Everything you need to know about the airbag
Safer than ever before
The introduction of the airbag has made driving safer. No wonder airbags are high on the list of requirements for car buyers.

Elements of passive safety
The airbag is just one feature of the safety concept for BMW cars. Find out what contributes to passive safety in a BMW.

A firm basis for survival
The safety passenger cell is the first line of defence in the design of a safe car. Special elements reduce the force of the impact.

Seat belt and airbag
An airbag can only be fully effective as a means of protection when used together with the seat belt and belt tensioner.

An insight into airbag systems technology
In a format that is clear and easy to understand, you will be told all about the airbag network, its components and what happens at the moment at which it is triggered.

The type of accident that triggers the airbag
A much-debated subject for our customers. Yet there are clearly defined criteria for triggering the airbag system.

The right approach to airbags in practice
The right seat position is a prerequisite for airbag protection. There are important basic rules to abide by, particularly when children are travelling.

Why...? Frequently asked questions
If you also have a question about the airbag system – you might just find the answer here.
An explosive subject
This is state-of-the-art technology, the kind everyone likes to have in their car. And yet it cannot be seen or felt. At least, providing everything’s progressing nicely.

The subject here is airbags – those life-saving sacks of air that inflate in a fraction of a second in the event of an accident, protecting the vehicle passengers concerned from injury. Since the first airbag was fitted in a BMW car at the beginning of the 1980s, a great deal has happened. Enormous strides have been made in development – from the simple driver’s airbag through to comprehensive systems consisting of eight "intelligent" airbags.

This document aims to provide basic information about the increasingly complex, but also increasingly intelligent, network of airbag components and the way it has become an integral feature of the entire safety system for BMW cars. This includes the main components, the way the airbag functions, and especially the way the airbag system reacts. There is a special need for explanations about this aspect. Often a customer assumes after an accident that an airbag should have been triggered. In reality, however, the triggering process is far too complex to be able to reach any conclusions just by a simple rule of thumb.

Yet another aspect is a focal point of this booklet: The right approach to a car that has an airbag. Having access to factual information about such subjects as the correct posture, children as passengers, and also how to deactivate the airbag ensures that customers have greater confidence in the technology.

Of course, each and every special case cannot be considered within the limits of this document. For more precise information about specific problems, it is still necessary to contact BMW directly.
The figures speak for themselves. Over the last 50 years, the number of passenger cars has multiplied. As roads have become increasingly busy, the number of traffic accidents has also increased dramatically. This unfortunate development was only too clearly apparent in Europe until the early 1970s.

This is why the leading car manufacturing companies intensified their efforts to achieve greater safety. During the 1980s and 1990s, pioneering safety concepts were introduced – not least by BMW. Amongst the active safety systems it is possible to name above all ABS (Anti-lock Braking System) and DSC (Dynamic Stability Control). As far as passive safety was concerned, seat belt tensioners and seat belt force limiters were introduced along with, of course, airbags. In addition, there has been any number of further technical solutions for increased safety.

All these efforts were crowned with success, as the figures demonstrate impressively. Whereas the number of cars continued to grow more or less unchanged, and the number of traffic accidents in which people were injured also increased, the number of accidents in the leading car markets resulting in fatalities was significantly reduced. Consequently, for instance, the annual number of fatalities in Germany caused by traffic accidents is the same as that in 1950, a time when there was hardly a “handful” of cars on the roads.

Since each and every injured or fatally injured person is still one person too many, BMW continues to work towards ensuring maximum vehicle safety. Even if there can never be 100 percent safety, it is still worth exhausting the technical possibilities as far as safety is concerned.

In the meantime, safety equipment plays a central role in the decision to buy a particular car. This is not only true of BMW customers. It is, however, an influential factor for BMW customers in particular. For only safe driving can mean driving pleasure.
Using Germany as an example:

The chart above shows the increase in the number of passenger cars. At the same time the number of registered accidents has increased, only decreasing in the 1990s. In contrast, the number of accidents in which people have been injured has decreased continually since 1970.

The chart opposite shows the development of accidents resulting in injuries to people, which are also falling, along with the strong decrease in traffic fatalities since 1970.

* all figures prior to 1991 are only for the former federal states
Safety as a system

Airbag systems make an important contribution to the safety of car passengers. However, they are by no means the only components of BMW cars that serve this purpose. Numerous technical design features ensure the maximum
BMW cars set the standards for safety in each of their car categories. The high level of safety is not simply the result of including individual components such as airbags. Rather, it is the result of a total concept where the car represents a safety system. Its individual components work together so effectively that maximum occupant safety is guaranteed in every situation. In this sense, the BMW safety system as a whole is worth far more than the sum of its individual parts.

BMW assigns particular importance to active safety. Ultimately, it is best if the passive safety elements never actually need to be used. Active safety begins, for example, with the headlamps, for a third of all accidents happen in the dark. BMW has led the way with new light technology such as the xenon lamp.

**Driver assistance systems** such as DSC (dynamic stability control) ensure directional stability in emergency situations. The modern anti-lock braking system with dynamic brake control (DBC) offers the driver support in emergency braking: the braking distance is optimised thanks to maximum brake pressure building up more quickly while at the same time the car is prevented from swerving.

Another important active safety element in BMW cars is the impressively designed suspension with its high-performance brake system. Even without electronic assistance, both offer a high level of reserve.
High-strength passenger cell

Seat belt

Sidebags

Energy absorber for light collisions (impact absorber)

High-strength passenger cell
Side impact protection

Seat with safety components to prevent "flying through"

Energy absorber for light collisions (impact absorber)

Deformation frame to absorb the impact energy

ITS head-level airbag

Front airbags

ITS head-level airbag
The complete car system is particularly striking when it comes to passive safety. The body forms a safety passenger cell with deformable components to absorb impact energy.

In addition, passengers are protected by a multiple restraint system: three-point seat belts for all seats, equipped with seat belt force limiters and pyrotechnic seat belt tensioners in front, as well as intelligent airbags, which are triggered depending on the type and severity of accident.

Sensors at various points on the car body determine the acceleration values to which the body is exposed. If certain limit values are exceeded, the airbag control unit triggers each of the required airbags – within milliseconds. The airbag control unit also switches the fuel pump off to minimise the risk of fire. The tank itself is located in a protected position in front of the rear axle and is made of high-density polyethylene.
possible degree of active and passive safety. Above all, the perfect combination of all safety components and the carefully considered design of the entire system are the key to optimum all-round protection.
The car body structure plays a decisive part in the high safety standard of BMW cars. It consists essentially of a high-strength passenger cell plus deformable crumple zones to the front and rear. The passenger cell with its rigid shape serves as survival space for the passengers. It also has to be able to withstand heavy impact. The body zones at the front and rear, on the other hand, are required to absorb as much energy as possible in the event of a crash, transforming it into deformation and heat. If the car is deformed beyond a certain degree, restraint systems such as the seat belt or airbag come into action. Harmonising the deformation characteristics of the front and rear body structure with the rigidity of the passenger cell ensures that, even in the case of asymmetrical impact (offset crashes), the passenger cell's protective function is maintained.

This design, the result of concerted effort, has led to BMW cars receiving the highest ratings in all crash tests for each class. For example, the BMW X5 was proved to be the safest car ever tested by tests carried out by the independent and reputable U.S. institute, the IIHS (Insurance Institute for Highway Safety). This was thanks, not least, to the X5’s sophisticated body design which ensures maximum passenger protection. It is representative of all BMW automobiles.
In the X5, the high **longitudinal impact** that occurs in a head-on collision is absorbed along several **force-conducting routes** by the underbody. The front longitudinal supports continue under the underbody and lead directly to the rear longitudinal supports. At the front, the underbody makes a homogeneous transition to the bulkhead which, with its support structure, represents an important link between the front structure,
the underbody and the side frame. Pre-determined load routes carry the force to the underbody, the lateral longitudinal supports, side frame and tunnel. Bulk reinforcements leading from the engine mountings to the A pillar protect the footwell from too powerful intrusions. In the engine compartment, a bulkhead crossmember, which links the two engine mountings, ensures there is optimum conduction of force into the tunnel.

Maximum effort and attention to detail even with the entry-level model: The body of the 3-Series compact offers one of the highest levels of safety in its class.
In this way, the collision forces are deliberately and evenly distributed throughout the entire car structure. Together with reinforcements in the transmission tunnel, a sill beam, lateral seat supports and bolted bridges in the tunnel area, the force is distributed across the entire underbody, and a high degree of **lateral rigidity** is achieved in the event of a side-on crash. In areas that are put under particular stress, especially in the pillars, additional metal profile plates are fitted to increase the level of rigidity.

In the event of a side-on crash, it is important that there should be collision protection in the doors. Here it is not a matter of using the (relatively weak) bending resistance of the steel profile, but of using its enormous tensile strength. In this way, the side impact protection profiles provide a great deal of resistance, while at the same time guiding the impact energy to the extremely strong pillars of the passenger cell.
The number one life saver

The seat belt is one of the oldest elements of passive safety and yet it remains the most important. It ensures that, in the event of collision with an obstacle, the passengers in a vehicle are not thrown forwards and possibly catapulted through the windscreen and out of the vehicle. To prevent this the belt has to absorb an enormous amount of energy: the forces occurring during a head-on collision with a solid obstacle at 32 mph (approximately 50 km/h) roughly correspond to the impact following free fall from the fourth storey of a building.

Together with the seat, the seat belt forms a basic safety system whose task is to keep passengers in their position in the event of an accident. For this reason, seat construction and the seat belt system are finely tuned. One important function of this composite unit is the so-called anti-submarining effect: suitable seat shell design and appropriate coupling points for the belt prevent passengers slipping under the seat belt in the event of an impact.

The seat belt can fulfil its function all the better, the more tautly it is positioned against the body. In the event of an impact, the passenger's body should move forwards as little as possible before being restrained by the belt in order to keep the risk of injury to a minimum. In its normal position, however, the belt is not completely taut against the body; there is always a little play so as to guarantee the passenger sufficient comfort. In order to prevent the negative effects of this belt slack, seat belt tensioners have been used for about a decade. In the event of an impact, these devices tension the seat belts within a fraction of a second, thereby eliminating the slack. The tensioners were initially of a mechanical design, operated by spring resistance.

Meanwhile, throughout the entire BMW range of models, there are now only pyrotechnic belt catch tensioners used, which work
by means of a propelling charge (similar to an airbag). This system was first introduced in standard production in 1994 on the E38.

The propelling charge pulls the belt catch approximately seven to eight centimetres **downwards** thereby evenly tensioning the belt in the passenger’s pelvic and chest areas. This tensioning is an effective means for combating the submarining effect, preventing the passenger from diving beneath the seat belt.

In addition to the belt catch tensioner, BMW sometimes (for example, on rear seat belts) fits so-called **end lock tensioners** which tension the belt by winding it in rapidly. On ignition, a pyrotechnic gas generator sets in motion a piston in a tube. A wire cable is attached to the piston and when it moves it causes a pulley to turn. This turning motion is transferred to the belt winding shaft. A roller coupling blocks the belt winding shaft so that it can no longer be turned back.

The principle of the belt catch tensioner: in the event of a crash the belt catch is pulled several centimetres downwards by means of a wire cable.
So that the restraining forces that the belt builds up do not become too great and represent in themselves a risk of injury, all BMW cars are equipped with **belt force limiters**. As soon as the threshold value for the restraining force is reached, the limiter permits the belt a defined amount of "slip", in order to reduce the energy being released in a slow and controlled manner.

In the event of an accident, the belt catch tensioner is controlled by the central control unit as soon as the defined threshold for the braking value is exceeded. From the onset of the crash it takes just **12 to 15 milliseconds** for the control unit to take over. It takes a further five to seven milliseconds for the belt catch tensioner to be triggered. The front airbag is triggered at the earliest 20 milliseconds after an impact. This means the seat belt tensioner is triggered first, ensuring that the passenger is seated in the correct position for the airbag to be triggered.

In addition, this triggering threshold for the belt catch tensioner is lower than the thresholds for the airbags. This design structure corresponds to the seat belt’s function as the **primary restraint**.
system. The available airbags form a secondary system that comes into action in major collisions. The airbags are best able to exercise their protective function effectively if the passengers' seatbelts are secured. It is therefore essential that the seat belt is secured so that the entire safety system in the car can provide the optimum protection.

An important element in this system is also the head restraints, which ensure that severe damage to the neck vertebrae is prevented. In the event of an impact, the restraint must cushion in a defined manner the passenger’s head when it is whipped back during an impact, without exposing it to unreasonably high levels of braking force. To achieve this, it is important above all that the head restraint is correctly adjusted for each respective passenger. In order to keep the distance before the head is cushioned as short as possible, the restraint should not be too far away from the head, and the height must be correctly adjusted: it is intended to support the passenger’s head and should not be at the neck level.

No more force than is bearable: a belt force limiter ensures that the belt is relaxed in a controlled fashion if the forces on the passenger reach the limit value.
For many years, the BMW development departments and passenger safety departments have been occupied with the subject of airbags. This meant that in April 1985, the company was one of the first car manufacturers in the world to offer a **driver’s airbag**, which was available as an option in the 7-Series (E23) of the time. In comparison with today’s steering wheels, the container on the airbag steering wheel was somewhat larger because the airsack technology still required a great deal more space. It only became possible as a result of later miniaturisation to develop smaller steering wheels, right through to sport steering wheels with an airbag, without a forfeit in safety.

As a consequence of customers’ increased interest in safety equipment, BMW made the driver’s airbag a main component of the standard equipment in 1990. In January of the same year, a **front-passerenger airbag** was offered for the first time, once again in the 7-Series of the time (E32). Along with the new front-passenger airbag, **seat occupancy recognition** was also used for the first time. This prevents the front airbag being triggered even though the front-passenger seat is not occupied. In addition, in the year 1994 the **safety battery terminal** made its first appearance in a BMW car (E38).

In September 1996 **sidebags** were introduced for the first time in the 7-Series of the E38 range, and hardly a year later (May 1997) the ITS head-level airbag (ITS – Inflatable Tubular Structure) made its debut in the same range. Within a very short time these achievements were benefitting the entire range of BMW models (apart from the convertible and roadster). And the development didn’t stop there: as early as March 1999, **intelligent airbags** made their appearance in BMWs (first in the E38 and E39). This meant it was possible to achieve the goal of the two front airbags opening up in two different stages, depending on the severity of the accident. This meant that occupant safety was increased still further.
In other areas too the control has been greatly optimised during the course of just two decades. The first generation of airbag control consisted of two sensors located in the two front wheel housings plus a central unit with an additional crash sensor. At that time a single output was sufficient to activate the driver’s airbag. The second generation used a central processing unit with two individual sensors (crash sensors), positioned at a 45° angle to the car’s longitudinal direction.

Whereas the third airbag generation brought with it, above all, a simplified electronics design, trust was placed in something completely new for the fourth generation: for the first time satellites, now used so often, came into use. This concerns electronic units for identifying a side-on crash, which are networked with the central processing unit. The fifth and sixth generation introduced primarily an improvement in actuating the airbags, for example, by means of "intelligent" airbag control.

The first BMW to offer an airbag from 1985: the first ever 7-Series (E23).
BMW cars can be equipped with up to eight airbags. In normal conditions, however, they are invisible to passengers. Nonetheless, all components are **permanently active** even when there is no acute danger: data streams constantly ensure communication between the airbag periphery and the central processing unit, the
At the heart of every BMW airbag system is the **central triggering unit** (indicated in grey in the illustration). All data comes together here, and from here the order is given to release one or more airbags. In addition, sensors are contained in this module to detect an impact and the direction of impact. The primary crash sensor is also located in the central processing unit, which constantly monitors the negative acceleration if the vehicle brakes. This signal is essential for triggering the front airbag.

In order to be able to make the correct decision in every situation, the microprocessor for the airbag control unit refers back to **external data** (indicated in red in the illustration). In this way, the microprocessor receives important information from both connected satellites. Here the values for the lateral acceleration are determined by means of sensitive sensors, and these values are a decisive criterion for triggering the sidebags. The seat occupancy recognition supplies other important information. This ensures that the airbag control only triggers the front-passenger airbag if the front-passenger seat is actually occupied.

All remaining data streams in the airbag network lead away from the central processing unit and control the periphery.

This includes the **protective mechanisms for a frontal collision** (indicated in the illustration in blue). They include the driver’s and front-passenger airbag. For more recent generations of BMW airbag systems (from 1999 onwards), the airbags can be triggered in two stages, depending on the severity of the impact. Not only are the front airbags triggered via this data path, but the pyrotechnic seat belt tensioners are also activated. They are an important component of the airbag philosophy and a decisive safety feature for BMW.
Central
Pressing
Unit

- Fuel pump
- Safety battery terminal 1
- Safety battery terminal 2
- Front passenger’s intelligent airbag (two-stage)
- Belt catch tensioner front-passenger
- Seat occupancy recognition, front passenger
- Sensor satellites
- ITS head-level airbag
- Front sidebag
- Rear sidebag
Another data channel leads to the sidebag periphery (indicated in yellow in the illustration). This is divided into a right and left branch which is activated depending on the type of side impact. Of course, the safety technology is identical for both sides. Consequently each sidebag in the front door is activated. If rear sidebags are present they are also triggered. In the same way, the ITS head-level airbag, present in many BMW cars, is triggered.

In addition to the airbag components themselves, yet more modules are controlled by the airbag control unit (indicated in green in the illustration). This includes the pyrotechnic safety battery terminal, which ensures the electric circuit is interrupted in the event of airbag operation. In cars with two main batteries, of course, they both possess this technology.

Equally, the fuel pump is switched off by the central processing unit following an impact, in order to minimise the risk of fire. The command to do this is given via the body bus in the car. The doors are also unlocked, the hazard warning system activated, and the interior lights switched on via the body bus. In cars with BMW ASSIST, an automatic emergency call to the rescue services control centre is initiated, and this contains precise information about the location of the accident.
brain of the airbag system. For behind the airbags there lies hidden a **complex electronic network**.
Even when the components of the airbag system are distributed throughout the entire passenger cell, the entire restraint system, consisting of up to eight airbags, is networked. The “brain” behind all system components is the central control unit – invisible to the passengers.

Airbag control unit

At the heart of the entire airbag system is its central control unit, in which all data comes together and which makes the decision to trigger the airbags. This electronic unit is centrally positioned on the propeller shaft tunnel. With the latest generation of control units, “intelligent” airbag control has made an appearance. It detects the severity of an impact and accordingly releases the driver’s and front-passenger airbag at different speeds and to different degrees (so-called smart technology).

Crash recognition plays a central role in this control unit. This is carried out by means of special crash sensors. Yet data from other sensors is also evaluated in the computer, for example, seat occupancy recognition. This is important for triggering the front-passenger front airbag. For only if the sensor registers that the seat is occupied is this airbag triggered in the event of an impact.

Based on the evaluation of all the information from the crash sensors and seat occupancy recognition, the control unit intervenes in the restraint system with an immeasurably small delay. In addition to the airbags, the pyrotechnic belt catch tensioners for driver and front passenger, the fuel pump cutout and the safety battery terminal are activated from here.
Thanks to its logical programming, when the airbag is triggered the system is in a position to make several decisions independently. The first decision concerns selecting the right airbags to trigger after the impact. Meanwhile, the electronic system is also ready to trigger the airbags to different degrees. It is generally true to say that triggering the airbags is a highly complex operation in which many matters have to be considered – especially as there are just a few milliseconds in which to make the decision (see section entitled “Philosophy”).

The central airbag control unit also has two further functions: firstly, a self-test originates from it, checking the entire airbag system. Secondly, it has a diagnostic function with a fault display, by means of which it is possible to determine any damage or errors.

Crash sensors

The basic requirement before an airbag is triggered is that the crash sensors have to have determined an impact. They constantly measure acceleration.
An extremely strong negative acceleration (braking) is interpreted as an impact. In fractions of a second, pulses are correspondingly transferred to the central airbag control unit. There the decision is then taken to trigger the airbags.

Some of the crash sensors are located in the housing of the central control unit. Only sensors responsible for triggering the side and head-level airbags are placed on the lateral seat supports. In these satellites, lateral acceleration is determined, which is essential for identifying whether it is necessary to trigger the airbags.

The other sensors, which are arranged in the control unit, are above all responsible for determining longitudinal acceleration. However, they also measure lateral acceleration. Reliably determining an impact is more difficult because the car can also accelerate and brake without external influence. For this reason, in addition to the piezoelectric acceleration meter there is also a mechanical one to aid control (Safing sensor).
In order to achieve maximum precision, two piezoelectric acceleration detectors are used, which are arranged at a 90 degree angle to one another, and offset from the car’s longitudinal axis by 45 degrees. In addition, the mechanical acceleration detector checks any frontal collisions. By means of this system consisting of three sensors in the central control unit, it is even possible to reliably determine crashes that are not exactly square to the direction of travel.

Driver’s airbag

The driver’s airbag is located in the container on the steering wheel. Naturally, even the BMW sport steering wheels, which only have a very small container, have a life-saving airbag. Depending on the model and size of the steering wheel, the volume of the driver’s airbag varies between 45 and 64 litres. In addition, the complete system contains the gas generator with igniter pellet necessary for inflation, plus the solid fuel. In some cars manufactured after 1999, this unit consists of a two-stage generator, which is triggered to a varying degree depending on the severity of the impact. To protect it against contamination, the

![Image of airbag]

The most important component: the driver’s airbag represented the beginning of the development and is the airbag needed most often.
The airbag is covered and identified with the inscription "SRS", "SRS airbag" or "Airbag". Here, SRS stands for Supplemental Restraint System. In the event of a head-on collision, the airbag protects the head, neck and chest areas.

**Front-passenger airbag with seat occupancy recognition**

The front-passenger airbag is located above the glove box. It is concealed beneath a firmly secured flap which bears the inscription "SRS" (Supplemental Restraint System), "SRS Airbag" or "Airbag". The entire module consists of an airbag of approximately **105 litres** plus the igniter unit, consisting of a gas generator, including igniter pellet, and solid fuel or compressed gas. Just like the driver’s airbag, the latest generation of front-passenger airbags (at the earliest, cars from 1999) contain a two-stage generator which is triggered according to the severity of the impact. The front-passenger airbag protects the passenger’s head, neck and upper chest area in the event of an impact to the front or at an angle to the front.

*Only if it is needed: the front passenger seat occupancy recognition only permits the front-passenger airbag to be triggered when the seat is occupied.*
To avoid the front-passenger airbag being triggered unnecessarily when the front-passenger seat is not occupied, the central control unit is linked to a seat occupancy recognition mechanism. Before the system will trigger the airbag, the sensors in the front-passenger seat have to report to the airbag control unit that the seat is occupied.

**Sidebags**

The sidebags are located behind a flap in the side panels of the front, and in some cases, the rear doors. They consist of an airbag of approximately 14 litres, the gas generator with igniter pellet, and the solid fuel or compressed gas. The sidebags are also identified in the area of the door lock with the words "SRS" (Supplemental Restraint System), "SRS Airbag" or "Airbag". The sidebags protect the chest area of persons seated on the side affected by the thrust of a side impact.
ITS head-level airbags

The head-level airbags are located along the A-pillar and the roof frame in the driver and front-passenger areas. These airbags are also referred to as an Inflatable Tubular Structure (ITS). The hose-like airbag tubes each have a volume of 13 litres. They also each have their own gas generator with igniter pellet and solid fuel or compressed gas, which are located beneath the instrument panel. The inscription "SRS" (Supplemental Restraint System), "SRS Airbag" or "Airbag" on the A-pillar indicates the module located under the trim panel (with hinge). The ITS head-level airbags protect the side of the head and neck area of persons on the side affected by the thrust of a side impact or an impact at an angle to the side.

Safety battery terminal

The safety battery terminal (SBT) is also part of the safety system. In the event of an impact it automatically disconnects the starter motor and the generator from the electric supply.
alternator from the electric supply, thereby preventing short circuits. The safety battery terminal is at the positive terminal of the battery and consists of a housing with retaining springs and a pyrotechnic propellant with igniter pellet. If the module receives a message from the control unit to trigger the airbags, the safety battery terminal igniter is also activated. The volume of gas created pushes the cable pin out of the battery terminal bracket, thereby interrupting the connection between the battery, the starter motor and the alternator. In cars with two main batteries, for example the E38 with M73 engine, both positive terminals are disconnected from the starter motor at the same time. However, the power supply to the rest of the vehicle’s system remains intact. This is protected by means of fuses if an accident triggers a short circuit.

Fuel pump cutout

As soon as the criteria for triggering an airbag are satisfied the fuel supply is automatically interrupted. This signal is sent by the airbag control unit via a data transfer line (body bus) to the instrument cluster, from where the signal is passed on via another data transfer line to the engine control unit. In addition, the hazard warning system and interior lighting are automatically switched on as soon as the triggering criteria are satisfied.

Automatic emergency call

In cars with BMW ASSIST, another function is connected to the complete airbag system: the automatic emergency call. If the crash sensors register a severe collision and trigger at least one airbag, then BMW ASSIST automatically transmits an emergency call. This means the vehicle data and precise location determined by the GPS navigation system are transmitted via the mobile phone SMS data channel to an emergency call centre.
In the blink of an eye

As soon as the limit values required to trigger an airbag are exceeded, the control unit activates the appropriate airbag. This means an appropriate ignition voltage is fed to the igniter pellet in the airbag. At this point the airbag generator burns the pyrotechnic propellant completely into nitrogen.

In a fraction of a second (front airbag approximately 40 milliseconds, sidebags approximately 20 milliseconds) the released gas streams into the airbag and opens it up. At the same time the airbag cover tears open at the rupture lines. Depending on the type of airbag, either the steering wheel container (driver’s airbag), the cover above the glove box (front-passenger airbag), or the side panels (side and head-level airbag) are affected.

In older cars when the airbag opens up, small quantities of harmless talcum powder might be released. This is used to protect the folds in the latent airbag from sticking together. As the airbag opens up, therefore, a thin, smoke-like mist might occur briefly; this has nothing to do with the airbag ignition fuel.
Calculated during a simulation: what will happen, and when, following an impact?
How, when, why?
Triggering an airbag

The airbag is one of the most important safety elements in modern cars. It has saved many human lives and prevented severe injuries. Yet each airbag also has an unavoidable level of aggression. Since the airbag, whatever volume of air it contains, has to open up fully within fractions of a second, its use is associated with a certain amount of potential risk to passengers. Above all, if a passenger is not sitting "in position" (see page 48 for additional information), there is a risk of injury as a result of the airbag opening up.

In order to reduce this potential risk as far as is humanly possible, the airbag is in fact only triggered when it is absolutely necessary. It therefore does not make sense, for example, to release an airbag as the result of a small "shunt" at walking pace. The risk of injury from the airbag would be greater than the minimum injuries that might be expected if no airbag came into action. Another aspect is the subsequent costs resulting from triggering an airbag. BMW does not want to impose the subsequent repairs and their associated expense on its customers unless it really makes sense to trigger the airbag.

For that reason an airbag will only be released if its protective effect outweighs the potential risk. At the point where a passenger feasibly has to expect more severe injuries if the airbag is not released than if it is, then an airbag must be released.

In this context, the seat belt plays a decisive role: an airbag can only be fully effective as a means of protection when used together with a fastened seat belt. At lower impact speeds, the seat belt, as the primary safety element, assumes the function of restraining the passengers. The front airbag only comes into action as the secondary restraint element. The effective action of the seat belts and airbags is harmonized. For this reason it is very important that the seat belt is always fastened during a journey.
The aggression of an airbag belonging to the new generation of **intelligent airbags** is significantly reduced because the airbag is released in several stages – depending on the severity of the accident. In the event of a minor impact, only the "gentle" stage of the airbag is ignited – it opens up more slowly. The delay between stage one and stage two is approximately ten milliseconds. In the event of more severe collisions, the airbag releases its full energy.

\[\text{AIRBAG}\]

\[\text{SEAT-BELT TENSIONER}\]

\[\text{AIRBAG CONTROL UNIT}\]

\[\text{SENSOR}\]

The acceleration values decide: as soon as the sensors report that certain threshold values for negative acceleration have been exceeded, the control unit triggers the pyrotechnic seat belt tensioner and possibly the airbags. There is a defined threshold value for each triggering command (BT = seat belt tensioner, AB1 = Airbag stage 1, AB2 = Airbag stage 2).
Any airbag – whether front, side, or head-level – is triggered in accordance with a **defined logic**. In the case of triggering a front airbag, it is decisive whether specific **threshold values** for the negative acceleration are reached, i.e. braking in the event of an impact. The sidebags are an exception; in their case, threshold values for positive acceleration must be exceeded before an

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*The most frequent type of accident: in a head-on collision, the impact energy (red arrow) acts in the same direction as the motion of the car (black arrow). If the vehicles only partly overlap, that does not change the energy initiated, although it might well change the deformation behaviour of the body and therefore also the acceleration forces occurring. These in their turn are decisive if an airbag is to be triggered. The degree of overlap can therefore influence whether or not an airbag is triggered.*
airbag is triggered. If the sensors in the car body report values higher than the respective threshold value, then the airbag control unit triggers the corresponding airbag, if necessary in several stages. Naturally, not every airbag is ignited indiscriminately, but only those that can definitely have a protective effect for the passengers.

For the decision whether to trigger the airbags and, if so, which ones, the direction from which an impact comes or in which direction the associated impact impetus is acting is always decisive. For example, for a front airbag to be triggered, only forces acting in a frontal direction are significant. The side forces are irrelevant. An example clarifies this principle: in the event of side impact there is no point in triggering the front airbags because there are no forces acting in this direction. Instead, in the event of a side-on collision it is, of course, the sidebags that need to be triggered. The opposite applies in the event of a straight head-

A clear situation: in a side-on collision, the impact energy only acts laterally on the right-hand car in the illustration. There is no frontal action. For this reason, as a rule (and where there is sufficiently high speed) only the sidebags and head-level airbags are triggered, not the front airbags.
on collision: here, the front airbags are required; the sidebags would be ineffectual.

The same principle also applies to all combinations between a purely head-on and a purely side-on collision: if two vehicles collide at an angle, then the forces acting on the front and side respectively also change as the angles vary. The entire impact energy, which can be imagined as a vector arrow, then separates into two smaller "arrows" – one to the front and one to the side. The size of each individual vector is a decisive factor in triggering the respective airbags.
The more oblique, the less likely it is that a front airbag will be triggered. As the angle between two colliding vehicles increases, the more the direction of movement of the upper car (black arrow) and the direction of the forces acting on the front of the lower car (red arrow) differ. The remaining impact energy (yellow arrow) acts laterally on the lower car and has no relevance for triggering the front airbag (of the lower car). Only forces acting on the front are decisive in triggering a front airbag.

Something similar applies to rear-end collisions. If a car is hit at the rear by another vehicle, the corresponding impetus acts upon the longitudinal axis of the car, but in the opposite direction. In such cases it would not make sense to trigger the front airbags. The residual impact energy acting on the passengers must in this case be absorbed by the seats and head restraints.
The logic of airbags often leads to misunderstandings: it is not rare for a car driver to think that the airbags (especially the front airbags) should have been triggered after an accident. In fact, however, in most cases the impact impetus acting on the front has not been big enough to merit releasing an airbag – even when accidents have appeared to be severe.

Moreover, it is not possible to see in a damaged car which forces have been acting in which direction on impact. Even severe body deformation is no indication that a correspondingly high impetus has occurred in the respective relevant direction. In the case of complex accidents there are too many factors at work for anyone to be able to make definite observations on a visual inspection.

It depends, for example, which body structures the impact has acted upon, for different areas of the body also demonstrate different deformation behaviour and different levels of energy absorption. Relatively soft parts of the body can be badly deformed even as the result of minimum energy impact; stronger structures absorb far greater forces before becoming deformed.

Special case, a rear-end collision: if a car collides with the car in front, the impact impetus still acts on the longitudinal axis, but in the case of the front vehicle it is in the “wrong” direction. The front airbags may well be triggered accordingly in the rear vehicle, but by contrast that would not generally be sensible in the case of the front vehicle.
It remains certain: an airbag must be triggered when it is really needed. If, in a case of doubt, it would cause more harm than good, then it must not come into action.

**It is not possible without further research to establish from a damaged vehicle whether an airbag should have been triggered or not.**

You cannot see it in a damaged vehicle: in the car shown above, the airbags were triggered, but not in the car below because the impact was not sufficiently severe.
People have to play their part

No matter how much value car buyers place on the safety equipment, they still know relatively little about the correct handling of the components. This lack of knowledge is particularly conspicuous in connection with the various airbags in the car. Although they are "Life-saver number one", they are invisible. Often that means that car passengers are hardly aware of their existence.

Yet it is precisely when dealing with the technically demanding airbags that important facts need to be noted. After all, the airbags are released in a fraction of a second. As a result of this speed, the bags are inflated under enormous pressure. If elementary rules are not observed, serious injuries can result.

Researchers into accidents often use the expression "out of position" to describe the fact that someone was not sitting in the correct seat position. This in particular represents a considerable risk. If, by contrast, the correct seat position is maintained in the car, the possibility of an injury being caused by an airbag, although it cannot indeed be excluded, is very unlikely.

The driver should adopt a comfortable seat position, at the same time observing the distance between himself and the airbag steering wheel. It generally applies that the greater the distance from the steering wheel, the safer the driver’s position is. It is also important that the driver only holds the steering wheel by the rim. This reduces the risk of injury to the hands and arms dramatically.

The front passenger must also adopt a correct seat position if he wants to protect himself from possible injuries. This concerns the distance from the airbag as well as the passenger’s body posture. Above all, resting the legs on the area above the glove box (where the airbag is located) is extremely dangerous. In the event of the airbag being triggered the result would be the most severe injuries
to the legs and spine. Nor should the passengers lean against the car door. If the sidebags located there are released, they could cause injury.

In order not to limit the function of the airbags and to maintain maximum passenger safety, it is essential that the following information should be taken into consideration: there should be no objects and also no person or animal between the airbag and the person concerned. The force from the triggered airbag would catapult them onto the passengers. The airbag covers should not under any circumstances be glued up, covered or tampered with in any way. Only in this way can the entire safety system function unhindered.
The youngest passengers need special protection in the car. All the safety systems in the passenger compartment, especially the seat belt and airbag components, are designed exclusively to protect adults. For this reason, children up to the age of twelve or a height of less than 1.50 metres require special safety equipment.

Small children must not be secured with a conventional seat belt. The seat belt system is not designed for a child’s body proportions. This means that when the diagonal belt is tightened it might injure the child’s neck, or the child might slip through beneath the belt because the transverse belt fixing is too wide. Even if these two situations do not apply, the child is at risk: because the seat belt is designed for far greater forces, the body is braked too abruptly, so leading to a dangerously high force.

Children must be accommodated in child seats that are both appropriate for their age and meet the legal requirements. The seat belt systems fitted to these seats are made to measure for the respective age group – regardless of whether they are restraint systems from a general accessories dealer, BMW original accessories, or integrated seats in a BMW car. What is important in every case is that the seat is correctly installed and located in the specified position in the vehicle, and that the children are correctly fastened in.

If a car has sidebags in the rear, the following rules apply before children should be transported. Children from the age of approximately nine months may be transported in suitable child seats on the two outer rear seat positions, because from this age they sit facing the direction of travel. Nonetheless, it is important to check that the distance between the door (in which the sidebag is located) and the child seat is as big as possible. Equally, care must be taken with older, and therefore more mobile, children that they do not lean out of the seat towards the door during the journey. If a
child is particularly active, it is possible to temporarily deactivate the rear sidebag.

Deactivating the rear sidebag is also recommended if the child is secured in a child seat facing opposite the direction of travel. Where special child seats that have not been approved by BMW are concerned, the child will be within the danger zone of the sidebag. For children of this young age, this seating position is the only safe one. However, because the airbag system is not set to this, the rear sidebag should be temporarily deactivated (see next section).

In general, it is recommended that children under the age of twelve years should only be transported on the rear seats. If, nonetheless, the situation arises where a child is transported on the front-passenger seat, then some important special features should be observed. In every case, child seats of the correct size and for the correct age must be used. If the car has sidebags, no backwards-facing child seats may be used. In all other cases, if children are transported on the front-passenger seat, care must be taken that the seat is fully pushed back. In addition, the child seats should be at the greatest possible distance from the sidebags located in the side panels.

It need not become a matter of strength: the original BMW ISOFIX child seats make securing children considerably easier.
Occasionally a customer wishes to deactivate individual airbags in the car. The reason for this is almost always that small children are to be transported on seats that are protected by airbags. Deactivating the airbag makes sense, for instance, if the car has sidebags in the rear, but the child seat is positioned facing opposite the direction of travel.

The same applies to the front-passenger front airbag and the corresponding sidebag, if the child is secured on the front-passenger seat facing opposite the direction of travel (for example, in a two-seater). But also, if it is not certain that children will keep to the correct seat position, the appropriate sidebag should be deactivated if there is any doubt.

This intervention must only be carried out at the express wish and at the full responsibility of the car owner. In case of a possible dispute about product liability, this permission, plus a description of the work carried out, must be documented. In some markets – Germany, for example – customers must in addition be made aware that the changes to the car are to be noted in the car’s documents.

An airbag can be deactivated in two ways, and both operations must always be carried out. Firstly, the airbag concerned must be released mechanically from the entire airbag system. To do this, the plug connectors in the igniter circuit are disconnected. Secondly, the airbag control unit is reconfigured using an appropriate code so that the airbag concerned is no longer controlled. Isolating the airbag mechanically and electronically guarantees to a high degree of certainty that the airbag will not be triggered.

Naturally, a deactivated airbag can be reactivated by reversing the procedure. Therefore, the dealers should independently contact
Only for professionals: an airbag may only be deactivated at a BMW dealership.

Double safety: the airbag is deactivated both mechanically and electronically.

the car owner at the latest after nine months to check whether the deactivation is still necessary. Ultimately, a completely functional airbag system is necessary if all the designed measures for passive safety are to be used fully.
"How does an airbag function?"
A central computer detects the drive status via several sensors. If certain threshold values for changes in motion are exceeded, one or more airbags are triggered. This is achieved by means of an electronic pulse, as a result of which the igniter pellet in the airbag propellant "explodes", filling the airbag with the released gas. After a short while, the gas escapes from the airbag again.

"How long have BMW cars had airbags?"
In 1984, a driver's airbag was offered in the 7-Series for the first time. Increasing demand ensured that during the 1990s the driver's and front-passenger airbag were not only fitted as standard, but other airbags were developed. As a result, sidebags came on the market, initially for the front seats, and shortly afterwards also for the rear window seats. Somewhat later the ITS head-level airbag (Inflatable Tubular Structure) was introduced. Present efforts in the development of airbags concern their increasingly individual ignition, which is oriented still more closely towards what happens in the event of an accident. BMW is already offering the first "intelligent" airbags with smart airbags.

"What is a smart airbag?"
No two impacts are the same. Extensive research work has shown that the operating principle of an airbag (especially the front airbags) can be optimised if they do not open up to their maximum size in a flash and then collapse again equally quickly. In this context, an airbag control system has been developed which is able to react differently depending on the severity of the impact. This relates above all to the speed of opening and the time it takes to fill with gas.

"What does Out of Position mean?"
This expression indicates that a passenger is not seated correctly in the vehicle. The passenger is therefore not in the position for which the airbag system was optimally designed. This is especially the case if a person is not secured with a seat belt. In the event of an impact, that person moves differently than a person wearing a belt. Being “out of position” holds an additional risk of injury, possibly considerable. This plays a big role in the transportation of small children in particular.

"How should a person sit in the car?"
Without exception wearing a seat belt. To avoid the risk of sitting "out of position", some further important basic rules should be observed. The distance to the steering wheel should not be too small. Under no circumstances should front passengers rest their legs on the area above the glove box, because that is where the front-passenger airbag is located. In
addition, arms should not be rested on the door in order to avoid injuries caused by a triggered sidebag.

"Why do children have to be transported in special seats?"
All the passive restraint systems in the car are designed for the size and weight of an adult and for that reason they offer insufficient protection for children. In order to guarantee that small children do not sit "out of position", they must be transported in child seats appropriate for their age. Here, BMW recommends that children should be transported exclusively on the rear seats. If a child seat is secured on the front-passenger seat, the airbags there must be deactivated.

"When do airbags need to be deactivated?"
As a matter of principle, children should be transported in child seats suitable for their age on the rear seats. If the car has rear sidebags, they should at least be deactivated if the child is being transported in a seat that faces backwards against the direction of travel. If a child younger than twelve years is being transported on an appropriate child seat on the front-passenger seat, it is essential that the front-passenger airbags and sidebags are deactivated.

"How are airbags deactivated?"
As a matter of principle, airbags are only deactivated at the express wish of the customer; the work must be carried out only at an authorised BMW workshop. This involves reprogramming the airbag control unit so that the airbag concerned is no longer actuated. In addition, the connection with the airbag is also mechanically disconnected. Both procedures can be reversed to reactivate the airbag. If front airbags are deactivated, in most cars the seat belt should also be replaced at the same time.

"Why is it necessary to be fastened in with a seat belt despite having airbags?"
The seat belts are the primary restraint system. The airbags, being the secondary restraint system, supplement the effectiveness of the seat belts. Just how closely interdependent the seat belt and airbag are is also shown by the fact that the belt tensioners are controlled by means of the same electronics as the airbag release system.

"Is it acceptable to make phone calls using a mobile phone in the car without an external antenna?"
Yes, a mobile phone may be used in the car without an external antenna. Suspicions that, as in an aeroplane, the radio waves could influence the airbag control unit have proved to be unfounded. However, using an external antenna is highly recommended. In addition, in most countries it is illegal to make a telephone call during a journey without a hands-free speaking system.

"Can an airbag steering wheel be replaced by a sport steering wheel?"
It is entirely possible to replace a standard airbag steering wheel with another steering wheel with an airbag. This includes a sport steering wheel. The only prerequisite is that
an original BMW part must be used. The parts may only be exchanged by trained mechanics at a BMW workshop.

"What has to be taken into consideration during the work in the workshop?"
Before work is carried out on any components in the airbag system, it is essential that the power supply is disconnected. It is sufficient to disconnect the car battery. This measure ensures that the airbag is not unintentionally triggered as the work is carried out.

"How must airbags be stored?"
At the storage depot airbag components, above all the airbag steering wheels, must be stored next to one another. Under no circumstances should they be stacked. This safety measure is intended to avoid a domino effect if an airbag is unexpectedly ignited. In addition, the steering wheels should not be stored with the airbag container facing downwards, but always with the container uppermost.

"What happens during an airbag self-test?"
After the ignition has been activated, the on-board electronics automatically carry out a self-test. This means that all components and contacts are tested for correct functioning. Until the self-test has been concluded (it takes a few seconds), the airbag indicator light will be illuminated in the instrument panel, then it will go out.

"What action is needed if the airbag indicator does not go out?"
If the airbag indicator does not go out after the engine has been started, or if it lights up during the journey, the system has diagnosed a fault in the airbag components. The car should be taken as soon as possible to a BMW dealership to have the problem rectified. There the exact error code can be determined using a diagnostics unit.

"Why wasn't the airbag triggered during an accident?"
One or more airbags will be triggered in accordance with a precisely defined logic and a clear philosophy: in BMW cars, airbags are only triggered if it is absolutely necessary and it will genuinely serve to protect the passengers. This means that in general, even in a severe collision
from the side or rear, the front airbags will not be triggered because in this case they can offer no protection. Conversely, in the event of a head-on collision the sidebags are not triggered. In practice, however, most accidents are more complex than these examples indicate. The crash sensors, however, are in a position to determine the exact direction of force and trigger the correct airbags in response.

“What does passive safety mean?”
All safety components that come into action during or after an accident are part of the passive safety system. This includes firstly the safety occupant cell. Since it has defined crumple zones, the safety occupant cell is able to minimise the impact energy. The seat belt system also belongs to the passive safety system, as do the belt tensioner and belt force limiter. Equally, the structure of the seats and the head restraints are elements of passive safety. The airbag system is also an important component, further increasing safety.

“Following an accident, is there any risk to passengers and helpers from airbags that have not been ignited?”
No, because when a car is stationary the airbags are not triggered. If, however, it should be necessary to move the car, the airbag system can be deactivated by a simple action: by disconnecting both cables from the battery with the ignition switched off, airbags that have not been triggered can be deactivated.

“Why does smoke appear when airbags are triggered?”
In older airbags a dust develops because the folded airbags are dusted with talcum powder. Chemical and medicinal analyses confirm that this is not harmful to health. However, this does not preclude the possibility of short-term irritation in the throat.

“Does the airbag get hot?”
No, the inflated airbag does not get hot. High temperatures only occur in some parts inside the car which are not accessible. These parts also cool down again within 15 minutes.

“In the event of a fire in the car, can an airbag be triggered or explode?”
The airbag priming cartridges are designed not to explode until temperatures reach more than 200 degrees Celsius. If this limit is exceed, then the airbags are triggered in the same way as in a “normal” ignition.
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