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E90 Dynamic Driving Systems

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Initial Print Date: 03/05 Revision Date: 06/05

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Dynamic Driving Systems

Model: E90

Production: From Start of Production

OBJECTIVES

After completion of this module you will be able to:

- Establish an understanding of the changes in the DSC system
- Understand the importance of the LDM
- Explain the operation of DCC
- Explain the operation of ACC
- Identify the changes in AFS

Dynamic Stability Control System

The E90 in the U.S. is equipped with a new Dynamic Stability Control System (DSC) referred to as MK60E5, manufactured by Continental Teves, which builds upon the systems used in other BMW models. With this system several new functions are introduced that result in significantly improved comfort during brake intervention (due to utilization of a PWM signal on the input control valves) and more precise wheel braking.

New functions introduced with MK60E5:

- Fading Support
- Braking Readiness
- Brake Disk drying
- Soft Stop
- Start Assist
- Electronic Control Brake Actuation (ECBA)
- Yaw Moment Compensation with AFS

These new functions contribute to increased directional stability, optimized comfort, enhanced system availability/response plus reduce the minimum braking distance.

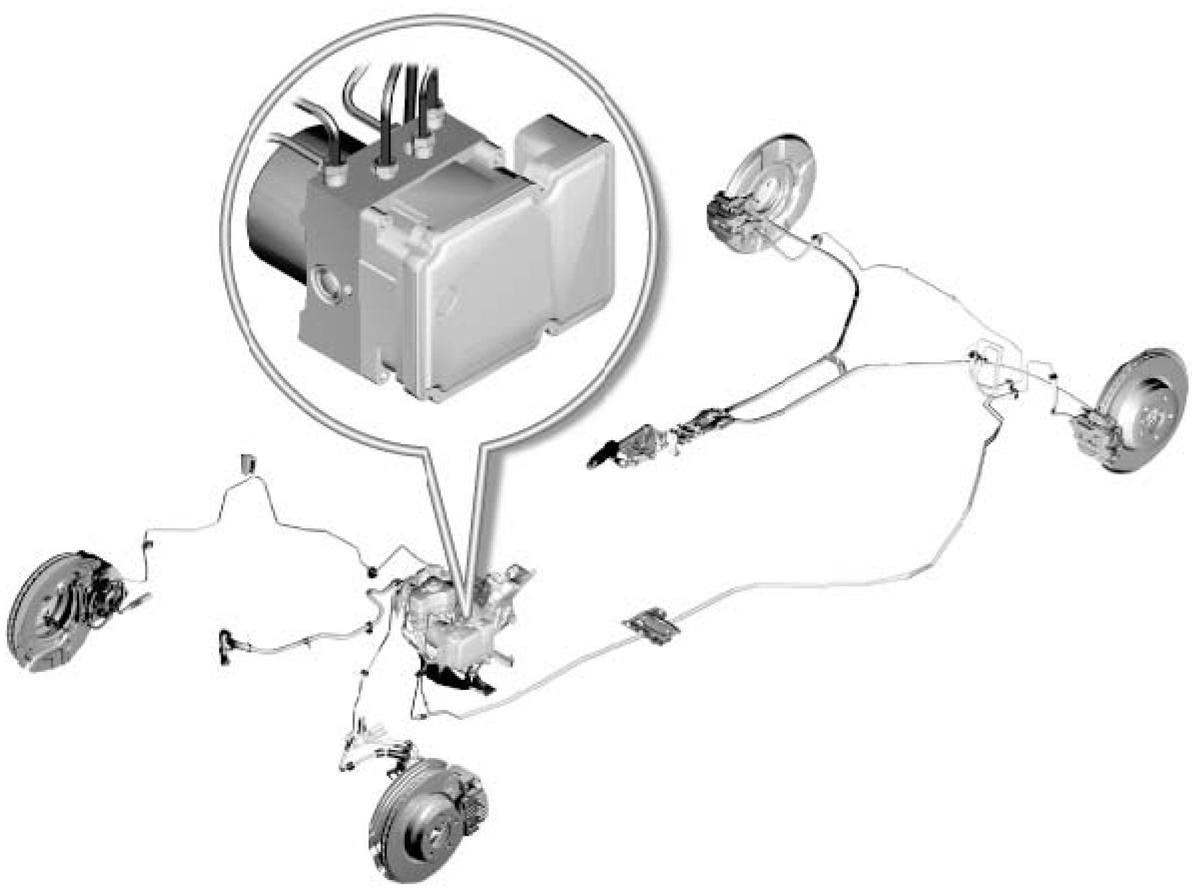
In the MK60E5 the designation "E5" represents the 5 pressure sensors which are integrated into the hydraulic control unit:

- 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

Note: That the labeling of the DSC button has been changed to DTC and the MK60E5 system will also be used on the New M5.

The new functions available on the MK60E5 DSC system are a result of the following additional components:

- Solenoid valves with variable map for flow rate - utilizes a PWM signal
- 5 brake pressure sensors integrated in the new DSC module
- 4 active wheel-speed sensors with direction of rotation detection
- 1 longitudinal-acceleration sensor on the circuit board of the DSC control module
- DSC sensor taken with redundant signals on vehicles with Active Steering (2x rate of yaw, 2x lateral acceleration)



Fading Support

High temperatures (>550°C) can occur at the brake discs when brakes are applied over a long period (i.e. brakes applied while traveling downhill) or as a result of multiple "extreme" brake applications (i.e. applied pressure >80 bar). As the temperature of the brake disc increases, the level of friction that can be generated when the brake pads are applied is decreased (coefficient of friction is reduced as brake disc temperature increases), which can result in a diminishing brake effect (fading).

In order to reduce the brake "fading" effect the DSC system (MK60E5) calculates the temperature of the brake discs, based on:

- Applied brake pressure
- Duration of brake application
- Rate of vehicle deceleration

In the event the DSC system detects fading, brake pressure is increased in line with the calculated temperature model in order to maintain a constant ratio of brake pedal force to vehicle deceleration (if necessary, pedal travel is increased to compensate for the fading effect).

The DSC system detects fading as follows:

- DSC compares the current vehicle deceleration with a nominal value based on the current brake pressure.
- DSC increases brake pressure until the nominal deceleration is achieved or until all wheels are subject to ABS control.
- Process is ended when the brake pedal is released.

Note: The increase in brake pressure depends on road speed (under 100 km/h).

At the time this function is activated, a Check-Control message (brake warning light) appears in the LCD display in the instrument cluster (warning threshold 1). If the brake-disc temperature increases further, the legally stipulated brake warning lamp is also activated (warning threshold 2).

Braking Readiness

If the DSC system notices that the accelerator pedal is released quickly, the brakes are immediately pretensioned, to shorten the brake apply response time. To accomplish this task the DSC system generates a low braking pressure by applying a PWM signal to the solenoid valves, without creating any measurable deceleration of the vehicle. By applying a small amount of brake pressure the working clearance between the brake pads and brake disc is reduced. If the brakes are not applied within a certain time, the brake pressure that was applied is reduced.

The pre-tensioning of the brakes depends on the vehicle's speed (above 70 km/h).

The Brake Readiness function is activated under the following conditions:

- Vehicle speed > 70 km/h
- Minimum time between rapid accelerator pedal release and brake application < 8 sec. (DME provides the signal regarding rapid release of accelerator pedal to DSC via PT-CAN)

Brake Disk Drying

Brake disk drying removes moisture that gathers on the brake disks while traveling on wet roads or in the rain.

In order to dry the brakes while the vehicle is traveling down the road, the DSC module generates a low brake pressure which ‘lightly” applies the brakes disks and “wipes down” the disks without creating a measurable deceleration of the vehicle.

The application of the low brake pressure signal is done on a cyclical (regular) basis and is dependent on:

- Road speed (greater than 70 km/h
- Signal from rain sensor indicating continuous wiper operation (e.g. stage 1 or 2)

The drying action cycle is performed approximately every:

- 200 sec during stage 1 operation
- 120 sec during stage 2 operation

Note: The cycle is altered if the brakes are applied by the driver during these times.

This function results in a shorter response time if the brakes are applied during the cyclical low brake pressure application.

Soft Stop

Soft stop prevents a “jerky” stop causing the occupants to "lurch" forward, when braking the vehicle to a standstill.

Activation of function:

- Light brake application (<25 bar) under constant pressure
- Road speed (under 5 km/h)

The soft stop function reduces the braking pressure at the rear axle just prior to the vehicle reaching a complete stop in order to reduce “jerking/jolt” effect normally encountered when reaching a standstill. The DSC system calculates the moment that standstill can be expected based on the current road speed plus rate of deceleration and reduces braking pressure accordingly.

Start Assist

The start-off assistant prevents the vehicle from moving unexpectedly, based on the degree of incline, as the driver releases the brake pedal and moves to the accelerator pedal (ie. when pulling away on a hill).

The “start assist” function is accomplished as follows:

- Gradient (degree of incline) is determined by the longitudinal-acceleration sensor located in the DSC control module.
- Based on the degree of incline, the necessary braking torque or engine torque is calculated by the DSC module.
- Brake pressure needed to hold the vehicle is momentarily maintained (approx 2 sec).
- Brake pressure is reduced as soon as the available engine torque is sufficient to move the vehicle or accelerator is not depressed within approx. 2 sec.

The function can be activated when driving forward or backwards and is deactivated when the parking brake is applied and can not be activated if the transmission is in neutral.

Note: If no move is made to pull away within approx. 2 seconds of the brake pedal being released, the start-off assistant will be deactivated.

Electronic Control Brake (ECB) Actuation Interface

The interface between Dynamic Stability Control (DSC) and Active Cruise Control (ACC) has been improved with the introduction of the Longitudinal Dynamic Management (LDM) system, which is responsible for the transmission of the signals associated with ACC/cruise control operation.

The software in the DSC control module has been enhanced and allows the demands of the ACC to be evaluated more quickly thereby allowing pressure at the brakes to be built up or reduced more efficiently with regard to vehicle deceleration and comfort.

Yaw Moment Compensation

With conventional systems, the driver has to actively steer the vehicle in a straight line if the brakes are applied on a road surface with non-uniform traction levels ("split μ"). In this situation counter steering keeps the vehicle in its track and helps to achieve acceptable braking distances.

On the E90, if the vehicle is equipped with the Active Front Steering (AFS) option and brakes are applied on a road surface with non-uniform traction levels ("split μ"), DSC in conjunction with AFS, initiates the active steering actions in order to stabilize the vehicle and shorten the braking distance. The function is accomplished by having the DSC control module calculate the yaw rate plus interpret information from the front steering angle sensor and transmit the information to the AFS control module, which establishes the yaw-moment compensation correction angle needed for stabilization/counter steering.

System Components

The DSC system consists of the following:

Inlet & Distribution Valves

These solenoid valves used to be digitally actuated: either OPEN or CLOSED.

On this system the inlet valves for the wheel brakes and distribution valves are actuated in such a way that the flow rate is variably controlled via a PWM signal.

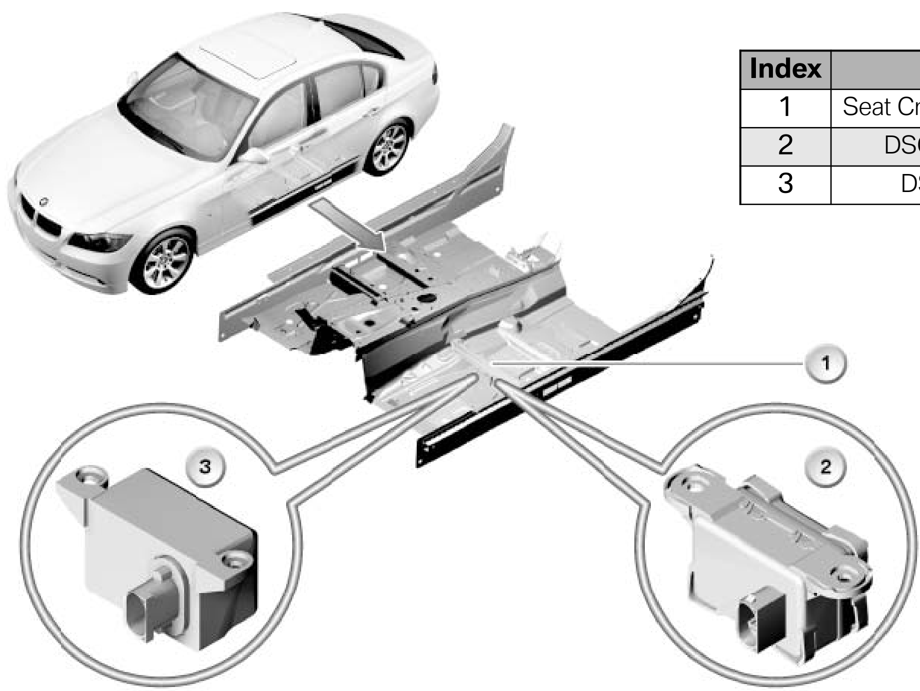
Wheel-Speed Sensors

Four active wheel-speed sensors measure the speed of the individual wheels. This type of sensor is also able to recognize the direction of wheel rotation.

DSC Sensor

The DSC sensor on vehicles equipped with active steering utilizes 2 yaw rate sensor elements to transmit redundant signals capturing the rate of yaw (rotation about the vertical axis) and lateral acceleration to the AFS module via the chassis CAN (F-CAN)

Index	Explanation
1	Seat Cross Member Driver's Side
2	DSC Sensor without AFS
3	DSC Sensor with AFS



DSC Module

The DSC module consists of the hydraulic module and the DSC control electronics.

All 5 brake pressure sensors are integrated into the valve block of the DSC module.

Note: The circuit board of the DSC control module also contains an integrated longitudinal-acceleration sensor which is used for the start assist function.

Steering-Angle Sensor

The steering angle sensor is located in the steering column switch cluster (SZL) and optically measures the angle of rotation of the steering wheel.

Signal path to the DSC control module: Steering column switch cluster -> F-CAN (looped through JBE) -> DSC control module

DTC Button

The DTC button is located in the center console between the central air vents and has three operating modes:

1. DSC operational (standard setting)
2. DTC operational (If DTC button is depressed once DSC switches Off)
3. DSC and DTC completely deactivated (If DTC button is depressed for extended period)

Signal path to the DSC control module: DTC button -> JBE -> PT-CAN -> DSC module

The instrument cluster receives the signal through the K-CAN.

Brake Fluid Level Switch

If the brake fluid level is too low, this will be detected (via a reed contact in the expansion tank) and an appropriate message is sent to the DSC control module.

DSC is deactivated if there is insufficient brake fluid.

Signal path to the instrument cluster: DSC module -> PT-CAN -> JBE -> K-CAN -> Instrument cluster

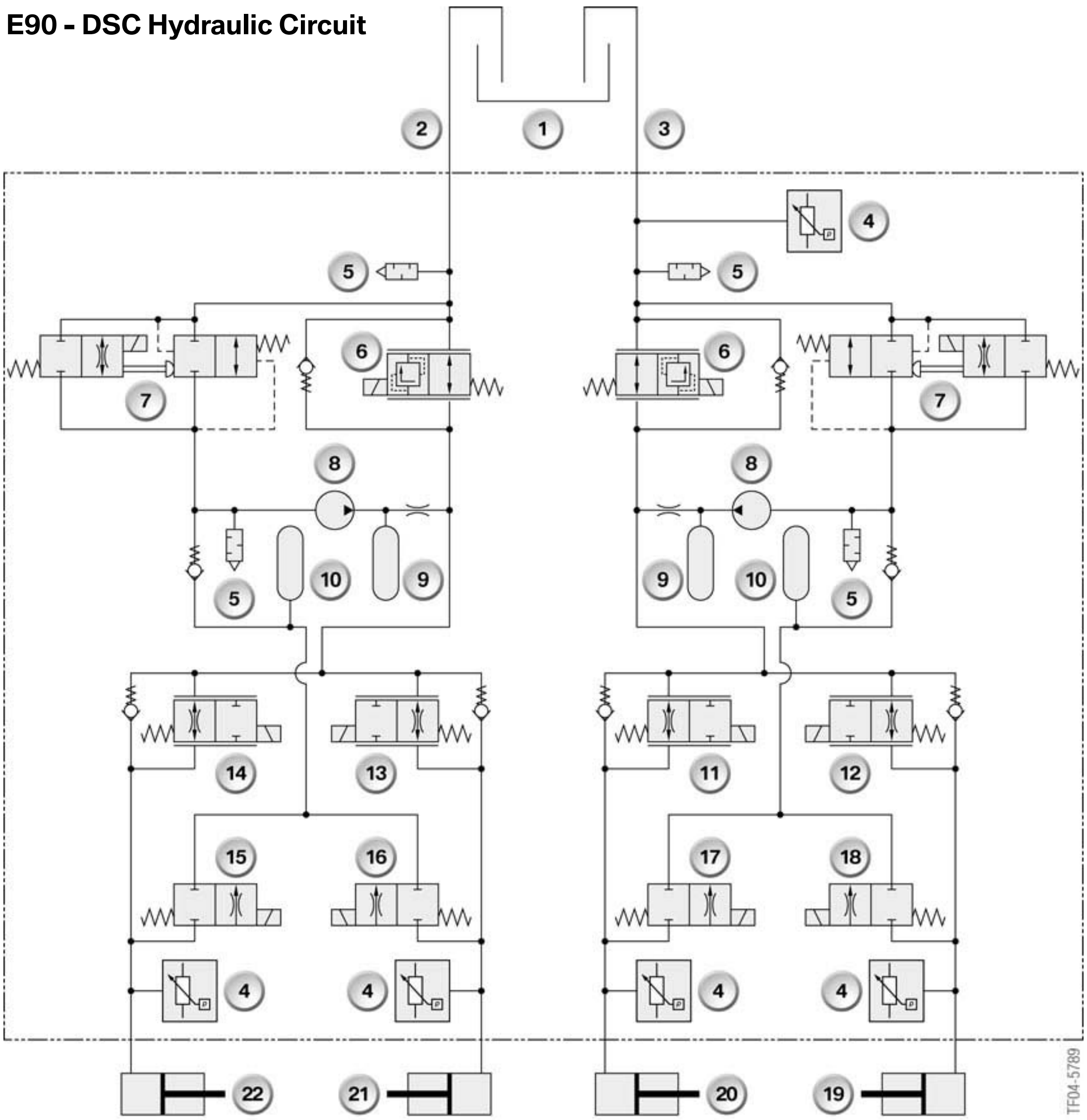
Brake Light Switch

Together with the signals from the brake pressure sensors, braking actions are recognized.

Parking Brake Warning Switch

DSC will recognize skidding that has been deliberately initiated by the driver and regulation will not take place, since a handbrake turn should remain technically possible.

E90 - DSC Hydraulic Circuit



Index	Explanation	Index	Explanation
1	Brake Fluid Expansion Tank	12	Inlet Valve (Analog), Right Front with Switching Orifice
2	Rear-axle Brake Circuit	13	Inlet Valve (Analog), Right Rear
3	Front-axle Brake Circuit	14	Inlet Valve (Analog), Left Rear
4	Pressure Sensor, Push Rod Circuit	15	Outlet Valve, Left Rear
5	Pulsation Damper	16	Outlet Valve, Right Rear
6	Isolating Valve	17	Outlet Valve, Left Front
7	Electric Changeover Valve	18	Outlet Valve, Right Front
8	Self-Priming Return Pump	19	Wheel Brake, Right Front
9	Damper Chamber	20	Wheel Brake, Left Front
10	Accumulator Chamber	21	Wheel Brake, Right Rear
11	Inlet Valve (Analog), Left Front with Switching Orifice	22	Wheel Brake, Left Rear

Sensor Information

Sensor	Functional principal	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 DSC control module	
5 pressure sensors	Integrated in hydraulic block	
Brake light switch	Hall principle	
Brake-fluid level switch	Reed contact switch	

* Wheel-speed sensors with grey shield = MK60E5 with direction-of rotation detection (the braking response when traveling in reverse is different then it is for vehicle traveling forwards, output to navigation system, EGS etc.)

* Wheel-speed sensors with black shield = MK60psi (Used on E87 Non U.S. Model) does not have direction of rotation capability

** For the start assist function

General Overview

The DSC system is a Driving Stabilization System and offers the following advantages:

- DSC optimizes driving stability when pulling away, accelerating, braking and coasting.
- DSC recognizes and reduces unstable driving conditions such as understeering or oversteering.
- DSC improves traction, especially with Dynamic Traction Control (DTC)

Within the limitations of the laws of physics, DSC helps to keep the vehicle on a safe course.

To do this, DSC must know the following parameters regarding the vehicles driving dynamics:

- Yaw rate as a measure of rotary movement of the vehicle around the vertical axis
- Lateral acceleration
- Road speed
- Longitudinal acceleration

In addition, the driver's intentions are recognized via input from:

- Steering angle sensor
- Brake pressure sensor
- Throttle setting/ accelerator pedal position

The values are used to establish the actual condition in which the vehicle is currently moving and to compare these values with those calculated by the DSC control module. If the actual values differ from the calculated values, DSC is activated and initiates brake actions or engine control functions.

Advantages:

The DSC system counters all dynamically unstable driving conditions within the physical limitations dictated by the laws of physics, to enhance driving comfort and safety.

Anti-lock Braking System(ABS)
ABS prevents the wheels from locking when the brakes are applied.

Advantage: Optimum utilization of road surface friction - the vehicle remains stable and steerable.

Brake pressure is regulated at all wheels to ensure that each wheel runs with optimum slip. When this happens, slip is controlled so that the maximum possible braking and lateral stability forces can be transmitted.

Electronic Brake Force Distribution (EBV)
EBV is a component of ABS and controls the brake force distribution between the front and rear wheels.

Advantage: Regardless of the vehicles load state, the best possible braking distance is achieved while maintaining driving stability.

Modern vehicles have relatively large brakes on the rear axle to shorten braking distances. To prevent the rear wheels from being overbraked in certain driving situations, EBV permanently monitors wheel slip and controls rear axle slip independent of the front axle.

Cornering Brake Control (CBC)
CBC is an extension of ABS. CBC enhances driving stability if the brakes are applied when cornering.

Advantage: If the brakes are applied in a corner, optimum brake force distribution ensures tracking stability.

When cornering, even very light braking can shift the axle-load distribution to the left or right so that driving stability is impaired. If required, CBC generates a stabilizing load moment when the brakes are applied lightly outside the ABS intervention range.

Automatic Stability Control (ASC)
ASC prevents the wheels from spinning when the vehicle is accelerating.

Advantage: Improved traction and vehicle stability.

If one of the wheels of the drive axle is on a high-grip surface and the other is on a slippery surface, the wheel tending to skid is braked.

ASC also intervenes in the engine control (to reduce the ignition angle, injection quantity, throttle valve setting) in order to reduce/inhibit vehicle acceleration in the event of wheel slip.

Dynamic Traction Control (DTC)
The functions of the DTC correspond to those of DSC with a slightly modified regulating characteristics. DTC is activated by deactivating DSC (DTC button depressed). DTC intervenes in the braking actions to imitate the function of a conventional differential lock.

Advantage: DTC allows better traction.

Vehicle stabilization intervention (e.g. reduced power output) is delayed slightly, compared to DSC, which enhances traction with a slight loss of driving stability.

This function offers a compromise between driving stability and traction, especially when accelerating and/or driving uphill on a loose surface or snow-covered road surface (surface friction requiring more slip).

DSC provides a high degree of driving stability with adequate traction, however DTC offers better traction with a slight reduction in stability. Therefore, the deactivation of DSC should be reserved for emergencies (driving in deep snow, for example).

Engine Drag Torque Control (MSR)
If the vehicle is operated in low gear while coasting downhill or if is the vehicle is suddenly shifted into a lower gear, the drive wheel may be slowed down by the engine braking effect to rapidly which can result in an unstable operating condition, resulting in the drive wheels locking up.

Engine Drag Torque Control (MSR) provides protection against locking of the drive wheels.

Advantage: The drive wheels retain their lateral stability in overrun mode.

The wheel speed sensors tell MSR as soon as the wheels are about to lock. MSR then briefly reduces the engine's drag torque by opening the throttle slightly.

Dynamic Brake Control (DBC)
DBC supports the driver in emergency braking situations. It does this by automatically increasing braking pressure if the brake pedal is not depressed with sufficient force.

Advantage: Shortest possible braking distances in emergency braking situations by achieving ABS regulation on all four wheels.

The brake pedal is frequently not depressed strongly enough in emergency braking situations. The ABS feedback control range is not reached (or not on all 4 wheels).

RPA: Tire Defect Indicator

RPA is not a driving dynamic function.

DSC uses the Run Flat Indicator (RPA) to monitor the tire pressure throughout the journey.

The RPA records the wheel speeds using the wheel-speed sensors of the Dynamic Stability Control (DSC). The RPA compares the speeds of the individual wheels with the average speed. In this way the RPA is able to detect a loss of tire pressure.

The RPA detects a drop in pressure below about 30% ± 10% of the initial value. The RPA indicator and warning light indicates a drop in tire pressure.

The RPA will indicate this after just a short distance, as a rule after a few minutes, from a certain minimum speed (e.g. 25 km/h) up to the permissible top speed.

Initialization is started manually. Then (after a journey has started), initialization runs automatically. In other words, the circumference of individual tires are recorded and evaluated.

The initialization phase lasts approx. 5 to 15 minutes for the individual speed ranges.

CBS: Condition Based Service

CBS is not a driving dynamic function.

Condition Based Service, as the name suggests, is a means of ensuring that the car is serviced as and when necessary. CBS comprises various maintenance operations, e.g. engine oil, spark plugs and brake pads.

The remaining distance for the front and back brake pads are calculated separately in the DSC control module.

When making the calculation, the condition of the brake pad wear sensors is taken into account (reference point at 6 mm and 4 mm).

Important !!! **Refer to ST056 Chassis Dynamics for more detailed information regarding the operation of the DSC System Functions.**

Workshop Exercise - Dynamic Stability Control

Check procedure for initialization of steering angle sensor using diagnostic equipment (DISplus/GT1).

Classroom Exercise - Review Questions

1. What new function are introduced with the MK60E5 system and what do they do?

2. On what other vehicle will MK60E5 be used?

3. What is the purpose of the 5 pressure sensors?

4. What is Yaw Moment Compensation? What option must the vehicle have installed?

5. What is different with the DSC button??

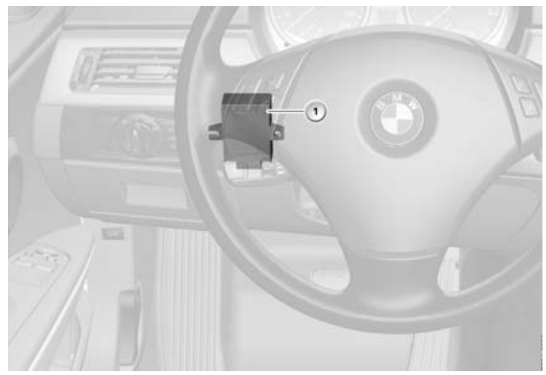
6. What is different with the wheel speed sensors used on the E90?

Longitudinal Dynamics Management

In previous BMW vehicles acceleration control was calculated by different modules (DME, DSC, ACC etc.) in order to activate the corresponding actuators with the relevant control signals. To take control of the increasing system complexity and reduce the number of possible variants that can exist, a new Longitudinal Dynamics Management (LDM) system is installed in the E90 which serves as the primary controller for DCC or ACC operation.

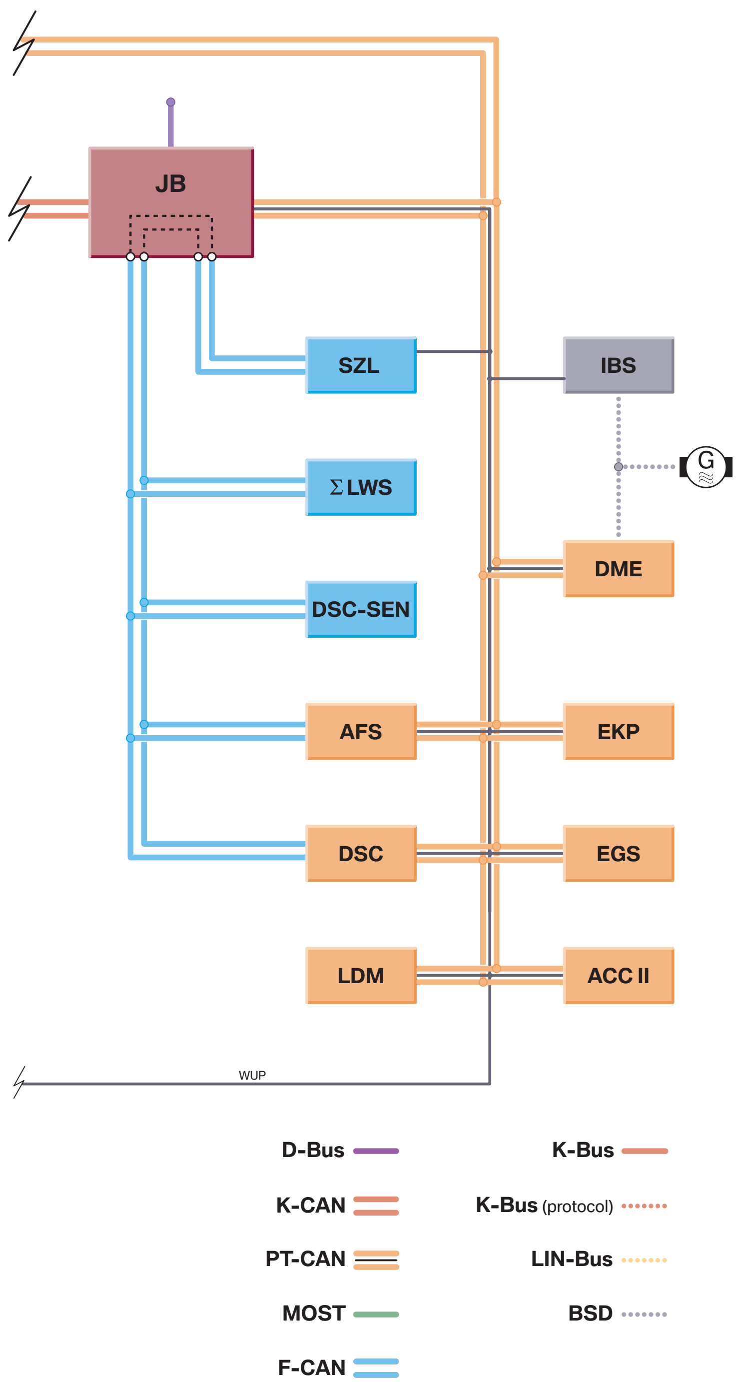
The LDM module records/monitors the requests/inputs received, calculates the corresponding setpoint/threshold values and forwards the information to the various control systems (i.e. DME, EGS, AFS, ACC, DSC, etc.).

The Longitudinal Dynamics Management (LDM) system is an independent control module (1) that is located behind the light switch in the E90.



Functions Implemented by LDM

The Longitudinal Dynamics Management (LDM) control module evaluates all relevant data for cruise control (i.e. ACC sensor sends the monitored vehicle information to the LDM control module for evaluation) and transmits information via PT-CAN to the other control modules (DME, EGS, DSC, ACCII, etc.).



The following functions are implemented within the LDM module:

Operator Interface
Receives data from the steering column stalk, such as acceleration, deceleration, activation or deactivation request.

Display Interface
Controls the output of information to the driver (ie. display of desired speed, desired distance, driver takeover request).

Status Control
Evaluates the drivers specifications (speed (v), setpoint/actual and yaw rate) and assigns each to one of the three responsible processing modules.

Vehicle Speed Controller
Calculates the acceleration/deceleration setpoint variable on the basis of the desired speed and the actual speed.

Lateral-Acceleration Controller
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.

Prioritizer
Decides which acceleration setpoint value is used by the cruise control and if necessary adaptive cruise control plus identifies how the Acceleration Controller can best alter/adjust vehicle acceleration or deceleration.

Interference Factor Estimator
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
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
Coordinates and controls the system partners DME, EGS and DSC, by outputting a set-point wheel braking torque and a brake release signal to the DSC and a setpoint wheel drive torque with drive release to the DME.

Monitoring
Monitors all the signal variables coming into the LDM. The programmed safety measures are also implemented here.

The in the E90 LDM has the following interface parameters:

- Steering column switch cluster (SZL)
- Instrument cluster (KOMBI)
- Brake (DSC)
- Drive (DME and EGS)
- Active Cruise Control (ACC sensor; optional extra)
  - Driver's footwell module (FRM; direction indicator)
  - Anticipatory Action for the overtaking assist function (direction indicator) Only with ACC!
- Car Access System (CAS; terminal status)

Diagnosis/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.

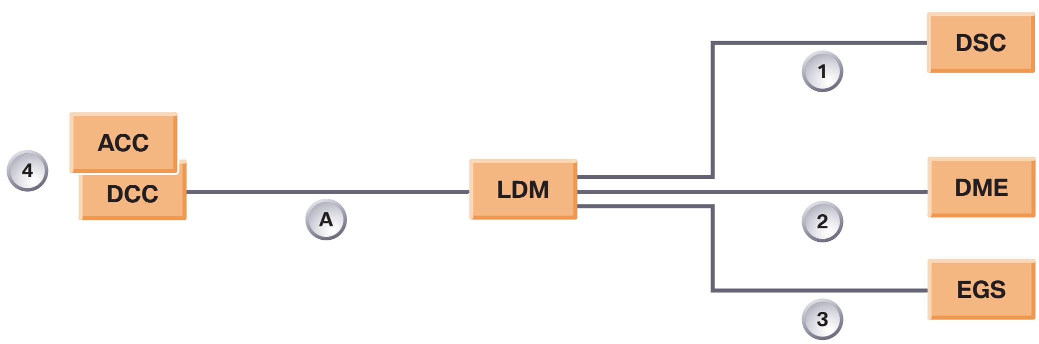
LDM Overview

The LDM is a control module that is used for drivetrain and brake coordination purposes , plus provides significant improvement with regard to automatic cruise control (ACC or DCC) with a general control function capability ranging from requesting acceleration to requesting braking (integrated function).

Interface: PT-CAN

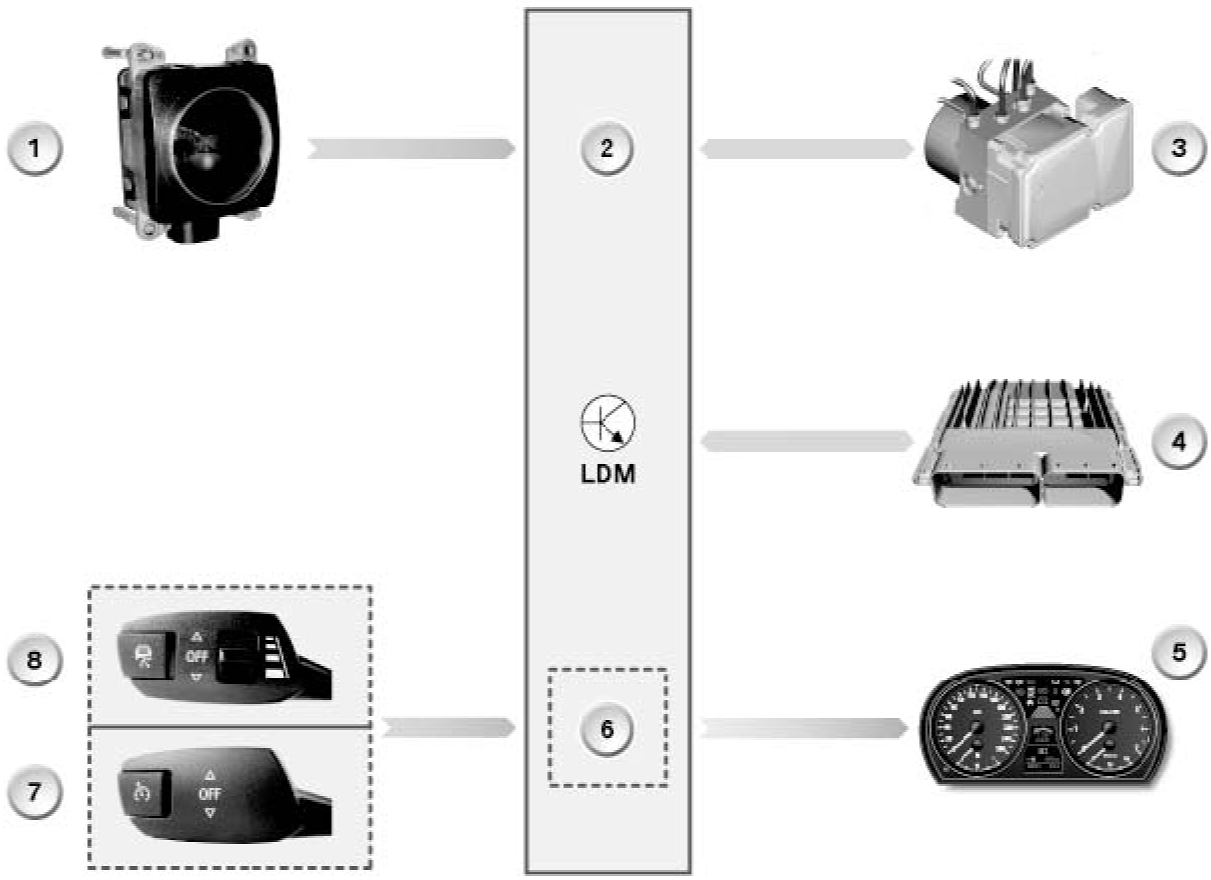
The LDM serves two primary functions:

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



Index	Explanation	Index	Explanation
1	Wheel Torque for Braking	DME	Digital Motor Electronics/Digital
2	Wheel Torque for Accelerating	DCC	Dynamic Cruise Control
3	Gearshift Request	DSC	Dynamic Stability Control
4	SZL Switch Inputs	EGS	Electronic Transmission Control
A	+/- setpoints / F-CAN	LDM	Longitudinal Dynamics Management
ACC	Active Cruise Control		

Longitudinal Dynamics Management - Input/Output



Index	Explanation
1	ACC sensor (if equipped)
2	LDM Module
3	DSC Module
4	DME/ECM Module
5	Kombi
6	Cruise Control with Braking Function (Integrated in LDM)
7	Cruise Control Stalk with DCC
8	Cruise Control Stalk with ACC

Classroom Exercise - Review Questions

1. Where is the LDM located?

2. What function is integrated into the LDM module?

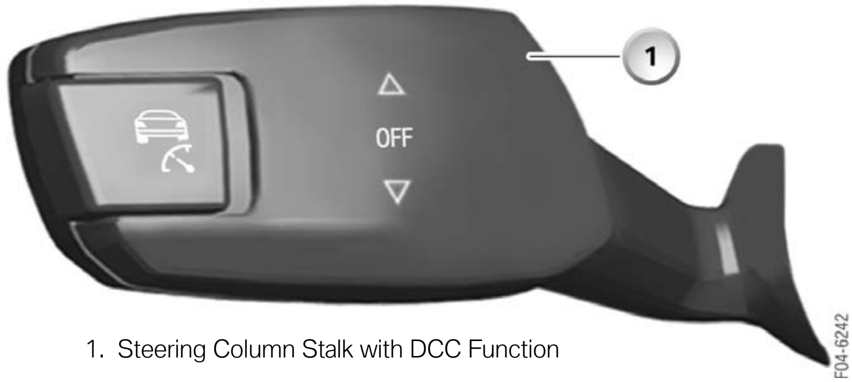
3. With what modules does the LDM interface?

NOTES PAGE

Dynamic Cruise Control (DCC)

For the U.S. market, the new E90 provides the customer with the ability to choose between two cruise control systems (DCC or ACC) which are available for the 6 cylinder engine variant.

Option 544: Dynamic Cruise Control (DCC) with braking function



1. Steering Column Stalk with DCC Function

Function

The new Dynamic Cruise Control (DCC) with brake function maintains the set speed at a constant level even on downhill gradients.

- Accelerating to the set speed - Engine intervention via the DME (acceleration of approx. +1.2 m/s^2)
- Decelerating to the set speed - Independent brake intervention via the DSC (DCC achieves a maximum deceleration of -2.5 m/s^2)
- Lateral acceleration is restricted to max. 4.0 m/s^2

In order to realize these functions the system requires the use of the Longitudinal Dynamics Management (LDM) , which is used to supply data/driver request signals to the DME.

Important!!!

Cruise control does not relieve the driver of his personal responsibility. Cruise control is a comfort system. Adjustments by the driver will always have a higher priority than cruise control.

The driver should decide whether (and how) the system is used based on road and traffic conditions and visibility.

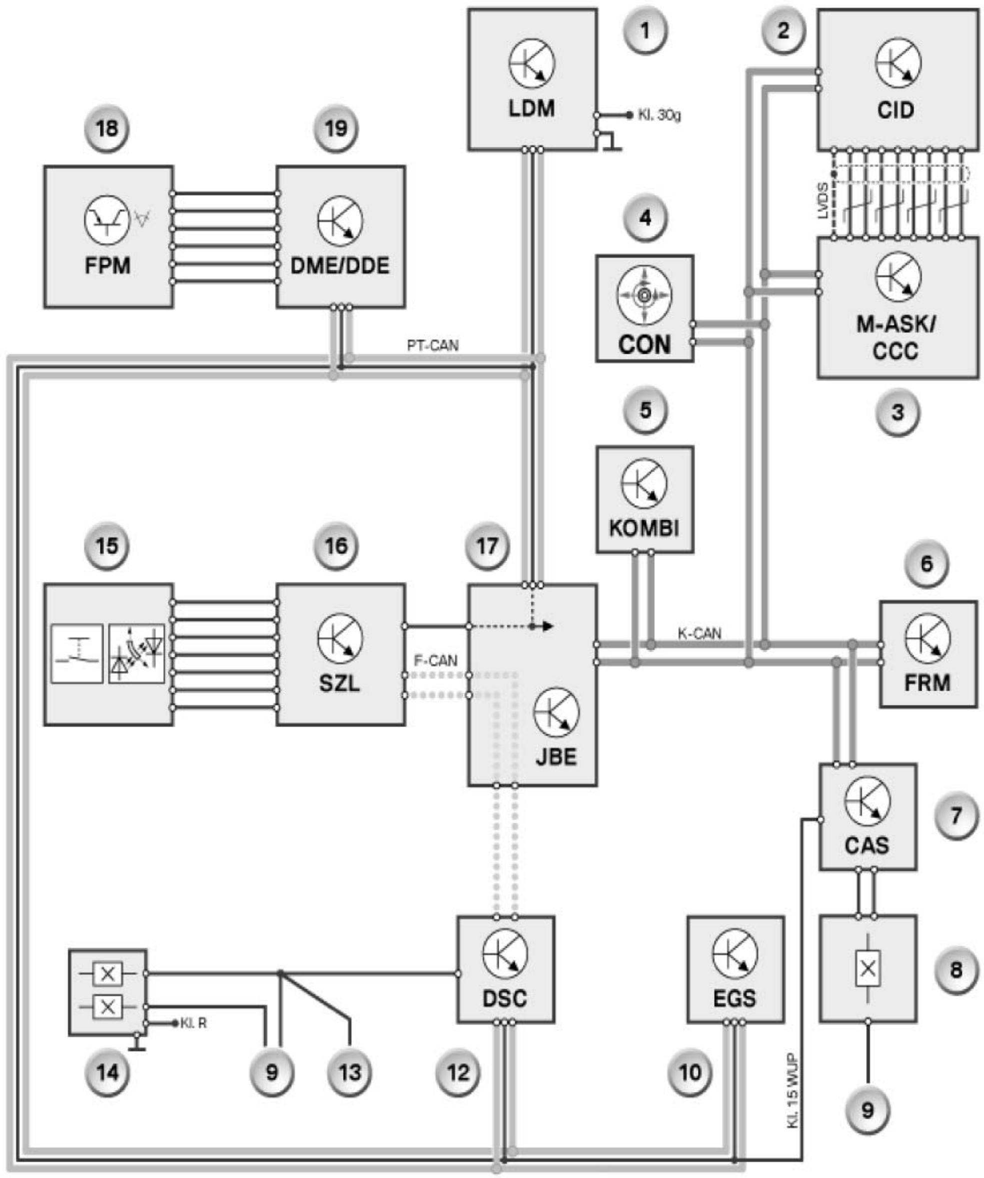
When the cruise control is active, the brake lights are actuated during automatic braking (required by law). If automatic braking is actuated, a signal is sent from the DSC to the Footwell Module (FRM).

Advantages

The advantage of the Dynamic Cruise Control with the brake function compared to a Cruise Control system without a braking function are:

- Constant road speed, even downhill is maintained as a result of brake intervention via the DSC
- Lateral acceleration in bends is restricted to a comfortable level
- Indicator disc in the instrument cluster shows the set speed
- Brief display in the LCD display of the instrument cluster when a speed is selected or previous setting is changed

Components Involved with DCC Function



Legend for Components Involved with DCC Function

Index	Explanation	Index	Explanation
1	Longitudinal Dynamics Module (LDM)	14	Brake Light Switch
2	Central Information Display (CID)	15	Cruise Control functions on SZL
3	Car Communication Computer (CCC)	16	Steering Column Stalk (SZL)
4	Controller (CON)	17	Junction Box Electronics (JBE)
5	Instrument Cluster	18	Accelerator Pedal Module (FPM)
6	Footwell Module (FRM)	19	Digital Engine Electronics (DME/ECM)
7	Car Access System(CAS)	Kl. 15 WUP	Activation wire from CAS (Terminal 15 wake-up)
8	Clutch Module	KL.30g	Terminal 30g active
9	To Digital Engine Electronics (DME/ECM)	F-CAN	Chassis CAN
10	Electronic Transmission Control (EGS)	K-CAN	Body CAN
11	N/A	LVDS	LVDS (Low Voltage Differential Signalling) data line
12	Dynamic Stability Control (DSC)	PT-CAN	Powertrain CAN
13	To Footwell Module (FRM)		

Cruise Control System Steering-Column Stalk
Cruise control is set and called up using the cruise control system steering-column stalk.

LDM Control Module (LDM)
The LDM is the interface to the engine and to the brake system.

In the LDM, the driver's entries regarding the cruise control system are monitored and evaluated. The Dynamic Cruise Control with brake function is integrated in the LDM.

If the Active Cruise Control option is installed, the LDM evaluates the data sent from the ACC sensor.

Instrument Cluster
The instrument cluster shows all displays for cruise control.

- Indicator disc in the round instrument shows the set speed.
- LCD display briefly shows the newly selected set speed (for approx. 6 seconds).
- LCD display also shows a Check-Control message.

DSC: Dynamic Stability Control
The current status of the vehicle is determined by the DSC by evaluating the following sensor signals:

- Yaw rate (measure of movement of the car about its vertical axis)
- Steering angle
- Brake pressure
- Wheel speeds (measure of the car's Road speed)

The DSC transmits data regarding the current vehicle status to the LDM, such as:

- Function request for current deceleration
  With automatic braking, the brake lights are activated depending on the deceleration values (legally prescribed).

Example: *The DSC is notified of a function request from the LDM via the PT-CAN to reduce the road speed. To fulfill this request, DSC intervenes in the brake system (goal: comfortable brake deceleration. No DSC intervention with regard to enhanced operating stability.)*

Digital Engine Electronics (DME/ECM)
The DME controls engine intervention (for example, reduction in engine output to reduce Road speed):

- Current torque request data is transmitted by the LDM to the DME
- Driver's command (signals from accelerator pedal module) data is transmitted to the LDM from the DME

Junction Box Electronics (JBE)
The JBE is the data interface/gateway between the K-CAN and the PT-CAN.

Accelerator Pedal Module
The accelerator pedal module signals the driver's command. This signal is required to check the respective driving status and is evaluated via the DME.

By pressing the accelerator pedal, the speed setpoint of the cruise control can be overridden at anytime.

Brake Light Switch
With the signals from the brake pressure sensors, braking actions are recognized. Cruise control is deactivated if braking actions are necessary.

Clutch Module (manual transmission only)
Clutch engagement/disengagement is recognized by a signal from the clutch module. During the clutch engagement/disengagement process, the engine speed is maintained at an optimal speed range by the DME. After the clutch has been reengaged, the DME will adjust back to the current torque request from the cruise control.

If the engine speed is too low or too high, the driver will be requested to change gear. This request is issued in the form of an acoustic signal and a Check-Control message.

Steering-Column Switch (SZL) Cluster
The SZL processes all data from the cruise control system steering-column stalk. The evaluated switch signals are transmitted onto the F-CAN as a CAN message.

Signal path: Cruise control inputs via stalk -> SZL -> F-CAN -> DSC ->PT-CAN -> LDM

Footwell Module (FRM)
When cruise control is in operation, the brake lights are actuated during automatic braking (legal requirement). To do this, a signal must be sent from the DSC to the footwell module via the PT-CAN.

Car Access System (CAS)
The CAS provides input signals relating to terminal status (e.g. terminal 15 ON).

Car Communication Computer (CCC) & Central Information Display (CID)
The CCC serves as the interface to the CID. The CID displays detailed information about the Check-Control messages. To back up the Check-Control message, CCC emits an acoustic warnings through the loudspeakers. The instrument cluster controls these warnings by means of the K-CAN.

Electronic Transmission Control (EGS) or SMG
The evaluated cruise control data is sent from the LDM to the DME. The EGS evaluates the data from the DME. The adaptive transmission control (component of the electronic transmission control) adjusts the shift characteristics of the driving program to the driver's commands and the driving situation.

System Deactivation

DCC can be activated from ***30 km/h (settable up to max. 250 km/h***) and is deactivated in the same manner as conventional/previous cruise control systems:

- Brake pedal actuation
- Deactivation of DSC
- Activation of DTC
- Active DSC intervention
- Deactivation by the driver
- Speed is reduced below 20 km/h
- In automatic transmissions: selection of "N"
- For manual gearboxes the system remains activated during a gearshift:

  Only if the clutch is deactivated for more than approx. 4 to 6 seconds, does the cruise control shut down. (If no gearshift or change in engine speed is made within 5 seconds of such a signal, cruise control will be deactivated.)

In the event of an operational/system error, the following Check Control (CC) message will appear:

Automatic Deactivation

System Malfunctions

Note: Unlike conventional cruise control, the driver 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.

Classroom Exercise - Review Questions

1. What is DCC ?

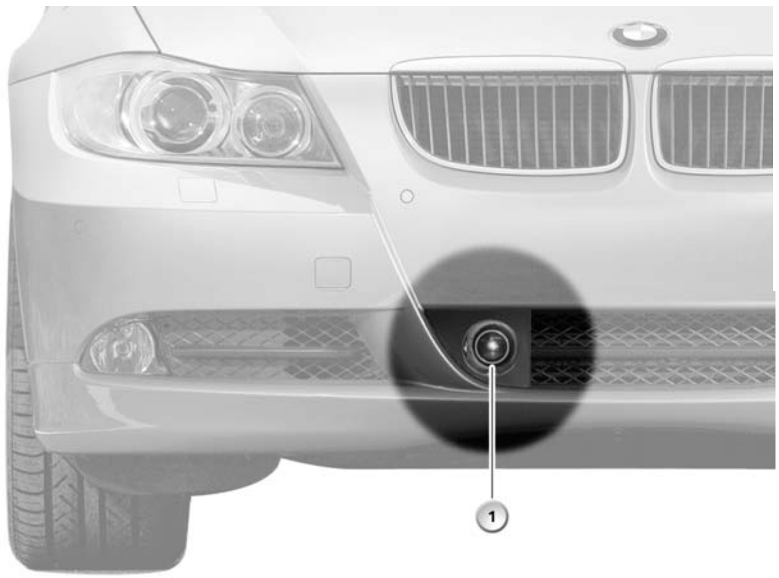
2. What is the advantage of DCC over previous conventional cruise control systems?

3. What function does the Junction Box Electronic Control Module serve with the DCC system?

4. What is the purpose of the Footwell Module (FRM) in the DCC system?

Active Cruise Control (ACC)

The 2nd generation ACC system was introduced on the E63/E64 (6 Series), with some minor modification this further developed ACC is offered in the E90.



Index	Explanation
1	ACC Sensor
2	ACC Stalk (SZL)

The Active Cruise Control (ACC) option provides cruise control function plus is able to maintain comfortable spacing from the vehicle a head.

The distance from the vehicle ahead can be selected from 4 fixed timed separations. As speed changes, so does the distance to the vehicle ahead. The legally prescribed minimum distance is not undershot in the adjusted status.

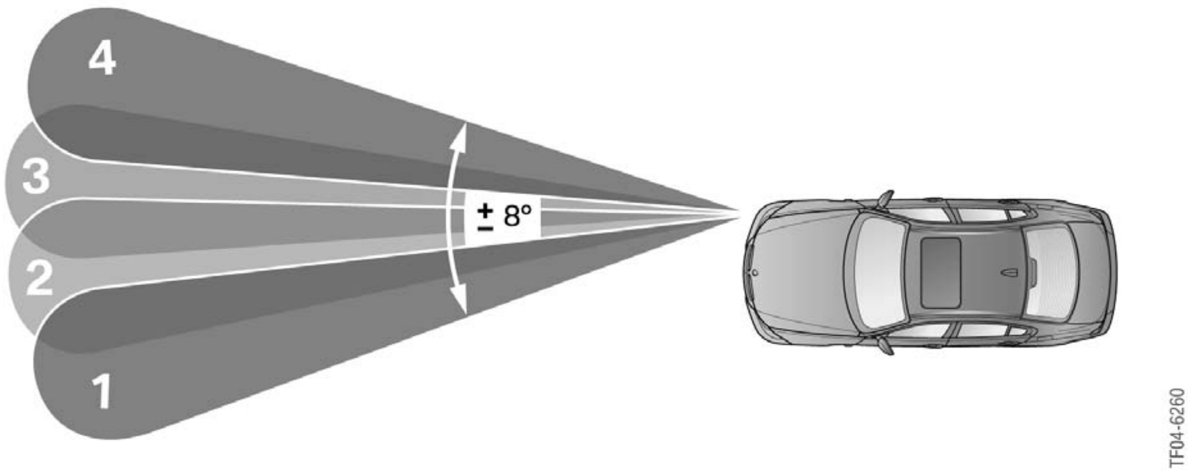
Differences between the Active Cruise Control option in the E90 and the Active Cruise Control option in the E63/E64:

- In the E90, the data for the Longitudinal Dynamics Management is evaluated in the LDM control module.
- In the E63/E64, the data for the Longitudinal Dynamics Management is evaluated in the ACC control module.

Important!!!

Cruise control does not relieve the driver of his personal responsibility. Cruise control is a comfort system. Adjustments by the driver will always have a higher priority than cruise control. The driver should decide whether (and how) the system is used based on road and traffic conditions and visibility.

Difference between 2nd Gen. and 1st Gen ACC



- 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.

Functions of ACC

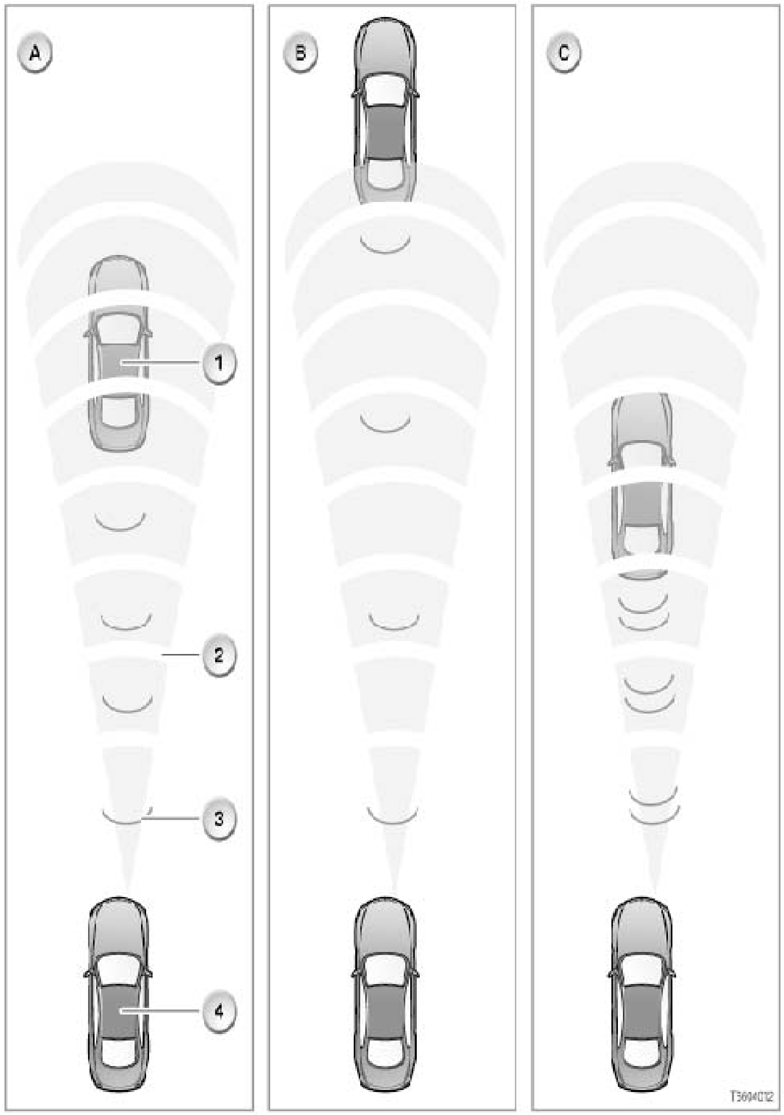
The Active Cruse Control (ACC) option contains several differences when compared to a conventional system such as:

- Monitor object ahead
- Cruise control
- Lens heating
- Low-voltage cutout and high-voltage protection for ACC sensor
- Self-diagnosis and compensation for minor horizontal adjustments

Monitor Object Ahead

The ACC systems views any vehicle traveling in the same lane as the subject vehicle, as an object. The operating limits of the system are as follows:

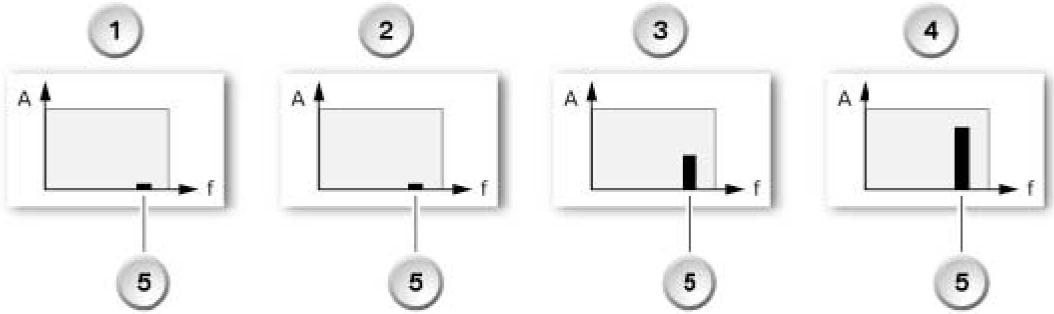
- **Object Detection**
  The range of the ACC sensor is limited (approx. 120 meters).
- **Vehicle Deceleration**
  The LDM is only able to effect limited deceleration (max. 2.5 m/s^2) via the Dynamic Stability Control (DSC). This means that the LDM is only able to compensate for a limited relative speed.
  If the limit of the functional range is reached, the driver is requested to act, as follows: Display for the monitored vehicle flashes red and an acoustic signal sounds.
- **Lateral Monitoring Range**
  The lateral monitoring range of the ACC sensor is limited, meaning that a monitored vehicle ahead could be lost due to a tight bend.
  In such cases, cruise control will not accelerate to the set speed for approx. 2 seconds. This will prevent the vehicle from accelerating too close to the vehicle ahead, which may only momentarily not be monitored.
  When driving straight ahead, this can cause a delayed reaction to another vehicle which may closely cut in front of the subject vehicle. The vehicle cutting in will not be monitored by the ACC system until it is clearly in the same lane as the subject vehicle.
- **Lateral Acceleration**
  The LDM limits the lateral acceleration up to approx. 4.0 m/s2 in favor of driving comfort. The LDM is unable to work in an anticipatory manner when the vehicle is cornering. It is only able to react to existing lateral acceleration when it is already on the bend. For this reason, the driver is responsible for ensuring that an appropriate speed is being driven as the vehicle enters the bend.

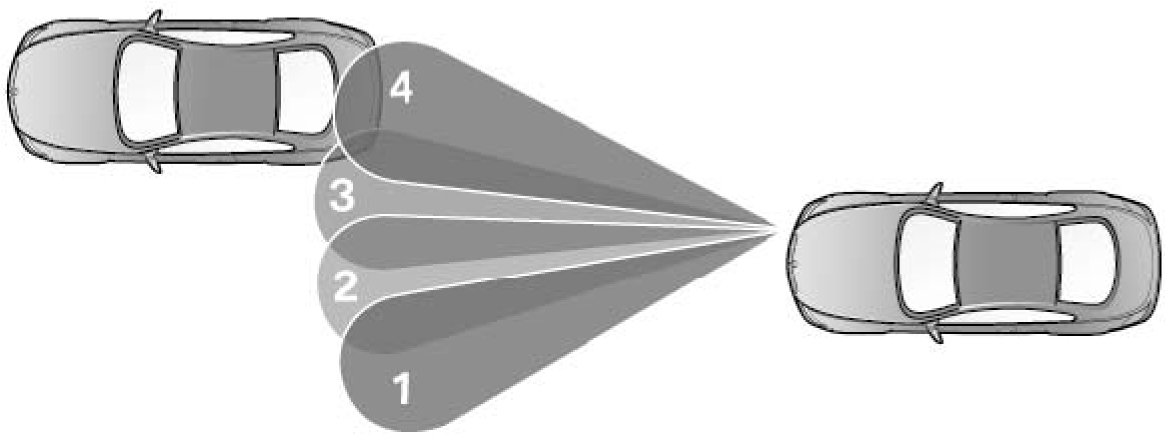


Index	Explanation
A	Distance between Vehicles Constant
B	Distance between Vehicles Increasing
C	Distance between Vehicles Decreasing
1	Object being Monitored
2	Radar Wave from ACC Sensor
3	Reflected Radar Wave from Monitored Object
4	Vehicle with ACC option (Subject Vehicle)

The radar waves received cannot distinguish between animals, vehicles and traffic signs. Traffic signs and parked vehicles standing next to the vehicle's lane could incorrectly be assigned to the lane. In order to prevent incorrect reactions, stationary objects and traffic in the other direction is ignored in the distance control.

Vehicles that are operating/traveling in other lanes are of generally of no interest for the ACC system.





Index	Explanation	Index	Explanation
1-4	Radar Beam	A	Signal Amplitude
5	Strength of Reflected Signal	F	Frequency

If an object is in the monitoring range, the reflected radar waves are received depending on the angle between the wheel axis and the object
4 antennas receive different amplitudes, depending on the amplitude of the signal received the system will react accordingly.

The ACC uses the turn signal indicator signal from the Footwell Module (FRM) for quicker recognition when changing lanes. In other words, if the turn signal indicator is activated prior to overtaking/passing, the vehicle being overtaken is ignored more quickly. On the other hand, in the event of a change to the previous lane, a vehicle driving there is monitored more quickly.

Cruise Control

The Active Cruise Control option differentiates between 2 driving conditions:

- Cruise control with specified set speed - A selected set speed (range 20 mph - 110mph) is automatically maintained on open roads without vehicles driving ahead.
- Cruise control with speed adapted to that of vehicle driving ahead - If a slower vehicle is detected on the vehicle's own lane, the vehicle's own speed will be adapted to that of the vehicle driving ahead.
  At the same time, a driver selected preset following distance for the vehicle is established (4 fixed, timed separations can be selected). The timed separation from a vehicle driving ahead is no less than 1.5 seconds under normal driving conditions.
  In certain conditions (e.g. when a vehicle cuts in a short distance ahead), this timed separation may briefly be less than 1.5 seconds.

System Activation

- Cruise control operation is only possible in speed range 30 km/h to 180 km/h
- The LDM limits the acceleration (approx. + 1.2 m/s^{2}) & deceleration (max. -2.5 m/s^2).
  Note: Acceleration when cornering is limited.
- The LDM can only conditionally compensate for high speed situations. (Safety concept, i.e. interference from the next lane or fast approach to a truck)
  If the deceleration induced by the cruise control is not sufficient, the driver will have to intervene directly.
- The timed separation from a vehicle driving ahead is no less than 1.5 second. In certain conditions (e.g. when a vehicle cuts in a short distance ahead), this timed separation may briefly be less than 1.5 second.
  If the deceleration induced by the cruise control is not sufficient, the driver will have to intervene directly.
- If the ACC sensor is blinded, the Active Cruise Control option shuts down. (Blinding, e.g. due to extremely heavy snowfall, through a layer of ice on the sensor or through dirt)
  Cruise control can be reactivated after the ACC sensor has been cleaned.
- System remains activated during a gearshift.
  Only if the clutch is deactivated for more than approx. 4 to 6 seconds, does the cruise control shut down. (If no gearshift or change in engine speed is made within 5 seconds of such a signal, cruise control will be deactivated.)

System Deactivation

System is deactivated in the same manner as conventional/previous cruise control systems:

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

  Display for monitored vehicle does not light up, the vehicle remains below the set speed and does not accelerate further

  Causes:

  - On sharp bends, the vehicle's speed will be controlled in such a way that lateral acceleration is no more than 4.0 m/s^2 to maintain driving comfort.
  - Rain, snow and fog absorb radar waves.
    This will significantly reduce the range of the ACC sensor.

Lens Heating

The lens of the ACC sensor is made of plastic. The built-in lens heating ensures better availability of the Active Cruise Control option in winter weather conditions.

The lens heating is activated by the ACC sensor. The heating is controlled via a pulse width modulated signal (PWM signal). The heating coil is integrated into the lens of the ACC sensor.

The lens heating is only activated within a certain ambient temperature range (approx. +5°C to -5°C). This is because: Only at temperatures around zero is snow wet or moist.

At temperatures well below this, snow will be dry. To prevent snow from thawing on the lens and creating an artificial coating, the heating is switched off below a certain ambient temperature. The current ambient temperature value is transmitted by the instrument cluster.

Conditions for activation:

- Engine ON
- ACC ON
- Ambient temperature between -5°C and +5°C

Safety Cutout:

- Temperature in ACC sensor over 50°C (measured by interior temperature sensor in ACC sensor control module)
- Voltage greater than 16 volts

The safety cutout shuts down the lens heating. The Active Cruise Control option remains activated (No fault memory entry).

Monitoring:

- The lens heating is monitored for open and short circuits in the heating coil.
- If the monitoring reports a fault, the Active Cruise Control option will be shut down. (Fault memory entry)
- Display for monitored vehicle does not light up, the vehicle remains below the set speed and does not accelerate further.

Causes:

On sharp bends, the vehicle's speed will be controlled in such a way that lateral acceleration is no more than 4.0 m/s^2 to maintain driving comfort.

Rain, snow and fog absorb radar waves.
This will significantly reduce the range of the ACC sensor.

Low-Voltage Cutout and High-Voltage Protection
The ACC sensor works with an operating voltage of 9 to 16 volts.

Low-Voltage Cutout:

If the on-board supply voltage drops below about 6.5 volts, the ACC sensor will perform a low voltage cutout and a fault memory entry will be stored.

A function block will be made when the on-board supply voltage drops below 9 volts.

The ACC sensor will be reactivated when the on-board supply voltage exceeds 9.8 volts again.

Self-Diagnosis and Compensation
External forces may change the alignment of the ACC sensor. A horizontal change leads to function limitations. (Function limitations encountered are, e.g.: Reaction to vehicles in the next lane or late reaction to vehicles in the same lane).

Self-diagnosis allows the ACC sensor to compensate for minor horizontal adjustments of up to 1°.

If a horizontal adjustment of more than 1° is detected, the Active Cruise Control option will be deactivated and a fault will be stored in the fault memory. A Check-Control message will be issued.

Classroom Exercise - Review Questions

1. What is ACC and what function does it provide?

2. On what vehicles is ACC available?

3. What is the difference between 1st and 2nd generation ACC systems?

4. What is the range of the ACC sensor?

5. When changing lanes with turn signal active how does ACC react?

Active Front Steering (AFS)

The Active Front Steering (AFS) system varies the steering gear ratio from direct to indirect and vice versa as a function of the vehicle's speed. Active Steering offers the following advantages:

- Direct steering (reduced gear ratio) with no more than minimal movements of the steering wheel at the low end of the speed range.
- More indirect steering (increased gear ratio) at higher speeds in conjunction with enhanced driving stability.

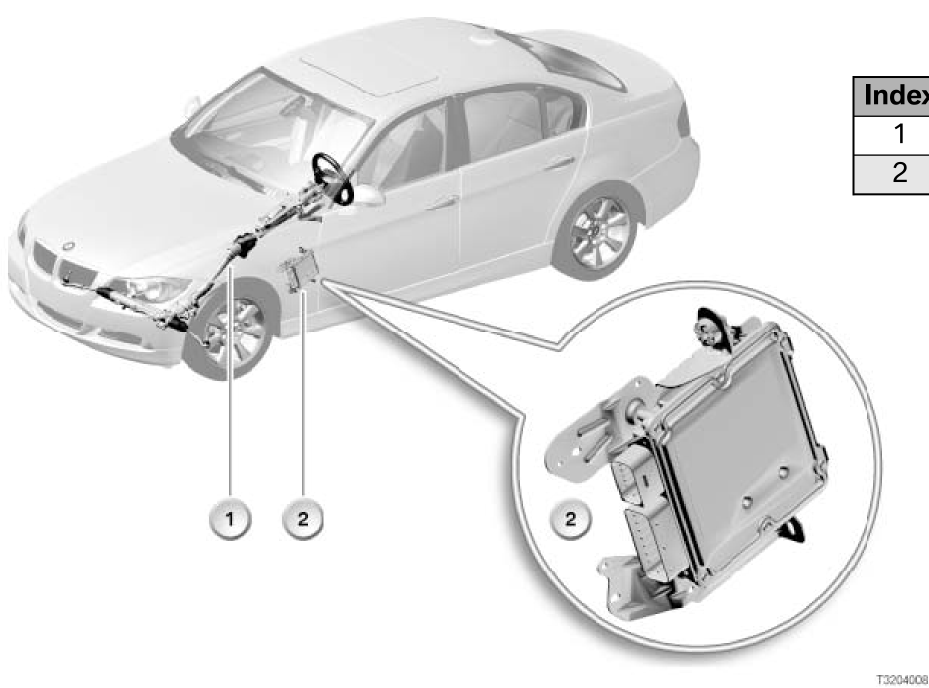
It would not be possible to provide the benefits offered by AFS with a conventional steering system, as there would inevitably be a need to compromise:

- Steering cannot be too direct as otherwise it would be overly sensitive when the vehicle is travelling at high speed, however direct steering is significantly more desirable for low speeds or when parking.

With AFS there is no need to compromise since the steering directness varies with speed, which results in three major benefits/enhancements:

- Agility
- Comfort
- Safety

With the introduction of the E90, Active Front Steering (AFS) becomes available as an option for the 3 Series.



Index	Explanation
1	Left Front fender
2	AFS Control Module

Benefits of AFS

Enhanced Agility
Up to about midway through the speed range (approx. 100 km/h), the directness of the steering means that the driver perceives the vehicle as more agile and easier to handle, plus there is no loss in feedback from the road surface right through the steering wheel.

Example: *A driver who has to avoid an unexpected obstacle has much better control, plus significantly enhanced steering precision and requires less work at the steering wheel.*

Enhanced Comfort
Current BMW models without AFS need more than three full turns of the steering wheel in order for the wheels to complete the arc from full lock in one direction to full lock in the other.

When the vehicle is travelling at low speed, AFS reduces this to less than two full turns of the steering wheel in order to go from lock to lock.The advantage with AFS:

The driver's task is easier when turning corners in city traffic or when maneuvering into parking slots where space is at a premium. On twisty roads such as mountain passes, the reduced steering angle means that the driver's hands remain in the ideal position on the wheel. There is no longer any need for the driver to feed the wheel through his or her hands, or to cross hands in a tight bend. The multifunction buttons on the steering wheel and the paddles for the sequential manual transmission (SMG) are always perfectly positioned relative to the driver's hands, regardless of the driving situation.

Enhanced Safety
A completely different set of conditions apply when the vehicle is travelling at high speed:

With the assistance of indirect steering there is increased stability when travelling straight ahead at high speeds (such as on highways) compared with conventional steering. At the same time, the yaw-rate control is in the position to stabilize the vehicle by correcting the steering angle when the vehicle is oversteering.

This supports the Dynamic Stability Control (DSC) function.

Like conventional systems, BMW's Active Steering features a steering column with a permanent connection from the steering wheel to the front wheels. The mechanical link ensures the operability of the steering system at all times, even in the event of disruption to or the complete failure of the system. The mechanical steering linkage, is essential in sustaining the authentic "feeling of steering" as perceived by the driver. True steer-by-wire systems are intrinsically unable to simulate the realism of this feedback from the road to the driver.

Functions

The AFS system available on the E90 is similar to the system available on the E60, E63 & E64, with some additional functions.

Standard Functions of AFS

Variable Steering Ratio
The steering ratio is dependent on the steering wheel angle and the vehicle speed

- More maneuverability and agility at lower and mid-range speeds
- Improved comfort when maneuvering in and out of parking spaces and other maneuvering (less gripping)
- Increased monitoring and safety during dynamic steering maneuvers (hands firmly on the steering wheel)
- Stable straightline stability at high speeds

Linked with Servotronic
AFS linked with Servotronic and an ECO valve for hydraulic delivery

Linked with DSC
Guaranteed vehicle stability in every road situation, also restricted intervention via the steering intervention.

- Stabilization intervention dependent on the driver's steering action

  Optimum support of the driver while maintaining steering "accuracy"
- Stabilization on all road surface traction levels (coefficients of friction)
- Early stabilization due to "more comfortable" steering intervention

  Reduction and postponement of DSC brake interventions

New Functions with E90

Variable Steering Coding
Two different "variable steering tuning" curves for standard and sport suspensions in the E90 (coded at the factory model/option specific)

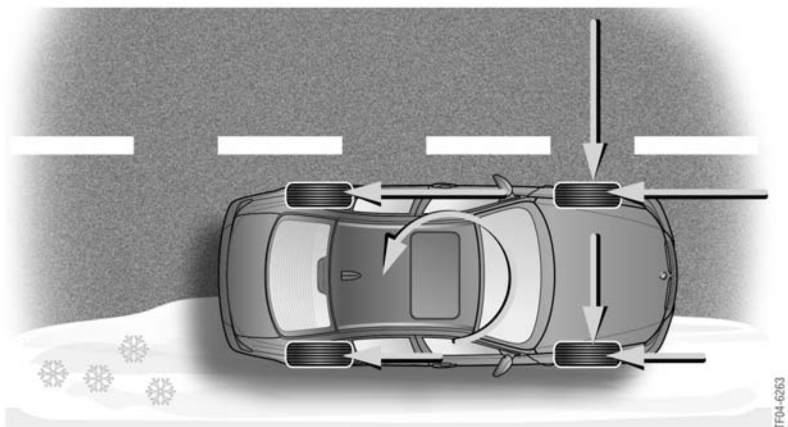
Additional Yaw Rate Sensor
Two yaw rate sensors in one housing- utilization of a DSC sensor with 2 yaw rate and 2 lateral acceleration sensors (redundancy)

DTC Switch
When DSC is switched off, the driving stabilization function (yaw-rate control and yaw moment compensation) is also deactivated. The variable steering-gear ratio always remains active.

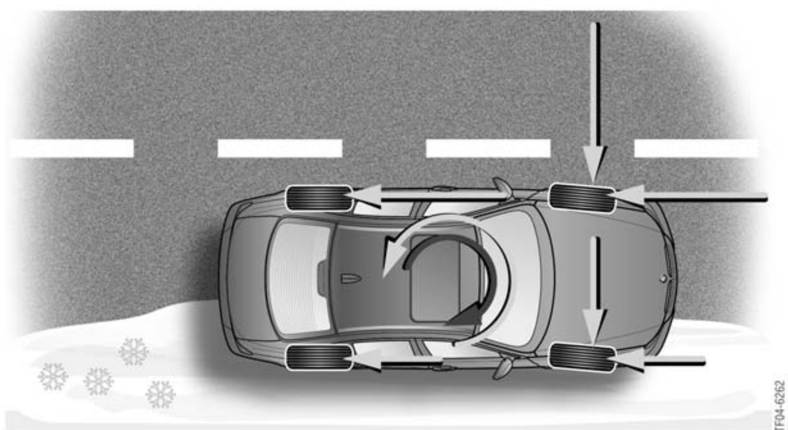
Yaw Moment Compensation

With conventional systems, the driver has to actively steer the vehicle in a straight line if the brakes are applied on a road surface with non-uniform traction levels ("ì-split"). In this situation countersteering keeps the vehicle in its track and shorten the braking distances.

On the E90, equipped with the Active Front Steering (AFS) option and brakes are applied on a road surface with non-uniform traction levels ("ì-split"), which results in the build-up of a moment/rotation about the vertical axis (yaw moment) rendering the vehicle unstable.



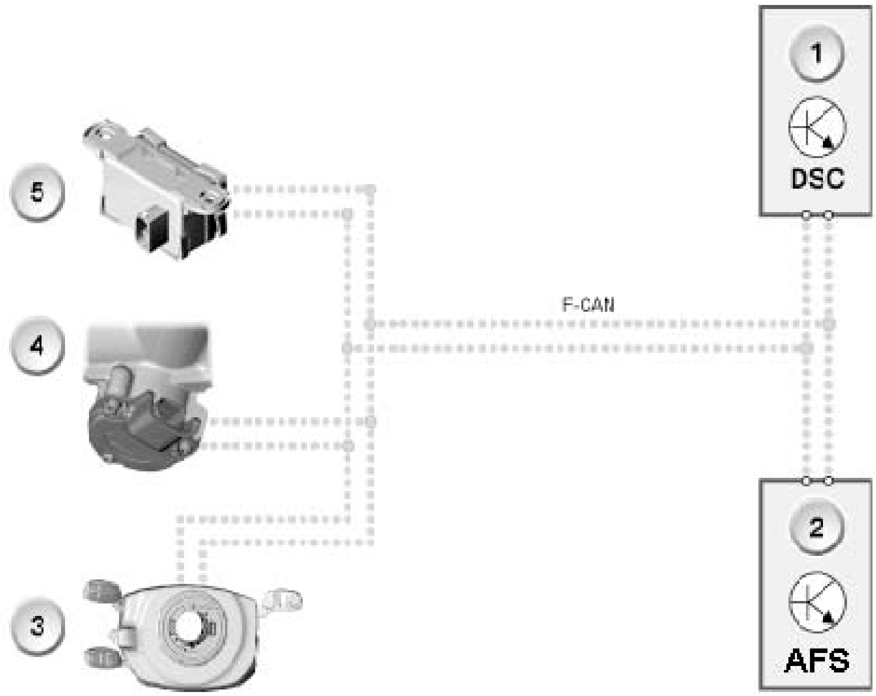
In this situation DSC in conjunction with AFS actuates active steering actions in order stabilize the vehicle and shorten the braking distance, by building up a counter moment/rotation (by counter steering) in the opposite direction which cancels the previously created yaw moment.



The function is accomplished by allowing the DSC control module to calculate the yaw rate plus interpret information from the front steering angle sensor. The DSC control module transmits the information to the AFS control module which establishes the yaw-moment compensation correction angle needed for stabilization, counter steering.

The braking distance is shortened 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.

Components of AFS System



Index	Explanation
1	DSC Module
2	AFS Module
3	Steering Angle Sensor in SZL
4	Total Steering Angle Sensor (LWS)
5	DSC Sensor

The sensors utilized by the Active Front Steering system are:

Motor-Position Sensor
The motor-position sensor registers the rotor position of the electric servomotor (angle of rotation). The motor position is communicated to the AFS control module.

Total Steering-Angle Sensor and Steering Angle Sensor
The total steering angle sensor captures the steering angle that the Active Front Steering produces at the steering box (total steering angle- angle at steering pinion). As far as its function is concerned, the total steering angle sensor corresponds to the steering angle sensor in a conventional steering system.

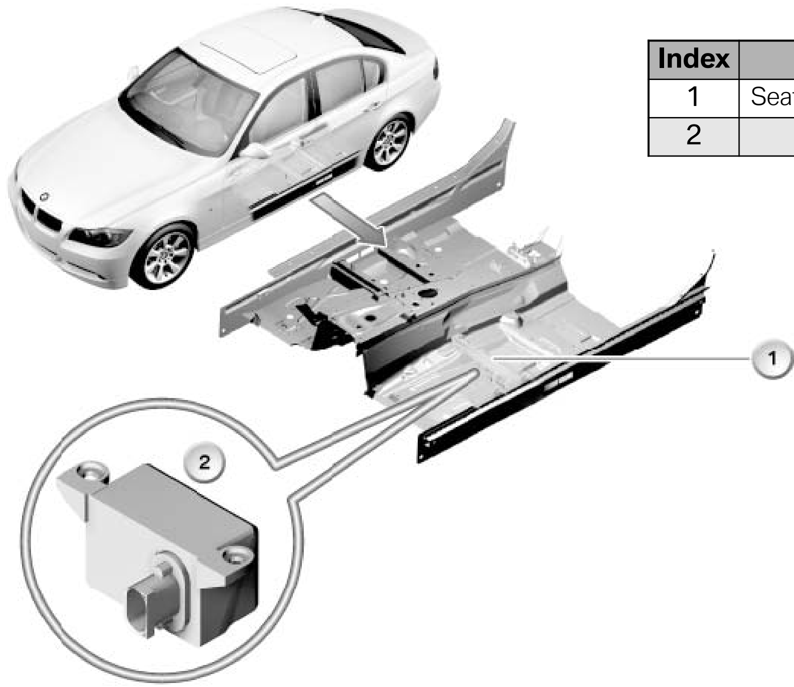
The steering angle sensor in the steering column switch cluster(SZL) captures the angle to which the driver turns the steering wheel. Both signals are needed by the AFS control module.

- The steering angle sensor is an optical sensor on the E90.

Both sensors are connected to the F-CAN in order to transmit data to the AFS and DSC modules.

DSC Sensor

The DSC sensor on vehicles equipped with active steering utilizes 2 yaw rate sensor elements to transmit redundant signals capturing the rate of yaw (rotation about the vertical axis) and lateral acceleration to the AFS module via the chassis CAN (F-CAN).



Index	Explanation
1	Seat Cross Member Driver's Side
2	DSC Sensor with AFS

The control modules involved with the AFS system are:

Active Front Steering (AFS) Control Module

The AFS control unit computes the nominal values for the electric servomotor of the planetary gearbox with override function.

Junction Box Electronics (JBE)

The Junction Box Electronics (JBE) forms the interface between the PT-CAN and the K-CAN (signals for instrument cluster) and provides a pass through for F-CAN.

Moreover, the AFS control module receives its power supply from the electrical distribution center in the junction box.

Dynamic Stability Control (DSC)

The DSC control module and the AFS control module are interconnected by the F-CAN (chassis CAN). The signals supplied by the DSC control module include the Road speed signal.

Digital Engine Electronics (DME/ECM)

The engine control module sends the signal indicating that the engine is running to the AFS control unit via the PT-CAN bus. The AFS control unit notifies the engine control of the approximate drive torque of the power-steering pump.

Car Access System
The vehicle is authenticated by the AFS control unit and the CAS control unit via the K-CAN / PT-CAN (vehicle identification numbers compared). Moreover, the CAS control unit transmits the wake-up signal for the PT-CAN.

The actuators driven by the Active Steering system are as follows:

Planetary Gearbox
The planetary gearbox with override function uses the electric servomotor to generate the resulting total steering angle at the front wheels.

Hydraulic Steering with Servotronic Valve
The conventional hydraulic steering provides the power-steering assistance. "Servotronic" (= speed dependent power-assisted steering) is part of the Active Steering option.

ECO Valve in the Power-Steering Pump
A vehicle fitted with the "Active Steering" option has a controlled-output power-steering pump controlled by AFS.

Warning Light and Check Control
The dedicated-function warning light in the instrument cluster lights up to indicate a fault in the Active Steering.

At the same time a Check-Control message is shown in the LCD display. The text for the Check-Control message can be called up in the Central Information Display (CID).

System Activation

Preconditions for activation for Active Front Steering are:

- Terminal 15 ON
- The engine must be running

Steering-wheel position and the position of the steered wheels are synchronized as soon as the engine is running. This ensures that the positions of the steering wheel and the road wheels match if, for example, the steering wheel was moved while the vehicle was at a standstill with the ignition switched OFF.

Note: The synchronization procedure can cause the steering-wheel or the vehicle's front wheels to move. Movements of the steering wheel or the vehicle's front wheels might be perceptible while synchronization is in progress.

Synchronization also occurs while the vehicle is on the move, but the process is extremely slow and virtually imperceptible.

General System Information

Track Setting

Track has to be reset after work on the steering. The procedure for adjusting track on a vehicle with Active Front Steering (total steering angle sensor) is not the same as that for a vehicle with a conventional power-assisted steering system.

Important: It is essential to follow the instructions in the Repair Instructions.

Power Supply

The Active Steering must be initialized again after the battery has been disconnected. To do this, proceed as follows:

- Start the engine (the "Active Steering inactive" Check-Control message appears)
- First turn the steering wheel as far as it will go counter clockwise and then as far as it will go clockwise

  or

- Alternatively the vehicle can be driven at about 30 to 40 km/h
- Turn off the engine and switch off terminal 15
- Start the engine and the Active Front Steering and all its functions are operational
- Clear the Fault Memory of the AFS module

Calibrating the Steering Angle Sensors

If the steering column switch cluster (SZL) is exchanged or reprogrammed, or if the steering box is exchanged: The steering-angle sensors must be recalibrated (offset). The motor-position sensor (angle) in the AFS control unit is initialized.

The total steering angle sensor on the steering box is calibrated relative to the center position of the steering rack by the manufacturer.

Radio-Reception Interference

Note: Be sure to secure the shield of the electric servomotor. Failure to connect the shield (3 phases of the electric servomotor) to the protective housing of the AFS module, will almost certainly impair radio reception as a result of interference.

Servotronic Valve

If a fault occurs (when de-energized, for example) the Servotronic valve switches to the characteristic for high speeds. Steering assistance is reduced accordingly.

Classroom Exercise - Review Questions

1. What is AFS?

2. What advantages/benefits does AFS provide?

3. Where is the AFS module located?

4. What is different with AFS regarding the E90?

5. What function does the Junction Box provide for AFS?

6. What is special about the DSC sensor and where is it located?