Passive Keyless Entry and Drive Systems

by Joerg Becker, Philips Semiconductors

The principles of the Passive Keyless Entry (PKE) and the Passive Keyless Go (PKG) systems.

For a couple of years now, some new passenger cars, especially those of the upper segment, have no longer been equipped with standard ignition keys. Instead, they are fitted with ID devices similar to chip cards or key fobs with several buttons. In 1999, the Mercedes S-Class was introduced with KeylessGo™, in which the Mercedes drivers wear a card in their pocket and only need to touch the door handle to open the car. Inside the car, they simply press a button to start the engine – without having to fumble for keys any longer.

This article describes the principles of the Passive Keyless Entry (PKE) and the Passive Keyless Go (PKG) systems. It focuses on the interface between the ID device ("key") and the vehicle.

Open Sesame

In the commonly used Remote Keyless Entry (RKE) systems, a button on the ignition key or key fob (the "ID device") needs to be pressed to unlock the central locking system of the vehicle by sending an infrared or UHF signal to the car. Now, with Passive Keyless Entry, the key can remain in the pocket.

The customer approaches the car and touches the inner area of the door handle. The sensor (for example, a capacitive sensor) in the door handle triggers the vehicle electronics to send out a low-frequency electromagnetic signal via special induction coil antennas embedded in the door and trunk handles. The working area of these antennas and the basic system design are shown in Figures 1 and 2.

By touching the door handle, the customer is automatically in the working area of one of these antennas. The LF signal coming from the vehicle now "wakes up" the ID device in the driver’s pocket, Figure 3. The picture shows a 125 kHz LF wake-up signal (Channel B of the oscillogram). The LF signal contains a data telegram, which basically consists of a preamble and a following wake-up pattern, Figure 4.

The preamble contains a certain number of Manchester coded digits to settle all operating points of the analogue part of the ID device (Automatic Gain Control, AGC and Data Slicer).

The purpose of the wake-up pattern is to establish a selective wake-up of the microcontroller. If the wake-up information transmitted to the ID device matches the stored values, the microcontroller will be woken up. Other
There will not wake up the microcontroller. This ensures a long lifetime for the battery in the ID device.

**3D Antenna Interface**

While the customer is approaching the vehicle, the ID device can remain in the pocket and therefore in any possible orientation, Figure 5. The LF wake-up signal from the vehicle comes with a certain orientation, because it is emitted by a single coil in the door latch. In order to ensure that this signal is reliably detected by the ID device, it contains a three-dimensional (x-y-z) LF antenna input circuit. In the following example, the x and y-axis antennas consist of SMD ferrite coils, while the z-antenna is embedded in the PCB (Figure 5).

**Challenge-Response Authentication**

The ID device analyses the wake-up pattern and the following bit stream ("challenge") and sends back a "response" via a UHF signal (e.g. 434 MHz) to the vehicle. This response is the result of cryptographic methods which are implemented in the ID device. Therefore, it is impossible for unauthorized persons to gain access to this information.

The vehicle itself picks up the UHF response from the ID device and crosschecks it with the internally stored cryptographic information. If authentication is successful, the vehicle will be unlocked. This challenge-response process only takes some 10 ms, so the customer does not recognize any delay between touching the door handle and the unlocking of the car.

**Passive Keyless Go**

After the driver has entered the car, the ID device remains in the pocket. The engine is started simply by pressing the start button. When this button is pressed, basically the same authentication procedure as for unlocking the car starts. The engine can only be started when the ID device is inside the car. This

---

**Verified.**

**Hardware-in-the-Loop Simulation with dSPACE Simulator – Cutting-Edge Technology for ECU Tests**

- Turn-key systems for hardware-in-the-loop simulation
- Designed for ECU function and integration tests
- Solution-oriented products
- Tool chain based on MATLAB®/Simulink®

dSPACE Simulator offers everything you need to test your ECUs: reproducibility through test automation as well as the simulation of complete vehicles or individual components. This makes early verification and quality assurance of the ECU possible – without the need for expensive vehicle prototypes. All-inclusive with dSPACE Simulator.

www.dspace.de