Participant's Manual

Dynamic Driving Systems E90

BMW Service

Aftersales Training

The information contained in this Participant's Manual is intended solely for the participants of this seminar run by BMW Aftersales Training.

Refer to the latest relevant "BMW Service" information for any changes/supplements to the Technical Data.

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Participant's Manual
Dynamic Driving Systems E90

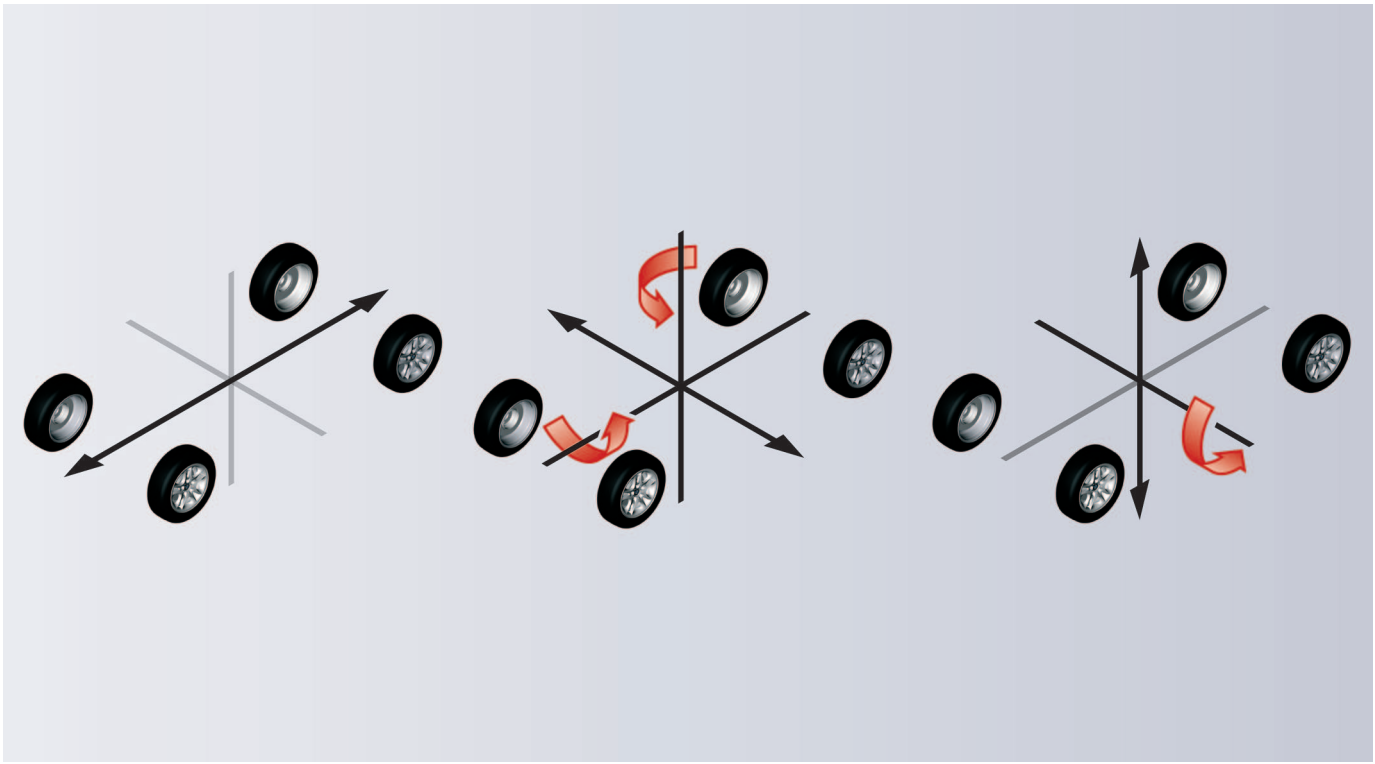
Dynamic Stability Control (DSC)

Longitudinal Dynamics Management (LDM)

Dynamic Cruise Control (DCC)

Active Cruise Control (ACC)

Active Front Steering (AL)



Information on this Participant's Manual

Symbols used

The following symbols are used in this Participant's Manual to facilitate better comprehension and to draw attention to important information.

⚠ contains information for better understanding of the described systems and their functions.

◄ identifies the end of an item of information.

Current content of Participant's Manual

In view of the constant further developments in the design and equipment of BMW vehicles deviations may arise between this Participant's Manual and the vehicles made available as part of the training course.

The background material refers exclusively to left-hand drive vehicles. The controls are in part arranged differently in right-hand drive vehicles than shown on the graphics in the Participant's Manual.

Additional information sources

You will find further information on the individual vehicle topic in the BMW diagnosis and repair systems as well as on the Internet under www.bmw.com.

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Dynamic Driving Systems E90

Objectives
Dynamic Driving Systems E90

Purpose of this Participant's Manual

The Participant's Manual is a document designed to accompany a seminar while at the same time serving as a source of reference.

The new developments in relation to the dynamic driving systems for the E90 model series are described in this Participant's Manual.

Many further developments in the E90

The dynamic driving systems in the E90 are for the most part further developments of established systems.

Exceptions are Longitudinal Dynamics Management (LDM) and the new availability of drive assist systems in a mid-size class vehicle.

Contents

Dynamic Stability Control (DSC) E90

Introduction
Dynamic Stability Control (DSC)

Variants

There will provisionally be two different DSC modules when the new 3 Series Saloon (E90) is launched onto the market:

- The four-cylinder models of the E90 will feature the MK60psi from Continental Teves, which was used for the first time in the E87.
- The six-cylinder models of the E90 will feature the MK60E5 from Continental Teves.

⚠ The lettering on the button has been changed in the E90 for all variants from DSC to DTC (Dynamic Traction Control). ◄

Features of the MK60psi

The abbreviation "psi" stands for "pressure sensor integrated". This means that the two pressure sensors on the tandem brake master cylinder (THZ) which have measured a brake pressure request have been combined to create a single plausibility sensor. The plausibility sensor has been integrated in the hydraulic control unit.

Additionally:

- Two-stage brake pad wear indicator incl. remaining-mileage calculation within the framework of requirement-orientated service (BOS)
- Link betweenthe DSC control unit and the Car Access System (CAS) to facilitate an electric steering lock (ELV) function
- Higher integration density in terms of sensors and control unit network in the vehicle.

Features of the MK60E5

The features of the system are characterized by significantly improved comfort during control interventions and by even more precise single-wheel braking thanks to the analogue control performance of the input control valves. This is achieved by means of a pulse-width-modulated signal (PWM).

It has been possible among other thing to reduce the braking distance to a minimum and to realize some new functions. The new functions contribute to increased directional stability, optimized comfort and improved system availability.

New functions:

- Fading support
- Braking readiness
- Dry braking
- Soft stop function
- Start assist
- ECBA interface (Electronic Control Brake Actuation) for ACC
- Yaw moment compensation in association with active front steering (AL).

MK60E5 - a further development of the MK60psi

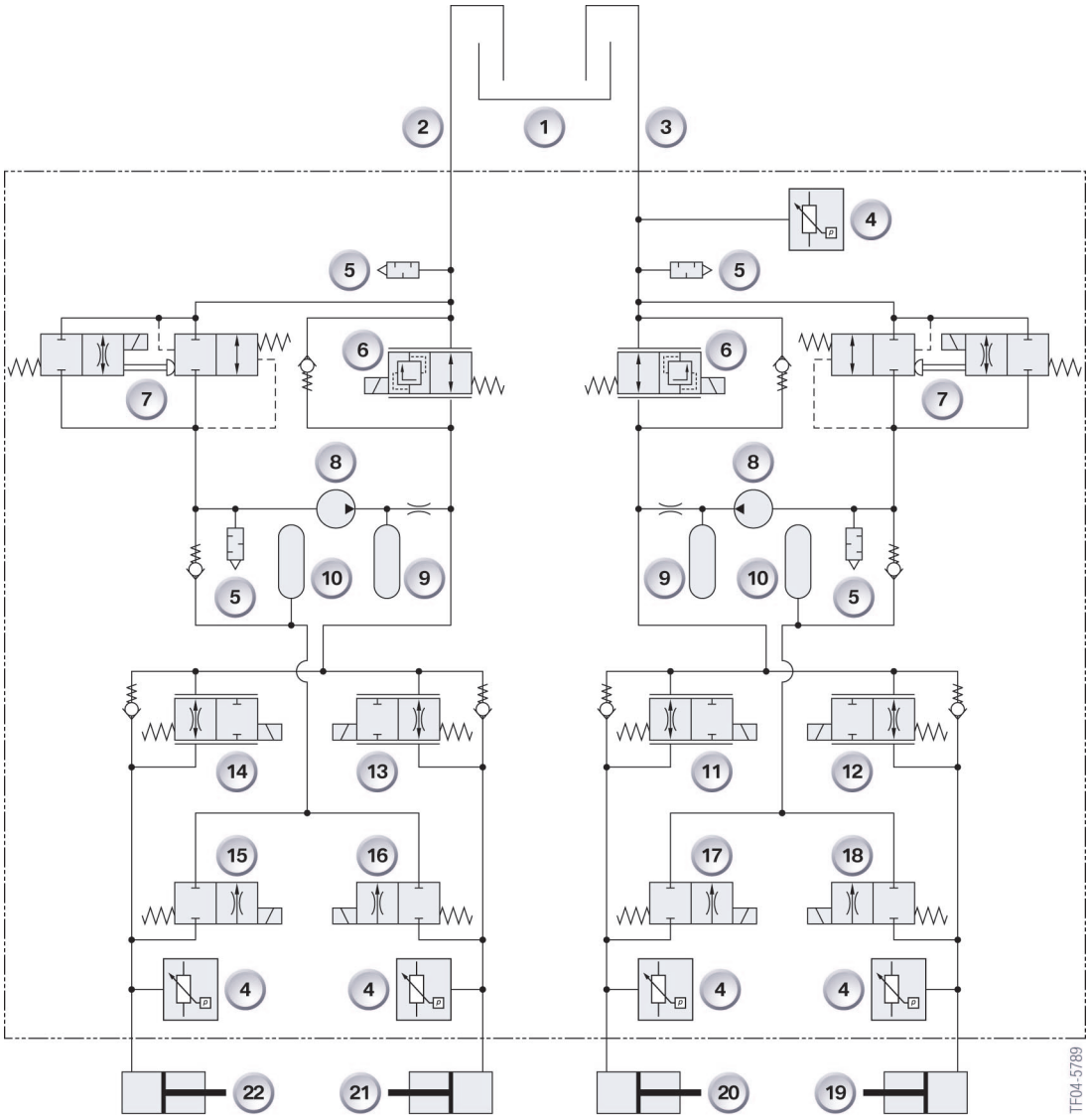
The MK60E5 (also installed in the E60 M5) is a further development of the MK60psi, which is used in the E87 and in the E90 with four-cylinder engines.

In the MK60E5 the designation "E5" stands for the 5 pressure sensors which are integrated in the hydraulic control unit:

- A combined pressure sensor on the inlet side which monitors the plausibility of the pressures of the tandem brake master cylinder (THZ)
- Four further sensors on the outlet side which measure the braking pressure of the assigned wheel brake

The MK60E5 DSC has as usual a DTC function and also a Runflat Indicator (RPA).

The lettering on the button has been changed in the E90 from DSC to DTC.



1 - DSC E90 hydraulic circuit diagram

Index	Explanation	Index	Explanation
1	Brake fluid expansion tank	12	Inlet valve, front right, with switching orifice, analogue
2	Rear-axle brake circuit	13	Inlet valve, rear right, analogue
3	Front-axle brake circuit	14	Inlet valve, rear left, analogue
4	Pressure sensor, push rod circuit	15	Outlet valve, rear left
5	Pulsation damper	16	Outlet valve, rear right
6	Isolating valve	17	Outlet valve, front left
7	Electric changeover valve	18	Outlet valve, front right
8	Self-priming return pump	19	Wheel brake, front right
9	Damper chamber	20	Wheel brake, front left
10	Accumulator chamber	21	Wheel brake, rear right
11	Inlet valve, front left, with switching orifice, analogue	22	Wheel brake, rear left

Sensors

Sensor system	Functional principle	Manufacturer
Active wheel-speed sensors*	Magneto-resistive principle	Teves
Steering angle sensor (LWS) in steering column switch cluster (SZL)	Optoelectronic	
Yaw rate sensor	Twin tuning fork principle	Teves
Lateral-acceleration sensor	Capacitive principle	Teves
Longitudinal-acceleration sensor**	Integrated in control unit	
5 pressure sensors	Integrated in hydraulic block	
Brake light switch	Hall principle	
Brake-fluid level switch	Reed contact switch	

* Wheel-speed sensors
Grey grommet = MK60E5 with direction-of-rotation detection (since the braking response when reversing is different from that when driving forwards, output to navigation system, EGS etc.)
Black grommet = MK60psi

** For the start assist function

Control unit

- Add-on control unit
- Integrated semiconductor relays (engine and valve relays)
- High computing capacity is provided by a 2 MB flash processor
- A longitudinal-acceleration sensor has been integrated in the DSC control unit in order to realize the start assist function

⚠ The control unit may only be replaced separately after the end of the first year; before this, it may only be replaced together with the hydraulic control unit! ◄

Hydraulic control unit

Continental Teves MK60E5

⚠ Available for the E90 in LHD and RHD versions (different part numbers). ◄

Front axle

- 2 inlet valves
- 2 high-speed outlet valves

Rear axle

- 2 inlet valves
- 2 high-speed outlet valves

Pressure generation

- Pump with two stepped piston pump elements
- Actuated via a common eccentric shaft
- ASC (Automatic Stability Control) and DSC operation: self-priming return pump
- Power-optimized pump motor (250 W)

Engine interventions

- Ignition timing
- Charge adjustment

Interfaces

- CAN bus interface (F-CAN, PT-CAN)

Additional DSC functions

ECBA interface (Electronic Control Brake Actuation) for ACC via LDM (Longitudinal Dynamics Management)

The ACC request in the DSC with regard to pressure build-up, pressure recording and modulation at the wheel brakes is optimally implemented in terms of deceleration and comfort via the ECBS interface.

Yaw moment compensation in association with AL

In conjunction with AL, it is possible for a braking yaw moment created by different friction coefficients, which was previously stabilized by DSC control, to be compensated without a reduction in braking power by an AL correction. For further details, see AL.

Fading support

For the purpose of setting a constant ratio of pedal force to vehicle deceleration, the brake pressure is increased in line with an arithmetical temperature model in order to compensate fading effects (if necessary, increased pedal travel in the event of brake heating).

Braking readiness

Braking readiness is established by DSC through an "initial application" of the brake pads. When DSC detects a braking manoeuvre to be expected, e.g. suddenly releasing the accelerator pedal, the air gap of the brake pads is bridged by a slight volume feed into the brake calipers, thereby establishing spontaneous braking readiness for the driver.

Dry braking

A further function for increasing safety is achieved by deceleration-free "dry braking" as needed of the brake discs with a slight application of the brake pads. The trigger for this function is the information on the rain sensor or on an active windscreen wiper activity.

Soft stop function

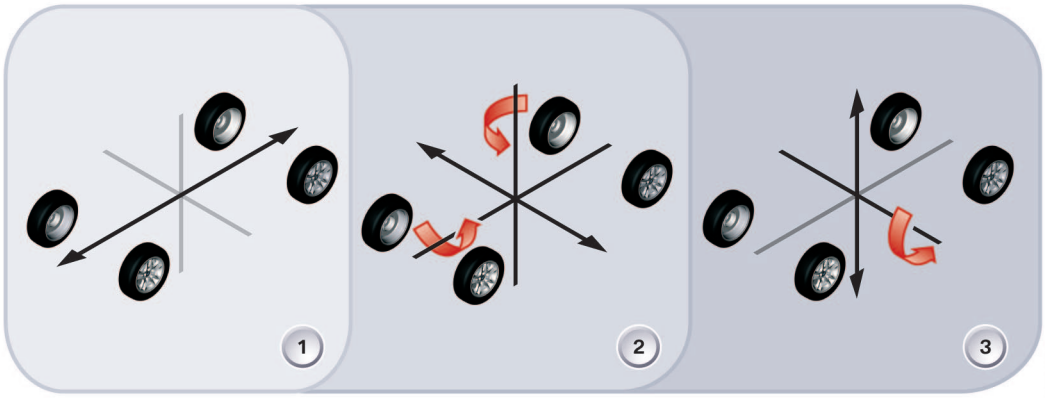
The uncomfortable jolt as the vehicle comes to a stop familiar primarily from cars with automatic transmissions is compensated with the function through a specifically controlled reduction of pressure shortly before the vehicle comes to a stop.

Start assist

This function briefly holds the vehicle, thereby allowing the driver to restart the vehicle with no rolling back on an uphill or downhill gradient without constantly having to depress the brake pedal or apply the parking brake.

Contents
Longitudinal Dynamics Management (LDM)

Introduction
Longitudinal Dynamics Management (LDM)



1 - Longitudinal, transversal and vertical dynamics

Index	Explanation
1	Longitudinal dynamics
2	Transversal dynamics
3	Vertical dynamics

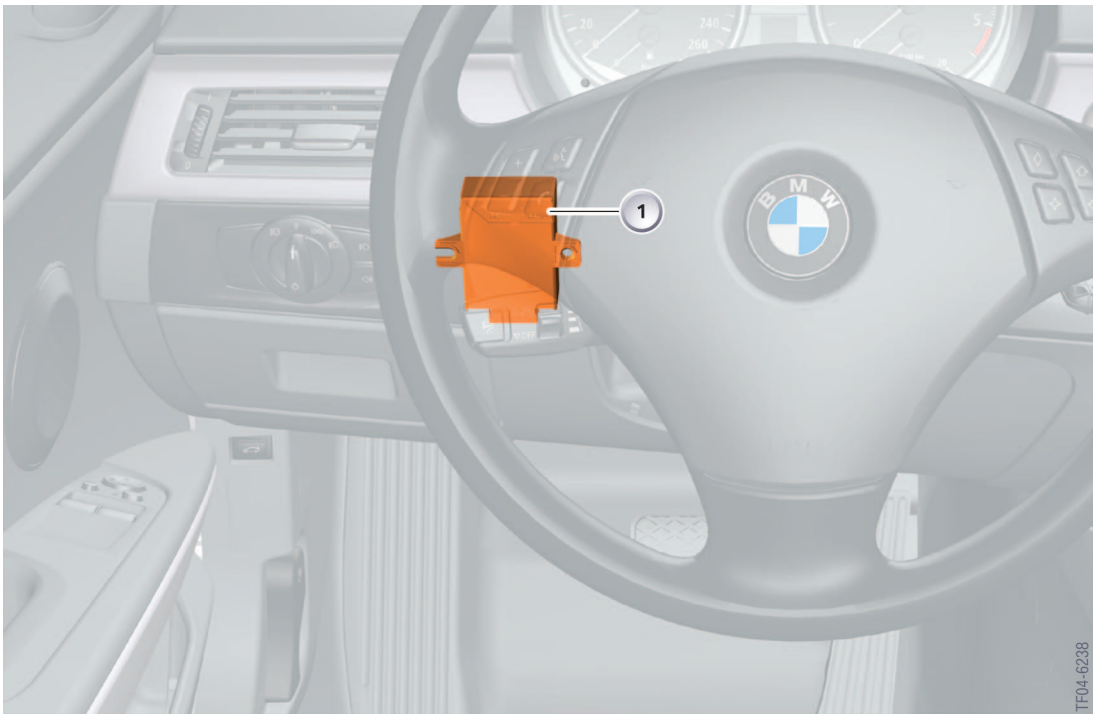
The new Longitudinal Dynamics Management system is provisionally installed in the E90 only in conjunction with ACC or DCC, i.e. it is only used in the six-cylinder models.

In previous BMW vehicles, acceleration control, such as "accelerating" or braking (negative acceleration), was calculated by different systems (DME/DDE, DSC, ACC etc.) in order then to activate the corresponding actuators with the relevant control signals.

This created a problem in that there was a build-up of a whole host of variants (engine, transmission and brake variants). In an E65, for example, there were 36 relevant car/engine/ transmission variants.

In order to take control of the increasing complexity over the course of time and the increase in variants, BMW has taken the decision to implement only **one** acceleration controller in the E90 vehicle network. This controller records the requests on the input side, calculates the corresponding setpoint variables and forwards them to the system partners such as DME/DDE, EGS, DSC, etc. Connected to a longitudinal-force controller, it coordinates and controls the actuators in all the vehicle configurations. The Longitudinal Dynamics Management system (LDM) is housed in an independent new control unit which is located in the E90 behind the light module.

System overview
Longitudinal Dynamics Management (LDM)

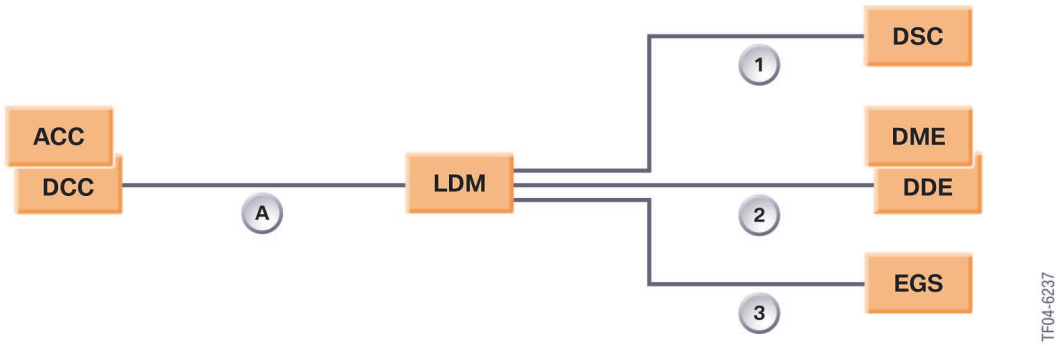


1 - Installation location of control unit

Index	Explanation
1	LDM control unit

The LDM is a control unit which is used for drivetrain and brake coordination purposes. It provides significantly improved automatic cruise control (ACC, DCC) with a general control function ranging from accelerating to braking.

Interface: CAN bus interface PT-CAN.

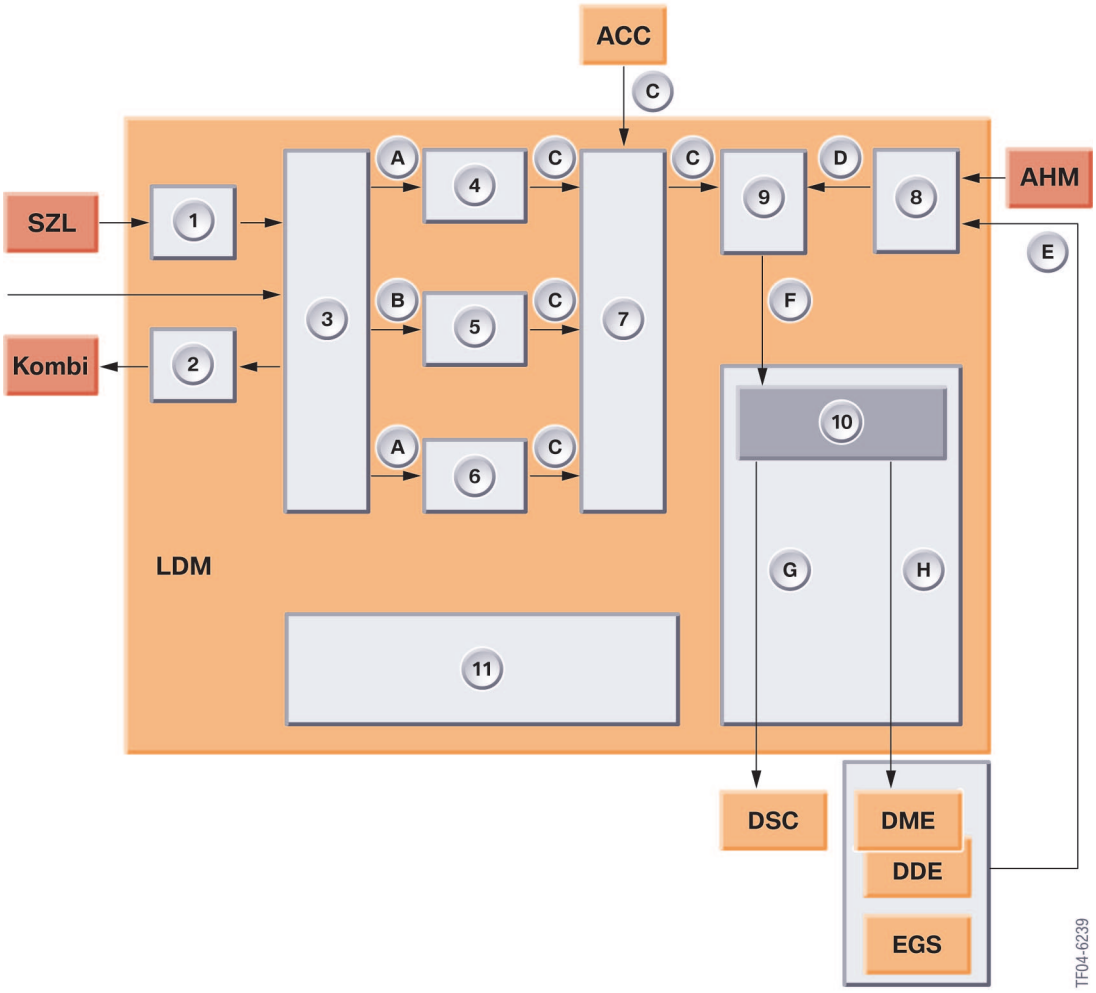


2 - Bus overview

Index	Explanation	Index	Explanation
1	Wheel torque for braking	DME/ DDE	Digital Motor Electronics/Digital Diesel Electronics
2	Wheel torque for accelerating	DCC	Dynamic Cruise Control
3	Gearshift request	DSC	Dynamic Stability Control
A	± a_setpoint	EGS	Electronic transmission control
ACC	Active Cruise Control	LDM	Longitudinal Dynamics Management

The LDM has two important primary functions to fulfil:

- Variant handling
  - LDM functions are configuration-dependent (coding-relevant function)
- LDM safety and functions are ensured by a central monitoring and redundancy system.



3 - LDM functions

Index	Explanation	Index	Explanation
1	Operator interface	D	a_interference factor
2	Display interface	E	M_wheel_actual_drive
3	Status control	F	M_wheel_setpoint
4	Vehicle speed controller	G	M_wheel_setpoint_brake
5	Lateral-acceleration controller	H	M_wheel_setpoint_drive
6	Comfort dynamics	ACC	Active Cruise Control
7	Prioritizer (minimum formation)	AHM	Trailer module
8	Interference factor estimator	DDE	Digital Diesel Electronics
9	Acceleration controller	DME	Digital Motor Electronics
10	Drive/brake coordination	EGS	Electronic transmission control
11	Monitoring	KOMBI	Instrument cluster
A	V_actual, V_setpoint	LDM	Longitudinal Dynamics Management
B	V_actual, yaw rate	SZL	Steering column switch cluster
C	a_setpoint		

Functions

Implemented functions in the LDM control unit

- "OPERATOR INTERFACE" module (1):
  Receives e.g. from the steering column stalk the "Acceleration" signal request, assigns this to a function and forwards it to the "Status control" module.
- "DISPLAY INTERFACE" module (2):
  Controls the output of information to the driver (e.g. display of desired speed, desired distance, driver takeover request) which is output by the "STATUS CONTROL" module.
- "STATUS CONTROL" module (3):
  Evaluates the specifications by the driver and assigns each of them to one of the three processing modules responsible. The variables here are speed (v), setpoint/actual and yaw rate.
- "VEHICLE SPEED CONTROLLER" module (4):
  Calculates the acceleration/deceleration setpoint variable on the basis of the desired speed and the deviating actual speed.
- "LATERAL-ACCELERATION CONTROLLER" module (5):
  Reduces the lateral acceleration in the bend/curve to an appropriate value and if necessary initiates an intervention when cornering. The actual lateral acceleration is calculated from the actual speed and a fault-corrected yaw rate.
- "COMFORT DYNAMICS" module (6):
  Available to the driver for specifying the acceleration and deceleration in the "CC" mode and is established here in the output of an acceleration/deceleration setpoint variable.
- "PRIORITIZER" (7):
  Decides which acceleration setpoint value is used by the cruise control and if necessary adaptive cruise control and which rate-of-change limiting is used in the "ACCELERATION CONTROLLER" module.
- "INTERFERENCE FACTOR ESTIMATOR" module (8):
  Estimates the acceleration interference factors (e.g. uphill/downhill gradient, rolling resistance) from the actual wheel drive torque and the changes to the vehicle mass due to the additional mass of a trailer and calculates an acceleration/deceleration interference correction variable.
- "ACCELERATION CONTROLLER" module (9):
  Converts the selected setpoint acceleration into an overall manipulated variable (total wheel torque) for drive and brake.
  The acceleration controller has to ensure that the specified setpoint acceleration of the vehicle (drive) is also achieved with the presence of external interference factors, such as e.g. uphill/downhill gradient. The acceleration controller ensures comfort typical for drive assist systems, such as e.g. jolt-free performance.
- "DRIVE/BRAKE COORDINATION" module (10):
  Coordinates and controls the system partners DME/DDE, EGS and DSC, by outputting a setpoint wheel braking torque and a brake release signal to the DSC and a setpoint wheel drive torque with drive release to the DME/DDE.
- "MONITORING" module (11):
  Monitors all the signal variables coming into the LDM. The programmed safety measures are also implemented here.

The LDM has the following interface parameters in the E90:

- Steering column switch cluster (SZL)
- Instrument cluster (KOMBI)
- Brake (DSC)
- Drive (DME/DDE and EGS)
- Active Cruise Control (ACC sensor; optional extra)
  - Driver's footwell module (FRMFA; direction indicator)
  - ANTICIPATORY ACTION for the overtaking assist function (direction indicator) - Only with ACC!
- Car Access System (CAS; terminal status)
- Trailer module (AHM; interference factor: mass)

Service information

The LDM is:

- codable
- programmable
- capable of self-diagnosis

An LDM failure is not signalled directly to the driver but is visible in the form of DSC/ACC/ DCC indications in the instrument cluster.

Contents

Cruise control with braking function (DCC)

Cruise control with braking function (Dynamic Cruise Control DCC)

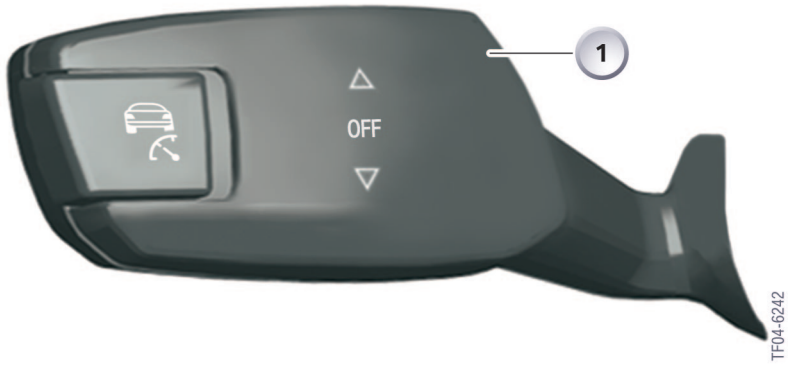
In the new E90 the customer can choose between three cruise control systems, which are however also dependent on the engine variant:

Option 540: Cruise control (FGR), for four-cylinder models

Option 541: Active Cruise Control (ACC) for six-cylinder models

Option 544: Cruise control with braking function (DCC), for six-cylinder models

ACC and DCC in the E90 need to be combined with an LDM, where the cruise control today still manages without this new control unit and as usual forwards its driver request signals directly to the DME/DDE.



1 - Steering column stalk with DCC function

Index	Explanation
1	Steering column stalk with DCC function

System overview
Cruise control with braking function (DCC)

Functions

The new cruise control with brake intervention maintains the set speed at a constant level even on downhill gradients by means of independent brake interventions.

DCC can be activated from 30 km/h (settable up to max. 250 km/h) and is deactivated by similar factors as for cruise control:

- Brake pedal actuation
- Deactivation of DSC
- Activation of DTC
- Active DSC intervention
- Deactivation by the driver
- Speed is reduced below 20 km/h
- In manual gearboxes: excessively long clutching operation (approx. 4 s, see Diagnosis)
- In automatic transmissions: selection of "N"

DCC achieves a deceleration of max. -2.5 m/s^2 and an acceleration of approx. +1.2 m/s^2.

The lateral acceleration is restricted to max. 4.0 m/s^2.

The primary emphasis has been placed on comfortable performance in this system configuration.

When the cruise control is activated, the brake lights are activated in the event of system-dictated braking (DCC) (required by law).

Unlike conventional cruise control, the driver in the E90 in DCC mode and with a manual gearbox can actuate the clutch and perform gearshifts without the system being deactivated. If however the driver does not pay attention to the gearshift request, the DCC is deactivated during slower driving at very high or very low engine speeds.

In the event of an automatic deactivation, the following Check Control message (CC) appears:

1 - CC message, cruise control

The following Check Control message appears if the system malfunctions:

2 - CC message, cruise control

Contents

Active Cruise Control (ACC)

Active Cruise Control (ACC)

Introduction

With the introduction of the new ACC in the E63/E64 (6 Series), the system can be referred to as a 2nd generation ACC. This further developed ACC is now offered in the E90. A connection to the navigation system is not envisaged in the E90 with ACC.

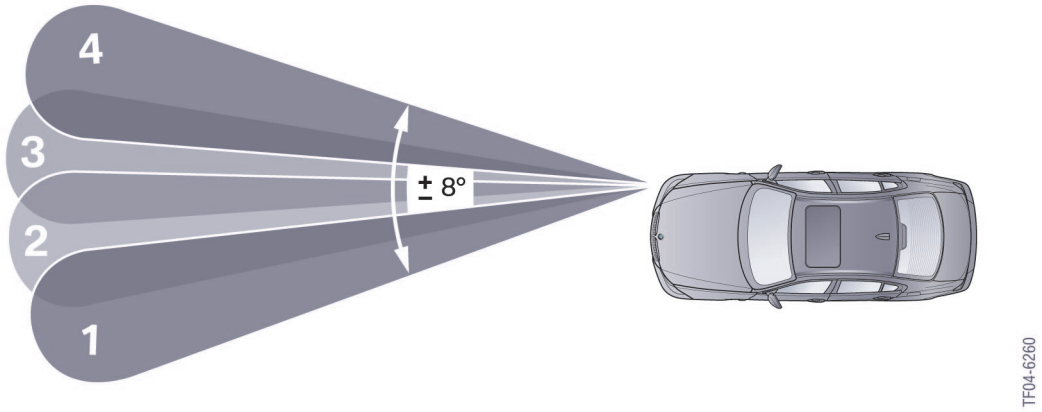
1 - ACC sensor in the E90

Index	Explanation
1	Installation location, ACC sensor

Differences of "Active Cruise Control" option in E90 from option in E63/E64:

The ACC control unit has been changed from the control unit for the "intelligent sensor" by the combination with the LDM because the functions are now evaluated and calculated in the new Longitudinal Dynamics Management control unit.

Differences of 2nd generation ACC option from 1st generation ACC (e.g. E60 before 03/05):



2 - Opening angle and radar beams

- ACC sensor (control unit) is 60 % smaller than previously
- 4 instead of 3 radar beams
- Horizontal opening angle of the radar sensor now ±8 instead of ±4
- Also new signal processing due to the higher data density (opening angle, 4 beams)
- Anticipatory acceleration action by ACC in the event of an imminent lane change through setting of the direction indicator by the driver.

Customer benefits of 2nd generation ACC:

- Earlier reaction to vehicles which cut in in front of own vehicle
- More stable following driving (bend/curve detection):
  - On tight motorway bends/curves
  - At motorway sliproads/exits
  - On winding country roads

Functions

The Active Cruise Control system has DCC functions and also automatic adaptive cruise control functions.

ACC can be activated from 30 km/h up to max. 180 km/h and is deactivated by similar factors as for DCC:

- Brake pedal actuation
- Deactivation of DSC
- Activation of DTC
- Active DSC intervention
- Deactivation by the driver
- Speed < 22 km/h
- In manual gearboxes: excessively long clutching operation (approx. 4 s, see Diagnosis)
- In automatic transmissions: selection of "N"

ACC achieves a deceleration of max. -2.5 m/s^2 and an acceleration of approx. + 1.2 m/s^2.

The lateral acceleration is restricted to max. 4.0 m/s^2.

The primary emphasis has been placed on comfortable performance in this system configuration as well.

⚠ No safety system! ◄

When the cruise control is activated, the brake lights are activated in the event of system-dictated braking (ACC) (required by law).

Contents
Active Front Steering (AL)

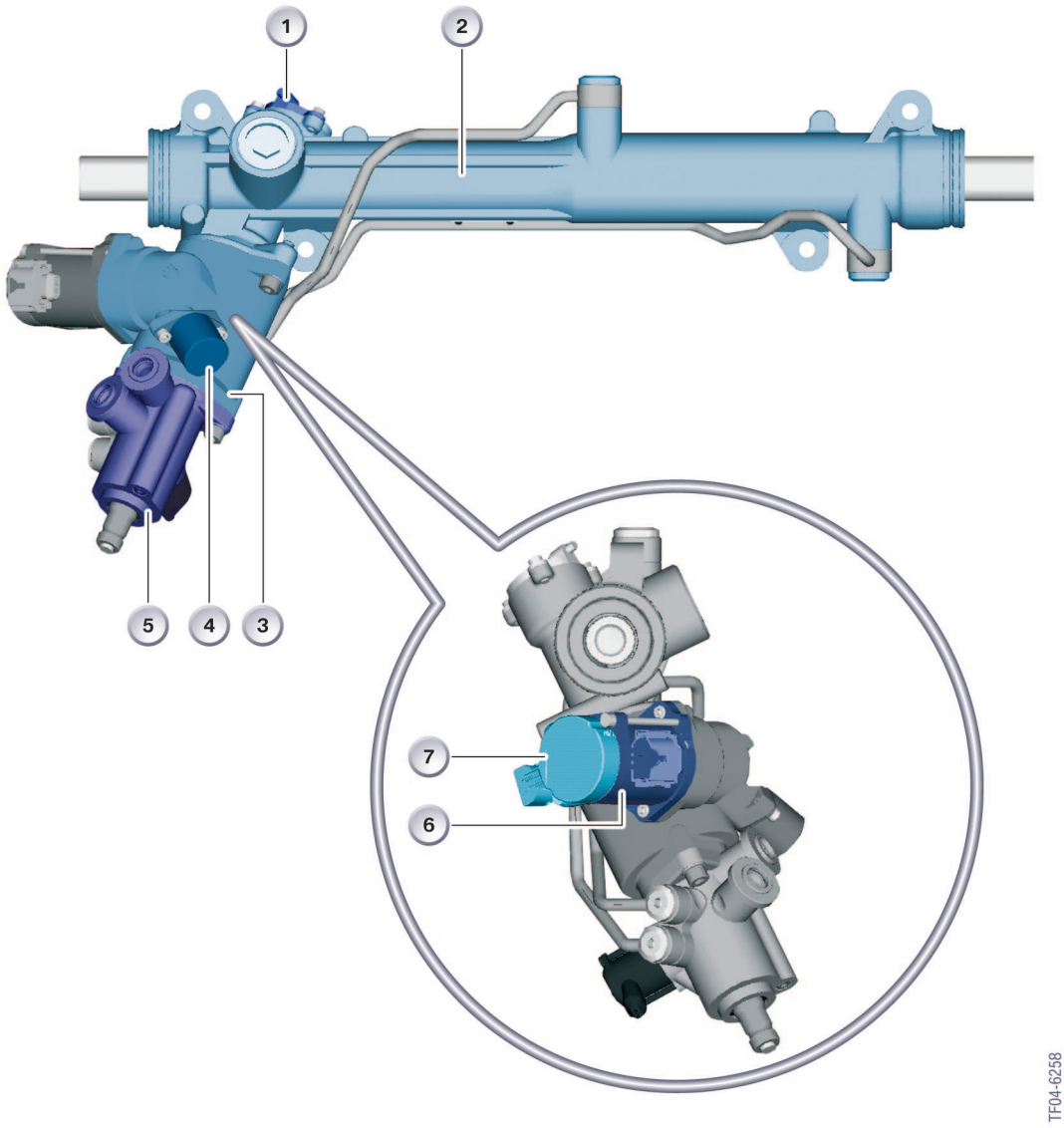
System overview
Active Front Steering (AL)

Introduction

One of the important further developments in the field of Active Front Steering is the combination of braking and steering interventions as this delivers a whole new quality of directional stability in the E90.

Option 217 Active Front Steering in the E90 can currently only be ordered for customers in the six-cylinder models. Servotronic in the E90 is only available in conjunction with Active Front Steering (no Option 216 as in the E60).

The mechanical layout of the steering system has undergone only minor changes and has been adapted to the space conditions in the E90.



1 - Overview of Active Front Steering mechanical components

Index	Explanation	Index	Explanation
1	Cumulative steering angle sensor	5	Steering spindle
2	Rack	6	Electric motor
3	Planetary gear housing	7	Motor position sensor
4	Magnetic interlock		

The installation location of the AL control unit is new in comparison with the E60 in that the control unit is no longer situated in the front passenger footwell but rather in the front left wheel arch underneath the wheel arch trim.

2 - AL control unit

Index	Explanation
1	Installation location, AL control unit

Functions

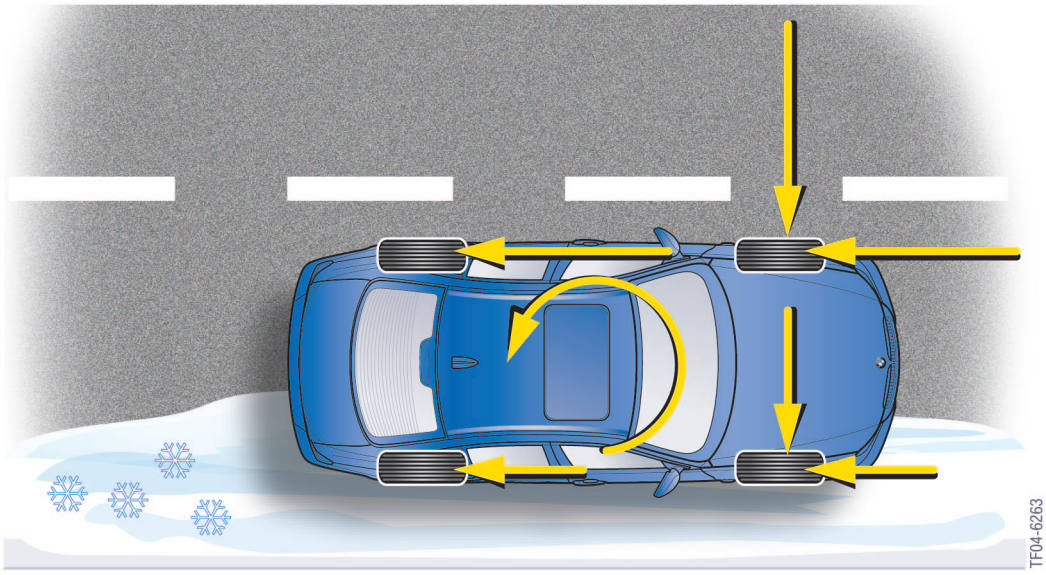
Previous functions of AL:

- The steering ratio is dependent on the steering wheel angle and the vehicle speed
  - More manoeuvrability and agility at lower and mid-range speeds
  - Improved comfort when manoeuvring in and out of parking spaces and other manoeuvring (less gripping)
  - Increased monitoring and safety during dynamic steering manoeuvres (hands firmly on the steering wheel)
  - Stable straightline stability at high speeds
- Linking with Servotronic (common tuning of steering ratio and steering force level) and an ECO valve for hydraulic delivery
- Stabilization intervention dependent on the driver's steering action
  - Optimum support of the driver while maintaining "accuracy"
- Stabilization with all road surface coefficients of friction
- Early stabilization on account of "more comfortable" steering intervention
  - Reduction and postponement of DSC brake interventions
- Linking with DSC
  - Guaranteed vehicle stability in every road situation, also restricted intervention via the steering.

New functions of AL in the E90:

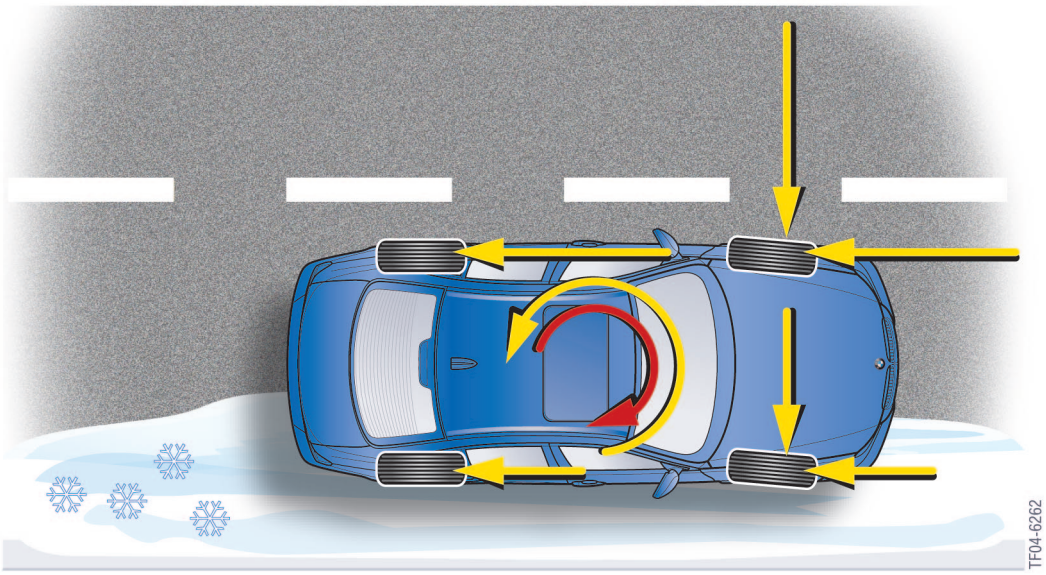
- Two different "variable steering tuning" curves for standard and sport suspensions in the E90 (coded in the factory)
- Two yaw rate sensors in one housing (redundancy and a necessary higher information density)
- Additional support of the DTC mode
- Braking stabilization by yaw moment compensation.

Yaw moment compensation



3 - µ-split braking with ABS

This new function represents a significant safety feature. In the case of braking on different road surface coefficients of friction (asphalt, ice or snow), a moment builds up about the vertical axis (yaw moment) rendering the vehicle unstable. In this case, DSC calculates the steer angle for the front wheels and the active front steering converts this input into an active countersteer.



4 - µ-split braking with DSC and AL

In this way a counter-moment builds up about the vertical axis and the previously created yaw moment is "compensated" (cancelled), i.e. this vehicle is stabilized by the skilful interplay of DSC braking and the AL steering function, delivery a new safety aspect unique in this car class.

This automatic early countersteer is dependent on the difference of the front wheel braking pressures.

Particular advantage of this function:

It shortens the braking distance because higher braking pressure differences at the rear axle are possible with yaw rate compensation via the steering. ABS on its own would set significantly lower pressure than is actually possible at wheels on a high coefficient of friction ("select low") and thus create a longer braking distance in this situation.

Abbreviations

ABS	Anti-lock braking system
ACC	Active cruise control
AHM	Trailer module
AL	Low beam headlight
	Active steering system
ASC	Automatic stability control
CAN	Controller area network
CAS	Car access system
CC	Check control
DDE	Digital diesel electronics
DME	Digital motor electronics
DSC	Dynamic stability control
DTC	Dynamic traction control
EGS	Electronic transmission control unit
ELV	Electric steering lock
F-CAN	Chassis CAN
FGR	Cruise control
KOMBI	Instrument cluster
LWS	Steering angle sensor
PT-CAN	Power Train Controller Area Network
PWM	Pulse width modulation
RPA	Tyre puncture warning
SZL	Steering column switch cluster
THZ	Tandem-brake master cylinder

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