

WHITE PAPER

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Beyond product codes: new opportunities for Radio Frequency Identification technology

The market possibilities opened up by low-cost, customizable RFID tags

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1 Introduction

Radio Frequency Identification (RFID) technology has achieved widespread, mass-market success in high-volume Electronic Product Code (EPC) and logistics applications, as well as considerable success in areas like smart ticketing and access control. However passive RFID has its limitations, and the potential for active (battery-driven) RFID technology to add real business across a range of applications is now being widely recognized.

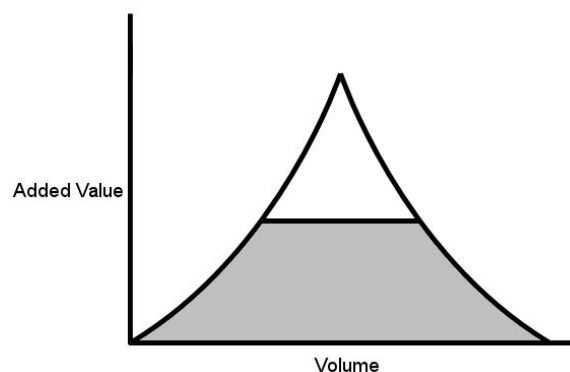
To date, however, the deployment of active RFID technology has been held back by the relatively high cost of meeting the particular – often unique – needs of the application, especially where the volumes involved are much lower than in item coding applications.

For RFID technology to move beyond simple identification applications, it may need to integrate some kind of data collection capability as well as a battery for active transmission, for example. The issue for technology developers and integrators is that these lower-volume applications are unlikely to attract the kind of attention from chip makers that has led to unit costs of less than US \$0.10 for basic passive tags.

Specialist active RFID modules using discrete or off-the-shelf components have been developed for high-value applications, where the typical USD30 unit cost can be justified. But for most other low- to mid-volume applications, the high development and manufacturing costs have proved a barrier to the adoption of RFID technology.

Now, however, RFID chip technology and expertise are available to produce customized active RFID tags for more sophisticated applications for USD5 or less. This represents a significant shift in market dynamics and opens up a wide range of applications where RFID technology can add real value.

In particular, it is now possible to produce multi-frequency, multi-function active RFID tags cost-effectively, which opens up significant opportunities for sophisticated applications in areas such as supply chain management and asset tracking. These could include sensors for cold chain monitoring, asset monitoring, real-time location systems (RTLS), and shock, temperature and pressure sensing. Active RFID is likely to add the greatest value in low- to medium-volume applications, as illustrated below.



This paper provides an overview of these applications and outlines the potential for customizable, multi-function active and semi-passive RFID technology and integration.

2 Established technology, growing uses

RFID is already well established in product identification, access and travel cards, and high-volume manufacturing and logistics – and the market is growing fast.

At the start of 2007, according to market analysts IDTechEx, cumulative shipments of RFID tags over the past 60 years amounted to 4.3 billion, with around one-quarter of these having been shipped during 2006. In 2007 alone, almost two billion RFID tags will be shipped, according to the firm.

IDTechEx expects the total RFID market (including hardware, systems and integration and other services) to be worth close to USD5 billion worldwide in 2007, with the biggest segment being RFID cards. The non-card market for RFID (labels, key fobs, tickets, etc.) is expected to be just under US \$2 billion. By 2017, the worldwide RFID market is expected to grow to just under US \$27 billion – with a significant proportion accounted for by the food and farming sector (US \$9.4 billion).

The driver behind much of this growth will be RFID's expansion into new, more 'intelligent' applications that go beyond the simple identification of an item using passive RFID tags. We shall see growing deployment in applications that require some form of data capture or interactivity with users and external systems. These will include sophisticated Real-Time Locating Systems (RTLS), sensing, monitoring and smart labelling applications across a range of industry sectors.

These applications demand the availability of low-cost, customizable active – or 'semi-active' – RFID tags. A semi-active tag is an RFID transponder that can behave like a passive tag, reflecting radio energy back to a reader, but also has an onboard energy source (battery) to power the RFID chip circuitry as well as an onboard sensor, for example, for part of the time. This enables longer read ranges, along with the ability not only to determine an item's location but also historical data relating to its environmental condition (temperature, exposure to shock, etc.) throughout its journey.

According to IDTechEx, active RFID applications will grow from 12.7 per cent of the total RFID market in 2007 to 26.3 per cent in 2017 (with a value of just over US \$7 billion).

A recent review of venture capital and private equity funding in the RFID field by *RFID Update* found that the lion's share of funding in the 18 months to December 2007 went to active RFID and RTLS companies. Out of a total investment of more than US \$433 million over the period, an estimated US \$165.2 million went to RTLS and active RFID firms.

This market growth is being driven by increasing demand for the intelligent tracking and location of goods, equipment and people, for reasons of safety, security, customer satisfaction and productivity. In addition, people will increasingly expect to use mobile devices – phones, PDAs, etc. – to buy goods and services, access buildings and transport, and obtain information from objects.

Broadly, these new applications for semi-active RFID fall into four categories:

- **sensing** – including food supply chain monitoring, equipment monitoring, and hazardous chemical sensing so that, for example, the temperature of fresh meat can be accurately monitored throughout its journey from producer to store
- **transport and logistics** – including tolling, payload measurement and sensing, driver authorization and ‘custodial’ matching to improve efficiency and ensure the right goods are delivered to the right place at the right time
- **asset tracking** – including IT equipment location and protection (of laptop computers, for example) and medical equipment tracking to improve the efficiency, security and safety of systems and information
- **access control** – including workforce safety and security, time and attendance and patient protection to enhance the safety and security of personnel and patients.

As applications in these areas will have widely varying requirements for integration, radio performance, data-handling capability and security, product and solution developers will need access to specialist RFID skill sets. These include digital and analogue design expertise, radio frequency engineering capability, integration expertise and application knowledge with experience of what works and does not work in real-world RFID implementations.

3 Custom RFID technology

One of the most fundamental enablers of the fast-growing market for active RFID solutions is the falling cost and size of RFID tags, and the increasing ability to customize them to the application concerned cost-effectively. This is important, as the uptake of low- and medium-scale active and semi-active RFID solutions demands well-adapted tags at the right price and size. As many of these solutions are highly specialist, 'closed' systems, standardization is not an issue, and should not hold back the development of novel RFID applications. Active RFID tags will need to be available for a variety of radio frequency bands, in order to meet a wide variety of application needs.

RFID tag technology is now available that can be implemented as custom chip implementations – according to the requirements for memory, size and power. For instance, there may be a requirement to integrate RFID-based environmental sensing in food logistics applications to a Bluetooth connection for onward transmission.

Assuming there is sufficient volume to justify the development costs, custom IC design – whether for stand-alone or SoC implementations – offers the advantage of enabling the designer to focus on meeting customer requirements in a way that cannot be achieved using standard products.

In a nutshell, custom IC design optimizes the cost of IP ownership and – as it is tailored specifically for purpose – it contains exclusively non-recurrent engineering. This means that for a given application, power usage, silicon area and memory can be optimized to a specific requirement, so reducing long-term cost, improving performance and extending battery life. Using custom IC design for RFID SoC implementations also means the host chipset designers do not need to become experts in a new area.

Innovision Research and Technology plc is already deploying its proven analogue and digital design capability to custom RFID IC design for a broad range of clients. The company can help its clients manage the complexity of navigating areas such as RFID IP patents and radio frequency engineering, across a number of industries with differing needs.

4 The multi-frequency, multi-function opportunity

Advances in RF design and the falling cost of integrated chip designs open up another area of great potential for active RFID technology: multi-frequency, multi-function tags. RFID tags that not only offer basic identification, but also the ability to sense and store information, as well as communicate it to other near-field devices, enable a new 'Internet of things' that has huge potential to add value across a wide range of applications.

As an illustration, in a supply chain management application – such as food production, distribution, storage and retail – multi-frequency tags could be used not only to provide product identification, but also to record environmental conditions during storage and transport, and then used to provide useful information to the end-consumer using an NFC reader, such as a mobile phone, in the store.

The active RFID tag in such a scenario could offer a combination of high-frequency (13.56MHz), UHF (approximately 900MHz) and the 2.45GHz band – enabling near-field reading/writing up to a few tens of centimetres away, as well as reading over distances of several metres.

Tags able to provide these multi-frequency capabilities can provide a 'bridge' between the RFID and NFC worlds and enable a variety of new and legacy systems to be utilized. Mesh networks of active tags would enable much more 'intelligent' applications of RFID technology, in which data about the objects the tags are attached to and their environment can be shared and updated much more quickly and widely.

One real-life example of the application of multi-frequency, multi-function RFID technology is a wireless tracking device developed by Innovision for a provider of enterprise tracking and security solutions. This uses a System on a Chip (SoC) design based on Innovision's in-house RFID analogue IP to dramatically reduce the size and cost of the company's tracking modules.

The new device enables the capture, processing and transmission of real-time information in areas such as supply chain management, mobile asset management, physical asset security, access control and condition monitoring. The first product is a software-definable battery-powered module that is small enough to be embedded into a variety of products, including computers, test equipment, medical equipment, credential cards, pallets and cartons.

5 Summary

We are moving towards an increasingly connected world, in which smart, networked devices increase opportunities for information sharing, automation and intelligence. In this environment, something more than passive RFID technology is needed, and RFID technology is expanding its role from that of straightforward identification to one that enables greater interactivity and data sharing than ever before.

This trend not only requires greater numbers of small, low-cost active RFID tags. It also demands ever-greater levels of integration and adaptation to more sophisticated, smaller-scale applications. RFID solution developers will require low-cost active RFID tag technology and custom design expertise that will enable adaptation to a huge variety of needs at competitive cost.

6 Glossary

Bluetooth	Short-range (10–100m) wireless communication protocol
GSM	Global System for Mobile communication
ISM	Industrial, Scientific and Medical
NFC	Near Field Communication
PDA	Personal Digital Assistant
RF	Radio Frequency
RFID	Radio Frequency Identification
SoC	System on Chip
UHF	Ultra High Frequency

Innovision Research & Technology plc
33 Sheep Street
Cirencester
Gloucestershire
GL7 1RQ
United Kingdom

www.innovision-group.com

Tel: +44 1285 888200
Fax: +44 1285 888190
E-mail: nfc@innovision-group.com