Service Training

Self-study Programme 353

Occupant Protection - Passive Systems

Design and function

... previously

... today

S353_077

The performance of motor vehicles has increased continuously in pace with their technical development. In combination with the simultaneous increase in vehicle density on the roads, this positive development has also led to increased driver attentiveness requirements.

Despite the multitude of good ideas implemented, particularly in recent times, in the field of active road safety, accidents can never be ruled out or avoided entirely.
Increasing research has therefore been conducted into technical possibilities for protecting vehicle occupants within the vehicle in the event of an accident. One initial step – implemented at the end of the 50s – was to restrain the occupants in their seats by means of seat belts in the event of a crash. At the beginning of the 80s, this progressed with the installation of airbags, which cushion the vehicle's occupants during a crash. These systems have been constantly extended and their functions improved.

The interior equipment fitted in modern vehicles differs significantly from that of previous vehicle generations. In the illustration above, this can be clearly seen from the dash panel and the steering wheel, which are designed accordingly in addition to the integrated airbags.

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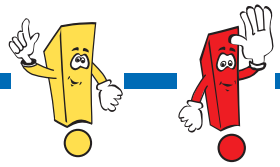

Important Note

The self-study programme shows the design and function of new developments.
The contents will not be updated.

For current testing, adjustment and repair instructions, refer to the relevant service literature.

Contents

The occupant protection system

The overall occupant protection system is sub-divided into the two categories of active and passive safety. The following overview is intended to show which safety elements are assigned to active and which to passive occupant protection.

Active safety

Active safety encompasses everything which may contribute towards preventing accidents wherever possible. This includes direct and comfortable steering, good running gear characteristics and co-ordination, good traction, effective brakes and high-torque engines.

Fatigue-free seats, clear visibility, good climate control plus clear and uncomplicated controls and displays help to maintain the driver's safety.

The active safety systems include the following systems, for example:

- Anti-lock brake system – ABS
- Traction control system – TCS
- Electronic stabilisation programme – ESP
- Electronic brake pressure distribution – EBD
- Automatic cruise control – ACC
- Electronic differential lock – EDL

S353_104

This self-study programme describes the passive occupant protection components, systems and functions fitted in Volkswagen vehicles.

Passive safety

Passive safety refers to all design engineering measures which serve to protect vehicle occupants from injury and to minimise the risk of injuries in the event of an accident.

The term particularly refers to collision behaviour and gives consideration to both personal protection and the protection of other road users in the event of an accident.

The most important passive safety features in modern vehicles include:

- The seat belt system with seat belt pre-tensioners, including child restraint systems
- The airbag system, consisting of front, side and curtain airbags
- A rigid passenger compartment with corresponding roof stiffness plus crumple zones in the front, rear and side areas
  (These protect the occupants by specifically dissipating the impact energy.)
- Roll-over protection for cabriolets
- Battery cut-off

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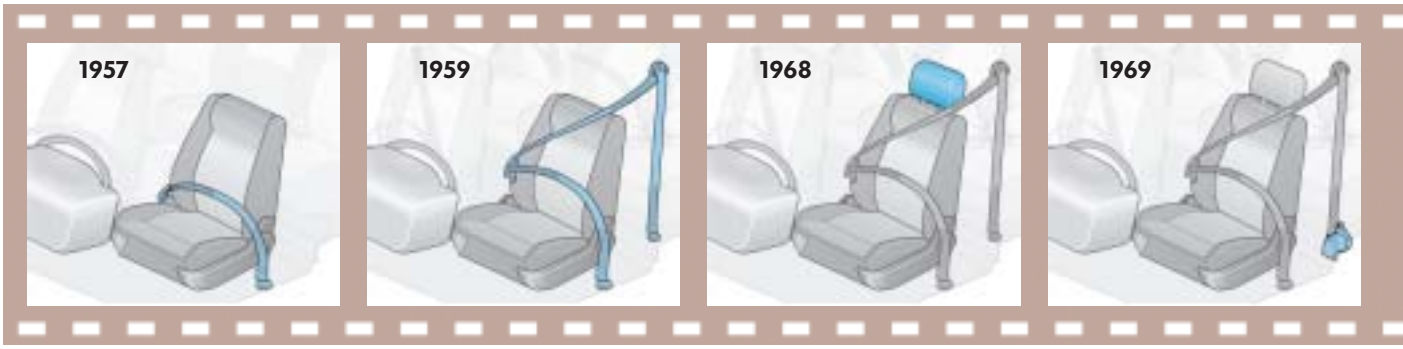
In brief

Historic outline of seat belt and airbag system development in automobiles



Lap belts
(static belt)

3-point seat belts
(static belt)

Front head restraints

Automatic seat belt retractor

Seat belt development

- Back in 1903, Frenchman Gustave Desiré Lebeau had a seatbelt, in the form of a shoulder belt which was applied crossways, patented. However, seat belts were not available until 1957. Initially installed only at the front, these were still pure lap belts, which held the body in the seat in the pelvis area. The upper body was not held in the seat, and was not therefore protected against a frontal crash.

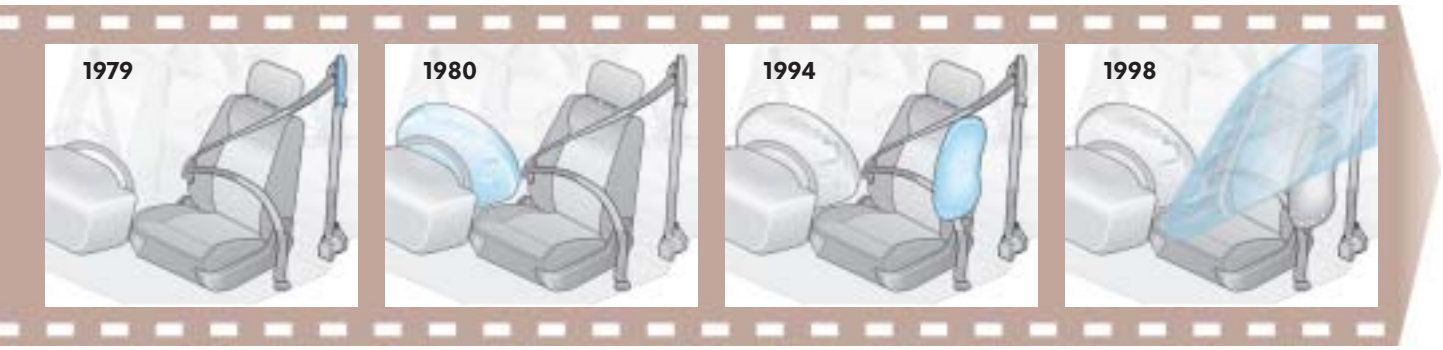
- In 1958, Nils Bohlin patented the first 3-point seat belt. In 1959, the first automobile manufacturer fitted these seat belts as standard. With the 3-point seat belt, the entire upper body was restrained.
  Initially, these belts were still "static" and did not adapt to the body.

- The seat belt system was sensibly enhanced by head restraints, which were first implemented in 1968. The neck area was protected against overstretching on occupant movement to the rear after a crash and also in the event of rear impact.

- The launch of the automatic retractor as of 1969 meant that the seat belt was retracted under spring force and therefore always adapted itself to the body.

- In 1979, application of the seat belt on vehicle occupants' bodies was further improved by the new shoulder height adjustment facility. This enabled the upper anchorage point on the body to be adjusted so that the belt routing adapted very well to the relevant body size.

- In 1980 – in combination with a driver airbag – a seat belt pre-tensioner was introduced for the first time on the front passenger seat. In the event of an impact, this tensioned the looser belt and therefore ensured that the seat belt was positioned taut against the body. The system was additionally enhanced by belt tension limiters (seat belt loops, torsional limiters).



Shoulder height adjustment

Front airbags – driver airbag, seat belt pre-tensioner – front passenger side

Side airbags

Curtain airbags

Airbag development

- A patent for an airbag was first registered in Germany by Walter Linderer in 1951.
  The patent was issued in 1953.
  It was only later – from 1980 onwards – that the first airbag was fitted as standard in an automobile (starting in the USA).

- High-volume airbags were used in the USA, as the wearing of seat belts was not a legal requirement.
  In Europe, lower-volume airbags were used, as seat belts were required to be worn by law.

- Airbags for the driver were introduced first, followed by passenger airbags.

- To protect against lateral impact, side airbags were introduced for the first time in 1994. Depending on equipment, these were fitted for the front and also the rear seats.
  This lateral protection was subsequently extended to the upper areas of the body. A so-called window airbag or curtain airbag was developed to achieve this. This stretched across the length of the window and protected the head area.

- Today, airbag development is particularly concerned with further developing deployment, the airbags' unfolding and the vehicle occupants' sinking into the airbags, in order to further reduce the risk of injury.

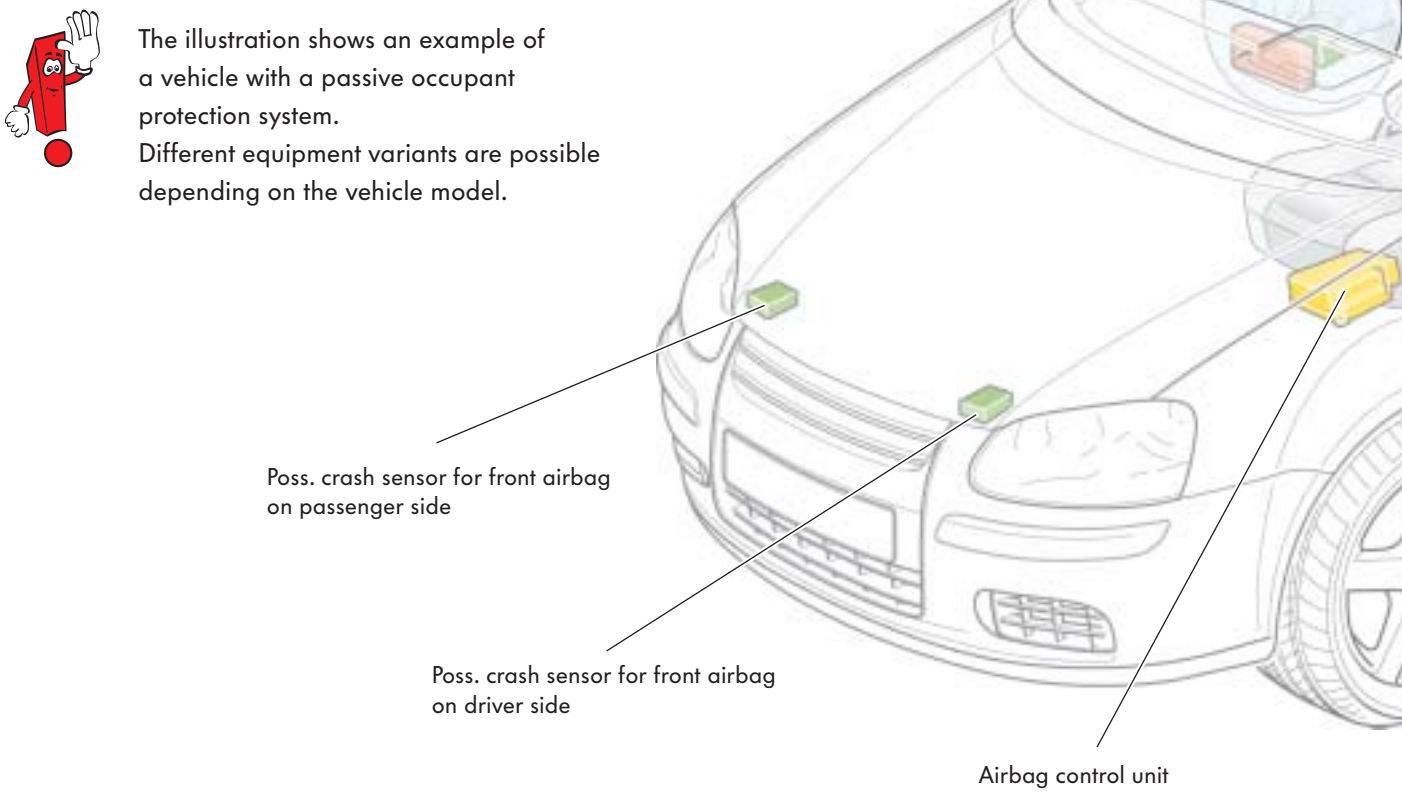
It is important to know that wearing a seat belt is the No. 1 safety measure.
All other measures enhance and increase safety, but only in combination with a seat belt which has been fastened.

General basics

The passive occupant protection system

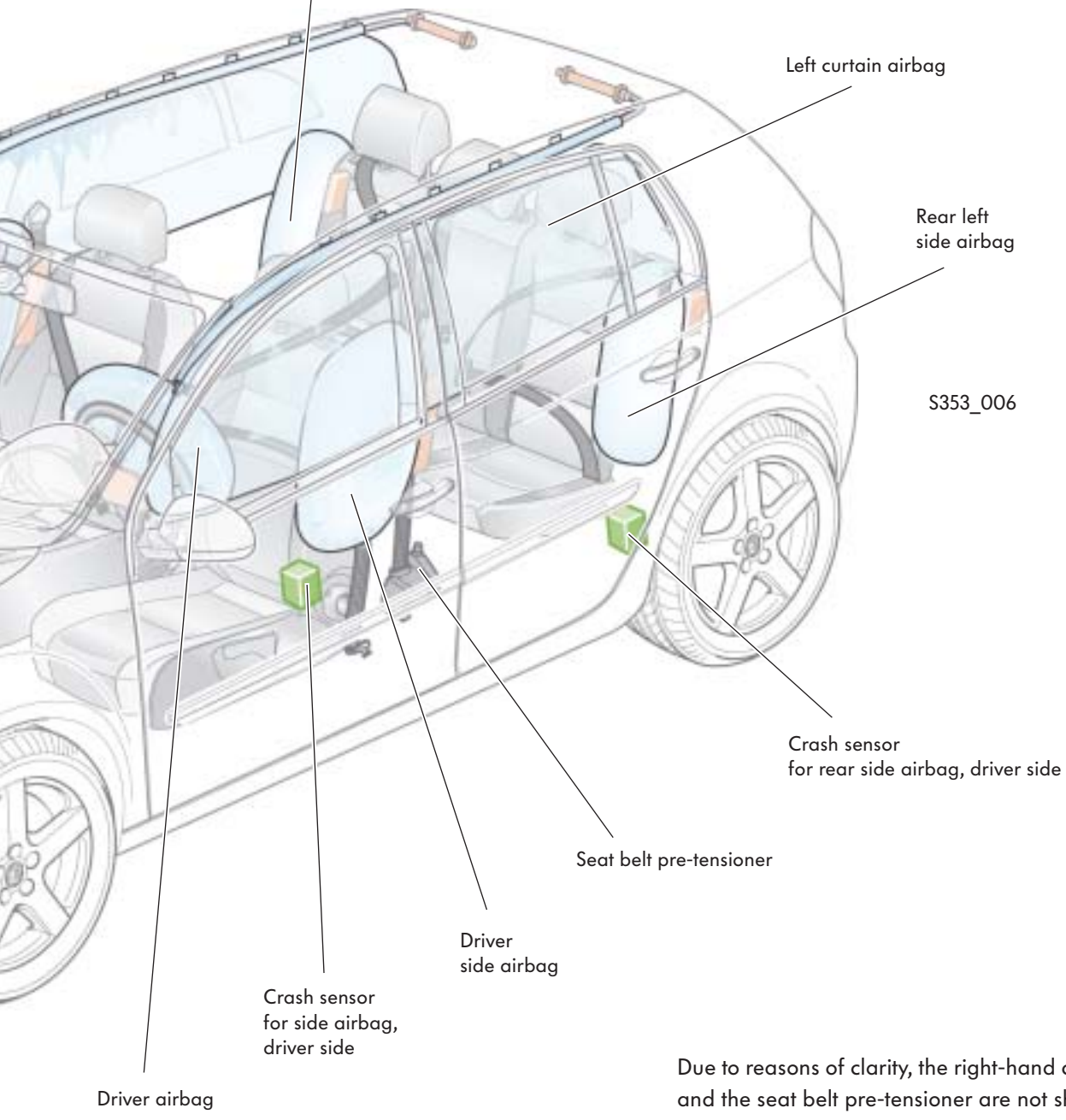
The passive occupant protection system consists of:

- Body
- Airbags
- Seat belts
- Seat belt pre-tensioners
- Belt tension limiters
- Seat design, poss. with active head restraints
- Child restraint systems
- Battery cut-off
- Control unit and sensor system



The illustration shows an example of a vehicle with a passive occupant protection system.
Different equipment variants are possible depending on the vehicle model.

Model-specific information on the airbag systems can be found in the self-study programmes for the relevant vehicle models. An overview is available from page 80.



Due to reasons of clarity, the right-hand crash sensors and the seat belt pre-tensioner are not shown in the illustration. These are located as on the left-hand side of the vehicle.

System component networking

The passive safety system may consist of the following components:

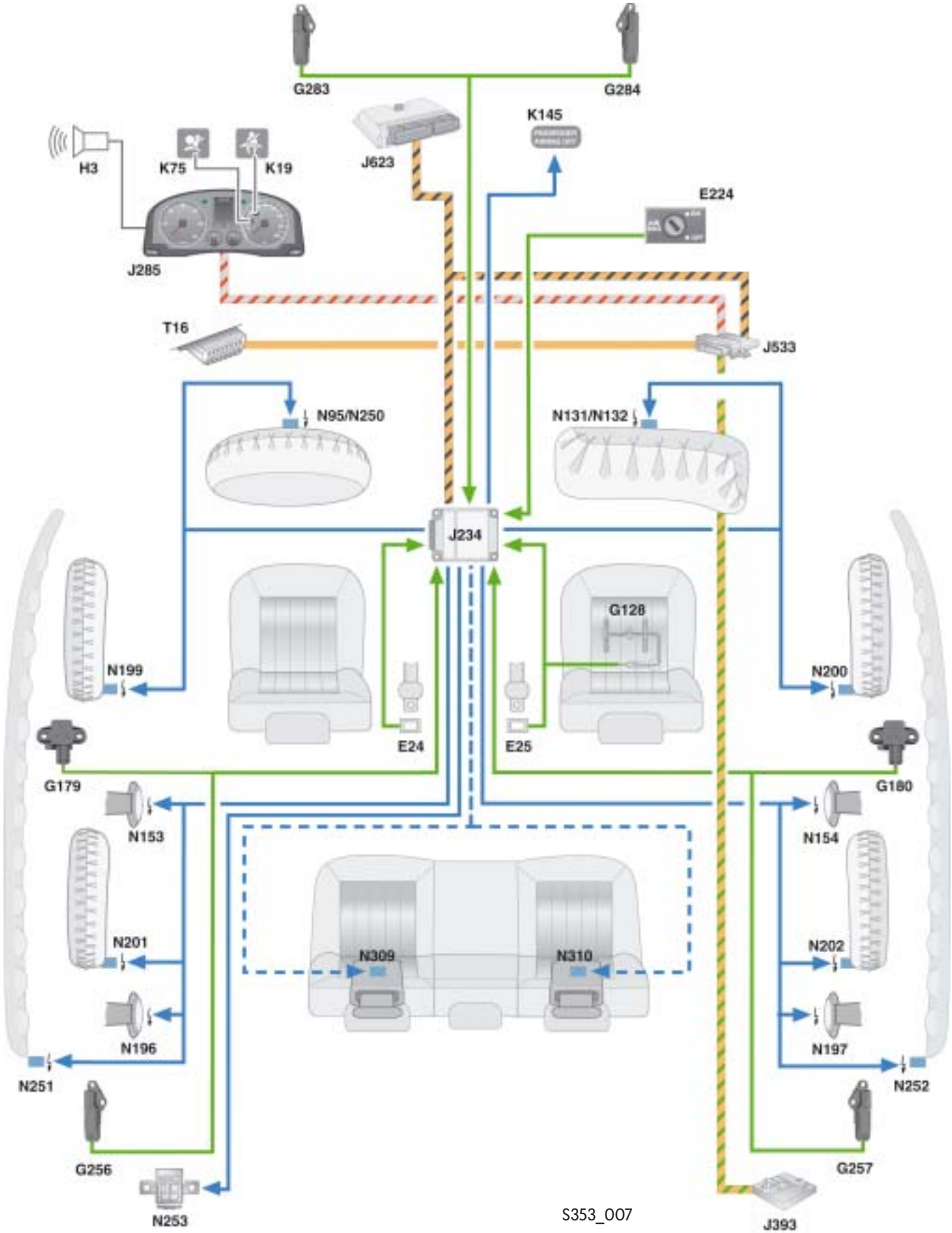
- Airbag control unit
- Driver and front passenger airbags
- Side airbags
- Curtain airbags
- Crash detection sensors
- Seat belt pre-tensioners
- Belt tension limiters
- Roll-over protection for cabriolets
- Battery cut-off elements (only in vehicles in which the battery is installed in the interior/luggage compartment)
- Switches in the front seat belt buckles
- Seat occupied sensor, front passenger seat
- Key operated switch to deactivate the front passenger front airbag with relevant warning lamp
- Active head restraints on the front seats

The adjacent system overview shows all possible passive occupant protection system components and their networking.
Not all of these parts necessarily have to be fitted in each vehicle model.

The convenience system central control unit is part of this overview, as it undertakes convenience functions such as e.g. switching on the hazard warning lights and unlocking the doors (in the event of a crash).

Legend

E24	Driver side belt switch
E25	Front passenger side belt switch
E224	Key operated switch to deactivate front passenger front airbag
G128	Seat occupied sensor, front passenger side
G179	Side airbag crash sensor on driver side
G180	Side airbag crash sensor on front passenger side
G256	Rear side airbag crash sensor on driver side
G257	Rear side airbag crash sensor on front passenger side
G283	Front airbag crash sensor for driver side
G284	Front airbag crash sensor for front passenger side
H3	Buzzer and gong
J234	Airbag control unit
J285	Control unit 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	Front passenger side airbag deactivated warning lamp (PASSENGER AIRBAG OFF)
N95	Driver side airbag igniter
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 on driver side
N197	Rear belt tensioner igniter on front passenger side
N199	Side airbag igniter on driver side
N200	Side airbag igniter on front passenger side
N201	Rear side airbag igniter on driver side
N202	Rear side airbag igniter on 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	Driver side roll-over protection solenoid (cabriolet only)
N310	Front passenger side roll-over protection solenoid (cabriolet only)
T16	16-pin connector (diagnostic connection)


G283
G284
K145
J623
H3
K75
K19
E224
J285
T16
J533
N95/N250
N131/N132
J234
G128
N199
N200
E24
E25
G179
G180
N153
N154
N201
N309
N310
N202
N196
N197
N251
N252
G256
G257
N253
J393
S353_007

General basics

Types of collision

Accident analyses show that approx. half of all severe accidents and accidents involving injured occupants occur at the front of the vehicle. In this case, the forces act frontally to obliquely on the vehicle.
A third of accidents primarily affect the left/right side of the vehicle. The rear end and roll-over are affected to lesser extents.

S353_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 venture project between the Federal Highway Research Institute and the Forschungsvereinigung Automobiltechnik e.V. (automobile technology research association). According to a random sample plan, some 2000 accidents per year are studied by two research teams in the areas of Hanover and Dresden. The data acquired in this way are regarded as statistically representative for answering many questions.

Impact situation

The various airbags serve to protect the occupants according to the relevant impact directions in the event of an accident. When the airbag control unit has detected a crash worthy of deployment, the systems are activated. Depending on the impact direction or angle, only certain airbags are activated. The airbag control unit also informs other vehicle systems of the crash event. This information is used to shut-off the fuel supply, etc. If a battery cut-off element is fitted, this is activated on airbag deployment.

Crash – front

Depending on the severity of the accident, only the seat belt pre-tensioners or the seat belt pre-tensioners and front airbags for the driver and front passenger may be deployed.

S353_069

Crash – frontal offset

The seat belt pre-tensioners or seat belt pre-tensioners and front airbags for the driver and front passenger and/or the relevant curtain airbags and/or the side airbags may be deployed.

S353_070

Crash – side

Depending on the vehicle model, the side airbags, curtain airbags and the seat belt pre-tensioners on the side of the vehicle affected by the collision may be deployed.

S353_071

Crash – rear

Depending on the vehicle model, the seat belt pre-tensioners and the battery cut-off element may be activated.

S353_205

Temporal sequence of a frontal collision

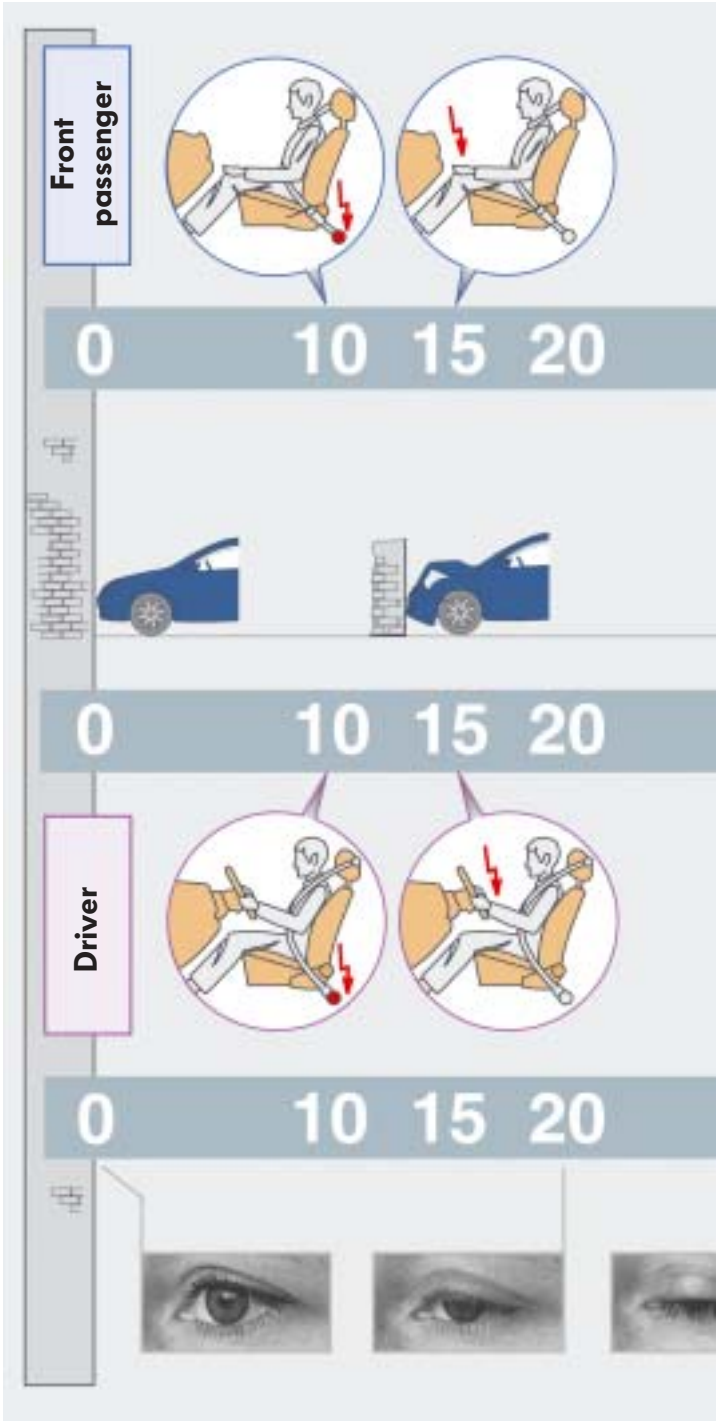
Up to a speed of e.g. 56 km/h, a period of approx. 150 milliseconds passes between the point in time of impact against a rigid obstacle and vehicle being stationary. Within this short period of time, a vehicle occupant has no opportunity to react.
He participates passively in the accident sequence.

Within this "blink of an eye",

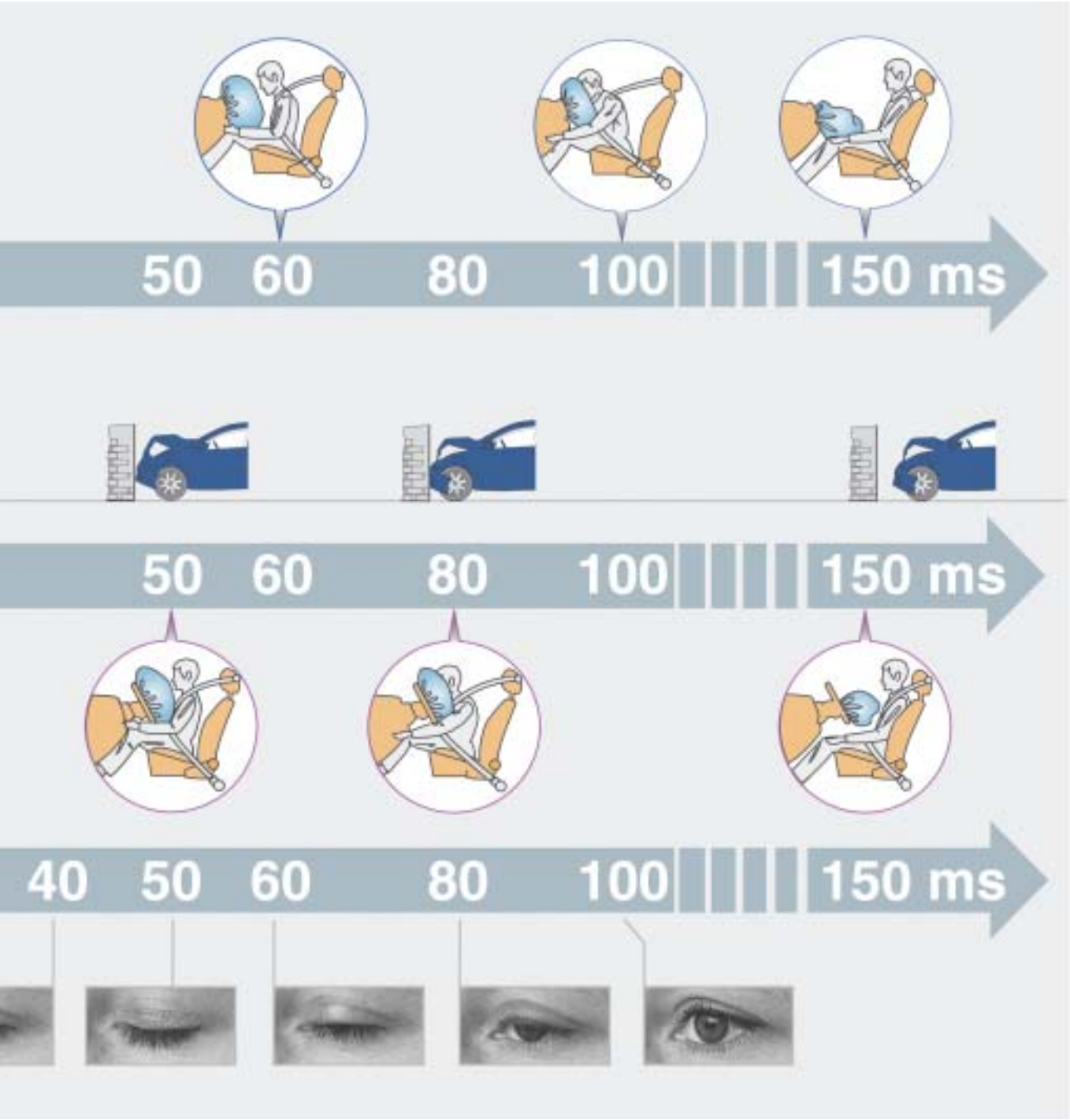
- The seat belt pre-tensioners,
- The relevant airbags and
- The battery cut-off (if fitted)
  must be activated.

These individual actions are controlled by the airbag control unit.

On completion of the protective function, the field of visibility to the front is cleared again by the airbag's collapsing.



The illustration shows the principle sequence of driver and front passenger airbag and seat belt pre-tensioner deployment. Differences may occur depending on the vehicle model.



S353_009

General basics

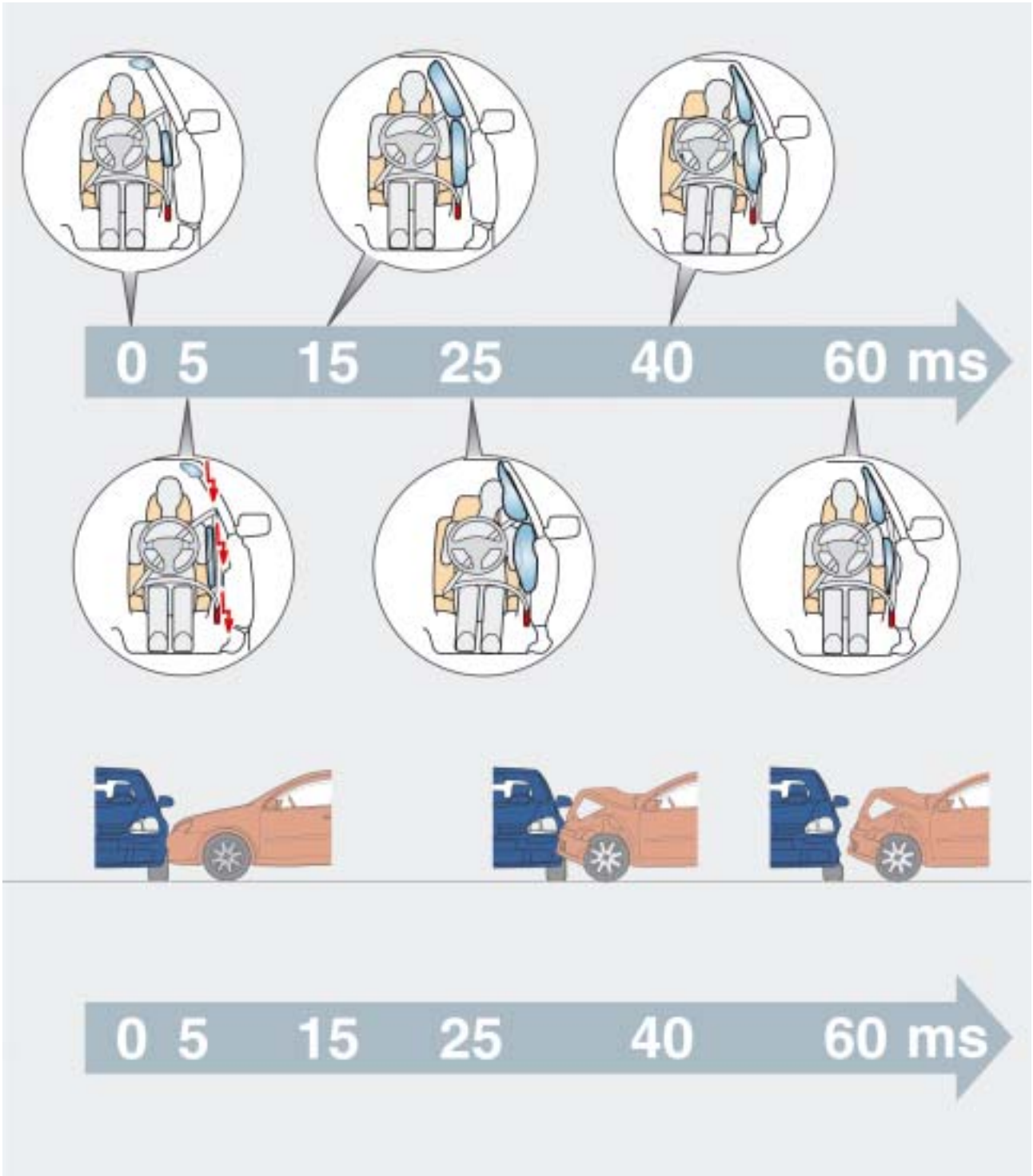
Temporal sequence of a lateral collision

As the crumple zone between the impacting vehicle and the occupants is very small, the protective measures must be introduced and carried out within the shortest possible time.

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

To maintain the protective functions of the curtain airbags even in the event of a possible, secondary accident – e.g. following a lateral crash with the vehicle's rolling over – the curtain airbags remain inflated for longer.

The illustration shows the principle sequence of side airbag, curtain airbag and seat belt pre-tensioner deployment. Differences may occur depending on the vehicle model.



S353_067

The airbags

Front airbags

Driver airbag

The driver airbag is inflated by what is called a pan-type gas generator. Its name is taken from its "pan-like" shape. This design form is particularly suitable for installation in the centre of the steering wheel.

The generator is fitted as both a single-stage and two-stage version.

S353_061

The driver airbag's gas generator is integrated into a housing which is installed centrally in the steering wheel's impact absorber.
This unit is also referred to as the airbag module.

Work on airbag systems must only be carried out by trained personnel.
In this regard, please also note the safety instructions in the current technical literature.

Front passenger airbag

Tubular gas generators are usually employed to inflate the front passenger airbag.
These can be both solid fuel generators and hybrid gas generators.

The generators are fitted as both a single-stage and two-stage version.

S353_062

The front passenger airbag's gas generator is integrated into a housing which is installed in the upper right area of the dash panel. This unit is also referred to as the airbag module.

To bridge the increased gap between the dash panel and front passenger in the event of a crash and offer good protection, the front passenger airbag has a different shape and a larger volume than the driver airbag.

In the Transporter, both an individual seat and a double seat bench may be installed on the passenger side,whereby this is equipped with a wider airbag than the individual seat.
If the vehicle is subsequently converted from an individual seat to a double seat bench or vice-versa, the front passenger airbag equipment must also be adapted accordingly.

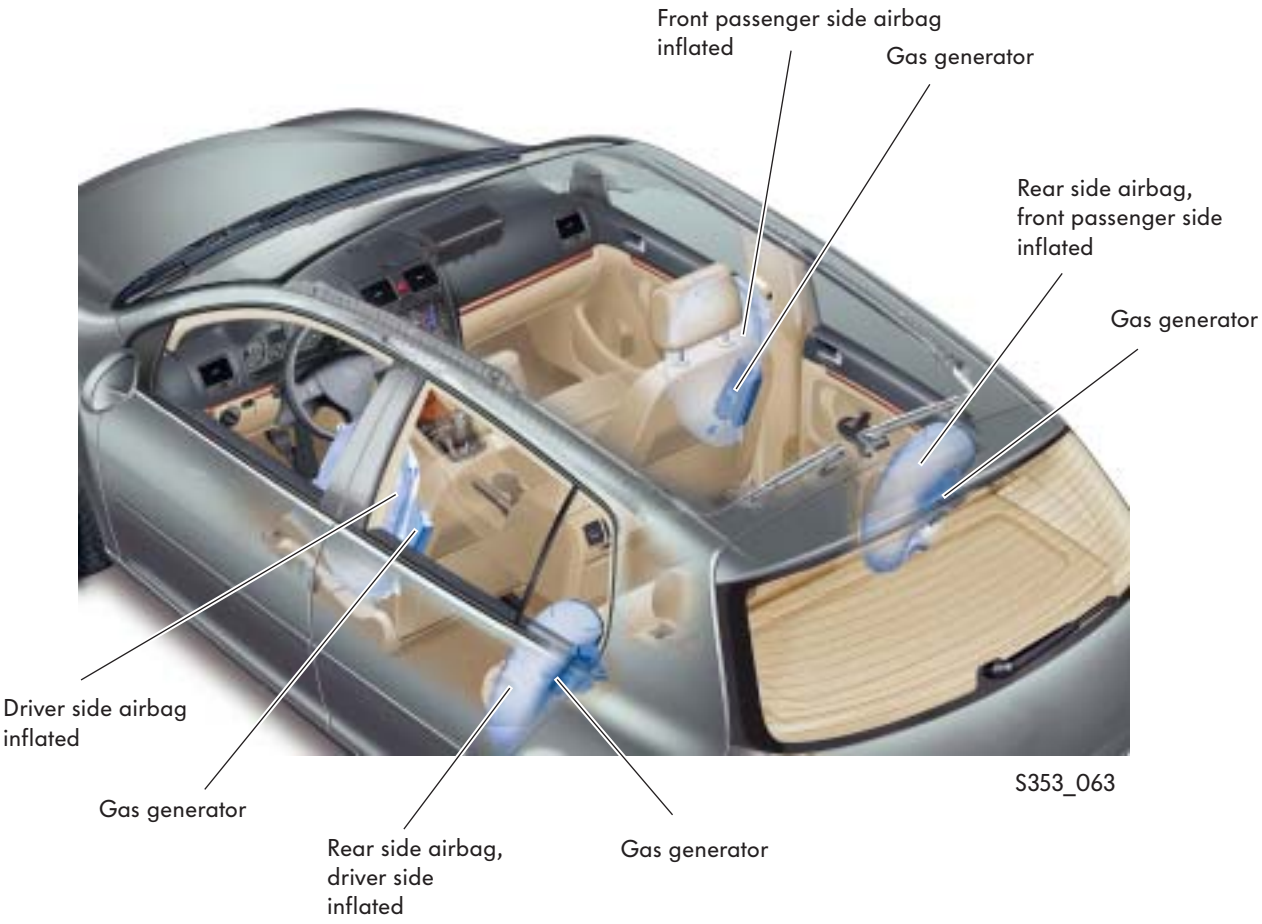
Passive occupant protection systems

Side airbags

Tubular gas generators are used to inflate the side airbags.

The gas generators which are used are single-stage solid fuel or hybrid gas generators.

The illustration shows a vehicle with all of its side airbags deployed.
In the event of a lateral crash, however, only the airbags on the affected side of the vehicle are deployed.



The airbag modules in the front seats are installed in the outer seat backrests. The airbag modules in the rear seats may be installed in the outer seat backrests or in the side trim.

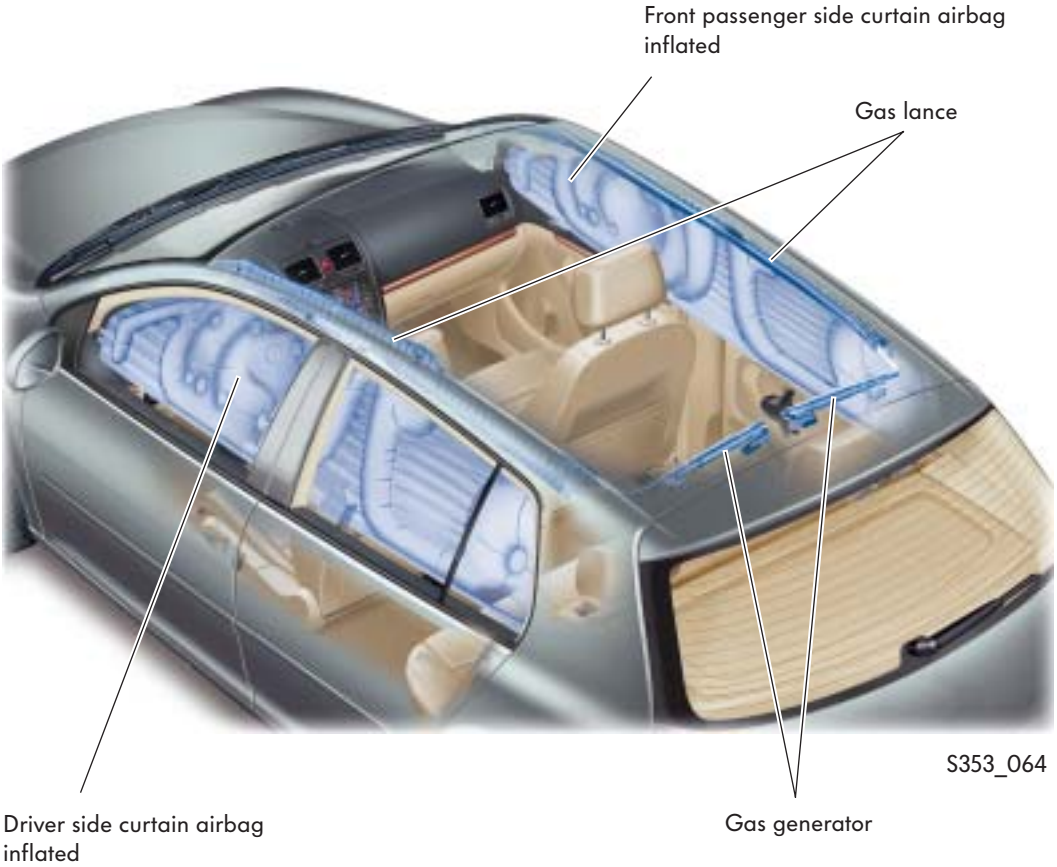
If the Transporter's front passenger seat is a rotating, individual seat, this seat must be turned in the direction of travel during vehicle operation.

Curtain airbags

Tubular gas generators are used to inflate the curtain airbags. Due to the installation conditions, which are usually very constricted, the generators have a very slim design form.

The gas generators which are used are single-stage hybrid gas generators.

The illustration shows a vehicle with both curtain airbags deployed.
In the event of a lateral crash, however, only the airbag on the affected side of the vehicle is deployed.



In the curtain airbag module, the gas generator is connected to a gas lance, which serves to rapidly and reliably distribute the airbag inflation gas in the airbag. The gas lance is integrated into the curtain airbag. It may be designed as a metal tube or a fabric hose.
Depending on the vehicle model, the gas generators may be installed in the front roof area beneath the sun visors, in the area of the B-pillar, between the C- and D-pillars and also in the rear roof area. The type and shape of the curtain airbags are also adapted to the relevant vehicle model.

Head-thorax airbags

In cabriolets, coupés and roadsters, so-called head-thorax airbags are fitted as side airbags.

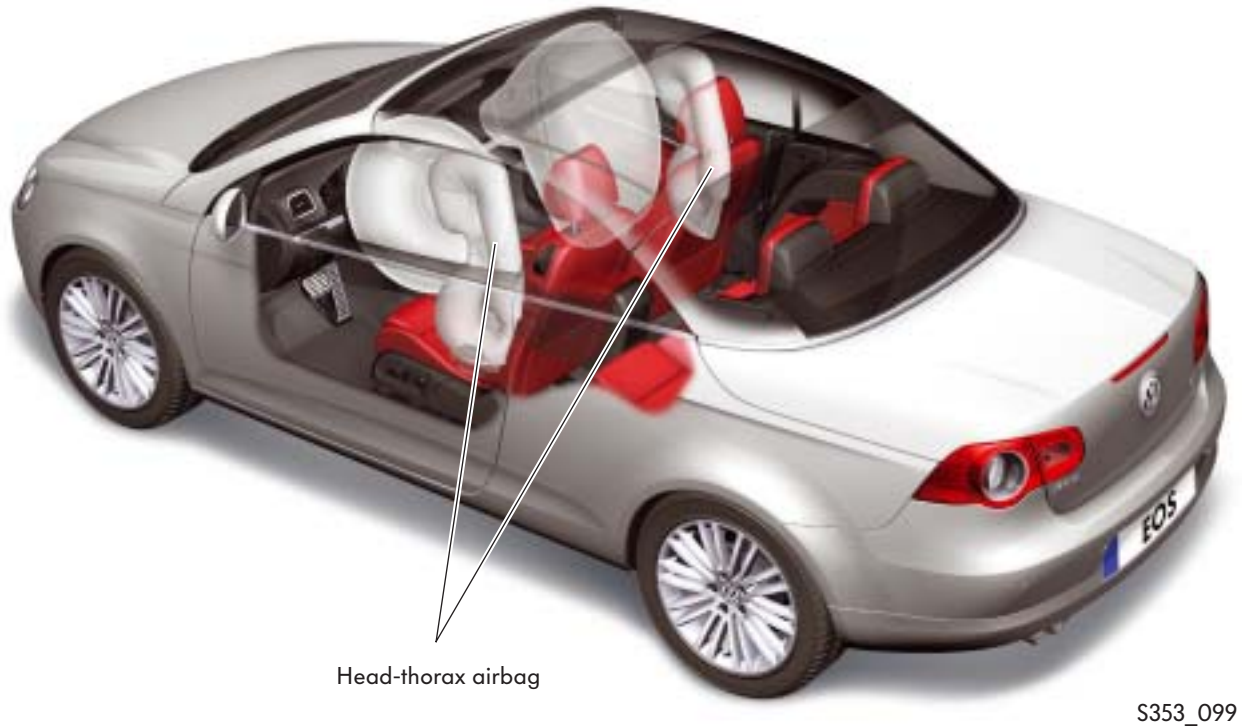
The airbag module's airbag is designed in such a way that it simultaneously acts as a side and curtain airbag.

At Volkswagen, these airbags are fitted in the:

- New Beetle saloon
- New Beetle cabriolet
- EOS

The head-thorax airbag shown in the New Beetle cabriolet

The head-thorax airbag shown in the EOS



Head-thorax airbag

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Passive occupant protection systems

Airbag gas generators

At the start of airbag development, gas generators which operated according to the priciple of solid fuel combustion were used exclusively to inflate the airbags. Hybrid gas generators were also subsequently used in addition to solid fuel generators.

If the airbag control unit detects a crash worthy of deployment, it activates the corresponding gas generators.

Depending on the vehicle model, one- or two-stage gas generators may be used for the driver and front passenger airbags.
In a one-stage gas generator, the entire gas generant is always ignited in one stage.
In gas generators with two stages, the two gas generants are activated in succession following a time lag.
The airbag control unit decides on the time gap between the two ignitions depending on the severity and type of accident. Depending on the vehicle, the lag may be between 5 ms and 50 ms.
The second stage supplies the airbag with an additional volume of air.

Both stages are always ignited. This prevents one gas generant from remaining active following airbag deployment (the exceptions are the US variants of the Phaeton and the New Beetle).

Solid fuel generators

The solid fuel generators consist of a housing, into which a solid fuel charge with ignition unit is integrated.

The structure and shape of the generator housing are adapted to the installation conditions. The generators are therefore distinguished according to their design form, e.g. pan-type gas generators and tube-type gas generators.

The solid fuel is in tablet or ring form. Following ignition of the solid fuel, an inflation gas occurs; this is not hazardous to the vehicle occupants and consists of almost 100% nitrogen.

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

Hybrid gas generators

The hybrid gas generators consist of a housing, into which a stored gas, which is compressed under high pressure, and a solid fuel charge with ignition unit are integrated.

The structure and shape of the generator housing are adapted to the installation conditions. These generators are usually tubular.
The main components are the pressure vessel with the airbag inflation gas and the gas generant (solid fuel) which is integrated into the pressure vessel or flanged onto it.

The solid fuel is in tablet or ring form. The stored and compressed gas is a mixture of inert gases, e.g. argon and helium. Depending on the design of the gas generators, this is pressurised to between 200 bar and 600 bar.

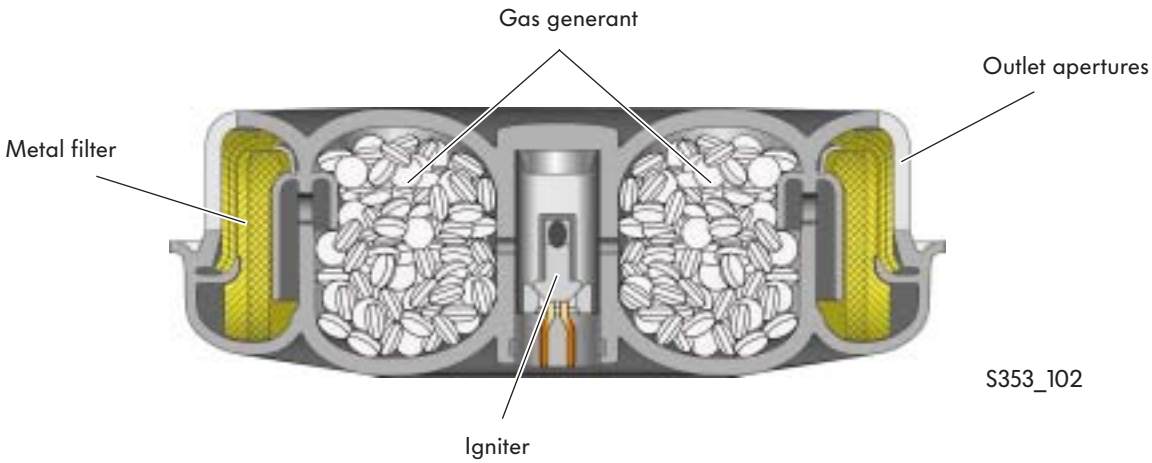
Ignition of the solid fuel opens the pressure vessel and leads to the occurrence of a gas mixture comprised of the solid fuel gas generant gas and the inert gas mixture.

Gas generator for driver airbag,

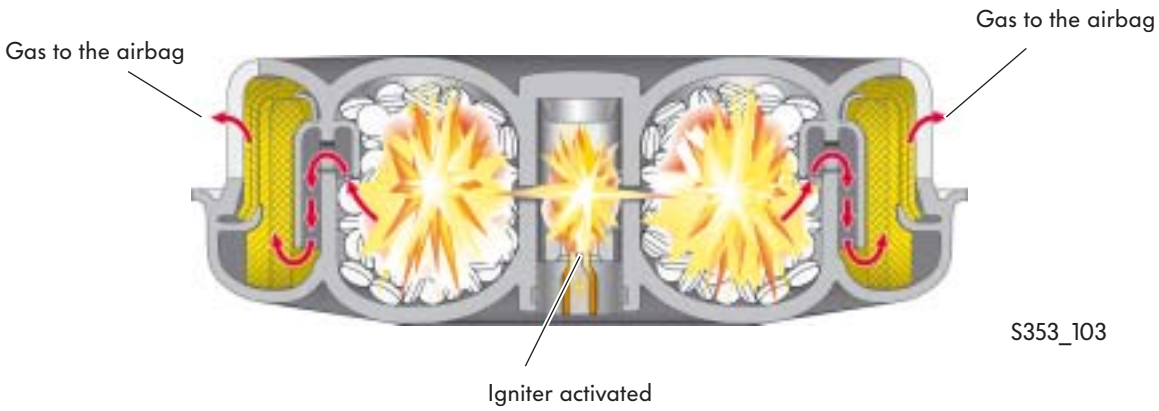
One-stage – solid fuel

Due to its pan-like design form, this generator is also referred to as a pan-type gas generator. The ignition unit is located centrally in a round housing (pan). The solid fuel is distributed around this in a ring shape. A metal filter is installed between the solid fuel and the outer housing wall. The metal filter has the task of cooling and cleaning the gas which occurs. This ensures that the entire gas generant in the gas generator combusts and that no burning components enter the airbag.
The generator is electricaly connected to the airbag control unit J234 via the coil connectors in the steering wheel unit.

Generator – not ignited



Generator – ignited



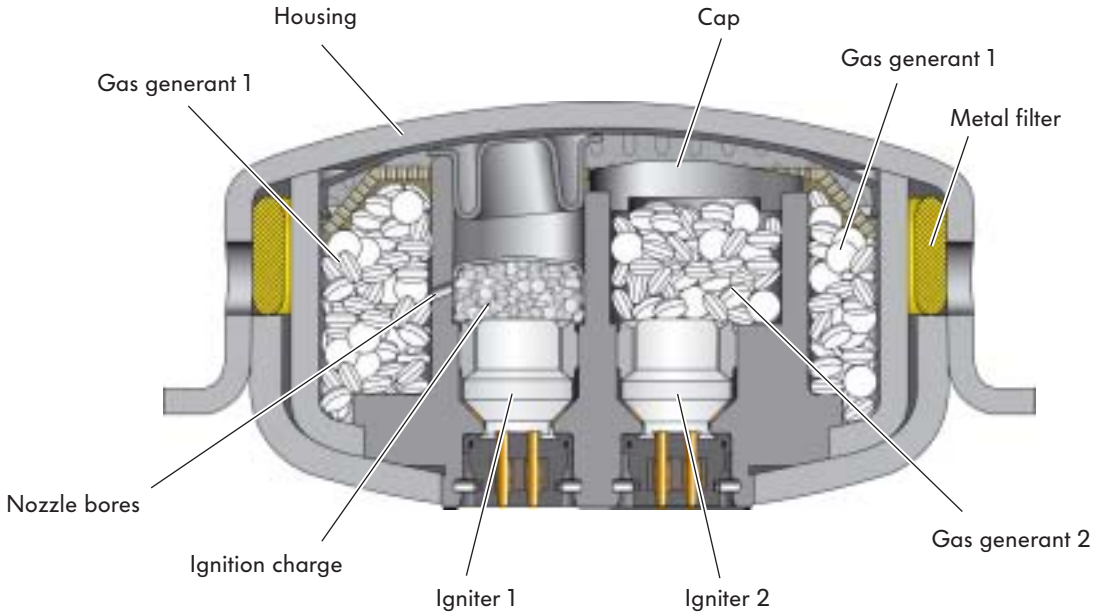
Function

- The igniter is activated.
- The gas generant is ignited and is burnt off abruptly.
- The gas which occurs flows through the metal filter into the airbag.

Two-stage – solid fuel

Pan-type gas generators with two deployment stages are also fitted on the driver side.

Generator – not ignited



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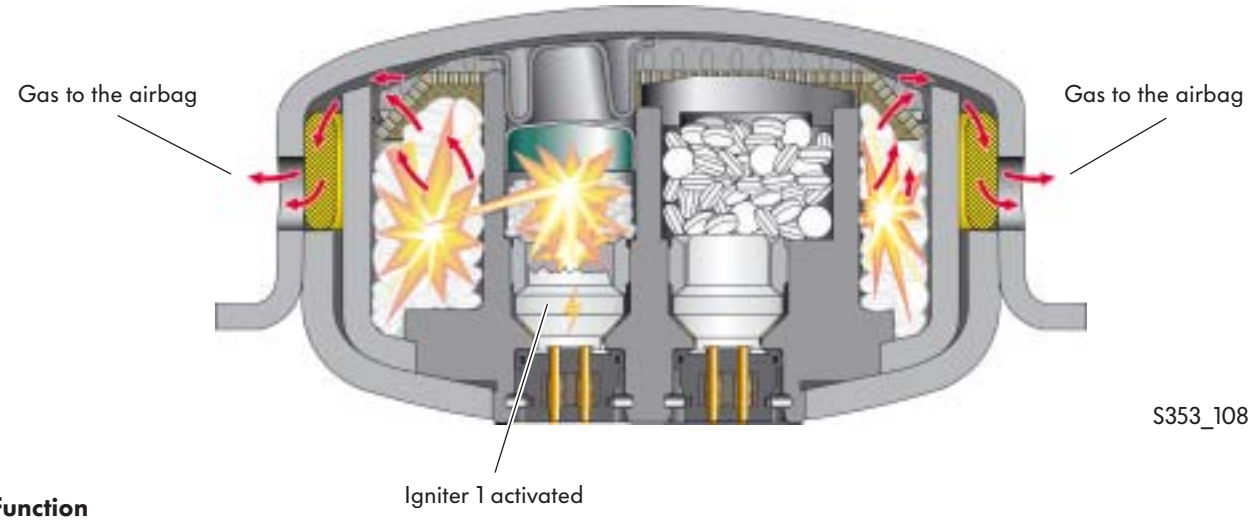
Generator – 1st deployment stage ignited

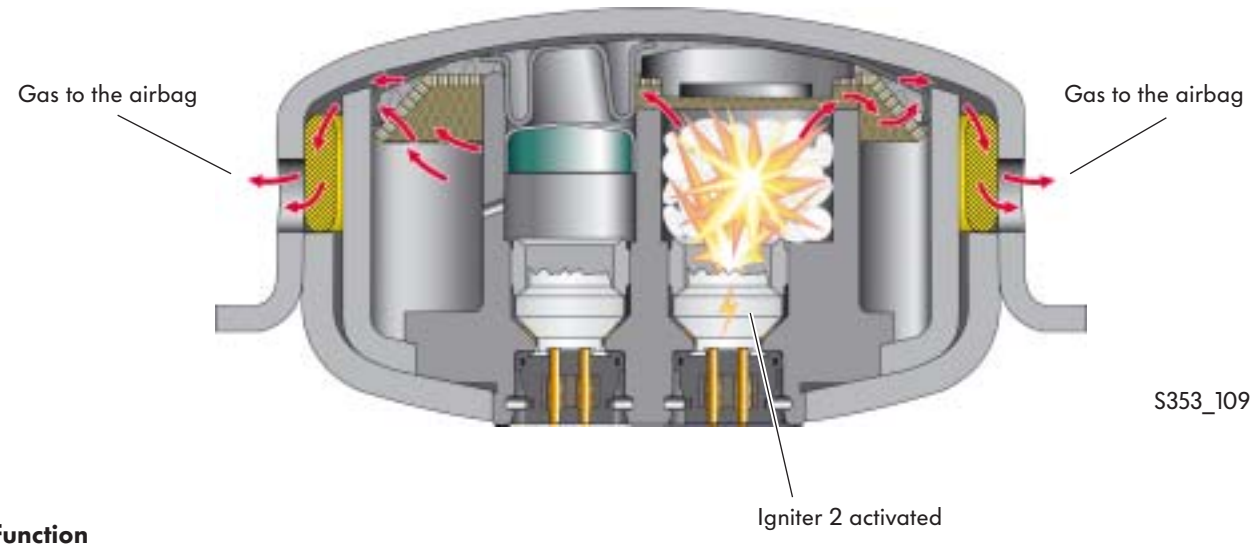


S353_108

Function

- Igniter 1 is activated.
- The ignition charge is ignited. This ignites the actual gas generant via the nozzle bores.
- The gas which occurs deforms the gas generator housing and enables the gas to flow out.
- The gas which occurs flows through the filter into the airbag.

Generator – 2nd deployment stage ignited



S353_109

Function

- Igniter 2 is activated.
- The gas which occurs enters the airbag via the 1st stage combustion chamber and the metal filter.

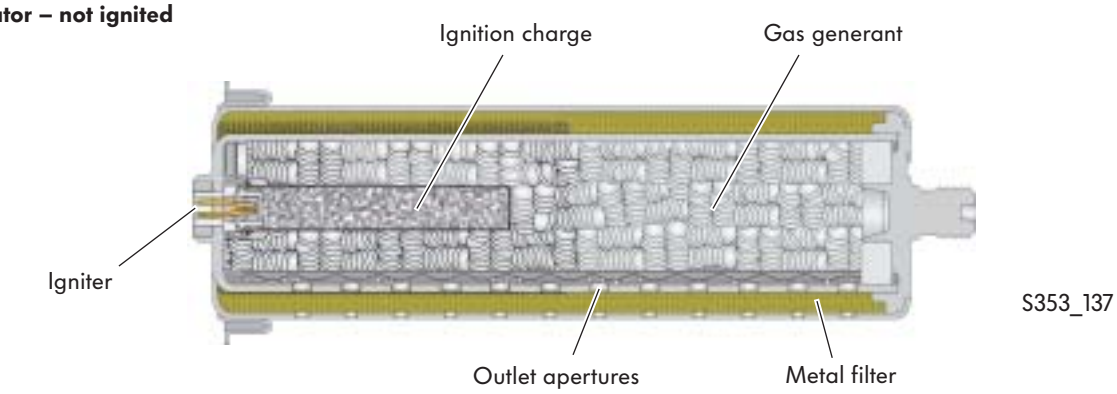
Gas generator for front passenger airbag,

Tubular gas generators are used for the front passenger airbags. They are therefore also called tube-type gas generators.

One-stage – solid fuel

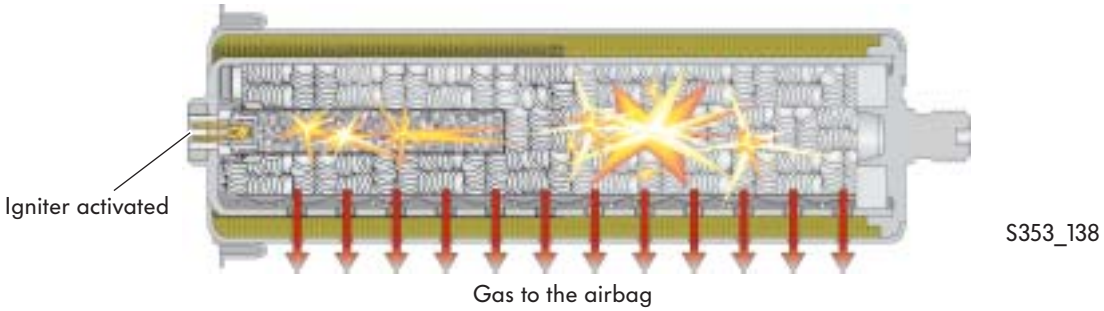
The generator consists of a housing, into which an igniter, an ignition charge and a gas generant are integrated. A metal filter is installed between the gas generant and housing.

Generator – not ignited



S353_137

Generator – ignited



S353_138

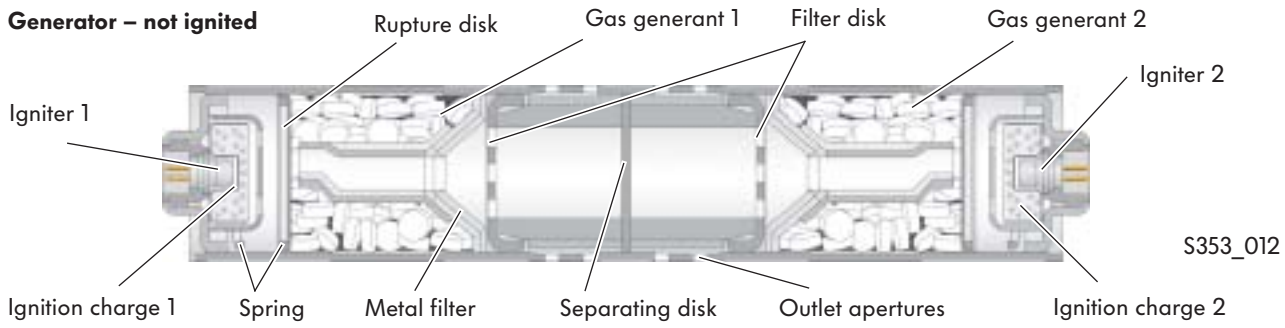
Function

- The igniter is activated.
- The ignition charge is ignited; this then ignites the actual gas generant.
- The gas which occurs flows through the metal filter into the airbag.

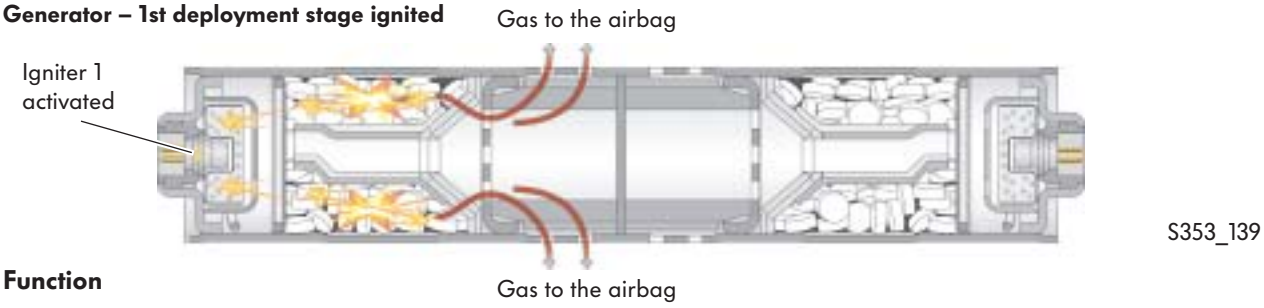
Two-stage – solid fuel (variant 1)

The gas generator consists of a housing, in which two solid fuel gas generators, which are separated by a partition, are located.

Generator – not ignited



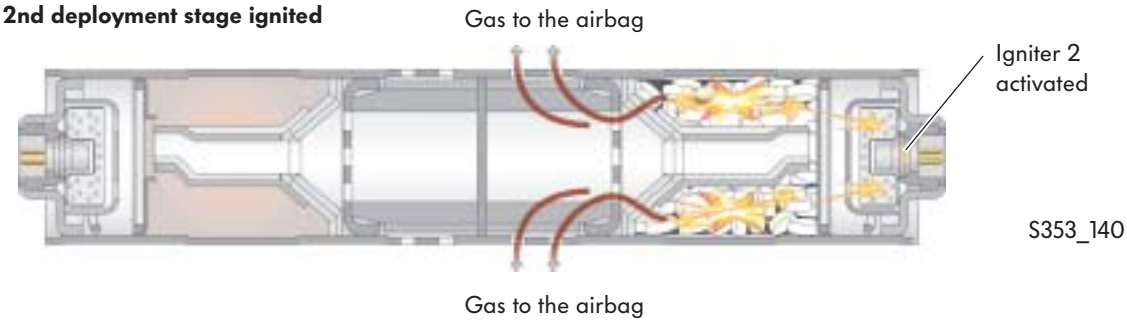
Generator – 1st deployment stage ignited



Function

- Igniter 1 is activated.
- Ignition charge 1 is ignited; this then ignites gas generant 1 after breaking through the rupture disk.
- The gas which occurs flows through the metal filter into the airbag.

Generator – 2nd deployment stage ignited



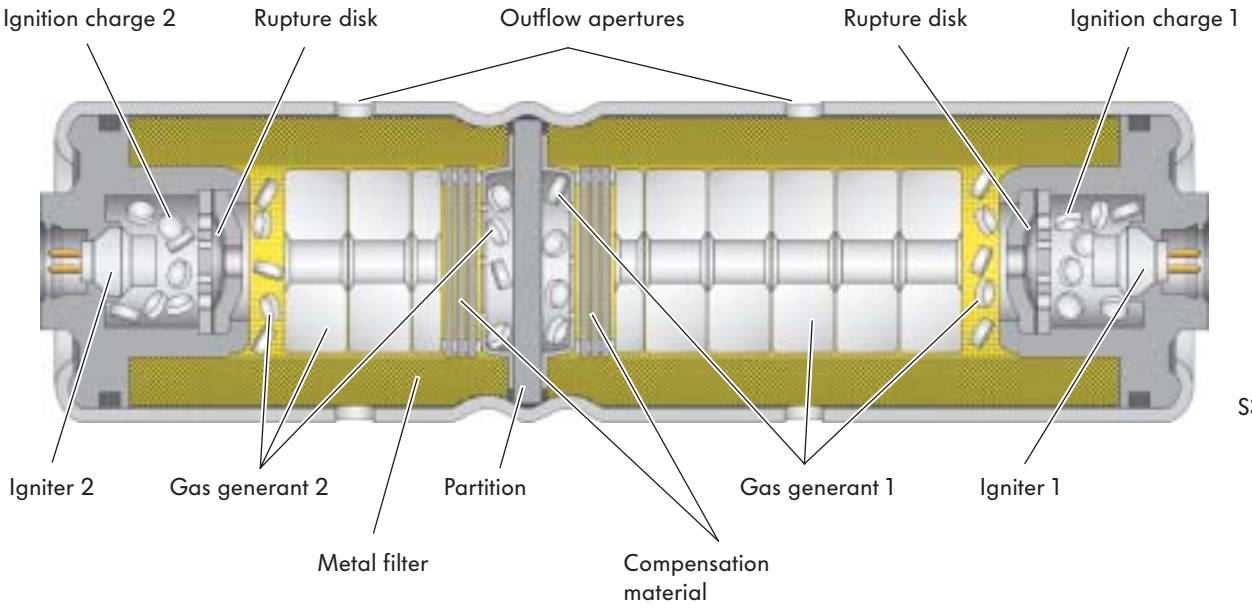
Function

- Igniter 2 is activated.
- The further procedure occurs after deployment of the 1st stage.
- The gas which occurs flows through the metal filter into the airbag.

Two-stage – solid fuel (variant 2)

The gas generant for the ignition charge consists of tablets. Hollow tablets are used for gas generant 1 and 2. The tablets' hollow design means that ignition of the entire gas generant is achieved faster.

Generator – not ignited



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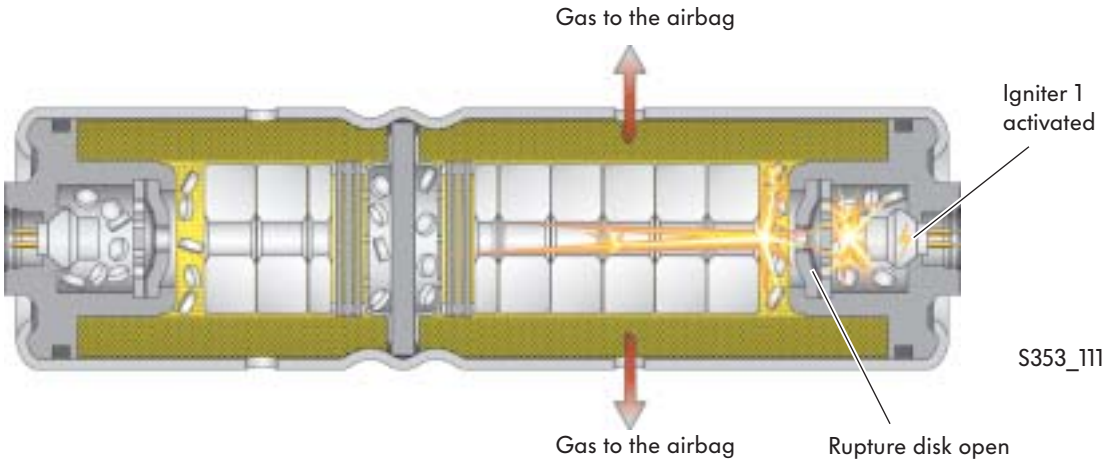
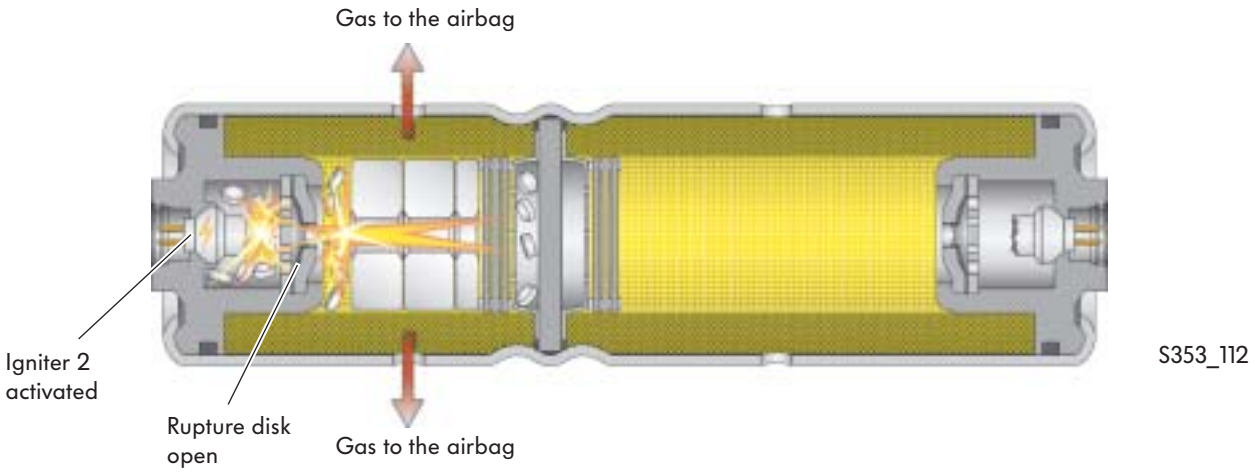
Generator – 1st deployment stage ignited



Function

- Igniter 1 is activated.
- Ignition charge 1 is ignited; this then ignites gas generant 1 after breaking through the rupture disk.
- The gas which occurs flows through the metal filter into the airbag.

Generator – 2nd deployment stage ignited



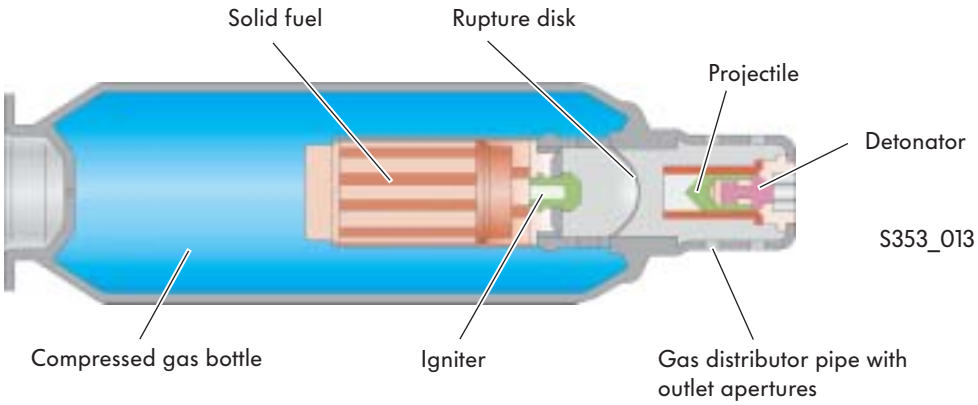
Function

- Igniter 2 is activated.
- Deployment of stage 2 occurs after deployment of the 1st stage.
- The gas which occurs flows through the metal filter into the airbag.

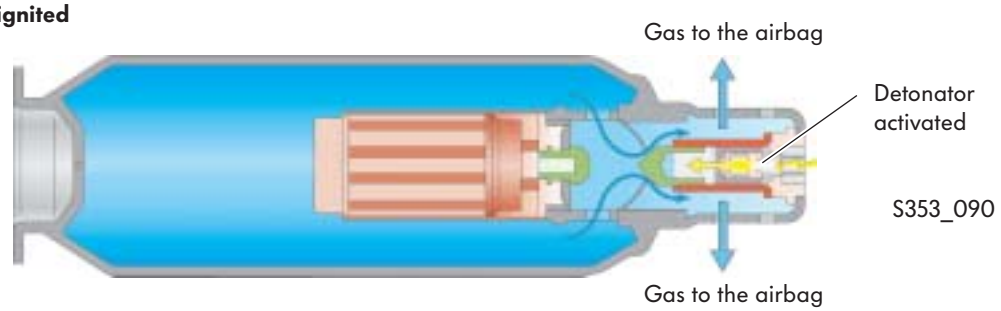
One-stage – hybrid (variant 1)

The one-stage hybrid gas generator consists of an ignition unit, a solid fuel charge and a compressed gas bottle.

Generator – not ignited



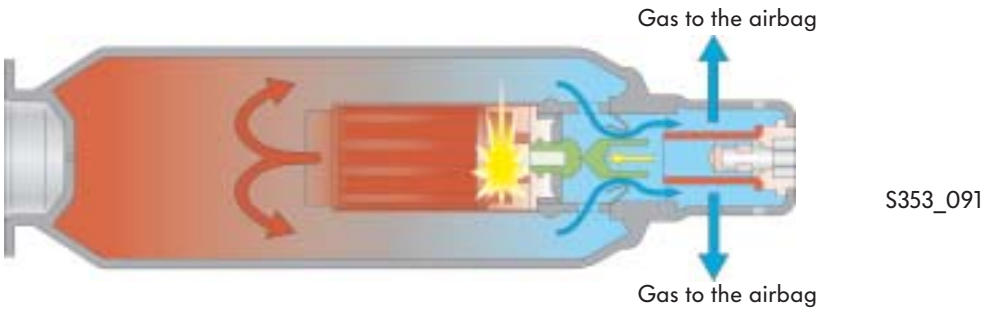
Generator – detonator ignited



Function

- The detonator is activated.
- The projectile is accelerated and breaks through the rupture disk; the pre-compressed, cold gas in the compressed gas bottle begins to escape.

Generator – gas generant ignited



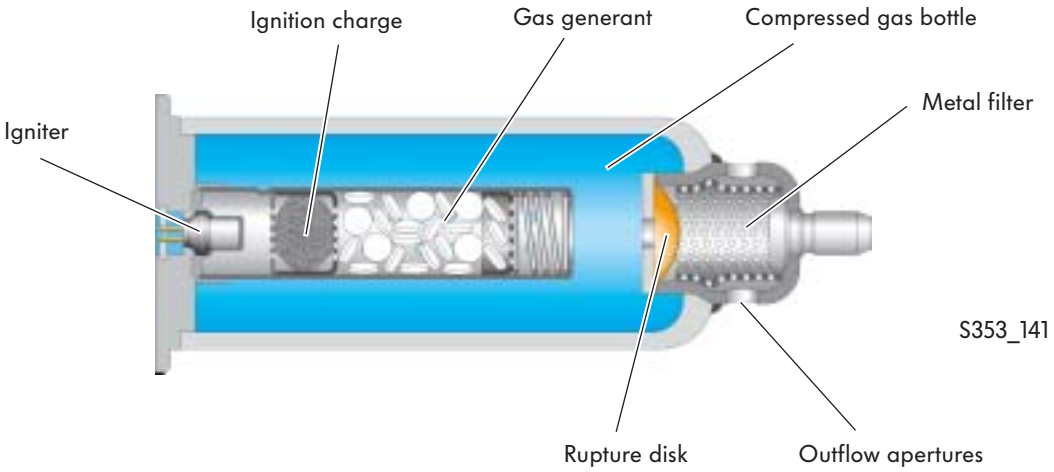
Function

- The projectile impacts onto the solid fuel charge igniter and ignites it.
- The gas mixture which occurs flows through the gas distributor tube and into the airbag.

One-stage – hybrid (variant 2)

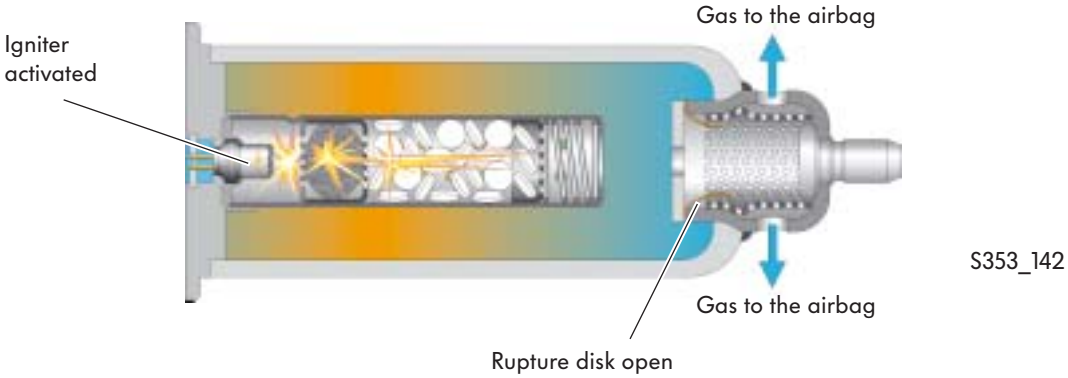
This one-stage hybrid gas generator consists of a compressed gas bottle in which an ignition unit is installed. This contains the igniter, the ignition charge and the actual gas generant.

Generator – not ignited



S353_141

Generator – ignited



S353_142

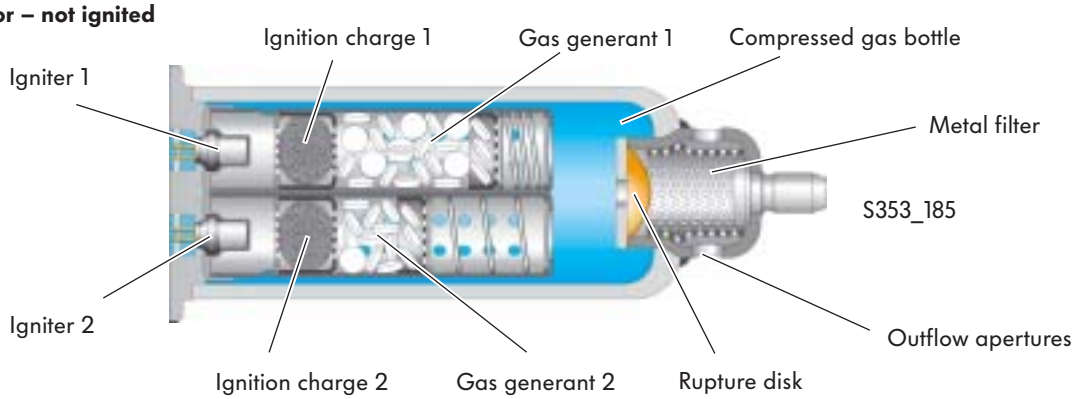
Function

- The igniter is activated.
- The ignition charge is ignited; this then ignites the gas generant.
- In the compressed gas bottle, the pressure increases until the rupture disk shatters.
- The gas which occurs flows through the metal filter into the airbag.

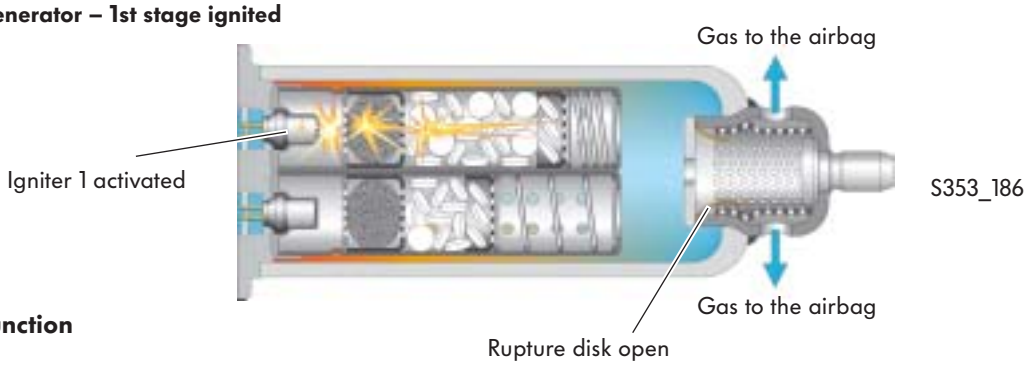
Two-stage – hybrid (variant 1)

The structure of this two-stage hybrid gas generator corresponds to that of the one-stage hybrid gas generator described above. However, the gas generator has a second stage, consisting of an igniter, ignition charge and gas generant.

Generator – not ignited



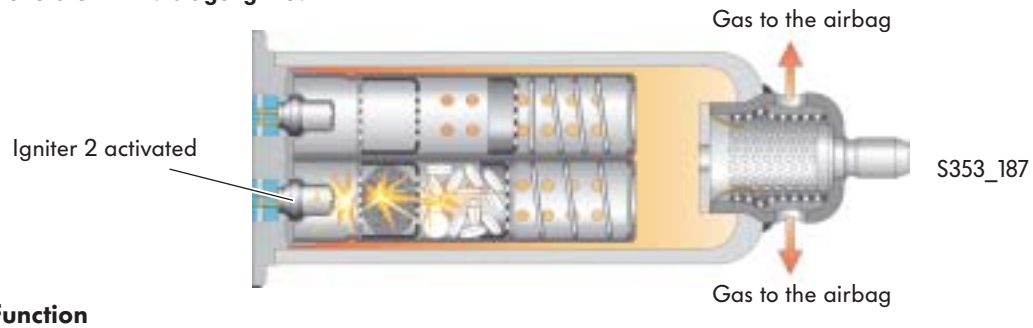
Generator – 1st stage ignited



Function

- Igniter 1 is activated.
- Ignition charge 1 is ignited; this then ignites gas generant 1.
- The gas which occurs causes the pressure in the compressed gas bottle to increase until the rupture disk shatters, and flows through the metal filter into the airbag.

Generator – 2nd stage ignited



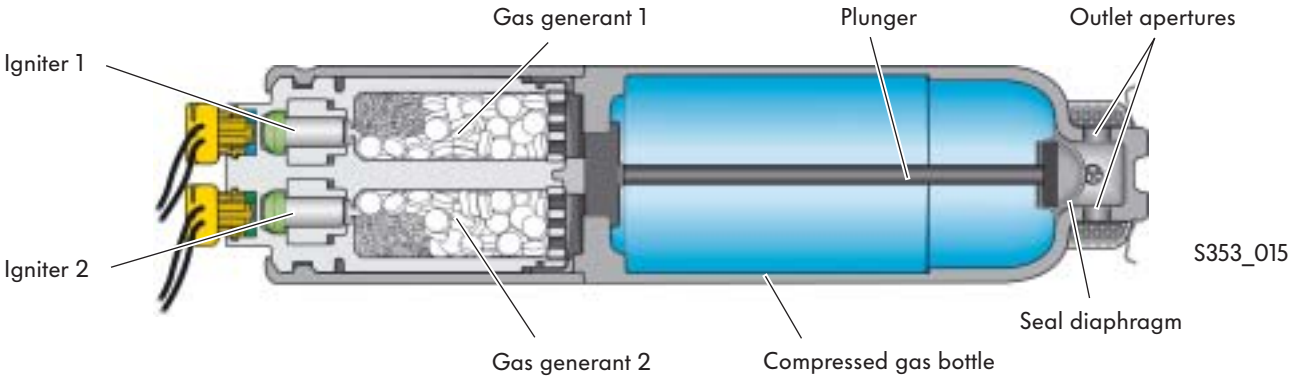
Function

- Igniter 2 is activated.
- The further procedure occurs after deployment of the 1st stage; the gas mixture flows into the airbag.

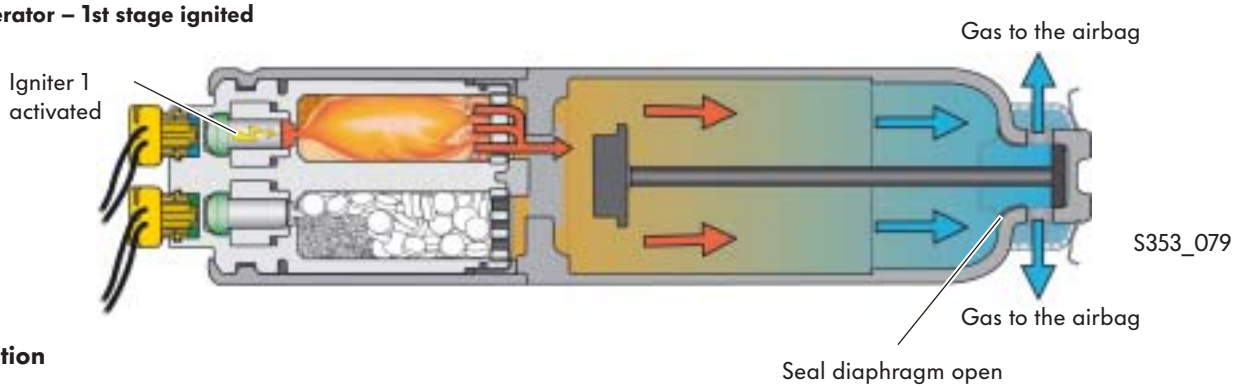
Two-stage – hybrid (variant 2)

The generator also has two separate solid fuel deployment stages. These are connected to a compressed gas bottle with integrated plunger system, in turn connected to a housing with outlet apertures for escaping airbag inflating gas.

Generator – not ignited



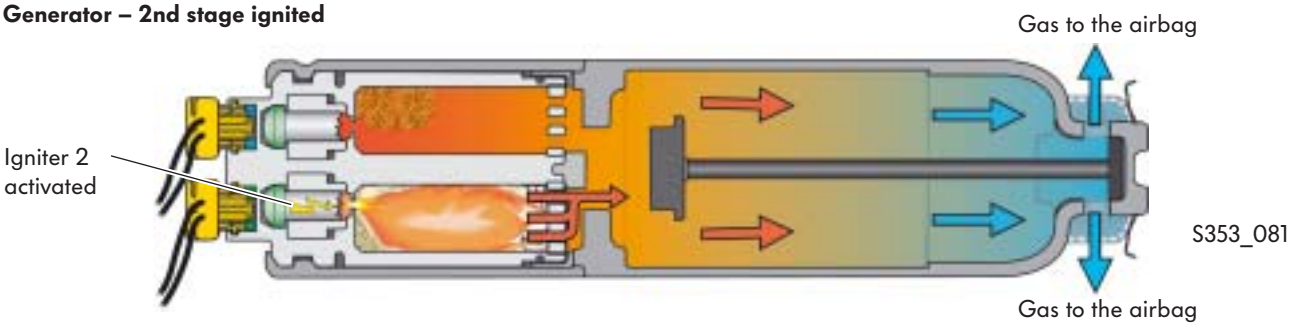
Generator – 1st stage ignited



Function

- Igniter 1 is activated and gas generant 1 is ignited.
- The gas which occurs moves a plunger, which opens the compressed gas bottle's seal diaphragm; the gas mixture continues to flow into the airbag.

Generator – 2nd stage ignited



Function

- Igniter 2 is activated.
- The further procedure occurs after deployment of the 1st stage; the gas mixture flows into the airbag.

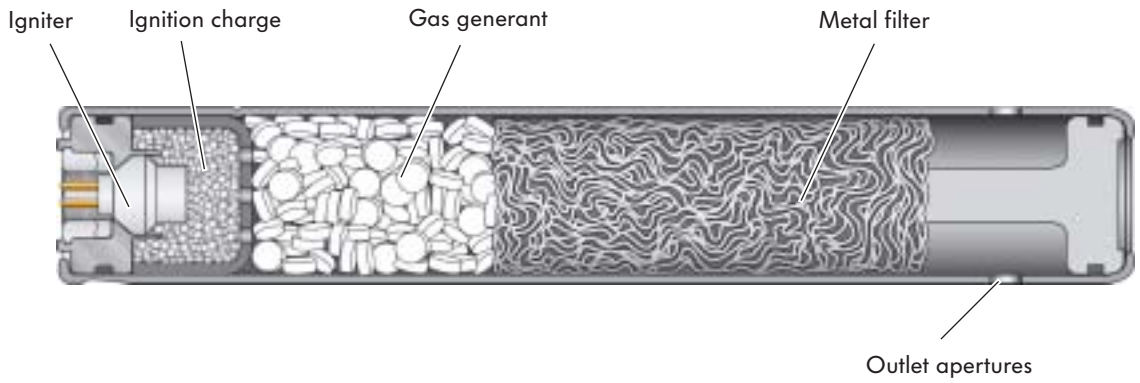
Gas generator for side airbag

Tubular gas generators are used for the front side airbags.

One-stage – solid fuel

The generator consists of a housing, into which an igniter, an ignition charge, the actual gas generant and a metal filter are integrated.

Generator – not ignited



S353_113

Generator – ignited

S353_134

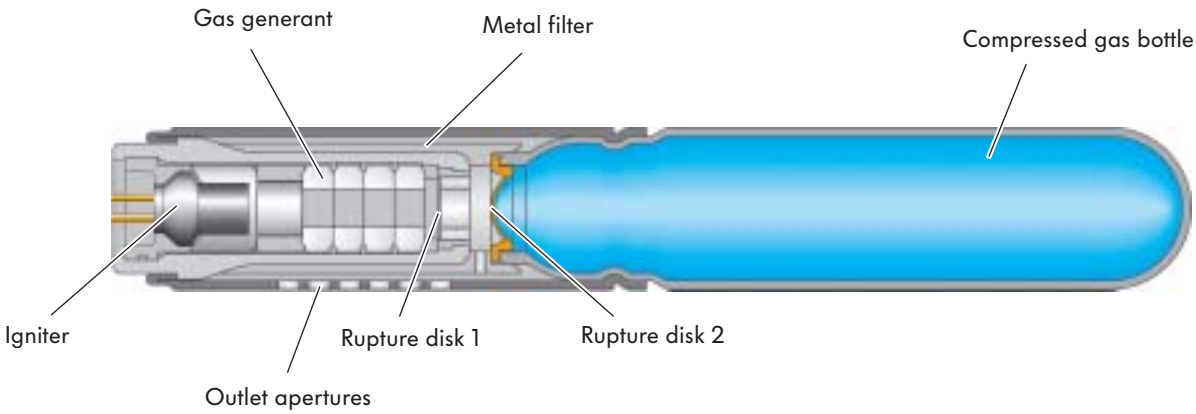
Function

- The igniter is activated.
- The ignition charge is ignited; this then ignites the gas generant.
- The gas which occurs flows through the metal filter into the airbag.

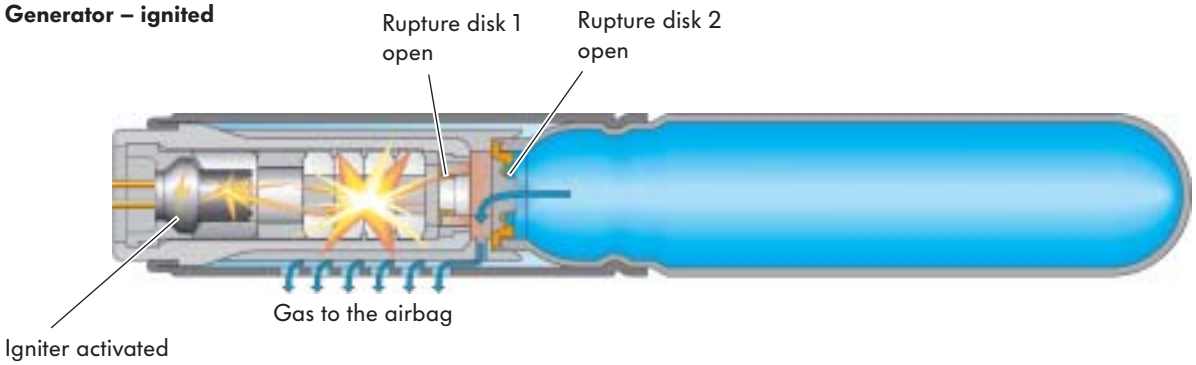
One-stage – hybrid

The generator consists of a housing with igniter, gas generant, metal filter and the axially flange-mounted compressed gas bottle.

Generator – not ignited



Generator – ignited



Function

- The igniter is activated and the gas generant is ignited.
- The gas which occurs breaks through the two rupture disks and mixes with the cold gas from the compressed gas bottle.
- The gas mixture flows out of the compressed gas bottle, through the metal filter and into the airbag.

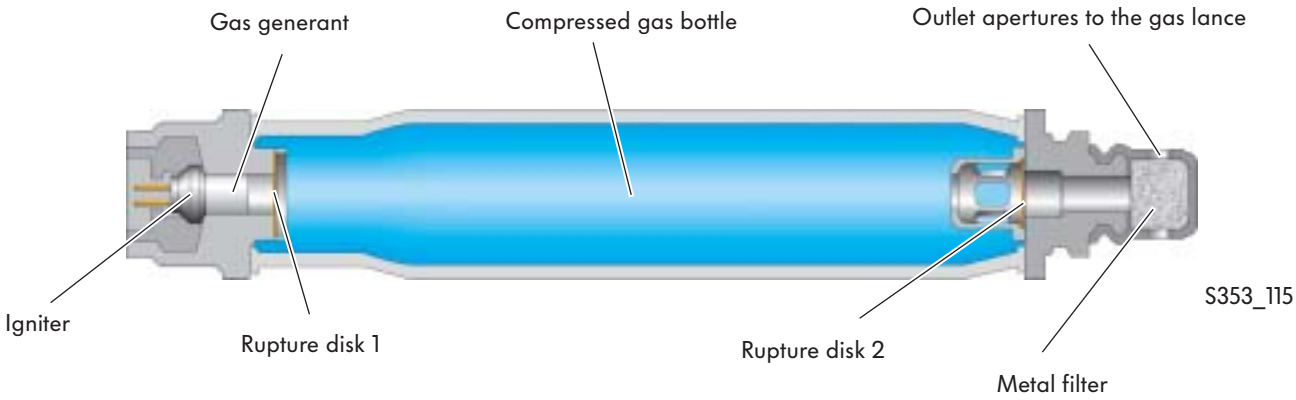
Gas generator for curtain airbag

Tubular gas generators are used for the curtain airbags.

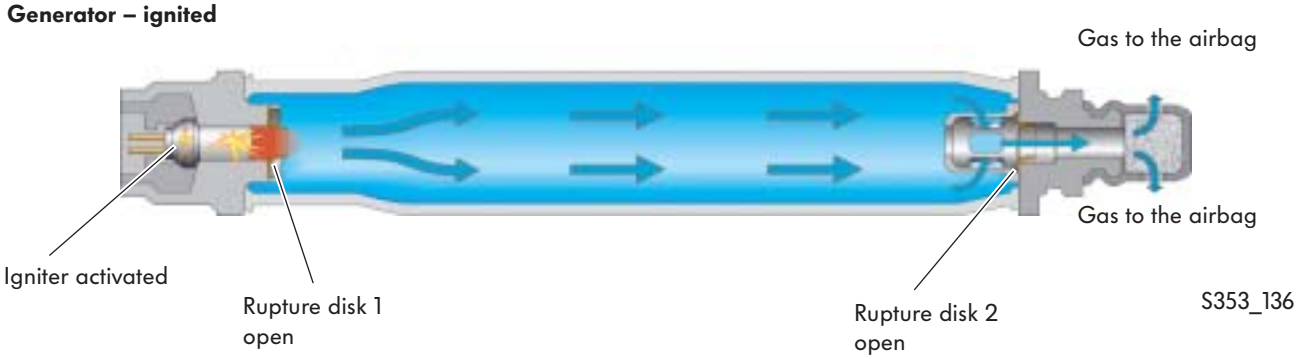
One-stage – hybrid (variant 1)

The generator consists of the compressed gas bottle, in which the igniter with gas generant is installed on one end and a metal filter with the outlet apertures to the gas lance is installed on the other side.

Generator – not ignited



Generator – ignited



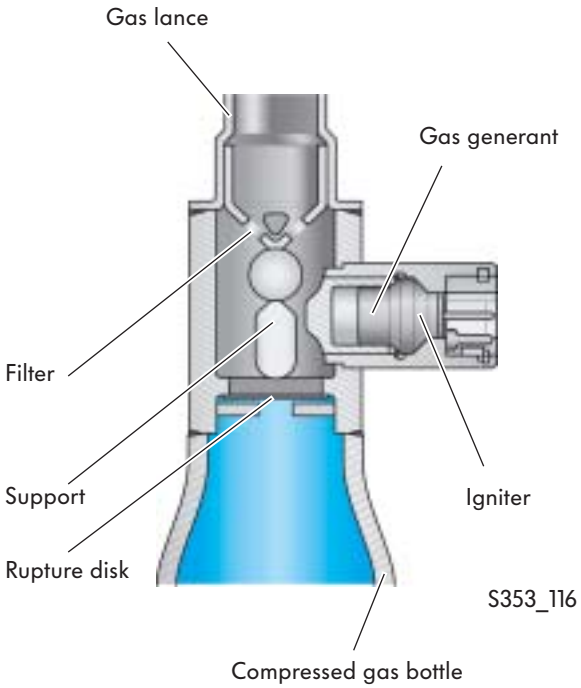
Function

- The igniter is activated and the gas generant is ignited.
- The gas which occurs breaks through rupture disk 1 and the pressure in the compressed gas bottle increases until rupture disk 2 breaks.
- The gas mixture now flows out of the compressed gas bottle, through the metal filter and into the airbag.

One-stage – hybrid (variant 2)

A design form in which the igniter is installed in the side of the generator is alternatively available.

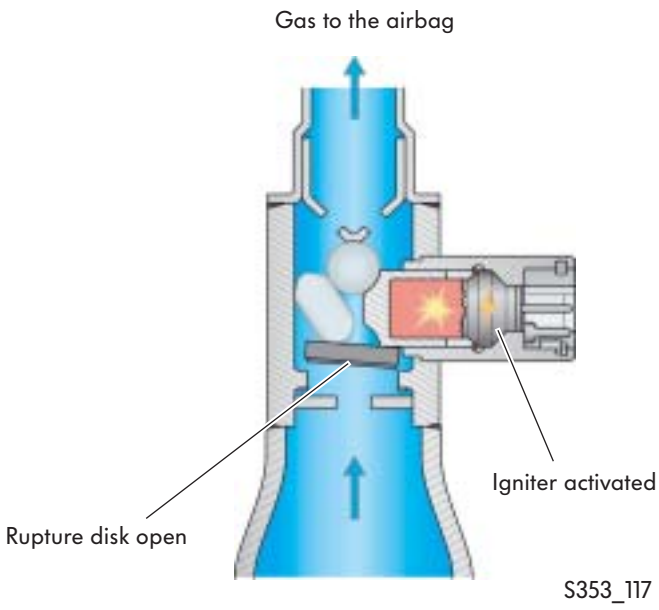
Generator – not ignited



Function

- The igniter is activated and the gas generant is ignited.
- As a result of this, the support is mechanically fired out from its seat.
- The cold gas which is stored in the compressed gas bottle now breaks through the rupture disk and flows through the filter into the airbag.

Generator – ignited



The seat belt pre-tensioners

Seat belt pre-tensioners tension the belt in the event of a crash in the seat belt's direction of tension. This reduces belt slack (play between the seat belt and body). The belt therefore prevents the occupant from moving forwards (relative to the movement of the vehicle) at an early stage.
A seat belt pre-tensioner is able to retract the seat belt by up to approx 130 mm within approx. 13 ms. If the counterforce acting on the seat belt is greater than the force of the seat belt pre-tensioner, seat belt pre-tensioning is ended.

According to the structure and principle of operation of the seat belt pre-tensioners, a distinction is made between:

- Cable-type seat belt pre-tensioners
- Ball-type seat belt pre-tensioners
- Wankel-type seat belt pre-tensioners
- Toothed rack-type seat belt pre-tensioners
- Strap-type seat belt pre-tensioners

These can be triggered both mechanically and electrically.

Depending on a vehicle's level of equipment, these are fitted either only in the front or also on the rear seats.

Mechanically triggered seat belt pre-tensioners

Cable-type seat belt pre-tensioners

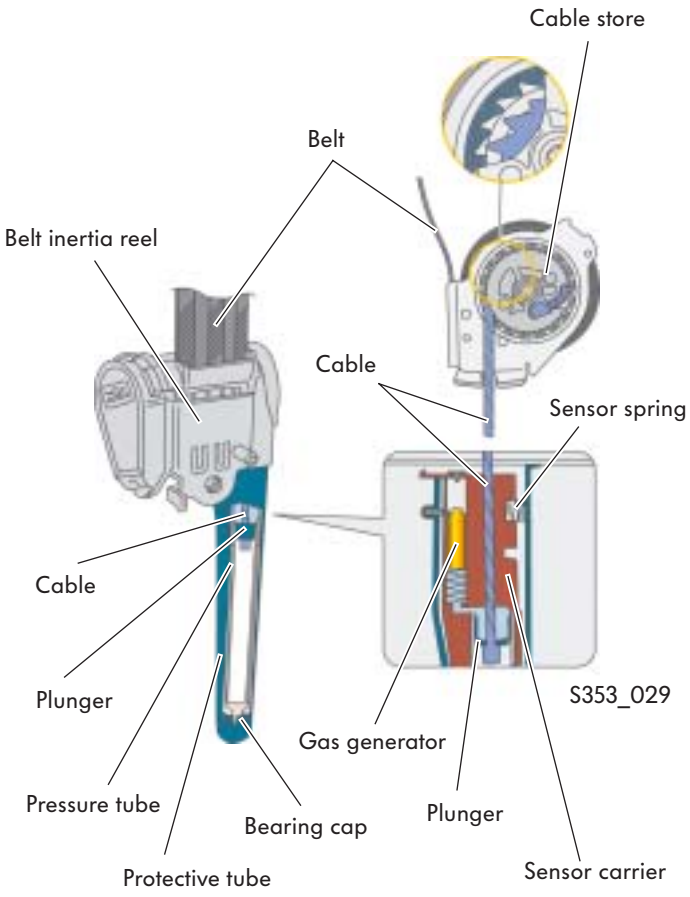
A mechanically triggered cable-type seat belt pre-tensioner is installed in the VW Polo up to YoM 1999, for example.

The system reacts mechanically at a specific deceleration value, and operates independently of the airbag control unit.

The seat belt pre-tensioner unit forms a module with the belt inertia reel. The system is mounted in a protective tube on a bearing cap, similar to a vertical pendulum. A cable is secured to a plunger. The cable is rolled up in a cable store above the protective tube.

The pre-tensioner unit consists of:

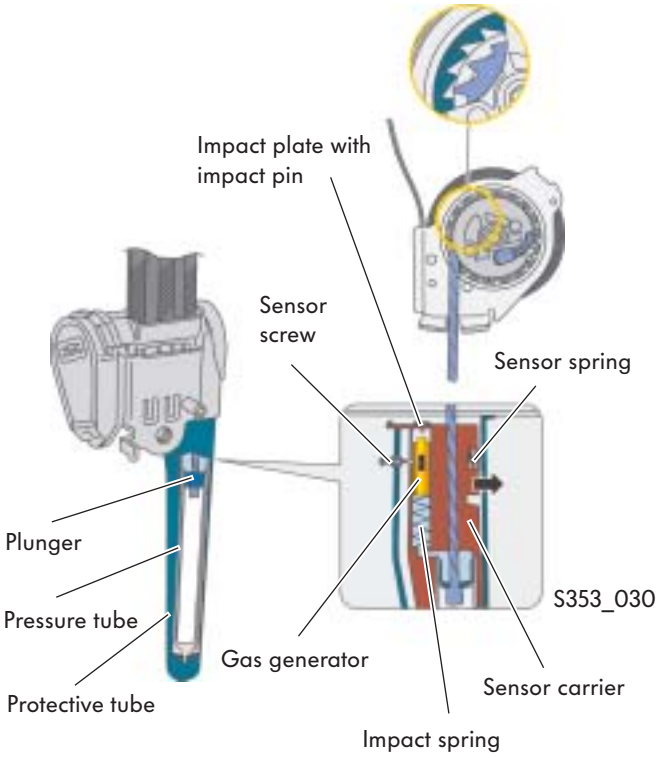
- The sensor system in the form of a spring mass system,
- A gas generator with pyrotechnical gas generant and
- A plunger with cable in the pressure tube.



Ignition:

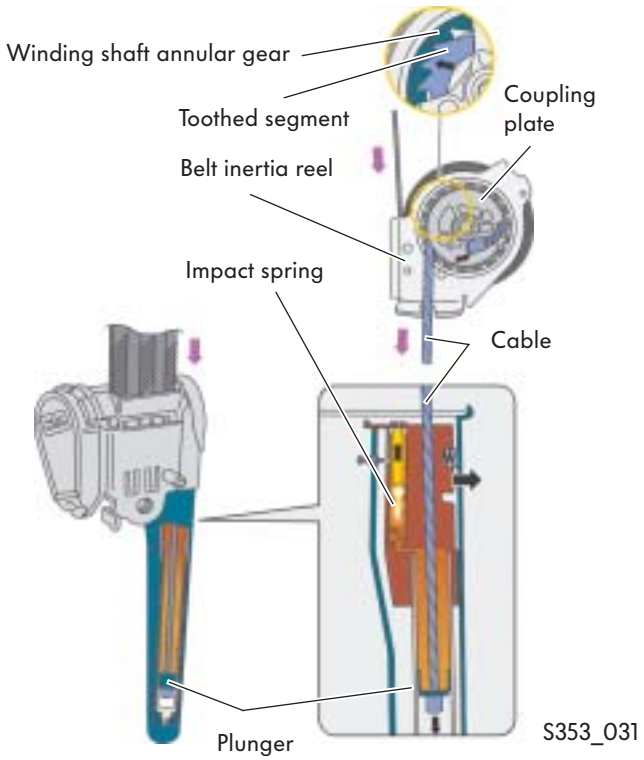
If vehicle deceleration exceeds a specific value in the event of a crash, the sensor mass begins to move counter to the sensor spring force. The sensor mass consists of the sensor carrier, the gas generator with the pyrotechnical gas generant, the impact spring, the plunger and the pressure tube.

If the sensor carrier has exceeded a specific travel on compression of the sensor spring, the gas generator, which is held by the sensor screw in its resting position, is vertically released. Due to the pre-tensioned impact spring, it is accelerated towards the impact pin in the impact plate. When the gas generator impacts onto the impact pin, the gas generator's gas generant is ignited.



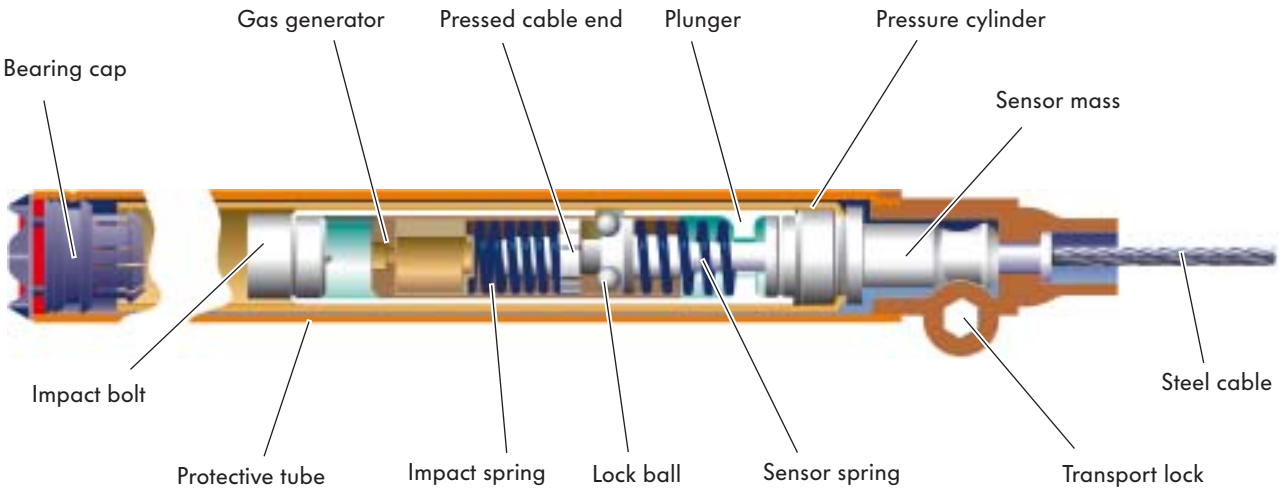
Tensioning:

The gas rapidly flows into the pressure tube and pushes the plunger down with the cable.
On initial movement of the cable, which is rolled up on the coupling plate, the toothed segment is shifted radially outwards from the coupling plate due to the acceleration force, and engages in the winding shaft's annular gear on the belt inertia reel.



Passive occupant protection systems

A further variant of a mechanically triggered cable-type seat belt pre-tensioner is installed e.g. in the VW Sharan.



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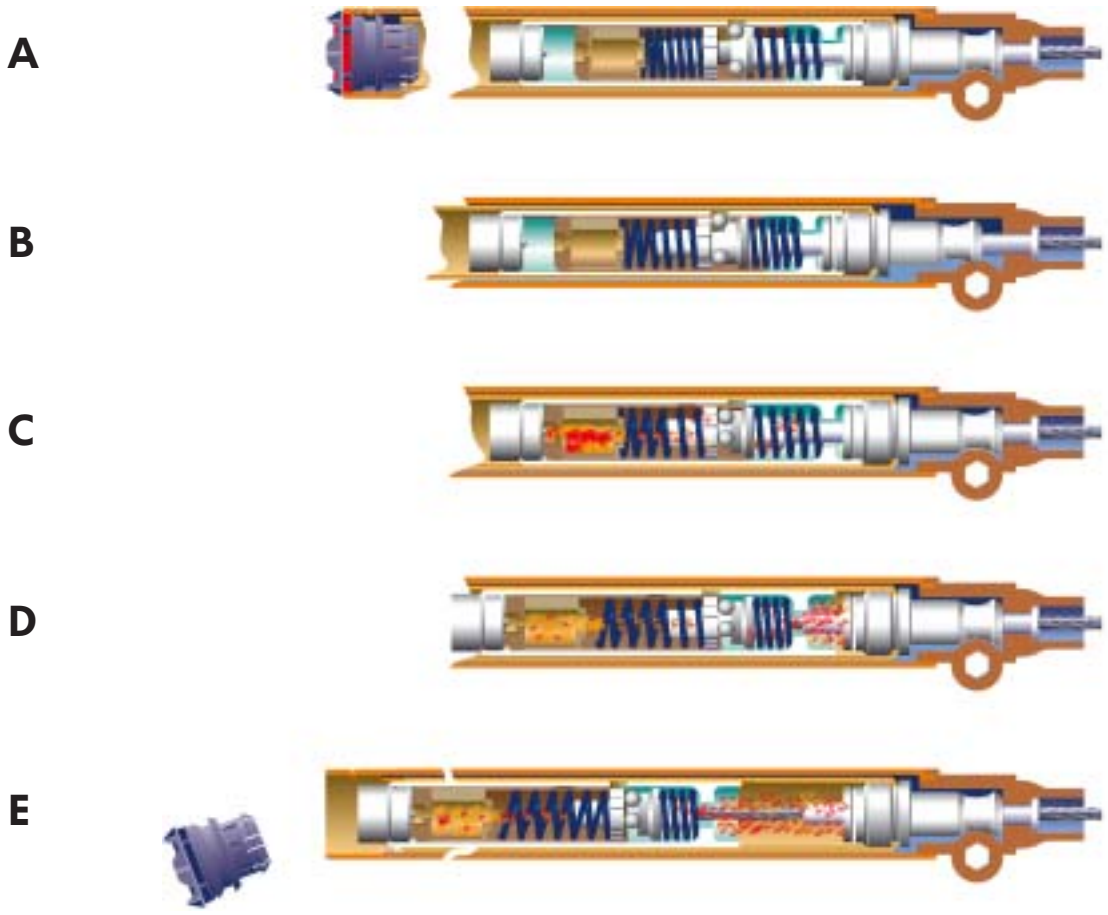
The system is connected to the inertia belt reel via a tensioning cable.

The mechanical sensor system and the pyrotechnical trigger are integrated into the trigger unit.
The sensor system operates mechanically at of a specific deceleration value, and operates independently of the airbag control unit.

Deployment steps



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Function

A The sensor unit, consisting of the sensor mass, pressure cylinder, plunger and gas generator, moves in the direction of travel until the lock balls engage radially past the sensor head.

B Due to the lock balls' radial engagement, the gas generator is released and accelerated towards the impact bolt with the pre-tensioned impact spring.

C When the gas generator impacts onto the impact bolt, the gas generant ignites.

D Due to the ensuing pressure, the plunger separates from the sensor mass.

E During the further course of expansion, the plunger carries the pressed cable end along and retracts the steel cable by up to max. 130 mm. The bearing cap is ejected.

Mechanically or electrically triggered seat belt pre-tensioners

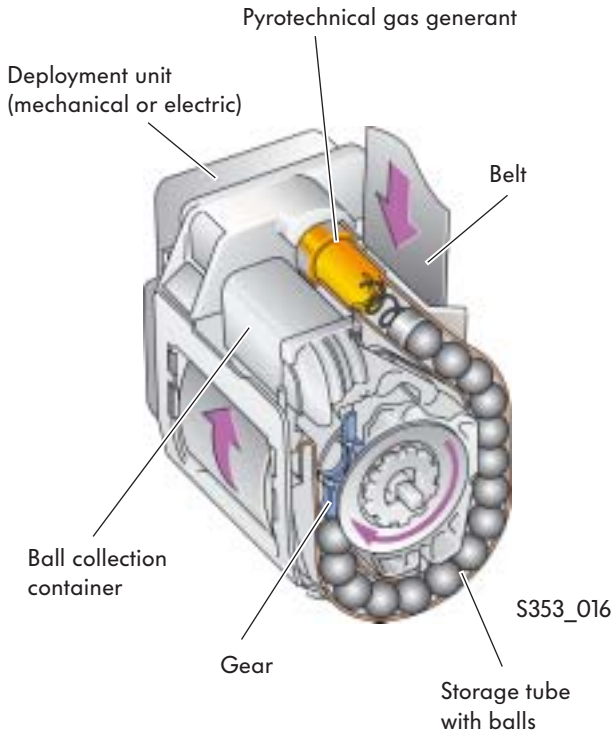
Ball-type seat belt pre-tensioners

Mechanically or electrically triggered ball-type seat belt pre-tensioners are used at Volkswagen.

The ball-type seat belt pre-tensioner consists of a compact unit, which encompasses the belt tension limiter in addition to seat belt fastened recognition facility.

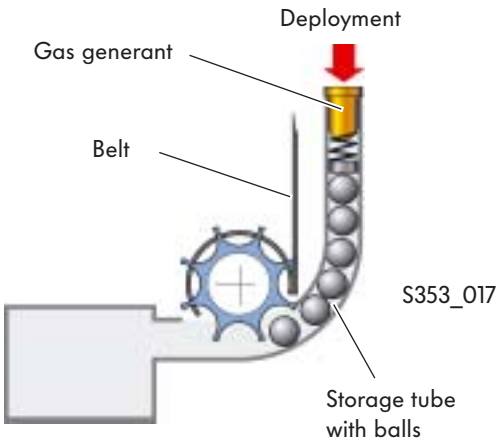
This seat belt pre-tensioner may be fitted on the front and rear seats.

Mechanical triggering only takes place if the seat belt fastened recognition facility has detected a fastened seat belt.

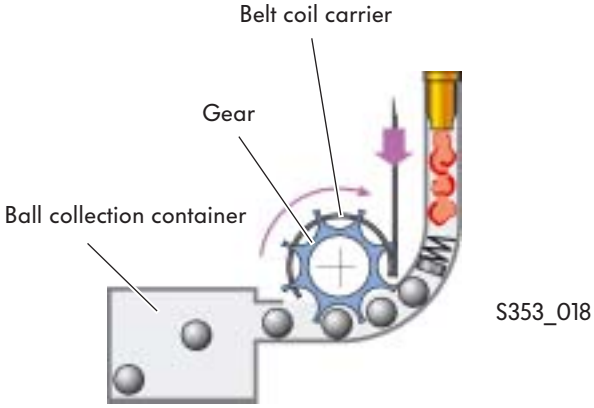


Function

The seat belt pre-tensioner is driven by balls. The balls are stored in a storage tube. In the event of a crash, the gas generant is ignited by a deployment unit. In the case of the electrically triggered seat belt pre-tensioner, the deployment unit is activated by the airbag control unit.



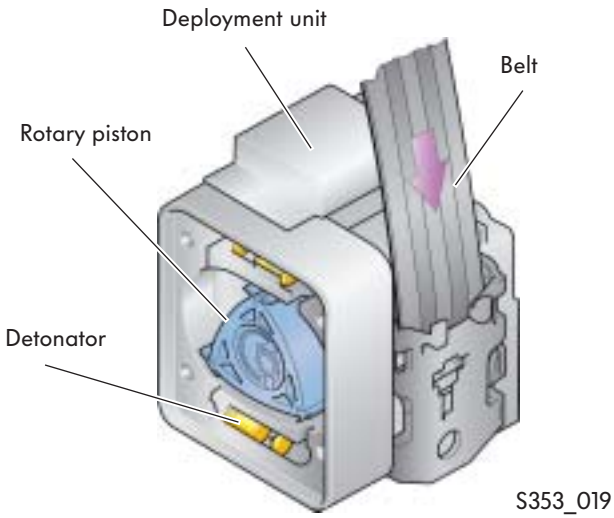
When the gas generant is ignited, the expanding gases set the balls in motion and drive them into the ball collection container via a gear.
As the belt coil carrier is firmly joined to the gear, it is also rotated by the balls and the seat belt is tensioned.



Wankel-type seat belt pre-tensioners

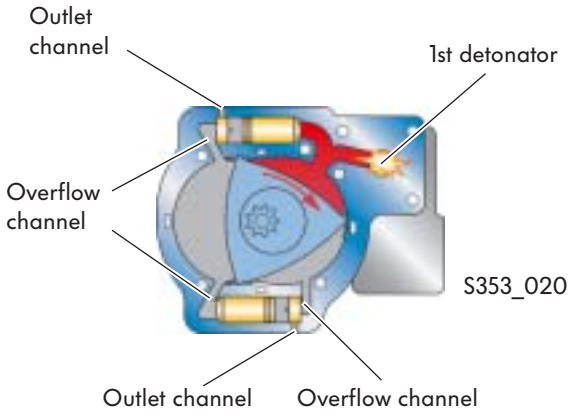
The Wankel-type seat belt pre-tensioner operates according to the rotary piston principle.

It is usually installed in the area of the rear seats.

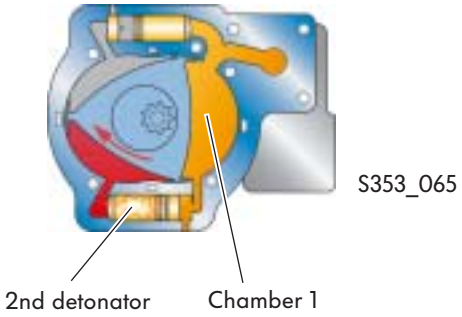


Function

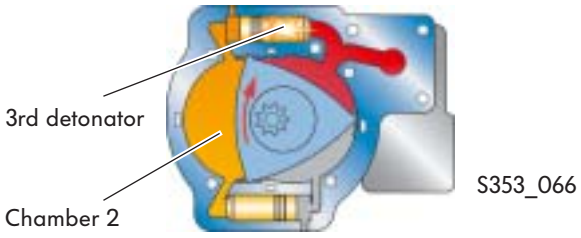
The 1st detonator is triggered mechanically or electrically. The expanding gas rotates the rotary piston. As the rotary piston is joined to the seat belt shaft, belt tensioning commences.



After reaching a certain angle of rotation, the rotary piston releases the overflow channel to the 2nd detonator. The working pressure in chamber 1 ignites the 2nd detonator. The rotary piston continues to be turned. The combusted gas from chamber 1 escapes via the outlet channel.



On reaching the 2nd overflow channel, the 3rd detonator is ignited due to the working pressure in chamber 2. The rotary piston continues to turn and the combusted gas from chamber 2 escapes via the outlet channel.



Electrically triggered seat belt pre-tensioners

Toothed rack-type seat belt pre-tensioners

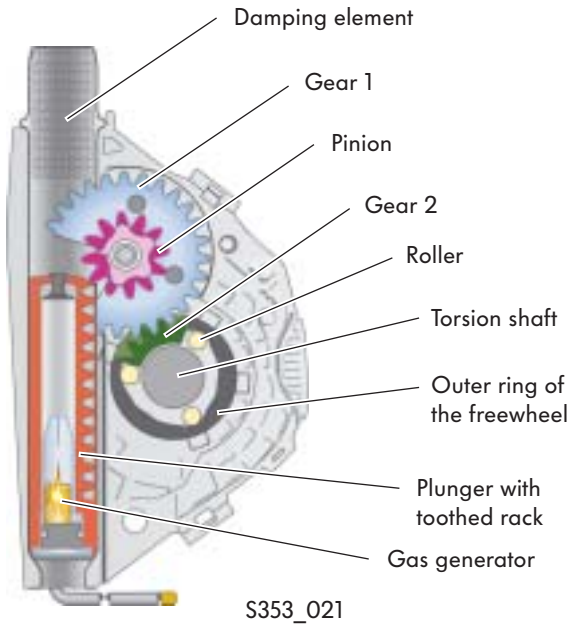
The toothed rack-type seat belt pre-tensioner forms a module with the belt inertia reel.

Toothed rack-type seat belt pre-tensioners are used for the driver and front passenger seats.

Function

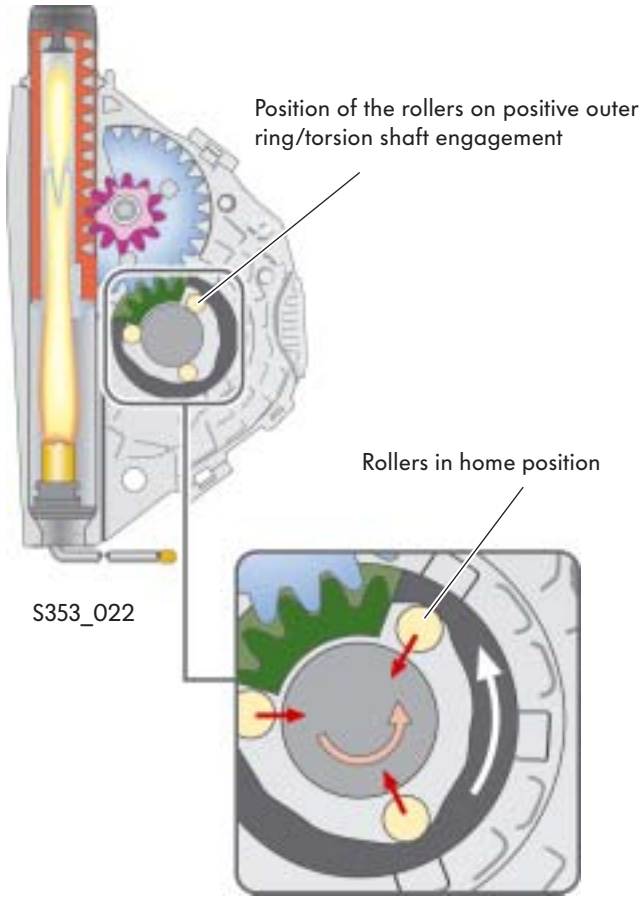
The signal from the airbag control unit ignites the gas generator's gas generant. The pressure which builds up causes the plunger, which is joined to the toothed rack, to move upwards. The toothed rack drives gears 1 and 2 via the pinion.

Start of deployment



Gear 2 is firmly joined to the outer ring of the freewheel for the torsion shaft. If this outer ring now rotates, the rollers are pressed inwards until they jam between the outer ring and the torsion shaft, thereby achieving positive engagement. The rotational movement is now transferred to the torsion shaft, and belt retraction begins.

End of deployment

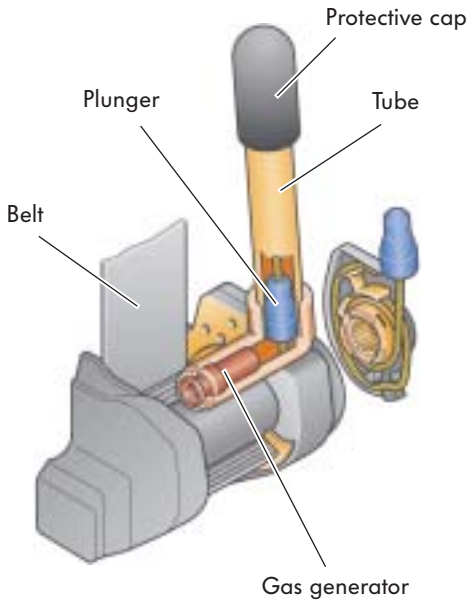


Cable-type seat belt pre-tensioners

The cable-type seat belt pre-tensioner forms a module with the belt inertia reel.

Cable-type seat belt pre-tensioners are used for the driver and front passenger seats.

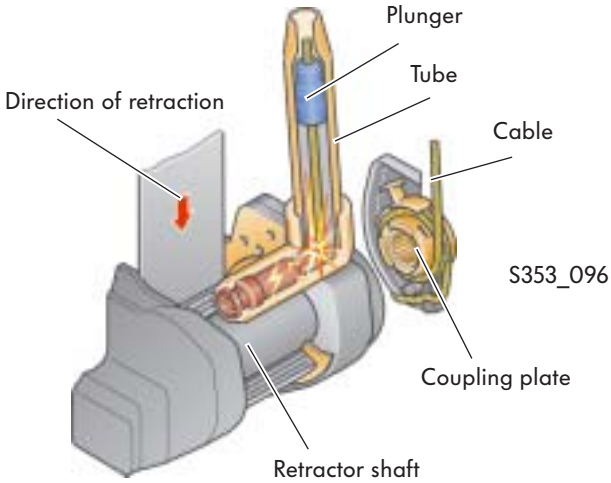
Not deployed



S353_095

Ignition of the gas generator leads to the creation of a gas mixture, which pushes the plunger with the attached cable upwards within a tube. Due to tensioning, the cable lies closely against the coupling plate connected to the retractor shaft and turns it in the direction of retraction.

Deployed



S353_096

Belt tension limiters

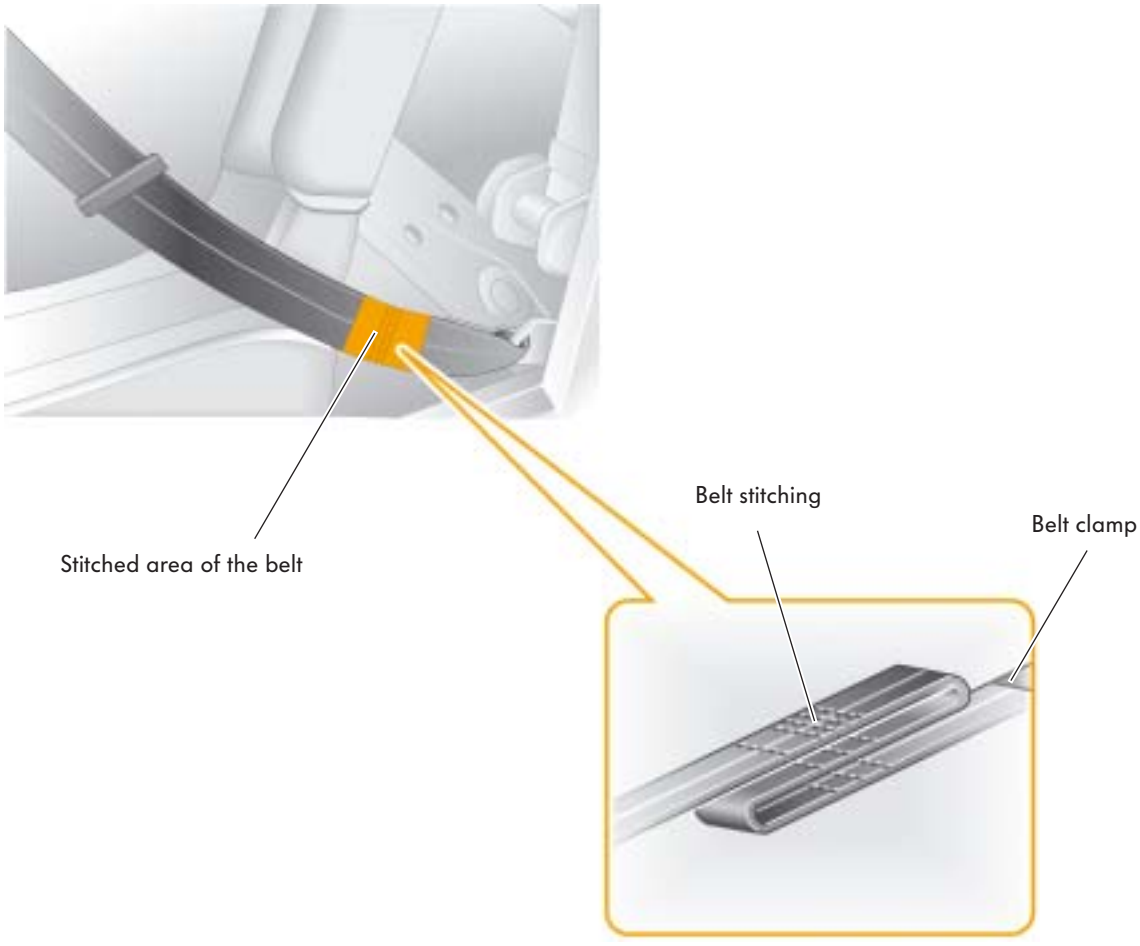
To prevent the loads which may act on the occupants in the event of an accident from becoming excessive, the belt inertia reels are equipped with belt tension limitation.

As of a certain load level, the belt tension limiter extends the belt slightly and allows the occupant to sink into the airbag, which has already inflated.

Belt stitched in the form of a loop

A very simple technical solution for limiting the belt force is a seat belt stitched in the form of a loop.

In the event of excessive tensile load, these seams tear open and the belt becomes longer. This reduces the tensile force and the load on the occupant.

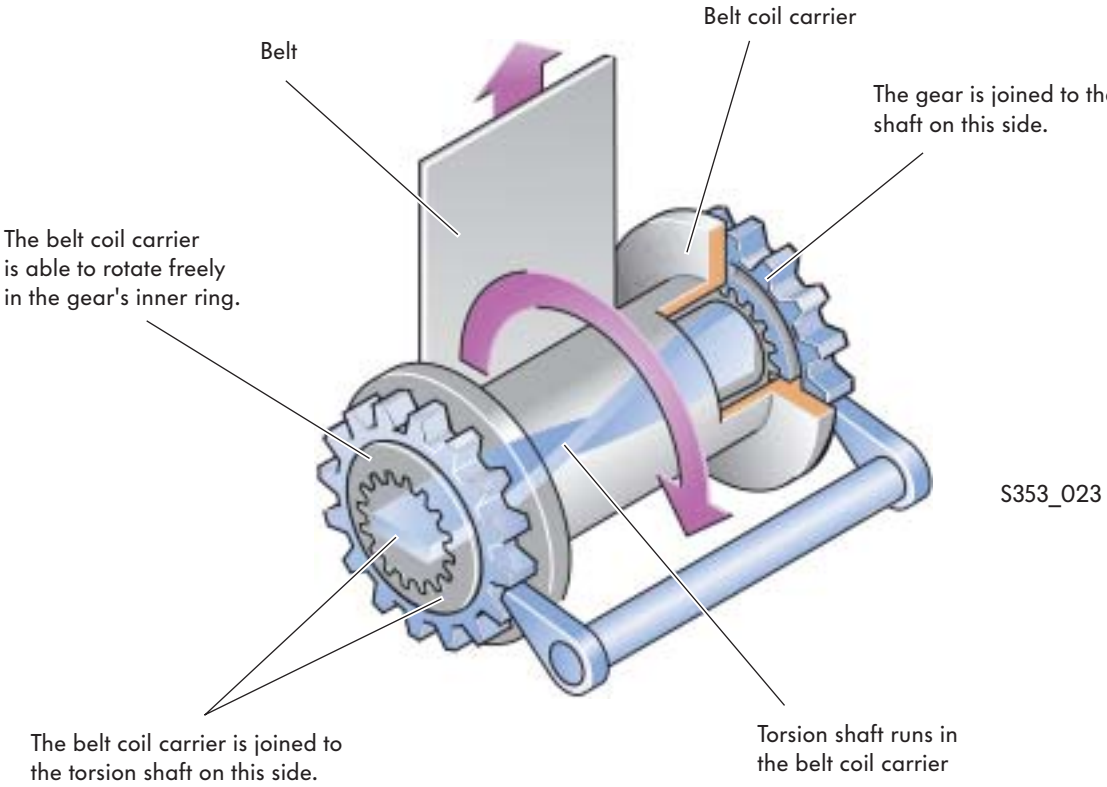


S353_082

Torsion limiter

This belt tension limiter is installed in both the ball-type seat belt pre-tensioner, the Wankel-type seat belt pre-tensioner, the strap-type seat belt pre-tensioner and the toothed rack-type seat belt pre-tensioner.

The belt's tensile load is limited by a torsion shaft in the belt coil carrier. Depending on the belt's tensile load, the torsion shaft is turned to a greater or lesser degree and therefore reduces peak loads.



Passive occupant protection systems

Head restraints

The front seats are designed in such a way that the likelihood of curvical spine injuries (e.g. whiplash) are reduced.

A distinction is made between active and passive systems in this case. In both systems, the risk of curvical spine injuries are reduced by reducing relative movement between the shoulder and head in the event of a rear impact.

In **passive** systems, the risk of curvical spine injuries are reduced by the specific design of the entire seat, the head restraint and the distance between the head and head restraint without moving parts.

In **active** systems, the head restraint is moved towards the occupant in the event of a rear impact.

Active head restraint

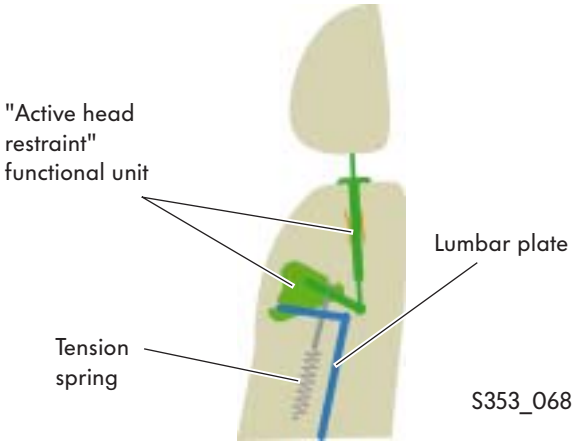
The active head restraint is a purely mechanical system, which shifts the head restraint forwards to the head in the event of a rear impact. This reduces relative acceleration between the shoulder and head during a crash.
The active head restraint system is a reusable system.

Function

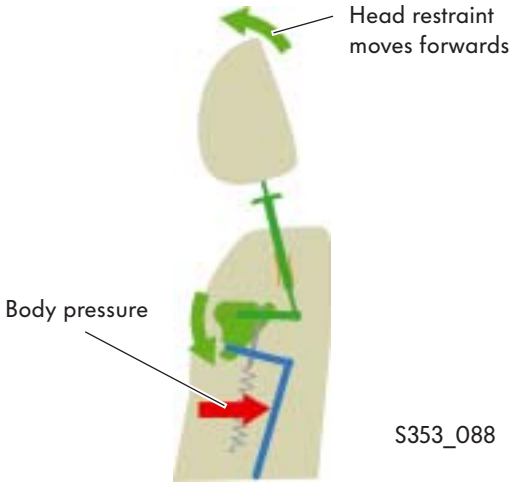
If an acceleration force acts on the rear end of the vehicle in the direction of travel, the vehicle's speed increases in relation to that of the occupants. This difference in speed is the result of the occupants' mass inertia. .

The occupants, who are pressed more intensively into the seat, increase the pressure on the lumbar plate in the seat backrest. The lumbar plate's movement is transmitted to the head restraint via a lever mechanism, and the head restraint is moved forwards to the head.
As soon as the body pressure is reduced, the system is returned to its initial position via the tension spring.

System not activated



System activated



Child seats

ISOFIX system

If vehicles are equipped with the ISOFIX system, separate child seats with ISOFIX brackets can be used. In this system, special brackets on the child seat are attached into the ISOFIX anchorage points in the vehicle. This connection securely holds the child seat in place.

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

S353_027

If child seats are to be used on the front passenger seat, the instructions in the owner's manual must be observed under all circumstances. Particular attention must be paid to deactivating the front passenger airbag when using child seats which face backwards.

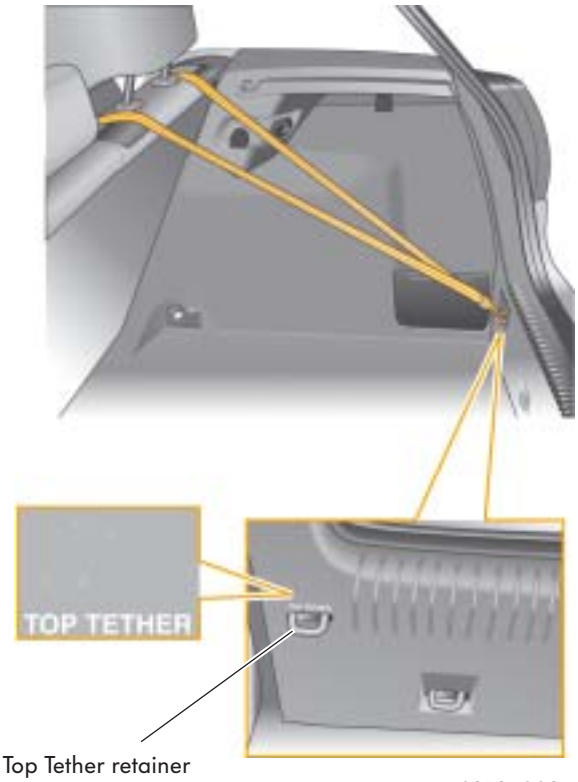
ISOFIX with Top Tether

In certain vehicle models, child seats with the ISOFIX system and an additional, upper retaining belt can also be used. This upper retaining belt is also called "Top Tether".

The additional, upper belt secures the child seat better. The child seat is thereby held against the seat backrest and prevented from tipping forwards.

The design may differ depending on the vehicle model. The illustration shows a Top Tether system in the VW Golf as of model 04.

The upper retaining belt is attached to the child seat's two upper retainers. The other end of the belt is attached to a retainer, specifically intended for this purpose, on the rear wall of the luggage compartment.
The eye is identified with the Top Tether symbol.



Top Tether retainer

S353_092

Integrated child seats

Depending on equipment, certain vehicle models may be fitted with integrated child seats for the two outer seats on the rear seat bench. These seats are suitable for children aged between 3 and 12 years.
Thanks to their fixed installation in the vehicle seat, together with a correctly worn seat belt, integrated child seats offer children very good protection in the event of a crash.

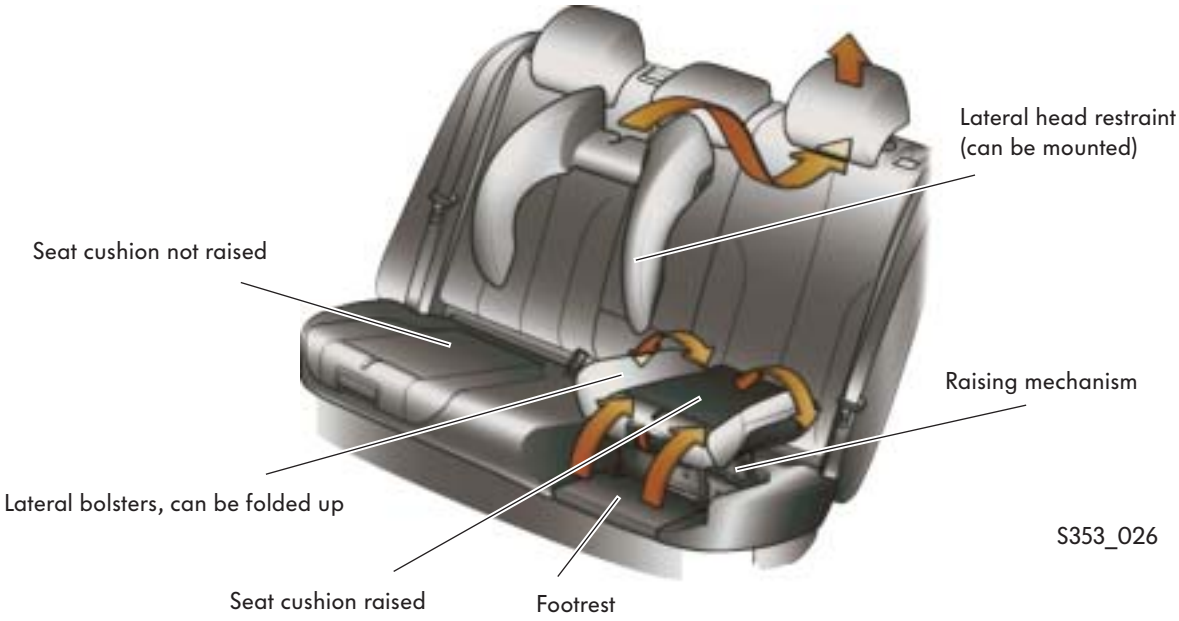
Integrated child seat in the rear seat bench

In addition to conversion to a normal seat (for adults), the child seat's raising mechanism also enables space-saving transportation of the child seat.

Folding the seat cushion up raises the height of the seat. The side bolsters have to be folded up manually. When the seat cushion is folded down, the side bolsters automatically return to their original position.

To prevent children's heads from falling to the side whilst sleeping, a lateral head restraint can be mounted beneath the head restraint on the rear seat bench, offering the body additional support.

S353_025



S353_026

Integrated child seat in the individual seat

In the VW Multivan, the integrated child seat is only available for the individual seat. A maximum of four individual seats with integrated child seat are possible per vehicle. The child seat fitted in the Multivan is suitable for children aged 9 months and over. To achieve this, a five-point seat belt system specifically optimised for young children is secured to the seat, guaranteeing secure and comfortable restraint.

The child seat can be optimally adapted to any age level, from 9 months to adult.

S353_203

The following child seat settings are possible:

A – Child seat with armrests folded down, adjusted for an adult

B – Child seat with lateral head restraint

C – Child seat with seat cushion folded up and lateral head restraint

D – Child seat with seat cushion folded up, lateral head restraint and folded-down auxiliary seat cushion with five-point seat belt system

S353_204

Passive occupant protection systems

Roll-over protection

Due to their open-topped design, cabriolets are equipped with special elements which help to protect occupants in the event of accidents.
This specifically includes the roll-over protection system.

When deployed, the roll-over protection system creates a protective zone for the occupants in combination with
the A-pillars.

The roll-over protection system will be described using the New Beetle cabriolet as an example.

S353_106

The airbag control unit contains a sensor for detecting the vehicle's imminent rolling over. Together with other sensors installed in the control unit, the accident severity is determined and the roll-over protection and seat belt pre-tensioners are deployed.

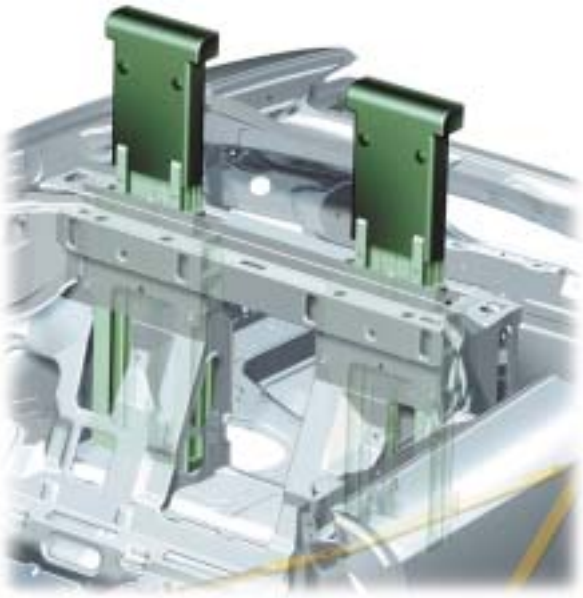
As soon as a seat belt pre-tensioner or airbag is triggered, the roll-over protection system is also deployed as a precaution in the event of a frontal, lateral or rear impact with high accident severity.

Function

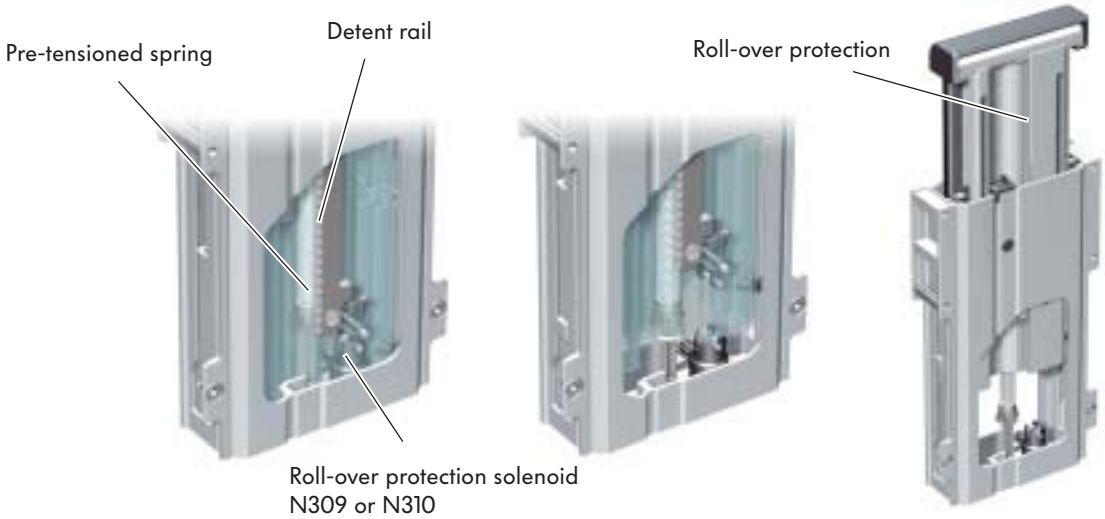
When de-energised, the roll-over protections are held in their lower position with a hook lever via the roll-over protection solenoids N309 and N310.

If the airbag control unit J234 detects a crash or the vehicle's imminent rolling over, the roll-over protection solenoids N309 and N310 release the roll-over system.

Overall roll-over protection system – in initial position



S353_032



S353_033

The pre-tensioned spring extends the roll-over protection within approx. 0.25 seconds, and the detent rail holds them in this position. After extending by just 80 mm, the roll-over protection can no longer be pushed back due to the detent rail.

An active roll-over protection can be mechanically released and returned to its initial position.

Battery cut-off elements

If the starter battery is installed in the vehicle's interior or luggage compartment, a battery cut-off element may be fitted. The task of this cut-off element is to interrupt the cable from the starter battery to the starter and alternator. If the cable to the starter and alternator short-circuits in the event of an accident, possible vehicle fires are avoided via this cut-off.

If an airbag is triggered during an accident, the battery cut-off element is also automatically activated. In a rear crash, the battery cut-off element is activated along with seat belt pre-tensioner deployment.

The following components are used as battery cut-off elements:

- Battery isolation igniter N253 in the battery safety terminal
- Battery cut-off relay J655 (with battery master/isolator switch E74)

Battery isolation igniter N253 (variant 1)

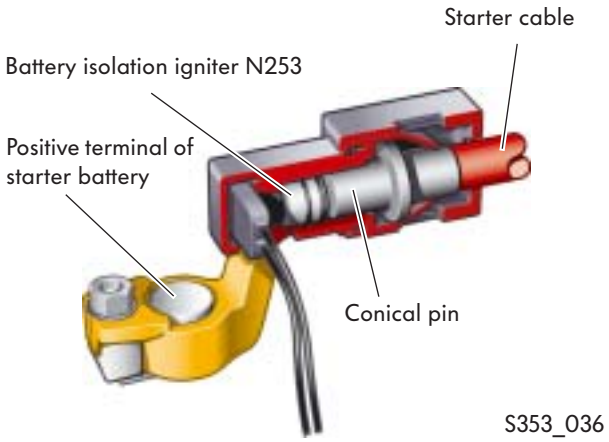
Battery safety terminals with an integrated battery isolation igniter N253 are installed in the Lupo 3L and the Phaeton.

This pyrotechnical component helps to interrupt the cable between the starter battery and the starter.

Function

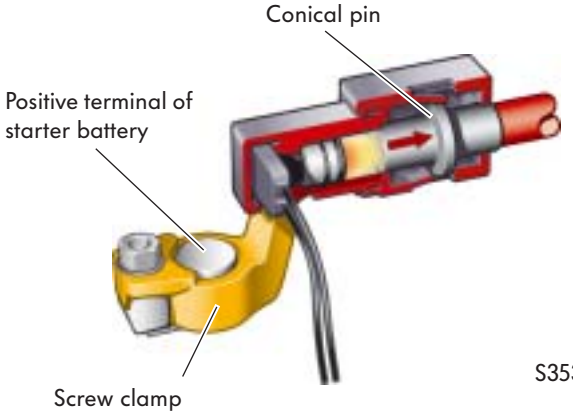
The battery safety terminal is secured directly on the positive terminal of the starter battery with a screw clamp. Ignition of the gas generant in the battery isolation igniter N253 and the resulting gases cause the conical pin to be pushed out from its initial position in the direction of the arrow.

Initial position



S353_036

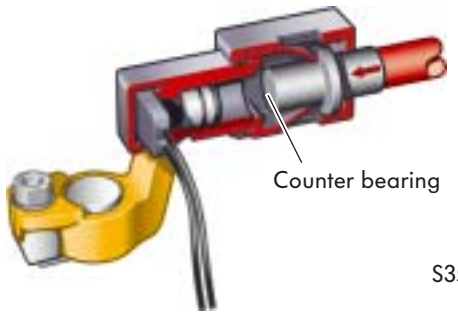
Ignition



S353_037

After the conical pin has been moved due to the expansion of the gas, it is prevented from returning to its position by a counter bearing. The electrical connection between the starter battery and the starter therefore remains interrupted.

Final position

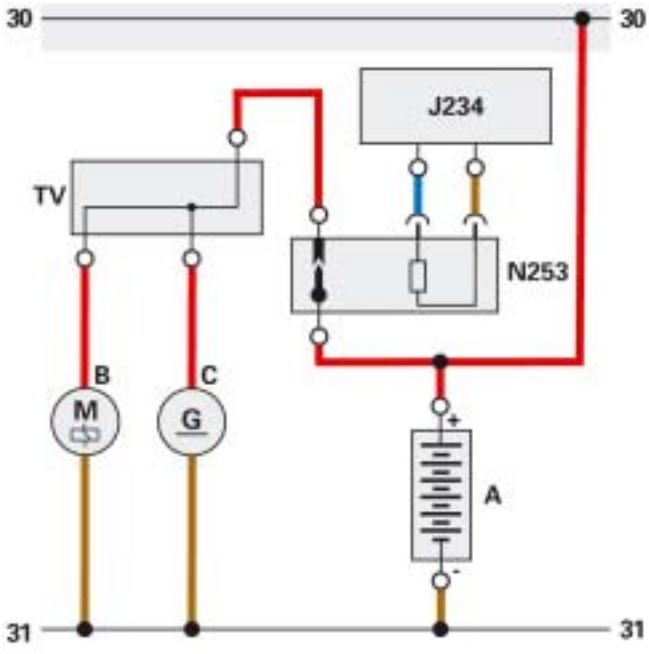


S353_039

The battery safety terminal with battery isolation igniter N253 receives an ignition signal from the airbag control unit J234. This signal is transmitted via a direct line from the airbag control unit J234 to the battery isolation igniter N253. As a result of this, the alternator's and starter's connection to the starter battery is interrupted.

A - Starter battery
B - Starter
C - Alternator

J234 - Airbag control unit
N253 - Battery isolation igniter
TV - Junction box

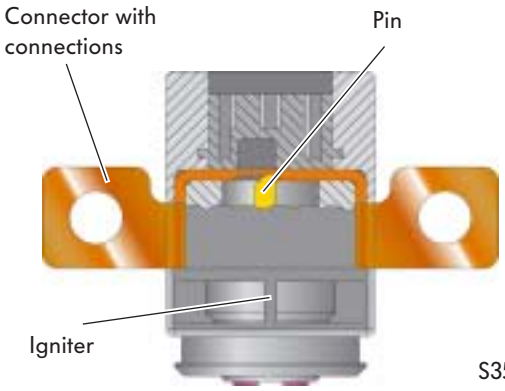


S353_120

Battery isolation igniter N253 (2nd variant)

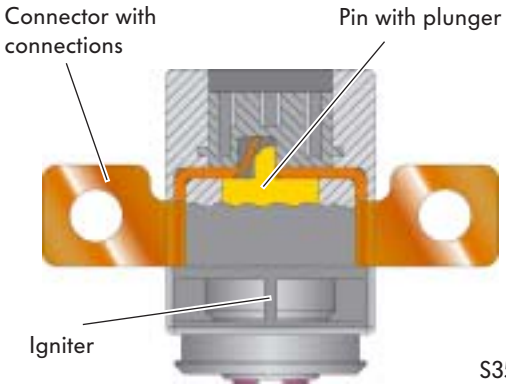
A further pyrotechnical component with which the cable between the starter battery and the starter can be separated exists in addition to the battery safety terminal.
Unlike the battery safety terminal, this component is based on interrupting a connector between the starter battery and starter connections. The battery isolation igniter N253 is installed in a separate plastic housing in the vicinity of the starter battery.

Initial position



S353_122

Final position



S353_123

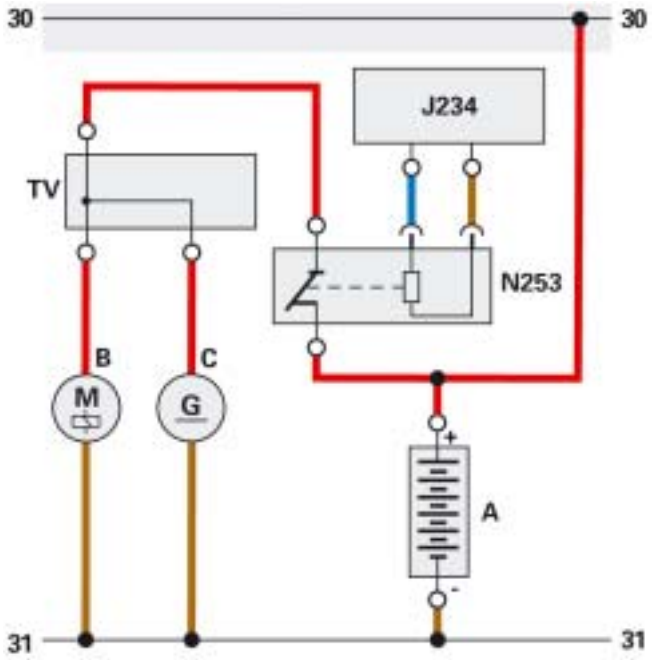
Function

The ignition of a gas generant leads to combustion within the battery isolation igniter N253. The resulting gases move the plunger with pin in such a way that the contact between the starter battery and starter connections is interrupted.

The battery isolation igniter N253 receives an ignition signal directly from the airbag control unit J234.
As a result of this, the alternator's and starter's connection to the starter battery is interrupted.

A - Starter battery
B - Starter
C - Alternator

J234 - Airbag control unit
N253 - Battery isolation igniter
TV - Junction box

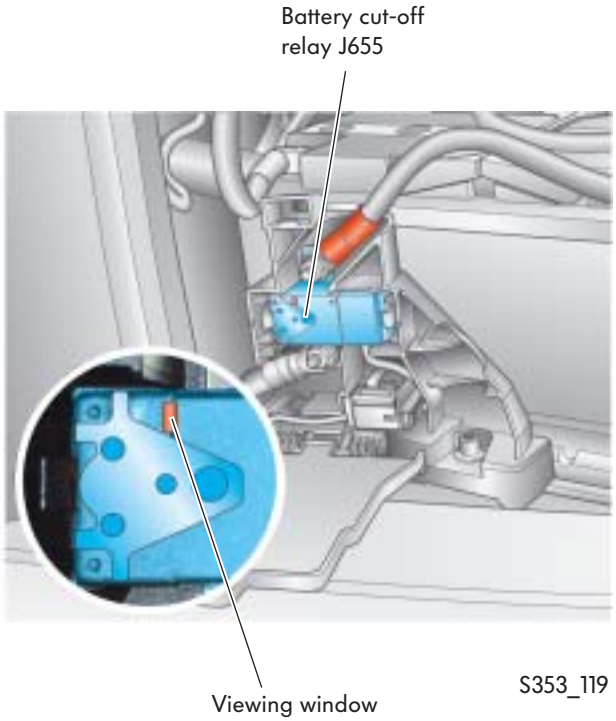


S353_121

Battery cut-off relay J655

The battery cut-off relay J655 is a further component with which the cable between the starter battery and the starter can be separated. The battery master/ isolator switch E74 is additionally integrated into the battery cut-off relay.

An activated battery cut-off relay J655 can be recognised via the viewing window. In the case of an interrupted cable, a white cover can be seen in the viewing window instead of a copper coil. The battery cut-off relay J655 must be renewed in this case.

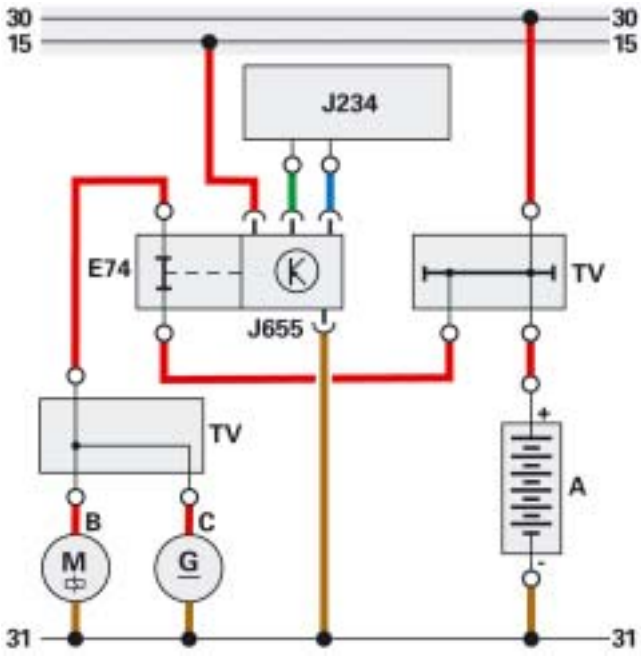


S353_119

The battery cut-off relay is triggered by the airbag control unit J234. In addition to actuation, the airbag control unit J234 also undertakes diagnostic monitoring and stores faults which have occurred.

A - Starter battery
B - Starter
C - Alternator

E74 - Battery master/isolator switch
J234 - Airbag control unit
J655 - Battery cut-off relay
TV - Junction box



S353_118

When deployed, battery cut-off elements and the battery cut-off relay J655, with and without reset button, must always be renewed. More detailed information can be found in the workshop manual applicable to the vehicle in ElsaWin.

System management

Airbag control unit J234

The electronics integrated into the airbag control unit J234 have the task of recording vehicle deceleration and vehicle acceleration and of recognising whether protection system deployment is necessary.
External sensors are also used to record vehicle deceleration and vehicle acceleration during an accident in addition to the internal sensors in the airbag control unit J234. Only once the information from all sensors has been evaluated do the electronics in the airbag control unit J234 decide whether and when the safety components are activated. Depending on the type and severity of the accident, only the seat belt pre-tensioners or the seat belt pre-tensioners and airbags, for example, are deployed.

The electronics in the airbag control unit J234 have the following main tasks:

- Crash detection (front, side, rear, roll-over*)
- Defined deployment of the seat belt pre-tensioners, airbags, battery cut-off and roll-over mechanisms*
- Seat belt warning (request to put on seat belts)
- Evaluation of all input information
- Permanent monitoring of the entire airbag system

* for cabriolet

- Storage of faults and information on deployed protection systems
- Fault indication via airbag readiness indicator lamp
- Independent energy supply via capacitor for a defined period of time of approx. 150 ms
- Notification of a crash event to other system components via drive CAN or discrete crash output (wired conventionally)

The steps required to renew an airbag control unit J234 can be found in the workshop manual applicable to the vehicle (ElsaWin) or in "Guided Fault Finding" or "Guided Functions".

Data exchange

The airbag control unit J234 is integrated into the drive CAN.

The airbag control unit transmits the following information on the drive CAN:

- Airbag warning lamp K75 on/off
- Seat belt warning on/off
- Diagnostic data
- Crash signal
- Crash information for the final control test
- ESP data
- Front passenger airbag on/off status

Amongst other purposes, the information that a crash has taken place is used by other control units to release the central locking system, if locked, shut off the fuel supply and activate the hazard warning lights.

Airbag warning lamp K75

The airbag warning lamp K75 indicates the functional readiness of the entire airbag system, as determined by the airbag control unit J234. A malfunction is indicated by constant illumination of the airbag warning lamp K75. In more recent models, actuation is carried out via the CAN bus. If the data message from the airbag control unit J234 is missing, the warning lamp is automatically switched on by the control unit in the dash panel insert J285.

S353_153

Crash sensors

Internal sensors in the airbag control unit J234

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

Airbag control unit J234 – housing sealed

S353_157

Crash sensor

The crash sensor is an acceleration sensor in the control unit; it records deceleration and acceleration in both the vehicle longitudinal axis (x axis) and the vehicle transverse axis (y axis).

Safety switch

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

This sensor also records vehicle deceleration and acceleration in the direction of travel (x axis) and informs the control unit electronics of this for plausibility checks.

Airbag control unit J234 – housing open

S353_158

Roll-over sensor

A sensor for detecting roll-over may additionally be installed in the control unit, e.g. in a cabriolet.

External sensors

External sensors are also used in addition to the internal sensors in the airbag control unit J234.

The following external sensors exist:

- Front airbag crash sensor for driver side and front passenger side G283 and G284
- Side airbag crash sensor on driver side and front passenger side G179 and G180
- Rear side airbag crash sensor on driver side and front passenger side G256 and G257

Front airbag crash sensors G283 and G284

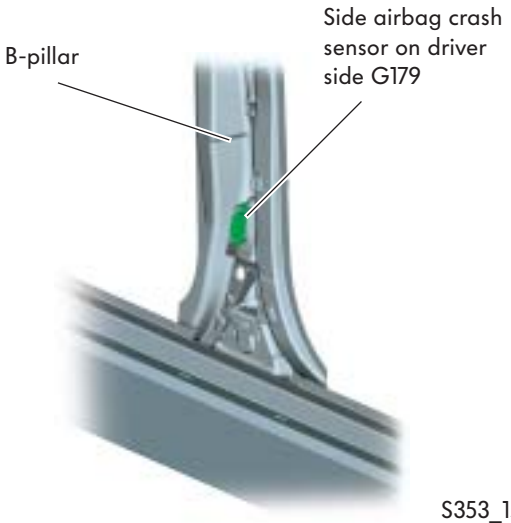
The front airbag crash sensors for driver side and front passenger side G283 and G284 are installed to improve frontal crash detection. These sensors are acceleration sensors, which measure vehicle deceleration and acceleration in the longitudinal direction. Depending on the severity of the accident, this enables the airbags to be deployed earlier. Earlier deployment increases the occupant protection effect.

S353_159

Side airbag crash sensors G179 and G180 – acceleration sensors

Both acceleration sensors and pressure sensors may be fitted as the side airbag crash sensors on the driver side and front passenger side G179 und G180.

The acceleration sensors are usually installed in the area of the B-pillar connection to the sill. These sensors measure the vehicle's transverse acceleration and forward this information to the airbag control unit J234.



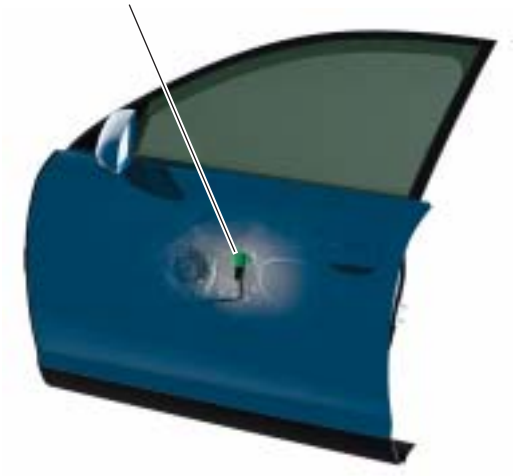
S353_155

Passive occupant protection systems

Side airbag crash sensors G179 and G180 – pressure sensors

The pressure sensors are installed in the right and left front doors. On deformation of the doors, the air pressure is increased for a short time. This pressure increase is recorded by the sensor and forwarded to the airbag control unit J234.

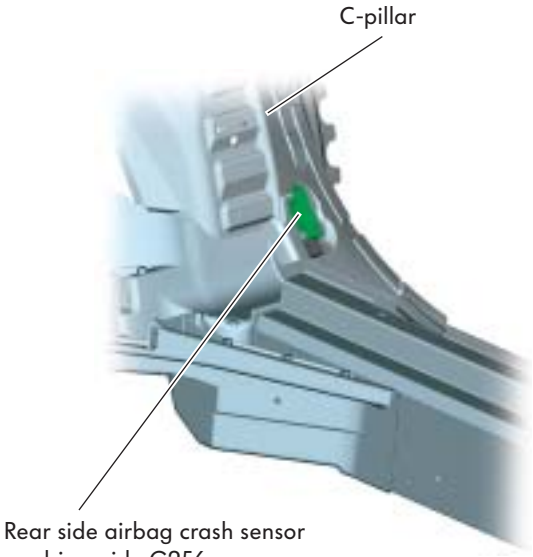
Pressure sensor (side airbag crash sensor on driver side G179)



S353_160

Rear side airbag crash sensors G256 and G257

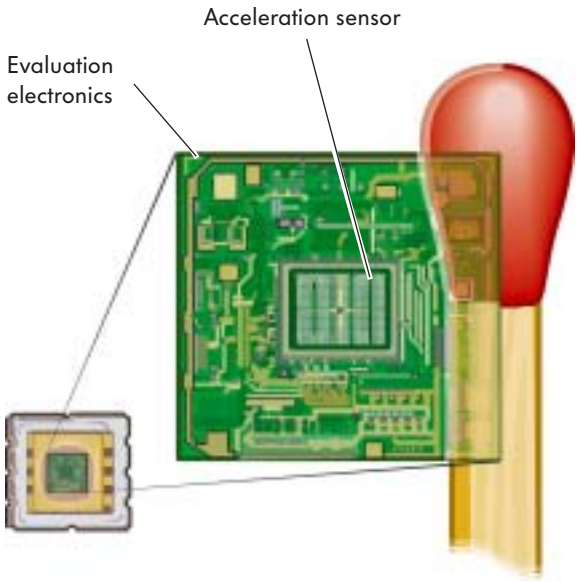
The rear side airbag crash sensors G256 and G257 are acceleration sensors. These sensors are installed in the vehicle in the area of the right and left C-pillar. Their task is to measure the vehicle's transverse acceleration and forward this information to the airbag control unit J234.



S353_156

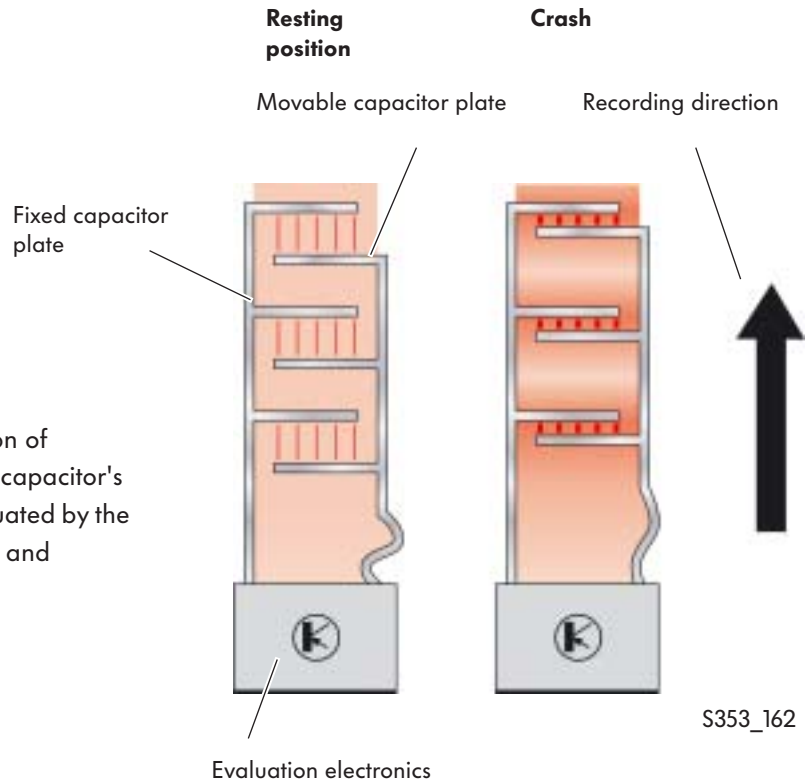
Function of the crash sensors – acceleration sensors

A crash sensor essentially consists of a housing, evaluation electronics and a micromechanical acceleration sensor.



S353_161

In simplified terms, the acceleration sensor is designed like a capacitor.
Some of the capacitor plates are fixed. Their counterparts are movably mounted and work as a seismic mass.



S353_162

If the seismic mass is moved in the direction of recording in the event of an accident, the capacitor's capacity changes. This information is evaluated by the evaluation electronics, digitally processed and transmitted to the airbag control unit.

Passive occupant protection systems

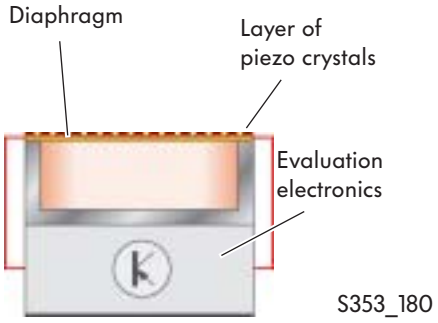
Funtion of the crash sensors – pressure sensors

In the event of a lateral crash, the crash sensors measure the abrupt change in air pressure in the front doors.
There are two types – a capacitive and a piezo-electric pressure sensor.
Both types of sensor are in the sensor unit with evaluation electronics, which are installed together in one housing.

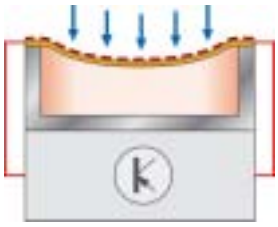
Piezo-electric pressure sensor

The piezo-electric pressure sensor unit consists of a sealed cavity, over which a diaphragm with piezo crystals is tensioned.

Via pressurisation, the diaphragm is pressed in and a movement occurs in the piezo crystals. This movement is processed as a voltage by the evaluation electronics and transmitted as a signal to the airbag control unit J234.



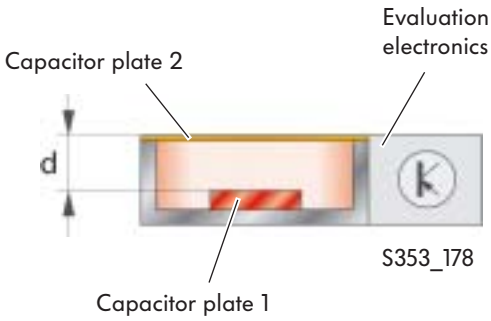
S353_180


S353_181

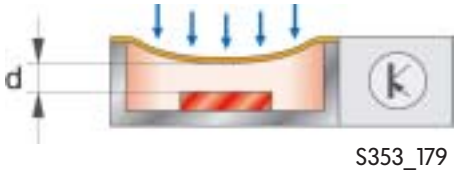
Capacitive pressure sensor

The capacitive pressure sensor unit is designed like a capacitor. To achieve this, capacitor plate 1 is located in a sealed cavity. Capacitor plate 2 is tensioned over this as a diaphragm.

If the diaphragm is pressurised, the distance (d) between the capacitor plates changes. This change is processed in the evaluation electronics and forwarded as a signal to the airbag control unit J234.



S353_178



S353_179

Seat belt warning

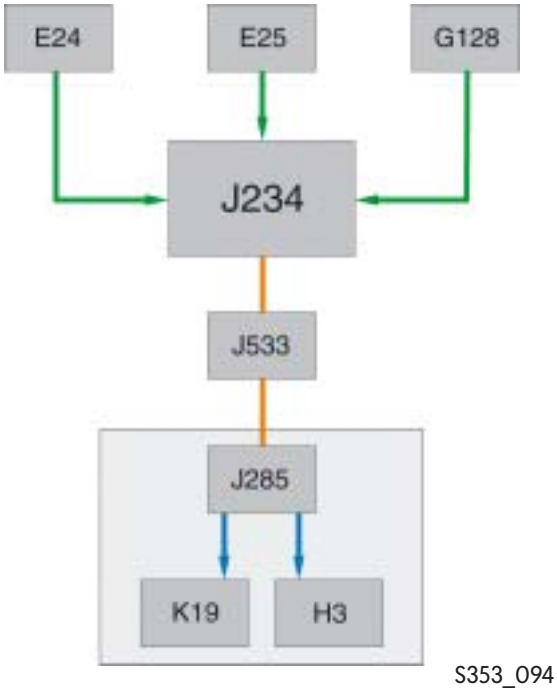
Systems which help the occupants not to forget important actions prior to the commencement of a journey are increasingly being integrated into modern motor vehicles.
This also includes the seat belt warning, which reminds occupants to put on their seat belts.
Depending on the vehicle model and model year, the airbag control unit evaluates whether the driver and also the front passenger have fastened their seat belts.

Not all models are equipped with a seat belt warning for the front passenger.

S353_154

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

The information is forwarded to the control unit in dash panel insert J285 via the data bus diagnostic interface J533. If the driver or front passenger are not wearing their seat belts, the seat belt warning system warning lamp K19 in the dash panel insert lights up. If a certain vehicle speed is reached, an acoustic warning is emitted via the buzzer and gong H3.



S353_094

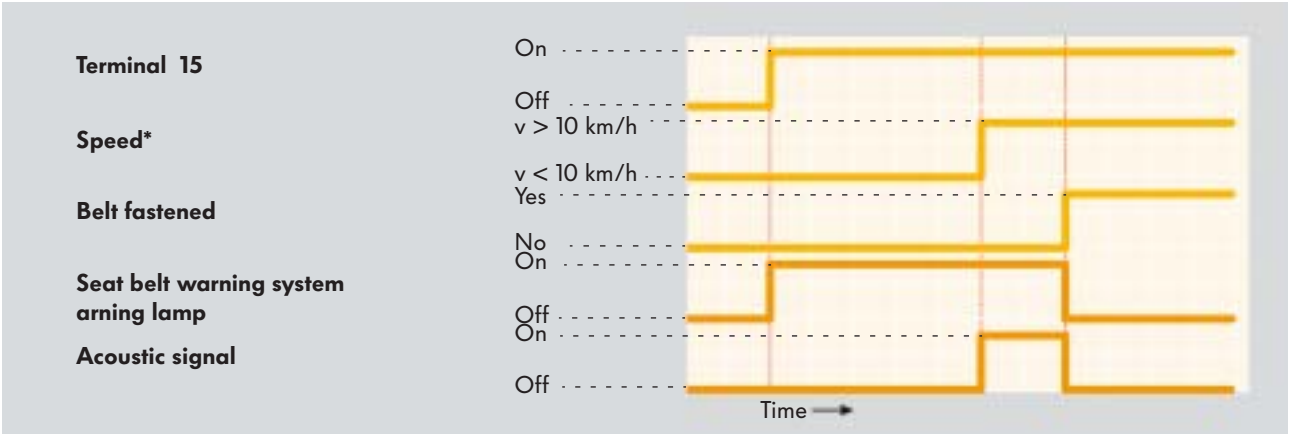
CAN data bus cable

Input

Output

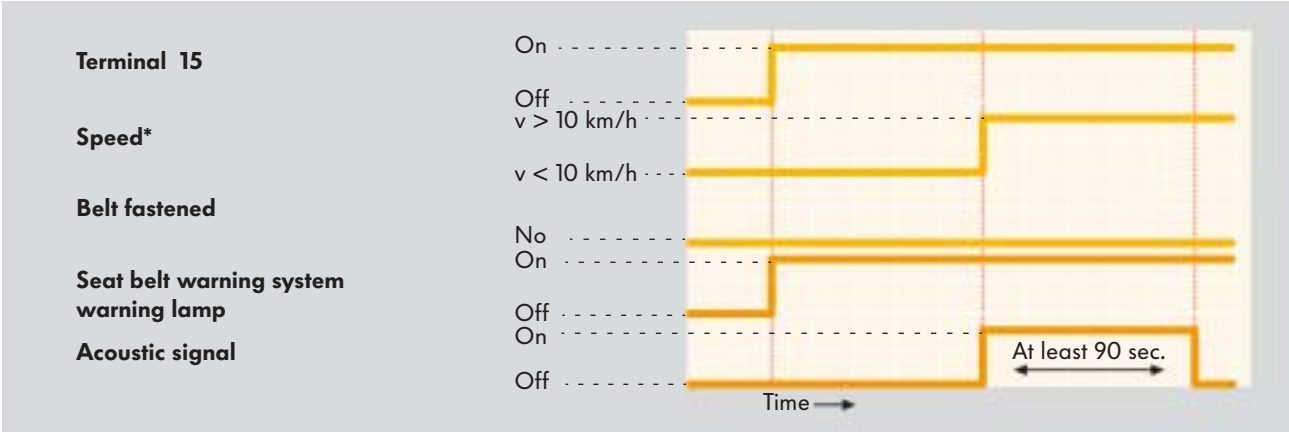
Seat belt warning time diagrams

Optical and acoustic signals – seat belts are fastened after a delay



S353_163

Optical and acoustic signals – seat belts are not fastened



S353_164

The warning is activated again if the seat belt status is changed during "terminal 15 on".

* depending on vehicle model

Seat occupied sensor, front passenger side G128

The seat occupied sensor, front passenger side G128 is a seat belt warning system component. This sensor consists of a plastic film with several individual contact sensors.

The seat occupied sensor, front passenger side G128 is installed in the front passenger seat between the seat cover and the seat padding. The position of the seat occupied sensor stretches over the rear area of the front passenger seat, and is selected in such a way that the relevant area of the seat surface is recorded.

S353_165

Seat occupied sensor,
front passenger side G128

Depending on load, the seat occupied sensor, front passenger side G128 changes its resistance.
If the front passenger seat is not occupied, the resistance of the seat occupied sensor, front passenger side G128 is high. Its resistance decreases as the load increases. As of a load of approx. 5 kg, the airbag control unit J234 detects "seat occupied".

G128 resistance evaluation	
Approx. 430 ohm and higher	Seat not occupied
Approx. 140 ohm and lower	Seat occupied

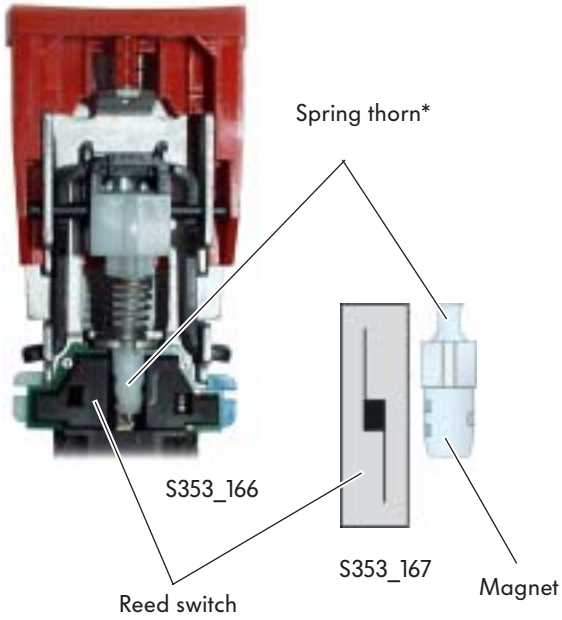
Driver side belt switch E24 and front passenger side belt switch E25

The driver side belt switch E24 and front passenger side belt switch E25 are further components of the seat belt warning system.

These components are integrated into the seat belt buckles on the front seats. Firstly, mechanically actuated open/close switches and secondly, so-called reed switches, are used as belt switches.

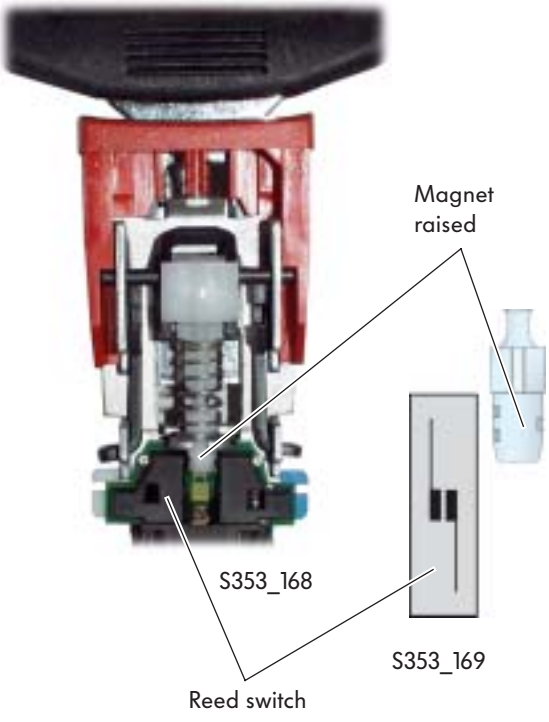
A reed switch is a magnetically actuated contact.

When a seat belt buckle is not actuated (latch plate not inserted), the reed switch is closed. In this position, the magnet installed on the spring thorn* acts on the reed switch.



If the latch plate is inserted into the seat belt buckle, however, the reed switch is open. When inserted, the latch plate causes the spring thorn* to be raised. This means that the magnet on the spring thorn* no longer acts on the reed switch, and the switch is open.

By measuring the resistance, the airbag control unit J234 recognises, in the case of both the mechanically actuated switch and the reed switch, whether or not the seat belt has been fastened.



* Spring thorn = spring-loaded thorn

Key operated switch to deactivate front passenger side airbag E224

If a child seat, in which the child is seated with its back to the direction of travel, is to be used on the front passenger seat, the front passenger airbag must be deactivated.

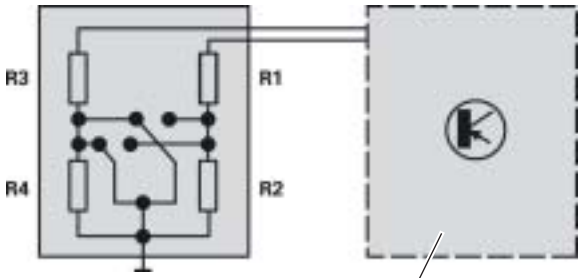
The key operated switch (E224) is used to deactivate the front passenger airbag and the front passenger side airbag and also illuminate the warning lamp (K145) – PASSENGER AIRBAG OFF.

S353_042

When activated, the front passenger side airbag deactivated warning lamp K145 (PASSENGER AIRBAG OFF) indicates to the occupants that the front passenger airbag is deactivated.

S353_043

Via the location of four resistors, two of which are always switched in series (either R1 and R2 or R3 and R4), clear recognition of the switch position is possible.
If the airbag control unit J234 detects a faulty key operated switch, a fault is entered in the memory and the front passenger side airbag deactivated warning lamp K145 (PASSENGER AIRBAG OFF) begins to flash.



S353_170

Airbag control unit J234

Passive occupant protection systems

Market-specific features

Occupant protection system additions for specific markets

To meet the legal and specific requirements in certain countries, vehicles may be equipped with additional systems.

Possible additional systems:

- Roll-over detection
- Front passenger side seat occupied recognition
- Knee airbags

Roll-over

In certain vehicle models (e.g. EOS and New Beetle cabriolet), an additional sensor for roll-over detection has been integrated into the airbag control unit J234. If roll-over is detected, the seat belt pre-tensioners and the curtain airbags are activated.

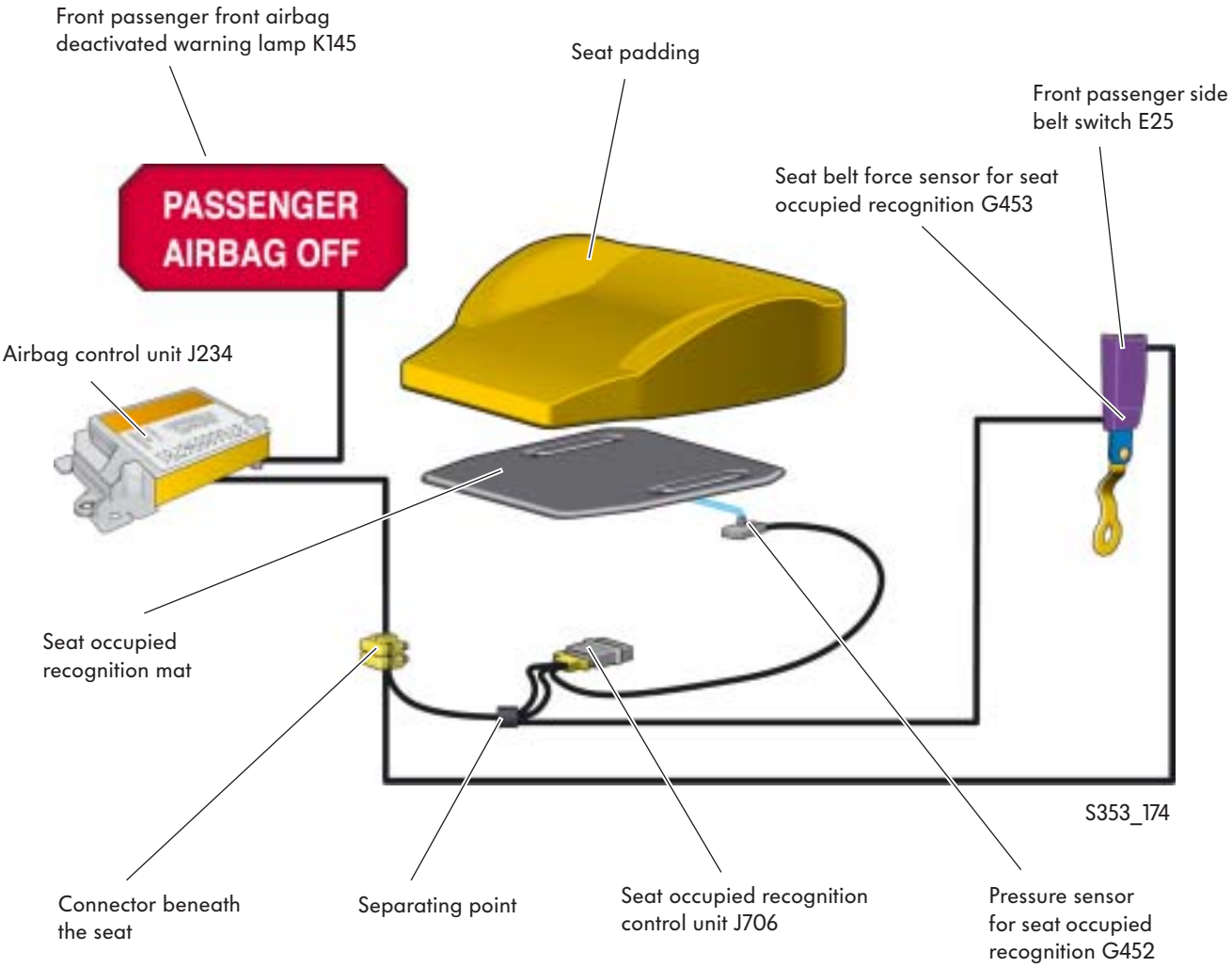
Front passenger side seat occupied recognition

If the airbag control unit J234 receives information that the front passenger seat is not occupied or a child seat is installed, the airbag control unit deactivates the front passenger airbag.
If the front passenger airbag is deactivated, this is indicated to the occupants via the front passenger side airbag deactivated warning lamp (PASSENGER AIRBAG OFF) and a text in the dash panel insert.

The system essentially consists of the following components:

- Seat padding
- Seat occupied recognition mat
- 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
- Front passenger side airbag deactivated warning lamp K145 (PASSENGER AIRBAG OFF)
- Airbag control unit J234

Seat occupied recognition system component networking



The positions of the installed components are fixed and must not be changed under any circumstances. Nor may individual system components be exchanged. In the event of a repair, proceed exactly according to the valid workshop manual and "Guided Fault Finding".

Passive occupant protection systems

Seat occupied recognition control unit J706

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

- The signal from the seat belt force sensor for seat occupied recognition states the level of tensile force on the seat belt.

- Based on the signal from the pressure sensor for seat occupied recognition, the seat occupied recognition control unit recognises the weight pressing on the front passenger seat. If a weight of less than approx. 20 kg is pressing on the front passenger seat and no or very little belt force is detected, the seat occupied recognition control unit detects "child seat" and reports this to the airbag control unit.
  The front passenger airbag is deactivated by the airbag control unit.

- If approx. 25 kg presses on the front passenger seat, for example, and the belt force exceeds a fixed value, the seat occupied recognition control unit detects that the child seat is additionally being pressed onto the seat padding by the seat belt with the child seat retention function. "Child seat" is detected, and the front passenger airbag is deactivated by the airbag control unit.

- As of a load in excess of approx. 25 kg and a lower belt force, the seat occupied recognition control unit assumes an adult person, and the front passenger airbag remains active.

The information from the sensors is continuously evaluated when the ignition is switched on. This ensures that the seat occupied recognition control unit recognises a change in seat occupation and reacts to it.
To prevent the occurrence of changing loads on the front passenger seat from leading to the immediate deactivation of the front passenger airbag during vehicle operation, the system operates with a certain time lag during driving. An acceleration sensor installed in the seat occupied recognition control unit reports vehicle movement to the electronics.

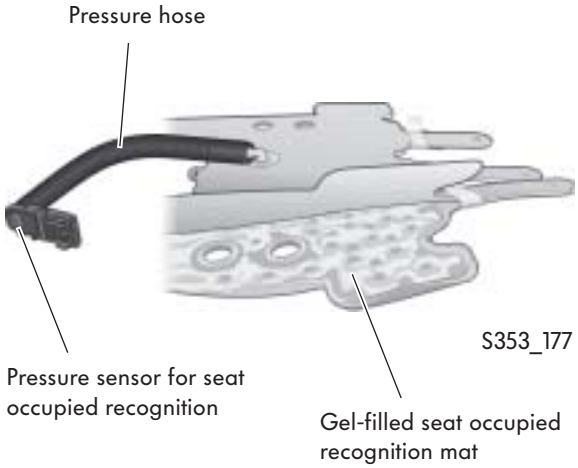
Seat load	**Belt force**	**Recognition**
Less than approx. 20 kg	Very low or none	Child seat
E.g. 25 kg	Very high	Child seat
Greater than approx. 25 kg	Low	Adult

Data exchange between the airbag control unit J234 and the seat occupied recognition control unit J706 takes place via the LIN bus.
Diagnostic monitoring is undertaken by the airbag control unit.

Depending on vehicle model, the belt inertia reels for the front passenger seat and the outer rear seats are equipped with the child retention function. Further information can be found the owner's manual for the relevant vehicle.

Pressure sensor for seat occupied recognition G452

The pressure sensor for seat occupied recognition G452 and the seat occupied recognition mat are one component.
The seat occupied recognition mat is filled with a silicone-like gel, and is located beneath the seat padding on the front passenger seat. If the front passenger seat is occupied, the pressure in the seat occupied recognition mat changes. The pressure sensor for seat occupied recognition detects this change and reports this, in the form of a voltage signal, to the seat occupied recognition control unit J706.
Depending on load, the voltage ranges between 0.2 V (high load) and 4.8 V (low load).
The seat occupied recognition control unit supplies the pressure sensor with a voltage of 5 V.



The replacement part (service kit) for seat occupied recognition (USA) is already pre-calibrated and must not be separated under any circumstances.

The service kit is comprised of:

- Seat occupied recognition control unit J706
- Pressure sensor for seat occupied recognition G452
- Seat occupied recognition mat
- Seat padding
- Wiring harness between seat occupied recognition control unit J706 and pressure sensor for seat occupied recognition G452

During assembly work, the pressure hose and the seat occupied recognition mat must not be kinked under any circumstances.

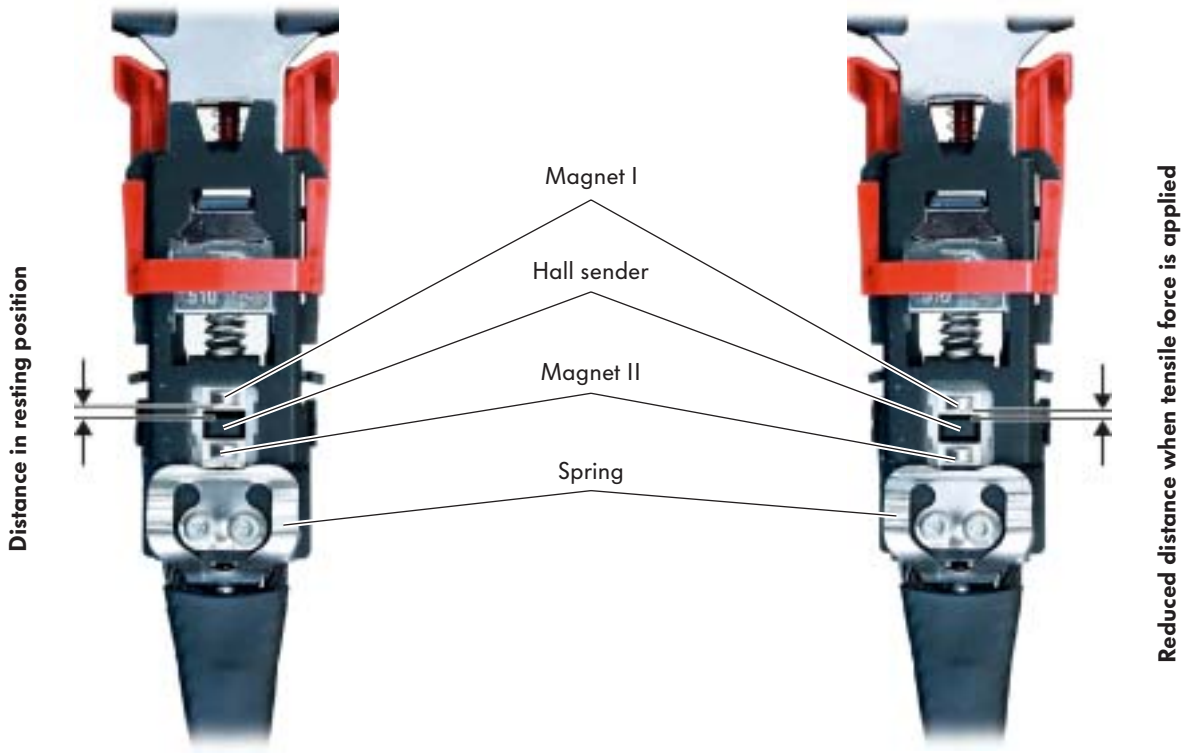
Passive occupant protection systems

Seat belt force sensor for seat occupied recognition G453

The seat belt force sensor for seat occupied recognition is integrated into the front passenger seat's belt buckle.
It essentially consists of two parts which can be pushed together and a Hall sender, which is located between magnets I and II. A defined spring holds the parts in their resting position. In this position, magnets I and II have no effect on the Hall sender.
When the seat belt is properly applied, a tensile force is exerted on the belt buckle.

The distance between the Hall sender and magnets I and II changes. The magnets' effect on the Hall sender changes, in turn changing the Hall sender's voltage signal. The higher the tensile force on the belt buckle, the more the parts move together. The seat occupied recognition control unit receives this information and evaluates it.

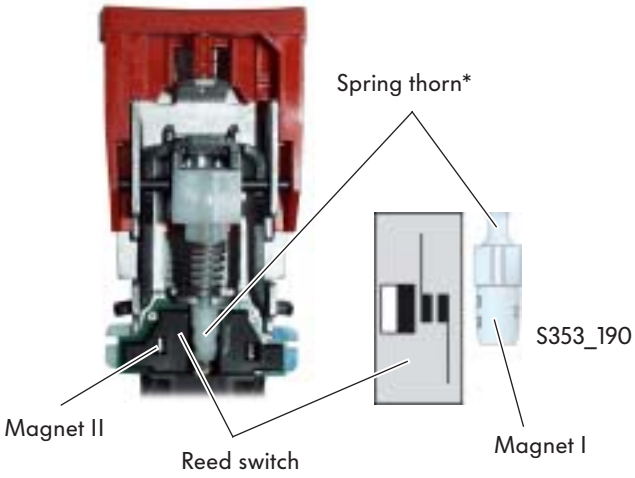
A mechanical stop ensures that the sensor element is not torn apart during a crash.



S353_175 S353_176

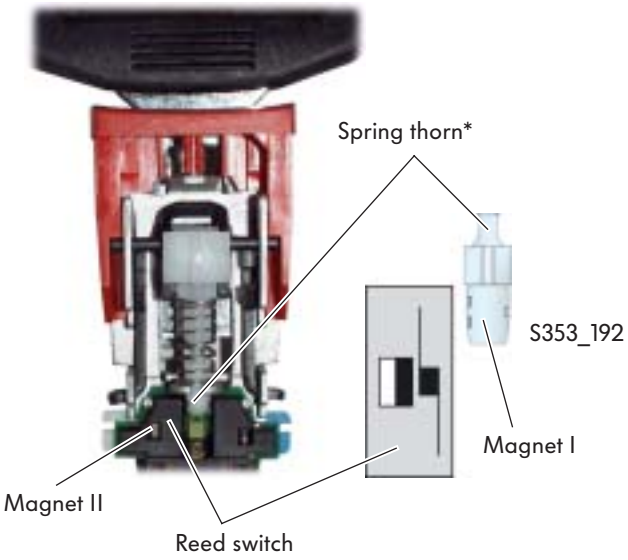
Driver side belt switch E24 and front passenger side belt switch E25

The belt switches (reed switches) are installed in the belt buckles on the front seats.
As long as the latch plate is not inserted into the belt buckle, magnets I and II act on the reed switch. The magnetic forces exerted by the two magnets counter each other. The reed switch is open.



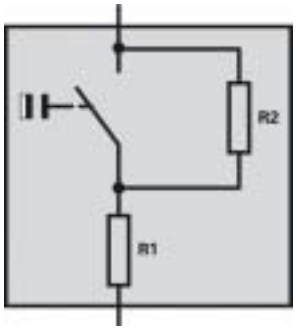
S353_189

Magnet I is located in the tip of the movable spring thorn*.
Like the reed switch, magnet II is firmly secured in the housing.
If the latch plate is inserted into the belt buckle, the spring thorn* with magnet I moves. Magnet II acts on the reed switch alone. The reed switch is closed.



S353_191

Two resistors are integrated into the circuit.
Depending on the position of the reed switch, measurement is carried out via one or both resistors.
Based on the resistance which is measured, the airbag control unit recognises whether or not the seat belt has been fastened.



S353_193

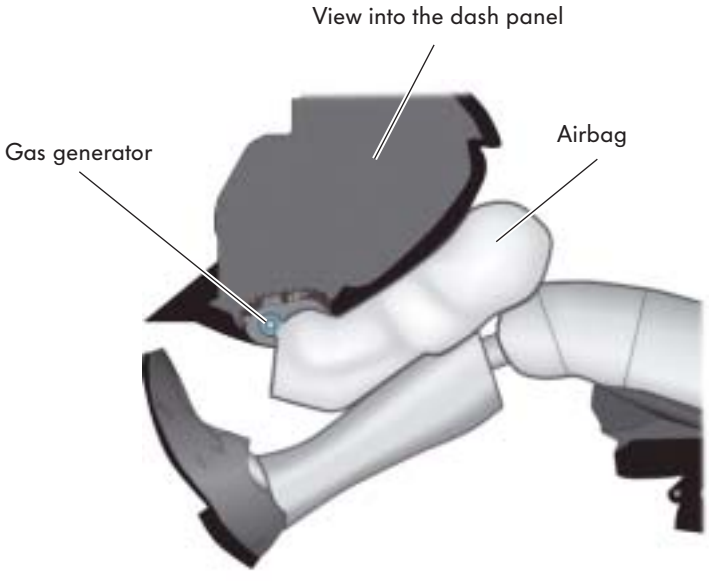
* Spring thorn = spring-loaded thorn

Front knee airbags

For specific markets, certain vehicle models may additionally be equipped with knee airbags.

S353_171

Knee airbag deployment increases the occupants protection further during vehicle deceleration at an earlier stage. Together with the driver and front passenger airbags, the airbag system is therefore able to meet the legal and specific requirements of certain countries in combination with the knee airbags.
On the driver side, the knee airbag is located in the footwell trim beneath the dash panel. On the passenger side, the knee airbag is installed behind the glove box lid.



S353_188

Notes

Vehicle overview

Overview of self-study programmes

Fox

S353_044

SSP 349

Golf 2004

S353_048

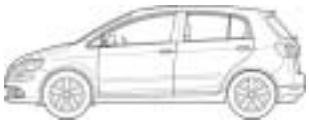
SSP 318

Lupo

S353_045

SSP 201
SSP 218

Golf Plus 2005



S353_049

SSP 338

Polo, Polo Classic and Polo Variant – all up to 2001

S353_075

SSP 166

Jetta 2006

S353_051

SSP 354

Polo, Polo Classic model 2002

S353_046

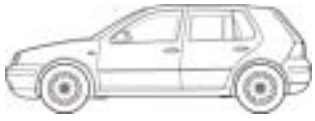
SSP 263

EOS

S353_076

SSP 355

Golf, Golf Variant up to 2003



S353_047

SSP 200

New Beetle

S353_052

SSP 211

Bora up to 2005

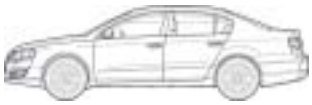
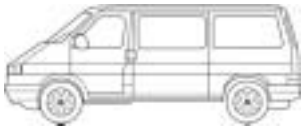
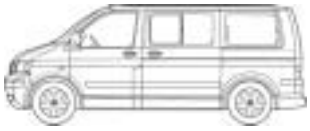
S353_050

New Beetle cabriolet

S353_053

SSP 281

SSP = self-study programme

Passat up to 2005 – saloon and Variant  S353_054 **SSP 251** **SSP 261**	**Caddy and Caddy pick-up**  S353_202 **SSP 179** **SSP 184**
Passat model 2006 – saloon and Variant  S353_055 **SSP 339** **SSP 356**	**Caddy model 2004**  S353_072 **SSP 328**
Phaeton  S353_056 **SSP 270**	**Transporter up to 2003**  S353_097 **SSP 129**
Touran  S353_057 **SSP 306**	**Transporter model 2003**  S353_073 **SSP 310**
Sharan  S353_058 **SSP 169**	**LT2**  S353_074 **SSP 188**
Touareg  S353_059 **SSP 297**	**Crafter**  S353_182 **SSP 369**

Test Yourself

Which answer is correct?

One or several of the answers which are provided may be correct.

1. How is occupant protection sub-divided in motor vehicles?

- [ ] a) Occupant protection is sub-divided into vitally necessary systems and those necessary to a limited extent.
- [ ] b) Occupant protection can be sub-divided into the two main areas of active and passive safety.

2. Which of the following systems form part of passive safety?

- [ ] a) Electronic brake pressure distribution
- [ ] b) Seat belt pre-tensioners
- [ ] c) Battery cut-off
- [ ] d) Airbags

3. As of when have passive safety components been available?

- [ ] a) A vehicle with a seat belt was first available in 1955.
- [ ] b) Head restraints have been available in combination with the three-point seat belt since 1959.
- [ ] c) The first vehicle with an airbag was available in 1980.

4. What are the temporal sequences of airbag deployment?

- [ ] a) Airbag deployment takes place after the airbag control unit has detected a crash worthy of deployment by evaluating the information from the crash sensors.
- [ ] b) The seat belt pre-tensioners are only triggered once the airbags have inflated.
- [ ] c) To retain the front airbags' full protective effect even following an impact, the airbag remains fully inflated.

5. How are the gas generants of airbag gas generators comprised?

☐ a) Solid fuel gas generators use a homogeneous, firmly pressed fuel block.

☐ b) The fuel used in solid fuel gas generators consists of solid fuel tablets.

☐ c) Hybrid gas generators essentially consist of a combination of a compressed gas bottle filled with inert gas and a connected ignition unit.

6. Which seat belt pre-tensioners are fitted in Group vehicles?

☐ a) Spiral pre-tensioners

☐ b) Wankel-type seat belt pre-tensioners

☐ c) Toothed rack-type pre-tensioners

7. How are the seat belt pre-tensioners fitted in Group vehicles triggered?

☐ a) Mechanically

☐ b) Electrically via a cable

☐ c) Electrically via radio

8. Why are battery cut-off elements fitted in vehicles?

☐ a) In the event of an accident, they are intended to prevent possible vehicle fires in connection with a possible short-circuit by separating the cable from the starter battery to the alternator and starter.

☐ b) If the starter battery is installed in the vehicle's interior or luggage compartment, a battery cut-off element is fitted.

☐ c) They are generally required on installing a second battery.

9. Where are crash sensors installed in the vehicle?

☐ a) Essentially, there is only one crash sensor within the airbag control unit.

☐ b) To enable better detection of a frontal crash, external crash sensors for the front airbags may be installed in the front end of the vehicle.

☐ c) Additional sensors, which are installed in the vehicle side area, exist to determine a lateral crash.

Answers:
1.b;2.b,c,d;3.c;4.a;5.b,c;6.b,c;7.a,b;8.a,b;9.b,c

000.2811.88.20 Technical status 04.2007

Volkswagen AG
Service Training VSQ-1
Brieffach 1995
D-38436 Wolfsburg