Annex acc. to FCC Title 47 CFR Part 15
relating to
Continental Automotive GmbH
BG744 CI

Annex no. 5
Functional Description

Title 47 - Telecommunication
Part 15 - Radio Frequency Devices
Subpart C – Intentional Radiators
Measurement Procedure: ANSI C63.4-2009

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Functional Description of the test equipment (EUT) - BG744 CI

Functional Description

VAG Immobilizer System
Bugatti BG744 Cluster Instrument

BG744 CI

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1. System overview

The module described in this document shall be used in the following system environment:

- VAG Immobilizer System WFS IV

An immobilizer prevents the engine from running unless the correct key (transponder) is present. This prevents the car from being "hot-wired" after entry has been achieved.

The microcircuit inside the key is activated by a small electromagnetic field that induces current to flow inside the key body, which in turn broadcasts a unique binary code which is read by the automobile's ECU. When the ECU determines that the coded key is both current and valid, the ECU activates the fuel-injection sequence.

Radio approval is required.

All requirements refer to the specification 'Lastenheft WFS IV Kombi Roadmap V2.1' of the Volkswagen AG.

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2. Overview/Short description of the module

This document describes a car immobilizer circuit based on basestation-IC LRES B2 (Delphi Megamos). The module is an integral part of the Audi AB2/TT instrument cluster.

The module performs the following functions:

- antenna driving with carrier frequency
- 100% AM modulation of the field for writeable transponder (write mode)
- AM/FM demodulation of the antenna signal modulation induced by the transponder (read mode)
- communication with microcontroller via two wire interface

The immobilizer module is the interface between the transponder inside the key and the microcontroller. The microcontroller controls all functions of the cluster instrument including the transponder communication.

The reader and the transponder are working as a wireless, magnetic coupled communication system, each with a resonant circuit tuned to the system's frequency (125,0 ± 5,0 kHz) as close as possible. The reader circuit (basestation) is working in series resonance, the transponder works with a parallel resonant circuit.

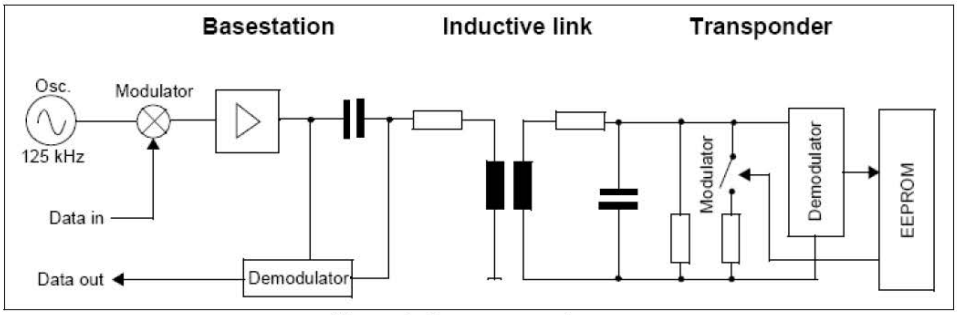

Figure 1: System overview

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The reader circuit provides energy to the transponder by an alternating electromagnetic field which is generated by the basestation antenna coil. By modulating this field, the reader can transmit (write) data to the transponder. The transponder will power up and return its on-chip data to the reader.

Figure 2 shows the principle of data transmission between basestation and transponder.

In the Write-Mode (Uplink) the basestation writes data into the transponder's EEPROM by performing an amplitude modulation of the magnetic field. The antenna drivers are switched on and off according to the data stream (100% AM).

The Read-Mode (Downlink) allows the transponder to transmit binary data to the basestation by load modulation, two different resistive loads are applied to the transponder's antenna. This modulation is recognized as a change in the amplitude of the antenna voltage at the basestation side

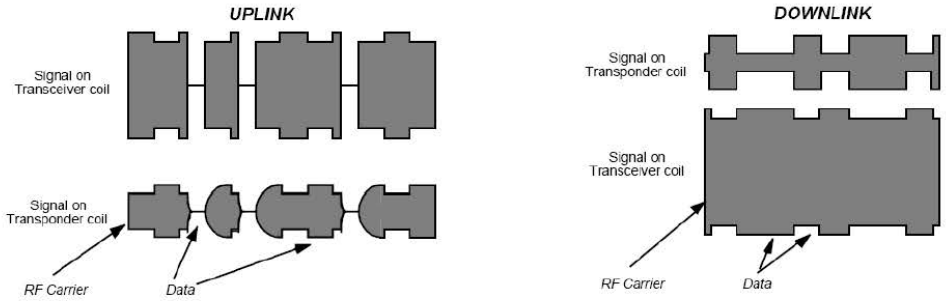

Figure 2: Principle of data transmission

The LRES ASIC is composed of two main blocks, Analog Front End (AFE) and Microprocessor Interface (µPI).

Analog Front End is a mainly analog circuit which performs the two main functions of an RFID basestation, transmission and reception.
Transmission involves antenna driving and AM modulation of the RF field. The antenna driver delivers a current into the external antenna to generate the magnetic field.
Reception involves the AM/FM demodulation of the antenna signal modulation induced by the transponder.

The Microprocessor Interface (µPI) is a digital block which connects the AFE with the external microcontroller. The communication between transceiver and the microcontroller is made via two wires (L/Z_IN and L/Z_OUT). L/Z_IN is the data input of LRES B2, L/Z_OUT is open drain output which is also used as input.

In read mode (observing the messages sent by the transponder) the L/Z_OUT pin provides a digital asynchronous signal coming from demodulator chain.
In write mode, the L_EN signal defines the operation of the microprocessor interface:

- When L_EN is high (Master Mode) µPI synchronizes to transponder listening window and provides on L/Z_OUT pin the bit clock for data which will be sent to transponder via L/Z_IN pin.

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- When L_EN pin is low (Slave Mode) microprocessor itself controls the communication with the transponder. L/Z_IN pin is directly controlling internal signal MOD. Signal MOD is directly controlling the antenna drivers. When it is high the drivers are off.

In this module L_EN is not connected to the microcontroller, pin is pulled up to the 5V supply voltage of the immobilizer circuit. This means that the Master Mode is always selected.

The oscillator of basestation IC is designed for usage of a 4MHz resonator. The 4MHz clock signal is divided down to a 125 kHz signal for antenna drivers and µP interface and provides some additional synchronisation signals for receiver chain, sampler and short circuit detector.

3. Transponder

The used transponder is a read/write RF transponder. It consists of an antenna configured as a resonant circuit, an EEPROM and modulator/demodulator circuits for data transmission.

The transponder is supplied by carrier of an electromagnetic field induced on the attached coil. The AC voltage is rectified in order to provide a DC internal supply voltage. When the DC voltage crosses the Power-On level, the transponder will enter the Standby Mode and expect commands. In Standby Mode a continuous sequence of Listen Windows (LIW) is generated. During this time, the transponder will turn to the Receive Mode (RM) until it receives a valid RM pattern. The transponder then expects a command to enter the desired mode of operation.

Features:

- On Chip Crypto-Algorithm
- Two Way Authentication
- Secret-Key in EEPROM (unreadable)
- Fix Device Identification
- User Memory (UM)
- Data Transmission performed by Amplitude Modulation
- Bit Period = 32 periods of carrier frequency
- Temperature Range -40 to +85°C
- 125 kHz Field Frequency
- On chip Rectifier and Voltage Limiter

4. Power supply

Because ANT drivers drive antenna with VDD and VSS power supply level all variations and noise in power supply are directly fed to antenna resonant circuit. Any supply voltage fluctuations or ripple are transferred into antenna current fluctuations by the antenna driver transistors. This is equal to a current modulation that results in a voltage modulation at the antenna tap point. There is no possibility for the demodulator to distinguish this modulation from the transponder modulation (transponder signal superimposed on antenna voltage is in the range of tens of mV). Especially in the passband of the demodulator filters (<10 kHz), the system is very sensitive against supply hum and ripple.

For this reason a separate linear voltage regulator is used for the immobilizer circuit.

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KL30 Voltage for guaranteed function and performance:

- Minimum Operating Voltage = 6.5V
- Nominal Operating Voltage = 13.5V
- Maximum Operating Voltage = 17V

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6. Technical data

- Carrier frequency: 125 kHz ± 5 kHz
- Carrier field strength: < 66 dBµA/m @10m
- Modulation: ASK
- Battery type: Car battery / 12 V
- Antenna: Internal loop antenna

6.1 Electrical characteristics

Parameter	Symbol	Min	Typ	Max	Unit	Conditions
Supply						
Supply voltage immobilizer module	V_{KL30}	6,5	13,5	17	V	
Supply voltage LRES B2	V_{DD}	4,5	5,0	5,5	V	
Supply current in sleep mode (Quiescent current)	$I_{DDsleep}$			40	µA	Full temp. range
Supply current excluding drivers current in normal mode (Current consumption)	I_{DDon}		5	10	mA	

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Power on reset level	V_{por}	1,4		3,6	V	Full temp. range
AGND level	V_{AGND}	2,35	2,5	2,65	V	Full temp. range
µC interface						
Input logic high	V_{IH}	0,8 VDD			V	Full temp. range
Input logic low	V_{IL}			0,2 VDD	V	Full temp. range
Input leakage current	I_L	-1		+1	µA	Full temp. range
L/Z_OUT sink current	I_{L/Z_OUT}			2,5	mA	
L/Z_OUT output logic low	V_{L/Z_OUT}			0,4	V	
Antenna circuit						
Carrier frequency	f_{ANT}		125		kHz	
Antenna circuit resonant frequency	f_{RES}	120	125	130	kHz	
Antenna voltage	V_{Coil1}	55	75	95	Vpp	L_{Coil} = 1.041mH ± 5%, Q_{Coil} = 8.55 ± 15%
Oscillator						
Resonator frequency	f_{OSC}		4		MHz	

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7. Labelling

7.1 Europe

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BG744CI
CE

7.2 USA

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Model: BG744 CI
FCC ID:KR5BG744CI

7.3 Canada

Continental
Model: BG744 CI
IC: 7812D-BG744CI

Owner Manual:

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 interference that may cause undesired operation.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

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