Understanding RFID

Automated ID is the technology of the future.

by ***Meghan Soderstrom***

Automation is driving the speed of commerce. Just think of your opportunities to use online banking, self-checkout at the grocery store or cellular phone-based Web browsing to purchase items. Automation increases efficiency, reduces data entry errors and allows you to devote time to other activities that add value to your life.

It seems automation's next mainstream use will be identification (ID). Radio frequency ID (RFID), a form of automated ID, has long been the tracking and ID technology of choice for the military. Now, it's making headway in the livestock industry and may be of particular value to cattle producers.

CWG recommendations

In July 2004, the Cattle Working Group (CWG) submitted its final report on the National Animal Identification System (NAIS) — a system that will individually identify each animal, track its movement through the supply chain and achieve 48-hour traceback should a disease outbreak occur. Under the NAIS, each animal will be identified with a 12-digit animal ID number (AIN). Each premises in the supply chain will be identified with a seven-character alpha-numeric premises ID number.

According to the final report, "The Cattle Working Group fully endorses the utilization of ISO-compliant RFID ear tags as the standard for implementing the NAIS in the U.S. cattle industry. CWG considers RFID ear tags to be the most practical technology today to automate the collection of individual animal identification for cattle."

CWG recommends the RFID tags be ISO 11784- and 11785-compliant, accompanied by a visual tag with the AIN printed on it, tamper-evident to preserve the integrity of the stored data, and able to meet the suggested performance standards. Also, Neil Hammerschmidt, NAIS coordinator, says the U.S. shield and manufacturer's logo now must be printed and engraved on the tag.

The CWG recommends the RFID tags be placed in cattle's left ear.

But, RFID involves more than using a special tag — typically, it's a four-part system including the tag, a reader, a computer and software. And, of course, there are many factors to consider.

The equipment

Dale Blasi, manager and director of Kansas State University's (K-State's) Beef Stocker Unit and Animal Identification Knowledge Laboratory, has been testing ID equipment since 1998. At the 2005 ID/Info Expo, he explained that, unlike bar codes or retinal imaging, RFID does not require line-of-sight to identify objects and communicate data about them. Instead, radio waves can retrieve and transmit information while penetrating solid objects.

Radio waves are the longest waves in the electromagnetic spectrum, he explains. Their frequency ranges from 100 kilohertz (kHz) to 10 gigahertz (GHz), with most tags registering at 134 kHz. Higher-frequency tags can often be read from longer distances and can store and transmit more data.

In July 2005, the U.S. Department of Agriculture (USDA) released a technical supplement to the NAIS Draft Program Standards. The technical supplement describes the components of an automated ID system and the technology behind them.

The RFID tag is called a transponder, and its reader is called a transceiver, the supplement explains. The transponder stores a serial number (in this case, the AIN) on a microchip that is attached to an antenna. The antenna enables the chip to transmit the ID information to the transceiver. Most commonly, the RFID tag is a button-type tag, and the accompanying visual ID tag looks like a traditional hanging tag.

Transceivers can be stationary or portable. The most common types exhibited at the ID/Info Expo trade show and used in RFID pilot projects are portable handheld wands or stationary mounted panels. After the transceiver reads the data, it has to be stored, which is where computers and software come in.

The transceiver converts the radio waves reflected from the transponder into digital information that can then be passed on to a computer for data storage and management, explains the *RFID Journal* Web site (*www.rfidjournal.com/faq*). Transceivers displayed at the trade show offer a variety of methods to transfer data. Some devices use wireless technology to transfer data to a remote base station or a personal digital assistant (PDA), which can then be downloaded on a home computer. Others have built-in Ethernet to automatically transfer data, while still others rely on USB ports. Of course, their prices vary widely depending on their capabilities.

Many companies at the trade show offered data management and reporting services, in addition to RFID tags and readers. The list of ID/Info Expo Trade Show exhibitors is available at *www.animalagriculture.org/id/idinfoexpo2005.*

ISO compliance

Although many manufacturers offer RFID tags for cattle, only those that are ISO 11784- and 11785-compliant will meet the NAIS requirements, according to USDA's technical supplement.

ISO is an international nongovernmental, nonprofit network of the national standards institutes of 156 countries. It sets international standards that provide a common technological language between suppliers and their customers, which facilitates trade and the transfer of technology. Although ISO sets standards, it does not enforce compliance, nor does it measure ISO-compliant products' performance, Blasi explains.

Officially called the International Organization for Standardization, the network's Web site (*www.iso.org*) explains that it gets its name from the Greek word "isos," meaning "equal." ISO is used in all countries to avoid different abbreviations in different languages.

ISO 11784 defines code structure for the data stored on the transponder. USDA's technical supplement explains that the code structure is defined by sequences of binary digits (0 and 1), called bits. Bit patterns store the three-digit country code (840 for the U.S.) and the national identification code (the 12-digit AIN). The 15-digit combination of country code and national ID code provides a unique worldwide ID number.

ISO 11785 defines the technical specifications of how the transceiver gathers data from the transponder, the supplement says. Communication between a transceiver

and a transponder can be either half-duplex (HDX) or full-duplex (FDX).

HDX vs. FDX

Data-gathering can be HDX or FDX. Blasi compares these different data transmission methods to a walkie-talkie and a telephone, respectively. HDX allows communication in only one direction at a time, like a walkie-talkie. This means the transceiver will send a signal to the transponder, the transponder will receive the signal, and then it will send a response signal to the transceiver. An HDX transponder sends only one response signal for each inquiry it receives from a transceiver.

FDX, on the other hand, permits simultaneous communication, like a telephone. Blasi says the transceiver and the transponder can be in constant communication, sending and receiving signals continuously. The transponder will send multiple response signals to the transceiver's inquiry.

Passive vs. active tags

Tag options vary depending on your needs and the limits of your pocketbook, Blasi explains. Active RFID tags have a battery, which broadcasts a signal to a reader similar to the way a cell phone transmits signals to a base station. Although battery life varies by manufacturer, it is generally limited to a few years. Active tags typically have a greater communication range and higher data-transmission rates. The internal battery increases the size of the tag and its price, he says.

Passive tags draw their power from the transceiver's energy since they do not have an internal battery, Blasi explains. When the transceiver sends radio waves to the transponder's antenna, it temporarily charges the tag so the antenna can respond. Passive tags are lighter and have virtually unlimited operational life. Their read range is more limited than active tags' range, but they are less expensive.

The cost of each tag can vary depending on its frequency, amount of memory, design of the antenna and packaging around the transponder, he notes.

Setting standards

The CWG recommends adhering to the durability and reliability standards established by the International Committee on Animal Records (ICAR). The animal identification subcommittee of ICAR evaluates the performance of conventional tagging and ID devices, and issues codes for approved manufacturers and devices. A list of manufacturers that signed ICAR's "Code of Conduct" as of October 2005 is available at *www.icar.org/manifacturer_code_of_conduct.htm.*

However, the CWG's final report states ICAR guidelines fall short of recommending standards for read rate and ranges. Instead, it recommends using a synthesis of international standards for read rate and range: Transponders must be reliably (99.5% success rate) machine-read in the field by a standardized dual HDX/FDX reader as cattle move by at a rate of 4 miles per hour (mph) in single file in a passage 48 inches (in.) wide.

CWG found that most recommendations for read ranges fell within 28 in. for stationary readers and 12 in. for handhelds, with at least a 95% read rate at 1 meter in an electromagnetic-interference neutral environment for all approved transponders.

Testing performance

Although manufacturers test their equipment and quantify its performance, consistency between tests is challenging because manufacturers have varying testing procedures, Blasi says.

"At the end of the day you need performance. There's some good stuff out there, and there's some stuff we've experienced that seems to be quite variable," he says in reference to the device testing he's done at K-State's Animal Identification Knowledge Laboratory.

He says factors affecting read range include power available to the transponder and transceiver, antenna characteristics and size, and competition from other devices emitting electrical signals.

Collision, also called anti-contention, occurs when two transponders compete for attention from the transceiver at the same time. As a result, data confusion may cause a misread or no read at all, he explains.

Frequency of the operation also influences performance. The *RFID Journal* generalizes device performance: Low-frequency tags are read from 1 foot (ft.) away or less, while high-frequency tags can read up to several feet or more. Active tags use batteries that can boost read ranges to hundreds of yards.

Environmental factors, such as extreme temperature, also challenge performance rates, Blasi adds.

The CWG recommends that an independent authority be established whose function is to serve as a national testing laboratory to which RFID equipment manufacturers would submit transponders and transceivers for evaluation. At press time, that authority had not been established.

Pilot test costs

Jim Akers, executive director of the Southeastern Livestock Network LLC, says panel-type readers are easiest to use, but are more expensive. "Current equipment allowed us to read tags at a rate of 92% to 99%," he says. "Equipment used for the pilot cost roughly $5,200 to equip one single-file alley at 32 inches wide."

Akers says handheld wands generally range in price from $500 to $1,500. He says hand reading at chute side is most accurate, but it is more labor intensive. If a tag is misread, cattle can be stopped and reread. Although this disrupts the market flow, "it may be a viable option for smaller operations," he notes.

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