



# RFID Tagging Technology

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## 1. Introduction

This paper reviews the technologies available within Radio Frequency Identification (RFID) with respect to its application within the supply chain industry.

It attempts to identify the capabilities and limitations of current technologies and to identify the direction of planned development together with the expected capability this will provide.

## 2. What is RFID

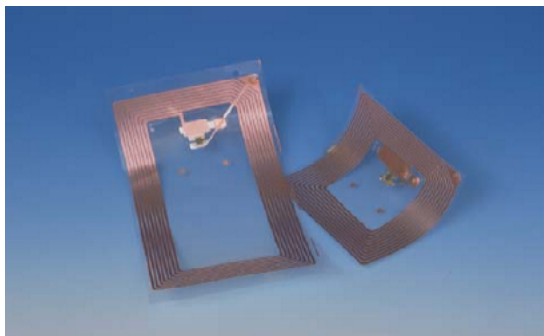
RFID is a method of auto identification that is suitable for identifying both products and assets within the supply chain environment. It is not a new technology and has been in the public domain for at least 10 years. Technical limitations and cost have so far proved to be a barrier to its widespread adoption. Unlike barcodes, it does not require line of sight.

RFID technology comprises 3 basic elements :-

- The RFID tag
- The RFID reader/writer
- The host line of business system

### 2.1 The RFID Tag

The RFID tag is a radio data device designed to carry data. It consists of a piece of integrated circuitry, some memory and an RF antenna. In some designs there is also a battery power source. These are known as active tags. Designs that do not have their own power source are known as passive tags.



A passive RF tag showing the integrated circuit and antenna

Designs are currently available for use at a variety of frequencies, typically 125 KHz, 13.56 MHz, 2.45GHz and around 900MHz.

Every tag is manufactured with its own unique identification number. Additionally, depending on the tag type and specification, the tag will have the ability to store more data. The amount of data can be up to 512 bytes for passive tags and up to 32Kb for active tags. With increased data capacity, the facility can be provided for organizing data into fields or pages that may be selectively interrogated during the read/write process. Depending on tag design, the memory can be read only (RO), write once read many times (WORM) or reads/write (RW)

WORM devices are user programmable. Read/Write devices are also user programmable but allow the user to dynamically change the data stored on the tag. Portable programmers are available that allow in-field programming of the tag while attached to the item being identified. More sophisticated tags can also have extra circuitry which allows a variety of additional I/O functions to be used. (i.e. they can record a temperature, time or other physical state of some system)



RF tags can be produced in an extensive variety of physical formats.

This can range from flat sheet designs suitable for conversion into labels to designs encased in plastic suitable for physical attachment to products or assets

## 2.2 The RFID Reader / Writer

The RFID reader/writer consists of some circuitry and an antenna. In the case of passive tags, the RF field created from the antenna both energises the tags and picks up their RF transmission of data. In the case of active tags, the RF field reads the tags and may also be used to activate the tag (i.e. switch it on for a programmable period of time)

Multiple tags can be read within a single field. However, the circuitry needs time to identify each individual tag I/D and to read the data from that tag. Thus, reading of multiple tags is not instantaneous. Depending on the number of tags within the field, the identification and reading process can take a significant amount of time.

Functions performed by the reader may include quite sophisticated signal conditioning, parity error checking and correction. Once the signal from the tag has been received and decoded, algorithms can be applied to decide if the signal is a repeat transmission and may then instruct the tag to cease transmission. This process, known as "Command Response Protocol", circumvents the problem of reading multiple tags in a short space of time. This type of interrogation is often known as "Hands Down Polling". The alternative but slower method of "Hands Up Polling" involves the interrogator looking for tags with specific identities and interrogating them in turn.

This topic is termed contention management and a variety of techniques have been developed to improve the process of batch reading. A further approach is to use multiple readers, multiplexed into one interrogator, but with associated increase in costs.

The antenna design and tuning is critical to the performance and operation of the system. Antenna designs can range from hand held devices to large freestanding or fixed installations. In the case of larger installations, they can be mounted within door frames or within the floor.

The orientation of the tag to the antenna is significant in the ability to read the tag. In general, tags are more easily read when the tag is parallel to the antenna although tags can be read at other orientations.

For these reasons, antenna design is a fundamental and unique part of any installation and will always require to be customized to the particular application.

### 2.3 The Host System

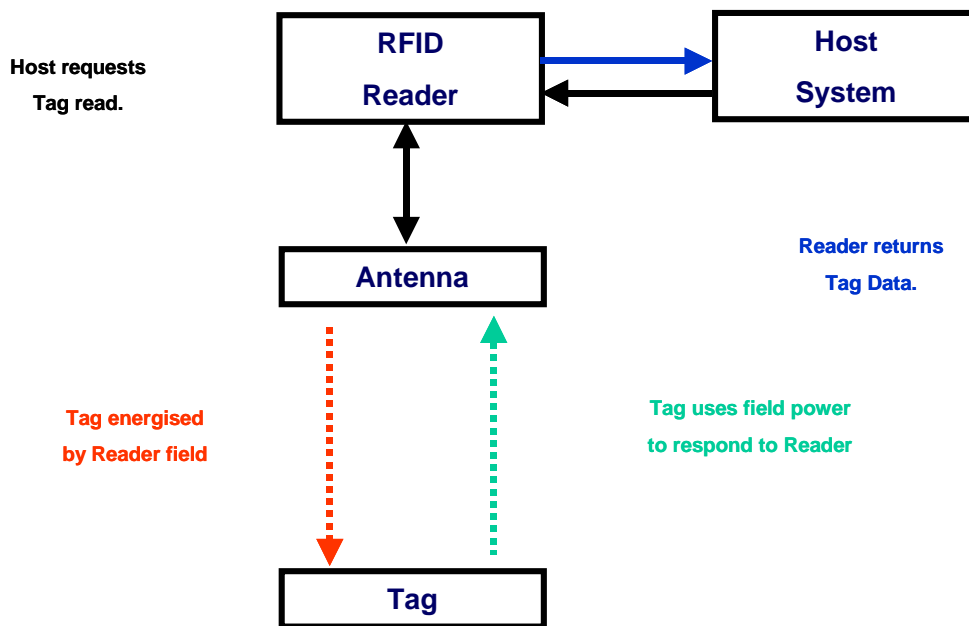
The host system is normally a line of business software application: typically an enterprise resource planning (ERP) system, warehouse management system (WMS), in-cab proof of delivery (POD) or proof of collection (POC) system.

In a similar manner to standard barcodes, RFID tags are merely an automated way to provide input data to the host system. However, RFID tags can also provide an automated output from the system allowing dynamic update of the data held on the tag.

In all cases, the host system will need software modifications to integrate the data provided by the RFID reader/writer.

## 3. How does RFID Work

In a system using passive tags, the tag is energised by the RF field from the reader and transmits its ID to the reader. Other data transmission depends on the protocol between reader and tag.



In the case of active tags, the tag is powered internally by a battery. The tag can be turned on by a suitable RF field from the reader (or other antenna). Once turned on it communicates with the reader using pre-determined protocols. Tag circuitry may allow programming of the tag to act as a beacon to regularly transmit its presence. The tag may also be programmed to turn itself off after a given period of inactivity.



### 4.3 Systems Integration

The key to success in all RFID projects lies in the quality of the system integration which is required to bring various components together to form a meaningful system . RF Tags cannot be considered to be a replacement for bar code labels and any project that uses this approach is doomed to failure.

The key strength of RFID is its ability to be covert and transparent in operation. A successful RFID project should not cause a visible change to the process or the way operators perform the process. It should be invisible to the operator as long as the process is being performed correctly. The RFID system only becomes apparent to the operator when something in the process is not being carried out correctly. The operator is then made aware, usually by some sort of alarm together with associated information on how to correct the mistake.

While there are limitations within different types of RFID technology, a detailed examination of the business objectives and actual processes tends to clearly identify the correct type of RFID technology applicable. Detailed analysis of the process is essential and this must be done both with the process engineer and the people who actually perform the process. (There are often significant differences between the two)

RFID is not perfect and can never be 100% accurate. Contingency must be made for tags that fail to be read.

The relatively high cost of RF tags tends to promote projects which use RF tags to track assets containing products rather than the actual products themselves. The host system is then used to track the products via their relationship to the asset. Typical assets include re-usable trays, containers, dollies, roll cages etc.

The economics become much more viable if the asset is used within a closed system. Additionally, RFID tends to lend itself to multiple use of the tag throughout the length of the supply chain. The ability to change data on the tag as it passes through the chain reinforces this ability and strength.

RF tagging can also be considered for higher value products or where the security of the product is paramount.

### 4.4 RFID Manufacturers

There are a wide number of manufacturers of both RF tags and RFID reader technology. The design and manufacture of the reader antenna is normally the responsibility of the systems integrator.

Significant manufacturers include :-

<b><i>Manufacturer</i></b>	<b><i>Products</i></b>	<b><i>Trade Names</i></b>
Texas Instruments	LF, HF	Tiris, Tag-It
Philips	LF, HF, UHF	MiFare, HiTag, I.Code
TagSys	LF, HF	Folio
E.M. Martin	LF, UHF	

#### **4.5 Standards**

Legislative bodies are developing standards which cover both the RF protocol and data format levels. ISO15693 has already been published covering high frequency passive tags called "Smart Labels" and products to this standard are available from multiple suppliers.

EAN and the Uniform Code Council (UCC) are promoting the adoption of a global standard for supply chain applications known as Global Tag (GTAG). This has the objective of allowing producers to apply a tag at manufacturing source which can be read on a global basis. GTAG uses a UHF passive tag format which has the same functionality as EAN128. It is hoped that this will allow interoperability and a smooth transition between bar codes and RFID tags.

Massachusetts Institute of Technology (MIT) is also working on a UHF RF tag standard.

ISO have also released a new standard, ISO18000 which defines UHF and other frequency passive tag formats. This should provide tags, available in both label and card formats, at a price below £1 which are capable of being read at a distance of about 2.5 metres using a single antenna. Deliveries of product to this standard are expected to begin early in 2003.

#### **4.6 RFID Benefits**

- Does not require line of site
- Extended data capacity compared with bar codes
- Tags can be hidden for security
- Tags can be protected for harsh environments
- Wide and versatile tag format
- Read/write can be automated for transparent operation
- Highly secure and difficult to replicate – ideal for authentication or warranty applications
- Data can be dynamically modified/updated for continuous re-use
- Multiple tags can be read at once

#### **4.7 RFID Drawbacks**

- Relatively high cost of tags
- Read/write range can limit application
- Multiple read/writes are time dependent
- Standards are still emerging and not mature
- Non-reads must be catered for within the system

### **5. Conclusion**

RFID technology is not a replacement for bar codes. It is available in a mature and usable format with standards beginning to emerge. Unlike bar codes, RFID does not require line of site. Due to tag cost it is currently more applicable to the transparent tracking of re-usable assets which have been previously associated with the products they hold.

Successful project implementation is dependent on the quality of the systems integrator who must have goods business and process knowledge, technical understanding of the component products and wide integration resource capability.