Integration and Power Management Open the Door for RKE Applications

ASSPs are meeting the challenges through the integration of mixed-signal technology and innovative power management schemes.

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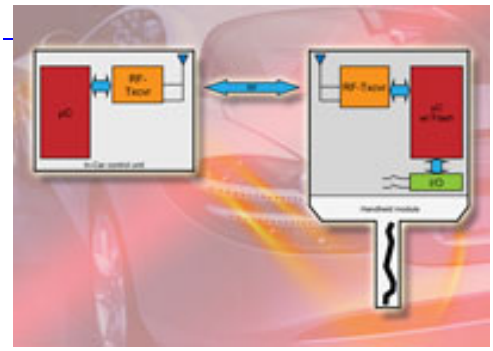

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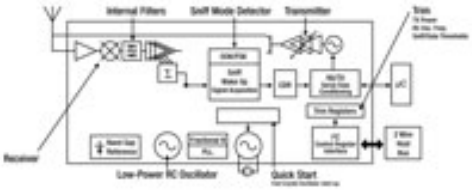
Wireless transceiver technology is truly established in the automotive industry with Remote Keyless Entry (RKE) now a standard feature of even basic specification vehicles. Following on its heels has been Passive Keyless Entry (PKE), dual transceiver devices that combine remote entry and remote starting, and systems that enable features such as tire pressure monitoring and car-to-home communications.

The main challenge for component manufacturers supplying technology into these fast growing areas is to provide reliable, cost-effective devices that have minimal power consumption, good range and of course comply with prevailing regulations. When considering applications in areas such as inside a key fob or tire, limited space often also presents a considerable challenge.

This article looks at how ASSPs use mixed-signal technology and innovative power management schemes to meet the challenge.

Progressing from the Breakthrough Application

Increasing electronic content to support convenience, safety and infotainment in both passenger and commercial vehicles has been one of the biggest stories in the automotive industry in recent years. One-way or simplex RKE adoption has been a major part of this evolution – or perhaps even revolution – with over 80% of all new vehicles now utilizing basic simplex technology to remotely unlock doors.



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Simplex RKE has proven to be the foundation and springboard for increasingly sophisticated and exciting vehicle-related wireless communications plus vehicle-to-home communications such as Johnson Control's Homelink system. Second and third generation systems using two-way (half-duplex) communications allow the implementation of PKE. Here, the vehicle locks when the key holder is within range (a few metres) of the fixed transceiver located within the vehicle that is continually polling for the presence of its paired counterpart. The vehicle unlocks when the key holder pulls the door handle. Extensions to the two-way concept can support functionality such as remote starting and tire pressure monitoring (TPMS).

Regulation

Being license free has helped the development and adoption of RKE and PKE products in vehicle applications. However, regulations - such as the Federal Communications Commission (FCC) in the United States, and European Telecommunications Standards Institute (ETSI) in Europe - that govern short-range, license free designs do impose some important restrictions. These may have more impact as automotive companies explore more complex, data hungry and sophisticated applications for two-way communications. For example, the regulations stipulate that voice, video or continuous data cannot be transmitted and that transmission times must not exceed five seconds. Other restrictions relate to maximum permissible field strengths that impact range.

The Enabling Technology

In addition to compliance with regulatory requirements, exciting and desirable second and third generation applications can only become reality if the various technical challenges can be met and at commercially viable cost level.

Combining transmit, receive and other mixed signal circuitry in close proximity has never been a straightforward task. For companies like ON Semiconductor who have experience in developing devices to allow the implementation of RKE, PKE and their evolutions, this is also set against the need to minimise power consumption in what is an entirely battery-powered environment. It is important to consider both the battery in the key fob and the vehicle battery itself. In fact, the power management of the vehicle-based RF module is perhaps more critical as the module is continually checking for a signal for it to be activated and therefore always drawing some current. This occurs while the engine is switched off so the battery strength is not being replenished. The system must use every way possible to minimise operating current and restrict ‘on time' without impacting overall performance.

When considering a RKE key, PKE transponder – which is often just credit card sized, or a tire valve fitted TPMS, efforts to keep the sensor/transmitter module

as small and lightweight as possible typically result in severe restrictions being imposed on battery size. Physics dictate that as the battery size is reduced, so the battery capacity also decreases with the effect of reducing the total available energy.

Long battery life is an important feature with vehicle manufacturers often specifying a minimum 10 year duty cycle from cells with total capacities as low as 220 mAhours. This would equate to in the region of 85,000 to 90,000 hours of use for a typical TPMS sensor/transmitter; allowing an average of just 2.5 µA continuous current consumption.

In order to maximise battery life - especially for the main vehicle battery that is continually being drained due the RF module polling when the engine is switched off - it is necessary to duty cycle power to various portions of the device. As part of this power management scheme, devices may include an ‘inactive' operating mode as well as an ‘active' mode. In a TPMS system the ‘active' mode would be triggered by car motion and increase the repetition rate of the tire pressure readings by up to 100 times compared to the ‘inactive' mode. The highest current consumption mode of a TPMS application is during RF transmission when it is up to five times higher than when in the pressure measurement processing mode. Additional power savings can be achieved if the pressure measurements are transmitted infrequently or only if a significant decrease in pressure is measured.

In the case of the two-way RKE systems, the active mode would be triggered by data sent by the key fob once the driver has pushed a specific button. Examples of this include remote engine start and remote cockpit temperature control. These messages are sent while the car engine is switched off, and so effective power management systems are essential so that the battery is not drained over longer periods of time due to the periodic polling of the vehicle-based transceiver.

A section of the circuit that is required to operate continuously is the RC oscillator for the wake-up timer. Another continuous current drain is the leakage of the device. The current consumption of the circuit in inactive mode, which can be expected to account for approximately 90% of the total 10 year lifetime, may be as low as 500 nA average current. This would allow the average current in active mode to be as high as approximately 2.8 uA.

Being able to quickly reach desired operating points can allow further power savings to be made in several circuits in a typical RF transceiver package. One circuit that usually requires significant start up time is the crystal oscillator. For situations such as this ON Semiconductor's ‘quick start crystal oscillator' IP can prove beneficial. This self-calibrating circuitry reduces the start time of the oscillator to between five and 10 µs, compared to the five to 10 ms required for a typical crystal oscillator.

So called ‘Sniff mode' IP can also be very helpful. Here, low-end, dedicated, embedded microprocessor logic is used to control physical IP, thereby lowering power consumption in both the chip and the external peripherals that it drives. Power conservation and overall system performance are optimized as all non-critical features are shut down during ‘off-time'. ‘Sniff mode' causes the device to

periodically wake up from this low power state and poll for a valid packet via Wake-On-Energy or Wake-On-Pattern programs. On chip intelligence to reduce the number of RF transmissions may also be utilized to help further minimise power consumption.

Size Matters

The integration of as much functionality as possible within a single device is highly desirable for RKE, PKE and related applications. This approach saves space by overcoming the need for many external components. The space saving achieved can either be harnessed to make the overall design smaller and therefore easier to accommodate within the vehicle, or, in the case of the key fob module, allow for a larger, longer life battery to be used.

To give customers the utmost flexibility and also allow them to benefit from volume-related economies, an ASSP-based solution for the transceiver makes good sense. This type of approach lets customers use the same basic device for applications on numerous platforms in different regions. Transceivers can be programmed to operate at the authorized frequency band for a given country, have specific wake-up patterns, use the customer's chosen protocol and be custom configured for many other parameters.

ON Semiconductor offers devices in compact, low profile packages, that incorporate an on-off keying (OOK)/frequency-shift keying (FSK)/ amplitude-shift keying (ASK) ISM band transceiver, plus an I2C interface, EEPROM, crystal oscillator, the PLL loop filter components, and onboard temperature sensing.

Cost

Low cost remains an essential criteria for high volume vehicle manufacturers operating in a hugely competitive and, in the current economic climate, smaller market. For applications such as TPMS, there is a large economic benefit to be gained by coupling the central controller with the RKE system that is already present in most vehicle platforms. The use of mature, high availability processes and IP can also help reduce cost compared to utilizing the latest smaller geometry techniques. For example ON Semiconductor uses proven 0,35 µm CMOS mixed signal technology. The inclusion of an economical EEPROM module, allows the storage of applications specific data. For TPMS this could be calibration and tire serial or position numbers, and for a car-to-home system information such as remote garage door codes could be stored. The reduced component count resulting from the integration of functionality and external components can also help in controlling costs.

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