

“Intelligent” fluid couplings communicate critical device and process data

By
Dennis Downs

Director of Business Development –
New Technologies
Colder Products Company

Like many other devices these days, some fluid connectors have gotten “smart.” Equipped with a control unit and RFID technology, intelligent quick disconnect coupling systems transmit information that can protect equipment, improve processes and even save lives in medical applications.

A select group of fluid connectors can now be found in the growing ranks of “intelligent” products. In addition to moving fluids, these high-tech connectors move data, thanks to the innovative use of wireless communication technology.

In medical settings, data-transferring intelligent fluid couplings can play many valuable roles. These include keeping track of device usage, and preventing connection errors that endanger both patients and expensive medical equipment. RFID-enabled couplings can also help protect brand integrity by ensuring the use of OEM-supplied devices and media. Though the technology is just starting to gain a foothold in the medical industry, its benefits could eventually help intelligent fluid couplings find a home in many types of medical devices and equipment.

RADIO FREQUENCY COMMUNICATION

To add intelligence to fluid couplings, two ingredients are necessary: a brain (such as

a PC or controller) to run the system and some means of wireless communication. In intelligent quick disconnect coupling systems, the wireless technology of choice is radio frequency identification, or RFID.

Intelligent couplings communicate by sending RFID signals between the two separated coupling halves attached to different devices or lines. Data is stored on an RFID tag embedded in the passive half of the coupling, known as the insert. Looking for the tag is an RFID reader housed in the active half of the coupling, called the body. When the two coupling halves are brought within a few centimeters of each other, the reader detects the tag, reads it, and sends the tag data to the control unit running the system. The control unit can also tell the reader to write new information to the tag.

Medical devices equipped with RFID technology can store and/or transfer important information such as product data (date of manufacture, batch/serial number, date/time put in service, number of uses remaining, etc.), auto-calibration parameters, media data (identification, amount remaining, expiration date), process cycle counts and notification of cycle completion. Electronic data capture and automatic documentation are faster and more efficient than manual processes, while also eliminating inaccuracies caused by human error.



MANY MEDICAL BENEFITS

RFID-equipped quick disconnect couplings perform many key functions that are beyond the capabilities of ordinary fluid connectors. As part of medical systems, they can:

- *Prevent connection errors in multiple-port systems.* Before a physical connection is actually made, the RFID reader reads the tag and tells the control unit what is being connected to each equipment port. If a misconnection is attempted, the control unit can display a warning, trigger an alarm or shut down the equipment until the error is corrected. Thus, the couplings ensure that each line will be connected to the correct port, preventing harm to patients, medical equipment and processes.

Consider, for example, an eye-surgery device with a saline line for eye irrigation and an air line that drives a pneumatic cutter. Used with this device, intelligent quick disconnect couplings will prevent patient and equipment harm that could be caused by misconnecting the saline and air lines.

- *Ensure correct operational settings.* Once the identification data on the tag has been read, the control unit automatically sets parameters such as pressure, flow rate and operating time to match requirements for the device that has been connected to the equipment port. With RFID tags in the cuffs of a blood pressure-monitoring system, for instance, the system automatically configures itself for either an adult or infant based on whether an adult- or infant-size cuff is connected to it. This eliminates the risk of human error in configuring the system, as well as the consequences of configuration errors for patients and equipment.
- *Enforce required limits on device usage.* The control unit can tell the reader to write to the tag attached to a limited-use device each time the device is connected to equipment. Or the reader can be told to write to a consumable device the amount of time the device has been used. When the threshold is reached in either case, the control unit reports to the operator that the connected device has reached the end of its life.



Data-transmitting fluid connectors include two parts: the coupling body (right), which houses an RFID reader, and the coupling insert (left), which houses an RFID tag. The reader can read and write information on the tag. Illustration depicts an IdentiQuik® non-spill coupling from CPC.

- *Make media checks.* Intelligent quick disconnect couplings can check to see if fluid used in a medical device is outdated or ensure that its parameters meet job specifications, thereby preventing accidental or intentional use of media that could harm patients or equipment. The couplings can also be used to check media amounts. When one machine performs a number of different tests, for example, an RFID tag can be attached to the line hooked up to the solution bottle for each test. As test doses from a bottle are used, the information is written to that bottle's tag, allowing the control unit to keep track of the number of additional tests that can be run with the solution quantity remaining in the bottle.
- *Monitor consumption of media.* RFID-enabled couplings can also be used to monitor media amounts. When one machine performs a number of different tests, for example, an RFID tag can be attached to the line hooked up to the solution bottle for each test. As test doses from a bottle are used, the information is written to that bottle's tag. This information stays with the consumable. When a container gets close to empty, the control unit will alert the operator that additional media is required before another procedure is started.

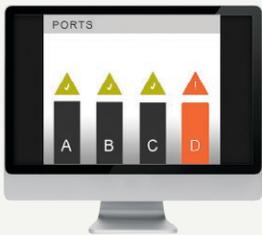
- *Protect brand integrity.* Used with a medical device, out-of-date, misapplied or inferior products can adversely affect the performance of the device, thereby damaging the reputation of the device and its manufacturer. Intelligent fluid coupling systems can detect such products and then take a number of actions to protect brand integrity. These include displaying a warning, triggering an alarm and shutting down the device. The systems can also take action to discourage improper usage. If a probe hooked up to a medical device is not on the list of probes approved by the device manufacturer, for example, the system could allow the probe to be used but slow its operation or degrade its performance in some other way that would not endanger a patient but would inconvenience the user.

CONSIDERATIONS IN MEDICAL APPLICATIONS

RFID-equipped quick disconnect couplings can withstand both ethylene oxide and autoclave sterilization, though they are not recommended for uses involving five or more autoclave cycles. On the other hand, the couplings cannot be sterilized with gamma radiation, since gamma rays erase data from the memories of current RFID tags.

Medical device and equipment designers must also bear in mind that metal placed near an RFID tag will affect the resonant frequency of the tag, which adversely impacts the processes of reading and writing to the tag. Designers, however, can easily prevent metal-related tag problems with help from a coupling supplier.

Potential RFID Applications



CONNECTION VALIDATION

Ensure correct connections in multiple-port systems – RFID reader reads tag and tells controller what is being connected to each equipment port; controller can display warning to operator or shut down equipment until error is corrected

Benefit: Each correct line is connected to correct port, preventing harm to equipment, process output or patient



OPERATIONAL CONTROL SETTINGS

Correctly set operational controls – Reader reads tag and tells controller what identification data is on the tag; controller automatically sets operating variables such as pressure, flow rate and operating time duration to match what is required for the device connected to the equipment port

Benefit: Reduces risk of human error in setting operational controls, preventing harm to equipment, process output or patient



USAGE CONTROL

Enforcement of single- or limited-use consumable devices: Controller tells reader to write to tag each time the limited-use device is connected to the equipment (or write the amount of time the consumable device has been used) and when this threshold has been reached, controller reports to operator that the connected device has reached the end of its life

Benefit: Reduces risk of damage to equipment, process output or patient due to overuse of consumable device



MEDIA VALIDATION

Prevent inferior consumable media from damaging equipment: Reader reads identification data on tag and controller verifies that the approved media/device is being connected to the equipment

Benefit: Reduces risk of damage to equipment, process output or patient; also provides brand protection



GENERAL PURPOSE TRACK AND TRACE

Maintain an accurate record of process steps: Media is placed in container with RFID tag, and as the container is connected to various pieces of equipment through each process step (e.g., add ingredients, mix, culture, curing, etc.), the reader on each piece of process equipment writes to the tag a record of what has been completed at that step

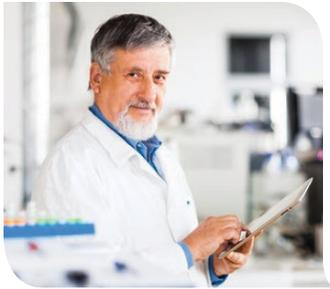
Benefit: Automated electronic recording of each process step eliminates human recording errors and the need for paper process records



PATIENT USE TRACK AND TRACE

Ensure correct garment, cuff, tool or other device is used and retired at the end of its useful life: RFID tag is attached to the garment or cuff used in patient's treatment, and reader writes patient data and record of use to the tag at initial use; with subsequent uses, reader reports tag identification and usage data to controller for verification and usage control

Benefit: Ensure correct device is being used by patient and that the device has not exceeded its useful life



Told that a customer’s device design calls for the tags to be placed within a certain distance of a metal component, a supplier can “tune” the tags to compensate for the nearby metal. Once the tags are properly tuned, there should be no problems when the device is in use.

Another issue designers should consider is whether the added cost of choosing intelligent quick disconnect couplings is justified by the benefits offered by RFID communication in a particular medical application.

In many cases, the decision to opt for intelligent couplings is a fairly easy one because the extra cost involved is insignificant compared to the overall cost of the medical system being designed.

Opting for intelligent couplings is also easier in situations involving significant risk and/ or potential liability — situations that are common in medical settings, where the health and even lives of patients are at stake.

Cost concerns about intelligent couplings have been eased in some cases by a new development: readers capable of handling multiple tags. Now, a single reader can be equipped with up to eight antennas to communicate with the tags on eight different ports. Though these multi-port readers cost more than one or two conventional RFID readers, they are much more economical than eight individual readers.

Multi-port readers are not like the normal RFID readers integrated into coupling bodies. Instead, they are circuit boards installed in a housing with the rest of a device’s electronics. Devices with multi-port readers still need coupling bodies to connect to coupling inserts, but these bodies are conventional units that transfer only fluids.

CONCLUSION

Today, intelligent quick disconnect couplings come in many sizes and configurations capable of fitting into medical applications. These include subminiature couplings used with surgical irrigation lines and non-spill designs that ensure drip-free disconnections for blood analysis and other medical procedures.

RFID capability can be added to popular coupling lines or be part of custom connector designs that meet the needs of unusual applications. Either way, users of the industry’s most advanced connectors will quickly see the value of adding smarts to their fluid-handling processes.



About CPC

Medical device manufacturers around the world rely on CPC’s quick disconnect couplings and fittings to quickly and securely connect and disconnect tubing used on a wide variety of equipment. Our connectors offer drip-free disconnections, are reliable even with repeated use and can prevent accidental misconnections for greater patient safety. We offer a wide range of sizes, materials and configurations, plus our unique hybrid connectors simplify equipment connections by transferring electrical signals, liquid and air in one easy step. We also custom-engineer solutions for any fluid or air handling application.

Smart fluid handling to take you forward, faster.

