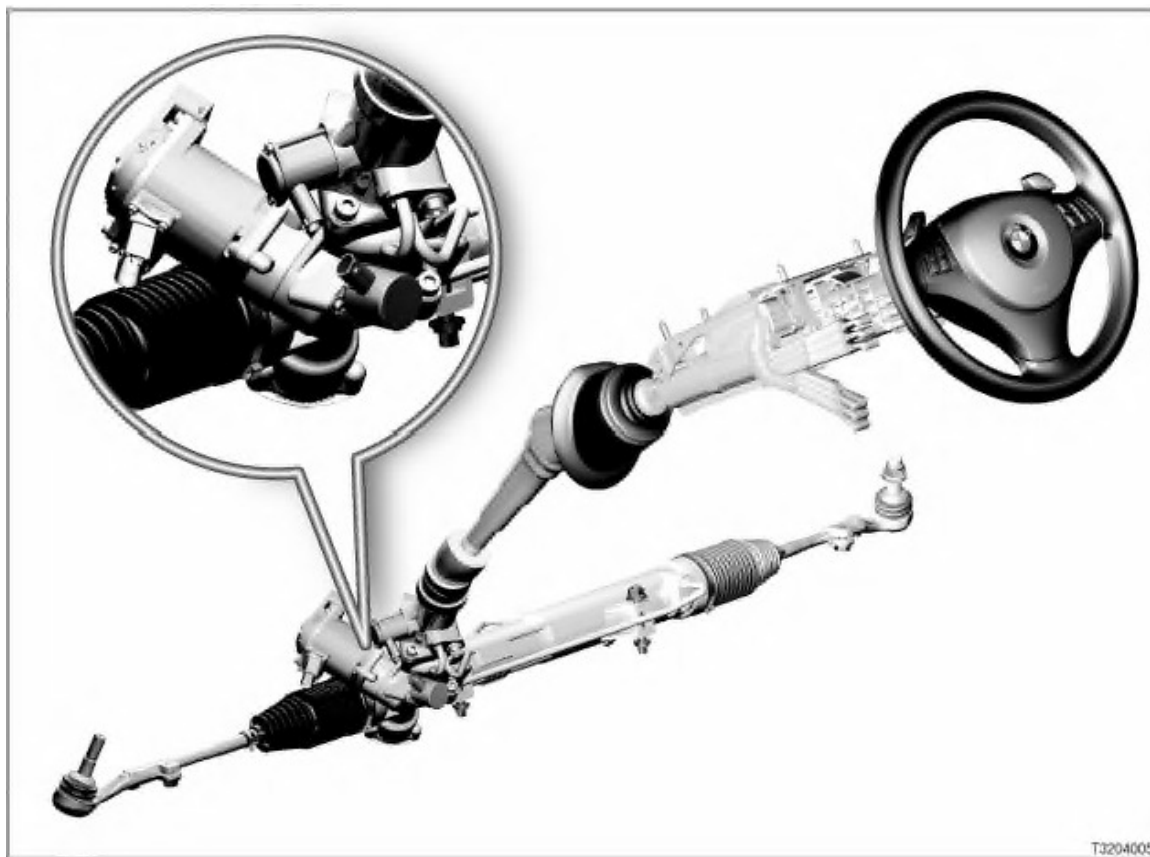


Active Steering

E60, E61, E63, E64, E70, E81, E87, E90, E91, E92, E93



Introduction

Active Steering is the most recent BMW development in the innovative steering systems sector. Active Steering varies the steering gear ratio from direct to indirect and vice versa as a function of the vehicle's speed.

[System overview ...]

The benefits of Active Front Steering are:

- direct steering with no more than minimal movements of the steering wheel at the low end of the speed range
- More indirect steering at higher speeds in conjunction with yaw-rate control

Active Steering, including Servotronic, is available as an option (option 217).

Active Steering gives the vehicle an even sportier character.

New for the E70 is the 3rd generation Active Steering:

- Yawing moment compensation has been fully integrated as a function in the Active Steering control unit
- Cumulative steering angle sensor discontinued
- Digital motor-position sensor
- Commissioning exclusively via service function in BMW diagnosis system

On the X5, Active Steering is available for the first time on an all-wheel drive vehicle.

In 03/2007 the actions described for the E70 will also be implemented on the BMW 5-Series. Other model series will follow later.

Note: On vehicles without active steering.

Option 216 "Servotronic" is **not** available without Active Steering.

Note: On BMW 3-Series not with trailer coupling.

New for the BMW 3-Series was:

- Yaw moment compensation as additional function
- Output stages for the Servotronic valve and the ECO valve are integrated into the Active Steering control unit
- Only 1 DSC sensor (redundant)

New for the BMW 5 and 6-Series from 09/2005 was:

- Active Steering control unit taken from BMW 3-Series
- This allows the Servotronic valve and the ECO valve to be directly actuated by the Active Steering control unit
- Only 1 DSC sensor as on BMW 3-Series

Note: On BMW 5 and 6-Series vehicles without Active Steering from 09/2005.

With option 216 "Servotronic", the body gateway module (KGM) actuates the Servotronic valve.

A conventional steering system inevitably constitutes a compromise:

on the one hand, the steering cannot be too direct as otherwise it would be overly sensitive when the vehicle is travelling at high speed. On the other hand it is practical to have much more direct steering for manoeuvring at low speeds and for parking. The new Active Front Steering system is the ideal trade-off. The directness of the steering of a vehicle fitted with AFS varies with speed.

This results in three major benefits:

- enhanced agility
- enhanced comfort
- enhanced safety

Enhanced agility

Up to about midway through the speed range (about 100 km/h), the directness of the steering means that the driver perceives the vehicle as more agile and easier to handle. A driver who has to avoid an unexpected obstacle, say, has much better control, plus significantly enhanced steering precision and less work at the steering wheel. There is no loss in feedback from the road surface right through the steering wheel.

Enhanced comfort

Current BMW models need more than three full turns of the steering wheel in order for the wheels to describe the arc from full lock in one direction to full lock in the other.

When the vehicle is travelling at low speed, Active Steering reduces this to less than two full turns of the steering wheel from lock to lock.

The advantage: The driver's task is easier when turning corners in city traffic or when manoeuvring into parking slots where space is at a premium. On twisty roads such as mountain passes, moreover, 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 applies 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 motorways) compared with conventional steering. At the same time, the yaw-rate control is in the position to stabilise 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 Front Steering features a steering column with a permanent connection from the steering wheel to the front wheels. This 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, what is more, 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.

The sensors incorporated into the Active Front Steering system are:

- **Motor-position sensor**

The motor-position sensor registers the rotor position of the electric servomotor. The rotor position is communicated to the control unit for Active Steering (AL control unit).

The 3rd generation Active Steering includes a digital motor-position sensor.

[more ...]

- **Cumulative steering angle sensor and steering angle sensor**

The cumulative steering angle sensor captures the steering angle that the Active Steering produces at the steering box.

As far as its function is concerned, the cumulative steering angle sensor corresponds to the steering angle sensor in a conventional steering system. The steering angle sensor in the steering column switch cluster registers the angle to which the driver turns the steering wheel. Both signals are needed by the control unit for Active Steering (AL control unit).

[more ...]

> From E70 (other model series to follow)

The cumulative steering angle sensor on the X5 is discontinued. Active Steering computes a "virtual" cumulative steering angle. The virtual cumulative steering angle is derived from the following signals:

- Steering angle sensor signal
- Motor-position sensor signal

[more ...]

The steering angle sensor on the BMW 1 and 3-Series is an optical sensor.

From 09/2005, the BMW 5 and 6-Series also have an optical steering angle sensor.

[more ...]

- **DSC sensor**

> E60, E61, E63, E64 up to 09/2005:

2 DSC sensors transmit redundant signals capturing the rate of yaw (rotation about the vertical axis) and lateral acceleration to the AL control unit via the chassis CAN (F-CAN).

[more ...]

> E70, E81, E87, E90, E91, E93, E93

Only 1 DSC sensor is needed for the Active Steering. This DSC sensor transmits redundant signals capturing the rate of yaw and the lateral acceleration.

[more ...]

> E60, E61, E63, E64 from 09/2005

Only 1 DSC sensor is needed for the Active Steering.

This DSC sensor transmits redundant signals capturing the rate of yaw and the lateral acceleration.

The control units networked for the purposes of AFS are as follows:

- **AL: Active Steering control unit**

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

[more ...]

- **SZL: Steering Column Switch**

The Steering Column Switch provides the steering angle.

- **SGM: Safety and gateway module**

> E60, E61, E63, E64 up to 09/2005

The safety and gateway module (SGM) drives the ECO valve in the power-steering pump and the Servotronic valve.

Moreover, the SGM forms the interface between the PT-CAN and the K-CAN (signals for instrument cluster).

- **KGM: Body gateway module**

> E60, E61, E63, E64 from 09/2005

The body gateway module (KGM) forms the interface between the PT-CAN and the K-CAN (signals for instrument cluster).

With option 216 "Servotronic", the KGM actuates the Servotronic valve.

- **JBE: Junction box electronics**

> E70, E81, E87, E90, E91, E92, E93

The junction box electronics (JBE) forms the interface between the PT-CAN and the K-CAN (signals for instrument cluster).

Moreover, the AL control unit receives its power supply from the distributor in the junction box.

- **DSC: Dynamic Stability Control**

The DSC control unit and the AL control unit are interconnected by the F-CAN (chassis CAN). The signals supplied by the DSC control unit include the road speed signal.

- **DME or DDE: digital engine electronics or digital diesel electronics**

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

- **CAS: Car access system**

The vehicle is authenticated by the AL 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 following actuators are actuated by the Active Steering:

- **Planetary gearbox with override function and electric servomotor**

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

[more ...]

- **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.

[more ...]

- **ECO valve in the power-steering pump**

A vehicle fitted with the "Active Steering" option has a controlled-output power-steering pump.

[more ...]

- **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).

[more ...]

System functions

The Active Front Steering system comprises the following functions:

- Steering assistance (= Servotronic)
- Variable steering-gear ratio (= Active Steering)
- Yaw-rate control (= damping of dynamic yaw)

A new function will be added in further development leading to the start of series production of the BMW 3-Series:

- Yaw-moment compensation when braking on a road surface with non-uniform traction
In further development from the **E70**, this function is entirely integrated in the Active Steering control unit (3rd generation). Further model series to follow.

Steering assistance

The steering assistance takes the form of conventional hydraulic steering (rack-and-pinion construction).

The speed-dependent steering assistance (= Servotronic) has been available in the E61 series since 03/2004. E63 and E64 have Servotronic as standard from start of series production. Servotronic has been standard on the E60 since 03/2005.

Active Steering and Servotronic are co-ordinated. Servotronic is controlled by the AL control unit.

The AL control unit actuates the Servotronic valve and the ECO valve in the power-steering pump via the Safety and gateway module (SGM). The ECO valve in the power-steering pump regulates the volume flow in the power-steering pump.

This arrangement means that only the volume flow needed for steering assistance at any given time is actually provided. In this way, the ECO valve affects the power consumption of the power-steering pump. Fuel consumption and carbon dioxide emissions (CO₂) from the vehicle's engine are reduced accordingly.

In vehicles without Active Steering, Servotronic is controlled directly by the safety and gateway module (except BMW 1 and 3-Series).

Clearly, therefore, the steering assistance and AFS are complementary, despite the fact that in terms of function, the two systems are fully independent of each other.

Variable steering-gear ratio

The variable steering-gear ratio function adapts the steering-gear ratio to the vehicle's road speed.

Steering is direct when the vehicle is moving at low speed. The planetary gearbox with override function contributes significantly to handling when the vehicle is moving at low speeds and when it is being manoeuvred into tight parking spaces.

It is not longer necessary for the driver to feed the steering wheel through his or her hands in order to manoeuvre. When the vehicle is at a standstill, less than 2 complete turns of the steering wheel is all that is needed to move the wheels from lock to lock.

At high speeds the steering-gear ratio increases. The steering becomes less direct, further improving the intrinsically high standard of steering systems featured to date in BMW vehicles.

The safety function:

The electric servomotor of the planetary gearbox is limited by an electric servomotor lock that blocks the worm gear of the planetary gearbox.

The electric servomotor lock is spring-loaded, with the force of the spring countered by the power supply. Any interruption of the power supply consequently locks the worm gear.

When the planetary gearbox is locked in this way, it ensures that the steering column enables the driver to steer the vehicle. Under these circumstances, the steering reacts like a conventional, direct, steering gear system.

The purely mechanical steering linkage between the steering wheel and the front wheels is sustained even if the Active Steering fails.

Yaw-rate control

If the vehicle tends to oversteer, for instance, when cornering, the yaw-rate control can correct the steering angle on the front wheels. This stabilises the vehicle (with the emphasis on convenience and comfort). In this road situation, therefore, the Active Steering supports Dynamic Stability Control (DSC).

DSC does not intervene unless the stabilising effect of the steering does not suffice to counteract the tendency to yaw.

Yaw-moment compensation when braking on a road surface with non-uniform traction

> BMW 1 and 3-Series

Active Steering now has an additional function for driving stabilisation.

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.

In such situations, the Active Steering performs this active steering intervention, so stabilising the vehicle.

Compared to pure ABS control, Active Steering with yaw moment compensation shortens the braking distance.

The driving stabilisation function of the Active Steering can be deactivated together with DSC with the DTC button (when DSC is completely deactivated). Together with the hydraulic power steering, the variable steering-gear ratio is always active.

> From X5 (3rd generation)

This function is completely integrated in the Active Steering control unit. Other model series will follow later.

Operation

Unlike DSC, which can be switched off by means of the DTC button, Active Steering cannot be deactivated. Yaw-rate control and yaw-moment compensation are also deactivated when DSC is switched off. The variable steering gear transmission ratio always remains active.

With the 3rd generation Active Steering, the yaw-rate control remains active when DSC is deactivated.

When DTC is activated, the DSC response thresholds have been widened. Active Steering increasingly assumes the function of driving stabilisation if the vehicle is oversteered.

Preconditions for activation

Preconditions for activation for Active front Steering are:

- Terminal 15 ON
- Engine running

Steering-wheel position and the position of the steered wheels are synchronised 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 synchronisation 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 synchronisation is in progress.

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

Notes for service staff

The following information is available for service staff:

- General information: [more ...]
- Diagnosis: [more ...]
- Encoding/programming: ---

Subject to change.