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Advanced Safety Electronics (ASE)

Model: E85

Production: Start of Production MY 2003

Objectives:

After completion of this module you should be able to:

- Relate the ASE component locations.
- Understand the operation of the ASE System.
- Explain the operation of the Battery Cable Monitoring System.

Purpose of the System

Advance Safety Electronics

Advanced Safety Electronics ASE is the passive safety system on the E85. The system is based on the same technology as the Intelligent Safety and Integration System (ISIS) of the E65/E66.

The ASE system consists of the Safety Information Module SIM and several control units, called satellites, that are linked across the *byteflight* bus. In the case of the MRS system there was only one central control unit. On the E85, the acceleration sensors are integrated into the satellites.

The actuators are directly connected to the satellites and are activated by the satellites. The satellites are fitted at strategic points in the car. The distributed sensor system in the car enables measurement of the accelerations occurring as close as possible to the outer shell of the body and at the location of the collision.

The direct recording and processing of the information in the control unit mean that significantly shorter reaction times can be achieved. The mechanical time lag within the body to a central control unit is eliminated.

The distributed sensors in the satellites provide redundant information that is interchanged via the *byteflight*. This leads to even more reliable trigger decisions. In comparison to the MRS systems used to date, the ASE enables, (for example in the event of a side-on collision) earlier triggering.

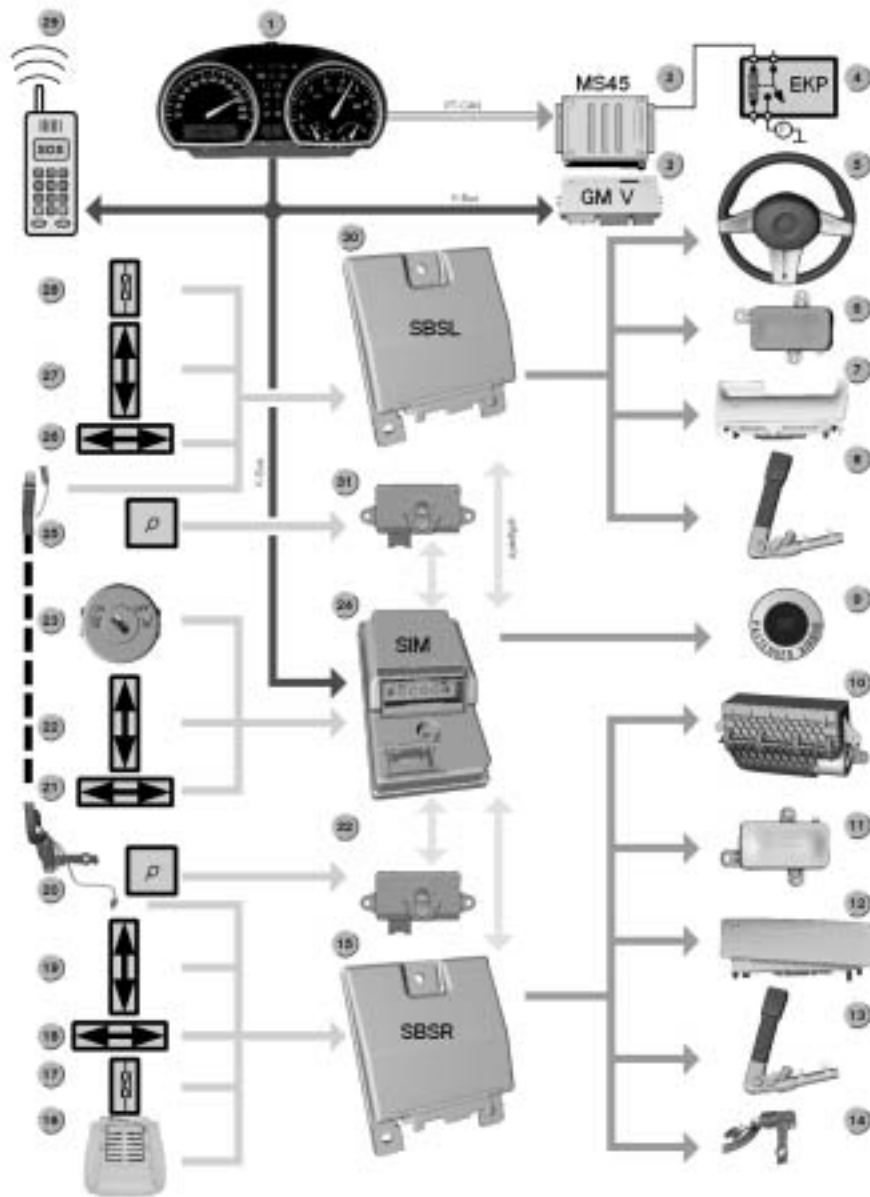
Advantages of the ASE System

- Networked airbag control system with optical bus byteflight
- More exact crash detection regarding the direction and strength of the impact
- Battery cable diagnosis with cutoff of the safety battery terminal when required
- Airbag switch for deactivation/activation of the front airbags on passenger side, side airbags and knee airbag on US models
- Deployment of a knee airbag for driver and passenger on US model

The crash situation is detected more precisely than on the multiple restraint system MRS. In the event of a crash, only those actuators are triggered that are necessary for optimum protection of the driver and passenger. This leads to lower repair costs and thus more favourable insurance classifications.

A number of acceleration sensors in the vehicle record the vehicle deceleration. The satellites exchange acceleration data. This provides an exact picture of the crash situation, enabling a timely and selective triggering of the actuators depending on the crash situation.

Advanced Safety Electronics IPO



- | | | |
|---------------------------------|---------------------------------|-----------------------------------|
| 1. Instrument Cluster | 11. Right Side Airbag | 21. Transverse Sensor in SIM |
| 2. DME Control Unit | 12. Right Knee Airbag | 22. Longitudinal Sensor in SIM |
| 3. GM V | 13. Right Seat Belt Tensioner | 23. Airbag Switch |
| 4. Fuel Pump Relay | 14. BST | 24. SIM |
| 5. Driver's Side Front Airbag | 15. SBSR | 25. Under Hood Battery Connection |
| 6. Left Side Airbag | 16. Seat occupancy sensor | 26. Transverse sensor in SBSL |
| 7. Left Knee Airbag | 17. Right seat belt switch | 27. Longitudinal Sensor in SBSL |
| 8. Left Seatbelt Tensioner | 18. Transverse sensor in SBSR | 28. Left Seatbelt Switch |
| 9. Airbag Indicator Lamp | 19. Longitudinal sensor in SBSR | 29. Telephone Emergency Call |
| 10. Passenger Side Front Airbag | 20. Trunk Battery Connection | 30. SBSL |

System Components

The ASE system consists of the following components:

- **byteflight bus**
- **Control Units**
 - SIM - With acceleration sensors
 - SBSL - satellite b-pillar on left side of vehicle
 - SBSR - satellite b-pillar on right side of vehicle
- **Sensors**
 - STVL - pressure sensor left door
 - STVR - pressure sensor right door
 - Seat occupancy sensor
 - B+ Cable Monitoring
 - Seat Belt Switches -Driver and Passenger
 - Airbag Switch
- **Actuators**
 - Driver's Side Airbag (2 stage)
 - Passenger Side Airbag (2 stage)
 - Side Airbags (2)
 - Knee Airbag Driver's Side
 - Knee Airbag Passenger Side
 - Seat Belt Tensioners (2)
 - BST
 - Airbag Indicator Light

byteflight

The increasing complexity of in-car electronics and the growing amount of sensors, actuators and electronic control units place higher demands on the high-speed data communication protocols.

None of the communication solutions available until now have been able to fulfill all these demands.

BMW together with several semi-conductor companies have developed **byteflight** a new protocol for safety-critical applications in automotive vehicles.

The **byteflight** is the bus system used exclusively for the ASE System (Intelligent Safety Integration System). This ASE System of the E85 contains the Safety and Information Module (SIM) and 4 additional satellite control modules.

The ASE System is a bus composed of Fiber Optic cables and control modules arranged in a STAR pattern with the SIM at the center of the system.

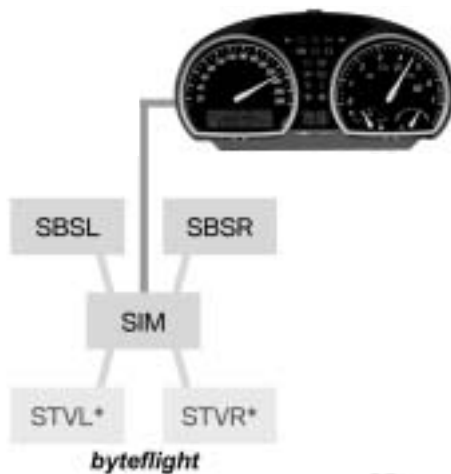
Since the **byteflight** is a star structure as opposed to the continuous ring structure of the MOST bus, the fiber optic cables carry the data bi-directionally, a single fiber optic cable connects each satellite directly to the SIM.

Each satellite contains a transmitter/receiver module for receiving and sending data to the SIM. The SIM contains 4 transmitter receiver modules for communication with the satellites simultaneously.

All information from each satellite is made available to every other satellite by the SIM.

Note:

Repairs to the **byteflight** fiber-optic cable are not permitted. Damaged cables must be replaced with new fiber optic cables.



ASE *byteflight* Bus System

Because of the use of **byteflight**, the ASE system has the following advantages:

- High communication speed
- Highest level of system security
- Faster trigger decisions
- Redundant information provided by the sensor
- Software update via bus
- Self-diagnostic procedure
- Mechanical safety switch is unnecessary
- No electromagnetic disturbances due to fiber-optic communication
- No electrical connection between transmitter and receiver module
- Simple system upgrade

Control Units

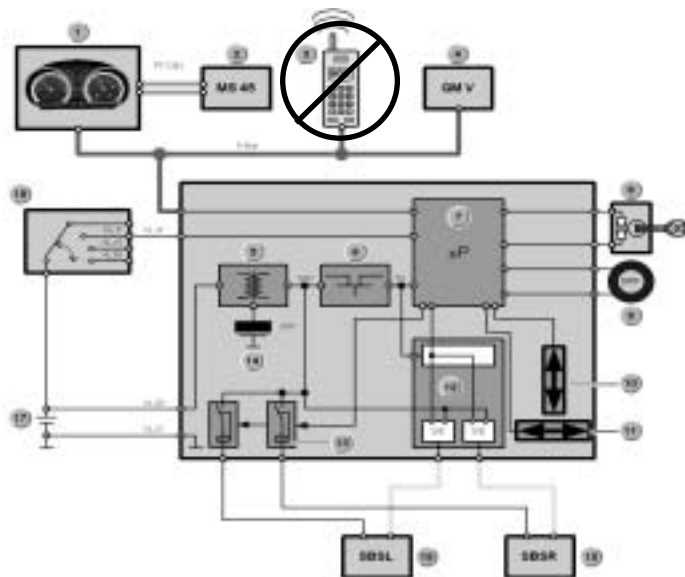
SIM

Located on the transmission tunnel behind the handbrake assembly, the Safety and Information Module (SIM) performs the following functions:



SIM Location

- Supplies voltage to the satellites and the pressure sensors (SBSL,SBSR and STVL,STVR) and supplies the voltage reserve for component activation.
- Bus Master functions for the optical bus communication system (**byteflight**).
- Gateway functions between **byteflight** and K-bus.
- Triggers Emergency Call System (If Phone equipped)
- Signals the DME for deactivation of fuel pump.
- Signals the GM to switch on interior lights, hazard warnings and unlock the doors.
- Monitors the integrated acceleration sensors.
- Allows airbag activation.
- Allows BST activation.



1. Instrument Cluster
2. DME
3. Mayday Function (Not available at this time)
4. GM V
5. Switching Controller
6. Voltage Regulator
7. Microprocessor
8. Airbag Switch
9. Airbag Indicator Lamp
10. Longitudinal Acceleration Sensor
11. Transverse Acceleration Sensor
12. Star Coupler
13. Distributor
14. Energy Reserve Capacitor
15. Right B-Pillar Satellite
16. Left B-Pillar Satellite
17. Battery
18. Ignition/Starter Switch

Power Supply

The SIM is supplied with voltage KL terminals 30 and ground from KL31. If the vehicle voltage is sufficient then a switching controller is supplied first, which supplies voltage to the intelligent Star Coupler and the power supply.

The second switching controller is supplied by KL 30 during operation and is controlled by the microprocessor via the cable SHDN 2. The capacitor is charged as of KL R.

The charging of the capacitor forms the emergency energy reserve. The capacitor voltage is 33V. (Energy Reserve in the E65 is 400v.)

Bus Master Functions

The SIM has two tasks to perform as Bus Master for the *byteflight*.

- Generation of the synchronization pulses (Sync. Pulse)
- Setting the satellites in alarm mode (Alarm Pulse)

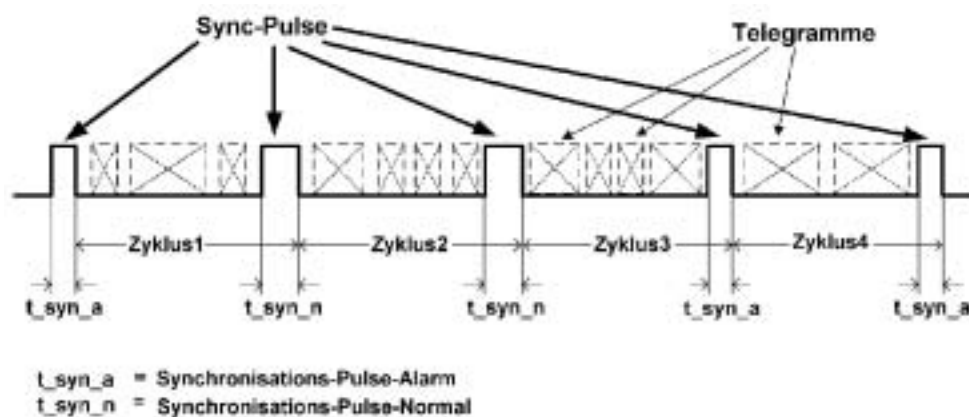
In the ASE, the SIM is configured as *byteflight* master (bus master). In principle, any satellite can be configured by software as bus master. However, there may only be one bus master in the system.

All other satellites (bus slaves) use the sync pulse for internal synchronization. Each slave can transmit telegrams between the sync. pulses on the *byteflight*.

The SIM provides the synchronization pulses at intervals of $250\mu\text{s}$. The alarm mode is transmitted across the width of the sync. pulse. The duration of a sync. pulse in alarm status is approx. $2\mu\text{s}$. Normally, the synchronization pulse lasts approx. $3\mu\text{s}$. The duration of a complete telegram can vary between 4.6 to $16\mu\text{s}$.

On the basis of all the available information provided by the sensors, the bus master (SIM) must decide whether the satellites are to be set in the alarm mode.

When the alarm mode is set by the SIM, all the trigger circuits (B+) of the ASE are placed on trigger standby.



Gateway

The SIM contains the gateway function between the byteflight and K-bus. This means that telegrams can be sent by the byteflight to the K-bus and vice versa.

The gateway function transfers both the content of functional telegrams as well as the telegrams for diagnosis.

Gateway from K Bus to *byteflight*

Information and messages for the ASE system are forwarded by the K-bus as telegrams to the byteflight (gateway function of the SIM). The telegrams are processed in the SIM.

The following telegrams are transmitted:

- Terminal status
- Kilometre reading
- Vehicle identification number

Gateway from byteflight to the K-Bus

The messages and information from the byteflight that are meant for other nodes on the K-bus are converted by the gateway function into a K-bus telegram. The following signals are transmitted in a telegram (crash telegram):

- Switch on airbag warning lamp, AWL
- Switch off electric fuel pump
- Switch off alternator
- Transmit emergency call
- Open central locking system
- Switch on passenger-compartment lighting and hazard warning light

Notes:

B-Pillar Satellites (SBSL and SBSR)

The left side B-Pillar Satellite (SBSL) controls and monitors the actuators for the left front airbag, the left side airbag (in the drivers door), the left seat belt tensioner and the left knee airbag.

The right side B-Pillar Satellite (SBSR) controls and monitors the actuators for the right front airbag, the right side airbag (in the passenger door), the right seat belt tensioner, the right knee airbag and the BST.

Both B-Pillar Satellites function as monitors for the BST.



SBSL Location



SBSR Location

The B-Pillar satellites are connected to the SIM via the byteflight. The power supply of the satellites is also from the SIM and it is buffered by the memory backup capacitor.

An acceleration sensor for the longitudinal and transversal acceleration is integrated in each B-Pillar satellite. The sensor provides voltage as a measured variable and transfers the value via the byteflight to the SIM and all other satellites.

The voltage signal is a measurement of positive and negative car acceleration and is evaluated in each satellite. The voltage signal is continuously provided to the SIM and other satellites.

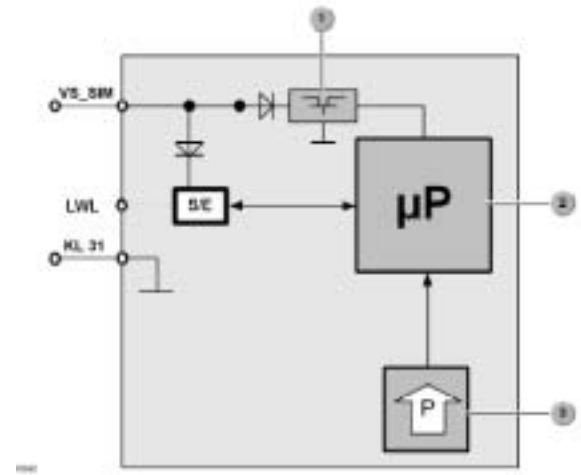
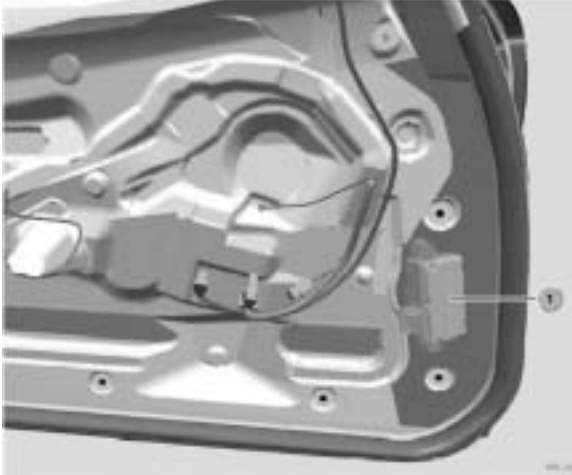
Sensors

Door Satellites (STVL/STVR)

The Door Satellites (STVL/STVR) are located in the left/right passenger doors.

The door satellites are connected to the SIM via the byteflight. Power supply for the door satellites is also provided by the SIM and is buffered by the memory backup capacitor.

A pressure sensor, which constantly monitors the pressure in the door, is integrated into each door satellite. Pressure changes in the door that occur during penetration of the outer door skin are evaluated and passed on through the SIM for airbag deployment activation.



1. Voltage Regulator	VS_SIM Voltage Supply
2. Microprocessor	KL31 Terminal 31
3. Pressure Sensor	LWL byteflight
S/E Transmitter/Receiver	

Seat Occupancy Sensor

A seat occupancy detection mat is installed in the seat cushion of the passenger seat. The sensor mat is identical to the mats used in previous models for the MRS systems. The sensor system consists of pressure sensors that use an electronic evaluation unit (SBE) to detect whether there is weight on the seat.

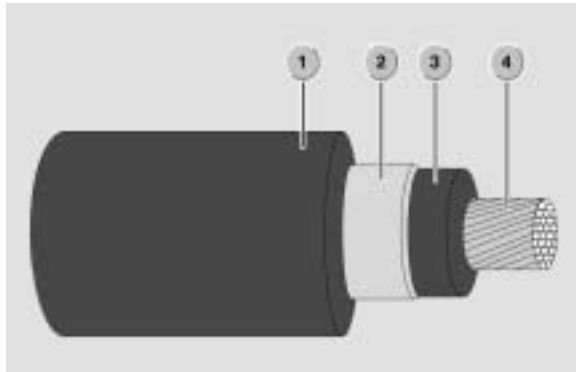
As a weight of approx. 12 kg (26.4lbs.), the seat is recognized as occupied. The electronic evaluation unit of the seat occupation mat is disconnected to the SBSR satellite.

The information regarding seat occupation is required for activation of the following functions:

- Airbag activation
- Activation of the seatbelt tensioners

B+ Cable Monitoring

The E85 B+ Battery Cable is routed from trunk area along the underside of the car into the engine compartment. If the cable is damaged in an accident or while driver over an obstacle, the BST is activated, protecting the vehicle from further electrical problems.



B+ Monitored Battery Cable

1. Outer insulation
2. Monitoring Shield
3. Insulation of aluminum cable
4. Aluminum cable 35mm2

The battery cable monitoring occurs via the low impedance shield of the battery cable, the monitoring shield. The monitoring point in the trunk at the BST is connected to the SBSR and the other monitoring connection in the engine compartment is connected to the SBSL.

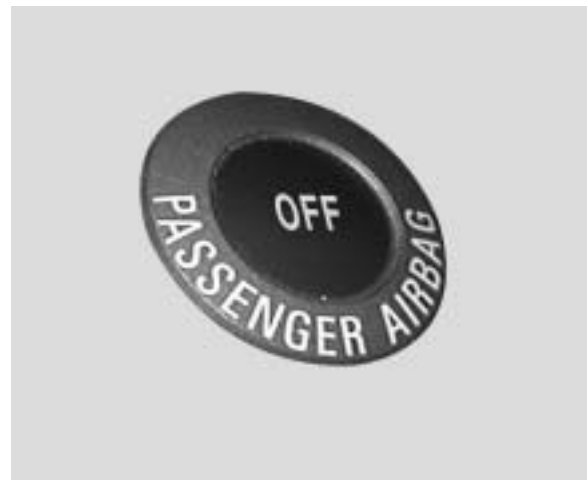
Seat Belt Switches

The Seat Belt Switches are located in the seatbelt buckles of the driver and passenger seat belt. The switch is a two wire hall switch and is supplied with voltage by the respective left and right B-Pillar satellites (SBSL/SBSR). The voltage is pulsed to the switch to reduce voltage consumption.

The seat belt switches are used to detect whether or not the seat belts have been fastened. The input from the switches is required for the following functions:

- Selective triggering of actuators in the event of a crash
- Activation of the Seat Belt Warning Lamp
- Out of the acoustic warning

Airbag Switch



The airbag switch is located on the right side of the dashboard at the A-Pillar and the indicator lamp for is located in the center console.

The airbag switch makes its possible for the driver to determine if the passenger front and side bags are active. The front passenger and passenger side airbag are activated or deactivated together only.

To prevent accidental activation or deactivation of the passenger airbags the switch may only be operated by the ignition key while the car is not moving and the passenger door is open.

The airbag indicator lamp consists of a number of LED's controlled by the SIM.

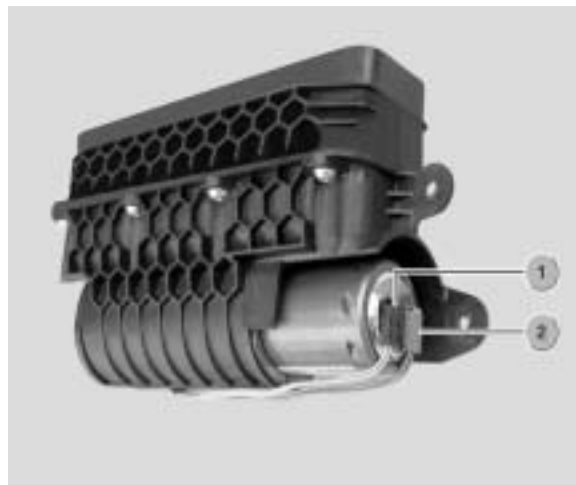
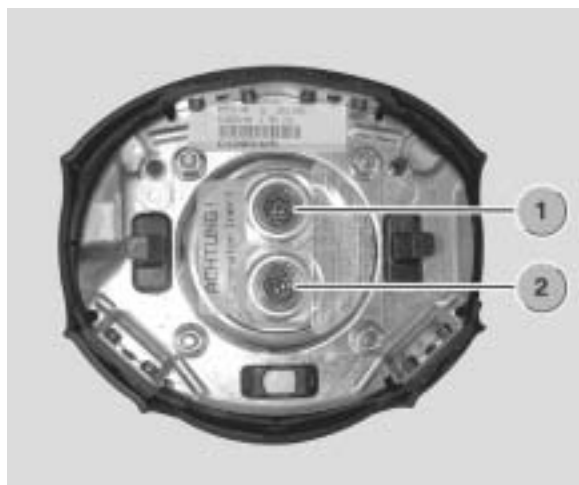
Actuators

Driver's Airbag

The Driver's Airbag is located in the impact pad of the three spoke steering wheel.

The Bag is equipped with a 2-stage gas generator and has a volume of approximately 60 liters.

Three colors are available to match the interior colors. (Black, Brown, Grey)



1. Stage 1
2. Stage 2

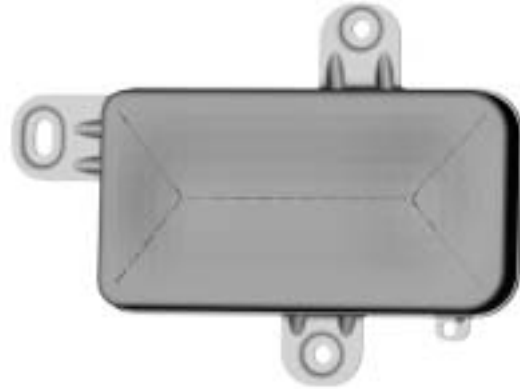
Passenger Airbag

The Passenger Airbag is located beneath an invisible flap in the dashboard. The airbag is a 2-stage design with a volume of approximately 125 liters. Depending on the severity of the crash, the two stages are ignited so the the bag can unfold in a defined manner.

Side Airbags



E85 Side Airbag in door



E85 Side Airbag Module

The side airbags in the doors reduce the risk of occupant injury in the torso region of the body in the case of a side-on crash.

The side airbags are located behind the door trim. The side airbags are secured to the inner door panel with 3 screws.

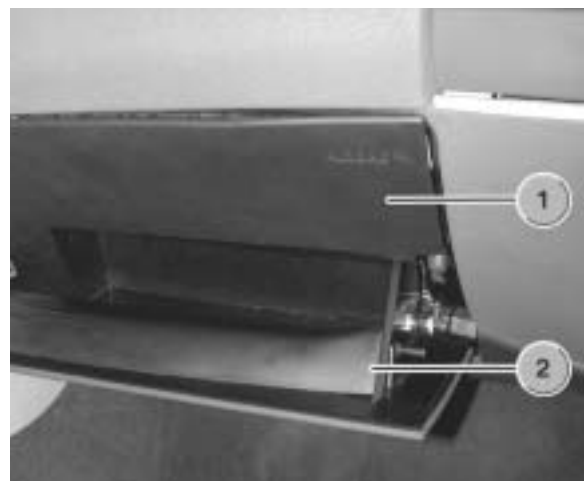
The side airbags are folded up in an aluminium housing with a plastic cover. The plastic cover has defined breaking points.

Knee Airbags



Drivers Knee Airbag

1. Drivers Side Knee Airbag



Passenger Knee Airbag

1. Passenger Knee Airbag
2. Glove Compartment

In the event of a crash, the knee airbag supports the knee, especially if the driver or passenger are not wearing seatbelts. This initiates a controlled forward shift of the upper body, which is cushioned by the relevant airbag.

The knee airbag is a one-stage airbag with gas generator. The volume is approx. 13 litres.

Seat Belt Tensioner

The pyrotechnic seatbelt tensioner has the task in the event of a crash to remove or reduce any belt slack in the pelvic and shoulder region.

The seatbelt tensioner is located on the driver's and/or passenger seat. The seat belt tensioners form a unit with the seat belt buckle.

The seatbelt tensioner consists of priming cap, generator, plunger and operating cable. The belt buckle switch is integrated in the seatbelt buckle.



Seat Belt Tensioner



Battery Safety Terminal

Battery Safety Terminal

In the event of a crash of sufficient severity or if the battery cable diagnosis is activated, the starter/alternator line is electrically and mechanically cut from the positive terminal of the battery.

The safety battery terminal is located directly at the positive terminal of the battery.

Airbag Indicator Lamp



The airbag indicator lamp is activated when the airbag switch assigns the state "**Passenger Airbag OFF.**"

The airbag indicator lamp is activated by the SIM.

The airbag indicator lamp is diagnosed and monitored. If a fault is found in the power supply or at the lamp, a fault entry is made in the SIM.

The airbag warning lamp is activated.

Principle of Operation

The SIM now has 4 transmit/receive modules to which the satellites are connected. The energy reserve in the SIM has been reduced to 33 V (ASE 400 V), as now only 4 satellites have to be supplied with voltage in the event of a crash.

New additions are the acceleration sensors for the X/Y direction.

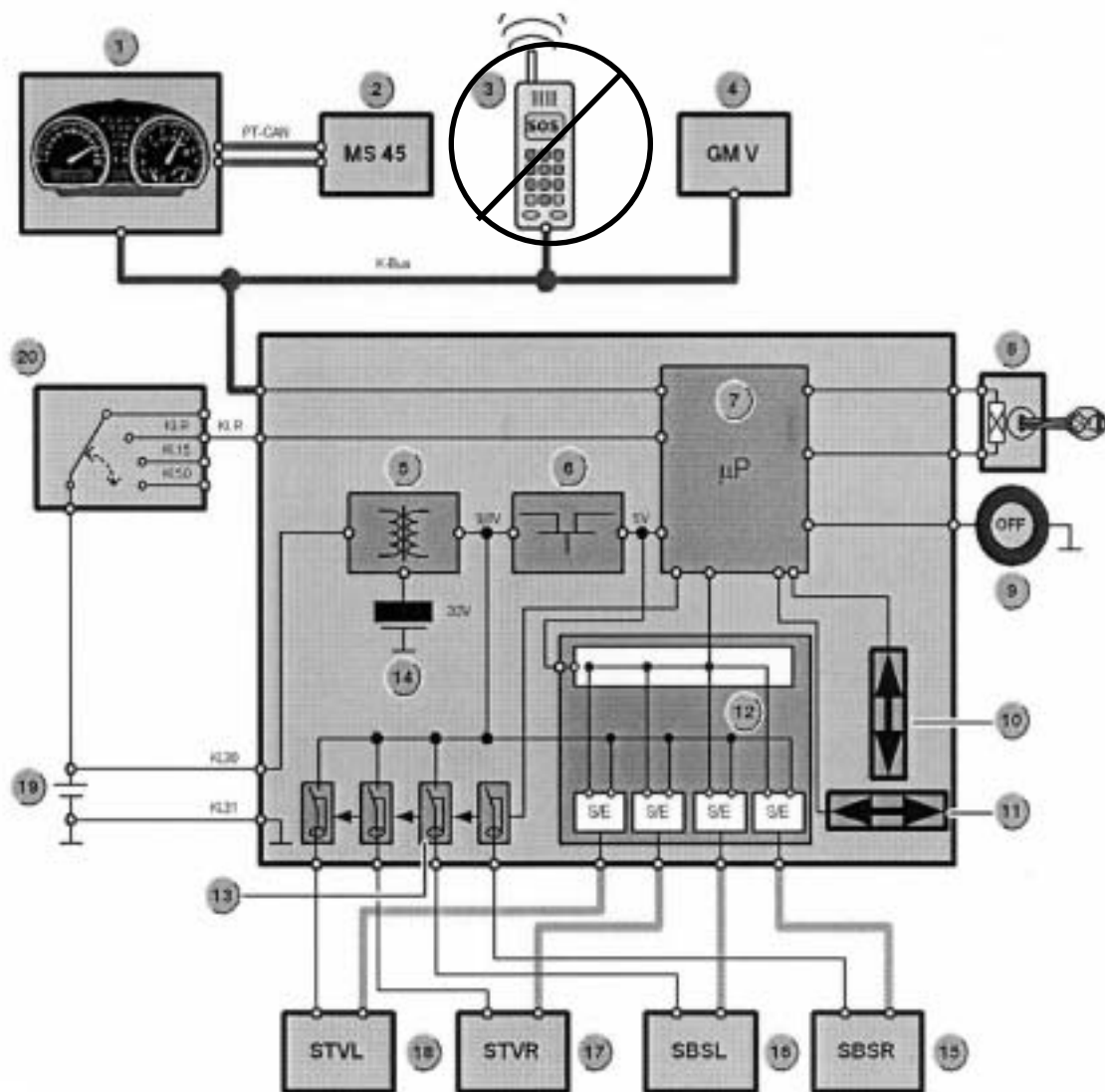
The acceleration sensors for the X/Y direction measure the longitudinal and transversal acceleration of the vehicle and are evaluated in the SIM. The sensors continuously provide the values determined. The values are transferred across the byteflight to all satellites, as are the measured values of the satellites. The algorithms in the satellites work with these measured values. The SIM compares the values and triggers the alarm mode via synchronization pulses if the severity is sufficient.

The alarm mode places the satellites in a triggerable state. Depending on the crash severity and the stored trigger algorithms, the actuators required in each case are activated.

Note:

If an airbag switch is fitted and the switch is in the position "deactivated," the front airbag on the passenger side and the side airbag are not placed in the triggerable state. The knee airbag and the seat belt tensioner are also not place in the triggerable state.

The vehicle centre satellite has been eliminated, as the SIM is fitted in the middle of car and the acceleration sensors are integrated in the SIM.



- | | |
|--|------------------------------------|
| 1. Instrument cluster | 11. Transverse Acceleration sensor |
| 2. DME Control Unit | 12. Star Coupler |
| 3. Telephone Emergency Call (Not Available at SOP) | 13. Distributor |
| 4. General Module GM V | 14. Energy Reserve |
| 5. Switching controller | 15. Right B-Pillar Satellite |
| 6. Voltage Regulator | 16. Left B-Pillar Satellite |
| 7. Microprocessor | 17. Right Door Satellite |
| 8. Airbag Switch | 18. Left Door Satellite |
| 9. Airbag Indicator Lamp | 19. Battery |
| 10. Longitudinal acceleration sensor | 20. Ignition/Starter Switch |

Airbag Triggering

Numerous crash and road tests under extreme conditions have been used to set the BMW triggering thresholds for all possible types of accidents.

The triggering thresholds are primarily divided into 4 groups according to crash severity:

- CS 0: no crash (parking damage)
- CS 1: light crash
- CS 2: crash of medium severity
- CS 3: severe crash

CS=Crash Severity

The triggering thresholds have been set depending on the crash severity and including other factors such as direction, overlap on collision, and depending on the evaluation as to whether the occupant was wearing a seatbelt or not.

This results in the various trigger thresholds for the activation of the various restraint systems.

Triggering in the event of errors

If a fault is detected in the seatbelt buckle detection system, it is assumed that the seatbelt is not fastened. The triggering threshold is lowered. In spite of the fault recognition, an attempt is made to activate the seatbelt lock tensioner.

If a fault is detected in the seat occupation detection system, it is assumed that the seat is occupied. The restraint systems are activated.

If a fault is detected in the airbag switch, it is assumed that a child's seat is fitted. The front airbag and side airbag on the passenger side are not triggered.

Triggering in the event of a crash

The following examples illustrate the actuators that can be activated:

- Front-end crash
- Side-on collision
- Rear crash

Front-end crash

In the event of a front-end crash, a distinction is made between crash severity "light to medium collision" or "severe collision" (CS 3).

In the case of crash severity from light to medium collision (CS 1/CS 2), the driver's/front passenger's airbag are not triggered if it is detected that the occupants are wearing seatbelts.

If the occupants are **not** wearing seatbelts, the driver's and front passenger's airbag would be triggered.

The seatbelt tensioners are triggered in all cases.

As of crash severity CS 2, the driver's/front passenger's airbag as well as the seatbelt tensioners are triggered. The safety battery terminal is activated, the electric fuel pump is switched off, and an emergency call is placed if a correspondingly prepared telephone is present in the vehicle.

In the US version, the knee airbags are also triggered.

Side-on collision

In the event of a side-on collision, a crash severity distinction is made between medium and severe collisions.

As of crash severity of CS 2 (medium collision), the side airbag is triggered on the impact side. In the event of crash severity CS 3 (severe collision), the safety battery terminal is also activated, the electric fuel pump is switched off, and an emergency call is placed if a correspondingly prepared telephone is present in the vehicle.

Rear crash

As of crash severity CS 2 (medium collision), the seatbelt tensioners are triggered.

In the event of crash severity CS 3 (severe collision), the safety battery terminal is also triggered, the electric fuel pump is switched off, and an emergency call is placed if a correspondingly prepared telephone is present in the vehicle.

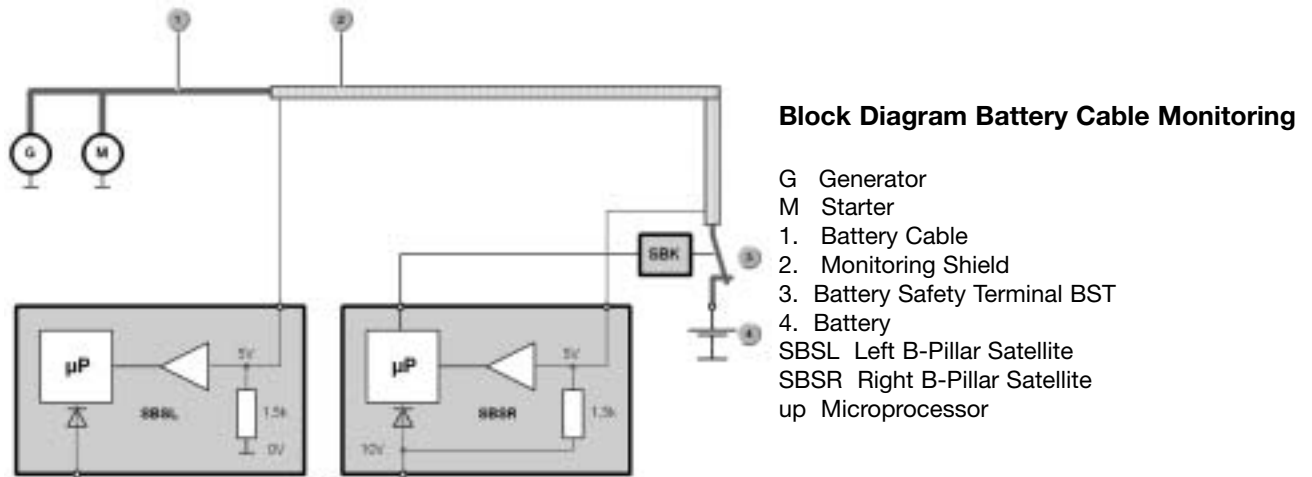
Knee Airbag

In the event of a crash of sufficient severity, the gas generator is ignited. The escaping gas fills the airbag, which tears open the cover of the knee airbag so that the airbag can emerge.

The airbag spreads out beneath the steering column and/or in front of the glove compartment and cushions the lower thighs of the occupant.

The support of the lower thighs initiates a controlled forward shift of the upper body, which is cushioned by the driver or passenger airbag.

The knee airbags can only be seen by the lettering "AIRBAG" on the cover of the airbag module as well as on the cable connection for the airbag module.



Battery Cable Monitoring

The battery cable is diagnosed by a special circuit between the SBSL and SBSR satellites.

The battery cable diagnosis takes place across the low impedance shield of the battery cable (monitoring shield). The monitoring shield monitors the state of the battery cable as follows:

There are connections to the left B-pillar satellite and the right B-pillar satellite at both ends of the shield. This means that there is usually the same voltage at the analog/digital converters in the satellites. If the voltages differ, there is a fault.

The monitoring shield consists of a low-impedance metal mesh. A connection cable exits from each end of the monitoring shield (at the safety battery terminal in the luggage compartment and at the battery earth point in the engine compartment).

The connection at the safety battery terminal in the luggage compartment is connected to the right B-pillar satellite. The second connection cable in the engine compartment is connected to the left B-pillar satellite.

The satellites contain analog/digital converters that are connected to the microprocessor of the satellite. The connection cables of the battery cable diagnosis are connected to the A/D converters.

The right B-pillar satellite contains a pull-up resistor.

The left B-pillar satellite contains a pull-down resistor of the same size.

The voltage supply of the satellite (approx. 10 V) is applied at the pull-up resistor. Ground is applied at the pull-down resistor.

The very low-impedance cable and the resistors of the same size mean that around half the voltage (approx. 5 V) is applied at the A/D converters.

Every 250 µs, the values are measured, triggered by the synchronization pulse. If the battery cable is OK, the values are transferred every 20 ms to the SIM. If a significant deviation of the values occurs, the new values are transferred immediately.

In the following cases, the battery cable is cut off by the safety battery terminal from the battery and the alternator is switched off:

- Short circuit to ground (body)
- Short to battery positive

If the outer insulation is damaged (e.g. due to friction/scuffing), but the monitoring shield has no connection to ground, the following case could occur:

Moisture (rain) would mean that the voltage would gradually fall. A short circuit to ground would be detected, but the safety battery terminal would not be triggered.

The entry "Implausible measured value" is set in the fault code memory. This would be indicated to the driver by the airbag warning lamp.

State	Measured Value SBSL	Measured Value SBSR
Battery Cable OK	5V	5V
Interruption of the diagnostic connection	0V	10V
Short circuit to ground	0V	0V
Short to B+	12v	12v

Service Notes

The following must be observed by Service:

- Battery cable diagnosis
- Safety battery terminal
- Airbag warning lamp

Battery cable diagnosis

If the shielding of the battery cable is damaged, the battery cable must be replaced completely. It is not permitted to repair the shielding.

Safety battery terminal

If the safety battery terminal is activated, the battery cable must be replaced completely. Repair is not intended.

Airbag warning lamp

If there is a fault and the airbag warning lamp is switched on, the mileage is also documented in the fault code memory in the instrument cluster.

A mileage reading that has been entered can not be overwritten. For this reason, in the case of an airbag fault, the fault code memory in the instrument cluster must also be checked and deleted.

Review Questions

1. The byteflight system is arranged as a _____ structure.
2. What advantages does the byteflight fiber optic system offer over a copper wired bus system. _____

3. What functions does the SIM perform ? _____

4. What is the purpose of the STVL/STVR Satellites? _____

5. What conditions must be met for the airbag switch to activate or deactivate the airbags? _____
6. Which airbags are activated/deactivated by the airbag switch? _____

7. What component supplies the voltage to the battery monitoring cable in the trunk? _____
8. Damage to ONLY the outer insulation of the monitored battery cable would result in what action being taken at the BST? _____

9. When must the monitored battery cable be replaced? _____

10. How is the ASE warning light in the Instrument cluster turned off?

