RFID: Beyond the Supply Chain

An examination of the potential of RFID in industrial automation, process control, and manufacturing.

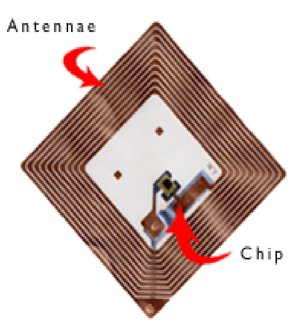
Radio Frequency Identification (RFID) technology is commonly considered for asset identification and tracking-type applications. These are customary and effective uses of this technology, yet potential also exists for increasing the use of RFID in process control, discrete manufacturing, utility operations, and many other industrial settings.

Like any other technology, RFID cannot exist in a vacuum. To be effectively utilized for any application—retail or industrial—an RFID system must communicate and work effectively with other hardware devices and software systems. As we examine this, let's start by reviewing what RFID is and how it works.

RFID Primer

Radio Frequency Identification is a technology where data is transmitted via radio waves on the electromagnetic spectrum. An RFID system consists of a radio frequency transceiver which both transmits and receives signals, and a miniature transponder in the form of an RFID "tag" that houses an antenna for receiving signals and a tiny chip containing the RF circuitry and the information to be transmitted.

RFID has many similarities with the barcode technology now found in nearly every retail outlet. However, a key difference is that RFID eliminates the need for scanners and line-of-sight reading that barcode technology relies on. Furthermore, RFID communication can potentially take place at a range of more than 90 ft. (27.4 m), a far greater distance than barcode technology supports.



A typical RFID tag.

RFID technology was first used in aircraft during World War II.

RFID is far from being a new technology. It was first developed during World War II as a way to distinguish friendly aircraft from that of the enemy. Allied planes were outfitted with a small transponder that would reply to an interrogating signal with an identifying response. In the sixties and seventies, RFID-based solutions were explored as a way to address security and safety concerns in the transport and use of nuclear materials. At the same time, RFID was experimented with in everything from access control to livestock tracking.

How RFID is Used Today

Today, RFID systems are most commonly used in applications for asset identification, tracking, and management. Data within an individual RFID tag identifies the asset and provides information such as the owner or manufacturer, intended destination, current location, serial number, and shipping and handling instructions. These types of applications typically use what are called "passive" RFID tags. In more sophisticated applications, more detailed data such as assembly instructions can be included in an "active" RFID tag. For example, an RFID tag in an automotive plant can specify the paint color for a car body as it enters a paint spray area on the production line.

RFID: Beyond the Supply Chain

RFID is also frequently used for identification purposes in toll payment and access control applications. In these settings, an RFID tag identifies a vehicle as it approaches a toll plaza or security gate and sends a signal to a lane controller or automated lock so that the vehicle can pass through unimpeded.

In short, by implementing RFID— a complete system of transceivers and tags—one can achieve visibility to any asset within the RF range. This visibility creates all types of monitoring and data acquisition capabilities, and the gathered data can be aggregated and used in innumerable ways. But perhaps more intriguing is the possibility—if RFID systems are cleverly integrated with an organization's line of business equipment—for that equipment to act almost independently on the information it receives via RFID. Once again, however, this is all contingent upon the RFID system's ability to successfully integrate with the other hardware and software systems found in the environment in which the RFID system is deployed. In industrial automation environments, these systems include devices like programmable logic controllers (PLCs), input/output (I/O) systems, and programmable automation controllers (PACs).

RFID tags are most commonly used to track consumer products.

Why RFID is so Popular

As mentioned, RFID has been around since the forties. So why is it just now being so widely heralded? Why did Walmart, the largest retailer in the United States mandate that suppliers use RFID technology to improve its inventory management operations? Why is the Social Security Administration using RFID to supplement (and in some cases replace) the handheld barcode scanning system it's been using for data acquisition in its warehouse management operations? And why is RFID now being used in industrial and manufacturing settings more than ever before?

There are several reasons. For one, RFID technology is relatively cheap and incredibly versatile. The small size and low cost of RFID tags, in particular, continue to drive the expense of RFID systems sharply downward. Additionally, though the RF environment can be adversely affected by moisture, weather, radiation, and other interference, it remains relatively reliable and uncomplicated as a communications medium. As we shall see, these two factors—low cost and simplicity—are what make RFID just as viable for identifying a lost pet as it is for classifying parts on an assembly line.

But perhaps the most important reason for the increasingly broad acceptance of RFID technology—particularly in the industrial automation sector—is standardization. This standardization includes the frequencies that RFID systems operate over, as well as the codes and protocols they are able to recognize and utilize. For example, the electronic product code (EPC)—which evolved from the UPC (Universal Product Code)— has now become the de facto standard for retailers. Moreover, significant progress continues to take place towards integrating EPC and ISO standards.

This standardization is what will continue to make RFID a popular and effective technology and much more viable for solutions in industrial applications. For example, there are many manufacturing applications where barcode systems help move products down an assembly line. At each successive stage of production, a barcode reader reads a serial label, and that information is sent to a computer that determines what the next step of assembly is. By comparison, RFID is able to facilitate this type of data collection and delivery much more effectively. In many instances, RFID systems' antenna-to-tag communication method is superior to that of barcodes, which utilize an interrogating beam of light that needs to be physically manipulated to pass over the linear barcode. Not only does RFID eliminate this need for line of sight, it's also capable of reading multiple tags simultaneously, as well as selected tags based on a query requesting certain criteria.

The Value of RFID

Until recently, the main value of RFID was in its ability to facilitate the transfer and sharing of the information it helps gather, which, in turn, can improve a number of business processes. Information has always been the single most important business driver. The more that's known about what's taking place at every level of the business, the better. The ability to access, aggregate, evaluate, and collate the right data can, among other things, tell you which business decisions need to be made in order to optimize manufacturing processes, manage inventory, staff properly, and streamline supply chain activities. It is for these reasons that businesses most often deploy RFID-based solutions. RFID provides the information needed to make properly informed decisions that positively impact the business. The ability and ease with which RFID aggregates and communicates data makes it a most effective means to feed today's supply chain management and other business management systems. This is why Walmart undertook its well-known RFID project or initiative which required its top one hundred suppliers (including companies like Gillette, Hewlett-Packard, Johnson & Johnson, and Kraft) to use RFID tagging on the cases and pallets they ship.

Beyond the Supply Chain

To move beyond asset management/inventory tracking/supply chain-type applications and fully prove its worth in industrial environments, RFID needs to work with the host of sensors, PLCs, I/O systems and controllers, wired and wireless data networks, protocols, and software packages utilized in these settings. Imagine the possibilities of being able to associate the data contained in an RFID tag with that relating to the sensor and actuator interfaces of an I/O system or other industrial device. The key to accomplishing this is finding a way for these industrial devices to communicate with the RFID system's reader/transceiver. Towards that end, many RFID companies have moved beyond USB and Bluetooth connectivity and now include Ethernet ports on the reader/transceivers they manufacture. Intermec (www.intermec.com), Alien Technology (www.alientechnology.com), and Symbol Technologies (www.symbol.com) are just a few that offer hardware of this type. This Ethernet connectivity means a great deal because it makes communicating RFID data to enterprise applications and databases running on PCs incredibly simple. Similarly, Ethernet-based controllers and I/O systems are able to provide these same PCs with important data relating to manufacturing machinery, utility equipment, and the like.

RFID technology can be used with PACs, PLCs, and I/O systems to improve manufacturing operations.

Let's examine this point a bit more closely. Over the last decade, Ethernet networking has grown increasingly popular as a communications medium for industrial applications, largely due to the fact that Ethernet has the ability to reach beyond the plant floor. Indeed, Ethernet is already entrenched as the standard in most corporate business settings, that is, most corporations' entire networking infrastructures are Ethernet-based. Significantly, any industrial controllers, I/O systems, data acquisition systems, or other devices with Ethernet connectivity can be recognized and function on these networks. Suddenly, thanks to the Ethernet networking interface, you now have the ability to access the controllers operating the systems and equipment on your plant floor, and send and receive production data, alarm messages, and status information over that network to any database running on any computer or server. This is commonly referred to as PC-based control and data acquisition.

So what we potentially have now in industrial settings is an RFID tag communicating to RFID readers/transceivers, which send the data to a computer. We also have industrial equipment (manufacturing systems, utility systems, etc.) controlled and monitored by and communicating with industrial controllers, I/O, and data acquisition systems, which in turn communicate data to computers. What's missing? Answer: the *direct* link from the RFID system to the industrial device. There is great value in establishing this connection.

RFID tags attach to automobile parts coming down an assembly line. The tag is read by a transceiver, which communicates with IO systems and PLCs controlling a robotic arm.

For example, RFID tags can include data and instructions for a controller, I/O system, or some other device to execute. In scenarios such as these, a connection is established where machines "talk" to one another and act independently—without a human interface. So, for instance, if an RFID tag contains information pertaining to a particular manufacturing or operational process, the RFID reader can read the tag, and an I/O system can poll the reader, get the information, and give the appropriate commands to the manufacturing or operational equipment it's controlling.

Here's an example: an RFID tag is attached to an individual part coming down an assembly line. The tag identifies the part, distinguishes it from similar parts, and provides specific instructions relating to the next stage of assembly—torque specifications, let's say. The RFID reader gets this information from the tag and an I/O system, PLC or other intelligent device polls the reader. This intelligent device then executes the necessary logic and gives the appropriate instructions to the manufacturing equipment it's controlling—in our example, a robotic screwdriver receives the correct torque settings and applies them to the part.

RFID in the Real World

The Sao Paulo, Brazil-based company Flextronics (www.flextronics.com) designs, builds, and ships consumer electronic, computing, medical, automotive and other products to a worldwide list of OEM customers. These customers include Motorola, Dell, Microsoft, Xerox, and Hewlett-Packard Company, who often just provide the packaging for products actually built by Flextronics. For example, most consumers assume that HP makes and ships its well-known line of printers itself. In reality, all printer components are collected and assembled by Flextronics and then shipped to HP retailers.

This being the case, Flextronics has had to implement RFID in its warehousing and shipping operations. (This is no doubt due in part to the mandates of Flextronics' OEM customers, who, in turn, have had to respond to the earlier mentioned RFID requirements of Walmart and other large retailers.) But a major difference between Flextronics and many other enterprises is that RFID plays a major role in the company's assembly processes. All printer housings include an RFID tag, manufactured by UPM Rafsec

Hewlett-Packard all-in-one printers.

(www.rafsec.com), containing basic information about the printer—product ID, original manufacturing date, etc. As the printer moves down Flextronics' assembly lines, the various components (cartridges, paper trays, rollers, etc.) are installed in the printer housing.

After each component or procedure is completed, the RFID transceiver adds data to the RFID tag indicating that a component, adjustment or test has taken place. At four different stages of the assembly process (the last of which is the product's final testing prior to shipping) an RFID reader reads the tag and sends the data over Ethernet to an Opto 22 SNAP industrial control system.

The Opto 22 system contains an intelligent industrial controller that uses sensor interfaces to connect to and communicate with a number of mechanical and electronic controls and systems on Flextronics' printer assembly line. After receiving the tag data indicating that a component has been properly installed or a line test successfully completed, the SNAP system validates the printer by sending commands to conveyors and other systems that send the printer down the assembly line to the next stage. If the tag data received by the SNAP system indicates that a part is missing or a test was failed or never conducted, the SNAP system routes the printer back to start the assembly process over again. If a severe problem exists, the SNAP system is programmed to reject the printer entirely and send the commands to convey the printer to an area designated for defectives.

Other Uses for RFID

So far, we have described two scenarios where RFID can be extended beyond uses in the supply chain, warehousing, and asset tracking and facilitate manufacturing and industrial automation processes more directly. Now let's examine one other way in which RFID can be implemented in the factory—in the area of validation and regulatory compliance reporting.

Many industries—oil and gas, pharmaceutical, automotive, and others—have strict requirements and guidelines (some self-imposed, others federally mandated) applicable to their manufacturing and processing operations. The FDA, for example, requires pharmaceutical manufacturers to maintain unalterable electronic records to prove that drugs and the raw ingredients used to make them have been stored at proper temperatures. This means that refrigeration system temperatures have to be constantly monitored and recorded in some sort of database. An easy way to accomplish this would be to affix a smart RFID to a lot of drugs (or ingredients) and integrate that tag with whatever industrial I/O system or device is being used to monitor the refrigerators.

With relatively simple configuration, the monitoring system can be programmed to acquire the data and communicate it to the RFID system. The RFID system can then write these temperature readings to the RFID tags affixed to each individual lot as it sits in the very refrigerator, warehouse, or storeroom that's being monitored. And once again, the physical medium enabling this communication is Ethernet. The RFID tag can carry this temperature data with it all the way through the supply chain and, in the event of an FDA audit or product recall, lot numbers can be quickly tracked to verified storage temperatures.

It is these kinds of scenarios—ones where industrial automation, control, and data acquisition systems seamlessly integrate with RFID systems, reading and writing to tags automatically—that offer the brightest hope for RFID to become a truly widespread technology. It's important to note that we already have the supporting infrastructure to accomplish this. We have the devices (I/O systems, PLCs, PACs, and the like) to make the necessary sensor-actuator connections. We have the communication protocols and industrial networks we need to make these new types of RFID applications a reality. All we need now are individuals throughout the organization—from C-level executives down to plant managers and operators—with the vision to recognize the value of RFID and the fact that it can function as more than an asset-tracking technology. It can, in fact complement all types of control and data acquisition systems and, with its unique features and capabilities, it's ideally suited for integration into new and existing industrial applications.

About Opto 22

Opto 22 develops and manufactures hardware and software for applications involving industrial automation and control, energy management, remote monitoring, and data acquisition. Opto 22 products use standard, commercially available networking and computer technologies; have an established reputation worldwide for ease-of-use, innovation, quality, and reliability; and are designed and made in the U.S.A. Opto 22 products are used by automation end-users, OEMs, and information technology and operations personnel in over 10,000 installations worldwide. The company was founded in 1974 and is privately held in Temecula, California, USA. Opto 22 products are available through a global network of distributors and system integrators. For more information, contact Opto 22 headquarters at +1-951-695-3000 or visit www.opto22.com.

Opto 22 • 43044 Business Park Drive • Temecula, CA 92590-3614 • www.opto22.com
SALES 800-321-6786 • 951-695-3000 • FAX 951-695-3095 • sales@opto22.com • SUPPORT 800-835-6786 • 951-695-3080 • FAX 951-695-3017 • support@opto22.com