What is RFID & How will it Impact My Business?

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What is RFID?

Radio Frequency (RF) technology has been around since WWII, when the Allied Forces first used it to identify friendly aircraft. Today this technology is used for mobile phones, toll tags, fuel pump key fobs, animal tracking both wild and domestic as well as many other applications.

In this booklet we will discuss the use of RF in automatic identification systems, the most rapidly growing segment of today's automatic data collection (AIDC) industry. RFID (radio frequency identification) uses radio frequency signals to identify "tagged" items, cases and pallets as they move through the supply chain. This data is then collected and transmitted to a host system using an RF Reader.

A Basic RFID System

- **RFID Device** (transponder, tag, smart label, card, etc.) – contains data about the tagged item
- **Antenna** – transmits the RF signals between the reader and the RFID device
- **Reader** – receives RF transmissions from an RFID device and transmits to a host system for processing

Will RFID replace Barcodes?

Most experts agree that RFID will coexist with traditional barcodes for many years to come. RFID is an extension of barcode data collection systems for enhanced tracking of items through the supply chain network.

New RFID label printers marry these two technologies for the best of both worlds. These printers are able to print barcodes, human-readable text, and graphics on the surface of a pressure sensitive label and then encode the RFID chip embedded as part of the label.

How does RFID work?

RF signals are electromagnetic waves classified according to their wavelength frequency. The most commonly recognized ranges are low (LF), high (HF), ultra-high (UHF) and micro-wave (uW). Current RFID technology uses frequency ranges from 50 kHz to 5.8GHz. The higher the frequency, the higher the throughput or rates of data transfer.

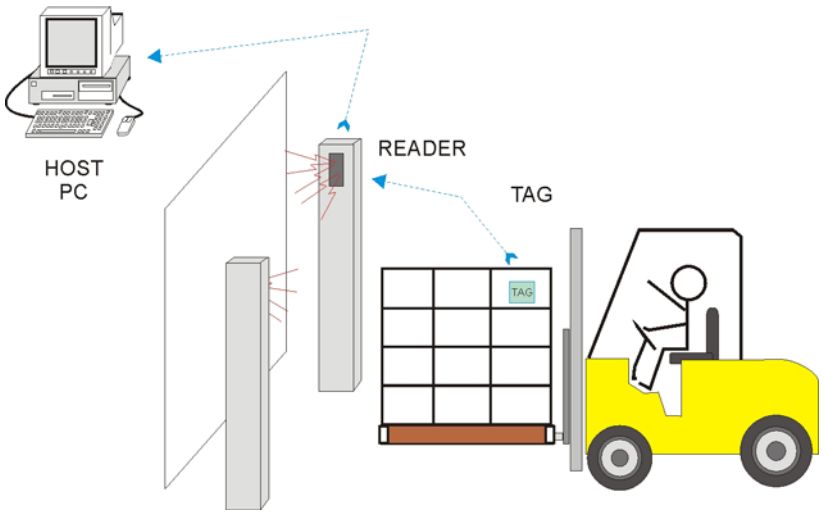
Typical RFID System Frequency Ranges

- **Low Frequency** (125 KHz) has a maximum read range of up to 20 inches
- **High Frequency** (13.56 MHz) has a maximum read range of up to 3 feet
- **Ultra-High Frequency** (868 MHz – Europe) (915 MHz – US) has a read range of 20 feet or more
- **Microwave Frequency** (2.45 GHz) has a read range of up to 1 meter as a passive tag or longer range as an active tag

Like a barcode system that uses an optical signal reader or scanner to interpret data contained in a barcode, an RFID system uses an RF reader to receive radio frequency signals from RFID devices containing stored data. Unlike barcode systems, RFID systems do not require line-of-site to read the RF tags. This along with the ability to read many tags at once is the major factor driving interest in RFID technology.

An RFID device such as a tag or label contains data, much more data than a barcode, which uniquely identifies the item it is attached to. Stored data can include; a description of the item, manufacture date, time the item passed a certain point in the supply chain, serial number and much more.

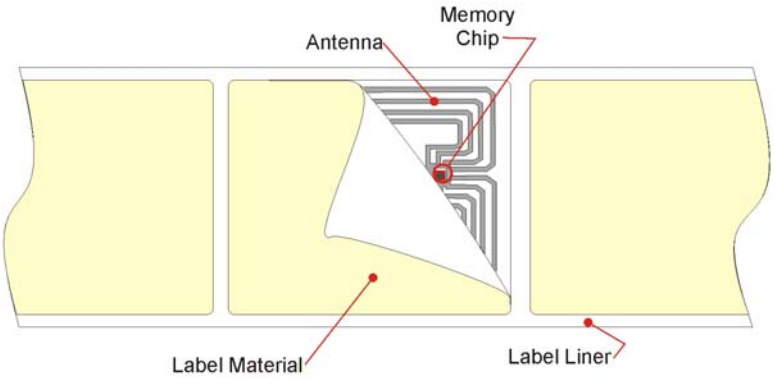
This data is transmitted from the RFID tag to the RFID reader, which in turn communicates to a host computer or information management system, which could be running a WCS (warehouse control system) or WMS (warehouse management system) application.



What is an RFID Tag?

There are a variety of tag designs, shapes and sizes. The basic structure includes a silicon chip (stores data) and an antenna (transmits data to a reader). Together these two components are referred to as the "inlay". The inlay in turn is embedded in a base material; paper, Mylar, plastic or film.

The differences in tag performance are determined by characteristics such as size, antenna, surface and shape. The physical properties of the product to be tagged will determine which tag to use for optimal performance. Packaging material, environment, tag placement and reader location all can affect tag read rates. There is not a one tag fits all solution.



RFID tags are available in active, passive and semi-passive forms. Each type of tag transmits RF signals to be received and decoded by an RFID reader. Every tag has a unique identifier, allowing its signal to be differentiated from other RF tags.

Types of Tags

- **Active** – uses an integrated battery to energize the tag, sending an RF signal to a reader. Active tags are able to transmit signals over greater distances, up to 300 feet indoors and 1,000 feet outdoors. Because these tags include a battery and more complex circuitry, they are much larger and more expensive ($10-$50 each) than passive tags. The life of the tag is limited to the life of the battery. However, by optimizing the circuitry and battery, some tags may last ten years or longer.

- **Passive** – the most common type of RF tag, passive tags operate without an internal battery source. Instead they obtain power to operate from the electromagnetic field generated by the RF reader. An RFID reader transmits an energy field that "activates" the tag and provides power to the chip, allowing the tag to transmit or store data. Transmission range for passive tags is limited compared to active tags, but with no battery the tags can be much smaller and less expensive (typically < $1ea). The price for these tags will continue to fall as demand continues to grow. Since passive tags do not have a battery, they have an unlimited lifespan.
- **Semi-Passive** – a combination of active and passive styles, this tag has an internal power source that only powers the on board circuits. Communicates to the reader in a similar manner as a passive tag.

EPC Tag Classes		
EPC Class	*Definition*	*Programming*
Class 0	"Read Only" passive tags	Programmed as part of the semiconductor manufacturing process
*Class 0+	"Write-Once, Read-Many" version of EPC Class 0	Programmed once by the customer then locked
Class 1	"Write-Once, Read-Many" passive tags	Programmed once by the customer then locked
Class 1 - Gen2	"Write-Once, Read-Many" passive tags. UHF Gen2 protocol ratified on Dec. 16, 2004 by EPCglobal	Programmed once by the customer then locked, this is the first royalty-free, global standard developed through the collaboration of over sixty companies and EPCglobal
Class 2	Rewritable passive tags	Can be reprogrammed many times
Class 3	Semi-passive tags	
Class 4	Active tags	
Class 5	Readers	N/A
* Not an EPCglobal defined class		

What are Smart Labels?

Due to the smaller, thinner size of passive tags, they can be integrated into a pressure sensitive label. These "smart" labels can be printed with human readable text or barcodes and then automatically applied to a product, box or pallet.

While some smart labels are encoded during the tag manufacturing process then printed, a more efficient method is to use an RFID Label Printer. An RF encoder integrated into a thermal transfer printer encodes the tag/label prior to printing text, graphics or barcodes onto the label.

An RF reader verifies the encoded data before the label is fed forward for application. If the tag does not read or its data does not verify the label is voided and removed prior to application. This process takes milliseconds to seconds depending on the amount of encoded data.

Label design software will bridge application software and the RFID label printer, telling the printer what type of tag and what data to encode to it.

Smart labels are made from flexible material that will not damage the printhead. Some tags use conductive inks to conduct the electronic signals in place of traditional metal antennas; this makes the tags even thinner. If the integrated circuit (IC) creates an uneven surface, which can affect print quality, a thicker label material can be used or the operator can avoid printing directly over the circuit.

For years to come, manufacturers will need both barcodes and RFID tags for product identification. Smart Labels and RFID printers accomplish this with a convenient, one step, one machine process to encode, print and verify RFID tags.

Why Use RFID?

By industry estimates, billions of dollars are lost each year due to supply chain inefficiencies and out-of-stock occurrences. RFID promises to improve supply chain efficiencies by giving more control and real time information to manufacturers. This, in turn, benefits the consumer by reduced out-of-stock incidents.

Improvements to Supply Chain

- **Time and Labor Savings** – "field" reading allows the scanning of multiple items in seconds without unloading a

pallet. This also eliminates the possibility of a receiving clerk failing to scan all items.

- **Increased Control** – tags with read/write capabilities permit data to be updated throughout the supply chain, highlighting problem areas and enabling faster responses.
- **Flexible Product Flow** – RFID as part of supply chain management enables real time decision making for a more flexible and responsive supply chain execution. Decisions can be made to redirect product flow to meet changing customer demands.
- **Enhanced Customer Service** – instant status information leads to more accurate delivery dates and increased ability to respond to urgent orders.
- **Security** – better tracking, reduced inventory shrinkage (loss), reduced counterfeiting

A study by EPCglobal estimates that RFID systems can improve demand forecast accuracy for consumer packaged goods manufacturers by 10-20%. Other projected benefits include a 10-30% reduction in required inventory levels and 1-2% sales improvement attributable to reduced out-of-stock occurrences. Additional studies have been done to illustrate additional benefits to be gained from RFID tagging throughout the supply chain.

Because RFID tags can be read through packaging, shipping containers and other material, incoming pallets do not have to be unloaded for scanning and identification. The shipping container and the items inside are read and identified instantly. This allows them to be automatically sent to a specific manufacturing line or routed for delivery.

For improved manufacturing processes, RFID tags can be applied to subassemblies. By integrating RFID systems into the manufacturing process items can be tracked and routed automatically through the assembly processes.

An item's RFID tag can be used to access a comprehensive history of that item stored on a host server. This can be as simple as a serial number or can include a detailed maintenance history. This information can then be used to verify warranty repairs or for product recalls.

Pharmaceutical companies can benefit from increased safety and security as well as a more efficient supply chain. RFID systems can monitor assembly and packaging processes to ensure medications are properly packaged and labeled. The use of unique identifying ID numbers makes counterfeiting much more difficult. Even if the package

and UPC are the same, the ID number will not match. RFID tags can also alert pharmacies when a drug is out-of-date or part of a recall.

Why now?

Many retailers, starting with Wal-Mart, are requiring their suppliers to add RFID tags to cases and pallets. While some say that the time line put in place by Wal-Mart is too aggressive, the push is on for use of RFID to streamline manufacturing processes and improve supply chain management.

It may be the retailers that are demanding implementation of RFID, but this technology has the potential to become as pervasive as barcodes in all aspects of industry. Those manufacturers that were skeptical of barcode labels when they were first required now realize the cost savings and efficiencies this technology has provided them. RFID technology could foster similar results.

RFID tags will not replace barcodes. Instead most experts agree that the two technologies will be used together for the foreseeable future. Human readable identification will still be needed in the event an RFID tag fails.

RFID Tagging Mandates

- **Wal-Mart** – Top 100 suppliers were required to RFID tag at the case and pallet level by January 2005, for limited items bound for three distribution centers. This will expand to twelve DCs by October 2005 and all other suppliers must comply by the end of December 2006.
    - Ultra-High Frequency (UHF) Tags
    - EPC Compliant - data structure and air interface protocol
    - Class 0 and Class 1 tags will be accepted until Class 1, Version 2 standards are approved and tags are widely available
    - No change to barcoding requirements
- **U.S. Department of Defense (DOD)** – Top suppliers were expected to be tagging pallets and cases and some packing material by January 2005. Schedule for remaining suppliers has not been determined.
    - Required on items that carry a UID

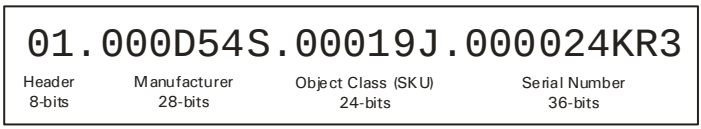
- Tag must be compatible with UID
- Will accept EPC Class 0 and Class 1 until Class 1, Version 2 is widely available

- **Target, Albertson's, Others** – Generally the same as Wal-Mart with a longer time line.
- **Healthcare Distribution & Management Association (HDMA)** – Want drug manufacturers and wholesalers to use EPC compliant RFID tags on cases of product by the end of 2005 and on "selling units" by 2007. Large drug wholesalers support this.
- **U.S. Food & Drug Administration (FDA)** - Would like RFID tags on drug packages by 2007. The FDA is not requiring RFID by 2007, but sees this as a feasible date for widespread use and plans to help and encourage RFID development. It is believed that this is needed to reduce counterfeiting and to track drugs from "factory to pharmacy".

Who is EPCglobal?

Originally developed at the MIT Auto-ID Center, EPCglobal is a joint venture between EAN International (Europe) and UCC (U.S.). The mission of this not-for-profit organization is to establish and support the Electronic Product Code (EPC) Network as the global standard for immediate, automatic, and accurate identification of any item in the supply chain of any company, in any industry, anywhere in the world. Their objective is to drive commercial adoption of the EPCglobal Network and RFID-based tracking technology.

The Electronic Product Code (EPC) differs from UPC and EAN barcodes in that it identifies an individual item, not just the manufacturer and type of item. For example, a can of green beans may have the same UPC label as all like cans of green beans, but an EPC identifies that specific can of green beans. The EPC# includes EPC manufacturer number, object class and unique item serial number.



The unique identifier is the foundation of the EPC Network and where the full power of RFID systems can be realized. This identifier facilitates item level tracking, real time supply chain management, more efficient

warranty and service management, faster more targeted product recalls and more.

EPCglobal is working with manufacturers, end-users, technology vendors and Auto-ID Labs (successor of Auto-ID Center) to establish web service standards to securely share RFID XML data across the web. This will allow real-time decisions and collaboration from any point along the supply chain.

Both background and current information concerning the EPC Network can be found at www.EPCglobalinc.org.

What are the main challenges of implementation?

Signal Disturbance - Because RFID is a radio technology it is subject to signal disturbance. This is particularly true when scanning products that contain large amounts of liquid or metal; metals reflect signals while liquids absorb them.

Applying labels to different locations on a pallet or carton can enhance reading performance. The way a pallet is put together or assembled can also impact reader operation. Tag size, frequency, orientation and placement may all need to be fine tuned for individual items. In some cases specially designed tags will be needed to overcome signal problems.

In warehouses with multiple readers, "reader collision" can occur. This is caused when the readers disrupt each other by sending a signal simultaneously. Similarly, "tag collision" occurs when two tags send a signal at the same time. Both conditions can be corrected by tweaking the timing of the reader and tag signals, a process that can be time consuming.

Standards – The directives from Wal-Mart and the U.S. DOD are driving suppliers to adopt RFID technology even though standards are still evolving. Any RFID system or process that is put into place today should have a clear upgrade path that will allow for the adoption of standards as they are defined.

RFID systems must also comply with all relevant government regulations regarding allowable frequencies, power output and emissions. In the U.S. the Federal Communications Commission (FCC) has authority over RFID technology.

Cost – As with implementing any new technology, cost is a major factor. Besides the on-going cost for the RFID tags, RF readers and software upgrades will be necessary.

Much has been written about the 5¢ RFID tag. This may be attained at some point in the future as demand increases and production becomes more efficient. For now, however, plan on tags ranging from 30¢ to 80¢ each.

Failure rate on RFID tags is still high. This brings into question whether to validate the tag before it is applied to the product or after. If validated and then applied the process may be slower. But if the tag is validated after it is applied, the case may be lost as well as the tag. In some instances the cost of the case is an additional $1-$3.

Purchasing departments will not be able to quickly switch tags when they find a cheaper supplier. New tags will probably have a different read distance and read pattern and therefore they will need to be field-tested first. Purchasers will be further limited because, at this time, tag configurations vary by print engine manufacturer. Tags must also be durable enough to handle environmental extremes and the physical abuse of real world shipping and handling.

Privacy – Although item level tagging will not be common for many years, consumer advocates are already raising questions regarding privacy once individual products are tagged. They believe that consumers should be told of the presence of RFID tags and given instructions on how to remove or disable the tags after an item is purchased.

Most advocates are not concerned with collecting information on pallets and cases in the supply chain. It is when information can be collected on the individual consumer, possibly without their knowledge, that raises their objections.

There are times when it might be beneficial to leave a tag "active" on a product after it leaves the store; returns, recalls or scanning pharmaceuticals for harmful drug interactions.

Data Management - Software will be one of the greatest challenges and one of the highest costs as manufacturers begin to implement RFID systems.

While RFID offers an almost limitless opportunity for gathering data on individual products and the supply chain that moves them, software must be developed to decode and analyze the data. IT infrastructure will need to be enhanced to absorb and manage the data generated and collected. It is estimated that millions of terabytes of data will be created each day once item level tagging is in place.

Where do I begin?

Careful planning is necessary for implementation of any new technology. Planning for the use of RFID demands a broad "big picture" view of a company's processes in tandem with vigilant attention to the details. Both operations and IT personnel should be involved in planning and execution of RFID technology.

A pilot test should be planned so as not to disrupt core components of a company's business. There are some early adopters of RFID technology that are offering their testing facilities on an outsourced basis. Test as many products as possible in as close to a real world setting as possible. Don't limit your testing to just the individual items, test with different tags, readers, pallet configurations and tag placement.

Don't forget or underestimate training. This is a new technology that affects how your business is structured. Adequate training will be needed to fully realize goals and assure employee buy-in.

Who is ID Technology?

ID Technology, a Division of Pro Mach, is a manufacturer and integrator of labeling, coding and marking equipment. The ID Technology product line includes Label Applicators, Label Printers, Printer Applicators, RFID Labeling Solutions, Small and Large Character Inkjet Printers, Laser Coders, Thermal Transfer Overprinters, Scanners, Verifiers, Software, Supplies as well as Field and Depot Service.

TECHNOLOGY

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