Functional description

of the

OCCUPANT CLASSIFICATION

and

Automatic Child Seat detection

Version:

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1. Function of the OC (Occupant Classification) and CSD (Child Seat Detection)

The OC / CSD System has to detect the state of the front passenger seat and provide the information to the Airbag ECU. This information is used to increase the protection of the passenger, by controlling the deployment of multistage Airbags dependent on the weight of the passenger.
If a child seat is detected on the passenger seat, then the airbag deployment must be prevented

1.1 Functions of the subsystem OCCUPANT CLASSIFICATION (OC)

The OC evaluates, in accordance to the installation place and the physical operational mode, the pressure distribution on the seats. The classification is performed by measuring and evaluating the typical shape and pressure distribution of human bodies or other objects. For a better judgement, some auxiliary quantities are determined and linked by a suitable algorithm.

All users can be assigned to an appropriate weight class. Weight classes are defined as follows:

Table: weight classes

Class	Corresponds tothe weight of the passenger of
Class 0	0 to 2 kg (applied on the surface)
Class 2	12 to 60 kg
Class 3	60 to 90 kg
Class 4	> 90 kg

Dependent on the tolerances of the system, the following classification table for persons is given. The distribution follows a Gaussian distribution showing the maximum in the required class.

required class	class 1	class 2	class 3	class 4
class 2a (12kg -30kg)	allowed	allowed	not allowed	not allowed
class 2b (30kg - 60kg)	not allowed	allowed	allowed	not allowed
class 3 (60kg - 90kg)	not allowed	allowed	allowed	allowed
class 4 (> 90 kg)	not allowed	not allowed	allowed	allowed

1.2 Function of the subsystem Automatic Child Seat Detection (CSD)

To detect a child seat on the front passenger seat, an inductive-linked system is used. To realise such a system, the transmit and receive antennas are printed on the sensormat. The ECU excites 2 resonators in the child seat, via a transmitting antenna.

With this system it is possible to detect the correct orientation of the child seat for both forward- and backward-facing child seats.

2. General System description

2.1 System design

The system consists of an ECU made up of a PCB plus housing and a sensor mat. The connection between the ECU's printed circuit board and the sensor mat is realised by a conductive glue. A 3 pin connector with the following pinout is used to connect the system to the airbag ECU:

Pin1 +12 V via Terminal 15 R (9V - 16 V)
Pin2 K-Line to realise serial communication to the Airbag ECU or diagnostic device
Pin3 Gnd.

2.1.1 Block diagram

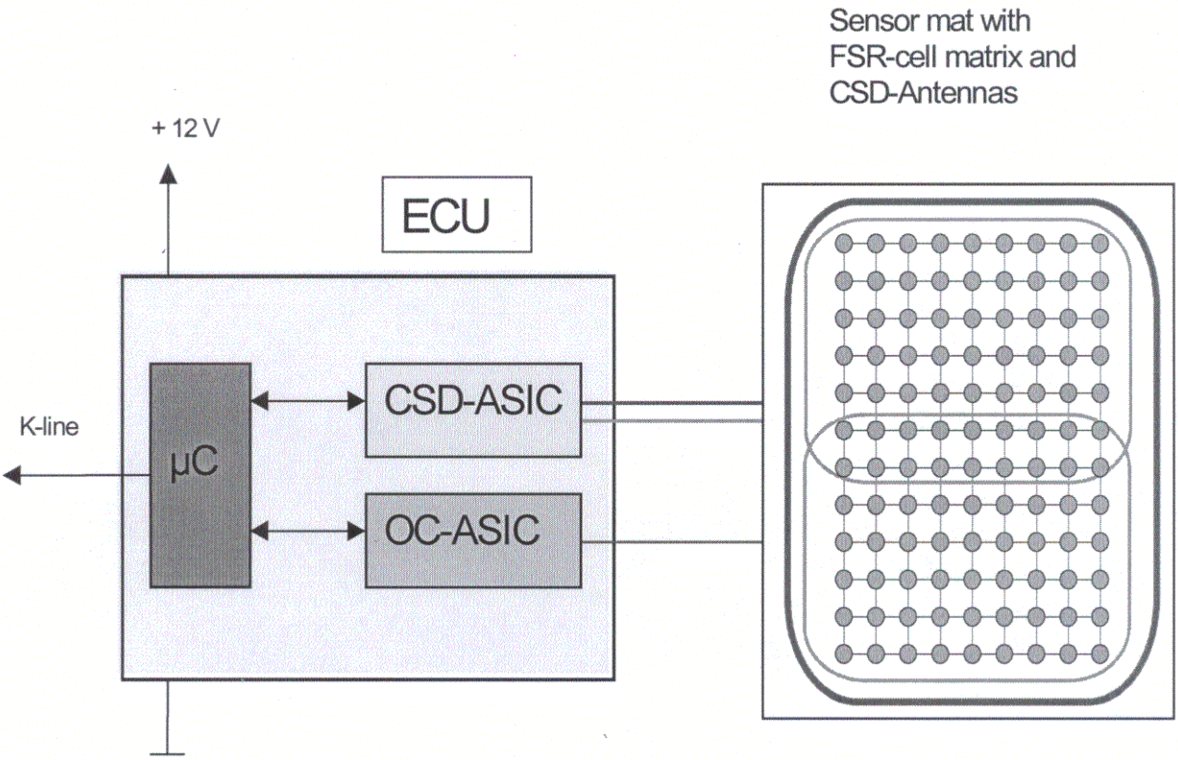


Figure 1: Block diagram of the OC/CSD-System

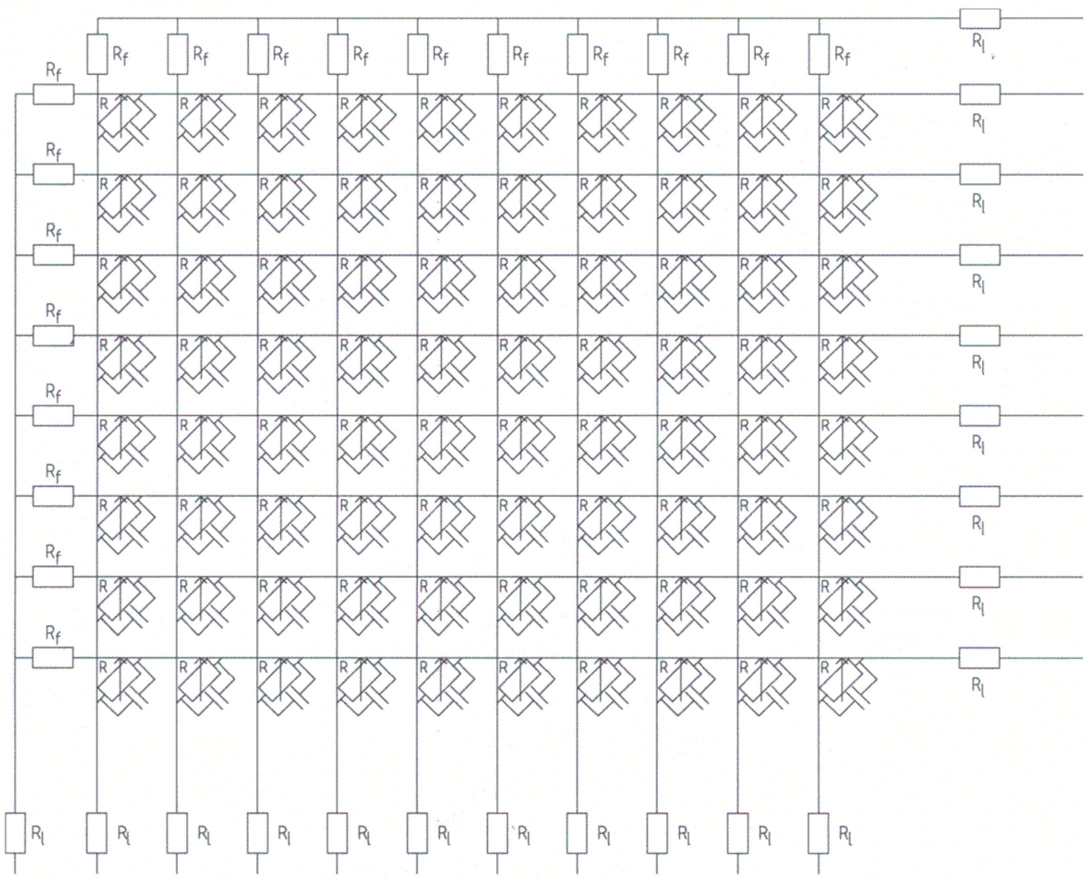
2.2 System tests

The system performs special system tests at every power on cycle. Also cyclic system tests are performed during normal running. These tests are for example measurements to check the hardware for proper working. In case of a failure the corresponding failure code is stored in the EEProm. The failure mode itself determines if the failure code is to be transmitted to the Airbag ECU or notIt depends on the failure mode if it is transmitted to the Airbag ECU or not.

3. System description for the OC Subsystem

3.1 Layout of the sensor mat

OC-SCHEMA



Line resistance: $R_l < 500\ \Omega$

Fixed resistor: $R_f < 10\ k\Omega$

Matrix resistor: $R < 500\ k\Omega$ if element is activated (FSR)

Capacitors: $C < 1nF$ if element is not activated

The shape, size and layout of the sensor mat is different for each type of seats. At the end of each row or colomn line (sensor line), one line monitoring resistor (fixed resistor) is applied. They are represented by additional connections to the electronics.

Each sensor line is fed back to the interface electronics to check the line integrity. Short circuits to ground or supply voltage are monitored also.

3.2 Evaluation of the OC classification

The OC Sensor mat consits of a maximum of 108 FSR (force sensitive resistors) elements arranged in a matrix form. The FSR-elements change their value due to the pressure coming from the weight of the person who is sitting on the seat. Each FSR element is measured for ist resistive value. These values are evaluated by software to profiles by parameterization. The characteristic parameters of the profiles are the base for the classification of the passengers. This is performed by a suitable algorithm. If the classification of an object is not clearly possible, then the "No clear classification of the Object possible" command is sent to the Airbag ECU.

4. System description CSD (Automatic Child Seat Detection)

4.1 Features of the CSD

The CSD electronics is qualified by the following features:

- A combined Sensormat with printed Antennas, one transmit- and two receive-Antennas are used.
- Generation of a sinusoidal Signal in the 130 kHz-Band for contact-less transmission of power and information to the transponder in the child seat.
- Adaptation of the transmitted signal to various environmental conditions by frequency and amplitude variation.
- Demodulation of the phase modulated signal from the transponder in the child seat.

4.2 Child seat detection

To detect a Child Seat the transmitting antenna is excited in the 130 kHz Band. The transmitting Antenna uses an excitation frequency of 123 to 133 kHz is used. The graduated frequency is selectable by the micro Controller graduated as follows: 123 kHz; 125 kHz; 127 kHz; 129 kHz; 131 kHz und 133 kHz. This enables an optimal adaptation of the resonant frequency to each resonator in the child seat. The child seat position is then determined by the evaluation of the signal strength (after the demodulation) in each receive antenna. The child seat type is read out from the resonators, supplementary to the child seat position information.

The adjustment of the transmitting current can be realised in three stages. If a child seat is detected, the lower current stage is used for the next scan. If no child seat is detected then the higher current stage is used for the next scan.

Table 1: Stages for the transmitting current

Currentstage	**Transmitting current[mA] $_{pk}$**	
	Min	**Max**
1	216	360
2	302	482
3	365	571

Table 2: Polling cycles of the CSD (switching cycles of the transmitting antenna)

State	Seat occupied (Class ≥ 1) Actual Value	Polling cycle [s]
No Childseat	No	1.44 s
No Childseat	Yes	40.32 s
Childseat detected	No	3,6 s
Childseat detected	Yes	3.6 s

For demodulation, the received signal is mixed with the frequency synchronised transmitted signal, whereby the desired signal (LF-Signal at 2,3 kHz for Resonator Type B right, and 3,3 kHz for Resonator Type A left) is obtained after a band pass filtering

Subsequently, the binary protocol of the transponder is obtained through another frequency synchronised demodulation. The receiving frequencies are obtained by dividing the transmitting frequency by 40 kHz (for left hand side) and 56 kHz respectively (for right hand side). At the evaluation of the frequencies for the left and right channel, it must be determined if the difference of the input level is satisfactory to decide on the Orientation of the Child Seat.

The Information from the resonators is sampled synchronously with the bits. Twenty bits of the resonator protocol are read out and evaluated. These 20 bits contain the header, the synchronisation part (6 bit) the transponder type (left / right) parity bit and four Child-Seat-Type-bits.

For the evaluation of the child seat type and orientation all information is used and must be conclusive.

NOTES: The manufacturer is not responsible for any radio or TV interference caused by unauthorized modificaitons to this equipment. Such modifications could void the user's authority to operate the equipment.

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interferecen that may cause undesired operation.