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RFID IN A NUTSHELL

RFID tags in a nutshell? Is that really possible? Not now, but maybe next year! RFID tags are going in and on everything from pharmaceuticals, to toys, keychains, season tickets, clothes, and even on kids. This growth represents a tenfold increase of where we are in 2004. One of the primary drivers of RFID this year is the push from Wal-Mart that requires its top suppliers to include RFID tagging on shipments by January 2005. The real question is how this technology will be deployed by different businesses. Everyone is talking about RFID, an industry poised to grow from infancy to a \$1.3 billion market by 2008.

What is RFID?

RFID stands for **radio frequency identification**, a technology that has been used for many years in inventory tracking and secure access applications. More recently, RFID technology has been a major thrust in the tag and label industry, as small labels and tags include RFID transponder inlays that, unlike bar codes, allow users to read without line of sight. This membrane-thin inlay can also identify multiple articles simultaneously. In addition, it offers read/write capabilities so users can update information.

A typical RFID label construction is shown in Figure 1. (view the image: http://www.dmia.org/sol_center/bptr/04sep30_bptr.html) The inlay is one additional layer in a typical pressure sensitive label construction. In the label or tag manufacturing process, the inlay is laminated between layers to become part of the label or tag. Inlays can be incorporated into existing stickers, labels, tickets or badges. Anywhere a pressure sensitive label can be placed, an inlay can be placed. Whether it is part of the packaging or part of the product, an RFID label can be embedded and hidden from sight.

Are you Using RFID?

RFID applications are all around us. MobilExxon Speedpass™ users carry an RFID transponder inside a key tag. Some high-end vehicles like Cadillac and Infiniti use an RFID transponder embedded in the ignition key that knows when the key is near the car, unlocking or locking the doors based on the proximity of the actual ignition key. Many big city marathon races use RFID tags to track the progress of each runner. In this application, the runner wears an RFID tag on their shoelaces that can be read at specific points in a race.

How RFID Works

At its most basic level, RFID is a wireless link used to uniquely identify objects. RFID systems use electronic devices called transponders or tags, and readers to communicate. These systems communicate via radio signals that carry data either unidirectionally or bidirectionally. When a transponder enters a read zone, data is captured by the reader and then transferred through standard interfaces to a host computer for storage or action. Once a link is established with a unique ID on an item, the automation process begins.

For example, consider the application of sorting boxes on a conveyor. At specific read points in the system, boxes are identified by location. A central monitor can immediately display this information. It is real-time information that can be shared with the manufacturer, with forwarders, and with the customer waiting for the shipment. The shipment can be automatically directed to the appropriate dock door, truck, carrier, etc. The shipment can be redirected while in transit if plans change, all without human intervention. This puts real time decision-making power into the hands of many functional areas up and down the supply chain. Having this vital information readily available enables management to respond rapidly to changing patterns of demand, and allows a company to provide superior service to customers.

What's on the Inside?

At the core of an RFID tag or label is a transponder inlay that is inserted between layers, usually in a pressure sensitive construction. The inlays, which are batteryless, are specifically designed to be converted into tag and label applications by a label manufacturer. As shown in Figure 2, (Open this issue in your browser to view the image: http://www.dmia.org/sol_center/bptr/04sep30_bptr.html) the inlay consists of two primary parts, the RFID silicon chip, and an antenna that circles the perimeter of the inlay. Inlays can be placed on a polymer tape substrate and

delivered in reels to the manufacturer, who in turn converts the inlays into usable RFID labels. Another technology is being used that prints the circuit and antennae, and does not use a pre-made inlay. With this technology, the label converter prints the antennae portion with special ink, and then attaches the RFID silicon wafer to the printed antenna. By printing the integrated circuit and antennae, the cost of the actual label drops significantly.

The premade inlays are more costly and require the added step of inserting them into the label. Obviously, printing the inlay in one production pass is quicker and more efficient, but the printed antennae do not have the high read rates enjoyed by the premade inlays. High read rates are critical for applications that require a 100% read rate.

Writing Data

Many applications of RFID labels include thermal direct or thermal transfer human-readable printing and bar codes on the face of the label. Therefore, the logical place for data to be written to RFID labels is at the bar code printer. Printer vendors such as Zebra technologies, Datamax, and Intermec have developed RFID writers that are built into their printers. Shown in Figure 3 (Open this issue in your browser to view the image: http://www.dmia.org/sol_center/bptr/04sep30_bptr.html) is a Zebra printer imaging and writing data to RFID labels. As the human readable data gets placed on the label, so does the electronic data. This "programming" of the label is based on the input at the user level.

The Wal-Mart Mandate

The RFID environment changed dramatically in June 2003 when Wal-Mart announced that it would require its top 100 suppliers to place RFID tags on shipping cartons and pallets by January 1, 2005. More recently, Wal-Mart announced that it is expanding its RFID efforts to 200 of its next-largest suppliers. This second group of suppliers must have their RFID tagging in place by January 1, 2006. In Wal-Mart's case, each RFID tag will store the electronic product code (EPC) for the items in the carton, automatically updating inventory in Wal-Mart's database. The RFID tag will be used to track products as they enter Wal-Mart's primary distribution centers and then as they are shipped to individual stores.

Keep in mind that the Wal-Mart mandate applies to shipping cartons of items, not the individual items going into the stores. The push is a big one for the automatic data capture industry, and only time will tell if the suppliers are up to the challenge of keeping Wal-Mart's inventory system happy in 2005.

Primary Issues Facing the Industry

The primary issue barring widespread adoption of RFID is the actual cost of the disposable tags. In 2003, the range of prices for tags was still as high as 50 to 90 cents. The RFID industry has long claimed that the critical price for widespread adoption is the five-cent tag. But a recent study from RFID research firm Arc Advisory Group predicts the price of RFID tags will only drop to a low of 16 cents by 2008, despite other industry estimates that the cost will reach the five cent mark in the next four years.

The manufacturing process and cost of materials continue to be the culprits driving prices so high. The ARC report specifically points to tag creation as the barrier to massive implementation and the illusive five-cent tag. There is no doubt that this technology will advance significantly over the next few years, however, its implementation depends on who can manufacture tags most efficiently and effectively. The challenge for label and tag converters is to make huge strides in production. The effectiveness must improve significantly over the next five years for companies to remain in this market.

Some experts believe that in order to get to the five-cent label, the printed antenna is a must. Today, premade inlays typically can cost 50 cents per piece, so an order for a million tags can quickly add up to major dollars. Costs are on a downward trend, but production and quality issues must be resolved to force prices down even further. Whatever the case, look for ongoing developments and advances with RFID inlay printing in the near future.

Applications for RFID

Applications for RFID continue to evolve and new ones are being created every day. The following is a summary of some interesting ones that are now being used.

Whose shirt is that?

Grantex Inc., Grand Rapids Michigan, is a large uniform supply company that uses RFID by sewing tags into rental uniforms. These RFID tags help Grantex track and sort thousands of uniforms. Not only can the RFID tag help sort clients' laundry, but it can also keep track of the number of times the garment has been laundered, or repaired, and when it should be pulled and replaced. For Grantex, RFID has helped them reduce sorting time, improve efficiency and capacity, and decrease their labor costs.

Despite concerns that the chips could be used to track the person wearing the uniform, the garments cannot be tracked outside of the Grantex laundry facility.

What happened to my tickets?

Season ticket holders in Europe are witnessing the evolution of their paper ticket into a plastic card with a contactless RFID chip embedded. In Holland, over a dozen professional teams have signed up to use a contactless smart card system. The cards are used for ticketing, concessions, and access control.

Smart Documents

The best examples of Smart Documents are identification documents such as passports, drivers' licenses, and employee badges for secure access.

In the case of a passport, embedding an RFID transponder into the passport as it is being assembled creates the smart document. The RFID inlay would be laminated inside the cover, causing the transponder to become an integral part of the document. The transponder contains all the specific information about the owner of the document, including photo, vital statistics, passport number, nationality, and last departure. The reading device for the smart document would be positioned at each passport control desk in every international airport. As the passport is passed to an agent in passport control, the RFID comes in proximity of the reader, and supplies data to the agent on their computer screen. The RFID automatically populates data fields so the agent has to key nothing. The data is stored to create a record of each person coming through passport control that day. The smart document's added protection is that the data on the transponder is encrypted and cannot be changed.

Other smart documents include drivers' licenses and employee badges. Both can be used in applications that require automatic fill-in of information.

On the Bus

Every weekday in the U.S., 440,000 school buses transport 24 million school children to and from school. Companies are using RFID to track students as they get on and off buses, allowing parents and administrators to track the whereabouts of children via the Internet. The system combines the use of RFID with GPS, which is already built into most school buses.

Finding a Lost Child

To alleviate the problem of lost children, some theme parks are adopting RFID tags that can be used to quickly locate a family member. Paramount theme parks have a program that allows each member of the family or group to wear RFID tags. The users can track whereabouts of the other group members at kiosks located throughout the park. In the event of a lost child, park security can assist in quickly finding the lost child. In the Star Watch system, antennae are located around the park to help locate others in your party. Legoland has a similar system.

Finding your Ball

Called Radar Golf, one California company is marketing a system where special RFID embedded golf balls are used in conjunction with a device that tells the proximity of the ball as the golfer approaches it. The RFID embedded golf balls are approved by the United States Golf Association, but the proximity device is not allowed in tournament play as it could be used to calculate accurate distances.

Where's My Car?

Car dealers across the US are looking at RFID systems to track inventory. A simple RFID chip can be used to track an entire fleet of cars, telling administrators where their entire inventory is located in real time. Car manufacturers are also implementing RFID to assist in tracking the vehicles as they leave the manufacturing plant and arrive at distribution centers.

Tracking Cattle

The South Dakota Animal Industry Board is developing a cattle-tracking system that includes ear tags for cattle. The tags will track the complete cattle cycle from birth to packing plant. The tags will tell when and where each animal was born and raised, transfers to other owners, and packing plant information.

The Rubber Meets the Road

The tire industry is looking at embedding RFID tags in car tires. Wanting to comply with The Transportation, Recall Enhancement, Accountability and Documentation Act, known as TREAD, many tire manufacturers are looking at RFID to assist in complying with the law. The Act requires manufacturers to report defects in motor vehicles, tires or other motor vehicle equipment. In this application, RFID tags will allow a tire to be tracked from manufacturing to disposal, and prevent rejected tires from being sold as new. After the tire industry witnessed the Ford Explorer/Firestone Tire problems, tire makers see RFID as a turnkey solution to tracking inventory after it leaves the manufacturing plant.

InFlowTech and RFID

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