1 Project Data

This project is a shared project in co-operation between the companies Helbako and Siemens.

2 Description of the System

2.1 General Product Data

The release of the passenger airbag must be prevented in case of the presence of a child seat on the passenger seat, because an airbag release might cause serious injuries of the child. Apart from this, a release of the passenger retract mechanism is not necessary if the passenger seat is not occupied, which would result in lower repair costs of the vehicle.
In this product specification, the interface electronics of the automatic child seat presence and seat occupancy detection (AKSE) shall be described.

As two different communication protocols are used for the data transfer from the AKSE to the airbag control unit, this shall be differed in the particular sections by the use of "a)" and "b)". In this case, the section mark "a)" shall be used for the "20 baud protocol" whereas the section mark "b)" shall be used for the "100 baud protocol".

2.2 General Test Conditions

The operation of the interface electronics is guaranteed with regard to the data and limiting values that are mentioned in this product specification. The values of the voltages, flows, performances, etc., which are mentioned hereinafter, refer to the connecting pins of the interface electronics.

2.3 Performance

2.3.1 General Description

The automatic child seat presence and seat occupancy detection system must fulfil the following tasks:

- Seat occupancy detection:
  The system is connected with a resistive foil printing sensor (FSR™) in the passenger seat. The condition of the sensor is periodically controlled and analysed. If there is a person on the passenger seat, his presence is detected from a defined seat weight and the status "passenger seat occupied" is set. This status is transferred to the airbag control unit in a protocol.
- Child seat detection:
  For the detection of a child seat on the passenger seat, an inductive coupling system is utilised. For this purpose, transmitting and receiving antennas are moulded on the foil printing sensor. The control unit inductively excites a resonator in the child seat by the transmitting antenna. This resonator gains its operating voltage from the exciting field and modulates a phase shift on the transmitting signal by the periodical change of its resonant frequency. The phase shift that is caused by the resonator is detected at the receiving antenna and will be regained by means of a demodulator (including the subcarrier frequency).

The system is able to detect the orientation of the child seat (in the forward and backward position). For this purpose, the system is constructed as follows: it is provided with a transmitting antenna and two receiving antennas that are positioned in the right and left half of the passenger seat. Furthermore, there are two resonators in the child seat.

2.3.2 Performance Characteristics

The interface electronics AKSE is characterised by the following performance:

- Utilisation of a combined sensor mat with transmitting and receiving antennas that are moulded on the foil printing sensor.
- Integration of all electronics on a board that is tightly connected with the sensor mat embedded in the passenger seat.
- Generation of a sinusoidal gating signal in the 130 kHz band for the contactless energy and information transfer.
- Adaptation of the transmitting signal to different environmental conditions by variation of the frequency and the amplitude.
- demodulation of the phase-modulated signal of the child seat resonators.
- Measuring of the resistance of the foil printing sensor to the seat occupancy detection
- Self-diagnosis of the performance part and the demodulation circuit
- Provision of an interface to the airbag control unit for the transfer of the AKSE status.
- Testing of the foil printing sensor and the transmitting/receiving antennas with regard to interruption and short circuit
- Analysis of the child seat resonators even in case of a failure of the reset function of the resonator.

These functions are realised by the operation of a micro controller which takes over the whole control. By means of a cyclic sequence of a test, the functional reliability of the system is guaranteed.

2.3.3 Seat Occupancy Detection

2.3.3.1 Operating Sequence

The measuring of the status of occupancy of the passenger seat is executed periodically with reference to the cycle time defined in chapter 2.4.2.2.2.4. For the differentiation of a line break and the non-occupied seat, the foil printing sensor is sequentially addressed by voltages with different polarisation. For the measuring of the resistance of the parallel-conducted SBE conductor lines, a series-connected diode is operated in conducting direction. Otherwise, in the case of measurement of the foil sensor resistance, this diode is operated in non-conducting direction and does not influence the measurement.

The resistance level for the transition of 'seat occupied' and 'seat non-occupied' is in the range of 48 kOhm R_{SBE} < 80 kOhm .

The request cycle for the seat occupancy detection depends on the latest status of the AKSE. The particular request cycles of the SBE are listed in chapter 2.4.2.2.2.4.

2.3.3.2 Self-controlling System

The self-controlling system of the SBE consists of measurements that are executed in cycles.

The cyclic tests that are executed on the basis of direct current measuring consist of the following examinations:

- Insulation resistance of the SBE to the transmitting antenna
- Insulation resistance of the SBE to the receiving antenna
- Insulation resistance of the SBE to earth
- Insulation resistance of the SBE to UBATT
- Short circuit in the SBE
- Interruption of the SBE
- Voltage drop of the switching transistors for the FSR analysis

Table 1 : Error thresholds SBE

Measurement		min	max
Insulation resistance of the SBE to the transmitting antenna	<	10 kOhm	980 kOhm
Insulation resistance of the SBE to the receiving antenna	<	12 kOhm	400 kOhm
Insulation resistance of the SBE to earth	<	10 kOhm	500 kOhm
Insulation resistance of the SBE to UBATT	<	100 kOhm	1 MOhm
Short circuit in the SBE	<	50 Ohm	150 Ohm
Interruption of the SBE	>	3 kOhm	8 kOhm
Voltage drop of the switching transistors for the FSR analysis	>	0.8 V	1.3 V

2.3.3.3 Error Qualification

a) For the 20 baud protocol the following applies

In the case of hardware failures, the tests are repeated according to the EEPROM parameter TD_QC. If the error occurs in a sequence of n times, the error message is transferred to the airbag SG with the next data protocol. The error qualification n can be set in the EEPROM parameter QUAL_ERR.

Once the error is qualified, the hardware is tested according to the cycle which is set in the EEPROM parameter TD_QC_ERR.

If no more hardware failure occurs, the tests are repeated according to the EEPROM parameter TD_QC. If no more error occurs in a sequence of n times, the new status is transferred to the airbag SG with the next data protocol. In case of an error dequalification, the EEPROM parameter QUAL_ERR is also applied.

During the qualification of an error, the status counters are not altered. Once the error is qualified, all status counters are reset.

b) For the 100 baud protocol the following applies

In the case of hardware failures, the tests are repeated according to the EEPROM parameter TD_QC. If the error occurs in a sequence of n times, the error message is transferred to the airbag SG with the next data protocol. The error qualification n can be set in the EEPROM parameter QUAL_ERR.

Once the error is qualified, the hardware is tested according to the cycle which is set in the EEPROM parameter TD_QC_ERR.

If no more hardware failure occurs, the tests are repeated according to the EEPROM parameter TD_QC. If no more error occurs in a sequence of n times, the new status is transferred to the airbag SG with the next data protocol. In case of an error dequalification, the EEPROM parameter QUAL_ERR is also applied.

During the qualification of an error, the status counters are not altered. Once the error is qualified, all status counters are reset.

2.3.4 Child Seat Detection

2.3.4.1 Operating Sequence

For the detection of the child seat, the transmitting antenna in the 130 KHz band is excited. With a variation of the frequency, the respective resonant frequency of both resonators in the child seat is determined. By means of the signal strength on both receiving antennas (after the execution of a phase modulation), the position of the child seat is determined. In addition, the type of child set is read out from the resonators.

The request cycle for the child seat detection depends on the latest status of the AKSE. The particular request cycles are listed in chapter 2.4.2.2.2.5.

After the evaluation of the subcarriers of the two demodulator channels and the IDs of the resonators, the latest status of the child seat detection is determined according to the decision matrix listed in chapter 2.3.4.4.

In case of a detected child seat and a sufficient subcarrier amplitude (EEPROM parameter : U_KSE_ID_MAX), a smaller transmission level is actuated with the next scan. If no child seat is detected or the subcarrier amplitude is lower than the value that is indicated in EEPROM (U_KSE_ID_IMIN) the maximum transmission level is used with the next scan.

If no subcarrier is determined, the cyclic demodulator test is executed which examines the receiving channels, demodulators as well as sample and hold filter structures.

2.3.4.2 Evaluation of Subcarriers

The demodulation of the receiving signal is effected by its combination with the frequency-synchronous transmitting signal; after the subsequent band-pass filtering, this results in a desired low-frequency signal (approx. 2.3 kHz in case of type B and approx. 3.3 kHz in case of type A). After this, the binary protocol of the resonator is determined by another frequency-synchronous demodulation. The reception frequency systematically results from the divisor factor 40 and 56 of the transmitting frequency. With the evaluation of the frequency rates for the right and left channel, it is determined whether a sufficient differentiation of the reception level is possible, and whether an allocation of the direction can be executed.

The limiting values for the decision on a sufficient differentiation are stored in the EEPROM and are to be specifically determined for each seat.

3 frequencies are examined with each frequency scan. If a scan executed the examination of the odd frequencies (1, 3, 5) , the even frequency levels (0, 2, 4) will be set for the next scan. With each frequency, the two receiving signals are subsequently demodulated by means of subcarrier A and subcarrier B. As the phase position between carrier and receiving signal is not known, the phase position of the created subcarrier is also shifted. The resulting output signals of the demodulator are scanned 64 times and the average value is calculated. The determined amplitudes are added for the 3 frequencies. The ratios of the 4 calculated subcarrier amplitudes determine the position of the child seat.

For a directional detection of the child seat position, which is independent of the mounting position, the right-left allocation of the receiving antennas can be exchanged by means of an EEPROM parameter(bit 5 in parameter ZAE_TYP). For the detection of the child seat direction, the following algorithm is applied:

1:

IF subcarrier A on the right demodulator channel is one factor X (EEPROM parameter K_KSE_HT_RAT) bigger than subcarrier A on the left channel,

AND subcarrier B on the left demodulator channel is one factor X (EEPROM parameter K_KSE_HT_RAT) bigger than the subcarrier B on the right channel,

AND subcarrier A on the right channel is bigger than the given minimum subcarrier (EEPROM parameter U_KSE_HT_MIN),