

The role of intelligent fluid connectors: Combining fluid and data transfer to control, protect and streamline processes

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A new category of tubing couplers that “talk” is ensuring safety, improving processes and protecting brands by enabling both fluid handling and the back-and-forth flow of data. This application of radio frequency communication is taking on critical tasks in equipment operation to help enhance machine performance, prevent human error and capture fluid and product data.

“Can you hear me now?” This question adopts new meaning in relation to today’s connectors that enable communication between fluid packages and the machines in which the fluids are used. These machine applications often involve the use of high-value consumables delivered via tubing (from bottles, bags or other fluid containment or transfer devices) to equipment such as 3-D printers or medical laboratory testing machines. With the right programming and radio frequency tuning, a communicating connector on the fluid package “talks” to its connector counterpart on the machine to relay anything from simple recognition to a multitude of data points.

At its most basic, a communicating connector identifies and authorizes the correct connecting port, thus preventing misconnections. But beyond solving basic connection errors, communicating connectors can take on quantitative and qualitative analysis and record-keeping tasks that until now have been left to human operators — and human error.

Fluid couplers that communicate wirelessly can ask and answer countless procedural and process questions. For example, does the fluid container being connected to the machine contain the brand of consumable for which the machine is designed? Is the fluid in the container past its expiration date? Is there enough material left in the container to complete the process without interruption? How much of the consumable will be left in the container when the process is complete? All of these types of data can be accessed, analyzed and recorded through the use of wireless communicating connectors coupled with a computer or programmable logic controller.

REAL-WORLD PROBLEMS FOR MACHINE MANUFACTURERS

Do machines that use fluid handling systems need the capabilities of communicating couplers? Here are some connection-related problems encountered in actual equipment applications.

Problem 1. Printing ink piracy

For a number of years, a manufacturer of high-volume inkjet printers was enjoying robust sales of its machines and proprietary printing inks. The printers were known for high speed and superb print quality, primarily due to the unique properties of proprietary inks that were free-flowing, fast-drying and nonfading. Eventually, however, equipment problems started to emerge. Printing machines started to malfunction due to clogged print heads, printing quality plunged and sales of the manufacturer’s proprietary inks dropped precipitously.



Upon investigation, the manufacturer found that customers had switched to a third-party supplier of ink that was refilling the company's branded ink containers with cheaper, inferior inks. *The company needed a way to prevent ink substitution in its printers in order to protect ink sales, equipment performance and its brand reputation.*

Problem 2. Medical lab testing errors

A manufacturer of an advanced blood analyzing machine used in hundreds of laboratories across the country also supplied a line of various bottled reagents, fluids to be used with the machine depending on the type of test to be performed. The machine operators not only had to be sure they connected the right reagent container to the machine, but they had to verify that the material was not past its expiration date and that the bottle contained enough reagent to complete the necessary tests without interruption. Barcodes on the bottles proved deficient because there was no ability to write information back to the bottles. *The company needed a way to ensure that lab technicians used the correct reagents to meet goals for both test lab productivity and accurate patient test results.*

Problem 3. Patient safety and record-keeping

A unique medical machine used in delicate eye surgery was designed with two tubing connections, one for the compressed air used to power a cutting device and one for the saline solution used for eye irrigation. Because the machine was often used in low-light surgical settings, there was a danger of inadvertently misconnecting the air and saline solution lines — which would cause injury to the patient's eye or damage to the machine. *The company needed a way to prevent misconnections while also automatically keeping track of the machine's setup and use as part of patient medical records.*



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.

WHAT IS A WIRELESS COMMUNICATING CONNECTOR?

A fluid coupler with wireless communication capabilities has two parts — a quick disconnect coupling body that houses a radio frequency reader/writer, and the coupling insert that houses a radio frequency data tag that can store data and communicate with the body. The data on the tag can be continually overwritten and changed when communicating with the reader/writer. The coupling body is usually part of a machine, while the insert is typically part of the consumable fluid container or source.

The two connector parts begin communicating as soon as they are determined by the application. At the prescribed distance — most often when the two coupler parts are close but not connected — the reader in the connector body communicates with the radio frequency tag in the insert. A PLC or computer in the machine indicates whether the connection is allowed or disallowed, based on preprogrammed parameters unique to each application. If the connection is allowed, additional data specific to the application can flow between the machine and the consumable package.



To avoid misconnections in multi-line environments, the IdentiQuik® MAR from CPC provides a convenient and economical solution that also reduces design redundancy and complexity.

The technology used in today's wireless fluid connectors is a communication protocol similar to the simple radio frequency identification (RFID) tags used in many passive product identification applications. These read-only RFID tags are simple and inexpensive; they're most often applied to products to facilitate inventory or packaging processes. An intelligent wireless fluid connector, however, is significantly more complex. Not only does the coupling body recognize its corresponding insert to prevent misconnections, but it can read and write a variety of data for use in process validation and record-keeping.

The technology used in fluid connectors with wireless communication capabilities is more complex than the technology in garden-variety RFID tags, but its use can enhance machine performance, provide valuable operational data and even reduce labor requirements. In the right applications, the added cost of a communicating coupler is insignificant when weighed against the potential costs of a wrong connection or the use of the wrong (or non-proprietary) media. In fact, controlling risk is often a major goal in critical commercial, industrial and medical applications.

APPLICATION BENEFITS OF WIRELESS COMMUNICATING COUPLERS

Intelligent fluid connectors with built-in wireless communication offer a wide range of capabilities for critical machine applications involving fluid handling.

Here are just some of the potential uses

and benefits of the technology.

- *Connection validation* — Ensure correct connections in multiple-port systems where the radio frequency tag tells the controller what is being connected to each equipment port; if an error is detected, the controller can display a warning to the operator or shut down the equipment until the error is corrected. Multiple-port systems further benefit from the use of a multi-antenna reader (MAR). The MAR provides a convenient and economical solution that reduces hardware duplication and complexity.

Benefits: Each fluid line is connected to the correct port, preventing equipment damage or safety issues.

- *Media validation* — Prevent inferior, expired or incorrect consumable media from damaging equipment. The reader in the connector reads the identification data on the consumable container's tag, and the controller verifies that the approved media is being connected to the equipment.

Benefits: Media validation reduces the risk of damage to equipment or the process output; it also provides brand protection.

- *Operational control settings* — The connector body reader reads the tag on the connected fluid medium and automatically sets operating variables, such as pressure, flow rate and operating time duration, to match the specific medium or operation.

Benefits: Operational control

settings reduce the risk of human error in setting operating controls, preventing harm to equipment or the process output.

- *General-purpose track and trace* — Maintain an accurate record of process steps — for example, when ingredients are added, when mixing occurs, what cultures are used and when curing is completed. The reader in the connector body writes data to the tag on the fluid containers indicating what operation has been completed in each step.

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

- *Usage control* — Intelligent wireless fluid connectors allow enforcement of single-use or limited-use consumables. The controller tells the reader/writer to write to the tag on the consumable each time the limited-use product is used. When the threshold has been reached, the controller reports that the consumable has reached its end of life.

Benefits: The availability of usage data helps reduce the risk of damage to the equipment or the process output.

- *Patient-use track and trace* — When used on patient-specific devices such as blood pressure cuffs, intelligent wireless couplers ensure that a cuff is retired at the end of its useful life. The connector reader writes patient data and a record of each use to the radio frequency tag on the cuff, thereby preserving usage data and patient identification. In addition, the operators were able to gain important data for automated medical record-keeping, such as date/time of use, duration of the procedure and consumption of fluids.

Benefits: The system ensures the correct cuff is being used on the patient, that tests were performed on schedule and that the cuff has not exceeded its useful life.

CONSIDERATIONS WHEN DESIGNING A WIRELESS CONNECTOR SYSTEM

When contemplating the use of communicating connectors in a machine design, it is best to work with a company with wireless communication expertise and application experience. While it may be tempting to implement radio frequency communication in-house, it is often more time-efficient and cost-efficient to partner with an experienced supplier. Here are some reasons why:

- *Components complexity* — Although wireless communication is a maturing technology, the tag and reader components used in fluid handling need to be specialized for the demands of the application. The majority of RF communication devices are designed to sense from as far away as possible. In fluid coupling applications, however, the goal is for the two halves to communicate only when the tag and reader are in close proximity.
- *Radio frequency tuning* — Critical to the success of any wireless communication application is the ability to deal with RF noise in the environment. The tags RF tuning compensates for any metal in close proximity to the reader/writer and tag. Without this special tuning, the metal interferes with the RF communication.
- *Security* — An experienced supplier of fluid connectors with wireless capabilities will be familiar with security issues and can work with machine builders to ensure that products will cope with today's and tomorrow's wireless security challenges.

- *Integrated components* — In-house machine builders can sometimes source RF/RFID parts from various vendors and get them to perform tolerably together. However, an experienced supplier of wireless fluid connectors rigorously tests the quality of its readers, tags and fluid connectors as a total system, ensuring better mating of wireless devices and fluid couplings.
- *Economics* — Proven suppliers of wireless fluid connectors usually purchase components in volume and can offer economies of scale not available to individual, one-off users.
- *Industry and market expertise* — A knowledgeable supplier of wireless fluid connectors will understand the current and future trends in the RF market and be able to provide machine designers and manufacturers with forward-looking solutions backed by experience.

SOLUTIONS TO MACHINE MANUFACTURERS' REAL-WORLD PROBLEMS

Knowing now what wireless communication can bring to fluid handling, here is how the three manufacturers discussed earlier in this paper answered their application needs.

Solution 1. Solving the ink piracy problem

By equipping the printer and ink containers with communicating fluid connectors, the OEM's machines now instantly know when a container with nonapproved ink has been connected. The machine is programmed to either alert the operator or prevent the printer from operating. Each ink container comes equipped with an RF read/write tag that communicates data about its color, authenticity, date of manufacture and remaining volume.

IdentiQuik® wireless communicating couplings from CPC are available in a wide variety of standard products including non-spill, chemically resistant and subminiature models plus custom-engineered designs to meet special application needs.



With this connector solution, the printer manufacturer is protecting its ink sales, facilitating warranty management and supporting its premium brand position. Users of the printing machines are assured a more trouble-free machine and the elimination of bad print runs due to ink connection errors.



Solution 2. Eliminating medical testing errors

In the medical testing example, the manufacturer of a blood analyzer wanted to ensure that lab technicians used the correct reagents for each test run. With the addition of wireless communication capability to the fluid connectors on the machine and reagent bottles, the blood analyzer can now alert the operator if an inappropriate reagent is about to be connected to the machine. The read/write connector on the machine can also read the radio frequency tag on the consumable fluid insert to determine if the reagent is outdated or might otherwise jeopardize the machine or the test.

As test doses from a reagent bottle are used, the information is written to that container's tag, allowing the control unit to keep track of the number of additional tests that can be run with the amount of solution left in the bottle.

Solution 3. Preventing connection-related eye surgery risks

In the third application, the eye surgery machine builder needed to prevent connections mix-ups between its air and saline lines, while also automatically keeping track of the machine's setup and use each time for medical records. By incorporating wireless read/write capability in the fluid connector bodies on the machine and read/write radio frequency tags on the air and saline insert lines, the manufacturer eliminated misconnection issues and reduced patient risks. The operators were able to gain important data operational control settings.

CONCLUSION

The concept of fluid connectors that talk is an elegantly simple solution for enhancing machine function and preventing operator errors. However, this solution is not simple in execution. The development path for applying couplers that exchange data wirelessly prior to or upon connection requires both connector and RF expertise. Machine designers considering the benefits of wireless communication will want to look for experienced component suppliers, so together your machines and high-value media packages can reply, "Yes, I can hear you now."



About CPC

CPC (Colder Products Company) is the leading global provider of quick disconnect couplings, fittings and connectors for use with tubing in fluid-handling applications. Our RFID-based Intelligent Fluid Connections redefine what's possible for controlling, protecting and streamlining fluid handling processes by enabling the robust transfer of fluid and information. CPC's broad range of 10,000+ innovative products allow flexible tubing to be quickly and safely connected and disconnected. CPC also engineers custom solutions to improve the overall functionality and design of equipment and processes in life sciences, bioprocessing, specialty industrial and chemical handling markets.

Smart fluid handling to take you forward, faster.

