

Document : **Function Description /
User Manual
for
Smart Key System**

Project : **Smart Key ECU & Smart Key Fob**

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Operation Guide

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.

Caution !

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

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1 System configuration

1.1 scope of SMART KEY SYSTEM

The System offers the following features:

- passive access for two doors, driver side and passenger side as well as trunk/tailgate
- passive start after interior detection of the SMART KEY FOB (without interior trunk and hat shelf detection)
- LF-RF communication (based on Siemens' SMART KEY system)
- passive access/locking of the two front doors via a toggle push button in the door handles
- passive access trunk/tailgate via the trunk lid switch at the trunk
- max. 2 SMART KEY FOBs can be handled by the system
- immobilizer backup antenna driver integrated into MSL
- communication to the engine management system via a single line interface
- communication to the MSL via a single line interface
- block of the steering column by the MSL device

1.2 short description of the SYSTEM

1.2.1 General Definition of SMART KEY

The SMART KEY system is a system that allows the user to access and operate a vehicle in a very convenient way. To access the vehicle no traditional key or remote control unit is needed.

The user carries a SMART KEY FOB which itself does not require any conscious actions by the user (e.g. operate a button). The SMART KEY system is triggered by pressing a push button in the door handle.

After being triggered the vehicle sends out a request in a limited range. If the SMART KEY FOB receives this request, it automatically sends a response to the vehicle. Then the system decides whether to perform a particular action (unlocking, locking...) or remain inactive.

In a similar manner the vehicle's Mechatronic Steering Lock (MSL) is released. Again, a communication between the vehicle and the SMART KEY FOB is needed before any actions will be performed.

1.2.2 Wireless Communication

Electromagnetic waves are used to exchange information between the vehicle and the SMART KEY FOB. Both, vehicle and SMART KEY FOB are equipped with a transmitter, a receiver and several antennas.

1.2.3 concept Description

With this concept it is possible to have a set of interior antennas that covers the vehicle's interior and a set of exterior antennas that covers the vehicle's exterior.

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For an unambiguous separation between the vehicle's interior and exterior it is sufficient that at least one area is covered exactly by the corresponding operating ranges of the antennas.

The functions of the SMART KEY system have to be provided in a clearly defined and limited range. For the up-link from the vehicle to the SMART KEY FOB, a magnetic field with a frequency of 125 kHz and ASK modulation is used. Inductive antennas in and at the vehicle radiate the electromagnetic energy.

Technical aspects of 125 kHz – magnetic field:

- virtually no reflections,
- cubical decrease of field strength → allows good range control,
- released frequency band (ISM),
- high penetration,
- low quiescent current demand due to 125 kHz input stage (SMART KEY FOB),
- less sensitive for detuning compared to higher frequency.

For the down-link from the SMART KEY FOB to the vehicle, the standard radio frequency (RF) is used (similar to the classic remote control functions) with FSK modulation.

1.2.4 System Architecture

The system is designed as an optional system, making it possible to equip vehicles of the same car-Line with different levels of access control systems.

The system is suitable to be integrated into an existing architecture that provides central locking functions with standard remote control. This proposal assumes that the following functions / devices are already present in the vehicle's architecture.

- Central locking system (latch / motor – drivers etc.)
- Standard body control functions
- Warning buzzer

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1.2.5 Main Functions

- The system allows the user to access and exit (unlock and lock) the vehicle without performing any actions with the SMART KEY FOB.
- The system allows the user to release the MSL and to switch the power modes (Off, Accessory, Ignition), as well as to start and stop the vehicle's engine without performing any actions with the SMART KEY FOB.
- Additionally, the system offers a so called "limp home mode", wherein the user can operate all vehicle functions by inserting the key into the MSL or by inserting the mechanical key blade into the door lock.

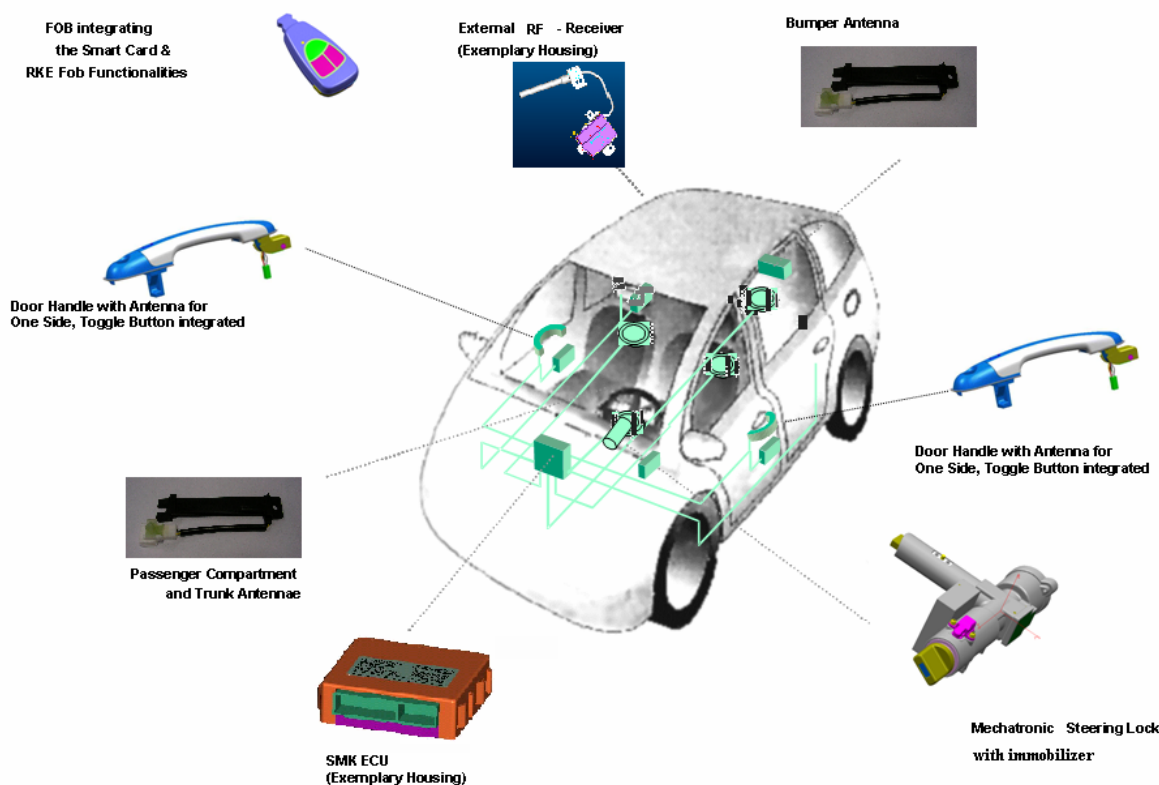


Figure 1: Offered System Components

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1.3 System Overview / Block Diagram

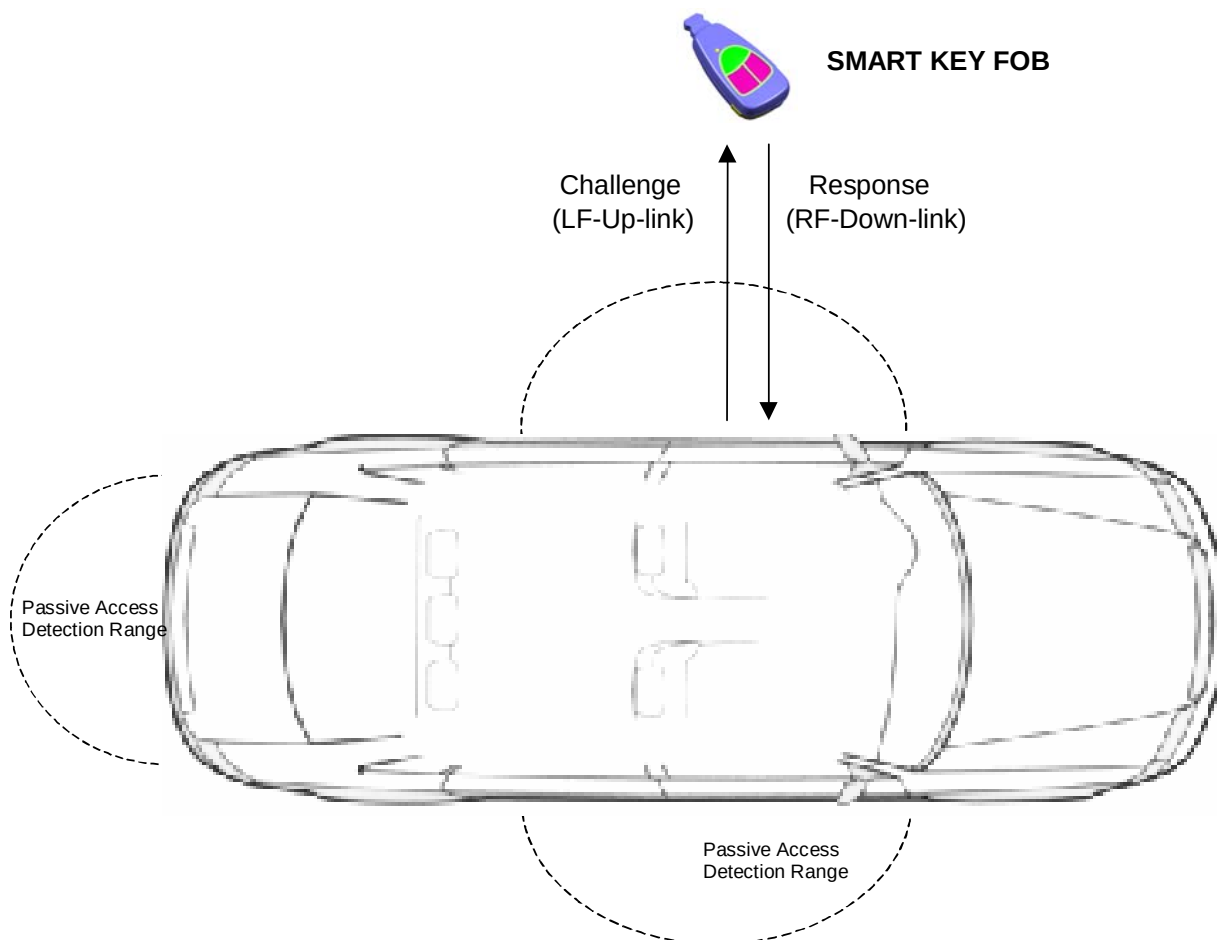


Figure 2: Principle of Communication

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System Architecture for SmartKey

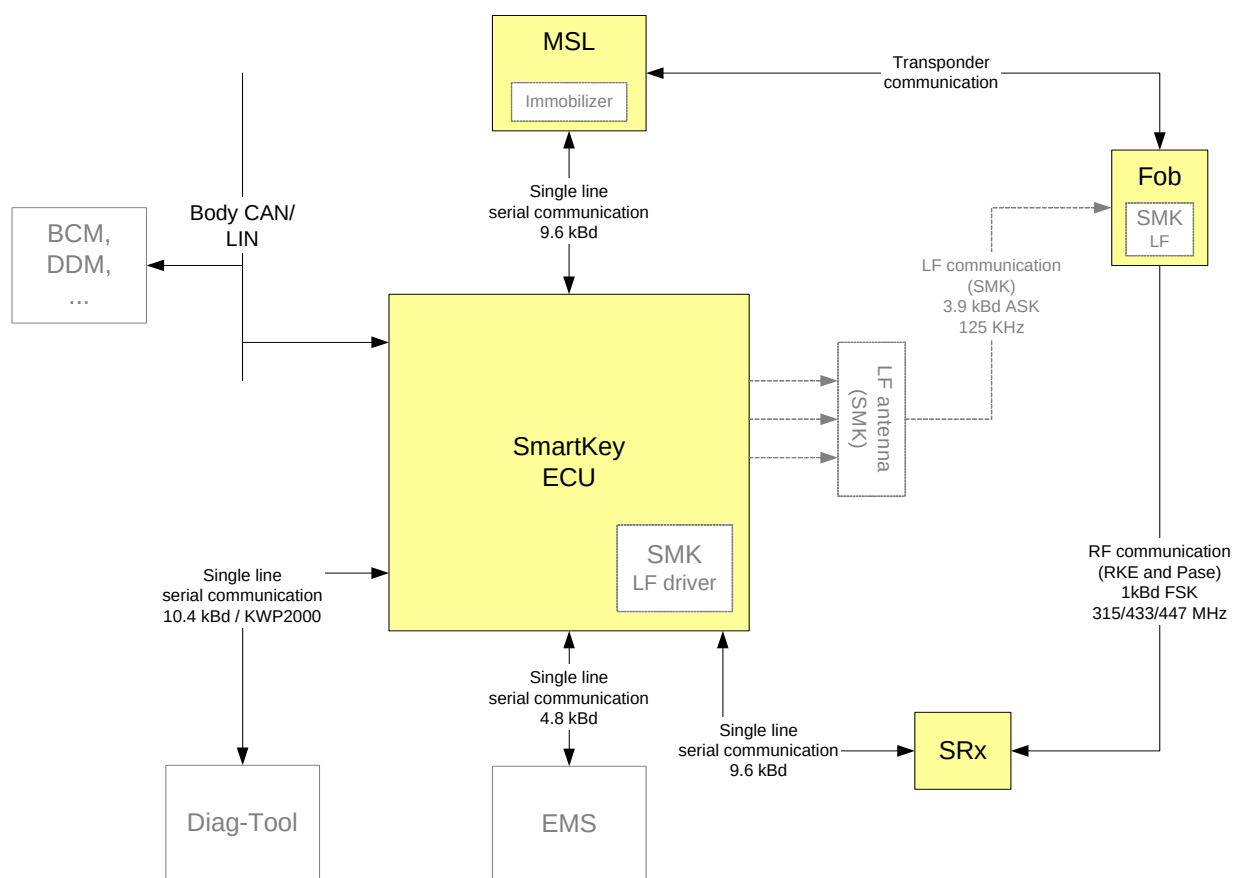
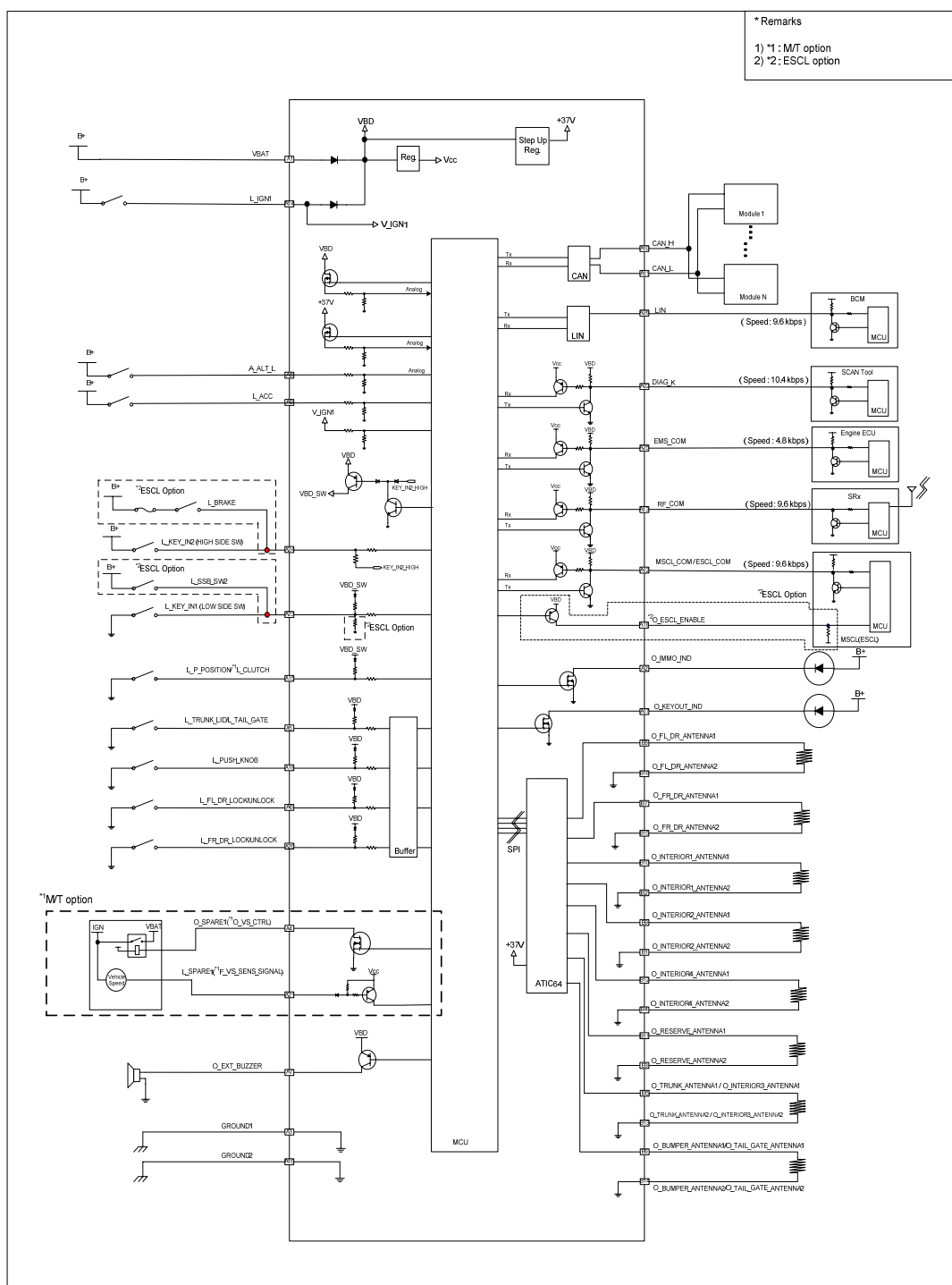


Figure 3: System Block Diagram

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2 SMK ECU Configuration

2.1 Block Diagram



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2.2 Pin Description

Function	I/O	Pin Description	Load Configuration	
			OFF configuration	ON Configuration
Analog Input	A1	VBAT	Switch Open	Connect to main Battery via Switch
	A8	A_ALT_L	Switch Open	Connect to main Battery via Switch
Logic Input	A9	L_ACC	Switch Open	Connect to main Battery via Switch
	A14	L_IGN1	Switch Open	Connect to main Battery via Switch
	A19	L_PUSH_KNOB	Switch Open	Connect to main Ground via Switch
	A6	L_FL_DR_LOCK/ UNLOCK	Switch Open	Connect to main Ground via Switch
	A20	L_FR_DR_LOCK/ UNLOCK	Switch Open	Connect to main Ground via Switch
	A5	L_TRUNK_LID/L_TAIL_GATE	Switch Open	Connect to main Ground via Switch
	A15	L_P_POSITION/ L_CLUTCH	Switch Open	Connect to main Ground via Switch
	A23	L_KEY_IN1(LOW SIDE SW)	Switch Open	Connect to main Ground via Switch
	A24	L_KEY_IN2 (HIGH SIDE SW)	Switch Open	Connect to main Battery via Switch
Output	A18	O_ESCL_ENABLE (O_SPARE2)	Output Off	Connect to main Ground via 1KOhm resistor and Output ON
	A17	O_KEYOUT_IND	Output Off	Connect to main Battery via resistor 1KOhm and Output ON
	A7	O_EXT_BUZZER	Output Off	Connect to main Ground via 1KOhm resistor and Output ON
	A2	O_IMMO_IND	Output Off	Connect to main Battery via resistor 1KOhm and Output ON
Antenna	B8	O_FL_DR_ANTENNA1	Output Off	Connect to main Ground via 200uH Antenna and Output ON
	B16	O_FL_DR_ANTENNA2		
	B7	O_FR_DR_ANTENNA1	Output Off	Connect to main Ground via 200uH Antenna and Output ON
	B15	O_FR_DR_ANTENNA2		
	B6	O BUMPER / O_TAIL_GATE_ANTENNA1	Output Off	Connect to main Ground via 200uH Antenna and Output ON
	B14	O BUMPER / O_TAIL_GATE_ANTENNA2		
	B5	O_TRUNK_ANTENNA1 / O_INTERIOR3_ANTENNA1	Output Off	Connect to main Ground via 200uH Antenna and Output ON
	B13	O_TRUNK_ANTENNA2 / O_INTERIOR3_ANTENNA2		
	B10	O_INTERIOR1_ANTENNA1	Output Off	Connect to main Ground via 200uH Antenna and Output ON
	B2	O_INTERIOR1_ANTENNA2		
	B9	O_INTERIOR2_ANTENNA1	Output Off	Connect to main Ground via

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	B1	O_INTERIOR2_ANTENNA2		200uH Antenna and Output ON
	B12	O_INTERIOR4_ANTENNA1	Output Off	Connect to main Ground via 200uH Antenna and Output ON
	B4	O_INTERIOR4_ANTENNA2		
	B11	O_RESERVE_ANTENNA1	Output Off	Connect to main Ground via 200uH Antenna and Output ON
	B3	O_RESERVE_ANTENNA2		
VS	A4	O_SPARE1 (O_VS_CTRL)	Output Off	Reserve (Relay)
	A21	L_SPARE1 (F_VS_SIGNAL)	Input Open	Reserve (Generate 200Hz)
Diagnostic	A22	DIAG_K	Open	Gerneral communication with LTT
EMS Com.	A25	EMS_COM	Open	Communication with LTT
CAN	A10	CAN_H(L_SPARE3)	Open	Communication with LTT in case of CAN option
	A11	CAN_L(L_SPARE4)		
Lin	A26	LIN(L_SPARE2)	Open	Communication with LTT in case of LIN option
RF interface	A13	RF_COM	Open	Comunication with LTT
MSL / ESL Com.	A12	MSCL_COM/ ESCL_COM	Open	Comunication with LTT
Ground	A3	GROUND1	Main ground	Main ground
	A16	GROUND2	Main ground	Main ground

2.3 SMART Key Ecu (SMK ECU)

The SMK ECU manages all functions related to “Passive Access”, “Passive Unlocking” and “Passive Authorization for Operation”.

It reads the inputs (Push button, MSL Knob Push Switch, PARK position Switch), controls the outputs (e.g. exterior and interior antennas), and communicates via the CAN/LIN (depends on the vehicle) as well as a single line interface to further devices of the car.

For communication with the SMART KEY FOB, the SMK ECU generates a request (challenge) as an encoded and modulated 125 kHz signal at the inductive antenna outputs and receives the SMART KEY FOB's response via the external RF receiver.

The main functional blocks of the SMK ECU are:

- Power supply
- Microcontroller with FLASH Memory
- Single Line Interface to MSL
- Single Line Interface to SRX
- Single Line Interface to EMS
- Input stage
- LF antenna amplifier/driver
- LIN communication with BCM/ETACS (except EN, VQ ; CAN communication)

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The LF antenna amplifier/driver generates a 125 kHz sinusoidal carrier signal which is distributed to the different antennas.

The signal is 100%-ASK modulated by switching on and off the carrier (the data is Manchester encoded). The power of the carrier is adjustable by software, which means, it is possible to set the power level of the antenna driver for every LF-telegram (e.g. power level stored in the EEPROM).

The LF antenna driver consists of a number of outputs with different switching features.

1. switch on/off driver door handle antenna
2. switch on/off passenger door handle antenna
3. switch on/off bumper antenna for access to the trunk
4. switch on/off interior antennae
5. switch on/off trunk antenna (except SUV)

The SMK ECU comprises:

- the electronics described above
- a plastic housing

Emitting LF Antennas:

Inductive antennas in and at the vehicle are used to transform the current, driven by the SMK ECU antenna driver, into a 125 kHz magnetic field, which is the carrier for the SMART KEY challenge.

Three antennas cover the vehicle's exterior: two antennas in the Door Handles (DS and PS) cover the area around the doors; one antenna in the rear bumper covers the area around the trunk/tailgate.

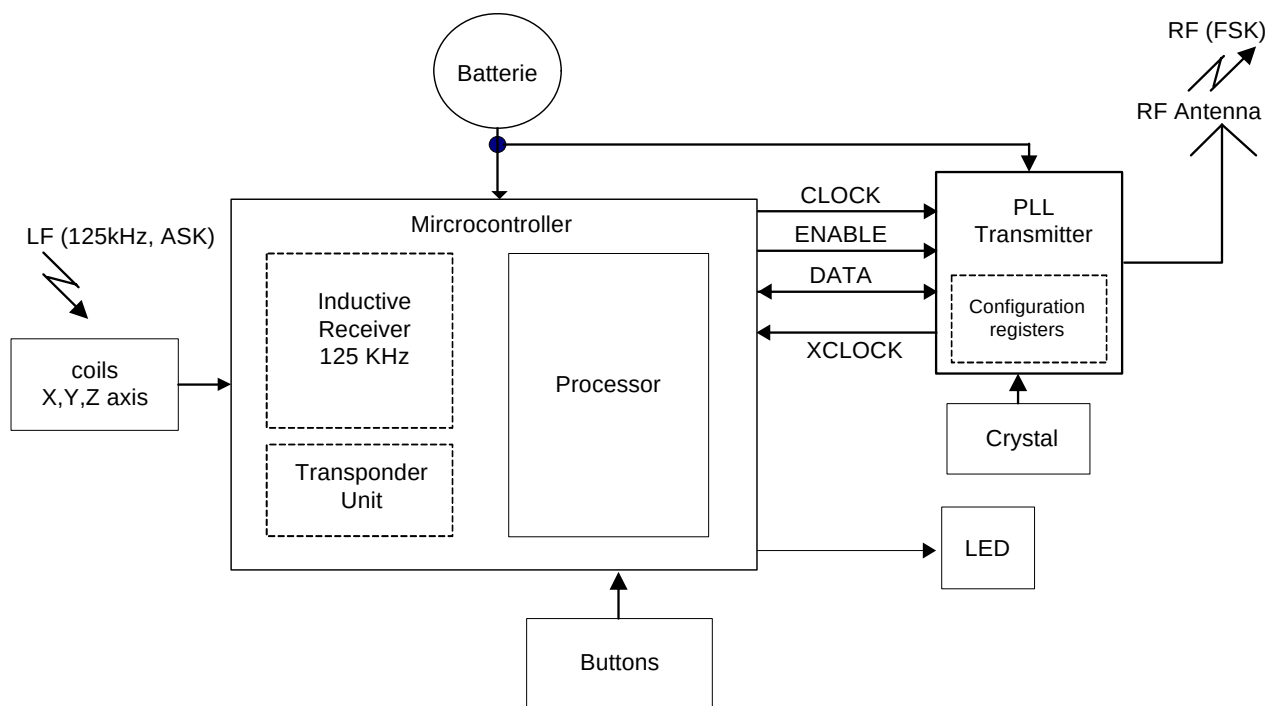
Up to three antennas cover the vehicle's interior and the trunk interior: two in the passenger compartment and one in the trunk. (In case of SUV, Three antennas cover the vehicle's interior and no trunk antenna)

Those antennas are based on either Vitrovac™ or ferrite core and have twisted pair terminals on standard pin header.

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3 SMK Fob Configuration (Transmitter)

3.1 Block Diagram



3.2 Technical Data of SMK Fob

Carrier Frequency NA/China : 315MHz
Field Strength NA/China : < 75.6uV/m at 3m
Deviation NA/China : 65~80kHz

Carrier Frequency EU : 433.92MHz
Field Strength EU : < 90uV/m at 3m
Deviation NA/China : 65~80kHz

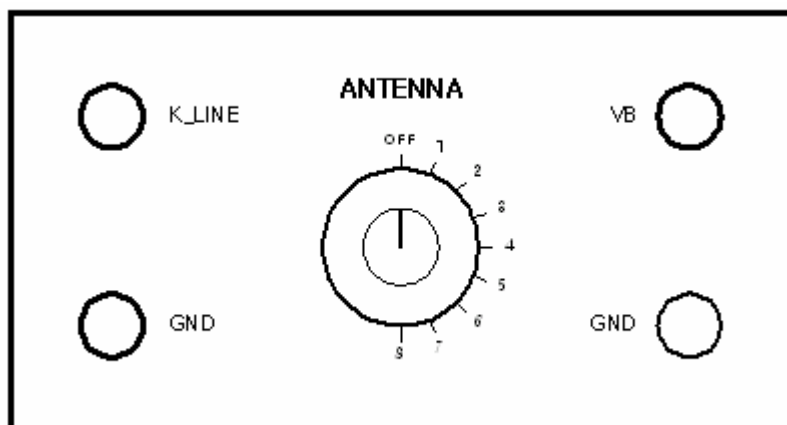
Carrier Frequency Korea : 447.725MHz
Output power Korea : < 10mW
Deviation Korea : < 5kHz

Modulation : FSK
Baud rate of RF : 1kBd
Supply voltage : 3V
Battery Type : Lithium, CR2032

4 SMK ECU Test Board for homologation

4.1 Shape of tool box

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4.2 Switch

No	Explanation	Remark
OFF	ALL ANTENNA OFF	
1	INTERIOR ANTENNA #1 OUTPUT	
2	INTERIOR ANTENNA #2 OUTPUT	
3	INTERIOR ANTENNA #3 OUTPUT	
4	INTERIOR ANTENNA #4 OUTPUT	
5	TRUNK ANTENNA OUTPUT	
6	BUMPER ANTENNA OUTPUT	
7	DRV DR ANTENNA OUTPUT	
8	AST DR ANTENNA OUTPUT	

4.3 Method to use Test board

- Prepare VB, GND, K_LINE, GND wire to connect Tool Box.
- Connect Power(VB, GND) to Tool Box.
- Connect communication line(K-LINE, GND) to Tool Box.
- Connect Harness connector to SMK ECU Unit.
- After selecting switch No. , give VB power to test board.(Do not give overvoltage)

5 SMK Fob for homologation

5.1 Button operation for homologation

- 1st time button pressing : Low side Frequency (Carrier wave continuous mode)
- 2nd time button pressing : High side Frequency (Carrier wave continuous mode)
- 3rd time button pressing : FSK Modulation (Modulated wave continuous mode)
- 4th time button pressing : Stop operation.

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