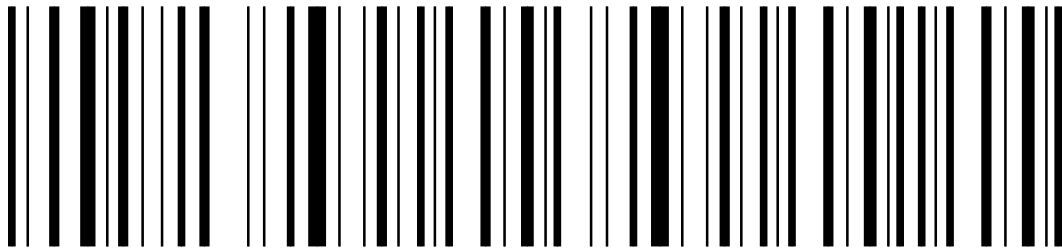


Zebra's RFID Readiness Guide: Complying with RFID Tagging Mandates



A P P L I C A T I O N W H I T E P A P E R



Zebra Technologies



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Executive Summary

Creating a radio frequency identification (RFID) system can be both challenging and highly rewarding. The challenge rises when RFID must be implemented on a deadline to satisfy a customer requirement, rather than just to address internal business efficiency improvements. Carefully considered systems can do both, as you will see.

An RFID compliance mandate specifies when and how tagging must be done. Unfortunately, many companies are left wondering where to begin. To that end, Zebra Technologies has produced this guide to help you determine your RFID readiness and how to get started with RFID. This white paper identifies and guides you through the important questions companies must answer to build a successful RFID program. This paper will:

- Provide an overview of RFID technology, standards, and specifications available for compliance tagging;
- Describe EPC™ (Electronic Product Code) technology that has been specified by the world's leading retailer and the U.S. Department of Defense for use in their RFID compliance programs;
- Illustrate how companies faced with compliance requirements can take advantage of RFID to improve their own shipping and inventory operations;
- Present labeling technology options; and
- Provide an overview of compliance tagging and the steps to implementing a system, including application planning, infrastructure evaluation, testing and operation.

Introduction

Zebra Technologies is a leading developer of technology and driver of standards for RFID and bar code labeling, and has helped thousands of customers successfully meet compliance labeling requirements. Our extensive experience with RFID users and standards bodies has given us insight into the questions that organizations face and the information they need. Here are the top eight questions to consider before developing an RFID system, along with tips, insight, and recommendations for answering them to ensure a successful implementation.

What Business Problem Am I Trying to Solve?

For many, the answer need go no further than “To keep the customer.” Compliance tagging mandates set a clear requirement for what the RFID system must do. Companies who only wish to comply with customer requirements and make no other use of RFID do not need to concern themselves with considering how RFID could improve inventory, warehousing, distribution, logistics, and security. However, the same tags and systems used to satisfy customer requirements also can be used to improve these and other operations. Implementing a compliance tagging system will require changes to operations. Companies should use the occasion to investigate how the changes could provide internal benefits.



Some product manufacturers considered bar code shipment labeling a nuisance and a burden when retailers first began requiring it. Today, however, these manufacturers wouldn't think of operating their distribution centers without bar codes because of the proven efficiency improvements the technology provides. RFID holds the same potential to improve operations. RFID will not replace bar code technology, but can effectively enhance bar code-based data collection systems where additional visibility or automated processing is desirable.

Many companies will meet their compliance tagging requirements with "smart labels," which consist of an RFID inlay (the chip and antenna combination) contained within an adhesive label. Smart label printers encode the RFID chip inside of the label material and can print text, bar codes, and graphics on the outside. Note that companies forging ahead with RFID compliance labeling initiatives are not saying that RFID will replace bar codes; quite the reverse—human readable information and bar coded data will still be required going forward, making RFID smart labels an excellent and obvious choice with which to begin RF tagging.

How is RFID Different than Bar Code?

It is important to understand the significant differences between RFID and bar code to appreciate the benefits RFID can provide. Bar code and RFID are both identification technologies that hold data that is accessed by some type of reader. In actuality, they complement each other very well and can be used effectively side by side in many applications. Bar code is an optical technology and RFID is a radio technology. The ways these technologies exchange data account for most of the differences between RFID and bar code and help determine where each identification technology is best put to use.

As a radio technology, RFID requires **no line-of-sight between** the reader and the tag to exchange data. RFID tags therefore can be read through packaging, including cardboard containers and plastic wrap used to seal pallets. RFID is subject to interference however, particularly from metal, so potential sources of interference must be recognized and accounted for during system planning.

Because no line-of-sight is required, tagged objects can be read regardless of their **orientation** through the use of optimized RFID systems. Items don't have to be placed label side up onto conveyors to be read, paving the way for unattended handling. If workers are used to place items on conveyors, they will be more productive if they don't have to locate and align labels when handling objects.

RFID readers can automatically recognize and differentiate all the RF tags in their reading field. This **simultaneous processing** capability provides additional flexibility for material handling, packaging and sortation operations because there is no need to maintain spacing between objects to ensure they will be read. The ability to read dozens or even hundreds of tags per second makes RFID ideal for high-speed sortation, receiving, cross docking and other applications.

The **data capacity** of RFID tags enables them to carry all the same information as bar codes and more. Just like bar code, RFID tags are available with different memory sizes and encoding options.

For more general information about RFID technology and smart label printing, see Zebra's white paper *RFID: The Next Generation of AIDC*.



What Compelling Reason Drives Me To Use RFID?

Users can take advantage of RFID performance features to create reading and sortation systems that operate with minimal or *no operator intervention* required. The traits are especially valuable in high-speed sortation and cross-docking operations, where manual labor is often the biggest limitation on throughput speed and processing accuracy. For ideas on how RFID could improve your business, review operations to determine if there are any consistent choke points or processes that require excessive human handling, such as placing items a certain side up on a conveyor. These processes are candidates to be automated with RFID, which can provide a good return on investment by reducing labor requirements and improving efficiency.

There are many possibilities to take advantage of unattended handling, and one of the most promising is for unattended monitoring. For example, manufacturers can use RFID to reduce their inventory shrink by 10 percent according to a study from consulting firm Accenture. RFID readers can be strategically placed, either hidden or visible, to create security zones within facilities. The readers could constantly, discretely monitor finished goods inventory, components, tools, equipment and other valuable items by reading the tags on all items within the read zone. Tags on items can trigger alarms or a discrete notification to a supervisor if unauthorized removal is attempted.

What Are the Benefits to My Business?

RFID tagging can produce many benefits besides enabling you to keep your customer. Tagging mandates are sprouting up in a variety of industries because organizations have become convinced that RFID can lower distribution and handling costs and reduce inventory levels by improving visibility. These benefits are available to the companies who must supply tagged goods just as much as they are to the customers who receive them. This has been proved over and over with various bar code labeling mandates, and it is believed that further process efficiency improvements will be achieved using RFID.

There are many ways for companies who are tagging to satisfy compliance requirements to take advantage of the RFID tags for internal operations. The best approach is to start evaluating a single, small application and to expand as experience and benefits are gained, all while carefully watching activities outside your organization to see where industry trends are moving, especially in respect to technology selection and standards. RFID can potentially benefit any process where items need to be identified, tracked, or moved. One approach is to work backward from where tags need to be applied to find the easiest and most logical places to begin internal use.

The shipping area can be a good place to start, since many companies will print and apply their compliance labels just prior to shipping. As shipments are being loaded, RFID tags on cases, cartons, and pallets could be read to log out the items and build a shipping manifest. By interfacing the RFID system with shipping or order management applications, shipments could be verified for accuracy by using the RFID readings to make sure all of the required items were loaded, and in the right quantity. Similar processes could be developed to expedite receiving.

Many organizations currently perform shipment verification by scanning bar code shipping labels as items are loaded, which prevents many shipping errors. Converting to RFID-based verification would enable shipments to be processed faster because RFID readers can capture data from dozens of packages simultaneously regardless of their orientation. Bar code shipment verification requires operators to scan each label, raising the possibility that items could be missed and unaccounted for.



Making only a small, incremental improvement to shipping accuracy can produce strong benefits, as the following calculation illustrates. Various analyses have established that shipping errors cost between \$60 and \$250 to resolve, depending on labor rates, shipping expenses, and the amount of clerical and administrative time required. Therefore, each 1 percent improvement in shipment accuracy should reduce shipping expenses between \$60 and \$250 per every 100 shipments. For a company that ships 100 orders a day, each 1 percent improvement in shipment accuracy would produce annual savings of \$15,600 to \$65,000.

Similar processes could be implemented at receiving to keep inventory accurate and reduce labor requirements. Consider that by using RFID at the carton or case level, receiving could be managed as a matter of exception—reporting automatically what has actually been received and comparing it with information received in an advance ship notice - rather than laboriously scanning in one case or carton at a time.

Shipment verification is just one way manufacturers can take advantage of RFID tags applied to meet customer mandates. Manufacturers could gain previously described security and shrink-reduction benefits by tagging finished goods inventory or creating a security system to monitor dock doors and other exit points. RFID tags could be used as a form of authentication to fight the growing problem of counterfeiting, which the International Chamber of Commerce estimates now accounts for 8 percent of global trade. Smart labels on packaging provide a method to audit distribution channels to detect counterfeit or diverted shipments. Tags on products could provide further authentication and a means to verify eligibility for warranty service.

EPCglobal, the organization formed to commercialize and support the Electronic Product Code RFID system that was originally developed at the MIT Auto-ID Center, offers a series of RFID business case analyses on its Web site, www.epcglobalinc.org. Of particular interest is a study titled “Auto-ID On Demand: The Value of Auto-ID Technology in Consumer Packaged Goods Demand Planning.” This study found that RFID systems can improve demand planning forecast accuracy for consumer packaged goods manufacturers by 10 percent to 20 percent. Other projected benefits include a 10 percent to 30 percent reduction in required inventory levels, and 1 percent to 2 percent sales improvement attributable to reduced out-of-stocks. Other studies in the series illustrate different ways companies can benefit from RFID tagging throughout the supply chain.

Many companies grudgingly gained their first experience with bar code and electronic commerce systems in response to customer mandates for bar code shipping labels and EDI communications. Suppliers often resented these programs and were skeptical of the benefits they could provide, but in time learned how to take advantage of them for internal operations. Early compliance labeling and EDI systems became the foundation for many of the highly efficient data capture and supply chain communication systems in place today. RFID will undergo a similar evolution, and early adopters will reap the greatest benefits.

Which Standards and Regulatory Considerations Apply?

Suppliers in compliance tagging relationships must meet customer tag performance and data requirements, and also comply with all relevant international regulations that govern electronic devices and radio communications. Fortunately, these requirements rarely contradict each other, although they must be reviewed whenever RFID operations are extended into different countries. As with bar code shipping labels, companies may develop proprietary compliance formats or base requirements on international or industry standards.

The two largest compliance tagging programs announced to date—by the world’s leading retailer and the U.S. Department of Defense (DoD)—each specified the use of EPC RFID technology. It is believed that other major



end users, such as Metro AG, the leading retailer in Germany, who have recently announced their intent to deploy RFID for pallet and carton tracking, will be adopting the specifications and standards being developed by EPCglobal. In respect to automatic identification and data capture systems, the EPC system defines data structures for producing unique ID numbers, and also defines the technical specifications for reader to tag communications, and tag (or reader sub-system) performance. The EPC system assigns an ID number to every tag to uniquely identify the tagged item. The EPC code serves as a serial number, or digital birth certificate, and can be used to distinguish an item (which may be a pallet, case, carton, or individual product) from similar items.

The EPC is a “license plate code,” which does not describe the item or its owner but provides a unique lookup identifier for databases that hold the information, just as with license plates on automobiles. EPC codes are similar in structure to codes standardized under the EAN.UCC system, which is the basis of much global trade and is created and maintained by EAN International (EAN) and the Uniform Code Council (UCC).

The unique identifier is the basis of the EPC system and is a constant in all EPC specifications. It represents a major difference from the EAN.UCC identification system as it pertains to retail trade, which includes UPC/EAN bar codes used on consumer goods around the world. UPC/EAN symbols typically only identify the manufacturer and type of product. If the product is a broom, every instance of that broom made by the manufacturer will have the same UPC number. In the EPC system, each broom would have a unique ID number, which facilitates item-level tracking. Unique identification is also useful for traceability, returns authorization and processing, warranty and service management and more.

EPC specifications differ in operating frequencies, tag functionality, and communications protocols. For pilot tests, the world’s leading retailer is permitting its suppliers to use the UHF band (860-930 MHz) versions of either EPC Class 0 or Class 1 tags. Class 0 is a read-only tag that operates in the 860-930 frequency band. Class 1 tags can be written to once after being programmed in the factory, but operates in the same frequency band as Class 0.

There are different versions (also known as “generations”) of EPC specifications in addition to the different classes. When this paper was drafted in January 2004, neither the world’s leading retailer nor the DoD had publicly committed to a specific EPC class and version for its initiatives, in part because the specifications continue to evolve. The world’s leading retailer has clearly stated it plans to use UHF EPC-compatible systems. Each organization is expected to announce its final requirements around the summer of 2004.

Specifications, standards, and terminology are continually being updated. To ensure compliance with customer requirements, consider the compliance specifications and other program documentation provided by your customer as the most authoritative guideline.

In addition to meeting customer requirements, RFID systems must comply with all relevant regulatory requirements. Governments regulate allowable frequencies, power output, emissions, and other performance characteristics. RFID regulation falls under the authority of the Federal Communications Commission (FCC) in the U.S. and various other bodies around the world.

RFID standards created by the International Organization for Standardization (ISO) in Geneva meet all worldwide regulatory requirements, so users can be assured their systems are available for worldwide use. However, RFID compliance requirements set by individual companies may not comply with ISO standards and may not be suitable for use worldwide. The ISO 18000 series of standards is being considered for many supply chain and compliance tagging systems. ISO 18000-Part 6 has already been ratified as a standard for RFID in the 860-930 MHz band. Numerous other ISO RFID standards for RFID have been ratified—with the 18000 series being most appropriate for item identification-type applications. Still more standards are coming close to final ratification.





EPC specifications are now in the process of being turned into standards, through due process, under the auspices of EPCglobal, which is a joint venture of EAN and the UCC. The EAN and UCC are committed to open, user-driven standards development processes, and jointly manage the EAN.UCC system for global commerce, which includes the UPC/EAN bar codes used on consumer goods around the world. As such, EPCglobal is ideally positioned and equipped to commercialize and standardize the EPC technical specifications, data structures, usage guidelines and continued development.

In summary, standards is a complex and rapidly changing area. Zebra, through our active participation in standards development activities, including EPCglobal, seeks to demystify the maze of standardization initiatives and always support appropriate standards with our comprehensive range of smart labeling solutions.

What Changes to the Information Systems Infrastructure Are Required to Use RFID?

RFID should change more than the way data is collected, it should provide new types of actionable information that create opportunities to do things differently and more efficiently. RFID can provide visibility into operations that were previously inaccessible because of limitations to bar code and other data collection technologies. Organizations can take advantage of ability to track items in more places, without human intervention, to create new features and applications. These capabilities are new, so software applications will need to be modified or developed to take advantage of them, and the IT infrastructure may need to be extended to support RFID operations.

RFID readers can automatically detect and identify all the tags in their reading field, which can potentially produce hundreds of readings per second. Each reading represents a data point that the enterprise information system may need to process. Hence identification data and ID event-related data (such as time, and location) will need to be collated and filtered using flexible rules, prior to being pushed to a business application, or submitted in response to a request for data. Otherwise, the RFID system could produce too much data and not enough quality information.

Middleware has been developed specifically to support RFID systems to filter data for legacy information systems and software applications. Some leading enterprise resource planning (ERP) and warehouse management system (WMS) software providers also offer middleware or software modules to support RFID use with their applications. Labeling software may also need to be modified, as discussed in the following section.

What Changes to Labeling and Packaging Processes Are Required to Meet Tagging Requirements?

Smart labels can be applied to meet most current compliance tagging requirements. Smart labels are a convenient option because they can be produced on demand and a single smart label can meet RFID, bar code and text marking requirements. However, there is more to compliance tagging than printing a new kind of shipping label. Successfully satisfying compliance tagging mandates requires planning for tag encoding, RFID media selection, label placement and software changes.

A smart label printer/encoder programs the RFID tag embedded in a smart label effectively at the same time the label is printed. This extends the flexibility of on-demand printing to meet encoding needs. Variable information,





such as order numbers, manifest information for mixed-load pallet labels, and Advance Ship Notice (ASN) data, can be conveniently encoded and printed on demand with smart label printers. Thermal printers are used for smart labeling. Thermal printers are available as traditional label printers or print engines for use with automated applicators to integrate into a variety of packaging and shipment labeling processes. Labeling software will need to be added or modified to support smart labeling and RFID encoding.

Most smart label printers use rolls of media with RFID inlays in the label stock, which requires the media to be changed each time printing operations switch between smart label and traditional printing. Zebra's Alchemy™ technology enables a single print station to produce smart labels and traditional labels on the fly without media changes, alternating as needed, under software control. Instead of using pre-converted smart label media, Alchemy bonds the RFID inlay to the label material only when smart labels are needed. So, if traditional shipping labels are needed for cartons being loaded on a pallet, and the pallet needs to be identified with RFID, an Alchemy station could produce all the necessary labels without requiring operators to change media or use two separate printers.

Compliance tagging may cause suppliers to change where they place labels on the package, carton or pallet. RFID is a radio technology and is subject to signal disturbance, particularly from metals, which reflect signals, and liquids, which absorb them. Placing labels on different areas of the pallet or carton can impact reading performance. Tag size, frequency, orientation and placement location all affect reading performance and may need to be adjusted for marking different types of objects.

Organizations may need to use several types of smart label media for identifying different objects or to meet incompatible compliance specifications from different customers. In this situation, it is important that printers can support all the required media and that procedures are established to prevent different smart label media from being used interchangeably.

Processes must also be established to prevent unreadable or erroneous smart labels from being applied to shipments. Smart labels occasionally aren't readable because of defective components or damage sustained during handling, and sometimes encoded information is incomplete or inaccurate. These problems are usually undetectable unless the tag is read after printing to validate readability and content. If problems are detected, processes must be in place to divert the label and prevent further output until the problem is resolved.

What Kind of Pre-deployment Testing Is Required?

Pilot projects and pre-deployment testing should uncover any interference, quality, or performance problems that need to be resolved before the system is deployed. As with any labeling system, the media and adhesive must withstand all the environmental and usage conditions the label will be exposed to throughout the supply chain. It is crucial to test all the different items that will be labeled under as many conditions as possible to ensure proper performance.

In addition to the conditions to be tested for as discussed above, a series of large-scale test runs should be conducted to determine if the smart labeling system can keep up with labeling volume requirements during normal and peak conditions. Smart labels take a little longer to produce than non-RFID shipping labels, and in a high-speed, automated labeling environment, this must be taken into account to ensure adequate throughput capacity.



More extensive functional testing may be required if RFID will be used for internal operations. Interference is the main concern; an experienced RFID solutions provider can provide an assessment of potential interference and suggest remedies. The assessment is similar to the site survey that is conducted before wireless LANs are installed. Interference can be avoided or mitigated 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 scope defined by the application requirements. Don't forget, if the driver for using RFID for internal applications is an externally generated labeling or tagging compliance directive, then certain choices that you would otherwise have been free to make will have already been determined.

With RFID, you probably can't test too much. There are many variables to test and contingencies to plan for. Dead spots where no reading is possible may mysteriously appear in a warehouse one day and disappear the next because different materials are on the shelves on which tagged products sit. Testing may not reveal every hurdle, but thorough planning can overcome them.

C o n c l u s i o n

Implementing an RFID compliance tagging system may seem daunting, but is quite manageable once you have a clear understanding of requirements and options. The topics presented here provide an excellent starting point from which you can begin to identify areas for further investigation and develop specific questions to advance your project. Maintaining consistent communication with customers, supply chain partners, technology providers and internal departments effected by the changes, and allowing ample time for system testing and refinement, will go a long way to making the project successful.

Zebra Technologies is a worldwide leading manufacturer of thermal on-demand bar code printers and RFID smart label compliance solutions. Zebra introduced the first combination bar code and RFID label printer/encoders to the market and has been extremely involved in global pilot programs ever since. Serving more than 90 percent of the Fortune 500, Zebra is working with many of its top retail customers and with the U.S. Department of Defense to help them evaluate the best blend of bar code and RFID solution to meet their business improvement objectives and supply chain RFID compliance requirements. Learn more about Zebra's RFID capabilities at www.rfid.zebra.com.



Notes



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