Low power contactless tag reader

Abstract
Contactless radiofrequency identification is popular in many electronic applications such as access control, automotive, object identification... Its uses a powerless tag (often a plastic card) whose power is provided by a reading coil in the form of a coupling voltage. This article describes a 125 kHz reader design using a Cypress PSOC CY8C26233 (20 pins, 8 Kbytes flash). In this application, a few passive components and no active component other than the PSOC is required to build a complete, versatile and very low-power reader.

Functional description
A 125 kHz square signal is produced by a digital bloc configured as PWM module (10, see figure 1). For a 2.2nF capacitor, L’s value is 737uH. The signal at the LC node is rectified by a diode to obtain its peak amplitude (1).

To minimize power consumption, a card detection mechanism is implemented: in idle state, all analog blocks are disabled. The CPU is woke up at a 8 Hz frequency by the sleep timer. Then, a 125 kHz pulse (2) (just one) is generated. LC resonates and produces a voltage which charges a capacitor whose decay time is related to the peak value. Measuring the delay with the amplitude detector (3) enables the CPU to detect the approach or removal of a tag (amplitude decreases when a tag is near the reading coil).

When a tag is detected, the PWM generator (10) is enabled and outputs a continuous 125 kHz square signal which is applied to the LC cell to generate the coupling signal. The card sends back its code by modulating the coupling signal which otherwise would have a constant amplitude. The modulated signal is rectified by a diode and its continuous component is blocked by the input capacitor. After amplification, the carrier frequency of 125 kHz is filtered out by a bandpass filter (6) which retains the two valid signal frequencies of 15.6 kHz (bit 0) and 12.5 kHz (bit 1). The resulting analog signal is finally applied to a comparator (7) to produce a digital signal for further processing by the CPU.

The digital signal at the output of the analog conditioning stage is decoded by firmware (11). When the decoding finishes, the valid result is sent at the output in binary form (13) and the PSOC returns to its idle state to reduce power consumption. In this state, it detects the removal of the tag before restarting the whole process again.

Detailed features
Flash ........................................3.5 Kbytes
RAM........................................25 bytes
Digital blocks .........................100%
Analog blocks .................50%
Average power consumption
  5V .....................................50 uA (best sensitivity)
  3.5V ...................................20 uA
  3.2V ................................120 uA (w internal boost converter)
  2.2V ................................220 uA (w internal boost converter)
Conclusions
As shown in figure 1, no external components other than the input stage (using only passive parts) is required to obtain a complete and versatile contactless reader. Reconfiguration of the analog conditioning stage and reprogramming of the firmware are always possible to adjust to a particular encoding scheme.

The PSOC has sufficient memory and processing resource to be programmed in C, thus enabling easy upgrade and adaptation for future extensions. Its built-in boost converter (9) enables the reader to function at voltages as low as 2V which is a rather unique feature. Its detection mechanism reduce the mean power consumption to very low levels and makes this contactless reader design a prime choice in portable applications.
Fig. 1: Contactless tag reader synopsis
* Strap, L2, D3 optionals (for V <3.3V)
Remove all for V>3.3V and connect V+ to VCC

**Figure 4 : contactless reader schematics**