F10 Chassis Dynamics

Edited for the U.S. market by:
BMW Group University
Technical Training
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BMW Service

General information

Symbols used

The following symbol / sign is used in this document to facilitate better comprehension and to draw attention to particularly important information:

Contains important safety guidance and information that is necessary for proper system functioning and which it is imperative to follow.

Information status and national-market versions

The BMW Group produces vehicles to meet the very highest standards of safety and quality. Changes in terms of environmental protection, customer benefits and design make it necessary to develop systems and components on a continuous basis. Consequently, this may result in differences between the content of this document and the vehicles available in the training course.

As a general principle, this document describes left-hand drive vehicles in the European version. Some controls or components are arranged differently in right-hand drive vehicles than those shown on the graphics in this document. Further discrepancies may arise from market-specific or country-specific equipment specifications.

Additional sources of information

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

- in the Owner's Handbook
- in the integrated service technical application

Contact: conceptinfo@bmw.de

The information in the document is part of the BMW Group technical training course and is intended for its trainers and participants. Refer to the latest relevant BMW Group information systems for any changes/supplements to the technical data.

Information status: **December 2009**

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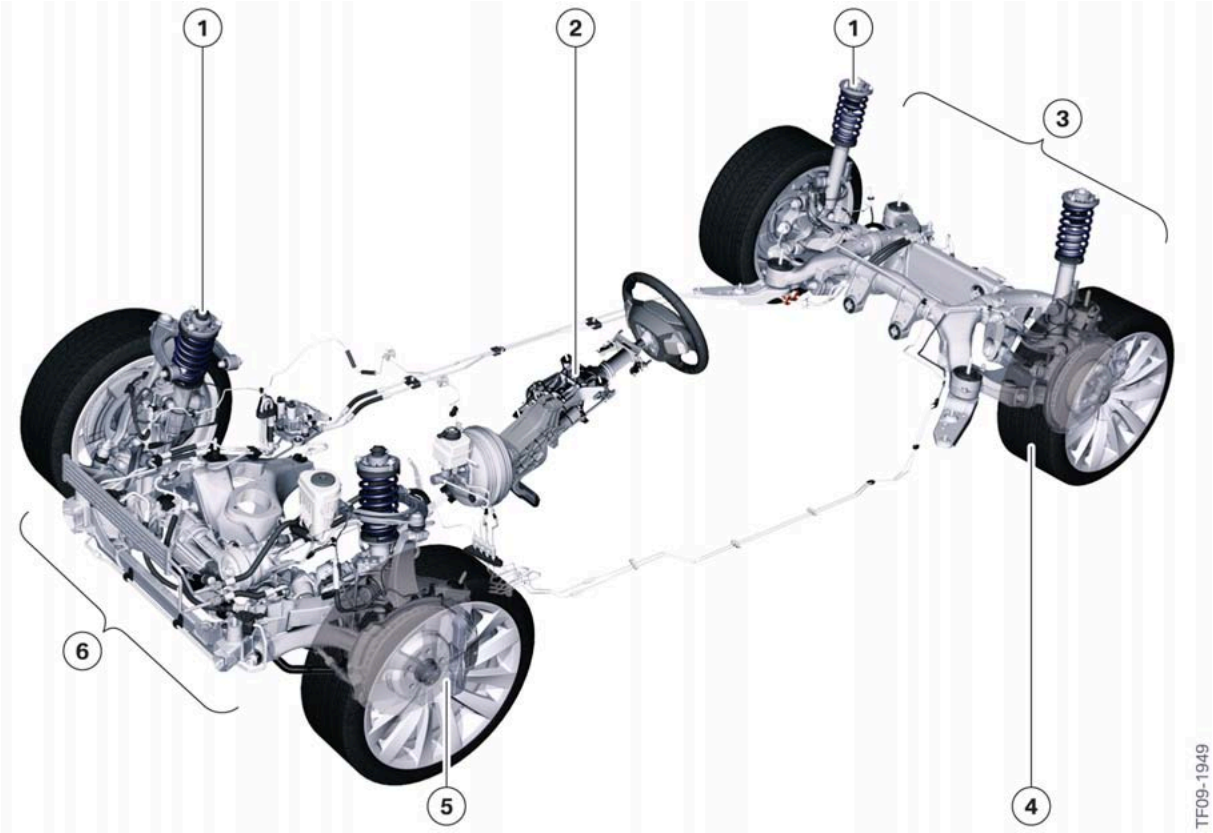
1. Introduction

1.1. Driving dynamics and comfort



F10 Chassis and suspension

Index	Explanation
1	Suspension/damping
2	Steering
3	Rear axle
4	Wheels
5	Brakes
6	Front axle

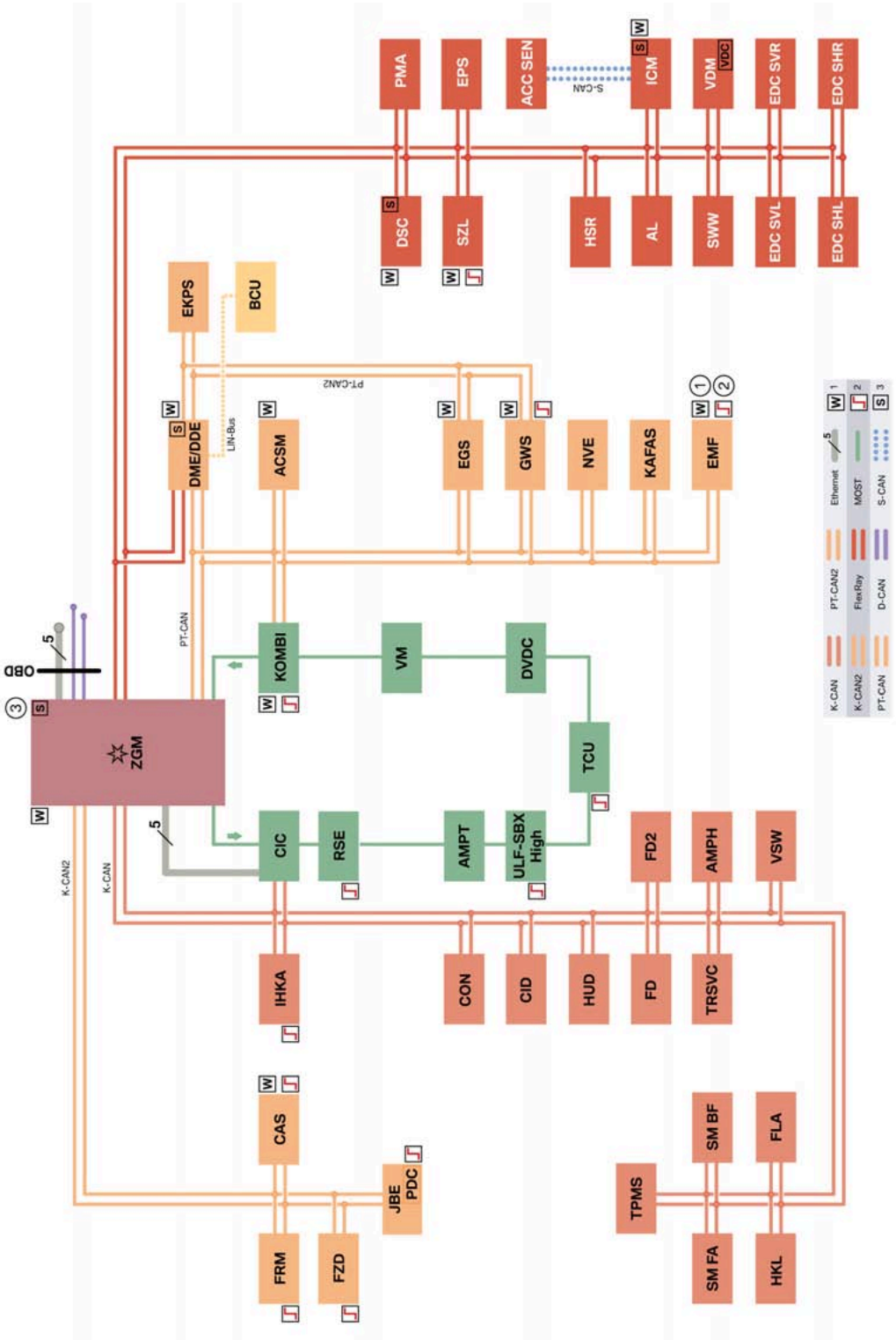
The chassis and suspension of the F10 are based on that of the F01, which set new standards in terms of driving dynamics and comfort. The chassis and suspension have been adapted to the F10 requirements resulting in exceptional driving dynamics with a continued very high level of comfort.

The familiar technological innovations from the F01 like Integral Active Steering, Integrated Chassis Management ICM, Dynamic Drive and Electronic Damper Control EDC are also installed in the F10.

F10 Chassis Dynamics

1. Introduction

1.2. Bus System Diagram



F10 Bus system diagram

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1. Introduction

Index	Explanation
1	Wakeable control units
2	Control units authorized to wake up the vehicle
3	Startup node control units, for starting up and synchronizing the FlexRay bus system
ACC-SEN	Active Cruise Control Sensor
ACSM	Advanced Crash Safety Module
AL	Active steering
AMPH	Amplifier High (high fidelity amplifier)
AMPT	Amplifier Top (top high fidelity amplifier)
BSD	Bit-serial data interface
BCU	Battery Charge Unit (charging unit for auxiliary battery)
CAS	Car Access System
CIC	Car Information Computer
CIC Basic	Car Information Computer Basic
CID	Central Information Display
CON	Controller
D-CAN	Diagnosis on Controller Area Network
DDE	Digital Diesel Electronics
DME	Digital Motor Electronics
DSC	Dynamic Stability Control
DVD	DVD changer
EDC SHL	Electronic Damper Control, rear left satellite unit
EDC SHR	Electronic Damper Control, rear right satellite unit
EDC SVL	Electronic Damper Control, front left satellite unit
EDC SVR	Electronic Damper Control, front right satellite unit
EGS	Electronic transmission control
EKPS	Electronic fuel pump control
EMF	Electromechanical parking brake
EPS	Electronic Power Steering
Ethernet	Cabled data network technology for local data networks
FD	Rear display
FD2	Rear display 2
FLA	High-beam assistant
FlexRay	Fast, preset and fault-tolerant bus system for use in automotive applications
FRM	Footwell module

F10 Chassis Dynamics

1. Introduction

Index	Explanation
FZD	Roof function center
GWS	Gear selector switch
HKL	Luggage compartment lid lift
HSR	Rear suspension slip angle control
HUD	Head-Up Display
ICM	Integrated Chassis Management
IHKA	Integrated automatic heating / air conditioning
JBE	Junction box electronics
KAFAS	Camera-based driver assistance system
K-Bus	Body bus
K-CAN	Body controller area network
K-CAN2	Body controller area network 2 (500 kBit/s)
KOMBI	Instrument cluster
LIN-Bus	Local Interconnect Network bus
Local-CAN	Local Controller Area Network
MOST	Media Oriented System Transport
MOST port	Media Oriented System Transport port
NVE	Night Vision electronics
PDC	Park Distance Control
PMA	Parking Maneuvering Assistant Control Unit
PT-CAN	Powertrain CAN
PT-CAN2	Powertrain controller area network 2
OBD	Diagnosis socket
RSE	Rear seat entertainment system
SDARS	Satellite tuner
SMBF	Front passenger seat module
SMFA	Seat module, driver
SWW	Blind Spot Detection
SZL	Steering column switch cluster
TCU	Telematics Control Unit
TPMS	Tire Pressure Monitoring System
TRSVC	Control unit for reversing camera and side view
ULF-SBX	Universal charger and hands-free unit, interface box (Bluetooth telephone)

F10 Chassis Dynamics

1. Introduction

Index	Explanation
VDM	Vertical Dynamics Management
VM	Video Module
VSW	Video switch
ZGM	Central Gateway Module

F10 Chassis Dynamics

2. Models

2.1. Comparison

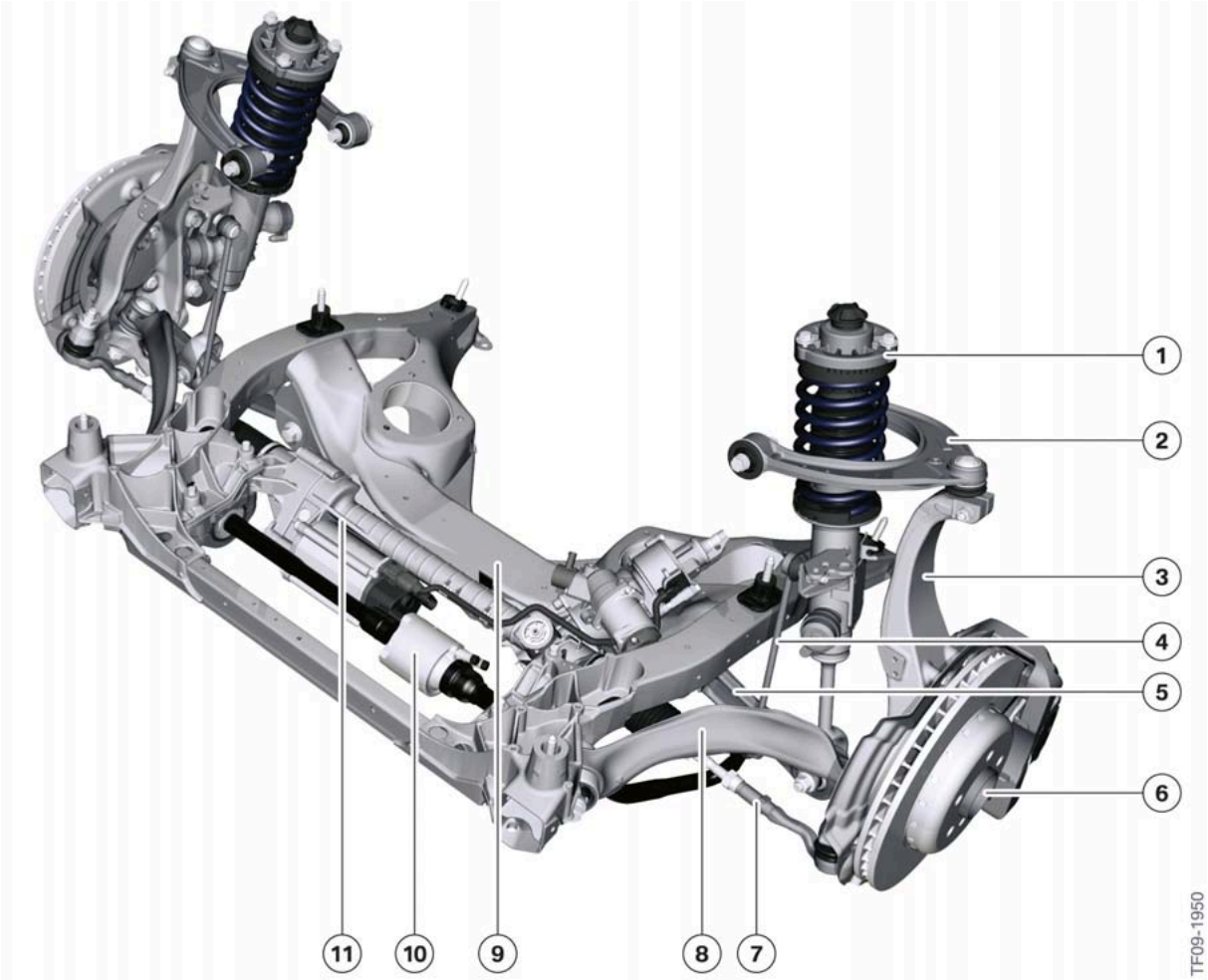
The following table provides an overview of the technical data of the chassis and suspensions of the E60 and F07 compared to the F10.

Description	E60 BMW 535i	F07 BMW 535i Gran Turismo	F10 BMW 535i
Wheelbase	2888 mm	3070 mm	2968 mm
Track width, front	1558 mm	1611 mm	1600 mm
Track width, rear	1581 mm	1654 mm	1627 mm
Basic wheel tires	225/50 R17 94W	245/50 R18 100W AS RSC	245/45 R18 96V RSC
Basic wheel rims	7.5J x 17 lS 20	8J x 18 LM 30	8J x 18 LM 30
Front axle	Two-joint spring strut front axle	Double-wishbone front axle	Double-wishbone front axle
Suspension/damping, front	Steel spring/ conventional or EDC	Steel spring/ conventional or EDC	Steel spring/ conventional or EDC
Stabilizer bar, front	Mechanical or hydraulic (Dynamic Drive)	Mechanical or hydraulic (Dynamic Drive)	Mechanical or hydraulic (Dynamic Drive)
Brake, front	Brake disc Ø 324 mm	Brake disc Ø 348 mm	Brake disc Ø 348 mm
Steering	Hydraulic steering or active steering	Hydraulic or Integral Active Steering IAL	Electromechanical power steering
Rear axle	Integral IV rear suspension.	Integral V rear axle	Integral V rear axle
Suspension/damping, rear	Steel spring or air spring/ conventional or EDC	Air spring/ conventional or EDC	Steel spring/ conventional or EDC
Stabilizer bar, rear	Mechanical or hydraulic (Dynamic Drive)	Mechanical or hydraulic (Dynamic Drive)	Mechanical or hydraulic (Dynamic Drive)
Brake, rear	Brake disc Ø 320 mm	Brake disc Ø 345 mm	Brake disc Ø 345 mm
Parking brake	Drum brake with parking brake lever and automatic cable adjustment	Drum brake with EMF (electromechanical parking brake)	Disc brake with EMF (electromechanical parking brake)

F10 Chassis Dynamics

3. Chassis and Suspension

3.1. Front axle



F10 Front axle

Index	Explanation
1	Spring strut
2	Top wishbone
3	Swivel bearing
4	Stabilizer link
5	Bottom wishbone
6	Wheel hub
7	Track rod
8	Tension strut with hydraulic mount
9	Front axle subframe
10	Anti-roll bar with hydraulic swivel motor (Dynamic Drive)
11	Steering gear

F10 Chassis Dynamics

3. Chassis and Suspension

The double-wishbone front axle introduced with the E70/E71 is used in a refined version in the F01/F02, F07 and F10. The axle is equipped for the use of an all-wheel drive. EDC or conventional shock absorbers can be installed.

For service, the steering gear can be lowered all the way.

3.1.1. Technical data

Description	F10
Caster angle	7° 0'
Camber	-0° 12' ± 30'
Total toe-in	10' ± 12'
Toe angle difference	≤ 12'
Steering axis inclination	9° 57'
Rim offset IS	30 mm for 17" and 18" 33 mm for 19"
Kingpin offset	2.77 mm for 17" and 18" 5.77 mm for 19"
Track width	1600 mm for 17" and 18" 1594 mm for 19"
Maximum wheel steering lock angle, outer	33° 0'
Maximum wheel steering lock angle, inner	42° 14'

3.1.2. Notes for Service

The following tables show when a wheel alignment at the front axle is necessary.

After replacing the following components:	Wheel alignment required
Front axle subframe	YES
Steering gear	YES
Bottom wishbone	YES
Rubber mount for lower transverse control arm	YES
Tension strut	NO
Rubber mount for tension strut	NO
Top wishbone	NO
Rubber mount for upper transverse control arm	NO
Track rod	YES
Swivel bearing	YES
Wheel bearing	NO

After replacing the following components:	Wheel alignment required
Spring strut	NO
Coil spring	NO
Mount	NO

Undoing or loosening the following connections:	Wheel alignment required
Front axle subframe to body (lowering)	NO
Steering gear unit to front axle subframe	YES
Lower transverse control arm to front axle subframe	YES
Lower transverse control arm to swivel bearing	NO
Tension strut to front axle subframe	NO
Tension strut to swivel bearing	NO
Upper transverse control arm to body	NO
Upper transverse control arm to swivel bearing	NO
Track rod to steering gear	NO
Track rod head to track rod	YES
Track rod head to swivel bearing	NO
Spring strut to lower transverse control arm	NO
Strut mount to body	NO
Lower steering shaft to steering gear	NO
Steering column to lower steering shaft	NO

3.2. Rear axle

The integral V rear axle installed in the F10 is an innovative further development of the Integral IV rear axle from the E60/65. The optimized lightweight construction rear axle made of aluminium has been specifically adapted to the new requirements for more power and torque. It integrates the required chassis control systems such as Integral Active Steering for greater driving dynamics and comfort.

For the exact operating principle of the integral active steering, refer to the information bulletin entitled "Transverse dynamic systems F01/F02".

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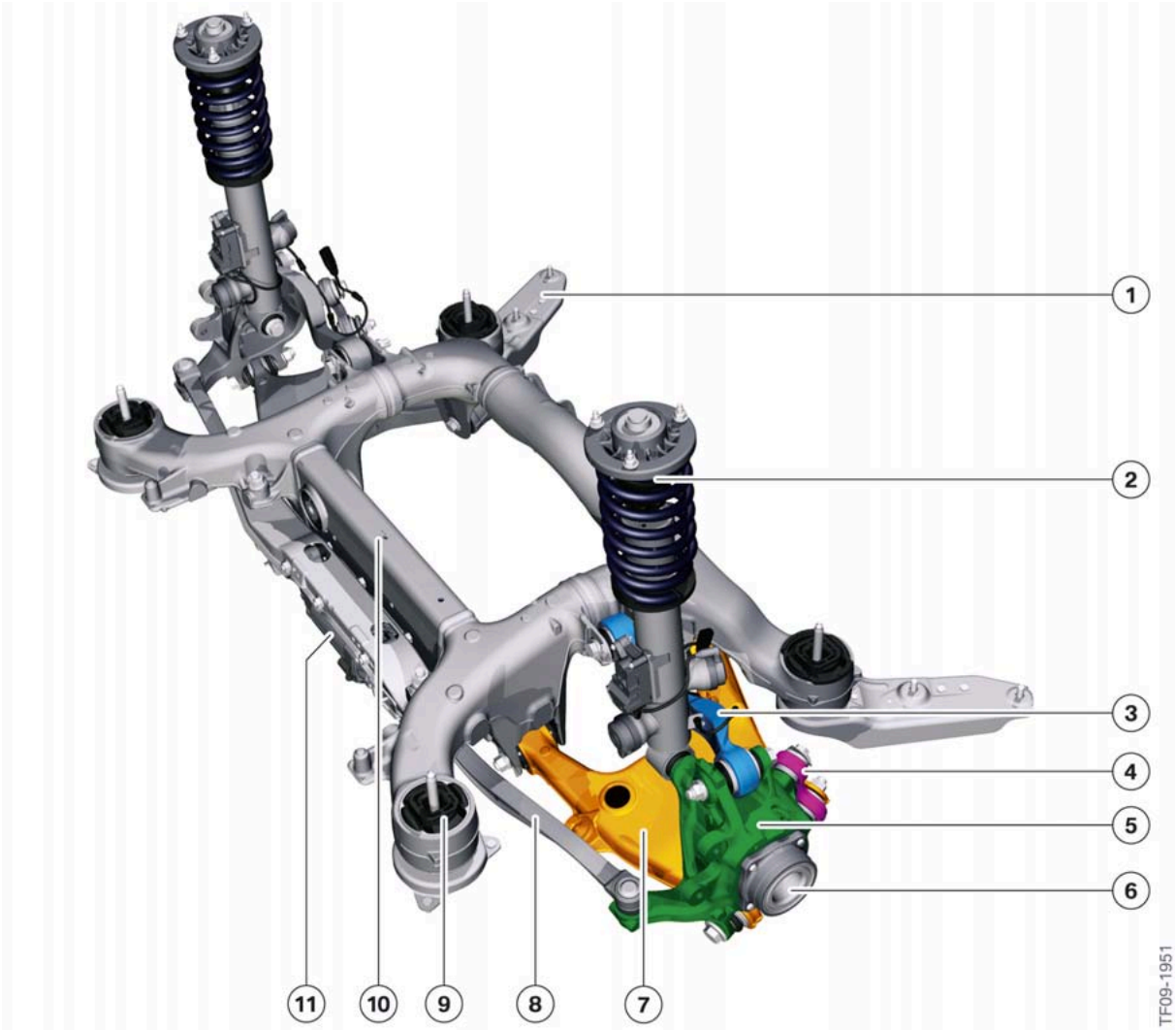
3. Chassis and Suspension



F10 Integral V rear axle

Index	Explanation
1	Thrust strut
2	Spring strut
3	Top wishbone
4	Integral link
5	Wheel carrier
6	Wheel bearing
7	A-arm (swinging arm)

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3. Chassis and Suspension

Index	Explanation
8	Track rod
9	Rubber mount for rear axle
10	Rear suspension subframe
11	HSR actuator

3.2.1. Technical data

Tires	Wheel rims	Total toe-in	Camber	Track width	Rim offset IS
225/55 R17	8J x 17	14' ± 12'	-1° 50' ± 25'	1627 mm	30 mm
245/45 R18	8J x 18	14' ± 12'	-1° 50' ± 25'	1627 mm	30 mm
275/40 R18	9J x 18	14' ± 12'	-1° 50' ± 25'	1599 mm	44 mm
275/35 R19	9J x 19	14' ± 12'	-1° 50' ± 25'	1599 mm	44 mm

3.2.2. Notes for Service

The following tables show when a wheel alignment at the rear axle is necessary.

After replacing the following components:	Wheel alignment required
Rear suspension subframe	YES
Rubber mount for rear axle	NO
Swinging arm	YES
Integral link	YES
Ball joint in swinging arm	YES
Control arm	YES
Wishbone	YES
Wheel carrier	YES
Wheel bearing	NO
Spring strut	NO
Mount	NO

Undoing or loosening the following connections:	Wheel alignment required
Rear axle support on body	NO
Front compression strut on body	NO
Rear compression strut on body	NO
Front swinging arm on rear axle support	YES

Undoing or loosening the following connections:	Wheel alignment required
Rear swinging arm on rear axle support	YES
Swinging arm on integral link/wheel carrier	YES
Integral link on wheel carrier	NO
Control arm on rear axle support	YES
Control arm on wheel carrier	NO
Wishbone on rear axle support	YES
Wishbone on wheel carrier	YES
Spring strut on wheel carrier/swinging arm	NO

3.3. Wheels

The F10 comes standard equipped with run-flat tires in all the models.

The following tables list the available tire sizes.

	528i	535i	550i
Front tire	225/55 R17 97W	245/45 R18 96V RDC	245/45 R18 96Y RSC
Rear tire	225/55 R17 97W	245/45 R18 96V RDC	245/45 R18 96Y RSC
Front rim	8J x 17 LM IS30	8J x 18 LM IS30	8J x 18 LM IS30
Rear rim	8J x 17 LM IS30	8J x 18 LM IS30	8J x 18 LM IS30
Optional tire available with sport package	275/40 R18	275/35 R19	275/35 R19

Note: The Tire Pressure Monitoring System (TPMS), which was introduced in 2005, continues to be used on the F10

3.4. Suspension/damping

The F10 is equipped as standard with conventional shock absorbers and coil springs on the front and rear axle. EDC/VDC is optional and, depending on the model, is also available combined with ARS in the optional equipment Adaptive Drive (option 2VA).

Electronic Damping Control, Active Roll Stabilization, and Adaptive Drive are available only in combination with the ZDH Dynamic Handling Package on the 535i and 550i. EDC is offered independently as an option on the 528i.

The EDC is the same Vertical Dynamic Control (VDC) introduced with the E70/E71 and later installed on F0x models.

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3. Chassis and Suspension

The EDC/VDC is a sub-function of the Vertical Dynamics Management (VDM). The servomotors and sensors on the shock absorbers, referred to as satellites, are connected to the VDM control unit via FlexRay. The drive dynamic control switch in the center console makes it possible to select the damping characteristics, which are stored in the VDM control unit.

Note: The EDC/VDC system is described in the F01/F02 "Vertical Dynamics Systems" training material available on TIS and ICP.

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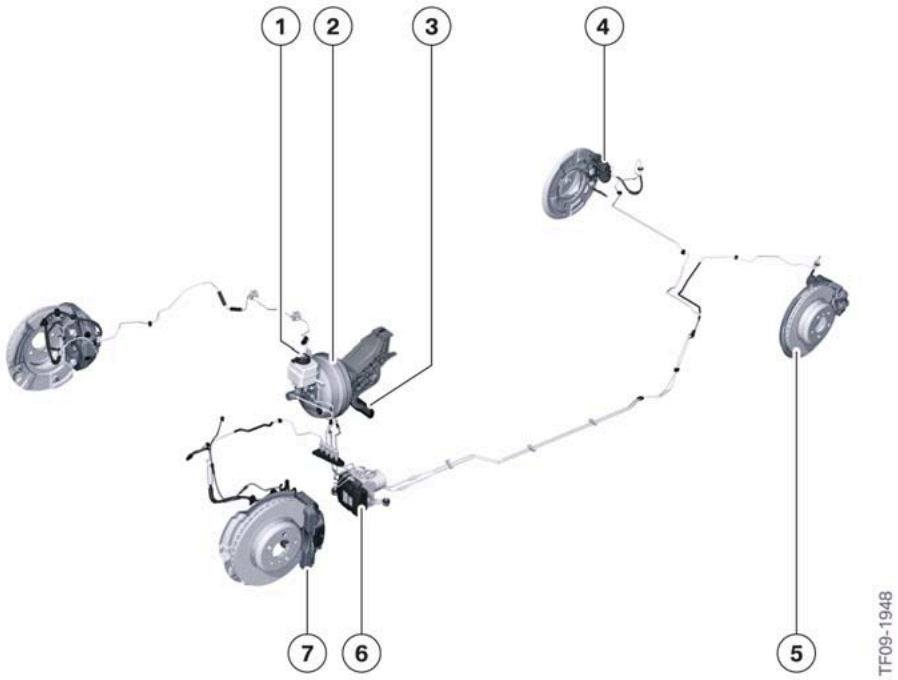
4. Brakes



F10 Brakes

Index	Explanation
1	Brake fluid expansion tank
2	Brake booster
3	Brake pedal
4	Electromechanical parking brake actuator
5	Brake disc
6	Dynamic Stability Control (DSC)
7	Brake caliper

4.1. Service brake

The F10 has a hydraulic dual-circuit brake system with a "front/rear split". Lightweight brake discs with riveted aluminium hubs are installed on all models. Conventional aluminium floating brake calipers are used on the front axle. Spheroidal graphite (SG iron) cast iron floating brake calipers with integrated EMF actuators (for the electromechanical parking brake) are used on the rear axle.

As on all BMW vehicles the brake pad wear monitoring for the Condition Based Service display is used.

The brake discs are ventilated at both the front and rear axle.

The following tables list the brake dimensions of the various engine versions.

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4. Brakes

Front axle	528i	535i	550i
Brake rotor diameter	348 mm	348 mm	374 mm
Brake rotor thickness	30 mm	30 mm 36 mm	36 mm
Brake piston diameter	60 mm	60 mm	60 mm
Type	Lightweight construction	Lightweight construction	Lightweight construction

Rear axle	528i	535i	550i
Brake rotor diameter	330 mm	330 mm	345 mm
Brake rotor thickness	20 mm	20 mm	24 mm
Brake piston diameter	44 mm	44 mm	44 mm
Type	Lightweight construction	Lightweight construction	Lightweight construction

4.2. Electromechanical parking brake EMF

The F10 uses an electromechanical parking brake EMF integrated into the rear brake calipers.

The system is similar to the EMF system introduced in the E89 Z4.

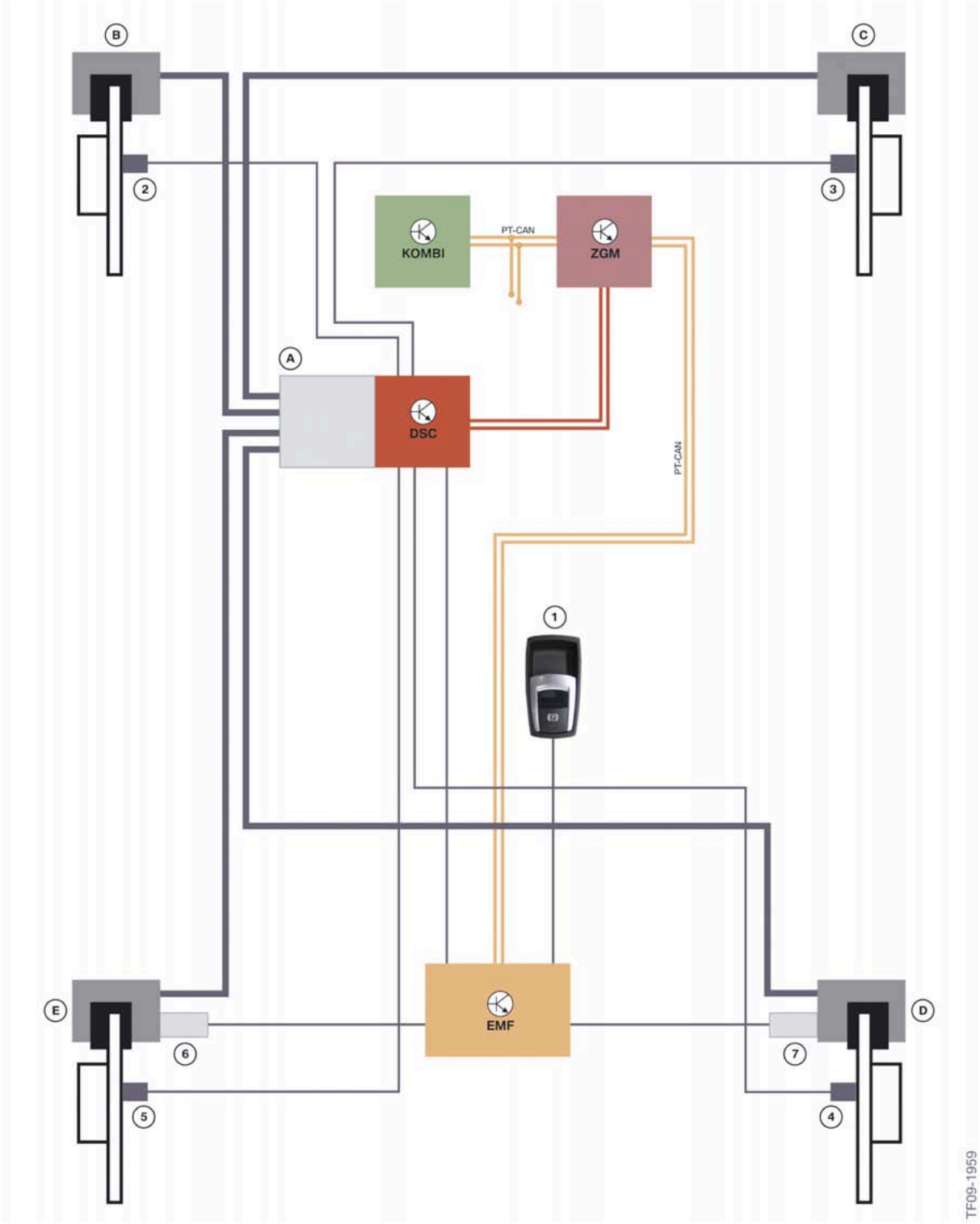
The use of the EMF offers the following advantages:

- Operation via an ergonomic button in the center console
- Reliable engaging and releasing of the EMF under all conditions
- Automatic protection of the hydraulic holding functions (See F10 Automatic Hold Function and Active Cruise Control ACC)
- A dynamic emergency braking function is ensured even with a low coefficient of friction via the (ABS) control systems
- The discontinuation of the parking brake lever in the center console creates space for new equipment features.

F10 Chassis Dynamics

4. Brakes

4.2.1. System overview



F10 System overview for electromechanical parking brake

F10 Chassis Dynamics

4. Brakes

Index	Explanation
A	DSC unit
B	Brake caliper, front left
C	Brake caliper, front right
D	Brake caliper, rear right
E	Brake caliper, rear left
1	Parking brake button
2	Wheel speed sensor, front left (not used for the EMF)
3	Wheel speed sensor, front right (not used for the EMF)
4	Wheel-speed sensor, rear right
5	Wheel speed sensor, rear left
6	EMF actuator, rear left
7	EMF actuator, rear right
EMF	Electromechanical parking brake
DSC	Dynamic Stability Control
JBE	Junction box electronics
KOMBI	Instrument cluster
PT-CAN	Powertrain CAN

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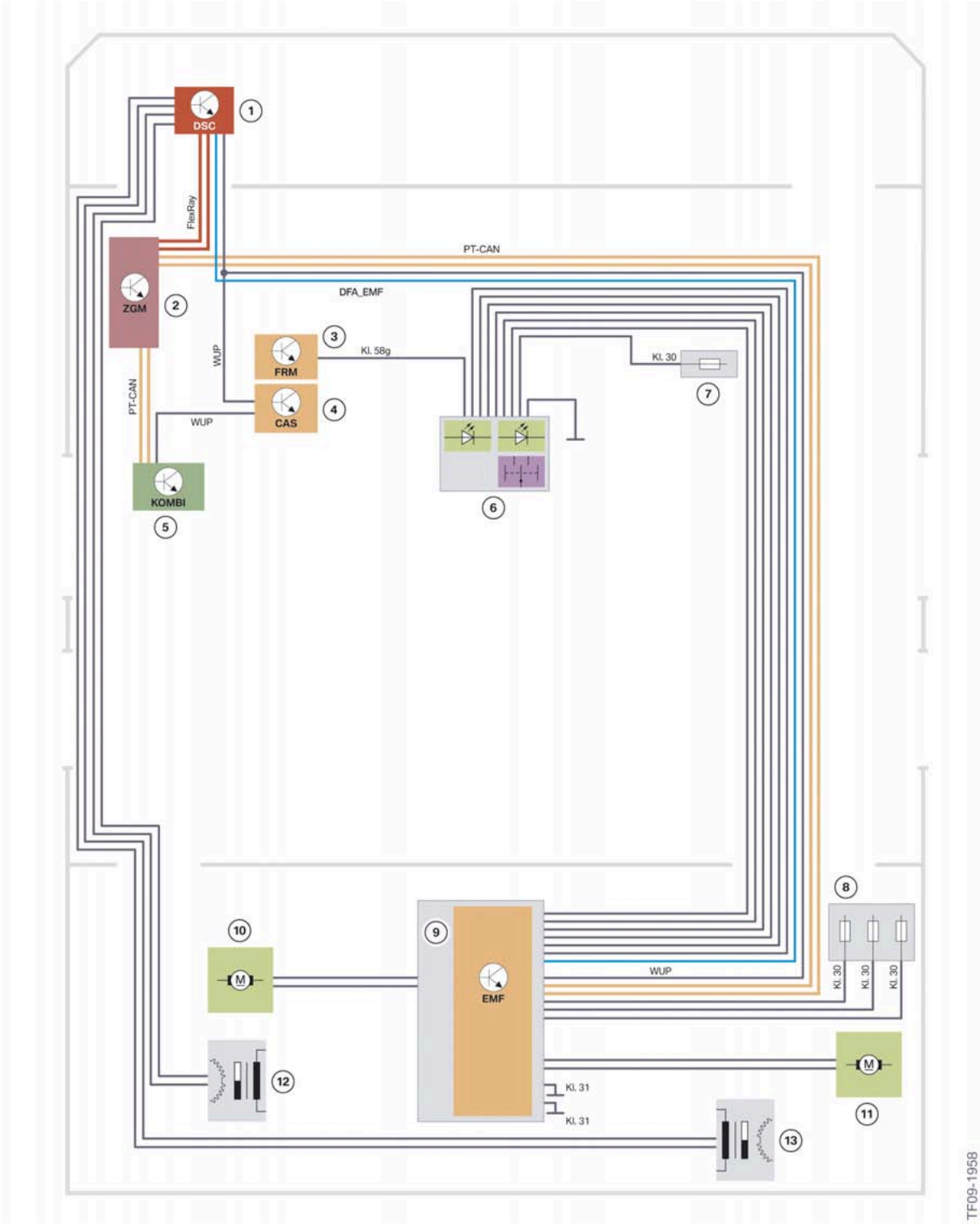
4. Brakes

4.2.2. System wiring diagram



F10 System wiring diagram for EMF

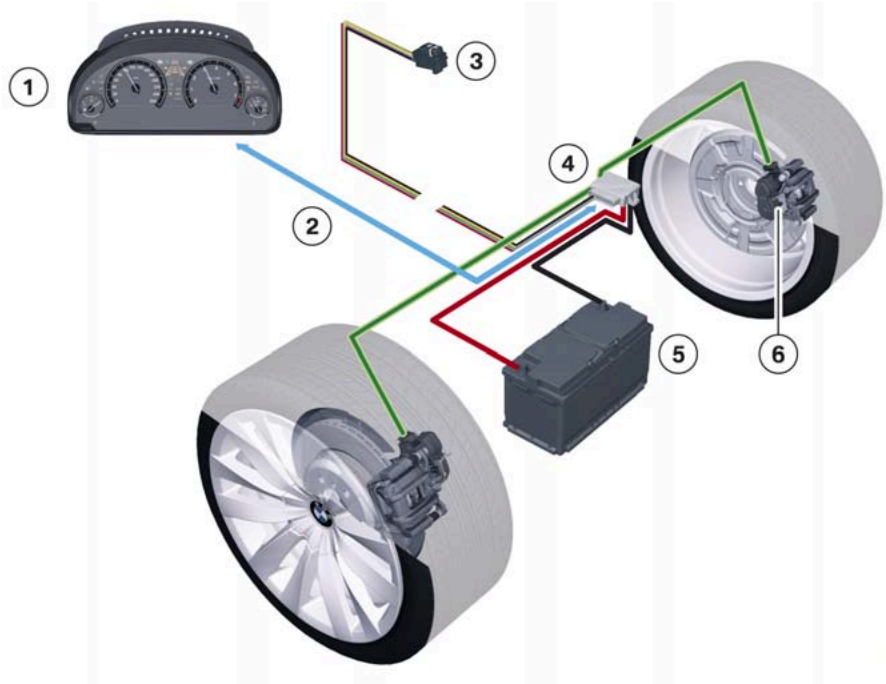
Index	Explanation
1	Dynamic Stability Control (DSC)
2	Central Gateway Module (ZGM)
3	Footwell module (FRM)
3	Instrument cluster (KOMBI)
4	Car Access System (CAS)
5	Instrument cluster (KOMBI)
6	Parking brake button
7	Front distribution box
8	Rear power distribution box
9	EMF control unit
10	EMF actuator, rear left
11	EMF actuator, rear right
12	Wheel speed sensor, rear left
13	Wheel-speed sensor, rear right
PT-CAN	Powertrain Controller Area Network
DFA_EMF	Redundant hard wired speed signal from DSC to EMF

Note: The DFA_EMF is a hard wired signal from DSC to EMF which carries a wheel speed information.

For safety reasons, it is very important, that the EMF NOT be activated as long as the vehicle is moving. Therefore the EMF uses two input signals to confirm vehicle speed: Bus-Signal and the DFA_EMF hard wired signal.

4.2.3. System structure

The EMF control unit receives the driver's command to engage the parking brake through the parking brake button. The vehicle condition is queried/detected via the electrical system connection and the bus systems. The control unit decides whether all conditions for engaging the parking brake are in place. If this is the case, the two EMF actuators on the rear brake calipers are activated.



F10 EMF functional principle

Index	Explanation
1	Instrument cluster
2	Flow of information
3	Parking brake button
4	EMF control unit
5	EMF actuator

4.2.4. System function

The self-locking facility in the spindle maintains the tension force even when de-energized, and the vehicle is held securely in place. After the required force is reached, the detected status is indicated by a red indicator light in the instrument panel and an additional red LED in the parking brake button.

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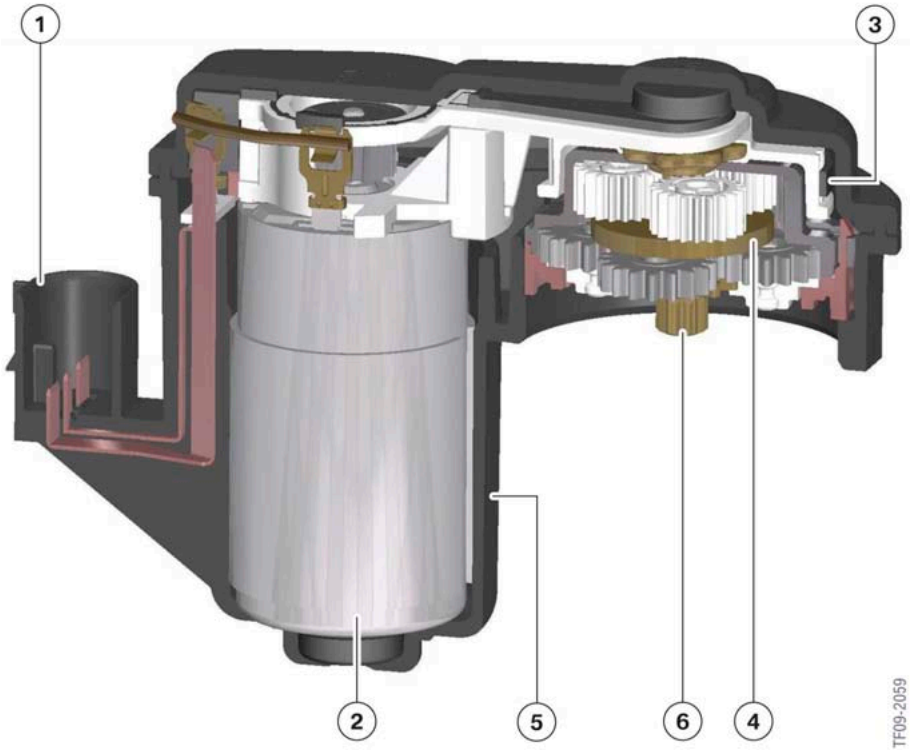
4. Brakes



F10 Structure of EMF actuator

Index	Explanation
1	Push-fit connection
2	Electric motor
3	Drive belt
4	Planetary gearing
5	Casing
6	Connection to spindle

The EMF actuator is fastened to the brake caliper and acts directly on the brake piston.

An electric motor (2) and a drive belt (3) transmit the force to a two-stage planetary gear train (4). The spindle shown in the following graphic is driven via the connection to the spindle (6).

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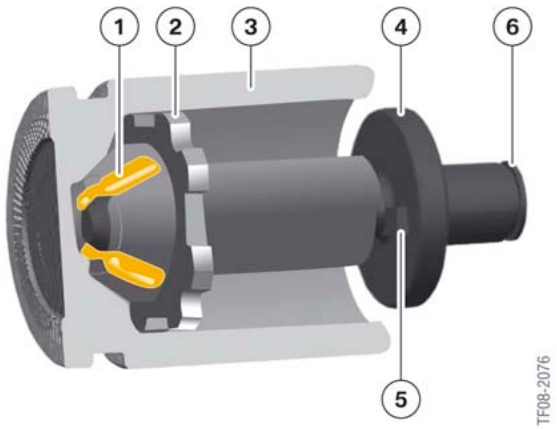
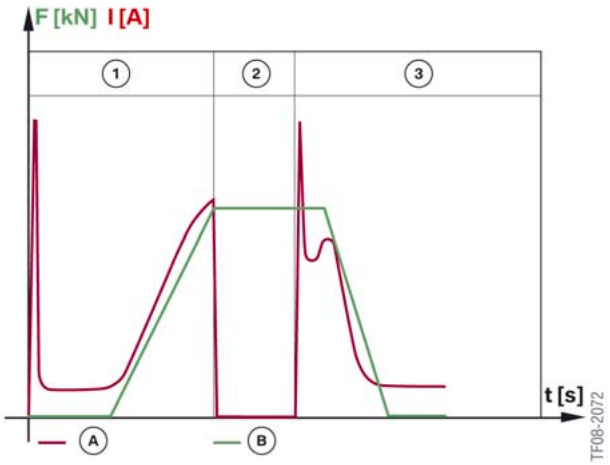
4. Brakes



F10 Spindle and spindle nut in the brake piston

Index	Explanation
1	Groove
2	Spindle nut with anti-twist lock
3	Brake piston
4	Spindle
5	Spindle end stop
6	Connection to the planetary gear train

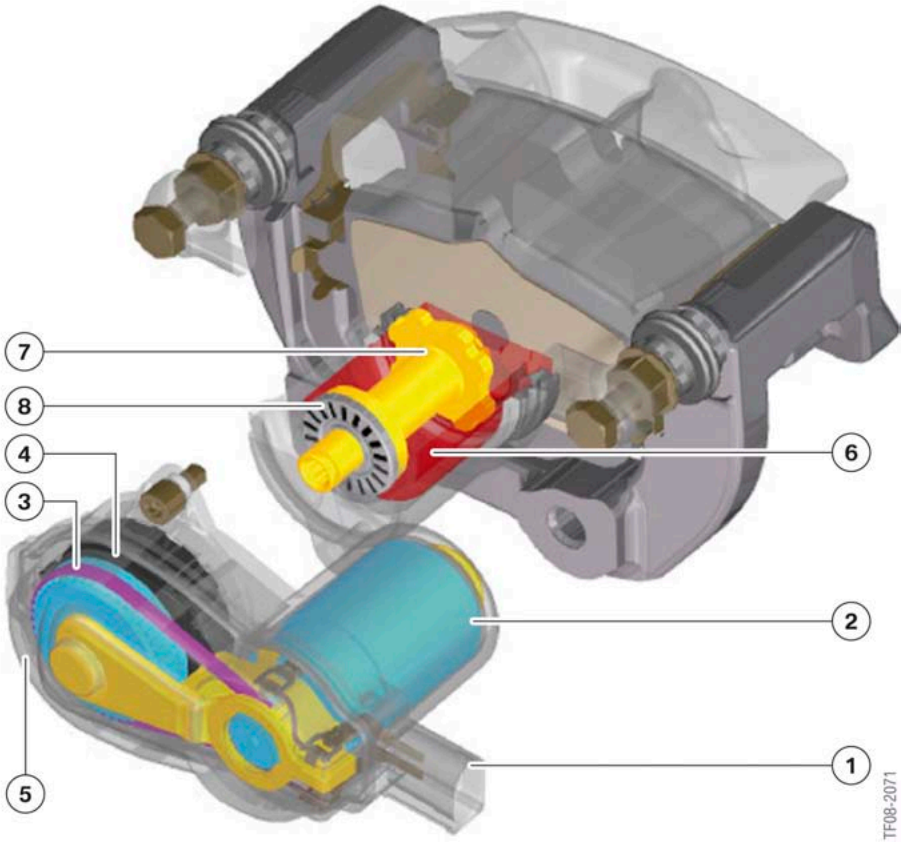


F10 Current-force curve EMF

Index	Explanation
A	Current curve
B	Force curve
1	Engaging the EMF
2	Engaged EMF
3	Disengaging the EMF

F10 Chassis Dynamics

4. Brakes



F10 Overview of EMF actuator with brake caliper

Index	Explanation
1	Push-fit connection
2	Electric motor
3	Drive belt
4	Planetary gearing
5	Casing
6	Brake piston
7	Spindle with spindle nut
8	Roller bearing

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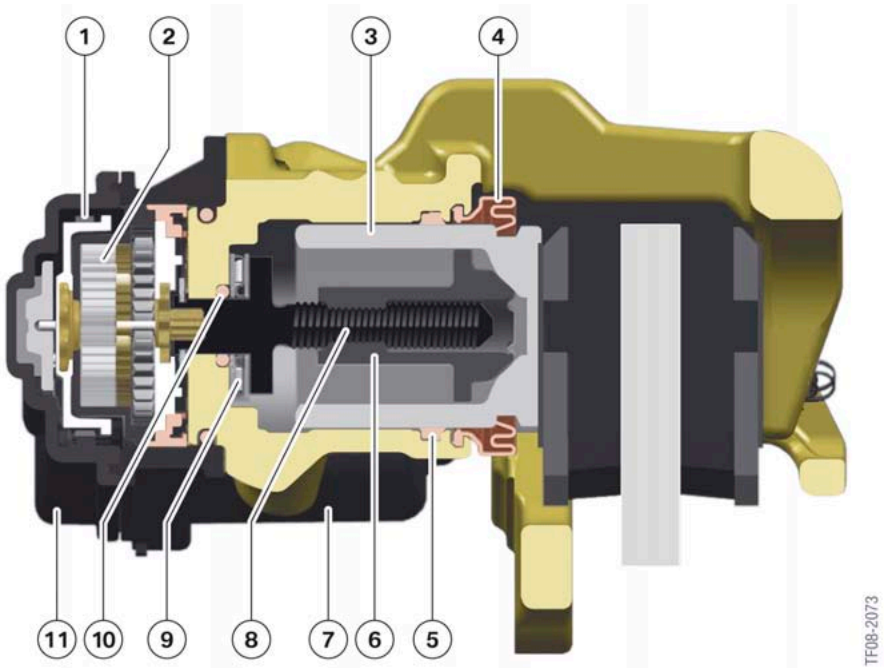
4. Brakes



F10 Parking brake engaged with new brake pads

Index	Explanation
1	Drive belt
2	Planetary gearing
3	Brake piston
4	Dust boot
5	Sealing ring
6	Worm nut
7	Electric motor
8	Spindle
9	Roller bearing
10	Sealing ring
11	Casing

The driver can trigger the process of engaging the vehicle's parking brake by pulling the parking brake button. The operating direction is the same as the operating direction of the previously used mechanical parking brake lever. The signal from the parking brake button is read in by the EMF control unit. The EMF control unit activates the EMF actuators on the rear brake calipers individually.

Engaging is possible in every logical terminal status. Engaging at terminal 0 is made possible by integrating terminal 30 into the EMF control unit. If the driver operates the parking brake button at terminal 0, the EMF control unit is woken up. The EMF control unit in turn wakes up the other control units on the vehicle. Only then can the EMF control unit receive the important information relating to vehicle standstill. In addition, the changed status of the parking brake can be displayed after the system has been woken up.

F10 Chassis Dynamics

4. Brakes

The status "parking brake engaged" is indicated by a red indicator light in the instrument panel and an additional red LED in the parking brake button. Once the parking brake is on, pulling the parking brake button again has no effect.

F10 Indicator light, parking brake engaged display

Rolling monitor with parking brake engaged

The rolling monitor function is intended to prevent the vehicle from rolling with the parking brake engaged. Rolling monitor is engaged whenever a state change of the parking brake from "disengaged" to "engaged" takes place and ends following a defined time after this state change.

A signal from the DSC is used as the input variable for roll-away detection. As soon as this signal indicates that the vehicle has started to roll away, a retensioning of the EMF actuators is carried out immediately. To do so, the EMF actuators are supplied with full current for 100 ms to increase the tension force. Afterwards, the system waits for 400 ms. If the vehicle rolls again, the retensioning process is repeated (a maximum of three times). If rolling of the vehicle is still detected after the third retensioning, the function ends with an entry in the fault memory.

Temperature monitoring

The temperature monitoring ensures compensation for the force reduction that takes effect from when hot brake discs cool off. The temperature monitoring is activated if the temperature exceeds a certain value during the state change of the parking brake from "released" to "engaged".

The temperature of the brake discs is calculated individually for each wheel by the DSC control unit and transmitted to the EMF control unit. During the state change, the higher of the two brake disc temperatures is used for the temperature monitoring. The corresponding temperature ranges are stored in a characteristic map along with the corresponding retensioning times.

Depending on the temperature during the state change, the corresponding retensioning times from the characteristic map are activated. When the first retensioning time is reached, the first retensioning takes place. After the second retensioning time expires, another retensioning takes place; yet another takes place after the third time expires. In the characteristic map, the value 0 can also be stored for one or more specific retensioning times. The respective retensioning operations are then omitted. The function ends when the last retensioning operation is completed.

Disengaging the parking brake

To disengage the parking brake, the parking brake button is pushed. However, for the parking brake to actually released, terminal 15 must also be ON and at least one of the following conditions must be met:

- The brake pedal must be depressed
- The automatic transmission parking lock must be engaged
- The clutch pedal actuated (vehicles with manual transmission only).

This prevents the vehicle rolling if, for example, another occupant of the vehicle (other than the driver) presses in the parking brake button.

Once the parking brake is released, the red indicator lamp in the instrument panel and the red LED in the parking brake button go out.

Activating the EMF actuator sets the spindle in motion. The spindle rotation moves the spindle nut away from the brake piston by a small defined distance.

Dynamic emergency braking

The law requires that vehicles have two means of applying the brakes (with the first being the brake pedal). In the F10, the second is the parking brake button on the center console. If the parking brake button is pulled while the vehicle is in motion, the dynamic emergency braking procedure is applied by the DSC system. This function is intended for emergency situations in which the driver is unable to apply the brakes by pressing the brake pedal. As a safety measure, other occupants of the vehicle can also use this to bring the vehicle to a stop if, for example, the driver suddenly loses consciousness.

Dynamic emergency braking hydraulically applies brake pressure at all four brakes. The DSC functions are fully active and the brake lights are activated. That represents a major advantage over manual parking brakes.

The dynamic emergency braking takes place only while the parking brake button is pulled. The deceleration set by the DSC is increased progressively. During the dynamic emergency braking, the EMF indicator light is activated in the instrument panel. In addition, a Check Control message and an audible warning signal are issued to make the driver aware of the critical situation.

If the driver uses the brake pedal and pulls the parking brake button at the same time to slow down, the DSC control unit prioritizes. The greater braking requirement is put into effect. If dynamic emergency braking is continued to the point of standstill, the vehicle continues to be held stationary after the parking brake button is released. The EMF indicator light on the instrument cluster remains active. The driver can then release the parking brake once again (see "Releasing the parking brake").

Parking brake fault

In the event of a fault of the parking brake, the EMF indicator light is activated and lights up in yellow in the instrument panel. A Check Control message is output.

F10 Indicator light, parking brake fault display

Emergency release

No emergency release of the parking brake is provided for the customer.

The parking brake can be unlocked by unscrewing the EMF actuators and manually turning back the spindles.

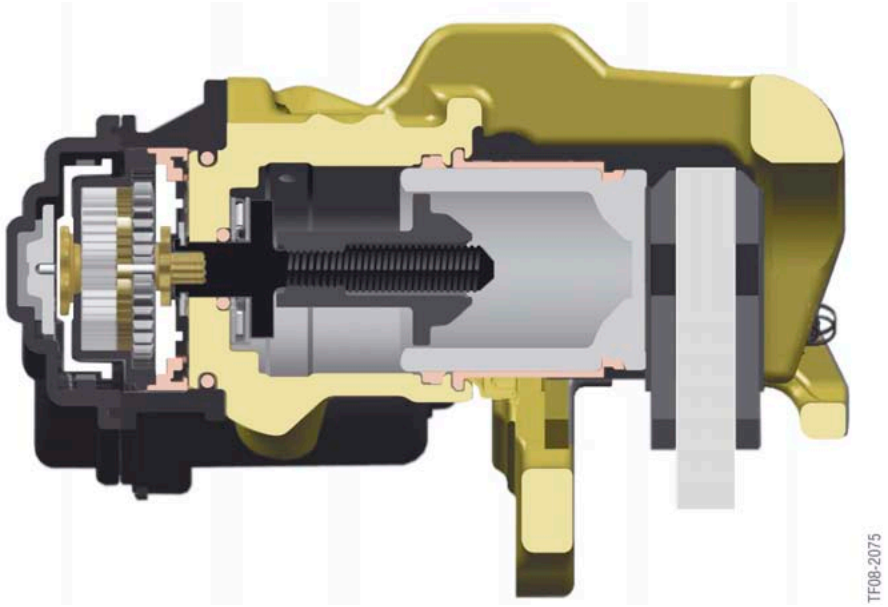
Note: No special tools are required to manually release the EMF at the calipers.

F10 Chassis Dynamics

4. Brakes

Changing the brake pads

To change the brake pads, the EMF actuator must be in the completely open position so that the brake piston can be pushed back. The EMF actuators can be activated and moved into the completely open position with the BMW (ISTA) diagnostics system. This position is necessary to change the brake pads. Once the installation position is reached, the installation mode is set automatically.



F10 Electromechanical parking brake with spindle nut in working position for exchanging the brake linings

Note: For safety reasons, as long as the EMF control unit is in installation mode, the parking brake cannot be activated. If the parking brake button is actuated despite this, the EMF indicator light flashes yellow in the instrument panel.

Installation mode can be cancelled in two ways:

- By running the "Reset installation mode" service function using ISTA
- By driving the car; a programmed minimum speed has to be exceeded.

After being changed, the brake pads must be bedded-in. This is necessary to ensure the brake pad and brake disc pairing assumes the specified friction parameters. Only then will the required braking force be reached.

Note: The exact procedure for bedding-in the service brakes is described in the Repair Instructions. The instructions must be followed exactly.

F10 Chassis Dynamics

4. Brakes

Brake test stand detection

Based on a plausibility check (wheel speed comparison), the EMF control unit detects the brake test stand and switches to brake test stand mode. Detection takes approximately 6 seconds.

By pulling the parking brake button multiple times in succession, the following target positions are approached:

- Brake pads applied
- Force 1 for the brake test stand
- Force 2 for the brake test stand
- Target force.

Alternatively, the parking brake button can also be pulled for a longer time in brake test stand mode. The individual target positions are then cycled through, spaced 3 seconds apart.

When the brake test stand mode is activated and the EMF actuators are released, the EMF indicator lamp flashes slowly.

When the brake test stand mode is activated and the EMF actuators are partially engaged, the EMF indicator lamp starts flashing quickly.

When the brake test stand mode is activated and the EMF actuators are completely engaged, the EMF indicator lamp is activated continuously.

The parking brake can be disengaged on the brake test stand without the brake pedal or clutch pedal being pressed. The brake test stand mode is terminated automatically when the vehicle leaves the brake test stand. The mode is also deactivated when the parking brake button is pressed or a fault is present.

F10 Chassis Dynamics

4. Brakes

Check Control messages

Description	Check control message	Central Information Display	Parking brake indicator light	Check Control symbol
Parking brake engaged	-	-		-
Installation mode	-	-		-
Brake test stand detected - actuator released	-	-		-
Brake test stand detected - actuator in intermediate position	-	-		-
Retensioning due to rollaway monitoring - vehicle with manual transmission	Parking brake overloaded!	Parking brake Parking brake overloaded. To park, secure the vehicle against rolling away.	-	
Retensioning due to rollaway monitoring - vehicle with automatic transmission	Parking brake overloaded!	Parking brake To park, ensure that selector lever position P is engaged.	-	
Disengaging the parking brake	Disengaging the parking brake	-		
Additionally press foot brake	Additionally press foot brake	-	-	

F10 Chassis Dynamics

4. Brakes

Description	Check control message	Central Information Display	Parking brake indicator light	Check Control symbol
Additionally engage selector lever position P	Additionally engage transmission P!	Parking brake To release the parking brake, also engage selector lever position P.	-	
Additionally press foot brake or clutch	Additionally press foot brake or clutch	-	-	
Parking brake button sensor fault	-	-		-
Redundancy loss, speeds	Parking brake fault!	Parking brake Parking brake malfunctioning. Please ask your nearest BMW Service Center to check this.		
Redundancy loss, parking brake button	Parking brake malfunctioning!	Parking brake Parking brake malfunctioning. Please ask your nearest BMW Service center to check this.		
Electromechanical mode - vehicle with manual transmission	Parking brake malfunctioning!	Parking brake No emergency braking function. When vehicle is at a standstill, parking brake can be engaged and released via button. Ask your nearest BMW Service Center to check this.		

F10 Chassis Dynamics

4. Brakes

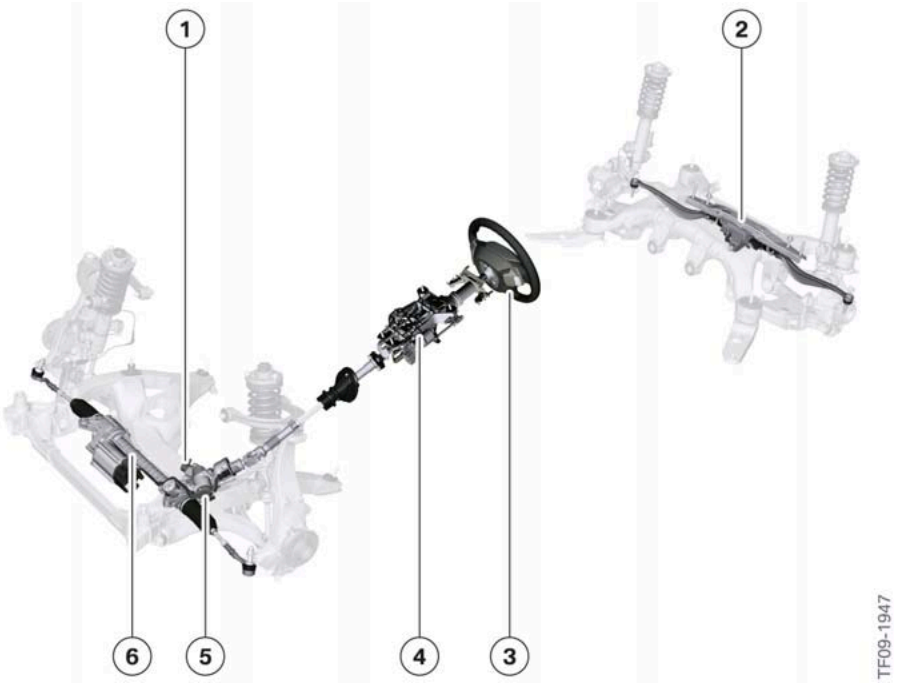
Description	Check control message	Central Information Display	Parking brake indicator light	Check Control symbol
Electromechanical mode - vehicle with automatic transmission	Parking brake malfunctioning!	No emergency braking function. When vehicle is at a standstill, parking brake can be engaged and released via button. Ask your nearest BMW Service Center to check this.		
immobilization - vehicle with manual transmission	Parking brake defective	Parking brake Parking brake defective. To park, secure the vehicle against rolling away. Ask your nearest BMW Service center to check this.		
immobilization - vehicle with automatic transmission	Parking brake defective	Parking brake Parking brake defective. To park, engage selector lever position P. Ask your nearest BMW Service Center to check this.		

F10 Chassis Dynamics

5. Steering

A vehicle's steering plays a central role in the chassis and suspension. The technological innovations introduced by BMW like active steering and rear axle slip angle control, are also used in the F10. Futhermore, the steering is now implemented completely electrically with the use of EPS (Electronic Power Steering).

This system is a modified and enhanced version of the E89 Z4 EPS.



F10 Steering components

Index	Explanation
1	Active steering lock
2	HSR actuator
3	Steering wheel
4	Steering column
5	Active steering servomotor with motor position angle sensor
6	Electromechanical power steering

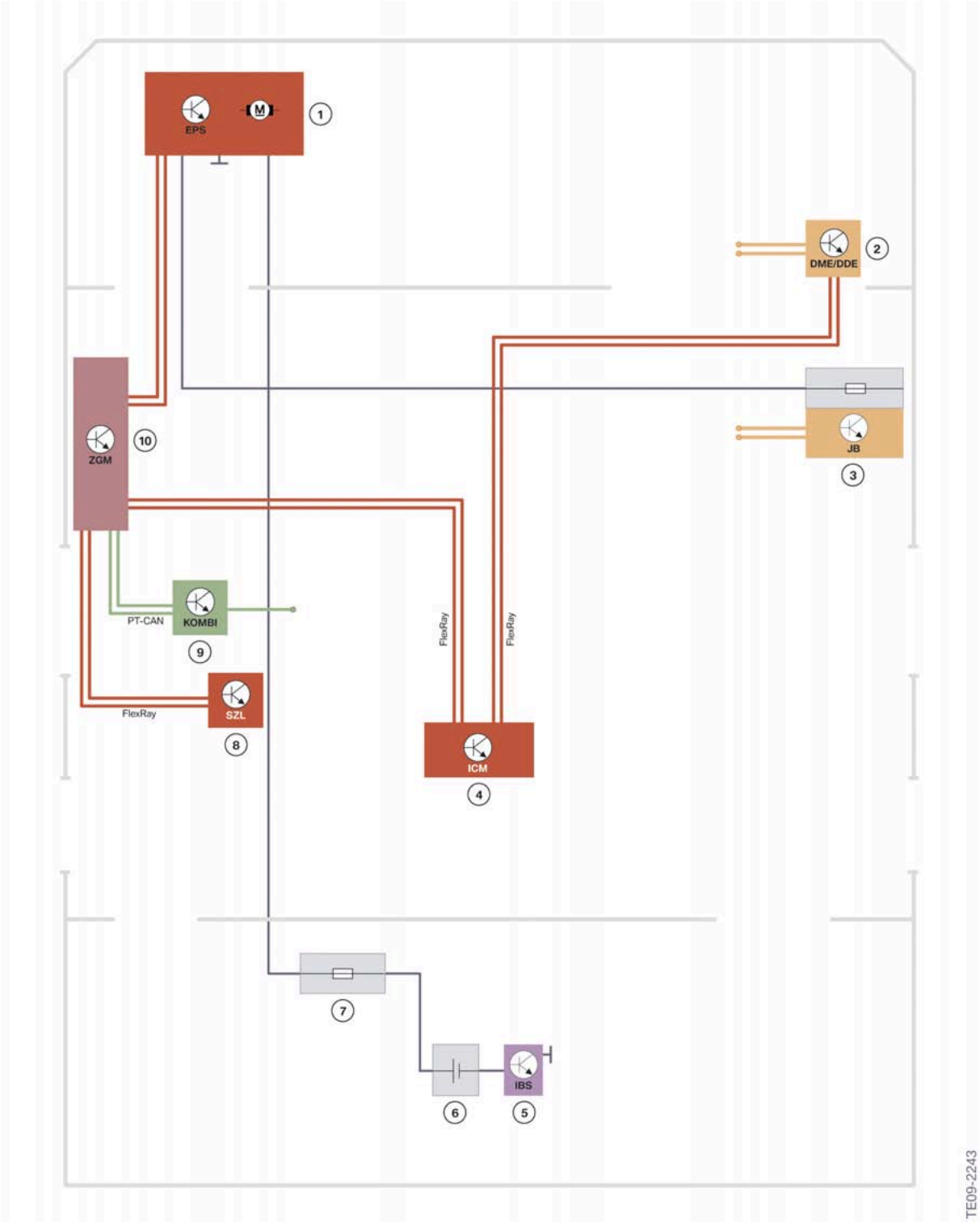
5.1. Basic steering

The F10 is the first BMW mid-range vehicle to be equipped with electromechanical power steering (EPS). The operating principle and structure of the EPS in the F10 is identical to that in the E89 and is explained the E89 Complete Vehicle training material under "Electric power steering with axial parallel arrangement (EPS w/APA)".

F10 Chassis Dynamics

5. Steering

5.1.1. System wiring diagram



F10 System wiring diagram for basic steering

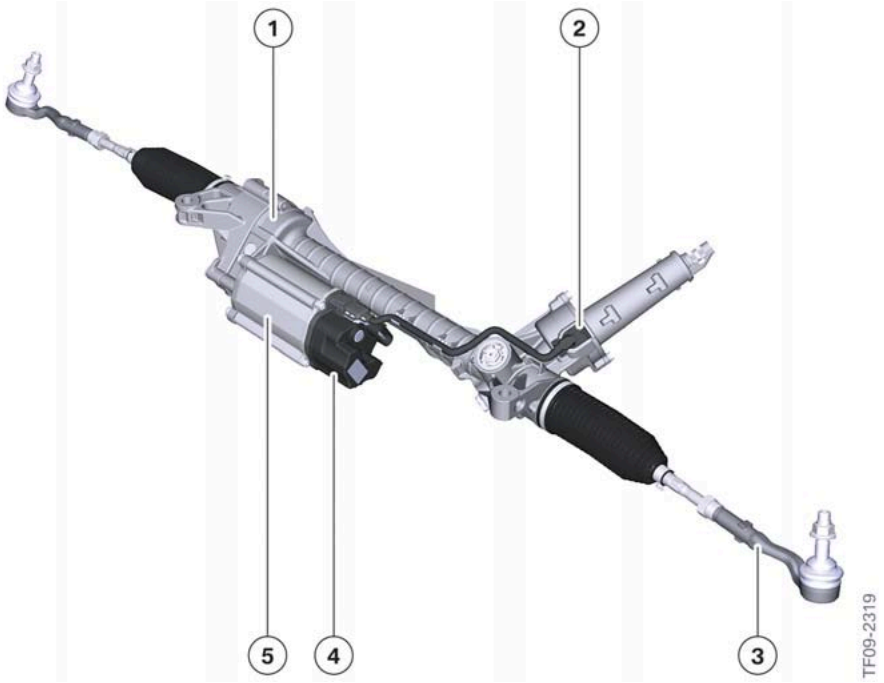
F10 Chassis Dynamics

5. Steering

Index	Explanation
1	EPS
2	Digital Motor Electronics (DME)
3	Junction box electronics with front power distribution box
4	Integrated Chassis Management (ICM)
5	Intelligent battery sensor (IBS)
6	Battery
7	Battery power distribution box
8	Steering column switch cluster (SZL)
9	Instrument cluster (KOMBI)
10	Central Gateway Module (ZGM)

5.1.2. System overview

The EPS enables average fuel consumption to be reduced by approx. 0.3 l/100 km (0.317 quart/62miles) compared to a conventional hydraulic steering system. This contributes to a reduction of CO_2 emissions.



F10 EPS

Index	Explanation
1	Speed reducer
2	Steering-torque sensor
3	Track rod
4	EPS control unit
5	Electric motor with motor position sensor

The EPS steering replaces the conventional hydraulic steering system. EPS is always equipped with the Servotronic function. Using the drive dynamic control switch, two different adjustments can be achieved: "Normal" and "Sporty".

The EPS is less sensitive to disturbance variables such as bumps and steering wheel vibration. It also contributes to the driving safety of the F10 with an active roll damping.

Because there is no oil in the EPS, it is more environmentally friendly than conventional hydraulic steering systems.

The EPS has Active return to center, this delivers optimum drivability. The EPS also makes it possible for the parking assistance to be implemented for the first time in a BMW vehicle.

For more information about parking assistance, refer to the "F10 Driver Assistance Systems" section in this training material.

5.2. Integral Active Steering

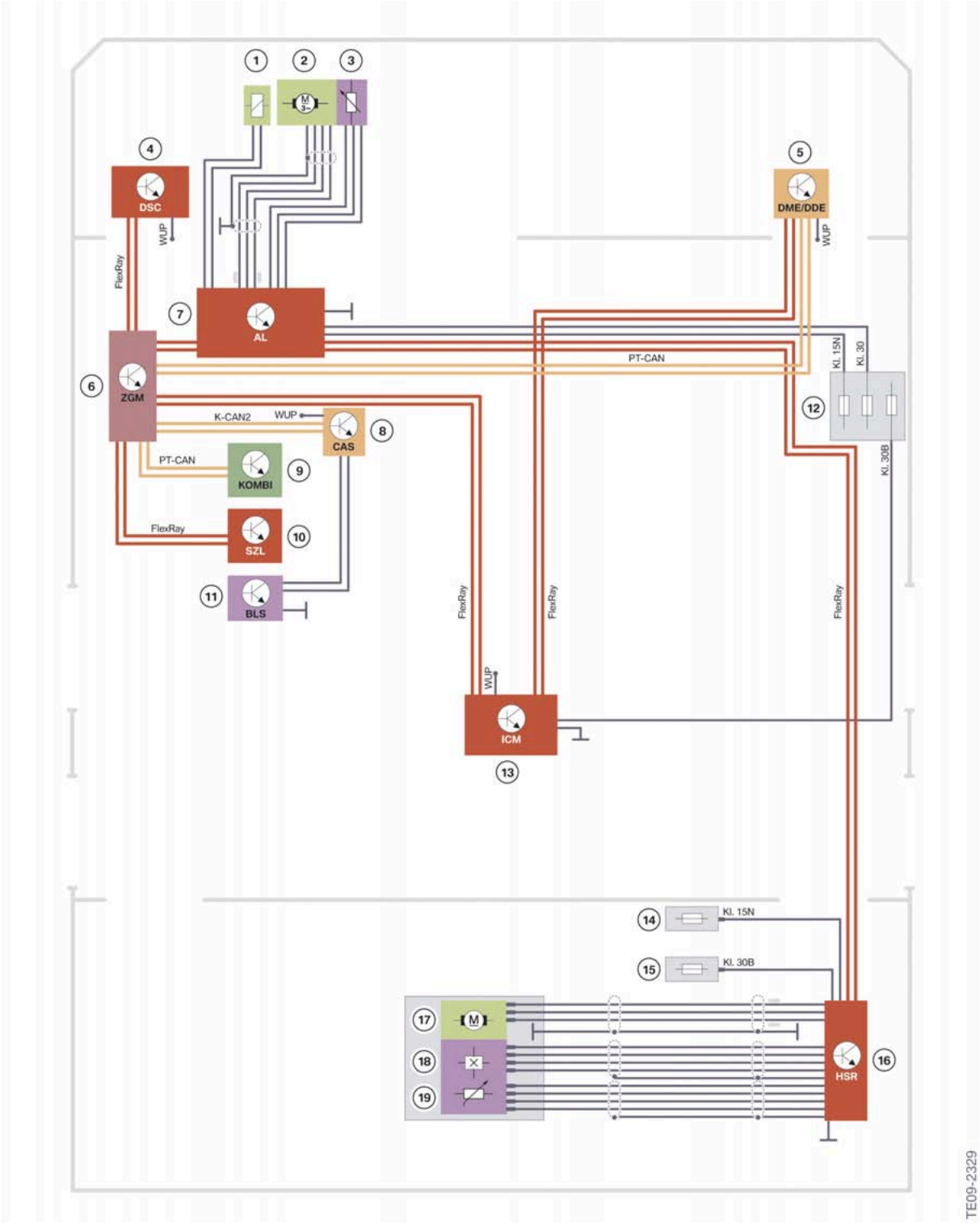
As with the F01 and F07, the optional equipment Integral Active Steering in the F10 is made up of two components: the rear axle slip angle control HSR and the active steering AL on the front axle. The EPS on the F10 has been especially adapted and modified to work with the active steering on the front axle.

The components of Integral Active Steering, active steering and rear axle slip angle control, cannot be ordered separately, but only as the Integral Active Steering package (option 2VH).

F10 Chassis Dynamics

5. Steering

5.2.1. System wiring diagram



F10 System wiring diagram for Integrated Active Steering

F10 Chassis Dynamics

5. Steering

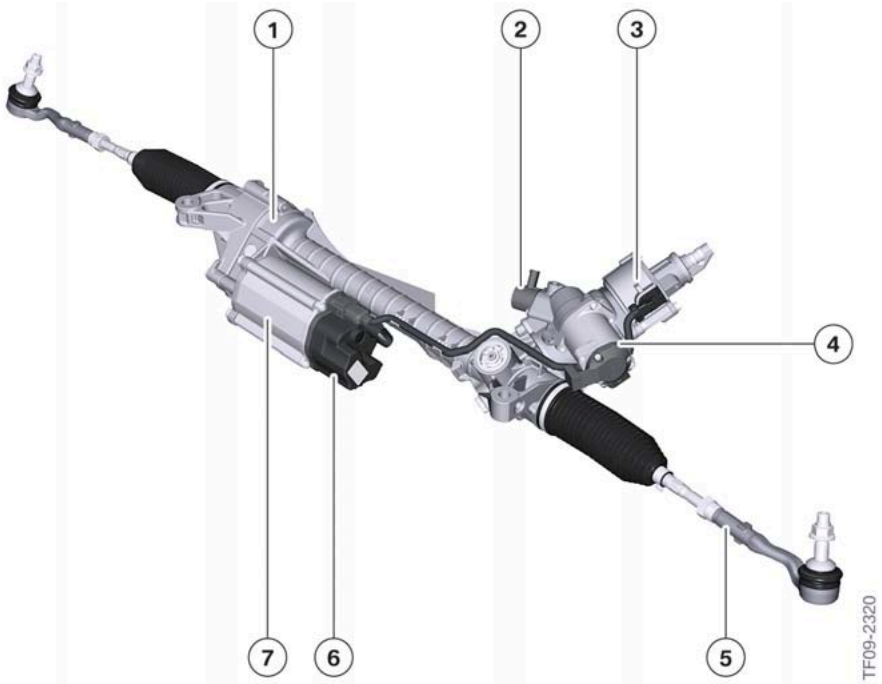
Index	Explanation
1	Active Steering lock
2	Active Steering electric servomotor
3	Active Steering motor angular position sensor
4	Dynamic Stability Control (DSC)
5	Digital Motor Electronics (DME)
6	Central Gateway Module (ZGM)
7	Control unit for Active Steering
8	Car Access System (CAS)
9	Instrument cluster (KOMBI)
10	Steering column switch cluster (SZL)
11	Brake light switch (BLS)
12	Front power distribution box
13	Integrated Chassis Management (ICM)
14	Rear right power distribution box
15	Battery power distribution box
16	Control unit for rear axle slip angle control (HSR)
17	HSR actuator
18	Hall-effect sensor
19	Track-rod position sensor

5.2.2. Active steering

With the optional equipment integral active steering, the steering gear is expanded by adding a planetary gearbox with override function, which implements a speed-dependent steering gear ratio that was already introduced with the E60.

F10 Chassis Dynamics

5. Steering



F10 EPS with active steering

Index	Explanation
1	Speed reducer
2	Active steering lock
3	Steering-torque sensor
4	Active steering servomotor with motor position angle sensor
5	Track rod
6	EPS control unit
7	Electric motor with motor position sensor

In the F10, electromechanical power steering is combined for the first time with the active steering planetary gearbox with override function (already familiar from the F01). As a result, the steering is implemented completely electrically.

Due to the higher weight of some engines and the higher steering forces associated with the greater front axle load, the power of a typical 12V steering system is no longer sufficient. For this reason, a 24V EPS system is installed in the F10, with the N63 engine and in conjunction with the optional Integral Active Steering equipment.

The following table explains when a 24V EPS is installed.

F10 Chassis Dynamics

5. Steering

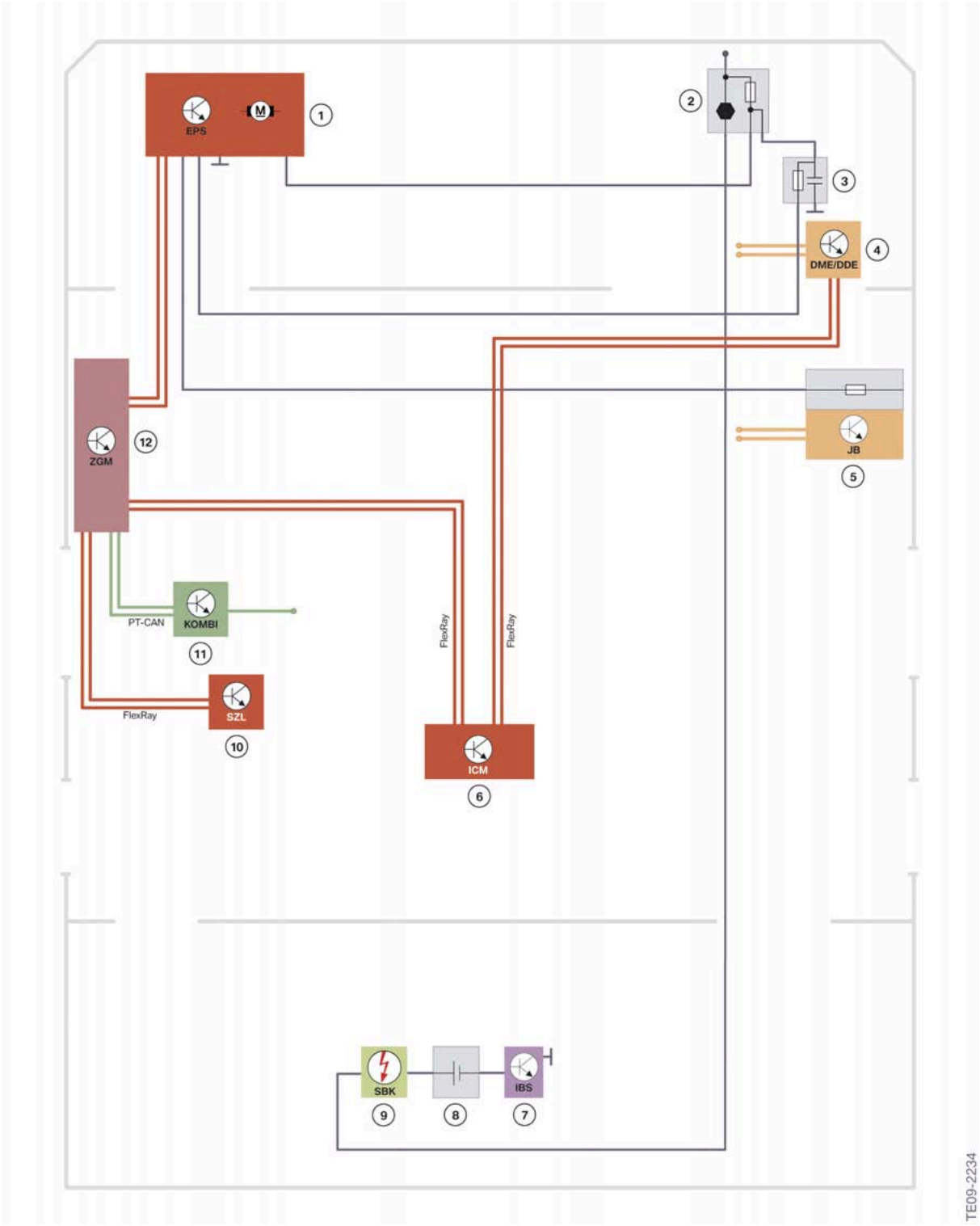
Engine	EPS voltage supply (only in combination with option 2VH)
528i	12V
535i	12V
550i	24V

EPS with 12V

Because active steering demands higher forces from the electromechanical steering, to comply with the higher current draw, when active steering is used in a vehicle with 12V EPS, the voltage is supplied by a separate positive battery connection point.

F10 Chassis Dynamics

5. Steering



F10 System wiring diagram EPS with 12V and active steering

F10 Chassis Dynamics

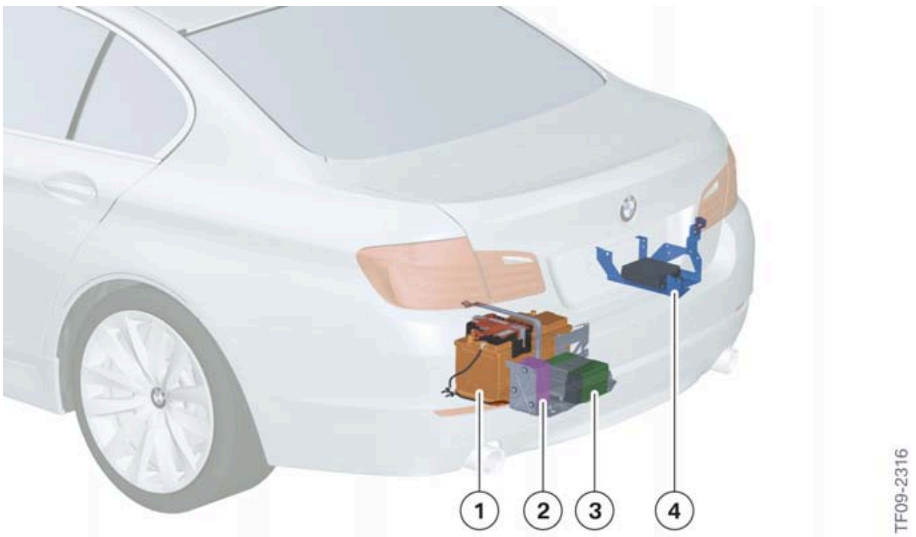
5. Steering

Index	Explanation
1	EPS
2	Positive battery connection point
3	Capacitor box
4	Digital Motor Electronics (DME)
5	Junction box electronics with front power distribution box
6	Integrated Chassis Management
7	Intelligent battery sensor (IBS)
8	Battery
9	safety battery terminal (SBK)
10	Steering column switch cluster
11	Instrument cluster (KOMBI)
12	Central Gateway Module (ZGM)

EPS with 24V

The higher weight of V8 and Diesel engines result in a higher front axle load. This in turn causes the power required for the steering servo to increase. In conjunction with the active steering, an even higher exertion of force is applied, and therefore even higher current is required for the steering servo. These high current made it necessary to increase the voltage supply of the EPS to 24V.

This requires an auxiliary battery, a separator and a charging unit for the auxiliary battery. These components are installed in the luggage compartment of the F10 550i (V8).



F10 550i 24V EPS components

F10 Chassis Dynamics

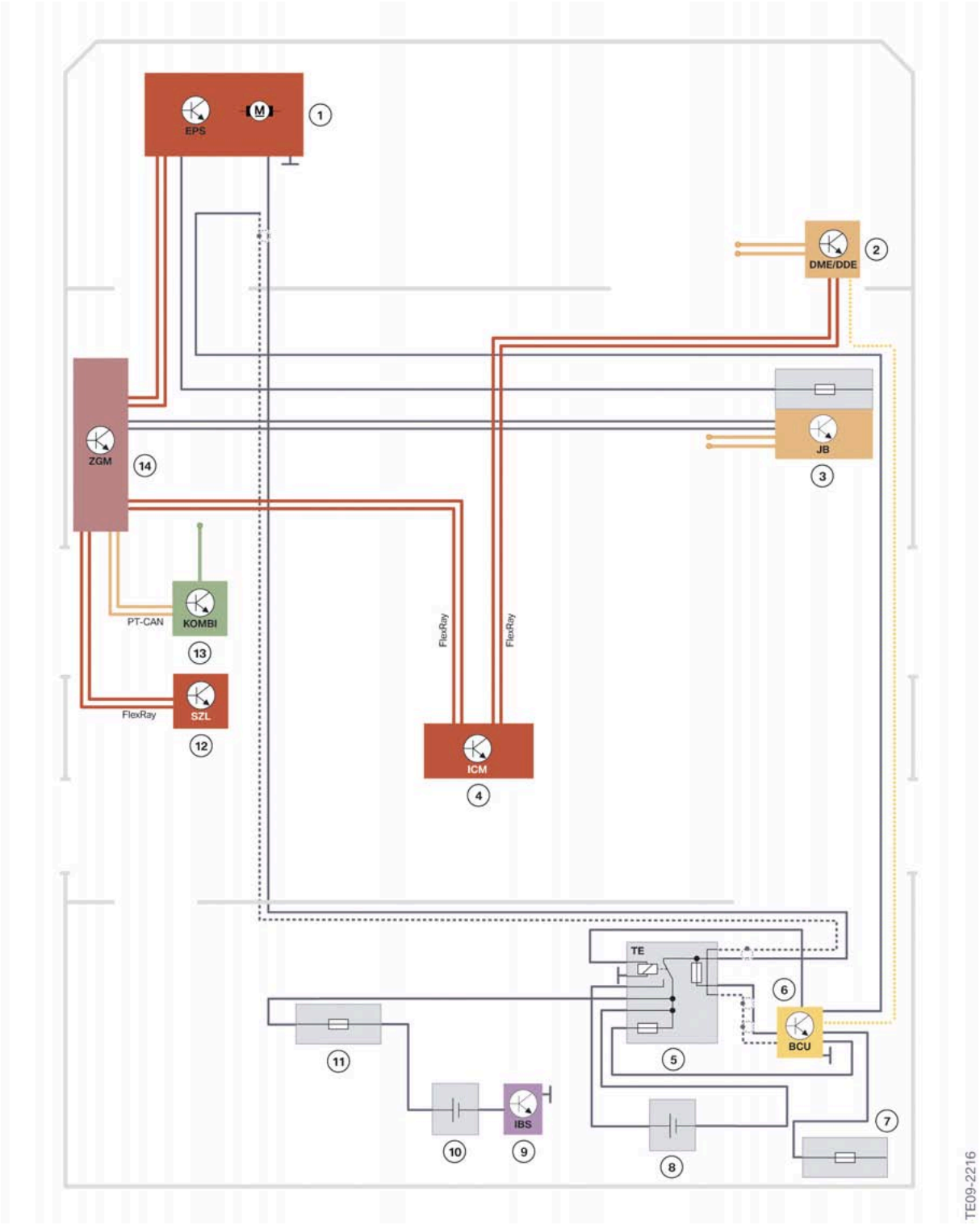
5. Steering

Index	Explanation
1	Battery
2	Separator
3	Auxiliary battery
4	Battery charging unit for auxiliary battery (BCU)

The following system wiring diagram shows the integration of the new components into the vehicle electrical system.

F10 Chassis Dynamics

5. Steering



F10 System wiring diagram EPS with 24V and active steering

F10 Chassis Dynamics

5. Steering

Index	Explanation
1	EPS
2	Digital Motor Electronics (DME)
3	Junction box electronics with front power distribution box
4	Integrated Chassis Management (ICM)
5	Separator
6	Battery charging unit for auxiliary battery (BCU)
7	Rear right power distribution box
8	Auxiliary battery
9	Intelligent battery sensor (IBS)
10	Battery
11	Battery power distribution box
12	Steering column switch cluster (SZL)
13	Instrument cluster (KOMBI)
14	Central Gateway Module (ZGM)

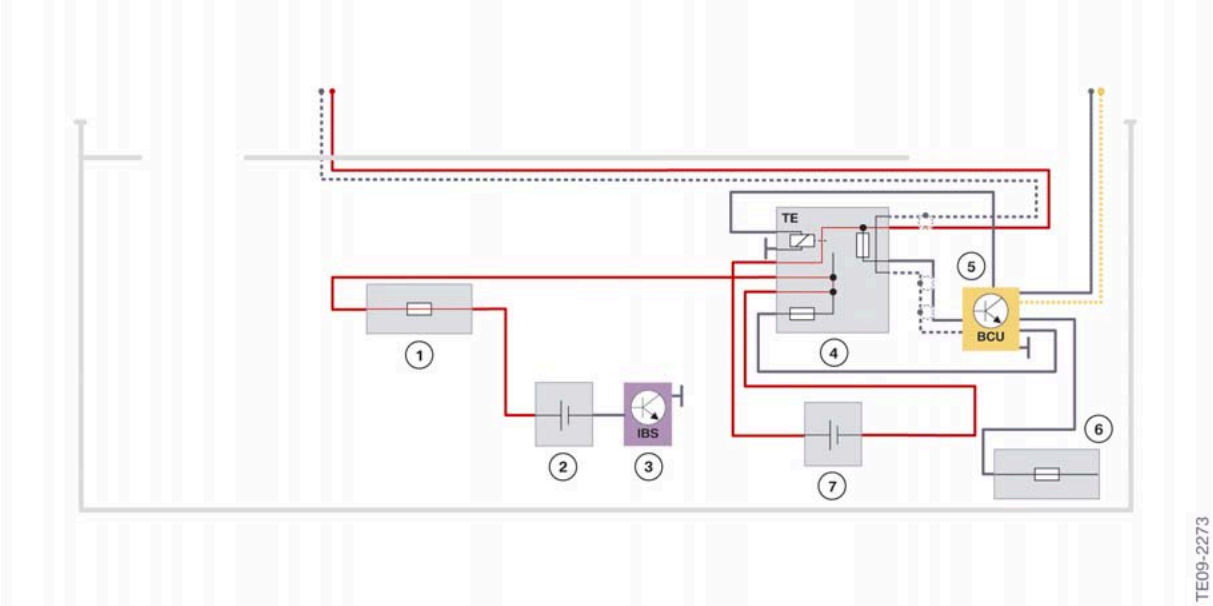
The BCU (charging unit) takes over the monitoring of the state of charge and the charging of the auxiliary battery with a 150W DC/DC converter. It monitors a cable (isolation) sheathing of the 24V line and it switches the relay in the separator with which the auxiliary battery is integrated into the circuit. The EPS is supplied with 24V only after this relay has been switched on. In the event of a fault, the EPS can also be operated with 12V. If there is no fault, the relay in the separator is switched as of terminal 15.

The 24V line is routed on the vehicle floor and is surrounded by a cable sheath which is monitored by the charging unit (BCU).

The following system wiring diagram details the various switch situations and the charging of the auxiliary battery.

F10 Chassis Dynamics

5. Steering



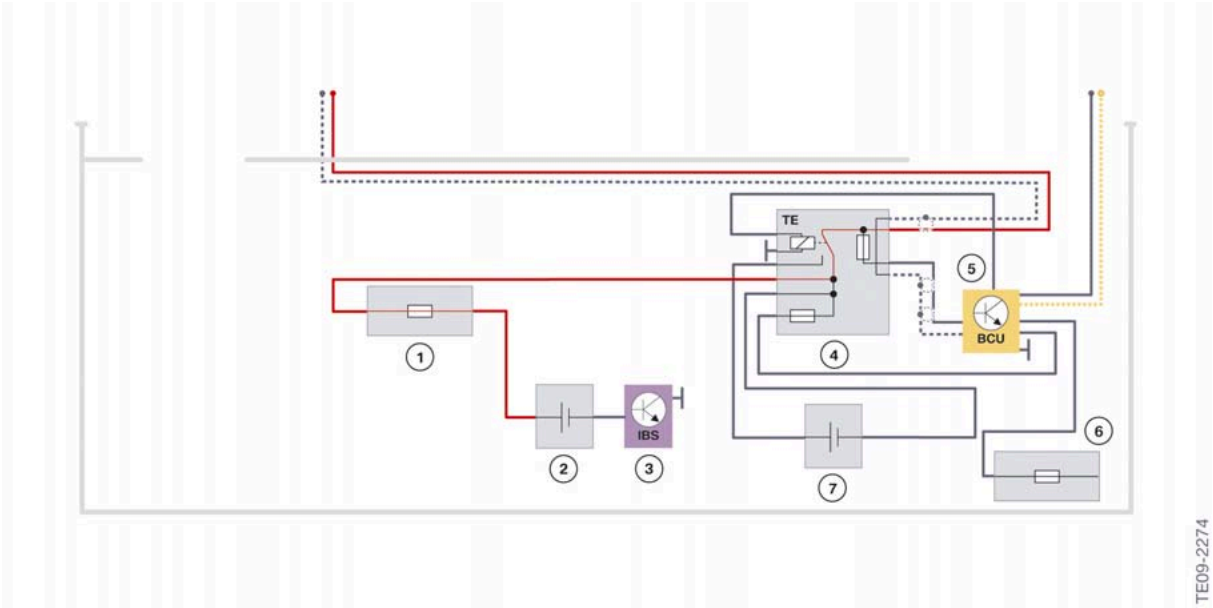
F10 24V operation of the EPS

Index	Explanation
1	Battery power distribution box
2	Battery
3	Intelligent battery sensor IBS.
4	Separator (here: 24V operation)
5	Charging unit for auxiliary battery (Battery Charge Unit BCU)
6	Rear right power distribution box
7	Auxiliary battery

In 24V operation mode, the battery and the auxiliary battery are connected in series by the relay in the separator. As a result, the EPS is operated with 24V.

F10 Chassis Dynamics

5. Steering



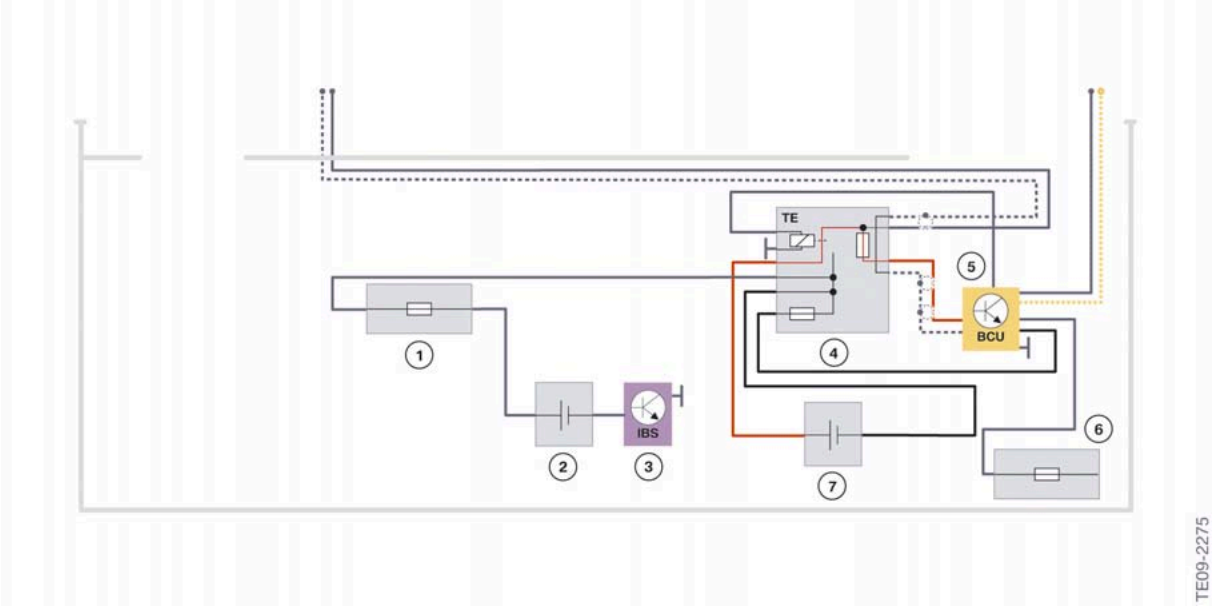
F10 12V operation in the event of a fault

Index	Explanation
1	Battery power distribution box
2	Battery
3	Intelligent battery sensor (IBS)
4	Separator (here: 12V operation)
5	Charging unit for auxiliary battery (Battery Charge Unit BCU)
6	Rear right power distribution box
7	Auxiliary battery

In the event of a fault or before terminal 15, the relay is open and the separator is in the 12V position. The auxiliary battery is no longer connected in series and is no longer in the circuit.

F10 Chassis Dynamics

5. Steering



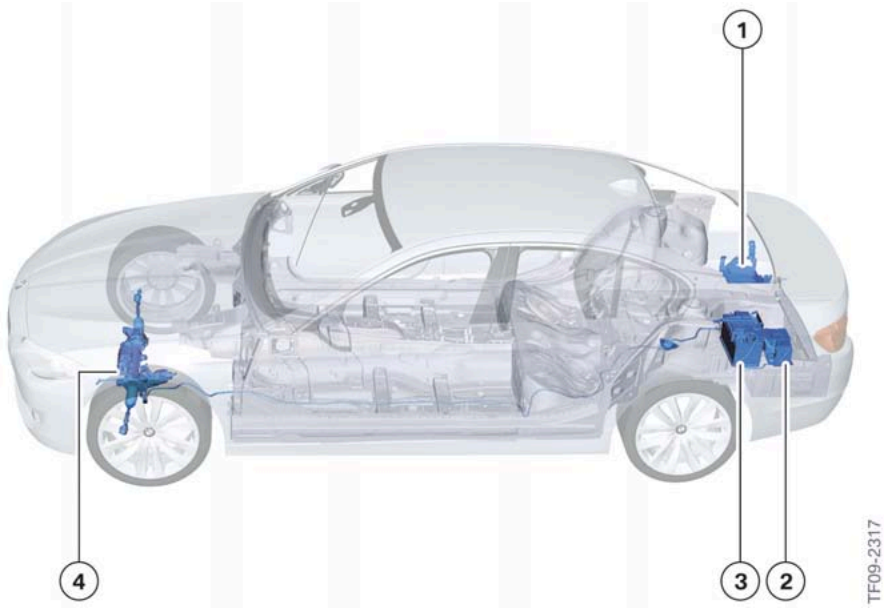
F10 Charging of the auxiliary battery in 24V operation

Index	Explanation
1	Battery power distribution box
2	Battery
3	Intelligent battery sensor IBS.
4	Separator (here: 24V operation)
5	Charging unit for auxiliary battery (Battery Charge Unit BCU)
6	Rear right power distribution box
7	Auxiliary battery

The auxiliary battery can be charged in 24V operation using the battery charging unit for the auxiliary battery. To do so, the charging unit takes the energy it uses for charging the auxiliary battery from the vehicle electrical system via the rear right power distribution box.

F10 Chassis Dynamics

5. Steering



F10 24V components and line routing

Index	Explanation
1	Battery charging unit for auxiliary battery (BCU)
2	Separator and auxiliary battery
3	Battery
4	EPS with active steering

5.2.3. Rear suspension slip angle control

The rear axle is equipped with integral active steering, thus increasing the comfort and driving dynamics. To review the operating principle of the integral active steering, refer to the F01/F02 Chassis and Suspension and Lateral Dynamics System training material available on TIS and ICP. The components of Integral Active Steering include front active steering and rear axle slip angle control. The Integral Active Steering package (option 2VH) cannot be ordered separately on the F10, but only as is part of the (ZDH) Dynamic Handling Package.

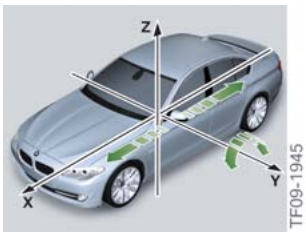
The (ZDH) Dynamic Handling Package also includes: Electronic Damping Control, Active Roll Stabilization and Adaptive Drive.

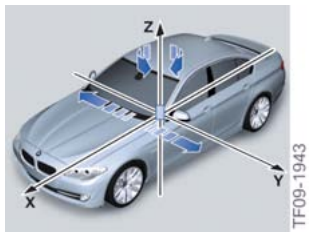
F10 Chassis Dynamics

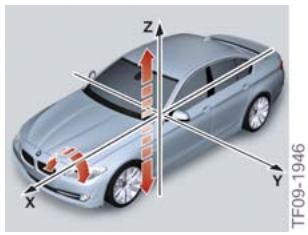
6. Dynamic Driving Systems

6.1. Force-transfer directions

The driving stability control systems can be distinguished by their basic force-transfer directions. Driving stability control systems can act both in and around an axis of the vehicle-fixed coordinate system X, Y and Z.







Force-transfer direction	Longitudinal	Pitch	Transverse	Yaw	Vertical	Roll
DSC	●			●		
Integral Active Steering			●	●		
VDM		●			●	
DCC	●					
ARS						●

6.2. Dynamic Stability Control

Dynamic Stability Control is standard in all BMW vehicles.

The DSC prevents spinning of the drive wheels when starting up and when accelerating.

The DSC also identifies unstable driving conditions, such as oversteer or understeer. The DSC helps to keep the vehicle on a safe course by applying brake interventions on the individual wheels (within the physical limits) and by reducing the engine output in order to control wheel spin and maintain traction.

It always remains the responsibility of the driver to adapt his or her driving style.

Even with the DSC, the laws of physics still apply.

Always Drive Safely!

The DSC system control unit is attached to a hydraulic valve block and it includes many individual functions that are listed in the following table.

F10 Chassis Dynamics

6. Dynamic Driving Systems

Function	Subfunction	Description
ABS		Antilock Brake System
	EBV	Electronic brake force distribution
	CBC	Cornering Brake Control
	DBC	Dynamic Brake Control
ASC		Automatic Stability Control
	MMR	Engine torque control
	MSR	Engine drag torque control
	BMR	Brake torque control
DSC		Dynamic Stability Control
	GMR	Yaw moment control
	SDR	Thrust differential control
	DTC	Dynamic Traction Control

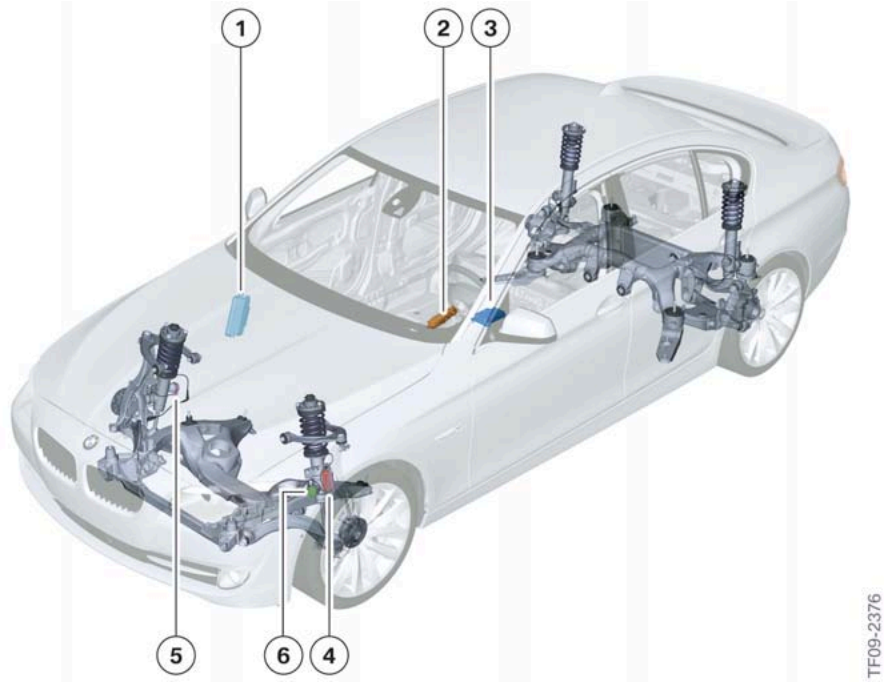
The DSC can be operated in three modes:

- Normal operation
- Dynamic Traction Control (DTC)
- DSC OFF

F10 Chassis Dynamics

6. Dynamic Driving Systems

6.3. Electronic Damper Control (EDC/VDC)



F10 Components of the VDM

Index	Explanation
1	VDM control unit
2	Drive dynamic control switch
3	ICM control unit
4	EDC satellite, front left
5	EDC control valve for rebound
6	EDC control valve for pressure stage

The F10 uses **Vertical Dynamics Management (VDM)** with **Electronic Damper Control (EDC)**.

Beginning with the F01/F02, the EDC is also called **VDC (Vertical Dynamic Control)** and is a function of the VDM.

The VDM was introduced with the E70/E71, enhanced for the F01/F02 and now further developed for the F10.

With Vertical Dynamics Control (VDC), independent electronic damper control for each wheel is possible, whereas EDC is only capable of front to rear adjustments.

During this process, the servomotors and the sensors on the shock absorbers, known as satellites, are connected to the VDM control unit via FlexRay.

The VDC and the Dynamic Drive (ARS for the vehicles BMW 535i, BMW 550i) are available only in combination as Adaptive Drive (option 2VA). EDC can only be ordered individually as optional equipment (option 223) on the BMW 528i.

F10 Chassis Dynamics
6. Dynamic Driving Systems

For more information regarding EDC/VDC, refer to the F01/F02 "Vertical Dynamics Systems" training material available on TIS and ICP.

6.4. Dynamic Drive (ARS)

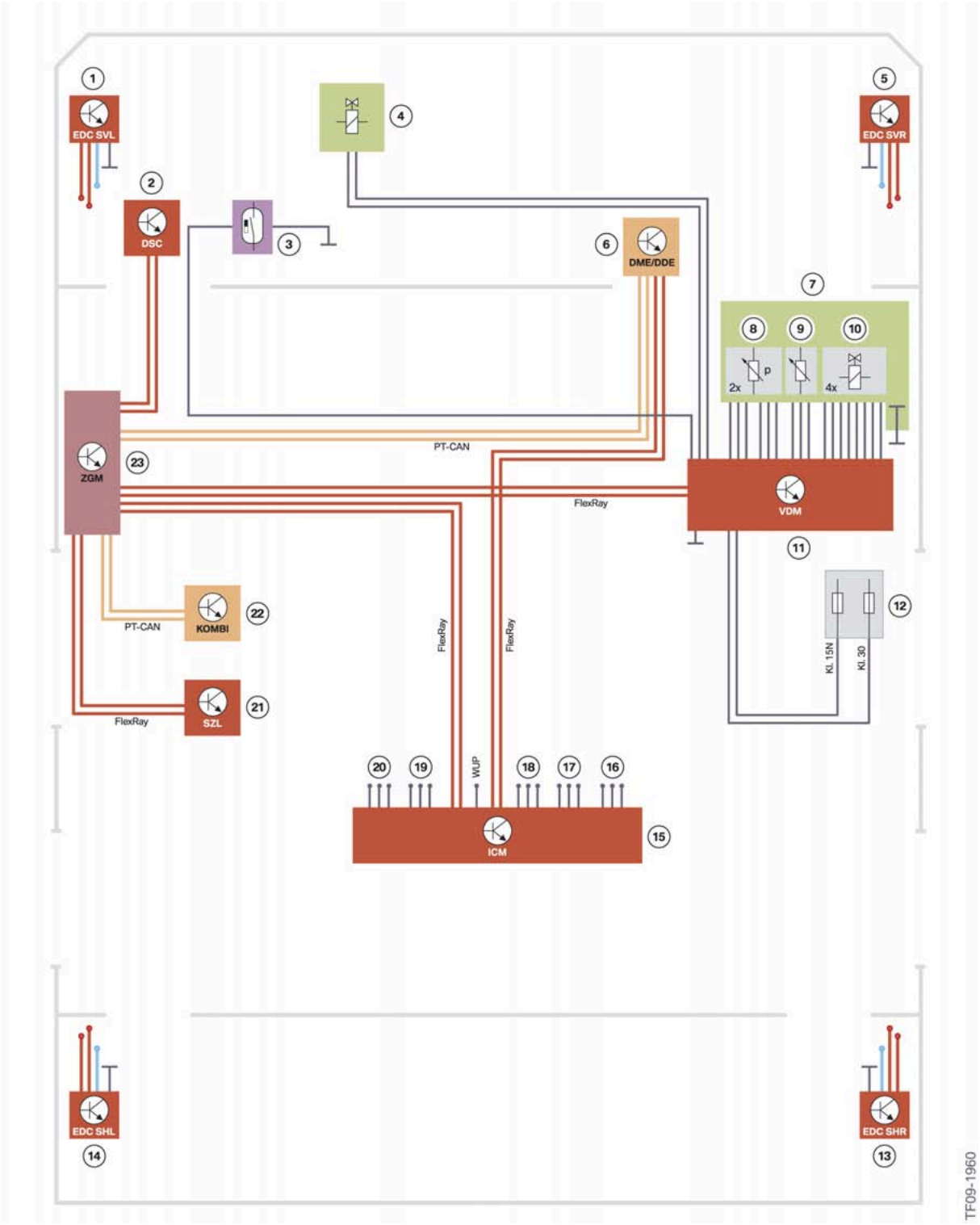
Dynamic Drive (ARS) was introduced for the first time in the E65/E66. As with EDC/VDC is mapped as a function in the VDM control unit.

Adaptive Drive (option 2VA) is available as and option on the F10 (in the BMW 535i and BMW 550i only)

For more information on Dynamic Drive (ARS), refer to the F01/F02 "Vertical dynamics systems" training material available on TIS and ICP.

F10 Chassis Dynamics

6. Dynamic Driving Systems



F10 System wiring diagram for Adaptive Drive

F10 Chassis Dynamics

6. Dynamic Driving Systems

Index	Explanation
1	Electronic Damper Control satellite, front left
2	Dynamic Stability Control
3	Hydraulic fluid level sensor
4	Intake restrictor valve
5	Electronic Damper Control satellite, front right
6	Digital Motor Electronics/Digital Diesel Electronics
7	Dynamic Drive valve block
8	Front suspension pressure sensor/rear suspension pressure sensor
9	Shift-position sensor
10	Fail-safe valve, direction valve and low pressure control valve
11	Vertical Dynamics Management
12	Front power distribution box
13	Electronic Damper Control satellite, rear right
14	Electronic Damper Control satellite, rear left
15	Integrated Chassis Management
16	Ride-height sensor, rear left
17	Ride-height sensor, front left
18	Ride-height sensor, front right
19	Ride-height sensor, rear right
20	Connection for driving dynamics control switch
21	Steering column switch cluster
22	Instrument cluster
23	Central Gateway Module

F10 Chassis Dynamics

6. Dynamic Driving Systems

6.5. Handling Setting Switch

F10 Center console

Index	Explanation
1	Driving dynamics control switch
2	Controller

F10 Chassis Dynamics

6. Dynamic Driving Systems

F10 Driving dynamics control switch

Index	Explanation
1	Driving dynamics control switch for equipment without Adaptive Drive
2	Driving dynamics control switch for equipment with Adaptive Drive

In the F10 (as in F01 and F07) we can also control all drive and stability control systems in combination through the driving dynamics control switch. The operating principle is identical to that in the F01. For vehicles with Adaptive Drive (option 2VA), four different modes are available on the driving dynamics control switch. For vehicles without Adaptive Drive (option 2VA), the "Comfort" stage is omitted and only three different modes can be configured. The driving dynamics control switch is then labelled with "Normal" instead of “Comfort”.

Note: Adaptive Drive combines EDC (Electronic Damper Control) with ARS (Active Roll Stabilization).

Sport mode can be adapted using the controller.

F10 Chassis Dynamics

6. Dynamic Driving Systems

F10 Sport mode adaptation

You can determine whether the sport mode is to apply to the chassis and suspension only, to the drive, or to both simultaneously.

6.5.1. Dynamic Driving Programs

For vehicles without Adaptive Drive

	Normal	Sport	Sport+
Drive systems			
Accelerator pedal characteristic	Normal	Sports	Sports
Shift program	Normal	Sports	Sports
Shift speed	Normal	Sports	Sports
Suspension control systems			
Power steering assistance	Normal	Sports	Sports
Integral Active Steering	Normal	Sports	Sports
Dynamic Stability Control	DSC on	DSC on	DTC

For vehicles with Adaptive Drive

	Comfort	Normal	Sport	Sport+
Drive systems				
Accelerator pedal characteristic	Normal	Normal	Sports	Sports
Shift program	Normal	Normal	Sports	Sports

F10 Chassis Dynamics

6. Dynamic Driving Systems

	Comfort	Normal	Sport	Sport+
Shift speed	Normal	Normal	Sports	Sports
Suspension control systems				
Power steering assistance	Normal	Normal	Sports	Sports
Integral Active Steering	Normal	Normal	Sports	Sports
Dynamic Stability Control	DSC on	DSC on	DSC on	DTC
Electronic damper control (EDC)	Comfortable	Normal	Sports	Sports
Dynamic Drive (ARS)	Normal	Normal	Sports	Sports

Bayerische Motorenwerke Aktiengesellschaft
Händlerqualifizierung und Training
Röntgenstraße 7
85716 Unterschleißheim, Germany