Technical training.
Product information.

F12 Chassis Dynamics

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BMW Service

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 the 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 technical training of the BMW Group 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.

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F12 Chassis Dynamics
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F12 Chassis Dynamics

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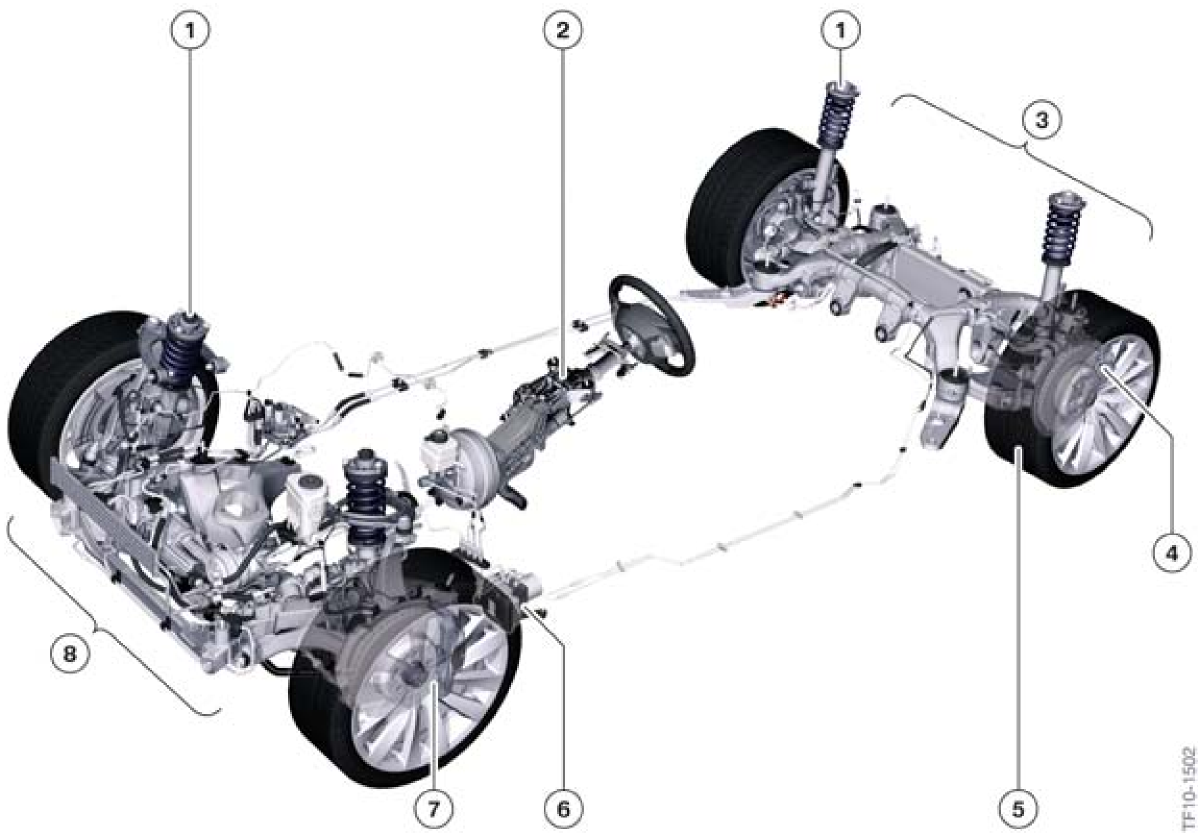
1.1. Driving dynamics and comfort



F12 Chassis and suspension

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1	Suspension/dampers
2	Electromechanical Power Steering (EPS)
3	Integral V rear axle
4	Electromechanical Parking Brake (EMF)
5	Wheels
6	Dynamic Stability Control (DSC)
7	Brakes
8	Double-wishbone front axle

The chassis and suspension of the F12 is based on the F10. It has been adapted to the specific requirements of the F12 in order to achieve outstanding driving dynamics while maintaining extremely high standards of comfort.

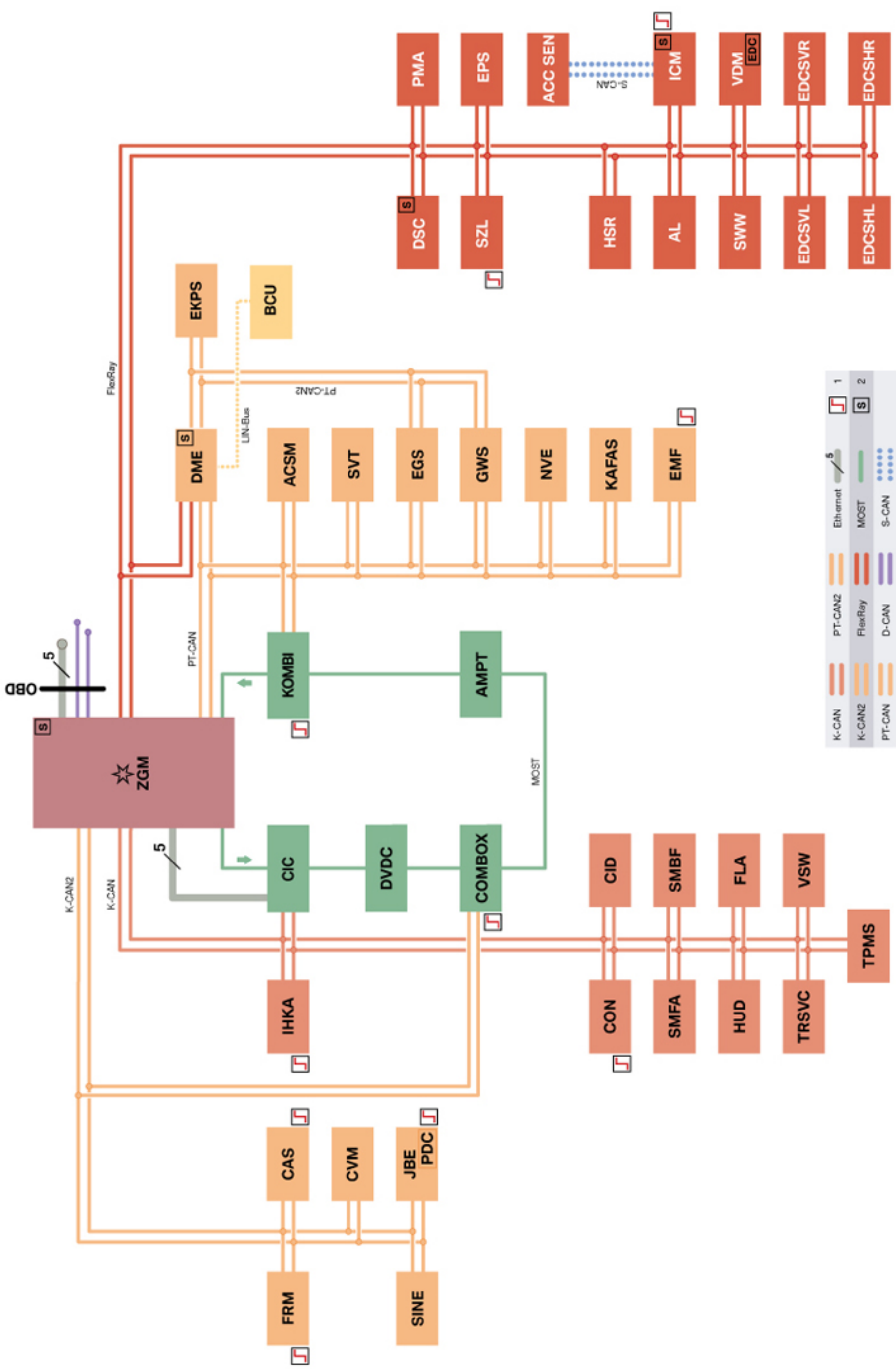
A double-wishbone front axle is used instead of the double pivot spring-strut axle of the E64. The integral V rear axle replaces the integral IV rear axle that featured in the E64.

F12 Chassis Dynamics

1. Introduction

The F12 features innovations already familiar from other BMW models, such as Integral Active Steering, Integrated Chassis Management (ICM), Dynamic Drive and Electronic Damper Control (EDC).

1.2. Bus system overview



F12 Bus System overview

F12 Chassis Dynamics
1. Introduction

Index	Explanation
1	Control units with wake-up authorization
2	Start-up 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
AMPT	Top HiFi amplifier
BCU	Battery Charge Unit (for auxiliary battery only w/IAC)
CAS	Car Access System
CID	Central information display
COMBOX	Combox (Combox multimedia, Combox multimedia with telematics)
CON	Controller
CVM	Convertible top module
DME	Digital Motor Electronics
DSC	Dynamic Stability Control
DVDC	DVD changer
EDCSHL	Electronic Damper Control satellite, rear left
EDCSHR	Electronic Damper Control satellite, rear right
EDCSVL	Electronic Damper Control satellite, front left
EDCSVR	Electronic Damper Control satellite, front right
EGS	Electronic transmission control
EKPS	Electronic fuel pump control
EMF	Electromechanical parking brake
EPS	Electronic power steering (electromechanical power steering)
FRM	Footwell module
GWS	Gear selector switch
HEADUNIT	Headunit (car information computer or car information computer basic II)
HSR	Rear axle slip angle control
HUD	Head-Up Display
ICM	Integrated Chassis Management
IHKA	Automatic integrated heating and A/C control unit
JBE	Junction box electronics
KAFAS	Camera-based driver support systems
KOMBI	Instrument panel
NVE	Night vision electronics

F12 Chassis Dynamics
1. Introduction

Index	Explanation
PDC	Park Distance Control
PMA	Parking maneuvering assistant
TPMS	Tire Pressure Monitor System
SINE	Siren with tilt alarm sensor
SMBF	Front passenger seat module
SMFA	Driver's seat module
SWW	Blind Spot Detection (Lane change warning)
SZL	Steering column switch cluster
TRSVC	Control unit for camera systems
VDM	Vertical Dynamics Management
VSW	Video switch
ZGM	Central gateway module

F12 Chassis Dynamics

2. Models

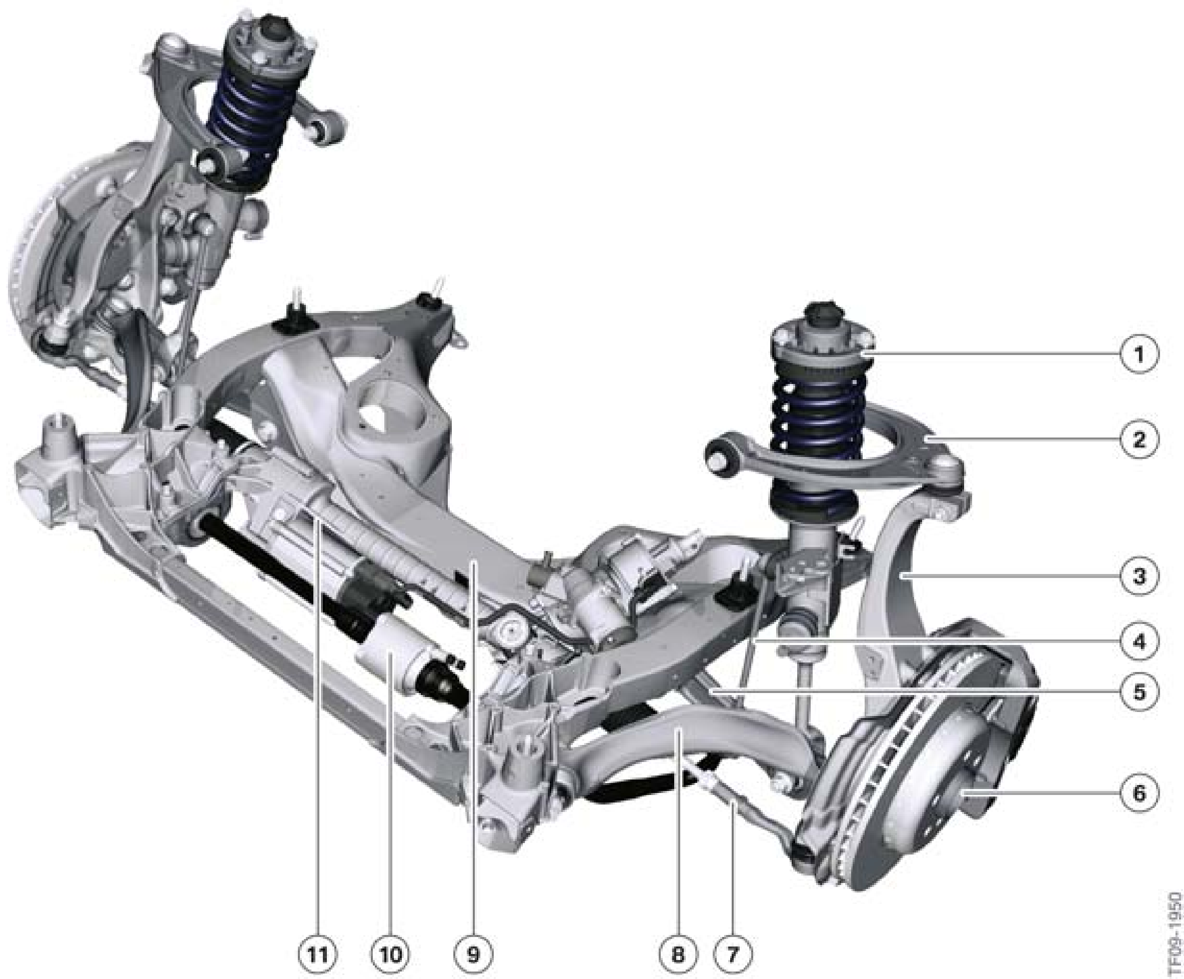
2.1. Comparison

The following technical data allows a comparison to be made between the chassis and suspension of the F12 and its predecessor the E64.

Designation	E64 BMW 650i	F12 BMW 650i
Wheelbase	2780 mm	2855 mm
Front track width	1558 mm	1600 mm
Rear track width	1596 mm	1657 mm
Tires, basic wheels	245/45 R18 96W	245/45 R18 96Y
Basic wheel rims	8J x 18 IS 14	8J x 18 IS 30
Front axle	Double pivot spring-strut front axle	Double-wishbone front axle
Springs/dampers	Steel spring/conventional or EDC	Steel spring/conventional or EDC
Anti-roll bar, front	mechanical or hydraulic (Dynamic Drive)	mechanical or hydraulic (Dynamic Drive)
Front brake disc dia.	348 mm	374 mm
Steering	Hydraulic or active steering	Electronic Power Steering EPS
Rear axle	Integral IV rear axle	Integral V rear axle
Rear suspension/dampers	Steel spring, conventional or EDC	Steel spring/conventional or EDC
Rear anti-roll bar	mechanical or hydraulic (Dynamic Drive)	mechanical or hydraulic (Dynamic Drive)
Rear brakes disc dia.	345 mm	370 mm
Parking brake	Drum brake with parking brake lever and automatic cable setting	Disc brake with electromechanical parking brake

F12 Chassis Dynamics
3. Chassis and suspension

3.1. Front axle



F12 Double-wishbone front axle

Index	Explanation
1	Spring strut
2	Upper wishbone
3	Swivel bearing
4	Anti-roll bar link
5	Lower wishbone
6	Wheel hub
7	Track rod
8	Trailing link
9	Front axle support
10	Anti-roll bar with hydraulic actuator (Dynamic Drive)
11	Steering box

F12 Chassis Dynamics

3. Chassis and suspension

The F12 double-wishbone front axle was originally introduced with the E70/E71. The design was further developed and also used in the F01/F02, F07, and F10.

Conventional shock absorbers or EDC can be installed in the double-wishbone front axle. In addition, It is can also be equipped for use in an all-wheel drive configuration.

3.1.1. Technical data

Designation	F12
Castor angle	7° 0'
Camber	-0° 29' ± 30'
Total toe-in	10' ± 12'
Toe difference angle	≤ 12'
Steering axis inclination	9° 57'
Rim offset IS	30 mm
Kingpin offset	2.89 mm
Track width	1600 mm
maximum outer steer angle	33° 0'
maximum inner steer angle	42° 14'

3.1.2. Service Information

The following tables show when wheel alignment of the double-wishbone front axle is necessary.

Component replaced	Wheel alignment required
Front axle support	YES
Steering box	YES
Lower Wishbone	YES
Rubber mount for lower wishbone	YES
Trailing link	NO
Rubber mount for trailing link	NO
Upper wishbone	NO
Rubber mount for upper wishbone	NO
Track rod	YES
Swivel bearing	YES
Wheel bearing	NO
Spring strut	NO
Coil spring	NO
Support bearing	NO

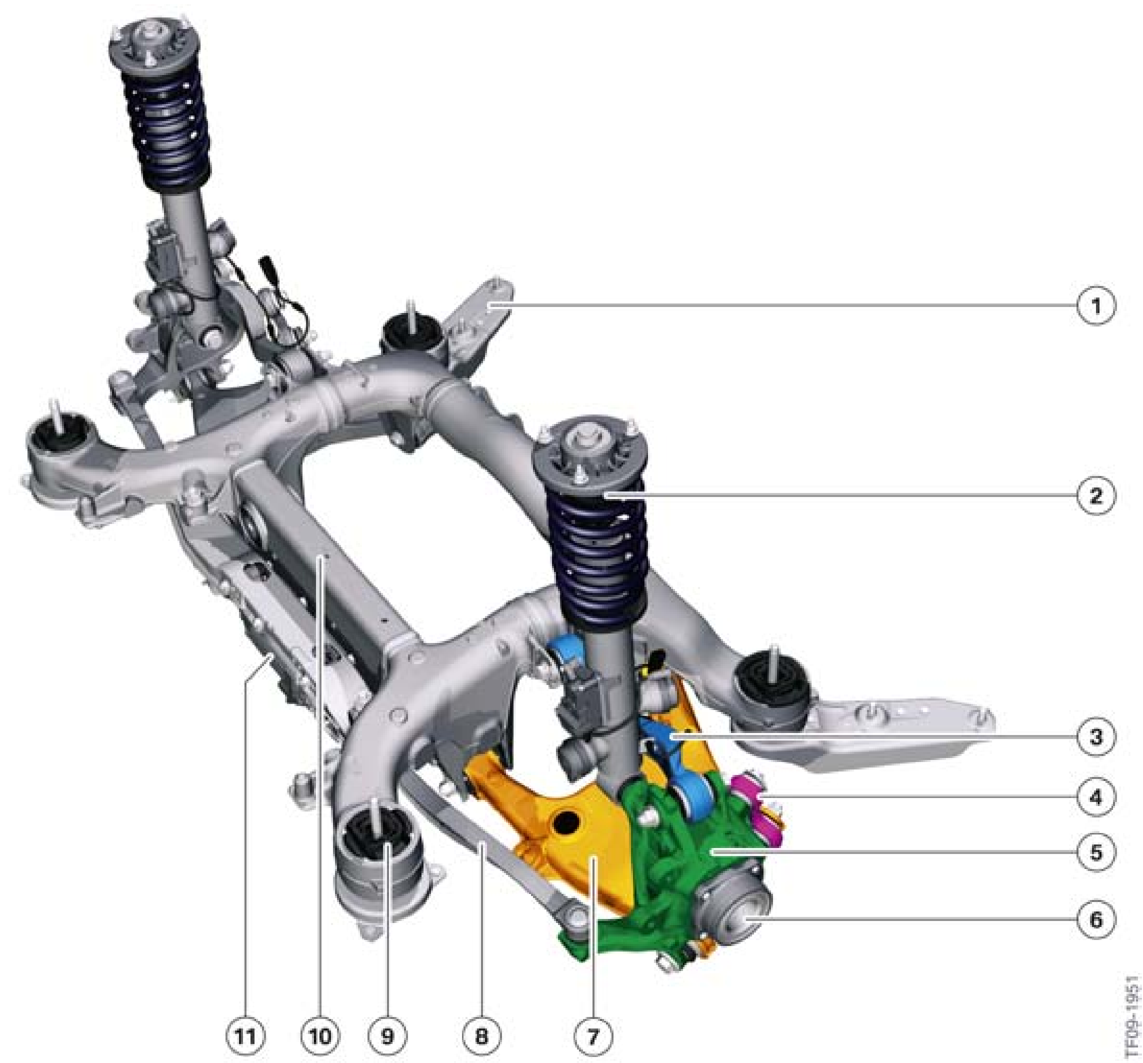
Screw connection unfastened	Wheel alignment required
Front axle support to body (lowering)	NO
Steering box to front axle support	YES
Lower wishbone to front axle support	YES
Lower wishbone to swivel bearing	NO
Trailing link to front axle support	NO
Trailing link to swivel bearing	NO
Upper wishbone on body	NO
Upper wishbone to swivel bearing	NO
Track rod to steering box	NO
Track rod end to track rod	YES
Track rod end to swivel bearing	NO
Spring strut to Lower wishbone	NO
Support bearing to body	NO
Bottom steering shaft to steering box	NO
Steering column to bottom steering shaft	NO

3.2. Rear axle

The integral V rear axle installed in the F12 is an innovative further development of the integral IV rear axle in the E60/65. The optimized lightweight rear axle made of solid aluminium has been specifically adapted to the new demands for more power and torque.

The integral V rear axle of the F12 is designed for the Integral Active Steering option code (SA 2VH) chassis and suspension control system .

3. Chassis and suspension



F12 Integral V rear axle

Index	Explanation
1	Compression strut
2	Spring strut
3	Upper wishbone
4	Integral link
5	Wheel carrier
6	Wheel bearing
7	Trapezoidal-link suspension (swinging arm)

Index	Explanation
8	Camber link
9	Rubber mount for rear axle
10	Rear axle support
11	HSR actuator

3.2.1. Technical data

	650i
Rear tire	245/40 R19
Rear wheel rim	19 x 8.5
Total toe-in	14' ± 12'
Camber	-1°50' ± 25'
Track width	1629 mm
Rim offset IS	44 mm

3.2.2. Service Information

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

Component replaced	Wheel alignment required
Rear axle support	YES
Rubber mount for rear axle	NO
Swinging arm	YES
Integral link	YES
Ball joint in swinging arm	YES
Camber link	YES
Wishbone	YES
Wheel carrier	YES
Wheel bearing	NO
Spring strut	NO
Support bearing	NO

Screw connection unfastened	Wheel alignment required
Rear axle support to body	NO
Front compression strut to body	NO
Rear compression strut to body	NO
Front swinging arm to rear axle support	YES

F12 Chassis Dynamics

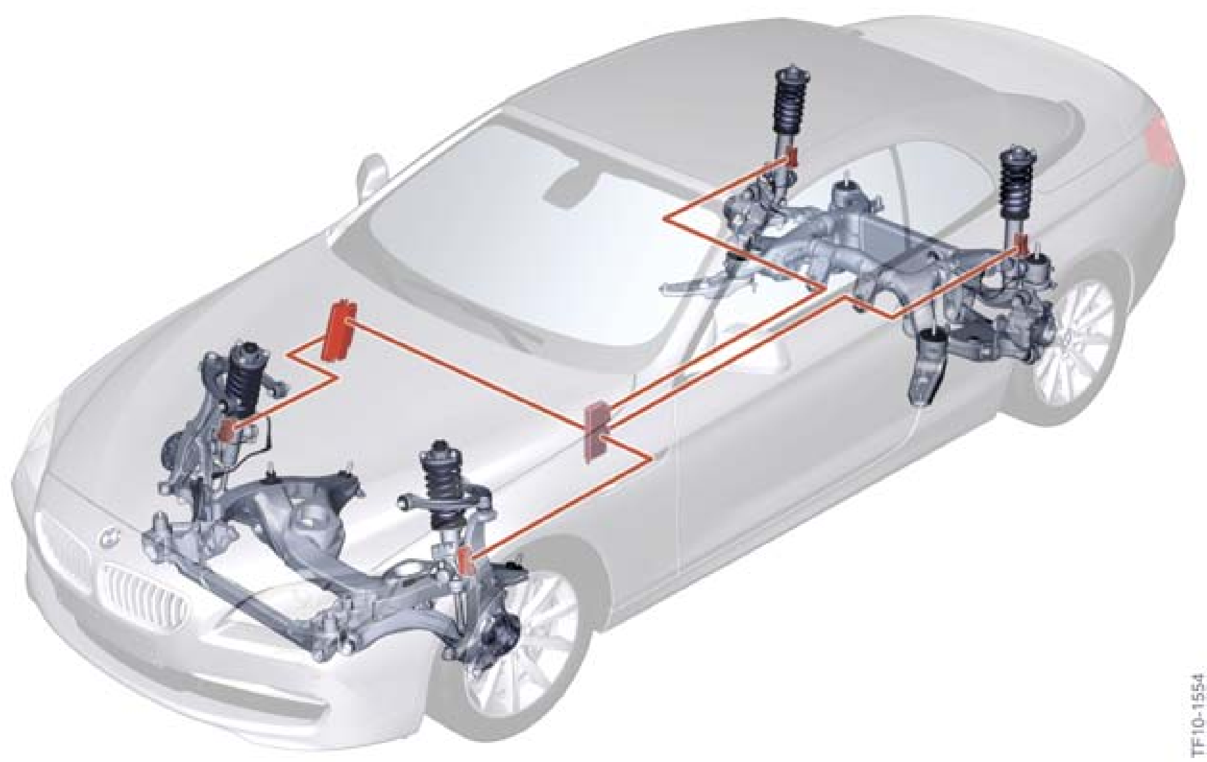
3. Chassis and suspension

Screw connection unfastened	Wheel alignment required
Rear swinging arm to rear axle support	YES
Swinging arm to integral link/wheel carrier	YES
Integral link to wheel carrier	NO
Camber link to rear axle support	YES
Camber link to wheel carrier	NO
Wishbone to rear axle support	YES
Wishbone to wheel carrier	YES
Spring strut to wheel carrier/swinging arm	NO

3.3. Suspension/dampers

Both axles of the F12 are equipped as standard with steel springs and EDC shock absorbers.

3.3.1. Electronic Damper Control (EDC)



F12 Components of EDC

Dynamic Damper Control is standard and is a sub-function of the Vertical Dynamics Management VDM. With EDC, the actuator unit and the specified satellite sensors at the shock absorber are connected to the VDM control unit via FlexRay. The damper characteristics stored in the VDM control unit can be selected via the drive dynamic control switch in the center console.

F12 Chassis Dynamics
3. Chassis and suspension

The primary objective of the EDC system is to increase ride comfort and maintain a high standard of driving safety without compromise. Greater ride comfort is achieved if the vertical movement of the vehicle body is virtually eliminated despite excitation of the vehicle due to the roadway (unevenness, joints) or cornering. This is why the adjustable dampers are operated using a soft, comfortable damping characteristic in as many situations as possible.

A high standard of driving safety is guaranteed if the wheels never lose contact with the roadway and deliver a high bearing force when necessary. This is why a harder damping action is set if the driving situation or driver intervention (e.g. steering, braking) is required.

In addition, the EDC control takes steering operations (e.g. transition from straight-ahead driving to cornering) into account based on the steering angle characteristic. If the EDC detects a rapid increase in the steering angle, the controller deduces that cornering is starting and can now set a harder damper setting at the outer cornering wheels as a preventative measure. The EDC therefore supports the ARS control and thus assists in reducing the rolling movement of the vehicle.

EDC can also detect when the driver is braking based on the information supplied by the DSC on brake pressure. A high brake pressure normally causes a pitching movement of the vehicle. EDC counteracts this by setting the front damper for higher damping forces. This also improves the braking force distribution at the front/rear which produces a small braking distance advantage (when compared to a vehicle without EDC).

The basic damping force level is adapted by the EDC controller depending on which damping program is selected by the driver (comfort/sport). Irrespective of this, e.g. even if the Comfort program is selected, high damping forces act on individual wheels in critical driving situations. A reference damping force is output via FlexRay for every wheel or damper according to the prioritization of the individual controller components. In addition, a default current value for the quiescent operating point is specified for the dampers.

3.4. Wheels & Tires

Run-flat tires are fitted in the F12 as standard.

	650i
Front tire	245/40 R19 all season run flat (standard) 245/35 R20 performance tire (option)
Rear tire	245/40 R19 all season run flat (standard) 275/30 R20 performance tire (option)
Front wheel rim	19 x 8.5 (standard) 20 x 8.5 (option)
Rear wheel rim	19 x 8.5 (standard) 20 x 9.0 (option)

3.5. Tire Pressure Monitor System

3.5.1. System function

The Tire Pressure Monitor System is installed in the F12.

The direct measuring TPM system (RDC) consists of the TPMS control unit with integrated reception aerial and four wheel electronics. It was possible to reduce the number of components and cost of the TPM system by integrating the reception antenna in the TPMS control unit.

The four wheel electronics transmit the tire pressure and temperature to the TPMS control unit via radio communication (433 MHz). Once the wheel electronics have been woken up, (vehicle speed > 20 km/h), a total of 25 telegrams are transmitted once at two second intervals. Providing the pressure does not drop, individual telegrams are then sent every 18 seconds from the wheel electronics to the TPMS control unit. As a prerequisite for the wheel electronics to go to sleep, the wheel must be at a standstill for more than five minutes.

Resetting the tire pressure values

The tire pressure values are reset via the instrument panel (KOMBI) or Central Information Display (CID). The TPMS text message appears, or the permanent TPMS indicator light lights up, in the instrument panel (KOMBI) when the teach-in process starts.

Teach-in process

During the teach-in process, the wheel electronics identification numbers (IDs) are transmitted to the TPMS control unit. The TPMS control unit can identify the wheel position of the corresponding wheel electronics via the identification numbers once the teach-in process is complete.

Two acceleration sensors are installed in each of the wheel electronics in order to be able to determine their positions. The acceleration sensors determine the wheel's direction of rotation. This means that it is possible to differentiate between the positions of the right/left wheel electronics at the vehicle.

The high frequency signals received are evaluated in order to determine whether the wheel electronics are at the front or rear axle. The TPMS control unit with integrated receiver is installed in the luggage compartment. The level of the signals received by the TPMS control unit from the wheels on the rear axle is higher than the level of signals sent by the wheel electronics on the front axle. This means it is possible to determine whether the wheel electronics are at the front or rear of the vehicle.

The entire teach-in process takes between roughly one and twelve minutes at the most. The following factors influence the time it takes to complete the process:

- The condition of the road (smooth or rough surface)
- The current mode of the wheel electronics (awake/gone to sleep)
- The RDC control unit already knows what the IDs of the wheel electronics are.

F12 TPMS– teach-in process complete

Once the teach-in process is complete, the RDC text message or solid TPMS indicator light is cancelled. Four green tire symbols subsequently appear in the CID.

Pressure drop

F12 TPMS– pressure drop

Once the teach-in process is complete, the wheel electronics send the pressure, temperature and also the identification numbers of the tires to the TPMS control unit at regular intervals when driving.

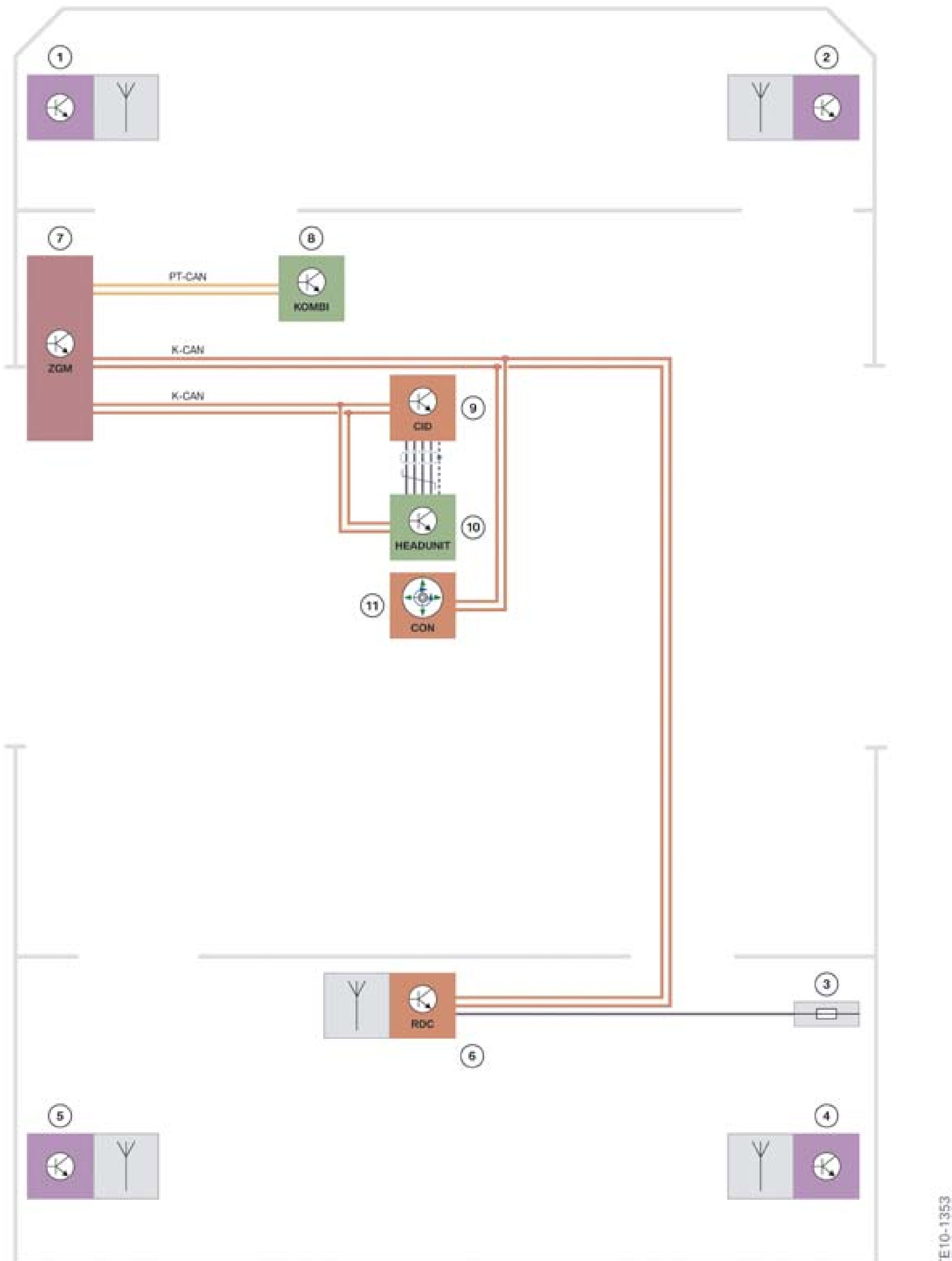
If a pressure change of > 20 kPa (0.2 bar, 2.9 psi) is identified within two successive pressure measurements, the wheel electronics for the relevant wheel immediately assumes a fast transmitting mode. It then sends information to the TPMS control unit at one-second intervals. If the tire pressure drops by more than 25%, the RDC text message "Tire Low" appears.

3.5.2. System overview

F12 System overview of TPMS

Index	Explanation
1	Wheel electronics (battery-operated sensor with transmitter unit 433 MHz)
2	Instrument panel KOMBI
3	TPMS control unit with integrated reception antenna

3.5.3. System wiring diagram



F12 System wiring diagram RDC

Index	Explanation
1	Wheel electronics, front left
2	Wheel electronics, front right
3	Luggage compartment power distribution box
4	Wheel electronics, rear right
5	Wheel electronics, rear left
6	Tire Pressure Monitor (TPMS)
7	Central gateway module (ZGM)
8	Instrument panel (KOMBI)
9	Central information display (CID)
10	Headunit
11	Central operating element
Terminal 30B	Terminal 30, basic operation

3.5.4. Notes for Service

Teach-in process

The wheel electronics must be taught in under the following circumstances:

- The tire pressure has been changed
- A tire change has been carried out
- Wheels have been replaced

The driver can start the teach-in process via the Central Information Display (CID) and the controller. For more information, refer to the vehicle owner's manual.

Service life of batteries for wheel electronics

The service life of the batteries installed in the wheel electronics is roughly 7.5 years. The current value of the service life counter in the batteries of the wheel electronics can be read out via the diagnosis system.

If the battery is fully discharged or faulty, a fault message is displayed via the TPMS.

Removing/installing the wheel electronics

The following points must be observed when removing/installing the wheel electronics of the Tire Pressure Monitor System:

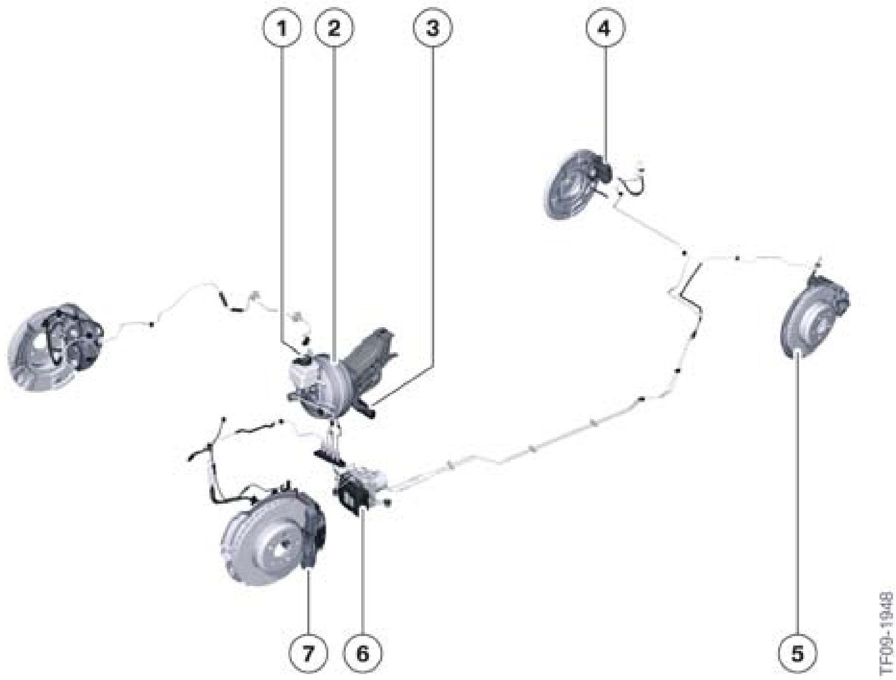
- Do not use high pressure cleaners to clean the wheel rim with integrated wheel electronics when the tire has been removed
- Replace the wheel electronics if tire sealant has been used
- Clean the valve and valve seat thoroughly before installing the wheel electronics
- To clean the wheel electronics, simply wipe down with a clean cloth.
- Do not apply solvents or cleaning agents to the wheel electronics, or clean them with compressed air

F12 Wheel electronics – TPMS

Index	Explanation
1	Data Matrix Code
2	BMW part number
3	FCC ID = approval for wireless operation
4	Wheel electronics ID
5	Transmission frequency (433 MHz)
6	Pressure sensor
7	Production date of wheel electronics
8	Tightening torque
9	Width across flats of union nut

F12 Chassis Dynamics

4. Brakes



F12 Brakes

Index	Explanation
1	Brake fluid expansion tank
2	Brake servo
3	Brake pedal
4	Actuator for Electromechanical Parking Brake (EMF)
5	Brake disc
6	Dynamic Stability Control (DSC)
7	Brake caliper

4.1. Service brakes

The F12 has a dual-circuit hydraulic brake system with front/rear split. Lightweight construction brake discs with riveted aluminium disc centers sections are installed at the front and rear axle of the F12. Conventional bracket-type aluminium floating calipers are used on the front axle while cast iron floating caliper brakes with integrated EMF actuator (for the Electromechanical Parking Brake) are installed at the rear.

The familiar brake pad wear monitoring function for the Condition Based Service display continues to be used.

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

F12 Chassis Dynamics
4. Brakes

Brake dimensions

Front axle	650i
Brake disc diameter	374 mm
Brake disk thickness	36 mm
Brake piston diameter	60 mm
Design	Lightweight construction

Rear axle	650i
Brake disc diameter	345 mm
Brake disk thickness	24 mm
Brake piston diameter	44 mm
Design	Lightweight construction

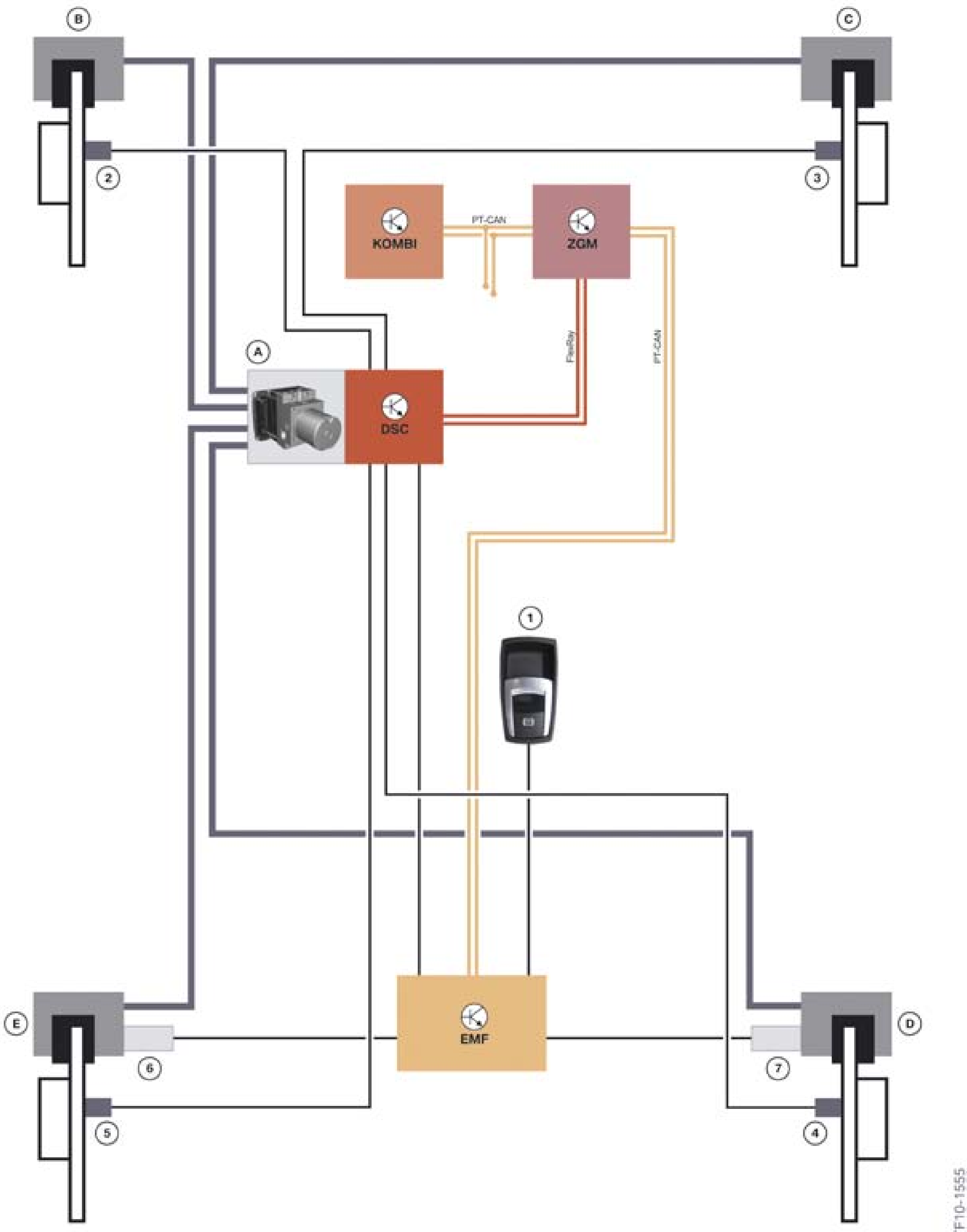
4.2. Electromechanical Parking Brake (EMF)

An EMF is integrated in the rear brake calipers of the F12.

The use of the electromechanical parking brake offers the following advantages:

- Operated via an ergonomic button in the center console
- Safe and reliable application and release of the parking brake under all preconditions
- Automatic protection of the hydraulic holding functions (automatic hold function)
- Dynamic emergency braking function ensured by way of the control systems (ABS) even on surfaces with a coefficient of friction
- The discontinuation of the parking brake lever in the center console creates space for new equipment features.

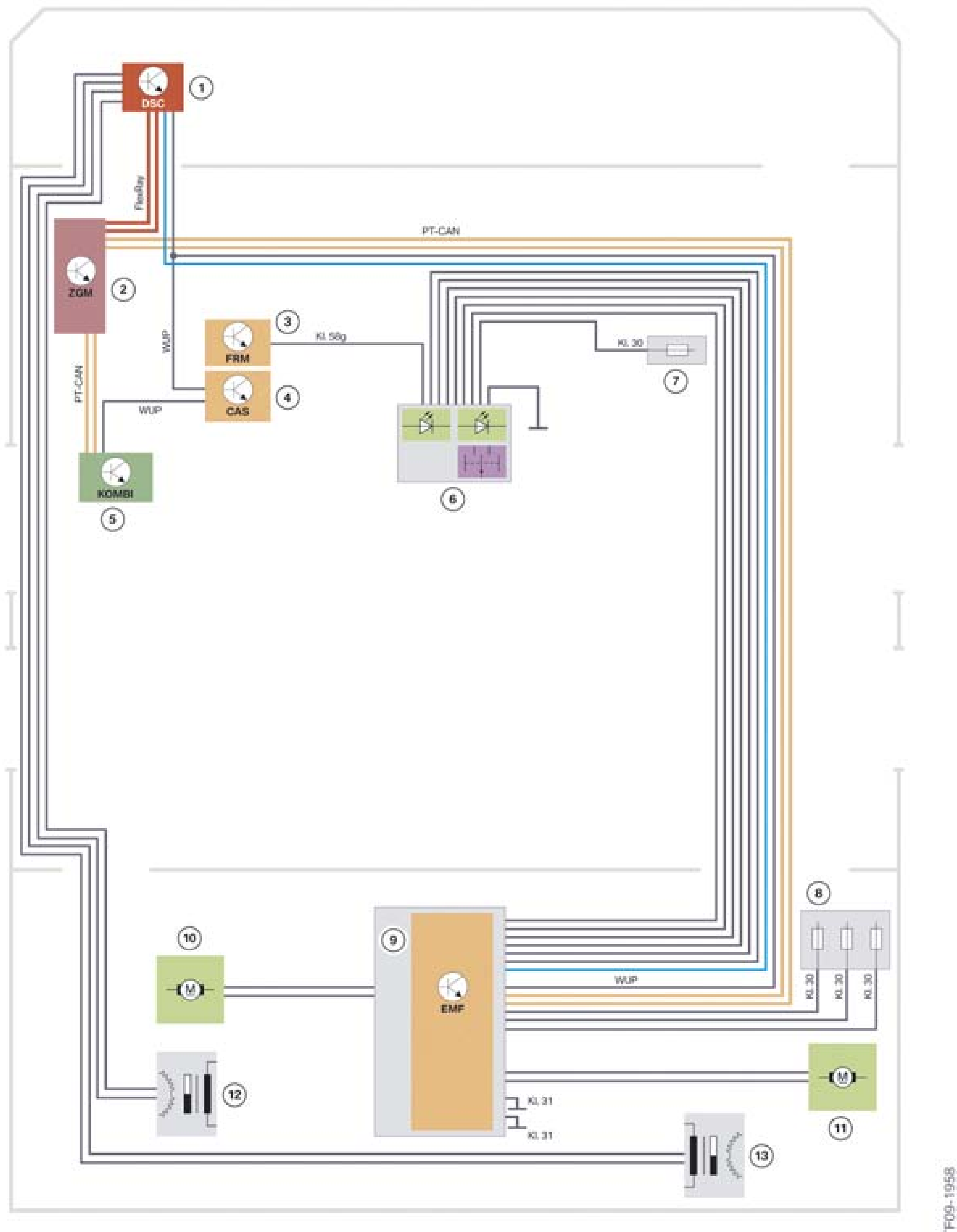
4.2.1. System overview



F12 System overview – Electromechanical Parking Brake (EMF)

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 EMF)
3	Wheel speed sensor, front right (not used for 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 panel
PT-CAN	Powertrain controller area network

4.2.2. System wiring diagram



F12 System wiring diagram – Electromechanical Parking Brake (EMF)

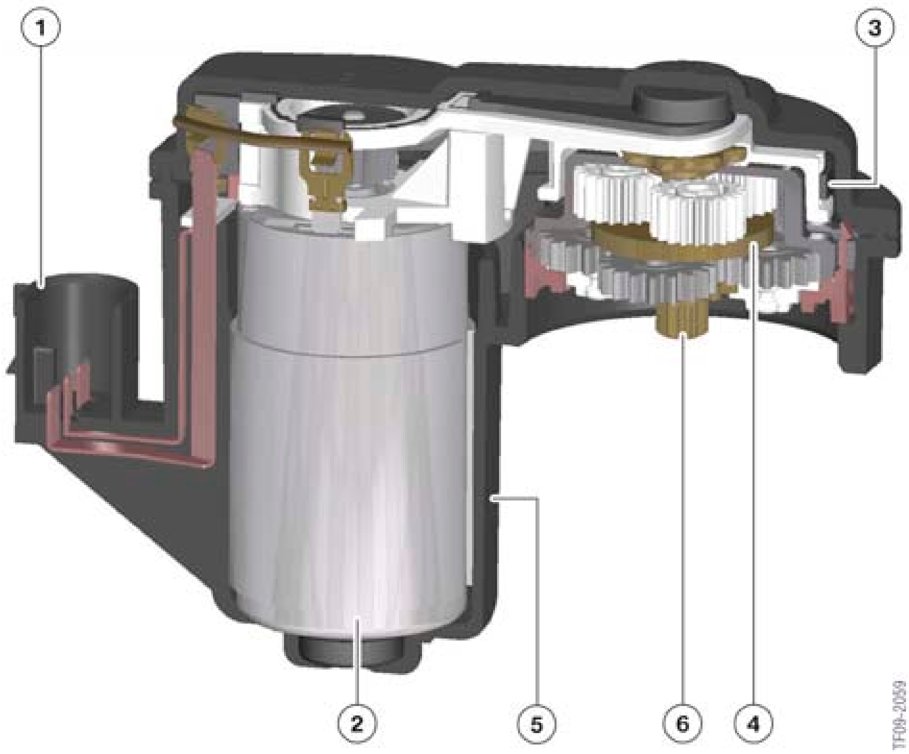
Index	Explanation
1	Dynamic Stability Control (DSC)
2	Central gateway module (ZGM)
3	Footwell module (FRM)
4	Car Access System (CAS)
5	Instrument panel (KOMBI)
6	Parking brake button
7	Junction box for the power distribution box
8	Luggage compartment power distribution box
9	EMF control unit
10	EMF actuator, rear left
11	EMF actuator, rear right
12	Wheel speed sensor, rear left
13	Wheel speed sensor, rear right

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.

4.2.4. System function

Due to the spindle's self-locking facility, the clamping force remains securely applied even when no power supply is connected, and the vehicle is thus securely held. Once the required force is reached, the parking brake applied status is indicated by a red indicator lamp in the instrument panel (KOMBI) and an additional red LED in the parking brake button.

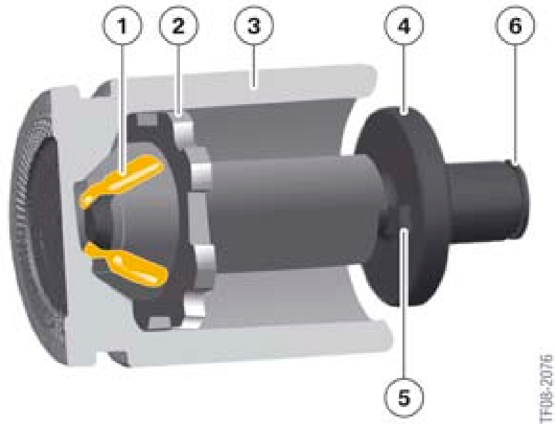


F12 Design of EMF actuator

Index	Explanation
1	Plug connection
2	Electric motor
3	Drive belt
4	Planetary gears
5	Housing
6	Connection to spindle

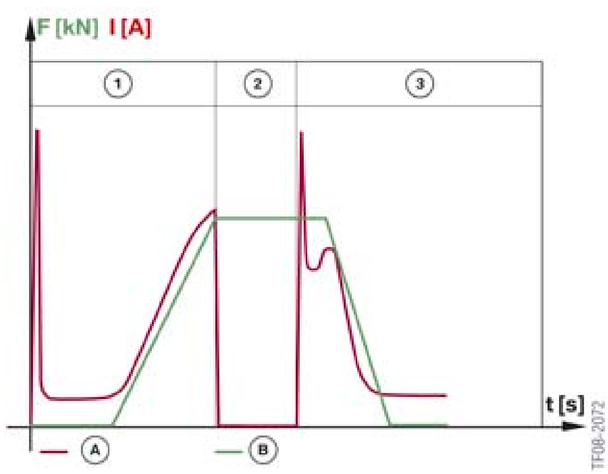
The EMF actuator is fixed to the brake caliper and acts directly on the brake piston.

The force is transmitted to a two-stage planetary gear system (4) by an electric motor (2) and a belt drive system (3). The spindle illustrated in the graphic below is driven via the connection to the spindle (6).



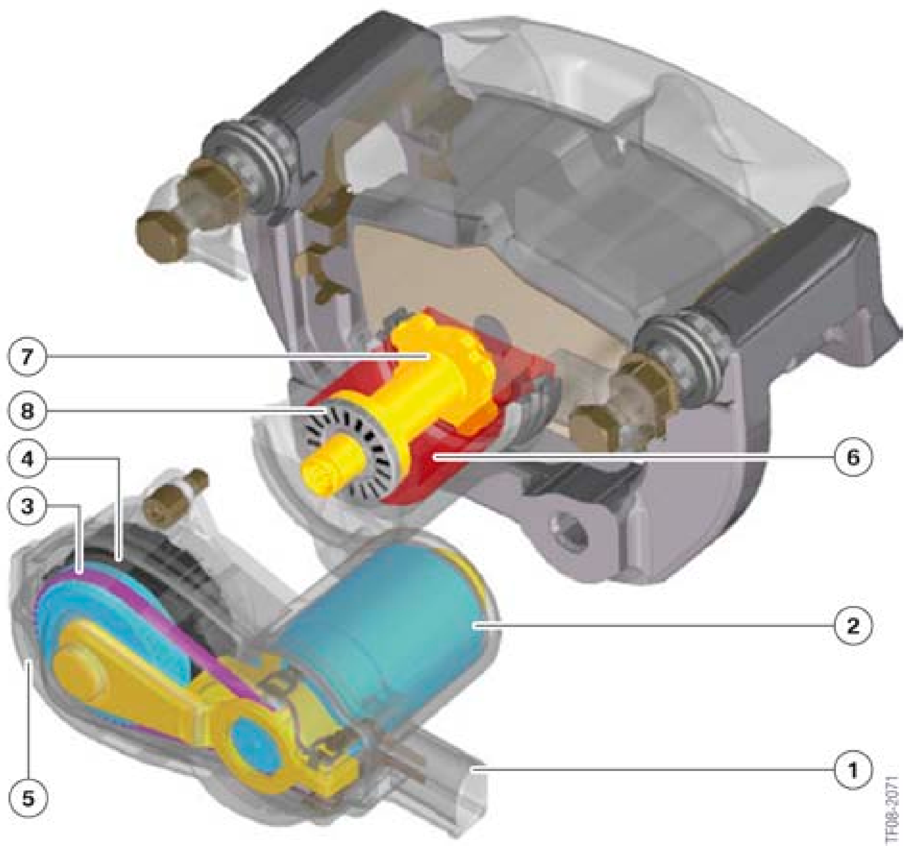
F12 Spindle and spindle nut in brake piston

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



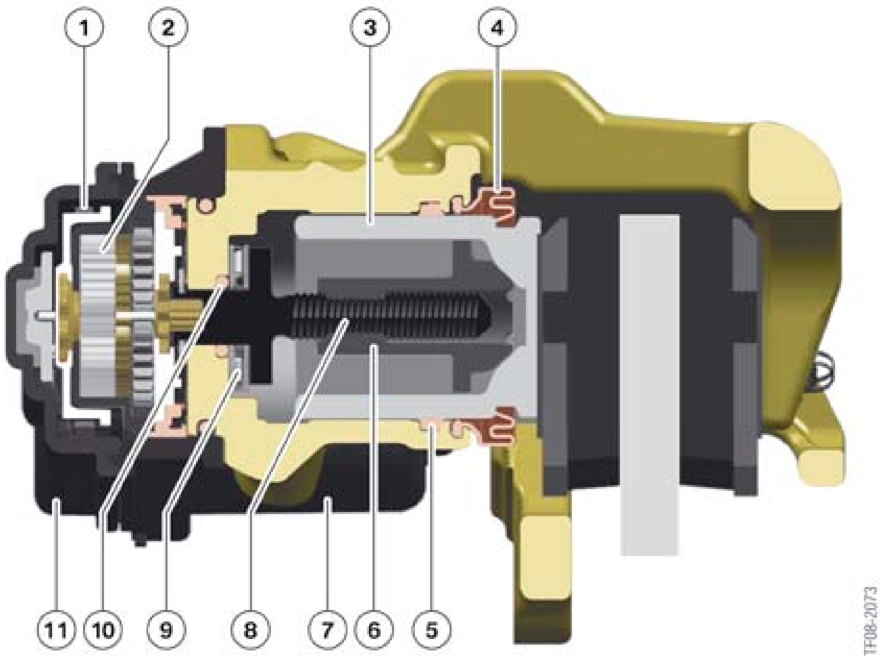
F12 Current and force progression of Electromechanical Parking Brake EMF

Index	Explanation
A	Current flow
B	Force flow
1	Applying parking brake
2	Parking brake applied
3	Releasing parking brake



F12 Overview of EMF actuator with brake caliper

Index	Explanation
1	Plug connection
2	Electric motor
3	Drive belt
4	Planetary gears
5	Housing
6	Brake piston
7	Spindle and spindle nut
8	Roller bearing



F12 Electromechanical parking brake EMF applied with new brake pads

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

The driver applies the vehicle's parking brake by pulling out the parking brake button. The operating direction is the same as for a mechanical parking brake lever. The signal from the parking brake button is imported by the EMF control unit. The EMF actuators on the rear brake calipers are individually controlled by the EMF control unit.

The parking brake can be applied in any logical terminal status. The connection from terminal 30 to the EMF control unit makes it possible to apply the parking brake at terminal 0. The EMF control unit wakes up if the driver operates the parking brake button at terminal 0. The EMF control unit then wakes up the other control units in the vehicle. Only then does the EMF control unit receive the essential information about vehicle standstill. In addition, the change of parking brake status can also be indicated once the system has woken up.

The "applied" status is indicated by a red indicator light in the instrument panel (KOMBI) 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.

F12 Indicator lamp for parking brake applied

Roll-away detection while parking brake applied

The roll-away detection function is designed to prevent the vehicle rolling away while the parking brake is applied. The roll-away detection function is always activated whenever the parking brake status changes from "released" to "applied" and terminates after a defined period of time from that change of status.

A signal from the DSC is used as the input variable for roll-away detection. As soon as that signal indicates that the vehicle is starting to roll during the detection window, the EMF actuators are immediately further tightened. That is achieved by applying maximum current to the EMF actuators for 100 ms in order to increase the clamping force. The system then waits for 400 ms. If the vehicle starts to roll again, the retightening process is repeated (up to three times). If rolling of the vehicle is still detected after retightening the parking brake three times, the function terminates and a fault is entered in the fault memory.

Temperature monitoring

The temperature monitoring function ensures that the loss of parking-brake force that occurs when hot brake discs cool down is compensated for. The temperature monitoring function is activated if the temperature is above a defined value on a change of parking brake status from "released" to "applied".

The temperature of the brake discs is calculated individually for each wheel by the DSC control unit and communicated to the EMF control unit. When the status changes, the higher of the two brake disc temperatures is used for temperature monitoring purposes. The temperature ranges and corresponding retightening periods are stored in a characteristic map.

The appropriate retightening periods from the characteristic map are applied according to the temperature on change of status. Once the first retightening period has elapsed, the parking brake is retightened for the first time. After expiry of the second retightening period, the parking brake is retightened again, and again after the third period has elapsed. The characteristic map may also contain the value 0 for one or more retightening periods. In that case, the corresponding retightening sequences do not take place. The function terminates when the last retightening sequence has been completed.

Releasing the parking brake

The parking brake is released by pressing the parking brake button down. However, for the parking brake to actually be released, Terminal 15 must be ON and at least one of the following preconditions satisfied:

- Brake pedal applied, or
- Automatic transmission parking lock engaged, or
- Clutch pedal depressed (vehicles with manual gearbox only).

That prevents the vehicle starting to roll when not intended, e.g. if another occupant apart from the driver presses the parking brake button. Once the parking brake is released, the red indicator lamp on the instrument panel (KOMBI) and the red LED in the parking brake button go out.

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

Dynamic emergency braking

The law requires that there are two operating facilities for the brakes. The second operating facility in the F12 after the brake pedal is the parking brake button in the center console. If the parking brake button is pulled up while the vehicle is moving, the DSC system performs a dynamic emergency braking operation in a defined sequence. This function is intended for emergency situations in which the driver is not able to brake the vehicle using the brake pedal. Other occupants can also bring the vehicle to a standstill in this way if, for example, the driver suddenly falls unconscious.

During dynamic emergency braking, brake pressure is generated hydraulically at all four wheel brakes. The DSC functions are fully active and the brake lights are operated. That represents a fundamental advantage over manual parking brakes.

Dynamic emergency braking only occurs while the parking brake button is being pulled. The level of deceleration applied by the DSC is steeply increased. During dynamic emergency braking the EMF indicator light on the instrument panel (KOMBI) is activated. In addition, a Check Control message is displayed along with an acoustic signal in order to draw the driver's attention to this special situation.

If the driver decelerates by pressing the brake pedal and pulling the parking brake button at the same time, the DSC control unit priorities and implements the higher braking demand. If dynamic emergency braking continues until the vehicle is at a standstill, the vehicle remains braked even after the parking brake button is released. The EMF indicator light in the instrument panel (KOMBI) remains on. The driver can then release the parking brake (see "Releasing the parking brake").

Parking brake fault

If the parking brake develops a fault, the EMF indicator lamp in the instrument panel (KOMBI) shows yellow. A Check Control message is displayed.

F12 Indicator light showing parking brake fault

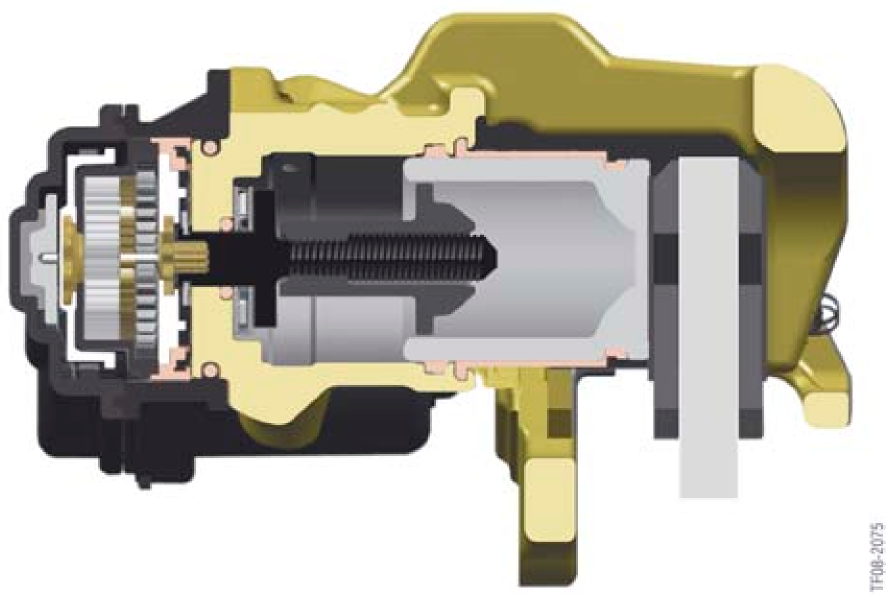
Emergency release

No provision is made for the customer to release the parking brake in emergencies.

The parking brake can be released by unscrewing the EMF actuators and manually screwing back the spindle.

Replacing brake pads

To replace the brake pads the EMF actuator must be in the fully released position so that the brake piston can be pressed back. The EMF actuators can be operated by means of the BMW diagnosis system and moved to the fully released position. That position is required in order to be able to replace the brake pads. Once the installation position is reached, installation mode is automatically activated.



F12 Electromechanical Parking Brake EMF, showing spindle nut in working position for brake pad replacement

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The parking brake cannot be applied while the EMF control unit is in installation mode for safety reasons. If the parking brake button is operated with the EMF control unit in this mode, the EMF indicator lamp on the instrument panel (KOMBI) flashes yellow.

Installation mode can be cancelled in two ways:

- By executing the service function "Reset installation mode" with the aid of ISTA
- By driving the vehicle and exceeding a programmed minimum speed.

The precise procedure for bedding-in the service brakes is described in the repair instructions. The instructions here must be precisely followed.

Brake test stand detection

The EMF control unit determines via a plausibility check (comparison of wheel speeds) that the vehicle is on a brake test stand and switches to brake test stand mode. This process takes roughly six seconds.

Pull the parking brake button several times in a row to approach the following target positions:

- Brake pads in contact
- Force level 1 for brake test stand
- Force level 2 for brake test stand
- Target force.

Alternatively, the parking brake button can be continuously held in the pulled-out position while brake test stand mode is active. The target positions are then approached one-by-one at three second intervals.

When brake test stand mode is active and the EMF actuators are released, the parking brake indicator light flashes slowly.

When brake test stand mode is active and the EMF actuators are partially applied, the parking brake indicator light starts to flash more quickly.

When brake test stand mode is active and the EMF actuators are fully applied, the parking brake indicator light remains permanently lit.

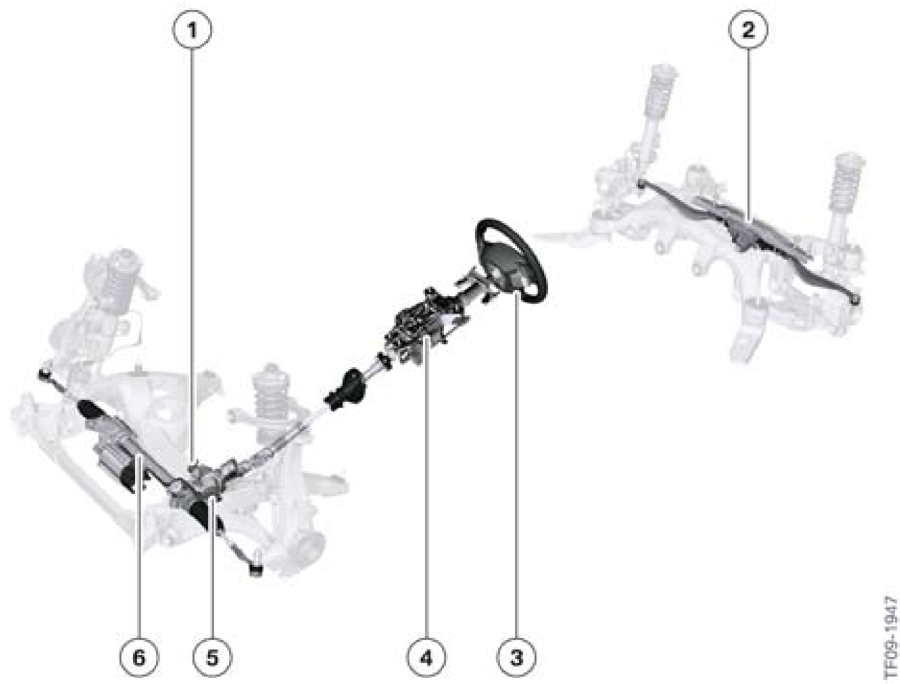
When the vehicle is on a brake test stand, the parking brake can be released without having to press the brake or clutch pedal. Brake test stand mode is automatically cancelled when the vehicle is driven off the brake test stand. It is also deactivated if the parking brake button is pressed in or if a fault is present.

F12 Chassis Dynamics

5. Steering

Electric Power Steering (EPS) is fitted to the F12 as standard. The steering is now entirely electrically operated and replaces the conventional hydraulic steering. The Electromechanical power steering with parallel-axis arrangement (EPS-APA) familiar from the F10 is used.

Active steering and rear axle slip angle control are available in the Integral Active Steering optional equipment package (2VH).



F12 Steering components with Integral Active Steering

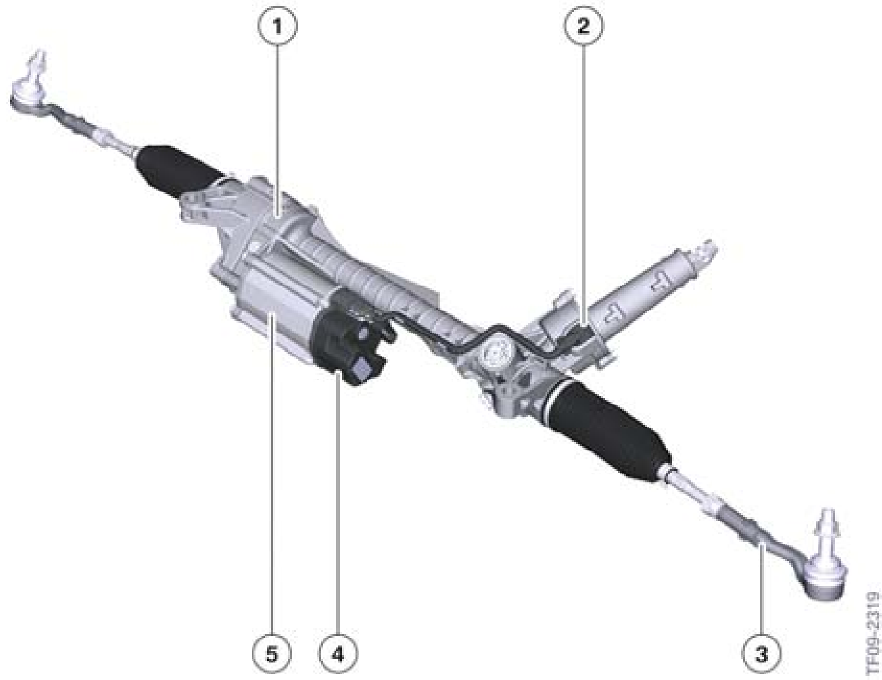
Index	Explanation
1	Active Steering lock
2	HSR actuator
3	Steering wheel
4	Steering column
5	Active steering servomotor with motor angular position sensor
6	Electric Power Steering (EPS)

F12 Chassis Dynamics

5. Steering

5.1. Basic steering

5.1.1. System overview



F12 Electric Power Steering

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

EPS steering reduces fuel consumption by roughly 0.3l per 100 km when compared to conventional hydraulic power steering. This helps reduce carbon dioxide emissions.

As there is no oil in an EPS, it is environmentally cleaner than conventional hydraulic power steering.

For reasons inherent in the system, EPS is always equipped with the Servotronic function. Two different settings (“Normal” and “Sporty”) can be accessed via the driving dynamic control switch.

The EPS is less sensitive to external disturbance variables such as shudder and steering wheel vibration. It also features active roll damping which enhances the driving safety of the F12.

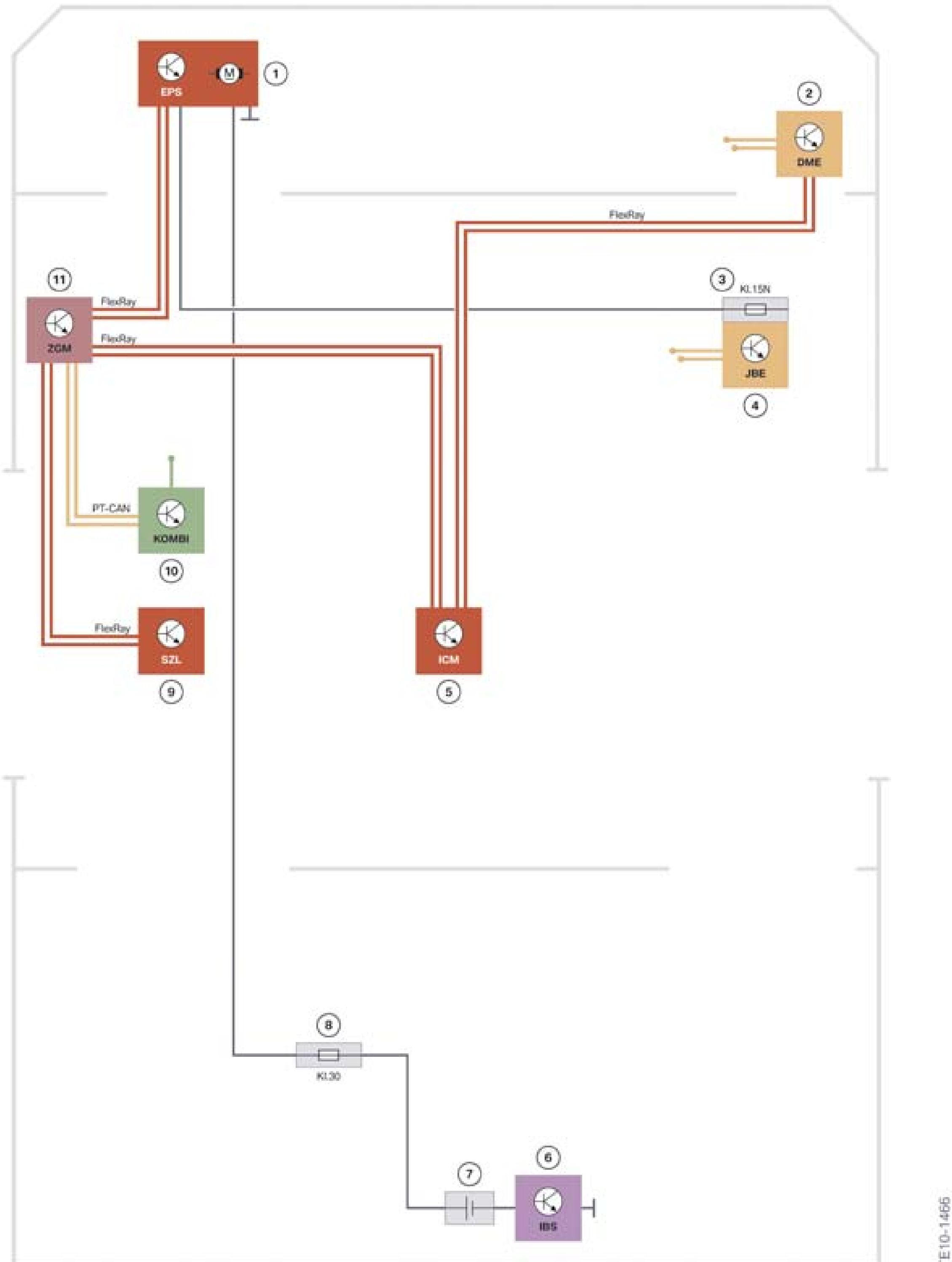
The return characteristics of the EPS are fully configurable. That means that optimum drivability can be guaranteed. In addition, the EPS allows implementation of the parking assistance feature.

5. Steering

The operating principle and design of the EPS are identical with those of the F10 and are described in detail in the F10 Chassis Dynamics training material.

For more information regarding the parking assistant feature refer to the "F12 Driver Assistance Systems" section of this training material.

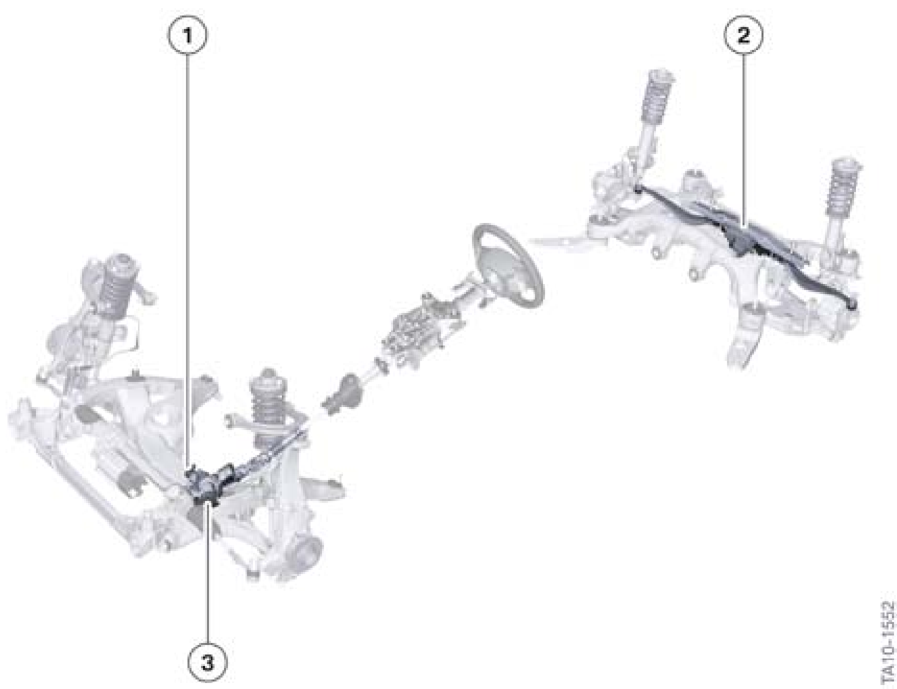
5.1.2. System wiring diagram



F12 System wiring diagram for basic steering

Index	Explanation
1	Electromechanical power steering (EPS)
2	Digital Motor Electronics (DME)
3	Junction box for the power distribution box
4	Junction box electronics (JBE)
5	Integrated Chassis Management (ICM)
6	Intelligent battery sensor (IBS)
7	Battery
8	Battery power distribution box
9	Steering column switch cluster (SZL)
10	Instrument panel (KOMBI)
11	Central gateway module (ZGM)
Terminal 15N	Ignition (after-run)
Terminal 30	Terminal 30

5.2. Integral Active Steering



F12 Integral Active Steering

Index	Explanation
1	Active Steering lock
2	HSR actuator
3	Active steering servomotor with motor angular position sensor

5.2.1. Functional ranges

The Integral Active Steering further improves driving dynamics through additional control interventions at the front and rear axle. The vehicle speed, lateral acceleration and yaw rate calculated from measured variables are compared with a set-point value. The difference between the set-point and actual value is converted into a reference yaw moment. The resulting control interventions are distributed in an optimum ratio between the active steering AL or rear axle slip angle control (HSR).

The EPS is supplemented by a planetary gearbox with override function in the steering gear input and an active steering servomotor. The active steering servomotor can modify the steering angle specified by the driver with reference to default values from the active steering control unit.

To do this, the active steering control unit evaluates the sensor signals, which include:

- Steering angle
- Wheel speed
- Yaw rate
- Lateral acceleration.

In the event that the system fails, the active steering servomotor is braked and disabled by a lock. The full range of vehicle maneuverability is retained as a permanent mechanical connection between the steering wheel and the front wheels exists.

Low speed range

The variable steering ratio of the active steering component reduces the steering effort required to move the front wheels from lock to lock to roughly two steering wheel turns.

At low speed ranges of up to roughly 60 km/h, the variable steering ratio of the front axle is coupled with an opposing steering angle at the rear axle. This increases the maneuverability of the vehicle.

High speed range

As the driving speed increases, the degree of steering angle amplification by the Active Steering component is reduced and the steering-gear ratio becomes less direct.

At the same time, the steering strategy adopted by the Integrated Active Steering changes. While at low speeds the rear wheels are steered in an opposing direction to the front axle, at higher speeds the steering angle is in the same direction.

As a result the instantaneous center of rotation shifts backwards. This corresponds to a vehicle with a longer wheelbase which enhances its directional stability. The radius of the curve becomes longer.

Active steering adds a further angle to the wheels at the front axle which means that the curve radius and required steering angle remain at the accustomed level.

F12 Chassis Dynamics
5. Steering

Overall, lane changes and steering maneuvers can be mastered with a greater degree of stability by coordinating steering interventions at the front and rear axle - without compromising agility and control.

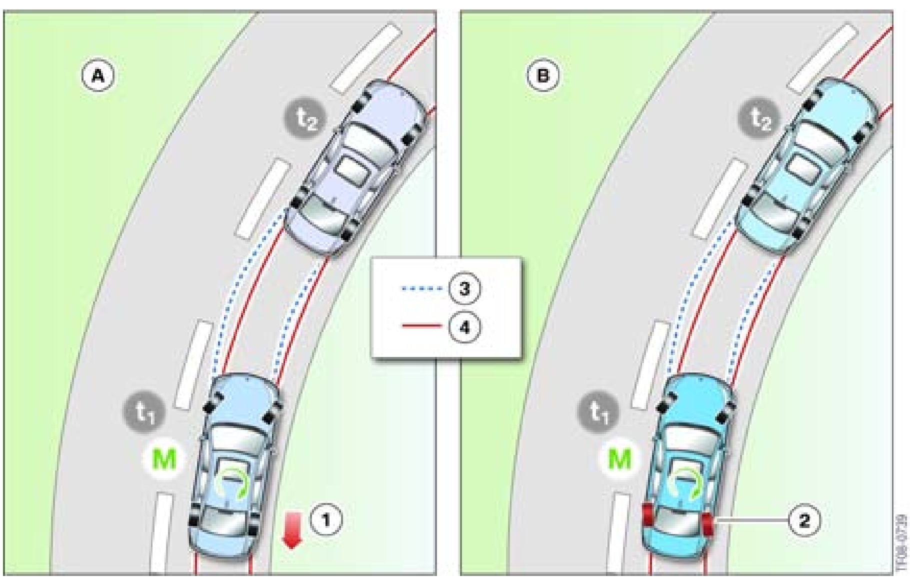
The combination of the active steering with the rear wheel steering gives the driver advantages in all speed ranges.

Stabilization when understeering

When changing lanes quickly, all vehicles have a tendency to produce a significant yaw response and can sometimes start to oversteer.

If the ICM dynamic handling controller detects a difference between the response desired by the driver and the reaction of the vehicle, it initiates coordinated steering interventions on the front and rear wheels. The speed of the stabilizing intervention is such that it is hardly perceptible by the driver.

Decelerating DSC brake interventions can largely be dispensed with which improves the stability and damping of the vehicle.



F12 Possible driving dynamics interventions during understeering

Index	Explanation
A	Prevention of understeer by individual brake modulation (DSC)
B	Prevention of understeer by rear axle steering intervention (IAL)
1	Individual brake modulation (DSC)
2	Rear-wheel steering intervention (IAL)
3	Course of an understeering vehicle
4	Course of a vehicle with neutral drivability
M	Yaw moment acting on the vehicle due to an intervention by the driving dynamics control

If the driver misjudges a bend when driving fast on a country road, the vehicle may understeer.

F12 Chassis Dynamics

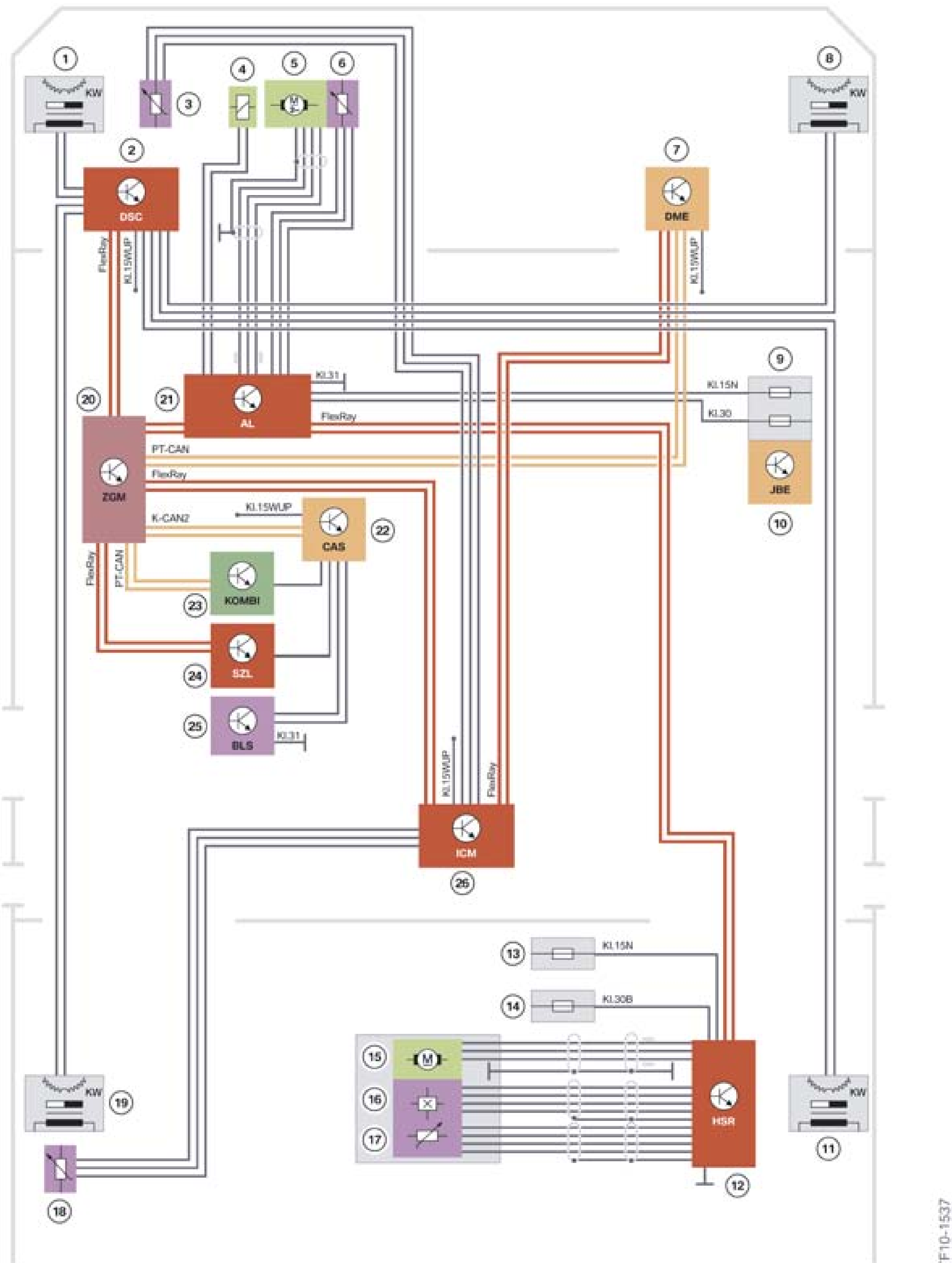
5. Steering

Owing to the principle of active steering, up till now it was only possible to respond to oversteering vehicle behavior with individual brake modulation of the outside rear wheel by the DSC.

With the introduction of active rear axle steering, corrective action is now possible in understeering situations through intervention of the Integral Active Steering which further increases active safety.

The components of Integral Active Steering "active steering AL" and "rear axle slip angle control HSR" cannot be ordered separately and are only available with the Integral Active Steering package (SA 2VH).

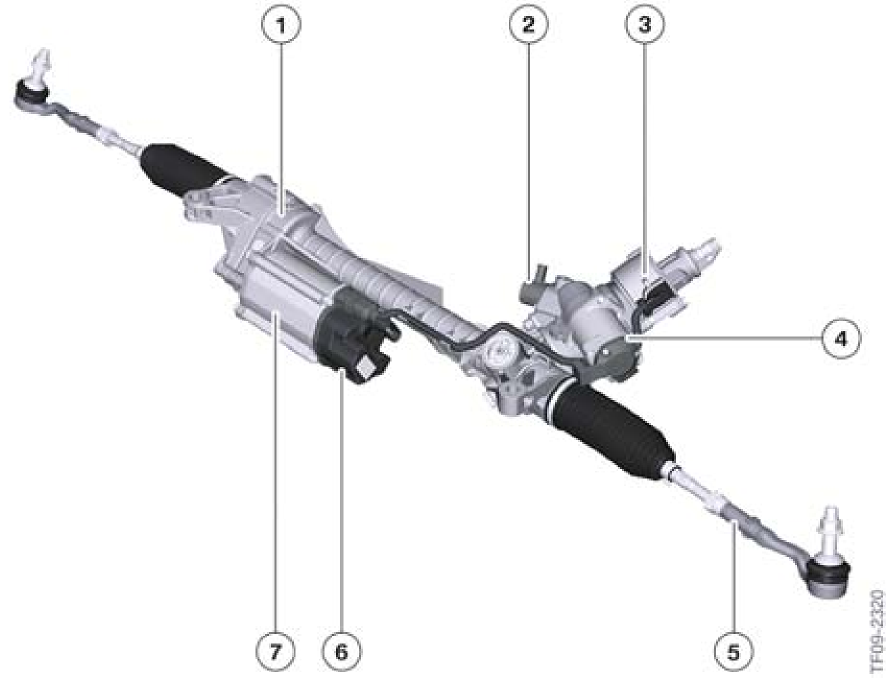
5.2.2. System wiring diagram



F12 System wiring diagram of Integral Active Steering

Index	Explanation
1	Speed sensor, front left
2	Dynamic Stability Control (DSC)
3	Ride height sensor, front left
4	Active steering lock
5	Active steering servomotor
6	Active steering motor angular position sensor
7	Digital Motor Electronics DME
8	Speed sensor, front right
9	Junction box for the power distribution box
10	Junction box electronics JBE
11	Speed sensor, rear right
12	Control unit, rear axle slip angle control HSR
13	Luggage compartment power distribution box
14	Battery power distribution box
15	HSR actuator
16	Hall effect sensor
17	Steering tie rod position sensor
18	Ride height sensor, rear left
19	Speed sensor, rear left
20	Central gateway module (ZGM)
21	Active steering control unit
22	Car Access System (CAS)
23	Instrument panel (KOMBI)
24	Steering column switch cluster (SZL)
25	Brake light switch (BLS)
26	Integrated Chassis Management (ICM)
Terminal 15N	Ignition (after-run)
Terminal 15WUP	Wake-up with terminal 15 ON
Terminal 30	Terminal 30
Terminal 30B	Terminal 30, basic operation
Terminal 31	Ground connection

5.2.3. EPS with 24 V

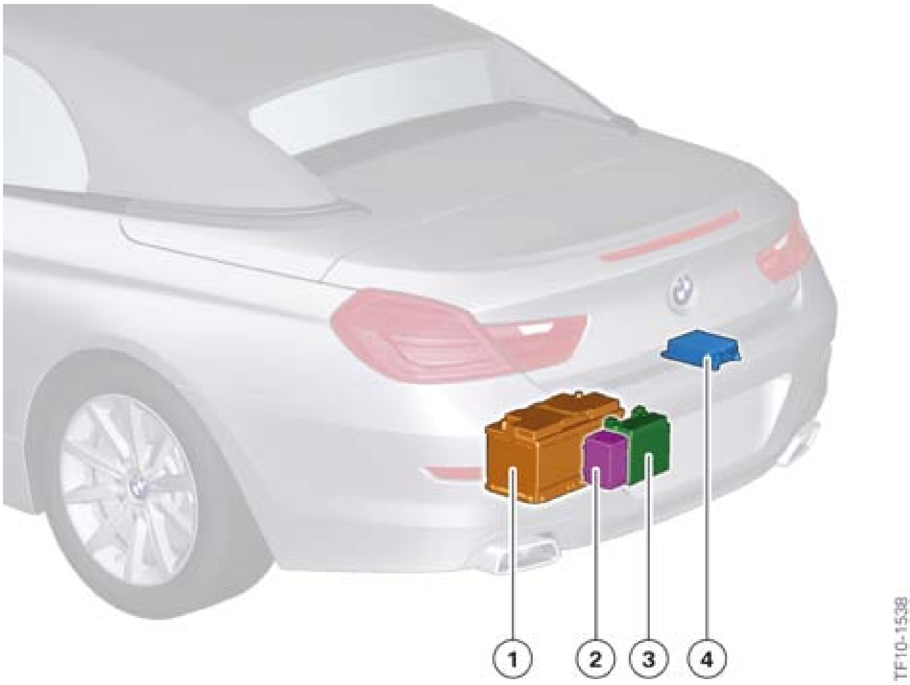


F12 Electric Power Steering (EPS) with active steering

Index	Explanation
1	Reduction gear
2	Active Steering lock
3	Steering-torque sensor
4	Active Steering servomotor with motor angular position sensor
5	Track rod
6	EPS control unit
7	Electric motor with motor position sensor

As with the F10 higher steering forces are required due to the active steering at the front axle, 12 V power steering would no longer be sufficient. An EPS with 24 V power supply is therefore used in the F12 in conjunction with the optional equipment Integral Active Steering (2VH).

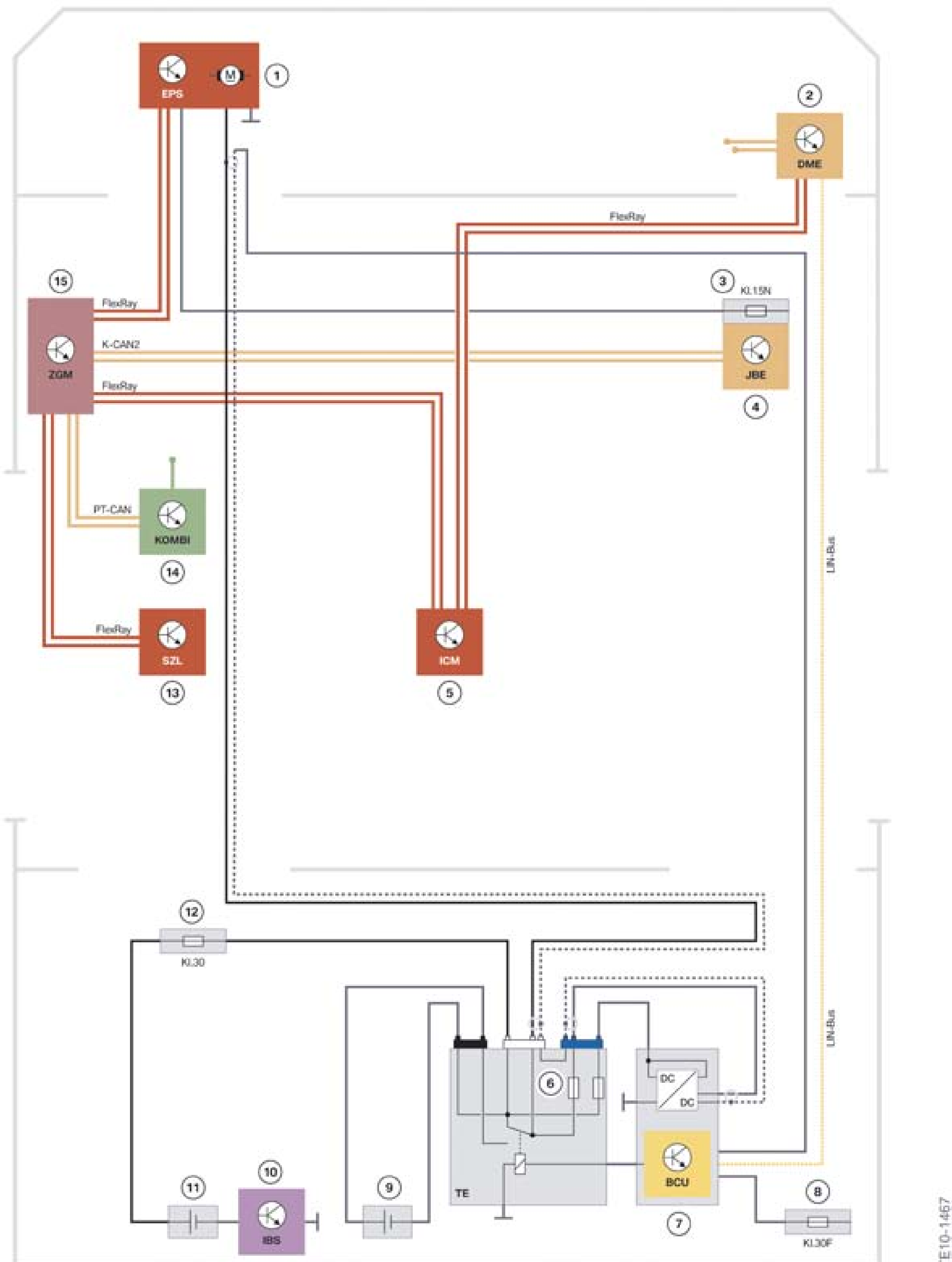
The necessary components, an auxiliary battery with charger and a separator, are installed in the luggage compartment of the F12.



F12 24 V components

Index	Explanation
1	Battery
2	Separator
3	Auxiliary battery
4	Charging controller for auxiliary battery (Battery Charge Unit BCU)

The following system wiring diagram shows how the 24 V components are incorporated into the vehicle electrical system.



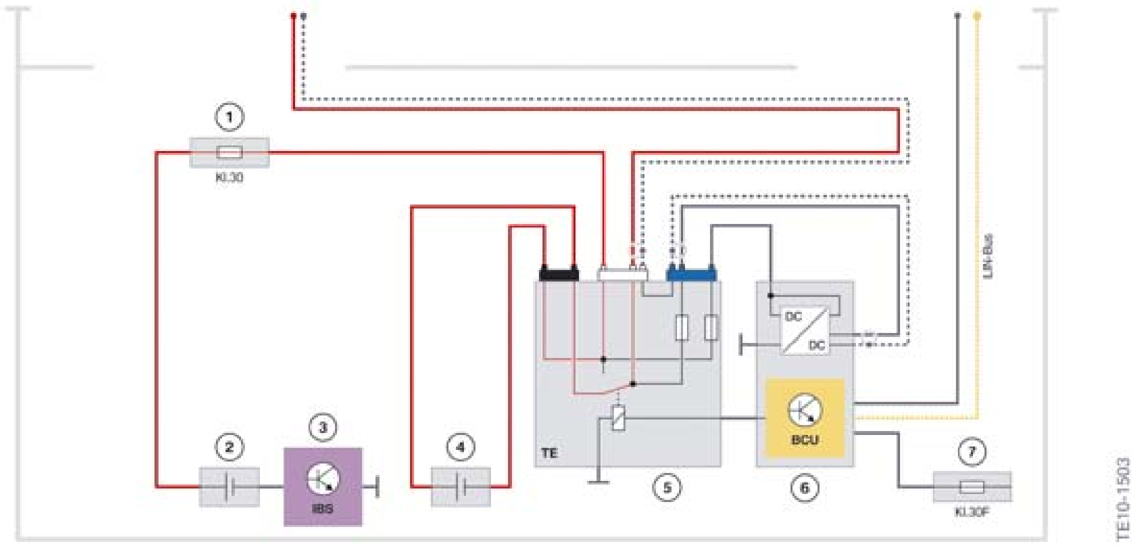
F12 System wiring diagram of EPS with 24 V and active steering

Index	Explanation
1	Electric Power Steering (EPS)
2	Digital Motor Electronics (DME)
3	Junction box for the power distribution box
4	Junction box electronics (JBE)
5	Integrated Chassis Management (ICM)
6	Separator
7	Charging controller for auxiliary battery (Battery Charge Unit [BCU])
8	Luggage compartment power distribution box
9	Auxiliary battery
10	Intelligent battery sensor (IBS)
11	Battery
12	Battery power distribution box
13	Steering column switch cluster (SZL)
14	Instrument panel (KOMBI)
15	Central gateway module (ZGM)
Terminal 15N	Ignition (after-run)
Terminal 30	Terminal 30
Terminal 30F	Terminal 30, fault-dependent
LIN-Bus	Local interconnect network bus

The BCU charges the auxiliary battery with the assistance of a DC/DC converter. It monitors the state of charge in the auxiliary battery and the cable shield that encloses the 24 V cable which is installed in the vehicle floor.

It switches the relay in the separator that integrates the auxiliary battery into the circuit. The EPS is only supplied with 24 V once this relay has been switched. If a fault develops, the EPS can also be operated using 12 V. If no fault develops, the relay in the separator is switched from terminal 15N.

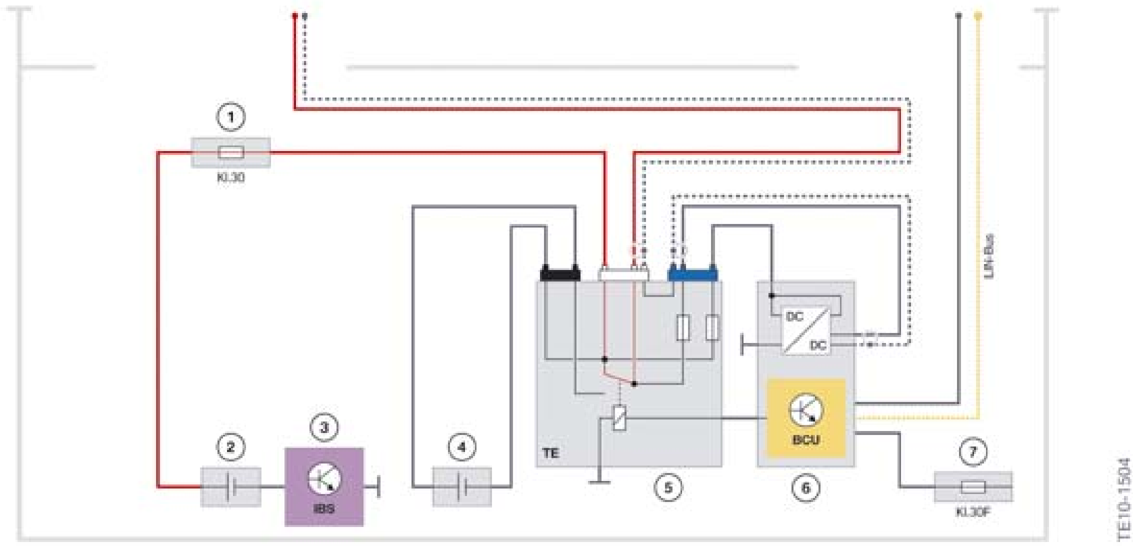
The following excerpts from the system wiring diagram show the various switching situations and the auxiliary battery charging operation.



F12 24 V operation of EPS

Index	Explanation
1	Battery power distribution box
2	Battery
3	Intelligent battery sensor IBS
4	Auxiliary battery
5	Separator
6	Charging controller for auxiliary battery (Battery Charge Unit [BCU])
7	Luggage compartment power distribution box
Terminal 30	Terminal 30
Terminal 30F	Terminal 30, fault-dependent
LIN-Bus	Local interconnect network bus

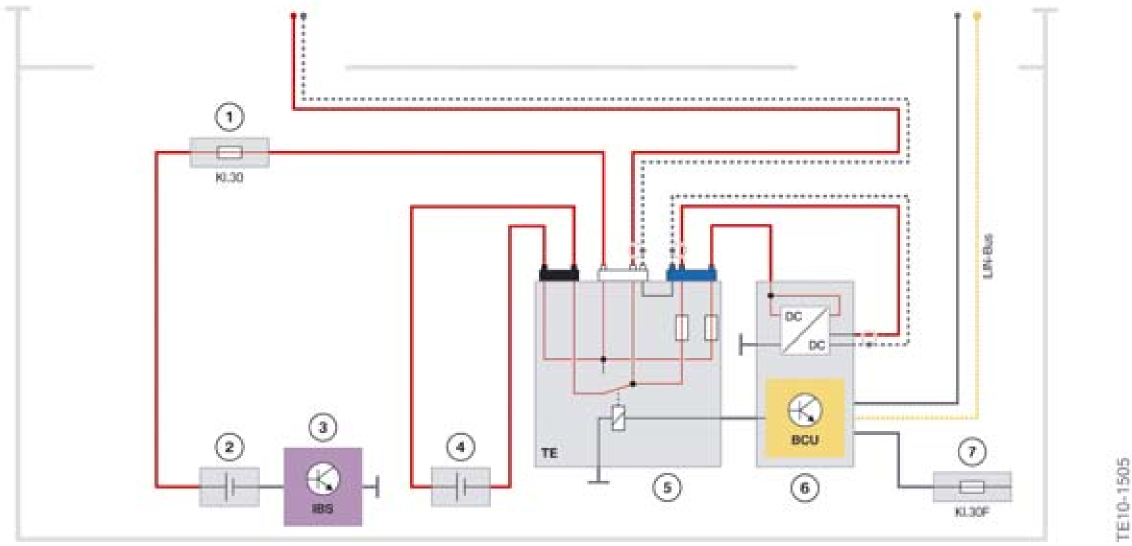
The relay in the separator connects the battery and auxiliary battery in series in order to operate the EPS with 24 V.



F12 12 V operation of EPS in event of a fault

Index	Explanation
1	Battery power distribution box
2	Battery
3	Intelligent battery sensor (IBS)
4	Auxiliary battery
5	Separator
6	Charging controller for auxiliary battery (Battery Charge Unit [BCU])
7	Luggage compartment power distribution box
LIN-Bus	Local interconnect network bus

The separator assumes the 12 V position before terminal 15 or if a fault develops. The auxiliary battery is no longer connected in series and is disconnected from the circuit.



F12 Charging the auxiliary battery in 24 V mode

Index	Explanation
1	Battery power distribution box
2	Battery
3	Intelligent battery sensor (IBS)
4	Auxiliary battery
5	Separator
6	Charging controller for auxiliary battery (Battery Charge Unit [BCU])
7	Luggage compartment power distribution box
LIN-Bus	Local interconnect network bus

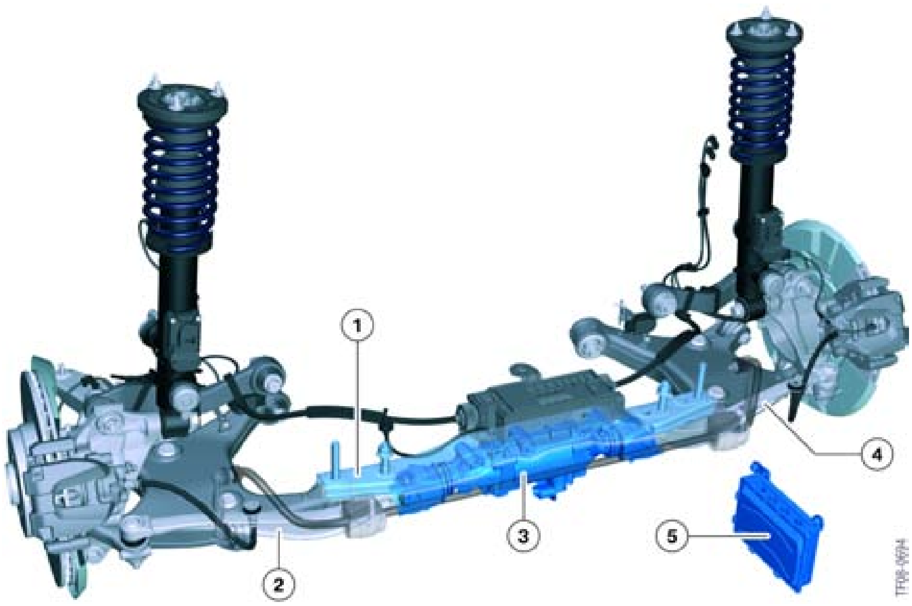
The auxiliary battery can be charged in 24 V mode using the battery charging unit. The charger draws the power required for this from the vehicle electrical system via the Luggage compartment power distribution box.

When the Electric Power Steering is in 24 V mode, the auxiliary battery is charged via the charging controller for auxiliary battery (BCU). As a voltage of 24 V is present in the EPS circuit due to the series connection of the main and auxiliary battery, the auxiliary battery can only be charged using a special measure.

This involves using a DC/DC converter in the charging controller for auxiliary battery (BCU) that produces different voltages at the input and output that are isolated from one another.

Energy is drawn from the vehicle electrical system and fed to the auxiliary battery.

5.2.4. Rear axle slip angle control HSR



F12 Installation location of HSR actuator at integral V rear axle

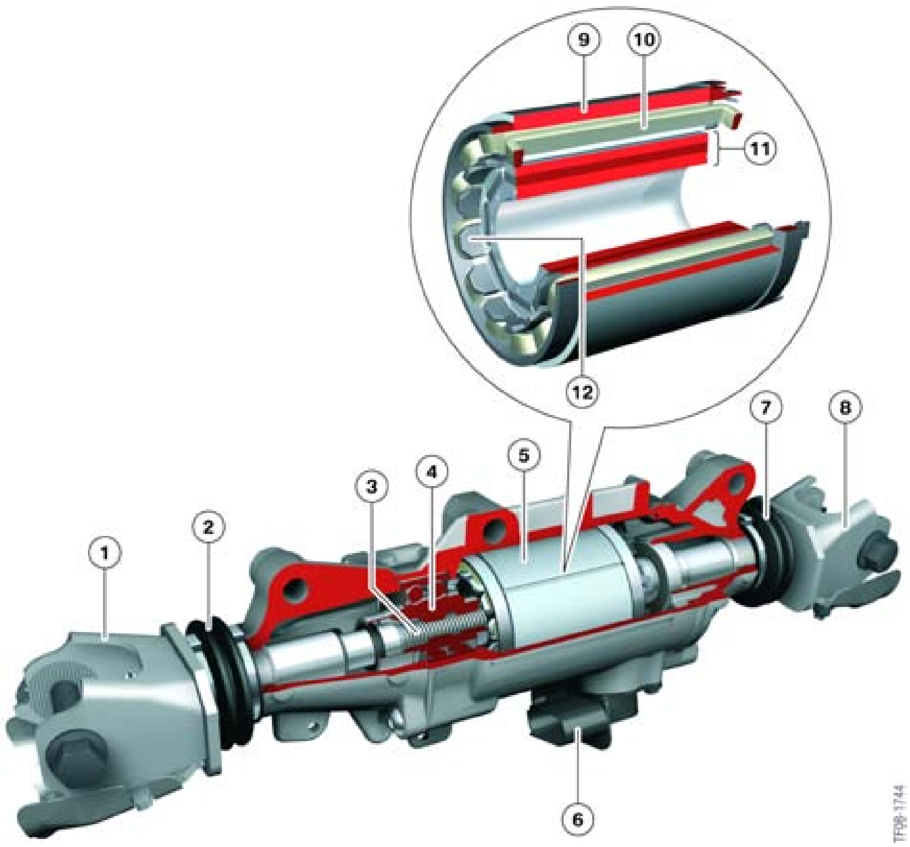
Index	Explanation
1	Mounting plate
2	Left camber link
3	HSR actuator
4	Right camber link
5	HSR control unit

The use of Integral Active Steering increases the overall ride comfort and dynamics of the vehicle by actively steering the rear wheels in certain conditions.

The special HSR actuator on the rear axle is fastened underneath a support plate on the rear axle support. This electromechanical actuator is located between the two camber links of the integral V rear axle. The rear wheel steering system includes a dedicated HSR control unit that controls and monitors the HSR actuator.

Control systems were designed independently of one another using the state-of-the-art technology.

In the F12 these systems are networked by the ICM. In the ICM architecture a central control unit has superseded the driving dynamics sensors previously used and constitutes a central driving dynamics controller.



F12 HSR actuator

Index	Explanation
1	Left track rod joint
2	Left shaft gaiter
3	Worm shaft
4	Spindle nut
5	Electric motor
6	Electrical connection
7	Right shaft gaiter
8	Right track rod joint
9	Iron casing
10	Armature winding
11	Rotor winding with iron core
12	Support/armature winding iron core

The electromechanical actuator essentially consists of an electric motor which moves the two track rods by means of a worm-and-nut steering gear.

The HSR actuator is designed for a maximum stroke of ± 8 mm which produces a maximum steering lock of ± 3° at the wheel.

The worm-and-nut rear-wheel steering gear is self-inhibiting. This means that if the system fails, the vehicle has the same drivability is a vehicle without rear wheel steering.

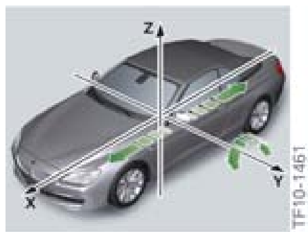
The components of Integral Active Steering "active steering AL" and "rear axle slip angle control" cannot be ordered separately and are only available with the Integral Active Steering package (SA 2VH).

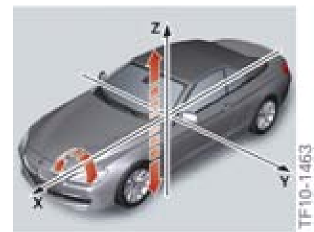
F12 Chassis Dynamics

6. Driving stability control

6.1. Directions of action

Driving stability control systems can be differentiated in terms of their basic effective directions. They can act along as well as around an axis of the vehicle's fixed X, Y or Z coordinate system.





Direction of action	**Longi-tudinal**	**Pitch**	**Lateral**	**Yaw**	**Vertical**	**Roll**
DSC	●			●		
Integral Active Steering			●	●		
VDM		●			●	
DCC	●					
ARS						●

6.2. Dynamic Stability Control DSC

The DSC prevents the driving wheels spinning when pulling away and accelerating.

In addition, the DSC detects unstable driving conditions such as oversteer or understeer. The DSC helps to keep the vehicle on a safe course within the physical limits by reducing engine power output and individually modulating the brake intervention at each wheel.

⚠

Driving style and safety always remains the responsibility of the driver, do Not rely solely on DSC to maintain stability of the vehicle.

The additional safety features afforded by the system should not be diminished by risky driving.

The DSC system and its hydraulic block mounted control unit incorporate a large number of individual functions which are listed in the table below.

Function	**Sub-function**	**Designation**
ABS		Antilock Brake System
	EBV	Electronic brake force distribution
	CBC	Cornering Brake Control
	DBC	Dynamic Brake Control

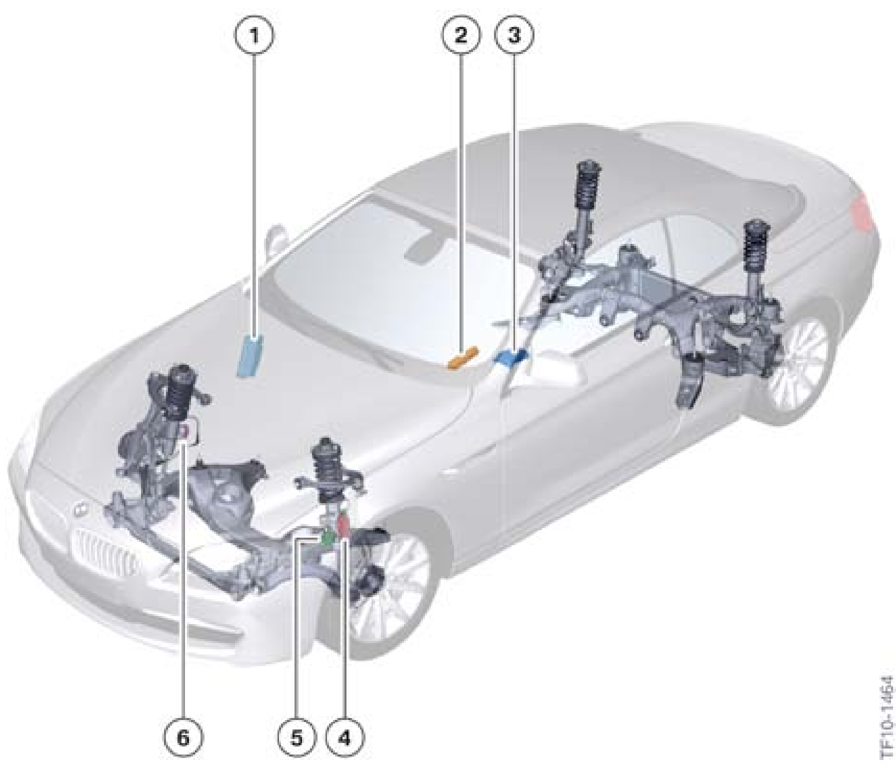
6. Driving stability control

Function	Sub-function	Designation
ASC		Automatic Stability Control
	MMR	Engine torque control
	MSR	Engine drag control
	BMR	Braking torque control
DSC		Dynamic Stability Control
	GMR	Yaw force control
	SDR	Overrun differential control
	DTC	Dynamic Traction Control

The DSC can be operated in three modes:

- Normal mode
- Dynamic traction control (DTC)
- DSC OFF.

6.3. Electronic Damper Control (EDC)



F12 Components of 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 compression stage
6	EDC control valve for rebound

The F12 features the **Vertical Dynamics Management (VDM)** with integrated **Electronic Damper Control (EDC)** function. The EDC was also referred to as Vertical Dynamics Control (VDC) in the large series from the F01/F02 onwards. The VDC introduced with the E70/E71 was systematically developed further for the F01/F02, F10 and now the F12 uses the latest version.

The EDC reduces undesirable vehicle movements that arise as a result of a dynamic driving style or uneven roadway. This achieves noticeable improvements in the following areas, even with a comfort-oriented sports suspension:

- Vehicle body comfort
- Tire comfort
- Driving dynamics.

With EDC, the actuator unit and the specified satellite sensors at the shock absorber are connected to the VDM control unit via FlexRay.

The vertical acceleration of the wheel is recorded by the acceleration sensors integrated in the satellite.

The movement of the vehicle body is determined based on the wheel acceleration and ride height signals. In addition, signals such as the vehicle speed are acquired via FlexRay and used to determine the reference forces for the damping action.

The current supply required for the rebound and compression stage valves at the dampers is switched based on the calculated reference force and the damper characteristic map.

In the F12, the Dynamic Damper control is standard and the optional Active Roll Stabilization (ARS, SA 229), is available as an option.

6.4. Active Roll Stabilization ARS (Dynamic Drive)

The Active Roll Stabilization ARS was introduced for the first time in the E65/E66. With the F12, this is available as option. (SA 229)

ARS can bring about a noticeable reduction in the lateral tilt of the body that occurs during fast cornering or avoidance maneuvers. During this process, the ARS reduces the required steering angle and also minimizes the unwanted interference created by the wheels on the axle.

The ARS significantly improves the bump steer as well as the load change response of the vehicle.

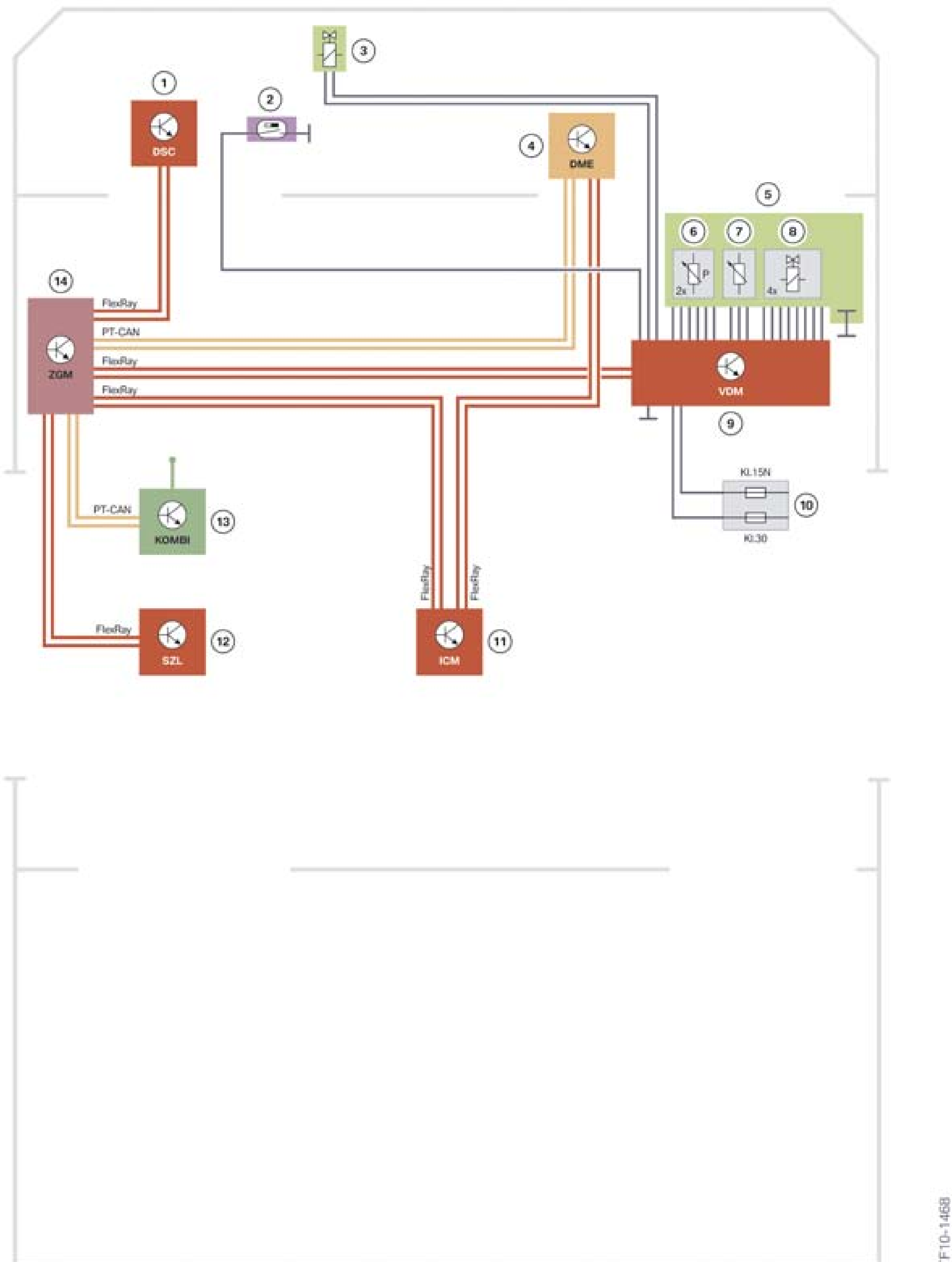
6. Driving stability control

With ARS the following variables are permanently measured or calculated:

- Vehicle speed
- Current lateral and longitudinal acceleration
- Body and wheel acceleration
- Steering wheel position
- Ride heights.

Control commands are sent to the hydraulic swivel motors of the anti-roll bars based on the data acquired in order to counteract the lateral tilting forces that occur.

6. Driving stability control

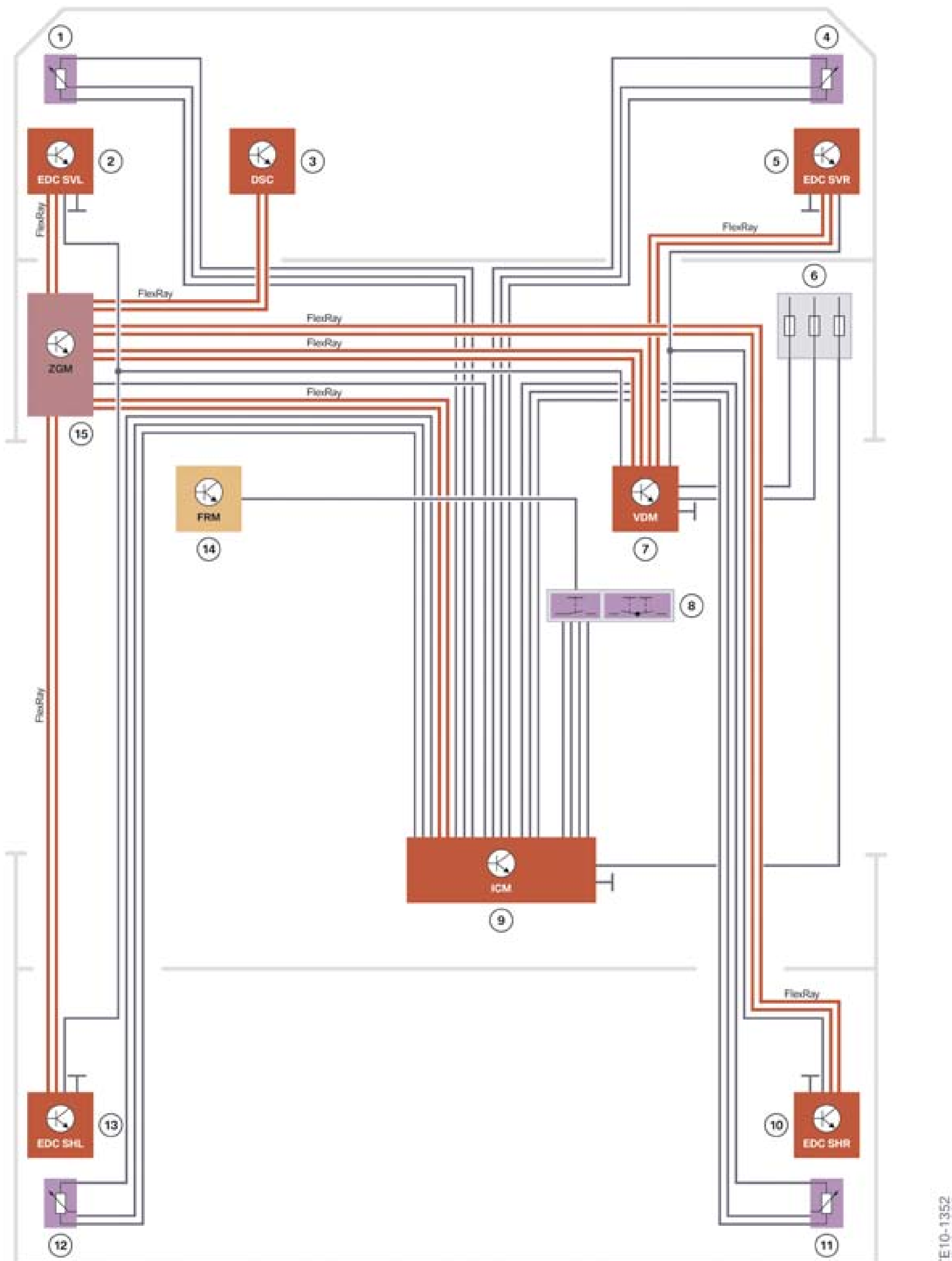


F12 Dynamic Drive system wiring diagram

6. Driving stability control

Index	Explanation
1	Dynamic stability control (DSC)
2	Hydraulic oil level sensor
3	Suction throttle valve
4	Digital Motor Electronics (DME)
5	Valve block, Dynamic Drive
6	Front suspension pressure sensor/rear suspension pressure sensor
7	Shift-position sensor
8	Failsafe valve, direction valve and pressure valves
9	Vertical Dynamics Management
10	Junction box for the power distribution box
11	Integrated Chassis Management (ICM)
12	Steering column switch cluster (SZL)
13	Instrument panel (KOMBI)
14	Central gateway module (ZGM)
Terminal 15N	Ignition (after-run)
Terminal 30	Terminal 30

6. Driving stability control



F12 EDC system wiring diagram

F12 Chassis Dynamics
6. Driving stability control

Index	Explanation
1	Ride height sensor, front left
2	Electronic Damper Control satellite, front left
3	Dynamic Stability Control
4	Ride height sensor, front right
5	Electronic Damper Control satellite, front right
6	Junction box for the power distribution box
7	Vertical Dynamics Management
8	Drive dynamic control switch
9	Integrated Chassis Management (ICM)
10	Electronic Damper Control satellite, rear right
11	Ride height sensor, rear right
12	Ride-height sensor, rear left
13	Electronic Damper Control satellite, rear left
14	Footwell module (FRM)
15	Central gateway module (ZGM)

6.5. Drive dynamic control switch

F12 Center console

F12 Chassis Dynamics

6. Driving stability control

Index	Explanation
1	Driving dynamic control switch
2	Controller

F12 Drive dynamic control switch

Index	Explanation
1	Drive dynamic control switch for equipment **without** Adaptive Drive (not US)
2	Drive dynamic control switch for equipment with Adaptive Drive

In the F12, the combined effect of all drivetrain and driving stability control systems can also be influenced via the driving dynamic control switch. The operating principle is the same as the F01. In addition to the three different modes of the DSC available through the DSC button, four different modes are available through the driving dynamics switch.

The Sports mode can be configured with through the iDrive Controller.
Sports mode configuration

The “Sport” mode allows the driver to personalize the individual settings with regard to drivetrain, chassis and suspension or both.

6.5.1. Handling dynamics programs

Dynamic Damper Control

	Comfort	Normal	Sport	Sport+
Drivetrain systems				
Accelerator characteristic	Normal	Normal	Sports	Sports
Shift program	Normal	Normal	Sports	Sports
Shift speed	Normal	Normal	Sports	Sports
Chassis and suspension systems				
Steering servo	Normal	Normal	Sports	Sports
Integral Active Steering	Normal	Normal	Sports	Sports
Dynamic Stability Control	DSC on	DSC on	DSC on	DTC
Electronic Damper Control	Comfortable	Normal	Sports	Sports
Dynamic Drive	Normal	Normal	Sports	Sports

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