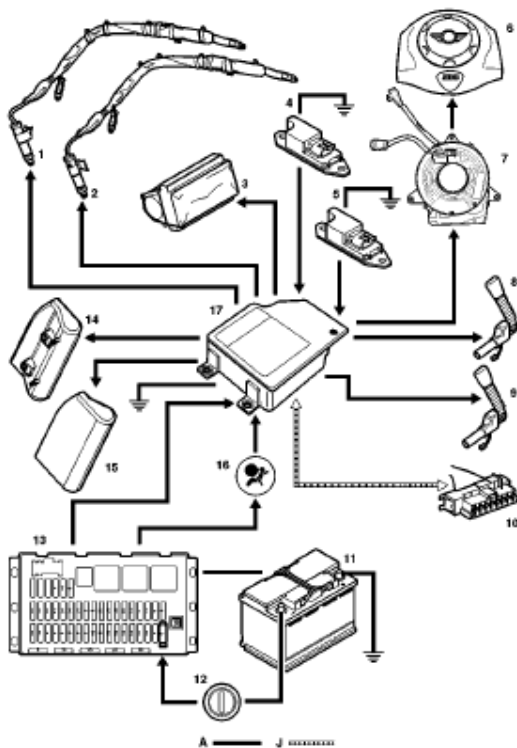


2002-09 GENERAL INFORMATION**Passive Safety Systems - Overview - MINI****MINI MULTIPLE RESTRAINT SYSTEM 4****MULTIPLE RESTRAINT SYSTEM (MRS 4)****Purpose of the System**

The multiple restraint system (MRS) provides enhanced passive protection for vehicle occupants in the event of a serious collision. The system is regarded as passive in the respect that it operates automatically without preconditional interactions by the vehicle occupants.

The MRS system consists the following components:

- MRS control unit
- Driver's airbag module
- Front passenger's airbag module
- Driver's side (thorax) airbag module
- Front passenger's side (thorax) airbag module
- Advanced Head Protection System (AHPS2) airbag - Right Hand
- Advanced Head Protection System (AHPS2) airbag - Left Hand
- Driver's seat belt pre-tensioner
- Front passenger's seat belt pre-tensioner
- MRS warning lamp (in instrument cluster)
- Crash sensor - side impact (x 2)
- Seat belt buckle switches
- Slip Ring



MRS 4 Components

- A. Hard Wired
- J. Diagnostic Bus
- 1. Advance Head Protection (AHPS2) Right side
- 2. AHPS2 Left Side
- 3. Front Passenger Airbag Module
- 4. Crash Sensor Side Impact Right Side
- 5. Crash Sensor Side Impact Left Side
- 6. Driver Airbag Module
- 7. Rotary Coupler
- 8. Front Seat Belt Pre-tensioner Right Side
- 9. Front Seat Belt Pre-tensioner Left Side
- 10. Diagnostic Connector
- 11. Battery
- 12. Ignition Switch
- 13. Passenger Compartment Fusebox
- 14. Side (Thorax) Airbag Left Side
- 15. Side (Thorax) Airbag Right Side
- 16. MRS Warning Lamp in Instrument Cluster
- 17. MRS Control Unit

Fig. 1: MRS 4 Components

Courtesy of BMW OF NORTH AMERICA, INC.

System Components



MRS Control Unit

The MRS Control Unit contains 2 internal collision detection sensors to determine the severity of the crash.

Fig. 2: MRS Control Unit

Courtesy of BMW OF NORTH AMERICA, INC.

The MRS control unit is secured centrally on the body floor panel (center tunnel - between the handbrake and the gear selector lever) by three nuts. A 50-pin connector provides the MRS control unit connection with the vehicle harness. Access to the control unit is only possible when the main floor carpet is removed from the vehicle.

Main Sensor

The main sensor is a deceleration detection device which is contained in the MRS control unit. The sensor consists of a spring and weight system which is attached to strain gauges in a Wheat stone bridge circuit. If a change in strain gauge resistance is greater than a preset value, it corresponds to a crash condition of sufficient severity to warrant MRS component deployment. In this case, the processor provides a signal to initiate airbag module and/or seat belt pre-tensioner deployment. Deployment will only be carried out if a confirmation signal that a crash condition is occurring is received by the MRS control unit. Crash condition confirmation is achieved by the simultaneous actuation of the safing sensor.

For side impacts, the side impact crash sensors provide additional inputs to the control unit for determining and confirming a crash condition in conjunction with the control unit's internal accelerometer.

For front angled impacts, the control unit acts in co-operation with the side impact crash sensors, to determine which airbags and seat belt pre-tensioners need to be deployed.

For rear impacts, the control unit uses a rear impact trigger threshold to determine that a severe rear collision has occurred and deploys all seat belt pre-tensioners, to restrain vehicle occupants.

Workshop Hint

Wheatstone Bridge circuits are used to measure resistance, inductance and capacitance. They consist of 4 resistors arranged in a diamond orientation. Excitation voltage is applied between the top and bottom of the diamond, output voltage is measured across the sides. One or more of the legs contain a resistive transducer, a strain gauge. Based on the change in resistance of the strain gauge the legs go from "balanced" to "unbalanced".

Safing Sensor

This sensor is also contained within the MRS control unit and is included in the control unit internal circuitry to prevent unintentional detonation of MRS components. The safing sensor is connected in series with the main sensor and operates at comparatively lower rates of deceleration. When the safing sensor closes in conjunction with the main sensor exceeding its trigger value, electronic switches are activated, allowing electrical current to be supplied to the driver and passenger airbags and the relevant seat belt pre-tensioners.

The operation of the side (thorax) airbag modules and the Advanced Head Protection System (AHPS2) airbags are controlled by electronic switching in response to the threshold value for the side impact sensors being exceeded.

Drivers Airbag Module

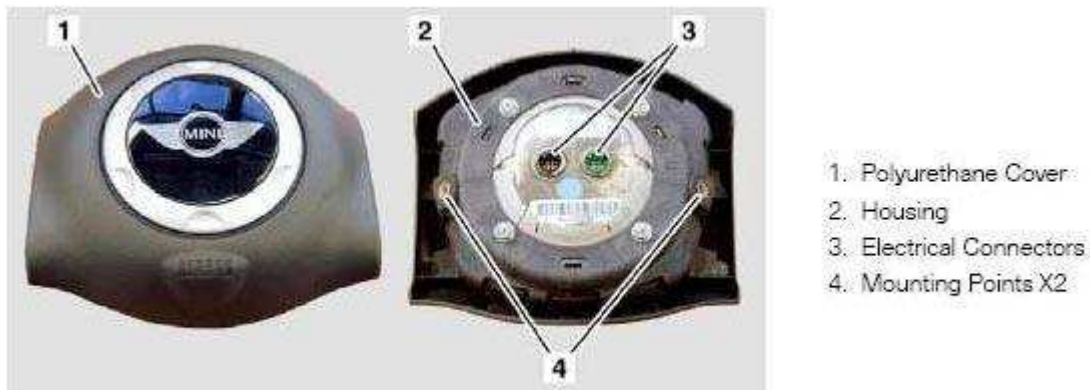
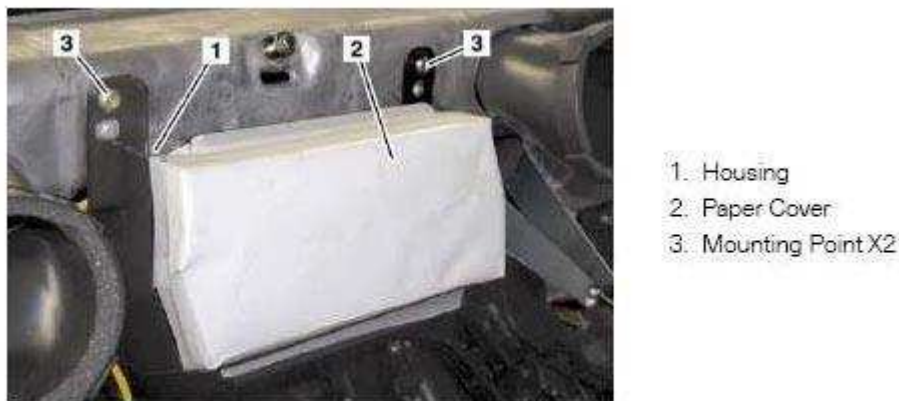


Fig. 3: Drivers Airbag Module

Courtesy of BMW OF NORTH AMERICA, INC.

The driver's airbag is of a two-stage design and attached to the steering wheel by two captive bolts. Electrical connection to the MRS control unit is provided via the rotary coupler. The fully inflated airbag has a capacity of 57 liters. Once the airbag is fully inflated, vents in the airbag prevent further pressure build-up, so that progressive deceleration is provided as the driver contacts the cushion and injury due to sudden impact forces is prevented. The design of the airbag is '**tuned**' to match the crush characteristics of the vehicle as well as the steering wheel and collapsing steering column behavior.

Passenger Airbag Module



Passenger Airbag Module

Fig. 4: Passenger Airbag Module

Courtesy of BMW OF NORTH AMERICA, INC.

The passenger front airbag module is located above the stowage tray, directly in front of the passenger seat. The airbag module is mounted to the body cross car beam by means of four Torx bolts, which are capable of withstanding the forces of deployment. The airbag container is a pressed steel fabrication that is designed to withstand the high rate of pressurization.

The unit contains a gas generator and igniter module, which incorporates the nitrocellulose igniter charge and pressurized gas chambers surrounded by a filter screen. The filter prevents solid combustion by-products from entering the airbag during deployment.

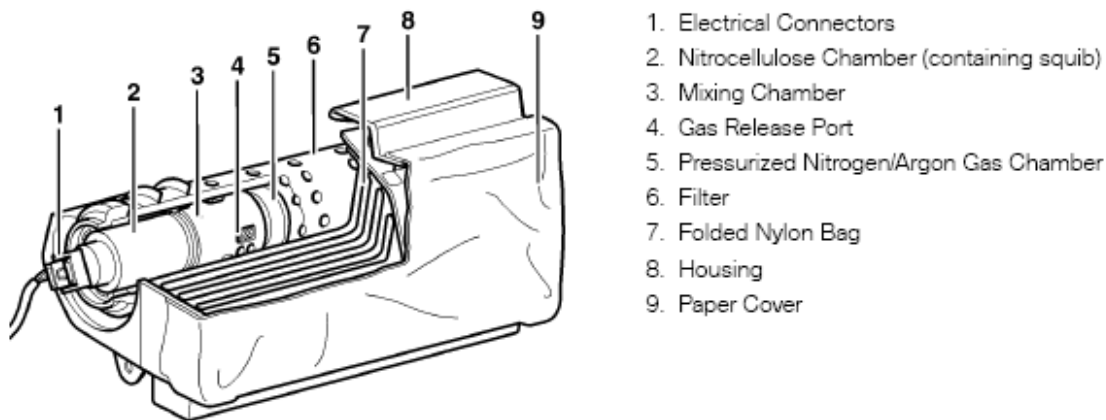
A link lead connects the airbag module to the main vehicle harness. The other end of the link lead terminates in a squib connector on the left hand side and a squib connector on the right hand side of the passenger airbag module.

Only disconnect the connectors from the airbag module if the airbag module is being removed, otherwise disconnect at the harness end of the link lead.

To disconnect the link lead at the airbag module end, lift the locking cap of the connector to unlatch, and then pull the connector away from the module. Do not pull on the link lead harness. When reconnecting, ensure the connector is fully mated in the socket of the airbag module then press the hinged locking cap into place to secure the connector in position.

The front of the airbag module has a strong paper cover which ruptures when the airbag is deployed. The unfolding airbag then breaks the deployment door perforations in the front fascia; the deployment door remains attached to the fascia by a plastic hinge on its upper inside edge.

Once free of the housing and fascia the airbag inflates to its full extent to provide a protective cushion between the front seat passenger and the fascia/windshield. Vents in the airbag prevent excess pressure bursting the bag and, as soon as the material in the gas generator is exhausted, the airbag deflates. The passenger front airbag has a capacity of 110 liters.



Components of Passenger Airbag Module

Fig. 5: Components Of Passenger Airbag Module
Courtesy of BMW OF NORTH AMERICA, INC.

Side (Thorax) Airbag Modules

**Side Airbag Module**

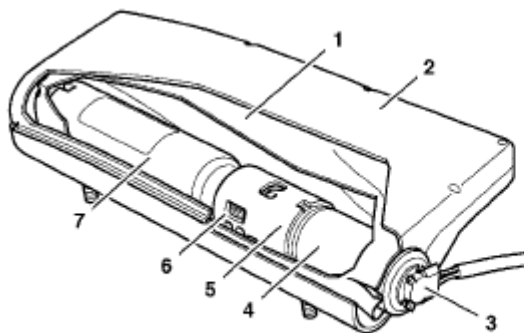
Fig. 6: Side (Thorax) Airbag Modules
Courtesy of BMW OF NORTH AMERICA, INC.

The driver and passenger side (thorax) airbags are mounted to the front seat backrest frame and are designed to protect the ribs and upper internal organs during side impacts. The modules are side specific (i.e. a right hand module must be fitted to a right hand seat and a left hand module must be fitted to a left hand seat). The side airbags are activated by a control signal from the MRS control unit in the event of a side impact or a front angled impact of sufficient severity to cause both front and side airbag deployment.

The side (thorax) airbag module consists of a molded plastic case which houses a folded nylon fabric bag, the gas generating capsules and an igniter squib. The rear of the side airbag module features two studs that are used for mounting the module to the seat frame and are secured in position by two nylon lock nuts.

The side airbag modules have a fly lead which terminates in a 2-pin connector. The connector connects to the control unit via the main harness and is located beneath the seat.

The side airbag has a capacity of 10.5 liters.



1. Folded Nylon Bag
2. Molded Plastic Case
3. Electrical Connector (Non-Removable)
4. Nitrocellulose Chamber
5. Mixing Chamber
6. Filter/Gas Release Port
7. Pressurized Nitrogen/Argon Chamber

Components of Side Airbag Module

Fig. 7: Components Of Side Airbag Module
Courtesy of BMW OF NORTH AMERICA, INC.

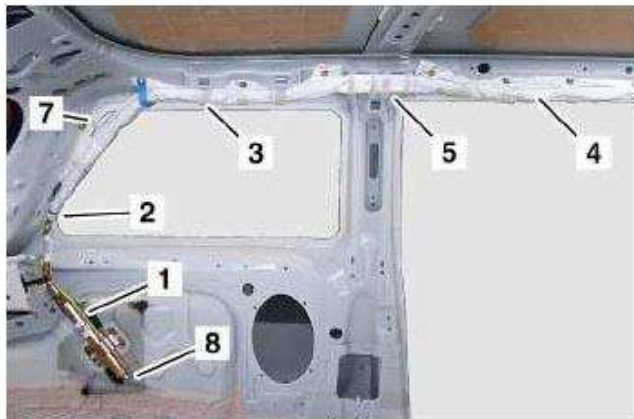
Workshop Hint

If a new side airbag module shows any sign of damage, ***DO NOT USE***.

Workshop Hint

Do not try to remove the connector at the module end, it is a permanent connection.

Advanced Head Protection System (AHPS2)



AHPS2

1. Igniter/Gas Generator
2. Crimped Metal Clip
3. Plastic Retaining Clips X 6
4. Inflatable Nylon Bag
5. Bracket (At Top of B Pillar)
6. Front Tether Strap (Secured on A Pillar)
not shown
7. Rear Tether Strap (Secured on C Pillar)
8. Electrical Connector

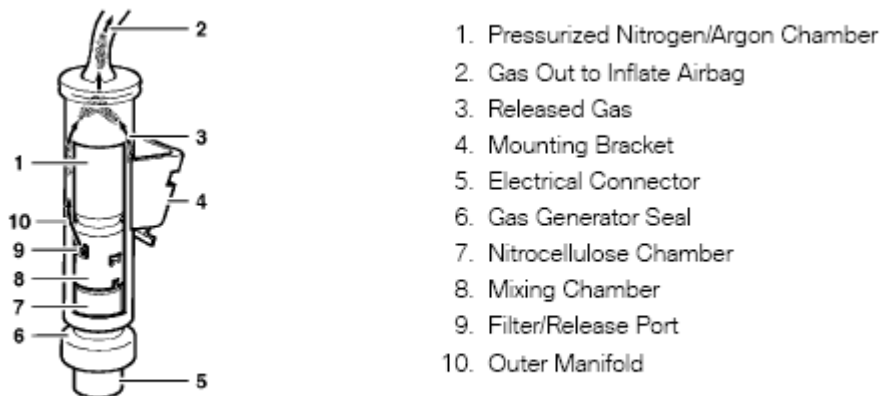
Fig. 8: Advanced Head Protection System (AHPS2)

Courtesy of BMW OF NORTH AMERICA, INC.

The head airbag, known as the Advanced Head Protection System (AHPS2) offers the vehicle occupants in the front and rear additional protection from impacts. The airbag is located behind the interior trim above the door and rear side glass. The igniter/gas generators are fixed to the body rear inner side panels in the luggage compartment. The airbag itself is tethered to the body by two securing straps and bolts, one at the A post, the other on the C post. In between the two tether points, the airbag is held in place with six plastic clips, which are designed to break apart as the airbag inflates. The center portion of the folded airbag is retained on a metal bracket which itself is secured to the body by two bolts and located at the top of the B post.

The 15 liter head airbag is filled with nitrogen/argon gas from a pressurized chamber and remains inflated slightly longer than conventional airbags, this is to provide additional head protection in the event of a secondary impact.

To disconnect the vehicle harness lead from the gas generator, lift the locking cap of the connector to unlatch and then pull the connector away from the module. Do not pull on the harness lead. When reconnecting, ensure the connector is fully mated in the socket of the airbag module then press the hinged locking cap into place to secure the connector in position.



AHPS2 Components

Fig. 9: AHPS2 Components

Courtesy of BMW OF NORTH AMERICA, INC.

Seat Belt Pre-Tensioners

Inertia reel three point seat belts are installed at each seat position, front and rear. The inertia reels are of the ALR (Automatic Locking Retractor) type. The MRS control unit at a slightly lower threshold level than the front airbags activates the front seat belt pre-tensioners.

The two pre-tensioners are side specific, but otherwise identical. Each pre-tensioner has a tube containing propellant and a piston. The piston is attached to a steel cable, the opposite end of which is attached to the seat belt buckle. An igniter (squib) in the base of the tube provides an ignition source when triggered by a fire signal from the MRS control unit. A fly lead with a 2-pin connector links the igniter to the vehicle's MRS wiring and is located on a bracket underneath the seat frame.

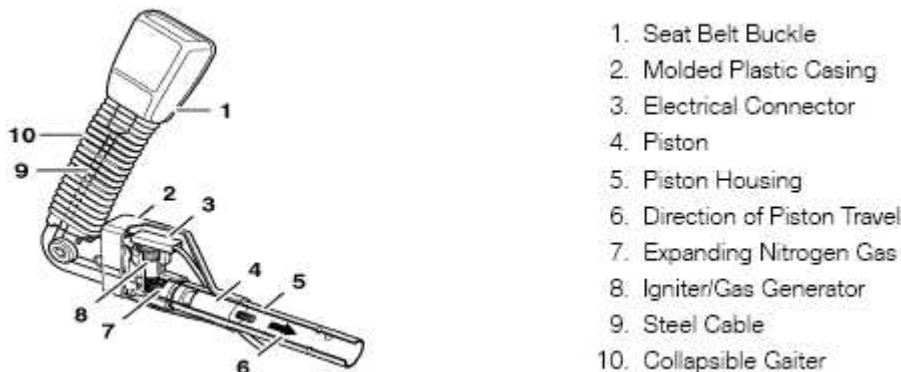


Fig. 10: Seat Belt Pre-Tensioners

Courtesy of BMW OF NORTH AMERICA, INC.

BST (Battery Safety Terminal) COOPER S Only

The BST is installed in the COOPER S due the battery location in the luggage compartment. Because of this, MINI implements a comprehensive electrical fusing system in the MINI with the goal of minimizing the danger of short circuits in the event of a severe accident.

To achieve this, the vehicle's electrical system was divided into the starter circuit and the vehicle system supply circuit. The vehicle system supply circuit is protected against short circuits by means of special high current fuses. The cable to the starter and the alternator - which cannot be protected by conventional methods of fusing since it must carry very high current when the starter is engaged and is permanently subjected to voltage - is protected by the Battery Safety Terminal (BST). This fusing method practically excludes the danger of a short circuit in the event of a severe accident.

The BST consists of a conventional clamp that is screwed onto the positive terminal from above and connected with a hollow cylinder. A propellant charge is stored in this hollow cylinder. Just as with the airbag and seat belt pre-tensioner, this pyrotechnic device is controlled and ignited from the MRS control module. The triggering strategy is also the same as for the triggering of the airbag, and it possesses identical protection logic. The overall unit is enclosed in a plastic shell that captures the cable if it is forced out and locks it so that a renewed contact is no longer possible.

Side Impact Sensors



Side Impact Sensor

The side impact crash sensors must be fitted in the correct orientation, and there must be no gap between the sensor and the body mounting position. Ensure the mounting screws are tightened to the correct torque. Be careful when refitting trim molding not to damage sensors or sensor harness.

Fig. 11: Side Impact Sensors

Courtesy of BMW OF NORTH AMERICA, INC.

Side Impact Sensor

The side impact crash sensors must be fitted in the correct orientation, and there must be no gap between the sensor and the body mounting position. Ensure the mounting screws are tightened to the correct torque. Be careful when refitting trim molding not to damage sensors or sensor harness.

The side impact sensors are located behind the rear lower quarter trim moldings, and mounted to the body floor via their own mounting brackets, in alignment with the rear seat cushion front mountings. Each sensor is attached to their body mounting bracket by two Torx bolts.

Each side impact sensor consists of an electronic accelerometer, microprocessor and serial link circuit. The sensor uses the accelerometer to determine the severity of a side impact, and if the impact is great enough to warrant multiple restraint operation, the sensor communicates the need for deployment to the MRS control unit via a single line serial link.

Seat Belts

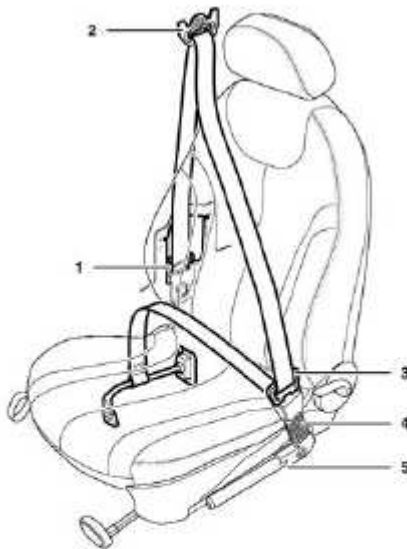
An inertia reel, three point seat belt is installed at each seat position (front and rear). The front seat inertia reels incorporate a liftshaft locking system with webbing sensor and car sensor activating mechanisms. The webbing

sensor activates the locking system if the webbing is subjected to a sharp pull. The car sensor activates the locking system if the vehicle is subjected to sudden deceleration or a severe tilt angle.

The inertia reel of each front seat belt is attached to the body B post, behind the rear quarter trim casing. A locating peg on the top front of the pre-tensioner unit mates with the B post to prevent rotation, and a bolt at the base of the unit secures the pre-tensioner to the body. The seat belt webbing runs from the inertia reel, up to a height adjuster on the B post to an anchor rail just above floor level. The height adjuster unit is attached to the upper B post by two Torx screws and the webbing runs through a 'D-loop', which is attached to the adjuster by a Torx bolt. The seat belt fixing point of the mechanism slides up and down the adjuster to provide the required seat belt setting. The webbing then passes through an aperture in the B post upper trim and the long end is attached to an anchor rail which is secured to the floor panel cross member at the base of the B post.

The buckle assembly for each seat belt is attached to the inboard side of each seat frame and incorporates a flexible stalk and pre-tensioner.

Seat belt warning switches are fitted into both front seat belt buckles. Both the driver and passenger buckle switches have three-wire switches, all of which are connected to the MRS control unit.

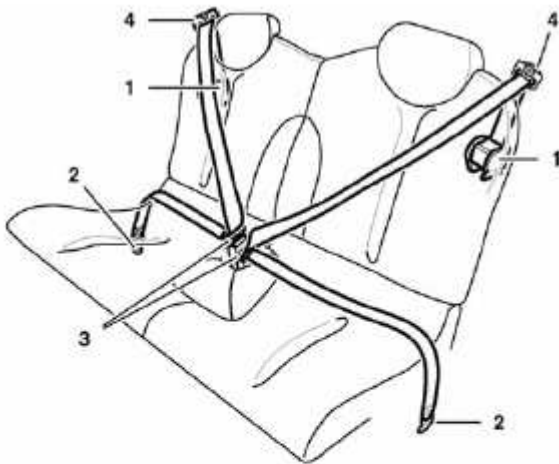


Front Seat Belts

1. Inertia Reel
2. Height Adjuster
3. Seat Belt buckle
4. Flexible Stalk
5. Pre-Tensioner

Fig. 12: Front Seat Belts

Courtesy of BMW OF NORTH AMERICA, INC.

**Rear Seat Belts**

- 1. Rear Seat Belt Inertia Reels
- 2. Seat Belt Anchor Points
- 3. Seat Belt Buckles
- 4. Upper Seat Belt Anchor Points

Fig. 13: Rear Seat Belts

Courtesy of BMW OF NORTH AMERICA, INC.

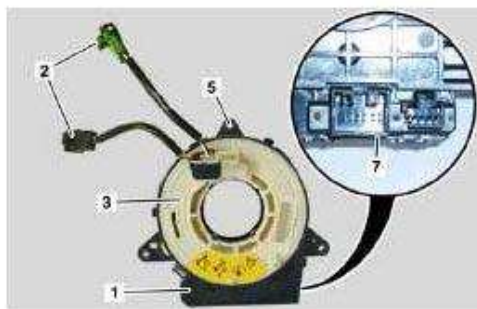
The inertia reel of both rear seat belts are attached to the body inner rear quarter panel. Each inertia reel is fixed to the body rear inner quarter panel by a bolt with a locating tag holding the assemblies in position on the body.

The seat belt webbing passes from the inertia reel through the C post upper trim with the long end of the webbing secured to the body rear inner quarter panel.

The buckle assembly for the rear seat belts is mounted directly to the body floor via a mounting bracket. This mounting bracket is secured by a single Torx bolt.

Slip Ring (Rotary Coupler)

The slip ring is installed on the steering column, behind the steering wheel to provide the electrical interface between the fixed wiring harness and the moveable driver airbag module. The rotary coupler is attached to the steering column casting by three screws.

**Slip Ring**

1. Outer Ring
2. Pigtail Connectors to Driver's Airbag Module X2
3. Rotary Unit
5. Mounting Holes X 3
7. MRS Harness Connector

Fig. 14: Slip Ring

Courtesy of BMW OF NORTH AMERICA, INC.

In addition to the wiring for the driver airbag, the slip ring also provides the wiring for other electrical functions built into the steering wheel area, these may include:

- Audio system remote control switches
- Cruise control system switches
- Horn switches

A rotating link harness is enclosed in a plastic cassette comprising outer and inner housings with integral connectors. The cassette contains a flat ribbon type flexible cable. The slip ring housing is part of the direction indicator and windshield wiper/washer housing. The complete assembly is attached to the steering column by three screws.

The slip ring connects to the driver's airbag module via two, 2-pin connectors at the end of a pigtail connector. A 4-pin socket is included at the rear of the rotary coupler that connects to a 4-pin plug from the main harness. When a slip ring is installed, it should be set at its

centered position while the vehicle's front road wheels are in the straight ahead position. The centered position of the slip ring is indicated by the white segment on the indicator wheel on the front face of the coupler. A new rotary coupler has a locking tab which ensures the unit is locked at its factory centered position. This peg should remain intact until just before steering wheel attachment.

MRS Warning Lamp

The red MRS warning LED is located in the instrument cluster and is illuminated for a short period after switching the ignition to position 1.

If a fault is present within the MRS, the LED will illuminate and remain on until the ignition is switched off. With the warning LED on the MRS may not operate in the event of a collision.



MRS Warning Lamp

Fig. 15: MRS Warning Lamp

Courtesy of BMW OF NORTH AMERICA, INC.

Principle of Operation

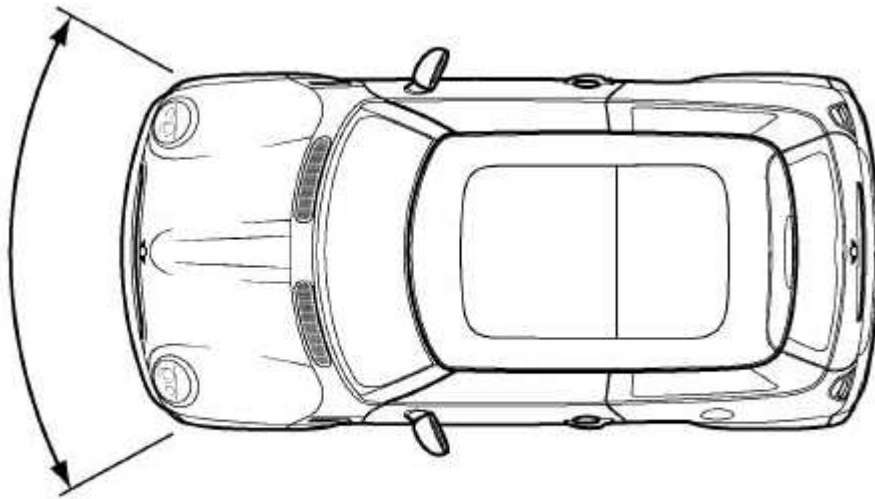
All system operations become active when the ignition switch is turned to position 1 and remains operational when the ignition switch is in the CRANK position (position 3). When the ignition switch is turned on, the MRS warning lamp illuminates for approximately 4 seconds and then turns off, this indicates that the system is functional.

Front Impacts

The front airbags, the front seat belt pre-tensioners and BST are deployed in the event of a frontal impact of sufficient severity that exceeds the MRS control unit impact trigger threshold.

When the accelerometer and safing sensor in the MRS control unit senses the impact, the control unit triggers the front airbag modules by firing an igniter:

- Driver's front airbag - the igniter in turn burns tablets of sodium azide, which generate a large amount of nitrogen gas causing airbag inflation.
- Passenger front airbag - the igniter causes pressurized gas to be released from integral gas canisters for airbag inflation.

**Front Impact Range****Fig. 16: Front Impact Range**

Courtesy of BMW OF NORTH AMERICA, INC.

The front airbags are fully inflated as the occupants move into contact with the airbag. After full inflation has been reached, the airbags then immediately discharge the gas from vent holes to provide progressive deceleration for the moving occupant and thus reduce the risk of injuries caused by the force of the airbag acting against the occupant.

The control unit simultaneously triggers the front seat belt pre-tensioner operation. An igniter in the seat mounted buckle assembly causes propellant to burn producing nitrogen gas.

The expanding nitrogen gas drives a piston along the piston tube, the rear of the piston is attached to a steel cable, and the other end of the steel cable is connected to the seat belt buckle.

The tension produced through the steel cable under the influence of the moving piston causes the buckle to be drawn down towards the buckle anchorage. The resulting shortened seat buckle stalk removes any slack in the seat belt in time to restrain the seat occupant during impact and airbag deployment.

The seat belt pre-tensioners have a lower activation threshold than the front airbags, therefore the pre-tensioner will deploy earlier. Depending on the severity of the crash it is possible that only the seat belt pre-tensioner will deploy and the front airbags will not (minor crashes).

The MRS control unit is able to distinguish between rough road conditions and a frontal collision. If the control unit's main sensor detects a frontal collision of sufficient severity and it is confirmed by the safing sensor, the control unit sends a fire signal to the relevant airbag module and seat belt pre-tensioner initiators.

Side Impacts

The driver and passenger side (thorax) airbags and the advanced head protection system (AHPS2) airbags are deployed in the event of a side impact of sufficient severity which exceeds the side impact trigger threshold of the side impact crash sensors. When the MRS control unit receives a signal from one of the side impact crash sensors in conjunction with the internal main sensor, the control unit activates the side (thorax) airbag and the

AHPS2 airbag on the side of the vehicle suffering the impact [also with a separate threshold the BST. The main sensor works as a "safing sensor" it must confirm the side impact request by the side sensors to deploy the airbags.

A current from the control unit triggers the module to ignite a small quantity of nitrocellulose to generate nitrogen gas. The expanding nitrogen gas punctures a pressurized argon and nitrogen gas chamber, the released gas mixes with the gas released from the nitrocellulose chamber and the combined gas expands causing airbag inflation. The inflating side (thorax) airbag bursts out of the seat cover at the outboard piping and pushes the seat occupant away from the impact force. At the same time, the AHPS2 airbag module is deployed using a similar deployment method; as the AHPS2 airbag expands it breaks out from beneath the headlining trim to protect the occupant(s) from head injuries.

When fully deployed, the side airbags offer additional protection to the front seat occupants in the event of a collision acting on the side of the vehicle. Either the driver's side airbag circuit or the passenger's side airbag circuit is activated depending on the side of the vehicle suffering the impact. After the airbags have fully inflated, the airbags progressively deflate the gas from vent holes to reduce the risk of injuries. The AHPS2 airbag deflates at a slower rate than for front and side (thorax) airbags, this is to provide additional head protection in the event of a secondary impact.

Rear Impact

The control unit detects the direction of impact, and if the impact exceeds the rear impact trigger threshold both front seat belt pre-tensioners and the BST are activated.

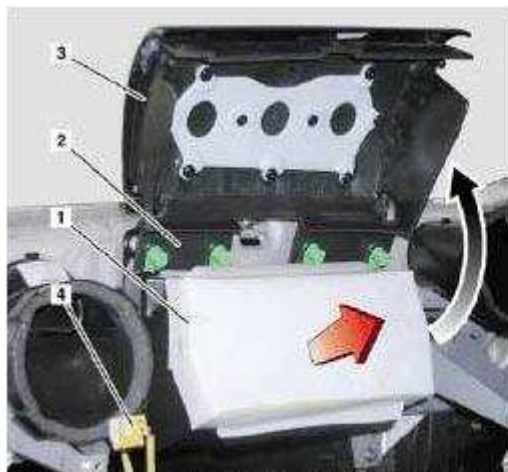
Front Angled Impacts

The deployment of airbags and seat belt pre-tensioners that occur when a vehicle is involved in a front angled collision is dependent on the speed and angle of the impact. Four possible conditions could apply:

- Impact is below the threshold for the control unit's front impact sensor and the side impact crash sensors - no response, none of the airbags or seat belt pre-tensioners are activated.
- The speed and angle of the impact is in excess of the front impact trigger threshold, but below the threshold of the side impact crash sensors - the driver's airbag, passenger's front airbag and front seat belt pre-tensioners are activated.
- The speed and angle of the impact is in excess of the side impact trigger threshold, but below the control unit's front impact trigger threshold - the driver's side (thorax) and AHPS2 airbag circuits are activated in a driver's side impact and the passenger side (thorax) and AHPS2 airbag circuits are activated in a passenger's side impact. In addition, both front seat belt pre-tensioners are activated.
- Both the front and side impact trigger thresholds are exceeded, the driver's front airbag, passenger's front airbag and both front seat belt pre-tensioners are activated. In addition, the side (thorax) airbags and the AHPS2 airbags on the side of the vehicle suffering the impact are activated.

Roll Over

The MRS system does not specifically detect roll over conditions, but if as a consequence of the crash situation the system front or side trigger thresholds are exceeded, the relevant airbags and front seat belt pre-tensioners are deployed.



1. Inflating Air Bag
2. Dash Panel Hinge
3. Dash Cover for Front Passenger Airbag
4. Module Locking Squib Connector x2

Passenger Side Airbag Deployment (<2005 MY)

Fig. 17: Passenger Side Airbag Deployment
Courtesy of BMW OF NORTH AMERICA, INC.

Workshop Hint

After repair of damage caused by a collision in which the airbag(s) did not deploy, the integrity of the MRS system must be checked using GT1.

Workshop Hint

Following deployment of the MRS within the vehicle, under any circumstances, all system components must be replaced.

Inertia Sensor (before 9/2002 production)



Fig. 18: Inertia Sensor
Courtesy of BMW OF NORTH AMERICA, INC.

Passive Safety functions handled by Inertia Sensor:

- Fuel pump shut-off.

2008 MINI Cooper

2002-09 GENERAL INFORMATION Passive Safety Systems - Overview - MINI

- Door unlock signal to BC1
- Window down Signal to BC 1
- Hazard warning lights on signal to BC1
- Turns interior lights on.

The inertia switch has a threshold of 14G's. When the threshold is exceeded the switch goes open. This open causes the shutoff of power to the fuel pump relay.

The BC1 sees the open and activates the door lock motors to the unlock position, supplies power to the windows for down operation for 750ms. and activates the hazard warning lights.