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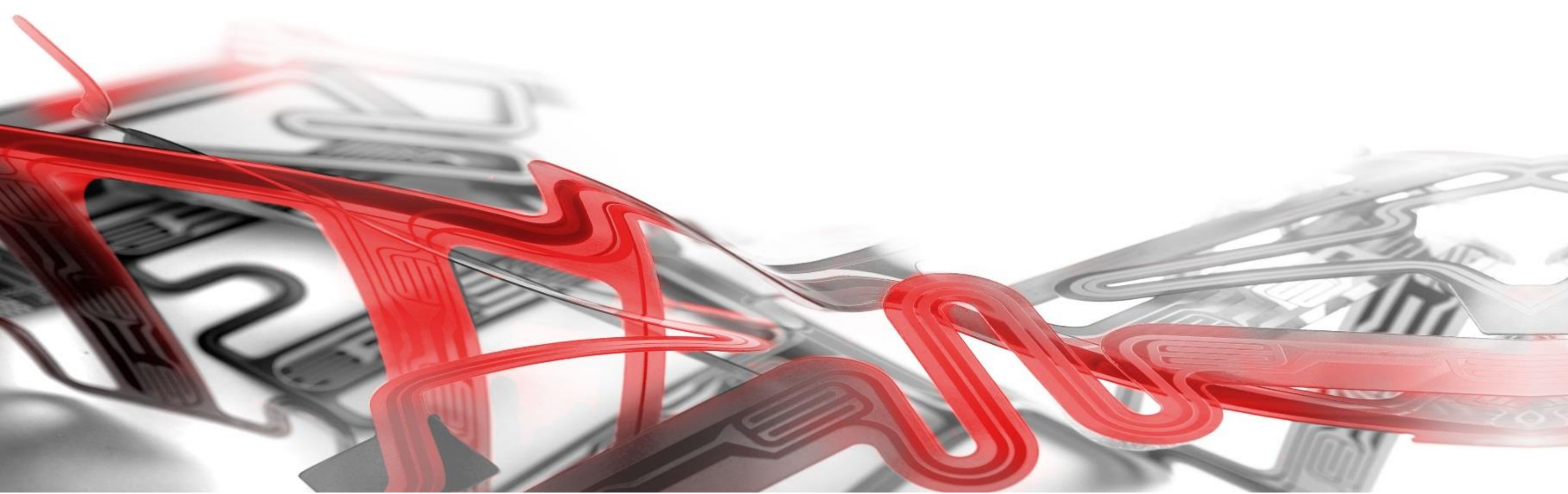
AKSE Product Specification

ASIC3



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1 Document History

Version	Date	Maturity	Author	Remark
0.0				
0.1	2016-05-20	Series	A. Mueller	Model number added
0.2	2016-10-10	Series	A. Mueller	Information added

2 Abbreviations

AD converter - Analogue to Digital Converter
AKSE - Child seat presence and orientation detection (in German: Automatische Kindersitzerkennung)
CRS - Child Restraint System
RCM - Restraint Control Module
RMI - Restraint system malfunction indicator (vehicle manufacturer specific)
µC - Micro Controller

3 Description

ASKE is an RFID sensing system, which is capable of determining the presence and orientation of a CRS placed on a passenger seat. Depending on the positioning of the CRS, different types of information are transmitted to the RCM, see *Figure 1*, which enables the adaptation of the airbag deployment specific to the occupancy situation.

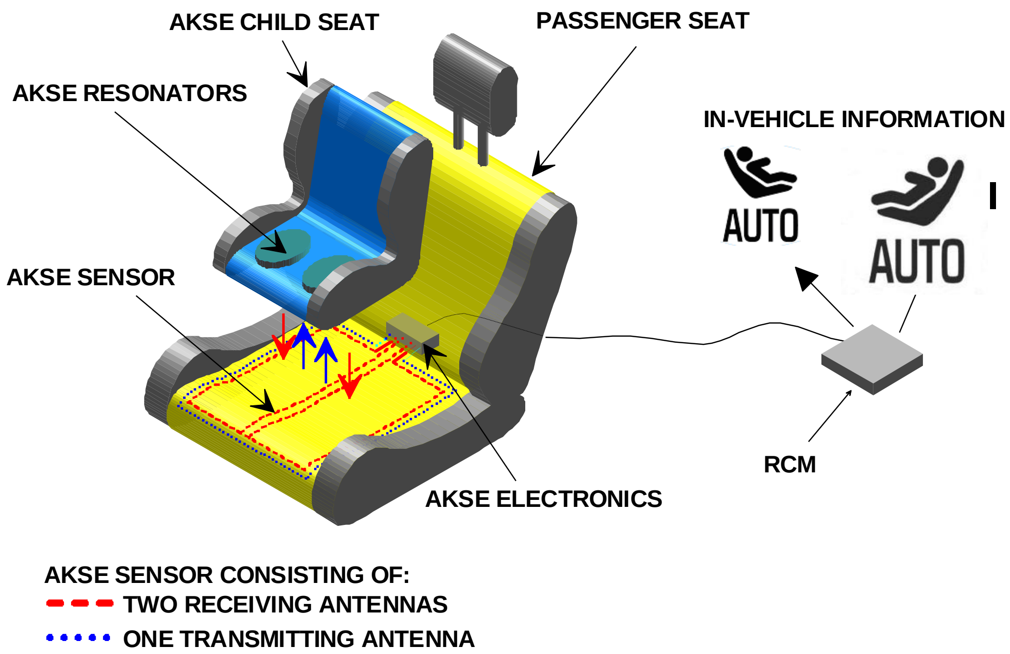

Figure 1: AKSE system topology

4 AKSE key features

In order to achieve its performance and, in addition, to provide fail-safe behavior in case of an error, the following features are implemented in the ASKE system:

- generation of a sinusoidal signal in the 130 kHz band for contact-less energy and information transmission;
- adaptation of the transmitting signal to different environmental conditions by variation of frequency and amplitude;
- de-modulation of the signal phase-modulated by the CRS resonators;
- monitoring of the power and demodulation circuits of the system via integrated self-diagnosis;
- interface to RCM for transmission of AKSE data;
- monitoring of transmitting and receiving antennas for disconnections and short circuits;
- detection of presence of CRS which are compliant to AKSE technology;
- detection of the orientation of CRS which are compliant AKSE

The following figure indicates the detectable positioning of the CRS.

Figure 2 — CRS in forward facing position

Figure 3 — CRS in rearward facing position

Figure 4 — Example of CRS wrong positioned

5 Block diagram

The following figure shows the block diagram of the AKSE sensor.

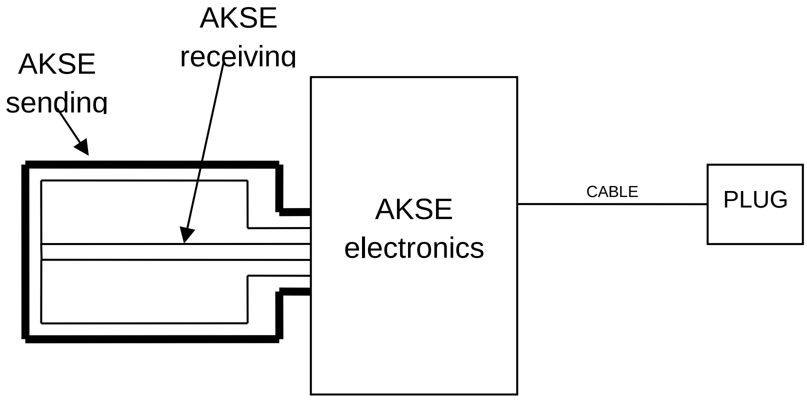

Figure 5: Block diagram of AKSE system

6 AKSE functionality

6.1 Principle

For the detection of an AKSE CRS on the passenger seat, an inductively coupled system is utilised. For this purpose, transmitting and receiving antennas are printed a foil like sensor mat. This sensor mat is connected to an electrical control unit, which inductively excites a resonator in the AKSE CRS by the transmitting antenna, see
Figure 1.

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 AKSE CRS (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 AKSE CRS.

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

The scanning cycle for the AKSE CRS detection depends on the latest status of the AKSE.

In case of a detected AKSE CRS and sufficient subcarrier amplitude, a smaller transmission level is actuated with the next scan. If no AKSE CRS is detected or the subcarrier amplitude is low, the maximum possible 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.

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6.2 Transmitting frequency generation

For the addressing to the transmitting antennas, a frequency within the scope of 123 up to 133 KHz is provided. By means of a microcontroller, six different transmitting frequencies can be chosen in order to find the optimal resonator working frequency. These six frequencies are around 123 KHz, 125 KHz, 127 KHz, 129 KHz, 131 KHz and 133 KHz and are subject to system tolerances. Design measures make sure that the limiting value of 135 KHz is not exceeded when the maximum frequency is set.

6.3 Transmitting current power amplifiers

The setting of the transmitting power is executed in the pre-selection mode in three levels that can be selected in dependence of the supply voltage of the AKSE (UBATT) and in dependence of the AKSE CRS detection. This pre-selection mode is of big advantage for the detected AKSE CRS in order to reduce the human-biological stress.

In the case of a wrong or no detection of a AKSE CRS, the power level that can provide the maximum transmitting power with an acceptable THD is chosen in order to reach sufficient detection range.
In order to reset the protocol transmission of the resonators, the transmitting power of the AKSE electronics is switched off and on for a short duration.

6.4 Demodulator

The voltages that are induced in the receiving antennas are decoupled and pre-amplified. After this, the two receiving signals are led to multipliers and synchronously demodulated with the original transmitting signal. By means of a subsequent low-pass filtering, all high-frequency signal parts are filtered. Then, the low-frequency signal of the resonators is pre-processed with SC filters while the further process is executed by means of AD conversion in the µC. The demodulator of the AKSE is designed to successful derive the resonator protocols out of the induced signal by demodulating the phase modulation received in the receiving antennas. A phase shift keying of 0.25° is sufficient for a protocol demodulation.

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6.5 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.

At least six different transmitting frequencies can be chosen by the electronics to find the resonant frequencies of both resonators. 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 several times and the average value is calculated. The ratios of the 4 calculated subcarrier amplitudes determine the position of the AKSE CRS.

6.6 Type Analysis

Once a minimum subcarrier level is exceeded, the analysis of the type of ASKE CRS is triggered. While reading the information sent by the resonators, a bit-synchronous scanning is executed. The received amplitude is measured several times in succession per bit. The extraction of the particular bits is performed by means of the average value of the samples that have been determined per bit.

The protocol of the resonator is valid when the following conditions are fulfilled:

- two bits of the header have been received correctly
- the synchronisation part has been detected correctly
- data bits have been received without parity errors
- divisor factor bit of the resonator protocol complies with the subcarrier
- type of AKSE CRS is valid, i.e. type is not equal to 0

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6.7 Decision Matrix

After the evaluation of the subcarriers of the two demodulator channels and the Ids of the resonators, the latest status of the AKSE CRS detection is determined according to the following decision matrix.

Table 1 : Decision Matrix KSE

	1 HT detected	2 HT detected sufficient differentiation	2 HT detected no sufficient differentiation
No ID	▪ interference signal ▪ type 0	▪ interference signal ▪ type 0	▪ interference signal ▪ type 0
1 ID	▪ only 1 resonator detected ▪ type as read out	▪ only 1 resonator detected ▪ type as read out	▪ only 1 resonator detected ▪ type as read out
2 identical ID	▪ not possible	▪ AKSE CRS forward/backward ▪ type as read out	▪ positioning of the AKSE CRS is not correct ▪ type as read out
2 different ID	▪ not possible	▪ only 1 resonator detected ▪ type 0	▪ only 1 resonator detected ▪ type 0

6.8 Detection range

Apart from the performance parameters of the AKSE sensor, the detection range of the AKSE CRS is also influenced by several parameters of the system. The most important influence factors are the following:

- Characteristics of the mounted resonators
- Characteristics of the resonator surrounding AKSE CRS
- Influence of the seat periphery
- Design of the ASKE transmitting and receiving antenna

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7 AKSE diagnosis

The diagnosis system of the AKSE consists of measurements that are executed cyclically.

The cyclical measurements consist of:

- Measurement with test signal (test of the receiving function including demodulator circle if no subcarrier is detected)
- Offset voltage demodulator
- Short circuit of the receiving antenna
- Interruption of the receiving antenna
- Insulation resistance of the receiving antenna to GND
- Insulation resistance of the receiving antenna to UBATT
- Short circuit of transmitting antenna
- interruption of the transmitting antenna
- Insulation resistance of the transmitting with regard to GND
- Insulation resistance of the transmitting with regard to UBATT
- Insulation resistance between transmitting and receiving antenna

In the test of the demodulator with the test signal, the complete signalling distance from the sender to the AD converter of the electronics' µC is tested. In this case, the carrier of the first demodulation is modulated with an internally produced subcarrier and the resulting signal is measured with the appropriate channel of the AD converter.

8 State Qualification

Every detected state of the AKSE system, including error states detected by the self diagnosis, is subject of state qualification before the corresponding information is sent to the RCM.

9 Electrical Characteristics

9.1 Voltages

The AKSE is connected to ignition (+12V, terminal 15 R).

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9.2 Current consumption

After the decay of the switch-on peak current caused by the charging of the input capacities, the maximum current consumption of the device amounts to Ieff = 600 mA and the minimum current 1 mA, for UBATT = 12 V.

9.3 Electrical Power

10 seconds after the connection of the power supply, a maximum power of 7.2 Watt occurs with a supply voltage of 12 V.

9.4 H-Field radiation

The H-field radiation is tested according EN 300 330-2 and does met the defined limits.

10 Electrical compatibility

10.1 Inverse-Polarity Protection

The device is protected against inverse polarity of the supply voltage.

10.2 Overvoltage Stability

Test voltage	: 27 V
Testing time	: 2 min

After this stress, the device is still fully functioning. Measurements and protocol outputs must not be executed during this influence.

10.2.1 Short Circuit Stability

External lines to the airbag control unit have a short circuit protection against earth or a supply voltage potential.

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