# RFID Technology for Warehouse & Distribution Operations.

## An RFID Primer

## Introduction

Warehouse and distribution center operations are at the center of the surge in radio frequency identification (RFID) activity. RFID is proving to be a cost-effective resource for saving time, improving visibility and reducing labor requirements for a variety of shipping, receiving and inventory management operations. This white paper presents an overview of RFID technology and how to use it in warehouses and distribution centers.

## Technology Overview

RFID uses radio signals to exchange data between a tag (also known as a transponder) and a read/write device (commonly called a reader or interrogator). Tags consist of a wireless chip and antenna that are housed in a label or other protective casing and attached to the item that is to be identified. The tag may be active, which means it has a battery to power its own transmission, or passive, which transmits using power received from the reader in the form of electromagnetic waves. Active tags have longer read ranges making them appropriate for asset management and real-time location systems (RTLS). Passive tags have a shorter read range and are smaller and less expensive than active tags making them the tag of choice for most supply chain applications.

The most common tag type used in warehouse and DC operations are passive adhesive “smart labels” applied to cases and pallets. A typical smart label has an RFID tag encoded within the label material, which is printed with text and bar code to support legacy operations. Chips and antenna can also be encased in more rugged tags to provide permanent asset and location identification or withstand exposure to high temperatures, industrial solvents, impact, and other conditions that make bar code or other forms of data collection impossible.

Readers have antennas for sending and receiving signals, a processor for decoding tag information, and may have additional software for more advanced data processing. Antennas may be separate from the processor and connected by cable for additional placement and configuration flexibility. There are many types of RFID readers. The most common include mobile readers integrated into handheld computers or

mounted on vehicles, and fixed-position units, which are typically mounted at dock doors and conveyor lines.

## Reading Characteristics

RFID's suitability for use in industrial environments is just one of the attributes that set it apart from bar code and other automatic identification and data collection (AIDC) technologies. One of the most significant is that no direct line of site is required between the tag and reader to exchange data. This enables tags to be read if they're not perfectly aligned with the reader, and even to be read through packaging material. Readers can also identify multiple tags simultaneously. Organizations can take advantage of these attributes to reduce labor requirements with automatically triggered reads and unattended, high-speed reading processes.

RFID tags offer secure, rewritable memory, which can be used to improve visibility, security and provide other advantages. Most RFID tags are read/write, and many have memory that can be partitioned so that some portions can't be changed (such as a serial number) while other portions can be updated, with transaction histories, storage records, pedigree information or other variable data. Electronic Product Code (EPC) RFID technology provides a standardized, unique serial number for each RFID tag. Many new supply chain processes are emerging to take advantage of unique, standardized and secure serialization that EPC provides.

Another characteristic of RFID technology that is useful for warehouse and DC operations is its read range. Depending on the tag style, antenna design, frequency and other variables, passive tags can be read from near contact to approximately 20 feet away. Active tags offer even longer range and are sometimes used for yard management and container tracking applications.

## Range and Sensitivity

Range can be an overvalued and misleading indicator of RFID system performance. The control and sensitivity that antennas and readers provide is often much more important than their range. Long read range can increase the chances of unintended reads. Kimberly-Clark Corp.'s distribution center environment for RFID provides a good example. A December, 2005 article in *CIO Insight* described a visit to a Kimberly-Clark DC where fixed-position RFID readers had been installed at multiple dock doors. "Look how close together the doors are," the article quoted Kimberly-Clark Director of Auto-ID Sensing Technologies Mike O'Shea as saying. "The reader on one door picks up the signals from something coming into the other door." O'Shea noted that outfitting the roughly 1,000 dock doors at various Kimberly-Clark facilities would not prevent the packing errors that are among the reasons the company is investing in RFID. In this case, and in many more warehouse and DC operations, finely tuned directional reading and control are more important than range to ensure only desired tags are read, and are read only when desired.

Vehicle-mounted RFID readers with high-performance antennas provide an outstanding degree of reading control, which is a leading reason that reading technique is being adopted rapidly.

## Frequencies and the EPC System

Frequency is one of the biggest variables affecting RFID range and performance. Nearly all RFID systems used for warehouse, distribution center and supply chain applications operate on one of three major frequency families: 13.56 MHz high frequency, common for short range (up to about 1 meter) reading; 860-960 MHz UHF, which includes the well-known EPCglobal Gen 2 standard and provides range of up to 20 feet; and 2.45 GHz microwave transmission, which is used in active tags that provide long range reading, commonly used for identifying cargo containers. Of the three, UHF technology is by far the most common and best suited for the majority of manufacturing and logistics needs. High frequency (13.56 MHz) technology is widely used in other applications and is a viable option for short-range applications. It is often promoted for item-level tagging, such as for product authentication and retail shelf management. Microwave (2.45 GHz) and 433 MHz technology are used in active tags that have their own power source. The power source adds size and expense to the tag, which is why active tags are used in fairly specialized applications.

UHF technology offers the range, speed, security and cost-effective equipment that many material handling, warehouse and manufacturing applications require. The EPC Gen 2 UHF standard was created specifically to support supply chain applications. EPC Gen 2 operates in the 860-960 MHz range, so it can be used throughout the world and poses no interference risk to IEEE 802.11-standard wireless networks (although interference is possible from older, 900 MHz wireless LANs). It supports high-speed reading, provides enough read range for most distribution operations, encodes Electronic Product Code numbers, which provide unique serialization, and makes additional memory available to users. Wal-Mart, Best Buy, Marks & Spencer, METRO Group, the U.S. Department of Defense and other leading RFID adopters are embracing Gen 2 and requiring their suppliers to apply Gen 2-compliant tags on shipments. Numerous RFID industry professionals, market researchers and analysts predict Gen 2 will become the dominant UHF protocol.

## Applications

RFID can be used for many common warehouse and DC inventory management operations, including receiving, putaway, picking and shipping procedures. RFID has high return on investment potential when applications take advantage of its reading characteristic to overcome previous limitations or to enable new business processes. With RFID, items can be monitored and identified at process points where other forms of data collection are impractical because of environmental or cost limitations. Factor in the ability to encode unique, secure serial numbers on tags, and it begins to become clear how RFID can lead to new

levels of visibility in inventory and supply chain operations. Reduced inventory levels, storage, handling and logistics expenses follow from improved visibility.

The following sections briefly describe how RFID is being used for a variety of common warehouse and DC operations and the value it provides.

## Receiving

Proven labor savings at receiving are a big driver for organizations who are requesting or requiring their suppliers to apply RFID tags on shipments. Pallets and/or cases are automatically identified as they are unloaded from the truck using either a fixed-position RFID reader mounted at the dock door, or a mobile reader mounted on a forklift. Forklift-mounted readers are efficient because they can be used throughout the facility and typically require a smaller investment, since fixed-position readers can only monitor a single dock door, but forklifts can service several. Data read from the pallet or case tag are transferred into the warehouse management system (WMS), updating its database. The system reconciles its orders and sends back information that will allow some items to be cross docked for immediate transport, while others can be staged and stored. If bar codes were being used here, all received items would have to be scanned, their labels clearly visible, by workers, making the process much more labor-intensive.

## Putaway

RFID can improve putaway accuracy by automatically associating stored goods with their actual putaway location, with no operator data entry or bar code scanning required. When cases or pallets are physically placed into storage, a forklift-mounted RFID reader can be triggered to automatically record the location code from a permanent tag at the location, plus the case or pallet ID tag, which saves operators the time of locating, aiming and scanning bar codes, and eliminates the possibility of key-entering the wrong location code.

## Security/Documentation

The location-reading principle of automated putaway can be modified to provide unattended location monitoring. This application requires a fixed-position reader to monitor a specific location, such as a portal or dedicated storage area. The application is valuable in select situations where there are strong needs for security, item availability or chain-of-custody documentation. For example, full-time RFID monitoring could be installed for a secure storage area to provide theft detection for high-value goods. Fixed-position readers could also provide documentation that perishables were kept in cold storage areas until being removed for shipment.

## Picking

Similar to putaway, RFID builds error-proofing into the picking process. Goods are automatically recorded by a forklift reader or other mobile RFID device as they are picked, and the transaction is checked by the

WMS or order management system to confirm the picked item belongs with the order. Tagged goods can also be automatically associated with the pallet they're placed on, saving data entry time during the pallet-build process. Forklift-mounted readers eliminate the orientation concerns and operator labor time associated with bar code scanning. For many manufacturers, using vehicle-mounted RFID to validate SKUs and quantify cases will allow for the elimination of redundant quality assurance processes.

## Shipping

RFID can validate pallet loads and improve shipping accuracy even if it isn't used as part of the picking process. A pallet of RFID-tagged cases can be identified through either an unattended portal reader or a vehicle-mounted or handheld device. The order management system or WMS would match the read data against the customer order to validate that no cases were missing and that case quantities were correct. The read data could also be used to trigger generation of a shipping label for the pallet (which itself may include an RFID tag) and to provide information for an advance ship notice (ASN). A scan at the shipping dock can be used to update information in logistics applications and to record the goods out of inventory. Lastly, RFID can even be used to validate the trailer if equipped with an RFID tag.

## Asset Tracking

Often it's beneficial to track the shipping container with RFID, if the container is a returnable or reusable asset. By using RFID tags on pallets, drums, racks and other shipping containers to track their movements and associate them with specific customer shipments, organizations build an accurate information foundation to recover more of their assets and manage them more efficiently. For example, leading U.K. retailer Marks & Spencer is tracking more than 4.5 million trays, roll cages, dollies and other returnable containers for its fresh produce logistics operations with RFID tags. Marks & Spencer uses LXE MX5 mobile handheld computers to read RFID tags on its logistics assets as they move in and out six distribution centers. By accurately tracking where assets are in the facility and in the supply chain, organizations can improve planning, reduce buffers and increase utilization, which all add up to real cost savings.

Asset tracking benefits aren't limited to logistics containers. Forklifts and other capital equipment, machines, tools, supplies and other assets can all be tracked and secured with RFID to improve visibility and availability, reduce losses and provide accurate information for asset management and other software applications. High-value assets and shipping containers are sometimes tracked with active RFID technology, because savings from loss or theft of these high-value items can offset the higher tag costs.

## Conclusion

RFID can often reduce or eliminate manual labor requirements, which provides direct cost savings and often improves accuracy, which produces other benefits. Many common warehouse and distribution center activities provide a strong opportunity to generate positive return on investment (ROI) from an RFID system. However, companies typically don't implement comprehensive, end-to-end RFID systems. Rather,

they selectively apply the technology to improve specific processes that are labor intensive or prone to creating delays or inaccuracies. By starting with a flexible RFID infrastructure, the investment can be leveraged and ROI improved by encompassing additional applications. Because RFID operations may evolve or expand, mobile readers are often advantageous to fixed-position models because they can be used for multiple applications. As applications grow, so does inventory visibility, which ultimately leads to lower inventory levels and more efficient supply chain operations.

This paper has provided a snapshot of RFID technology and how it can be used to improve warehouse and DC operations. Browse LXE's Web site, www.lxe.com, for more white papers, customer profiles and product information. EPCglobal, a leading standards organization, has information about the EPC RFID system and its uses in various industries available at its U.S. Web site, www.epcglobalus.org. AIM Global, the trade association for the automatic and data capture industry, has good RFID background information and user profiles available on its site, www.aimglobal.org.

LXE Inc. improves supply chain performance by applying over 30 years' experience developing rugged wireless computers and RF data collection networks.

From handheld and vehicle mount computers, advanced auto-identification technologies, and RF network infrastructure, to our award-winning customer support – LXE's easy-to-use, mobile computing products are as reliable as the people who install and support them.

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