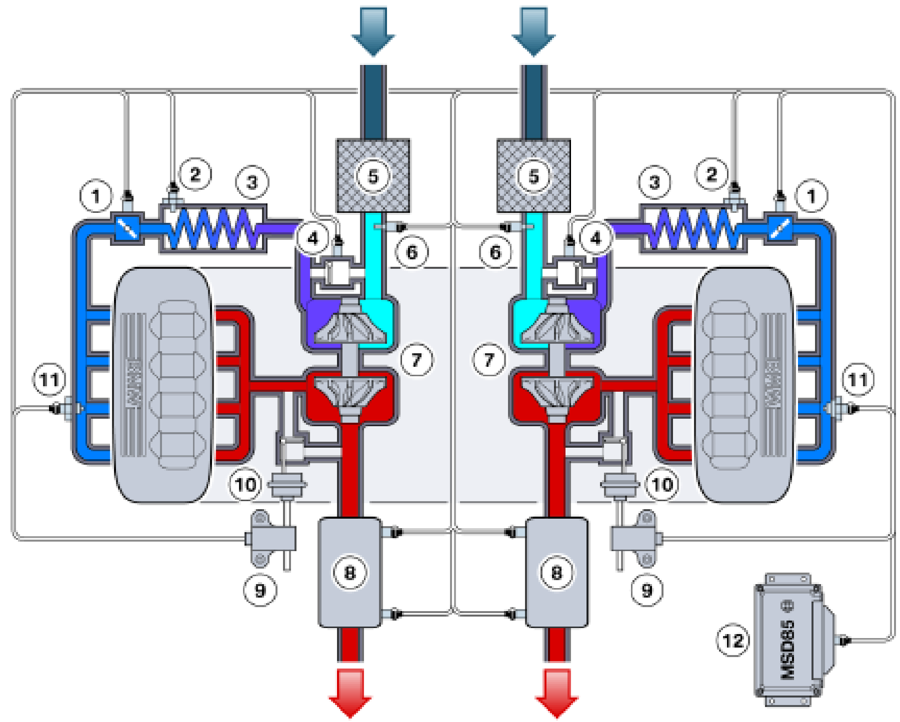
Air Management

Air Intake and Exhaust System

The main change to the air intake and exhaust system of the N63 engine is the interchanged positions of the intake and exhaust sides.

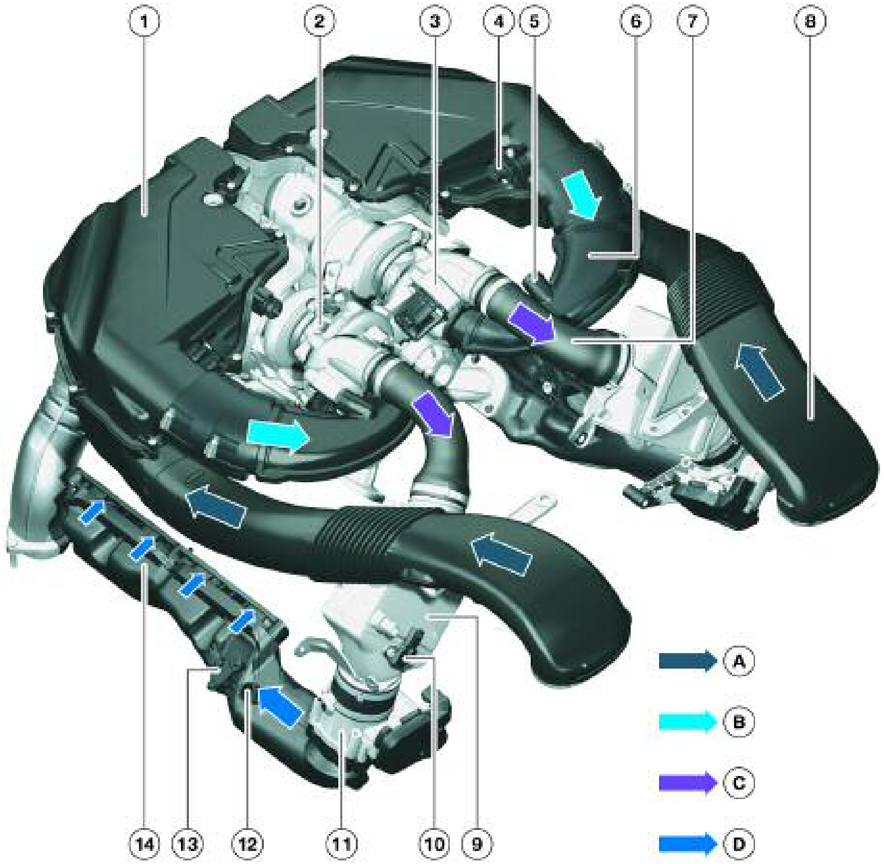
Consequently, the exhaust manifolds and turbochargers as well as the catalytic converters are located in the V-space of the engine.

This arrangement makes the N63 engine very compact despite the turbocharging. Another new feature is indirect charge air cooling with intercoolers mounted on the engine.



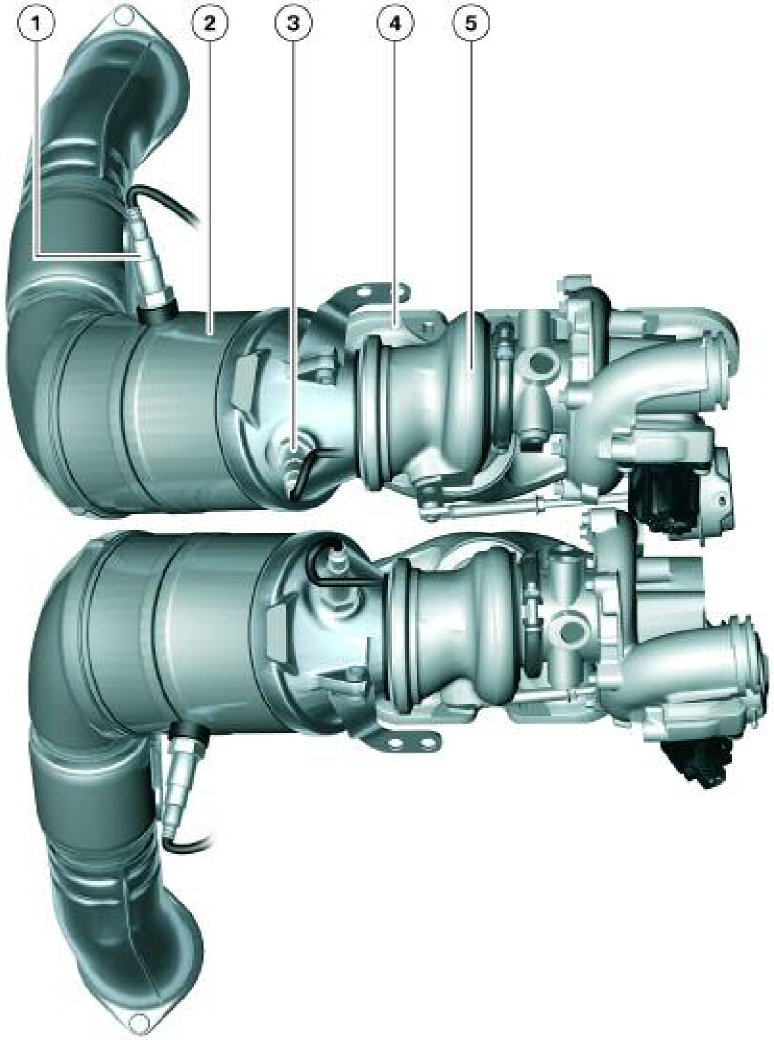
Index	Explanation	Index	Explanation
1	Throttle valve	7	Exhaust turbocharger
2	Charge air temperature and pressure sensor	8	Catalytic converter
3	Intercooler	9	Electro-pneumatic pressure converter (EPDW)
4	Diverter valve	10	Watergate valve
5	Intake silencer	11	Intake manifold pressure sensor
6	Hot-film air mass meter		Digital Motor Electronics (DME)

Air Intake System



Index	Explanation	Index	Explanation
1	Intake silencer	8	Unfiltered air pipe
2	Exhaust turbocharger	9	Intercooler
3	Diverter valve	10	Charge air temperature and pressure sensor
4	Hot-film air mass meter	11	Throttle valve
5	Crankcase breather connection for turbocharged engine operation	12	Crankcase breather connection for naturally aspirated engine operation
6	Clean air pipe	13	Intake manifold pressure sensor
7	Charge air pipe	14	Intake manifold

Exhaust System



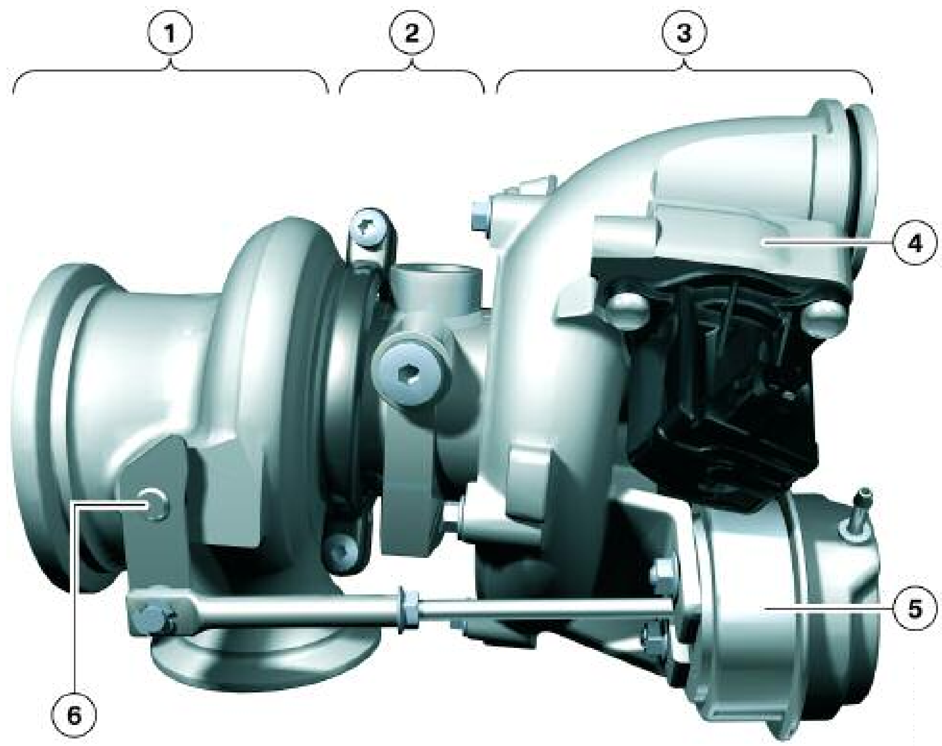
Index	Explanation	Index	Explanation
1	Oxygen sensor (monitor sensor LSF4.2 after catalytic converter)	4	Exhaust manifold
2	Catalytic converter	5	Exhaust turbocharger
3	Oxygen sensor (monitor sensor LSF ADV before catalytic converter)		

Turbocharging

The turbocharging principle of the N63 engine is very similar to that of the N54 engine. Two relatively small, parallel-connected exhaust turbochargers ensure rapid response already at low engine speeds.

The boost pressure is controlled by means of wastegate valves. Diverter valves are also used.

Exhaust Turbocharger



Index	Explanation	Index	Explanation
1	Turbine	4	Diverter valve
2	Bearing Pedestal	5	Vacuum unit
3	Compressor	6	Wastegate valve

Principle of Operation

The turbocharger is driven by the engine's exhaust gasses, i.e. exhaust gasses under pressure are routed by the turbocharger turbine and in this way delivers the motive force to the compressor, which rotates on the same shaft. It is here that the induction air is precompressed in such a way that a higher air mass is admitted into the engine's combustion chamber.

In this way, it is possible to inject and combust a greater quantity of fuel, which increases the engine's power output and torque.
The turbine and the compressor can rotate at speeds of up to 175,000 rpm. The exhaust inlet temperature can reach a maximum of 950°C.

Because of these high temperatures, the turbochargers of the N63 engine are not only connected with the engine oil system but also integrated in the engine coolant circuit.

In connection with the auxiliary electric coolant pump on the N63 engine, even after the engine has been switched off, it is possible to dissipate the residual heat from the turbochargers, thus preventing the lubricating oil in the bearing housing from overheating.

Bi-turbocharging

Great importance is attached to turbocharger response in the N63 engine. A delayed response to the driver's command, i.e. the accelerator-pedal position, is not acceptable.

The driver therefore must not experience any so-called "turbo lag". This requirement is met in the N63 engine with two relatively small turbochargers, which are connected in parallel. Each cylinder bank drives one exhaust turbocharger.

The advantage of smaller turbochargers lies in the fact that, as the turbocharger runs up to speed, the lower moment of inertia of the turbine causes fewer masses to be accelerated, thus allowing the compressor to attain a higher boost pressure in a shorter amount of time.

Boost Pressure Control

The boost pressure of the turbochargers is directly dependent on the flow of exhaust gas which reaches the turbocharger turbines. Both the velocity and the mass of the exhaust gas flow are directly dependent on engine speed and engine load. The engine management system uses wastegate valves to control the boost pressure.

These valves are operated by vacuum units, which are controlled by electropneumatic pressure converters (EPDW) via the engine management system.

The vacuum is generated by the permanently driven vacuum pump and stored in a pressure accumulator. The system is designed to ensure that these loads/consumers do not have a negative influence on the brake boost function.

The flow of exhaust gas to the turbine wheel can be influenced with the wastegate valves. When the boost pressure has reached its desired level, the wastegate valve begins to open and direct part of the exhaust-gas flow past the turbine wheel.

This prevents the turbine from further increasing the speed of the compressor. This control option allows the system to respond to various operating situations.

In the idle phase, the wastegate valves of both turbochargers are closed. This enables the full exhaust-gas flow available to be utilized to speed up the compressor already at these low engine speeds. When power is then demanded from the engine, the compressor can deliver the required boost pressure without any noticeable time lag.

In the full-load situation, the boost pressure is maintained at a consistently high level when the maximum permissible torque is reached by a partial opening of the wastegate valves. In this way, the compressors are only ever induced to rotate at a speed which is called for by the operating situation.

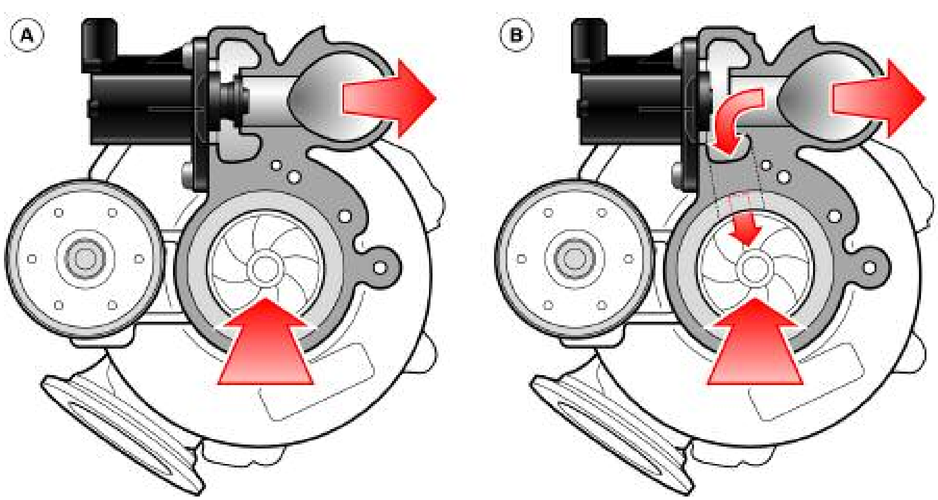
Opening of the wastegate valves takes drive energy from, the turbine thus limiting the charger speed and preventing overspeed. In addition, there is no further increase in boost pressure, thus benefiting fuel consumption.

At full-load the N63 engine operates at an overpressure of up to 0.8 bar in the intake manifold.

Blow-off Control

The diverter valves in the N63 engine reduce unwanted peaks in boost pressure which can occur when the throttle valve closes quickly.

They therefore have an important function with regard to engine acoustics and help to protect the turbocharger components.



Index	Explanation	Index	Explanation
1	Diverter valve, closed	2	Diverter valve, open

A vacuum is generated in the intake manifold when the throttle valve is closed at high engine speeds. This leads to a build-up of high dynamic pressure after the compressor which cannot escape because the route to the intake manifold is blocked.

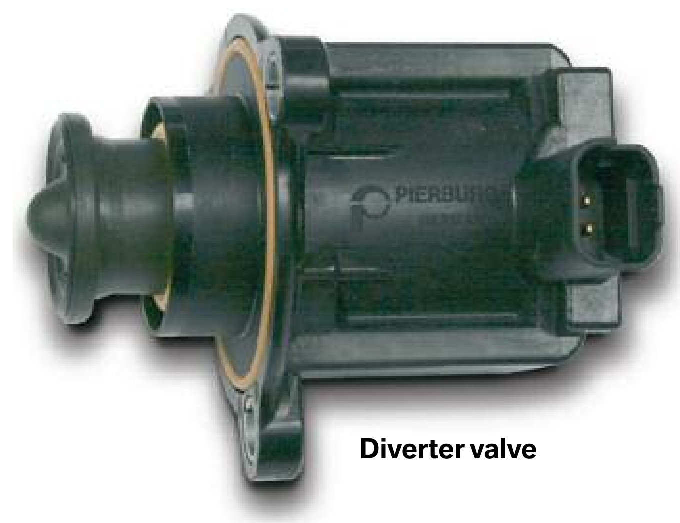
This leads to a "pumping up" of the turbocharger. This means that

- a clearly noticeable, disruptive pumping noise can be heard,
- and this pumping noise is accompanied by a component-damaging load being exerted on the turbocharger, since high-frequency pressure waves exert axial load on the turbocharger bearings.

The diverter valves are electrically operated valves. When the throttle valve closes, the boost pressure (upstream of the throttle valve) and its increase are compared with stored target values.

The diverter valves are opened if the actual values exceed the target by a certain value. As a result, the boost pressure is diverted to the intake side of the compressor.

This procedure prevents the disruptive and component-damaging pumping effect from occurring.



Diverter valve

Charge Air Cooling

Indirect charge air cooling is used for the first time on the N63 engine. The charge air is not routed directly to an air-to-air heat exchanger.

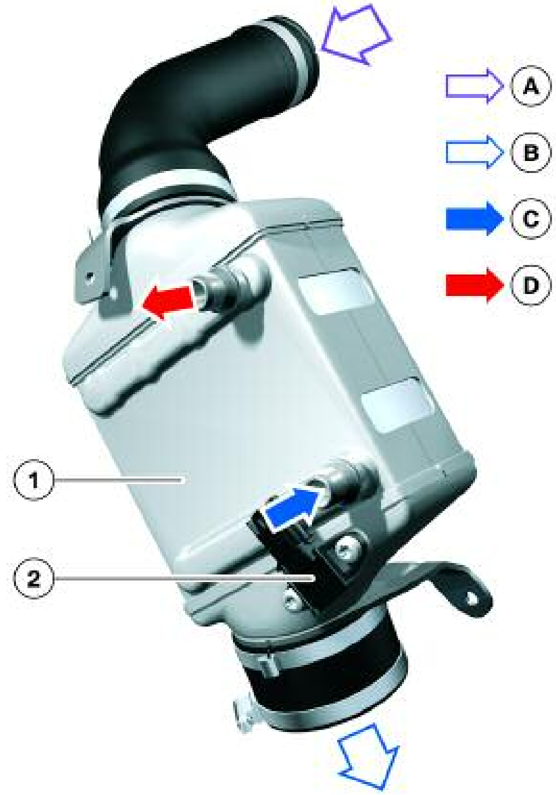
The charge air is cooled by means of an air-to-coolant heat exchanger. The N63 engine therefore features a separate self contained low-temperature coolant circuit.

Cooling the charge air serves to increase power output as well as reduce fuel consumption. The charge air heated in the turbocharger by its component temperature and by compression is cooled in the intercooler by up to 80°C.

This increases the density of the charge air, which in turn improves the charge in the combustion chamber. This results in a lower level of required boost pressure. The risk of knock is also reduced and the engine operates with improved efficiency.

Indirect charge air cooling has the advantage of requiring little space as the system can be mounted directly on the engine. Due to the near-engine installation position, the distinctly shorter pipe length required for charge air routing also have a positive effect.

In this way, pressure loss has been substantially reduced, thus improving power yield and engine response.



Index	Explanation	Index	Explanation
A	Hot charge air	D	Hot coolant
B	Cooled charge air	1	Intercooler
C	Cooled coolant	2	Charge air pressure/temperature sensor

Load Control

Load control of the N63 engine is realized by means of the throttle valve and the wastegate valves.

The throttle valve is the primary component in this process. The wastegate valves are actuated to bring about a fine tuning of the boost pressure. At full load the throttle valve is completely open and load control is undertaken by the wastegate valves.

The load control graphic shows that the wastegate valves are integrated in load control in all operating situations of the N63 engine on the basis of characteristic map control.

Controlled Variables

Among other things, the following variables influence boost pressure control in the N63 engine:

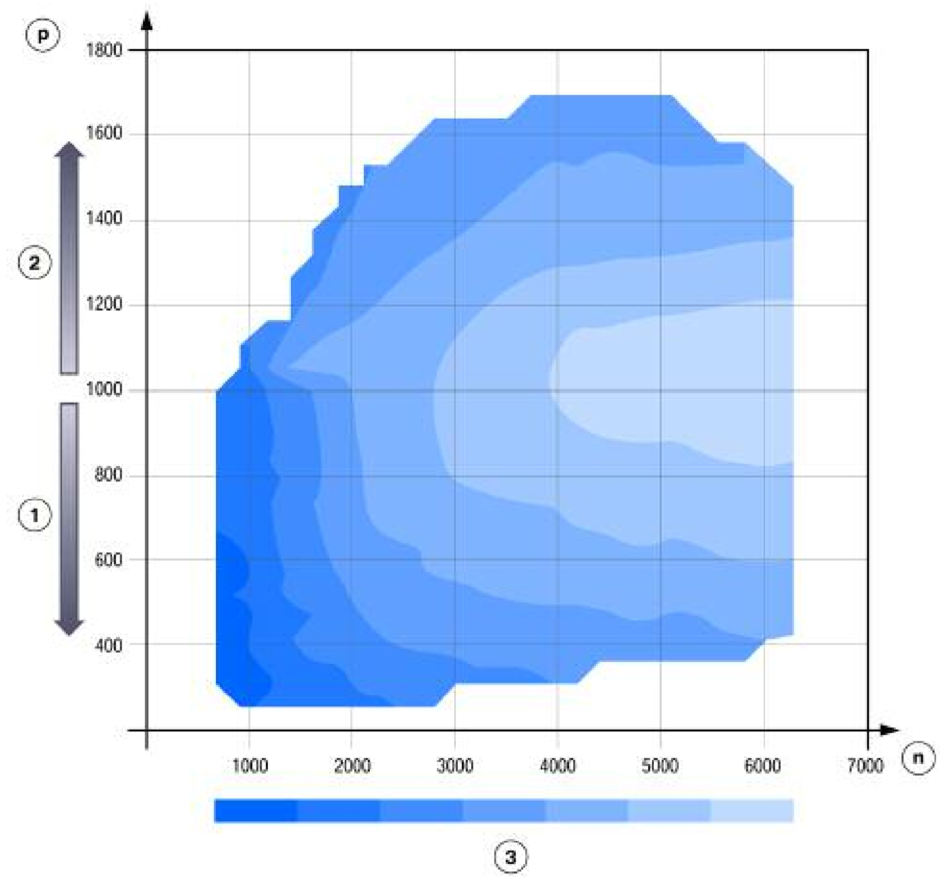
- Intake-air temperature
- Engine speed
- Throttle-valve position
- Ambient pressure
- Intake-manifold pressure
- Pressure before the throttle valve (reference variable)

The electropneumatic pressure transducers are activated by the engine control unit on the basis of these variables.

The result of this activation can be checked from the boost pressure achieved, which is measured before the throttle valve.

There follows a comparison of the boost pressure achieved with the setpoint data from the characteristic map, which can, if necessary, give rise to an activation correction.

The system therefore controls and monitors itself during operation.



Index	Explanation	Index	Explanation
n	Engine speed in RPM	2	Turbocharged operation
p	Absolute pressure in intake manifold (mbar)	3	Dark = wastegate closed Light = wastegate open
1	Naturally aspirated operation		

Limp-home Mode

In the event during operation of malfunctions, implausible values or failure of any of the sensors involved in turbocharger control, activation of the wastegate valves is shut down and the valve flaps are thus fully opened. Turbocharging ceases at this point.

The list below sets out those components or functional groups of the N63 engine in which a failure, a malfunction or implausible values result in boost pressure control being deactivated.

The driver is alerted to a fault of this type by the emission warning lamp.

- High pressure fuel system
- Inlet VANOS
- Exhaust VANOS
- Crankshaft sensor
- Camshaft sensor
- Boost-pressure sensor
- Knock sensors
- Intake-air temperature sensor

One principle of vehicle repair is particularly important in this respect:

When diagnosing any fault, particularly with a turbocharged engine, it is important to focus on causes rather than the effects.

With regard to the diagnosis and subsequent repair of turbocharging components, it is important to ensure that they are also actually identified as defective components with the diagnostic technology available. It is always vital to ensure that the cause of the fault is determined and rectified and that if necessary work is not carried out on symptoms of fault consequences.

Thus, for instance, a leaking flange on the intercooler can have far-reaching consequences.

The N63 engine also is governed by three golden rules of procedure:

1. It is important to not immediately blame the turbocharger for all power related complaints. Turbochargers are frequently mis-diagnosed and unnecessarily replaced.
   If blue smoke emerges from the exhaust system, check whether the air cleaner is contaminated or the engine is consuming too much oil because of wear.
   If the turbocharger is running too loud, inspect all the connections on the turbocharger pressure side. If black smoke or a loss of power is detected, in this case check the engine and the connecting pipes first.

2. Main causes of turbocharger damage:
   - Insufficient lubrication and consequently bearing failure.
   - Foreign bodies damage the turbine and impeller. The resulting imbalance will reduce efficiency and may cause rotor damage.
   - Contaminated lube oil causes scoring on shaft journals and bearings. Elements entering the turbocharger system from the out side such as sand, dirt, screws and the like will be trapped by a filter before the compressor.

   Service the filters at regular intervals (service intervals).

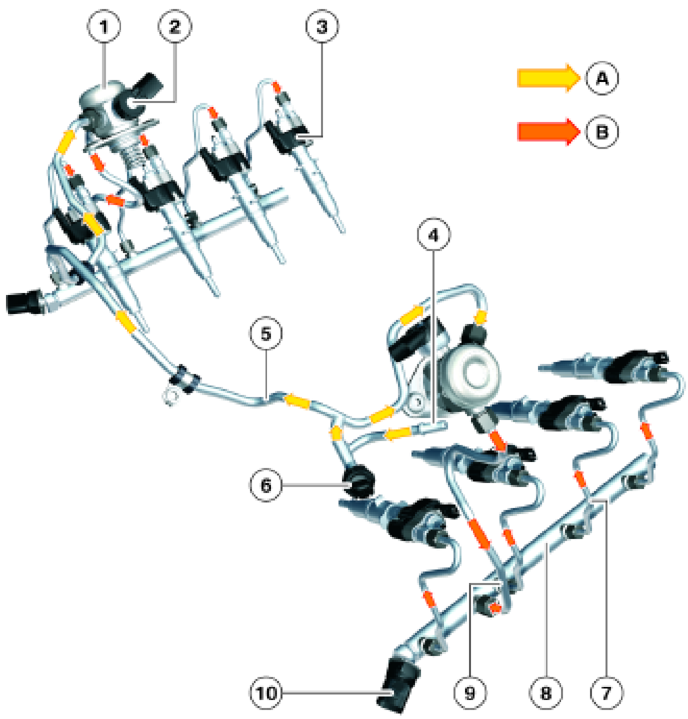
3. Do not make any alterations to the turbocharger.

   Never attempt to tamper with or alter the boost-pressure control linkage. If the turbocharger operates at higher boost pressures than permitted by the engine manufacturer, the engine may run hot and pistons, cylinder heads or engine bearings may fail, or the safety function of the engine electronics may respond and activate the engine's limp-home program.

Fuel Supply and Management

High-precision Injection (HPI)

The fuel is delivered from the fuel tank by the electric fuel pump via the feed line at an admission pressure of 5 bar to the high pressure pump.



Index	Explanation	Index	Explanation
1	High pressure pump (2 x)	6	Low pressure sensor
2	Volume control valve	7	High pressure fuel line
3	Piezo-injector	8	Fuel rail
4	Low-pressure feed from fuel pump	9	High pressure fuel line (pump to rail)
5	Low pressure feed line	10	Rail pressure sensor (2 x)

The admission pressure is monitored by the low pressure sensor. The fuel is delivered by the electric fuel pump in line with demand. If this sensor fails, the electric fuel pump continues to run at 100% delivery with terminal 15 ON.

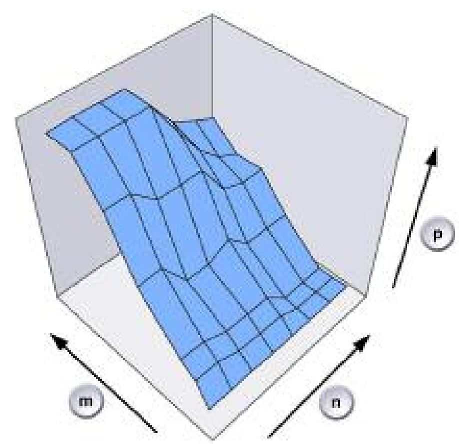
The fuel is compressed in the permanently driven single-piston high pressure pump and delivered through the high pressure line to the rail.

The fuel accumulated under pressure in the rail in this way is distributed via the high pressure lines to the piezo-injectors.

The required fuel delivery pressure is determined by the engine-management system as a function of engine load and engine speed. The pressure level reached is recorded by the rail pressure sensor and communicated to the engine control unit.

Control takes place by means of the volume control valve based on setpoint/actual value adjustment of the rail pressure.

Configuration of the pressure is geared towards best possible consumption and smooth running of the N63 engine. 200 bar is required only at high load and low engine speed.

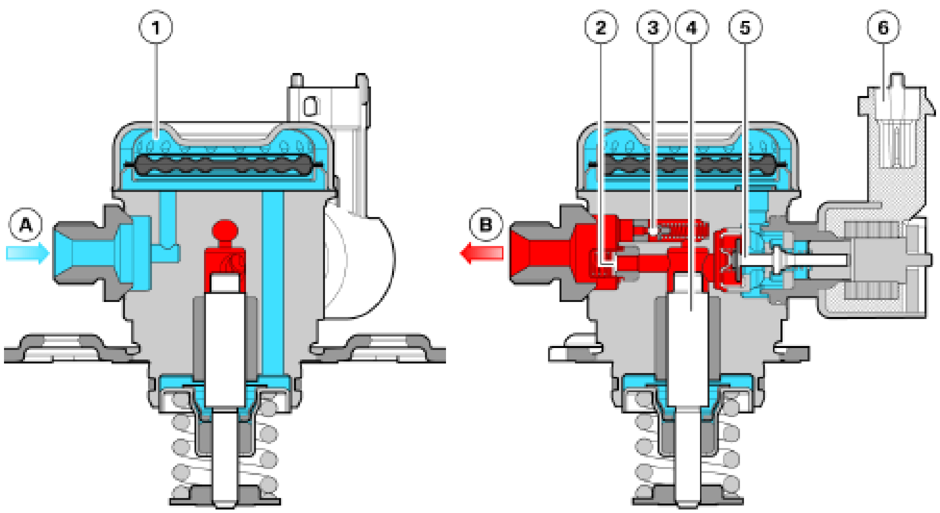


Index	Explanation
p	pressure
m	Engine load
n	Engine speed

Design and function of high pressure pump

The fuel is delivered via the supply passage at the admission pressure generated by the electric fuel pump to the high pressure pump.

From there, the fuel is directed via the volume control valve and the low pressure non-return valve into the fuel chamber of the plunger and-barrel assembly.



Index	Explanation	Index	Explanation
A	Low pressure connection	3	Pressure relief valve
B	High pressure connection	4	Piston
1	Equalization chamber	5	Volume control valve
2	High pressure non-return valve	6	Electrical connection for the volume control valve

The fuel is placed under pressure by a piston in this plunger-and-barrel assembly and delivered via the high pressure non-return valve to the high pressure port. The high pressure pump is bolted to the cylinder head and is driven by a three-point cam on the camshaft.

This means the piston is permanently moved by the three-point cam as soon as the engine is running. Fuel therefore continues to be pressurized for as long as new fuel is supplied to the high pressure pump via the volume control valve.

The volume control valve is activated by means of the engine management connection and determines the delivered quantity of fuel.

The pressure is controlled by the volume control valve opening and closing in the direction from the plunger and barrel assembly to the fuel inlet.

The fuel drawn in by the piston is largely forced back into the pressure inlet when the volume control valve is opened.

The maximum pressure in the high pressure area is limited to 245 bar. If excessive pressure is encountered, the high pressure circuit is relieved by a pressure relief valve via the ports leading to the low pressure area.

This is possible without any problems because of the incompressibility of the fuel, i.e. the fuel does not change in volume in response to a change in pressure.

The pressure peak created is compensated for by the liquid volume in the low pressure area. The equalization chamber is incorporated in the feed to the high pressure pump. It has the task of reducing the pressure peaks produced by piston movement in the low pressure system.

When the piston generates pressure, fuel passes between the piston and its guide. This is intentional for lubrication purposes.

A higher pressure is produced at the rear of the piston as it moves downwards. This could give rise to the danger of fuel being forced through the seal of the piston out of the pump and into the engine oil system. The connection to the equalization chamber ensures that there is never a pressure higher than the fuel feed behind the piston.

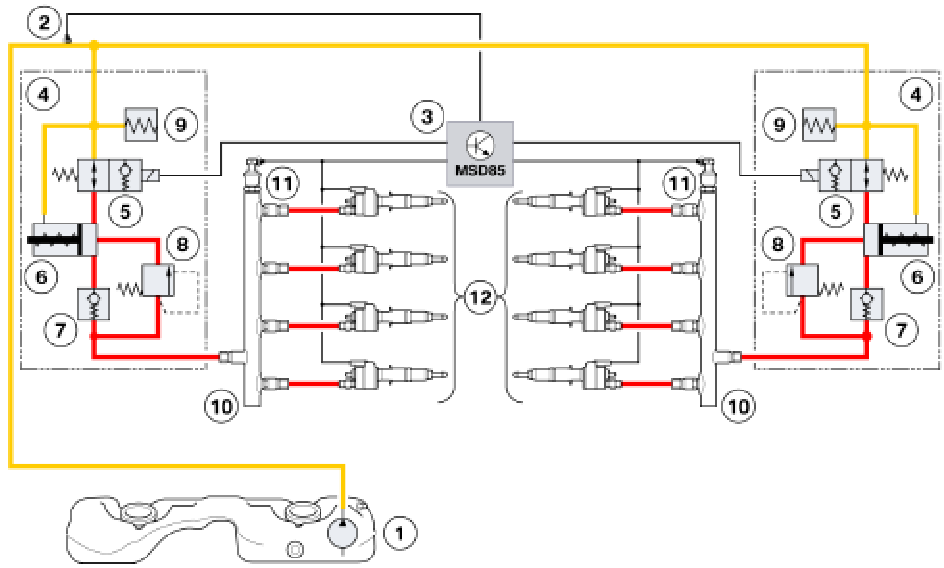
When opened, the volume control valve prevents pressure fluctuations being transmitted into the low pressure system as changes in volume before and after the piston are equalized.

Hydraulics diagram of fuel system

The volume control valve controls the fuel pressure in the rail. It is activated by the engine management system via a pulse-width modulated (PWM) signal.

Depending on the activation signal, a restrictor cross-section of varying size is opened and the fuel-mass flow required for the respective load point is set.

The pressure relief valve additionally provides the option of reducing the pressure in the fuel rail by directing the fuel out of the high pressure system back into the pump element.



Index	Explanation	Index	Explanation
1	Electric fuel pump	7	High pressure non-return valve
2	Low pressure sensor	8	Pressure relief valve
3	Engine control module	9	Rail
4	High pressure pump	10	Rail pressure sensor
5	Volume control valve	11	Piezo-injectors
6	High pressure pump element		

Fuel Injectors

The fuel injectors on the N63 are the familiar piezo-electric design carried over from the N54.

The outward opening, piezo injectors are an integral part of the spray-guided injection strategy used on the HPI injection system.

This type of piezo-injector ensures that the injected fuel spray cone remains stable, even under the prevailing influences of pressure and temperature in the combustion chamber.

This injector design permits injection pressures of up to 200 bar and extremely quick opening of the nozzle needle. In this way, it is possible to inject fuel into the combustion chamber under conditions released from the power cycles limited by the valve opening times.

The piezo-injector is integrated together with the spark plug centrally between the inlet and exhaust valves in the cylinder head. This installation position prevents the cylinder walls or the piston crown from being wetted with injected fuel.

A uniform formation of the homogeneous air/fuel mixture is obtained with the aid of the gas movement in the combustion chamber and a stable fuel spray cone.

The gas movement is influenced on the one hand by the geometry of the intake passages and on the other hand by the shape of the piston crown. The injected fuel is swirled in the combustion chamber with the boost air until a homogeneous mixture is available throughout the compression space at the point of ignition.

Injector Adjustment

As with the piezo injectors from the N54, the injector adjustment must be carried out when the injectors are replaced.

When the injectors are manufactured, a multitude of measurement data is recorded at specific points in the factory. In this way, the tolerance ranges for injector-quantity adjustment are determined and specified in a six-digit number combination.

Information on the lift performance of the injector is also added for injector voltage adjustment. Injector adjustment is required because of the individual voltage demand of each piezo-actuator.

An allocation is made to a voltage demand category, which is included in the number combination on the injector. These data are transmitted to the control unit.

During engine operation, these values are used to compensate for deviations in the metering and switching performance.

When replacing an injector, it is absolutely essentially to carry out an injector adjustment.

Injection Strategy

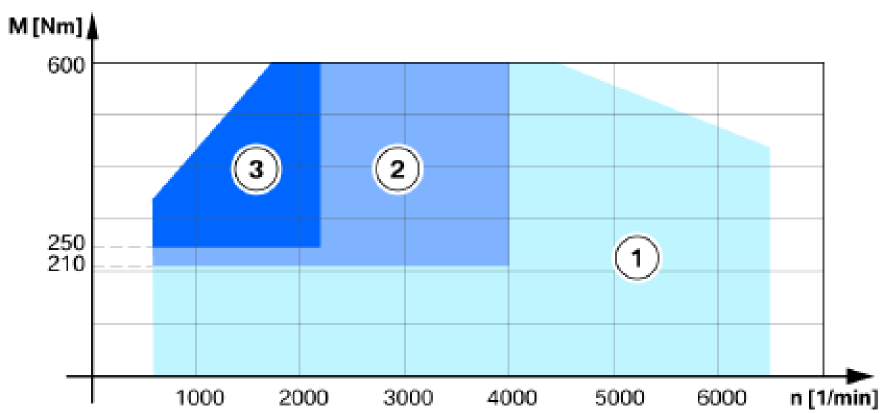
Injection of the fuel mass required for the operating situation can take place in up to three individual injections. Which option is used in the relevant operating situation is dependent on engine load and speed.

Here the actual time resulting from the engine speed available for metering the fuel is an important framework quantity.

The following graphic shows the fuel injection strategy for an engine at operating temperature.

A special situation during the operation of any engine is the range in which a high load occurs at low engine speed, so-called "Low End Torque" operation. In this operating situation, the required fuel mass is metered to the engine in three individual injections.

This results in a highly effective mixture formation which in the final analysis has the effect of both increasing power output and saving fuel.



Index	Explanation	Index	Explanation
n	Engine speed	2	Two-time injection
m	Torque	3	Three-time injection
1	One-time injection		

Operating Mode: Catalytic-converter Heating

In order to bring the catalytic converters up to operating temperature as quickly as possible, the N63 engine has a catalytic converter heating mode for when the engine is started from cold.

In this mode, combustion heat is intentionally introduced into the exhaust train and not used first and foremost to develop power output. The point of ignition is moved to 30° crankshaft angle after TDC.

The main quantity of the required fuel is injected before TDC and mixed with the boost air. The piston is situated after TDC in its downward travel such that the air/fuel mixture is already expanding again, which reduces the ignitability of the mixture.

In order to ignite the mixture reliably, a small residual quantity of fuel is injected 25° crankshaft angle after TDC and this guarantees an ignitable mixture at the spark plug.

This small fuel quantity therefore provides for ignition of the residual charge in the combustion chamber. This operating mode is set by the engine-management system after a maximum period of 60 seconds from engine starting but is terminated if the catalytic converter response temperature is reached earlier.

Injector control and adaptation

The fuel mass required for the operating situation is injected by the piezo-injector into the combustion chamber. This mass can be influenced by three correcting variables:

- the rail pressure
- the injector opening time
- and the injector opening lift

The injector opening time and the injector opening lift are activated directly at the piezo injector. The opening time is controlled via the signal ti and the opening lift via the energy quantity in the activation of the piezo-injector.

Injector adaptation
The fuel masses and injection cycles determined from the load/speed map are included in a pilot-control program map. Here, while further framework parameters are taken into consideration, the energy quantities and injector opening times required to activate the injectors are determined. The N63 engine can be safely and reliably operated with these characteristic map values.

For optimization of:

- Emission values
- Smooth running
- Fuel consumption
- Power output

The controlled variables of energy quantities and injector opening times are continuously monitored. This occurs on a cylinder-selective basis by way of lambda closed-loop control.

The residual oxygen in the exhaust gas is measured in each case for cylinder bank 1 and cylinder bank 2. The new oxygen sensors permit allocation to the individual cylinders.

This measurement result is compared with the values expected from the set correcting variables. The result of a deviation is that the injector opening signal is adapted. This adaptation is stored in the control unit and is therefore available for subsequent engine operation.

However, these stored values are lost when the system is flashed and must be relearned. A further adaptation of the injector activation takes place depending on time and use. This cylinder-selective adaptation involves a check of the residual oxygen content with a conclusion as to the cylinder causing the situation.

To this end, it is necessary for part of the exhaust gas flow not to be swirled in the turbocharger. For this reason, the flap of the wastegate valve must be fully opened, i.e. swung out of the exhaust-gas flow. This wastegate flap position extends beyond its normal opening position in engine operation.

Based on the result of this cylinder-selective monitoring, the energy quantity is adapted if necessary to activate the injectors.

Furthermore, the cylinder-selective adaptation includes if necessary an adaptation of the injector opening signal based on smooth running monitoring of the N63 engine.

Overall adaptation of the injectors is limited to a 15% additional quantity.

HPI Limp-home mode
If a fault is diagnosed in the system, such as e.g. failure of the rail pressure sensor, the volume control valve is de-energized; the fuel then flows via a so-called bypass into the rail.

In the event of HPI limp-home mode, turbocharging is deactivated by an opening of the wastegate valves.

Causes of HPI limp-home mode may be:

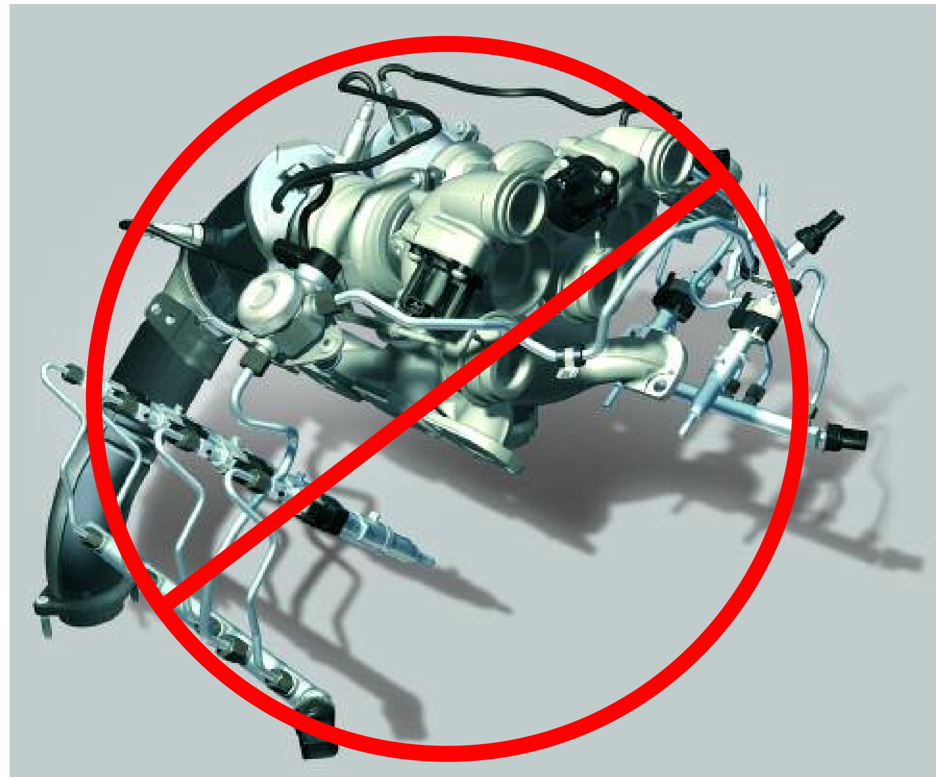
- Implausible rail pressure sensor values
- Failure of volume control valve
- Leakage in high pressure system
- Failure of high pressure pump
- Failure of rail pressure sensor

HPI System Service

Fuel System Safety

ACHTUNG! Öffnen des Kraftstoffsystems bei Kühlmitteltemperatur über 40 °C nicht zulässig. Gefahr von Körperverletzung. Reparaturanleitung beachten.
CAUTION! Do not open the fuel system if the coolant temperature is above 40 °C/104 °F – risk of injury! Consult the repair manual.
ATTENTION ! Il est interdit d'ouvrir le système d'alimentation en carburant lorsque la température du liquide de refroidissement est supérieure à 40 °C. Risque de blessure. Respecter les instructions du Manuel de réparation.
¡ATENCIÓN! Prohibido abrir el sistema de combustible cuando la temperatura del líquido refrigerante supere los 40 °C. Peligro de lesiones. Consultar el manual de reparaciones.
注意！ 冷却液温度高于40摄氏度时禁止打开燃油系统。存在身体伤害的危险。注意维修说明。 7567417

- Working on this fuel system is only permitted after the engine has cooled down. The coolant temperature must not exceed 40°C. This must be observed without fail, otherwise there is a danger of fuel sprayback on account of the residual pressure in the high pressure system.
- When working on the high pressure fuel system, take particular care to ensure conditions of absolute cleanliness and follow the work sequences described in the repair instructions. Even the tiniest contaminants and damage to the screw connections on the high pressure lines can cause leaks.
- When working on the fuel system of the N63 engine, it is important to ensure that the ignition coils are not fouled by fuel. The resistance of the silicone material is significantly reduced by heavy fuel contact. This can cause sparkover at the spark-plug head and cause misfires.
- Before making modifications to the fuel system, remove the ignition coils without fail and protect the spark-plug slot against the ingress of fuel with a cloth.
- Before refitting the piezo-injector, remove the ignition coils and ensure conditions of absolute cleanliness.
- Ignition coils heavily fouled by fuel must be replaced.



Note: Do not open fuel lines until the coolant temperature has cooled to below 40 degrees Celsius (104 degrees Fahrenheit).

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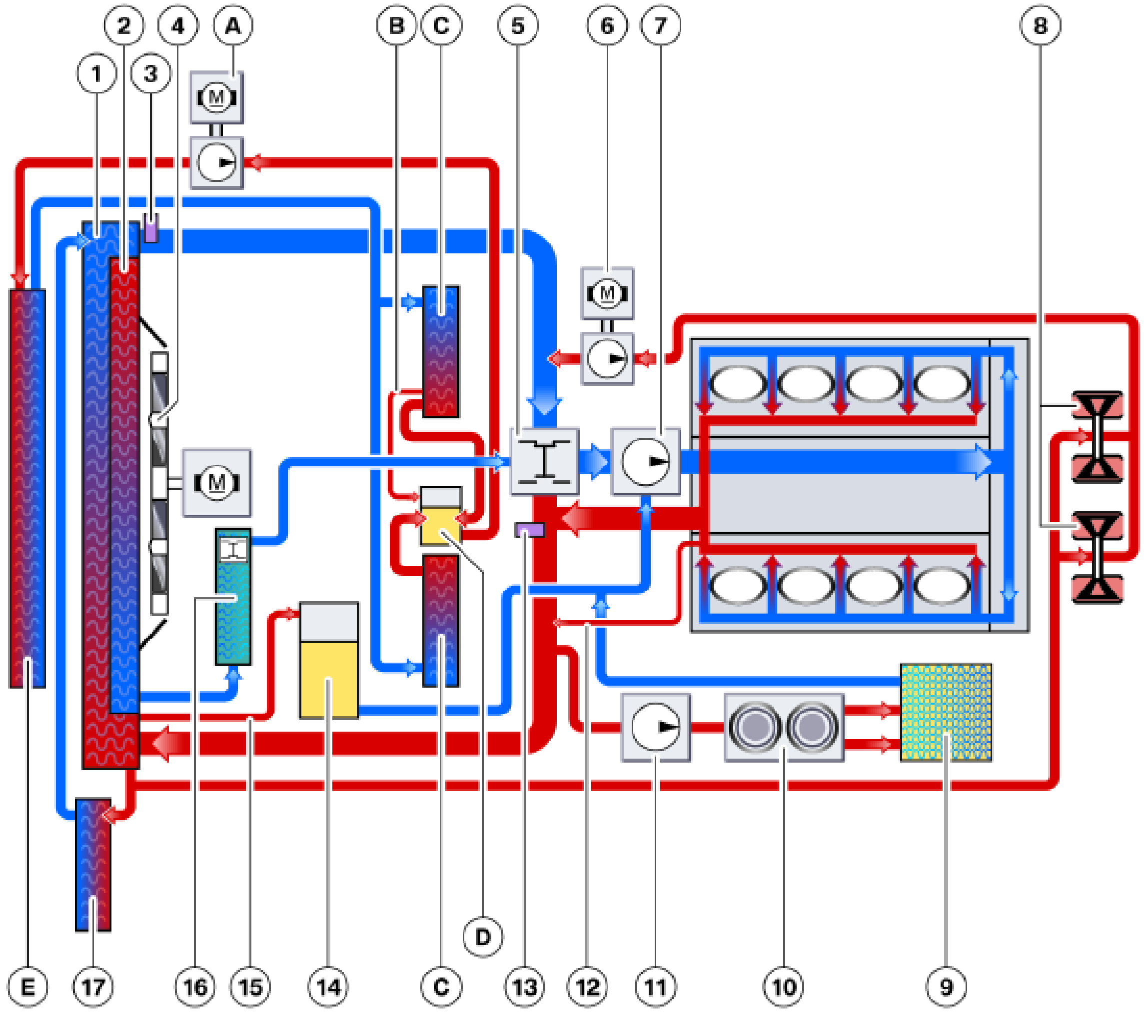
Performance Controls

Cooling System

Due to the exhaust turbocharging system and the compact arrangement of the turbochargers in the V-space, the heat output of the N63 engine is very high. Correspondingly, great significance is attached to the cooling system. In addition, an indirect charge air cooling system has been developed for the first time where the charge air is cooled by an air-to-coolant heat exchanger. There are two separate cooling circuits for engine and charge air cooling.

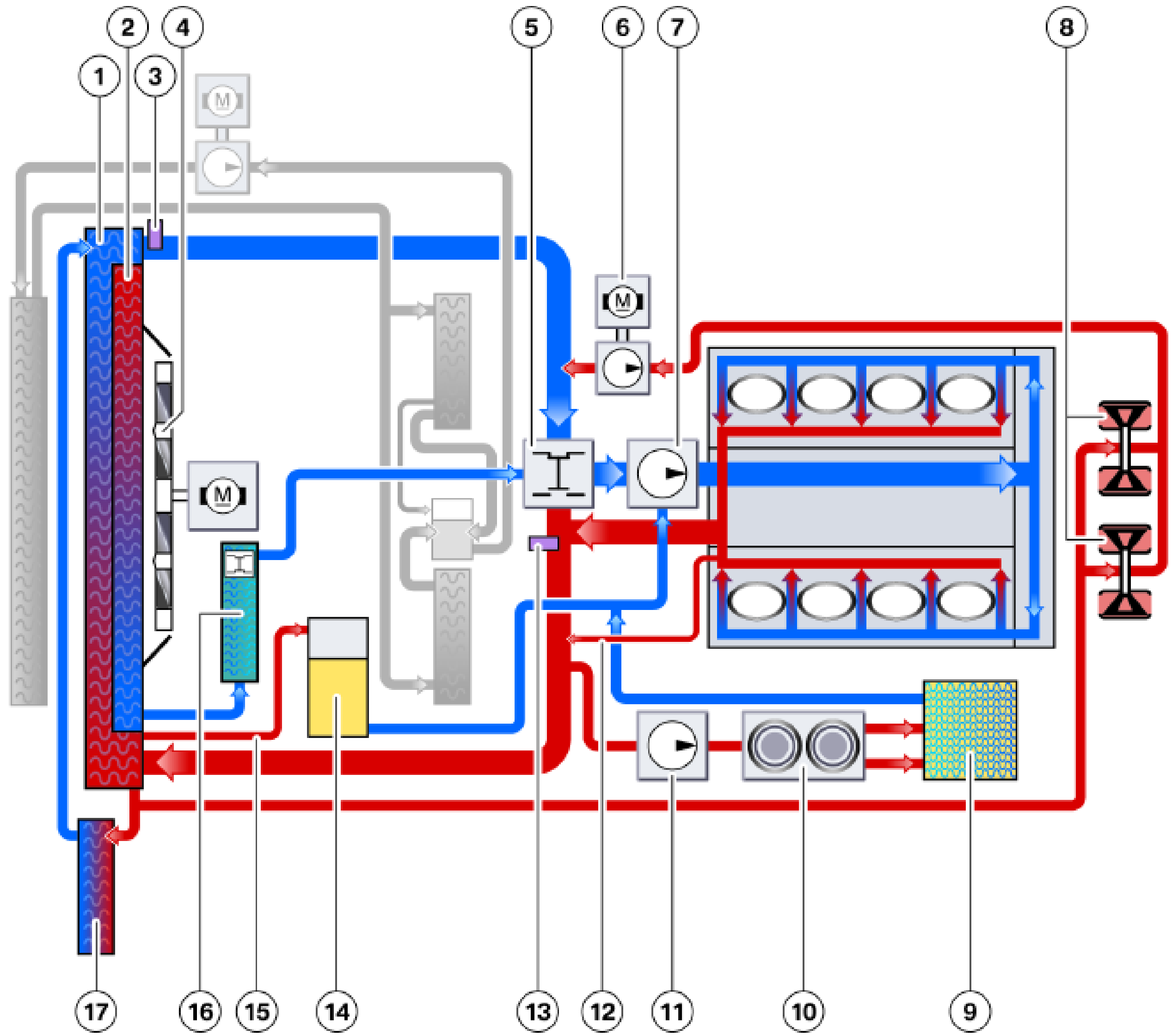


Index	Explanation	Index	Explanation
1	Radiator	12	Vent line
2	Radiator for transmission cooling	13	Coolant temperature sensor at engine outlet
3	Coolant temperature sensor at radiator outlet	14	Expansion tank
4	Electric fan	15	Vent line
5	Characteristic map thermostat	16	Transmission fluid-to-coolant heat exchanger
6	Electric auxiliary coolant pump for turbocharger cooling	17	Auxiliary coolant radiator
7	Coolant pump	A	Electric coolant pump for charge air cooling
8	Exhaust turbocharger	B	Vent line
9	Heating heat exchanger	C	Intercooler
10	Duo-valve	D	Expansion tank for charge air cooling
11	Electric auxiliary coolant pump for vehicle heating	E	Radiator for charge air cooling

Engine Cooling

The engine cooling system undertakes the classic task of carrying heat away from the engine and maintaining a defined operating temperature as constant as possible. As on the N54 engine, the two turbochargers are also cooled.

The N63 engine features a conventional coolant pump that is driven by the belt drive. This pump cannot be used to continue cooling the turbochargers after the engine has been shut down.



Index	Explanation	Index	Explanation
1	Radiator	10	Duo-valve
2	Radiator for transmission cooling	11	Electric auxiliary coolant pump for vehicle heating
3	Coolant-temperature sensor at radiator outlet	12	Vent line
4	Electric fan	13	Coolant-temperature sensor at engine outlet
5	Characteristic map thermostat	14	Expansion tank
6	Electric auxiliary coolant pump for turbocharger cooling	15	Vent line
7	Coolant pump	16	Transmission fluid-to-coolant heat exchanger
8	Exhaust turbocharger	17	Auxiliary coolant radiator
9	Heating heat exchanger		

Auxiliary coolant pump for turbocharger cooling

The electric coolant pump on the N54 engine features an after-running function to carry away the heat build-up from the turbochargers after the engine has been shut down.

For this function, the N63 engine is equipped with an additional electrically operated coolant pump with an output of 20 W. This pump is also used during engine operation to assist turbocharger cooling.

The auxiliary electric coolant pump cuts in, taking the following factors into consideration:

- Coolant temperature at engine outlet
- Engine oil temperature
- Injected fuel quantity

The heat input into the engine is calculated based on the injected fuel quantity. This function is similar to the heat management function on 6-cylinder engines.

The after-running period of the auxiliary electric coolant pump can extend up to 30 minutes. The electric fan also cuts in to improve the cooling effect.

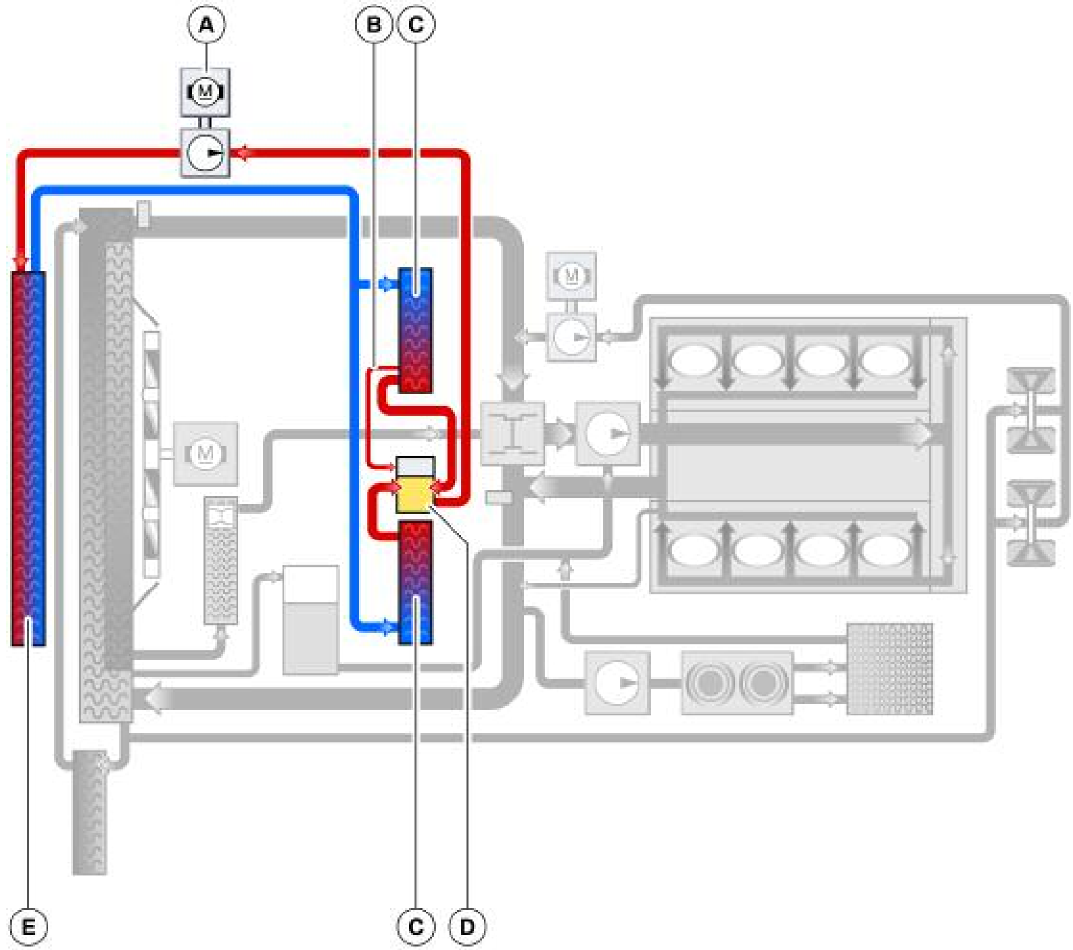
As in previous systems, the electric fan runs for a maximum of 11 minutes, however, it now operates more frequently.

System Protection

As on the N54 engine, in the event of the coolant or engine oil being subject to excessive temperatures, certain functions in the vehicle are influenced in such a way that more energy is made available to the engine cooling system, i.e. temperature increasing loads are avoided.

Charge Air Cooling

With the introduction of the N63 engine, indirect charge air cooling is used for the first time at BMW. Heat is taken from the charge air by means of an air-to-coolant heat exchanger. This heat is then given off via a coolant-to-air heat exchanger into the ambient air. For this purpose, the charge air cooling system has its own low temperature cooling circuit, which is independent of the engine cooling circuit.



Index	Explanation	Index	Explanation
A	Electric coolant pump for charge air cooling	D	Expansion tank for charge air cooling
B	Vent line	E	Radiator for charge air cooling
C	Intercooler		

Intercoolers

The intercoolers are installed on the end faces of the cylinder heads. They operate in accordance with the counterflow principle and cool the charge air by up to 80°C.

Electric Coolant Pump

The coolant circuit for charge air coolant is operated with a 50 W pump. This pump does not run automatically when the engine is turned on.

Pump actuation depends on the following values:

- Outside temperature
- Difference between charge air temperature and outside temperature

Venting

A separate venting routine is provided for the purpose of venting the low-temperature circuit of the charge air cooling system. This venting is initiated in the same way as for the cooling circuit on 6-cylinder engines.

The venting test module can be found in the “Service Functions” section of the diagnostic program.

Classroom Exercise - Review Questions

1. What type of pump is used for the high pressure fuel pump?

   A. Vane pump
   B. Piston pump
   C. Gear pump
   D. None of the above

2. When the N63 is at a low engine speed under high load, the fuel pressure is about:

   A. 150 bar
   B. 200 bar
   C. 225 bar
   D. 245 bar

3. The diverter valves for “blow off” control are:

   A. Vacuum actuated
   B. Mechanically actuated
   C. Electrically actuated
   D. None of the above

4. The boost pressure of the N63 engine, under full load, is:

   A. 0.6 bar
   B. 0.8 bar
   C. 0.9 bar
   D. 1.1 bar

5. The pre-catalyst O2 sensors are:

   A. LSF 4.2
   B. LSU ADV
   C. LSU4.9
   D. LSH25

Classroom Exercise - Review Questions

6. The new “pre-catalyst” O2 sensors are ready for operation:

A. in 60 seconds
B. in less than 2 minutes
C. in 30 seconds
D. in less than 5 seconds

7. The new engine management system for the N63 is designated”

A. MSV70
B. MSD85
C. MSD80
D. MSVN63

8. The new N63 engine uses ______________ technology for the HPI system.

A. Wall guided
B. Spray guided
C. Lean running
D. Stratified

9. In order to heat the catalytic converters, the HPI injection system will inject additional fuel:

A. 25 degrees ATDC
B. 30 degrees BTDC
C. 150 degrees BTDC
D. 5 degrees BTDC

10. When servicing the fuel system on the N63 engine,
the fuel lines must not be opened until the coolant temperature is:

A. Below 200 degrees C
B. Below 100 degrees C
C. Below 104 degrees F
D. Below 72 degrees F

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E71 Chassis Dynamics Workbook

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Chassis Dynamics

Model: E71

Production: From Start of Production

OBJECTIVES

After completion of this module you will be able to:

- Identify the new components utilized in the dynamic driving system for the E71.
- Explain the purpose, function, and location of all the dynamic driving system control units.
- Explain the operation of the QMVH read differential.
- Explain the benefits to utilizing the QMVH read differential.
- Identify service concerns for the new QMVH rear differential.

Introduction

In the E70, the BMW Group introduced a new generation of dynamic driving systems that have now been comprehensively developed and enhanced in the X6 (E71). The regulating strategy of the individual systems, consistently subdivided into longitudinal, lateral and vertical dynamics, forms the basis for the wide variety of driving dynamics functions.

In the X6, the BMW Group has developed a complementary drive and dynamic driving system that enables a distinct increase in agility, stability and traction, as well as an increase in safety, without compromising dynamics or efficiency.

The complete package in the X6 includes the dynamic driving systems:

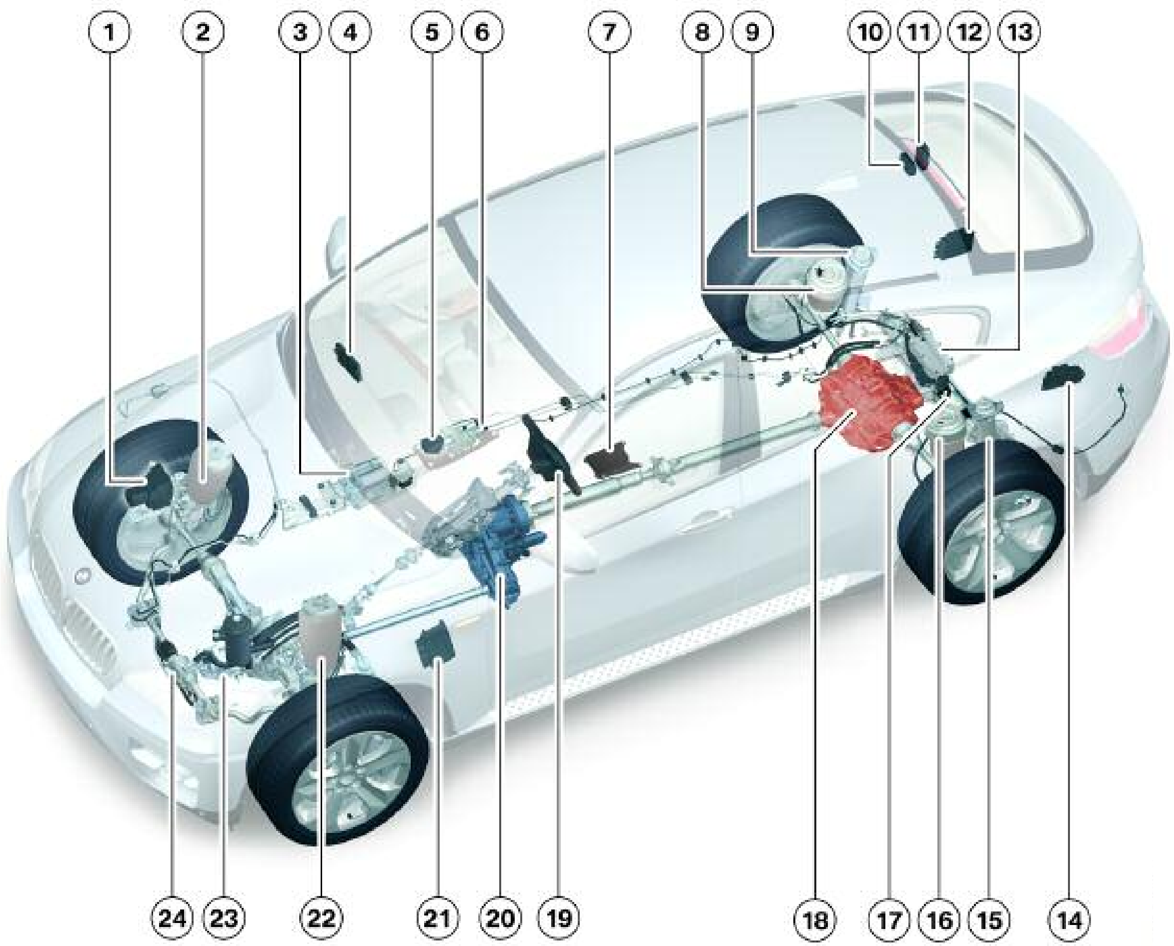
- Dynamic Drive
- Vertical Dynamic Control
- Adaptive Drive
- Electronic Height Control
- Dynamic Stability Control
- Active Steering
- xDrive
- Dynamic Performance Control

All these functions enable the highest degree of dynamic driving performance through intelligent interaction between the systems. The slogan "The Ultimate Driving Machine" is more than just an integrated policy behind the development of each BMW vehicle.

In the E71, Dynamic Performance Control forms an integral part of the standard equipment and complements xDrive and Dynamic Stability Control, serving as an additional module to increase active safety and enhance the brilliant driving dynamics. As an option, the E71 customer can also order BMW innovations in the field of dynamic driving systems, e.g. Active Steering. When combined and interlinked in the E71, these individual modules create superior driving dynamics for more intense and safer enjoyment of the Ultimate Driving Machine.

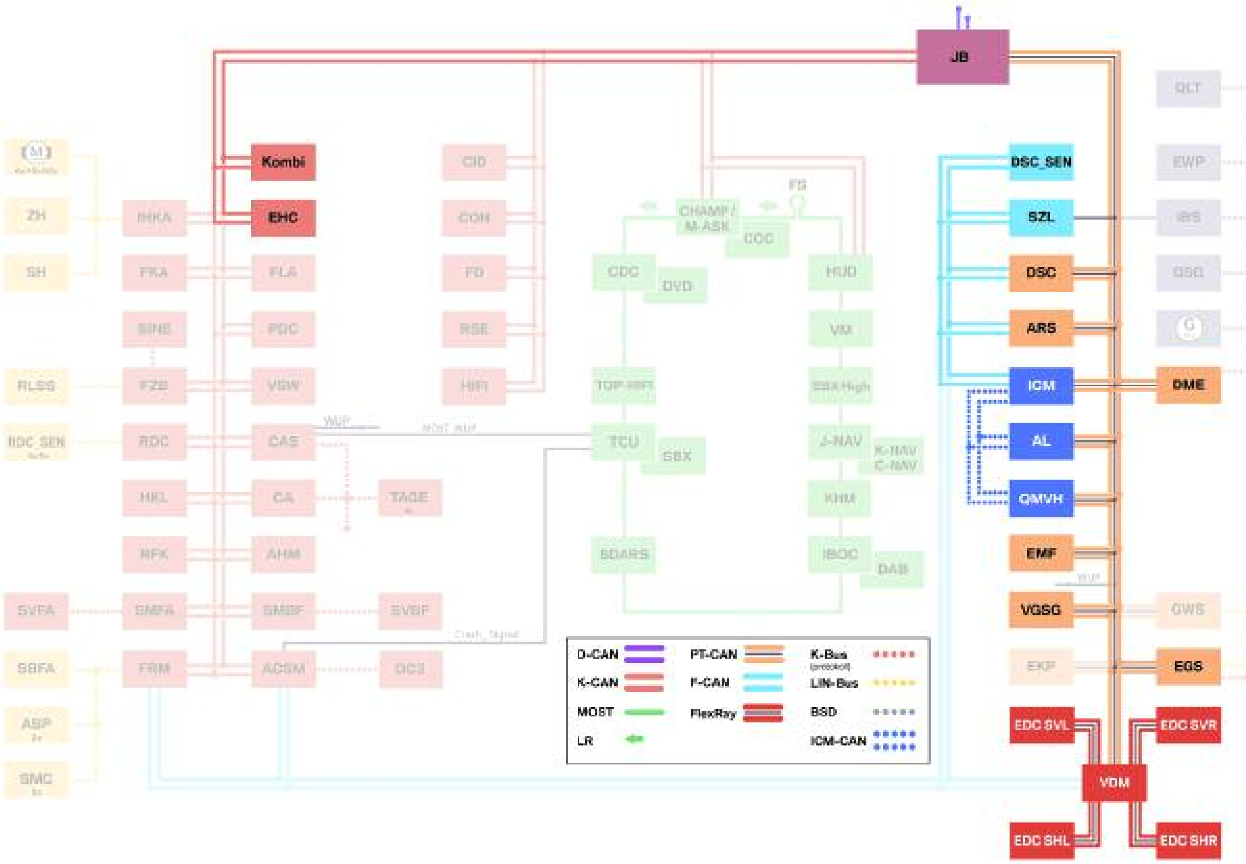
System Overview

Chassis Dynamics Components in the Vehicle



Index	Explanation
1	Dynamic stability control
2	EDC satellite, front right
3	EHC air supply unit
4	ARS control unit
5	DSC sensor
6	ARS valve block
7	ICM control unit
8	Air spring, rear right
9	EDC satellite, rear right
10	EHC control unit
11	VDM control unit
12	QMVH control unit
13	Electromechanical parking brake
14	Transfer box control unit
15	EDC satellite, rear left
16	Air spring, rear left
17	ARS hydraulic motor, rear axle
18	Rear differential with superimposing gear units [QMVH]
19	SZL with steering angle sensor
20	Transfer case
21	AL control unit
22	EDC satellite, front left
23	Power steering pump
24	ARS hydraulic motor, front axle

Bus System Overview

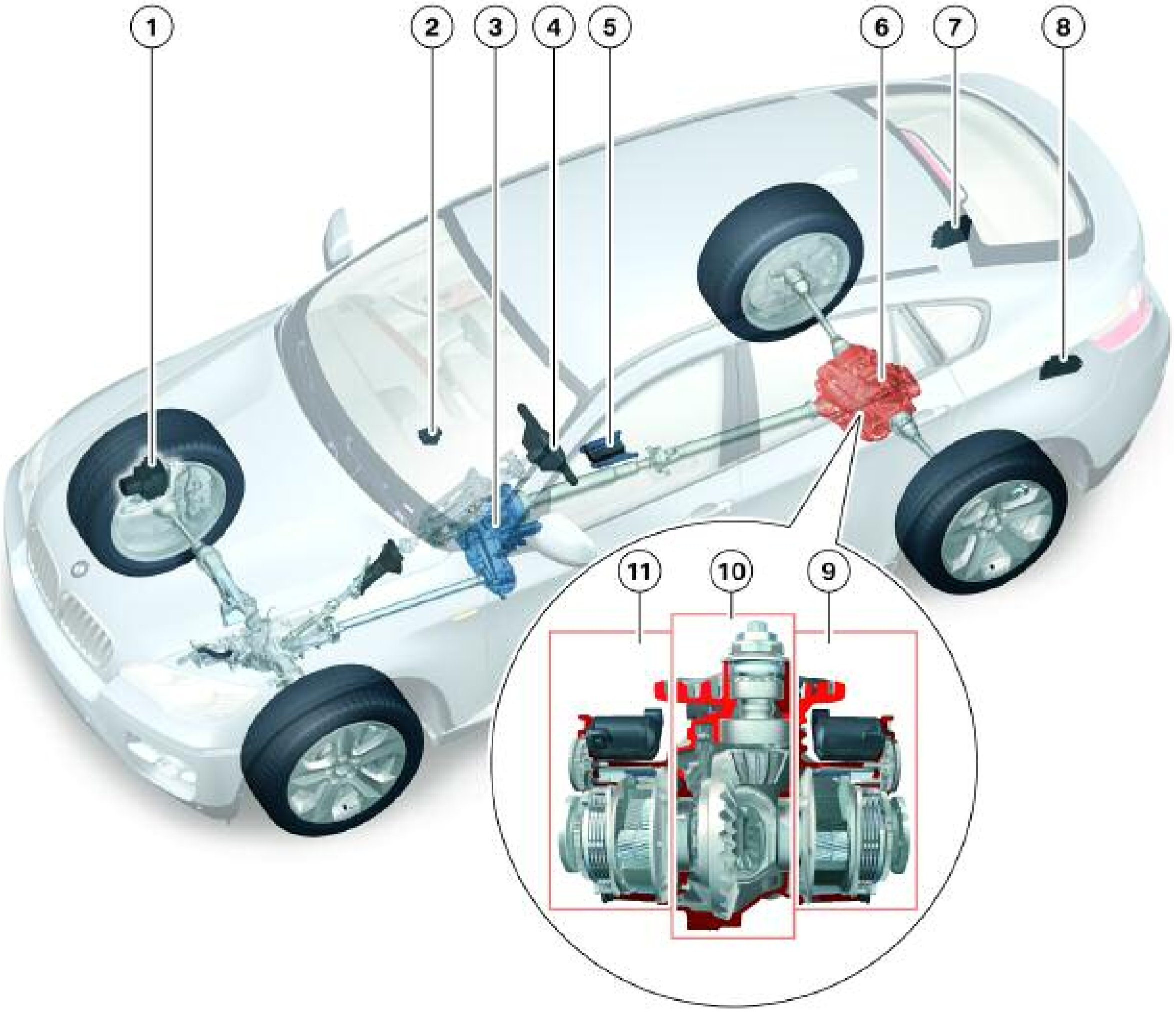


The diagram shows the control units and bus systems that are related for the dynamic driving systems.

One of the differences between the E71 and the E70 is that a new control unit known as Integrated Chassis Management (ICM) has been introduced. This ICM coordinates longitudinal and lateral dynamic control functions, which include the familiar Active Steering and the new Function Dynamic Performance Control [with QMVH]. The ICM-CAN has been introduced as a new bus system especially for the ICM system network. It connects the ICM, AL and QMVH control units.

Index	Explanation
AL	Active Steering
ARS	Active anti-roll bar
DME	Digital Engine Electronics
DSC	Dynamic stability control
DSC_SEN	DSC sensor
EDC SHL	EDC satellite, rear left
EDC SHR	EDC satellite, rear right
EDC SVL	EDC satellite, front left
EDC SVR	EDC satellite, front right
EGS	Electronic transmission control unit
EHC	Electronic Height Control
EMF	Electromechanical parking brake
ICM	Integrated Chassis Management
JB	Junction box
KOMBI	Instrument cluster
QMVH	Lateral torque distribution on the rear axle
SZL	SZL with steering angle sensor
VDM	Vertical Dynamics Management
VGSG	Transfer box control unit
ICM-CAN	Integrated Chassis Management

System Overview - Dynamic Performance Control



Index	Explanation
1	Dynamic stability control
2	DSC sensor
3	Transfer case
4	SZ steering column switch cluster
5	ICM control unit
6	Rear differential with superimposing gear units
7	QMVH control unit
8	Transfer box control unit
9	Superimposing gear unit, right
10	Angle drive with differential
11	Superimposing gear unit, left

This second diagram of the system overview focuses in particular on the new dynamic driving system, Dynamic Performance Control. With Dynamic Performance Control, a new system network will be introduced in the form of the Integrated Chassis Management. This will result in changes that affect the interaction of the dynamic driving systems.

The Active Steering is particularly affected by this, which is why the two equipment variants with/without Active Steering are both explained in the following pages.

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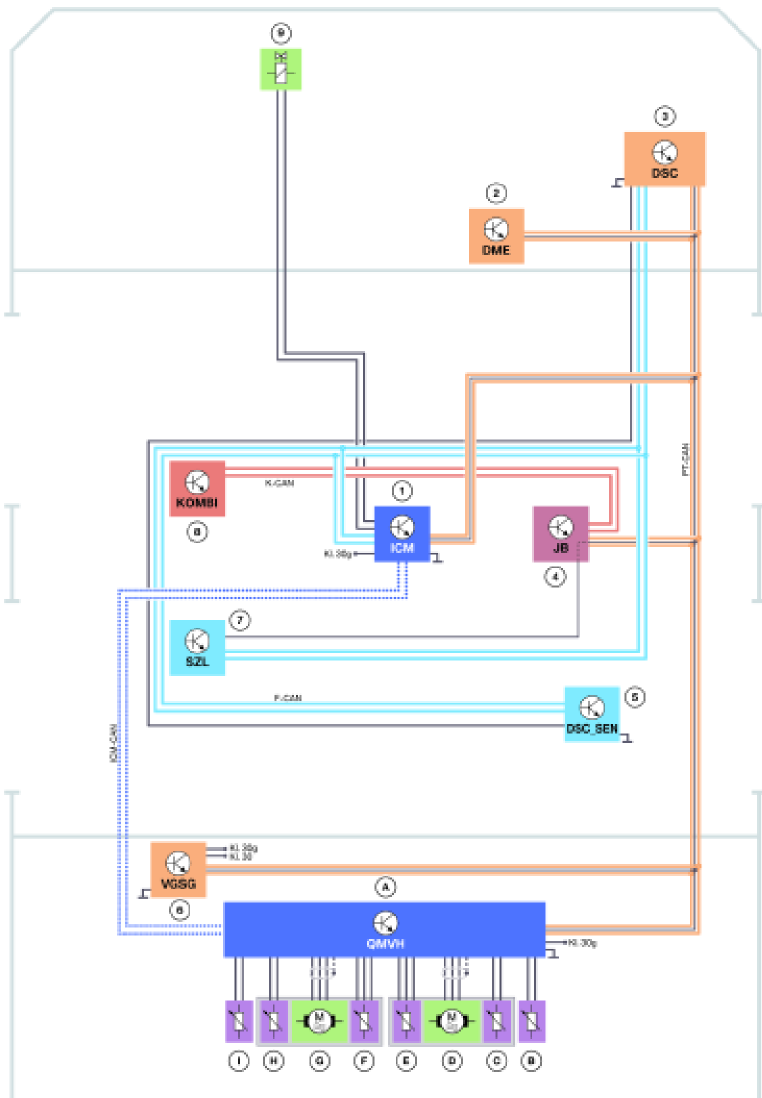
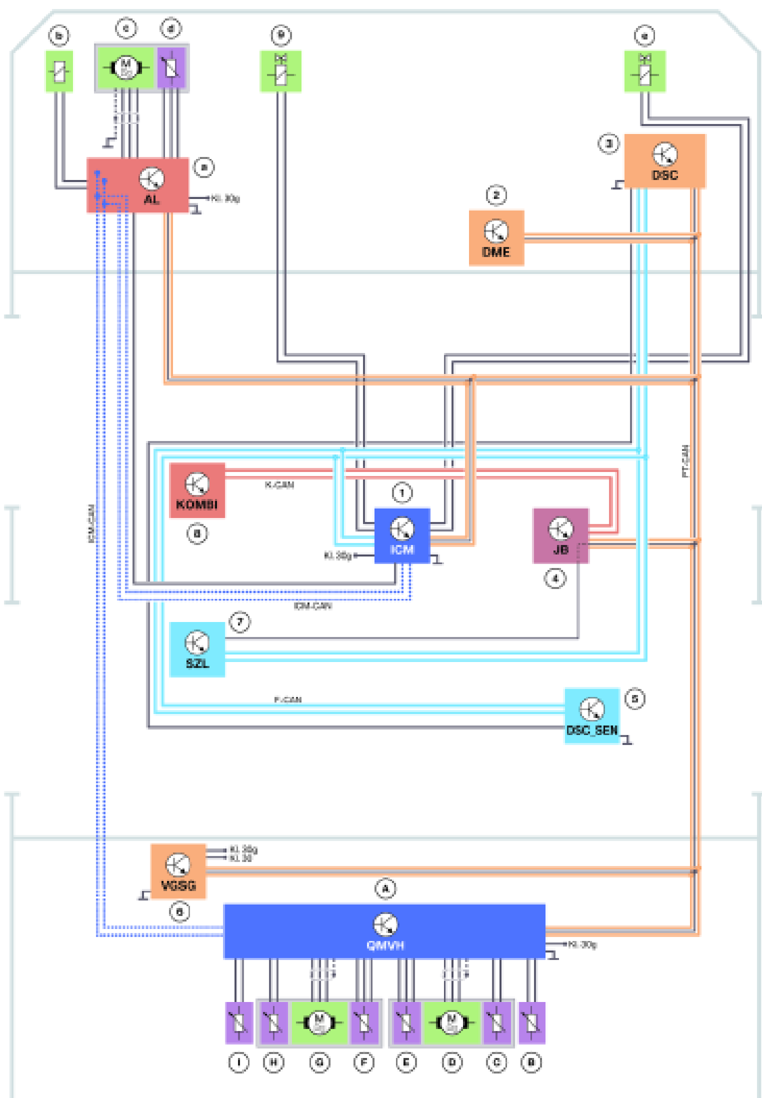
System Circuit Diagram for Dynamic Performance Control without Active Steering



Index	Explanation
1	Integrated Chassis Management
2	Digital Motor Electronics/Digital Diesel Electronics
3	Dynamic stability control
4	Junction box
5	DSC sensor
6	Transfer box control unit
7	Steering column switch cluster with steering angle sensor
8	Instrument cluster
9	EVV valve
A	Lateral torque distribution on the rear axle
B	Temperature sensor for the transmission oil in the superimposing gear unit, right
C	Temperature sensor for the electric motor in the superimposing gear unit, right
D	Electric motor in the superimposing gear unit, right
E	Motor position sensor in the superimposing gear unit, right
F	Motor position sensor in the superimposing gear unit, left
G	Electric motor in the superimposing gear unit, left
H	Temperature sensor for the electric motor in the superimposing gear unit, left
I	Temperature sensor for the transmission oil in the superimposing gear unit, left

An electronically controlled bypass valve (EVV) is fitted on all variants of the E71 in order to control the volumetric flow in the hydraulic circuit for the power steering. It is actuated by the ICM control unit.
If Active Steering is not fitted, the ICM-CAN is routed directly from the ICM control unit to the QMVH control unit.

System Circuit Diagram for Dynamic Performance Control with Active Steering



Index	Explanation
1	Integrated Chassis Management
2	Digital Motor Electronics/Digital Diesel Electronics
3	Dynamic stability control
4	Junction box
5	DSC sensor
6	Transfer box control unit
7	Steering column switch cluster with steering angle sensor
8	Instrument cluster
9	EVV valve
A	Lateral torque distribution on the rear axle
B	Temperature sensor for the transmission oil in the superimposing gear unit, right
C	Temperature sensor for the electric motor in the superimposing gear unit, right
D	Electric motor in the superimposing gear unit, right
E	Motor position sensor in the superimposing gear unit, right
F	Motor position sensor in the superimposing gear unit, left
G	Electric motor in the superimposing gear unit, left
H	Temperature sensor for the electric motor in the superimposing gear unit, left
I	Temperature sensor for the transmission oil in the superimposing gear unit, left
a	Active Steering
b	Solenoid lock
c	Active Steering electric motor
d	Active Steering motor position sensor
e	Servotronic valve

The topology of the ICM-CAN bus system differs greatly between the two variants with/without Active Steering. If Active Steering is fitted, the ICM-CAM is routed from the ICM control unit to the AL control unit. The ICM-CAN is picked up in the AL control unit and forwarded to the QMVH control unit.

System Components

Rear Differential with Superimposing Gear Units

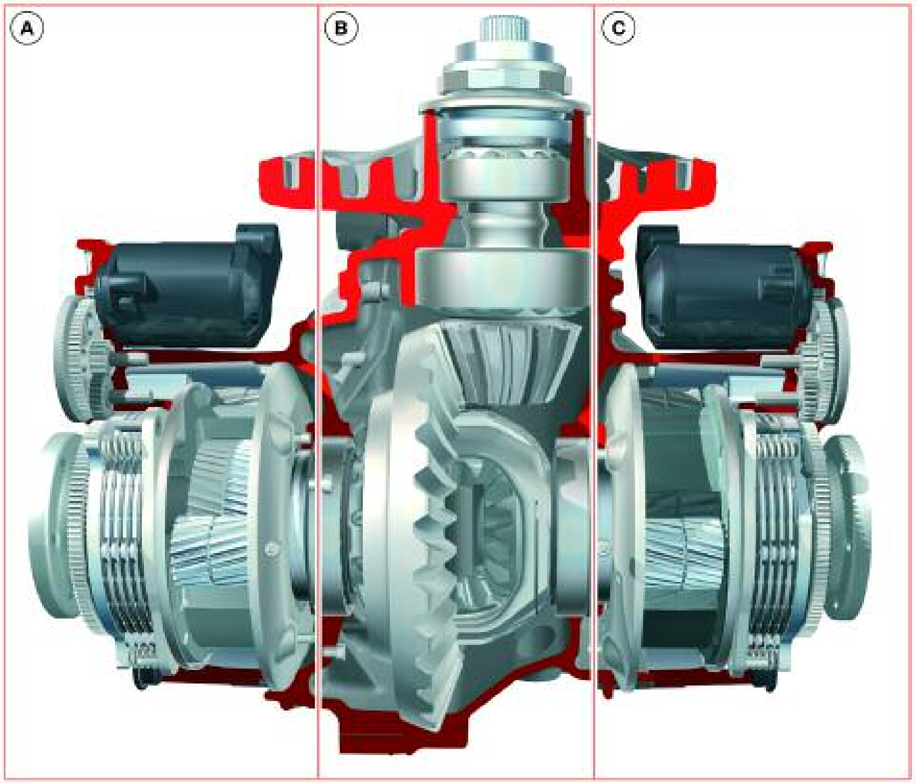
For Dynamic Performance Control, a rear differential is used that essentially consists of a conventional rear differential, supplemented by superimposing gear units on the left and right.

The only difference is the welded connection of the ring gear and pinion gear (previously bolted).

The two superimposing gear units are practically identical in terms of their structure, but differ slightly in terms of their detail. For example, the electric motors and planetary trains on the left or the right are different.

This rear differential also has three oil reservoirs, subdivided in a similar way to in the picture, which are vented by a common duct.

Design of the rear differential with superimposing gear units



Index	Explanation
A	Superimposing gear unit, left
B	Angle drive with differential
C	Superimposing gear unit, right

There are therefore three filler plugs and three drain plugs on this rear differential.

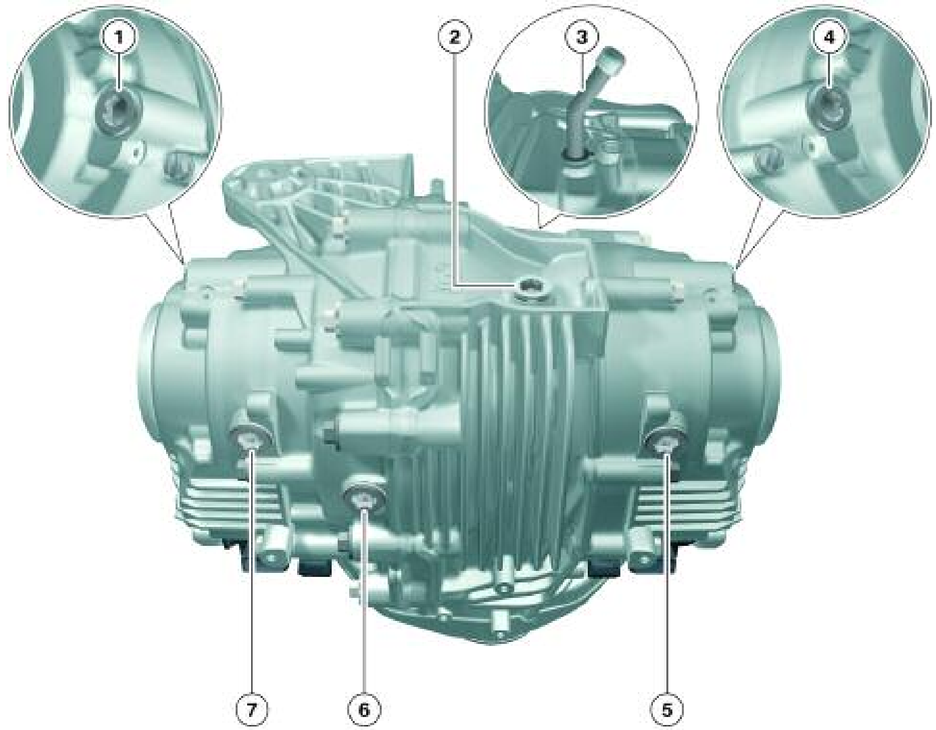
In the center part (angle drive with differential gear), the standard oil (hypoid oil) is used and, in the left and right superimposing gear units, a special ATF is used.

Longlife oils are provided as standard in the rear differential with superimposing gear units. There are some exceptions dependent on the service life/use of the unit.

All three reservoirs have a common vent on the top of the transmission case.

Note: The angle when the rear differential unit is removed and reinstalled must be no more than 45°. This could potentially cause the two types of oil to cross contaminate through the common vent.

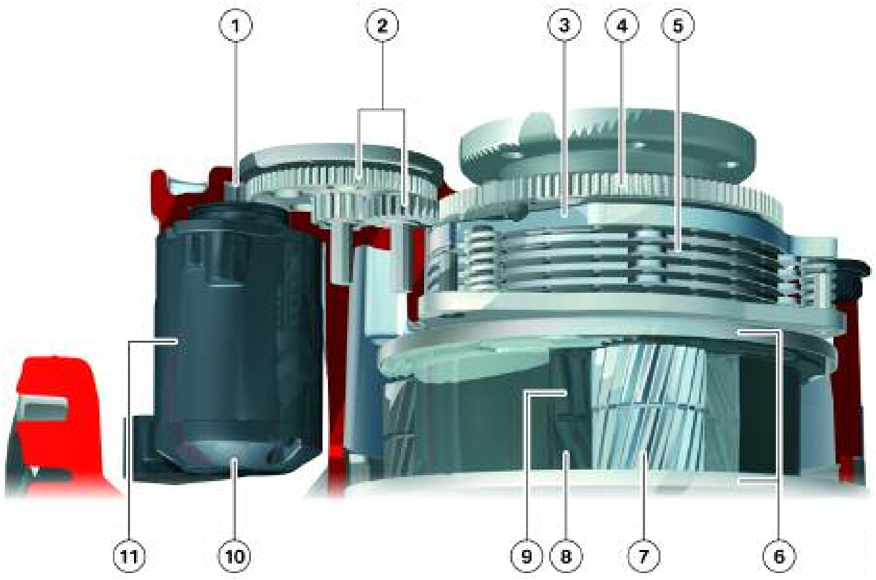
Oil reservoirs of the rear differential with superimposing gear units



Index	Explanation
1	Filler plug for the left superimposing gear unit
2	Filler plug for the angle drive with differential gear
3	Vent
4	Filler plug for the right superimposing gear unit
5	Drain plug for the right superimposing gear unit
6	Drain plug for the angle drive with differential gear
7	Drain plug for the left superimposing gear unit

Construction of the Superimposing Gear Units

The two superimposing gear units essentially consist of an actuator (electric motor), transmission gearing, a ball ramp, a multi-plate clutch and a planetary gear set. In contrast to standard planetary gear sets, this one does not contain a ring gear.



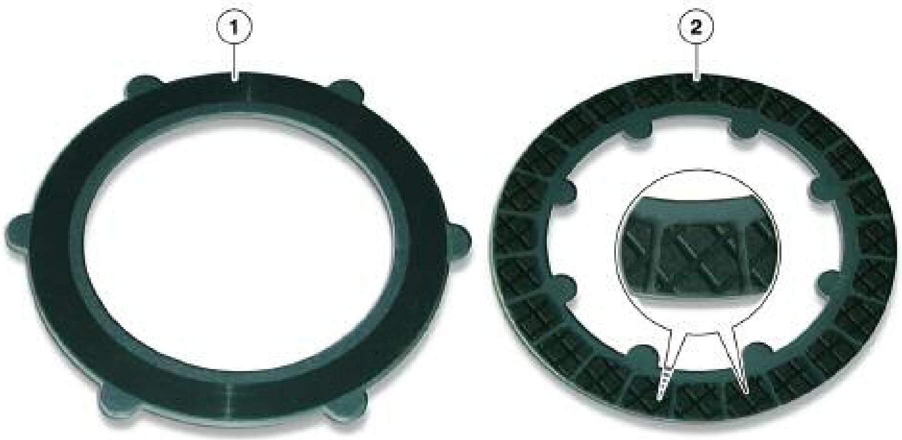
Index	Explanation
1	Electric motor drive pinion
2	Transmission gears
3	Ball-ramp pressure plate
4	Ball-ramp drive gear
5	Multi-plate clutch assembly
6	Planet carrier
7	Planetary gear
8	Inner sun gear
9	Outer sun gear
10	Motor position sensor
11	Right electric motor

Multi-plate Clutch and Ball Ramp

The multi-plate clutch and the ball ramp are designed in such a way that they are always de-energized if there is fault in the electric motor. In this event, the pressure spring assemblies now take on an important role between the ball ramp and the support plates.

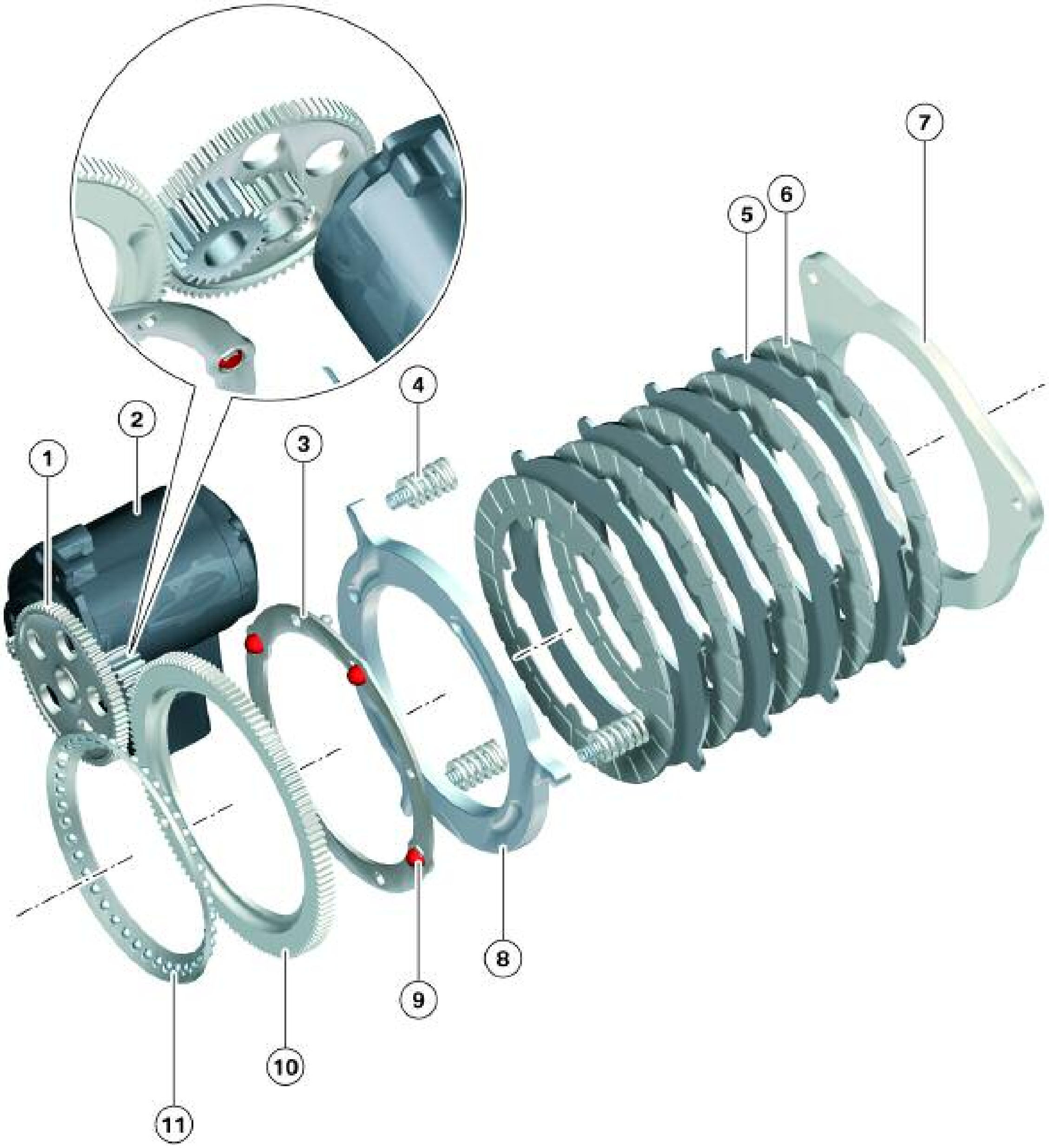
The pressure spring assemblies open the multi-plate clutch via the ball ramp and the freely rotating electric motor and hold it fully open. This ensures, among other things, that the loss of torque distribution is established in the event of a fault.

Construction of the multi-plate clutch



Index	Explanation
1	Plate carrier
2	Friction plate

Exploded view of the multi-plate clutch



Index	Explanation
1	Transmission gears
2	Left electric motor
3	Ball guide ring
4	Pressure spring assemblies
5	Plate carrier
6	Friction plate
7	Support plate
8	Ball-ramp pressure plate
9	Balls (4x)
10	Ball-ramp drive gear
11	Ball bearing for left output shaft

Electric Motors

These are three-phase asynchronous motors.

The three-phase voltage is generated by the QMVH control unit. This creates a rotating electromagnetic field around the metallic rotor which generates torque in the rotor.

An asynchronous-motor design was selected because it guarantees a high level of power with a simple construction.

Furthermore, the shaft of an asynchronous motor can be moved freely when the phase voltage is switched off. This is an integral part of the safety concept, because the phase voltage is switched off in the event of a fault.

The left and right electric motors have different constructions. The phase voltage and temperature sensor connectors (2) are also coded differently. This will prevent the two motors from being mixed up or incorrectly connected.

The two electric motors are connected to the superimposing gear units via the screw connections for the motor mounting (4). The electric motors thus have contact with the oil supply for the superimposing gear units.

Because the bearing (6) is not sealed, not only the pinion but also the entire rotor for the electric motor rotate in the oil. For this reason, the following housing seals are fitted to the electric motors:

- Sealing ring (5)
- Sealing ring at the join with the motor position sensor (not shown)
- Seal at the connector for the phase voltage and temperature sensor (2), see the Sensor system section.

Left electric motor

Index	Explanation
1	Motor position sensor connector
2	Connector for phase voltage and temperature sensor
3	Screw connection for bearing cap
4	Screw connection for motor mounting
5	Seal
6	Bearing
7	Electric motor pinion

Note: Please refer to Service Information section for important procedures to follow when replacing motors.

Sensor System

The following sensors, integrated in the Dynamic Performance Control components, are therefore an integral part of the system.

- Temperature sensors for the electric motors.
- Temperature sensors for the superimposing gear unit transmission oil.
- Motor position sensors.

There is one of the sensors mentioned above for each superimposing gear unit and each electric motor.

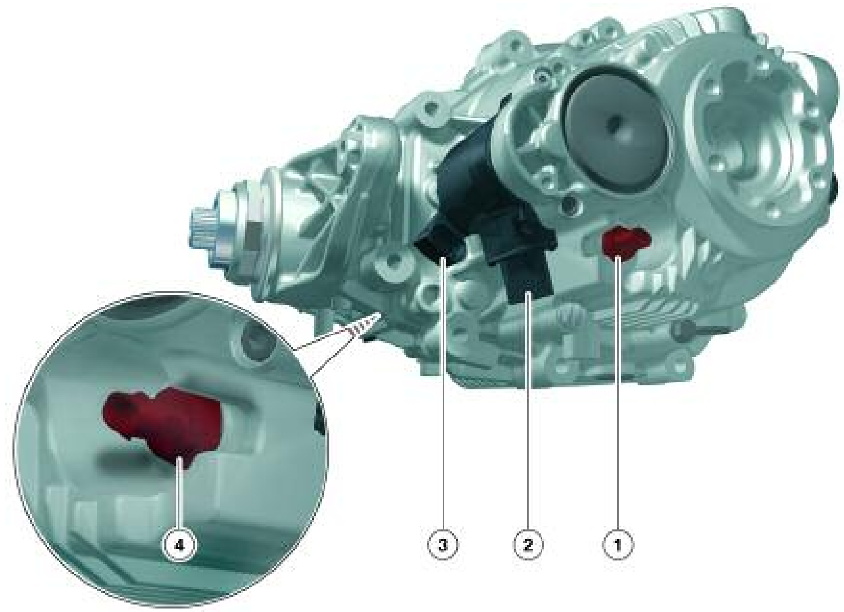
Motor Position Sensor

The motor position sensor is located on the rear of the electric motor (the side opposite the pinion). The sensor is identical to the one used for the Active Steering actuating motor. The sensor thus works according to the magnetoresistive principle and transmits the data digitally to the QMVH control unit via a two-wire line.

Oil Temperature Sensors

The two sensors for determining the temperature of the transmission oil in the two superimposing gear units are arranged symmetrically on the two sides.

Connector and sensors for the transmission oil temperature



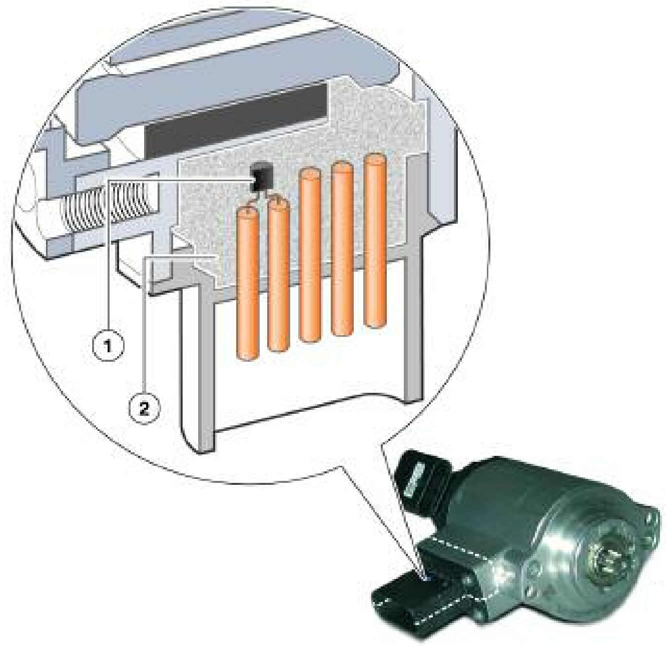
Index	Explanation
1	Connector for the left transmission oil temperature sensor
2	Connector for phase voltage and temperature sensor for the left electric motor
3	Connector for the left motor position sensor
4	Connector for the right transmission oil temperature sensor

Electric Motor Temperature Sensor

The temperature sensor for the electric motor is located in the immediate vicinity of the connector through which the electric motor is supplied with the phase voltage.

The temperature sensor for the electric motor (1) is a temperature-dependent resistor. The QMVH control unit measures the resistance and thus determines the temperature that is present in the electric motor. In the diagram, you can see the sealant (2) that was mentioned earlier which seals the housing to the connector. This prevents oil from escaping at this location. At the same time, the sealant performs the task of a heat conductor, so that the temperature sensor is exposed to practically the same temperature as the rest of the components of the electric motor.

Temperature sensor for the electric motor



Index	Explanation
1	Temperature sensor for the electric motor
2	Sealant

Mechanical Interfaces

The rear differential with superimposing gear units for Dynamic Performance Control is bolted onto the rear axle carrier in the same way as the conventional rear differential.

The propeller shaft is fixed to the rear differential with a double nut as on the E70.

The output shafts are fitted in different ways on the E71 and E70.

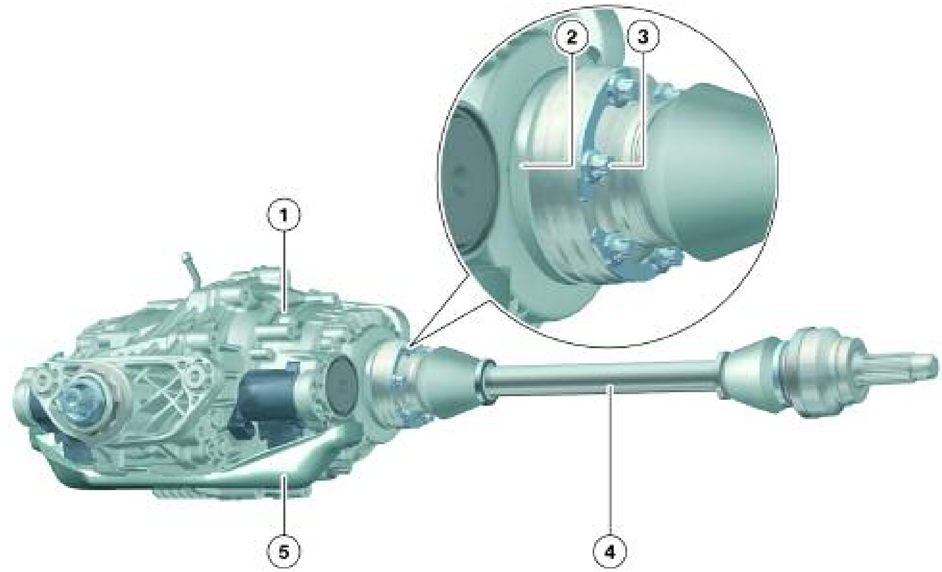
On the E70, the output shafts are inserted in the rear differential.

On the E71, the actual output shafts are bolted to the output shaft flange.

The heat conduction and protective plate (5) shown in the diagram has the following tasks:

- Protects the connectors on the electric motors from stone impact.
- Diverts heat from the exhaust system so that it does not heat up the rear differential too much.

Fitting of the left output shaft in the E71



Index	Explanation
1	Rear differential with superimposing gear units
2	Output shaft flange
3	Bolting of output shaft to output shaft flange
4	Output shaft
5	Heat conduction and protective plate

Workshop Exercise - QMVH Rear Differential

Using an instructor designated mockup or vehicle, answer the questions below.

Locate the filler and drain plugs on the QMVH unit. Make a triangle around the filler plugs and circle the drain plugs.

Side View

Bottom View

Rear View

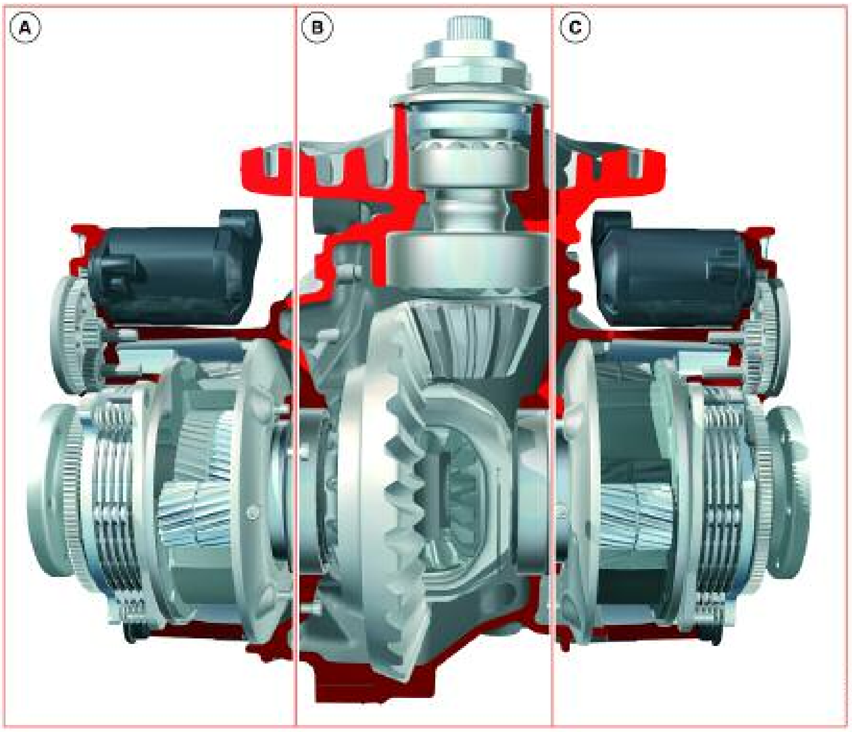
How many drain/filler plugs are there? Why?

Description	Quantity on Unit
Δ Fill Plug	
O Drain Plug	

Does the oil in the left/right (superimposing gear section) of the unit have to be replaced? If so, when?

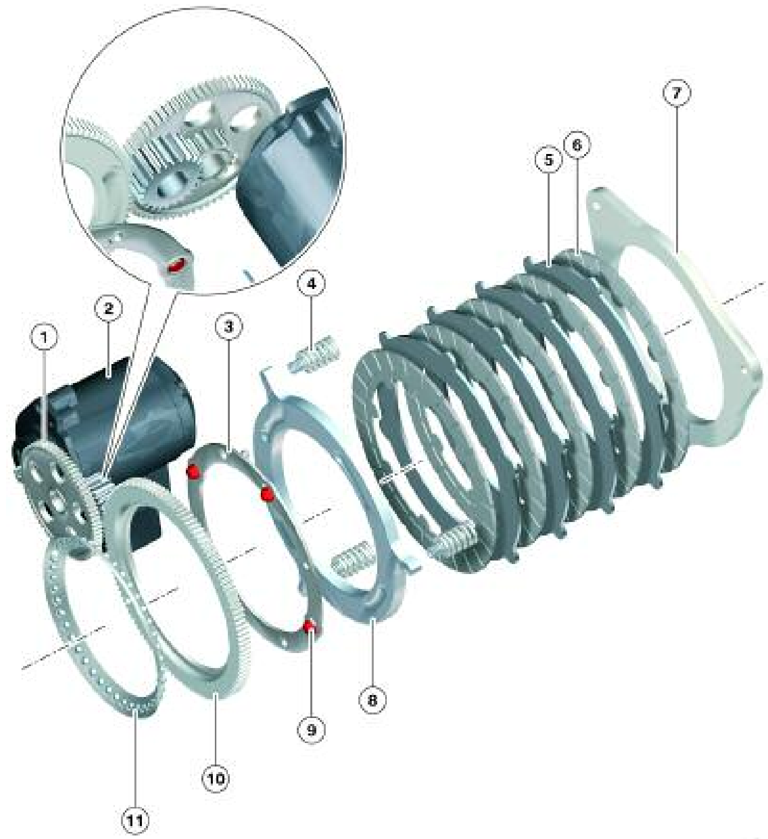
Section of Rear Differential	Type of Fluid	BMW Part Number
QMVH Superimposing Gears		
Conventional Differential		

Workshop Exercise - QMVH Rear Differential (continued)



Why is it important to remember that the QMVH unit is actually three components in one when servicing the oil?

When replacing the QMVH unit, what precautions must be taken with reference to the vent lines on the unit?



What is the function of item number 4 in the diagram above?

Examine the electronic motors on the QMVH rear differential. Are they interchangeable?

❑ Yes ❑ No

Bus Systems

The dynamic driving systems communicate via the usual bus systems, such as the Powertrain CAN (PT-CAN) and the Chassis CAN (F-CAN).

The F-CAN still performs the function of transmitting pure sensor signals. The signals from the DSC sensor and the steering wheel sensor in the steering column switch cluster have top priority. Despite the fact that the PT-CAN and F-CAN work at a high bit rate of 500 kbps, they would have been overloaded by the signals from the new ICM and QMVH control units. For this reason, a new sub-bus, the ICM-CAN, has been introduced.

The ICM-CAN is a sub-bus for the dynamic driving systems and connects the ICM, AL and QMVH control units. It is a two-wire bus on which data is transmitted at 500 kbps. The two terminating resistors, each with 120 Ω, are located in the ICM and QMVH control units.

The ICM-CAN cabling in the vehicle varies considerably between the two variants with/without Active Steering.

If Active Steering is fitted, the ICM-CAN is routed from the ICM control unit to the AL control unit. The ICM-CAN is picked up in the AL control unit and forwarded to the QMVH control unit.

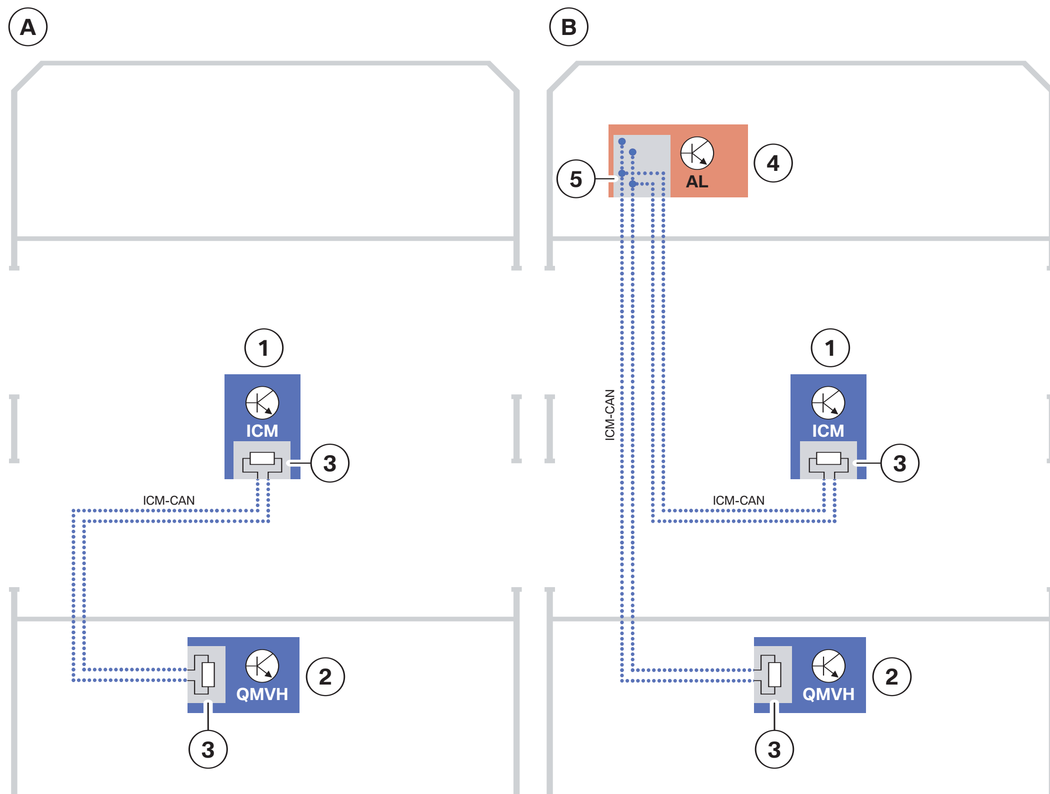
If Active Steering is not fitted, the ICM-CAN line is routed directly from the ICM control unit to the QMVH control unit.

These control units use the ICM-CAN to exchange setpoint values and actual values, as well as status signals. These signals are only required locally for implementing the Dynamic Performance Control and Active Steering functions.

In contrast, signals that the dynamic driving systems exchange with other control units are still transmitted via the PT-CAN. The PT-CAN is also the bus system via which the ICM, AL and QMVH control units communicate with the diagnostic system.

The ICM control unit does not therefore perform the function of a diagnostics gateway.

Layout variants for the ICM-CAN in the E71



Index	Explanation
A	Without Active Steering
B	With Active Steering
1	Integrated Chassis Management
2	Lateral torque distribution on the rear axle
3	ICM-CAN terminating resistor
4	Active Steering
5	ICM-CAN (picked up and forwarded)

QMVH Control Unit

Design

The QMVH control unit is fitted at the rear right of the luggage compartment.

As you can see from the following diagram, it is a dual-processor control unit. Power semiconductors are also integrated in the control unit which function as output stages.

Each processor is responsible for controlling one of the electric motors. In addition, each processor monitors the computed results of the other in order to meet the high safety requirements. The output stages can be separated before a fault has any critical effects.

The output stages are used to generate the phase voltages and transport the energy required to control the electric motors.

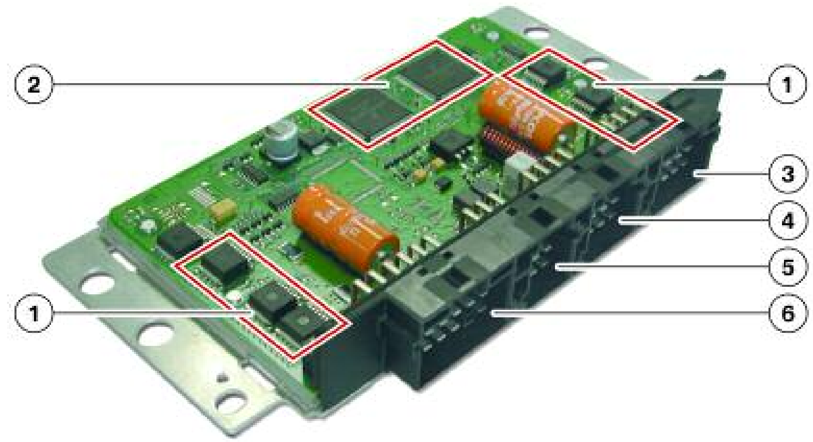
Because the electric motors are three-phase asynchronous motors, the three phases must be operated with alternating voltage. The phases are generated by high-frequency pulsing of the DC voltage present in the vehicle electrical system.

The high-frequency pulsing creates the risk that electromagnetic interference will be emitted. This would have a detrimental effect on radio reception, because the associated aerials are located near to the installation location of the QMVH control unit.

For this reason, the lines along which the electric motor phases are actuated are shielded. The ground connection is located on the connector for the QMVH control unit.

There is also an ground connection from the wiring harness to the rear axle carrier.

QMVH control unit without housing cover



Index	Explanation
1	Output stages from power semiconductors
2	Two processors
3	Pin socket [right superimposing gear unit]
4	Pin socket [vehicle electrical system]
5	Pin socket [unassigned]
6	Pin socket [left superimposing gear unit]

The two outer pin sockets (3) and (6) are used to connect the wiring harnesses that lead to the superimposing gear units.

Pin socket (4) connects the control unit to the vehicle electrical system: the supply voltage, PT-CAN and ICM-CAN are connected here.

Pin socket (5) is not assigned and remains unused.

Operation

The QMVH control unit receives a request from the ICM control unit to transfer a certain amount of torque to the left or right rear drive wheel. The control unit must convert this setpoint value into phase voltages for the electric motor to be actuated. The following calculation steps are required for this:

- Deciding which superimposing gear unit needs to be activated. The side that should receive more of the available torque must be activated.
- Converting the torque to be transferred into a braking force at the superimposing gear unit.
- Determining the necessary adjustment path of the plates from the braking force that the plate assembly must generate.
- Calculating the motor rotation angle to achieve the required adjustment path of the plates.
- Determining the amplitude and progression of the three phase voltages.

During the adjustment process, the QMVH control unit uses the motor position sensor to measure whether and how far the electric motor has already moved. Once the calculated specified angle is reached, the actuation is changed so that the rotational angle achieved is maintained. A motor position regulation therefore takes place. The regulation principle is similar to that for Active Steering.

The QMVH control unit also carries out monitoring functions. This allows faults in the electronics and in the actuating elements to be detected which cause the function to be deactivated. In the event of a fault, the lines to the electric motors are disconnected. They are then de-energized and can no longer execute undesirable adjustment processes.

The multi-plate clutches also open, so that a previously active torque transfer is withdrawn.

The rear differential (and therefore the entire system) thus behaves like a conventional differential in the event of a fault.

As well as detecting faults, the QMVH control unit also monitors the signals from the temperature sensors on the rear differential. A protective function is thus implemented, which reduces the actuating element controls if the temperature is too high. This is intended to counteract any further heating (see also the Functions section). Both the temperatures in the electric motors and the temperatures of the transmission oils in the two superimposing gear units are taken into consideration.

ICM Control Unit

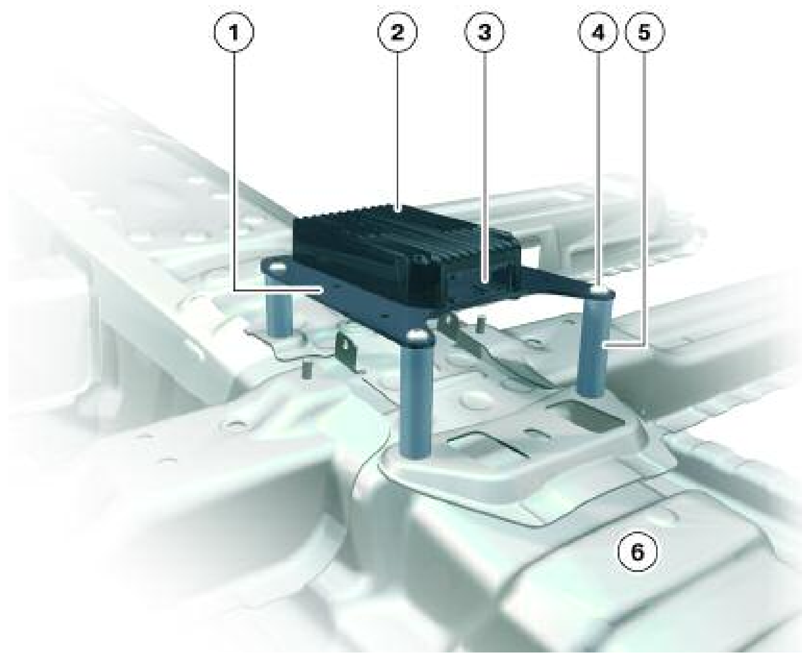
The ICM control unit is installed on the transmission tunnel (6). The lower section of the housing is bolted to the body work using spacer sleeves (5). The upper section of the housing has a ribbed structure for better heat dissipation. The ICM control unit has only one pin socket, which is used to make contact with the supply voltage, the bus systems and the control lines.

The ICM control unit only contains output stages for the steering proportional valve (EVV - electronically controlled bypass valve) and the Servotronic valve.

The ICM control unit is connected to three bus systems: the PT-CAN, the F-CAN and the new ICM-CAN.

The ICM control unit makes calculations that have a decisive influence on the vehicle behavior. This results in both high safety requirements and a need for a large calculating capacity. For these two reasons, the ICM control unit is equipped with two processors.

Installation location of the ICM control unit



Index	Explanation
1	Lower section of housing
2	Upper section of housing
3	Connector
4	Mounting bolt
5	Spacer sleeve
6	Transmission tunnel

Active Steering

Virtually all of the components of Active Steering in the E71 are identical to those in the E70. To be precise,

- the electric motor with motor position sensor,
- the proportional valve (electronically controlled bypass valve, EVV) and
- the Servotronic valve are identical in the two vehicle models. The AL control unit has a different construction in the E71 and is only designed as an actuating control unit.

Active Steering Control Unit

The AL control unit is located at the front left in the A-pillar extension under the wheel arch trim.

It is a dual-processor control unit. Power semiconductors are also integrated in the control unit which function as output stages. The dual-processor concept was selected in order to meet the high safety requirements.

The output stages (2), consisting of power semiconductors, are used to generate the phase voltages and transport the energy required to control the actuating motor.

Because this is a three-phase synchronous motor, the three phases must be operated with alternating voltage.

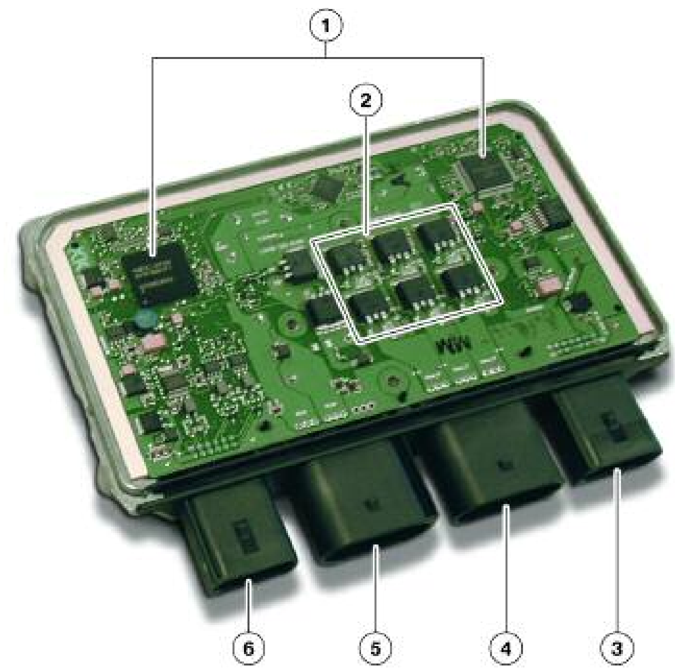
The phases are generated by high-frequency pulsing of the DC voltage present in the vehicle electrical system. For this reason, shielding is also used here. The shielding connects the electric motor to ground via the wiring harness to the body work.

Connector (3) accommodates signal lines between the control unit and actuating element for Active Steering. These are the control lines to the solenoid lock and the signal lines for the motor position sensor.

Load is supplied to Active Steering via the connector (4). This DC voltage is converted into the phase voltages by the output stages in the control unit and sent to the electric motor at connector (5).

Connector (6) contains the contacts via which the control unit is supplied with power and those for connecting the two bus systems, PT-CAN and ICM-CAN.

Active Steering control unit without housing cover



Index	Explanation	Index	Explanation
1	Processors	4	Connector [voltage supply]
2	Output stages	5	Connector [phase voltages]
3	Connector [signal lines]	6	Connector [vehicle interface]

Note: The control units of the E70 and E71 cannot be interchanged.

ARS

At SOP for the E71 in April 2008, certain alterations will also be made simultaneously in the E70.

Key modifications to the ARS:

- Discontinuation of the additional ARS lateral acceleration sensor
- Discontinuation of the two pressure-relief valves on the front axle oscillating motor
- Discontinuation of the two exterior pulsation dampers on the front axle oscillating motor.

Control Unit

The ARS control unit is located in the vehicle interior near the right-hand A-pillar.

The ARS control unit is supplied with power via terminal 30 and is protected by a 10 A fuse. The ARS control unit is activated exclusively by the Car Access System (CAS) on a CAN wake-up line after "ignition ON".

A vehicle authentication process takes place when the system is started. This compares the vehicle identification number from CAS with the vehicle identification number which is encoded in the ARS control unit.

Then the ARS control unit's hardware and software are checked.

All outputs (valve solenoids and sensors) are subjected to a comprehensive check for short circuits and circuit breaks. If there is a fault, the system switches the actuators to a safe driving mode.

The ARS control unit switches off if there is undervoltage or overvoltage.

The ARS control unit learns the offset for the steering angle and the lateral acceleration during start-up and during driving.

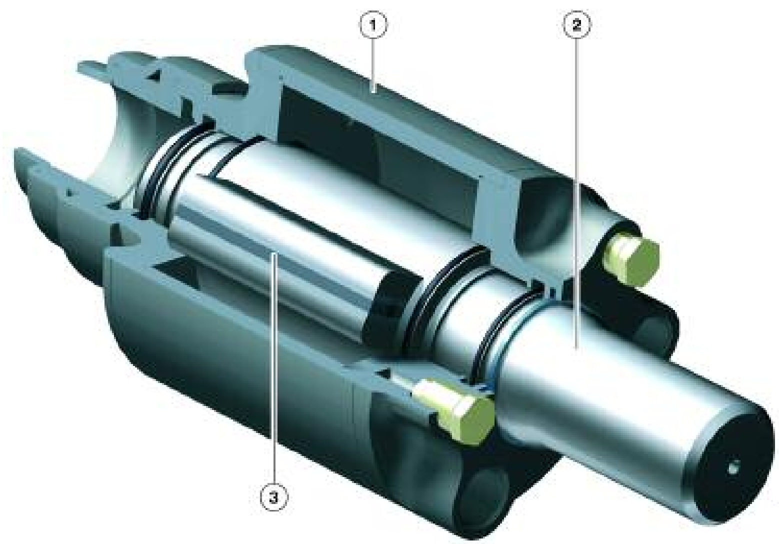
Active Anti-roll Bar

The oscillating motor and the oscillating motor housing are joined by one half of the anti-roll bar.

The active anti-roll bar consists of the oscillating motor and the anti-roll bar halves fitted to the oscillating motor, with press-fitted roller bearings for their connection to the axle carriers. The use of roller bearings ensures optimum comfort thanks to better response and reduced control forces.

A thin coating of grease on the roller bearing does not impair the function of the active anti-roll bar.

Similarly, a totally new inner pulsation damping system is introduced, which is integrated into the construction of the oscillating motor shaft. This eliminates the need for the two pressure relief valves on the front motor.



Index	Explanation
1	Oscillating motor housing
2	Inner pulsation damping system
3	Oscillating motor shaft

EMF

Similarly to the E70 , the E71 is fitted as standard with an electro-mechanical parking brake (EMF). On E71 and E70 vehicles produced from 10/07, this dynamic emergency brake and parking brake is complemented by the automatic hold function which functions the same as on the E65/E66.

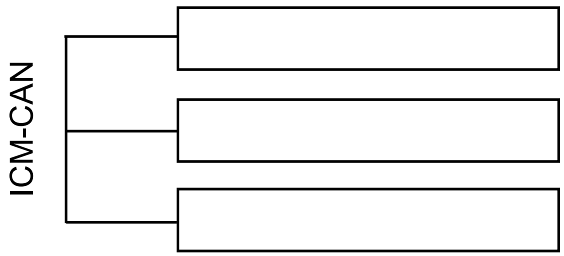
The Automatic Hold button is located in the center console.

Index	Explanation	Index	Explanation
1	EMF button	2	Automatic hold function button

Workshop Exercise - ICM-CAN

Using an instructor assigned E71 vehicle, pin out the ICM-CAN and answer the following questions.

1) *Using the workbook or system wiring diagram, fill in the missing modules of the ICM-CAN.*



2) Disconnect all the connections to the QMVH control unit and measure the resistance between ICM-CAN High and ICM-CAN Low. *Circle the best possible answer.*

60Ω 100Ω 120Ω 240Ω

3) In which control modules are the terminal resistors located for the ICM-CAN? *Circle the best possible answer.*

QMVH

ICM

AL/AFS

DSC

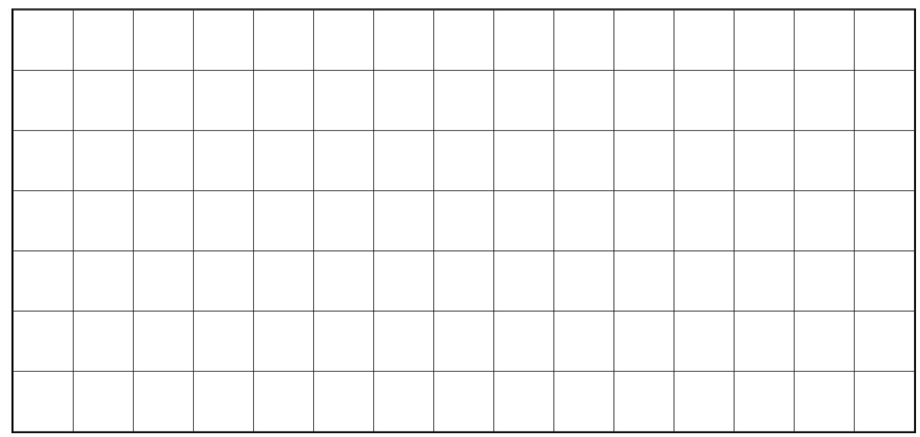
4) Where are the following control units located?

QMVH ______________________

ICM ______________________

AL/AFS ______________________

5) Locate the QMVH Control Module and pin out the ICM-CAN. *Draw the oscilloscope pattern displayed in the in the space provided below.*



Integrated Chassis Management (ICM)

A new feature in the E71 is the continuation of the concept of a higher-level dynamic driving control with Integrated Chassis Management.

The introduction of the ICM control unit is rather secondary. Of more significance, is the fact that all the dynamic driving systems in the vehicle can be coordinated in a more harmonized way using the ICM.

The previous approach of using one control unit for each main direction of movement has not been applied in the E71. Instead, the ICM control unit coordinates both longitudinal and lateral dynamic processes. In concrete terms, this means that Active Steering and the new Dynamic Performance Control function are controlled by the ICM.

However, this does not mean that the ICM has exclusive decision-making powers over the type and degree of the intervention of all the dynamic driving systems. One reason for this is that the DSC and xDrive systems used in the E70 are to be largely adopted in the E71. The E71 therefore shares the following similarities with the E70:

- If the vehicle needs to be restabilized when it is in its limit range, the DSC calculates the need for the brakes to be applied and applies them. This is also the case in the E71 despite the coordination function of the ICM.
- The DSC calculates the longitudinal distribution of the drive torque for xDrive and transmits the setpoint value to the transfer case control unit. There, the drive torque is distributed between the front and rear axles through activation of the multi-plate clutch.

The DSC therefore remains the determining control unit in the E71 when it comes to stabilizing the vehicle's behavior in the limit range. In this case, the DSC sends commands to the ICM to cease control by Dynamic Performance Control. However, while the vehicle is stable, the ICM has full decision making authority over the activation of Dynamic Performance Control.

The Active Steering functions (in particular the yaw-rate control) are not affected by this withdrawal of control. They continue to be implemented even if the vehicle's behavior is unstable, because they help to stabilize it.

The Vertical Dynamics Management (VDM) is still responsible for controlling the vertical dynamics. Signals regarding the current driving situation are naturally exchanged between the ICM and VDM.

Monitoring the Vehicle Status

The Integrated Chassis Management (ICM) control unit calculates the current driving situation from the signals listed below. This refers only to the longitudinal and lateral dynamic driving status.

- Wheel speed signals from all four wheels
- Longitudinal acceleration
- Lateral acceleration
- Yaw rate

The ICM control unit thus knows how the vehicle is actually moving at that moment.

To be able to optimize the vehicle behavior, the dynamic driving systems require information about how the driver wishes the vehicle to move. The driver's command is determined from the following signals:

- Accelerator pedal angle, current engine torque and gear ratio
- Application of the brake pedal and current brake pressure
- Steering angle

The ICM control compares the driver's command and the current actual movement of the vehicle and calculates whether intervention from the Active Steering and Dynamic Performance Control systems is necessary and what form this should take.

Coordinated Intervention by the Dynamic Driving Systems

Intervention by dynamic driving systems that operate in the longitudinal and lateral directions have the following objectives:

- To optimize the rotational motion of the vehicle about the vertical axis by effecting a yaw moment. This will increase the stability and/or the agility, depending on the driving situation.
- To improve the traction of the vehicle.

The Integrated Chassis Management allows these objectives to be achieved to a greater extent. The ICM acts as a coordinator and distributes the tasks to one or more systems.

To date, the following options have been available (and continue to be) for intervention to achieve the objectives stated above. The corresponding dynamic driving systems are indicated in brackets:

- Individual application of the wheel brakes (ASC+T, DSC)
- Adjustment of the current engine torque (ASC+T, DSC, MSR)
- Distribution of the drive torque between the rear and front axles (xDrive)
- Adjustment of the steering angle of the front wheels, regardless of the driver's input (Active Steering).

In the E71, a further option for improving the traction and optimizing the rotational motion is available for the first time. The Dynamic Performance Control allows the drive torque to be distributed in a controlled way between the driven rear wheels.

The coordinated interventions by the systems with the help of the Integrated Chassis Management bring about several advantages.

In some driving situations, it can prevent more than one system providing the same intervention.

For example, systems such as Dynamic Performance Control act as an enhancement to xDrive before the unstable driving situation even occurs. This happens without the driver being aware of it and avoids further intervention by Active Steering or Dynamic Stability Control.

Active Steering in the ICM Network

The functions of Active Steering that are perceptible to the customer in the E71 are identical to those in the E70. Active Steering also provides:

- a variable steering-transmission ratio that changes according to the vehicle's road speed and
- Yaw-Rate Control Plus (GRR+), which is used to stabilize steering interventions, not only when the vehicle is oversteering, but also when it is being braked on surfaces with various friction coefficients.

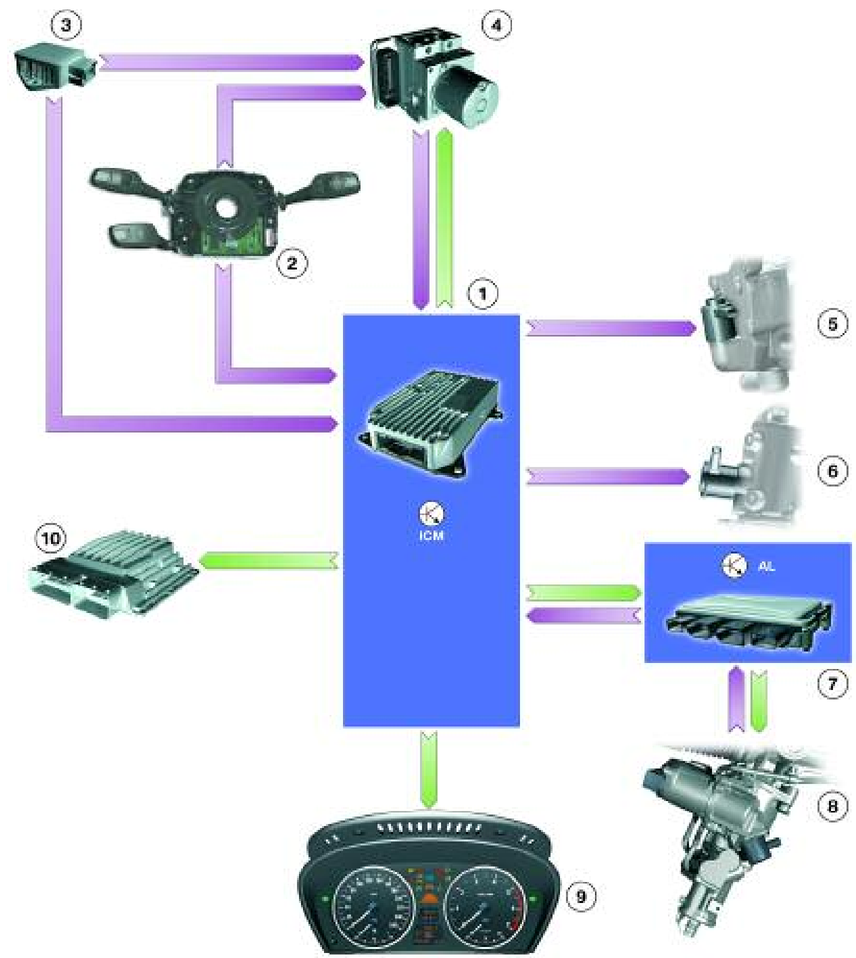
Just some of the parameters have been specifically adapted for the new E71 vehicle type.

The distribution of the functions between the control units and thus their interaction have changed. This is due to the new ICM control unit network in the E71.

The Integrated Chassis Management is the control unit in which the higher-level dynamic driving functions for Active Steering are calculated. As already described, the current driving situation is analyzed. The input variables for this are provided by:

- the steering column switch cluster (steering angle and steering-angle speed),
- the DSC sensor (yaw rate, lateral acceleration and longitudinal acceleration) and
- Dynamic Stability Control (wheel speeds) In addition, the driver's directional input is analyzed using the steering angle and the steering-angle speed (both signals from the steering column switch cluster).

Active Steering IPO



Index	Explanation	Index	Explanation
1	Integrated Chassis Management	6	Servotronic valve
2	SZL with steering angle sensor	7	Active Steering (control unit)
3	DSC sensor	8	Active Steering (actuator)
4	Dynamic stability control	9	Instrument cluster
5	Proportional valve (EVV)	10	Engine control system (DME)

The Integrated Chassis Management uses the current driving situation and the driver's directional input to calculate the individual setpoint values for the variable steering transmission ratio and the Yaw-Rate Control Plus. Once these have been prioritized, the ICM provides a resulting setpoint value. This is a specified angle to which the front wheels should be adjusted.

The Active Steering control unit receives this setpoint value and has the principal task of controlling the actuating elements such that the setpoint value is achieved. The Active Steering control unit is therefore purely an actuating control unit. This is the main difference from the previous implementation of Active Steering. There, the control unit not only controlled the actuators, but also calculated the higher-level regulating functions.

In order to ensure that the setpoint value is applied, Active Steering control unit reads the signal from the motor-position sensor. This additional steering angle for Active Steering is also communicated to the ICM control unit and then to the DSC control unit.

To remain consistent with the E70, the DSC control unit in the E71 also calculates the cumulative steering angle from the steering angle and the Active Steering steering angle.

The DSC control unit provides the cumulative steering angle to the other control units via the PT-CAN.

All variants of the E71 equipped with Active Steering automatically receive the Servotronic function. This function is controlled by the ICM control unit.

All variants of the E71 steering system also contains a proportional valve that is also controlled by the ICM control unit. The valve is known as an electronically controlled bypass valve (EVV).

The volumetric flow generated by the power steering pump is distributed between the steering valve and a bypass valve according to the level of power steering assistance required. This distribution is infinitely variable.

The less power steering assistance required, the more hydraulic fluid is diverted to the bypass circuit. Because the hydraulic fluid in the bypass circuit has no task to perform, it means that the power steering pump consumes less power. In this way, the proportional valve has a hand in reducing fuel consumption and CO2 emissions.

ICM Interfaces

The ICM control unit has two further interfaces with partner control units for the Active Steering function. These are:

- Instrument cluster
- Engine control system

Instrument Cluster

If the ICM control unit detects a fault in the Active Steering system (faulty input signal, faults in the control unit or in the Active Steering actuator), it activates the usual steering warning lamp and the associated Check Control message. This request is implemented by the instrument cluster.

Engine Control Module

If there is a high level of steering activity, in particular at low road speeds, the cooling requirement in the hydraulic system increases.

To prevent overheating, the ICM control unit can ask for the speed of the electric fan to be increased. This request is sent via the PT-CAN to the engine control system, because the latter directly controls the electric fan.

Classroom Exercise - Component Functions and Operation

Using the workbook material, please complete the following table:

Component or Function	Module responsible for Logic or Processing	Module responsible for Actuation or Output
EDC		
AL/AFS		
DPC/QMVH		
xDrive		
DSC		
ASC		
ABS		
MSR		
Automatic Hold		
EVV		
Servotronic		
ARS		
EHC		
Total Steering Angle		N/A

Dynamic Performance Control

Distribution of the Drive Torque (xDrive w/o DPC)

The BMW xDrive all-wheel-drive system regulates the variable distribution of the drive torque between the front and rear axles, resulting in a longitudinal distribution of the drive torque. In the current xDrive generation, the distribution is performed by an adjustable multi-plate clutch. xDrive helps to improve the traction and stability of the vehicle.

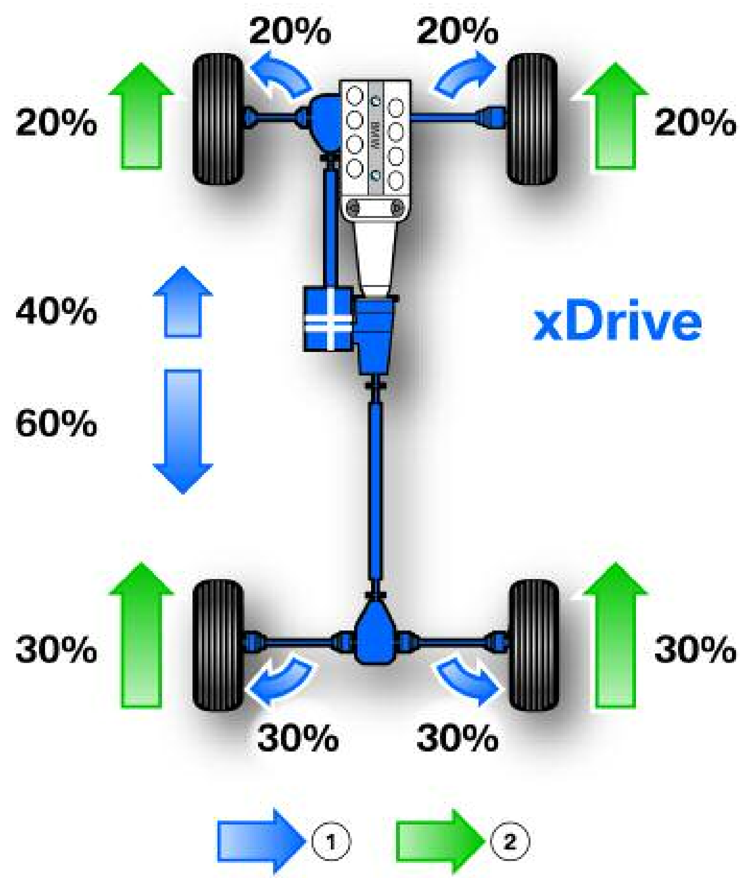
In the situation shown, the distribution of the drive torque by xDrive is the standard distribution. 40% is distributed to the front axle and 60% to the rear axle.

The front and rear axle transmissions distribute the drive torque equally to both sides. In terms of driving force, 20% is available at each front wheel and 30% at each rear wheel.

This distribution is appropriate for driving in a straight line.

Because the drive torque is equal at the left and right wheels, any differing friction coefficients on the left and right are not initially factored in (of course, ASC+T will intervene if one or more wheels are threatening to spin as a result).

Longitudinal distribution of the drive torque by xDrive



Index	Explanation
1	Drive torque distributed by xDrive
2	Driving force at the wheel

Distribution of the Drive Torque (xDrive w/ DPC)

Dynamic Performance Control now also enables infinitely variable distribution of the drive torque between the wheels on the rear axle. Instead of a longitudinal distribution, as provided by xDrive, Dynamic Performance Control provides a lateral distribution of the drive torque. That is why, in technical documentation, the term "rear axle lateral torque distribution" often appears as a synonym for the sales designation "Dynamic Performance Control".

A new rear differential developed on the basis of a conventional differential allows the torque flow to and from the wheels to be controlled.

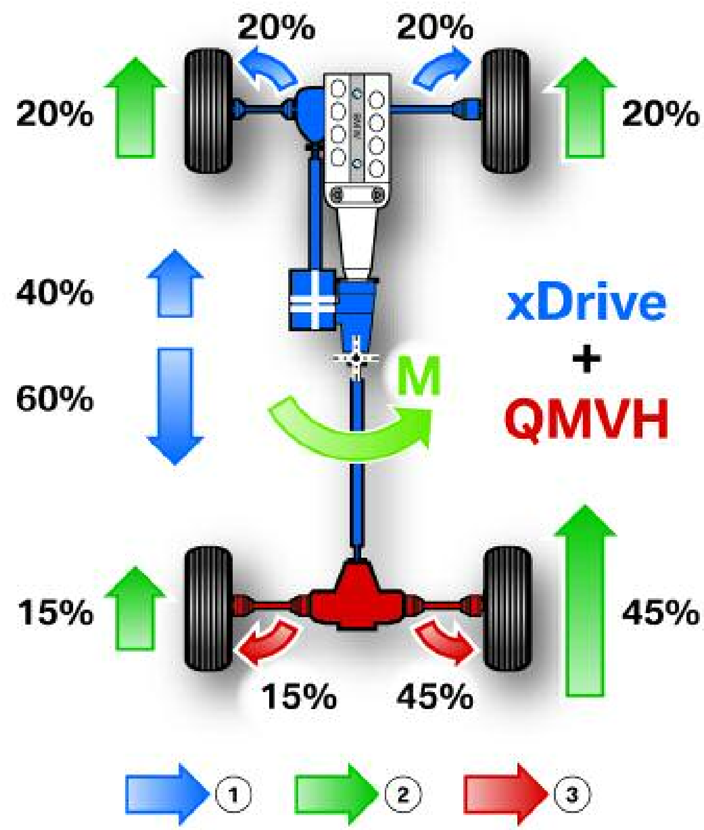
This means that not only can stability and traction be further increased, but the vehicle's agility can also be improved.

The combination of the xDrive and Dynamic Performance Control systems is able to further improve the vehicle behavior under acceleration and on surfaces with different friction coefficients on the left and right. Lets assume that the right rear wheel is on dry asphalt and the left rear wheel is on snow. In addition to the longitudinal distribution of the drive torque by xDrive, Dynamic Performance Control allows the drive torque to be distributed between the rear wheels. In this situation, the majority of the drive torque will be transmitted to the right rear wheel, because the left rear wheel can only generate relatively little driving force due to the low friction coefficient. This can avoid ASC+T having to intervene by applying the brakes.

The uneven distribution of the torque at the rear wheels has a second effect that is also used by Dynamic Performance Control.

Torque (M) is generated about the vertical axis of the vehicle. This means that the rotational motion of the vehicle about the vertical axis when cornering can be intentionally influenced. You can use this effect to turn the vehicle harder into a corner or to dampen the rotational movement.

Longitudinal distribution by xDrive,
lateral distribution by Dynamic Performance Control (QMVH)



Index	Explanation
1	Drive torque distributed by xDrive
2	Driving force at the wheel
3	Drive torque distributed by Dynamic Performance Control
M	Torque about the vertical axis of the vehicle (= yaw moment)

Fixed Distribution of the Drive Torque with Conventional Rear Differential

A conventional rear differential consists of an angle drive and a differential gear and always distributes the drive torque equally (50:50) to both sides. Different rotational speeds are balanced out.

The different gear ratios for the various vehicle models are achieved by the different number of teeth on the drive pinion and crown gear.

Distribution of the Drive Torque by the Rear Differential with Mechanical Locks (limited-slip differential)

A open/conventional differential has two beneficial features:

- The speed of the drive wheels can differ from each other because of the different distances they cover when cornering.
- The drive torque is always distributed equally to both drive wheels and does not therefore generate any yawing.

These benefits are counterbalanced by a major disadvantage if the tire-road adhesion is different at the two wheels. The propelling forces that are to be transferred to the road are then limited to the lower of the two potential adhesion levels at the drive wheels.

If the adhesion ratio is unfavorable on one side, it means that a vehicle (without electronic dynamic driving system) would not be able to move off. The drive torque would be converted into useless rotational acceleration for the wheel with the lower potential adhesion level, while the higher potential adhesion of the second drive wheel remains unexploited.

Selectable and self-locking rear differentials are fitted in order to eliminate this disadvantage of the differential gear.

Variable Distribution of the Drive Torque in the Rear Differential with Superimposing Gear Units

The new rear differential with superimposing gear units abolishes this fixed torque distribution by the differential gear. The differential gear is supplemented by a superimposing gear unit on each side. These provide a second additional path along which the drive torque can be transmitted.

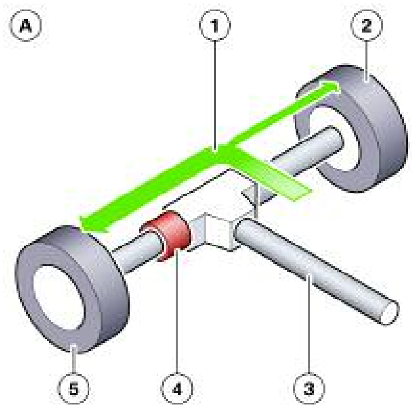
In all three load situations:

- traction,
- coasting and
- overrun

the BMW Dynamic Performance Control system allows the torque to be ideally distributed between the two rear wheels.

A - Torque Transfer Under Traction

The **traction** load situation means that the engine is generating a positive drive torque. In this respect, the functions of the BMW Dynamic Performance Control hardly differ from those of the competition. The BMW system can transfer up to 1,800 Nm of drive torque from one wheel to the other.

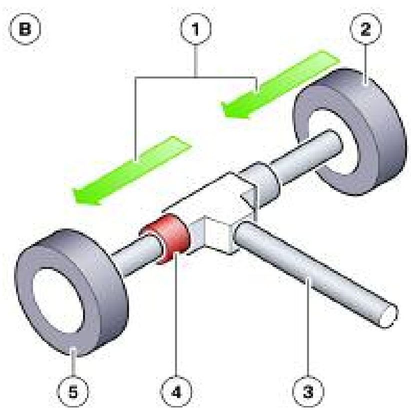


Index	Explanation
1	Lateral distribution of the torque
2	Left rear wheel
3	Propeller shaft
4	Activated superimposing gear unit
5	Right rear wheel

The competitive advantage of the BMW system becomes clear in other load situations.

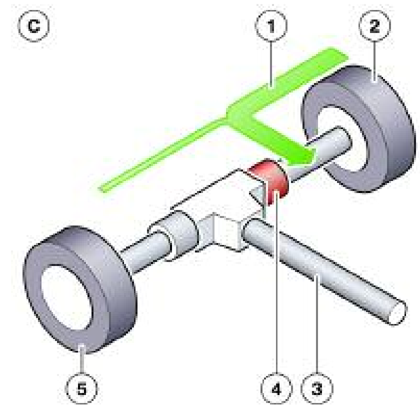
B - Torque Transfer During Coasting
During **coasting**, there is no drive torque (0 Nm).
When there is power being transmitted between the engine and transmission, this occurs when the engine torque is exactly equal to the loss torques. It also occurs if the driver disconnects the power transmission between the engine and the gearbox (selector lever in the neutral position).

There is then zero torque at the input to the rear differential. In contrast to the competitors' systems, Dynamic Performance Control can also bring about torque transfer in this load situation. If a wheel is to receive positive torque, an equal amount of negative torque will occur at the other wheel.



Index	Explanation
1	Lateral distribution of the torque
2	Left rear wheel
3	Propeller shaft
4	Activated superimposing gear unit
5	Right rear wheel

C - Overrunning: Negative Torque in the Propeller Shaft
If the engine is delivering negative torque, e.g. during overrun fuel cut-off, this is known as overrunning. Even in this case, Dynamic Performance Control allows torque transfer, i.e. a negative torque can also be distributed asymmetrically to the two wheels. The torque transfer can even be increased to such an extent that there is an extremely large negative torque at one wheel and a slight positive torque at the other wheel.



Index	Explanation
1	Lateral distribution of the torque
2	Left rear wheel
3	Propeller shaft
4	Activated superimposing gear unit
5	Right rear wheel

Improved Traction

Accelerating Out of Corners

Dynamic Performance Control enables improved cornering traction by adapting the torque distribution to the potential adhesion between each tire and the road.

The vehicle can be accelerated out of the corner more quickly without impairing directional stability.

The rolling motion of the vehicle when cornering generates different wheel contact forces. The contact forces at the wheels on the outside of the corner are greater than those at the wheels on the inside of the corner.

Therefore, the maximum forces that can be transferred to the road are greater at the wheels on the outside of the corner than at the wheels on the inside of the corner. Dynamic Performance Control has an ingenious way of using this effect. If the driver accelerates while cornering, more drive torque is distributed to the rear wheel on the outside of the corner than to the rear wheel on the inside of the corner. In this way, the adhesion potential of the rear wheels is better exploited. Overall, the vehicle can make use of a greater drive torque to accelerate in the corner.

Driving off on Surfaces with Varying Friction Coefficients

The improved traction when pulling away will be particularly noticeable to the driver when the road surface has various friction coefficients. This mixture of friction coefficients makes the variable distribution of the drive torque between the individual wheels more evident.

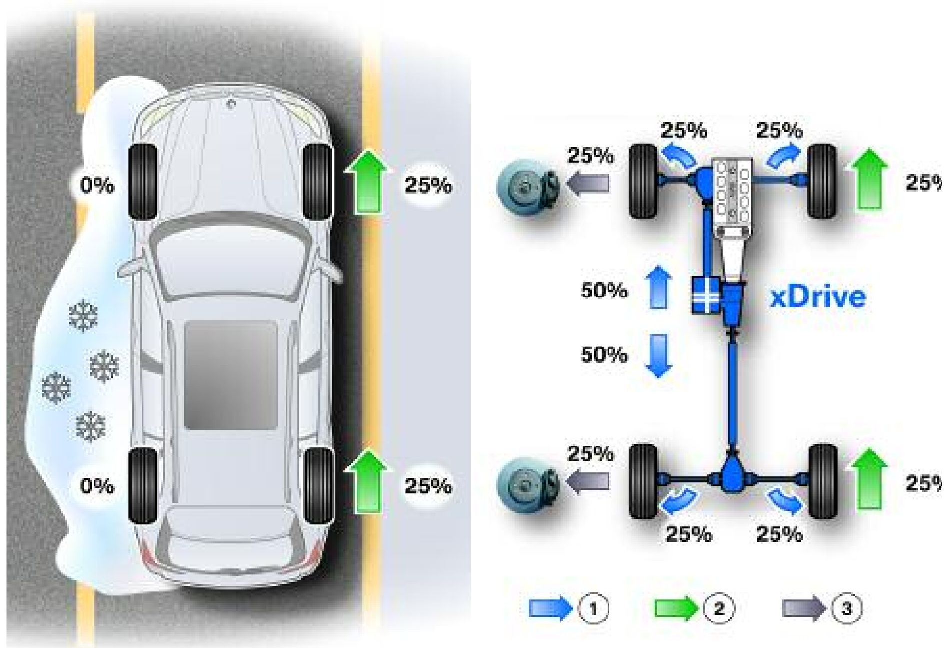
Dynamic Performance Control distributes the drive torque to the side where more power can be transferred.

Lets look at a situation where the vehicle is pulling away with different friction coefficients on the left and right sides to compare the basic principles for torque distribution in xDrive and Dynamic Performance Control.

- xDrive

In this situation, the xDrive system distributes the drive torque equally to the front and rear axles. The front and rear axle transmissions transfer the drive torque evenly to the left and right sides. The front and rear wheels on the left-hand side cannot, however, transfer any driving force to the icy road. ASC+T applies the brakes to the left wheels, converting their proportion of the drive torque into heat. The entire proportion of the drive torque transferred to the wheels on the right-hand side (25% each) is available for acceleration.

In effect, then, 50% of all the torque generated for pulling away is efficiently utilized.



Index	Explanation
1	Drive torque distributed by xDrive
2	Driving force at the wheel
3	Driving force not available due to braking by ASC+T

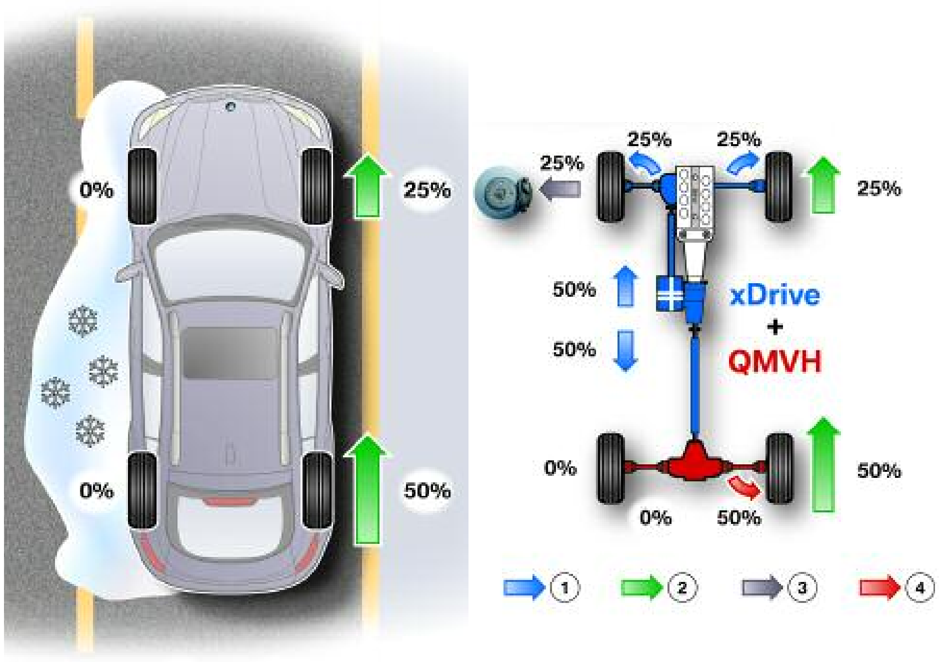
- xDrive with DPC

The combination of the two systems, xDrive and Dynamic Performance Control, further improves the already good pulling away performance on surfaces with various friction coefficients. Dynamic Performance Control detects that the left rear wheel is threatening to spin using the wheel speed signals (in a similar way to ASC+T). Instead of ASC+T reducing the drive torque by applying the brakes, Dynamic Performance Control diverts virtually all of the drive torque at the rear axle to the right rear wheel.

Because a QMVH differential is only used on the rear axle, the torque distribution at the front wheels remains unaffected. ASC+T still needs to apply the brakes here to prevent the left front wheel from spinning.

There is now a total of 75% of the drive torque available for pulling away (50% at the right rear wheel, plus 25%at the right front wheel).

Particularly on surfaces with various friction coefficients, a vehicle with Dynamic Performance Control will have more tractive force at its disposal and will thus be able to accelerate harder than a vehicle that is only equipped with xDrive. By laterally distributing the drive torque, Dynamic Performance Control therefore improves traction when pulling away.



Index	Explanation
1	Drive torque distributed by xDrive
2	Driving force at the wheel
3	Driving force not available due to braking by ASC+T
4	Drive torque distributed by Dynamic Performance Control

Increased Agility

The intelligent interaction between the mechatronic systems, DSC and xDrive, guarantees excellent traction and stability.

However, there is a certain conflict of objectives, which generates more stability at the expense of agility.

Dynamic Performance Control, which is also a mechatronic system, is a logical enhancement to DSC and xDrive, because it can provide an infinitely variable distribution of the drive torque between the left and right wheels on the rear axle. This is pretty much regardless of how much input torque there is.

The conflict between stability and agility is therefore resolved for the first time.

Increased agility can be perceived in the following dynamic benefits:

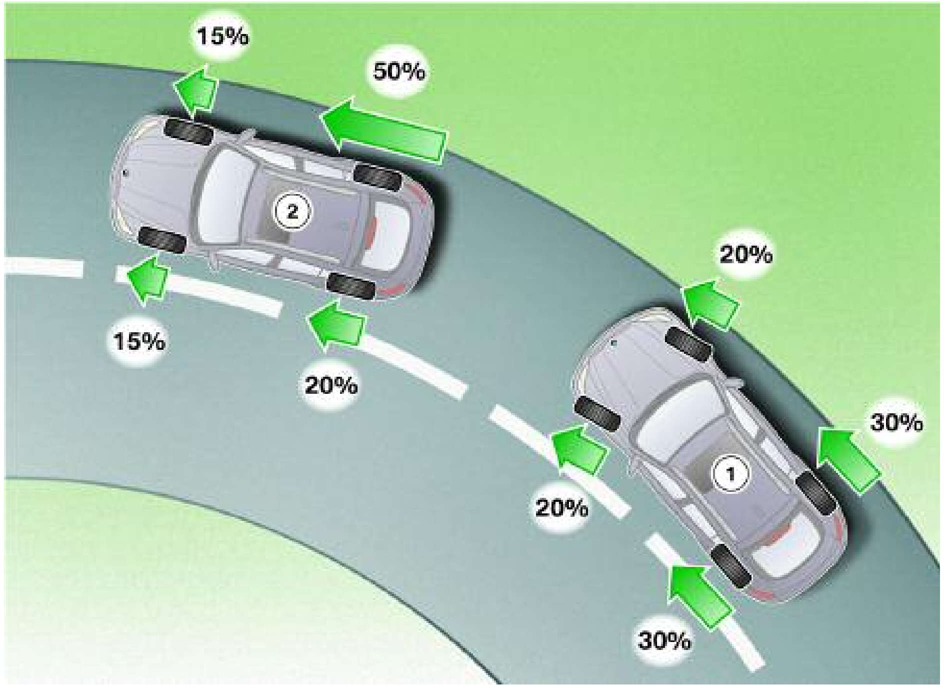
- Smaller steering angle requirement
- Less of a tendency to understeer

The vehicle responds more sensitively to steering input. With asymmetric drive torque distribution at the rear axle, Dynamic Performance Control effects an optimum yaw moment.

This controlled additional torque about the vertical axis of the vehicle makes it more "willing" to turn corners and reduces the amount of steering input required.

Less steering effort means greater steering comfort, reduced understeer and more precise steering through corners.

Increased agility in cases of understeer



Index	Explanation
1	Entering the corner, threatening to understeer
2	Torque distribution, understeer eliminated

Greater Directional Stability

As well as the considerably increased responsiveness of the vehicle with less steering input, any oversteer can also be noticeably controlled by the distribution of torque.

Dynamic Performance Control increases vehicle safety by appropriately damping the rotational motion of the vehicle about the vertical axis.

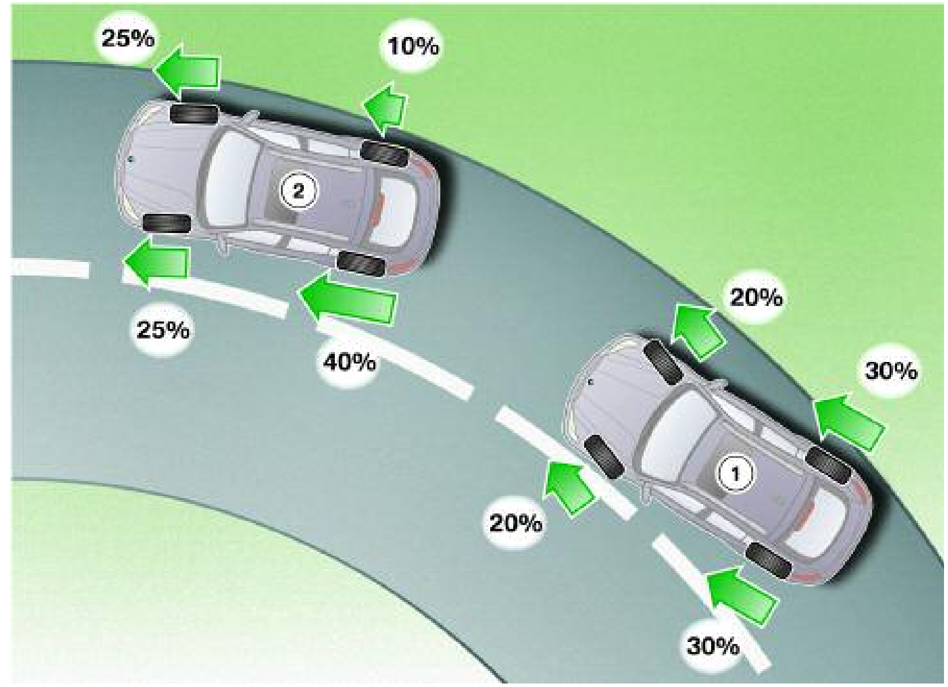
At the first sign of instability, e.g. oversteer, the drive torque at the rear axle is diverted to the wheel on the inside of the corner, thus preventing the rear of the vehicle from kicking out.

As soon as the vehicle is dynamically stable again, the torque distribution by xDrive also returns to the basic 40:60 distribution.

If the directional stability still remains close to the limit, DSC will of course also intervene. In this way, the various dynamic driving systems work together, coordinated by the Integrated Chassis Management, to achieve a common objective and to complement each other.

The result is, for example, more easily controlled vehicle behavior when you need to take evasive action.

Increase in directional stability for the example of oversteer



Index	Explanation
1	Entering the corner, threatening to oversteer
2	Torque distribution, oversteer eliminated

Operating Modes and Displays

Normal Mode

The Dynamic Performance Control functions cannot be switched on and off. The system is available once the engine is switched on.

Evidently, no torque is transferred in gear P, because the vehicle is stationary and no power is being transmitted to the wheels. However, in gears N and R, the system can affect torque transfer.

The driver will get a new functional display for Dynamic Performance Control, which can be called up as one of the on-board computer screens and make permanently visible in the instrument cluster. If the display for Dynamic Performance Control was active last time the vehicle was driven, it will automatically appear again the next time the vehicle is driven.

Due to legal requirements, the vehicle's odometer reading must always be displayed for a fixed time after the engine is started. For this reason, a small symbol for Dynamic Performance Control appears when the engine is started with the odometer reading underneath it. This small symbol is also displayed if the driver switches to the Dynamic Performance Control screen from another on-board computer screen.

After a few seconds, the symbol is switched to full size for better legibility. It shows the drive train and the vehicle wheels from above, as well as the current torque distribution by xDrive and Dynamic Performance Control.

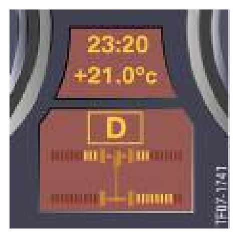
The amount of torque at a wheel is shown by the number of narrow segments. Together, the segments form a bar, the length of which is a measurement of the amount of torque at the wheel. In this view, only positive values are possible. If the torque drops to a value of 0 Nm, the segments disappear completely from the wheel concerned. Negative values are also displayed like this and so cannot be clearly indicated.

A few typical examples of the display with the full-size symbol are shown below.

Dynamic Performance Control display with small symbol and odometer reading (displayed upon engine startup)

Dynamic Performance Control display with standard longitudinal distribution (front/rear) and even lateral distribution (left/right)

Dynamic Performance Control display with longitudinal distribution biased to the rear and even lateral distribution (left/right)



Dynamic Performance Control display with standard longitudinal distribution (front/rear) and lateral distribution biased to the right

Break-in Phase

There are no different or additional running-in instructions for the rear differential with superimposing gear units than those that already exist for the conventional rear differential. Nor is there any diminished or reduced functionality due to the new rear differential.

Wear Over the Service Life

Notable wear occurs to two system components of the rear differential: the multi-plate clutches and the transmission oil in the superimposing gear units (see also the System components section). There are mathematical models for these two components that either compensate for the wear or monitor for impermissibly high values.

Continuous wear to the multi-plate clutches is offset by appropriate control of the electric motors. Constant adaptation processes running in the background determine the position of the electric motors at which there is no torque transfer. The last detected "zero position" during a driving cycle is saved in the QMVH control unit and is available as the start value for the next driving cycle.

Wear to the multi-plate clutches can be compensated for throughout their entire service life. This is ensured by their design and the configuration of the electric motor adjustment range.

Frictional wear and loading due to high temperatures also age the transmission oil in the superimposing gear units. For this reason, a wear algorithm is calculated that takes account of the following variables:

- Age of the transmission oil in the superimposing gear units
- Number of times a superimposing gear unit has been actuated
- Temperature of the transmission oil in the superimposing gear units

If the vehicle is driven with a normal or even a dynamic driving style, the transmission oil can be used for the entire service life of the vehicle without requiring changing. The result of the wear algorithm remains in the permissible range.

Only if the vehicle is driven with an extremely sporty driving style might it become necessary to change the transmission oil during the vehicle's lifetime. The wear algorithm then generates a fault code memory entry. The diagnostic system uses this fault code memory entry to suggest a transmission oil change.

Please note that when we talk here about transmission oil and changing it, we are only referring to the two reservoirs of the superimposing gear units.

The oil in the differential is a service life supply, as before.

Driving Off with a Limited Steering Angle Signal

The steering angle sensor in the steering column switch cluster (SZL) is only able to measure the relative steering angle directly. Its measuring range is between -180° and +180°.

The absolute steering angle can be calculated from the relative steering angle by counting the steering-wheel turns. This information is lost if the SZL not supplied with voltage (e.g. if the battery is disconnected). When the vehicle is subsequently started, only the relative steering angle is available initially. The SZL uses the signals from the wheel-speed sensors to determine the information about the steering-wheel rotation when first pulling away.

The following situation can be particularly problematic for all-wheel drive vehicles. The SZL was disconnected from the voltage supply. The vehicle is started on a snow covered road, for example. The driver depresses the accelerator pedal forcefully to pull away causing all the wheels to spin and requiring ASC+T to brake them again.

In this situation, the SZL may not be able to immediately determine the information about the steering wheel rotation. It is not possible again until the slipping stops. In the meantime, the full functions of Dynamic Stability Control and Dynamic Performance Control are not available.

During this transition period, the driver is informed of the limited availability of the stability control systems by the DSC warning lamp and a Check Control message.

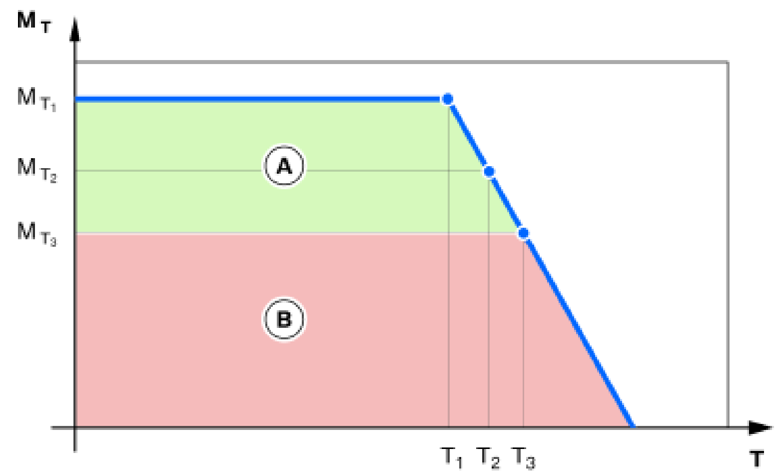
However, in this case, it is not a question of a fault, but a temporary unavailability of the systems. In the event of a complaint, the customer should be informed of this possibility.

Excessive Temperature

Excessive temperature can occur in the two electric motors or in the transmission oil in the superimposing gear units. Excessive temperature can cause damage to components or unduly high levels of wear.

The following measures are applied to prevent this.

Degradation of the torque transfer as a function of temperature



Index	Explanation
MT	Percentage performance of the required torque transfer by DPC
A	Normal operation without driver information
T	Temperature of the electric motors and/or the transmission oil in the QMVH
B	Restricted operation with driver information

Note: The system is able to detect a "sporty driving style". If it does so, the temperature threshold is temporarily increased by approximately 25°C.

The temperature of the electric motors and the transmission oil in the two superimposing gear units is measured. The signals from the temperature sensors are analyzed by the QMVH control unit.

In the first temperature range, the QMVH control unit makes available the full amount of torque transfer (M_{T1} = 100%). If the limit value T_1 is exceeded, the QMVH control unit reduces the torque transfer performance.

In the example shown, the transmission oil in one superimposing gear unit has temperature T_2. The torque transfer is then reduced to M_{T2} = 80%. If the Integrated Chassis Management requires a torque transfer of 1,000 Nm, only 800 Nm is provided by the QMVH control unit.

The reduced performance is reported back to the ICM control unit, so that it can be taken into consideration for the higher-level dynamic driving control. The reduced work of the superimposing gear units reduces the input of frictional heat, thereby preventing further heating.

The driver is not informed of the limited function of Dynamic Performance Control until the vehicle handling is markedly altered by the reduction in torque transfer. This threshold is marked as M_{T3} in the diagram. The relevant display - see below - is not activated until this point.

xDrive and/or DPC not available

System Not Available

If xDrive or Dynamic Performance Control (or both) is not available, the function display is dimmed. Because the customer does not then benefit from the large bar display, the display is also switched to the smaller symbol size.

The driver cannot determine whether xDrive or Dynamic Performance Control is causing the fault in the system using only the dimmed function display. The distinction can be made using the associated Check Control message.

A failure of Dynamic Performance Control has a similar effect to the failure of Dynamic Stability Control. Driving stability is limited.

Therefore, if there is a system fault in Dynamic Performance Control, the same Check Control symbol is used as for DSC. An instruction in the Central Information Display asks the driver to drive carefully. In addition to this Check Control message, the fixed warning lamp in the instrument cluster is constantly lit yellow.

Display in the event of a DPC system failure

The Check Control symbol for a fault in the xDrive system shows the customer that all-wheel drive is no longer available.

Check Control symbol for xDrive fault

Dynamic Performance Control in the ICM network

The ICM control unit's monitoring of the driving situation can be used for both systems (AL/AFS and DPC). The interpretation of the directional input at the steering wheel by the driver is also of use for the two systems. For the Dynamic Performance Control system, the engine torque requested by the driver and the torque provided at the transmission output are also analyzed. The ICM control unit therefore reads the relevant signals from the engine control system and the electronic transmission control system.

A particular feature in the ICM network is the xDrive system, which is used to help control the longitudinal distribution of the drive torque.

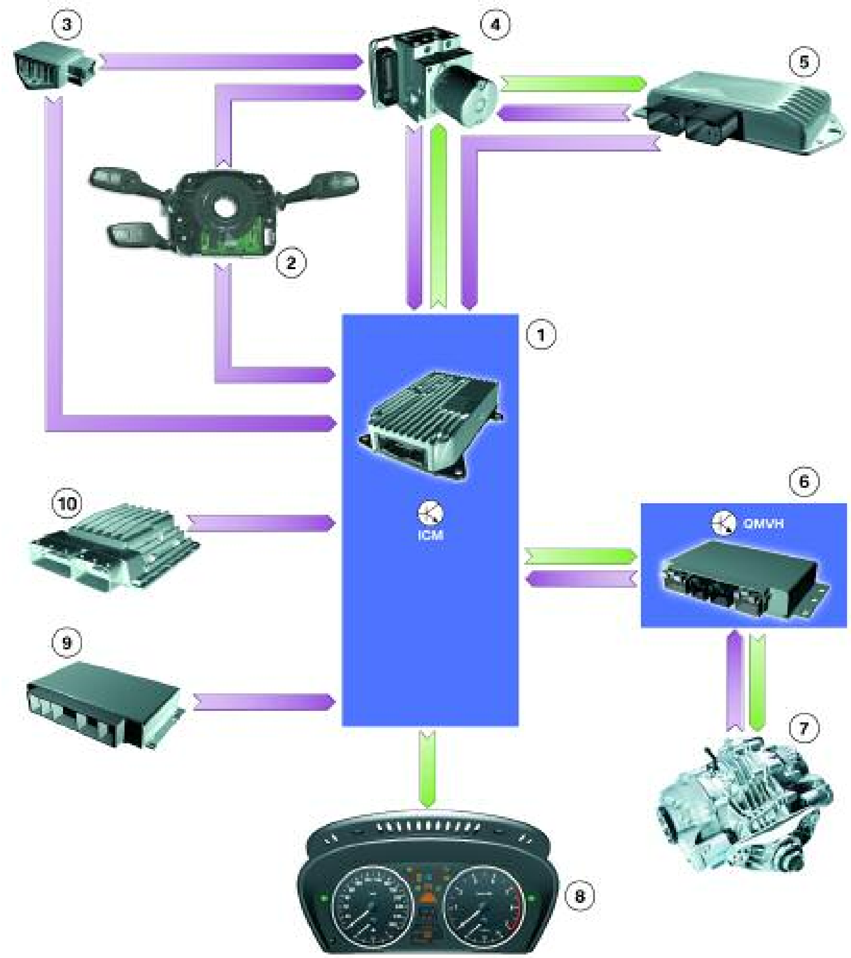
As in the all-wheel-drive vehicles already available on the market, the DSC control unit in the E71 continues to calculate the setpoint value for the distribution of the drive torque between the front and rear axles. The transfer case control unit applies this setpoint value and feeds back the actual value of the torque distribution. In the E71, it is no longer only the DSC control unit that receives this signal, but also the ICM control unit, so that the drive torque available at the rear axle can be determined.

Using the current driving situation, the driver's input and the drive torque available at the rear axle, the Integrated Chassis Management calculates a setpoint value for the QMVH control unit. This specifies how much drive torque should be transferred from which rear wheel to the other and is sent via the ICM-CAN.

The QMVH control unit has the task of implementing this setpoint value by energizing the actuating elements. In doing so, it must first detect which side, i.e. which of the two superimposing gear units, needs to be energized. This should occur on the side on which the greater drive torque should be applied.

The QMVH control unit in the E71 is purely an actuating control unit, in a similar way to the Active Steering control unit.

Dynamic Performance Control IPO



Index	Explanation	Index	Explanation
1	Integrated Chassis Management	6	Rear axle lateral torque distribution
2	SZL with steering angle sensor	7	QMVH rear differential
3	DSC sensor	8	Instrument cluster
4	Dynamic stability control	9	Electronic transmission control
5	Transfer box control module	10	Engine control system (DME)

In order to ensure that the setpoint value is applied, the QMVH control unit reads the signals from the motor position sensors. There is also motor position control for Dynamic Performance Control in the same way as for Active Steering.

The QMVH control unit uses the motor position to determine the drive torque that is actually transferred and transmits this information back to the ICM control unit.

The interface between the ICM control unit and the instrument cluster serves to activate the function displays and to indicate fault statuses. See the "Operating modes and displays" section.

Service Information

Running-in Phase

There are no different or additional running-in instructions for the rear differential with superimposing gear units than those that already exist for the conventional rear differential.

Driving Off with a Limited Steering Angle Signal

If the steering column switch cluster (SZL) has been disconnected from the voltage supply, only the relative steering angle can initially be measured. The SZL does not calculate the absolute steering angle using the wheel speed signals for calibration until the vehicle has been driven for a few meters.

Until this point, only limited functions of the Dynamic Stability Control and Dynamic Performance Control dynamic driving systems are available. The driver will not normally notice this phase.

A Check Control message is only issued if the driver pulls away sharply on a surface with low friction immediately after the engine has been started. However, there is not a technical fault. Once the steering angle sensor has been calibrated with the wheel speeds, all functions of the dynamic driving systems are automatically available again.

Excessive Temperature

Excessive temperature can occur in the electric motors or in the transmission oil in the superimposing gear units. This can cause damage to components or unduly high levels of wear. To prevent this, the requested torque transfer is only implemented to a reduced extent if excessive temperature is detected.

This reduction happens without the driver noticing. A Check Control message is not issued until the vehicle's behavior is noticeably altered by the reduction. A careful driving style will automatically result in the components being cooled, so that the full functionality is soon available again.

The system is able to detect a "sporty driving style". If it does so, the temperature threshold is temporarily increased by approximately 25°C.

QMVH Unit

The angle when the rear differential with superimposing gear units is removed and refitted must be no more than 45° due to risk of the oils mixing together through the common vent.

Electric Motors

The following must be observed when one or both of the electric motors are being replaced:

- When an electric motor is removed, small quantities of oil may escape. This volume of oil is so small in relation to the overall volume that it is not necessary to top up the transmission oil.
- Only the correct left/right motor may be used for the replacement. Identify the electric motor correctly using the Electronic Parts Catalogue.
- Following the replacement of one or two new electric motors, a set-up process must be started using the diagnostic system. This will transfer data from the motor position sensor to the QMVH control unit.

Control Unit
The QMVH control unit continuously calculates wear data for the transmission oil and multi-plate clutches during normal operation. The control unit also reconciles the control unit data with the fitted electric motors.

A digital interface with the motor position sensors is used for this purpose. This results in the following particularities if the QMVH control unit needs to be replaced during the course of a repair.

Before The QMVH control unit is removed, all data regarding the status of the rear differential with superimposing gear units must be read out, if possible, using the diagnostic system.

Once the new QMVH control unit has been fitted, programmed and coded, the diagnostic system must be used to work through a set-up procedure.

During this, the data that was previously read out regarding the status of the rear differential with superimposing gear units will be written to the new control unit. The control unit will also be set to a mode which restarts all adaptation processes, so that perfect interaction between the control unit and the superimposing gear units can be established as soon as possible.

ICM Control Unit

When the ICM control unit is coded, the vehicle identification number is written to the control unit. This means that a simple exchange between two vehicles does not provide a solution to a fault. Following the programming or replacement of an ICM control unit, coding must therefore be carried out. This is part of the set-up process conducted by the diagnostic system.

During normal driving, the ICM control unit carries out calibration processes on the sensor signals. The offset of the steering wheel angle is determined in this way, for example. Values of this type are required for the higher-level dynamic driving regulation. Following the programming or replacement of an ICM control unit, these calibration processes must be explicitly initiated. The diagnostic system has a corresponding Service function.

The actual calibration process does not take place until the next trip. The sensor signals cannot be calibrated to each other until the dynamic situations actually occur. This process takes place in the background, so that the customer will not realize it is happening.

As you were already able to see from the bus overview and the distributed functionality, the ICM control unit is not an independent control unit. Instead, it is in a close network with the QMVH and AL control units and, of course, the DSC. All these control units use similar or identical sensor signals (e.g. wheel speeds, yaw rate, steering wheel angle). Take this background information into consideration when performing diagnostics on the dynamic driving systems, for example, do not only check the fault memories of the individual control units, but the fault memories of all the control units in the network.

Workshop Exercise - Service Functions for Dynamic Performance Control

Diagnostic Software Version ________

Using an instructor designated vehicle, run a short test on an E71 and complete the following questions.

In the Service Functions section of the Function Selection; Under which major heading does the QMVH system appear?
Circle the correct major group below.

Maintenance

Drive

Chassis

Body

Vehicle Information

Does the sub group appear as QMVH? If not what is the sub group for QMVH called in the diagnostic software?

____

What test plans are available under for the QMVH system?
Write them in the spaces provided below.

____

____

____

Run the test plan for oil replacement.

How does a technician know that the oil for the QMVH system must be replaced?

____

____

____

Run the test plan for Startup QMVH.

What are the two options given?

[1] _______________

[2] _______________

What options are given under option [2]?

____

____

____

____

____

____