Active Cruise Control

The active cruise control system ACC is an expansion of the conventional cruise control system FGR. A new feature is the convenient distance and cruise control by means of automatic engine management and brake intervention.

ACC system functions

A radar sensor determines the distance, angle and speed of moving objects in front of the vehicle. The driver can preselect a required speed in the range from 30 kph to 180 kph (ACC in steps of 10 kph, ACC2 stepless); it is displayed in the instrument cluster. Furthermore, it is also possible to choose between three fixed time-based distance stages. This means that the distance from to the vehicle in front changes with speed.

ACC is a convenience system. This means driver interventions always have higher priority than the ACC control.

ACC provides the following functions to the driver:

- Cruise-control system (FGR) with given required speed
  Cruise control with adaptation to the speed of the vehicles in front
  Maintaining a distance to the vehicle in front - set by the driver
  Specific brake intervention ensures the set speed is not exceeded even when driving downhill

ACC function limits

The following variables are limited for the purpose of ensuring reliable ACC operation:

- ACC operation only possible from 30 km/h to 180 km/h
- The ACC acceleration and deceleration are limited for reasons related to comfort.
- The time gap to a vehicle ahead is not less than 1 s. Under certain conditions, e.g. if a vehicle cuts in closely, this time gap can be below 1 s for a brief period
- ACC should only be used under adequate visual conditions.
- The detection range of the radar sensor is limited.
- A vehicle cutting in can cause delayed responses in the ACC. For this reason, do not use ACC on winding roads or where it is necessary to change lanes frequently.
- Large speed differences, e.g. quickly approaching a heavy goods vehicle, cannot be regulated.
- Driver intervention will be necessary if the rate of deceleration of the ACC is not sufficient.
- ACC cannot be used in stop-and-go traffic. The driver must take control of the vehicle by braking in good time.
- Following interventions from the slip control systems ASC or DSC, ACC is deactivated for safety reasons. It can be switched on again. On roads with low coefficients of friction (ice, etc.), however, ACC should not be activated.

If the ACC is no longer able to maintain the selected distance, a signal is sent indicating that the driver should take control. The ”object detected” lamp begins to flash.

Unexpected system behaviour

A system situation that requires explaining may occur if the function limits of the system are reached in ACC mode. Such situations are described in the following:

Limited range and deceleration

On the one hand, the radar sensor has a limited range of 120 m while, on the other hand, the ACC system is provided a maximum deceleration of only 2.0 m/s2 by the DSC. The ACC can therefore automatically control only a limited relative speed. When the system has reached its functional limits, the driver is requested to assume control by the flashing ”object detected” lamp.

Side visible area

The leading vehicle may be lost when cornering due to the limited side field of vision. When cornering, the ACC vehicle is not accelerated to the required speed for approx. 2 s in order not to drive up too close to the

leading vehicle which may be not detected for only a short time.

When driving straight ahead, the response of the ACC to a vehicle cutting in close may be delayed. The vehicle that cuts in is not detected before it is positioned on the same lane as the ACC vehicle.

Switching off

The system switches off if 'blinded' by extremely thick snow cover. It can be reactivated after cleaning the radar sensor.

The system switches off in the event of prolonged control interventions by the ASC or DSC, i.e. at critical coefficients of friction. It can, however, be reactivated.

In both cases, after being reactivated the ACC resets the long following distance of 2 s.

Special situations

The driver recognises these in that the "object sensed" lamp does not light up, the vehicle remains below the required speed and no longer accelerates.

- In tight curves, the ACC regulates the speed in such a way that the lateral acceleration is a maximum of 3 m/s2 for reasons related to comfort. This applies both in open-road and follow driving modes
- Rain, fog and snow absorb the radar beams. The range can be reduced quite considerably and in extreme cases ACC can no longer be used.
- Brows of hills and depressions may obstruct detection, causing objects to be lost
- In very rare cases objects can be detected with incorrect measured values (mainly angles), e.g. by reflection of the radar waves on tunnel walls and crash barriers.

Lane prediction (anticipated driving lane)

Lane allocation is a central function in the ACC system. Pure object detection is not sufficient for the ACC. The detected objects must be brought into a relation with the driver's own intentions. Vehicles are only relevant for a control operation when they are in their own driving lane.

The lane prediction is an estimate on the basis of the current dynamic driving state. Since the ACC cannot recognise the lane progression, it must depend on the current own driving status.

In order to select the right object for distance control, ACC must calculate the driving lane in advance. For the next 2 - 4 seconds, the driven radius of the bend is assumed to continue to be valid for the lane progression, an assumption that virtually always applies on motorways and on trunk roads. The lateral deviation of every detected object with respect to the precalculated lane can be determined with the lane prediction facility.

The received radar signals cannot differentiate between living creatures, vehicles and road signs. Road signs or parked vehicles next to the driven lane may therefore be mistakenly allocated to the own lane. In order to exclude defective reactions, stationary objects are for the most part ignored.

ACC control unit

The ACC sensor (transmitter and receiver) and the electronic components are integrated in the ACC control unit.

ACC composite system

ACC is a composite system with distributed functions in various partner control units.

The partner control units transmit their information across the data buses in the vehicle to the ACC control unit.

System	Function
ACC control unit	Object detection Lane prediction Distance and cruise control

DSC	Brake pressure Brake light activation Curve information Speed (not E38)
Steering angle sensor	Corner information
Motor control	Activation of throttle valve Torque interface
Gearbox management	Gear information
Instrument cluster	ACC displays for model series E38: road speed
Light module	Brake light
Multifunction steering wheel	Operation

Dynamic Stability Control DSC

To activate the ACC function, the brake system must be fully functional and the brake pedal as well as the parking brake must not be operated. The system is always deactivated when the brake pedal is pressed.

The interface ACC/DSC has the following functions:

- DSC provides ACC with all the relevant driving dynamic variables for longitudinal control and lane prediction.
- ACC sends deceleration requests to the DSC.

When the engine drag torque is not sufficient for deceleration, the ACC builds up the brake pressure via the DSC hydraulic unit in order to decelerate the vehicle. If deceleration has been triggered by ACC, DSC activates the brake lights via the light module.

The following signals sent by the DSC are used by the ACC control unit:

- Wheel speeds
- Average wheel speed
- Yaw rate
- Longitudinal acceleration (for plausibility monitoring)

Detection of downhill driving

If the DSC deceleration control is intact, the ACC initiates deceleration. The DSC informs the gearbox control unit that brake intervention is taking place. The gearbox control unit uses this information to detect downhill driving. To protect the brakes against overloads, the gearbox control unit downshifts one or two gears depending on the situation.

Steering angle sensor LWS

The information relating to the steering angle is used in the ACC to calculate dynamic driving variables.

Engine management system DME/DDE

The interface has the following functions:

- Transmission of torque request (acceleration) by the ACC
  ACC requests engine torque from the DME/DDE. Its value is between the maximum drag torque and a torque that corresponds to an acceleration of 1.2 m/s2.
- Transmission of the operating information of the cruise control system (FGR).
- Position of the driving pedal
  The ACC can be overruled at any time by pressing the accelerator pedal. For this reason, not only the operation and position but also the operability of the accelerator pedal position sensor are determined

at the accelerator pedal. If the driver exceeds the ACC acceleration request with the accelerator pedal, a signal is sent to the ACC control unit to the effect that the ACC is no longer to intervene. At the same time, the gearbox control receives the information that the driver is now actively taking control of driving. In contrast to the cruise control (FGR), the accelerator pedal can be fully pressed without the ACC cutting out. The ACC system is not operable if an actuator (throttle valve), pedal position sensor or control are defective.

Gearbox control (automatic transmission)

The interface serves the sole purpose of implementing comfort functions, i.e. no functions relevant to safety are affected.

In the event of restricted functionality of the gearbox control, gearbox or of the sensor system, the ACC system cannot be activated or is switched off if in operation. ACC is switched off by moving the gear selector lever to N, P or R.

There is no intervention in the decision authority of the gearbox control unit with regard to gear selection. However, special gearshift maps are used. These prevent, e.g., oscillating shifts but still trigger the necessary downshifts in the event of the corresponding acceleration requests. In addition, when driving downhill (with ACC brake intervention) forced downshifts are triggered after a certain time in order to avoid overloading the brake system.

There is no direct signal path between ACC and gearbox control unit. The ACC status information is sent indirect via the DME/DDE.

Instrument cluster

The instrument cluster undertakes all display/indication functions necessary for ACC operation.

Lens heating

The lens is heated to ensure the ACC is effective in winter and in poor weather conditions. This system is designed as a resistance heating system with the heating coil integrated in the plastic body of the lens. After the engine start, the lens heating in all ACC operating modes is switched on depending on the outside temperature.

Snow is wet at temperatures around freezing. Snow is dry at considerably lower temperatures. The lens heating system is therefore switched off at temperatures below -7 °C. Otherwise the dry snow crystals would thaw and then adhere more readily to the lens.

To prevent the lens body from overheating, the lens heating system is switched off when the temperature inside the unit exceeds 50 °C. The temperature is measured by the interior temperature sensor of the ACC control unit. The ACC control unit is switched off at a system voltage > 16 V in order to protect the processor.

The lens heating is monitored by the ACC control unit for faults.