Implementing Ultra-Thin Low Complexity UHF RFID

By Thomas Gyger,
EM Microelectronic Marin SA.

Logistics and supply chain management (SCM) applications are key areas where RFID technology is expected to further improve process and data capture automation. A successful deployment of RFID technology will however depend on the technology price/performance ratio. This article highlights design considerations around the EM4222, an UHF RFID chip newly developed by EM Microelectronic Marin SA.

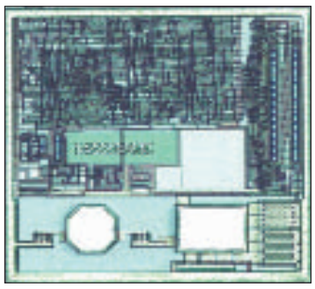

Figure 1: Die shot of the EM4222 UHF RFID.

With a very small footprint, slightly above a quarter of a square millimetre, the EM4222 is a passive read-only UHF transponder optimised to yield the absolute minimum die area and thus production costs. The chip features read-only UHF and microwave operations and has two pads for the antenna attachment.

Circuit characteristics

The EM4222 is powered by a reader transmitted RF beam, which is received and rectified to generate the chip supply voltage. A pre-programmed code is transmitted to the reader by varying the amount of energy that is reflected back to the reader. The circuit is frequency independent and has been designed for RF coupled applications. Depending on the type of antenna, it may typically be used at frequencies such as 869 MHz, 902-928 MHz or 2.45GHz. Through on-chip oscillator and on-chip rectifier, UHF transponders can be implemented very efficiently avoiding the need of any external component other than the antenna. Data transfer rates of 256kbit/s, reading rates of 120tags/s and reading ranges of several meters can be achieved, with the actual performance subject to country specific standard for maximum emitted power, operating frequency, antenna design and reader performance as well as environmental parameters. Applications range from pallet-level down to item level identification. In logistics applications running in several tens of millions of units, prices are below $0.10 each. For applications requiring a totally unnoticeable integration of the transponder circuit, the chip can be back-lapped down to 2 mils.

Design considerations

A RFID system is usually constituted by a set of transponders and one or more readers. The best performance will be reached through an application-specific tag design, taking into account and carefully balancing the following parameters: central frequency, frequency bandwidth, antenna dimension and shape, antenna polarisation, tag substrate and target material. Once the tag has been designed, the air interface with the reader should be considered. In the lower frequency domains such as 125kHz and 13.56MHz, energy and data are being transferred by means of the magnetic field. For most applications working with inductive coupling techniques, it is reasonable to admit a uniform distribution of the magnetic field. In UHF systems however, energy transmission and data communication occur through the electrical field. Distribution characteristics of UHF and microwave fields are determined by the propagation and reflections of the RF signal. Different types of material present in the considered volume will reflect the RF signal and produce multipath fading effects, resulting in the annulation of the RF field in some spots. Tags located in such "cold spots" will eventually not get a reader signal and therefore not respond to the reader. The simulated UHF RF field of figure 2 illustrates that some tags (red dots) do not receive a signal, while others do (green dots). For all the tags to be read, one would have to move either the tags or the RF field. At the transponder level first, it is possible to cope with this particular RF field distribution with a simple and efficient protocol. Each transponder has to respond quickly as soon as it gets into the field. Furthermore, with the long-range capability of UHF tags, simultaneous presence of several tags in one reader beam becomes the standard for most applications, hence the need for an efficient anti-collision protocol.

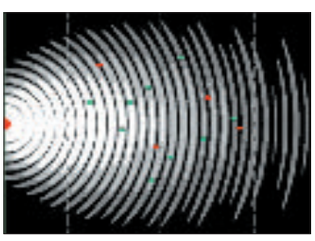

Figure 2: A simulated UHF RF field shows some non-covered tags (red dots).

Addressing the tags

There are two main anti-collision techniques: Reader Talk First (RTF) and Tag Talk First (TTF). The basic idea behind RTF is that tags remain quiet until specifically addressed or commanded by a reader (tags are woken up). Circuits operating in RTF-mode need to feature at least a command interpreter, which results in increased chip complexity. They also need to be energised when the readers wants to address them, which may not be guaranteed in UHF applications. A TTF tag like the EM4222, announces itself to the reader by transmitting an ID when it detects the presence of a reader, taking advantage of any situation without having to wait for a reader command. TTF tags are less complex (also smaller and cheaper) than RTF tags, they also require less bandwidth. At the system level some tags may be missing if the system remains static, hence either the tags or the electrical field should be moved at some point. This explains the best performance of UHF RFID in logistics and SCM applications, where data capture most often occurs when items are moved from one place to another. If for some reasons, it is not possible to move the targets during the read process, it is also possible to implement time multiplexed multiple antenna or multiple reader schemes.

EM Microelectronic Marin SA,
Tel+41-32-7555111
Fax+41-32-7555403