Service Training

Occupant Protection - Passive Systems

Self-Study Programme 410

Occupant Protection - Passive Systems

... then

... now

410_077

The technical development of the motor vehicle has also seen a continuing increase in engine performance. This positive development, in combination with increasing vehicle density on roads and traffic congestion, has led to ever-increasing demands on driver alertness.

Despite the many improvements that have been made with respect to active motoring safety, especially in recent years, accidents can never be completely ruled out or avoided.
For this reason, current research has been increasingly focusing on technical solutions for the protection of vehicle occupants in an accident. The first step in this direction was taken during the late 1950s with the introduction of seat belts designed to hold vehicle occupants in their seats during a collision. In the early 1980s further progress was made with the introduction of airbags designed to cushion vehicle occupants during a collision. These systems have been the subject of ongoing development and improvement.

Today's vehicles are very different to the vehicles of earlier generations with respect to their interior equipment. In the above illustrations this is best evidenced by the dash panel and the steering wheel, which today are specially designed to accommodate integral airbags.

Contents

The Self-Study Programme teaches the design and function of new vehicle models, automotive components or technologies.

The Self-Study Programme is not a Repair Manual!
The values given are intended as a guideline only and refer to the software version valid at the time of publication of the Self-Study Programme.
The images/graphics contained in this Self-Study Programme are basically intended for better comprehension of the context.

For information about maintenance and repair work, always refer to the current technical literature.

Reference

Note

Summary

The occupant protection system

The occupant protection system as a whole is a combination of active and passive safety systems. The following overview gives a brief description of the respective safety elements intended for active and passive occupant protection.

Active safety

Active safety refers to everything designed to help prevent an accident from happening. It includes features such as direct and comfortable steering, good suspension characteristics, well-tuned suspension systems, very good traction, effective brakes and torquey engines.

Seats that reduce fatigue, clear visibility, good climate control, understandable and uncomplicated instruments and controls help the driver to remain alert.

The following systems are also active safety features:

- Anti-lock Braking System - ABS
- Traction Control System - TCS
- Electronic Stabilisation Program - ESP
- Electronic Brake Pressure Distribution - EBD
- Adaptive Cruise Control - ACC
- Electronic Differential Lock - EDL

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This Self-Study Programme describes components, systems and functions of the passive occupant protection systems on Audi vehicles.

Passive safety

Passive safety is a general term covering all design measures intended to protect the car's occupants against injury or to at least reduce the severity of injuries.

The term refers in particular to the car's behaviour in collisions (crash tests) and not only includes protection for the car's occupants but also for other road users (partner protection).

The most important safety features of today's cars include:

- the safety belt system with belt tensioners including child restraint systems
- the airbag system with front, side and head airbags
- a deformation-resistant occupant cell with roof stiffness as well as crumple zones at the front, rear and sides
  (they protect the occupants by absorbing the impact energy in a controlled fashion).
- Roll-over protection in cabriolets
- The battery disconnect

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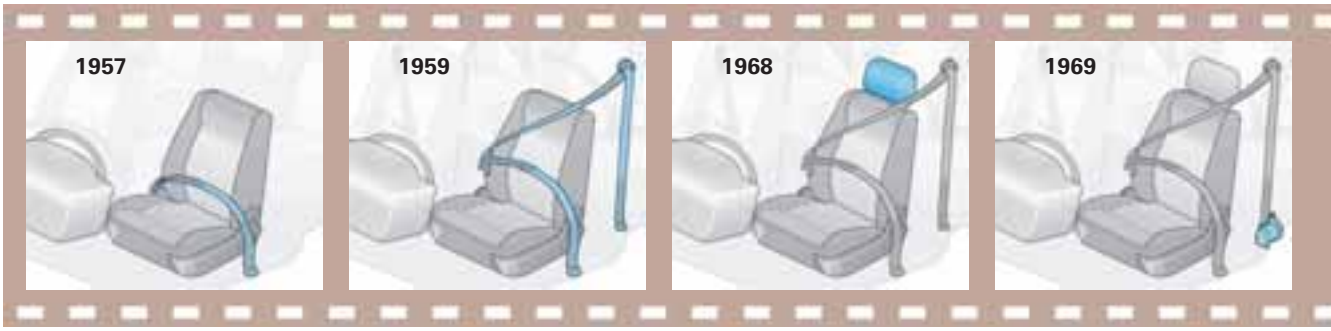
Summary

Historical account of the development of belt and airbag systems in automobiles



Lap belts (static belts) | **3-point seat belts (static belts)** | **Front head restraints** | **Inertia reel seat belt**

The development of the seat belt

- As long ago as 1903, Frenchman Gustave Desiré Lebeau filed a patent for a safety belt in the form of a crossover shoulder belt. However, seat belts as we know them did not become available until 1957. These early seat belts, initially fitted on the front seats only, were comprised of a simple lap belt which held the occupant's lower body (pelvis) firmly in position in the seat. The upper body is not held securely in the seat, and therefore not protected against impact to the front.

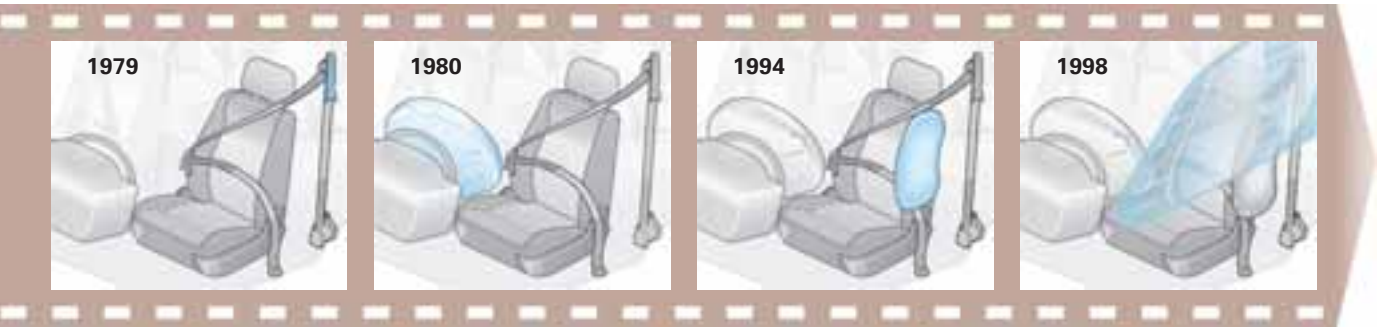
- In 1958 Nils Bohlin filed a patent for the first 3-point seat belt. The first automobile manufacturers introduced these seat belts as standard in 1959. The 3-point seat belt restrains the occupant's whole upper body during an impact.
  These safety belts were initially "static" in nature, and were not adaptable to the occupant's body.

- The safety belt system was improved with the introduction of head restraints in 1968. The head restraint protects the neck from hyperextension following a front or rear-impact crash.

- The introduction of the inertia reel seat belt in 1969 saw the advent of spring-retracted seat belts which adapted to the body of the wearer upon sudden deceleration or impact.

- A new shoulder height adjustment device introduced in 1979 further provided better positioning of the seat belt relative to the body of the occupant. It allows the upper seat belt pivot on the car body to be adjusted in such a way that the belt adapts very well the occupant's body size.

- The first belt tensioner was introduced in 1980 - in combination with a driver airbag - on the front passenger seat. It takes up slack in the seat belt during an impact and thereby ensures that the seat belt webbing is pulled firmly against the vehicle occupant. The system was later augmented to include belt force limiters (belt loops, torsion limiters).



Shoulder height adjustment

Front airbag - driver airbag, belt tensioner - front passenger side

Side airbags

Head airbags

The development of the airbag

- The first patent for an airbag was filed in Germany by Walter Linderer in 1951.
  The patent was awarded in 1953.
  It was not until 28 years later - in 1980 - that the first airbag was fitted as standard in an automobile (initially in the USA).

- Large-volume airbags were used in the USA because the wearing of seat belts was not mandatory.
  Airbags with a lesser volume were used in Europe because the wearing of seat belts was compulsory by law.

- At first, airbags were fitted only on the drivers side, but later passenger airbags became available.

- Side airbags were first introduced in 1994 in order to afford side impact protection. They can be fitted on the front and rear seats, depending on equipment level.
  The scope of side impact protection was later extended to include the upper body areas. To this end, a so-called window airbag or head airbag was developed. This airbags extends over the length of the front window and protects the head area during a side impact.

- Today the development of new airbags is mainly focused on improving deployment, inflation and cushioning performance in order to in order to further minimise the risk of injury in the event of a collision.

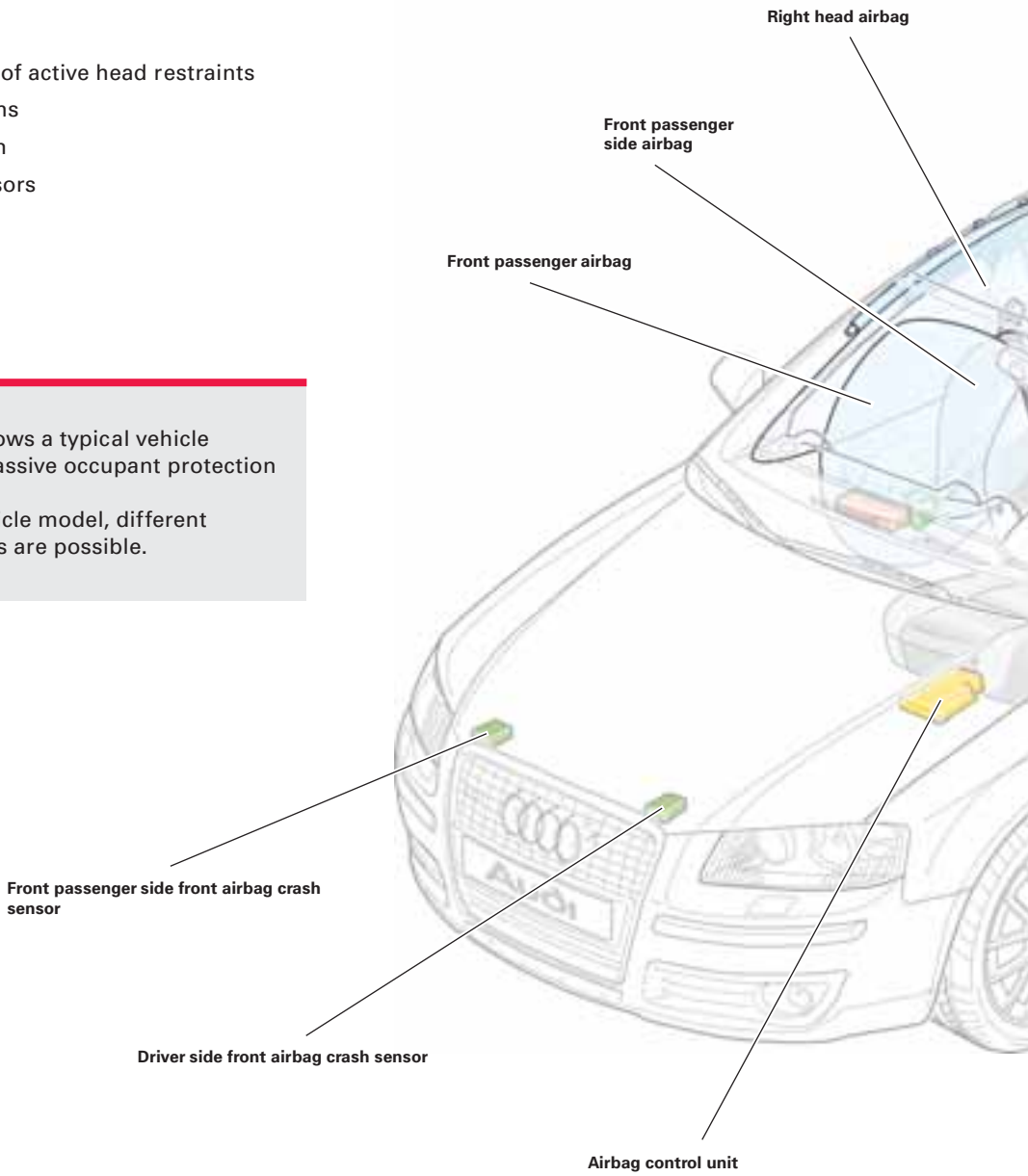
Note

It is important to be aware that the wearing of a seat belt is the no. 1 safety precaution.
All other precautions simply serve to augment and enhance safety, but are only effective in combination with a fastened seat belt.

The passive occupant protection system

The passive occupant protection system is comprised of:

- Bodyshell
- Airbags
- Seat belts
- Belt tensioners
- Belt force limiters
- Seat design, e.g. use of active head restraints
- Child restraint systems
- Battery disconnection
- Control unit and sensors

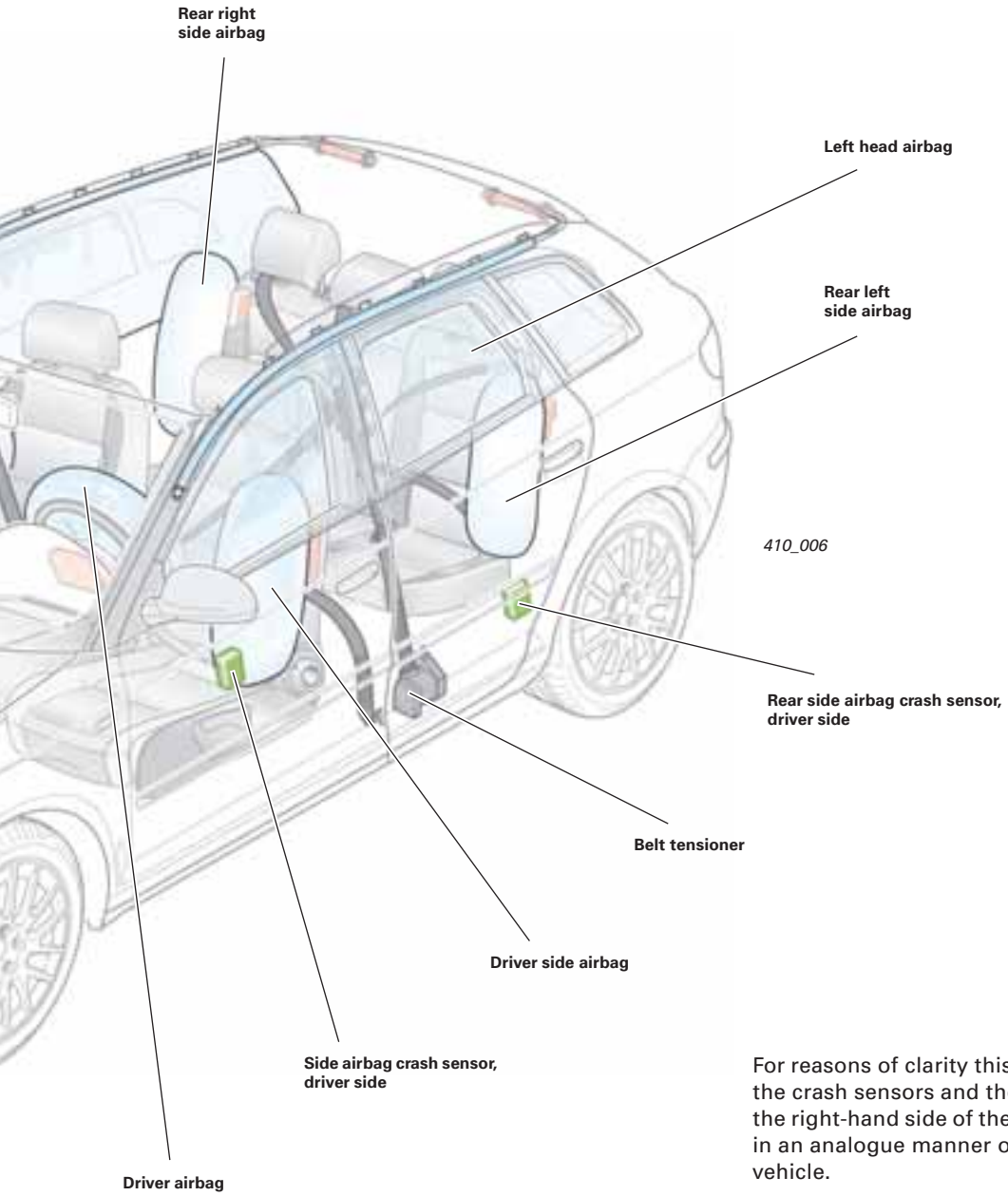


Note

The illustration shows a typical vehicle equipped with a passive occupant protection system.
Depending on vehicle model, different equipment variants are possible.

Reference

For model-specific information about airbag systems, please refer to the Self-Study Programmes applicable to the vehicle model in question. You will find an overview on page 72.



For reasons of clarity this drawing does not show the crash sensors and the belt tensioner fitted on the right-hand side of the vehicle. They are arranged in an analogue manner on the left-hand side of the vehicle.

The networking of system components

The passive safety system includes the following components:

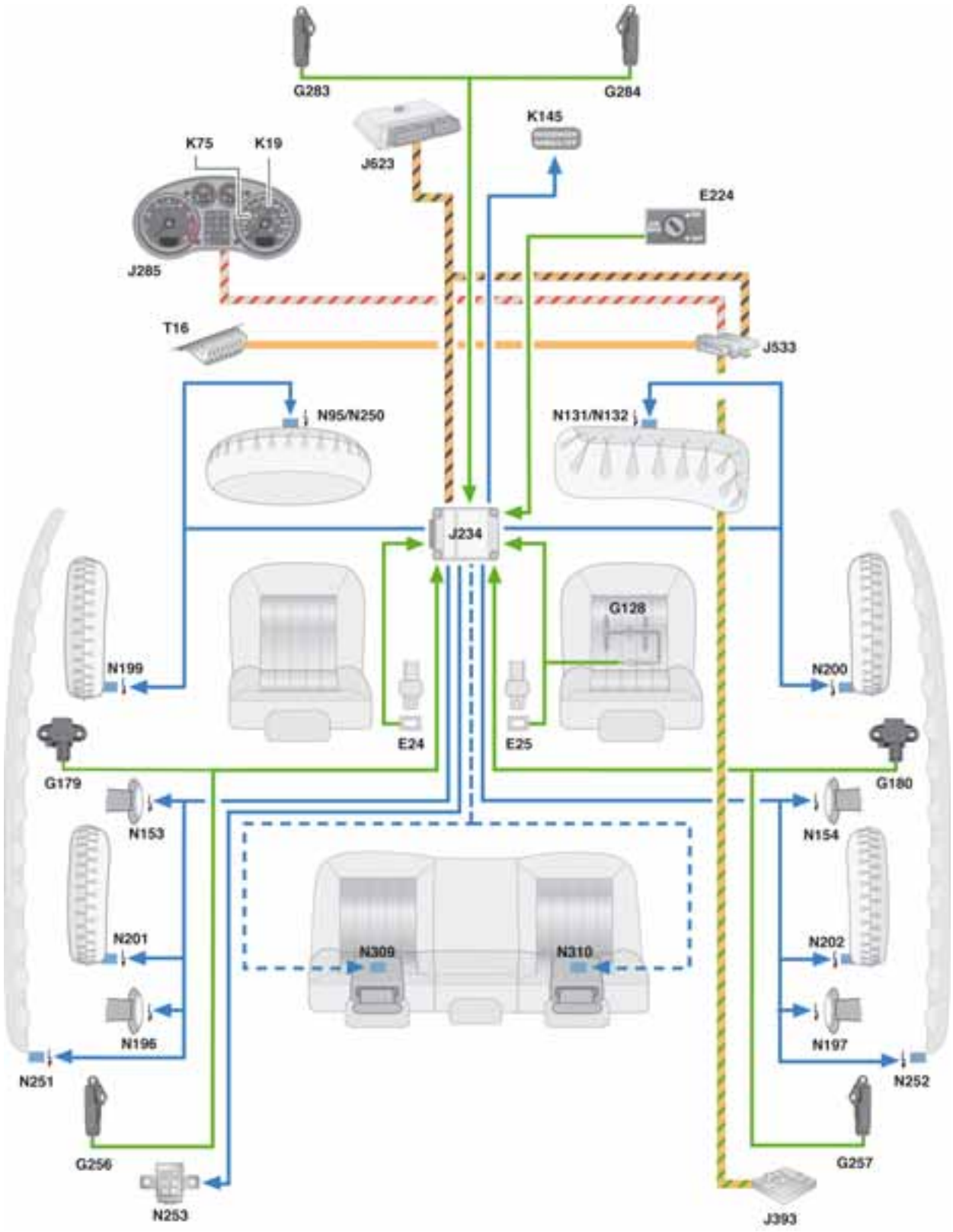
- Airbag control unit
- Driver and front passenger airbag
- Side airbags
- Head airbags
- Collision detection sensors
- Belt tensioners
- Belt force limiters
- Roll-over protection (Cabriolet)
- Battery disconnectors (for vehicles with battery installed in the interior/luggage compartment only)
- Switches in the front seat-belt buckles
- Seat occupied sensor, front passenger side
- Key switch for disabling the front passenger front airbag and the relevant warning lamp
- Active head restraints in the front seats

The adjacent system overview shows all possible component parts of the passive occupant protection system and how they are networked. Not all these parts need necessarily be fitted on every vehicle type.

The convenience system central control unit is included in this overview because it performs convenience functions, such as switching on the hazard warning light system and opening the doors (in the event of a crash).

Legend

E24	Driver side belt switch
E25	Front passenger side belt switch
E224	Airbag disabling key switch, front passenger side
G128	Seat occupied sensor, front passenger side
G179	Side airbag crash sensor, driver side
G180	Side airbag crash sensor, front passenger side
G256	Rear side airbag crash sensor, driver side
G257	Rear side airbag crash sensor, front passenger driver side
G283	Driver side front airbag crash sensor
G284	Front passenger side front airbag crash sensor
J234	Airbag control unit
J285	Control unit with display in dash panel insert
J393	Convenience system central control unit
J533	Data bus diagnostic interface (Gateway)
J623	Engine control unit
K19	Seat belt warning system warning lamp
K75	Airbag warning lamp
K145	Passenger airbag off warning lamp (PASSENGER AIRBAG OFF)
N95	Airbag igniter, driver side
N131	Front passenger side airbag igniter 1
N132	Front passenger side airbag igniter 2
N153	Driver seat belt tensioner igniter -1-
N154	Front passenger seat belt tensioner igniter -1-
N196	Rear belt tensioner igniter, driver side
N197	Rear belt tensioner igniter, front passenger side
N199	Side airbag igniter, driver side
N200	Side airbag igniter, front passenger side
N201	Rear side airbag igniter, driver side
N202	Rear side airbag igniter, front passenger side
N250	Driver side airbag igniter -2-
N251	Driver side curtain airbag igniter
N252	Front passenger side curtain airbag igniter
N253	Battery isolation igniter
N309	Roll-over bar solenoid, driver side (Cabriolet only)
N310	Roll-over bar solenoid, front passenger side (Cabriolet only)
T16	16-pin connector (diagnostic port)


G283
G284
K145
K75
K19
J623
E224
J285
T16
J533
N95/N250
N131/N132
J234
G128
N199
N200
E24
E25
G179
G180
N153
N154
N201
N202
N309
N310
N196
N197
N251
N252
G256
G257
N253
J393

410_007

Types of collision

Accident analyses show that approximately half of all serious accidents or accidents involving injured occupants involve the front end of the vehicle. The forces act on the vehicle frontally to diagonally. One third of all accidents occur on the left or right side of the vehicle. A small proportion of accidents involve the rear end and roll-over.

410_008

Front	51.1 %		Side	32.0 %	
Rear	14.1 %		Roll-over	2.8 %	

Data source: GIDAS

GIDAS (German in Depth Accident Study) is a joint project of the German Federal Highway Research Institute and the German Automotive Research Association. Every year, according to a sampling plan, some 2000 accidents are studied by two survey teams working in the Hannover and Dresden areas.
The data acquired in this way may be considered statistically representative and can be used to solve a number of questions.

Impact situations

The various airbags deploy to protect for the occupants according to the direction of force acting on the vehicle during an impact. When the airbag control unit detects an impact which meets the deployment criteria, the relevant systems are activated. Depending on the direction or angle of impact, only certain airbags are activated. In addition, the airbag control unit notifies the other vehicle systems about the collision event. This information is used, among other things, to shut off fuel feed to the engine.
If a battery disconnector is fitted, it is activated when the airbag deploys.

Collision - head-on

Depending on the severity of the impact, only belt tensioners or belt tensioners and driver and front passenger front airbags are activated.

410_069

Collision - diagonal frontal

The belt tensioners or belt tensioners and driver and front passenger front airbags and/or the respective head airbags and/or the side airbags may be activated.

410_070

Collision - side-on

Depending on vehicle model, the side airbags/head airbags and the belt tensioners may deploy on the impacted side of the vehicle.

410_071

Collision - rear

Depending on vehicle model, the belt tensioners and the battery disconnector may be activated.

410_205

The time sequence of a head-on collision

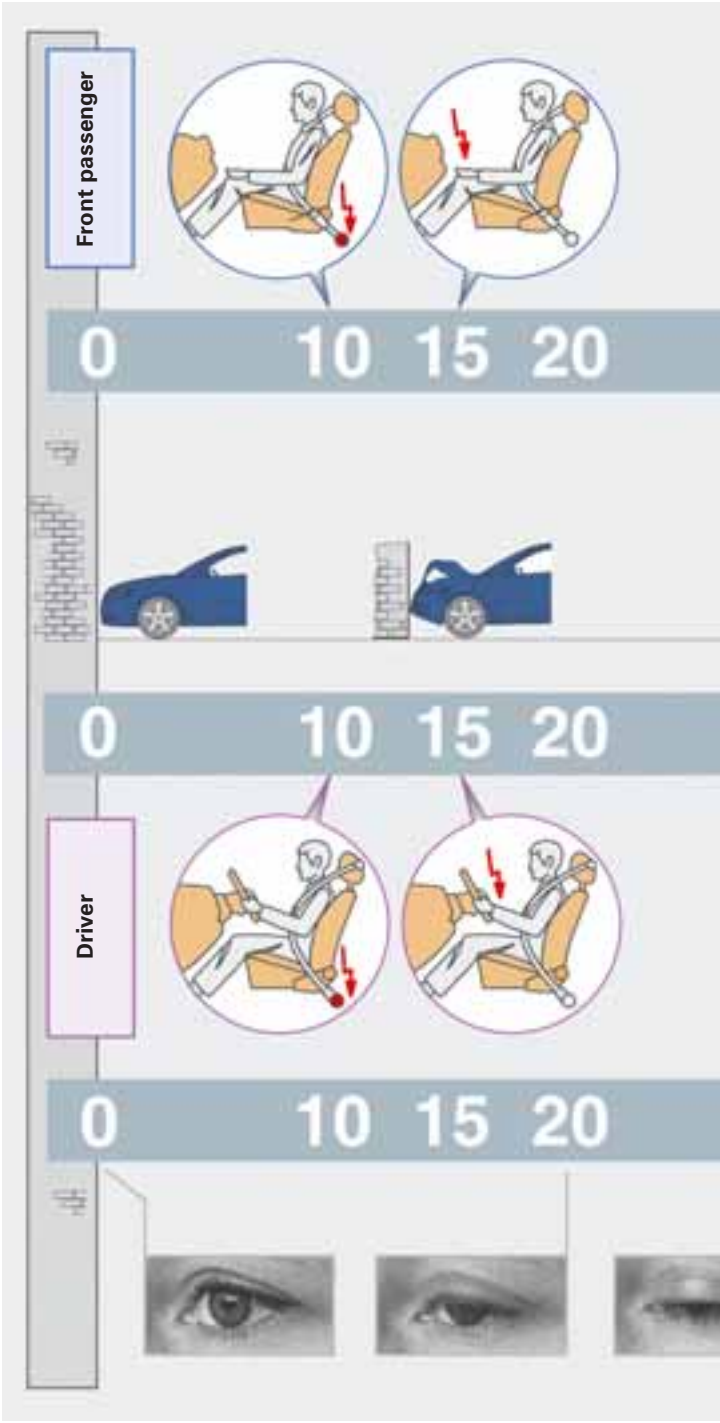
If the vehicle is travelling at a speed of, say, 56 kph, the elapsed time from the moment of impact with a rigid obstacle to standstill of the vehicle is approximately 150 milliseconds.
The occupant of a motor vehicle cannot react within such a short space of time.
The occupant participates passively in the accident.

The following systems must deploy within this "instant":

- the belt tensioners,
- the appropriate airbags and
- the battery disconnector (if fitted).

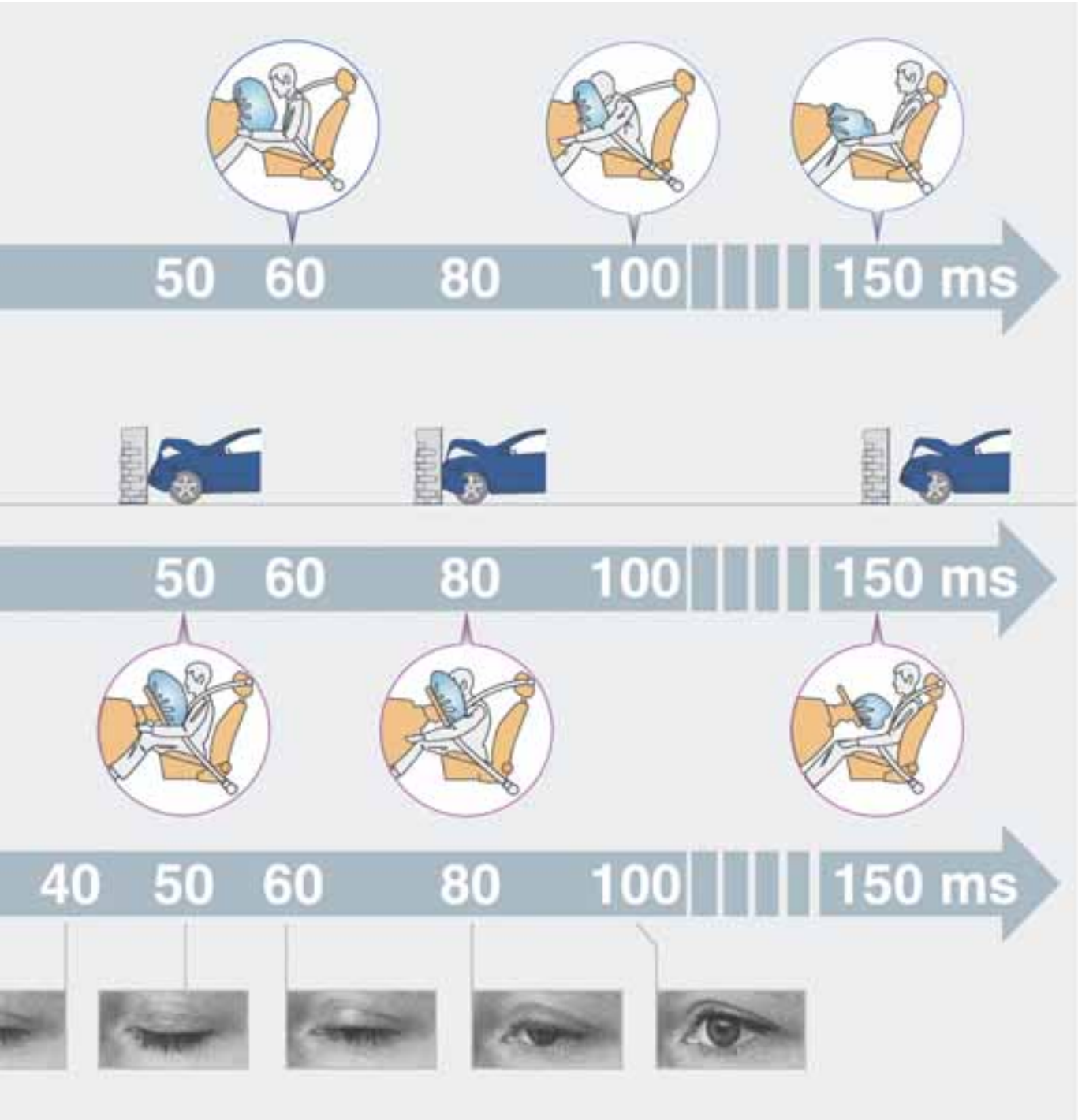
All of these individual actions are controlled by the airbag control unit.

After the airbag has accomplished its safety function, it deflates (collapses) providing a clear field of vision again.



Note

The illustration shows the basic deployment sequence of the driver and front passenger airbags, as well as the belt tensioners.
This sequence may differ depending on vehicle type.



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The time sequence of a side impact

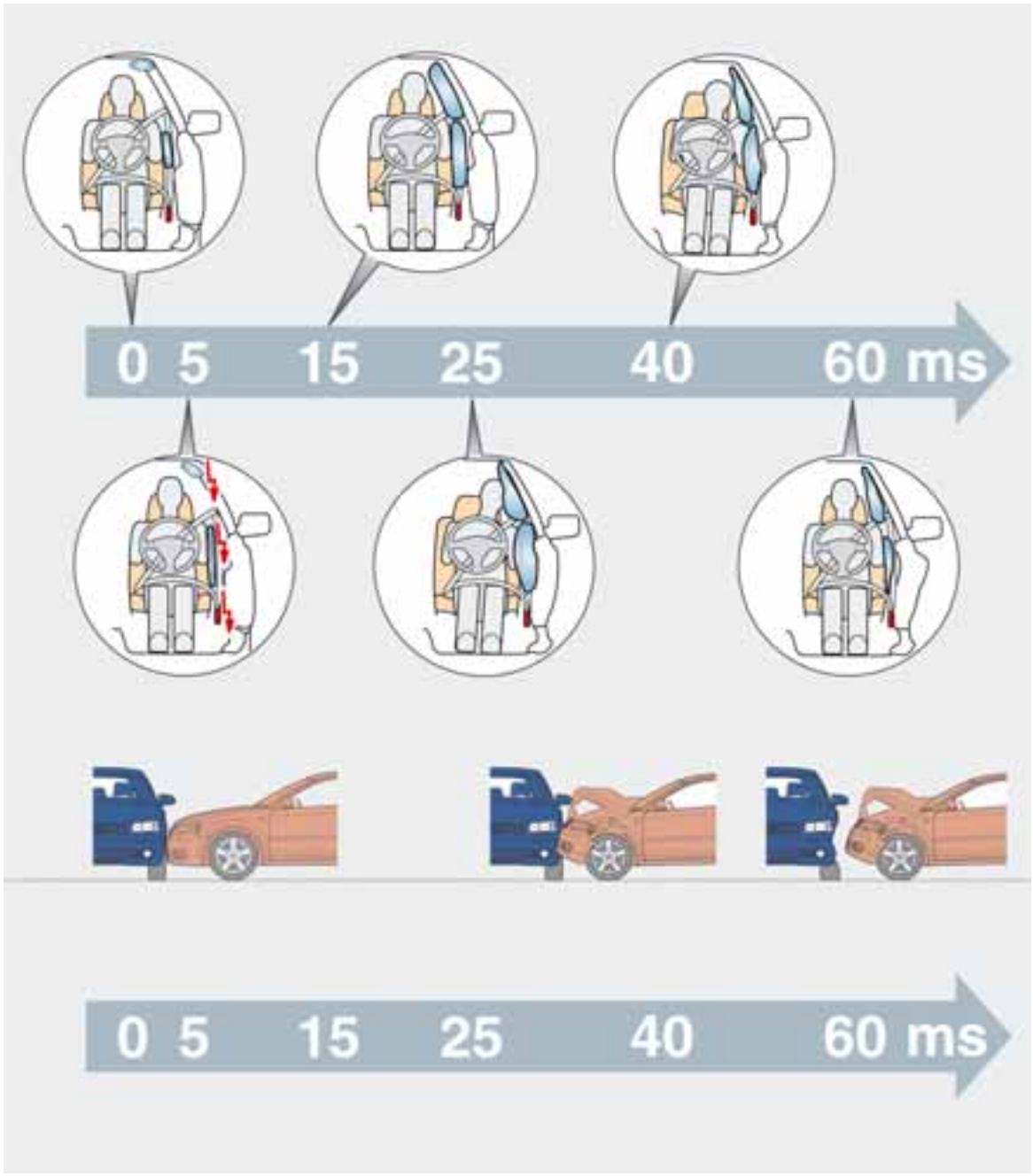
Since the crumple zone between the impacting vehicle and the occupants is very small, the appropriate safety precautions must be initiated and implemented within an extremely short amount of time.

The side and head airbags are therefore fully inflated within approx. 15 ms.

To preserve the safety function of the head airbags in the event of a possible secondary collision, e.g. vehicle roll-over following side impact, the head airbags remain inflated for longer.

Note

The illustration shows the basic deployment sequence of the side and head airbags, as well as a belt tensioner. This sequence may differ depending on vehicle type.



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Airbags

The front airbags

Driver airbag

The driver airbag is inflated by a so-called pot gas generator. It derives its name from its pot-like shape. This design is ideal for centric installation in the steering wheel.

The generator is available both in single stage and dual stage versions.

410_061

Driver airbag inflated

The gas generator of the driver airbag is integrated in a housing installed centrically in the steering wheel impact absorber.
This unit is also referred to as the airbag module.

Note

Work on airbag systems may only be performed by trained personnel. Please observe the safety instructions given in the current technical literature.

Front passenger airbag

Tubular gas generators are generally used to inflate the front passenger airbag. They may take the form of solid fuel generators or hybrid gas generators.

The generators are available in a single and dual stage versions.

410_062

The front passenger airbag gas generator is integrated in a housing in the upper right section of the dash panel. This unit is also referred to as the airbag module.

To fill the larger distance between the dash panel and the front passenger in the event of a collision and to ensure that a good level of protection is provided, the front passenger airbag has a different shape and a larger volume than the driver airbag.

The side airbags

Tubular gas generators are used to inflate the side airbags.

Single stage solid fuel or hybrid gas generators are used as gas generators.

The illustration shows a vehicle with fully deployed side airbags.
In a side impact, however, the airbags only deploy on the side of the vehicle where the impact occurs.

The front seat airbag modules are installed in the outer seat backs. The rear seat airbag modules are installed in the outer seat backs or in the side trim.

The head airbags

Tubular gas generators are used to inflate the head airbags. Due to normally very confined installation space, the generators have a slimline design.

Single stage hybrid gas generators are used.

Audi uses the name sideguard for its head protection airbags.

In a side impact, only the airbag on the impacted side of the vehicle is deployed.

410_064

For reasons of clarity this drawing only shows only the right head airbag.

In the head airbag module, the gas generator is connected to a gas diffuser which ensures a fast and even distribution of the airbag inflation gas. The gas diffuser is integrated in the head airbag. The diffuser may take the form of a metal pipe or braided tube.

Depending on vehicle model, the gas generators can be fitted in the front section of the roof under the sun visors, in the vicinity of the B-post, between the C and D posts or in the rear roof section. Type and shape of the head airbags are adapted to each individual vehicle model.

The head-thorax airbags

So-called head-thorax airbags are used as side airbags in the cabriolet, Coupé and Roadster models.

The airbag module is designed in such a way that it simultaneously performs the tasks of the side and head airbags.

The head-thorax airbag is used on the following Audi models:

- TT Coupé
- TT Roadster
- A4 Cabriolet

The head-thorax airbag, exemplified on the TT Roadster

410_099

The head-thorax airbag, exemplified on the Audi A4 Cabriolet

410_106

The airbag gas generators

In the early stages of airbag development, gas generators working on the solid fuel combustion principle were used for inflating airbags. At a later stage, hybrid gas generators were introduced along with the solid fuel generators.

When the airbag control unit detects a collision whose severity is above the deployment threshold, it activates the appropriate gas generators.

Depending on vehicle model, single or dual stage gas generators can be used for the driver and front passenger airbags.
In a single stage gas generator, the entire propellant charge is ignited in a single instance.
In dual stage gas generators, the two propellant charges are activated in a staggered fashion.
The airbag control unit sets the time interval between the two deployments depending on the severity and nature of the accident. The interval may be between 5 ms and 50 ms depending on vehicle type.
The second stage supplies the airbag with additional air volume.

Both stages are always ignited. This ensures that no propellant charge remains active after the airbag has deployed.

The solid fuel generators

The solid fuel generators consist of a housing in which a solid fuel block and igniter unit are integrated.

The design and shape of the generator housing are adapted to the installation space. A distinction is made, in respect of shape, between pot gas generators and tubular gas generators.

The solid fuel is used in tablet or ring form.
After the solid fuel has been ignited, a harmless gas consisting of nearly 100 % nitrogen is generated in order to inflate the airbags.

The hybrid gas generators

The hybrid gas generators consist of a housing in which a compressed gas stored under high pressure and a solid fuel with igniter unit are combined.

The design and shape of the generator housing are adapted to the installation space. Most generators are tubular in shape.
The main components are the pressurised container containing the airbag inflation gas and the propellant charge (solid fuel), which is integrated in or flanged onto the pressurised container.

The solid fuel is used in tablet or ring form. The stored and compressed gas is a mixture of noble gases, e.g. argon and helium. Depending on gas generator design, the gas is stored at a pressure of between 200 bar and 600 bar.

The pressurised container is opened by the igniting solid fuel, resulting in a gas mixture consisting of the gas produced by the solid propellant charge and the noble gas mixture.

Note

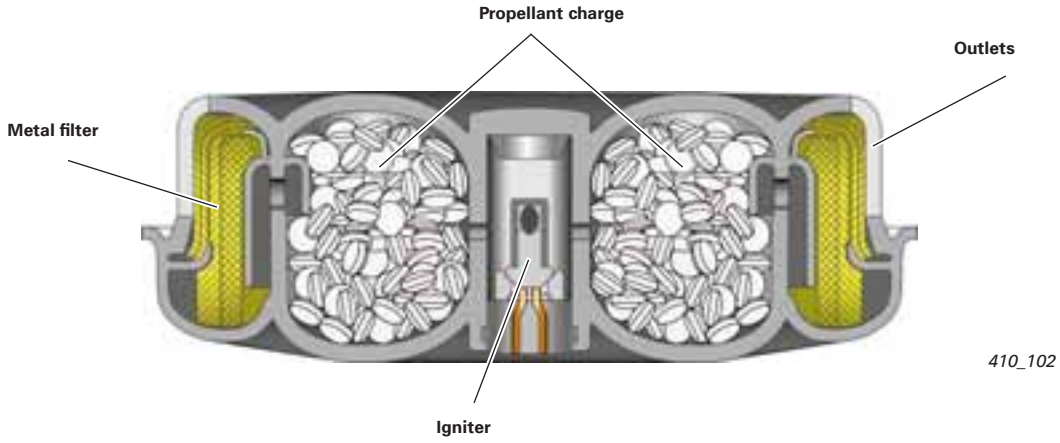
All non-ignited gas generators are hermetically sealed from the ambient environment.

The driver airbag gas generator

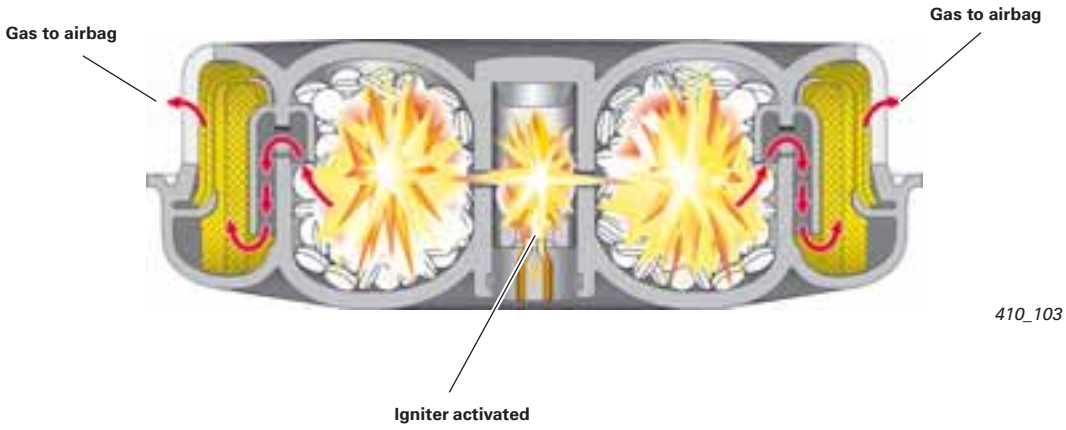
Single stage - solid fuel

This generator is also referred to as a pot gas generator, due to its pot-like shape. The igniter unit is arranged centrically in a round housing (pot). Solid fuel is distributed around the igniter unit in an annular fashion. A metal filter is interposed between the solid fuel and the outer wall of the housing. The task of the metal filter is to cool and clean the evolving gas. This ensures that the entire propellant charge in the gas generator combusts and that no burning constituents enter the airbag.
The electrical connection between the generator and the airbag control unit J234 is made by the coil spring in the steering wheel unit.

Generator - non-ignited



Generator - ignited



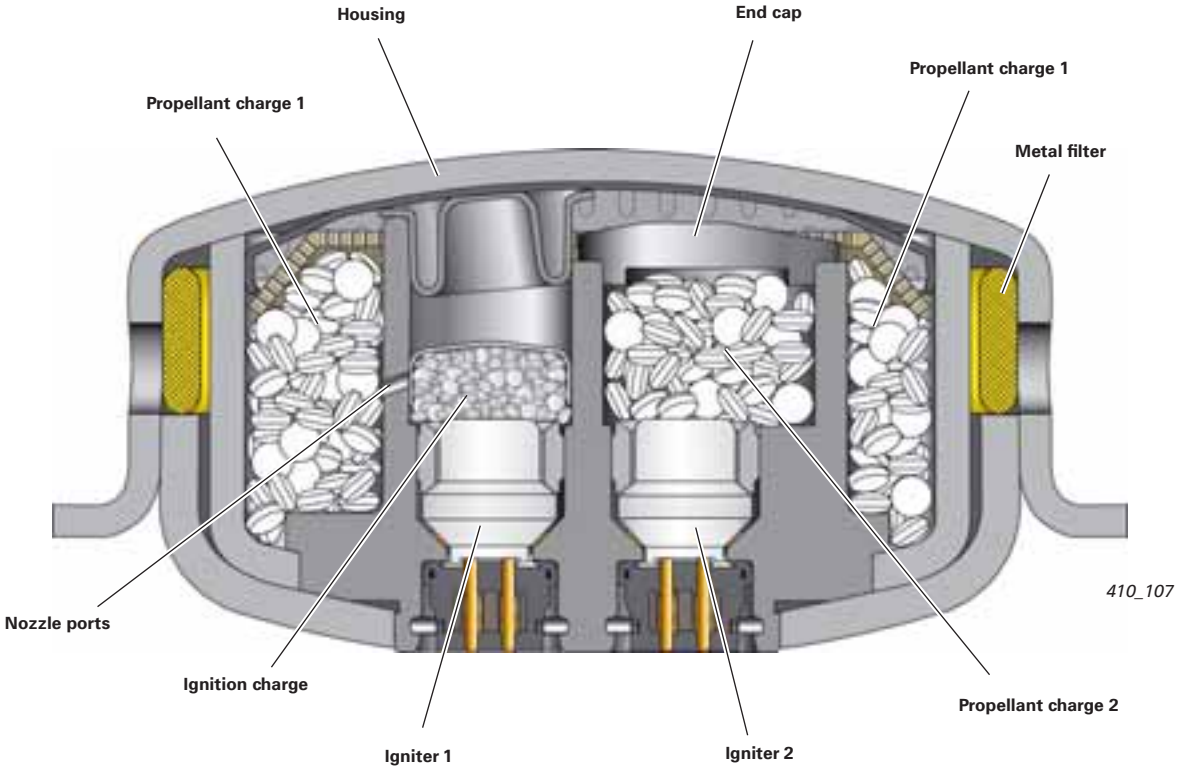
Function

- The igniter is activated.
- The propellant charge is ignited are burns explosively.
- The evolving gas diffuses through the metal filter and into the airbag.

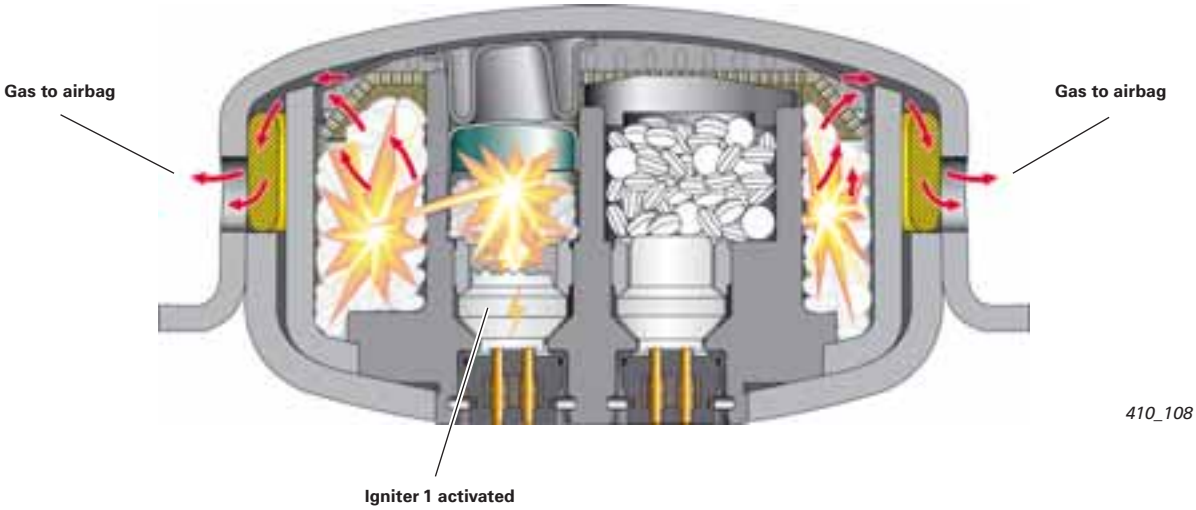
Dual stage - solid fuel

Dual stage pot gas generators are also used on the driver's side.

Generator - non-ignited



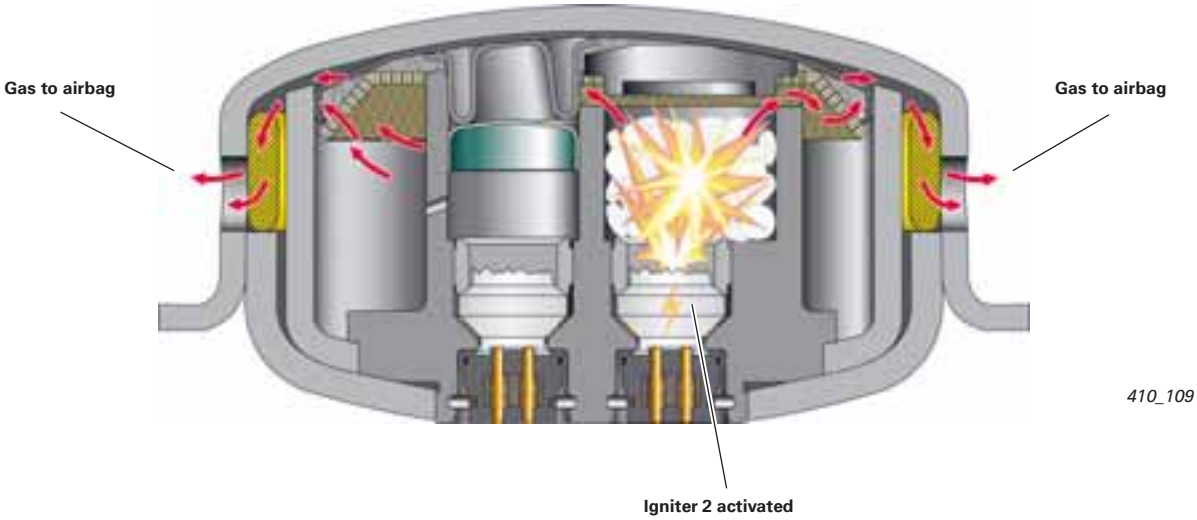
Generator - 1st deployment stage ignited



Function

- Igniter 1 is activated.
- The ignition charge is ignited. This ignition charge ignites the actual propellant charge through the nozzle ports.
- The evolving gas deforms the gas generator housing and allows the gas to escape.
- The evolving gas flows through the metal filter into the airbag.

Generator - 2nd deployment stage ignited



Function

- Igniter 2 is activated.
- The evolving gas flows into the airbag through the 1st stage combustion chamber and the metal filter.

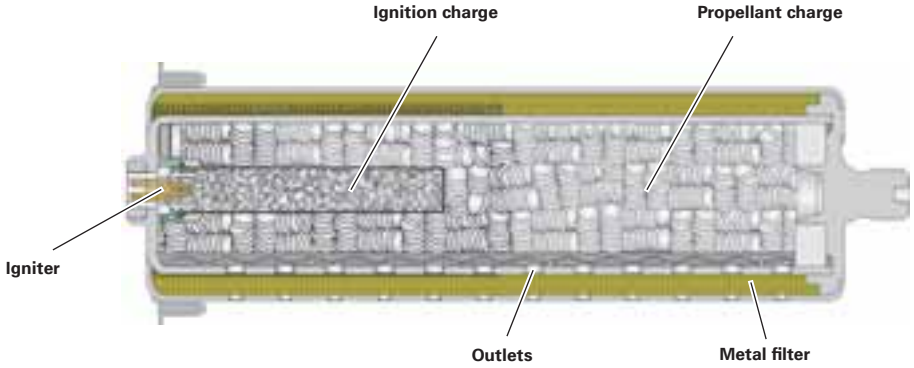
The front passenger airbag gas generator

Tubular gas generators are used for the front passenger airbags. For this reason, they are also referred to as tubular gas generators.

Single stage - solid fuel

The generator consists of a housing accommodating an igniter, an ignition charge and a propellant charge. A metal filter is interposed between the propellant charge and the housing.

Generator - non-ignited



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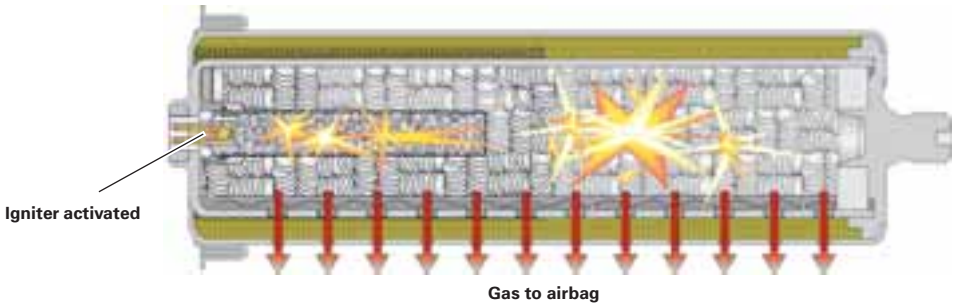
Generator – ignited



410_138

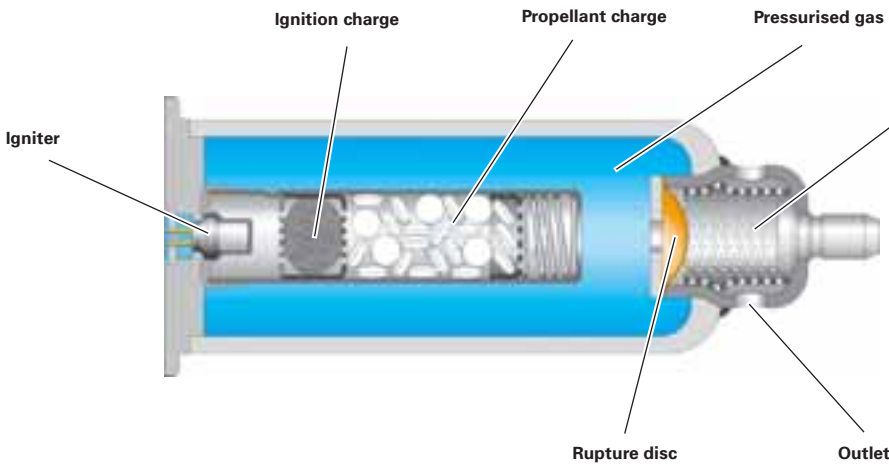
Function

- The igniter is activated.
- The ignition charge is ignited and, in turn, subsequently ignites the actual propellant charge.
- The evolving gas flows through the metal filter into the airbag.

Single stage – hybrid

This single stage hybrid gas generator consists of a pressurised gas cylinder housing an igniter unit. The igniter unit is comprised of the igniter, the ignition charge and the actual propellant charge.

Generator – non-ignited



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Generator – ignited

410_142

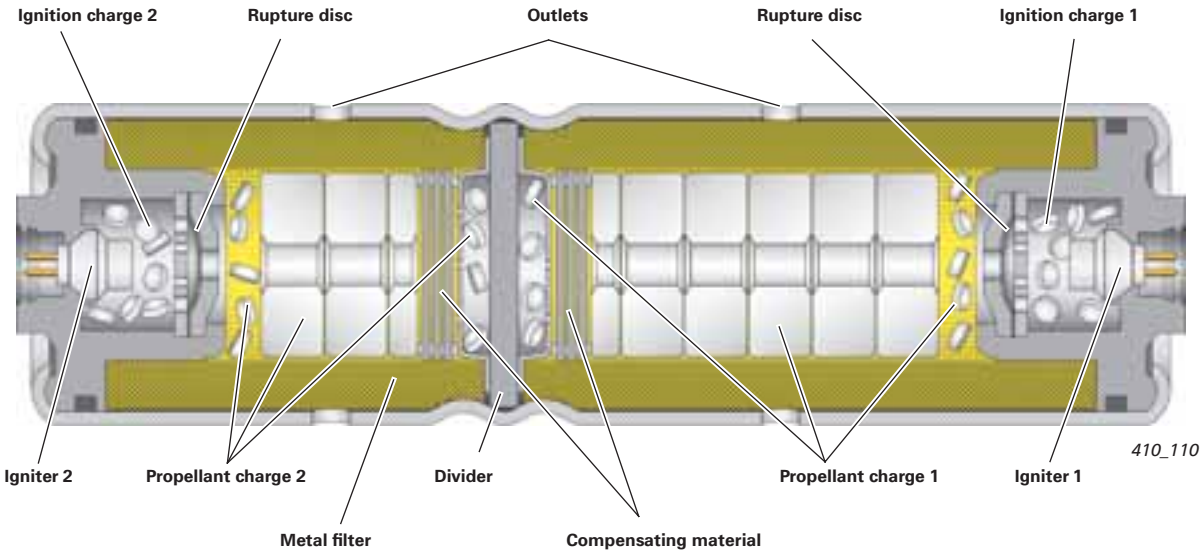
Function

- The igniter is activated.
- The ignition charge is ignited and, in turn, subsequently ignites the propellant charge.
- The pressure inside the pressurised gas cylinder increases until the rupture disc bursts.
- The evolving gas flows through the metal filter into the airbag.

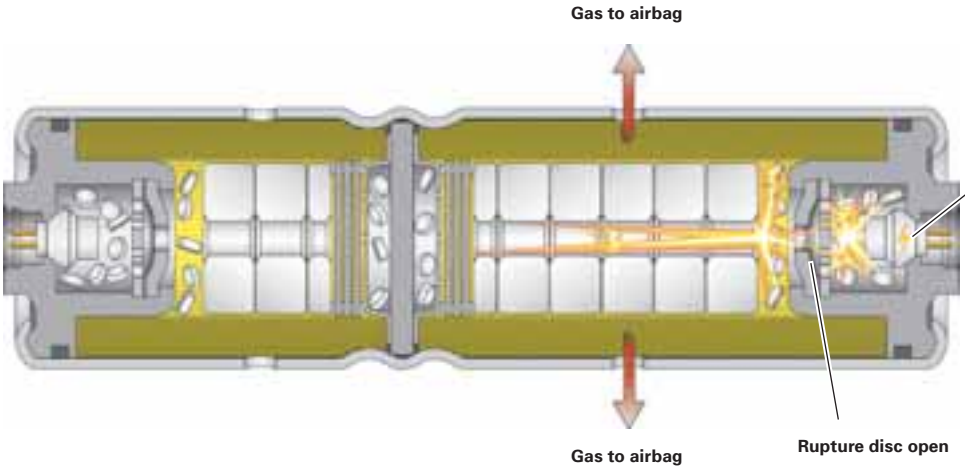
Dual stage – solid fuel

The propellant for the ignition charge is made up of tablets. Hollow tabs are used for propellant charges 1 and 2. The entire propellant charge ignites more quickly due to the hollow design of the tabs.

Generator - non-ignited



Generator – 1st deployment stage ignited



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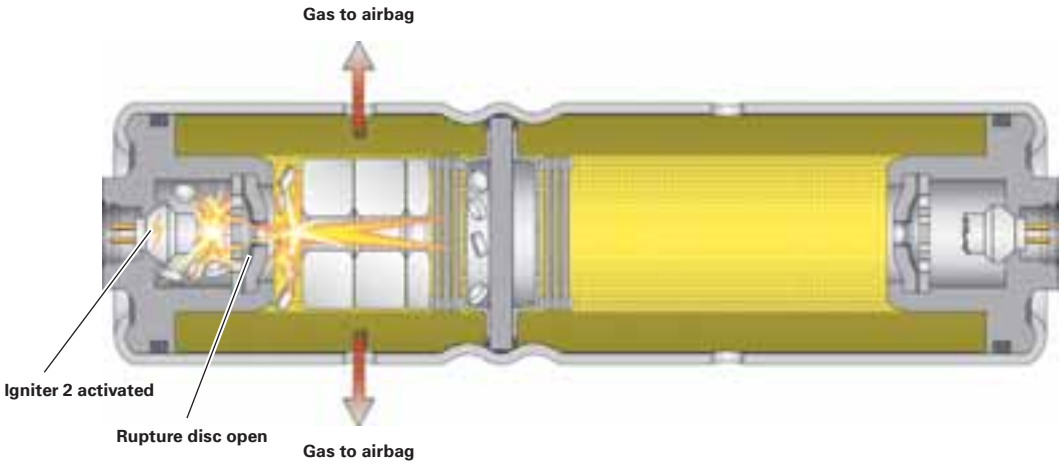
Function

- Igniter 1 is activated.
- Ignition charge 1 is ignited and, in turn, ignites propellant charge 1 after bursting the rupture disc.
- The evolving gas flows through the metal filter into the airbag.

Generator – 2nd deployment stage ignited



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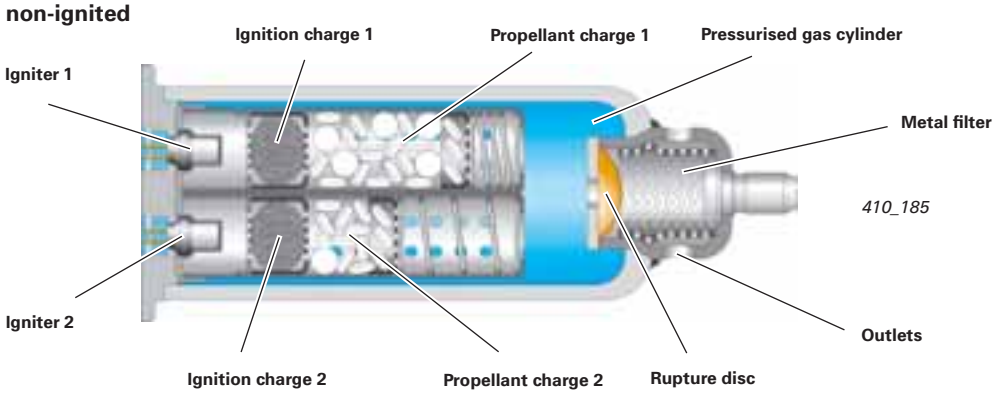
Function

- Igniter 2 is activated.
- The 2nd stage deploys in exactly the same way as the 1st stage.
- The evolving gas flows through the metal filter into the airbag.

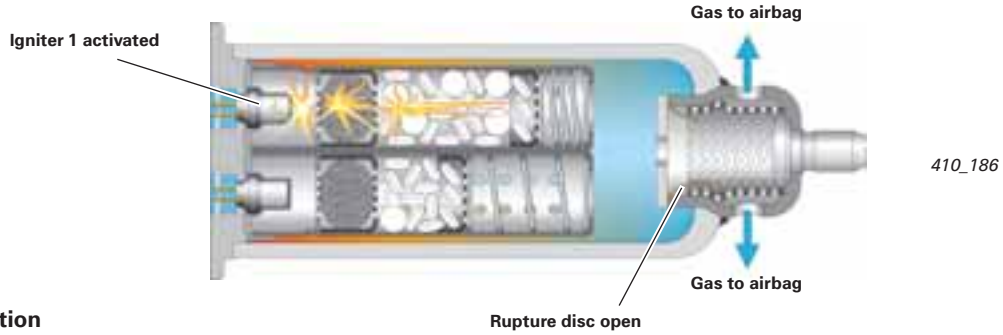
Dual stage - hybrid (1st variant)

This dual stage hybrid gas generator has the same design as the aforementioned single stage hybrid gas generator, except that the gas generator possesses a second propellant charge.

Generator - non-ignited



Generator – 1st stage ignited



Function

- Igniter 1 is activated.
- Ignition charge 1 is ignited and, in turn, subsequently ignites propellant charge 1.
- The evolving gas causes the pressure inside the pressurised gas cylinder to increase until the rupture disc bursts and diffuses through the metal filter into the airbag.

Generator – 2nd stage ignited

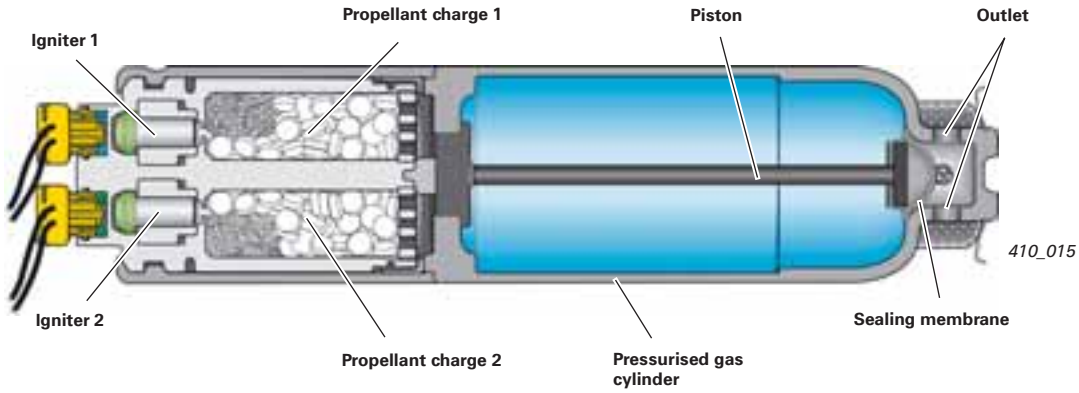
Function

- Igniter 2 is activated.
- The sequence thereafter is otherwise identical to the 1st deployment stage. The gas mixture is admitted into the airbag.

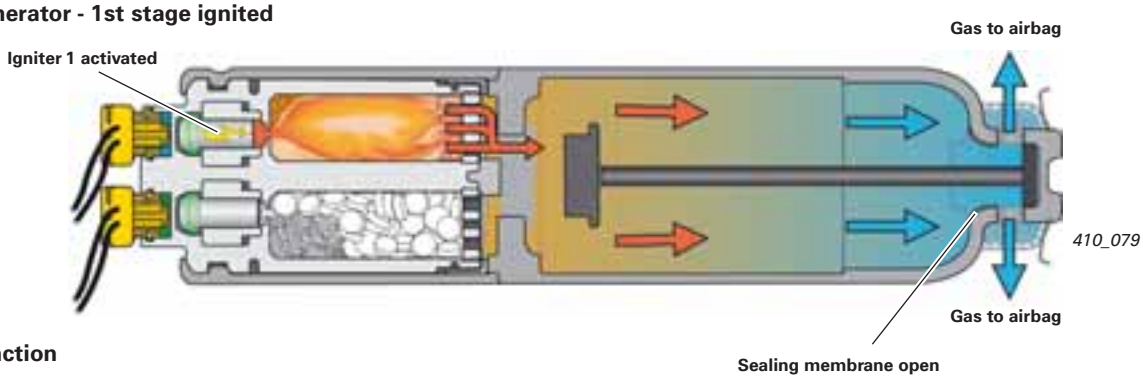
Dual stage - hybrid (variant 2)

The generator also has two separate solid fuel deployment stages. They are connected to a pressurised gas cylinder with an integrated piston system and adjoining housing with outlets for the escaping airbag inflation gas.

Generator - non-ignited



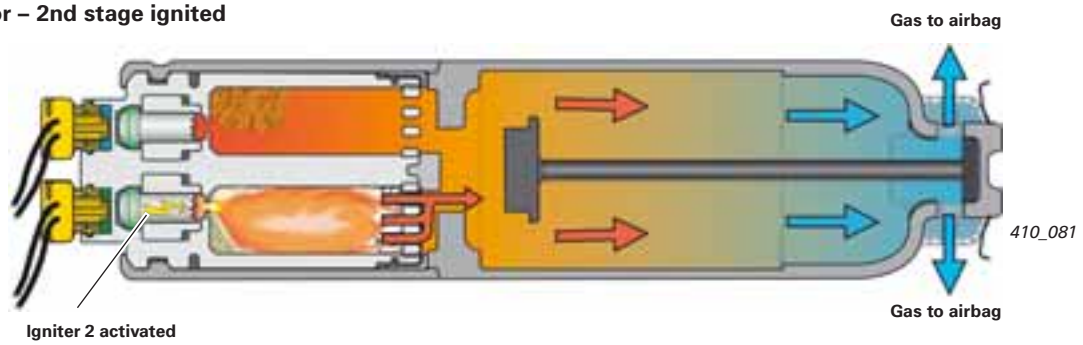
Generator - 1st stage ignited



Function

- Igniter 1 is activated and propellant charge 1 is ignited.
- The evolving gas accelerates a piston, which opens the sealing membrane on the pressure cylinder, thereby admitting the gas mixture into the airbag.

Generator – 2nd stage ignited



Function

- Igniter 2 is activated.
- The sequence thereafter is otherwise identical to the 1st deployment stage. The gas mixture flows into the airbag.

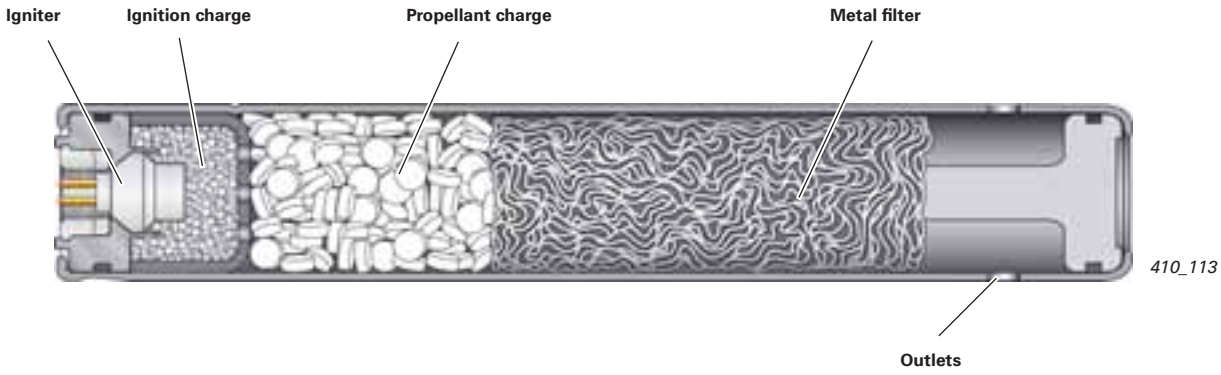
The side airbag gas generator

Tubular gas generators are used for the front passenger airbags.

Single stage – solid fuel

The generator is comprised of a housing accommodating an igniter, an ignition charge, the actual propellant charge and a metal filter.

Generator – non-ignited



Generator – ignited

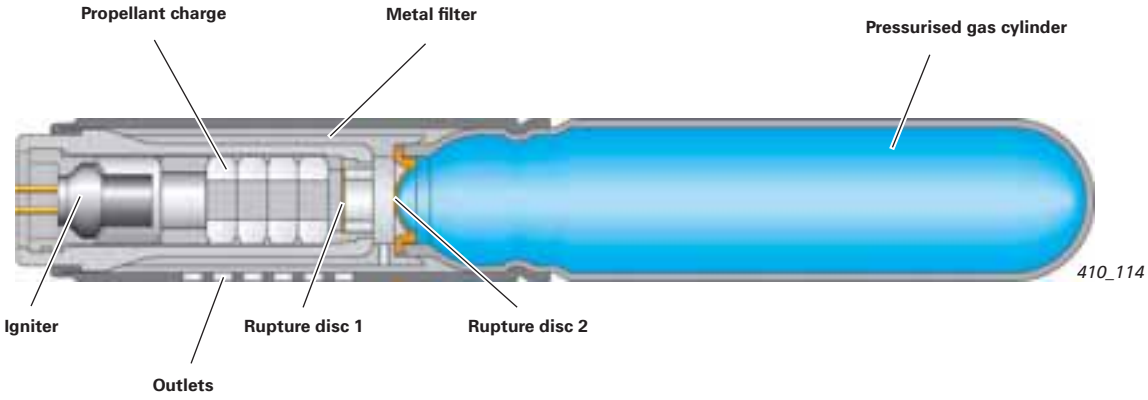
Function

- The igniter is activated.
- The ignition charge is ignited and, in turn, subsequently ignites the propellant charge.
- The evolving gas diffuses through the metal filter into the airbag.

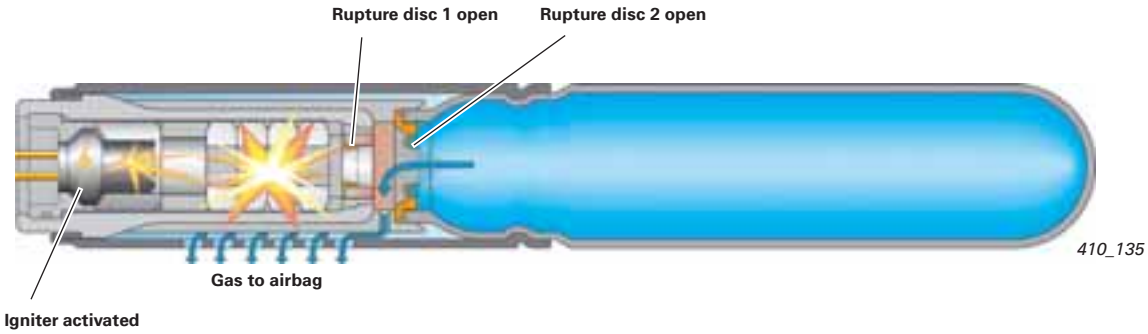
Single stage – hybrid

The generator consists of a housing accommodating an igniter, propellant charge, metal filter and an axially flange-mounted pressurised gas cylinder.

Generator – non-ignited



Generator – ignited



Function

- Igniter is activated and propellant charge is ignited.
- The evolving gas breaks through the two rupture discs and mixes with the cold gas flowing from the pressurised gas cylinder.
- The gas mixture flows out of the pressurised gas cylinder, through the metal filter and into the airbag.

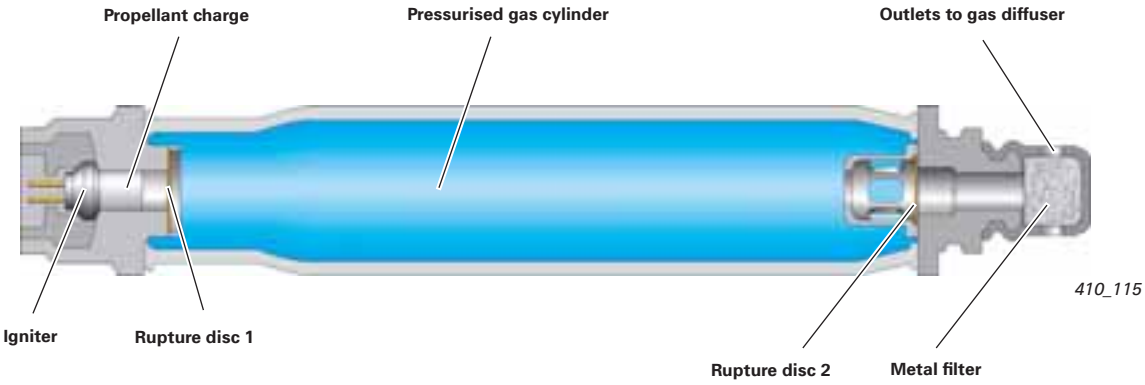
The head airbag gas generator

Tubular gas generators are used for inflating the head airbags.

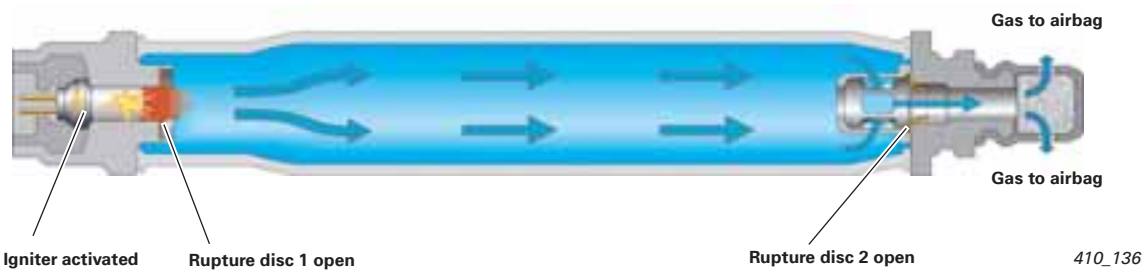
Dual stage - hybrid (variant 1)

The generator consists of the pressurised gas cylinder accommodating the igniter with propellant charge on one side and a metal filter with outlets to the gas diffuser on the other side.

Generator – non-ignited



Generator – ignited



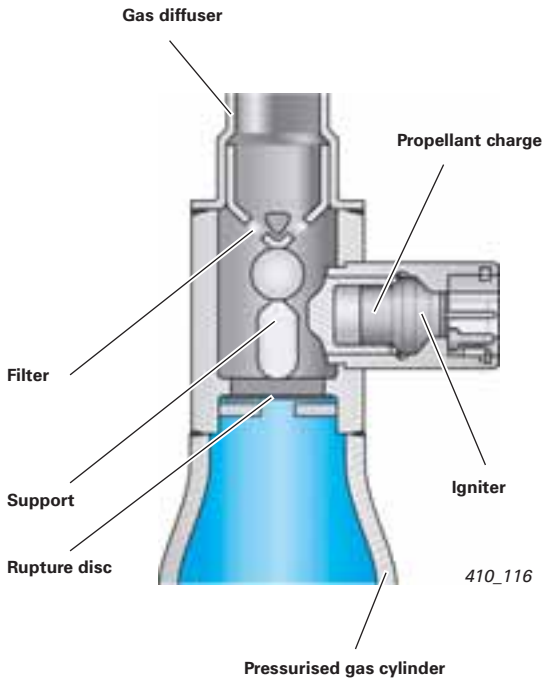
Function

- Igniter is activated and propellant charge is ignited.
- The evolving gas breaks through rupture disc 1 and the pressure in the pressurised gas cylinder increases until rupture disc 2 bursts.
- The gas mixture now flows out of the pressurised gas cylinder, through the metal filter and into the airbag.

Dual stage - hybrid (variant 2)

As an alternative, the igniter can be installed in the generator at the side.

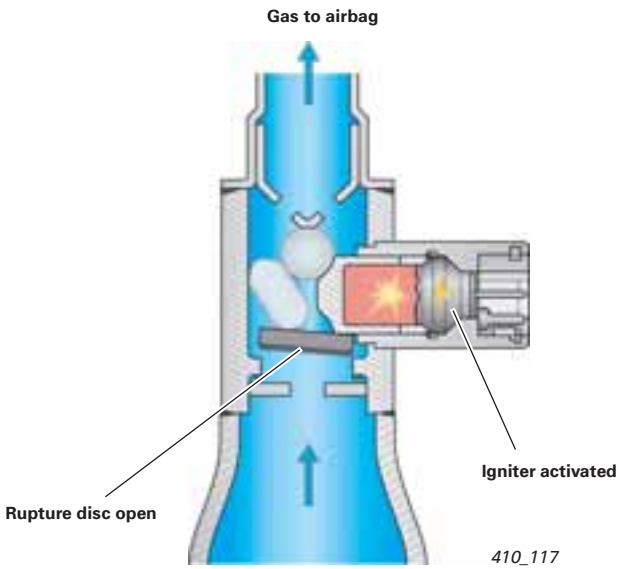
Generator - non-ignited



Function

- Igniter is activated and propellant charge is ignited,
- thereby mechanically firing the support out of its seating.
- The cold gas stored in the pressurised gas cylinder now breaks through the rupture disc and diffuses through the filter into the airbag.

Generator – ignited



Belt tensioners

During a collision, belt tensioners retract the seat belt against its pull direction. This reduces belt slack (looseness between the seat belt and the body). The inertia-reel seat belt now prevents forwards motion of the occupant from at a very early stage in the collision.
A belt tensioner is capable of retracting the seat belt by up to approx. 130 mm within approx. 13 ms. The belt is tensioned until the counter-force acting on the seat belt is greater than the force of the belt tensioner.

Belt tensioners are classified as follows according to their design and operating principle:

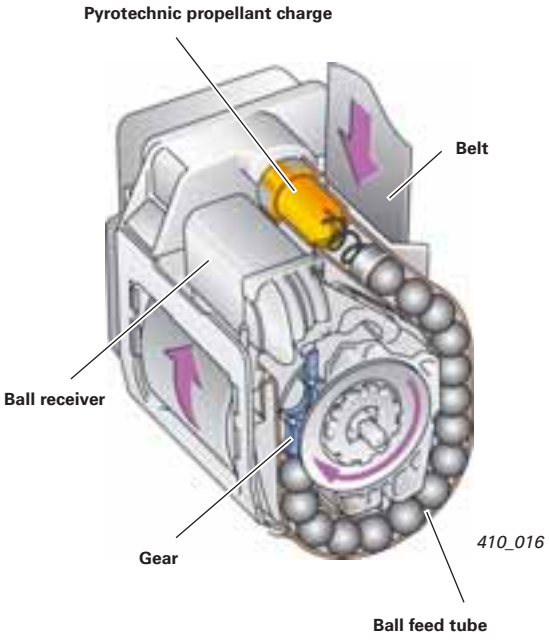
- Ball belt tensioners
- Rotary belt tensioners
- Rack and pinion belt tensioners
- Cable-pull belt tensioners
- Band belt tensioner

Depending on a vehicle's equipment level, belt tensioners are either installed on the front seats only or additionally on the rear seats.

The ball belt tensioner

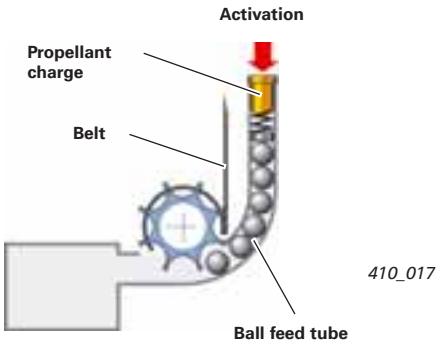
The ball belt tensioner consists of a compact unit, which also includes the belt force limiter.

This type of belt tensioner is used on the front and rear seats.

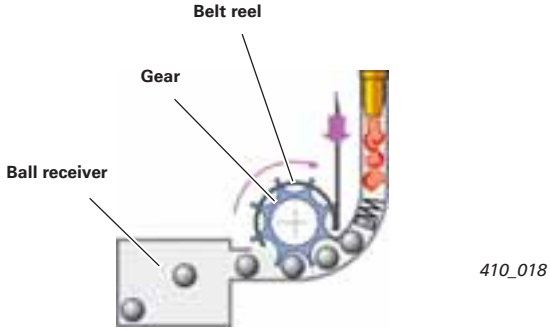


Function

The belt tensioner is driven by balls which are bearing-mounted inside a feed tube. In the event of a collision, the airbag control unit ignites the propellant charge.



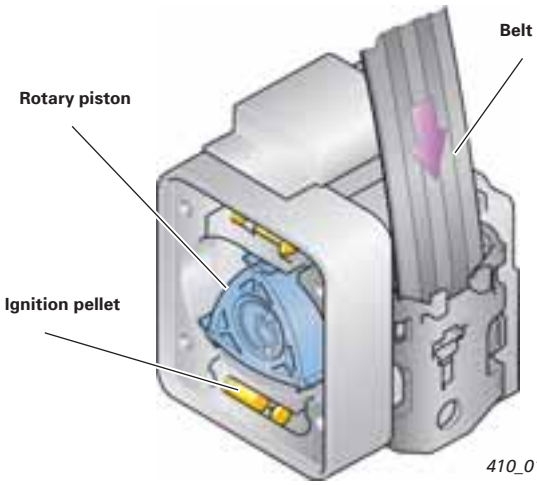
After the propellant charge has been ignited, the expanding gases set the balls in motion and drive them via a gear into the ball receiver.
As the belt reel is rigidly connected to the gear, it is also rotated by the balls and thereby tensions the seat belt.



The rotary belt tensioner

The rotary belt tensioner operates on the rotary piston principle.

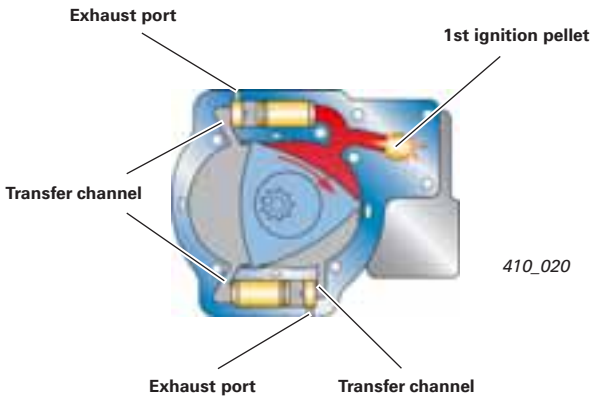
It is usually installed on the rear seats.



410_019

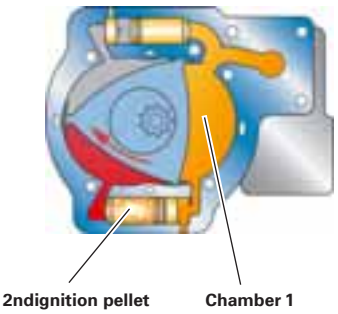
Function

The 1st ignition pellet is electrically initiated. The expanding gas causes the rotary piston to rotate. Since the rotary piston is connected to the seat belt retractor shaft, the seat belt begins to tighten.



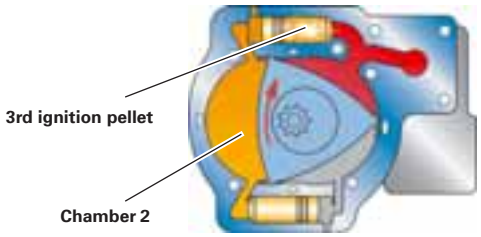
410_020

Once the a certain angle of rotation is completed, the rotary piston releases the transfer channel to the2nd ignition pellet. The working pressure inside chamber 1 ignites the 2nd ignition pellet, causing the rotary piston to rotate further. The combusted gas flowing from chamber 1 escapes through the exhaust port.



410_065

When the gas reaches the 2nd transfer channel, the 3rd ignition pellet is ignited by the working pressure in chamber 2. The rotary piston rotates further and the combusted gas flowing from chamber 2 escapes through the exhaust port.



410_066

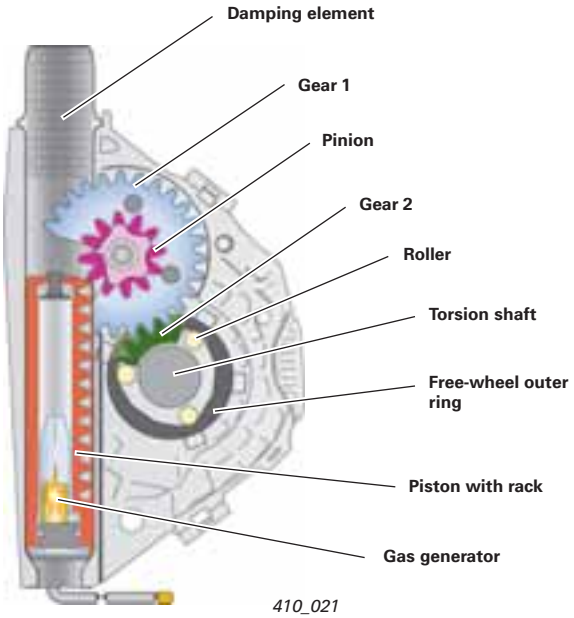
The rack and pinion belt tensioner

The rack and pinion belt tensioner is combined with the seat belt retractor to create a unit.

Rack and pinion belt tensioners are used for the driver and front passenger seats.

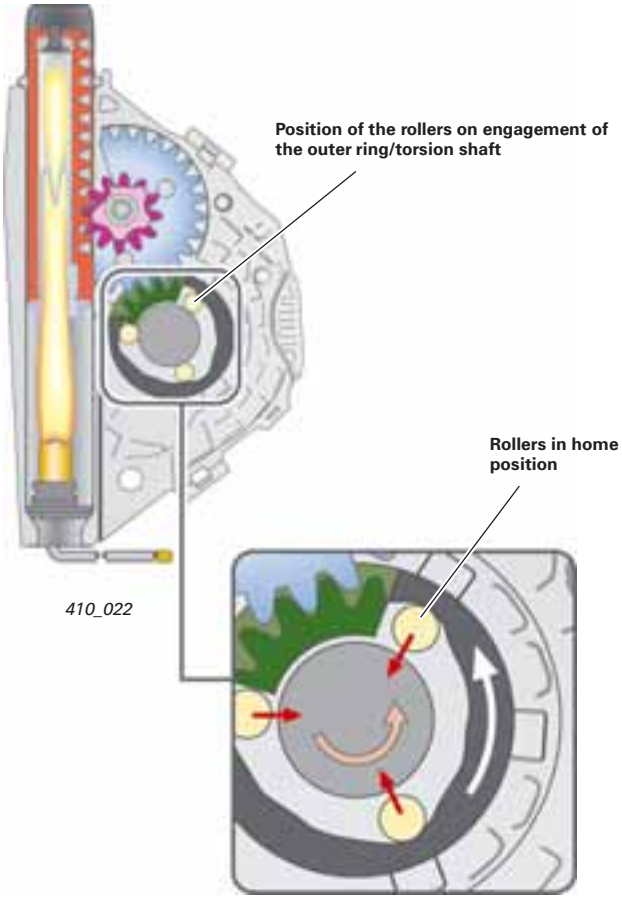
Function

The signal from the airbag control unit ignites the propellant charge of the gas generator. The increase in pressure causes the piston connected to the rack to move upwards. The rack turns gears 1 and 2 via the pinion.



deployed

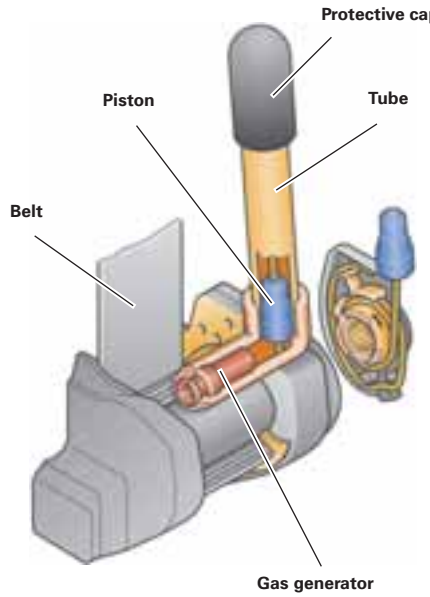
Gear 2 is rigidly connnected to the outer ring of the torsion shaft free-wheel. When this outer ring rotates, the rollers are pushed inward until they mate between the outer ring and the torsion shaft. The rotational motion is now transmitted to the torsion shaft and the seat belt begins retract.



The cable-pull belt tensioner

The cable-pull belt tensioner is combined with the seat belt retractor to create a unit.

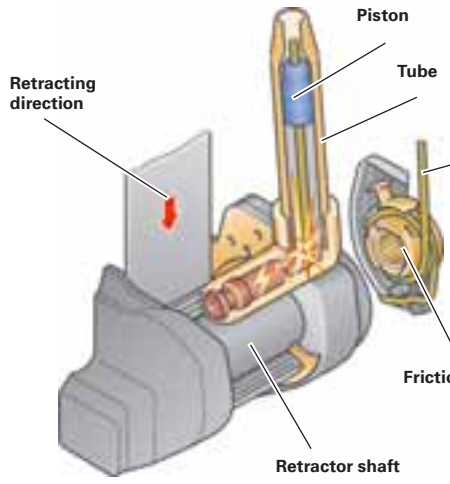
Cable-pull belt tensioners are fitted on the driver and front passenger seats.



410_095

Ignition of the gas generator produces a gas mixture which pushes the piston and the cable attached to it upwards inside a tube. As a result of the tensioning effect, the cable is pulled firmly against the friction disc connected to the retractor shaft and rotates the disc in the retracting direction.

deployed



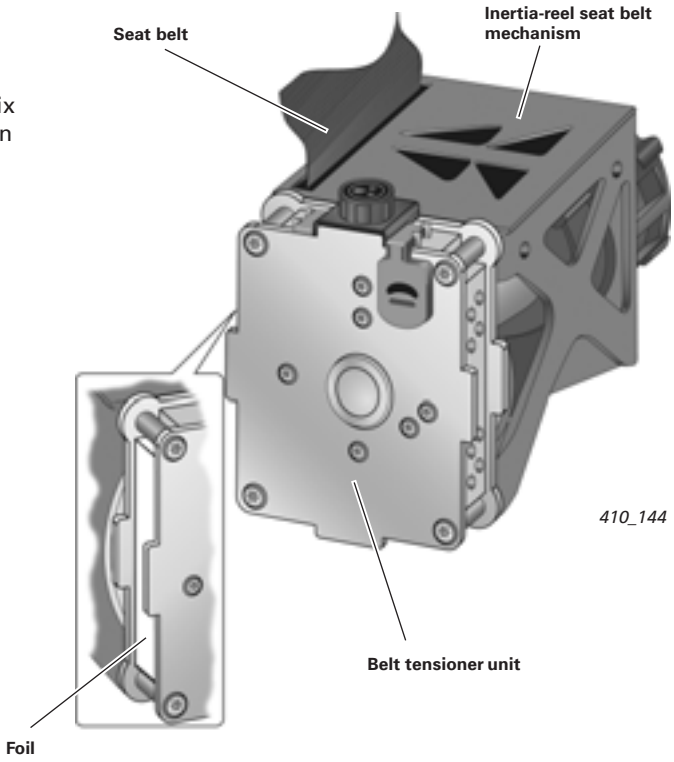
410_096

The band tensioner

The band tensioner is used, for example, for the driver and front passenger seats on the Audi TT Coupé ´07.

If the rear seats on the Audi TT Coupé ´07 have Isofix fixing eyelets, band tensioners are also installed on these seats.

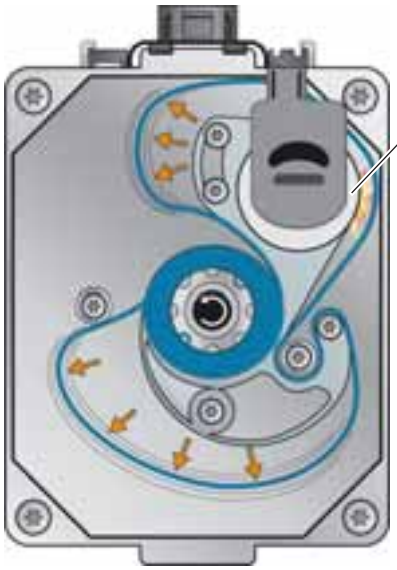
The band tensioner is attached to the side of the inertia-reel seat belt mechanism.



Function

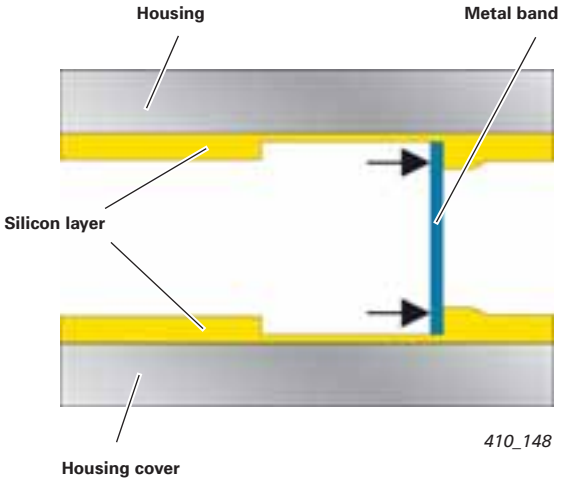
A metal band is wound round the retractor shaft of the automatic belt retractor. The two open ends are connected to the seat belt retractor shaft.
The closed end is looped around the band tensioner igniter.

The belt tensioner igniter is located within the metal band loop. When the igniter is activated by the airbag control unit, the resulting pressure enlarges the metal band loop. The movement of the metal band exerts a pull on the seat belt retractor shaft, which thereupon begins to rotate, tensioning the seat belt.



410_146

The housing and the surface of the housing cover between which the metal band moves are coated with a layer of silicon. When the metal band moves, it pushes a section of this silicon layer ahead of itself, thereby ensuring a tight seal and reducing pressure losses.



410_148

Note

For information about how to test a belt tensioner and how to identify a deployed belt tensioner, please refer to the Workshop Manual valid for the vehicle in ElsaWin.

Belt force limiter

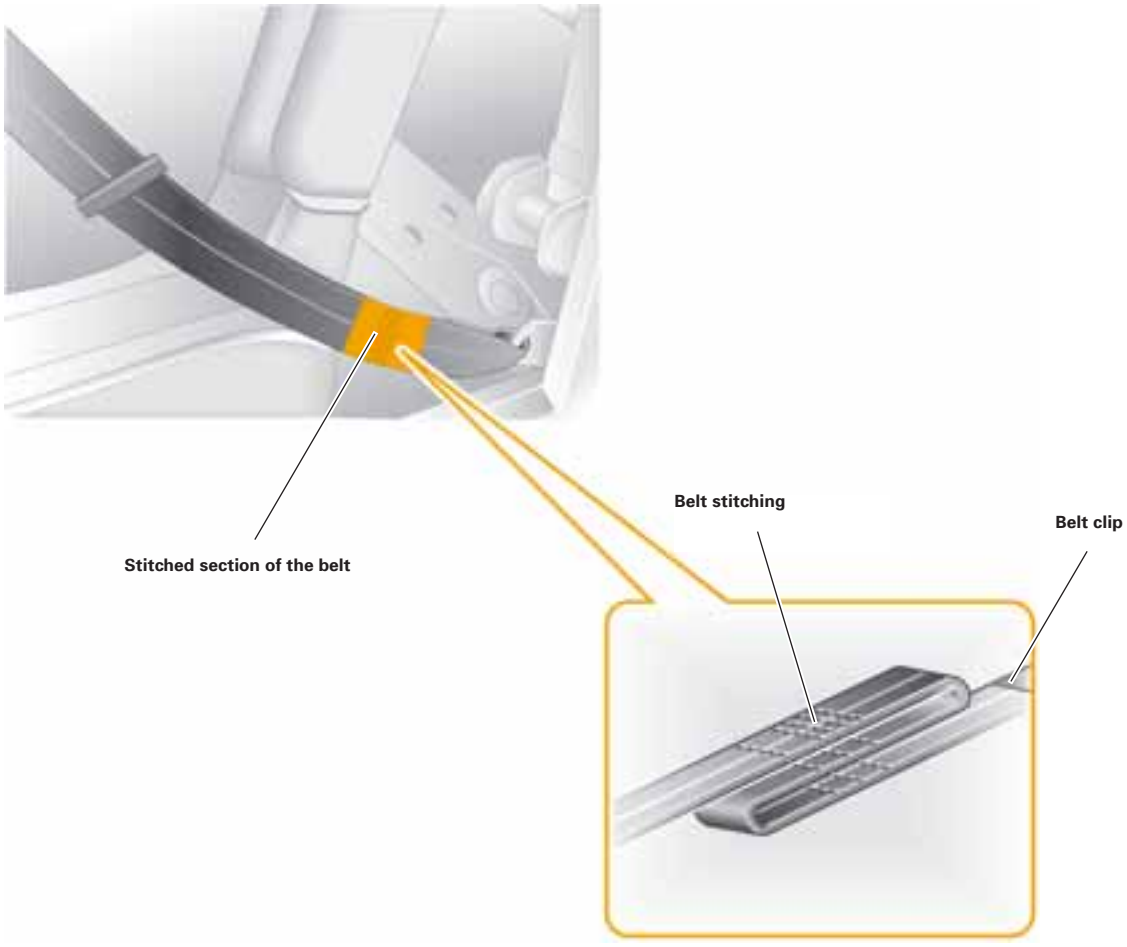
To ensure that the loads acting on the occupants during a collision do not reach too high a level, the inertia-reel seat belts are fitted with a belt force limiter.

The belt force limiter releases slack in the belt as of a certain defined load level and allows the body of the occupant to plunge into the already inflated airbag.

The loop stitched belt

A very simple technical solution for limiting belt force is a loop stitched belt.

When the tensile load exceeds the critical value, these stitches tear and the belt becomes longer. This minimises tensile force and reduces the load on the occupants.

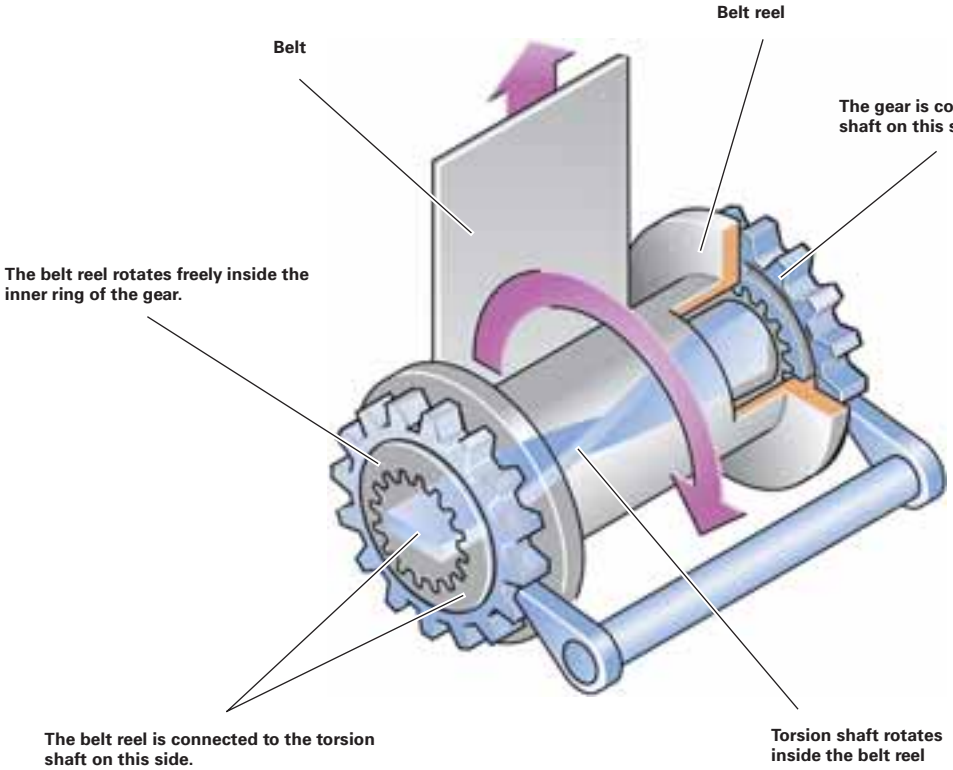


410_082

The torsion limiter

Belt force limiters are integrated in the ball belt tensioner, the rotary belt tensioner, the band tensioner and the rack and pinion belt tensioner.

The tensile force of the belt is limited by a torsion shaft inside the belt reel. Depending on the tensile force of the belt, the torsion shaft is rotated to a greater or lesser extent, thereby reducing load peaks.



410_023

Head restraints

The front seats are designed in such a way as to reduce the probability of neck injury (e.g. whiplash).

A distinction is made between active and passive systems. Both systems minimise the risk of neck injury by reducing relative acceleration between the shoulder and head during a rear impact.

In the case of **passive** systems, the risk of neck injury has been reduced by designing the entire seat, the head restraint and the distance between the head and head restraint without the use of moving parts.

In the case of **active** systems, the head restraint is moved towards the occupants during a rear impact.

The active head restraint

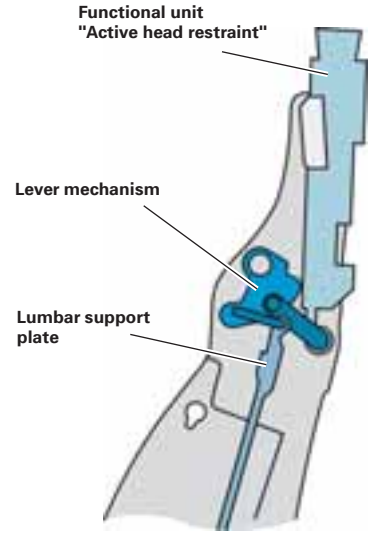
The active head restraint is a purely mechanical system which, in the event of a rear collision, displaces the head restraint forwards towards the head. This reduces relative acceleration between the shoulder and head during a collision.
The active head restraint system is a reversible system.

Function

When an acceleration force acts on the rear end of the vehicle in the direction of travel, the velocity of the vehicle increases relative to the velocity of the occupants. The difference in velocity results from the inertia of the occupants.

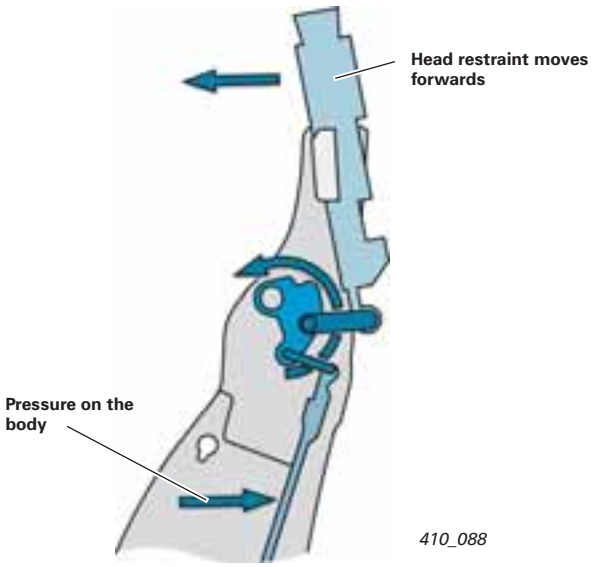
The occupants are pushed further back into the seat, thereby increasing pressure on the lumbar support plate in the seat back. A lever mechanism transmits the movement of the lumbar support plate to the head restraint and moves the head restraint forwards towards the head.
As soon as the pressure on the body decreases, the system is returned to its starting position by a tension spring.

System not activated



410_068

System activated



410_088

Child seats

The ISOFIX system

If vehicles are equipped with the ISOFIX system, separate child seats with ISOFIX mounting brackets can be used. With this system, special mounting brackets on the child seat are engaged into the Isofix anchorages on the vehicle. This connection provides a secure fitting for the child seat.

The two outer rear seats and the front passenger seat can be prepared for the ISOFIX system.

410_027

The integrated child seat

Depending on equipment level, some models come with integrated child seats for both outboard seats of the rear seat bench.

The rear seat bench of the Audi TT Coupé '07 is, for example, approved as a weight class III (22-36 kg) child seat.

Note

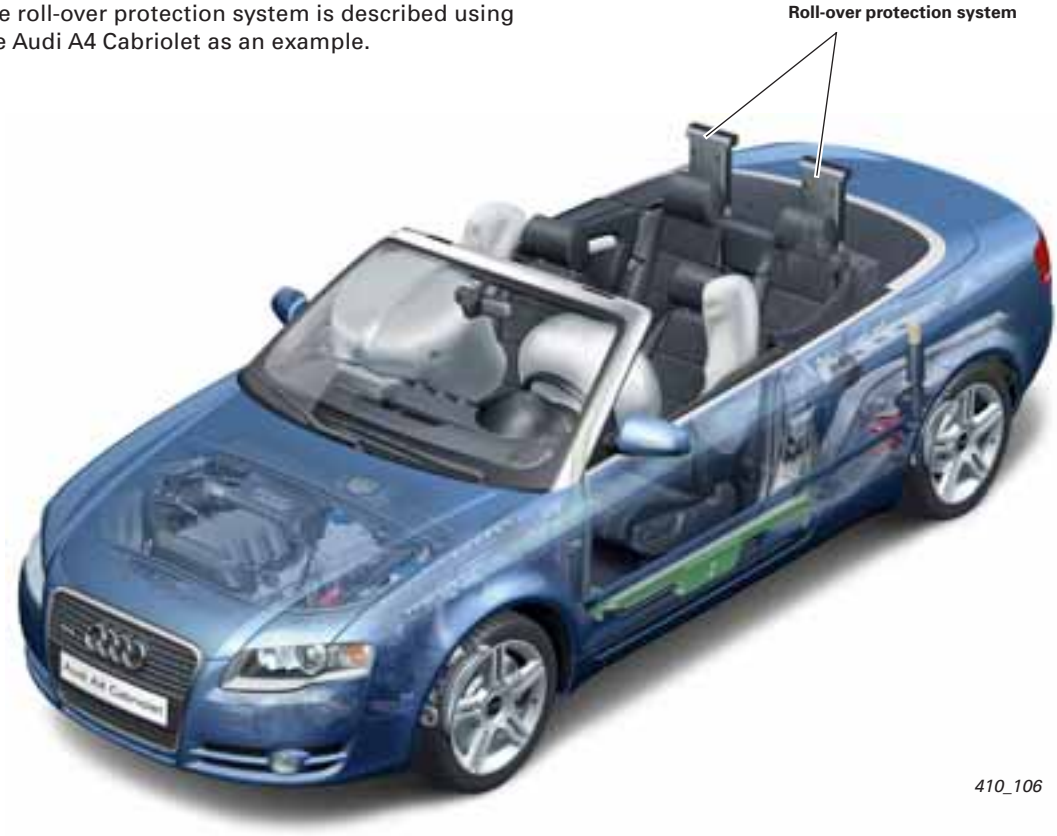
When using child seats on the front passenger seat, the instructions given in the operating manual must be observed. In the case of rearward facing child seats, it is very important to ensure that the front passenger airbag is switched off.

Roll-over protection

Due to their open-top design, cabriolets are equipped with special elements which protect the occupants during accidents.
These include, in particular, the roll-over protection system.

When activated, the roll-over protection system, in combination with the A-posts, creates a survival zone for the occupants.

The roll-over protection system is described using the Audi A4 Cabriolet as an example.



A sensor which can detect an impending roll-over is integrated in the airbag control unit. This sensor, together with other sensors integrated in the control unit, measures the severity of the collision, and, if appropriate, the roll-over protection system and belt tensioners are deployed.

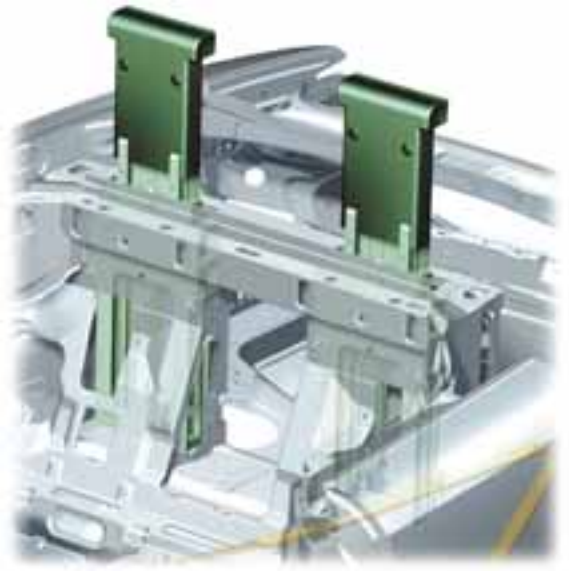
In addition, as a precaution, the roll-over protection system is also deployed during a front, side or rear impact with a high accident severity as soon as a belt tensioner or airbag is ignited.

Function

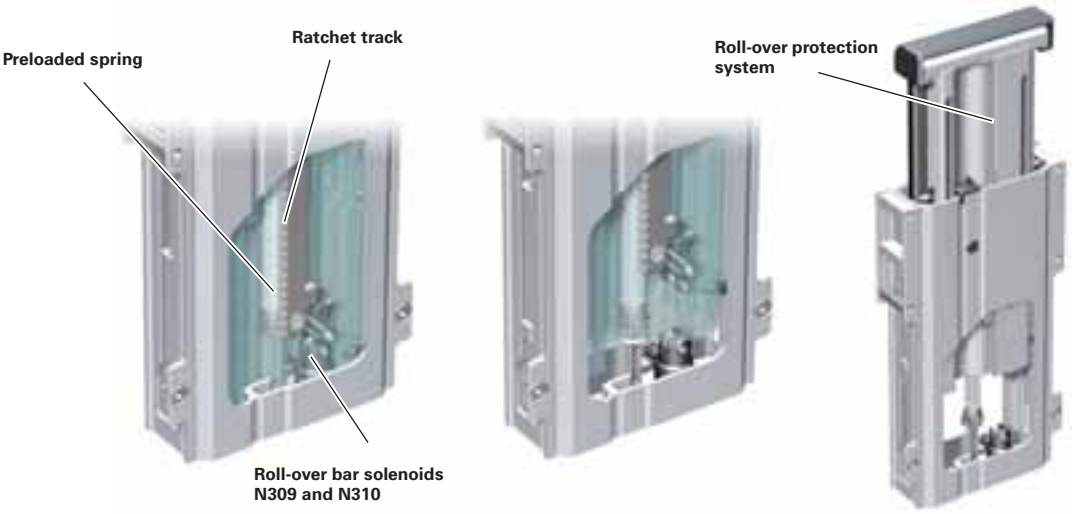
When deenergised, the roll-over protection system is held in the lower position by a hooked lever attached to roll-over bar solenoids N309 and N310.

When the airbag control unit J234 detects a crash or an impending roll-over, the roll-over bar solenoids N309 and N310 enable the roll-over protection system.

Roll-over protection system in starting position



410_032



410_033

The roll-over protection system is extended within approx. 0.25 seconds by the preloaded spring and held in this position by the ratchet track. Once the roll-over protection system has extended a distance of 80 mm, it can no longer be forced back because this is prevented by the ratchet track.

An activated roll-over protection system can be mechanically unlocked and returned to the starting position.

Battery disconnectors

If the starter battery is installed in the vehicle interior or in the luggage compartment, a battery disconnector can be used. The task of this disconnector is to break the line connecting the starter battery to the starter and generator. If a short circuit occurs in the line connected to the starter and generator during an accident, the disconnector prevents a potential fire from developing.

If an airbag is ignited during an accident, the battery disconnector is also activated automatically. During a rear collision, the battery disconnector is activated when the belt tensioners deploy.

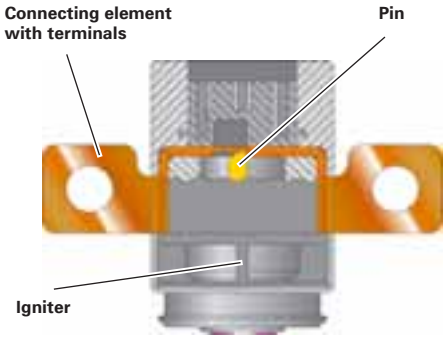
The following components are used as battery disconnectors:

- Battery isolation igniter N253
- Battery cut-off relay J655

The battery isolation igniter N253

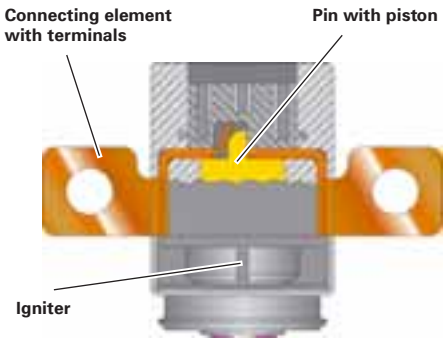
This component works by disconnecting an element connecting the starter battery and starter terminals. The battery isolation igniter N253 is accommodated in a separate plastic housing in immediate proximity to the starter battery.

Starting position



410_122

End position



410_123

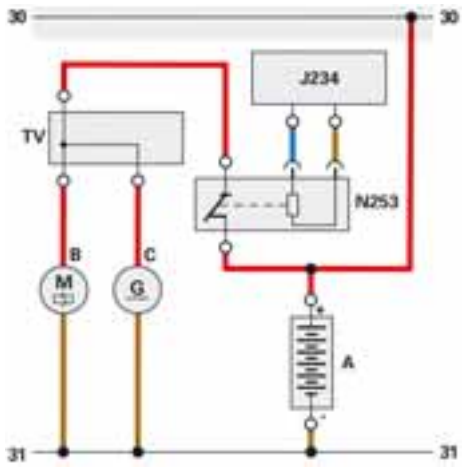
Function

A combustion process is initiated inside the battery isolation igniter N253 through ignition of a propellant charge. The evolving gases displace the piston with pin in such a way that contact between the starter battery and starter terminals is broken.

The battery isolation igniter N253 receives an ignition signal directly from the airbag control unit J234, whereupon the generator and starter are disconnected from the starter battery.

A - Starter battery
B - Starter
C - Generator

J234 - Airbag control unit
N253 - Battery isolation igniter
TV - Line distributor

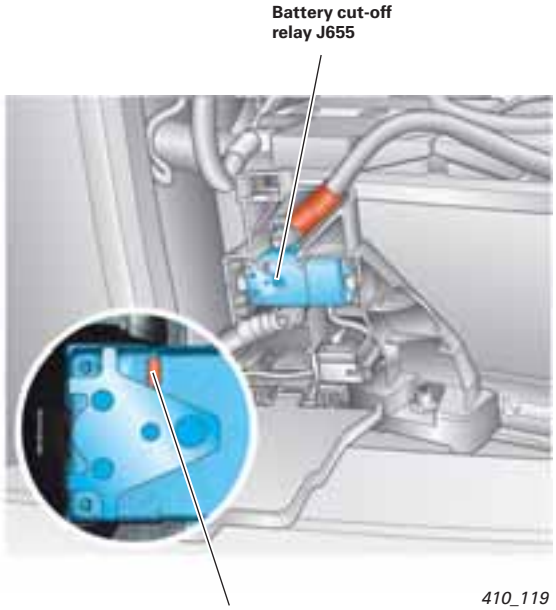


410_121

The battery cut-off relay J655

The battery cut-off relay J655 is another component which can be used to break the line between the starter battery and the starter.

An activated battery cut-off relay J655 can be identified through the indicator window. If a line is broken, a white cover can be seen through the indicator window instead of a copper coil. In this case, the battery cut-off relay J655 must be replaced.

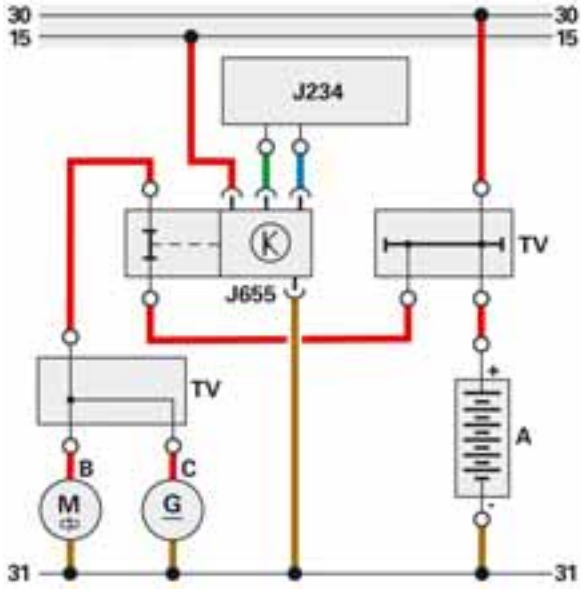


410_119

The battery cut-off relay is initiated through the airbag control unit J234. In addition to activating the battery cut-off relay, the airbag control unit J234 functions as a diagnostic watchdog and registers any faults which occur.

A - Starter battery
B - Starter
C - Generator

J234 - Airbag control unit
J655 - Battery cut-off relay
TV - Line distributor



410_118

Note

Tripped battery disconnectors as well as the battery cut-off relay J655, with and without reset button, must always be replaced. For further information, refer to the Workshop Manual valid for the vehicle in ElsaWin.

System management

The airbag control unit J234

The task of the electronics integrated in the airbag control unit J234 is to measure vehicle deceleration or acceleration and to decide on the deployment of protection systems.
In addition to the internal sensors integrated in the airbag control unit J234, external sensors are used to measure the vehicle deceleration or acceleration during an accident. Once the information received from all sensors has been evaluated, the electronics in the airbag control unit J234 decide whether and, if so, when and what safety components are to be activated. Depending on the nature and severity of the accident, the electronics may, for example, decide to deploy only the belt tensioners or the belt tensioners together with the airbags.

The main tasks of the electronics in the airbag control unit J234 are as follows:

- Collision detection (front, side, rear, roll-over*)
- Defined deployment of the belt tensioners, airbags, battery disconnect and roll-over protection mechanisms*
- Seat belt reminder (occupants are reminded to fasten seat belts)
- Evaluation of all input information
- Permanent monitoring of the entire airbag system
- Storage of faults and information on deployed protection system
- Fault indication via failure warning lamp
- Independent power supply via capacitor for a defined period of approx. 150 ms
- Indication of a collision event to other system components via powertrain CAN bus or discrete collision output (conventionally wired)

* on the cabriolet

Note

For a description of the procedure for replacing a control unit J234, refer to the Workshop Manual (ElsaWin) valid for the vehicle or to "Guided Fault Finding" or "Guided Functions" .

Data exchange

The airbag control unit J234 is integrated in the powertrain CAN bus.

The airbag control unit sends the following information to the powertrain CAN bus:

- Warning lamp K75 ON/OFF
- Seat belt reminder ON/OFF
- Diagnostic data
- Crash signal
- Crash information for the final control test
- ESP data
- Front passenger front airbag ON/OFF status

The crash information is used by the other control units, among other things, to open a closed central locking system, to shut off the fuel feed and to activate the hazard warning light system.

The airbag warning lamp K75

The airbag warning lamp K75 indicates when the airbag control unit J234 has determined that the airbag system is ready for operation. In the event of a fault, the airbag warning lamp K75 is lit continuously. In more recent models, the airbag warning lamp is activated via the CAN bus. If no data message is r eceived from the airbag control unit J234, the warning lamp is activated automatically by the control unit with display in dash panel insert J285.

410_153

The crash sensors

The internal sensors in the airbag control unit J234

A crash sensor and a safety switch are integrated in the airbag control unit J234 as internal sensors.

The crash sensor

An acceleration sensor integrated in the control unit serves as the crash sensor. It measures acceleration and deceleration on the vehicle's longitudinal axis (x-axis) and transverse axis (y-axis).

The safety switch

In the more recent control unit generations, the mechanical safety switch has been replaced by a micromechanical acceleration sensor.

This sensor likewise measures the acceleration and deceleration of the vehicle in the direction of travel (x-axis) and transfers this information to the control unit electronics for plausibility check.

The roll-over sensor

A roll-over sensor may also be installed in the control unit, e.g. in the cabriolet.

Airbag control unit J234 - closed housing

410_157

Airbag control unit J234 - open housing

410_158

The external sensors

In addition to the internal sensors in the airbag control unit J234, external sensors are also used.

The following external sensors exist:

- Front airbag crash sensor, driver and front passenger sides G283 and G284
- Side airbag crash sensor, driver and front passenger sides G179 and G180
- Rear side airbag crash sensors, driver and front passenger sides G256 and G257

Front airbag crash sensors G283 and G284

The front airbag crash sensors for the driver and front passenger sides, G283 and G284, are installed for improved head-on collision detection. These sensors take the form of acceleration sensors which measure the vehicle's acceleration and deceleration in the longitudinal direction.
This information enables airbag to be ignited earlier depending on the severity of the accident.
Earlier airbag deployment can improve the level of occupant protection.

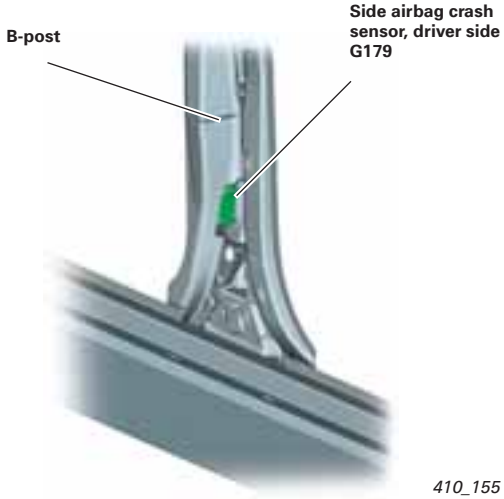
Front airbag crash sensors G283 and G284

410_159

Side airbag crash sensors G179 and G180 - acceleration sensors

Both acceleration sensors and pressure sensors are used as crash sensors for the side airbags on the driver and front passenger sides, G179 and G180.

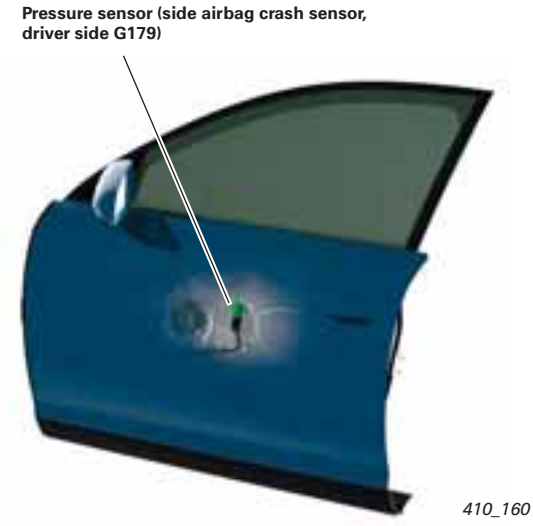
The acceleration sensors are usually installed at the interface between the B-post and the sill.
These sensors measure the transverse acceleration of the vehicle and send the information to the airbag control unit J234.



410_155

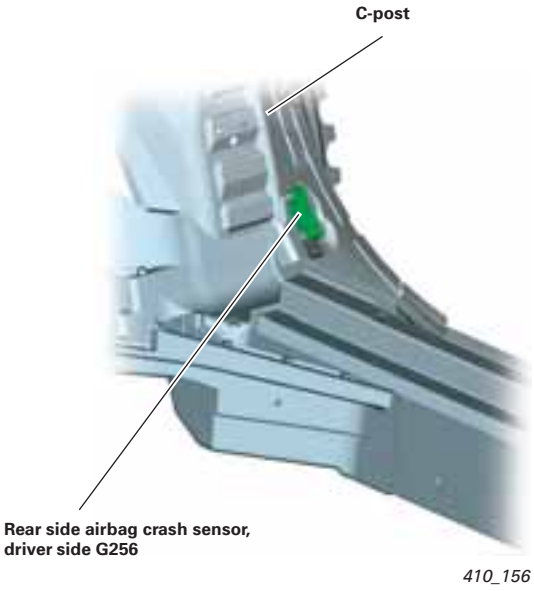
Side airbag crash sensors G179 and G180 – pressure sensors

The pressure sensors are installed in the left and right front doors. If the doors become deformed, this leads to a transient increase in air pressure. This increase in air pressure is measured by the sensor, and the information is relayed to the airbag control unit J234.



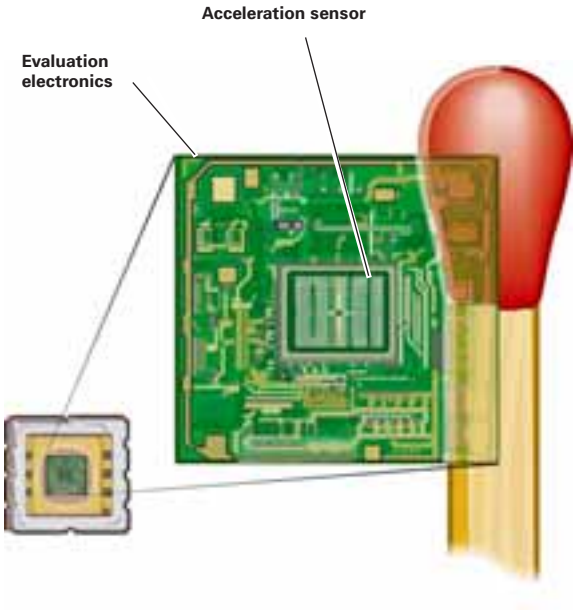
The rear side airbag crash sensors G256 and G257

Side airbag crash sensors G256 and G257 are acceleration sensors. They are installed in the vehicle in the area of the left and right C-posts. Their task is to measure the vehicle's transverse acceleration and to relay this information to the airbag control unit J234.



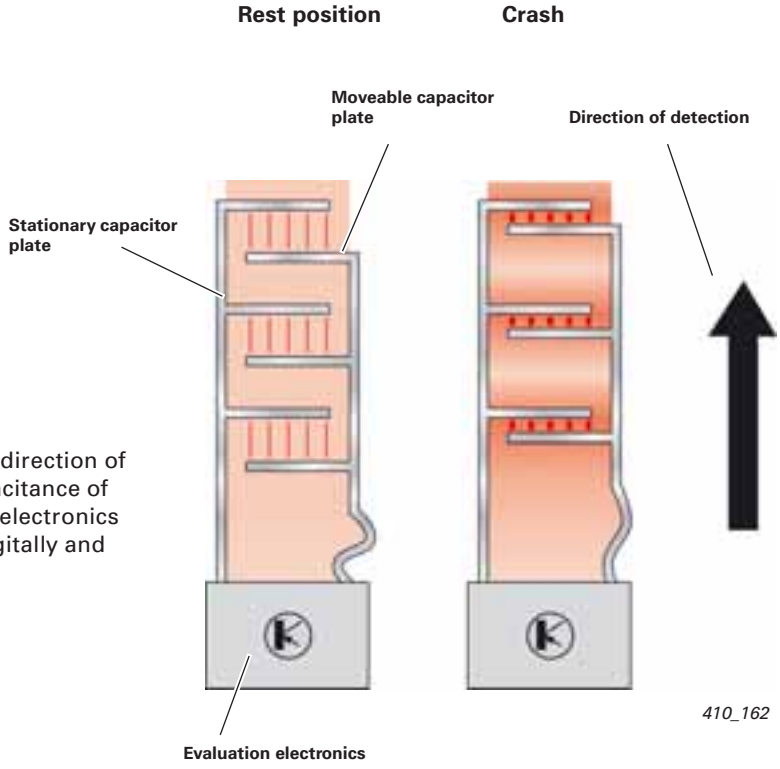
The operating principle of the crash sensors - acceleration sensors

A crash sensor is basically comprised of a housing, evaluation electronics and a micromechanical acceleration sensor.



410_161

The acceleration sensors is, in simple terms, designed in much the same way as a capacitor. Several of the capacitor plates are stationary. The matching parts are moveably mounted and act as a seismic mass.



410_162

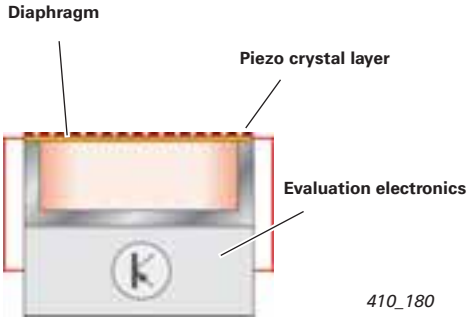
If the seismic mass is displaced in the direction of detection during an accident, the capacitance of the capacitor changes. The evaluation electronics analyse this information, process it digitally and send it to the airbag control unit.

The operating principle of the crash sensors - pressure sensors

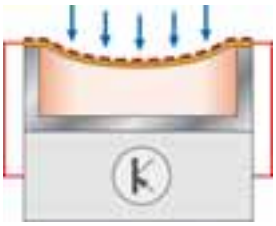
These crash sensors measure the sudden change in air pressure in the front doors during a side impact.
There are two types of pressure sensor - capacitive pressure sensors and piezoelectric pressure sensors.
Both types of sensor are comprised of a sensor unit with evaluation electronics jointly installed in a housing.

The piezoelectric pressure sensor

The sensor unit of the piezoelectric pressure sensor consists of a sealed cavity across which is stretched a diaphragm with piezo crystals.
The application of pressure from the outside presses the diaphragm inwards causing a shift in charge within the piezo crystals.
This shift in charge is processed as a voltage by the evaluation electronics and transmitted in signal form to the airbag control unit J234.



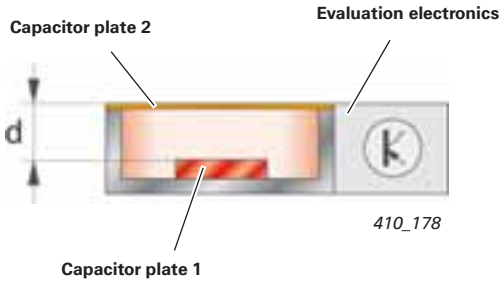
410_180



410_181

The capacitive pressure sensor

The sensor unit of the capacitive pressure sensor is designed like a capacitor. Capacitor plate 1 is arranged inside a sealed cavity. Capacitor plate 2 is stretched over it as a diaphragm.
When pressure is applied to the diaphragm, the distance (d) between the capacitor plates changes.
This change is processed in the evaluation electronics and relayed in signal form to the airbag control unit J234.



410_178

410_179

The seat belt reminder

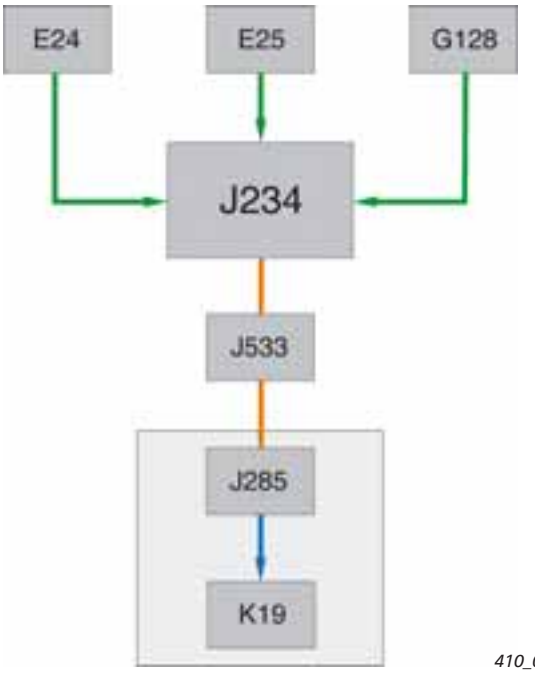
Modern vehicles are increasingly being equipped with integrated systems which alert the occupants to necessary safety precautions before setting off on a trip.
These include the seat belt reminder which sounds an alarm reminding occupants to fasten their seat belts.
Depending on vehicle type and model year, the airbag control unit determines whether the driver and/or the front passenger are wearing a seat belt.

Not all models feature a seat belt reminder for the front passenger.

410_154

When the ignition is turned on, the airbag control unit J234 queries the driver side belt switch E24, the front passenger side belt switch E25 and the seat occupied sensor G128 and evaluates this information.

The information is sent via the data bus diagnostic interface J533 to the control unit with display in dash panel insert J285. If the driver or front passenger is not wearing a seat belt, the seat belt warning system warning lamp K19 in the dash panel insert comes on. When the vehicle exceeds a certain speed threshold, an acoustic warning is issued.



410_094

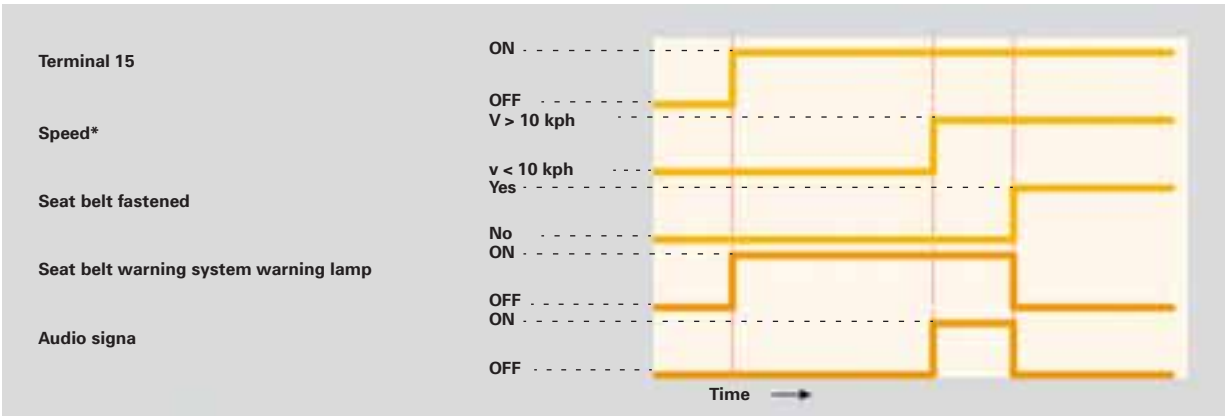
CAN data bus line

Input

Output

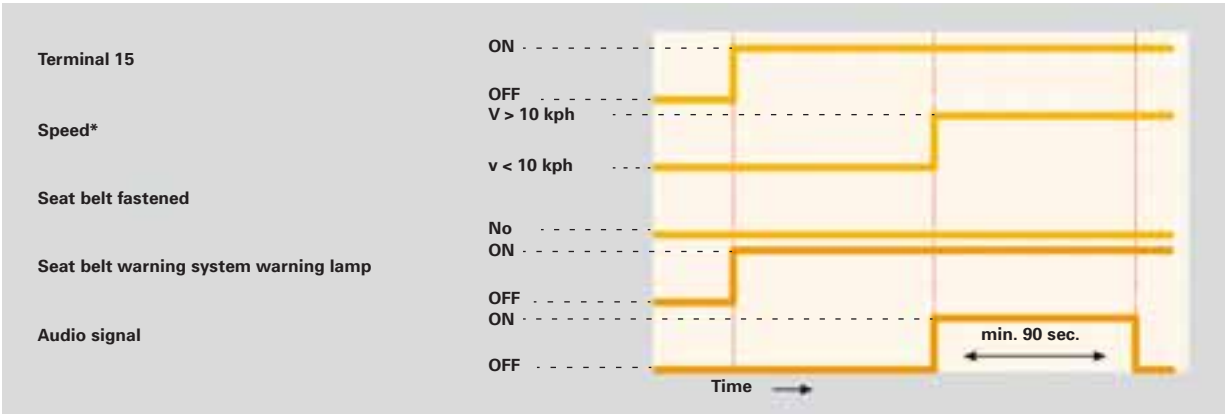
Time diagram for the seat belt reminder

Audio and visual signals - seat belts fastened late



410_163

Audio and visual signals - seat belts are not fastened



410_164

The warning is reactivated if the status of the seat belt changes during the "terminal 15 on" cycle.

* depending on vehicle model

The seat occupied sensor, front passenger side G128

The seat occupied sensor, front passenger side G128 is an integral part of the seat belt reminder system. This sensor is comprised of a plastic film and a multiplicity of individual contact sensors. The seat occupied sensor, front passenger side G128 is built into the front passenger seat between the seat cover and the seat squab. The position of the seat occupied sensor extends over the rear section of the front passenger seat and has been chosen in order to cover the relevant region of the seat squab.

410_165

The resistance value of the seat occupied sensor, front passenger side G128 varies as a function of load.
When the front passenger seat is not occupied, the resistance of the seat occupied sensor, front passenger side G128 is high. This resistance value decreases with increasing load. A load of approx. 5 kg or higher signifies to the airbag control unit J234 that the seat is occupied.

Evaluation of resistance by G128	
approx. 430 ohms and greater	Seat not occupied
approx. 140 ohms and less	Seat occupied

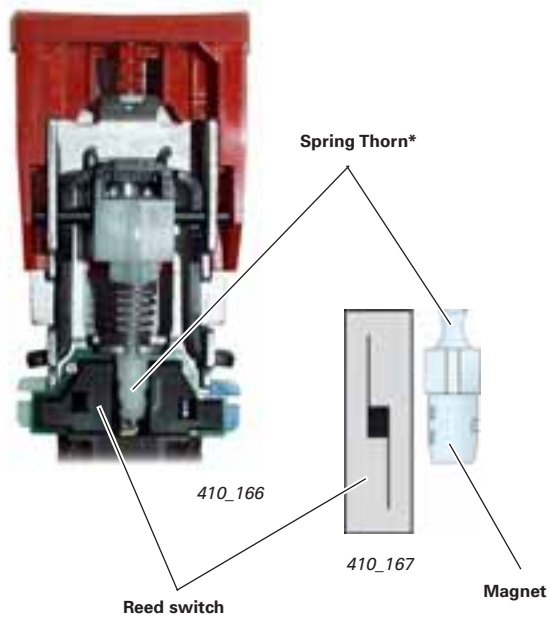
The driver side belt switch E24 and the front passenger side belt switch E25

Other components of the seat belt reminder system are the driver side belt switch E24 and the front passenger side belt switch E25.

These components are integrated in the seat belt buckles on the front seats. Both a mechanically actuated open/close switch and a so-called reed switch are used as seat belt switches.

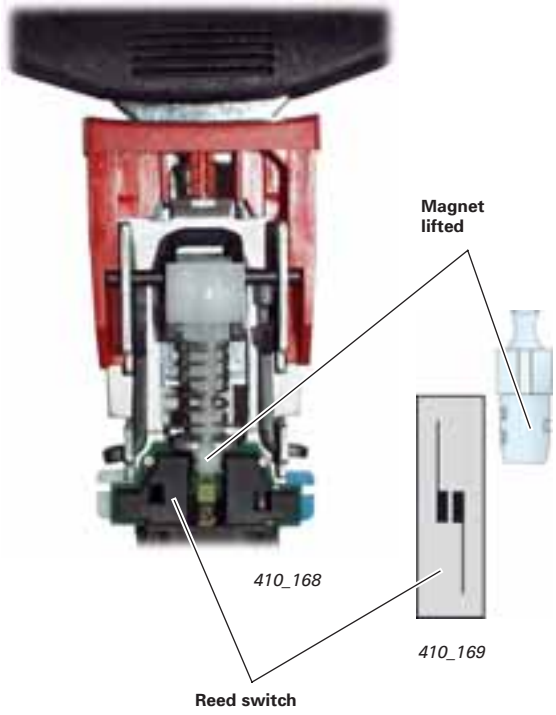
A reed switch is a magnetically actuated contact.

The reed switch is closed when a seat belt buckle is not engaged (seat belt tongue not inserted into seat belt buckle). In this position, the magnet mounted on the Spring Thorn* acts on the reed switch.



The reed switch opens when the seat belt tongue is inserted into the seat belt buckle. The inserted seat belt tongue lifts the Spring Thorn*. As a result, the magnet on the Spring Thorn* no longer acts upon the reed switch and the switch opens.

The airbag control unit J234 performs a resistance measurement to detect whether the seat belt is fastened or unfastened, regardless whether a mechanically actuated switch or a reed switch is used.



* Spring Thorn = spring-loaded arbor

The airbag disabling key switch, front passenger side E224

Before using a rearward facing child seat on the front passenger seat, the front passenger front airbag must be switched off.

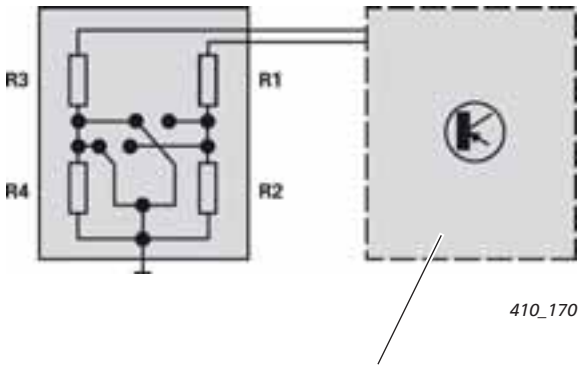
The airbag disabling key switch, front passenger side E224 and the associated passenger airbag off warning lamp K145 (PASSENGER AIRBAG OFF) are required in order to switch off the front passenger front airbag.

410_042

An activated passenger airbag off warning lamp K145 (PASSENGER AIRBAG OFF) indicates to the occupants that the front passenger front airbag is switched off.

410_043

The layout of the four resistors, two of which are always connected in series (either R1 and R2 or R3 and R4), is such that the switch position is clearly recognisable.
When the airbag control unit J234 detects a faulty key switch, a fault is registered in the fault memory and the passenger airbag off warning lamp K145 (PASSENGER AIRBAG OFF) begins to flash.



410_170

Airbag control unit J234

Market-specific features

Additions to occupant protection system for specific markets

To comply with the statutory and specific requirements of several countries, the vehicles can be equipped with auxiliary systems.

Possible auxiliary systems:

- Roll-over detection
- Seat occupied recognition sensor, front passenger side
- Knee airbags
- Rear belt tensioner

Roll-over

An additional roll-over detection sensor has been integrated into the airbag control unit J234 on some vehicle models (e.g. Audi Q7). When a roll-over is detected, the belt tensioners and the head airbags are activated.

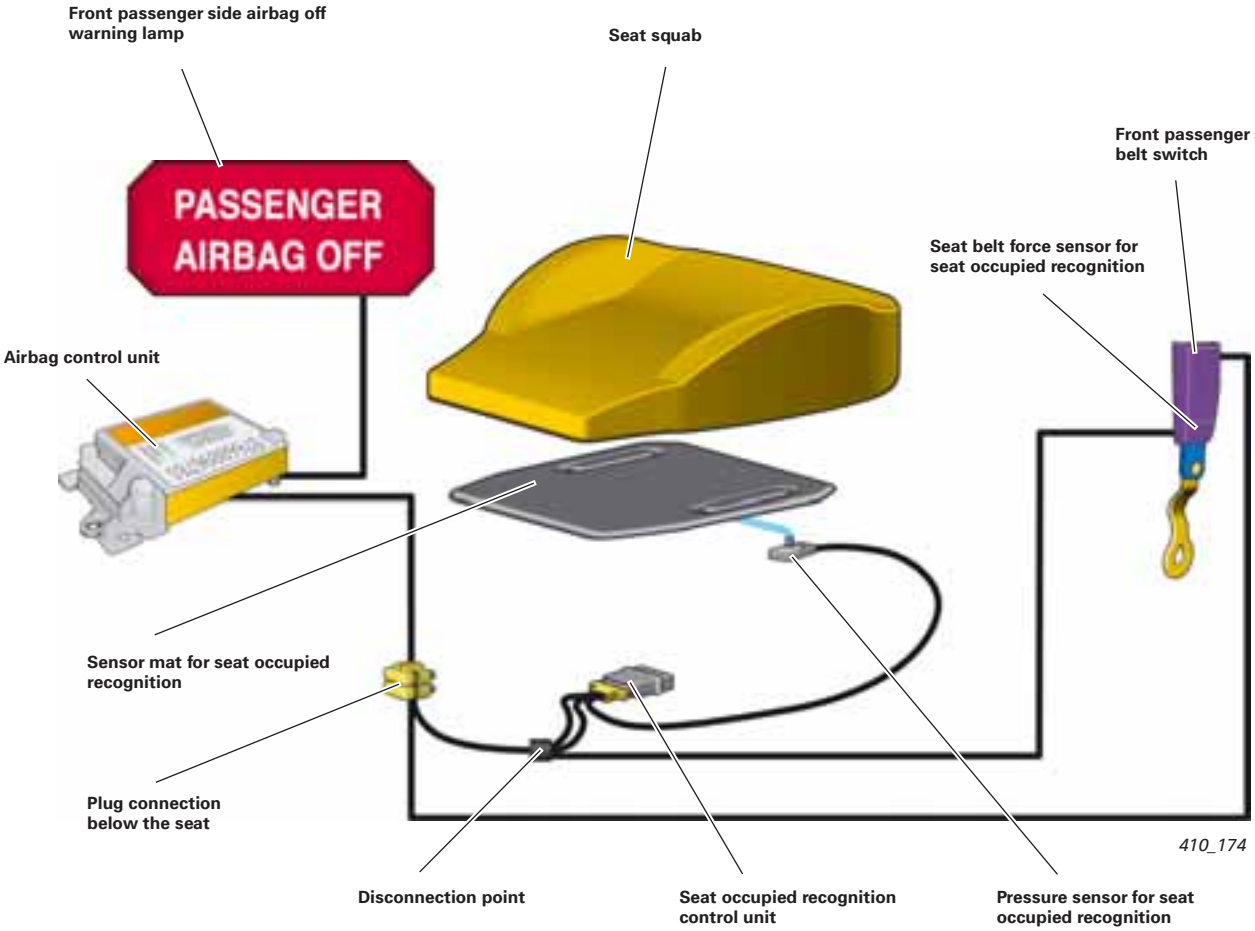
Seat occupied recognition sensor, front passenger side

When the airbag control unit J234 is informed that the front passenger seat is not occupied or a child seat is fitted, the airbag control unit switches the front passenger front airbag off.
If the front passenger front airbag is switched off, this is indicated to the occupants via the passenger airbag off warning lamp (PASSENGER AIRBAG OFF) and via a text message in the dash panel insert.

The system is basically comprised of the following components:

- Seat squab
- Sensor mat for seat occupied recognition
- Pressure sensor for seat occupied recognition G452
- Seat occupied recognition control unit J706
- Front passenger side belt switch E25
- Seat belt force sensor for seat occupied recognition G453
- Passenger airbag off warning lamp K145 (PASSENGER AIRBAG OFF)
- Airbag control unit J234

Networking of the seat occupied detection system components



Note

The positions of the installed components are predetermined and must not be changed under any circumstances. Individual components of the system must not be replaced either. Repairs must be carried out exactly in accordance with the valid Workshop Manual and "Guided Fault Finding".

The seat occupied recognition control unit J706

The seat occupied recognition control unit J706 evaluates the signals generated by the pressure sensor for seat occupied recognition G452 and the seat belt force sensor for seat occupied recognition G453.

- The signal from the seat belt force sensor for seat occupied recognition indicates the tensile force acting on the seat belt.

- The signal from the pressure sensor for seat occupied recognition signifies to the seat occupied recognition control unit the weight on the front passenger seat. If the weight on the front passenger seat is less than approx. 20 kg and if no or a very low seat belt force is detected, the seat occupied recognition control unit identifies a "child seat" and signals this to the airbag control unit.
  The front passenger front airbag is switched off by the airbag control unit.

- If a weight of, say, approx. 25 kg is placed on the front passenger seat and if the seat belt force exceeds a predetermined threshold value, the seat occupied recognition control unit determines that the child seat restraint function is active and the child seat is applying additional pressure to the seat squab via the seat belt. A "child seat" is detected and the airbag control unit switches the front passenger front airbag off.

- When a load of greater than approx. 25 kg and a low seat belt force are detected, the seat occupied recognition control unit assumes that an adult is occupying the seat, and the front passenger front airbag remains active.

The information supplied by the sensors is constantly evaluated while the ignition is on. This ensures that the seat occupied recognition control unit is able to detect a change in seat occupancy and respond to this appropriately.
To ensure that a change of load on the front passenger seat while driving does not lead to immediate deactivation of the front passenger front airbag, the system has a certain delayed action while the vehicle is in operation. An acceleration sensor integrated in the seat occupied recognition control unit signals the movement of the vehicle to the electronics.

Seat load	Seat belt force	Recognition
less than approx. 20 kg	very low or no	child seat
e.g. 25 kg	very high	child seat
greater than approx. 25 kg	low	adult

Data is exchanged between the airbag control unit J234 and the seat occupied recognition control unit J706 via LIN bus.
The airbag control unit carries out diagnostic monitoring.

Note

The inertia-reel seat belt for the front passenger seat and the outer rear seats feature a child lock function, depending on vehicle model. For further information, please refer to the Owner's Manual.

The pressure sensor for seat occupied recognition G452

The pressure sensor for seat occupied recognition G452 and the sensor mat for seat occupied recognition create a unit.
The sensor mat for seat occupied recognition is filled with a silicon-like gel and is located beneath the front passenger seat squab. When the front passenger seat is occupied, the pressure inside the sensor mat for seat occupied recognition changes. The pressure sensor for seat occupied recognition detects the change of pressure and sends this information in the form of a voltage signal to the seat occupied recognition control unit J706. Depending on load, the voltage varies between 0.2 volts (high load) and 4.8 volts (low load).
The seat occupied recognition control unit supplies a voltage of 5 volts to the pressure sensor.

410_177

Pressure sensor for seat occupied recognition

Gel-filled sensor mat for seat occupied recognition

Note

The replacement seat occupied recognition system, or Service Kit (USA), comes pre-calibrated and must not be separated under any circumstances.

The Service Kit consists of:

- Seat occupied recognition control unit J706
- Pressure sensor G452
- Sensor mat for seat occupied recognition
- Seat squab
- Wiring loom between seat occupied recognition control unit J706 and pressure sensor for seat occupied recognition G452

The pressure hose and the sensor mat for seat occupied recognition must not under any circumstances be folded/kinked during assembly work.

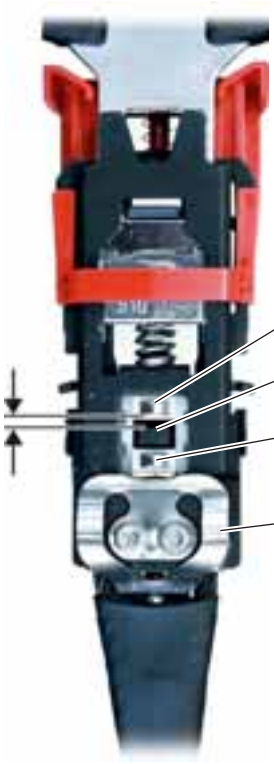
The seat belt force sensor for seat occupied recognition G453

The seat belt force sensor for seat occupied recognition is integrated in the front passenger seat belt buckle.
It is basically comprised of two parts which can be displaced relative to one another and a Hall sensor which is located between magnets I and II.
A fixed-rate spring holds the parts in the rest position. In this position magnets I and II do not have any effect on the Hall sensor.
Proper fastening of the seat belt exerts a tensile force on the seat belt buckle.

The distance between the Hall sensor and magnets I and II changes. This also changes the effect of the magnets on the Hall sensor and therefore also the voltage signal generated by the Hall sensor. The higher the tensile force acting on the seat belt buckle, the further the parts move apart. The seat occupied recognition control unit receives this information and evaluates it.

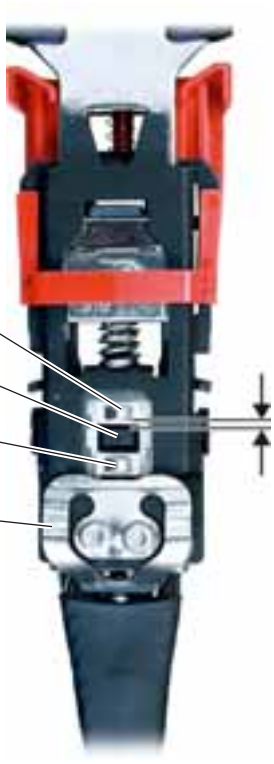
A mechanical stop prevents the sensor element from being torn apart during a collision.

Rest position



410_175

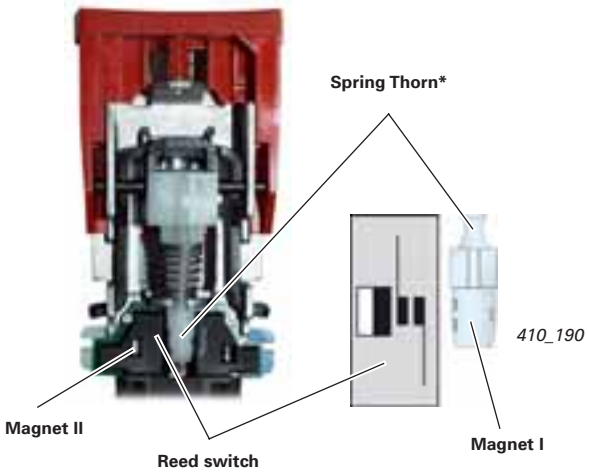
with tensile force



410_176

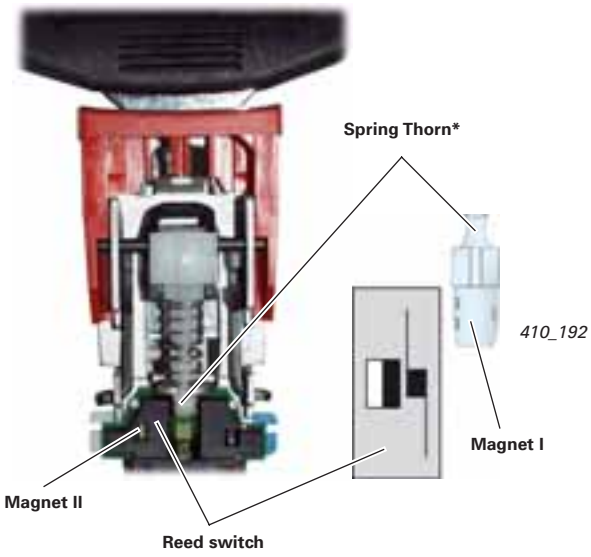
The driver side belt switch E24 and the front passenger side belt switch E25

The seat belt switches (reed switches) are integrated in the seat belt buckles on the front seats.
Magnets I and II act upon the reed switch as long as the seat belt tongue is not inserted into the seat belt buckle. The magnetic forces of the two magnets cancel each other out. The reed switch is open.



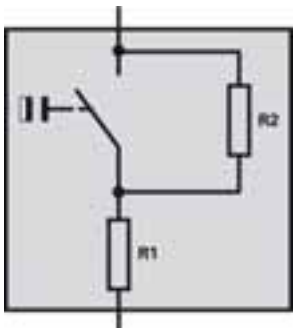
410_189

Magnet I is located in the tip of the movable Spring Thorn*.
Magnet II, like the reed switch, is held fixed in place inside the housing.
When the seat belt tongue is inserted into the seat belt buckle, this moves Spring Thorn* and magnet I along with it. Now only magnet II is acting on the reed switch. The reed switch is closed.



410_191

Two resistors are integrated in the circuit.
Depending on the position of the reed switch, either one or both of the resistors is used for measurement.
The measured resistance tells the airbag control unit whether the seat belt has been fastened or not.



410_193

* Spring Thorn = spring-loaded arbor

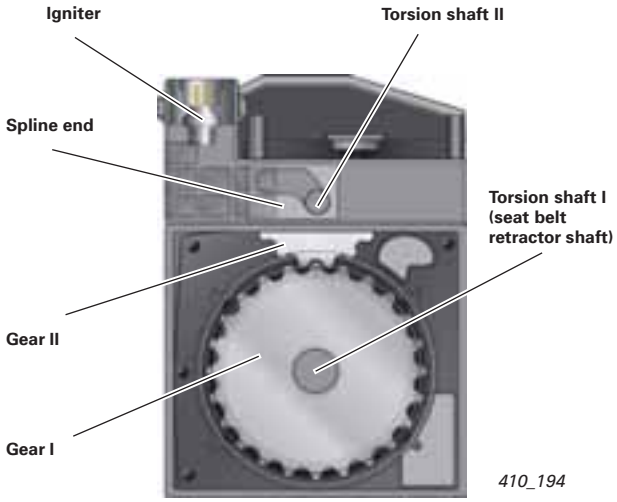
The belt force limiter, driver side G551 and the belt force limiter, front passenger side G552

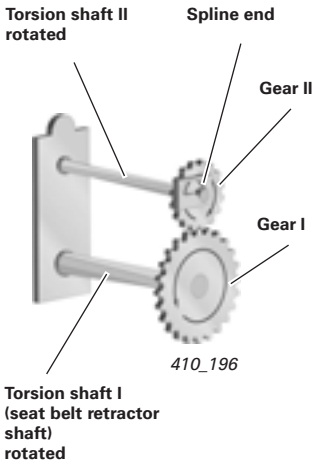
On the Audi TT Coupé ´07 for the North American market, the front inertia-reel seat belts are equipped with dual stage belt force limiters.
To keep the load exerted by the seat belt on the body of the occupants within safe limits, the seat belt is allowed to unwind in a controlled manner via two torsion shafts - the belt force limiter.

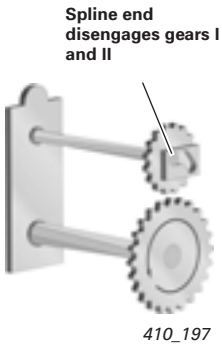
The belt tensioner (band tensioner) has unwound the seat belt within the defined bounds and the inertia-reel seat belt locks the seat belt retractor shaft. The seat belt can no longer be pulled out.
If the occupant is accelerated further forwards due to centrifugal force, the belt force limiter will allow the seat belt to unwind when a certain force threshold is exceeded. Both torsion shafts are rotated.

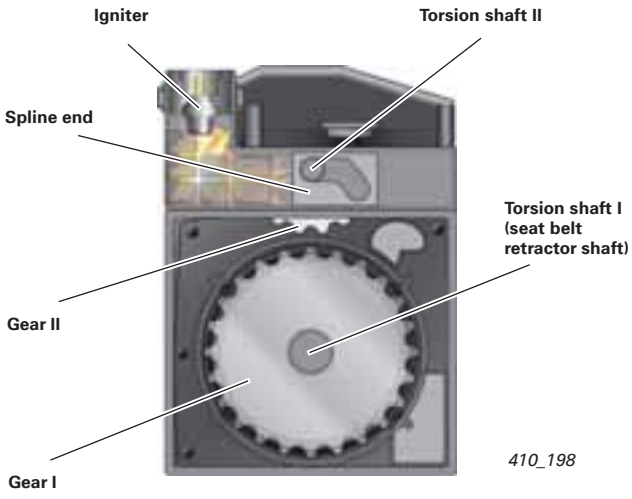
Gear I is rigidly connected to torsion shaft I (seat belt retractor shaft) and gear II is rigidly connected to torsion shaft II.
In the initial state both gears are in mesh with each other.

The belt force limiter igniter is activated after a predefined time interval. The spline end disengages gear II from gear I. Seat belt force is now limited only by the seat belt retractor shaft. The body of the occupant can immerse into the fully inflated airbag.









The front knee airbags

Several models can be equipped with additional knee airbags for specific markets.

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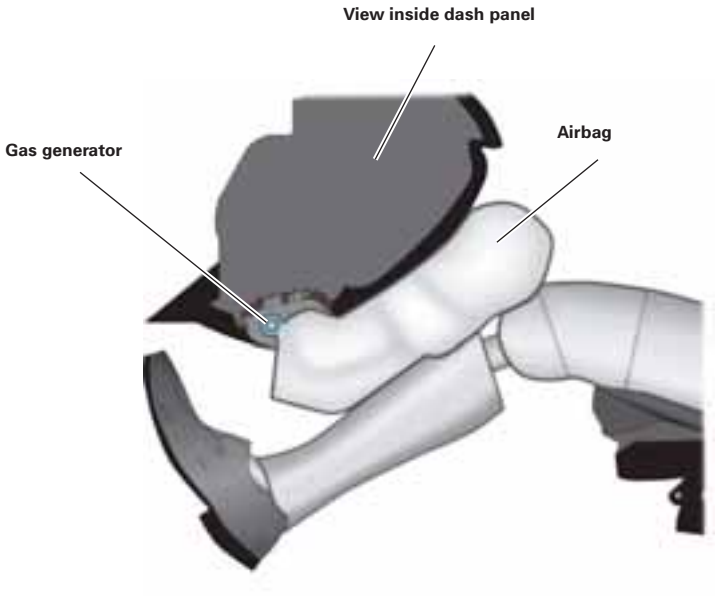
The ignited knee airbags allow the occupants to participate in the vehicle deceleration process earlier. The airbag system comprising the driver and front passenger front airbags, in combination with the knee airbags, can therefore be configured to meet the statutory and specific requirements of several countries.
On the driver side, the knee airbag is integrated in the footwell trim panel beneath the dash panel.
On the front passenger side, the knee airbag is positioned behind the glove box lid.



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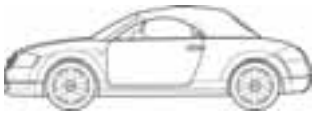
Vehicle overview

Audi A2  *410_125* **SSP 239**	**Audi A6 ‘05 (saloon and Avant)**  *410_130* **SSP 323** **SSP 344**
Audi A3 ´04  *410_126* **SSP 312**	**Audi A8 ‘03**  *410_183* **SSP 282**
Audi A3 Sportback  *410_127* **SSP 332**	**Audi Q7**  *410_184* **SSP 361**
Audi A4 ´01 (saloon and Avant)  *410_128* **SSP 254**	**Audi TT Coupé ‘98**  *410_199* **SSP 207**
Audi A4 ´05 (saloon and Avant)  *410_131* **SSP 343**	**Audi TT Roadster**  *410_200* **SSP 220**
Audi A4 Cabriolet  *410_129* **SSP 278**	**Audi TT Coupé ‘07**  *410_201* **SSP 380**

SSP = Self-Study Programme

For information about new technologies across model lines, refer to Self-Study Programme 213 "New Technologies ‘99" .

Test yourself

Which of the following answers is correct?

One or more of the answers given may be correct.

1. How is occupant protection in motor vehicles classified?

- ☐ a) Occupant protection is classified into essential systems and nonessential systems.
- ☐ b) Occupant protection is classified into active and passive safety.

2.Which of the following systems is part of the passive safety system?

- ☐ a) Electronic brake pressure distribution
- ☐ b) Belt tensioner
- ☐ c) Battery disconnector
- ☐ d) Airbags

3. When did passive safety components first become available?

- ☐ a) The first vehicle fitted with a seat belt was introduced in 1957.
- ☐ b) Head restraints became available in combination with the three-point seat belt as long ago as 1959.
- ☐ c) The first vehicle to be equipped with an airbag was introduced in 1980.

4. What is the time sequence of an airbag deployment cycle?

- ☐ a) After the airbag control unit has detected a collision which, based on an evaluation of information supplied by the crash sensors, is determined to meet the deployment criteria, the airbags are deployed.
- ☐ b) The belt tensioners are not ignited until the airbags are inflated.
- ☐ c) To ensure that the full protective effect of the front airbags is preserved after the impact, the airbag remains fully inflated.

5. What are the propellants used in airbag gas generators made of?

- [ ] a) Solid propellant gas generators use a homogeneous, compacted block of fuel.
- [ ] b) The fuel used by solid propellant gas generators is comprised of solid fuel tablets or tabs.
- [ ] c) Hybrid gas generators are basically comprised of a combination of a pressurised gas cylinder filled with noble gas and an igniter unit.

6. Which belt tensioners are used on Audi models?

- [ ] a) Coil tensioners
- [ ] b) Band belt tensioners
- [ ] c) Rack and pinion belt tensioners

7. How are belt tensioners activated on Audi models?

- [ ] a) mechanically
- [ ] b) electrically (by cable)
- [ ] c) electrically (by radio)

8. Where are crash sensors installed on the vehicle?

- [ ] a) There is only one crash sensor, and it is located inside the airbag control unit.
- [ ] b) To ensure better head-on collision detection, external front airbag crash sensors are installed in the front end of the vehicle.
- [ ] c) To detect a side impact, extra sensors are installed in the side of vehicle.

Solutions:
1. b; 2. b, c, d; 3. c; 4. a; 5. b, c; 6. b, c; 7. b; 8. b, c

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