Technical training.
Product information.

F90 Complete Vehicle

BMW Service

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General information

Symbols used

The following symbol is used in this document to facilitate better comprehension or to draw attention to very important information:

Contains important safety information and information that needs to be observed strictly in order to guarantee the smooth operation of the system.

Information status and national-market versions

BMW Group vehicles meet the requirements of the highest safety and quality standards. Changes in requirements for environmental protection, customer benefits and design render necessary continuous development of systems and components. Consequently, there may be discrepancies between the contents of this document and the vehicles available in the training course.

This document basically relates to the European version of left-hand drive vehicles. Some operating elements or components are arranged differently in right-hand drive vehicles than shown in the graphics in this document. Further differences may arise as a result of the equipment specification in specific markets or countries.

Additional sources of information

Further information on the individual topics can be found in the following:

- Owner's Handbook
- Integrated Service Technical Application.

Contact: conceptinfo@bmw.de

The information contained in this document forms an integral part of the BMW Group Technical Qualification and is intended for the trainer and participants in the seminar. Refer to the latest relevant information systems of the BMW Group for any changes/additions to the technical data.

Information status: **September 2017**
Technical training.

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1. Introduction

The new BMW M5 will be the most exciting and emotionally appealing high-performance sedan in this series that BMW M has put out to date. The sixth generation of the high-performance sports vehicle will be launched in 2018 with M xDrive, an all-wheel technology that even further intensifies the dynamic potential of the Business sedan. Apart from the marked performance enhancement, the new BMW M5 features considerably better suitability for every day use, superiority on the road and improved efficiency. This model is the logical next step in the development of an exceptionally successful vehicle strategy that was initiated with the introduction of the first BMW M5 in 1984.

1.1. M history

F90, predecessor generations (front: F10 M5 from right to left: E60 M5, E39 M5, E34 M5, E28 M5)

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1. Introduction

1.2. Vehicle profile F90 M5

F90, M5

- **Design and aerodynamics:** M-specific characteristics in front, side and rear area. Clever aerodynamic design in front, side and rear area and vehicle underbody. For the first time, a CFRP roof is installed.
- **Engine/transmission/power transmission:** Efficient, with even more powerful and more spontaneous linear power development. 3 selectable engine dynamics control programs. M automatic transmission with Drivelogic. M all-wheel drive, fully variable between the front and rear axles, or between the rear and front axles, with the option of selecting a pure standard drive that enables the driver to handle the vehicle in highly dynamic situations. Electronically regulated M rear axle differential lock.
- **Engine sound:** Ambitiously sporty in both the lower and upper speed and performance range, as well as an Active Sound Design system which makes the engine sound in the passenger compartment, in conjunction with the original noise, a desired overall experience. The engine sound can be influenced via the setting of the exhaust flaps with a button.
- **Steering:** Direct and precise variable M EPS with selectable Servotronic support (at 3 stages). M steering wheel including M shift paddle and now with 2 mounted freely programmable mode buttons.
- **Chassis and suspension/Chassis and suspension dynamics design:** M sports suspension, selectable driving dynamics program from comfortable to sporty in 3 stages. Optimal driving precision and adapted interplay of steering, suspension and damping action according to the selected program.

M Dynamic Stability Control with 3 drive modes, configured by the driver. 3 additional modes in the M DSC OFF mode; the following are available: 4WD, 4WD Sport and 2WD.

- **Seating comfort:** M sports seats with a high-quality upholstery in BMW Merino leather.
- **Ergonomics of interior equipment:** M instrument cluster, M Drive menu, M Head-Up Display, M seats, M specific decorative strips, M footpad and sill trims.
- **Assistance systems:** The driver assistance systems are available to the same extent as in the G30.

The F90 BMW M5: "The most exciting and emotional high performance sedan".

1.3. Vehicle profile F90 BMW M5 "First Edition"

To support the market introduction, there is a BMW M5 "First Edition" that is limited to 400 vehicles. The BMW M5 "First Edition" differs from the BMW M5 series in terms of the following features:

- **Exterior:** Side gills, radiator grille frame, tailpipe trims of exhaust system and the BMW M5 logo on the tailgate in black. Door handles in the vehicle color without chrome barrette trims. Exclusive external color in "Frozen Aventurin Red Metallic"
- **Engine sound:** Sport exhaust system as standard.
- **Rims:** 20-inch light alloy wheels in design in Jet Black gloss as standard.
- **Comfort:** Comfort Access as standard.
- **interior:** Multifunction seat in full Merino leather in smoke white with contrasting-color stitching in dream red, as standard, floor mats with trim in smoke white with contrast stitching in dream red, center console with decorative strips with Piano Finish Black with "M5 First Edition" insert and the serial number "1/400".

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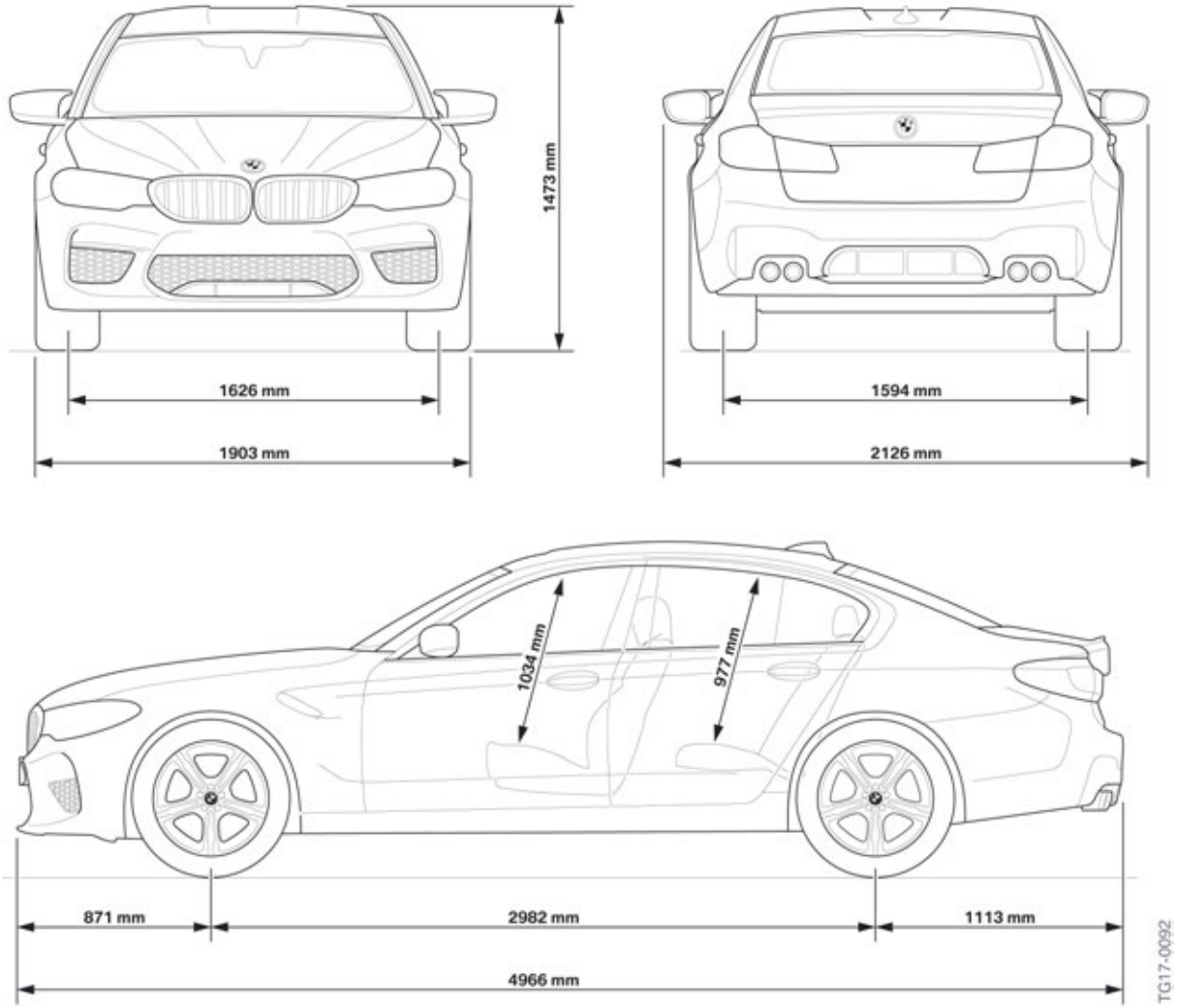
2. Technical Data

2.1. Garage dimensions



F90, M5 dimensions

2.2. Comparison of technical data in BMW

Designation	Unit	F10 M5	G30 M550i	F90 M5
Engine series		S63B44T0	N63B44O2	S63B44T4
Engine control		MEVD17.2.8	DME 8.8.0	DME 8.8.T
Transmission type designation		GS7D36BG	GA8HP75Z	M8HP75Z
Length	[mm]	4,910	4,962	4,966
Width	[mm]	1,891	1,868	1,903
Height	[mm]	1,456	1,467	1,473
Number of seats		5	5	5

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2. Technical Data

Designation	Unit	F10 M5	G30 M550i	F90 M5
Luggage compartment volume	[l]	520	530	530
Maximum speed	[mph]	155*	155*	156*/190**
Acceleration 0 - 60 mph	[s]	4.2	3.9	3.2
Nominal engine power at engine speed	[kW / hp] [rpm]	412/560 6,000-7,000	340/456 5,500-6,000	441/600 5,600-6,700
Torque	[lb-ft]	502	480	553
Curb weight	[lbs]	4,387	4,372	4,370
Approx. fuel tank capacity	[g]	21	20.1	20.1
Exhaust emission standards		LEVII	ULEV125	ULEV125

* electronically controlled; ** electronically controlled in conjunction with optional equipment M Drivers Package.

2.2.1. BMW EfficientDynamics measures

- TwinPower Turbo technology
- Direct fuel injection with Valvetronic
- Volume-flow-controlled oil pump with map control
- Automatic engine start/stop function
- Efficient 8-speed M automatic transmission
- M Servotronic (EPS)
- Brake energy regeneration.

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3. Body

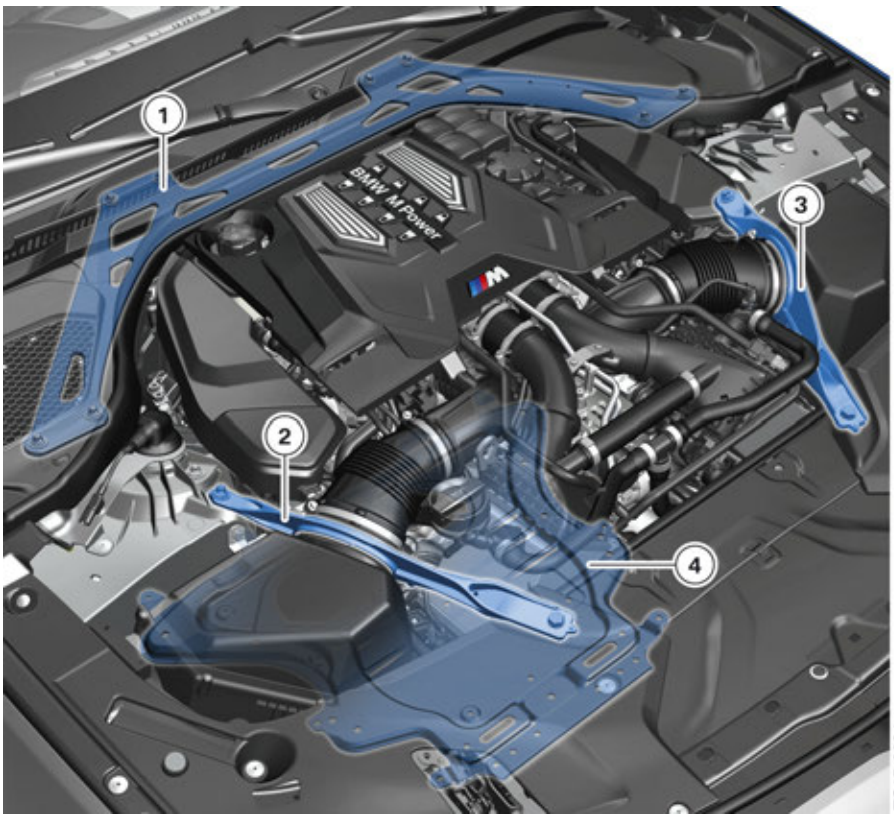
3.1. Rigidity

3.1.1. Chassis and suspension components and rigidity concept

Front area of vehicle

The following measures were implemented in the front area of the vehicle for the connection of the chassis and suspension components and to increase the vehicle rigidity:

- Front-end strut with feed-through
- Strut brace bridge
- Stiffening plate.



F90, stiffness measures in the front area

Index	Explanation
1	Strut brace bridge
2	Front-end strut with feed-through, right
3	Front-end strut with feed-through, left
4	Stiffening plate (adopted from G30)

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3. Body

To be able to implement the intake concept of the S63B44T4 engine, special front-end struts were developed for the F90. Because the front-end struts are found in the area of the air intake duct, the front-end struts had to be equipped with special feed-throughs for intake air lines. The front-end struts are manufactured using an aluminium pressure casting method and further stiffen the front end. All other measures for stiffening the front end are the same as in the G30 production vehicle.

The front-end struts must be removed and reinstalled to change the air filter insert. The screw cycles on the aluminium pressure cast spring strut dome must be noted. It may be necessary to rework the threads on the aluminium pressure cast spring strut dome using threaded inserts to ensure their strength after multiple removal/reinstallation cycles.

For necessary service work the current information and specifications in the documents in ISTA must be observed in each case.

Rear area of the vehicle

The following measures were implemented in the rear area of the vehicle for the connection of the chassis and suspension components and to increase the vehicle rigidity:

- Steel cross struts with a connection to the rear axle support
- Aluminium cross-member on the vehicle underbody in the area of the rear seat bench for mounting the cross struts.

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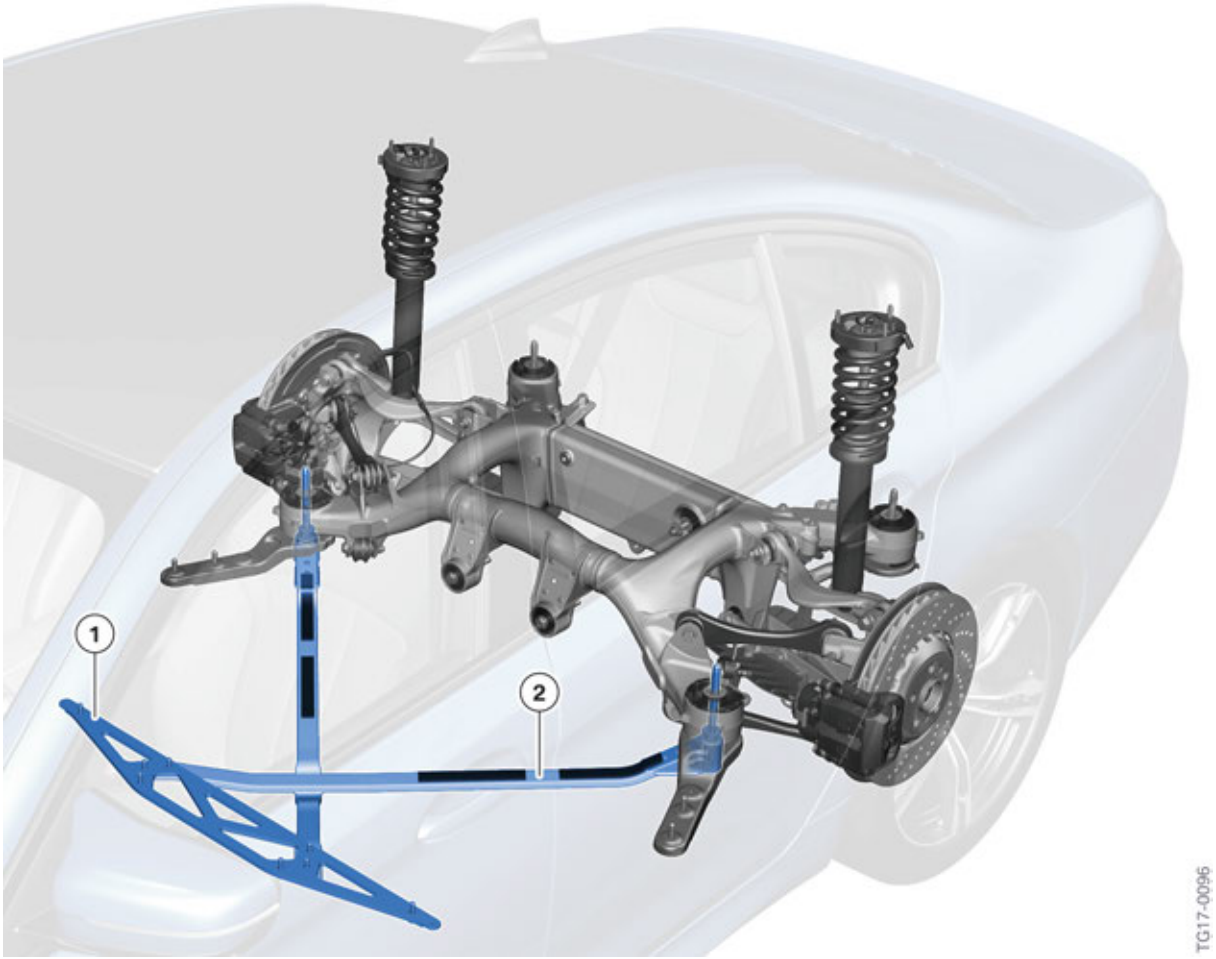
3. Body



F90, stiffness measures in the rear area

Index	Explanation
1	Cross member
2	Cross strut

3.2. Exterior

3.2.1. Front

Bumper, front

The bumper panel in the M-specific design has flaps at the bottom for reducing the drag at the front axle. It is painted in the vehicle color, including the PDC sensors. Due to the necessary air inlets no fog lights are offered. The frame and the double-rib longitudinal bars of the BMW M5 radiator grille are

finished in black as standard with high-gloss struts and the BMW M5 model designation. The optional Side View camera and the Parking Maneuver Assistant (PMA) sensor are integrated at the front/side similar to the G30 production vehicle.

The ornamental grilles at the bottom are black. Optionally, radar sensors for the driver assistance systems are installed in the front bumper.

F90, front view

The outside temperature sensor is located behind the radiator grille in the F90. The previous installation location for the outside temperature sensor in the air ducts for brake system cooling was not possible in the F90 since the measured values were not plausible on account of the greater heat dissipated by the S63B44T4 engine and brake system while the vehicle is at a standstill.

Headlights

The front headlights are carry-over parts from the G30. The adaptive LED headlights are installed as standard. The M specific bumper panel was adapted to the position and shape of the headlights in F90.

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3. Body

Hood

As in the G30, the hood of the F90 is made of aluminum but has its own BMW M5 pattern.

Braces were fitted in the middle section to reinforce the hood.

The supporting inner structure, as well as the outer skin of the engine compartment lid, are made from aluminum.

Front end and air ducts

The air intake duct and the intake air filter, as well as their positioning, are new.

There is an adapted air duct both for the center radiator assembly and for the upper low-temperature radiator and the two radiators in the wheel arches. The lower engine compartment shielding is a one-piece design for rigidity reasons. It includes the air duct of the horizontal engine oil cooler and optimizes its flow.

3.2.2. Side view

F90, side view

Exterior mirror and sill

As standard, the M-specific exterior mirrors are heated, have integrated turn signal indicators, have memory and fold-in functions, and the passenger's side exterior mirror has automatic tilt in reverse.

The BMW M5 exterior mirrors have a prominent design and have been optimized in terms of their aerodynamic properties. The full side sill trim has been taken over from the M sport package.

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3. Body

F90, gill and mirror

Front side panel

The front side panels of the F90 are made from aluminium.

Striking design features include the M gills and the BMW M5 model designation on the front left and right side gill trim.

The front side panels are also new for tire clearance.

Rear side panel

The rear side panels were fully taken over from the G30 production vehicle. To ensure the legally required wheel arch area cover in the rear in the F90, wheel arch covers of plastic are installed on the rear side panel.

Roof

For the first time, a CFRP roof is being used in a BMW M5 sedan, and is bonded to the body using an adhesive. The roof line has an aerodynamic contour in the middle part and continues the specific pattern of the hood.

If the customer decides in favor of the optional moonroof in the F90, the CFRP roof is deleted and the moonroof is installed.

The production of the CFRP roof is a multi-layer design and is sealed with a layer of clear coat.

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3. Body

F90, CFRP roof

Rim design

Cast 19" M BMW light-alloy wheels are used as standard at the front and rear. Mixed tires with the sizes 275/40 ZR19 at the front and 285/40 ZR19 at the rear are used. The cast M BMW light-alloy wheels with 20" and the mixed tires in the size 275/35 ZR20 at the front and 285/35 ZR20 at the rear can also be ordered as optional equipment.

F90, rim design

Index	Explanation
1	20" M wheel, optional equipment
2	20" M wheel, optional equipment, Jet Black

3.2.3. Rear view

A striking design feature is the 4 round exhaust tailpipes.

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3. Body

F90, rear view

The rear bumper panel was taken over from G30 with M sport package. The rear diffuser and the trim of the exhaust system were newly developed for the F90, and the appearance of the exhaust system were optimized aerodynamically. The ultrasonic sensors are painted in the vehicle color. The rear spoiler, which stems from the M sport package of the G30, creates the end of the F90 rear.

3.2.4. Underbody, thermal protection and cooling

Underbody

The complete underbody is fully panelled as part of the aerodynamic concept of the F90 in order to reduce and uniformly distribute the lift at the front and rear axles. This highlights and optimizes the driving dynamics concept, particularly at higher speeds. The underbody panelling was adapted in terms of the cooling and flow around and through the drive components and chassis and suspension components, without compromising the aerodynamics.

Thermal protection

New heat insulation:

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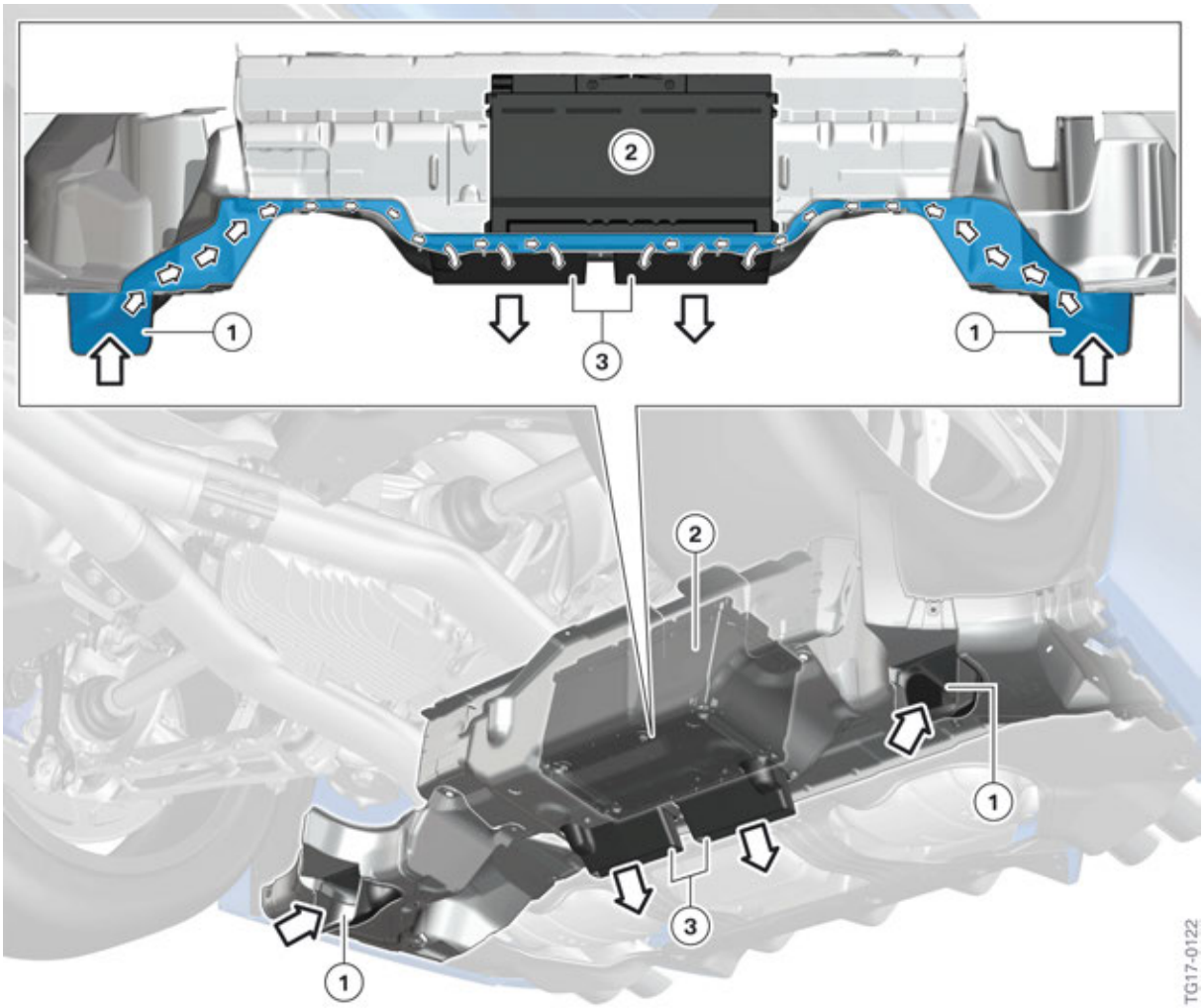
3. Body

- Various heat insulations of the underbody panelling on the left and right are new
- The heat insulation of the fuel tank is new
- The heat insulation of the tunnel is new
- The heat insulation of the front and rear silencer is new
- A completely new heat insulation of the luggage compartment prevents the luggage compartment heating up too much by the exhaust air flow of the rear axle differential.

Cooling

The F90 is equipped with a lithium-ion battery for the voltage supply. Due to the packaging-space-based positioning of the lithium-ion battery between the rear axle differential and the rear silencer in the luggage compartment, a cooling channel has been implemented.



F90, cooling of the lithium-ion battery

Index	Name
1	Intake cooling air
2	Lithium-ion battery
3	Outlet cooling air

To avoid an excess temperature of the lithium-ion battery when using on racetracks under thermally unfavorable conditions, the air ducts are installed in the underbody panelling in the area of the luggage compartment well. The air ducts use the aerodynamics of the vehicle underbody to direct the air current under the luggage compartment well for cooling while the vehicle is moving. The cooling channel protects the lithium-ion battery against excessive temperatures and thus against long-term damage.

To achieve sufficient cooling of the lithium-ion battery by the air ducts, the cooling air intake air vents and outlet air vents must be checked for contamination and even clogging. If contaminated or clogged, remove the contamination or obstruction.

3.3. Interior

3.3.1. Driving area and steering wheel

M driving area

F90, M operating area

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3. Body

M leather steering wheel

The M leather steering wheel with multifunction buttons is built on a magnesium skeleton. The M shift paddles are located above the thumb depressions: Left: downshift, right: upshift.

The steering wheel has increased in its outer diameter to 380 mm compared with the G30. The steering wheel rim is reinforced and ergonomically optimized from a round to an oval cross-section, improving the driver's grip.

The colored M stitching constitutes another difference from the production G30 steering wheels. The M leather steering wheel in the double-spoke design with a stainless steel center trim and with M inscription is black leather.

The vibration element for lane departure warning and lane change warning is integrated for the first time in the steering wheel of a BMW M5.

Two red M buttons are mounted above the multifunction buttons as the multifunction switch blocks for the driver assistance systems in the steering wheel remain as in G30. For more details, please see the chapter "M configuration menu".

F90, M leather steering wheel

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3. Body

3.3.2. M sports seats

M sports seats

The M seats are standard equipment. The starting basis is the sports seat from the G30.

These are fully electric sports seat with integrated side airbag and a seat belt buckle pretensioner. The seats are operated by means of a control switch on each seat. The 3 memory functions for the driver's seat can be retrieved via the 3 buttons in the door trim panel. The control unit is installed at the bottom of the seat. To increase safety, the crash-active head restraints are installed as standard.

M seat features (driver and front passenger):

- Merino leather
- Heated seats
- Electric forward/back, seat height, seat angle,
  backrest angle and head restraint height adjustment
- Manual head restraint depth and seat depth adjustment
- Memory function for the driver's seat
- Pneumatic backrest width adjustment

Additional Features

This M multifunction seat additionally offers:

- Backrest upper section adjustment
- Electrical seat depth adjustment
- Memory function for the driver's seat and front passenger seat
- M-specific moulded bolsters in the seat area for increased side support
- M-specific molded backrest for increased support in the shoulder and bolster area
- Lumbar support with high and lower adjustment
- Backrest width adjustment
- Illuminated M logo in the backrest

The seats are operated by means of a control switch on each seat. The 3 memory functions for the driver's seat can be retrieved via the 2 buttons in the door trim panel. The control unit is installed at the bottom of the seat.

Optional equipment for the M multifunction seat as part of the Executive Package

- Active seat ventilation
- Massage function

In the optional equipment "Rear Seat Entertainment", the screens are attached to the backs of the seat backrests of the M multifunction seats.

Rear seats

Full foam set with backrest and seat distribution and an upper body angle of 26°. The seat has a 40/20/40 division. The integrated head rests and the individual seats with moulded side sections accentuate the sporty character of the rear seats. The special design layout of the headliner ensures optimum headroom.

Optional equipment: Seat heating.

3.3.3. Doors and strips

Doors

The door trim panels come with M-specific decorative strips.

M decorative strips

The following trims are offered in the F90:

- Aluminium structure with pearl-effect chrome accent strip, exclusively offered in the M5 as a standard equipment.
- BMW Individual Piano Finish black interior strips. The manufacturing process is intricate and requires a high level of workmanship.
- Aluminium carbon structure, dark, with accent strip dark chrome.

Sill trims, footpad and mobility kit

- Sill trims with M lettering
- M footpad for driver
- An emergency wheel as in the G30 is not offered with the F90. A Mobility Kit is included with the vehicle as standard.

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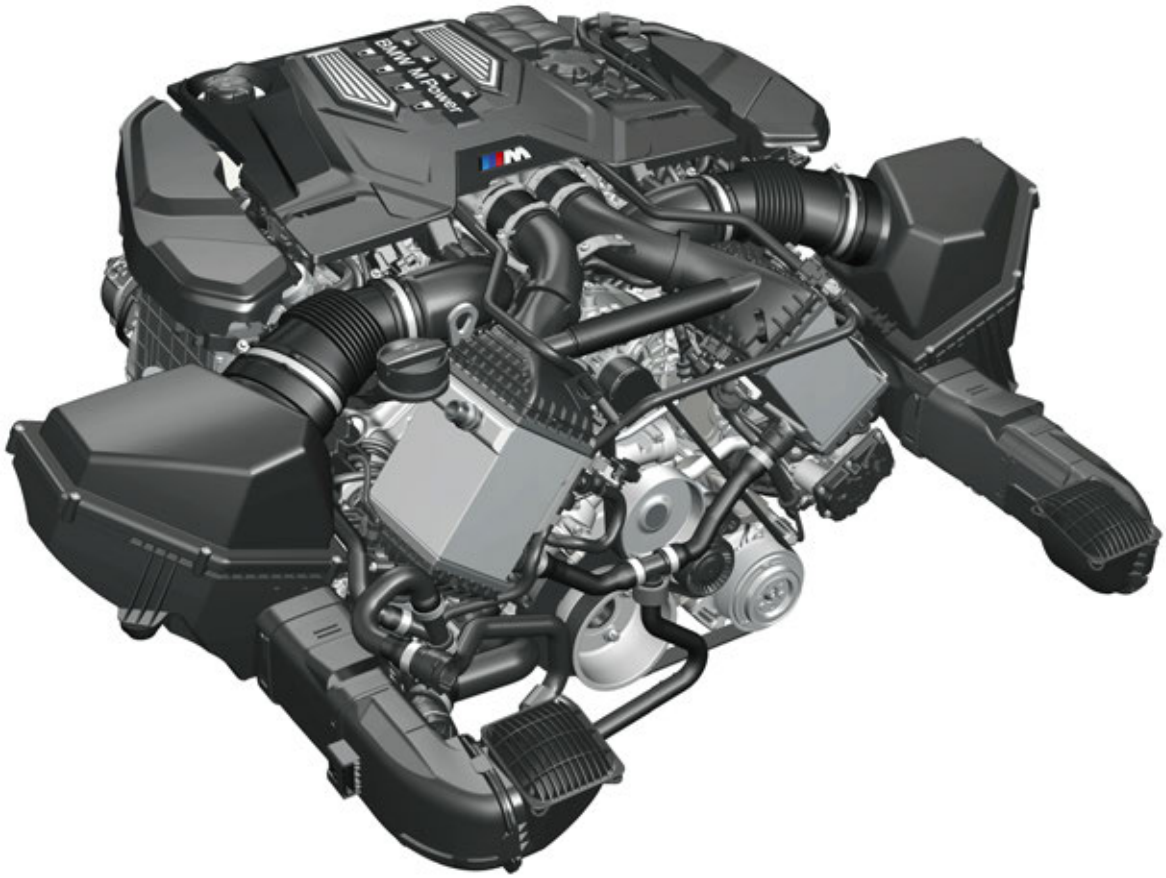
4. Engine

4.1. M TwinPower turbo engine S63B44T4



F90, S63B44T4 engine

The S63B44T4 engine is the power plant for the F90. It is an advancement of the S63B44T0 engine and technically based on the N63TU2 engine. There is no engine with the designation S63B44T3 at BMW M GmbH.

This document describes only the differences to the S63TU2 engine.

Model designation	Engine designation	Series introduction
BMW M5	S63B44T4	11/2017

4.2. Technical data

	Unit	S63B44T0	S63B44T2	S63B44T4
Series		F1x/F06	F85/F86	F90
Model designation		BMW M5/M6	BMW X5 M BMW X6 M	BMW M5
Design		V8	V8	V8

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4. Engine

	Unit	S63B44T0	S63B44T2	S63B44T4
Displacement	[cc]	4395	4395	4395
Firing order		1-5-4-8-6-3-7-2	1-5-4-8-6-3-7-2	1-5-4-8-6-3-7-2
Bore hole/Stroke	[mm]	89/88.3	89/88.3	89/88.3
Power output at engine speed	[kW (HP)] [rpm]	412 (560) 6,000-7,000	423 (567) 6,000-6,500	441 (600) 5,600-6,700
Cutoff speed	[rpm]	7,200	6,800	—
Torque at engine speed	[lb-ft] [rpm]	500 1,500-5,750	553 2,200-5,000	553 1,800-5,600
Compression ratio	[ε]	10:1	10:1	10:1
Valves per cylinder		4	4	4
Digital Motor Electronics		MEVD17.2.H	MEVD17.2.H	DME 8.8.T

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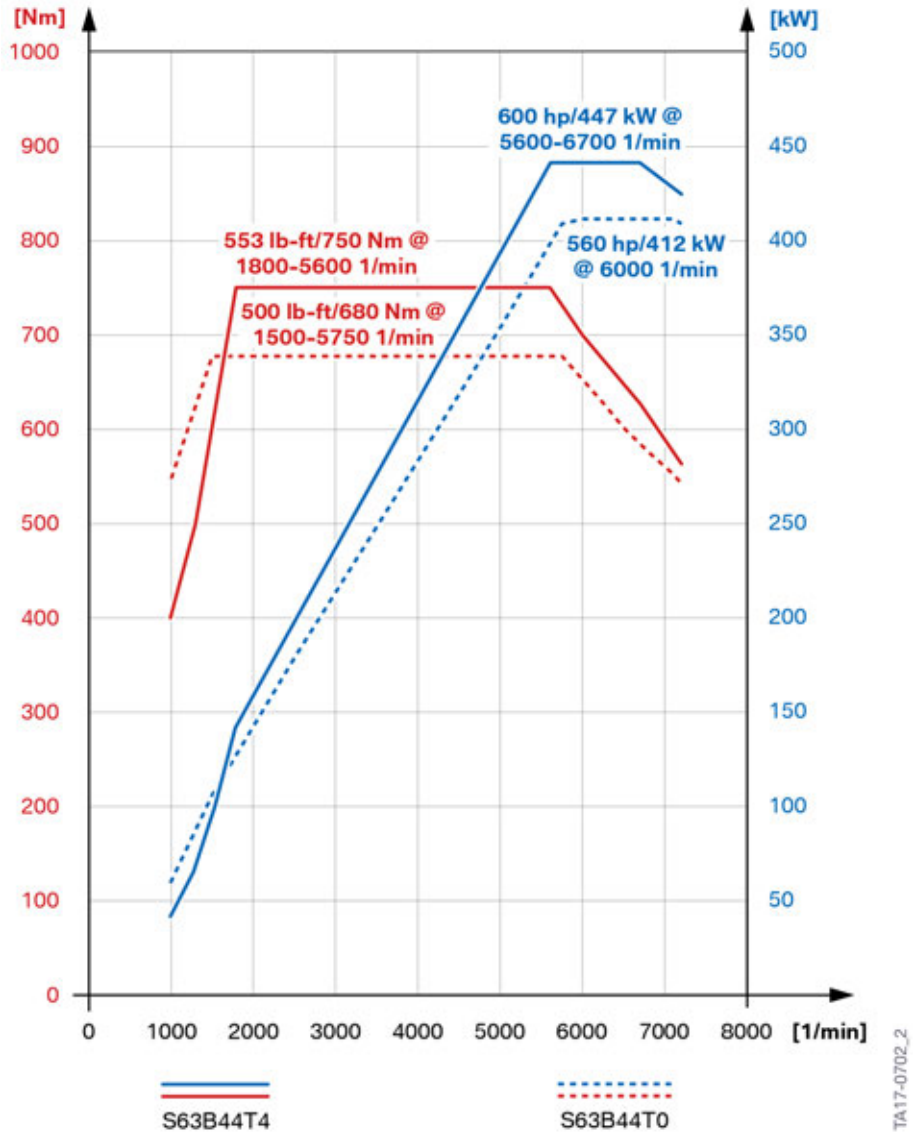
4. Engine

4.3. Full load diagram



S63B44T4 engine, full load diagram

4.4. Engine mechanics

4.4.1. Crankcase

The crankcase in the S63B44T4 engine was taken over from the N63TU2 engine and adapted to the S63T4. As in the N63TU2 engine, the crankcase is manufactured from low pressure gravity die casting AlSi17Cu4Mg. The cylinder barrels are made from Alusil. Like its predecessor in the S63B44T0 engine, the closed-deck crankcase in the S63T4 engine is characterized by a double main bearing screw connection with side wall connection.

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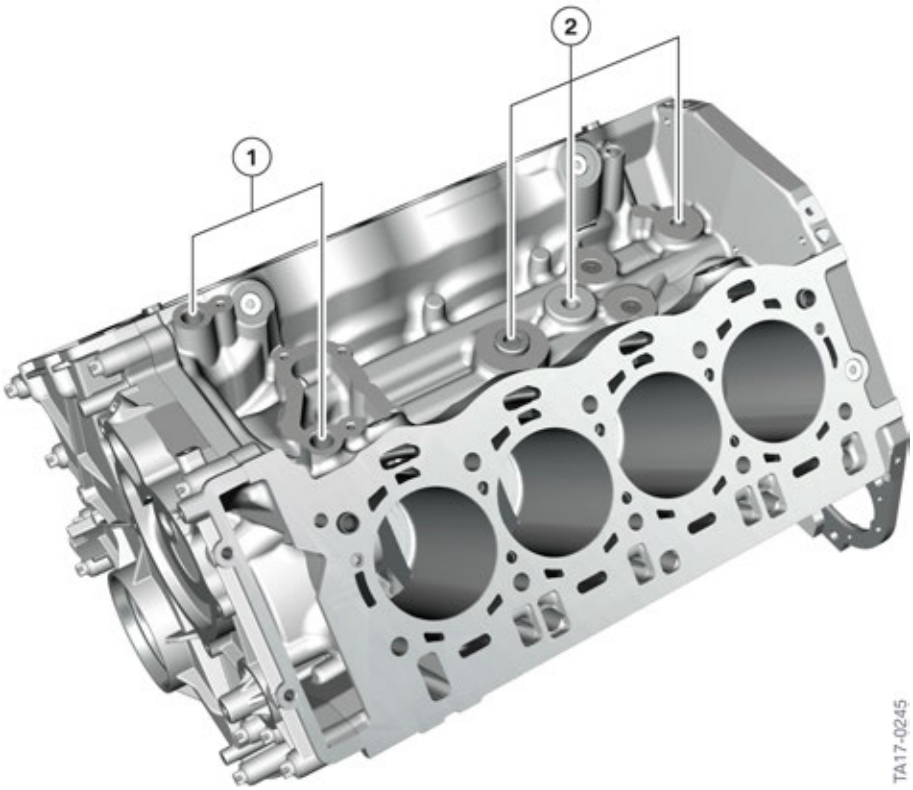
4. Engine

The crankcase cast part consists of the cylinder bores with Alusil raceways, the bearing ways with the bore holes for the crankshaft and associated bearings and the water jackets of the cylinders.

In the V-chamber of the S63B44T4, the connections that are used in the N63TU2 for the engine oil coolant heat exchanger are closed.

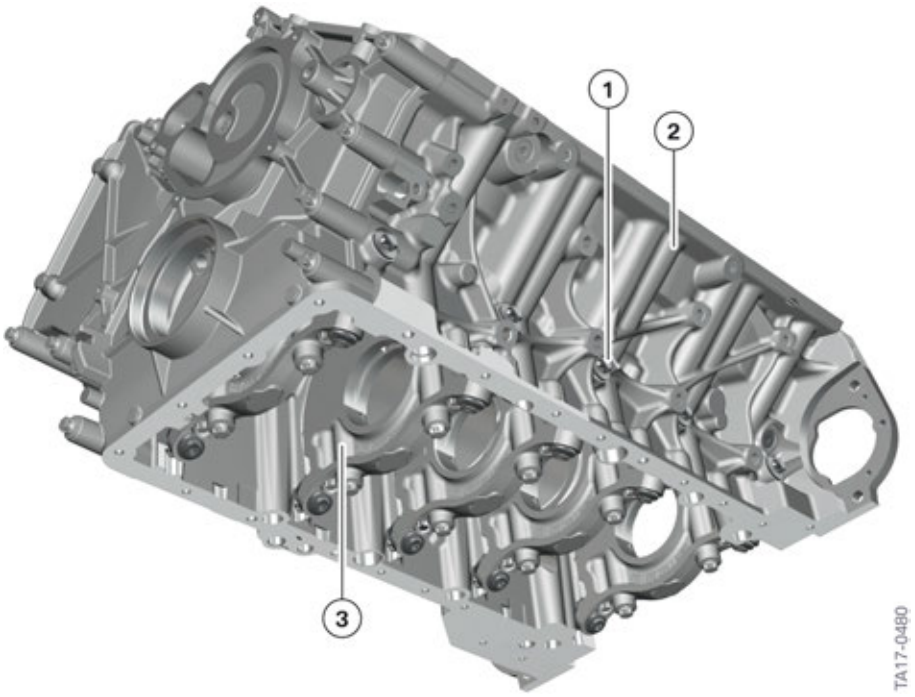


S63B44T4 engine, crankcase

Index	Explanation
1	Exhaust turbocharger oil supply
2	Closed connections of the engine oil coolant heat exchanger in the S63B44T4 engine

The S63T4 engine features the already familiar, external air/engine oil heat exchanger that is installed in front of the cooling module.

The crankcase of the S63T4 engine has undergone further changes to certain details. The most prominent change is the additional bolt connection for the main bearing caps on the crankcase. In the S63T4 engine, a triple main bearing cap bolt connection is used that encompasses the double main bearing cap bolt connection with side panel connection, already in use in the N63TU2 engine, and an additional bolt connection laterally in the crankcase.



S63B44T4 engine, main bearing cap screw connection

Index	Explanation
1	Lateral main bearing cap bolt connection
2	Crankcase
3	Main bearing cap bolt connection with side panel connection

The additional bolt connection was necessary to adapt the crankcase to the even higher power output and torque values of the S63T4 engine.

4.4.2. Crankshaft drive

The crankshaft drive without the pistons of the S63T4 engine has been taken over entirely from the S63B44T2 engine. In terms of the oil discharge concept, however, the pistons correspond to the pistons of the N63TU2 engine.

The S63T4 engine uses newly developed cast pistons. The shape of the piston crown in the S63T4 engine was modified in order to achieve a compression ratio of 10:1 in the as opposed to 10.5:1 in the N63TU2 engine. In addition, the piston crown was adapted for use of the solenoid valve injectors with a fuel injection pressure of 350 bar.

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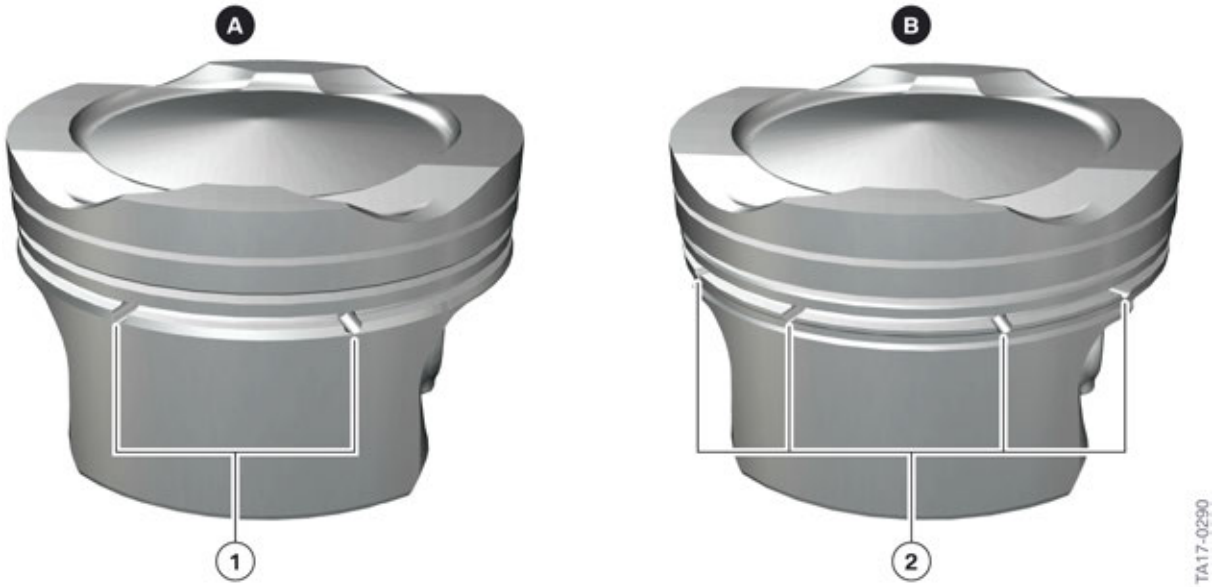
4. Engine

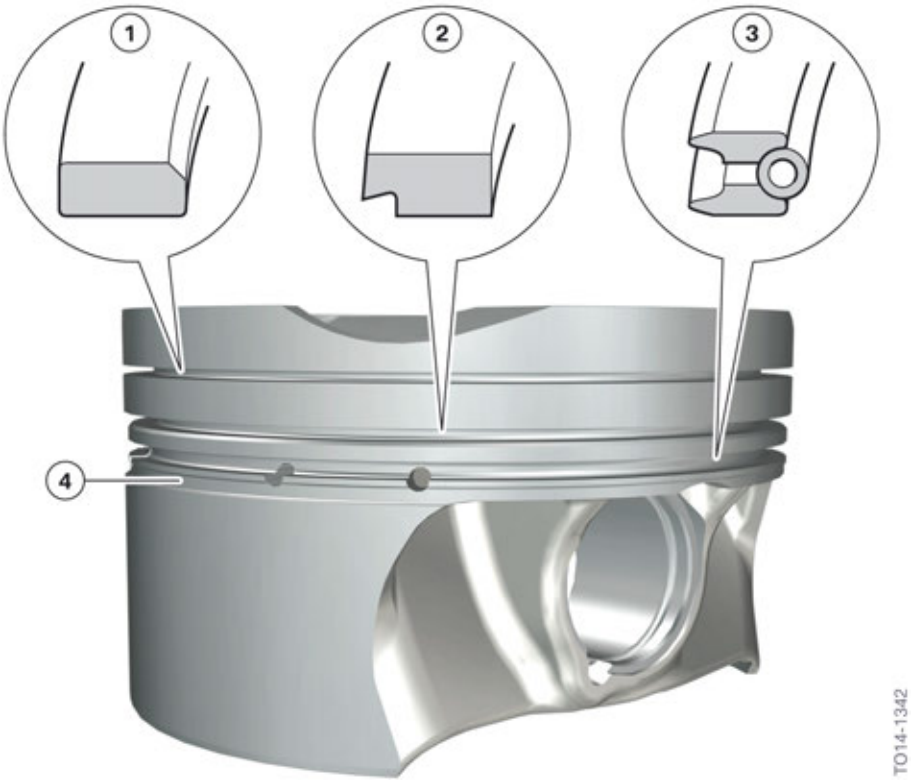


S63B44T4 engine, piston comparison

Index	Explanation
A	S63B44T2 engine, piston
B	S63B44T4 engine, piston
1	4 oil drains
2	8 oil drains

In order to improve the drainage of oil in the S63T4 engine, the piston was fitted with an additional oil groove underneath the oil scraper ring groove, as on the N63TU2 engine. Together with the 8 oil drains in the piston skirt, the additional oil groove facilitates the drainage of the oil pushed down by the oil scraper ring when the piston moves down. This prevents the oil from being carried past the piston rings, in particular when the engine is in coasting overrun mode (during which a vacuum is generated in the combustion chamber).

In terms of the piston rings, the ring package from Federal Mogul have been carried over. The oil scraper ring in the S63T4 engine is executed as a "UFlex" ring from Mahle.



S63B44T4 engine, cast pistons with piston rings

Index	Explanation
1	Plain rectangular compression ring with ball-shaped tire tread (B-ring)
2	Taper faced piston ring (NM-ring)
3	U-ring with spiral expander (UFlex)
4	Additional oil groove

For further information on the crankshaft drive of the S63T4 engine, please refer to the Reference Manual for the S63TU Engine.

4.4.3. Cylinder head

The cylinder head of the S63T4 engine is based on the same concept as the N63TU2 engine and has the same partially integrated intake system. Thanks to this intake system partially integrated in the cylinder head, the flow characteristics of the incoming fresh air have been optimized and the space required to install the intake pipe has been significantly reduced. Feed-throughs, such as for the new injectors for the HDEV 6, were specifically adapted to the cylinder head of the S63T4 engine.

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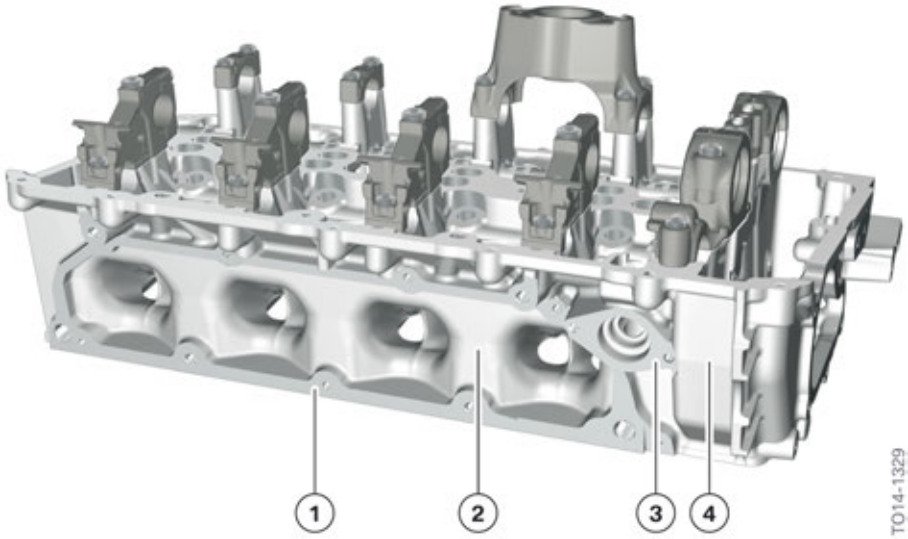
4. Engine



S63B44T4 engine, cylinder head

Index	Explanation
1	Sealing flange for intake system
2	Partially integrated intake pipe
3	Flange for Valvetronic servomotor
4	Cylinder head, bank 1

The coolant flow in the cylinder head is separate from the coolant flow in the cylinder jackets. By taking over the VANOS solenoid valves into the cylinder head cover and thus also the VANOS adjusters (as is already the case for the N63TU2 engine and the modular engines), the bore holes for the VANOS solenoid valves in the cylinder head could be dispensed with, meaning the associated engine oil ducts in the cylinder head can also be simplified.

The Valvetronic technology of the 3rd generation is also used in the S63T4 engine. The Valvetronic servomotor is connected on the outer side at the cylinder head.

The combination of exhaust turbocharger, Valvetronic and direct fuel injection is known as **T**urbo **V**alvetronic **D**irect **I**njection (TVDI).

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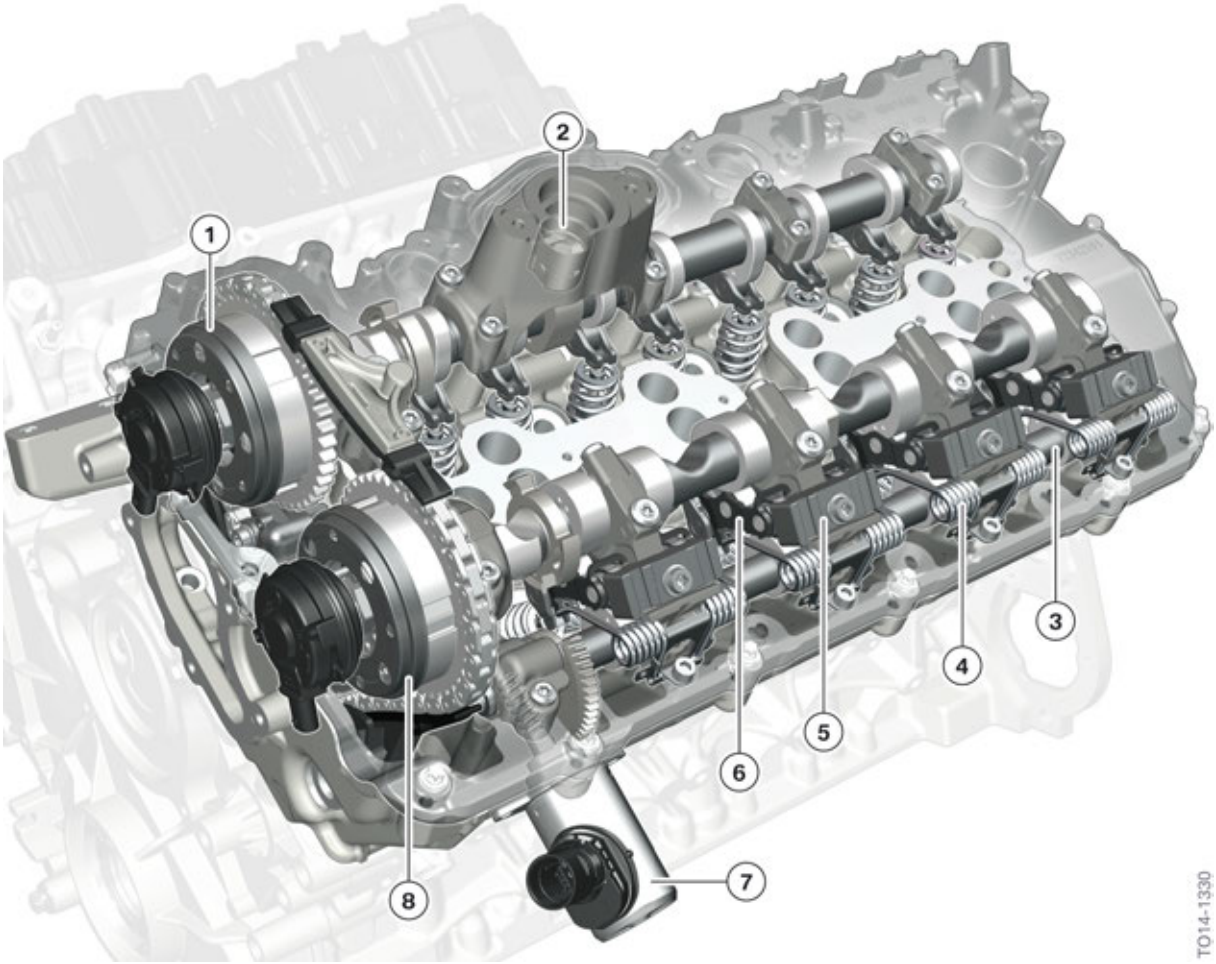
4. Engine



S63B44T4 engine, cylinder head with Valvetronic

Index	Explanation
1	VANOS, exhaust side
2	Roller tappet, high-pressure pump
3	Eccentric shaft
4	Torsion spring
5	Gate
6	Intermediate lever
7	Valvetronic servomotor
8	VANOS, intake side

4.4.4. Cylinder head cover

The cylinder head covers of the S63T4 engine are of the same design as those in the S63B44T0 engine. As in the S63B44T0 engine, a labyrinth oil separator is used to discharge oil in the blow-by gases. Each bank has its own oil separator. Further information on the cylinder head cover and crankcase ventilation can be found in the Reference Manual of the S63TU Engine.

4.5. Oil supply

4.5.1. Differences in the oil supply

- Sump with a small front oil sump as a volume buffer
- Plastic oil deflector in the top section of the sump with an integrated seal for better separation from the front and rear oil sump
- Oil pump as external gear pump with map control
- Additional suction pump
- Inner and outer oil spray nozzles with defined opening pressure
- Top and bottom sections of the sump are new parts, since they feature a mount for the map control valve and have been adapted for the external gear pump with suction pump.

4.5.2. Oil supply adaptations

The volume-flow-controlled pendulum-slide pump already in use in the N63TU2 engine is NOT used in the S63T4 engine. The reason for this is that the S63T4 engine has an additional suction pump for the front oil sump. With the same concept involving a volume-flow-controlled pendulum-slide pump, this would have been too large for the limited space. In addition, the volume-flow-controlled pendulum-slide pump used in the N63TU2 engine would not have been capable of providing a reliable oil supply in the high engine speed ranges that occur in the S63T4 engine.

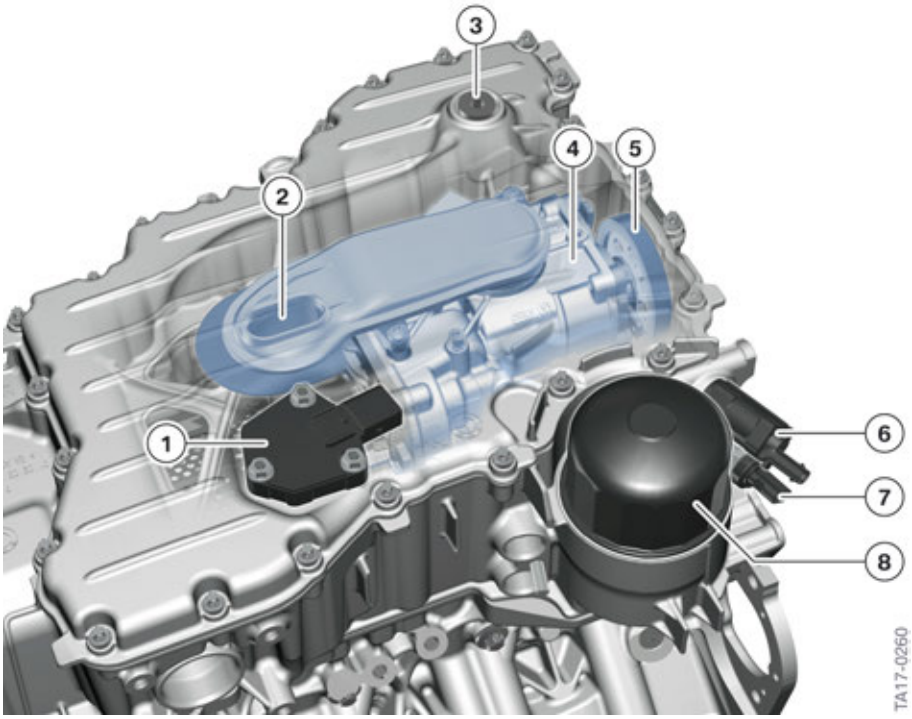
For this reason, a so-called external gear pump is used with an integrated suction pump, which is likewise executed as an external gear pump. This combination is more compact at a higher delivery rate than the volume-flow-controlled pendulum-slide pump.

The external gear pump is volume-flow-controlled and is supplemented by a map control.

The oil filter module is integrated in the upper oil sump section on the left-hand side of the engine. The oil pressure sensor and the characteristic map control valve for the characteristic map-controlled oil pump are screwed to the upper section of the oil filter module.

The upper oil sump section is screwed to the crankcase using a beaded metal gasket. The lower oil sump section is likewise screwed to the upper oil sump section. Like the upper oil sump section, the lower oil sump section is made from die-cast aluminium and supports the oil-level sensor and oil drain plug.

The position and length of the oil pump intake snorkel has been adapted to the geometric shape of the oil pump. An additional suction pump was flange-mounted onto the oil pump. This was necessary in order to adapt the oil supply to racetrack use. This ensures a secure oil supply, even when the oil level is displaced during lateral and longitudinal accelerations, as can occur during racing applications.



S63B44T4 engine, oil sump with oil pump

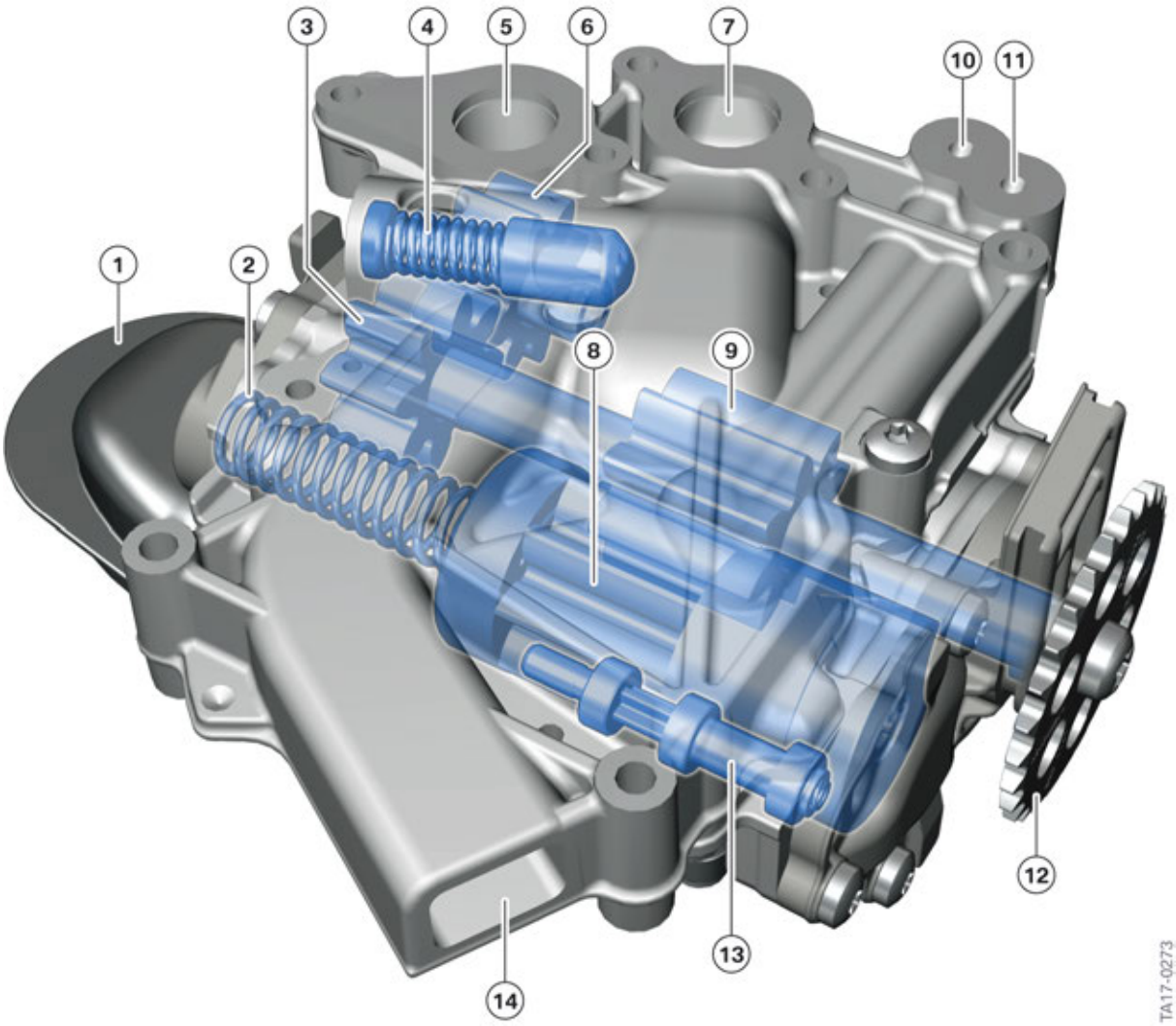
Index	Explanation
1	Oil-level sensor
2	Oil intake snorkel, sump, rear
3	Oil drain plug
4	Characteristic map-controlled external gear pump
5	Chain drive of the crankshaft
6	Map control valve
7	Oil pressure sensor
8	Oil filter cover

4.5.3. Oil pump

The oil pump is bolted to the crankcase and is driven by the crankshaft via a chain.

F90 Complete Vehicle

4. Engine



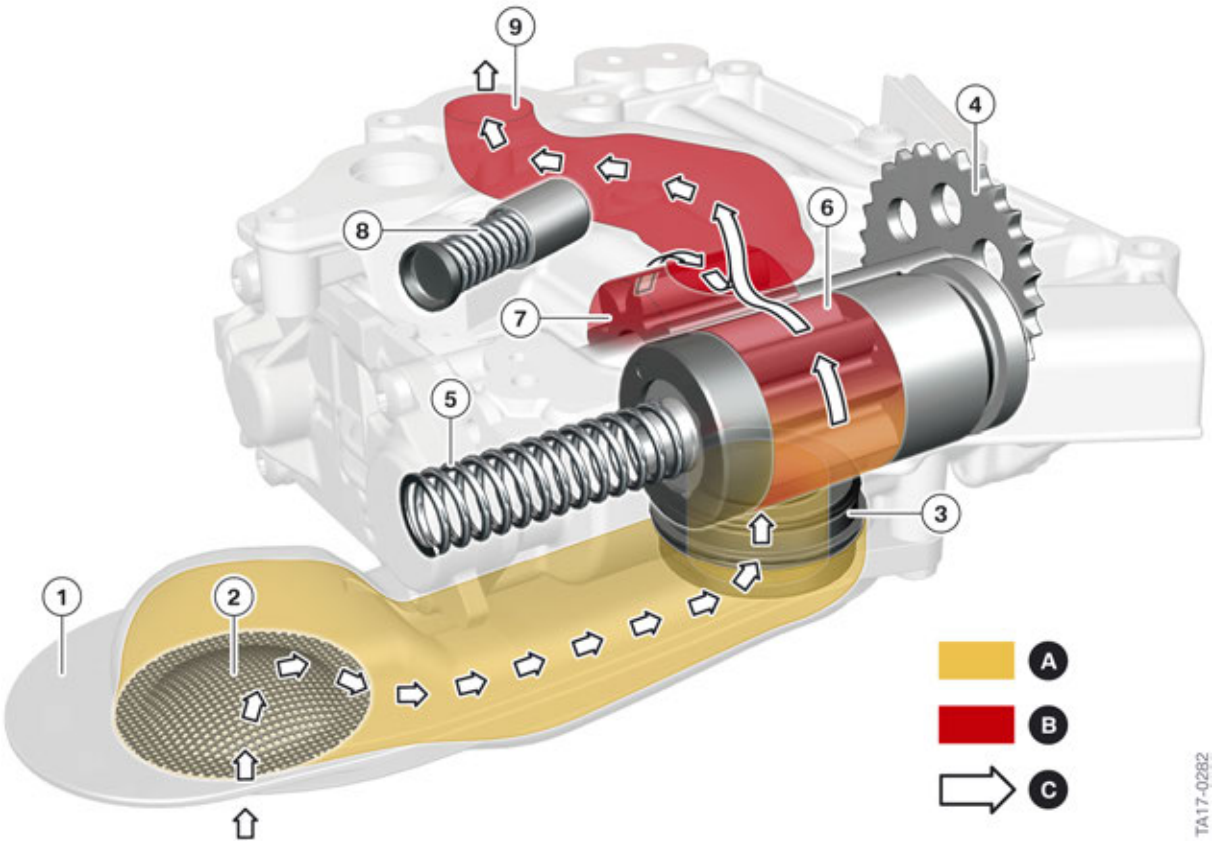
S63B44T4 engine, oil sump with suction pump

Index	Explanation
1	Oil intake snorkel, sump, rear
2	Pressure control spring
3	Drive gear suction pump
4	Pressure relief valve
5	Intake port, sump, front (suction pump)
6	Suction pump impeller
7	Engine oil duct
8	Axially movable impeller
9	Sprocket
10	Control line, second-level control (emergency operation)

Index	Explanation
11	Control line of map control valve (map control pressure)
12	Drive gear for oil pump
13	Control plunger
14	Outlet, suction pump

From the oil intake snorkel, the oil is pumped by the external gear oil pump via the gears into the engine oil duct, into the engine block and to the oil filter.

The non-driven oil pump gear can be axially shifted in this pump, thereby varying the delivery rate. Axial shifting is effected by the oil pressure from the filtered oil duct coming from the main oil duct, which can be varied via the map control valve by means of a control piston. The operating principle of the external gear oil pump ensures that the required oil quantity and the oil pressure are supplied in each case.



S63B44T4 engine, external gear oil pump

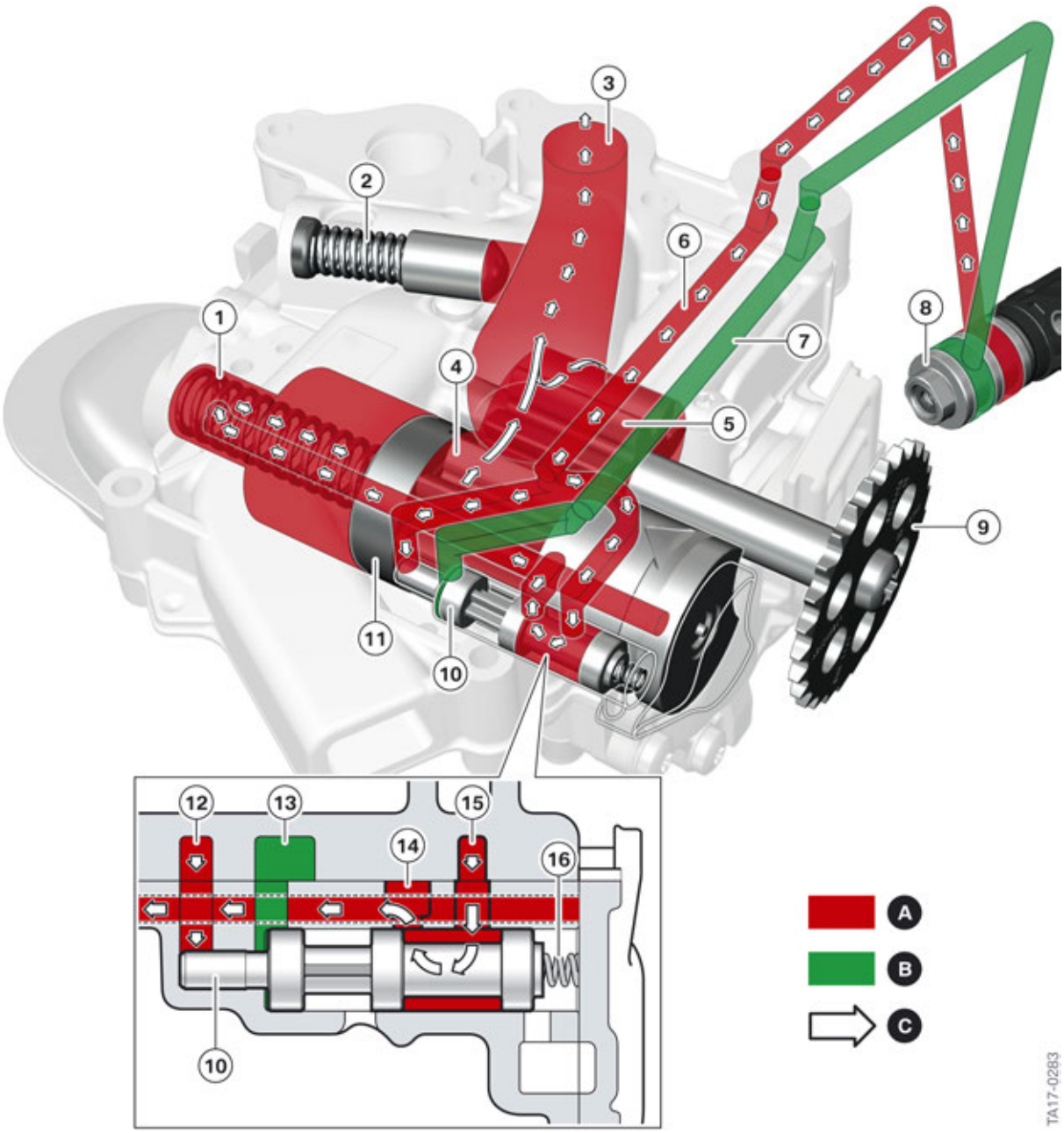
Index	Explanation
A	Intake side
B	Major thrust face
C	Direction of flow/direction of rotation
1	Oil intake snorkel, sump, rear

Index	Explanation
2	Intake pipe with strainer
3	Spring diaphragm
4	Oil pump drive
5	Pressure control spring
6	Axially movable impeller
7	Sprocket
8	Pressure relief valve
9	Oil duct into the engine block (unfiltered oil)

A spring diaphragm (3) is installed at the end of the intake pipe. The spring diaphragm dampens any acoustically unusual pressure vibrations caused by the movement of the unfiltered oil in the intake pipe.

Maximum delivery

In its basic position, the oil pump is held in the maximum delivery position by the pressure control spring (1). This position can also be actively approached via the map control valve (8) from the minimum delivery position. The map control valve (8) is switched so that the oil can flow into the sump via the map control valve (8). This position of the map control valve (8) also transfers the oil pressure from the filtered oil duct via the oil duct (15) to the rear side of the piston pressure side (11) of the axially movable impeller (4). This oil pressure on the piston (11) supports the pressure control spring (1) and presses the axially movable impeller (4) into the maximum delivery position.



S63B44T4 engine, maximum delivery

Index	Explanation
A	Second level control pressure
B	Map control pressure
C	Oil pressure
1	Pressure control spring
2	Pressure relief valve

Index	Explanation
3	Oil duct into the engine block (unfiltered oil)
4	Axially movable impeller
5	Sprocket
6	Control line, second-level control (emergency operation)
7	Control line of map control valve (map control pressure)
8	Map control valve
9	Oil pump drive
10	Control plunger
11	Piston pressure side of the axially movable impeller
12	Second level control pressure
13	Map control pressure
14	Oil duct to the piston pressure side
15	Oil duct coming from the map control valve
16	Control piston spring

Minimum delivery

If the map control pressure is transferred to the larger surface area of the control piston (10) via the control line (7) by the map control valve (8), the map control pressure exceeds the second level control pressure due to the surface area difference on the control piston (10). The map control pressure presses against the control piston spring and thus adjusts the control piston (10) toward minimum delivery. By setting the control piston (10) to minimum delivery, the control piston (10) opens the oil duct on the piston pressure side (16). The filtered oil from the oil duct (15) is now sent to the front piston pressure side (11) of the axially movable impeller (4). On account of the axial shift caused by the oil pressure, the planes of contact of the external gear wheels are reduced and the delivery rate of the filtered oil decreases. The oil on the rear piston pressure side can flow back into the sump via the oil duct outlet (14) and the oil return flow (18).

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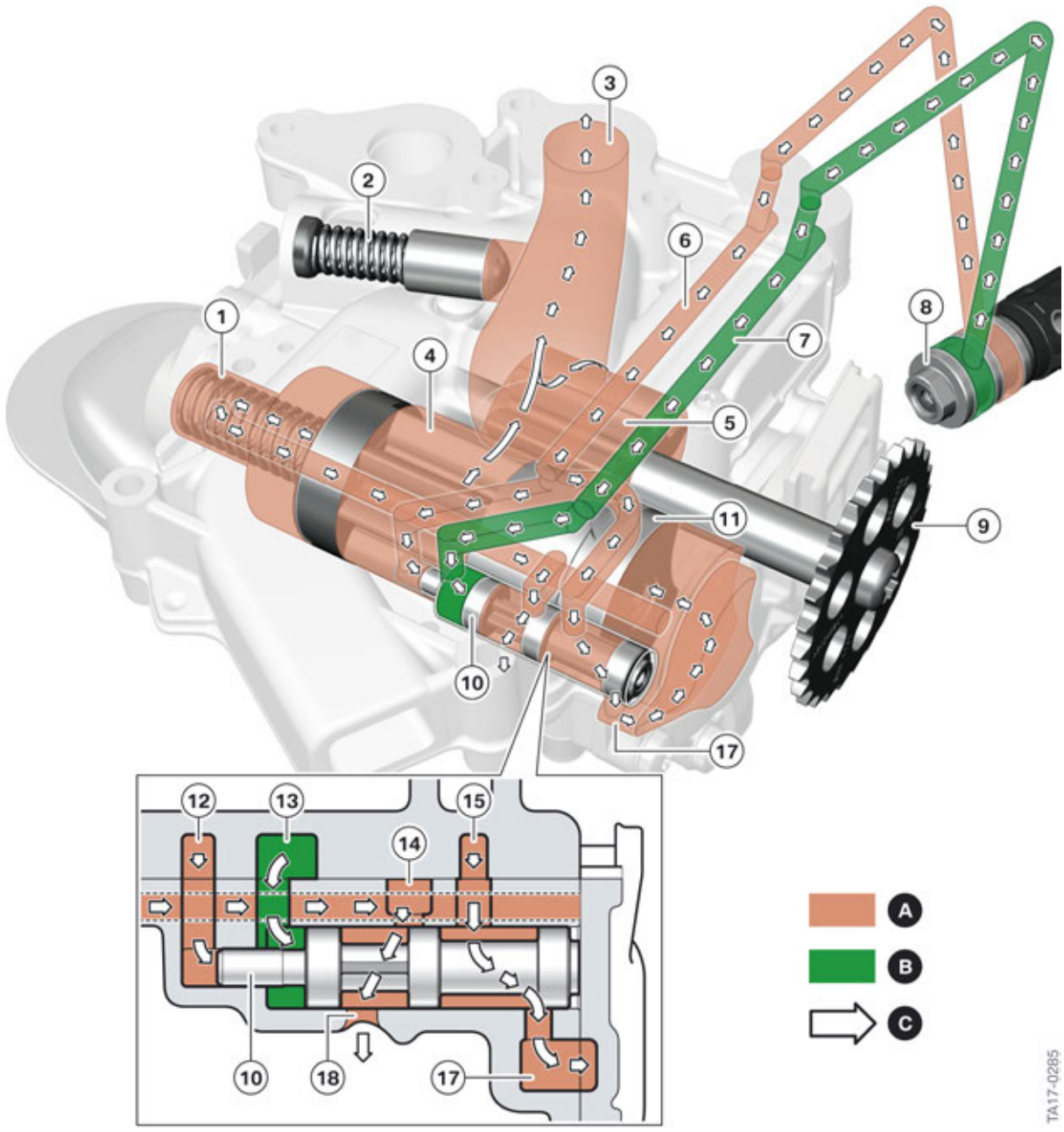


S63B44T4 engine, minimum delivery

Index	Explanation
A	Second level control pressure
B	Map control pressure
C	Oil pressure
1	Pressure control spring
2	Pressure relief valve

Index	Explanation
3	Oil duct into the engine block (unfiltered oil)
4	Axially movable impeller
5	Sprocket
6	Control line, second-level control (emergency operation)
7	Control line of map control valve (map control pressure)
8	Map control valve
9	Oil pump drive
10	Control plunger
11	Piston pressure side of the axially movable impeller
12	Second level control pressure
13	Map control pressure
14	Oil duct outlet
15	Oil duct coming from the map control valve
17	Oil duct to the piston pressure side
18	Oil return from piston to sump

Through the interaction of the map control with the control piston (10), the delivery rate of the oil can be influenced via the axially movable impeller (4) by means of the Digital Motor Electronics (DME).

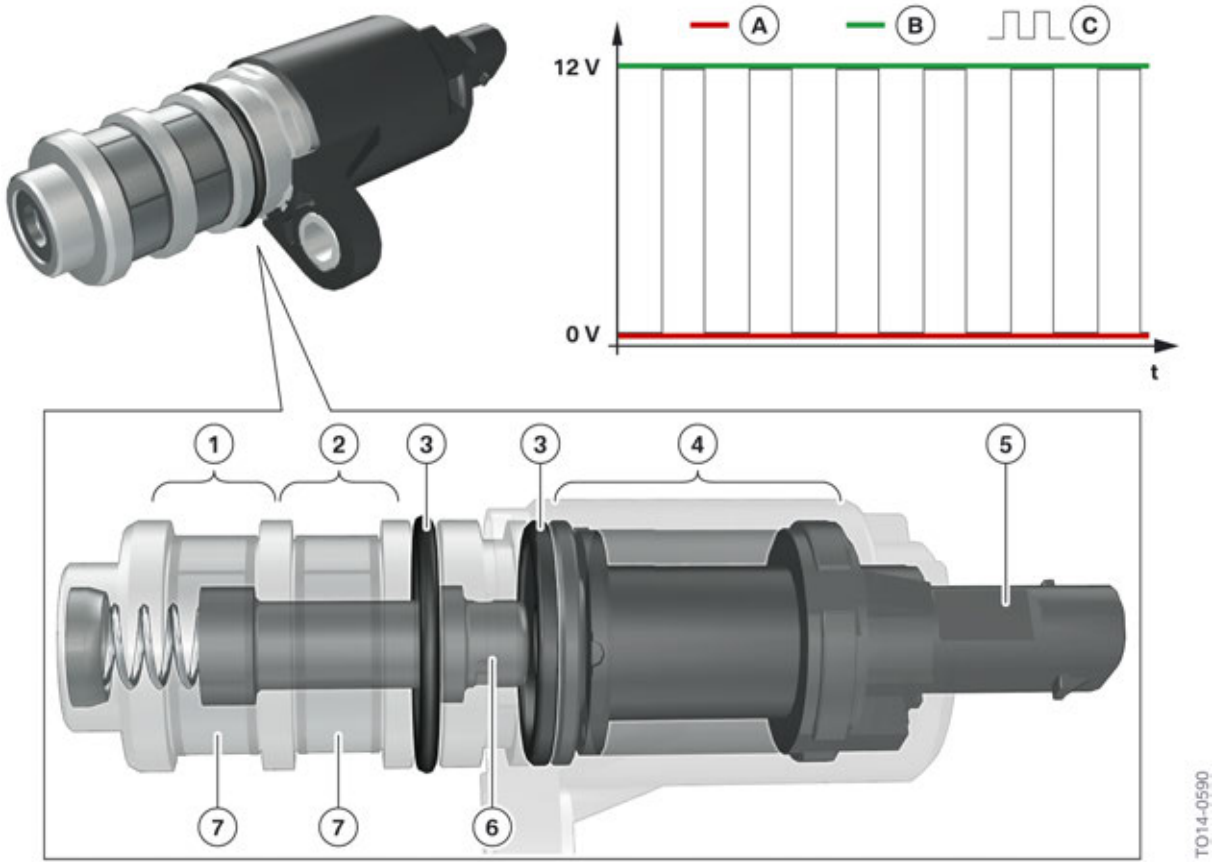
Second-level control (emergency operation)

During normal operation or if the map control fails, the delivery rate is determined via the second level control. The second-level control pressure (6) acts on the smaller, rear surface of the control piston (10). The second level control pressure (6) presses against the control piston spring and thus adjusts the control piston (10) toward minimum delivery. By setting the control piston (10) toward minimum delivery, the control piston (10) opens the oil duct to the front piston pressure side (16). The filtered oil from the oil duct (15) is now moved to the front piston pressure side (11) of the axially movable impeller (4). On account of the axial shift caused by the oil pressure, the planes of contact of the external gear wheels are reduced and the delivery rate of the filtered oil decreases.

4.5.4. Map control valve

On the S63T4 engine, the characteristic map control valve is installed on the oil sump and is connected with the oil pump via bore holes in the oil sump and crankcase. This design negates the need for interference-prone cable ducts into the oil sump.

The map-controlled control valve is a proportional valve which can control the oil pressure seamlessly.



S63B44T4 engine, characteristic map control valve

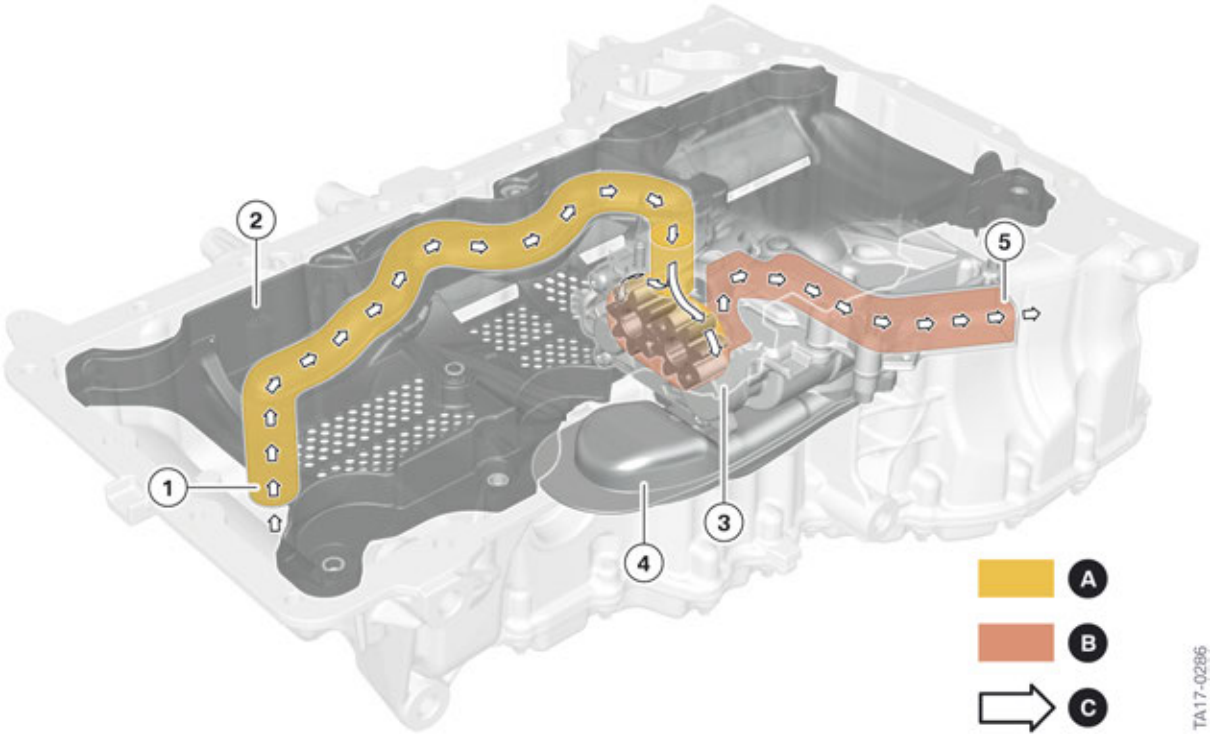
Index	Explanation
A	Voltage value, maximum actuation for control chamber, maximum pressure
B	Voltage value, minimum actuation for control chamber, depressurized
C	Voltage value at 50% actuation
1	Oil duct to oil pump
2	Oil duct from the oil filter
3	Sealing ring
4	Solenoid coil
5	Electrical connection
6	Valve spool
7	Filter

The oil pressure sensor is connected to the main oil duct and delivers the actual oil pressure at the Digital Engine Electronics (DME). The DME calculates the required target oil pressure based on the engine's operating point and the temperature. A pulse-width modulated signal is sent to the map-controlled control valve based on the determined set-point deviation. Depending on the pulse-width modulated signal, the width of the valve spool opening in the map control valve varies. Depending on

the available opening cross-section, more or less engine oil can flow from the oil duct of the oil filter into the oil duct and to the oil pump. This oil flow changes the position of the control piston in the oil pump, and therefore the delivery rate of the pump.

4.5.5. Oil supply during high acceleration

In order to adapt the oil supply to motor racing requirements, a second oil pump was installed as a backup. The second oil pump, the suction pump, supports the return flow of the oil from the front areas of the oil sump back to the rear area of the oil sump.

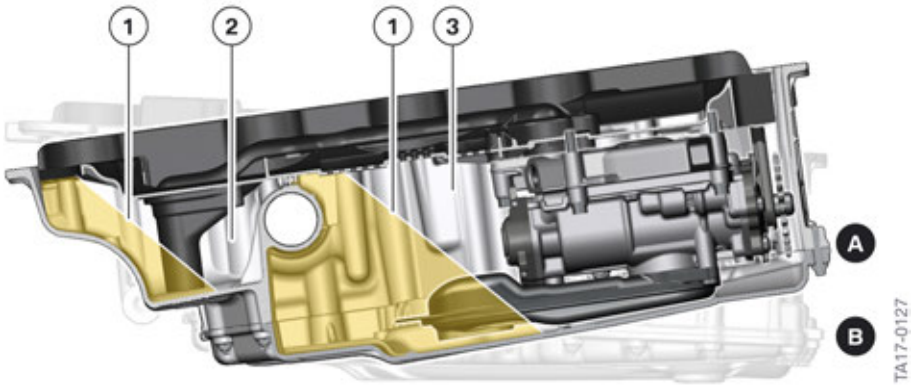


S63B44T4 engine, suction pump

Index	Explanation
A	Intake side
B	Output side
C	Direction of flow/direction of rotation
1	Return pipe
2	Oil deflector
3	Suction pump
4	Oil intake snorkel, sump, rear
5	Return opening

With these changes, the oil supply can be guaranteed up to a longitudinal acceleration of 1.3 g. Even in the case of lateral acceleration, for example during cornering, this structure enables a secure oil supply up to constant 1.3 g.

In these driving situations, the engine oil is drawn out of the front of the sump through the front oil intake snorkel by the suction pump during longitudinal acceleration. The drawn-in oil is delivered back to the rear part of the oil sump via the return flow pipe in the oil deflector. There the external gear oil pump can take up the oil again via the rear oil intake snorkel and deliver it to the engine lubrication points.

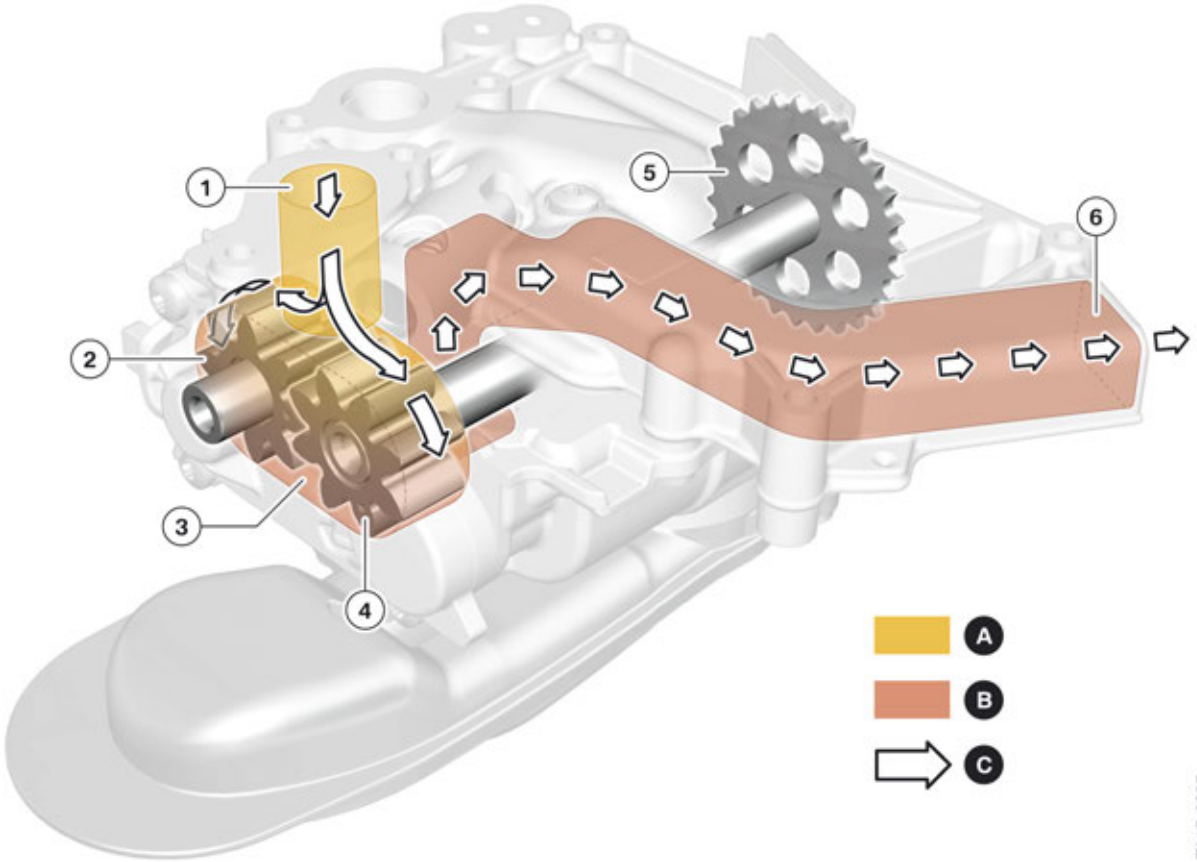


S63B44T4 engine, oil sump with suction pump

Index	Explanation
A	Sump in the event of extremely negative longitudinal acceleration (hard braking)
B	Sump during normal driving
1	Oil level in event of extreme negative longitudinal acceleration (hard braking)
2	Front oil sump
3	Rear oil sump

The suction pump is a external gear pump. The outer upper chamber of the gear pump is the suction chamber. The oil intake snorkel from the front sump is connected to the suction chamber and the engine oil is drawn off through the return flow pipe in the oil deflector.

The lower chamber is a pressure chamber. Via the pressure chamber, the drawn-in engine oil is delivered back to the rear oil sump via the return opening in the upper section of the oil pump unit. The engine oil in the rear oil sump is thus available again to the oil pump via the oil intake snorkel.



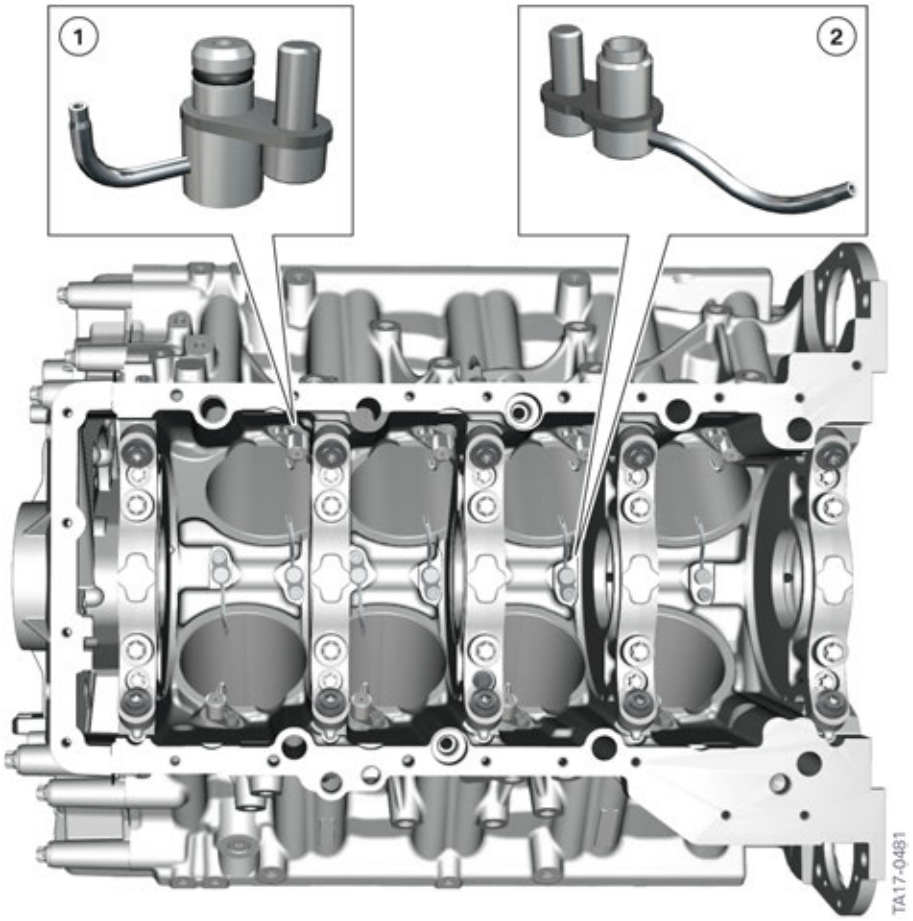
S63B44T4 engine, suction pump

Index	Explanation
A	Intake side
B	Output side
C	Direction of flow/direction of rotation
1	Intake chamber
2	Impeller
3	Pressure chamber
4	Sprocket
5	Oil pump drive
6	Return opening

4.5.6. Oil spray nozzles/piston crown cooling

The oil spray nozzles for piston crown cooling are used from the N63TU2 engine. The difference is, along with the already familiar inner oil spray nozzles, additional outer oil spray nozzles have been added as well. The oil spray nozzles incorporate a non-return valve to enable them to open and close only from a specific oil pressure. The opening pressure and closing pressure have been adjusted

compared with the N63TU2 engine. Each cylinder features 2 oil spray nozzles, one inner and one outer, that have the right mounting orientation on account of their styling. In addition to the piston crown cooling, these are also responsible for the lubrication of the wrist pins.



S63B44T4 engine, oil spray nozzles for the piston crown cooling

Index	Explanation
1	Outer oil spray nozzle
2	Inner oil spray nozzle (as in the N63TU2 engine)

Thanks to the oil pump, supplemented by the characteristic map control, the oil pressure can be reduced to under 3.3 bar in the warm-up phase. As a result of this reduction, there is insufficient oil pressure at the oil spray nozzles to open the nozzles. This measure also suppresses the intended function of the oil spray nozzles, namely to cool the piston crowns in the warm-up phase. The effect of this is that the piston crowns heat up faster and thus less fuel is condensed at the cold piston crowns in the warm-up phase, resulting in higher particle values as a result of unburned fuel. When a certain operating temperature is reached, the oil pressure is increased by the characteristic map control of the volume-flow-controlled oil pump, which raises the oil pressure to above the opening pressure for the oil spray nozzles and thus activates the piston crown cooling.

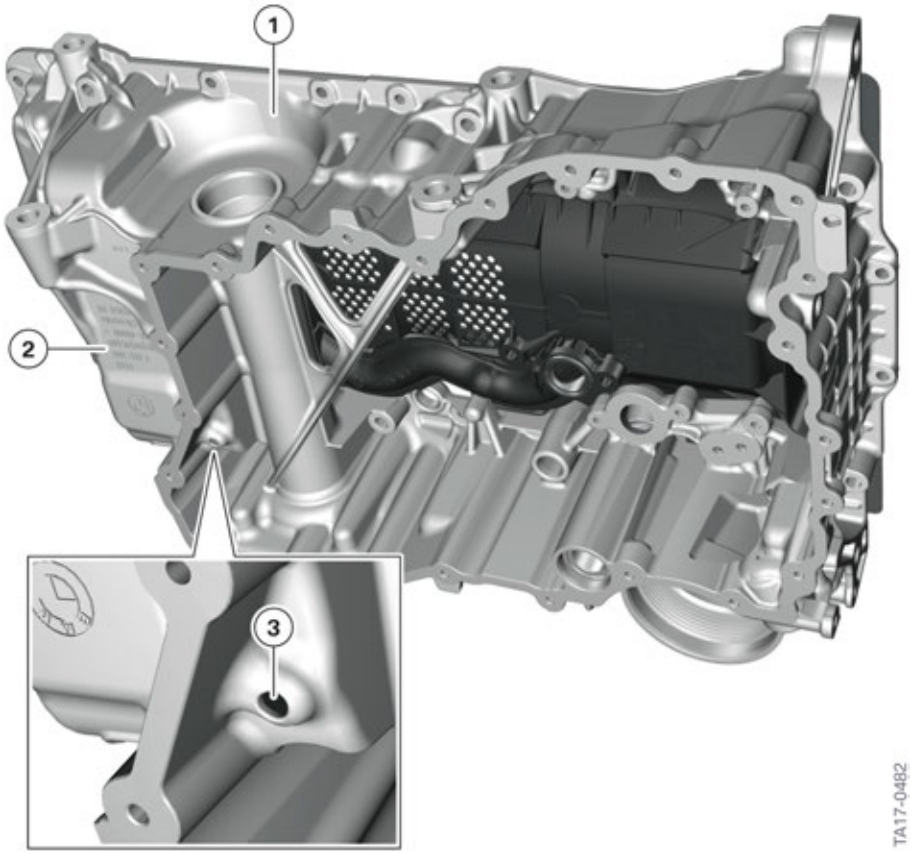
The oil spray nozzles are not opened until an oil pressure of 4.4 bar is reached in order to ensure sufficient piston crown cooling under a high engine load.

	S63B44T2 engine	S63B44T4 engine
Inner oil spray nozzle		
Opening pressure	2.25-2.65 bar	3.3-3.7 bar
Closing pressure	2.0 bar	3.0 bar
Outer oil spray nozzle		
Opening pressure	—	4.5 bar
Closing pressure	—	4.2 bar

4.5.7. Service information

Similarly to other BMW M vehicles with S engines, **one** engine oil change is scheduled at 1,200 mile (running-in check) on the F90 with the S63B44T4 engine.

To ensure that the engine oil in the front, smaller sump is drained completely during an engine oil service, the upper section of the sump features a small drain hole through which the engine oil can flow to the rear sump.



S63B44T2 engine, drain hole

Index	Explanation
1	Front, smaller oil sump
2	Rear oil sump
3	Drain hole

The current engine oil recommendations and capacities can be a found in the current documentation of the BMW workshop information system (ISTA) or the vehicle Owner's Handbook.

4.6. Exhaust emission system

4.6.1. Exhaust turbocharger

As already featured in the S63B44T2 engine, 2 twin-scroll technology exhaust turbochargers are used.

The exhaust turbochargers are supplied with exhaust gas as in the S63B44T2 engine via 2 cross-bank 4-in-2 exhaust manifolds, which is required for the special function of the twin-scroll exhaust turbocharger.

The S63B44T4 engine has 2 exhaust turbochargers supplied by Honeywell. The exhaust turbochargers are twin-scroll exhaust turbochargers and, with the exception of the compressor and wastegate valve actuation, were taken over from the S63B44T2 engine. The compressor and impellers were newly designed for the S63B44T4 engine and thus adapted to its performance structure. Both exhaust turbochargers are a common part for both banks. As on the N63TU2 engine, a blow-off valve was removed.

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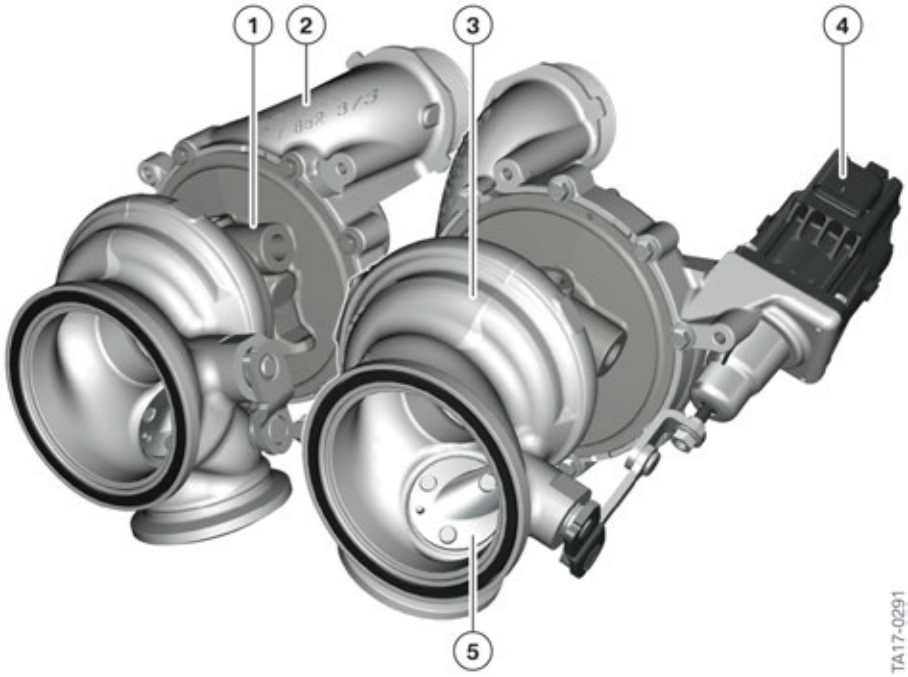


S63B44T4 engine, exhaust turbocharger

Index	Explanation
1	Bearing seat
2	Compressor housing
3	Turbine housing
4	Electric wastegate valve controller
5	Single-part wastegate valve

One-piece wastegate valves are used, increasing robustness.

On installation, precise alignment of the exhaust turbocharger is necessary. Please strictly observe the repair instructions!

Charging pressure control

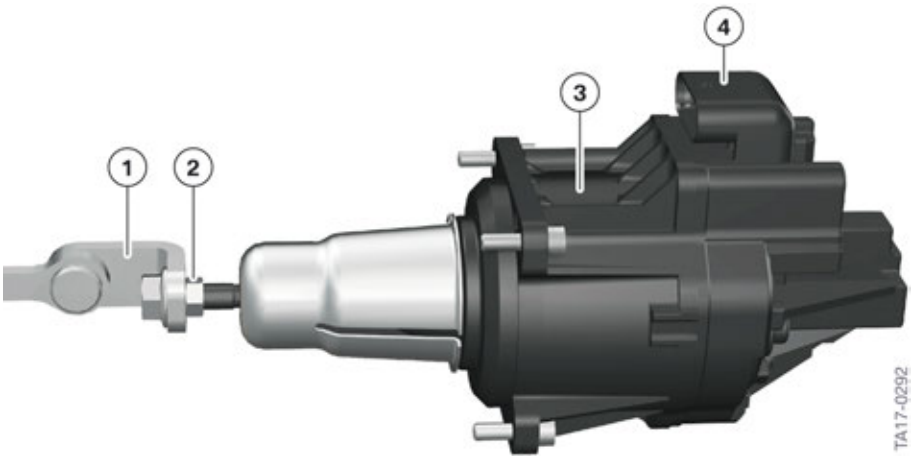
An electrical wastegate valve actuator controls the charging pressure control on the S63B44T4 engine.

In contrast to a vacuum-controlled charging pressure control, the following components are not required:

- Vacuum unit
- Vacuum lines
- Electro-pneumatic pressure converter
- Vacuum reservoir.

This results in the following advantages:

- Faster control speed
- More precise control
- Simpler diagnosis
- Fewer components
- Larger opening angle of wastegate valve.



S63B44T4 engine, electric wastegate valve controller

Index	Explanation
1	Connecting linkage
2	Adjusting linkage
3	Actuator
4	Plug connection

A direct current motor and a sensor are located in the electric wastegate valve controller. resulting in a total of 5 electrical connections on the component. The wastegate valve is opened or closed by a lifting movement of the linkage.

The electric wastegate valve controller can be replaced separately during a service. Each time the adjusting linkage is released, the system must be re-adjusted using the ISTA diagnosis system. This measure is not required when replacing the entire exhaust turbocharger as the linkage is preset.

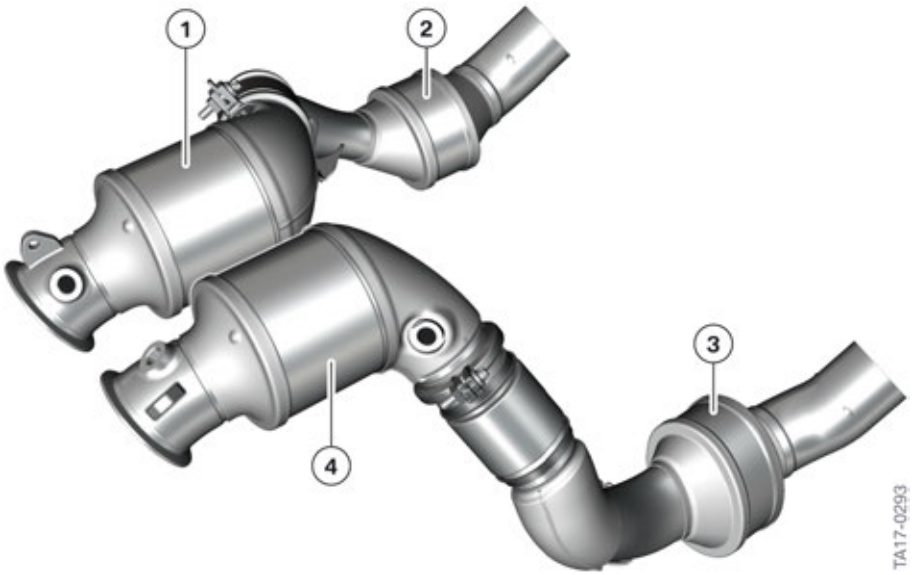
If the electric wastegate valve controller is replaced individually, a teach-in routine must be performed using the ISTA diagnosis system.

The sensor is used to determine the position of the wastegate valve. The wastegate valve can move to any required position between maximum open and maximum closed. When the sensor signal or actuator drops out, the wastegate valve adopts the open position to allow charging pressure to build up. This ensures the journey continues with reduced engine performance.

As the position sensor is a linear Hall sensor, a resistance measurement for testing the sensor is not permitted.

4.6.2. Catalytic converter

The S63T4 engine has 2 catalytic converters per cylinder bank, each with one ceramic monolith.



S63B44T4 engine, catalytic converters

Index	Explanation
1	Catalytic converter near engine, bank 1
2	Secondary catalytic converter, bank 1
3	Secondary catalytic converter, bank 2
4	Catalytic converter near engine, bank 2

Oxygen sensor before catalytic converter

The oxygen sensor (LSU 5.2) from Bosch is used as a control sensor before the catalytic converter. The function is comparable to the oxygen sensor (LSU AVD) and therefore is not described in detail here. This oxygen sensor was used in the S63T4 engine for the first time.

The oxygen sensor before catalytic converter (LSU 5.2) is characterized by the following advantages:

- High signal running, especially in charged operation due to lower M dynamic pressure dependence
- Increased durability thanks to reduced pump voltage
- Increased accuracy
- Rapid operating readiness < 7 s
- Higher heater output at 10 W
- Increased temperature compatibility
- Improved system connector with better contact properties.

The LSU 5.2 has an extended measuring range. It is thus possible to measure precisely from oxygen sensor 0.65 and higher. The new oxygen sensor is operational earlier, meaning exact measured values are available after only 7 s.

The measuring dynamics of the sensor is higher, whereby it is possible to determine the air/fuel ratio in each cylinder separately and thus also control it. As a result, a homogeneous exhaust flow can be adjusted, the emission levels lowered and the long-term emission behavior optimized.

Oxygen sensor after catalytic converter

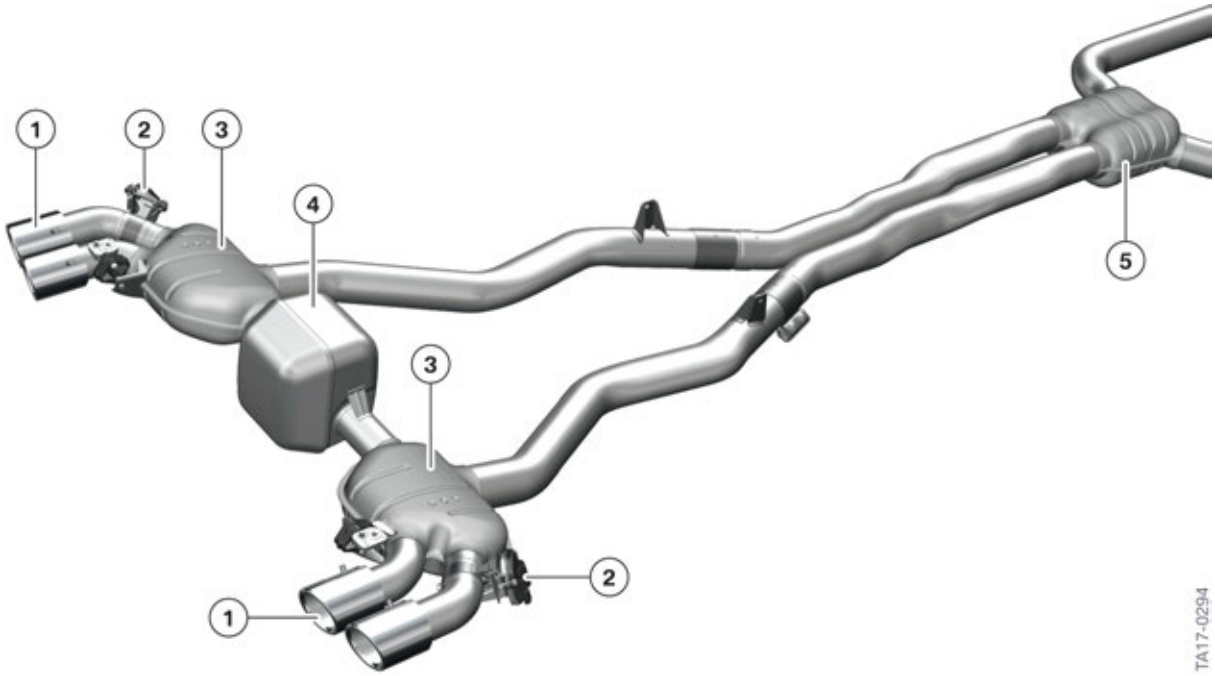
The oxygen sensor after the catalytic converter is also called a monitoring sensor. The monitoring sensor LSF XFOUR from Bosch is used which is the successor sensor to the LSF 4.2.

The LSF Xfour needs the DME 8.8 for signal evaluation and is characterized by the following properties:

- In order to achieve faster response characteristics after the engine has started (halved compared with the LSF 4.2), a heater with a greater degree of regulation has been integrated into the LSF Xfour.
- This improves signal stability.
- Less space is required for installation.
- Thanks to the high temperature resistance and optimal thermal shock protection, the resistance to condensation in the exhaust tract following a cold start has been improved.

4.6.3. Exhaust system

- Pneumatic exhaust flaps replaced by electrical exhaust flaps
- M-specific, emotive startup sound on engine starting
- Sporty and unmistakable feedback of the exhaust sound to the vehicle occupants.



S63B44T4 engine, exhaust system

Index	Explanation
1	Twin tailpipe
2	Electrical exhaust flaps actuator
3	Rear silencer
4	Resonator
5	Center silencer

The production exhaust system of the F90 features chrome-plated tailpipe trims as an optical identifying feature.

4.6.4. Sports exhaust system

A sport exhaust system is available as optional equipment on the First Edition M5, as of market introduction.

The design of the sport exhaust system only differs from the production exhaust system in the internal structure of the middle silencer. The inside of the middle silencer features a cross connection of the two exhaust pipes from bank 1 to bank 2, in addition to the perforated transitions. This design measure in the area of the middle silencer creates a sound pattern for the F90 with sport exhaust system that is considerably stronger, wider in bandwidth and more emotional compared to the production exhaust system.

A further, more emotional adaptation of the internal sound in the F90 with sports exhaust system is additionally achieved with a different tuning of the Active Sound Design ASD.

The sport exhaust system of the F90 features black chrome-plated tailpipe trims as an optical identifying feature.

4.6.5. Electrically controlled exhaust flaps

Electrically controlled exhaust flap(s)

The exhaust flap is integrated into the rear silencer in the outer exhaust tailpipes. The exhaust flap is operated by an axially arranged electric motor with integrated gears and electronics. The electrical controller for the exhaust flap has the following connections:

- Voltage supply (+)
- Ground (-)
- Actuating wire (signal line).

At low engine speeds and low engine loads, the noise level can be significantly reduced by closing the exhaust flap. At high engine speeds and high engine loads, the exhaust gas counterpressure can be reduced by opening the exhaust flap.

The exhaust flap is activated (using pulse width modulation) by the Digital Motor Electronics (DME). The input variables are:

- Engine speed
- Engine load
- Driving speed.

The exhaust flap cannot adopt an intermediate setting; it is either fully opened or closed. The flap moves towards the respective mechanical end stop using pulse-width modulated signals (PWM signals). If faults are detected or the actuation stops, or after the engine has been stopped, the preferred position is the closed position. On vehicles with the M Sport exhaust system, the exhaust flap is open in Sport mode.

Electrical exhaust flap	S63B44T4 engine
Installation location	right and left
PWM signal open	10% duty cycle
PWM signal closed	90% duty cycle

The electrical controller of the exhaust flap can be replaced separately. The controller can be moved into an installation position using the ISTA diagnosis system.

The exhaust sound of the F90 is geared towards the F1x M5/M6, but is much more pronounced. The exhaust flaps are operated on a demand-oriented basis and can be influenced by setting the engine dynamics control buttons to **“Efficient”**, **“Sport”** or **“Sport+”**.

Apart from the engine dynamics control buttons, the position of the exhaust flaps can also be influenced by the sound button in the center console switch cluster. Because no default value is stored in the "Efficient" engine dynamics control for the engine start sound that would lower the noise level, it is possible that this would have an unfavorable effect on the sound produced by the vehicle in residential areas. For this reason, the exhaust flaps can be influenced and closed independently of

the engine dynamics control setting to Efficient, Sport or Sport+ via the sound button. By pressing the sound button, the sound produced can quickly be changed to a quieter exhaust sound without influencing the engine dynamics control settings.

The sound button is connected with the Body Domain Controller (BDC) via a LIN bus.

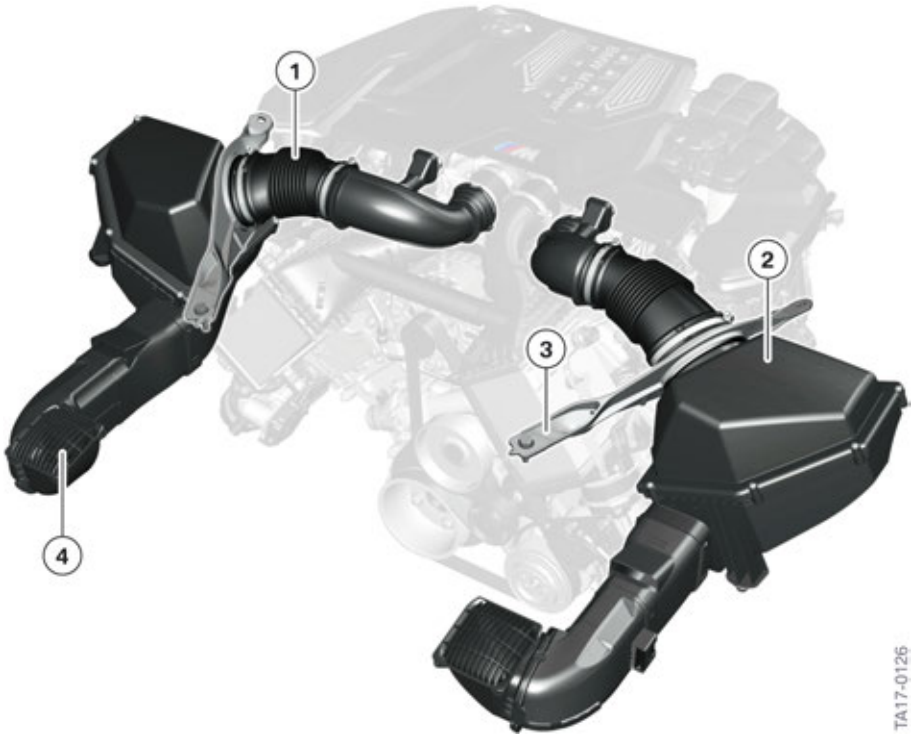
Please note that the outer exhaust flaps on the S63B44T4 engine may be closed when idling. As such, no emission measurement can be performed at these exhaust tailpipes.

4.7. Air intake system

4.7.1. Air duct

The air intake system was newly adapted to the F90. The most important change to the air intake system is the adaptation of the design in order to fit the space in the F90 engine compartment.

By eliminating the hot film air mass meter and optimizing the clean air line without compromising in terms of the front end stiffness, the pressure losses in the air intake duct/clean air line could be improved by approximately 28% although the air flow rates increased for the S63T4 engine.



S63B44T4 engine, intake silencer

Index	Explanation
1	Clean air pipe
2	Air filter housing
3	Strut brace with clean air pipe pass through
4	Unfiltered air intake

The front-end struts must be removed and reinstalled to change the air filter insert. The bolting threads on the aluminium pressure cast spring strut dome must be noted. It may be necessary to rework the threads on the aluminium pressure cast spring strut dome using threaded inserts to ensure their strength after multiple replacement cycles.

Current information and specifications can be found in the documents of the BMW workshop information system (ISTA).

4.7.2. Air mass determination

The intake air mass is not measured directly via a hot film air mass meter, but is calculated in the DME. For this calculation, a pre-calculation (filling model) is programmed in the DME. The following signals are applied to this calculation.

Signals:

- VANOS setting (load sensing)
- Throttle valve position (throttling)
- Intake air temperature (air density correction)
- Engine temperature (air density correction)
- Engine speed (cylinder charging)
- Intake manifold differential pressure (throttling correction)
- Ambient pressure (air density based on altitude correction).

The air mass calculated in this way is adjusted and corrected if necessary in line with the oxygen sensor signals (air/fuel ratio) and the injection period (fuel quantity). Should the oxygen sensors fail, a fault memory entry is made in the DME (air mass plausibility). Adjustment to the calculated air mass does not apply in this case.

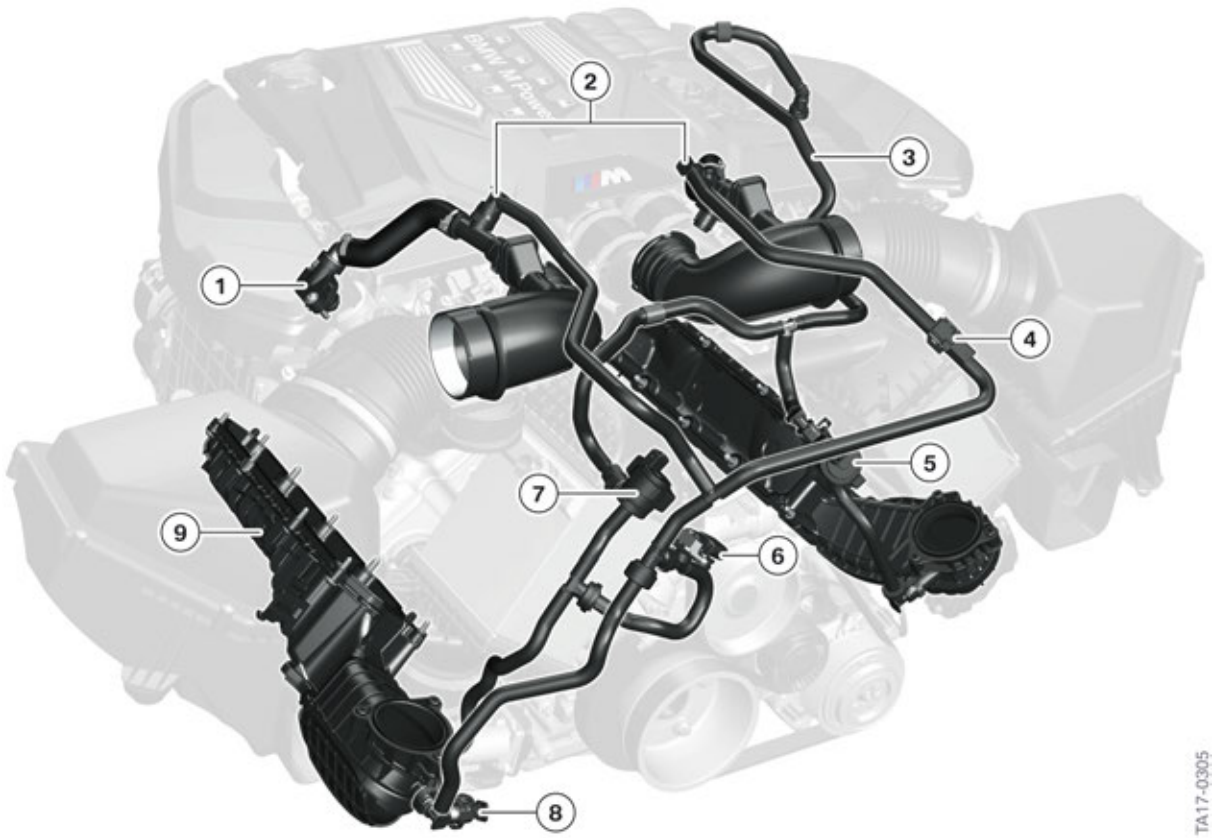
The monitoring of the crankcase ventilation and tank ventilation for leakage, which is legally required in the US, is achieved in the S63T4 engine by means of the crankcase pressure sensor and tank ventilation pressure sensor. For this reason, the hot film air mass meter could also be deleted.

4.7.3. Crankcase ventilation/tank ventilation

Crankcase pressure sensor and tank ventilation differential pressure sensor

Further systems are monitored for compliance with the legally required emission limits. Systems that are included with the S63T4 engine are leak monitoring of the crankcase ventilation and tank ventilation.

To detect a leakage in the crankcase ventilation or tank ventilation, a crankcase pressure sensor and a tank ventilation differential pressure sensor are used in the S63T4 engine and are connected to the engine control units DME 1 and DME 2.



S63B44T4 engine, crankcase pressure sensor

Index	Explanation
1	Crankcase ventilation connection, cylinder head cover
2	Crankcase ventilation/tank ventilation connection on intake system
3	Tank ventilation line to carbon canister
4	Crankcase pressure sensor
5	Tank vent valve, bank 2
6	Tank ventilation differential pressure sensor
7	Tank vent valve, bank 1
8	Crankcase ventilation line connection
9	Intake manifold

Blow-by gases and gases from the tank ventilation contain a large quantity of hydrocarbon concentrates. Existing control systems in the S63T4 engine, such as the crankcase ventilation and tank ventilation, return these gases to the combustion chamber in a controlled manner via the intake system. To ensure that a malfunction such as leakage will not cause noncombustible hydrocarbons to escape into the atmosphere, the crankcase ventilation is monitored by a crankcase pressure sensor and the tank ventilation is monitored by a tank ventilation differential pressure sensor.

The leakage is detected on the basis of defined set-point values in the characteristic map of the DME. For this purpose, the DME performs the following steps:

- Measurement of the pressure in the crankcase ventilation and in the tank ventilation system under an engine load and engine speed defined in the characteristic map.
- Comparison of the actual pressure reading with the set-point pressure value stored in the characteristic map.
- If the set-point pressure value is exceeded, a leakage is detected.
- Output of a Check Control Message for driver information.

A leak is most easily detected by the crankcase pressure sensor and the tank ventilation differential pressure sensor at a medium engine speed between 500 rpm and 3,000 rpm. The engine load for leak detection in the case of the crankcase pressure measurement is between 20% and 80% on average.

Leak detection can also be performed using the hot film air mass meter (HFM). A leak is detected by the HFM on the basis of different air mass flows or mixture adaptations. By using the crankcase pressure sensor and the tank ventilation differential pressure sensor, the HFM can be deleted on the S63B44T4 engine.

The tank ventilation differential pressure sensor is connected to the DME 1, while the crankcase pressure sensor is connected to the DME 2 and also monitored by it.

Carbon canister

A carbon canister with a larger volume is also used. The basic function of the carbon canister has not changed. The greater volume only serves to hold a greater quantity of fuel vapors and to achieve a longer intermediate storage before flushing by the tank vent valve.

S63B44T4 engine, carbon canister

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4. Engine

4.8. Fuel preparation

4.8.1. Low-pressure fuel system

In the F90 with the S63T4 engine, a 20 gallon fuel tank is used.

To monitor the fuel pressure, a fuel low-pressure sensor is used that measures and monitors the fuel pressure on the low-pressure side. The fuel low-pressure sensor is connected to and monitored by the DME 1.

4.8.2. High-pressure fuel system

For the S63T4 engine, the high-pressure injection HDE 6 is used.

Changes were made in regard to the fuel injection pressure, which can now range up to 350 bar. Increasing the fuel injection pressure from 200 bar to 350 bar results in the following advantages:

- Improved fuel atomization
- More efficient air/fuel mixture
- Reduced fuel wall film formation
- Shorter injection periods

These advantages due to the fuel injection pressure increase to 350 bar led to the following improvements:

- Reduction in particle emissions
- Improved engine response under high engine load
- Improved engine response under M dynamic engine operation

Bosch high-pressure fuel injection valves with the designation HDEV 6 with CVO are used. Due to the fuel system pressure increase from 200 bar to 350 bar, the solenoid valve injectors HEDV6 were optimized using suitable materials and coatings. In the high-pressure pump, the pump piston and plunger were modified and the materials were adjusted. Its design is already in use in the previous 3, 4 and 8-cylinder engines.

Work on the fuel system is only permitted after the engine has cooled down. The coolant temperature must not exceed 104°F. This stipulation must be observed without fail, as otherwise there is a risk of fuel being sprayed back on account of the residual pressure in the high-pressure fuel system.

When working on the high-pressure fuel system, it is essential to adhere to conditions of absolute cleanliness and to observe the work sequences described in the repair instructions. Even the slightest contamination and damage to the screwed fittings of the high-pressure lines can cause leaks.

When working on the fuel system of the S63B44T4 engine, it is important to ensure that the ignition coils are not fouled with fuel. The resistance of the silicone material is greatly reduced by sustained contact with fuel. This may result in flashovers on the spark plug head and thus in misfires.

- Before making any modifications to the fuel system, without fail remove the ignition coils and protect the spark plug shaft against ingress of fuel by covering with a cloth.
- Prior to a new installation of the solenoid valve injectors, the ignition coils must be disassembled and the highest possible level of cleanliness ensured.
- Ignition coils heavily fouled by fuel must be replaced.
- The CVO function comprises the system components "Injector" and "Digital Motor Electronics" (DME). These components therefore have to be identified with the vehicle identification number in the EPC in the event of a replacement.
- For injectors and a DME which supports the CVO function, the injection quantity compensation during the replacement of one of the components is omitted.
- An excessive rotational angle at the injector shank, and excessive tensile and compression forces during removal and installation can lead to damage and therefore leaks in the fuel system.
- For any service work required, the current information and specifications in the documents in the Integrated Service Technical Application (ISTA) must be observed in each case.

4.9. Cooling

4.9.1. System overview

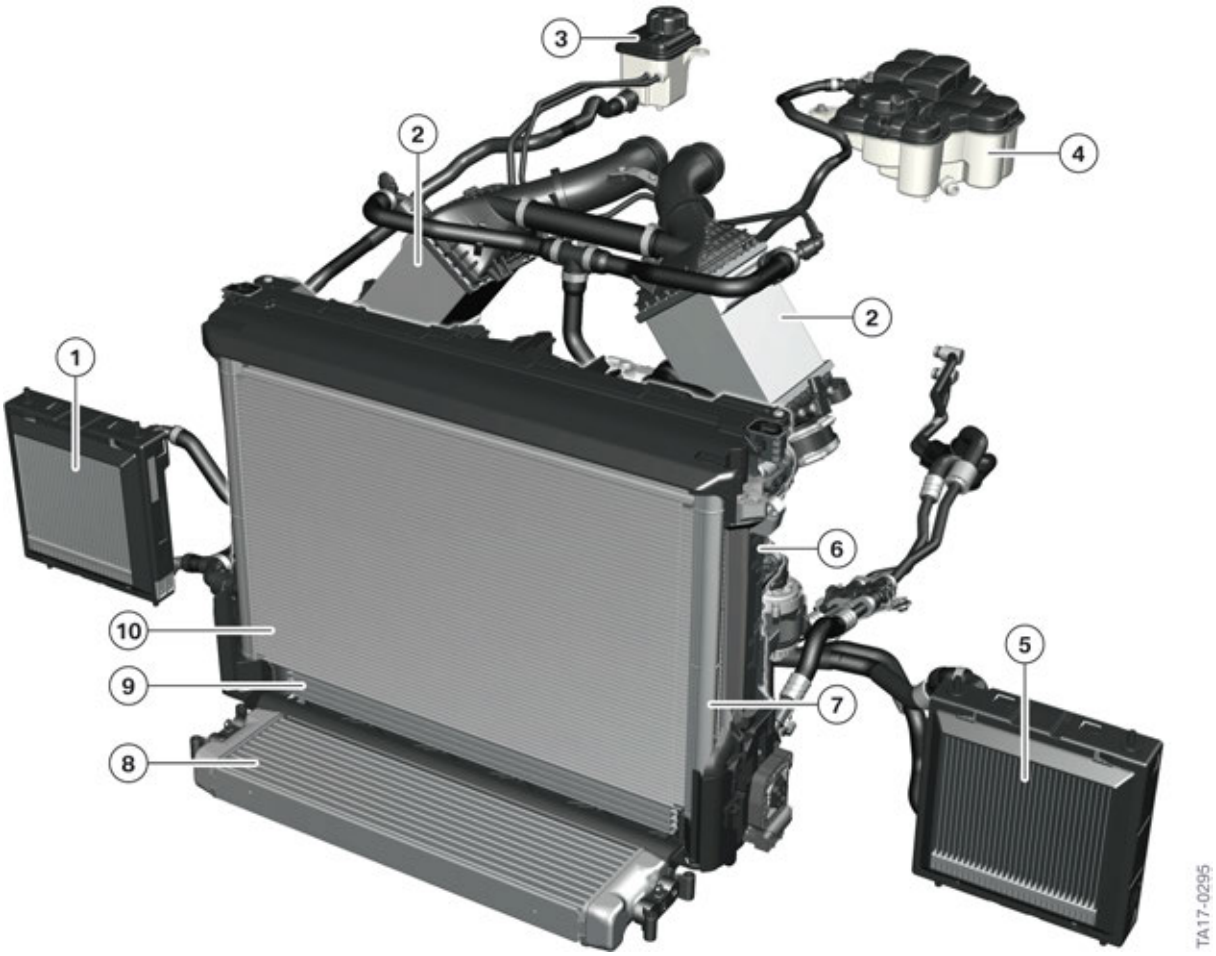
The cooling system too exhibits similarities to the S63B44T2 and N63TU2 engines. The engine and charge air cooling both have separate cooling circuits.

Differences in cooling between the S63B44T2 and S63B44T4 engines:

- Adaptation of the installation position of the additional coolant cooler for charge cooling to F90
- Adaptation of the installation position of the transmission oil cooler to F90
- Adaptation of the installation position of the engine oil cooler to F90
- Adaptation of the installation position of the radiator to F90
- The coolant guide concept in the engine block and cylinder head was taken over from the N63TU2 engine
- Engine cooling coolant hoses optimized by larger cross-sections with regard to coolant flow
- Charge air cooling coolant hoses optimized by larger cross-sections with regard to coolant flow
- Connections on the charge air cooler optimized with regard to coolant flow
- Bypass pipe between the charge air coolers.

F90 Complete Vehicle

4. Engine



S63B44T4 engine, radiator assembly from the front

Index	Explanation
1	Upstream low-temperature radiator, charge air
2	Indirect charge air cooler
3	Expansion tank, low-temperature circuit
4	Expansion tank, high-temperature circuit
5	Auxiliary radiator, engine
6	Radiator, engine
7	A/C condenser
8	Engine oil cooler
9	Transmission oil cooler
10	Low-temperature cooler, charge air

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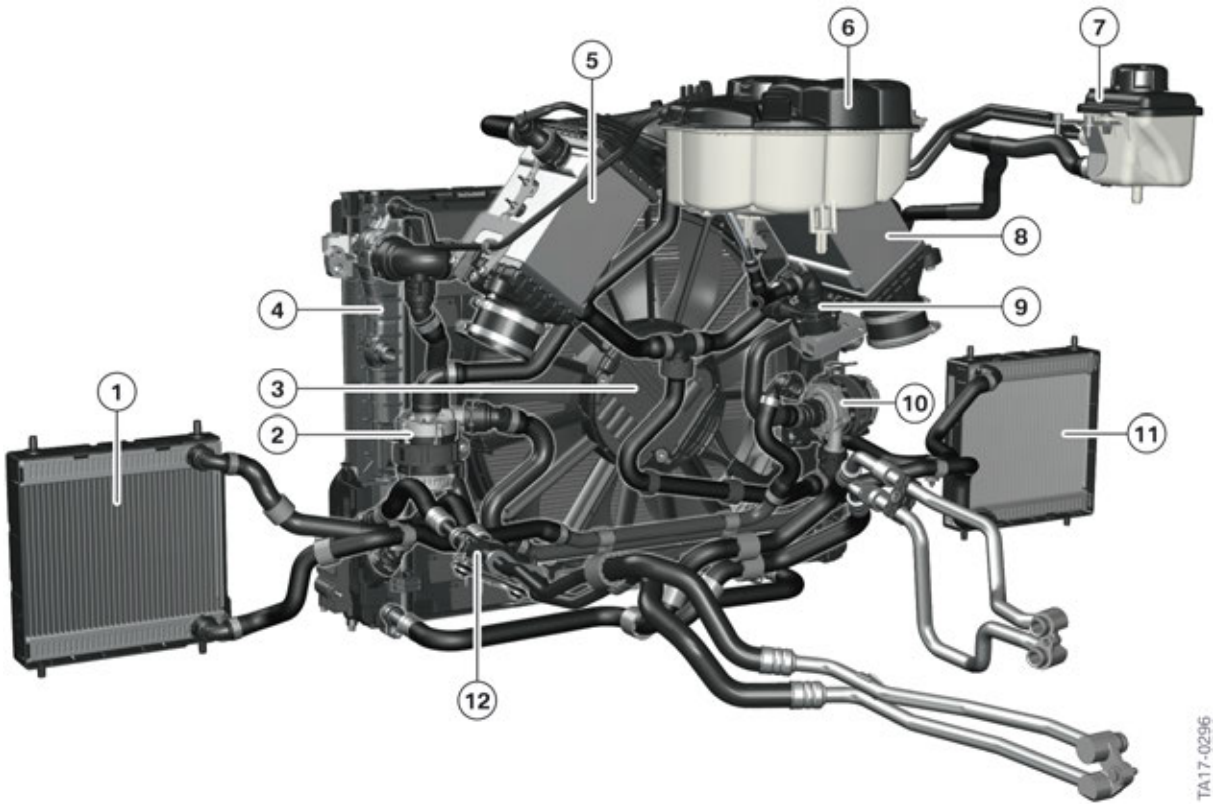
4. Engine



S63B44T4 engine, radiator assembly from the rear

Index	Explanation
1	Auxiliary radiator, engine
2	Electric coolant pump, low-temperature circuit, charge air 2
3	1000 watt electric fan
4	Radiator, engine
5	Indirect charge air cooler, bank 2
6	Expansion tank, high-temperature circuit
7	Expansion tank, low-temperature circuit
8	Indirect charge air cooler, bank 1
9	Electric coolant pump, exhaust turbocharger
10	Electric coolant pump, low-temperature circuit, charge air 1
11	Upstream low-temperature radiator, charge air
12	Thermostat, transmission oil cooler

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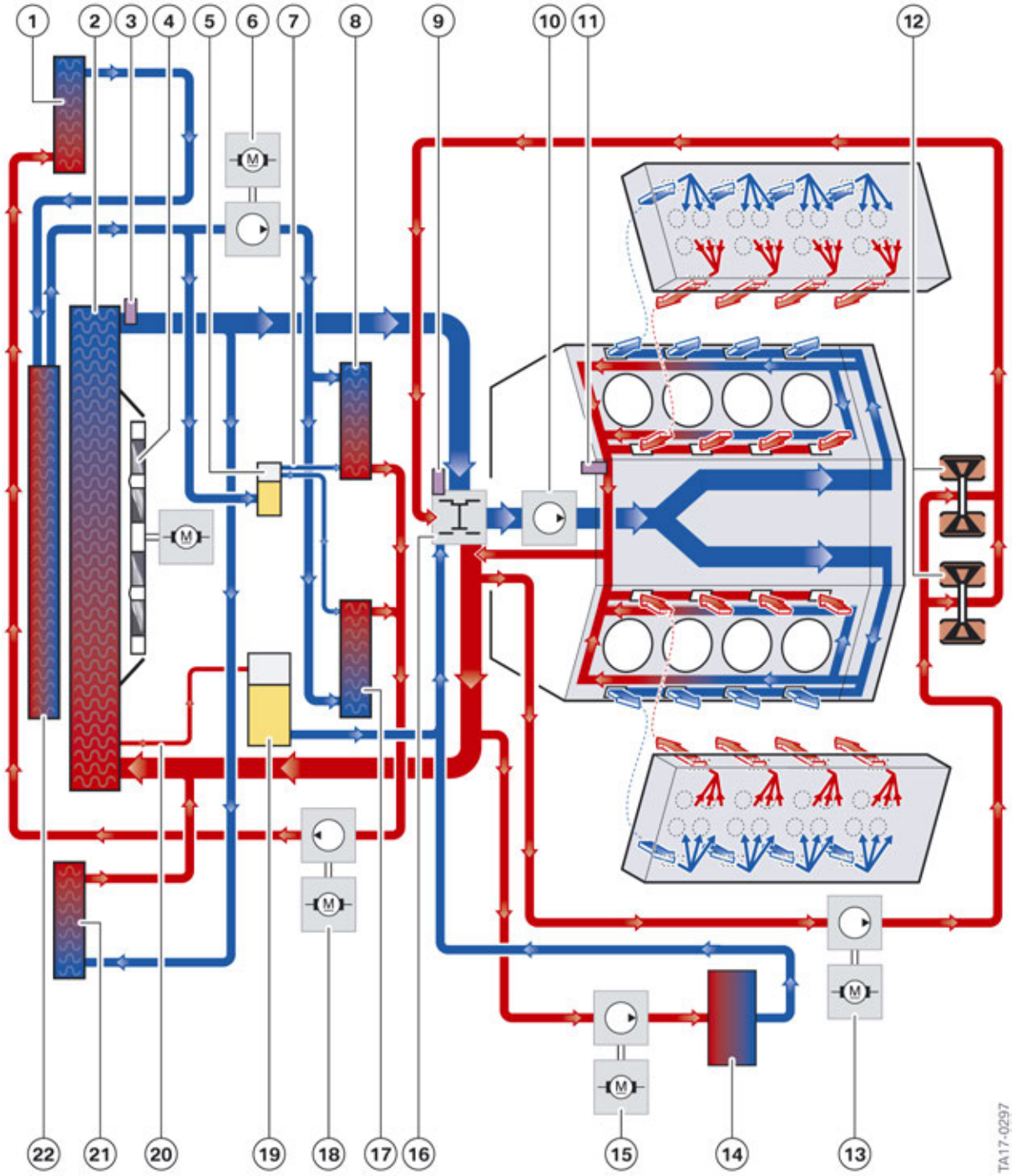
4. Engine



S63B44T4 engine, complete cooling system, schematic

Index	Explanation
1	Upstream low-temperature radiator, charge air
2	Radiator, engine
3	Coolant temperature sensor at radiator outlet
4	Electric fan
5	Coolant expansion tank, low-temperature circuit, charge air
6	Electric coolant pump, low-temperature circuit, charge air 1
7	Ventilation line, low-temperature circuit
8	Indirect charge air cooler, bank 1
9	Heater, map thermostat
10	Mechanical coolant pump
11	Coolant temperature sensor
12	Exhaust turbocharger
13	Electric coolant pump, exhaust turbocharger
14	Heat exchanger for heating system
15	Electric coolant pump, heating, vehicle interior
16	Data-map thermostat
17	Indirect charge air cooler, bank 2
18	Electric coolant pump, low-temperature circuit, charge air 2
19	Coolant expansion tank, engine
20	Tank ventilation line
21	Auxiliary radiator, engine
22	Low-temperature cooler, charge air

4.9.2. Engine and exhaust turbocharger

The engine cooling system is an independent coolant circuit known as the "**high-temperature circuit**". It comprises the conventional engine cooling and cooling of the turbochargers. The vehicle interior heating is also supplied by the coolant circuit of the engine cooling system.

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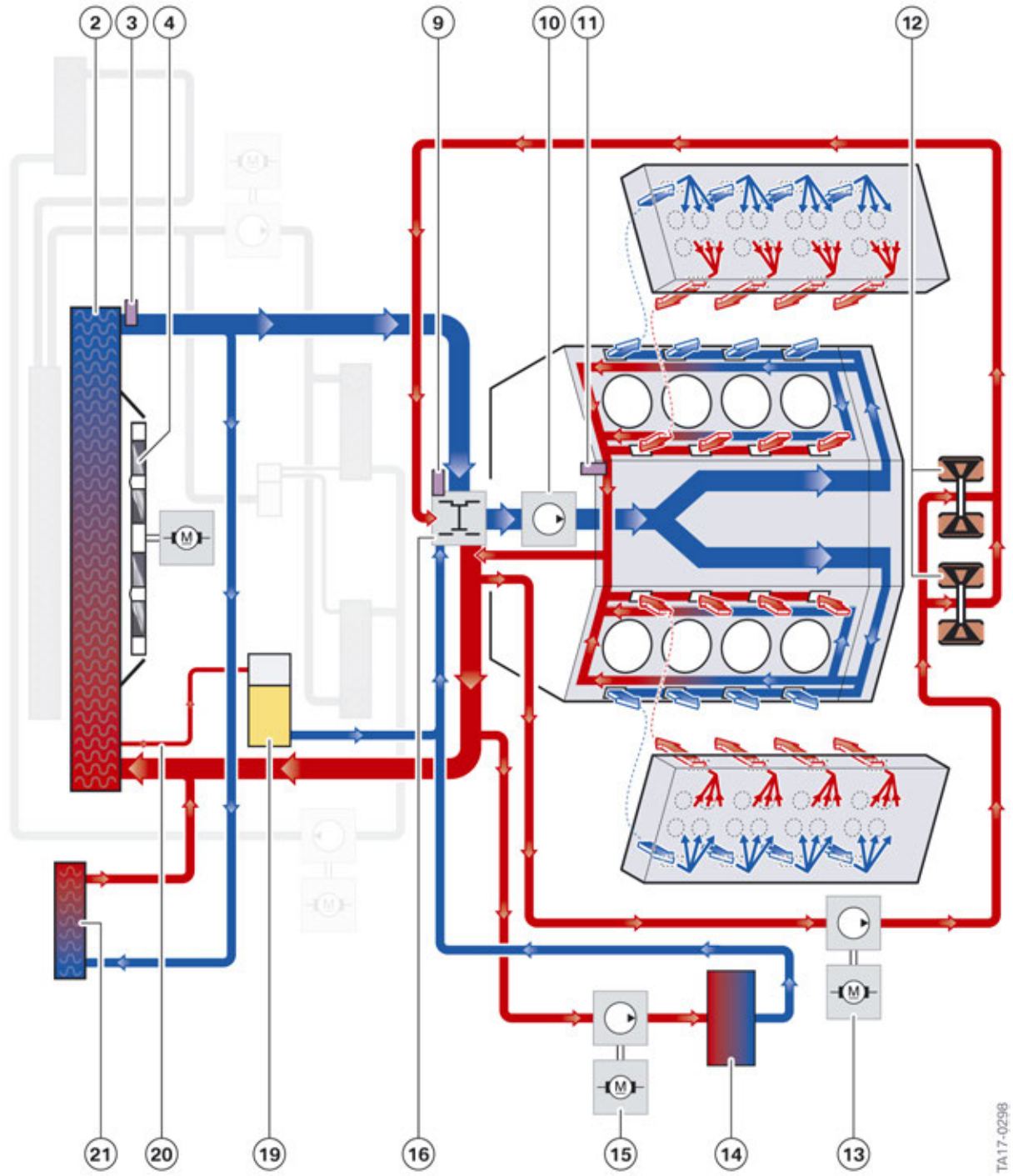
4. Engine



S63B44T4 engine, cooling for turbocharger, schematic

F90 Complete Vehicle
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Index	Explanation
2	Radiator, engine
3	Coolant temperature sensor at radiator outlet
4	Electric fan
9	Heater, map thermostat
10	Mechanical coolant pump
11	Coolant temperature sensor
12	Exhaust turbocharger
13	Electric coolant pump, exhaust turbocharger
14	Heat exchanger for heating system
15	Electric coolant pump, heating, vehicle interior
16	Data-map thermostat
19	Coolant expansion tank, engine
20	Tank ventilation line
21	Auxiliary radiator, engine

The conventional coolant pump is driven via a belt and cannot be used for cooling the exhaust turbocharger after the engine has shut down. For this reason there is an electric coolant pump, which works at a power of 20 W, for this separate coolant circuit. But also during engine operation the electric coolant pump is switched on taking into account the following factors:

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

Using these values the heat input to the engine is calculated. The after-run of the electric coolant pump can last up to 30 minutes. To improve the cooling effect, the electric fan is activated and can run for up to a max. of 11 minutes.

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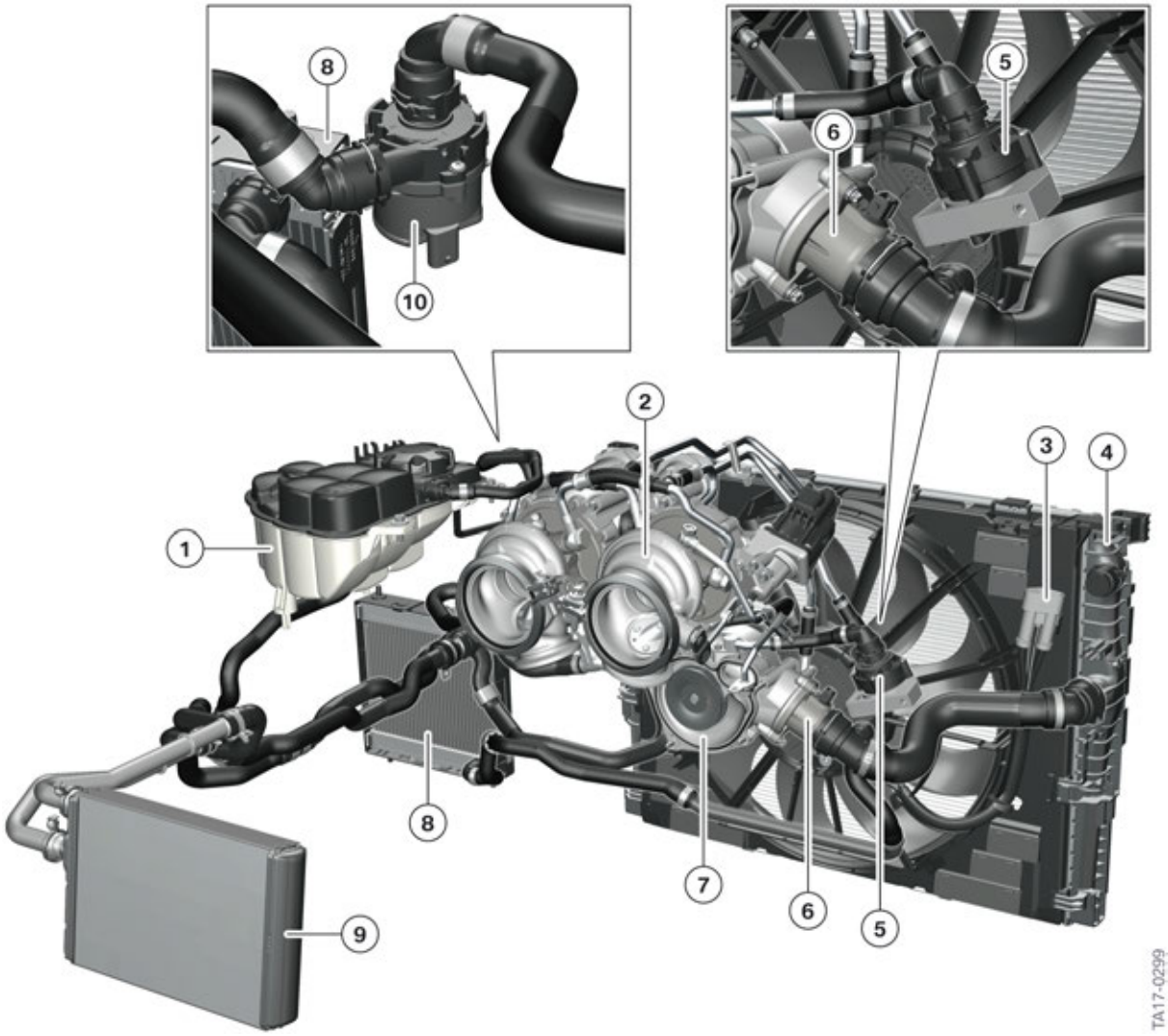
4. Engine



S63B44T4 engine, engine cooling with turbocharger, components

Index	Explanation
1	Coolant expansion tank, engine
2	Exhaust turbocharger
3	Electrical connection, electric fan
4	Radiator, engine
5	Thermostat
6	Mechanical coolant pump
7	Auxiliary radiator, engine
8	Heat exchanger for heating system
9	Electric coolant pump, heating, vehicle interior

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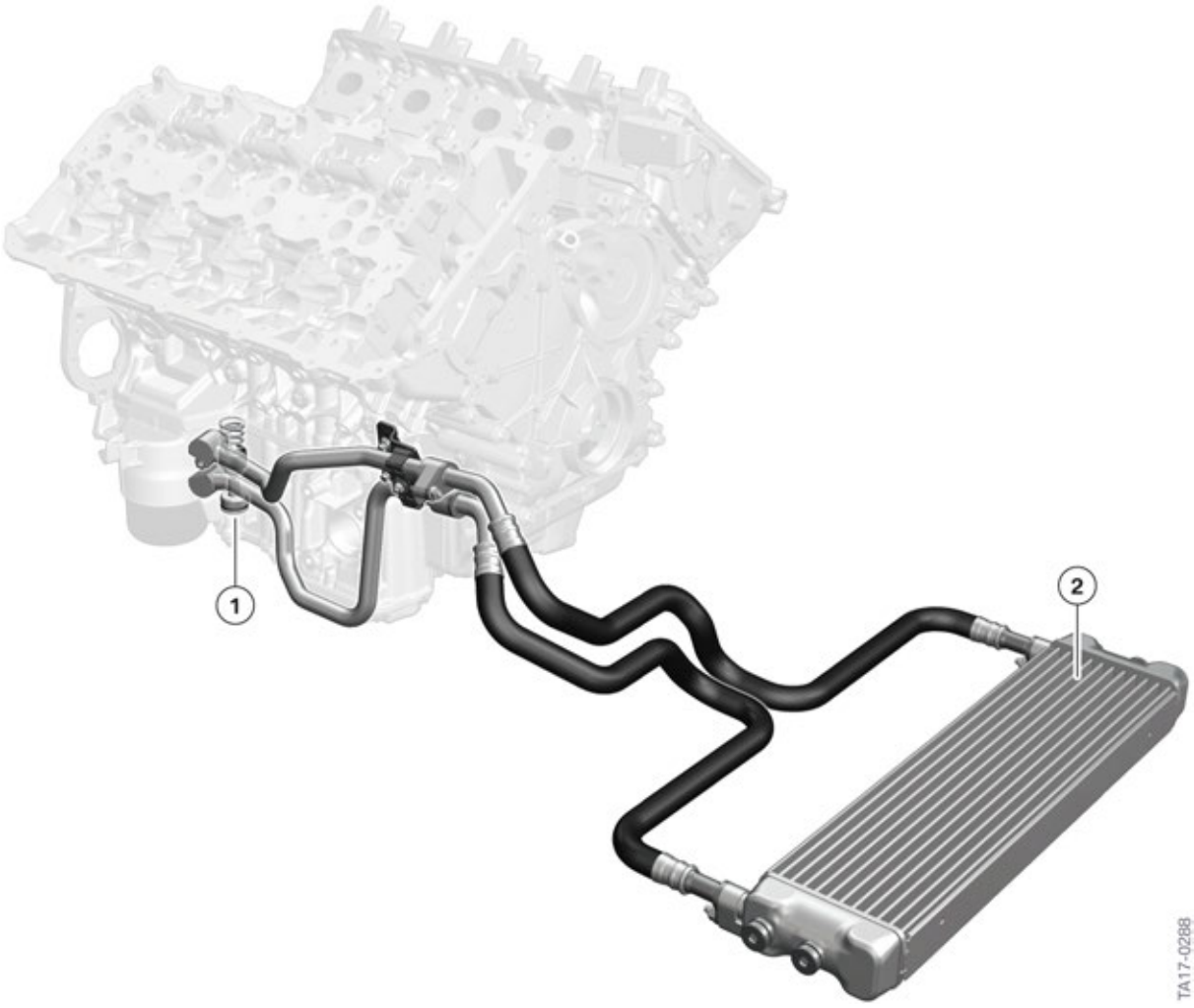
4. Engine

4.9.3. Engine oil cooling

The S63T4 engine has an air-coolant heat exchanger for cooling the engine oil which is built-in flat in front of the cooling module. To make possible quick heating-up of the engine oil, a thermostat is integrated in the oil sump upper section. The thermostat releases the flow to the engine oil cooler at an engine oil temperature of 212°F and is fully open at an engine oil temperature of 293 °F.



S63B44T4 engine, engine oil cooling

Index	Explanation
1	Thermostat
2	Upstream engine oil cooler

4.9.4. Charge air cooling

For charge air cooling, the system again makes use of an "**indirect**" charge air cooling, which is cooled by a separate coolant circuit, the "**low-temperature circuit**".

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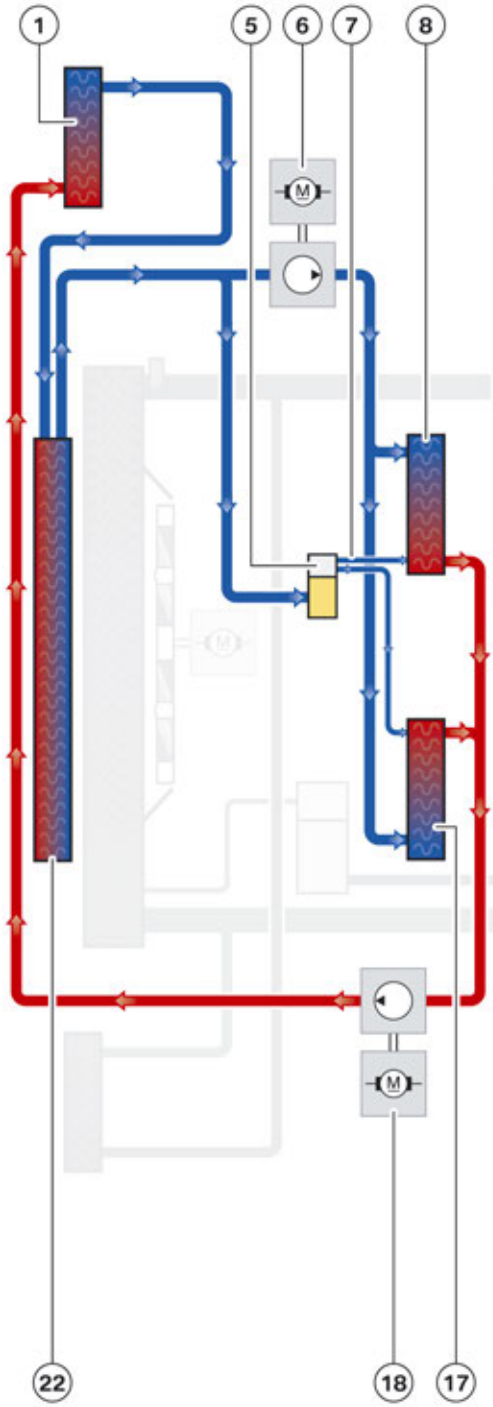
4. Engine

Because a large surface area is available to the F90 for the radiators at the front of the vehicle, 2 low-temperature charge air coolers are used. One low-temperature charge air cooler is located directly after the front of the vehicle as the first component of the radiator assembly. A second low-temperature charge air cooler is located on the right next to radiator assembly. These 2 low-temperature charge air coolers are supplied with coolant via an independent cooling system with 2 electric coolant pumps.



S63B44T4 engine, charge air cooling, schematic

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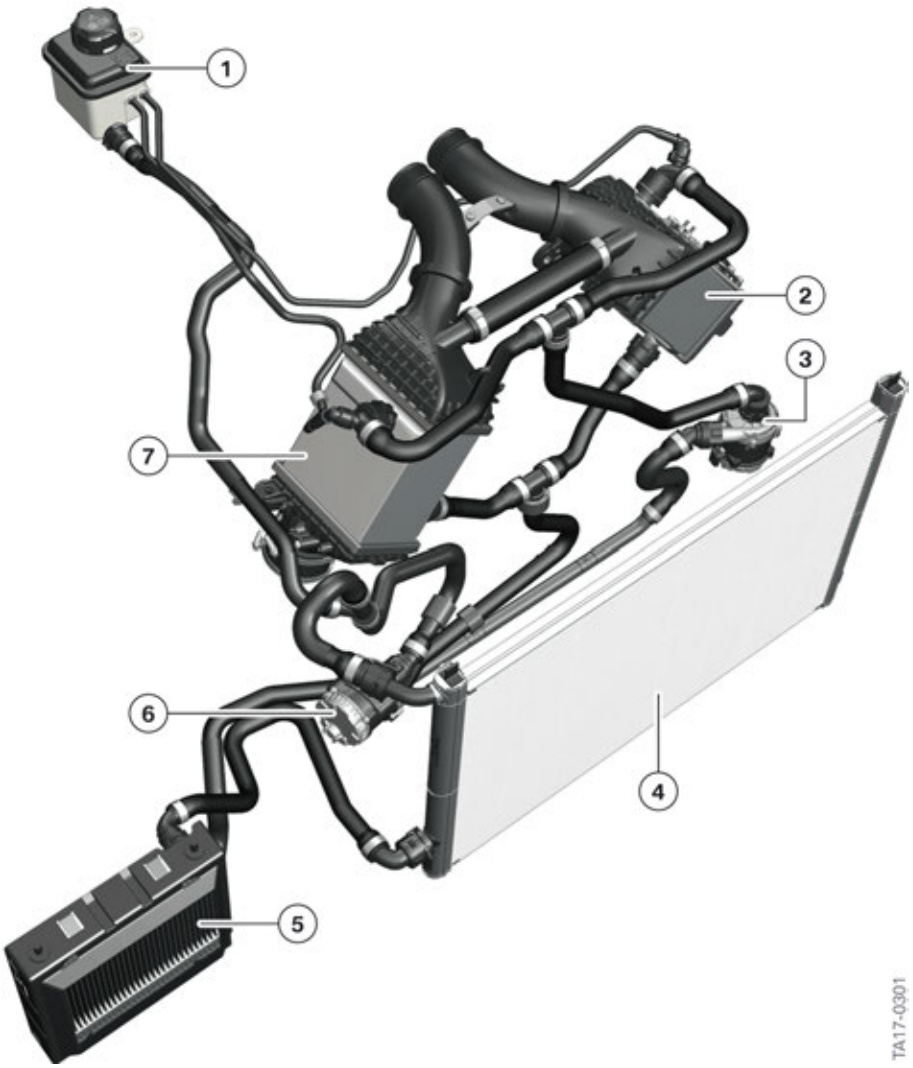
4. Engine

Index	Explanation
1	Upstream low-temperature radiator, charge air
5	Coolant expansion tank, low-temperature circuit, charge air
6	Electric coolant pump, low-temperature circuit, charge air 1
7	Ventilation line, low-temperature circuit
8	Indirect charge air cooler, bank 1
17	Indirect charge air cooler, bank 2
18	Electric coolant pump, low-temperature circuit, charge air 2
22	Low-temperature cooler, charge air



S63B44T4 engine, charge air cooling components

Index	Explanation
1	Coolant expansion tank, low-temperature circuit, charge air
2	Indirect charge air cooler, bank 2
3	Electric coolant pump, low-temperature circuit, charge air 2
4	Low-temperature cooler, charge air
5	Upstream low-temperature radiator, charge air
6	Electric coolant pump, low-temperature circuit, charge air 1
7	Indirect charge air cooler, bank 1

The S63B44T4 engine again uses 2 electric auxiliary coolant pumps, as on the S63B44T2 engine, for the charge air cooling low-temperature circuit. Unlike on the S63B44T0 engine, which had an additional auxiliary low-temperature charge air coolant radiator on each cylinder bank, plus an additional electric coolant pump for the charge air low-temperature circuit, the S63B44T4 engine utilizes a pump for the feed and a pump for the return. The indirect charge air coolers are connected in series to the respective circuit.

Both 50 W pumps have self-diagnosis and dry-running protection, which can lead to fault code entries in the DME. If the engine speed is increased by 15 minutes over a period, the auxiliary water pumps are switched off and a fault code is stored in the DME. The expansion tank does not have a coolant level switch and does not automatically detect when the fluid level is too low.

If the electric coolant pump is removed and then to be reused, it is important to ensure that it is set down still filled with coolant. Drying out may cause the bearings to stick. If this is not done the electric coolant pump may possibly not start, which in turn may result in engine damage.

Before installing, turn the pump impeller manually to ensure that it moves freely.

Charge air cooler

The charge air coolers have, in contrast to the S63B44T2 engine, been adapted to the installation space of the F90. The charge air coolers achieve the same performance data as those of the S63B44T2 engine.

- Charge air cooler temperature input: approx. 320 °F
- Charge air cooler temperature output: approx. < 122° F
- Cooling power: 32 KW
- Charging pressure: 2.7 bar
- Pressure loss through charge air cooler: < 50 mbar

The charge air coolers in the S63T4 engine have a connecting piece between the charge air cooler of bank 1 and the charge air cooler of bank 2. The connecting piece between the charge air coolers enables a pressure compensation between the two banks.

The pressure compensation results in the following advantages:

- No pressure peaks in the charge air duct
- Optimal use of characteristic maps by the engine control.

S63B44T4 engine, charge air cooler comparison

Index	Explanation
A	Charge air cooler S63B44T2
B	Charge air cooler S63B44T4

The system supplier of the charge air coolers is Delphi.

Cooling power limits

If under extreme conditions such as for example in countries with high outside temperatures and the cooling power reaches its limits on the racetrack under race conditions, the cooling power of the vehicle air conditioning is reduced as the very first measure. Reducing the cooling power for the air conditioning ensures that there is sufficient cooling power available for the engine cooling and charge air cooling. If the cooling power for the engine cooling and charge air cooling still cannot be ensured even after the cooling power of the air conditioning has been eliminated, the engine performance and engine speed are gradually reduced before the CC message is output. In this way, constant and rapid lap times over a lengthy period can be achieved on the racetrack even at high ambient temperatures. The driver is alerted by a Check Control message if the cooling power of the engine cooling or charge air cooling reaches its limits. In the event of a customer complaint relating to the cooling power of the vehicle's air conditioning system, it is essential first to take these boundary conditions into consideration before starting troubleshooting on the cooling system and on the air conditioning.

4.9.5. Active air flap control

The active air-flap control, as used in the G30 production vehicles, is not used in the F90.

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4. Engine

4.10. Engine electrical system

A new generation of Bosch engine control units is used in the F90. Its appearance is characterized by a uniform housing and a uniform connector strip. However, the hardware inside has been adapted to various applications.

The control unit code (DME 8.x.yH) can be broken down as follows.

Abbreviation	Meaning
DME	Digital Motor Electronics
8	Control unit generation (modular platform)
x	Number of cylinders as a hexadecimal figure
y	Vehicle electrical system architecture
H	Hybrid version

Number of cylinders as a hexadecimal figure:

- 3 = 3-cylinder engine
- 4 = 4-cylinder engine
- 6 = 6-cylinder engine
- 8 = 8-cylinder engine
- C = 12-cylinder engine.

Vehicle electrical system architecture:

- 0 = vehicle electrical system 1 (large series)
- 1 = vehicle electrical system 2 (small series).

Examples for petrol engines:

- DME 8.4.0H = B48 PHEV* (vehicle electrical system 1)
- DME 8.6.1 = B58 (vehicle electrical system 2)
- DME 8.8.0 = N63TU2 (vehicle electrical system 1)
- DME 8.8.T = S63T4 (vehicle electrical system 1)
- DME 8.C.0 = N74TU (vehicle electrical system 1).

*PHEV = Plug-in Hybrid Electric Vehicle.

As such, the S63T4 engine has Bosch Digital Motor Electronics with the designation DME 8.8.T. There is a separate engine control unit fixed to the engine for every bank. The actuators and sensors of cylinder bank 1 are assigned to the DME 1 control unit; accordingly, the DME 2 control unit is responsible for the functions of cylinder bank 2. DME 1 is the master control unit and receives all information concerning the entire engine, such as regarding the crankshaft sensor, and provides it to the DME 2 control unit directly or via the bus system. Due to the variety of sensors and actuators it was deemed necessary to use 2 control units.

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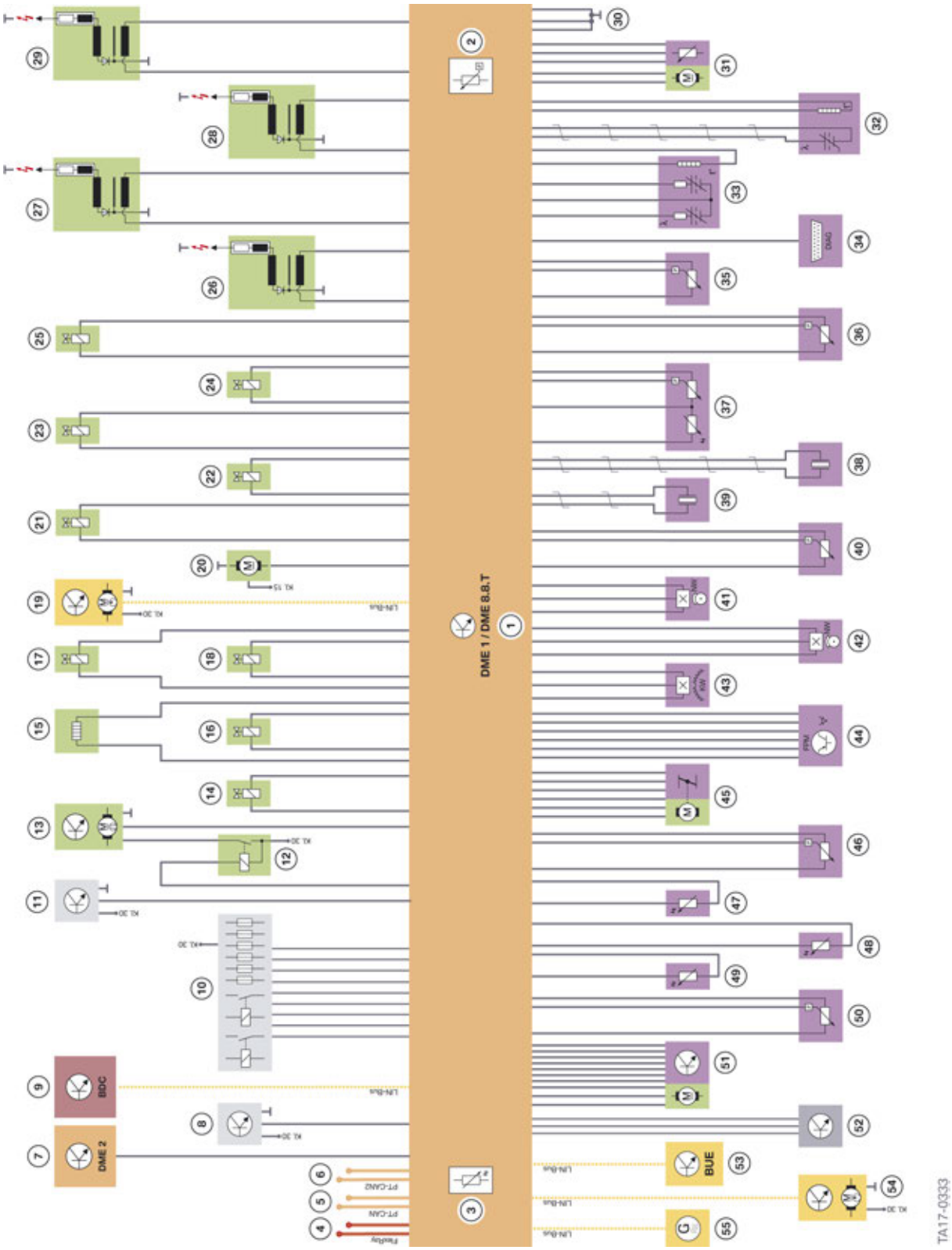
4. Engine

4.10.1. DME 1 control unit



S63B44T4 engine, DME 8.8.T DME 1

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4. Engine

Index	Explanation
1	DME 1 8.8.T
2	Ambient pressure sensor
3	Temperature sensor
4	FlexRay
5	PT-CAN
6	PT-CAN2
7	DME 2 connection
8	Tank leak diagnosis, Natural Vacuum Leak Detection (NVLD)
9	Body Domain Controller (BDC)
10	Power distribution box (symbolic)
11	Fuel pump control electronics (FPC)
12	Relay for electric fan
13	Electric fan
14	Map-controlled valve, oil pump
15	Data-map thermostat
16	Tank vent valve
17	VANOS solenoid valve, intake camshaft
18	VANOS solenoid valve, exhaust camshaft
19	Electric coolant pump, exhaust turbocharger
20	Electrical exhaust flap controller (EAKS)
21	Fuel quantity control valve
22–25	Injectors
25–29	Ignition coils
30	Earth
31	Electric wastegate valve controller
32	Oxygen sensor LSF Xfour
33	Oxygen sensor LSU 5.2
34	Diagnostic connector
35	Charge air temperature and charging pressure sensor upstream of throttle valve
36	Rail pressure sensor
37	Charge air temperature and intake-manifold pressure sensor after throttle valve
38	Knock sensors cylinder 1-2
39	Knock sensors cylinder 3-4
40	Fuel low-pressure sensor

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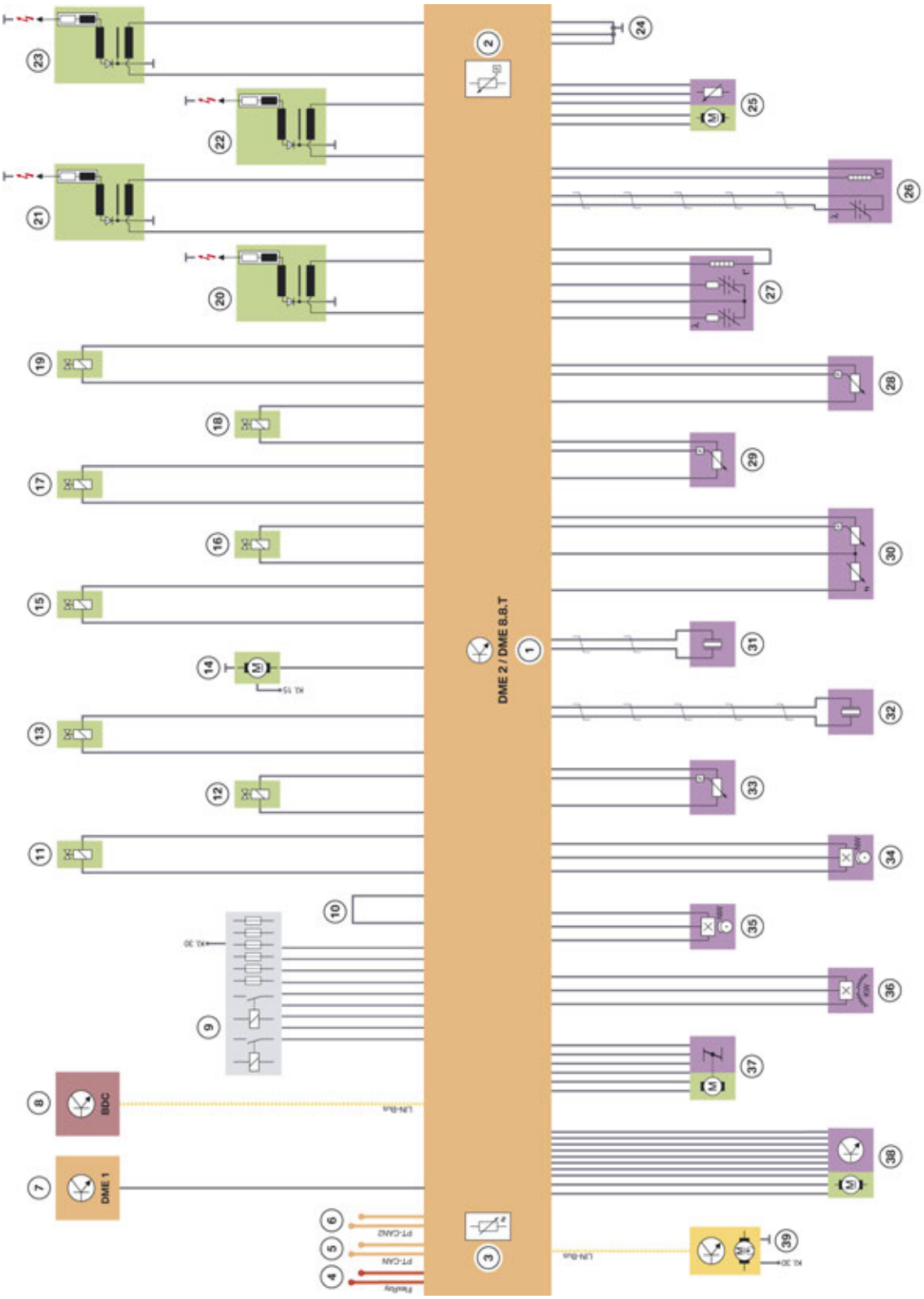
4. Engine

Index	Explanation
41	Camshaft sensor, intake camshaft
42	Camshaft sensor, exhaust camshaft
43	Crankshaft sensor, signal is looped through to DME 2
44	Accelerator pedal module
45	Throttle valve
46	Tank ventilation pressure sensor
47	Coolant temperature sensor
48	Coolant temperature sensor at radiator outlet
49	Oil temperature sensor
50	Oil pressure sensor
51	Valvetronic servomotor
52	Oil-level sensor
53	Battery supervision circuits (BUE)
54	Electric coolant pump, charge air cooler
55	Alternator

F90 Complete Vehicle

4. Engine

4.10.2. DME 2 control unit



S63B44T4 engine, DME 8.8.T DME 2

F90 Complete Vehicle

4. Engine

Index	Explanation
1	DME 2 8.8.T
2	Ambient pressure sensor
3	Temperature sensor
4	FlexRay
5	PT-CAN
6	PT-CAN2
7	DME 1 connection
8	Body Domain Controller (BDC)
9	Power distribution box (symbolic)
10	DME 1–DME 2 encoding
11	VANOS solenoid valve, intake camshaft
12	VANOS solenoid valve, exhaust camshaft
13	Fuel quantity control valve
14	Electrical exhaust flap controller (EAKS)
15	Tank vent valve
16–19	Injectors
20–23	Ignition coils
24	Earth
25	Electric wastegate valve controller
26	Oxygen sensor LSF Xfour
27	Oxygen sensor LSU 5.2
28	Charge air temperature and charging pressure sensor upstream of throttle valve
29	Rail pressure sensor
30	Charge air temperature and intake-manifold pressure sensor after throttle valve
31	Knock sensors cylinder 5-6
32	Knock sensors cylinder 7-8
33	Crankcase pressure sensor
34	Camshaft sensor, intake camshaft
35	Camshaft sensor, exhaust camshaft
36	Crankshaft sensor
37	Throttle valve
38	Valvetronic servomotor
39	Electric coolant pump, charge air cooler

F90 Complete Vehicle

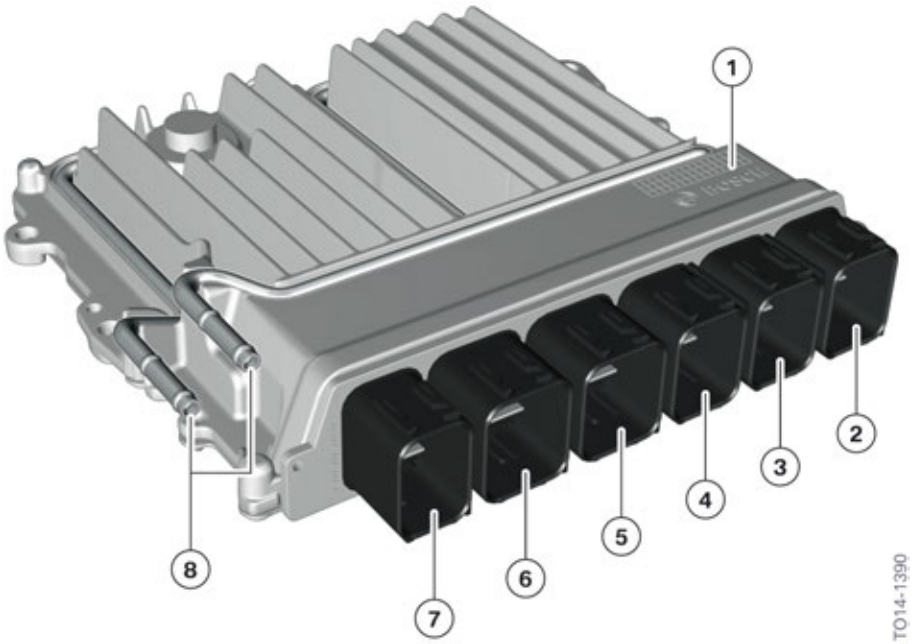
4. Engine

Do not attempt any trial replacement of control units.

Because of the electronic immobilizer, a trial replacement of control units from other vehicles must not be attempted under any circumstances. An immobilizer adjustment cannot be reversed.

The connector concept is identical to that on the modular engines and features a Nano MQS connector system (Micro Quadlok System). There is a logical division into 6 modules.

Measurements on the wiring harness may only be taken using measuring procedures approved by BMW. Use of the incorrect tools, such as measuring probes, can damage the plug-in contacts.

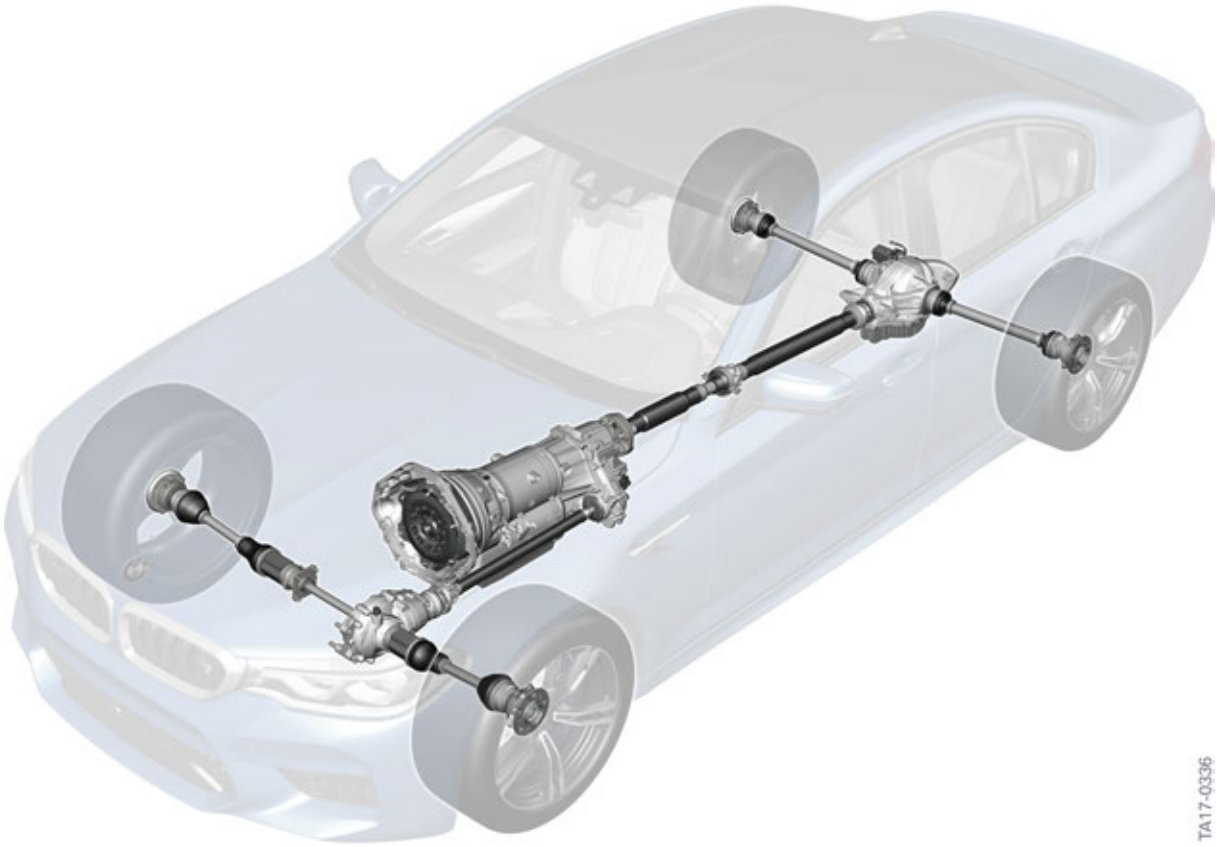


S63B44T4 engine, connections for DME 8.8.T

Index	Explanation
1	Engine control unit DME 8.8.T
2	Module 100, vehicle connection
3	Module 200, sensors and actuators 1
4	Module 300, sensors and actuators 2
5	Module 400, Valvetronic servomotor
6	Module 500, DME supply
7	Module 600, injection and ignition
8	Coolant connections (not connected for the S63B44T2/T4 engine)

F90 Complete Vehicle

5. Drivetrain



F90, power transmission

5.1. M automatic transmission/ M GWS

5.1.1. M automatic transmission

The F90 uses an M automatic transmission with Drivelogic and the designation GM8HP75Z. This is referred to as M8HP75 in the following.

With the M Sport automatic transmission M8HP75, which is based on the 8HPTU, the customer is able to enjoy significantly more spontaneous gearshifts and further optimized control of the converter lockup clutch.

This has been made possible by the further development of converter technology to effectively dampen rotational irregularities in the drivetrain with a turbine torsional vibration damper. In this way it has been possible to reduce even further the operating ranges in which the converter lockup clutch has to be controlled with the result that the converter lockup clutch is closed in the vast majority of driving situations. This provides for an even more direct connection of the M8HP75 transmission to the complete drivetrain, resulting in an even sportier driving experience and reduced fuel consumption.

The power transmission capability of the torque converter has been adapted to the increased torque of the S63T4 engine.

F90 Complete Vehicle
5. Drivetrain

In the F90, the **“Idle coasting”** function known from BMW vehicles is not implemented. However, the M8HP75 supports, as known from current BMW vehicles, the **“ConnectedShift”** function.

Transmission ratios comparison F1x M5/M6 - F90 M5

	F1x M5/M6	F90 M5
Transmission designation	GS7D36BG (Getrag)	M8HP75 (ZF)
Steering axis inclination	7.2	7.8
Maximum engine speed [rpm]	7,200	7,200
Torque [lb-ft]	500	553
Ratio [:1] 1st gear	4.806	5.000
Ratio [:1] 2nd gear	2.593	3.200
Ratio [:1] 3rd gear	1.701	2.143
Ratio [:1] 4th gear	1.277	1.720
Ratio [:1] 5th gear	1.000	1.313
Ratio [:1] 6th gear	0.844	1.000
Ratio [:1] 7th gear	0.671	0.823
Ratio [:1] 8th gear	-	0.640
Ratio [:1] reverse gear	4.172	3.478

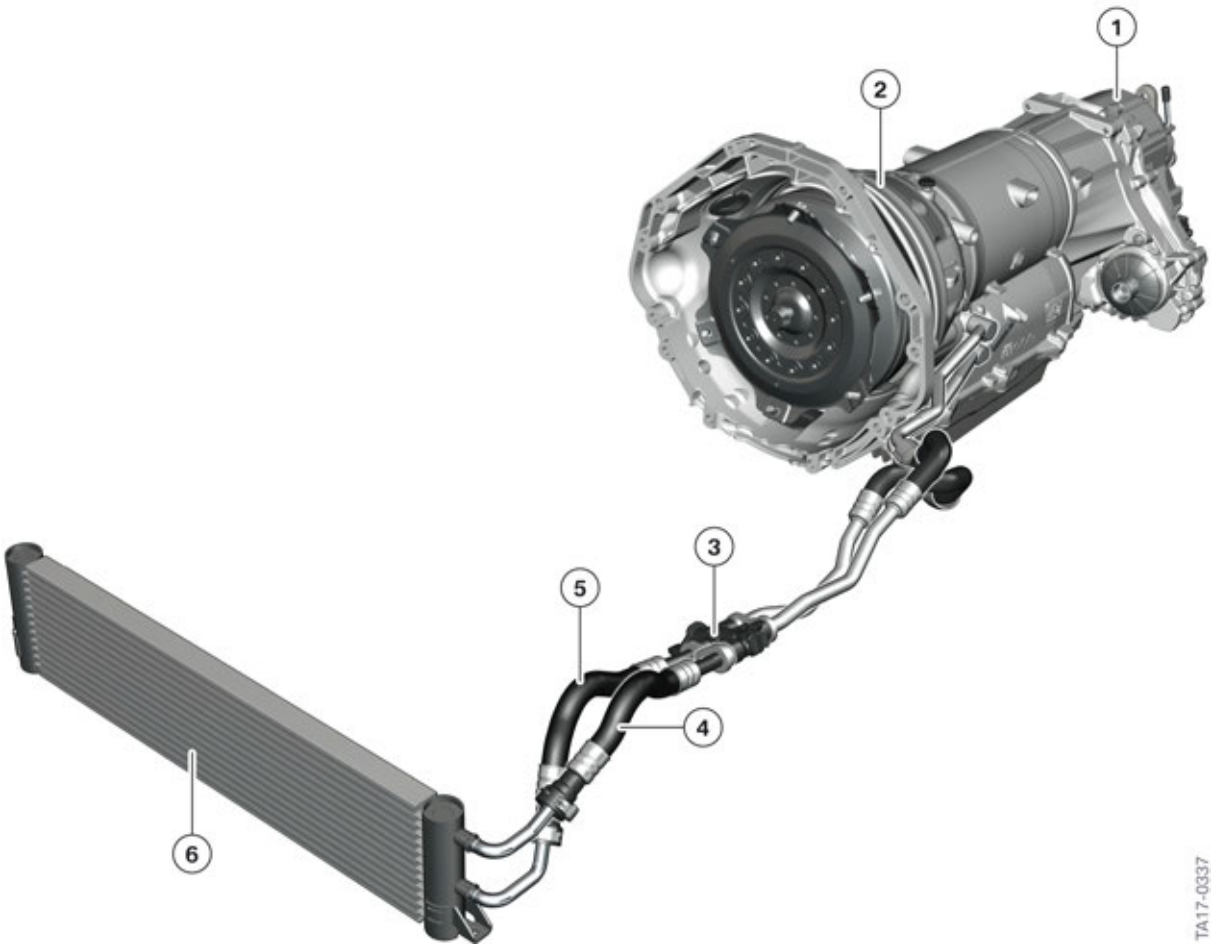
Transmission oil cooling

The plastic transmission oil sump has been replaced by an aluminium version with larger cooling fins and the opening point of the transmission oil thermostats has been lowered, improving the cooling of the M8HP75 transmission.

A transmission oil cooler is used to cool the M8HP75. This additional transmission oil cooler, which is designed as a plate heat exchanger, operates according to the oil-to-air heat exchanger principle and is installed vertically in front of the radiator assembly.

F90 Complete Vehicle

5. Drivetrain



F90, transmission oil cooling

Index	Explanation
1	Transfer case (M VTG)
2	M automatic transmission
3	Thermostat
4	Transmission oil return
5	Transmission oil feed
6	Transmission oil cooler (oil-to-air heat exchanger principle)

In some of the outside lines and hoses that conduct transmission oil to the additional transmission oil cooler, the cross section was optimized. This results in a greater oil flow rate, translating into more efficient cooling of the M automatic transmission.

The thermostat of the transmission oil cooler opens at 169°F and is fully open at 205°F.

F90 Complete Vehicle
5. Drivetrain

5.1.2. M gear selector lever/ M GWS

The M automatic transmission is operated using the M gear selector lever (M GWS) or the shift paddles on the steering wheel.

A common gear selector switch of the type used in BMW automatic transmissions or M double-clutch transmissions is not being used. Instead, a combined M GWS with an integrated Drivelogic switch and parking lock button is used.

The M-specific shift pattern, as used for the M double-clutch transmissions, was retained.

F90, M GWS

Index	Explanation
1	Drivelogic button
2	Gear indicator display (with M-specific shift pattern)
3	Parking lock button

It is possible to choose and change between an automatic **“D mode”** and a manual **“Manual mode”**. In each mode there are 3 driving programs, which can be selected and activated with the **“Drivelogic switch”**.

Drivelogic

The number of driving programs is the same as in F85/F86 vehicles. The operation of the Drivelogic button has changed. While a normal pressure switch for clicking through the options is installed in the F85/F86, the F90 makes use of one rocker switch to increase the driving program and one rocker switch to reduce the driving program.

After each change between manual mode and Drive mode, the last selected driving program is active.

After each engine start, driving program 1 is active in Drive mode.

D mode/Drive mode

Automated mode, all the forward gears are automatically shifted. Kickdown is triggered by depressing the accelerator pedal beyond the pressure point.

Three driving programs are available for selection:

1: Efficient driving, comfort shifting time

2: Fast driving, sport shifting times

3: Sporty driving shifting time.

Manual mode/sequential mode

The gears can be manually shifted by means of gearshift paddles on the steering wheel **"+** or **–"** or the gear selector lever **"forward** and **back"** at the matching driving speed and engine revs. The selected gear is maintained even when the engine speed limitation is reached, but an automatic downshift is performed when the vehicle drops below the gear-specific minimum driving speed.

When the manual mode is selected for the first time after terminal change (engine restart), the last Drivelogic stage used is active.

Three driving programs are also available here for selection:

1: Comfortable, smooth gearshifts in all driving conditions

2: Sporty, fast gearshifts, light gearshift jolts permitted at higher engine loads and speeds

3: Maximum sporty shift speed and gearshifts are the requirement for the activation of Launch Control.

To use the highest, i.e. the third driving program, the M DSC does not have to be activated.

5.1.3. Launch Control

During the vehicles first 3,100 miles, the Launch Control must not be used!

The Launch Control is released at the factory. Release of the Launch Control is no longer restricted to the 1,200 mile running-in check.

Premature wear occurs as a result of the high load on the vehicle components when using Launch Control.

F90 Complete Vehicle
5. Drivetrain

Launch Control

Function: Launch Control enables optimal acceleration when driving off on a non-skid roadway.

Sequence	Precondition/Action
1.	The vehicle must be stationary, the engine running and at operating temperature (approx. 10 mile warm-up journey).
2.	The M Dynamic Stability Control (M DSC) is deactivated. (4WD)
3.	The manual mode and the third Drivelogic driving program are selected.
4.	The brake pedal is gently pressed with the left foot and held.
5.	The accelerator pedal is depressed fully and held in this position.
6.	In the M instrument cluster a flag symbol must appear (if not, check notes and steps 1-5).
7.	An optimum engine speed for pulling away is adjusted.
8.	The left foot is taken off the brake within 5 seconds.

F90, Launch Control active (example image)

Activation

- Launch Control automatically shifts up using the shortest possible gearshift times and performance-optimized shift points as long as the driver keeps the accelerator pedal fully depressed.
- The start flag in the instrument cluster remains active.

A renewed Launch Control start is possible as long as the transmission oil temperature satisfies the preconditions for this.

Automatic deactivation

- The driver leaves (even if only briefly) the accelerator pedal full-load range during acceleration.

A manual intervention in the automatic upshift, for example via the gearshift paddles on the steering wheel or the gear selector lever, does not interrupt the Launch Control process.

If one of these preheating/precooling conditions is breached, it is not possible to activate the Launch Control.

Also at excessive transmission oil temperature (e.g. repeat Launch Control or race-like start), activation is blocked up until an acceptable temperature threshold is reached.

The start flag goes out with every deactivation and the automatic forced upshift is cancelled.

Premature wear occurs as a result of the high load of the vehicle with use of the launch control.

5.1.4. Emergency gearbox release

A mechanical emergency transmission release is available and can be accessed through the vehicle underbody. In addition, an electronic emergency gearbox release is implemented as it is in automatic transmissions of current BMW vehicles. For towing away, please observe the information in the Owner's Handbook of the vehicle.

Release is possible if the starter motor can crank the engine. Apply the parking brake before manual release of the parking lock to prevent the vehicle from rolling away.

Sequence	Precondition/Action
1.	Engage selector lever position N.
2.	Press and hold the brake.
3.	Press the start/stop button (the starter motor must start up audibly).
4.	Keep the start/stop button pressed.
5.	With your free hand, press the selector lever into selector lever position N and keep it there until selector lever position N appears in the instrument cluster.
6.	A CC message is displayed in the KOMBI and in the CID.
7.	Release the start/stop button and the selector lever.
8.	Release the brake as soon as the starter motor stops.

Maneuver the vehicle out of the danger area and then secure to prevent it from rolling away. Further information can be found in the Owner's Handbook for the vehicle.

5.1.5. Service information

Transmission oil circuit

For work required on the oil circuit of the automatic transmission, for example after an accident, or if the oil circuit has to be opened for a repair, there must be maximum cleanliness. This includes:

- Optimal cleaning of the outer oil circuit areas before disassembly of the components or opening the oil circuit.
- Immediate closure of openings and lines after disassembly without delay and using clean original plugs. Do not use unsealed components or replacement parts of the oil circuit without checking for cleanliness.
- The work area in which an automatic transmission is opened must be extremely clean and secured against dirt contamination, also during work interruptions.

Lifetime oil

Currently, as with the F85/F86 X5 M/X6 M with M automatic transmission, for the F90 with M automatic transmission a transmission oil change is **not** scheduled at 1,200 mile (running-in check), nor anytime there after.

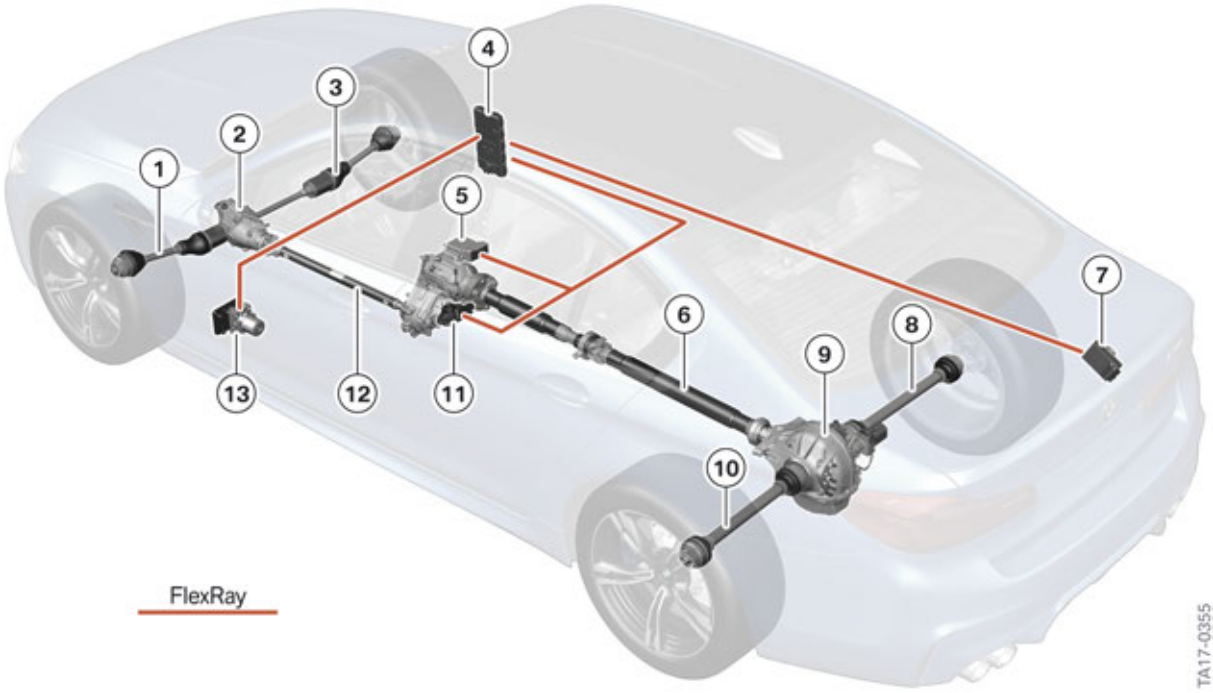
Current transmission oil recommendations and capacities can be found in the current documentation of the BMW workshop information system (ISTA).

5.2. M xDrive

High performance driving dynamics on the one hand and the every-day qualities of a Business sedan on the other. This is how the M concept can best be described in which the individual drive components are perfectly tuned to each other. With the M xDrive, whose integral component is the active M differential on the rear axle, is now celebrating its premiere in the new BMW M5 as a drive technology that combines the agility and precision of the rear-wheel drive with the superiority and driving stability of an all-wheel drive. Thus, the new BMW M5 can be handled in the usual sporty and precise manner both on the racetrack and on the road, even in unfavorable conditions such as wet roads and snow, while achieving a noticeable enhancement in traction and control all the way to the dynamic driving limits. The agile rear-oriented design is achieved by allowing the M xDrive to bring the front axle to bear only when the rear wheels have reached their limits and additional traction force is required. Even when applying a very sporty driving style and a demanding high performance, the new BMW M5 with M xDrive is predictable and easy for the driver to control, so that the superior performance of the Business sedan can be experienced to an even greater degree.

F90 Complete Vehicle

5. Drivetrain



F90, system overview, M xDrive

Index	Explanation
1	Front output shafts, left
2	Front axle differential
3	Front output shafts, right
4	Body Domain Controller (BDC)
5	Advanced Crash Safety Module (ACSM)
6	Prop shaft
7	Control unit, regulated M rear axle differential lock (M GHAS)
8	Rear output shafts, right
9	M rear axle differential lock
10	Rear output shafts, left
11	M transfer case, (M VTG)
12	Front propeller shaft
13	M Dynamic Stability Control (M DSC)
FlexRay	FlexRay bus

5.2.1. Four-wheel drive

The M xDrive used in the F90 is based on the all-wheel drive of the G12 with the ATC13 transfer case.

F90 Complete Vehicle

5. Drivetrain

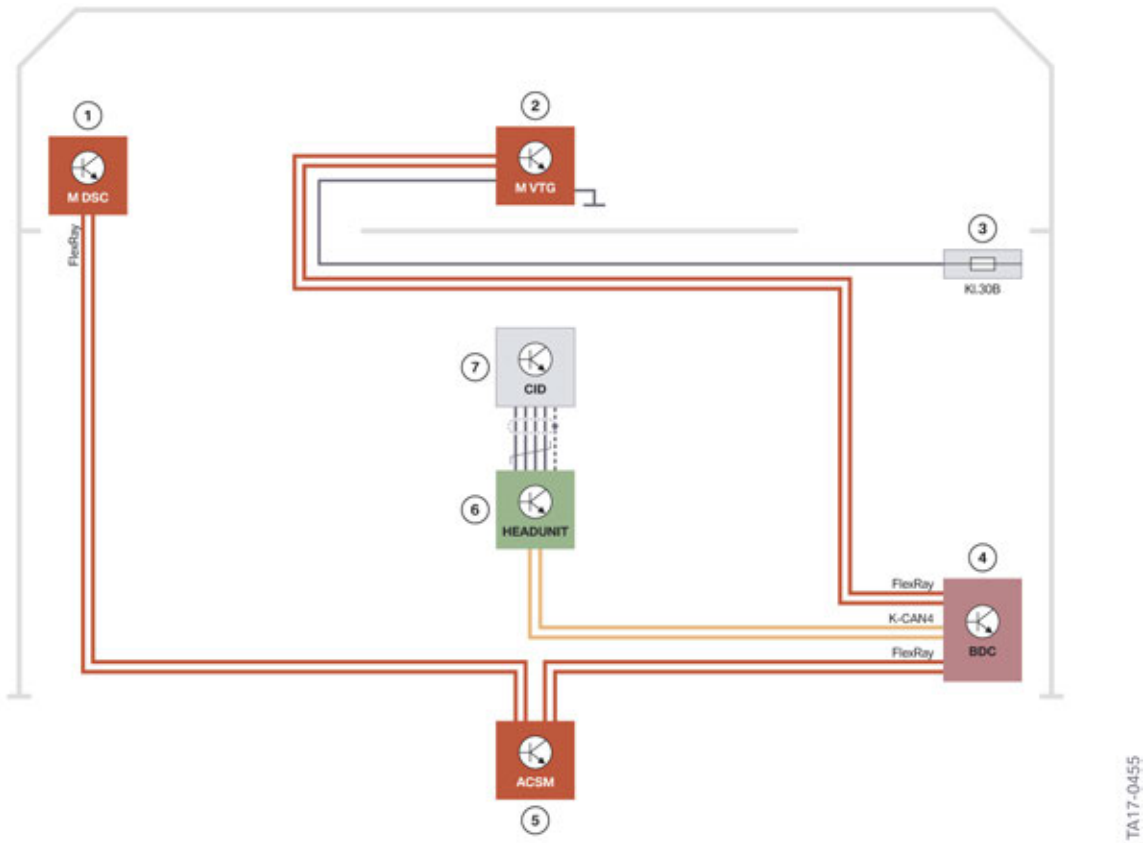
The transfer case of the F90 has the following new features:

- Design measures were used to adapt the ATC13 transfer case of the G12 to the higher output and torque of the S63T4 engine in the F90.
- The control of the multi-disc clutch by the M VTG control unit for transferring the torque to the front axle was specifically adapted for the M design in combination with other control systems. This makes it possible to realize a rear-oriented all-wheel drive design with the option of driving with a pure real-wheel drive.
- Design measures for reinforcing the drivetrain permit a more direct M-specific vehicle response.

The torque generated by the engine is stepped up in the automatic transmission and is supplied via the transmission output shaft to the transfer case. The transfer case has the task of variably distributing the torque to the front and rear axles depending on the driving situation. Since a rigid connection of the rear axle with the front axle is not possible due to possible differences in the wheel speeds, there is a multi-disc clutch inside the transfer case. The multi-disc clutch performs the task of variable torque distribution between the two drive axles.

General information on BMW xDrive can be found in the Reference Manual of the G12 Powertrain.

5.2.2. M VTG system wiring diagram



F90, M VTG system wiring diagram

Index	Explanation
1	M Dynamic Stability Control (M DSC)
2	M transfer case (M VTG)
3	Power distribution box, front right
4	Body Domain Controller (BDC)
5	Advanced Crash Safety Module (ACSM)
6	Headunit (Headunit) (M-specific)
7	Central information display (CID)

In contrast to the rear-based standard all-wheel drive of the BMW VTG control, the BMW M VTG control only applies torque to the front axle after the rear axle exhibits slip and additional drive torque transfer to the rear axle is therefore no longer effective. The slip defined in this way on the rear axle, before the drive torque is transferred to the front axle via the BMW M VTG control, has the effect that the new BMW M5 handles more like a rear-wheel-drive vehicle in terms of the driving dynamics.

5.2.3. Service information

- The vehicle must **not** be driven when the front propeller shaft has been removed.
- The vehicle must **not** be towed if only one axle is raised.
- The oil change for the transfer case is necessary every 5th engine oil service (50,000 miles). However, a fault code entry with an oil change recommendation for the transfer case oil is stored when a mileage of 93,000 miles is exceeded.
  When refilling the transfer case oil, it is necessary to move the oil partition to the open position using the BMW ISTA diagnosis system.
- Various test plans are available in the BMW diagnosis system ISTA for Service.

The tire tread depth as well as the tire manufacturer should be the same on the front and rear axles if possible in order to ensure proper functioning of the xDrive. It is also advisable to only use tires that have been approved or recommended by BMW.

5.2.4. Transfer Case oil change

The oil change for the transfer case is done every 5th engine oil service (50,000 miles).

The transfer case does not have an oil drain plug. The existing oil must be removed using an extractor unit.

The new transfer case oil can be filled using an oil filler pump.

In order to ensure that the entire oil change has been completed, the oil bulkhead must remain open for the duration of extraction and filling.

The Service employee can move the oil bulkhead to the open position by means of the “Service function > Transfer case VTG > Oil change” in the BMW ISTA diagnosis system.

Current transfer case oil recommendations and capacities can be found in the current documentation of the BMW workshop information system (ISTA).

5.2.5. Active M differential

The active M differential on the rear axle is an integral part of the M xDrive.

This electronically/electromechanically controlled M rear axle differential lock was developed specifically for the F10 M5 and is also used in F06/F12/F13 M6, F80/F82/F83/F87 and again in the new F90 M5.

The active M differential was again revised for the F90, adapting it to the greater performance and torque of the F90.

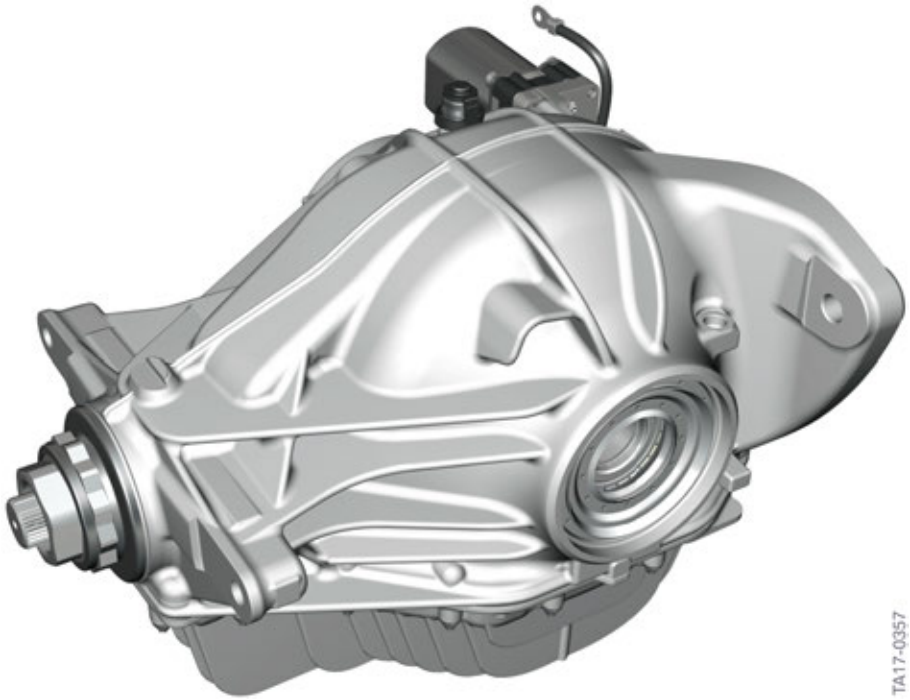
- Disc set reinforced with carbon lining
- Geometric adaptation of the rear axle transmission housing
- Geometric adaptation of the ball ramp.

The M rear axle differential, size HAG 220 (crown wheel Ø 220 mm), is used with a M rear axle differential lock. The system designation for this is "regulated M rear axle differential lock", the control unit designation is M GHAS (**G**eregelte **H**inter **A**chsgetriebe **S**perre (regulated rear axle differential lock)).

The gear ratio of the rear axle differential HAG 220 is 3.154:1.

This M rear axle differential can be recognized by an aluminium oil sump assembled from below and an electric motor which is visible from the outside.

The M rear axle differential weighs 95 lbs.



F90, M GHAS external view

Demand-controlled lock

The lock is a demand-controlled rear axle differential lock which is active in the following situations:

- Driving off
- Differential speed at the rear axle for straight-ahead driving under tension due to various coefficients of friction, left/right
- M dynamic cornering
- Power oversteer (drifting)
- Stabilization in coasting/overrun mode.

Traction, handling and driving stability are optimized by adjusting a defined differential speed or differential torque at the rear axle.

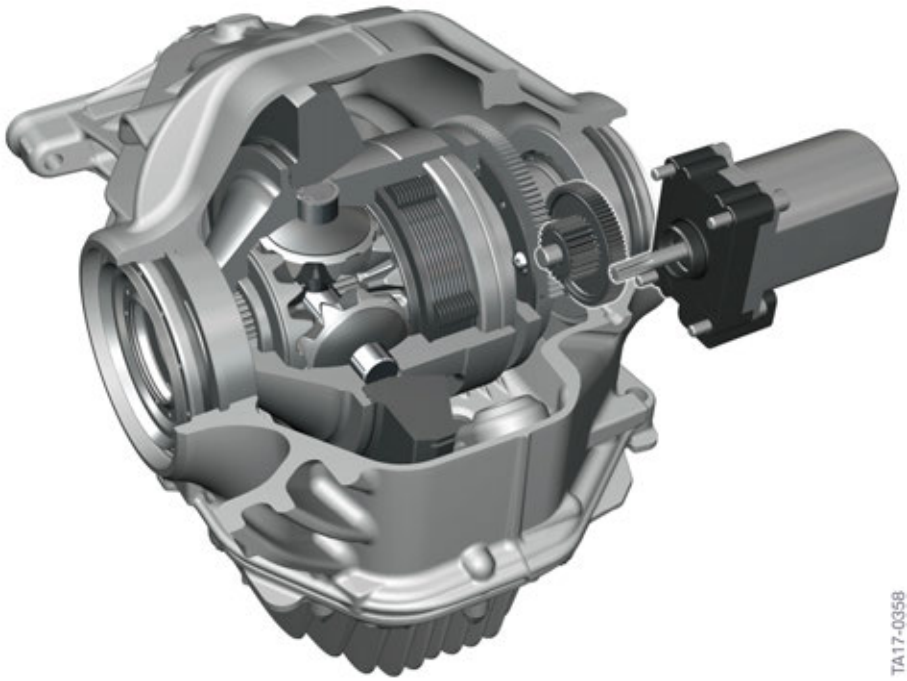
The regulated M rear axle differential lock works with a position-controlled electric motor and a ball ramp.

5.2.6. Structure/Function

The lock-up torque is generated by a multi-disc clutch. The necessary axial pressure is applied to the multi-disc clutch by the position-controlled direct current motor by means of gears and a ball ramp mechanism. The clutch package operates between the expansion tank housing (steel outer discs) and the right output (steel inner discs with carbon friction lining).

F90 Complete Vehicle

5. Drivetrain



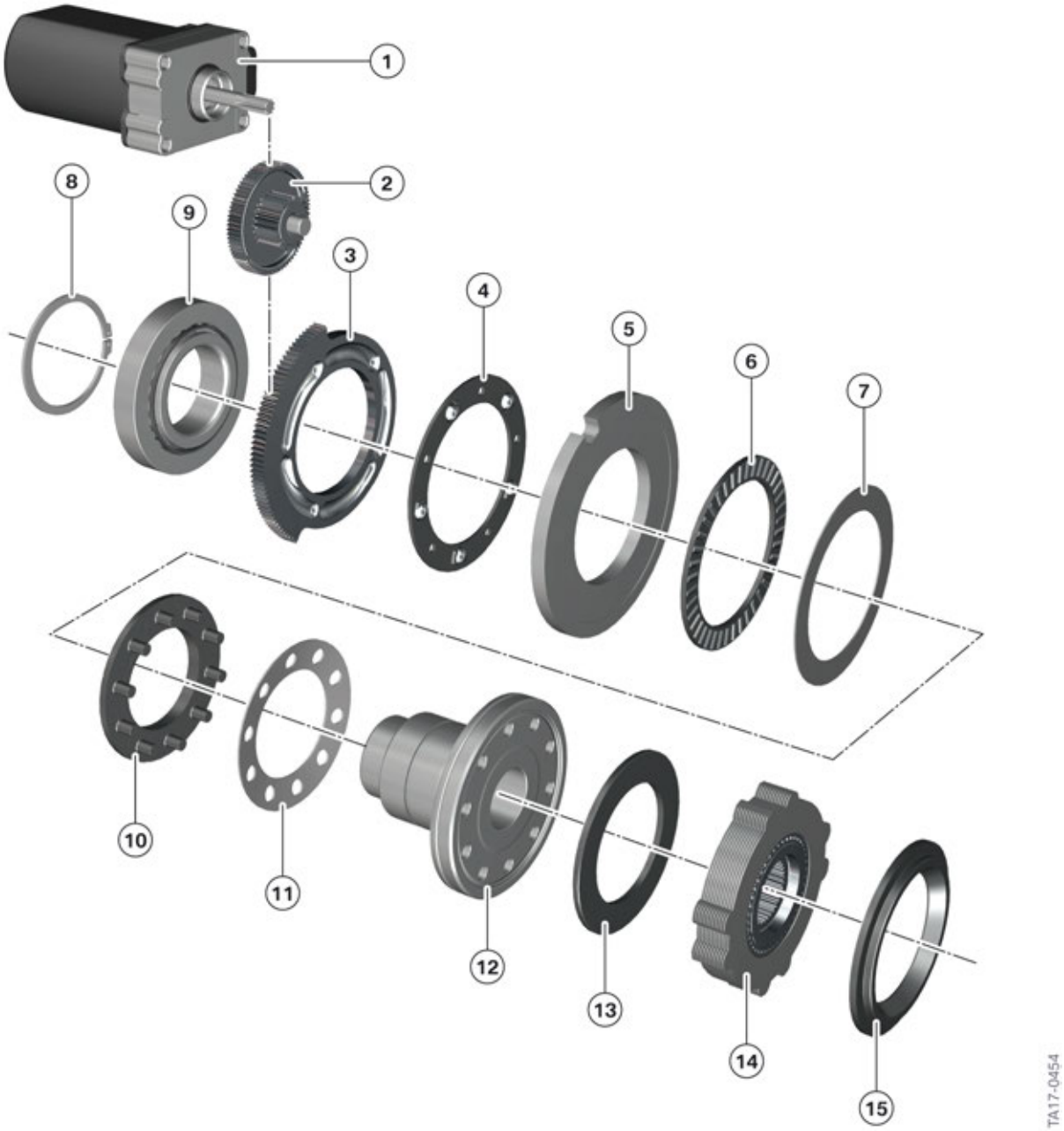
F90, rear axle differential, section view

System components:

- Wiring harness
- Regulated differential lock control unit (M GHAS)
- Electric motor and transmission gearing
- Lock

F90 Complete Vehicle

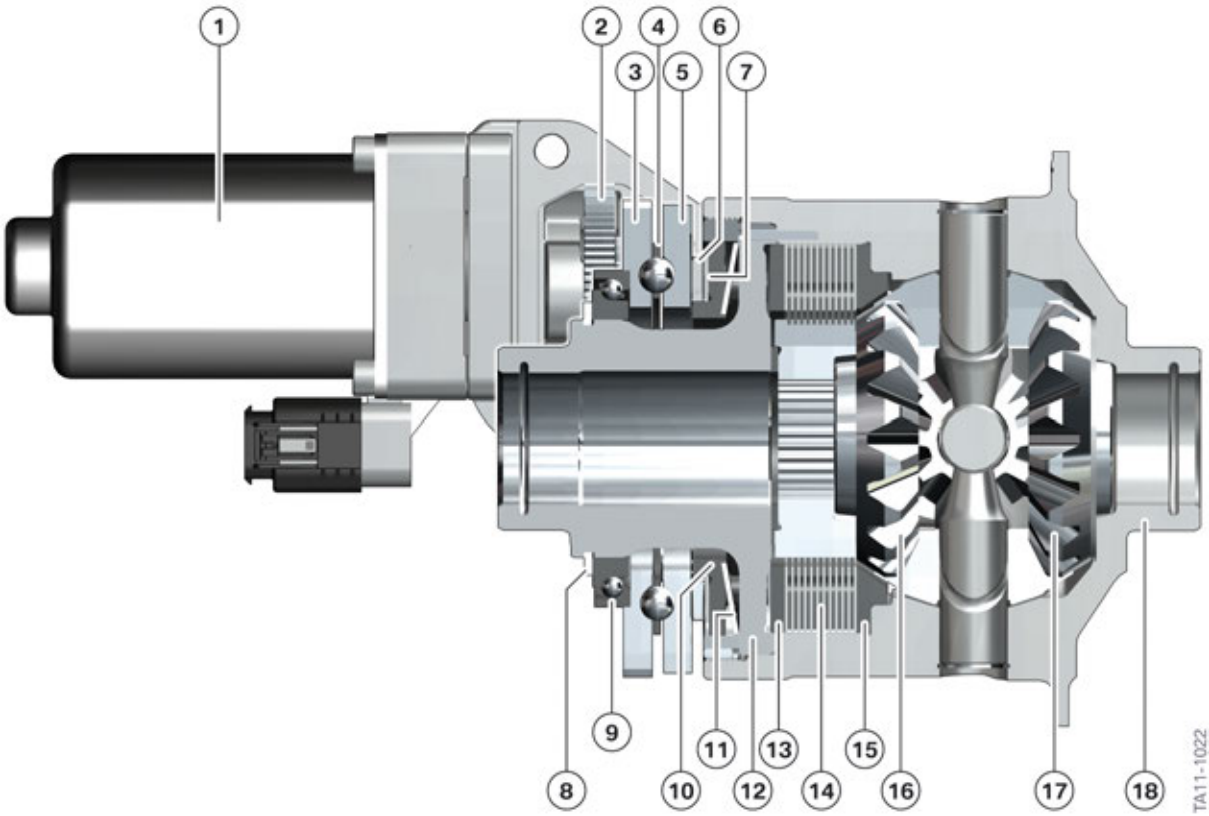
5. Drivetrain



F90, components, inner parking lock: Exploded diagram

Index	Explanation
1	Electric motor
2	Intermediate gear
3	Ball ramp consisting of geared mobile adjusting disc and first half of ball ramp
4	Balls/Spherical washers
5	Fixed pressure disc with second half of ball ramp
6	Axial needle bearing

Index	Explanation
7	Axial bearing thrust washer
8	C-clip (ball bearing fixing)
9	Ball bearing between inner output hub and differential housing
10	Disc spring pressure ring
11	diaphragm spring
12	Differential lid (connected to differential housing, cannot rotate)
13	pressure plate
14	Disc set
15	Counter pressure plate



F90, parking lock differential, section view

Index	Explanation
1	Electric motor
2	Intermediate gear
3	Ball ramp consisting of geared mobile adjusting disc and first half of ball ramp
4	Balls/Spherical washers
5	Fixed pressure disc with second half of ball ramp

Index	Explanation
6	Axial needle bearing
7	Axial bearing thrust washer
8	C-clip (ball bearing fixing)
9	Ball bearing between inner output hub and differential housing
10	Disc spring pressure ring
11	diaphragm spring
12	Differential lid (connected to differential housing, cannot rotate)
13	pressure plate
14	Disc set
15	Counter pressure plate
16	First output bevel gear
17	Second output bevel gear
18	Differential housing (connected to outer discs)

The electric motor (1) is bolted on to the housing and the pressure disc fixed to the second ball ramp half (5) in the housing. The mobile components of the ball ramp (2, 3 and 4) generate the necessary axial displacement of the pressure disc (5). These components are not subject to the differential transmission rotation and are disconnected from the rotating components by an axial needle bearing (6).

The components with the index 6 to 18 belong to the differential and rotate proportional to the rear axle gear speeds.

The lock is effected between the right output (16) and the differential housing (18) and counteracts a difference in speed between the output bevel gears (16 and 17). The disc spring (11) opens the lock when the engine is not supplied with current.

5.2.7. System information

The M DSC control unit evaluates the dynamic handling characteristics parameters made available by other control units via the FlexRay data bus and determines the lock-up torque to be applied. The M DSC control unit can also request separate and higher-level locking interventions to stabilize the vehicle both when the M DSC is activated and deactivated.

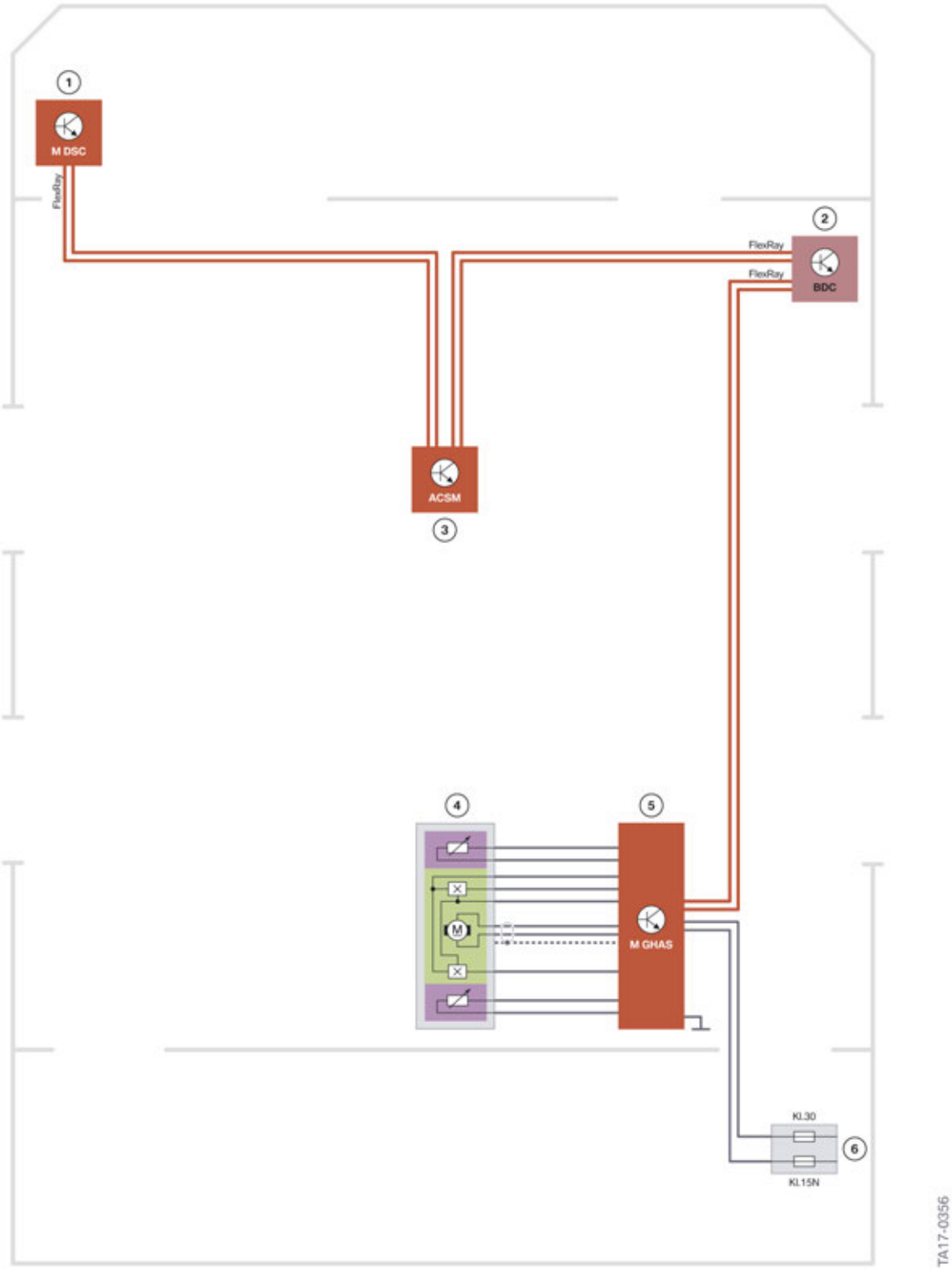
The position-controlled direct current motor is activated directly by the power electronics of the M GHAS control unit with vehicle voltage via a pulse-width-modulated signal. The frequency is approx. 4 kHz and the maximum current level is 30 A.

To determine the position and the direction of rotation of the electric motor it is equipped with 2 hall effect sensors.

F90 Complete Vehicle

5. Drivetrain

System wiring diagram



F90, M GHAS system wiring diagram

Index	Explanation
1	M Dynamic Stability Control (M DSC)
2	Body Domain Controller (BDC)
3	Advanced Crash Safety Module (ACSM)
4	Components of the regulated M rear axle differential lock
5	Regulated M rear axle differential lock (M GHAS)
6	Power distribution box, rear

Interfaces

The M GHAS control unit works with the following control units and includes the following information:

Control unit	Bus system	Information
BDC	FlexRay	- Terminal status - Vehicle identification number (for encoding) - Vehicle condition (power management and fault memory block, e.g. in the event of voltage drop by engine start)
DME	FlexRay	- "Engine running" signal
M DSC	FlexRay	- Wheel speed - Set-point axial torque distribution - Stabilization status - Brake value - Tolerance adjustment of wheel (adjustment of different wheel circumferences) - Driving speed
ACSM	FlexRay	- Lateral acceleration - Yaw rate - Road longitudinal tilt - Steering angle

Electric motor location determination

To determine the position of the electric motor, 2 hall effect sensors in the engine are evaluated.

To determine the characteristic curve of the lock-up torque via the engine position, recalibrations are regularly performed to compensate the wear in the clutch.

To be able to assign a certain position of the servomotor a certain coupling lock-up torque and to take the wear influences into account while doing so, a reference run is performed after the vehicle engine is switched off. During this reference run the engine is subjected to a defined current level. The lock-up torque of 0 lb-ft is assigned to the resulting position.

Temperature monitoring

A total of 3 temperature sensors are installed. The temperature of the control unit (driver output stage), the temperature of the electric motor and the transmission oil temperature are monitored.
The temperature thresholds are:

- Control unit 185 °F
- Electric motor 320 °F
- Oil temperature 374 °F

5.2.8. Service information

- For a replacement of the M GHAS control unit, an encoding (activation of vehicle-related characteristic curve) and then an initial calibration are necessary and then the fault memory must be deleted.
- After the replacement of the entire M rear axle differential a calibration must be performed and then the fault memory must be deleted.
- For a replacement of the electric motor, electric motor plus intermediate gear or oil temperature sensor, only the fault memory must be deleted.

The final drive oil is currently replaced at 1,200 miles (run-in check) and at every 5th engine oil change.

Because the disc material was change to include carbon content in the disc set, a different rear axle transmission oil is now used. The fluid is Hypoid Axle Oil G4.

Current rear axle differential oil recommendations and capacities can be found in the current documentation of the BMW workshop information system (ISTA).

If, due to a fault, the M GHAS lock function is switched off or fails, a blocked differential is automatically reopened as the lock function is not self-locking. The driver is warned/informed and the following effects can be expected:

1. Deterioration of traction with dynamic driving style and low coefficients of friction, particularly with different coefficients of friction, left/right.

2. Possible deterioration of stability in dynamic driving situations.

F90 Complete Vehicle

5. Drivetrain

5.3. Differential

5.3.1. Front axle differential

The front axle differential VAG175AL already deployed in the G12 is also used here.

Technical data

Front axle differential 175AL	Specifications
Oil volume	0.6 L
Oil grade in BMW Service	Hypoid Axle Oil G2
Maximum input torque	960 lb-ft
Possible ratios	3.15
Weight including oil	32 lbs

Current front axle differential oil recommendations and capacities can be found in the current documentation of the BMW workshop information system (ISTA).

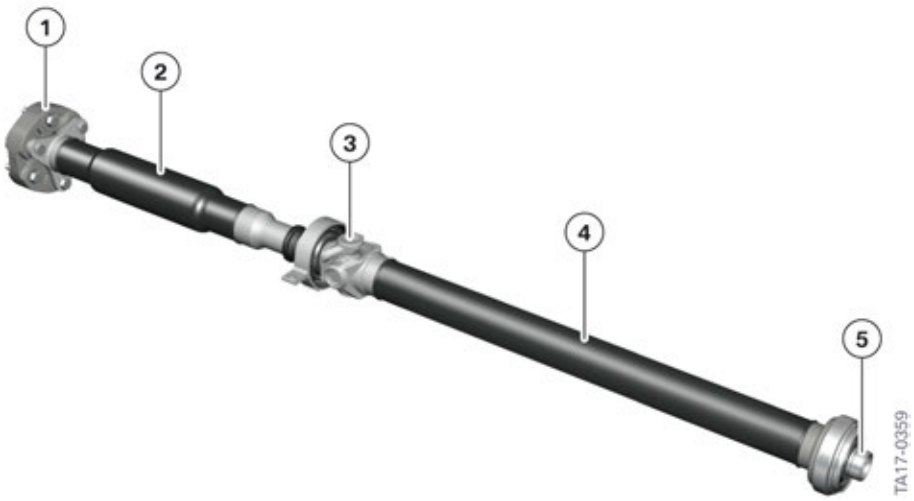
5.4. Propeller shafts and output shafts

5.4.1. Front propeller shaft

The front propeller shaft was taken over from the G12 for the F90.

5.4.2. Rear propeller shaft

The propeller shaft of the F90 is a steel propeller shaft. The propeller shaft, the center mount, the flange on the flexible disc to the transfer case and the flange on the rear axle differential have been adapted in terms of design and strength to the increased torque of the F90.



F90, propeller shaft

Index	Explanation
1	Flexible disc joint
2	Front partial shaft with crash element
3	Middle bearing, propeller shaft with sliding piece and universal joint
4	Rear partial shaft
5	Connection, rear axle differential

The maximum permissible deflection angle of the propeller shaft must not be exceeded when working on the propeller shaft center bearing. The instructions in the current repair instructions in ISTA absolutely must be followed.

It is important to follow the procedures in the current repair instructions in ISTA regarding inserted and bolted propeller shafts on the rear axle differential.

5.4.3. Front output shafts

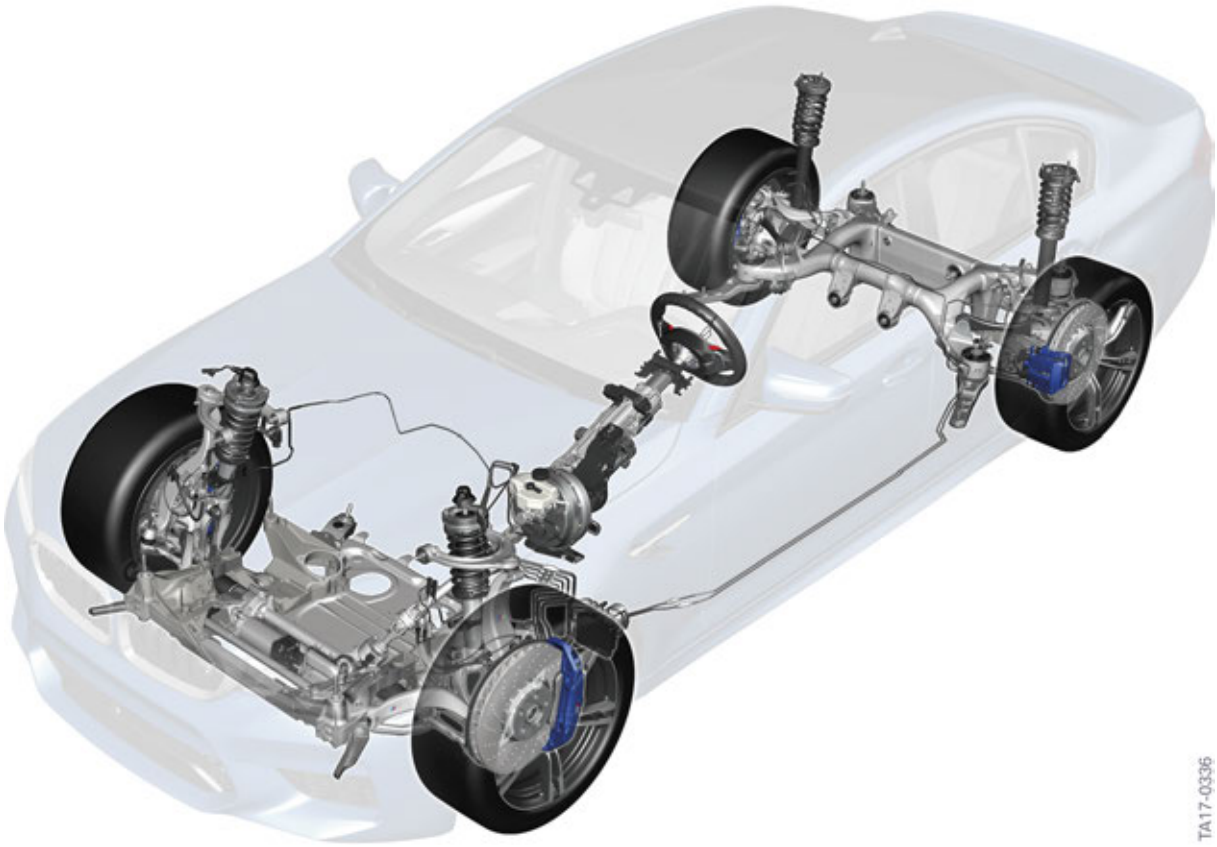
The front output shafts have been adapted in terms of design and strength to the increased torque of the F90.

5.4.4. Rear output shafts

The rear output shafts have been adapted in terms of design and strength to the increased torque of the F90.

F90 Complete Vehicle

6. Chassis and Suspension



F90, chassis and suspension, complete

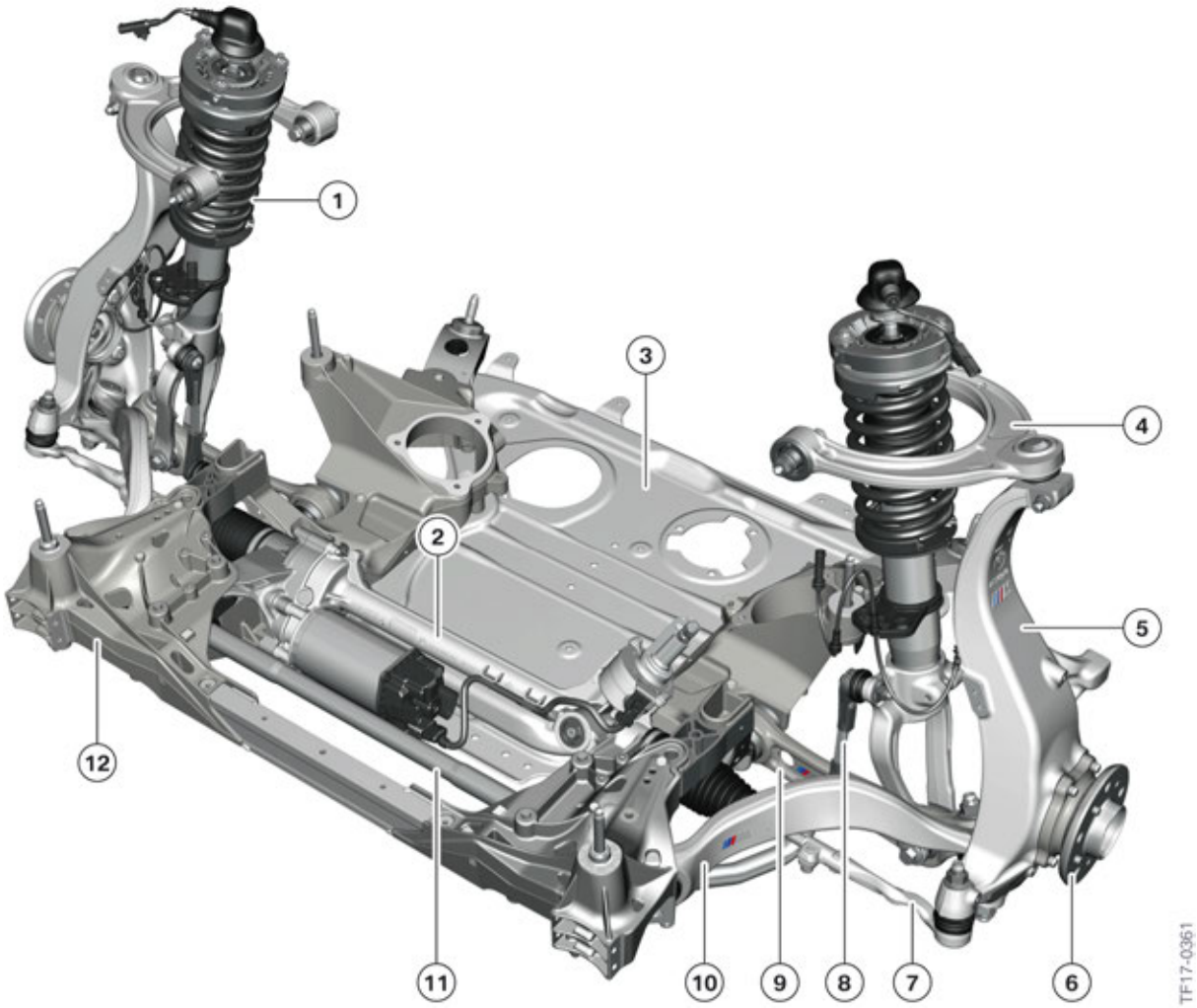
The chassis and suspension is based on the technology of the G30, whereby almost all components are again new and specific to M or have been adapted.

Designation	Unit	F10 M5	G30 M550i	F90 M5
Wheelbase/turning circle	[mm/m]	2,964/12.6	2,975/12.24	2,982/12.6
Front track width	[mm]	1,627	1,600	1,626
Rear track width	[mm]	1,582	1,597	1,594
Front axle		Double-wishbone axle	Double-wishbone axle	Double-wishbone axle
Steering		Hydraulic rack-and-pinion steering VARIOSERV®	Electronic Power Steering EPS	Electronic Power Steering EPS
Average overall ratio		13:1	16.3:1	14.3:1
Rear axle		Integral-V multilink rear axle	Integral-V multilink rear axle	HA5 Rear axle
Axle ratio		3.154	2.813	3.154

F90 Complete Vehicle
6. Chassis and Suspension

6.1. Front axle

The F90 is the first M sedan with a driven front axle. The front axle is based on the double-wishbone front axle of the G30. All components or the bearings are new to M or have been adapted and the M front axle support has been reinforced with a stiffening plate, typical of M.



F90, double-wishbone front axle

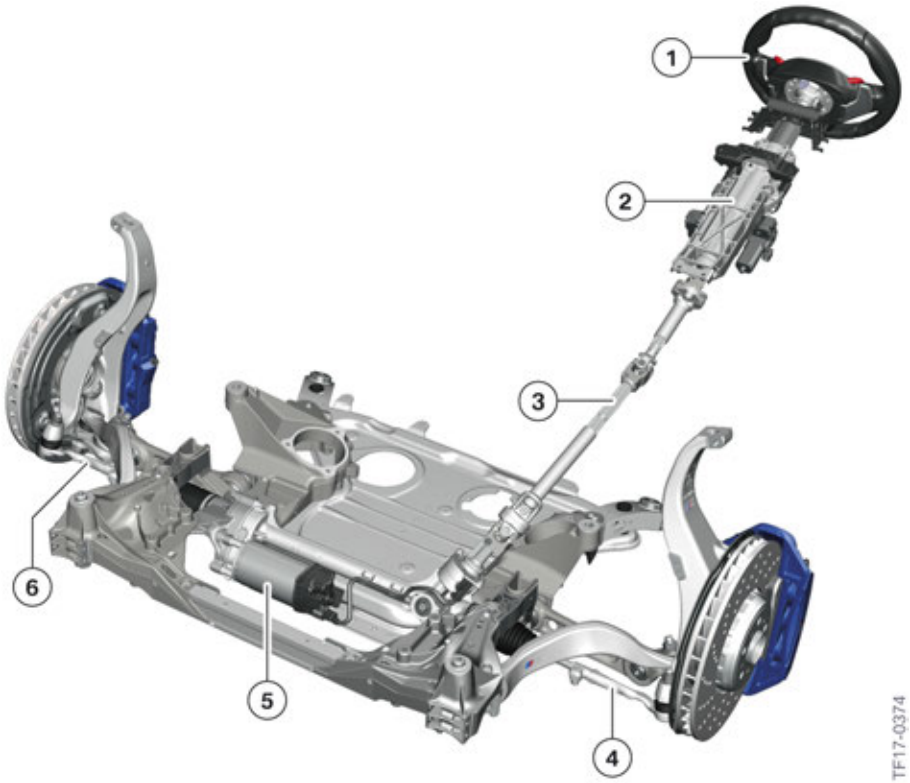
Index	Explanation
1	M spring strut with support bearing
2	M Servotronic (EPS)
3	Stiffening plate (adopted from G30)
4	M wishbone, top
5	M swivel bearing

Index	Explanation
6	M wheel hub
7	M track rod
8	M anti-roll bar link
9	M wishbone, bottom
10	M trailing link with hydro mount
11	M anti-roll bar
12	Front axle support (taken over from G30)

6.1.1. Steering

Within the framework of the EfficientDynamics measures for the F90, the steering used is a rack-and-pinion steering with electrical power steering assist "M Servotronic with EPS".

For power assistance during steering an electric motor is housed parallel to the rack at the steering gear housing.



F90, steering

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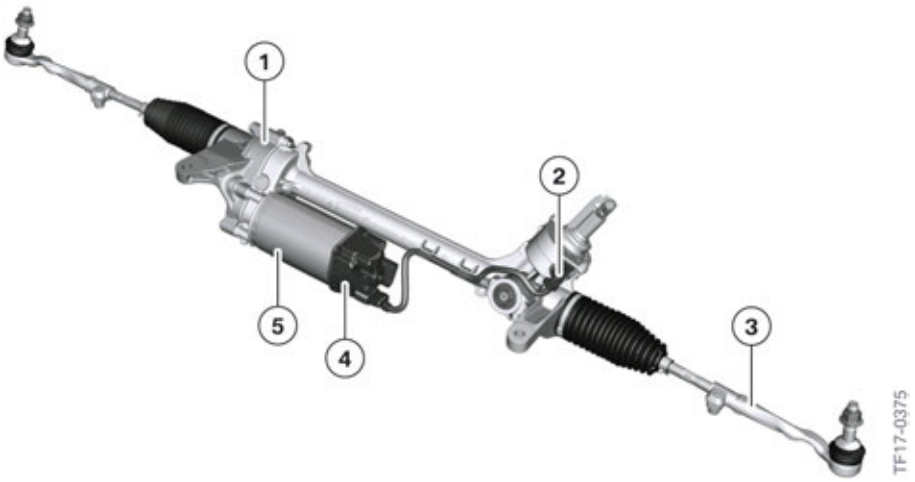
6. Chassis and Suspension

Index	Explanation
1	M steering wheel
2	Adjustable steering column
3	Steering column
4	Track rod, left
5	M Servotronic (EPS)
6	Track rod, right

The M Servotronic (EPS) is an independent development for the F90. All components of the M Servotronic (EPS) have been developed specifically for the F90. With this measure the development of the steering was able to be coordinated to the typical M properties. Special attention was paid here to the typical M features:

- Direct steering sensation
- Driving condition feedback
- M dynamic driving in the limit range.

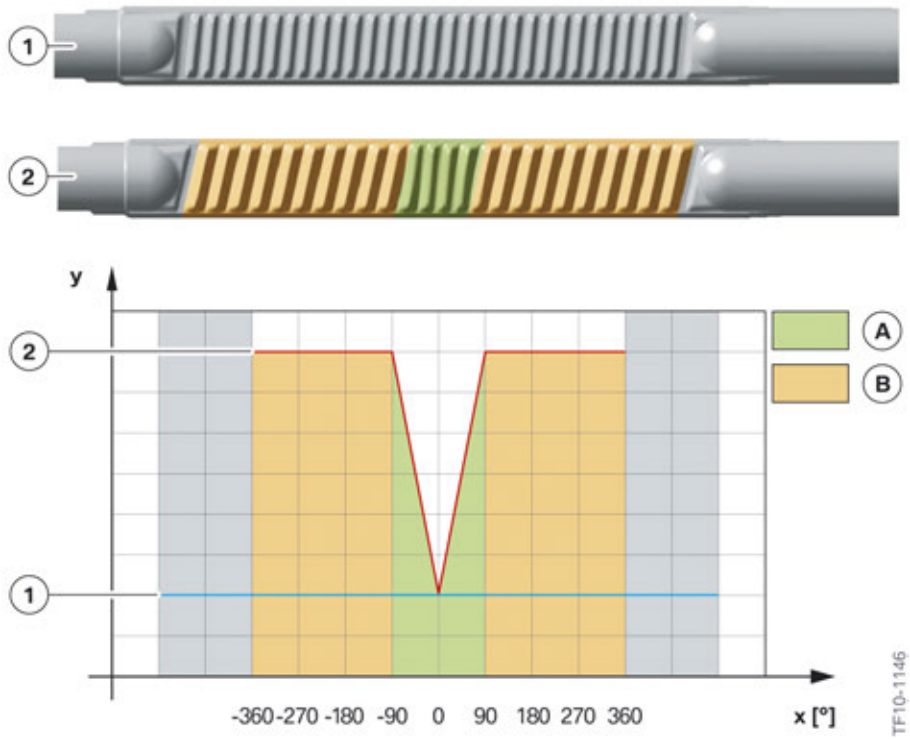


F90, M Servotronic (EPS)

Index	Explanation
1	Reduction gear
2	Steering-torque sensor
3	Track rod
4	Control unit, M Servotronic (EPS)
5	Electric motor with rotor position sensor

F90 Complete Vehicle
6. Chassis and Suspension

The ratio of M Servotronic (EPS) has been adapted to the F90 (F90 14.3:1 — G30 16.3:1); of particular note is the fact after an eighth of a turn of the steering wheel the rack ratio increases by 8%.



F90 Comparison of steering gear ratio, M Servotronic (EPS) steering

Index	Explanation
1	Rack, basic version G3x (constant gear geometry)
2	Variable sport steering rack F90 (variable gear geometry)
A	More indirect steering gear ratio (variable sport steering)
B	More direct steering gear ratio (variable sport steering)
x	Steering angle
y	Rack travel

With the use of the M Servotronic (EPS) in the new F90, the “Parking Maneuver Assistant” parking assistance system is now also offered.

The system supplier of M Servotronic (EPS) is Bosch.

6.1.2. M Servotronic

The Servotronic function known from conventional hydraulic steering systems is also used in the M Servotronic (EPS) and is installed in the F90 as standard. It is a M Servotronic, which functions according to the same operating principle as in production vehicles. The difference in the M Servotronic is that 3 stages can be selected in comparison to 2 stages in the production vehicles, and it has a separate button in the M driving dynamics button panel in the center console. Using the button or via the M1/M2 buttons, the driver can switch between "Comfort", "Sport" and "Sport+". Here the corresponding characteristic curve is activated and in Sport direction the power steering support is also noticeably withdrawn. The program selection can also be configured in the CID and selected using the M1/M2 buttons on the steering wheel.

M drive dynamic control switch, program description, M Servotronic:

- “COMFORT”: Focus on light and comfortable steering torques with perfect feedback from the road surface at the same time.
- "SPORT": Greater rise in the steering force and perceptibly more feedback for sporty M dynamic driving, both for every day use and at the dynamic driving limit.
- "SPORT+": Even greater rise in the steering force and high steering force level for the greatest possible feedback and clear sporty steering sensation.

6.1.3. Steering angle sensor

The information on the steering angle in the F90 is not recorded by the EPS via a separate sensor on the steering wheel but instead is computed based on the rotor position angle of the EPS motor in relation to the steering wheel.

The EPS delivers the position of the rack via FlexRay to the M Dynamic Stability Control (M DSC). During this process, the EPS calculates the absolute position of the rack based on the current motor position of the EPS motor and the number of complete revolutions performed by the motor starting from the zero position (straight-ahead driving position).

Taking this position as the starting point, the M DSC determines the wheel-specific steering angle among other things using the stored ratio parameters (rack to wheel-specific steering angle) and transmits this via FlexRay. This wheel-specific steering angle is used by the M DSC among other things as a reference variable for internal control functions.

In cases where the absolute value is not available from the EPS (loss of terminal 30, flash process), the absolute value is determined through interaction between M DSC and EPS using an adaptation function in which the steering wheel is turned from end stop to end stop (e.g. straight-ahead position -> left -> right -> straight-ahead position).

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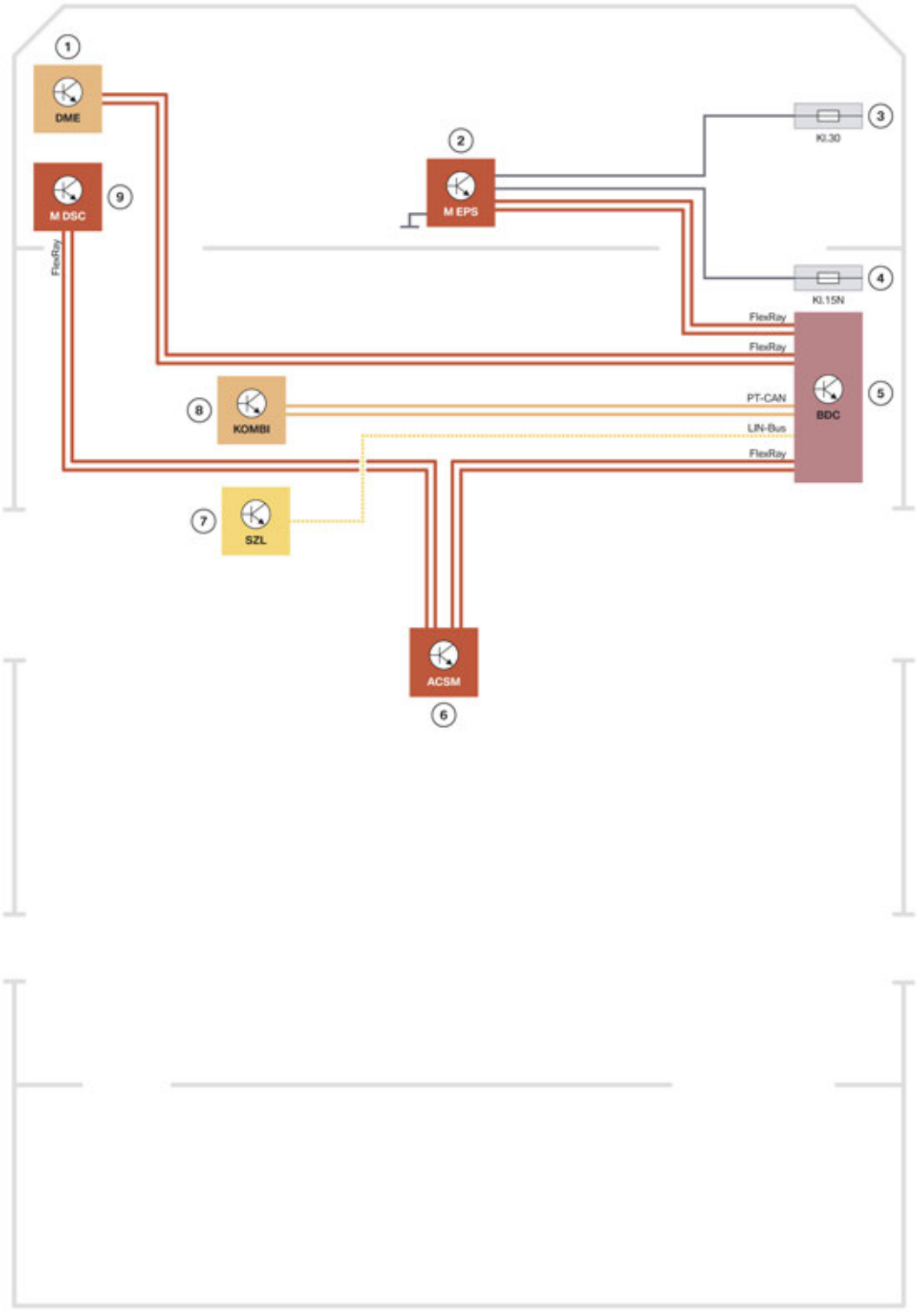
6. Chassis and Suspension

6.1.4. System wiring diagram, M Servotronic



F90, system wiring diagram, EPS

Index	Explanation
1	Digital Motor Electronics (DME)
2	M Servotronic (EPS)
3	Power distribution box, engine compartment
4	Power distribution box, front
5	Body Domain Controller (BDC)
6	Crash Safety Module (ACSM)
7	Steering column switch cluster (SZL)
8	Instrument cluster (KOMBI)
9	M Dynamic Stability Control (M DSC)

6.2. Rear axle

The rear axle is based on the HA5 rear axle from the G12 and the G30. Many components and bearings are new to the F90 or have been adapted. The rear axle support specific to the F90 is bolted onto the body with M-specific hard rubber mounts.

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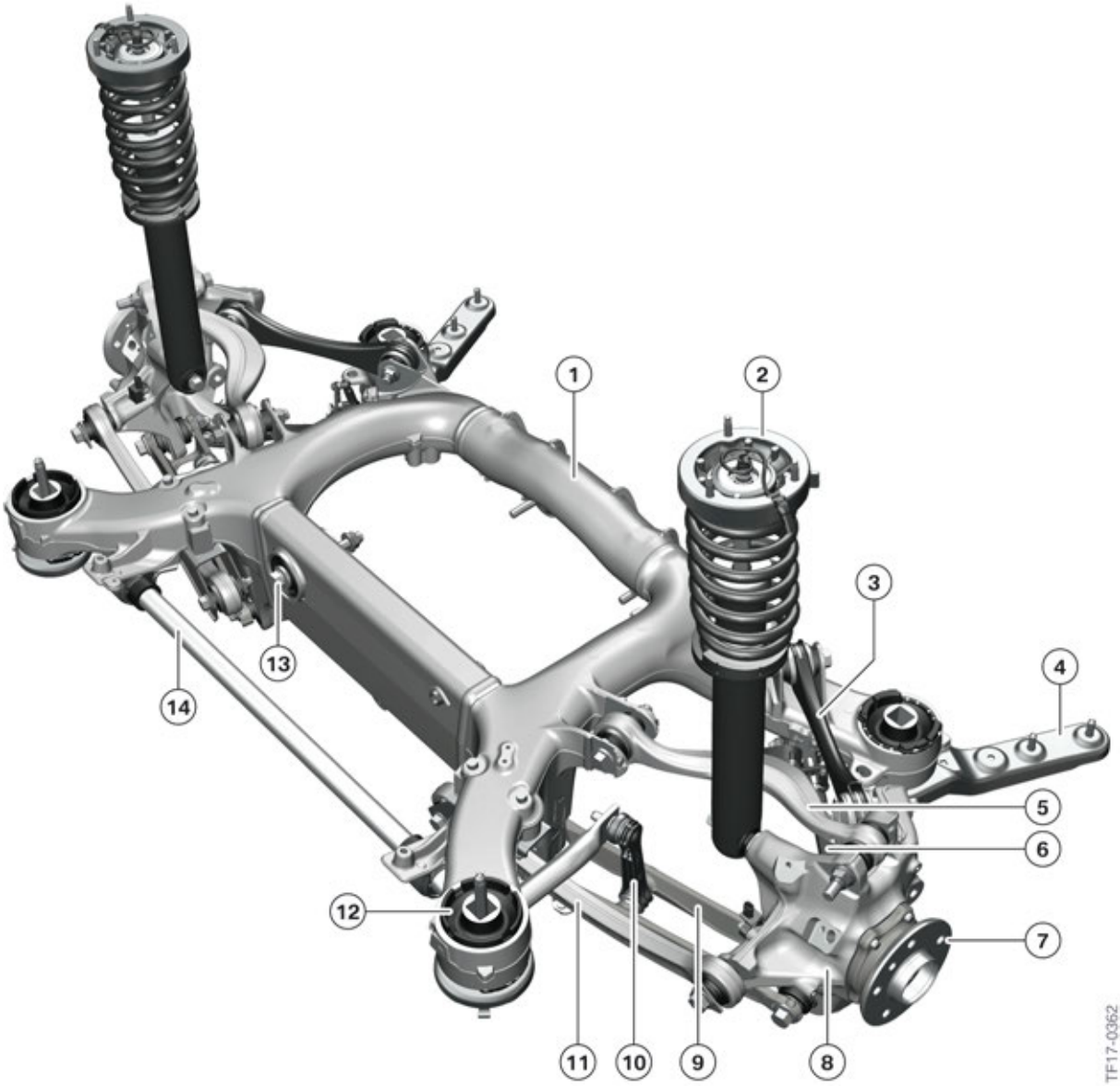
6. Chassis and Suspension



F90, HA5 rear axle

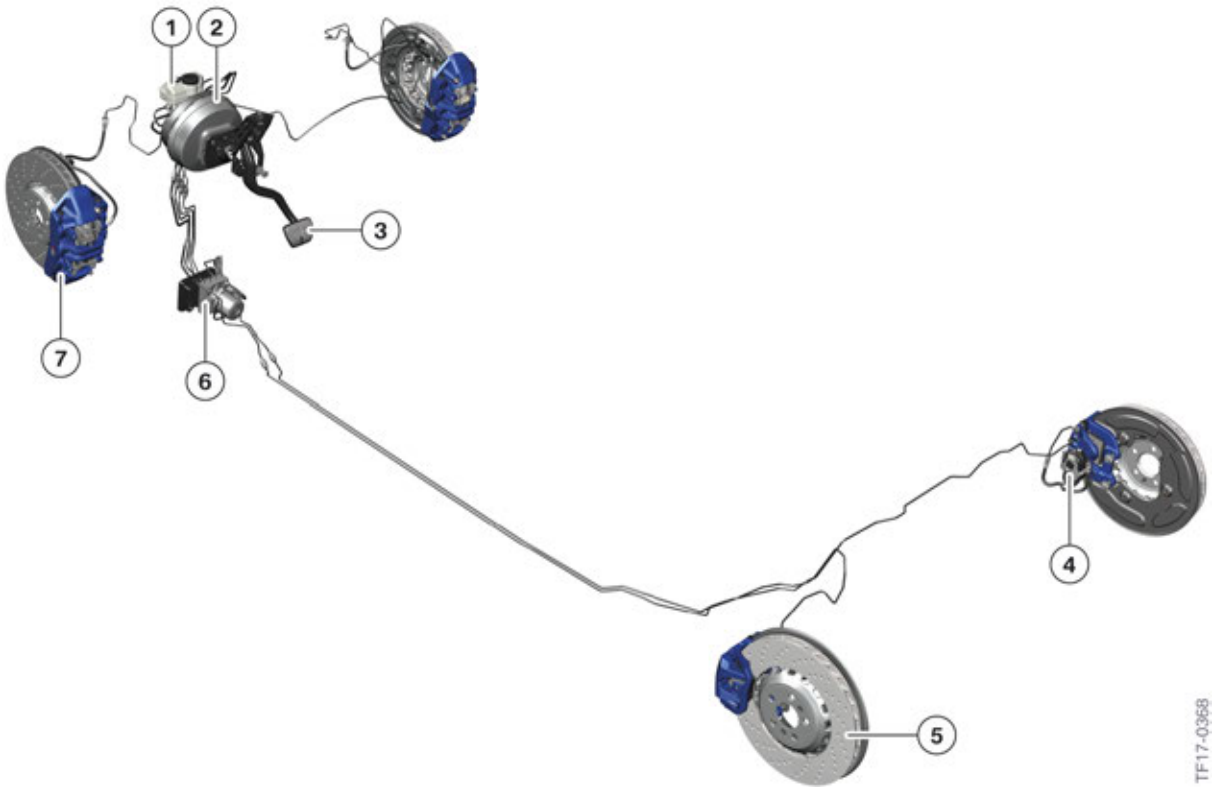
Index	Explanation
1	M rear axle support
2	M spring strut with M support bearing
3	M control arm
4	Compression strut (taken over from G12)
5	M wishbone
6	Trailing arm (taken over from G12)
7	M wheel hub
8	M hub carrier

Index	Explanation
9	Camber control arm (taken over from G12)
10	Anti-roll bar link (taken over from G12)
11	M track control arm
12	Attachment point of rear axle bearing (with hard rubber mount)
13	Attachment point for rear axle final drive
14	M anti-roll bar (Ø 30 mm)

6.3. Brakes and wheels/tires

6.3.1. Brakes

M compound brake



F90, brake system

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6. Chassis and Suspension

Index	Explanation
1	Brake fluid expansion tank
2	Brake servo (left-hand drive vehicle)
3	Brake pedal
4	Rear single-piston floating caliper with actuator for the electromechanical parking brake (EMF)
5	Rear brake disc
6	M Dynamic Stability Control (M DSC)
7	Front six-piston fixed caliper

The M compound brake provides even greater braking power than the sport brake offered with the M550i. In a direct comparison it also offers:

- Reduction in the vehicle weight, resulting in improved agility and dynamics, accelerating ability and fuel consumption
- Reduction in the rotating mass, resulting in improved accelerating ability, response and handling
- Increased fading stability and greater thermal resistance
- Perforated brake disc ring: sporty appearance, optimized response on wet roads
- Intelligent lightweight construction
- Technology transfer from M sport
- Unique, authentic M design.

Designation	Unit	F10 M5	G30 M550i	F90 M5
Front brakes		6 pistons, fixed caliper	4-piston fixed caliper	6 pistons, fixed caliper
Brake disc, front	[mm]	400 x 36	374 x 36	395 x 36
Rear brakes		1 piston, floating caliper	1 piston, floating caliper	1 piston, floating caliper
Brake disc, rear	[mm]	396 x 24	345 x 24	380 x 28
Parking brake		EMF	EMF	EMF

The front brakes are entirely specific to F90. It is a large-sized, perforated M compound brake disc combined with a six-piston fixed caliper. Its diameter is 21 mm larger than that of the M550i. The exterior of all brake calipers is blue metallic in color with the M logo.

F90, front brake

The diameter of the rear perforated M compound brake disc is 35 mm larger than that of the 550i. The rear brake caliper, apart from the blue paint but including the electromechanical parking brake, was taken over from production vehicles and is a single-piston floating caliper.

The characteristic maps of the M Dynamic Stability Control have been adapted specifically to the M design.

As is already familiar from the G12, the F90, like the G30, does not have Integrated Chassis Management (ICM). The ICM functions are distributed between the optional equipment system (SAS) and the M DSC.

Modification to brake pad wear monitoring

As in predecessor M models, the F90 now only has one brake pad wear sensor on the left front axle. The second is at the right rear axle.

M carbon ceramic brakes

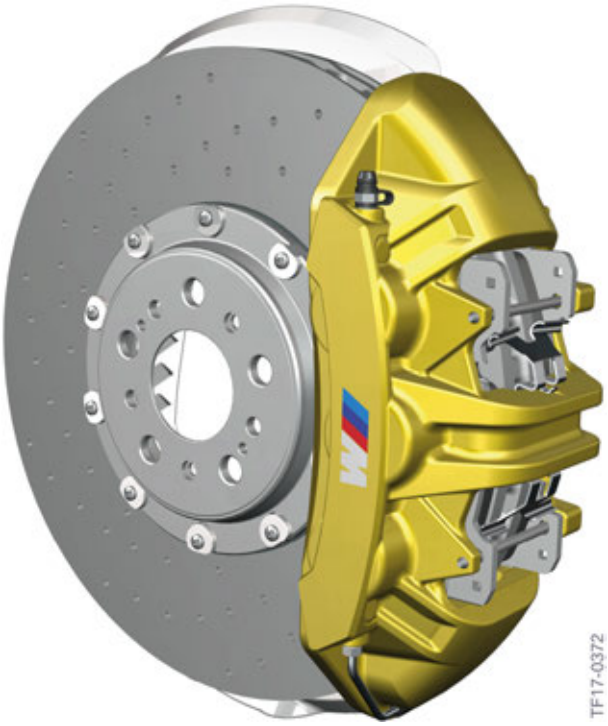
The M Carbon ceramic brake is available from the production launch of the new F90. It can be ordered as optional equipment for the F90, as is already the case for F80/F82 and F83.

The M Carbon ceramic brake system is also called the C/SiC brake system.

Depending on the situation, this offers a further increase in braking power over the M compound brake. In a direct comparison it also offers:

- Even more direct/spontaneous use of brake force
- Maximum heat resistance even with continuous sporty operation
- Higher fading stability

- Significantly reduced wear
- 15 lbs weight reduction of rotating wheel masses
- Increased suitability for winter driving conditions thanks to corrosion resistance.



F90, M carbon ceramic brake, front axle

As a visible distinguishing feature to the M Compound brake system the brake calipers are painted in gold with a colored M logo.

The brake discs are manufactured by Brembo SGL Carbon Ceramic Brakes GmbH.

Designation	Unit	F10 M5	F90 M5
Front brakes		6 pistons, fixed caliper	6 pistons, fixed caliper
Brake disc, front	[mm]	410 x 38	400 x 38
Rear brakes		1 piston, floating caliper	1 piston, floating caliper
Brake disc, rear	[mm]	396 x 26	380 x 28
Parking brake		EMF	EMF

Further information on the M Carbon ceramic brake can be found in the Reference Manual "M Carbon Ceramic Brake System".

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6. Chassis and Suspension

For necessary service work the current information and specifications in the documents in ISTA must be observed in each case.

6.3.2. Wheels/tires

F90, wheels

Index	Explanation
1	19” M production wheel
2	20” M wheel optional equipment

The following wheel/tire combinations are offered:

Standard equipment

Designation	F10 M5	G30 M550i	F90 M5
LM EH2+ wheel rim, standard wheel at front (cast)	9J x 19 Styling 345M	8J x 19	9.5 J x 19 Styling 705M
LM EH2+ wheel rim, standard wheel at rear (cast)	10J x 19 Styling 345M	9J x 19	10.5 J x 19 Styling 705M
Standard tires, front	265/40 ZR 19	245/40 R 19	275/40 ZR19
Standard tires, rear	295/35 ZR 19	275/35 R 19	285/40 ZR19
Run Flat Tires	No	Yes	No

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6. Chassis and Suspension

Optional equipment

Designation	F10 M5	F90 M5
LM EH2+ wheel rims (forged) styling 706M	9 J x 20	9.5J x 20
LM EH2+ wheel rims, rear (forged) styling 706M	10J x 20	10.5 J x 20
Front tires	265/35 ZR 20	275/35 ZR 20
Rear tires	295/30 ZR 20	285/35 ZR 20

The components of the above-listed wheel/tire combinations have been developed specially for the F90. This can be recognized by the star on the outer side of the tire, among other things.

Other combinations may have a negative effect on the performance and the drivability of the F90.

Winter equipment

Designation	F10 M5	F90 M5
19” wheel rim front/rear axles (cast)	9J x 19 Styling 408M	9.5J x 19 – 10.5J x 19 Styling 705M
19” tires, front/rear axes	255/40 R19 100 V M+S XL	265/40 R19 V M+S – 285/40 R19 V M+S
Chain assembly possible on rear axle, chain type:	Rudmatic	Pewag
20” wheel rim front/rear axles (cast)	9 J x 20 Styling 409M	—
20" tires	255/35 R20 97 V M+S XL	—
Chain assembly possible on rear axle, chain type:	Rudmatic	—

The components of the above-listed wheel/tire combinations have been developed specially for the F90. This can be recognized by the star on the outer side of the tire, among other things.

Other combinations may have a negative effect on the performance and the drivability of the F90.

6.4. Dynamic handling control systems

The M-specific coordination of the driving dynamics (longitudinal, transverse and vertical) was perfected on the Nürburgring Nordschleife. The main criteria was handling and the lap times.

6.4.1. Vertical Dynamics Management

The EDC function integrated in the M vertical dynamic platform (M VDP) controls the adjustable dampers.

The drivability can be shifted toward the individual driving dynamics direction via the EDC button in the M drive dynamic control switch on the center console. The program selection can also be configured in the CID and selected using the corresponding M1/M2 buttons on the steering wheel.

Electronic Damper Control

None of the EDC control valves known from the G30 are installed on the shock absorbers on the outside, but control valves typical of the M design are. The shock absorbers were developed with ZF Sachs and the system has been adapted to the F90 .

The EDC works with infinitely variable valves in the absorbers. The hydraulic oil flow is controlled via electromagnetic control valves. It is thus possible to make available the damping force actually required at all times.

The following variables, among others, were processed into the corresponding control variables in the M vertical dynamic platform (M VDP): vertical acceleration, wheel speed (M DSC), steering angle change (M EPS), angle change rate (ACSM) and damper piston speed .

In addition, the ride height between the wheel suspension and body is used as a control, reference and load variable and is read off of the ride height sensors of the headlights. Two sensors each are installed at the front and rear. They operate on the basis of the potentiometer principle and their signal is made available to the M VDP.

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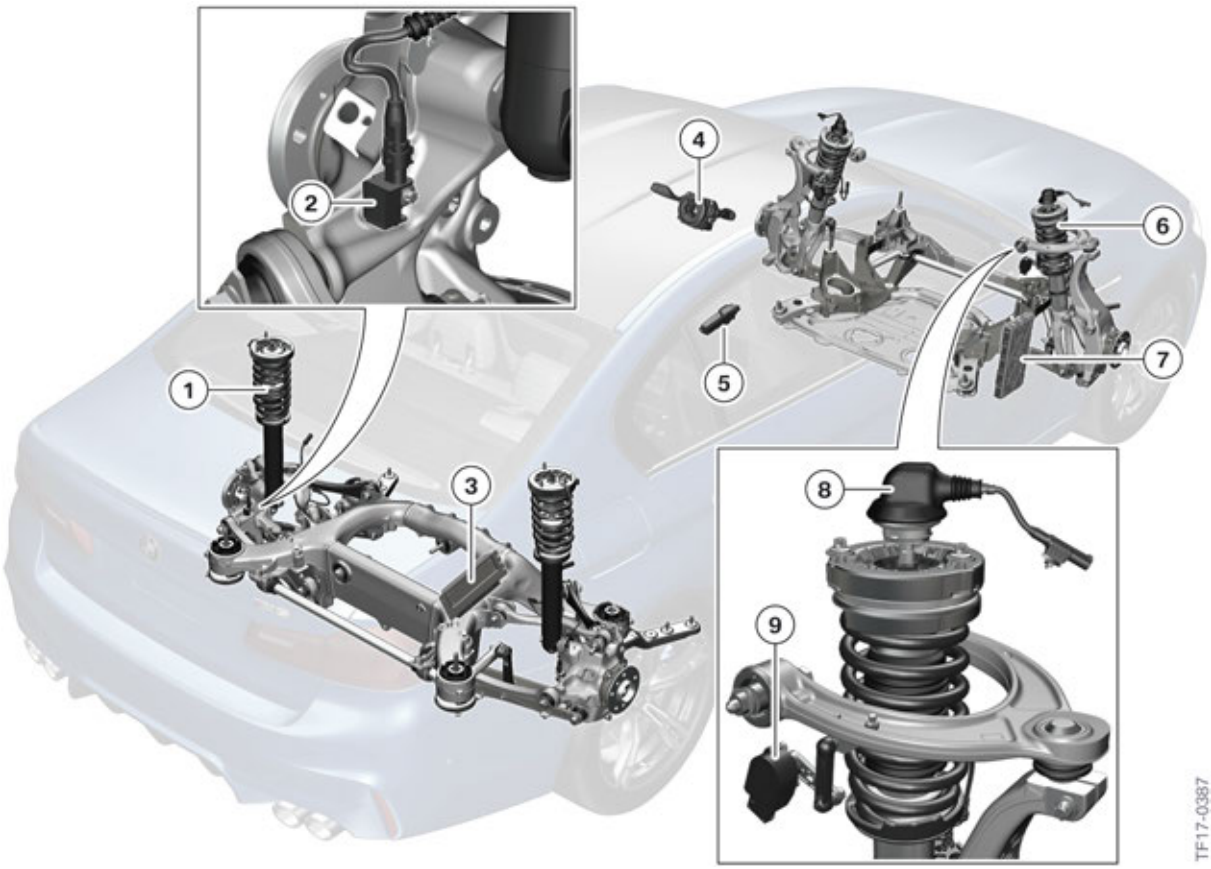
6. Chassis and Suspension

System overview



F90, EDC system overview

Index	Explanation
1	Electronic adjustable damper, rear
2	Rear left vertical acceleration sensor
3	M vertical dynamic platform (M VDP)
4	Steering column switch cluster (SZL)
5	EDC button
6	Electronic adjustable damper, front
7	Body Domain Controller (BDC)
8	Electrical connection, EDC valve
9	Ride height sensor, front right

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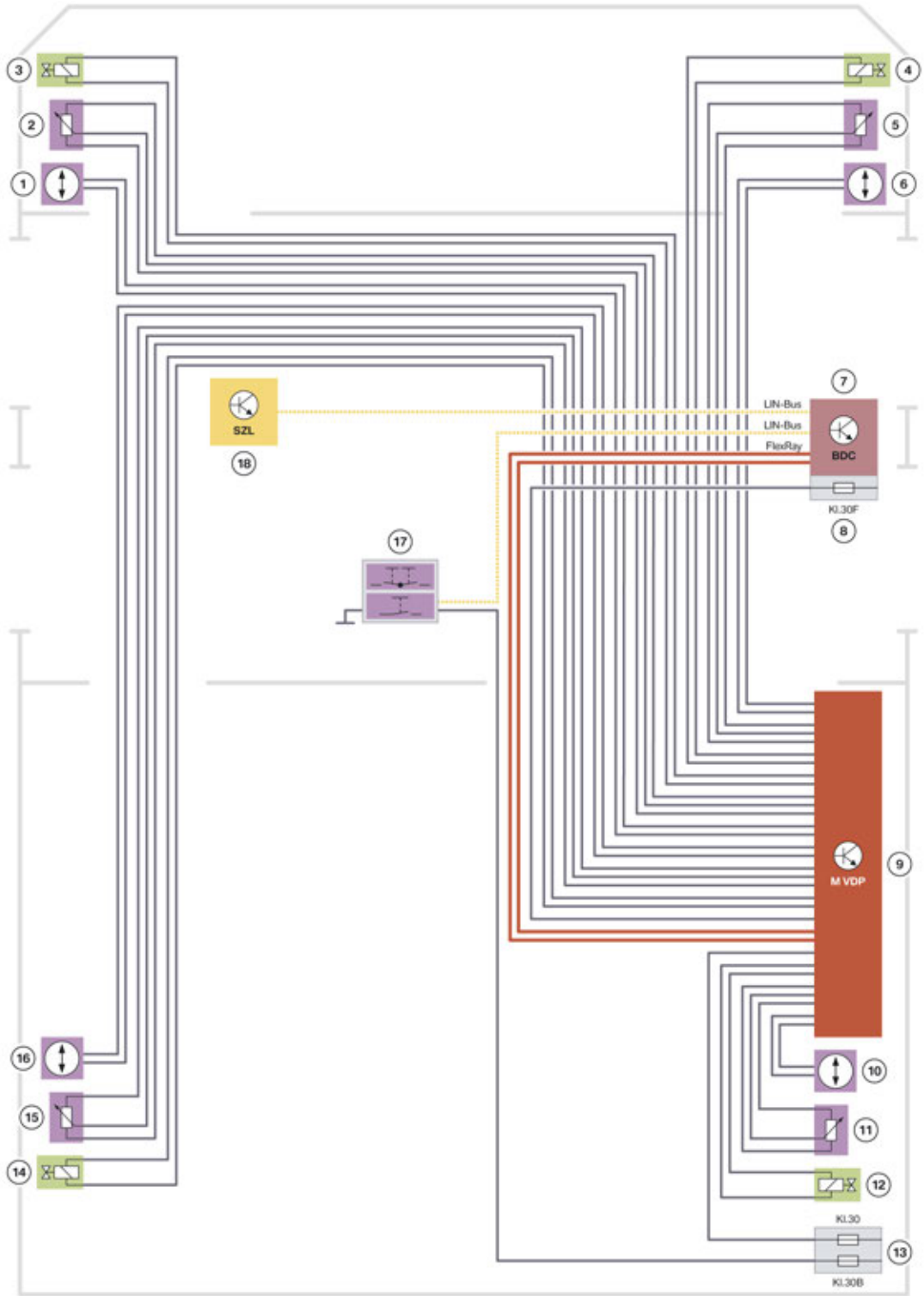
6. Chassis and Suspension

System wiring diagram



F90, EDC system wiring diagram

Index	Explanation
1	Vertical acceleration sensor, front left
2	EDC control valve, front left
3	Ride height sensor, front left
4	EDC control valve, front right
5	Ride height sensor, front right
6	Front right vertical acceleration sensor
7	Body Domain Controller (BDC)
8	Power distribution box, front
9	M vertical dynamic platform (M VDP)
10	Rear right vertical acceleration sensor
11	Ride height sensor, rear right
12	EDC control valve, rear right
13	Power distribution box, rear
14	EDC control valve, rear left
15	Ride-height sensor, rear left
16	Rear left vertical acceleration sensor
17	EDC button
18	Steering column switch cluster (SZL)

System function

The Electronic Damper Control (EDC) is a variable, electronically controlled shock absorber adjustment system that controls the vertical dynamics. The front axle damper and rear axle damper can be controlled independent of each other. The EDC adapts the damping forces of the shock absorber more or less instantly to the changing road or driving conditions.

The EDC consists of:

- 4 continuously variable shock absorbers with coupled rebound/compression stage adjustment
- M VDP control unit
- 2 vertical acceleration sensors on the front axle (swivel bearing) for determining the wheel movement
- 2 vertical acceleration sensors on the rear axle (wheel bearing) for determining the wheel movement
- 4 ride height sensors
- Body Domain Controller as gateway.

The sensors in the vehicle permanently measure:

- The body and vertical acceleration
- The current lateral and longitudinal acceleration
- The vehicle speed
- The steering wheel position.

Based on this measured data, the M VDP control unit calculates the control commands to be sent to the electromagnetic valves in the shock absorbers for each individual wheel according to the road profile and driving situation. This means that the damping forces will always be applied according to requirements.

This improves ride comfort and also increases driving dynamics.

This improves the vehicle's:

- Suitability for long-distance journeys
- Enhanced body stability and agility
- Improves driving safety by minimizing wheel load fluctuations and reducing the stopping distance.

M sports suspension (EDC) button option

The EDC button is connected with the Body Domain Controller via the LIN bus. The BDC forwards this information via the FlexRay bus to M VDP.

In the F90 Electronic Damper Control there are options "Comfort", "Sport" and "Sport+".
All three programs have an M dynamic control in the F90.

Note:

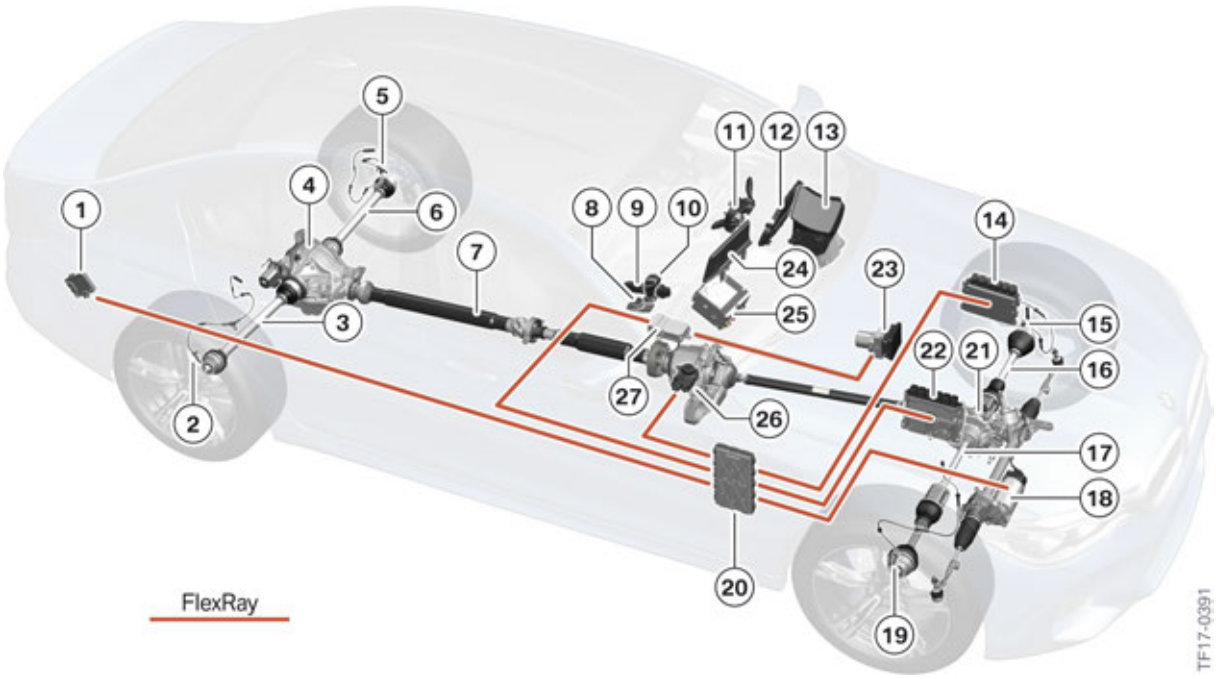
In the first E92/E90 M3 models, the EDC had the 3 options, "Comfort", "Normal" and "Sport", whereby with the "Sport" option there is no M dynamic control, but the dampers are set very hard. This is primarily suited for a cone slalom on an even surface. However, the fastest possible times on normal roads cannot be achieved with the "Sport" option. The E93 M3 was set to the "Sport" mode after standard production, and all successor models and also the F90 M5 are set to "Sport+" dynamic control.

M drive dynamic control switch, EDC program description:

- "Comfort" emphasizes the comfortable design in the F90 in order to satisfy any comfort requirements an M5 customer may have. The basic damper hardness is comfortable without forfeiting safe handling in an emergency (such as during rapid evasive maneuvers).
- "Sport" supports a demanding M dynamic and sporty driving style with increased basic damper hardness and sufficient remaining comfort (for example on country roads or bumpy racetracks such as the Nürburgring Nordschleife).
- "Sport+" in the F90 means that dynamic control now also takes place here, and basic damper hardness is increased further in comparison to "Normal". It may therefore also be the best selection for the fastest times on different route profiles on very even surfaces, unlike a route profile similar to a "cone-lined slalom".

6.4.2. M Dynamic Stability Control (M DSC)

The M DSC represents the longitudinally dynamic system network. This control unit coordinates the interaction between the M Servotronic, engine control, M VTG and the regulated M rear axle differential lock (M GHAS).



F90, longitudinal dynamics system overview

Index	Explanation
1	Regulated M rear axle differential lock (M GHAS)
2	Wheel speed sensor, rear right
3	Output shaft, rear left
4	M rear axle differential lock
5	Wheel speed sensor, rear left
6	Output shaft, rear left
7	Prop shaft
8	Controller (CON)
9	M drive dynamic control switch
10	M gear selector switch (M GWS)
11	Steering column switch cluster (SZL)
12	Instrument cluster (KOMBI) (M-specific)
13	Head-Up Display (HUD) (M-specific)

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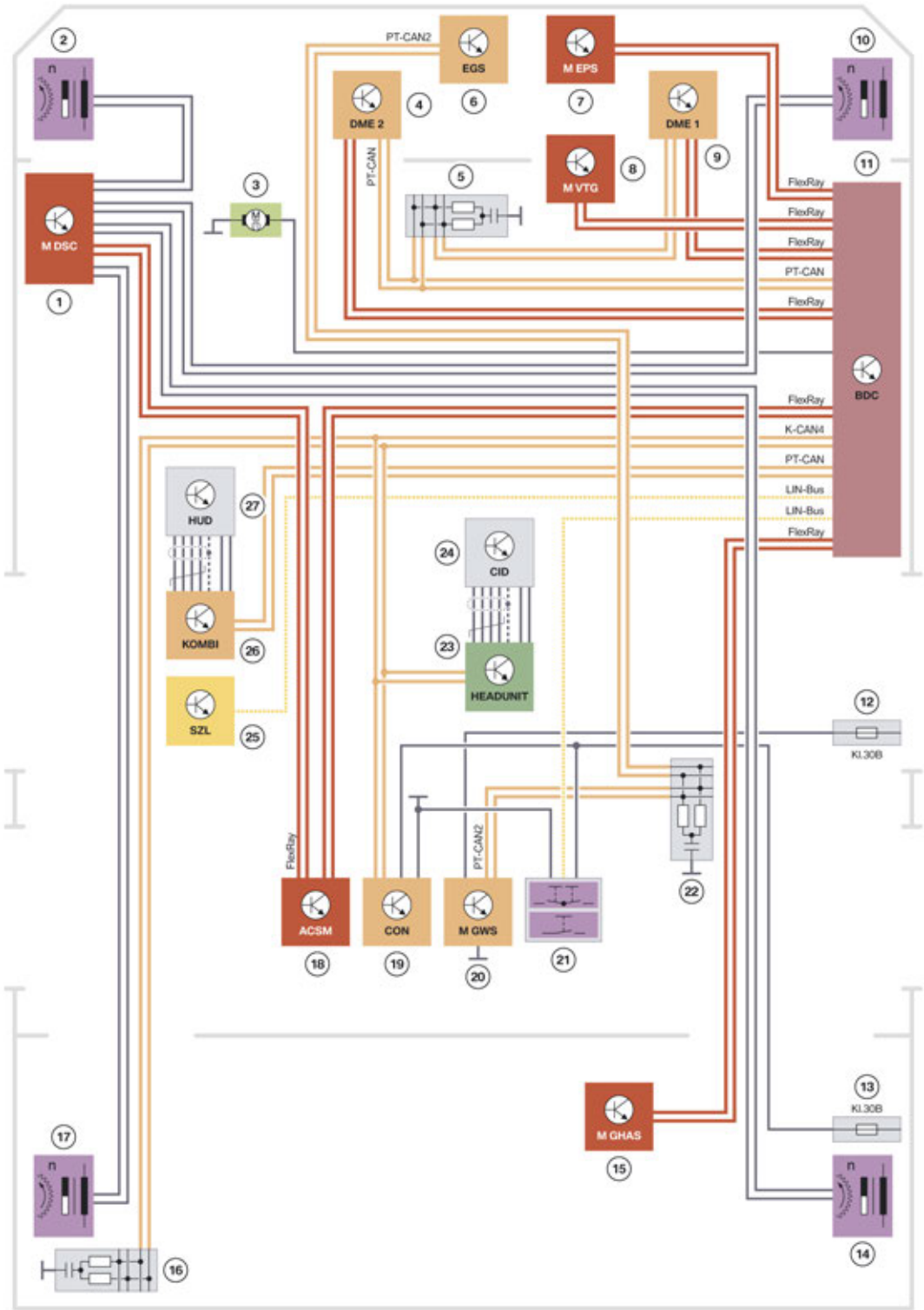
Index	Explanation
14	Digital Motor Electronics 2 (DME 2)
15	Wheel-speed sensor, front left
16	Output shaft, front left
17	Output shaft, front right
18	M Servotronic (M EPS)
19	Wheel-speed sensor, front right
20	Body Domain Controller (BDC)
21	Front axle differential
22	Digital Motor Electronics 1 (DME 1)
23	M Dynamic Stability Control (M DSC)
24	Central information display (CID)
25	Headunit (M-specific)
26	M transfer case, (M VTG)
27	Advanced Crash Safety Module (ACSM)

F90 Complete Vehicle

6. Chassis and Suspension

System wiring diagram



F90, system wiring diagram, longitudinal dynamic

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Index	Explanation
1	M Dynamic Stability Control (M DSC)
2	Wheel-speed sensor, front left
3	Auxiliary coolant pump, heating
4	Digital Motor Electronics 2 (DME 2)
5	PT-CAN terminating resistor
6	Electronic transmission control (EGS)
7	M Servotronic (M EPS)
8	M transfer case, (M VTG)
9	Digital Motor Electronics 1 (DME 1)
10	Wheel-speed sensor, front right
11	Body Domain Controller (BDC)
12	Power distribution box, front
13	Power distribution box, rear
14	Wheel speed sensor, rear right
15	Regulated M rear axle differential lock (M GHAS)
16	K-CAN4 terminating resistor
17	Wheel speed sensor, rear left
18	Advanced Crash Safety Module (ACSM)
19	Controller (CON)
20	M gear selector switch (M GWS)
21	M drive dynamic control switch
22	PT-CAN2 terminating resistor
23	Headunit (M-specific)
24	Central information display (CID)
25	Steering column switch cluster (SZL)
26	Instrument cluster (KOMBI) (M-specific)
27	Head-Up Display (HUD) (M-specific)

6.4.3. Integrated actuation (longitudinal transverse dynamics)

Integrated actuation is used in the F90. The integrated actuation in the M DSC comprises the DSC, which is responsible for the longitudinal dynamics, and an transverse dynamics management control unit (QDM) integrated in the DSC control unit. This means that the current driver's choice is distributed to the appropriate actuator via the M DSC control unit. This results in the following advantages during driving for the F90:

- Excellent traction, especially on low coefficients of friction
- M-specific agility and playfully intuitive control of the vehicle
- Superiority in every day use
- Variable functions of the M xDrive are possible, depending on the driver's choice.

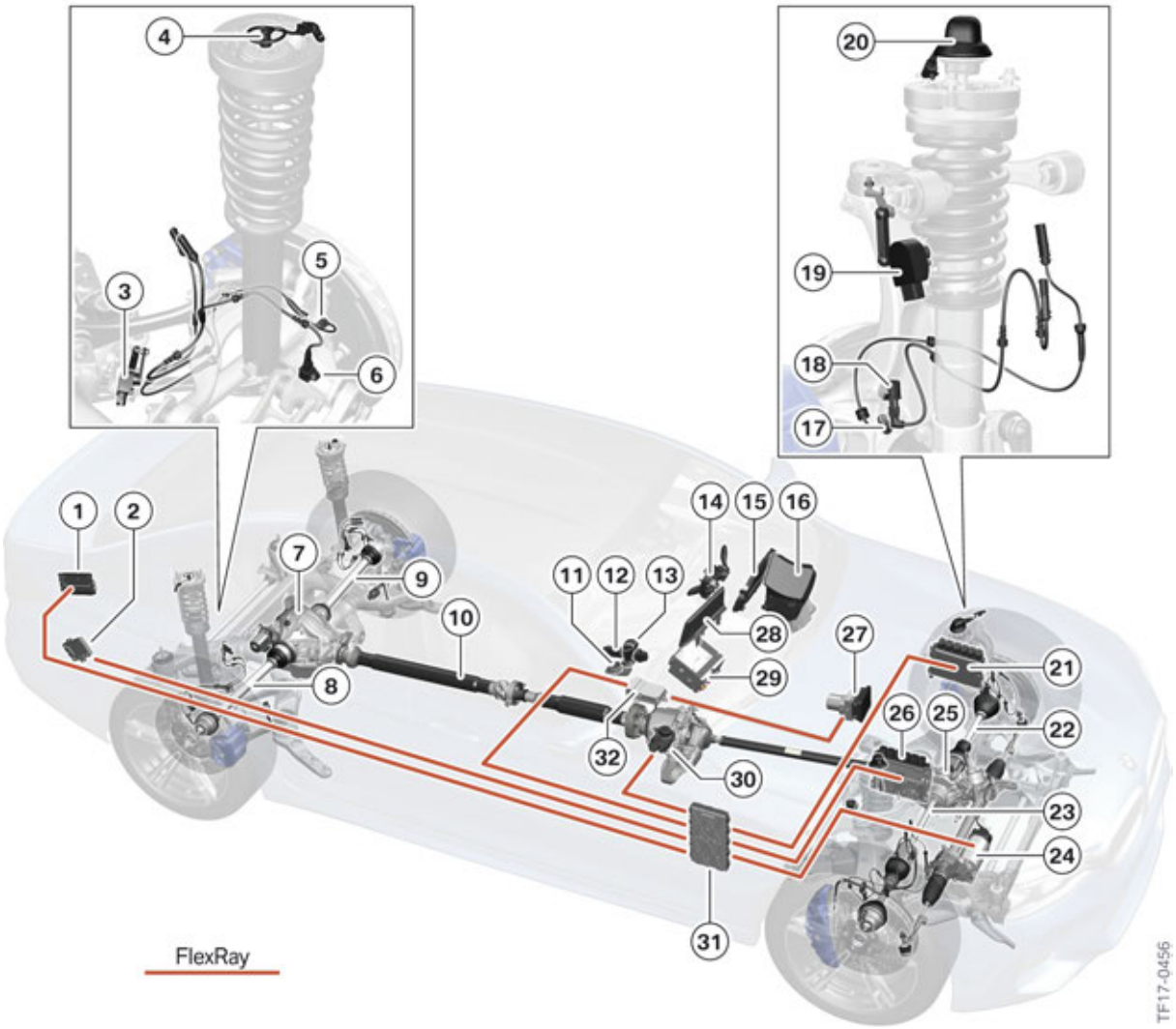
The actuator and control units that are used depending on the driver's choice are:

- M Servotronic (M EPS)
- M VDP and Electronic Damper Control (EDC)
- M regulated M rear axle differential lock (M GHAS)
- M Dynamic Stability Control (M DSC)
- M transfer case (M VTG)
- Digital Motor Electronics (DME).

The transverse dynamics management control unit QDM is not a separate control unit, but is integrated in the M DSC. It therefore cannot be replaced separately.

F90 Complete Vehicle

6. Chassis and Suspension



F90, system overview, integrated actuation

Index	Explanation
1	M vertical dynamic platform (M VDP)
2	Regulated M rear axle differential lock (M GHAS)
3	Ride height sensors, rear
4	Electrical connection, EDC valve, rear
5	Wheel speed sensors, rear
6	Vertical acceleration sensor, rear
7	M rear axle differential lock
8	Output shaft, rear left
9	Output shaft, rear left
10	Prop shaft

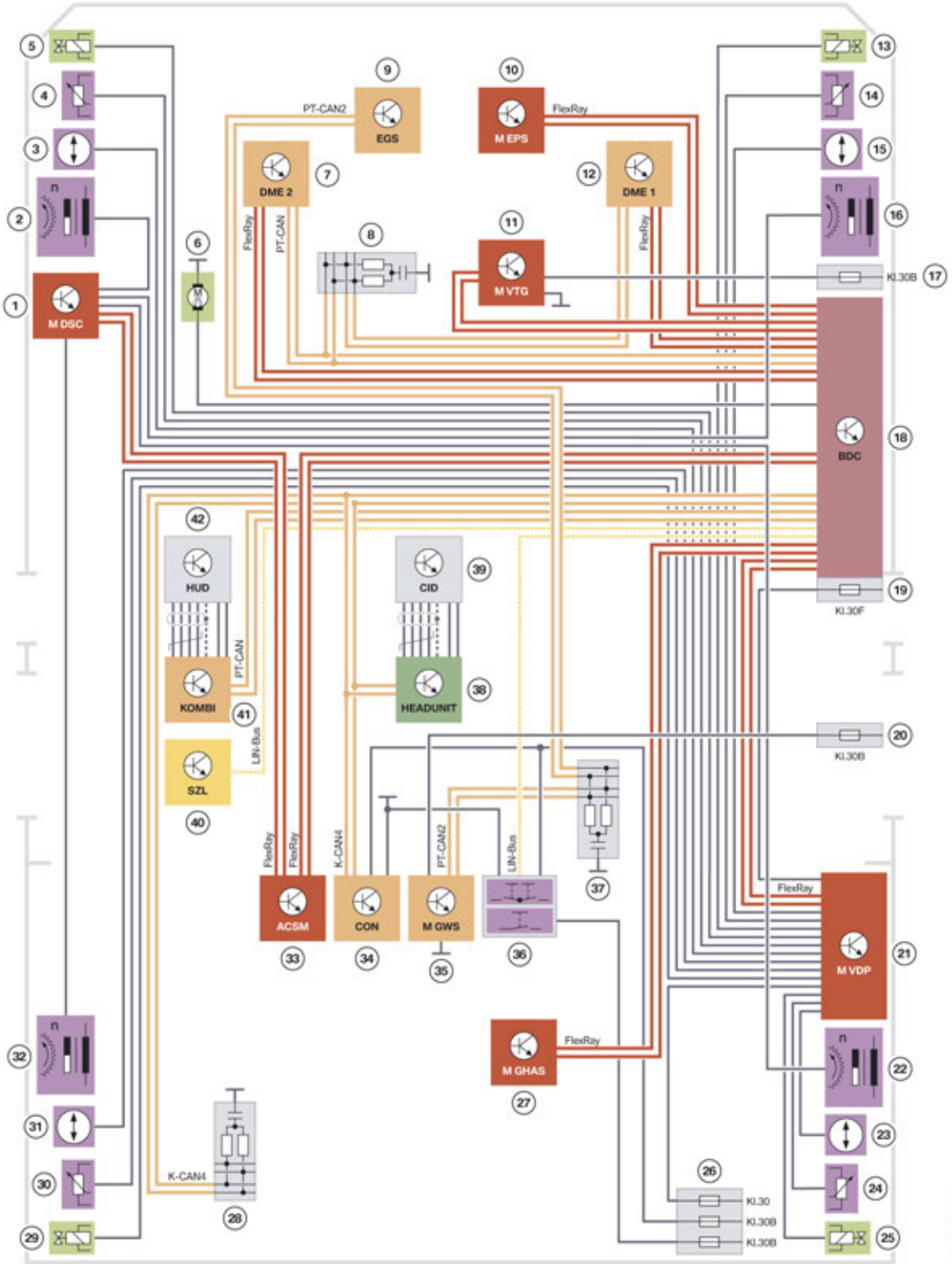
F90 Complete Vehicle
6. Chassis and Suspension

Index	Explanation
11	Controller (CON)
12	M drive dynamic control switch
13	M gear selector switch (M GWS)
14	Steering column switch cluster (SZL)
15	Instrument cluster (KOMBI) (M-specific)
16	Head-Up Display (HUD) (M-specific)
17	Wheel speed sensors, front
18	Vertical acceleration sensor, front
19	Ride height sensors, front
20	Electrical connection, EDC valve, front
21	Digital Motor Electronics 2 (DME 2)
22	Output shaft, front left
23	Output shaft, front right
24	M Servotronic M EPS
25	Front axle differential
26	Digital Motor Electronics 1 (DME 1)
27	M Dynamic Stability Control (M DSC)
28	Central information display (CID)
29	Headunit (M-specific)
30	M transfer case (M VTG)
31	Body Domain Controller (BDC)
32	Advanced Crash Safety Module (ACSM)

F90 Complete Vehicle

6. Chassis and Suspension

System wiring diagram



F90, system wiring diagram, integrated actuation (simplified)

F90 Complete Vehicle
6. Chassis and Suspension

Index	Explanation
1	M Dynamic Stability Control (M DSC)
2	Wheel-speed sensor, front left
3	Vertical acceleration sensor, front left
4	Ride height sensor, front left
5	EDC control valve, front left
6	Auxiliary coolant pump, heating
7	Digital Motor Electronics 2 (DME 2)
8	PT-CAN terminating resistor
9	Electronic transmission control (EGS)
10	M Servotronic (M EPS)
11	M transfer case (M VTG)
12	Digital Motor Electronics 1 (DME 1)
13	EDC control valve, front right
14	Ride height sensor, front right
15	Front right vertical acceleration sensor
16	Wheel-speed sensor, front right
17	Fuse 30B (power distribution box, front)
18	Body Domain Controller (BDC)
19	Fuse 30F (power distribution box, front)
20	Fuse 30B (power distribution box, front)
21	M vertical dynamic platform (M VDP)
22	Wheel speed sensor, rear right
23	Rear right vertical acceleration sensor
24	Ride height sensor, rear right
25	EDC control valve, rear right
26	Power distribution box, rear
27	Regulated M rear axle differential lock (M GHAS)
28	K-CAN4 terminating resistor
29	EDC control valve, rear left
30	Ride-height sensor, rear left
31	Rear left vertical acceleration sensor
32	Wheel speed sensor, rear left
33	Advanced Crash Safety Module (ACSM)
34	Controller (CON)
35	M gear selector switch (M GWS)

Index	Explanation
36	M drive dynamic control switch
37	PT-CAN2 terminating resistor
38	Headunit (M-specific)
39	Central information display (CID)
40	Steering column switch cluster (SZL)
41	Instrument cluster (KOMBI) (M-specific)
42	Head-Up Display (HUD) (M-specific)

6.4.4. M dynamic mode and M DSC OFF mode

In M Dynamic Mode (MDM) the control threshold of the brake interventions is expanded/raised and the engine power reduction by DSC is applied significantly later. This enables driver-oriented dynamic and sporty driveability. The "M DSC OFF" mode is described separately in one of the following chapters.

The DTC button is connected with the BDC via the LIN bus. The BDC forwards this information via the FlexRay bus to the M DSC.

F90 Complete Vehicle
7. General Vehicle Electronics

7.1. Voltage supply

7.1.1. Overview

The voltage supply for the vehicle electrical system in the F90, as in the F80/F82 and F83, is provided by a lithium-ion battery.

The voltage supply from the lithium-ion battery is based on the same concept as the voltage supply used in the F80/F82 and F83. The voltage supply in the F90 was adapted in the following areas:

- Software of the battery supervision circuits (BUE)
- Energy management
- Vehicle electrical system structure
- Fuse protection up to 134 A for the EPS
- Deletion of the vehicle electrical system support (BUM) through use of the lithium-ion battery
- Deletion of 24-V steering through use of the lithium-ion battery (weight savings of approx. 90 lbs due to deletion of additional 12-V battery, DC/DC converter, etc.).

Lithium-ion batteries are categorized according to their structure and/or the material used for the electrodes. In this case it is lithium-iron phosphate. The outer appearance of the lithium-ion battery does not differ from a normal battery; all components of the lithium-ion battery are located in the same housing, just as they are in a conventional lead-acid battery, or AGM battery.

All other functions and components of the voltage supply are based on the G30. Further information can be found in the Reference manual "G30 Complete Vehicle" General Vehicle Electronics.

F90, lithium-ion battery

7.1.2. Advantages

The following advantages come with the use of a lithium-ion battery and were decisive for the use of this technology in a high-performance vehicle like the F90:

- **Lower weight:**
  With the use of the lithium-ion battery the weight was able to be reduced by approx. 30 lbs. The lithium-ion battery only weighs 30 lbs in comparison to a conventional AGM 90 Ah battery which is approx. 60 lbs.
- **CO_2 savings:**
  A CO_2 saving can be achieved with automatic engine start/stop function (MSA) availability. With a conventional lead-acid battery, the regeneration capacity is not as high as with a lithium-ion battery as a result of the intelligent generator control. The lithium-ion battery can absorb considerably higher currents in a shorter time for charging in comparison to the lead-acid battery. This makes it ideal for use in vehicles with intelligent generator control (IGR).
- **Cycle life:**
  The number of available full cycles for a lithium-ion battery is considerably higher than for a conventional lead-acid battery. The lithium-ion battery is therefore the optimal alternative for use of the automatic engine start/stop function (MSA) in conjunction with the intelligent generator control (IGR). The battery life is also higher than that of the traditional lead-acid battery.
- **Maintenance-free:**
  Maintenance-free, as no maintenance is required after topping up with distilled water (not with AGM batteries).
- **Ideal voltage level:**
  With the use of lithium iron phosphate cells ($LiFePO_4$), which have a nominal voltage of 3.3 V per cell, a nominal voltage of the lithium-ion battery of 13.2 V could be achieved.
- **Very high intrinsic safety:**
  Lithium iron phosphate cells ($LiFePO_4$) generally have a lower hazard potential than other lithium-based batteries.

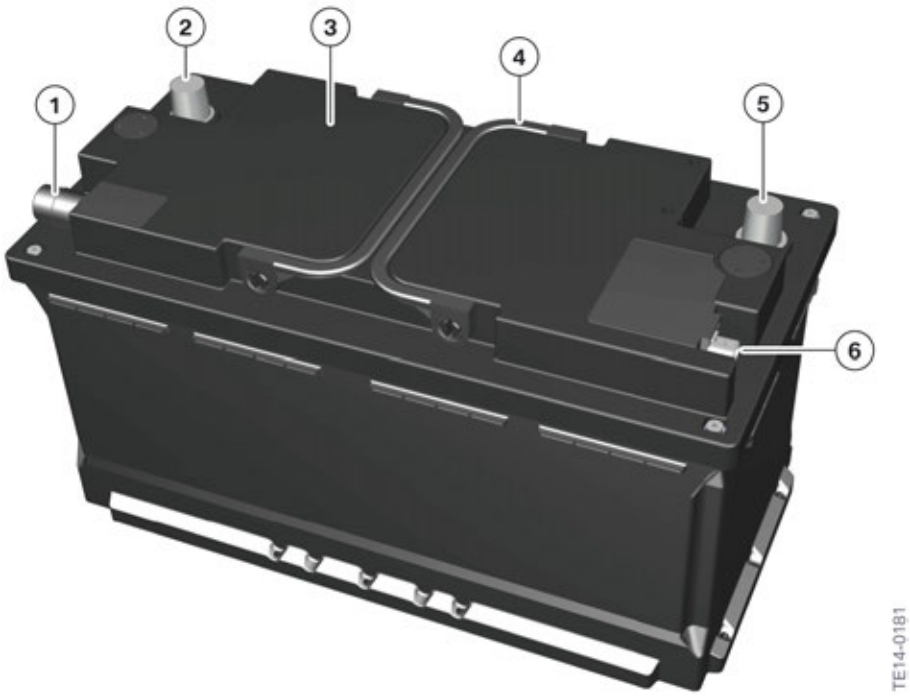
7.1.3. Comparison of lithium-ion battery/lead battery

Designation	Unit	Lead-acid battery/ AGM battery	Lithium-ion battery
Nominal voltage	[V]	12	13.2
Cell voltage	[V]	2	3.3
Rated capacity	[Ah]	90	69
Number of cells		6	4
Weight	[lbs]	60	30
Possible charging cycles		Approx. 350	Approx. 2,000
Charging end voltage Ideal/Maximum	[V]	14.2/16	14.4/temperature-dependent

Designation	Unit	Lead-acid battery/ AGM battery	Lithium-ion battery
Discharging		No total discharge protection/ battery damage	Total discharge protection at 8 V
Battery sensor system		Intelligent battery sensor (IBS)	Battery supervision circuits (BUE) in battery
Housing	[DIN]	LN5	LN5
Ventilation		Standard housing with ventilation line	Standard housing with extended ventilation line (18.5 mm)
Application range		Every vehicle	Only in F80/ F82/F83/F90

7.1.4. Structure of the lithium-ion battery

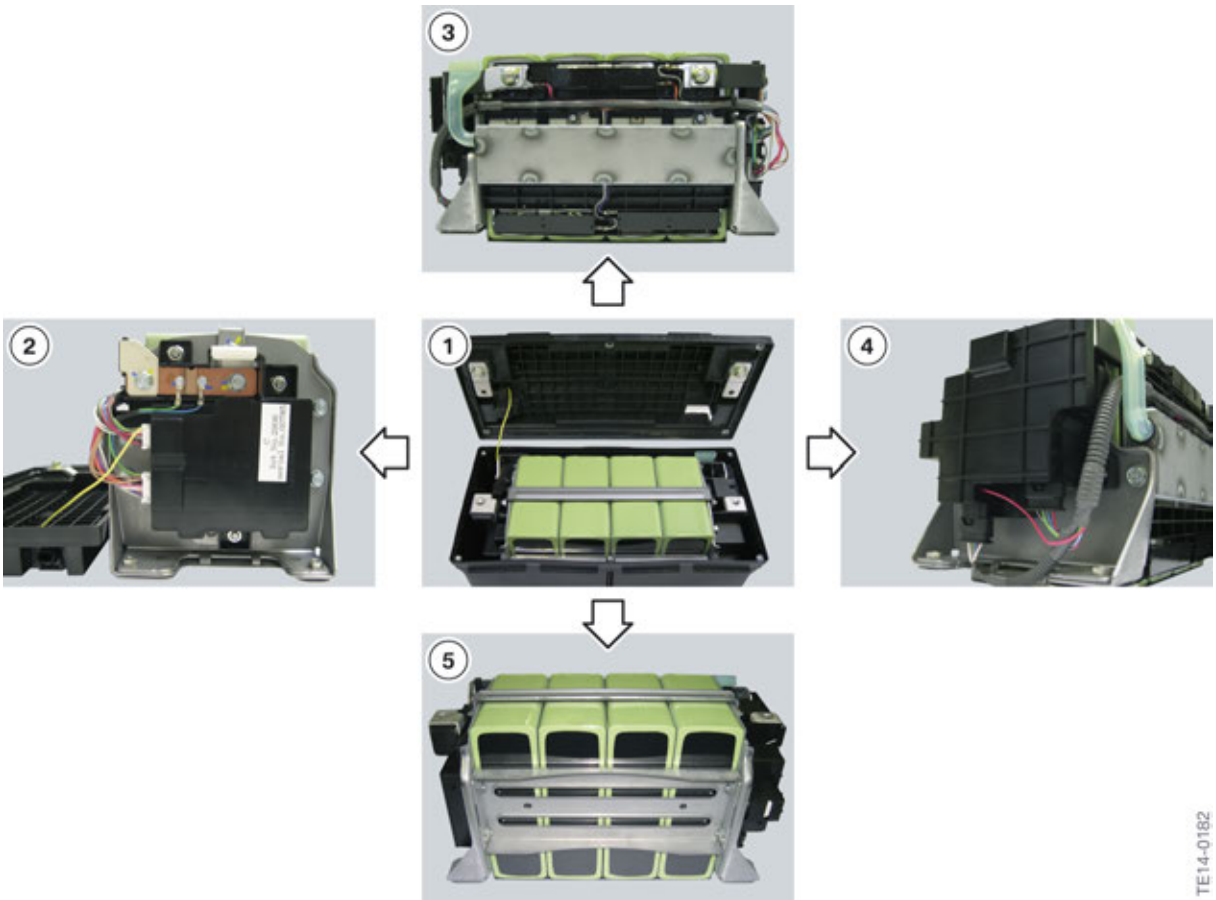
External structure



F90, lithium-ion battery, external view

Index	Explanation
1	Ventilation connection
2	Positive terminal
3	Battery housing
4	Installation/Removal Handles
5	Negative terminal
6	LIN connection

Inner structure



F90, lithium-ion battery

Index	Explanation
1	Inner structure
2	Battery supervision circuits (BUE) with precision resistor
3	Metal ventilation chute
4	Electronic disconnect switch (2 relays)
5	4 lithium-ion cells

7.1.5. Function

In addition to the 4 cells, there are also electronics and a battery isolating switch (2 relays) in the housing of the battery.

Integrated electronics "Battery supervision circuits"

The integrated electronics, or battery supervision circuits (BUE), are responsible for the:

- Communication via LIN data bus with DME
- Diagnostics
- Wake-up function via LIN bus
- Current monitoring of the individual cells and battery
- Closed-circuit current monitoring
- Voltage monitoring of the individual cells and battery
- Cell voltage adaptation with counter function via passive system (resistance)
- Start monitoring
- Temperature monitoring with resulting temperature model
- Internal resistance monitoring
- State of charge monitoring
- Battery condition monitoring
- Battery capacity monitoring
- Data memory for battery information
- Activation of the battery isolating switch in the event of a fault.

The battery supervision circuits use the plug connection of the IBS. This is why there is no IBS installed in the F90. All functions of the IBS are assumed in the F90 by the battery supervision circuits.

The battery supervision circuits cannot be replaced separately and are only offered together with the battery.

Battery isolating switch

The battery isolating switch is activated by the battery supervision circuits and is responsible for protecting the lithium-ion cells from external and internal influences in the event of a fault.

The following parameters may have effects on the position of the battery isolating switch:

- Voltage
- Current
- Temperature.

The following table illustrates the possible positions of the electronic disconnect switch:

Position	Voltage	Current	Temperature
Battery isolating switch open	Over voltage or Under voltage	Short circuit current	Temperature via 176°F
Battery isolating switch closed	Normal	Normal	Normal

The battery isolating switch cannot be replaced separately and is only offered together with the battery.

7.1.6. Actions in the event of a fault

Cause	Impact and effects	Measure
Overloading	Battery isolating switch opens.	Remove voltage source. Battery isolating switch closes again after voltage drop.
Fully discharge (1 battery cell under 2 volt for longer than 10 seconds)	Battery isolating switch opens.	Connect charger/Jump-start. Battery isolating switch closes again after voltage detection.
Gas emission (cell fault, misuse)	Smoke formation  Caution: Risk of burning! Caution: Hazardous gases	Remove people from danger area. Provide fresh air. Replace battery. Replace ventilation hose.
External impacts and effects	Damage to housing, poss. mechanical cell damage or damage to internal components.	Replace battery and dispose of battery properly.
Gas emissions with ignition source over 932 °F	Gas ignites with corresponding concentration and ignition source.  Caution: Risk of burning! Caution: Hazardous gases	Remove people from danger area. Provide fresh air. Inform fire department. Extinguish using a standard fire extinguisher. Replace battery if necessary. Replace ventilation hose if necessary.

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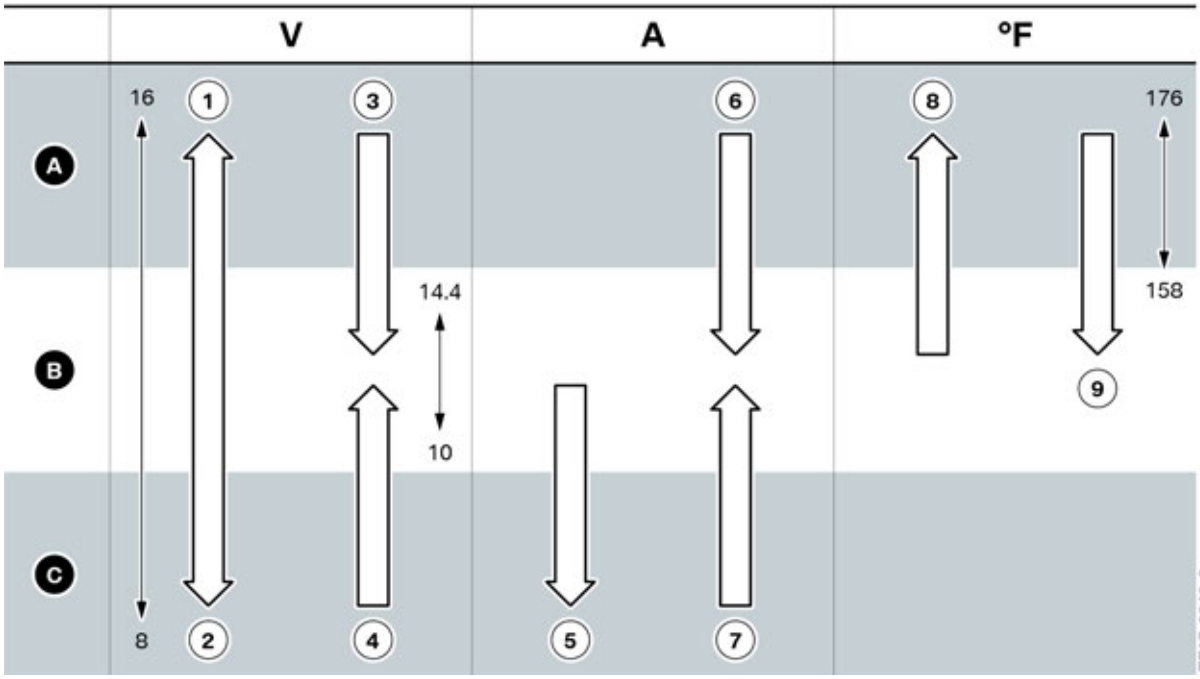
7. General Vehicle Electronics



F90, possible battery isolating switch positions

Index	Explanation
V	Voltage in volts
A	Current in A
°F	Temperature in degrees Fahrenheit
A	Battery isolating switch open
B	Battery isolating switch closed
C	Battery isolating switch open
1	Overvoltage-overload protection (cell voltage > 4 V/battery voltage > 16 V)
2	Undervoltage-total discharge protection (cell voltage < 2 V/battery voltage < 8 V after 30 seconds)
3	Overvoltage removed (battery voltage < 14.4 V for 2 seconds)
4	Charging voltage applied (battery voltage > 10 V for 2 seconds)
5	Short circuit current
6	Terminal voltage < Module voltage (for > 2 seconds)
7	Charging voltage applied
8	Temperature > 176°F
9	Temperature < 158°F

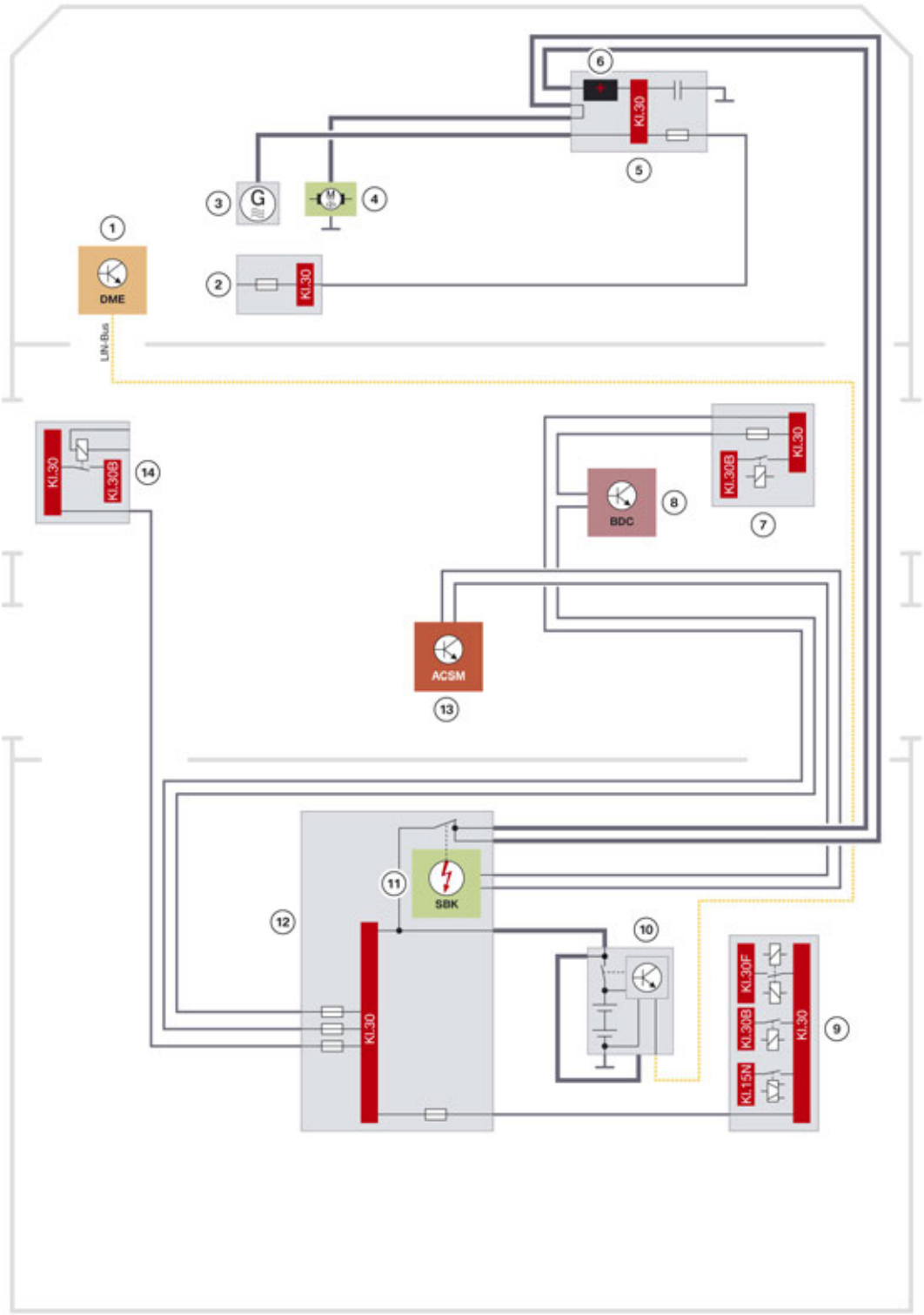
If the cell voltage of a battery cell falls below 2 V and the battery isolating switch opens, this becomes noticeable by a vehicle electrical system without voltage. Electrical functions are therefore no longer available. In this case the battery should not be replaced straight away as an initial measure. It is generally sufficient to recharge the battery. As soon as the battery supervision circuits detect a voltage over 10 V for between 2 and 18 seconds, the battery supervision circuits close the battery isolating switch again. The vehicle electrical system is supplied with voltage again. All electrical functions are available again. The battery is then charged again.

The lithium-ion battery only has to be replaced if the battery isolating switch no longer closes or the energy diagnosis in ISTA specifies a replacement.

F90 Complete Vehicle

7. General Vehicle Electronics

7.1.7. System wiring diagram



F90, voltage supply

Index	Explanation
1	Digital Motor Electronics (DME)
2	Power Distribution Module (PDM)
3	Alternator
4	Starter motor
5	B+ jump start terminal point
6	Power distribution box, engine compartment
7	Power distribution box, front right
8	Body Domain Controller (BDC)
9	Power distribution box, luggage compartment
10	Lithium-ion battery with battery supervision circuits (BUE)
11	Safety battery terminal (SBK)
12	Battery power distribution box
13	Advanced Crash Safety Module (ACSM)
14	Power distribution box, front left
Terminal 30	Permanent positive
Terminal 30B	Terminal 30 basic operation
KL 30N	Ignition (after-run)
Terminal 30F	Terminal 30, fault-dependent

7.1.8. Service information

Charging

To charge the lithium-ion battery during service, use chargers recommended by BMW.

Please observe the operating instructions of the charger manufacturer.

The maximum charging voltage of the lithium-ion battery of 14.4 V cannot be exceeded. For this reason, use a charger recommended by BMW.

For necessary adjustment work on the charger, the current information and specifications in the documents in the Integrated Service Technical Application (ISTA) must be observed in each case.

Identification

The lithium-ion battery is labelled with a corresponding sticker on the top of the battery: **"Li-ion 30"**.

Replacement

The lithium-ion battery does not differ in appearance but in terms of the different vehicle electrical systems of the F80/82/83 and the F90 and the resulting software differences of the battery supervision circuits (BUE). The F90 lithium-ion battery is therefore incompatible with F8x M3/M4 and vice-versa. The batteries can be differentiated using the part numbers on the battery.

Disposal

Information on the disposal of the lithium-ion batteries is available from your Parts Department.

General handling of lithium-ion battery

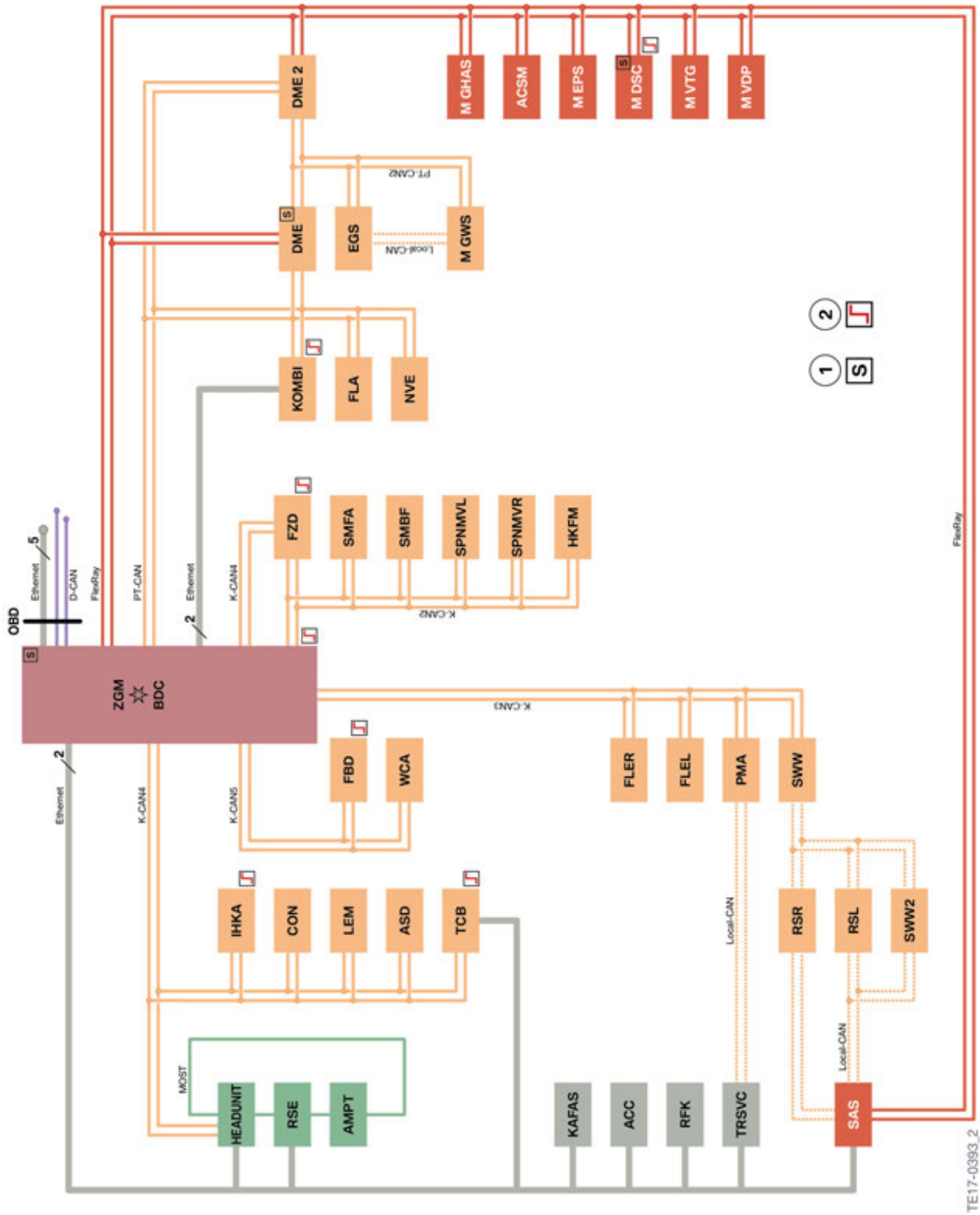
Instructions on the handling of lithium-ion battery are available in the safety data sheet.

For any service work required, the current information and specifications in the documents in the Integrated Service Technical Application (ISTA) must be observed in each case.

F90 Complete Vehicle

7. General Vehicle Electronics

7.2. Bus overview



F90, data bus overview

Index	Explanation
1	Start-up node control units for starting and synchronizing the FlexRay bus system
2	Control units with wake-up authorization
ACC	Active Cruise Control
ACSM	Advanced Crash Safety Module
AMPT	Amplifier Top (top high fidelity amplifier)
ASD	Active Sound Design
BDC	Body Domain Controller
CON	Controller
D-CAN	Diagnosis-on-Controller Area Network
DME 1	Digital Engine Electronics 1
DME 2	Digital Engine Electronics 2
EGS	Electronic Transmission Control
Ethernet	Cable-based data network technology for local data networks
FBD	Remote control service
FLA	High-beam assistant
FLER	Frontal Light Electronics Right
FLEL	Frontal Light Electronics Left
FlexRay	Fast, preset and fault-tolerant bus system for use in the automotive sector (10 MBit/s)
FZD	Roof function center
Headunit	Headunit (M-specific)
HKFM	Tailgate function module
IHKA	Integrated automatic heating / air conditioning
KAFAS	Camera-based driver support systems
K-CAN2	Body Controller Area Network 2 (500 kBit/s)
K-CAN3	Body Controller Area Network 3 (500 kBit/s)
K-CAN4	Body Controller Area Network 4 (500 kBit/s)
K-CAN5	Body Controller Area Network 5 (500 kBit/s)
KOMBI	Instrument cluster (M-specific)
LEM	Light effect manager
Local CAN	Local Controller Area Network
M DSC	M Dynamic Stability Control
M EPS	M Servotronic (Electric Power Steering)
M GHAS	Regulated M rear axle differential lock
M GWS	M gear selector lever

Index	Explanation
M VDP	M vertical dynamic platform
M VTG	M transfer case
MOST	Media Oriented System Transport (22.5 MBit/s)
NVE	Night Vision Electronics
OBD	Diagnostic socket
PT-CAN	Powertrain Controller Area Network (500 kBit/s)
PT-CAN2	Powertrain Controller Area Network 2 (500 kBit/s)
PMA	Parking maneuver assistant
RFK	Rear view camera
RLS	Rain/light sensor
RSE	Rear Seat Entertainment system
RSL	Radar sensor left (avoidance assistant)
RSR	Radar sensor right (avoidance assistant)
SAS	Optional equipment system
SMBF	Seat module, front passenger
SMFA	Seat module, driver
SPNMVL	Seat pneumatics module front left
SPNMVR	Seat pneumatics module front right
SWW	Lane change warning
SWW2	Lane change warning (2)
TCB	Telematic Communication Box
TRSVC	Top rear side view camera (Surround View)
WCA	Wireless charging tray
ZGM	Central gateway module

The following deviations exist in comparison with the standard G30:

FlexRay
The S63T4 engine exclusively obtains the DME variant .8.8.T.

The rear axle slip angle control (HSR) and electric active roll stabilization rear-front (EARSH-EARSV) control units are deleted since this optional equipment is not offered with the F90. Through the special software application of the M GmbH, the control units of the Electronic Power Steering (EPS), transfer case (VTG), Dynamic Stability Control (DSC) and vertical dynamic platform (VDP) become M Servotronic (M EPS), M transfer case (M VTG), M DSC and M vertical dynamic platform. The regulated M rear axle differential lock (M GHAS) is an additional new feature.

PT-CAN2
A PCU is not built in since no auxiliary batteries are used in the F90 as they are in G30. Through the special software and hardware application of the M GmbH, the gear selector switch (GWS) becomes M gear selector switch (M GWS) with Drivelogic button.

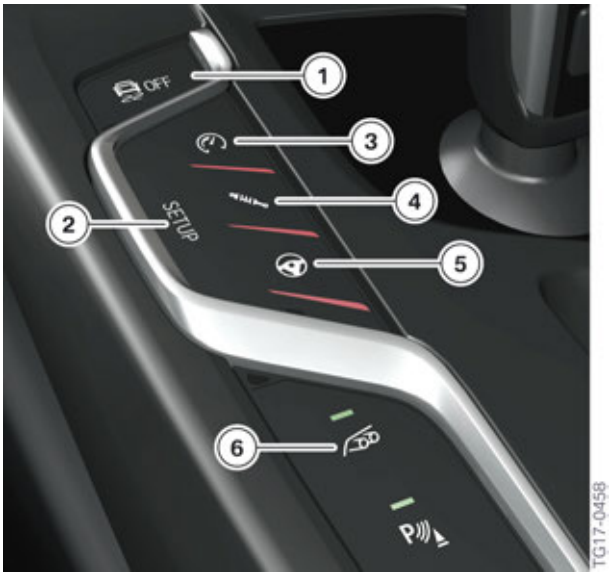
F90 Complete Vehicle
7. General Vehicle Electronics

7.3. On-board information

7.3.1. M configuration menu

Configuration via the center console switch cluster:

Via the M drive dynamic control switch in the center console, the driver can adapt the vehicle to his or her individual needs.



F90, M drive dynamic control switch

Index	Explanation
1	M DSC-OFF
2	SETUP button (direct jump into the configuration menu in the CID)
3	Engine dynamics control
4	Electronic Damper Control
5	Steering Control
6	Exhaust flap control

The "Setup" button in the center console can be used to jump directly into the M configuration menu in the CID.

Configuration via the CID:

The M configuration menu can be found in the Settings menu. There are now 2 individually adjustable configurations, Setup M1 and Setup M2.

F90 Complete Vehicle

7. General Vehicle Electronics

F90, M configuration menu

Index	Explanation
1	Configure M1
2	Configure M2
3	M xDrive
4	Head-Up Display M view

The following settings can be made in the respective M configuration menu:

- M Dynamic Stability Control
- M xDrive (provided DSC OFF is selected)
- Engine
- Chassis and suspension
- Steering

F90, M configuration menu

Index	Explanation
1	DSC
2	M xDrive
3	Engine
4	Chassis and suspension
5	Steering

and

F90 Complete Vehicle

7. General Vehicle Electronics

- Transmission shift program with Drivelogic
- Head-Up Display

F90, M1 configuration

Index	Explanation
6	Transmission
7	Head-Up Display
8	Reset M1

The settings performed there are called up by pressing the corresponding button of the 2 available M buttons on the multifunction steering wheel.

F90, M button

Index	Explanation
1	M1 Button
2	M2 Button

The activation of an M configuration is displayed by a M1 or M2 symbol in the instrument cluster. The corresponding symbol flashes if, for example, ABS, M DSC or M xDrive intervene upon activation of the request or if a malfunction exists in the system. A renewed activation is only possible after the intervention is completed or the malfunction has been eliminated.

F90, M configuration, instrument cluster

During driving, the retrieved configuration can be changed at any time. The corresponding M driving dynamics control switch must be operated for this purpose. The M1 or M2 symbol in the instrument cluster goes out.

An efficient/comfortable configuration is set by default in the factory for the M1 button and a sporty configuration for the M2 button. This setting can be adapted in the M configuration menu to the customer's needs and also reset again to the factory setting. Each M button is individually configured and the overall configuration is also assigned to the vehicle remote control being used.

The following functions and configurations can be selected and set:

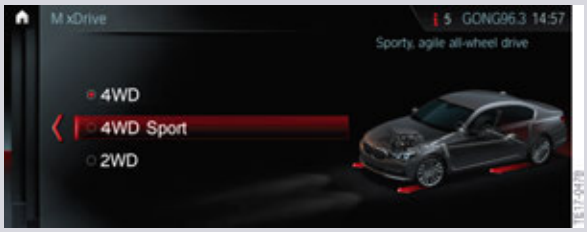
M Dynamic Stability Control (M DSC)

- **ON** Maximum possible driving stability with 4WD.
- **MDM** Reduced stabilizing intervention with 4WD Sport. Permits driving with a higher lateral and longitudinal acceleration on dry and wet roadways.
- **OFF** Stability control switched off. ABS control remains active.

M DSC OFF

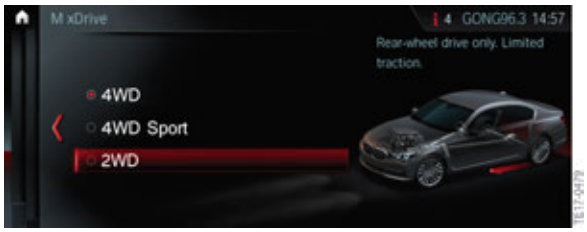
When M DSC is deactivated, the M xDrive menu is automatically displayed in the central information display. In the M DSC OFF mode, the customer can select 1 of 3 M xDrive modes:

4WD M DSC OFF with traction-optimized all-wheel drive



4WD Sport M DSC OFF with sporty agile all-wheel drive

- Oversteering possible



2WD M DSC OFF with a pure standard drive

- Unlimited oversteering possible

The selected M xDrive mode is displayed in the instrument cluster and can also be stored as part of the configuration in the M1/M2 setup.

Engine dynamics control including ASD (Active Sound Design) and exhaust flaps

- **Sport +** Response spontaneous and direct, with maximum dynamics
- **Sport** Dynamic, sporty response
- **Efficient** Comfortable response (city traffic, on snow), minimized consumption

Electronic Damper Control

- **Sport +** Consistently sporty
- **Sport** Balanced
- **Comfort** Comfort-optimized tuning

M Servotronic (EPS)

- **Sport +** High steering force, significant feedback
- **Sport** Medium steering force, noticeable feedback
- **Comfort** Low steering force

Sound pattern

- **Sport/Sport +**
- **Comfort**

Head-Up Display

- M view
- Standard view

Drivelogic

- Drivelogic program "S" switch position (bar) 1-3
- Drivelogic program "D" switch position (bar) 1-3

Configuration quick save

The modified setting or a new setting performed using the M driving dynamic control switch can also be assigned permanently to one of the two M buttons on the steering wheel. The corresponding M button on the steering wheel must be held down for a longer period until confirmed by an acoustic signal. The current configuration is assumed and overwrites the previously saved setting. This enables a quick adaptation or saving without calling up the M configuration menu.

If the driver is not aware that holding down an M button overwrites the current configuration/setting, this may lead to a customer complaint.

Live adjustment

During the drive, the desired ideal tuning of the individual driving dynamics systems is determined using the drive dynamic control switches and then, before "Residing OFF", one of the two M buttons on the steering wheel is pressed for a long period until the acoustic signal is heard.

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7. General Vehicle Electronics

7.3.2. M instrument cluster

The M instrument cluster of the F90 is based on the multifunctional instrument display (12.3" TFT display) of the G30 and was already in use in the G12.

The following M-specific changes exist in comparison with the G30:

- Speed and engine speed display correspond to the drive concept (200 mph in 20 mile classification, 8,000 rpm)
- Typical M red needle, lighting of the dial in white (also during the day without driving light), M5 inscription.

F90, instrument cluster

M-specific displays:

- MDM M dynamic mode symbol in place of the DTC
- Additional digital speed indicator
- Display of all-wheel-drive mode
- M1 = M Setup 1
- M2 = M Setup 2
- Display of gear
- Display of Drivelogic (bar symbol such as a button)
- Display of system status: Engine dynamics, damper control and M Servotronic (EPS)
- Shiftlight function within the engine speed display (only active if not activated in HUD)
- Temperature-dependent, variable engine-revolutions advance-warning field
- Yellow indicator light to indicate standard drive.

In the instrument cluster, the current configuration of the engine dynamics, damper control and steering systems is shown in the upper area between the speed indicator and the engine speed display. This function can be activated under Settings in the Configuration menu display.

The confirmation of the M configuration for M DSC, engine dynamics, transmission, EDC and M Servotronic is also issued centrally in the instrument cluster.

For setting/adjustment work in the engine dynamics, EDC and M Servotronic systems the response of the button activation is also effected as a list in the instrument cluster.

7.3.3. M Head-Up Display

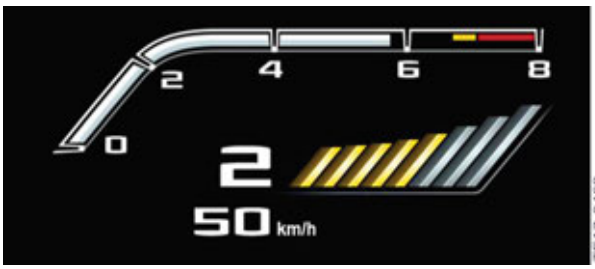
The multi-color head-up display can switch to the M-specific display.

The following information/parameters can be shown:

- Shift point indicator by Shiftlight function
- Engine speed via speed bar and temperature-dependent engine-revolutions advance-warning field
- Transmission shift level
- Driving speed.
- Road sign recognition
- Navigation displays.

F90, Head-Up Display with navigation

If the shiftlight function is activated in the HUD, it is automatically deactivated in the instrument cluster.



F90, Head-Up Display with shiftlight function

The M-specific display for corresponding configuration in the M Drive menu is activated via the M button on the steering wheel or by selecting it from the Head-Up Display configuration menu.

7.3.4. Active Sound Design

The Active Sound Design (ASD) is described in the Reference Manual “F10 M5 Complete Vehicle”.

The ASD settings are coupled to the engine dynamics control settings:

- Engine dynamics Efficient = ASD Comfort
- Engine dynamics Sport = ASD Sport
- Engine dynamics Sport+ = ASD Sport+

7.3.5. Antenna system

Due to the use of the CFRP roof in the F90, the Telematic Communication Box 2 (TCB2) is installed under the roof-mounted antenna without the felt pad usually used in the G30.

If the Telematic Communication Box 2 is replaced, the felt pad must be removed before installation.

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