



**“THE RFID GUIDEBOOK”
(REVISION 8)**



FOREWORD

Built upon a strong foundation of over 60 years of experience, SATO solutions enable any business to quickly and efficiently identify anything—be they products, components, actions or people.


Since its incorporation in 1940, SATO has been known to be insatiable in its pursuit of innovation and provision of labour-saving solutions to meet society's needs. In 1962, SATO's hand labeller was a worldwide best-seller. Then, in 1974, SATO developed the world's first printer for barcodes and OCR characters, and took the lead when the rising tide of in-store marking swept across the retailing industry.



Barcodes proved ideal for computer input, so SATO moved far beyond the retail trade, developing electronic printers that were soon in service throughout the economy. SATO has then maintained its lead as a manufacturer of automatic identification systems and related consumable supplies. It revolutionised the bar coding industry by introducing the Data Collection System (DCS) and Labelling concept – a total barcode and labelling solutions approach providing high quality barcode printers, scanners/hand held terminals, label design software and consumables.

SATO has been supplying high frequency (HF) RFID solutions for some years, and fully supports the Uniform Code Council's (UCC) Electronic Product Code (ePC) initiatives as well as the recent Wal-Mart and Metro mandates that require their top 100 suppliers to embed RFID tags at the case and pallet level by 2005.

Many of Wal-Mart's and Metro's Top 100 suppliers are longstanding SATO customers who look to SATO to help satisfy their RFID requirements. Labelling an item with a barcode, or RFID tag, allows that item to be immediately and accurately tracked throughout its despatch trail.

SATO is a publicly listed company in  Japan and has worldwide offices in  United States,  Germany,  United Kingdom,  Poland,  Belgium,  Singapore,  Malaysia,  Thailand and  China. Reported revenues in 2002 were US\$445 million. SATO stocks are traded on the first section of the Tokyo Stock Exchange. Whether you are required to implement an RFID compliant system, or are just looking to increase internal efficiency, you can trust SATO to provide you with complete support from start to finish. More information can be found at www.satoworldwide.com.



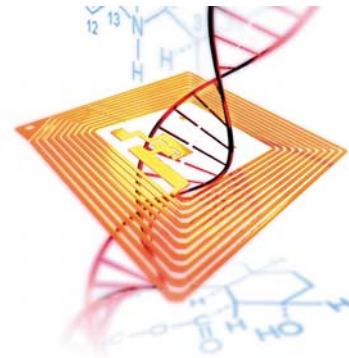
EXECUTIVE SUMMARY

Radio waves are commonly used to transmit and receive information to avoid the use of wires. While RFID (Radio Frequency Identification) technology has been available for many years, it was not until recently that interest in using RFID for business, healthcare, and governmental applications took off.

It can be a challenge to understand and apply RFID within a specific deadline, but very gratifying once it is successfully implemented. RFID tagging can help improve internal operations as well as enable more effective communication with trading partners.

Other acronyms for RFID: IC tag, "Smart tag", RF tag

SATO has compiled this guidebook with a focus on promoting better understanding and awareness of RFID technology. This can provide useful insights on the importance of RFID integration, and can help you determine whether you are prepared to put a winning RFID system into action. This RFID guidebook will:



- Introduce RFID technology, standards, specifications, types of tags
- Identify the pros and cons of RFID implementation
- List major retailers that expressed interest in establishing a RFID system
- Explain how RFID can benefit various industries
- Summarise the challenges that are involved in the global marketplace concerning RFID
- Describe the testing process involved to evolve an RFID concept into a working pilot
- Present labelling technology options



“ THE RFID GUIDEBOOK ”

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WHAT IS RFID?

RFID is best described as a wireless memory chip, or “smart tag”, that is attached to both the product and transport packaging.

Q: How does an RFID system work?

RFID offers higher data storage capacities, higher identification speeds, and greater immediacy and accuracy of data collection. RFID readers control the wireless reading and writing of information stored on an RFID tag by generating a radio frequency field around the antenna. The RF field gives the tag power (if passive tag), and a way to transfer data from the tag to the reader. The tag modulates the reader's RF field, and the reader can detect this. Likewise, the reader turns the RF field on and off in the right sequence in order to write the tag.

Q: Why are supply chain management companies embracing this technology?

An increasing number of supply chain management companies worldwide are embracing RFID technology to identify multiple items in a single container in an expeditious manner—a feat that is not always possible with bar-coding systems. The technology's enhanced accuracy and security in data collection makes it an ideal data collection platform for the healthcare, pharmaceutical, manufacturing, warehousing, logistics and retail sectors.

History of RFID

Q: What was the first application of RFID?

RFID can be traced back to World War II days, when the British military needed to find a way to identify whether an approaching aircraft was friend or foe. Even today, as more sophisticated navigation technology becomes accessible, the United States military is currently using various forms of RFID.

Q: When was RFID first used to track inventory or livestock?

In the 1980s, Compaq Computer had begun using RFID tags to trace components through the production process. The railroad industry has also used RFID to track nearly every rail car in North America, while the agricultural industry has used RFID tags to trace its livestock.

Q: What was the first implementation of RFID towards consumer applications?

Additionally, RFID has also been used for various consumer applications. Vehicle transponders use RFID to communicate with toll booths on bridges, expressways, or special toll roads to automatically deduct funds from the account holder of the transponder.

Q: What is the driving force behind the initiative of so many companies to implement RFID?

One of the major reasons is because a few major retailers, along with the U.S. Department of Defense (DoD), have decided to utilise RFID technology within their supply chain management. The major retailers are mandating that their top 100 suppliers utilise RFID tags on all product deliveries by 2005.

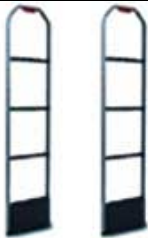


Q: What was the “real” reason behind implementing RFID in today’s society?

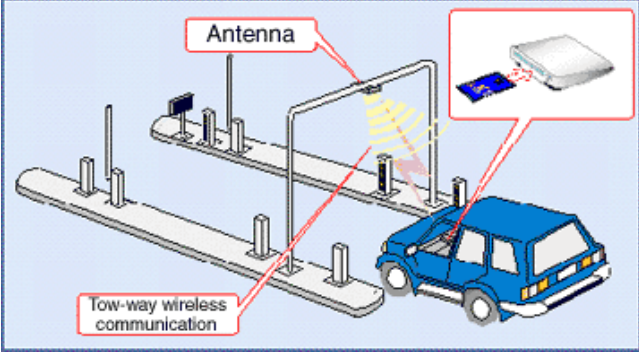
The main reason for implementing RFID lies in one simple fact: our competitive global market demands a change in the way business is conducted. To stay competitive means to conduct business with greater efficiency, to deliver goods more rapidly, and to lower overhead costs.

Below is a chart recounting the history of RFID:

Decades of RFID

Decade	Event
1940's	<ul style="list-style-type: none"> • Radar refined and used. Major World War II development effort. • RFID invented in 1948. 
1950's	<ul style="list-style-type: none"> • Early explorations of RFID technology, laboratory experiments.
1960's	<ul style="list-style-type: none"> • Development of the theory of RFID. • Start of application field trials.
1970's	<ul style="list-style-type: none"> • Explosion of RFID developmental work for electronic article surveillance (EAS) to counter theft, improve animal tracking, vehicle tracking and factory automation • Tests of RFID accelerate. • Very early adopter implementations of RFID. 
1980's	<ul style="list-style-type: none"> • Commercial applications of RFID enter mainstream.



1990's	<ul style="list-style-type: none"> • Emergence of standards. • RFID, such as electronic toll collection, deployed throughout the U.S. • RFID becomes part of everyday life with a single tag capable of handling multiple applications such as electronic toll collection, parking lot access and fare collection, gated community access, and campus access. 
Early 2000s	<ul style="list-style-type: none"> • Development and implementation of RFID for supply chain management, healthcare/pharmaceuticals, library information systems
2003 - Present	<ul style="list-style-type: none"> • Major retailers mandates to suppliers to implement pallet and case level tagging by January 2005 spark rapid RFID research and development

Various Frequencies (LF, HF, UHF)

Since RFID uses electromagnetic radio waves for its operation, its effectiveness is subject to the same physical laws governing any other RF operating device. The distance between the RF interrogator antenna, the corresponding RFID tag, and the frequency, are all directly interrelated.

Q: What is the difference between low-, high-, and ultra-high frequencies?

Similar to your radio tuning into different frequency channels to listen to different stations, RFID tags and readers must both be tuned to the same frequency in order to communicate. The most regularly used frequencies among RFID systems are low- (around 125 KHz), high- (13.56 MHz) and ultra-high frequency (860-950 MHz). Radio waves behave in a different way at different frequencies, so you must choose the best frequency for the correct application.

	Low Frequency	High Frequency	Ultra High Frequency
Operating Range	125 KHz	13.56 MHz	860 – 950 MHz
Read Range	10 cm	1 m	Up to 3 m
Power Consumption	Low	Moderate	High
Data Transfer Rate	Slow	Moderate	Fast



Application	<ul style="list-style-type: none"> • Point-of-Sale • Small scale Retail applications 	<ul style="list-style-type: none"> • Library systems • Patient identification 	<ul style="list-style-type: none"> • Airline baggage tag • Tracking of controlled drugs • Pallets • Cases
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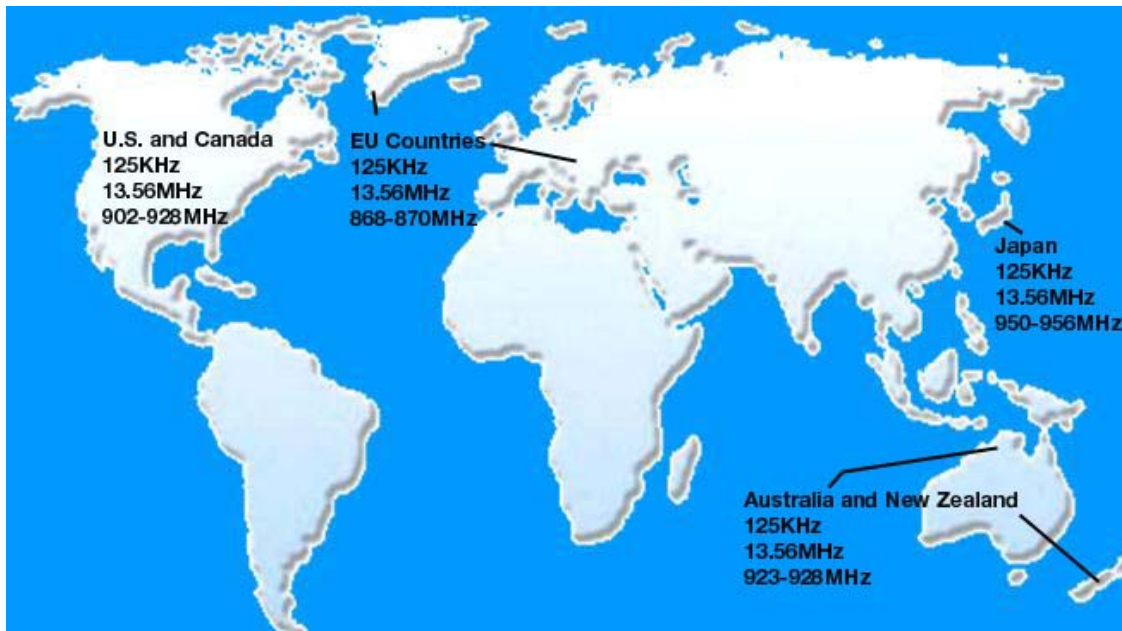
Regional Map of Frequencies

Q: How many frequency bands are used around the world for RFID applications?

Currently, eight frequency bands are used around the world for RFID applications. However, the majority of companies, including SATO, tend to organise these bands into the low, intermediate, and high range.

Q: Do all countries use the same frequencies?

No. Presently, Europe uses 868-870 MHz for UHF while the U.S. uses 902-928 MHz. Japan is in the process of designating RFID to fall somewhere in the 950-956 MHz range. The governments regulate the power limits of readers to limit interference with other devices. SATO's solution can currently select a frequency anywhere in the 860-950 MHz range, which makes it globally compatible. And SATO will continue developing products that will conform to the ever changing RFID global standards. Below is a map showing the frequencies used by major markets such as U.S. and Canada, EU countries, Japan, and Australia and New Zealand:



Components of an RFID System

A basic RFID system consists of three components:



1. A programmable RFID tag for storing data;
2. An antenna to facilitate the reading and writing of data into the tag;
3. A reader that encodes/decodes the data in the tag's integrated circuitry

The RFID Tag

The programmable RFID tag is an integrated circuit (IC) embedded in a thin film medium. Information stored in the tag is transmitted via radio frequencies to an RF

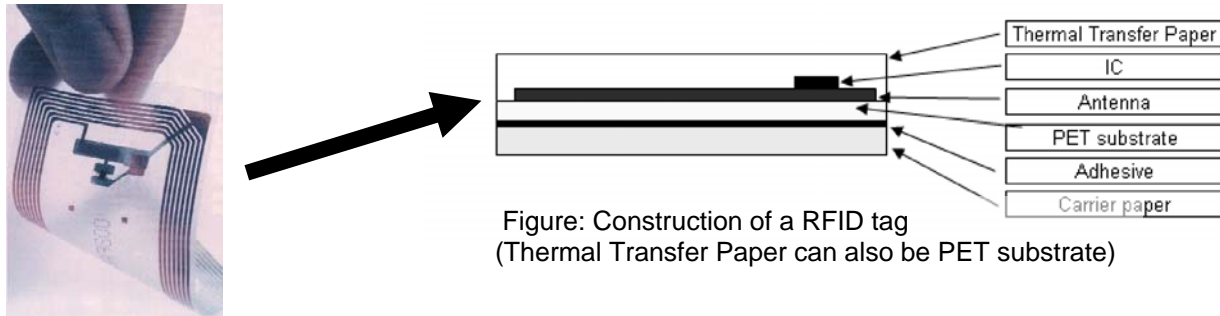


Figure: Construction of a RFID tag
(Thermal Transfer Paper can also be PET substrate)

reader. The performance characteristics of the RFID tag will then be determined by factors such as the type of IC used, the read/write capability, the radio frequency and the read range.

Q: What are the differences between passive and active tags?

RFID tags are categorized as either passive or active (also semi-passive).

Passive tags do not have an independent power supply, and must absorb their power from the host reader. There exist passive RFID tags with the capability to store a few kilobytes of data.

Active tags come with their own battery power source to start up the tag operation. As a result of the built-in battery, active tags can operate over a longer range but have a shorter service life and are more costly. What makes the active tags attractive is the extended reading distance, which can be up to many miles—allowing communications with even orbiting satellites. For a lower cost of implementation, passive tags are a more attractive solution.

Q: What are the characteristics of RFID tags in terms of data storage capabilities?

The information that can be stored inside an RFID tag is defined by its read/write characteristics. For a read-only tag, the information to be stored within it must be recorded during the manufacturing process and cannot be erased. Typically, the information stored is a unique “serial number” to allow one tag to be distinguished from another. Read-only tags are therefore useful for identifying an object, much like the “license plate” of a car. For a read/write tag, data can be written to and erased from the IC on demand. Depending on the application, a rewriteable tag can be updated hundreds of times, and its reusability can help to reduce the number of tags that need to be purchased.

Q: What does an RFID reader do?



RFID readers are capable of automatically recognising and distinguishing all the RF tags within their reading field. This capability allows the RFID reader to simultaneously process all the data and provide for efficient material handling, packaging, and sorting of inventory. Not only will these RFID readers be able to track tagged items and equipment, but they can also be used to track patients (i.e. in hospitals).

DIFFERENCES BETWEEN RFID AND BARCODES

RFID and barcode are both identification technologies that allow identification data to be stored and read back with a reader. While barcodes have been around for ages, the idea of using RFID in applications such as supply chain management is a new concept. Hence, RFID has been coined as the “wireless” or “radio” barcode.



Q: What are the differences between barcodes and RFID?

In contrast to barcode technology, which employs optical reader to read data, RFID reads data using radio technology. The concept of RFID tags driven by its greater data capacity that enables it carry more information than barcodes. RFID technology also enables tag reading from a greater distance, even in harsh environments, unlike optical barcode readers, has no line-in-

sight requirements in order to send and receive information.



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Q: Why are line-of-sight barcode readers at a disadvantage over RFID readers?

Line-of-sight between the label and a barcode reader is often difficult, unfeasible, or even impossible to achieve in industrial environments due to conditions such as dust or label fading. By transferring data via radio waves, RFID has an advantage over barcodes in that RFID tagged objects could be read through packaging, whether or not they can be seen by our eyes. RFID solutions can thus significantly condense redundant inventory stock, help to reduce inventory loss, and facilitate better quality assurance by providing the end-user with real-time product information.

Q: Will RFID technology ever replace the ever-present barcode?

SATO believes that RFID tags will not replace, but complement the ever-present barcode system. Given the growing popularity and viability of RFID, it can be expected that majority of the industries using barcode technology will experience pressure to implement RF (radio frequency) tagging systems to some extent, to complement or supplement barcodes.

DIFFERENT TYPES OF RFID

Inductive Coupling



A very common type of RFID implementation is the **inductive coupling system**. This works in the HF (high-frequency) range at close distances.

The system consists of a powered reader and a passive tag. The passive tag receives power from the reader by means of a scientific principle called inductive coupling. Basically, the principle states that power can be transmitted from one **inductive** circuit (the reader) to another **inductive** circuit (the unpowered tag) if there is a shared magnetic field (**coupling**) between them. Once power is fed to the tag through this coupling, the integrated circuit in the tag can then send data to the reader using the same waves of electromagnetic energy sent by the reader.

Q: What are some of the typical applications for inductive coupling tags?

Typical applications for inductive coupling RFID tags include: RF EAS (electronic article surveillance), smart cards, access control, apparel, baggage control, biometrics, item level tagging, libraries, and transport.

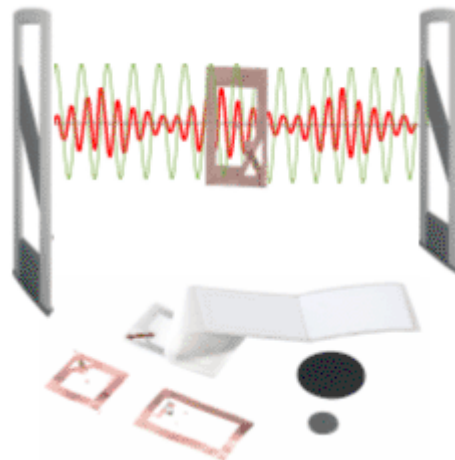
Frequency area:
HF 13.56 MHz

Distance:
Within 120 cm vicinity

Data Carrier:
Communication passive
Energy supply passive

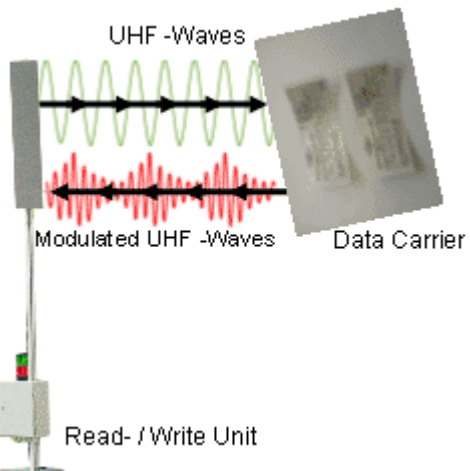
Serial Number:
64 Bit

Data Capacity:
< 1kbit EEPROM



Electromagnetic "Back scatter" passive

RFID tags that use back scatter technology reflect back to the reader a portion of the radio waves that reach them. Data can ride along the reflected signal through a process called modulation. Compared to the HF that is present in inductive coupling systems, the UHF (Ultra-High frequency) frequencies used here are capable of operating at a greater range. Both the communication and energy data carriers are passive and work to two-way remote control units. The RF writer is transmitting the signal in which transponder generates the necessary bounce back a mirror signal which is modulated back to the RF reader-writer. applications include: baggage handling, supply chain pallet and case tagging.



supply similarly reader- the energy to Typical and



Frequency area:
UHF 860-950 MHz

Distance:
Long range around 3 to 4m

Data Carrier:
Communication passive
Energy supply passive

Serial Number:
96 Bit

Data Capacity:
0 to 2K bytes information WORM,
R/W

"Backscatter" Battery-assisted Passive

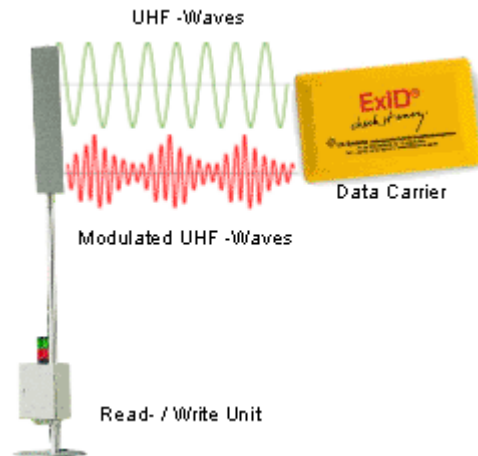
The battery-assisted passive system relies on a battery located inside the tag as its energy supply. The communication data carrier is passive and the transponder functions similarly to a smaller "smart label" tag, but the energy supplied to the IC inside the tag is provided by the battery. Typical applications using back scatter semi-active RFID tags include: electronic toll collection.

Frequency area:
UHF 860 – 950 MHz
UHF 2.45 GHz

Distance:
Long range around 4 to 8m

Data Carrier:
Communication passive
Energy supply active

Serial Number:
10 digit number ID



Active Tags

Also available are systems that have data carriers which operate with active communications as well as an active energy supply. These systems are more costly to implement but are very flexible and able to handle longer ranges. The RF reader-writer transmits data to the tag and the tag is generating its own modulated wave back to the RF reader. Mobile phones operate using the same principle. Typical applications include: electronic toll collection and real-time location of goods.



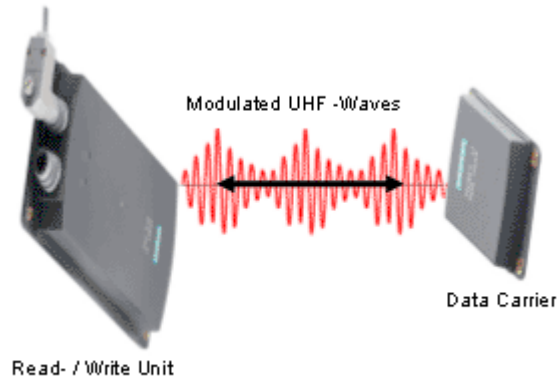
Frequency area:
UHF 2.45 GHz

Distance:
Long range around 3 to 15m

Data Carrier:
Communication active
Energy supply active

Serial Number:
32 Bit + 16 Byte PROM

Data Capacity:
Up to 32 Kbytes RAM



Q: What is the difference between passive and active tags?

Passive tags rely on the airwaves emitted by RFID readers as a power source, instead of relying on battery power. This essentially gives passive tags an unlimited lifespan. Power is derived from the active RF reader's electromagnetic field. Without a battery, passive tags are generally smaller and lighter in comparison to active tags. But the read range is shorter and much smaller than that of an active tag.

Active tags capture attention of the reader and function using battery power. A battery is either connected to, or built into the tag. Active tags can operate over greater distances but are usually more expensive due to the cost and size of the battery.

WHAT ARE THE PROPOSED STANDARDS OF RFID?



Q: Who is EPCglobal?

EPCglobal, a global RFID organisation, is in charge of establishing EPC (electronic product code) standards. The organisation is a joint venture between EAN International and Uniform Code Council (UCC) as our implementation partners have many years of experience in administering global standards. The EPCglobal Network employs Electronic Product Code™ (EPC) and Radio Frequency Identification (RFID) technologies. These standards offer the potential for increased efficiency and accuracy through automation, tracking and security through improved visibility and collaboration by providing a globally standard framework for information exchange.

Q: What are the key goals of EPCglobal?

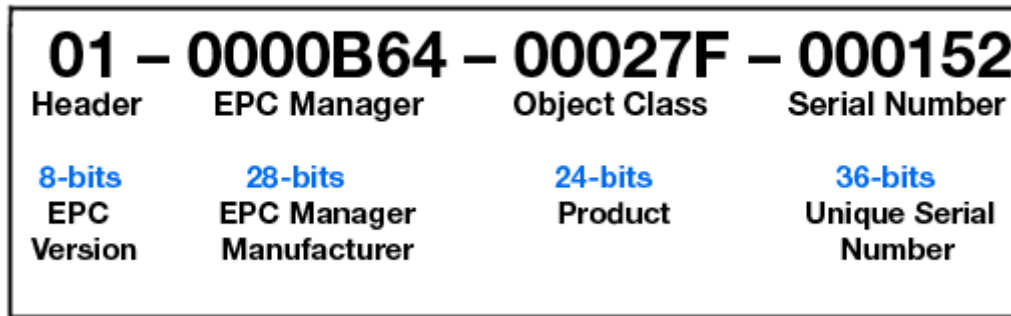
The EPCglobal Network aims to enable trading partners to minimise shrinkage and shortages, accelerate order processing and increase responsiveness to consumer demand by enabling the flow of real-time information about goods enabled within the



supply chain. Efficiency in handling physical goods during processes such as receiving, counting, sorting, and shipping is better improved.

Below is an example of a 96-bit EPC data structure, which consists of the header, in which the first 2 bits must contain zeros, the EPC Manager (manufacturer number), Object Class (identifies product), and the factory or end-user programmable serial number (an uniquely assigned number for each individual item).

96-bit Data Structure



Q: Does RFID conform to EPCglobal specifications and will it meet Wal-Mart and U.S. Department of Defense (DoD) requirements?

Wal-Mart and the U.S. Department of Defence are major factors in determining the standard for the technical specifications that are to be used in RFID tags. RFID conforms to the EPC Global specifications, however the EPC Class 0 and 1 protocols, although they conform to ISO (International Organization for Standardization) standards, are incompatible with each other. Therefore, Class 1 Generation 2 RFID is in the process of merging these two protocols to gain approval by ISO.

Who is ISO?

The International Organization for Standardization (ISO) is a non-governmental organization, although its members are not, with a network of the national standards institutes of over 140 countries, on the basis of one member per country. The Central Secretariat in Geneva, Switzerland coordinates the system. ISO holds a special position between the public and private sectors. Some of its member institutes are part of the government structure of their countries or mandated by their government, while other members are from the private sector, having been set up by national partnerships of industry associations.

Q: What is ISO’s role in regards to RFID?

ISO is responsible for moving RFID towards the EPCglobal’s (then known as Auto-ID) Electronic Product Code, which could become the de facto standard for UHF. Matrics and Alien Technology are already selling RFID tags that conform to EPCglobal’s Class 0 and Class 1 tags respectively.

Q: What types of regulatory requirements must RFID systems comply?



Specifications, standards, and terminology are continually updated. RFID systems must comply with all relevant regulatory requirements as local governments regulate allowable frequencies, power output, emissions, and other performance characteristics. RFID standards created by the International Organisation for Standardization (ISO) in Geneva meet all worldwide regulatory requirements, so users can be assured their systems are available for global use.

Q: Will the tags work globally?

EPCglobal is in progress with a goal and mission to establish a global standard for immediate, automatic identification of any RFID item in the supply chain of any company, in any industry, anywhere in the world. Additionally, different regions of the world have designated different frequencies for RFID; thus, tags that are able to handle a wider range of frequencies would have more global coverage. Additionally, UHF tags, despite the target design frequency, can be read by another UHF frequency (i.e. a 915 MHz tag can be read with an 868 MHz reader and vice versa) given that the reader can support the handling of multiple frequencies. However, a degradation of performance can be expected when using mismatched components.

DIFFERENTIATION BETWEEN EPC TAG PROTOCOLS

The current specifications of the EPC (Electronic Product Code) protocol are open standards with the intention of allowing any vendor to manufacture products to either one of these specifications. Unfortunately, these protocols are not interoperable. A single reader can't read all these tags unless it is a multi-protocol reader. *While Class 0 and 1 are tag protocols, Class 2, 3, and 4 are not distinct protocols, but different configurations.* Differences lie in the following:

CLASS 0 - READ ONLY

Class 0 is a read-only tag, which is the simplest type of tag where the EPC data is written only once into the tag during manufacture, resulting in a unique ID number assigned only to that particular tag. The memory is then disabled from any further updates. Class 0 is also used to define a category of tags called EAS (electronic article surveillance) or anti-theft devices, which have no ID, and only announce their presence when passing through an antenna field.

CLASS 0 PLUS - READ-WRITE

There is a newer version of the Class 0 tag, the Class 0 plus, which can read and write, and in which the transponders generally provide a tamper-proof fix factory-set identification code. Other than the read-write capabilities of this tag protocol, the Class 0 plus tag is identical to the Class 0 tag.

CLASS 1 - WRITE ONCE READ ONLY (WORM)

Class 1 is a read-write tag allowing the end-user to input any serial number. Both operate in the 860-950MHz frequency band. This offers advantages in many applications where



the identification code needs to be changed or where variable data is more important than a unique identity.

As far as Class 1, Generation 2 specifications are concerned, it calls for RFID tags that are WORM (write-once-read-many), which implies that it is one-time programmable, and carries a 96-bit EPC (Electronic Product Code) with an additional 32 bits in order to execute error correction and the kill command. The kill command renders the tag inoperable and is useful for end-users in areas such as the retail industry where tags need to be killed at the point-of-sale and never allowed to be activated again. Another great feature of this protocol is a robust anti-collision algorithm so an RFID reader can swiftly read many EPC tags within its read field. This new standard will be optimised to work globally by conforming to the ISO standards.

CLASS 2 – READ-WRITE

This is the most flexible type of tag, allowing users to read and write data into the tag's memory. They are typically used as data loggers, and therefore contain more memory space than what is needed for just a simple ID number.

CLASS 3 – READ-WRITE (with on-board sensors)

These tags contain on-board sensors for recording parameters like temperature, pressure and motion, which can be recorded by writing into the tags memory. As sensor readings must be taken in the absence of a reader, the tags are either semi-passive or active.

CLASS 4 – READ-WRITE (with integrated transmitters)

Similar to miniature radio devices, Class 4 tags are capable of communicating with other tags and devices without the presence of a reader, denoting that they are active tags with their own battery power source.

Q: What are the benefits of read-only vs. read-write tags?

Read-only tags: These RFID tags generally provide a fixed factory-set identification code that is tamperproof. The unique code, known as a "License Plate", enables the tag to be cross-referenced with a database, thereby allowing the tagged item to be closely followed and monitored. The data on the EPC is a unique serial number.

Read-write tags: The customer can modify the tag's data. This offers advantages in many applications where the identification code needs to be changed, or where variable data is more important than a unique identity.

PROS AND CONS TO USING RFID



As with many advanced technologies, there exist pros and cons in the use of RFID. Nonetheless, the majority of these cons can be overcome in order to maximise the utility of such technologies. RFID happens to be one of these technologies.

Pros



This wireless technology is capable of slashing a great deal on overhead costs by accelerating order processing and increase responsiveness to consumer demand by enabling the flow of real-time information about goods within the supply chain in a time efficient approach. Time and labour costs can be reduced. If optimally implemented, it would result in the positive effect of sprinkling lower costs down the supply chain to the consumer. In addition, systems can easily be built to set off an alarm when an item passes through an exit “reader” but had not been passing through the checkout “reader”. This effectively deters and detects theft.

Q: How does improved visibility free up capital?

Implementing an RFID system helps to improve inventory visibility which in turn lowers safety stock. For this reason, the overall carrying cost for inventory is reduced, and this inventory reduction frees up working capital.

Q: How is product traceability improved?

Product traceability with RFID is immensely improved as it is able to professionally manage tasks ranging from product life cycle control, automation of transaction and settlement management, logistic efficiency, to rationalisation of manufacturing production control. This translates to additional productivity. RF readers are then capable of reading data that is stored on the chips at a distance, without line-of-sight scanning or physical contact. This is possible because readers can automatically recognise and differentiate all the RF tags in their reading field, which provides additional flexibility for material handling, packaging, and sorting operations. Individual items could be identified, where the current barcode scheme does not distinguish between the two items of the same type (e.g. two identical packs of popcorn). As a result, the shopper will experience shorter queues and quicker checkout times while merchants can keep track of inventory in real-time so products that are running low could be re-shelved and irrelevant inventory reduced.

Q: How does it make more business sense to utilize RFID to tag items that move through harsher environments?

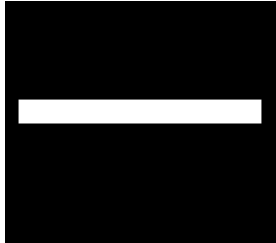
Companies that are capable of uniquely identifying items can expect to see a huge potential benefit. Barcode labels are prone to wearing out and fading in harsh environments because the line-of-sight requirement dictates that such labels be placed physically on the packaging.

Conversely, RFID technology enables much greater accuracy in tracking and tracing goods and the containers that hold them, even in harsh environments, since RFID tags do not wear out and don't require line-of-sight to function. Additionally, RFID can uniquely



identify products, cases, and other items to provide increased productivity and save on labour costs compared to barcodes, virtually eliminating the need to have people locate items and manually scan barcodes.

Cons



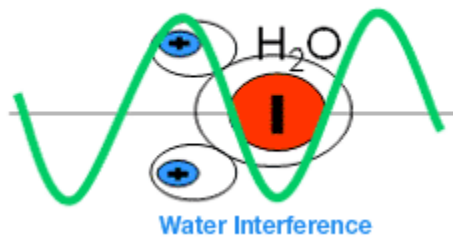
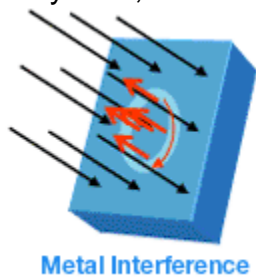
Unfortunately, every technology has its limits. RF tags and transponders transfer information by way of radio waves and are subjected to interference—predominantly by metal and liquid products, especially when merchandise is packaged in metal cans or containers. These potential sources of interference must be recognised and accounted for during system planning.

Q: Which tags work better near metal and fluids?

Tags with lower frequencies tend to read better near metals or fluids. This is due to radio waves bouncing off of metal and or being easily absorbed by water in correlation to higher frequencies.

Q: Why are consumers expected to see cost increases passed to them when the key purpose of RFID is to lower costs?

Consumers may see cost increases passed to them during the initial stages of RFID tag implementation. This is due to the necessary changes of the information systems infrastructure, such as middleware, which is designed with support for RFID systems in order to filter information to software applications. Another problem could happen if an item has a defective RFID tag that could not be read. These items would require manual entry at checkout, inventory time, receiving time, etc.



Q: How will European supply chain centres be negatively impacted by regulations imposed by ETSI?

While global companies are moving rapidly to adopt RFID systems that can operate in the UHF spectrum, regulations proposed by the European Telecommunications Standards Institute (ETSI) won't enable European companies to use UHF systems for supply chain management. ETSI currently allows only 0.5 watts of effective radiated power (ERP) in a narrow 250 kHz band range from 869.4 to 869.65 MHz. This allocation is for short-range devices which can only be on 10 percent of the time. The Federal Communications Commission (FCC) of the United States is more lenient on U.S. companies, allowing them to deploy RFID readers that emit 4 watts effective isotropic radiated power in the



Industrial, Scientific, and Medical (ISM) band from 902 to 928 MHz. This is more than sufficient both in terms of power and bandwidth.

Negative impacts may result from European supply chain centres attempting to implement RFID solutions as a result of current ETSI regulations. To maintain efficiency, most distribution centres would require many readers with a 100 percent duty cycle. However, if limitations imposing that the reader be off for 100 milliseconds could mean that 10 items will be missed when items pass a reader at a rate of 100 items per second. This is clearly unacceptable in an industry requiring 99.9% accuracy or better. The results of these wattage and duty cycle limitations will not only harm companies; it will pointlessly slow the adoption of RFID systems which are designed to improve supply chain efficiencies, reduce waste, and lower the cost of goods. Also, the ideals of having a single global standard would become much more difficult to achieve.

WHY ARE MAJOR RETAILERS PUSHING FOR RFID?



Major retailers such as Wal-Mart and METRO have been pushing to implement RFID throughout the supply chain. The main incentive for these retailers to push for RFID: product traceability. RFID technology enables automatic inspection of incoming goods where delivery of goods to a store is read during transport to the retail outlet, read again at the retail outlet to be identified, and then finally moved out to the storefront. The readings can contain information such as point of origin, processed date, product's expiration date and temperature, and scanning can be done from up to 30 feet away.

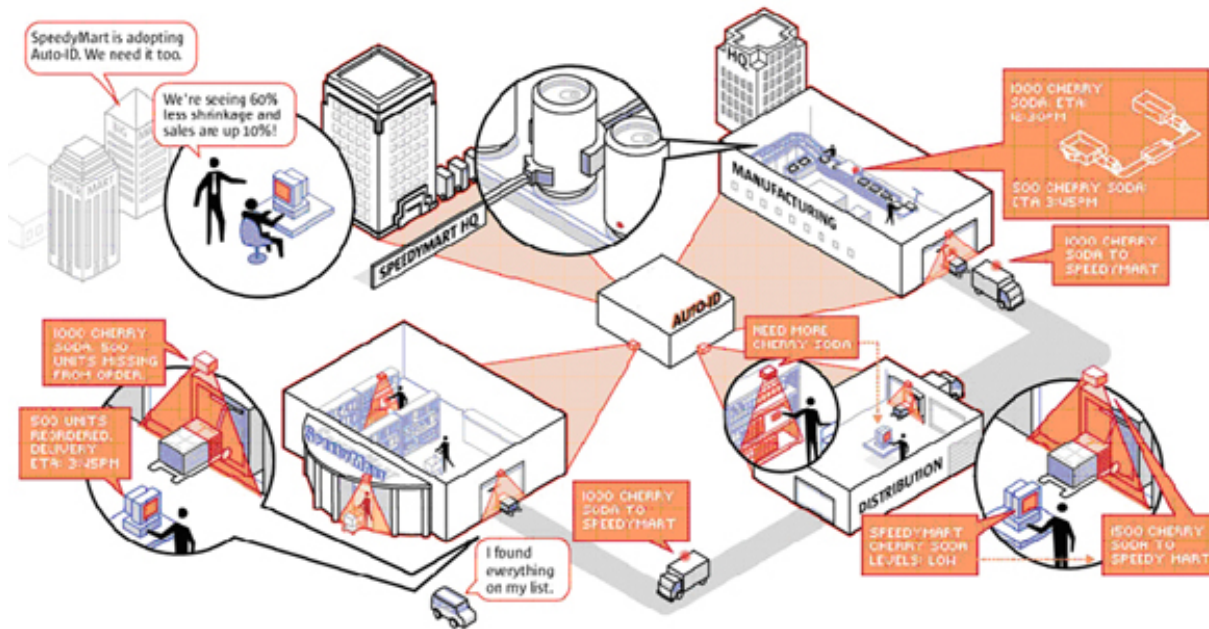
Q: How will large entities such as Wal-Mart and U.S. Department of Defense (DoD) impact the supply chain with regards to RFID?

Wal-Mart and the Department of Defence are critical trading partners for many manufacturers, and there will be a huge impact on speeding up the suppliers' RFID plans if they mandate the use of tags for certain deliveries. However, the first applications of RFID will be for tracking reusable assets such as containers, yard equipment and lorries.

In recent years, the cost of RFID tags has dropped from several U.S. dollars to less than USD\$1.00, making RFID increasingly cost-effective for higher volume applications. The changes in social needs (on the consumer end) to have access to production centres, manufacturing, and distribution records of products purchased, particularly for perishable foods, has partially driven big retailers to make use of RFID tags within the supply chain.



(Courtesy of EPCglobal and XPLANE)



For that reason, goods can be effortlessly located alongside the whole process chain. By doing so, losses would be reduced and out-of-stock situations virtually eliminated, ensuring a contented customer who finds everything he/she desires whereas the retailer optimises its efficiency in fulfilling supply and demand, providing a win-win situation across the supply chain.

Q: How can RFID-enabled retail outlets gain a competitive edge over non-RFID equipped retailers?

Major retailers continue to be aggressive in this competitive global market. Minimising costs in transportation by strategically placing retail outlets near distribution centres offers a competitive edge where the company can regularly supply its stores directly—often on a daily basis. This becomes more realistic when distribution centres take advantage of RFID technology to swiftly keep track of store inventory at any specified moment. SATO believes that RFID in its most basic form can provide an ultimate solution in inventory management in comparison to standard barcodes as it can carry more data and act as a portable database, complementing the needs of major retailers.

HOW RFID CAN BENEFIT THE END-USER

RFID creates opportunities for various industries to change the way their data is collected towards more efficient methods. The rapid growth of networking, such as the Internet, can benefit the end-users of various industries by permitting remote database access to acquire information on the tagged object at higher speeds and at lower cost compared to just a few years ago. Example of areas that could significantly benefit from RF tagging include: pharmaceuticals, supermarkets, parcel delivery service, garment industry, airline industry, and government sectors, access control.



Healthcare

In the past 10 years, erroneous patient data has become a major factor leading to serious medical mishaps. Research demonstrates that around 25 percent of patient deaths are caused by the errors in patient-data processing.

Thus, the demand for fail-safe accuracy in managing patient data has become the driving force for RFID systems in the healthcare industries in the past few years.



Q: How can RFID help to reduce human error in hospitals?

Some of the key policies are to eliminate errors and infections caused by wrongly administered blood transfusions. Storing and handling blood and blood products expeditiously, like plasma, is critical. In RFID-equipped hospitals, patient wear wristbands with RFID tags containing encoded medical information. This secure patient-data system greatly reduces the possibility of human error and can prevent a majority of unnecessary medical mishaps as all prescription bags would also contain an embedded RFID tag containing details of the medication. Before any patient is given medication, an RFID reader tallies the information between the tags in the patient and the prescription bag. Information about the patient’s medical allergies, or other relevant patient care criteria, is also highlighted on the RFID host compute. By double-checking information between the tag on the patient and the medication, medical mishaps can be greatly reduced

and even avoided.

Q: How else can RFID help to prevent counterfeit drugs from entering the market?

RFID could be used to create a “pedigree”, or a secure record documenting where the drug was manufactured and that it was distributed under safe and secure conditions. Reliable RFID technology would make counterfeit duplication of medications either extremely difficult or unprofitable. It can also protect consumers from acquiring access to dangerous counterfeit drugs and eliminate these counterfeits from the market altogether with an RFID solution. Improving the standards in the healthcare industry is a growing concern.

In this application, the patient’s name and details, such as type, are stored in a database.

A RFID tag number is created to correspond to that database. 13.56 MHz tag technology is selected because this frequency performs better near fluids than UHF. Each 13.56 MHz RFID contains information about the bag and its content. A hand-held portable reader terminal simply reads each bag and immediately displays its details, avoiding mix-up.





Supermarkets

Tracking shipments of fresh foods with RFID, in combination with sensors that measure temperature and other physical attributes, allows for quick identification and destruction of contaminated batches. Meat and produce make up roughly 15 to 20 percent of most supermarket sales, averaging roughly 30 percent of profits, and are the most commonly shoplifted items. Profits could nearly double by effectively using RFID tags to protect these items.

Supermarkets could customise and display its special deals accordingly with the shopping habits of each shopper.

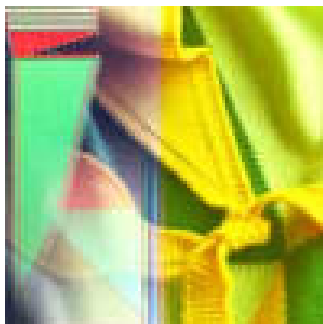


Parcel Delivery Service

Traditionally, each parcel that goes through the parcel delivery service runs through the process of generating a tracking number, printing a waybill (shipping document) for the consumer, and generating a label with the same tracking number to affix onto the parcel. The barcode tracking number is then read at pick-up, into and out of the originating city-station, through the sorting hub, into the destination city-station, onto the delivery truck, and at the delivery to the consignee. It is a time-consuming process which

requires manpower to handle each parcel by hand in order to scan the label and to keep the consumer updated with synchronized delivery status by accessing the information on the internet. RFID tags provide a simple solution to this complicated process by allowing for real-time scanning of every RF tagged parcel upon arrival and departure simultaneously with minimal manpower. This provides the delivery service and the consumer with more precise information and will facilitate in speeding the delivery time to its target destination.

Garment Labelling



RFID tags can also be used to label high quality textiles. This improves the reading capability and facilitates handling. It also ensures traceability. The print image is independent of the information programmed into the RFID tag. To implement RFID tags on high quality textiles benefits retailers by operating as a theft deterrent system. It can also provide for smoother transactions and improved customer service in cases where the shopper decides to exchange items. Because each item can have its own unique EPC code, the retailer could easily keep a record



of exactly which item was exchanged by which shopper, in cases where the retailer needs to contact the shopper, perhaps regarding a defective item.

Airline Industry



The aviation industry has focused on enhancing airline and airport security with the efforts of providing travellers along with airport and airline staff a terrorism-free transportation hub. Implementing RFID boarding passes will provide the ability to track airline passengers, enhancing airport security by allowing security personnel to keep a close eye on all passengers in the airport. RFID baggage tags can be implemented in order to better provide more detailed information regarding all baggage going through security checkpoints, such as passenger information, destination, and other useful data which help to facilitate security enhancement. The process of identifying frequent flyers with RFID is also possible, allowing them special privilege to queue in a secure “express lane” during the boarding process to provide them with value-added service.

Government Sector



Countries with busy airports, seaports, and border crossing points would find RFID tracking technology beneficial. Customs could scan incoming cargo at airports and seaports to quickly trace the origin and travel route of each case within the container. Lorries that travel across border points can be identified with government-registered RF tags that identify relevant background information as to speed up the queue and minimise traffic, all while obtaining more in-depth information. Border crossing cards with RFID allows for collecting more detailed information about each individual, such as biometric data, which would not be easy to attain where a high volume of individuals cross the border daily. Passports and visas are starting to have RFID tags embedded in order to keep more accurate records of human traffic entering and leaving a country. As an anti-terrorist measure, RFID tracking is designed to put a stop to the smuggling of weapons of mass destruction into cargo containers and transporting them abroad.

Access Control



In access control systems, RFID does more than just maintain head-count. RFID also provides authorisation and records arrival and departure times, making time registration easy. It enables fast access to the working area, eliminating queues at doors. This feature can be fully automated or done via a wall terminal.



The system can also manage canteen payments. Within the company, RFID technology allows for better planning processes and machine and employee management. To maximise reading performance, this RFID solution is based on a 13.56 MHz system.



Library Information Systems

The tracking of library assets and their loan processing is a very time-consuming process. Traditional bar coding systems help to improve the process somewhat.

However, only RFID technology can offer various enhanced features:

Efficient processing – As each rentable library item contains an embedded RFID tag, its availability can be tracked much more efficiently than with manual updating. Library items can be checked in or out much faster than with the outdated manual processing. In fact, with RFID, processing of returned items no longer requires human intervention. An item going down the return slot would be read by an RFID reader, which then transmits updated information to the library system to indicate that the item has been checked-in, without requiring library staff to manually scan each returned item. This allows libraries to offer certain facilities around-the-clock, without incurring high costs.

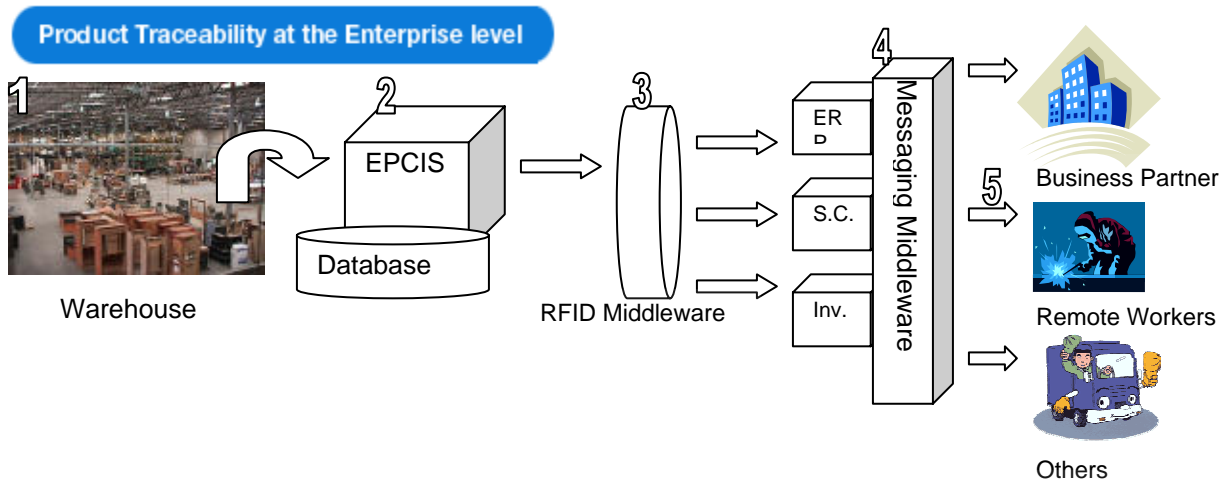
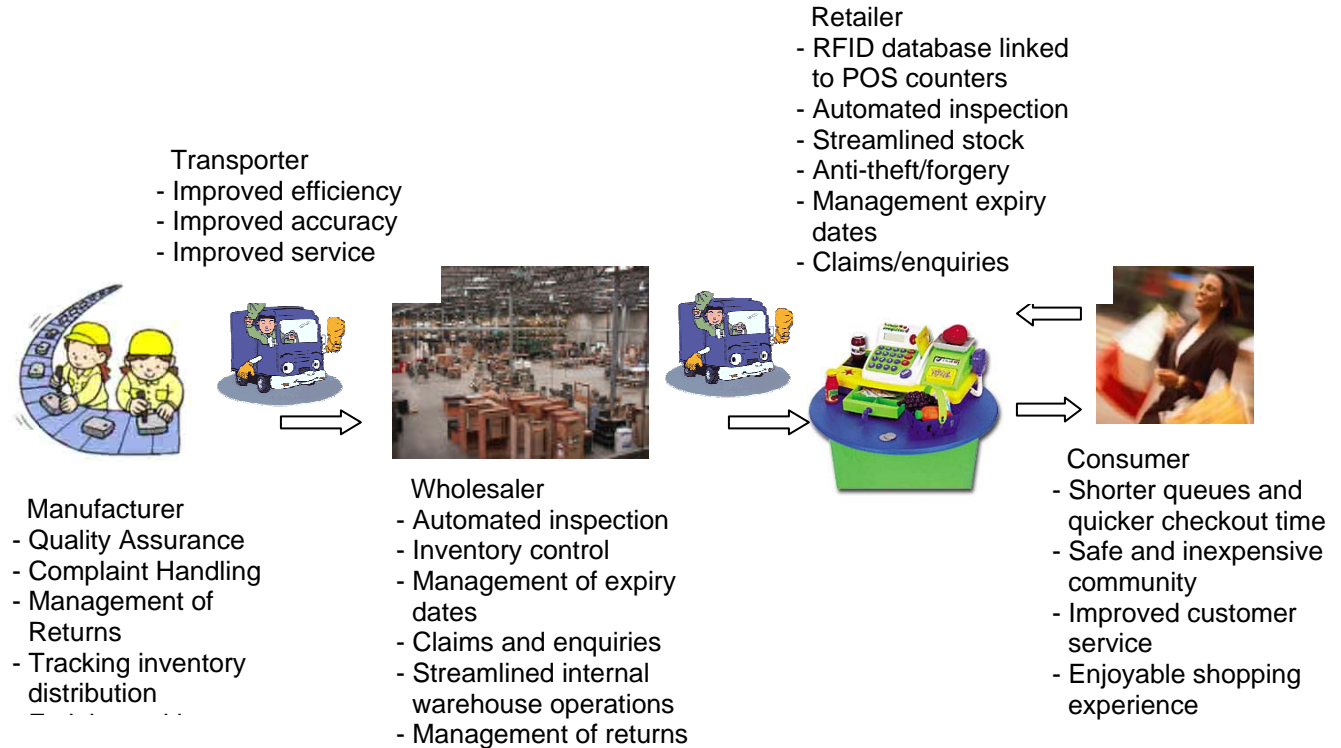
Security – If a tagged library item has not been checked out, any attempt to remove it from the library premises will be detected via the RFID antenna at the entrance gate.

Inventory management – Book inventory processes that previously took weeks or months to execute can now be shortened to mere hours using RFID tagging. Wearing or carrying a portable RFID terminal, a librarian only needs to walk through a corridor of book shelves to check the status of the books available. The RFID reading device reads item information from the books' IC chips and then automatically interfaces with the library inventory software system to update to databases.



PRODUCT TRACEABILITY

Product traceability is the life cycle of the product. The diagram below shows the improved effects of product traceability in a RFID supply chain.



EPCIS – Electronic Product Code Information Service

ERP – Enterprise Resource Planning, **S.C.** – Supply Chain, **Inv.** – Inventory

Traceability Process

1. RFID reader scans tags on pallet cases as they are loaded onto the warehouse loading dock



2. An automatic data collection system transfers the information to the database and to the EPCIS (Electronic Product Code Information Service) to number and identify each piece of data
3. RFID middleware translates, integrates, and filters data for use with enterprise applications
4. Applications such as ERP (Enterprise Resource Planning), supply chain management, logistics, and inventory access the data for analytics, dashboard, and portals used by management and workers
5. Messaging middleware transports information to partners, remote workers, and others.

CHALLENGES TOWARDS SUCCESSFULLY IMPLEMENTING RFID IN THE GLOBAL MARKETPLACE



Q: What are the primary challenges of successfully implementing RFID in a global marketplace?

The primary challenges of successfully implementing RFID in the global marketplace mainly include elements such as cost factors, consumer privacy concerns, and security factors. As mentioned earlier, costs are slowly becoming affordable, and it is only a matter of time before costs drop more rapidly as companies begin to adopt the technology.

Q: Why are anti-RFID protesters against RFID implementation?

Privacy and security issues are major challenges to RFID implementation. Anti-RFID protestors assert that RFID violates the privacy act in various countries since these chips can be embedded into products and covertly read without our knowledge. For example, a small tag embedded into an article of clothing or shoes could be activated every time the customer entered or left the store where the item was bought. Privacy advocates fear that tags can be left “active” after the sale, with data on the tag remaining accessible to anyone with a RF reader. Nevertheless, there exists the ability to “deactivate” the tag through either a “kill” command or by writing zeros to clear all relevant data to protect privacy.

Q: Are there any benefits to the consumers if the tags are left “active”?

The advantage of leaving RFID tags active after a purchase would allow consumers to have the ability to return goods without a receipt or send an item back to the manufacturer without filling a warranty card as the product and serial information would have already been stored in the product’s tag. This eliminates the need for paper proof of purchase, translating to lower overhead costs.



Q: Does that mean that privacy activists want RFID technology to disappear altogether?

The majority of privacy activists do not believe in abandoning RFID technology. These activists hope for companies who implement this technology to at least adopt rules of conduct. Activists suggest an absolute ban on hidden tags and covert readers, and that any presence of RFID tags or readers should be visible or declared. Additionally, they contend that technology should not be used to secretly unmask the identity of people who choose to remain anonymous.

COSTS OF IMPLEMENTING RFID

RFID costs involve tags and tag readers that send or receive data, in addition to the software infrastructure that manages such data. As with any type of investment,



establishing a more efficient infrastructure to increase profitability comes with an initial cost. The reconfiguring of warehouses, packaging, and even business processes may perhaps be essential to maximise the return on the RFID investment.



There are three factors that determine the cost of RFID tags:

- Cost of chip
- Cost of inlay
- Cost of assembly

Q: How are tag costs affecting the way many companies in supply chains are implementing RFID?

At the time this paper was written, inlays cost as little as USD\$0.30 or as much as USD\$50 depending on the type of tag and application. Due to the price of these tags, it will not always be practical to apply RFID tags on an item-level basis (applying the RF tag to each and every item). This is especially true for cheaper items such as candy bars, soft drinks, and so forth. A common solution to minimising tag cost is to, instead, apply them on a case-level basis in which an entire container of items is tagged with one RFID tag containing information such as the sales order number, point of origin, manufacturing date, item information, quantity of pieces within the batch, target destination, and so forth.

Q: What will need to be done to the technical infrastructure to successfully support RFID?

To handle the RFID data, suppliers will likely need to upgrade their information technology systems such as servers, storage, wireless infrastructure, and software. Once the RFID tags are loaded with data, the reader infrastructure must be managed. Then middleware must be configured to manage filtering of data coming from the tags that are moving along supply chain. The middleware layer must be aware that the tag is an event when seen for the first time but recognised as irrelevant data when repeatedly read. After the data has been filtered through this layer, it must be sent to the appropriate





applications. Companies usually have multiple applications that demand RFID data, including warehouse management systems, inbound supply chain systems, planning systems, order management systems, and data warehouse and analytics systems. Massive amounts of information are being transmitted all over the network.

Q: What will need to take place in order for RFID tag costs to drop?

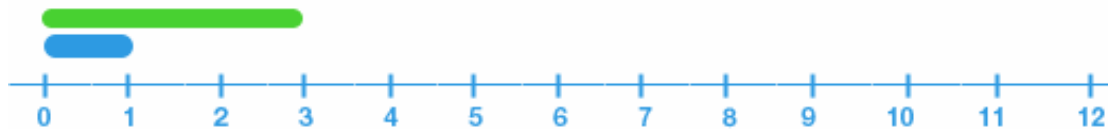
Costs are slowly decreasing, but expected to drop more rapidly as companies begin to adopt the technology. Standardisation will drastically bring down the cost of RFID, thus making more economic sense for researchers to allocate resources towards addressing issues such as the following: tag costs, large-scale production, sensor accuracy, improved read-write performance, reader costs, and interoperability for one RFID standard.

TESTING STAGE

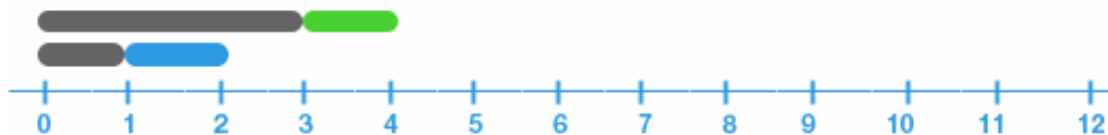
Prior to system deployment, proper testing should be done to uncover any interference, quality, or performance problems. The labelling solution must be able to withstand environmental conditions to which it will be exposed throughout the supply chain. Whether the fundamental tests are being done internally, outsourced, or both, proper bench trials are crucial to test the equipment and media in all possible conditions to ensure optimal performance.

The process from concept to working pilot will usually take longer than companies anticipate. This is due to the relatively immature status of RFID in certain respects. Pilot testing involves trial and error, especially during the early to mid-stages of testing. Barcodes must also be factored into the testing element as the co-existence of barcodes and RFID will be a reality for a number of years, and it might still be a practical choice to use barcodes for certain data collection in the general RFID scheme.

The initial phase is to build up a business case and delineate the new RFID-enabled process flows. The goal of this phase is to establish an expected return on investment and to focus on either how to comply with the least burdensome cost or scrutinize whether internal benefit could be achieved. This phase typically lasts between 1-3 months.



Typically lasting about a month, the technology immersion phase of the pilot test involves getting familiar with RFID technology at the hands-on level. An RFID “starter kit” could be obtained to test how RFID operates in an office, warehouse, or lab environment. A common mistake that should be avoided in this phase is spending too much time experimenting with this technology instead of moving with further product testing.

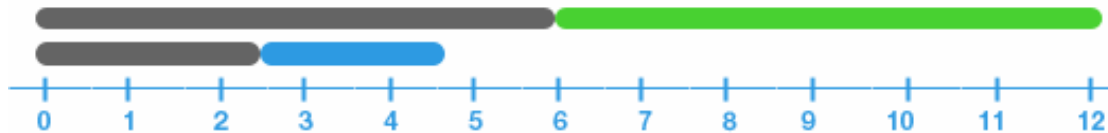




Lasting two to eight weeks, on average, a series of large-scale tests should be conducted to determine if smart labelling can keep up with labelling volume requirements during normal and peak conditions. The objective of this product testing phase is to gain in-depth understanding of variables such as: the product itself, packaging configuration, pallet configuration, tag type (between vendors, active versus passive), reader configuration and antenna placement, and reading time required for a tagged product to be encoded/decoded or read in the read zone. Interference can be avoided or minimised by using different styles and sizes of RFID antennas and tags, and experimenting with different frequencies, power output levels, and tag mounting options, all within the application requirements. It is crucial to thoroughly record test data if no automated tools to track actual read performance exist. “Trial and error” cycles that is done in identical or very similar environments to the final site of RFID implementation is necessary to achieve results in the pilot tests.



The final pilot testing phase is where RFID tags and readers are used to simulate the actual production environment. This is the “ready-or-not” stage. The end-user employs this phase to validate the business and test cases that were developed during the preliminary phases of testing and to ensure that the entire range of the equipments and media perform as expected. Although time varies depending on the degree of RFID integration and project intricacy of the end-user, the common range typically runs from two to six months.





SATO's Hardware

The SATO CL series - maximum performance for a minimal price!

Printing labels has never been easier or quicker with the CL series; with the high speed throughput power of these enhanced printers, it simply means that "time to first label" is almost instantaneous! These 4" wide printers not only come with a choice of 203dpi or 305dpi print heads but also have an internal memory which can be expanded to save an immense number of True Type™, graphics and formats. In addition, you also have a choice of interface board: LAN, USB, IEEE1284 or the high speed RS-232C.



(1) Heavy duty industrial chassis promises durability and extended periods of high speed use

Features	Functions	Benefits
RFID option	Supports the latest embedded Radio Frequency Chips that encode data between the label and liner	No 'line-of-sight' requirement and make reading multiple items possible
Heavy Duty Industrial Construction	Withstands harsh operating environments Built for extended periods of high-speed use	Sturdy chassis ensures durability; allows printer to be used in harsh environments for long periods of time
203dpi (CL408e) / 305dpi (CL412e) resolution	Two printer models to satisfy different print resolution requirements	Provides a choice of print resolutions to suit varying printing needs
32-Bit RISC	Quick processing time; high throughput speed; reduces obsolescence	Ensures fast data processing and almost instantaneous throughput Time saver!
Windows® Compatible	End users can use any windows application software with this printer	Maximizes compatibility, flexibility and ease-of-use
Interface Connectivity	Plug & play interface cards for Serial, Parallel, Ethernet, WLAN	Low cost for connectivity upgrade Support all common types of communication needs



SATO RFID Kit

SATO's RFID Kit offers a convenient and inexpensive way to produce labels and tags with RFID capability for a wide variety of new applications including:

- Pallet Labels
- Case labels
- Asset Tracking
- Anti-Theft
- Factory Automation
- Process Control
- Industrial ID
- Healthcare
- Baggage Tags

Utilising high frequency chips embedded in the labels, the SATO RFID Kit enables the CL408e and CL412e printers to simultaneously print on the label and program the chip inside the label. Additionally, the information encoded in the label or tag can be changed during its lifetime, which makes it unnecessary to remove and re-label any items.

There are currently two types of RFID solutions, which can be customised to cater to your needs. SATO is also currently demonstrating units using the UHF frequencies that EPC Global and Wal-Mart are considering for use in their standards, which also conform to ISO standards.

Q: Can SATO RFID printers withstand environmentally demanding requirements?

Yes, our CL408e/412e printers from the "e" Series can withstand harsh operating environments and are built for extended periods of high-speed use due to the sturdy chassis and the CL series' durable design.

All RFID kits include the following:

- CL408e/412e UHF RFID Printer
- Label Gallery TruePRO
- Smart Labels



The UHF Kit includes the following:



MP9320 Reader



UHF Antenna



ICCM



RFID Labels



Software

SAMSys MP9320 UHF Long-Range Reader

The MP9320 supports a variety of UHF tag protocols and provides the best defence against future obsolescence (or “future proof”) since it is upgradeable to new, emerging protocols and standards. With RF connections of up to four antennas, the MP9320 easily adapts to loading dock and portal installations for aggregated container tracking, pallet tracking, and inventory management.

UHF Antenna

The UHF Antenna works with the MP9320 reader to accommodate long range applications.

Interrogator Control and Concentrator Module (ICCM)

The Interrogator Control function manages the communications protocol and the flow of data between the RFID tags and the readers. With the ICCM Development Kit, you can test out different tag protocols to ensure which one is best suited for each application, test your application server interface, remote diagnostic report, and a local reader network.

Features include:

- VGA Touch Screen LCD
- Multi-Protocol support
- Supports any combination of SAMSys stand-alone reader products to facilitate multi-frequency solutions
- Connection support to PLC's, printers, direction sensors, and other devices

RFID Labels

SATO's strategic partnership with CCL Label ensures that our RFID labels are of high standards and perform optimally with SATO CL400 series printers. Labels that are offered with the UHF Starter and PRO packs include:

- Smart Labels TT 4" x 6" (100mm x 150mm), UHF ePC Class 1 (250/roll)
- Smart Labels, DT 4"x6" (100mm x 150mm), UHF ePC Class 1 (250/roll)

Label Gallery TruePRO Software

Labelling solutions uniquely designed for SATO printers.



Label Gallery is a unique label design & production suite of software based on an easy-to-use and intuitive user interface designed specifically for SATO Printers. Label Gallery offers a family of professional labelling software products including a multi-lingual user interface and complete barcode printing solutions for desktop and enterprise users.

The Perfect Solutions for any labelling needs.

The HF Kit includes the following:



HF Reader



RFID Labels



Software

HF Reader

Designed for short-range applications, this reader can be used as a stand-alone solution or in a networked environment using the SAMSys Interrogator Control Module (ICM).

RFID Labels

SATO's strategic partnership with CCL Label ensures that our RFID labels are of high standards and perform optimally with SATO CL400 series printers. Labels that are offered with the HF Starter and PRO packs include:

- Smart Labels TT 4" x 6" (100mm x 150mm), HF (ICODE, Tag-It, ISO15693) (250/roll)
- Smart Labels, DT 4"x6" (100mm x 150mm), HF (ICODE, Tag-It, ISO15693) (250/roll)

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The Perfect Solutions for any labelling needs.



CONCLUSION

Although it may appear overwhelming for you and many trading partners to participate in adopting RFID technology, you will appreciate the payoffs that come with an overall understanding of fundamentals and requirements: the potential cost-savings and strategic benefits of RFID are highly advantageous. The goal is to develop an expected return on investment. RFID has a great potential to lend a hand to large retailers and manufacturers, and even small to mid-sized businesses can be more competitive by creating new efficiencies. RFID presents an opportunity for the supply chain to improve efficiency, trim down on wastes, and reduce costs for consumers. By moving into the storefronts, RFID is likely to help retailers provide consumers with smarter products, better service, and innovations that will help to improve your standard of living. For RFID to thrive in the supply chain, it is crucial for business partners, clients, technology providers, and any other departments affected by these changes to establish consistent communication channels to allow plenty of time for productivity improvements and success in RFID adoption.



GLOSSARY OF RFID TERMS

(Courtesy of Association for Automatic Identification and Mobility)

Active Tags

Tags which use batteries as a partial or complete source of power. They are further differentiated by separating them into those with replaceable batteries and those which have the batteries inside a sealed unit or what may be termed unitized active tags.

Addressability

The ability to address bits, fields, files or other portions of the storage in a tag.

Alignment

The orientation of the tag to the reader in pitch, roll, and yaw.

Antenna

Antennas are the conductive elements which radiate, and/or receive energy in the radio frequency spectrum, to and from the tag.

Bidirectional

Capable of operating in either of two directions which are the opposite of each other. For example, a tag which can be read or written from either side is bi-directional.

Capacity

The number of bits or bytes that can be programmed into a tag. This may represent the bits accessible to the user or the total number including those reserved by the manufacturer, e.g. parity or control bits.

Capture Window/Field

Region of the scanner field in which a tag will operate.

Closed Systems

A system in which relevant data regarding the attributes of the object is stored in a common data base, accessible via data link by referencing the individual ID code. It usually refers to a system under the control of a single owner or authority.

Code Plate

See Tag

Controller

See Multiplexer

Electromagnetic Coupling

Systems which in use a magnetic field as a means of transferring data or power are said to use an electromagnetic coupling.



Electronic Label
See Tag



Electrostatic coupling

Systems which use the inducing of a voltage on a plate as a means of transferring data or power are said to use electrostatic coupling.

Error

Any operation or data which is not in accord with the design or input to the system.

Error Correcting Code (ECC)

Supplemental bits in a data transfer used in conjunction with a polynomial algorithm, in order to compute the value of missing or erroneous data bits (e.g. for a 32 bit data transmission, 7 additional bits are required.)

Error Correcting Mode

Mode of data communication in which missing or erroneous bits are automatically corrected.

Error Correcting Protocol

The rules by which the error correcting mode operates.

Error Management

Techniques used to ensure that only correct information is presented to the user of the system.

Error Rate

The number of errors per number of transactions.

Exciter

The electronics which drive an antenna are called the exciter or transmitter. Together with the antenna they are called a scanner.

Expansion Port

A plug accessing additional I/O capability on a computer or peripheral device.

Factory Programming

The programming of information into a tag occurring as part of the manufacturing process resulting in a read only tag.

Field Programming

Programming information into the tags may occur after the tag has been shipped from the manufacturer to an OEM customer or end user or in some cases to the manufacturer's distribution locations. Field programming usually occurs before the tag is installed on the object to be identified. This approach enables the introduction of data relevant to the specifics of the application into the tag at any time; however, the tag would typically have to be removed from its object. In some cases, change or duplication of all data in the tag is possible. In other cases, some portion is reserved for factory programming. This might include a unique tag serial number, for example.



Field Protection

The ability to limit the operations which can be performed on portions or fields of the data stored in a tag.

Flat Panel Antenna

Flat, conductive sheet antennas, usually made of metal plate or foil.

Frequency

The number of times a signal executes a complete excursion through its maximum and minimum values and returns to the same value (e.g. cycles).

I.D. Filter

Software that compares a newly read ID with those in a data base or set.

Inductive Coupling

Systems which use the inducing of a current in a coil as a means of transferring data or power are said to use inductive coupling.

In Use Programming

Many applications require that new data or revisions to data already in the tag, be entered into the tag, while it remains attached to its object. The ability to read from and write data to the tag while attached to its object is called in-use programming. Tags and systems with this capability are called read/write tags and systems.

Interrogator

See Reader and Programmer

Life

Functional period within which no maintenance, adjustment or repair is to be reasonably expected.

Memory Cards

A read/write or reprogrammable tag in credit card size

Memory Modules

A read/write or reprogrammable tag

Misread

A condition that exists when the data presented by the reader is different from the corresponding data in the tag.



Mobile Inventory Vehicle

Vehicle equipped with a system for locating tagged vehicles, containers, and other objects for the purpose of inventory control.

Modulation

The methods of modulating or altering the carriers in order to carry the encoded information are quite varied. They include amplitude modulation (AM)/ phase modulation (PM), frequency modulation (FM), frequency shift keyed (FSK), pulse position (PPM), pulse duration (PDM) and continuous wave (CW). In some cases, different modulating techniques are used in each direction (to and from the tags).

Modulation, amplitude (AM)

Data is contained in changes in amplitude of the carrier.

Modulation, phase (PM)

Data is contained in the changes in the phase of the carrier.

Modulation, frequency (FM)

Data is contained in the changes in the frequency of the carrier.

Modulation, frequency shift keyed (FSK)

Data is contained in the changes between two frequencies of carrier.

Modulation, pulse duration (PDM)

Data is contained in the duration of pulses.

Modulation, pulse position (PPM)

Data is contained in the position of pulses relative to a reference point.

Modulation, continuous wave (CW)

Data is contained in a carrier which is switched on and off.

Multiplexer (multiplexor)

A device which supports multiple scanners or antennas by checking each in accordance with some scheduling scheme which may be either round robin or priority based. This reduces the total amount of electronics in the system at the expense of having all scanners being "blind" part of the time. These devices are called multiplexers or multichannel readers or just controllers.

Nominal

The value at which a system is designed assures optimal operation. Tolerance considers the "normal" deviation of variable factors.

Nominal Range

The range at which a systems can assure reliable operation, considering the normal variability of the environment in which it is used.



Omnidirectional

Capability of a tag to operate in any orientation.

Open Systems

Application in which reader/writers do not have access to a common data base.

Orientation

Alignment of the tag with respect to the scanner, measured in pitch, roll, and yaw.

Orientation Sensitivity

The degree range is decreased by non-optimal orientation.

Passive Tags

Passive tags contain no internal power source. They are externally powered and typically derive their power from the carrier signal radiated from the scanner.

Port Concentrator

A device that accepts the output from a number of communications interfaces and introduces them into a communication network.

Power Levels

Levels of power radiated from a scanner or tag, usually measured in volts/meter.

Programming

Adding or altering in a tag.

Programmability

In order to be identifiers of specific objects, tags must at some point have their identity and/or other data entered into them. This capability is called programmability.

Programmer

Some tags which can have their contents changed by a set of electronics in close proximity or in electrical contact with it. Those electronics and their packaging are called a programmer.

Projected Life

This is defined in terms of number of read and/or write cycles, or in active tags this may include shelf life.

Proximity sensor

A device that detects and signals the presence of a selected object at or near the sensor's location.

RF/DC



Systems which communicate over a radio link between a host computer and a data source e.g. keyboards, data terminals, readers for OCR, Bar Codes, Mag Stripes, RF/ID etc. RF/DC enhances the capabilities of Automatic ID Systems by providing the capabilities of hard wired data communications without the physical restrictions interconnecting wires.



RFID

Systems that read or write data to RF tags that are present in a radio frequency field projected from RF reading/writing equipment. Data may be contained in one (1) or more bits for the purpose of providing identification and other information relevant to the object to which the tag is attached. It incorporates the use of electromagnetic or electrostatic coupling in the radio frequency portion of the spectrum to communicate to or from a tag through a variety of modulation and encoding schemes.

RF/AIS

Radio Frequency Automatic Identification Systems

Range

The distance at which successful reading and/or writing can be accomplished.

Read

The decoding, extraction and presentation of data from formatting, control and error management bits sent from a tag.

Read Only

See Factory Programming

Readability

The ability to extract data under less than optimal conditions.

Read Rate

The maximum rate at which data can be read from a tag expressed in bits or bytes per second.

Read/Write

Many applications require that new data or revisions to data already in the Tag, be entered into the Tag, while it remains attached to its object. Tags with this capability are said to be reprogrammable and are called read/write tags, memory cards or memory modules.

Reader

The device containing the digital electronics which extract and separate the information from the format definition and error management bits. The digital electronics perform the actual reading function. These read electronics may also interface to an integral display and/or provide a parallel or serial communications interface to a host computer or industrial controller.

Reader/Writer

The set of electronics can change the contents of tags while they remain attached to their object are called a reader/writer. (*See also reader*).

Reprogrammable



Many applications require that new data or revisions to data already in the tag, be entered into the tag, while it remains attached to its object. The ability to read from and write data to the tag while attached to its object is called in-use programming. Tags with this capability are said to be re-programmable and are called read/write tags, memory cards or memory modules.

SAW

Surface Acoustic Wave. A technology in which radio frequency signals are converted to acoustic signals in a piezoelectric crystalline material. Variations in phase shift on the reflected signal can be used to provide a unique identity.

Scanner

The antenna's, transmitter (or exciter) and receiver electronics integrated in a single package called the scanner. They may be combined with additional digital electronics including a microprocessor in a package called a reader.

Sensor

A device that responds to a physical stimulus and produces an electronic signal. See *Scanner*.

Separation

Operational distance between two tags.

Signaling Technique

A complete description of the modulation, encoding, protocol, and sequences required to communicate between two elements of a system.

Speed

The rate at which something occurs.

Tag

The transmitter/receiver pair or transceiver plus the information storage mechanism attached to the object are referred to as the tag, transponder, electronic label, code plate and various other terms. Although transponder is technically the most accurate, the most common term and the one preferred by the Automatic Identification Manufacturers is "tag".

Transponder

See *Tag*

Verify

To assure that the intended operation was correctly performed.

Write

The transfer of data to a tag, or the tag's internal operation of storing the data; the term may include reading back the data in order to verify the write operation.



Write Rate

The rate at which information is transferred to a tag, written into the tag's memory and verified as being correct. It is quantified as the average number of bits or bytes per second in which the complete transaction can be performed.



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Web: www.sirit.com

- **Takaya**

Takaya manufactures RFID systems, specialising in RFID tags and readers, and security equipments such as access control and anti-theft equipments to provide crime prevention solutions for businesses.

Web: www.takaya.co.jp (In Japanese)



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