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Products & Services

RFID Basics

PAXAR

RFID Basics

Introduction

Radio Frequency Identification (RFID) technology has been attracting considerable attention with the expectation of improved supply chain visibility for both suppliers and retailers. It will also improve the consumer shopping experience by making it more likely that the products they want to purchase are available.

Recent announcements from some key retailers have brought the interest in RFID to the forefront. This guide is an attempt to familiarize the reader with RFID technology so that they can be asking the right questions when considering the technology.

What is RFID?

RFID (Radio Frequency Identification) is a method of identifying unique items using radio waves. Typical RFID systems are made up of 2 major components: readers and tags. The reader, sometimes called the interrogator, sends and receives RF data to and from the tag via antennas. A reader may have multiple antennas that are responsible for sending and receiving the radio waves. The tag, or transponder, is made up of the microchip that stores the data, an antenna, and a carrier to which the chip and antenna are mounted.

RFID technology is used today in many applications, including security and access control, transportation and supply chain tracking. It is a technology that works well for collecting multiple pieces of data on items for tracking and counting purposes in a cooperative environment.

Is All RFID Created Equal?

There are many different versions of RFID that operate at different radio frequencies. The choice of frequency is dependent on the requirements of the application.

Three primary frequency bands have been allocated for RFID use.

- Low Frequency (125/134KHz) – Most commonly used for access control and asset tracking.
- Mid-Frequency (13.56 MHz) – Used where medium data rate and read ranges are required.
- Ultra High-Frequency (850 MHz to 950 MHz and 2.4 GHz to 2.5 GHz) – offer the longest read ranges and high reading speeds.

Applications for RFID within the supply chain can be found at multiple frequencies and different RFID solutions may be required to meet the varying needs of the marketplace.

Many of today's RFID technologies cannot reliably cover areas wider than 4 to 5 feet, making them unsuitable for wide openings that are the norm in manufacturing, distribution and store

receiving dock environments. Since UHF (Ultra High Frequency) can cover portals up to 9 feet wide it is gaining industry support as the choice bandwidth for inventory tracking applications including pallets and cases.

Technology providers are developing readers that work with multiple system protocols and frequencies so that users will be able to choose the RFID products that work best for their market and products.

RFID tags are further broken down into two categories:

- **Active RFID Tags** are battery powered. They broadcast a signal to the reader and can transmit over the greatest distances (100+ feet). Typically they can cost $4.00 - $20.00 or more and are used to track high value goods like vehicles and large containers of goods. Shipboard containers are a good example of an active RFID tag application.

- **Passive RFID Tags** do not contain a battery. Instead, they draw their power from the reader. The reader transmits a low power radio signal through its antenna to the tag, which in turn receives it through its own antenna to power the integrated circuit (chip). The tag will briefly converse with the reader for verification and the exchange of data. As a result, passive tags can transmit information over shorter distances (typically 10 feet or less) than active tags. They have a smaller memory capacity and are considerably lower in cost ($1.00 or less) making them ideal for tracking lower cost items.

There are two basic types of chips available on RFID tags, **Read-Only** and **Read-Write**. Read only chips are programmed with unique information stored on them during the manufacturing process. The information on read-only chips can never be changed.

With Read-Write chips, the user can add information to the tag or write over existing information when the tag is within range of the reader. Read-Write chips are more expensive that Read Only chips. Another method used is something called a "WORM" chip (Write Once Read Many). It can be written once and then becomes "Read Only" afterwards. This is a desirable format since companies will be able to write an EPC (electronic product code) to the tag when the product is produced and packaged.

How Will RFID Affect Our Industry?

RFID is expected to provide huge advantages to manufacturers by offering the tools to better plan production and respond more quickly to market demand. It will facilitate automation of inventory counts and speed shipping and receiving at the distribution level. For retailers, it will help to reduce stock-outs, enable product tracking and potentially reduce theft and streamline the POS function. RFID will also open other merchandising opportunities and help with the overall consumer buying experience.

Due to the current cost of the technology (both tags and infrastructure), the initial phase of adoption for retailers is at carton and pallet marking applications. The current technology being adopted for carton and pallet labeling is passive UHF tags (850 MHz – 950 MHz). As the cost of tags and readers comes down, a wider adoption at the item marking level will develop.

In order for RFID to grow quickly, it is important that standards be developed so that the technology providers are working toward a common goal of providing low cost and compatible technologies. Not only will it drive down costs, but standards will also help users to reap the greatest benefit from their investment by providing value throughout the whole supply chain.

Organizations Focused on Developing RFID Standards

EPCglobal, Inc., a division of the Uniform Code Council, and its sponsors are working to standardize a new Electronic Product Code (EPC) as the next standard for identifying products. Their goal is not to replace existing bar code standards but to expand the information available down to unique identifiers for each marked item, and to enable more automatic reading. EPC utilizes the basic structure of the Global Trade Item Number (GTIN).

EPCglobal, Inc. has proposed open standards for tags and readers with the intention of bringing the costs down to a level where RFID tags could be applied to individual items. The work may lead to the creation of a new global Internet network that would allow companies to track items and enable end users to access the full benefits of RFID.

EPCglobal, Inc. has developed a specification for RFID tags to be used in the retail sector. The specification does not mandate what type of tag to be used but is intended to provide guidelines on data structure and how the tags should perform so that they can be used over a common platform. It is tailored around the experiences gained from the implementation of UPC and its success in the marketplace for more than 25 years. The specification requires that the chip contain an Electronic Product Code (EPC). The chip must be able to communicate according to an open standard and meet some minimum requirements so that it can be read by reading devices anywhere.

The Electronic Product Code (EPC)

The EPC is a number made up of a header and 3 sets of data as shown in the figure below. The header identifies the EPC version number – which will allow for different lengths or types of EPC later on. The second part of the number identifies the EPC manager – typically this would be the manufacturer of the item the EPC is attached to. The third part is called object class and refers to the exact type of product– most often the stock-keeping unit (SKU). The fourth series of numbers is the serial number that is unique to the item. (The second and third sets of data are similar in function to the numbers in UPC barcodes.)

Above is an example of a 96-bit EPC. It will allow sufficient capacity for 268 million companies. Each manufacturer will have the ability to create up to 16 million object classes with 68 billion serial numbers in each class. This should provide sufficient capacity to cover all products

manufactured in the world for many years to come. As an interim step, the Auto-ID center is also proposing a 64-bit tag in order to minimize cost in the near term.

Potential Issues That Need Consideration When Choosing The Type Of RFID And Method For Application To Your Products Or Packaging.

Enthusiasm within the RFID industry has resulted in much hype about the technology over the past several years. As a result, it is important to embrace the technology with a bit of caution. The following are some of the issues that require close scrutiny when investigating RFID:

- ***Tag Cost*** – This should not to be confused with chip cost. Although the goal is to bring the cost of the tag (chip and antenna) down to 5 cents, this goal is in the future since it both assumes manufacturing breakthroughs and is predicated on consumption in the billions of tags per year. Today, the cost is closer to "less than 50 cents" for a read/write solution in high (millions) volume. Ultimate tag cost will also be very much dependent on the type of chip required (read only versus read/write), size of the antenna needed and how it is packaged to meet a specific application.

- ***Tag Size*** – Tag size is dependent on the read range desired. Although the chips are very tiny, they will not operate without being mounted to an antenna. The size of the antenna will determine the read distance performance of the tag so understanding the size of the antenna needed for the application is more important than the size of the chip alone.

- ***Infrastructure Cost*** – Much focus appears to be placed on the tag cost since it is a recurring expenditure. Reader cost and infrastructure costs for implementing RFID must also be looked at very closely as well. Both the software systems requirements and physical environment in which RFID is intended to be used, are critical to the ultimate performance of a system and may require changes to accommodate using it effectively. As an example, RFID chips cannot be read through metal objects. Other forms of electromagnetic interference may also impede performance of the technology and require changes to the physical environment where RFID will be used. The number and types of readers will also be a major expenditure depending on your application.

- ***Read Distances*** – Read distances for RFID are very much dependent on the frequency chosen for the application. Tag orientation also affects the read range as the range diminishes as the tag is rotated from being perpendicular to the path to the reader. Reading reliability is quite good when labels are alone in a reader field like cases on a conveyor line, but less certain when the labels are randomly oriented as with labeled cases on a skid. The antenna size (both on the tag and the readers) will also be a determining factor. Hand held readers are not capable of using as much power as stationary readers and as a result provide shorter read distances.

- ***Government Regulation*** – Governments around the world regulate the use of the frequency spectrum. Different countries have already assigned certain parts of the spectrum for other uses and as a result, there is virtually no part of the spectrum that is available everywhere in the world for use by RFID. This means that a RFID tag may not work in all countries. As an example if you choose the Ultra High Frequency (UHF) frequency that

operates at 915MHz in the U.S. and you ship your product to Europe, they may not be able to be read it since Europe operates in the UHF spectrum at 869Mhz. This is an important consideration when operating in a global environment.

- ***Anti-Collision*** – This is an important feature of RFID chips/readers since it will allow multiple tags to be read while grouped in one reader field. It is not available on all RFID tags but is an important feature if you are planning to use RFID for inventory counts, shipping and receiving where multiple tags need to be read at the same time.

- ***Privacy Issues*** – Consumer groups have expressed concern over the potential (real or imagined) privacy invasion that might result with widespread RFID item marking. These groups are pushing for legislation that will require manufacturers to advise consumers that the products contain RFID devices and must provide a means so that the devices can be disabled at point of purchase. These issues are most prevalent at the item marking level and will have little impact on the implementation of carton and pallet labeling.

What Is PAXAR's Commitment To RFID?

Paxar Corporation is committed to aggressively participate in the developing market for RFID products. Our goal is to become a major worldwide source for RFID supplies and the printers which program them for all popular RFID systems, targeting particularly the supplies used for apparel and retail applications.

Paxar is positioned to meet the RFID carton and pallet labeling requirements of major retailers with our Monarch brand line of products. The Monarch® Model 9855™ RFID printer writes and verifies EPC-compliant data to a Class 1 915 MHz RFID chip then prints the human readable and barcode data on the same label. The Monarch line of RFID products is optimized to meet the read and write standards of major retailers. In addition, Monarch's Fastrax™ and Service offerings help our customers optimize their processes in order to provide the peace of mind needed when entering into a new technology. Only Monarch products offers this full line of RFID printers, supplies, and service.

With worldwide manufacturing, including service bureaus, Paxar is uniquely positioned to offer innovative, market-driven RFID solutions to major retailers and apparel manufactures.

Paxar is a member of EPCglobal, the organization setting standards for RFID use in the retail supply chain.

For more information, contact Paxar at **937.867.6650, press 5.** You can also visit us on our website at www.paxar.com.

RFID
Glossary of Commonly Used Terms

A

Active Tag – An RFID tag that uses a battery to power its microchip and communicate with a reader. Active tags can transmit over the greatest distances (100+ feet). Typically they can cost $20.00 or more and are used to track high value goods like vehicles and large containers of merchandise.
Agile Reader – A reader that can read different types of RFID tags – either made by different manufacturers or operating on different frequencies.
Antenna – A device for sending or receiving electromagnetic waves.
Anti-Collision – A feature of RFID systems that enables a batch of tags to be read in one reader field by preventing the radio waves from interfering with one another. It also prevents individual tags from being read more than once.
Automatic Data Capture (ADC) – Methods of collecting data and entering it directly into a computer system without human intervention. Automatic Identification (Auto-ID) Refers to any technologies for capturing and processing data into a computer system without using a keyboard. Includes bar coding, RFID and voice recognition.
Auto-ID Center – A group of potential RFID end users, technology companies and academia. The Auto-ID center began at the Massachusetts Institute of Technology (MIT) and is now a global entity. It is focused on driving the commercialization of ultra-low cost RFID solutions that use Internet like infrastructure for tracking goods throughout the global supply chain. The Auto-ID Center organization is now EPCglobal.

B

Bit – The smallest unit of digital information - A binary code – a single '0' or '1', where many different codes can be developed to represent pertinent information. A 96-bit EPC is a string of 96 zeros and ones.
Byte – 1 byte = 8 bits. One byte of memory is needed to generate an alpha character or digit. So bytes can be thought of in terms of characters.

C

Chip Based RFID –Refers to RFID tags that contain a silicon computer chip and therefore can store information and transmit it to a reader.
Collision – Radio Signals interfering with one another. Signals from tags and readers can collide.

D

Die – A tiny square of silicon with an integrated circuit etched on it – more commonly known as a silicon chip.

E

Electronic Article Surveillance Tags (EAS) – Single bit (either 'on' or 'off') electronic tags used to detect items for anti-theft purposes. EAS technology is similar to RFID in that it uses similar frequency bands.
Electromagnetic Compatibility (EMC) – The ability of a technology or product to coexist in an environment with other electro-magnetic devices.

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Electronic Product Code (EPC) – A standard format for a 96-bit code that was developed by the Auto-ID Center. It is designed to enable identification of products down to the unique item level. EPC's have memory allocated for the product manufacturer, product category and the individual item. The benefit of EPC's over traditional bar codes is their ability to be read without line of sight and their ability to track down to the individual item versus at the SKU level.
EPCglobal – The association of companies that are working together to set standards for RFID in the retail supply chain. EPCgloval is a joint venture between EAN International and the Uniform Code Council, Inc.

F

Frequency – Refers to a band of operation for radio-based technologies. Frequencies allocated for RFID use exist in the low, high, ultra-high and microwave frequency bands. Each frequency has its own advantages and disadvantages such as read distance, tag size and resistance to electronic noise.

G

GTAG (Global Tag) – A standardization initiative of the Uniform Code Council (UCC) and the European Article Numbering Association (EAN) for supply chain tracking applications using UHF RFID frequencies.
Global Trade Item Number (GTIN) – A superset of bar code standards that are used internationally. In addition to manufacturer and product category, GTIN also includes shipping, weight and other information. The EPC is designed to provide continuity with GTIN.

H

High-Frequency RFID (13.56 MHz) – RFID that uses the high-end 13.56MHz radio frequency band. Features medium sized tags with relatively good reading distances. In the U.S. 13.56MHz tags can be typically read at approximately 3-4 inches with a handheld reader and 4 to 6 feet with a portal reader.

I

Integrated Circuit (IC) – Another name for a chip or microchip
Interrogator – An RFID reader

L

Line-of-Sight – Technology that requires an item to be "seen" to be automatically identified by a machine. Unlike bar codes and OCR technologies, RFID tags can be read "through" merchandise and most packaging with no line of sight required.
Low-Cost RFID – Typically refers to RFID tags that cost less than $1.00 with typically 3 feet of read range.

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Low Frequency RFID (125 & 134 KHz) – Low frequency radio band allocated for RFID use. The main disadvantage of low frequency RFID is its cost and relatively slow data transfer as well as its inability to read many tags at the same time.

M

Multiple Tag Read/Write – Refers to the ability of RFID systems to read multiple tags at the same time. Reading and writing of multiple tags is achieved through the anti-collision feature of RFID.
Microwave RFID Frequency (2,450MHz or 2.45GHz) –A microwave frequency band allocated for RFID use. Used for Item level tracking including retail merchandise. Typically microwave RFID technologies feature the smallest label footprint and read distances up to 18 inches with a handheld reader and perhaps up to 4 feet with a portal reader. This frequency also offers fast data transmission, but is somewhat more bothered by shielding of liquid products and reflections from metal structures, etc.

P

Passive RFID Tag – An RFID tag that does not use a battery. Passive tags draw their power from the reader. The reader transmits a low power radio signal through its antenna. The tag in turn receives it through its own antenna to power the integrated circuit (chip). Using the energy it gets from the signal, the tag will briefly converse with the reader for verification and the exchange of data. As a result, passive tags can transmit information over shorter distances (typically 10 feet or less) than active tags. They are considerably lower in cost ($1.00 or less)
making them ideal for tracking lower cost items.
Perpetual Inventory – The ability to know one's inventory position at any given time. RFID offers the promise of being able to perform automatic inventory counts.

R

Radio Frequency Identification (RFID) – A method of identifying items uniquely using radio waves. Radio waves do not require line of site and can pass through materials like cardboard and plastic but not metals and some liquids.
Read Range – The distance from which a reader can communicate with a tag. Several factors including frequency used, orientation of the tag, power of the reader and design of the antenna affect range.
Reader – Also called an interrogator. The RFID reader communicates via radio waves with the RFID tag and passes information in digital form to the computer system. Readers can be configured with antennas in many formats including handheld devices, portals or conveyor mounted.
Read Only Tags – Tags that contain data that cannot be changed. Read only chips are less expensive than read-write chips.
Read-Write Tags – RFID chips that can be read and written multiple times. Read/Write tags can accept data at various points along the distribution cycle. This may include transaction data at the retail point of sale. They are typically more expensive than read only tags but offer more flexibility.
RFID Transponder – Another name for a RFID tag. Typically refers to a microchip that is attached to an antenna, which communicates with a reader via radio waves. RFID tags contain serial numbers that are permanently encoded, and which allow them to be uniquely identified.

RFID
Glossary of Commonly Used Terms

RFID tags vary widely in design. They may operate at one of several frequency bands, may be active or passive and may be read-only or read-write.

S

Savant – Distributed network software that manages and moves data related to Electronic Product Codes (EPC)
Smart Label – A label that contains an RFID chip and antenna. These labels can store information such as a unique serial number and communicate with a reader.

T

Tag – The generic term for a radio frequency identification device. Also sometimes referred to as smart labels.
Tag Collision – Interference caused when more than one RFID tag sends back signals to the reader at the same time.
Transponder – A combination transmitter-receiver that is activated when it receives a predetermined signal. RFID tags are sometimes referred to as transponders.

U

Ultra-High Frequency (UHF; 850 to 950 MHz) – Ultra-high frequency radio band allocated for RFID use. UHF RFID can send information faster and farther than high and low frequency tags. UHF RFID is gaining industry support as the choice bandwidth for inventory tracking applications including pallets and cases. UHF RFID features larger tags and readers with the longest read distances (2-3 feet with handheld readers and more than 9 feet with portal readers)

W

"WORM" Chip (Write Once Read Many) – It can be written once and then becomes "Read Only" afterwards.

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