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Process Data Communications with the Antaris FT-NIR Analyzers – Analog, Digital, OPC and LIMS

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Key Words

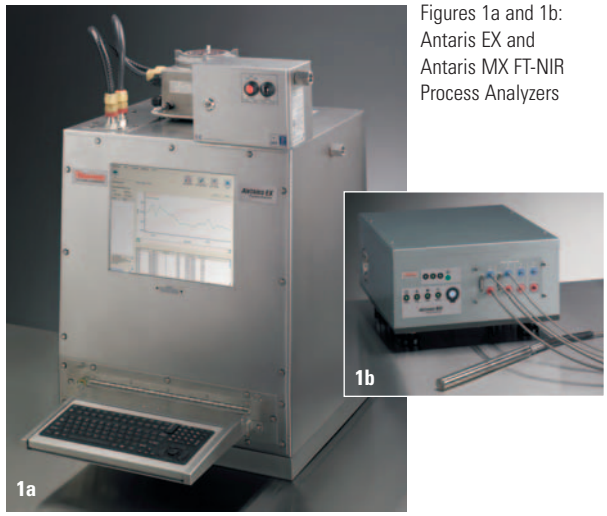
- Antaris
- FT-NIR
- OPC
- PLS
- Process Communication

Introduction

Using analytical data to improve manufacturing processes has been standard practice in many industries for decades. How the data is communicated and utilized depends greatly on the type of measurement that is needed. Some discrete, in-process measurements like temperature or pressure only require analog input or output whereas other, more complex, types of information like spectroscopic data sets require higher order data processing and communication. These higher order processes include not only analog I/O, but also digital I/O and Object Linking and Embedding, or OLE, for Process Control. The latter technique, commonly referred to as OPC, allows the inclusion of computer-based data analysis which includes spectroscopic parameters, pass/fail or logical events in a universal computer communication format. OPC was designed to let computers talk to one another using a traditional server/client relationship for in-process data communication without concerns traditionally associated with computer compatibility. In addition, OPC can be "translated" into a large number of machine or instrument-specific languages allowing a modern interface to both older and newer systems.

Real-time feed forward and feedback of analytical data is an essential part of understanding and controlling any manufacturing process. The end result of data feedback can be as simple as adjusting a valve to produce the desired condition change based on known spectroscopic signals from the analyzer. Or, data can be fed into a more elaborate, centralized process control scheme. There are many different ways that analyzers, computers and process control systems can communicate to control a process including OPC using Ethernet communications, or digital I/O and analog I/O using a traditional PLC. All these communication techniques can be used with Thermo Electron Corporation's Antaris™ Fourier Transform Near-Infrared (FT-NIR) analyzers with RESULT™ software.

Data communication and storage are essential to both development- and production-scale operations but each has a different set of requirements for data handling and archival. In a production environment, data is used to make decisions for changing process conditions that, for example, optimize the yield of a product or monitor an endpoint. Data obtained by a process analyzer, however, rarely resides on the instrument that generated it. The greater use of this information is in feed forward or feedback. Process control and process monitoring applications require the process data be sent to a central process control center. In process monitoring or data archival applications, the data is sent to a centralized data historian or remote information management system for long term storage. This archived data can then be used to investigate quality problems or to improve process parameters. In product and process development, data may be stored on the process instrument to gain insight into new process technologies and scale-up production runs, but this data does not require real-time data transfer. It does require pertinent data to be stored on the process instrument for retrieval at a later date. RESULT software facilitates information management for both development and production applications.



Figures 1a and 1b: Antaris EX and Antaris MX FT-NIR Process Analyzers

Increasingly, FT-NIR, a molecular-spectroscopy technique, is finding use as an online measurement tool to discern component concentrations due to its ease of use, speed and accuracy. FT-NIR can generate a great amount of in-process data regarding both chemical and physical characteristics. Common examples of processes that incorporate near-infrared data are reaction-endpoint determination in the chemical industry, production QA/QC for polymers, and moisture content in pharmaceutical solid dosage forms. The methodology for implementing data communications for an online FT-NIR analyzer is extremely varied. With RESULT software, Thermo provides an easy-to-use yet powerful interface to bring FT-NIR analyzers seamlessly into any process control scheme using digital and analog I/O and OPC communications.

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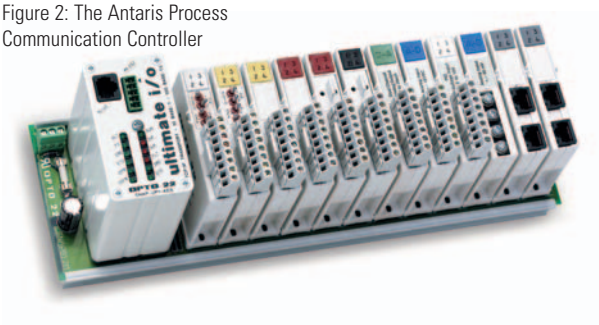
Experiment

The Antaris MX and Antaris EX FT-NIR process analyzers (Figures 1a and 1b) were used for testing communication protocols with an Ethernet-linked PLC (The Antaris Process Communication Controller) configured with appropriate I/O modules (both digital and analog – see Figure 2). This controller was developed for use with RESULT software and is also available directly from Thermo. Once the digital and analog channels are set up in the workflow, the analyzer can be seamlessly integrated into existing PLC systems with simple wire connections to the Antaris Process Communication Controller.

Figure 2: The Antaris Process Communication Controller



For OPC communications, RESULT software works as an OPC server upon installation, and customizable workflows within RESULT provide the specified information to the client computer. The server/client relationship can easily be set up using traditional DCOM protocols for Microsoft® Windows® communicating over a conventional Ethernet network.

OPC Communication

OPC is a standard format for communicating process control data from an instrument to a host computer. By implementing OPC protocols through a data server, programming efforts are minimized. RESULT software reports data directly to the client computer via an OPC reporting event (Report to OPC) in the RESULT workflow.

A workflow is a customizable series of electronic commands to which the computer and analyzer respond. For instance, if the goal of the analysis was a raw material identification, the instrument would collect spectra using a fiber optic probe and then compare the spectrum to a library of known compounds. The software could then issue a pass or fail report based on this result. All of these steps, or events, would be automated and controlled by RESULT software to execute exactly the same way every time regardless of operator. A customized fit to any manufacturing process (see Figure 3) is the essence of RESULT's electronic workflow.

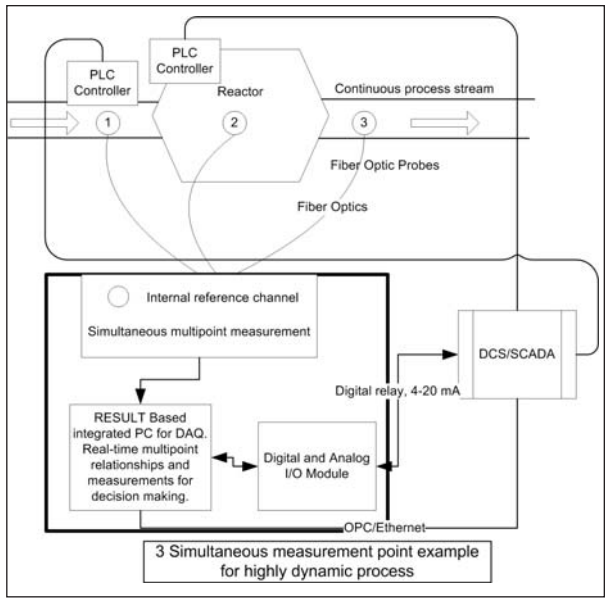


Figure 3: Process loop drawing for FT-NIR Analyzer

The Report to OPC event in RESULT allows the workflow designer to add a step in the workflow where an OPC server computer reports any selected data to the OPC client. The user adds this event to the workflow by simply clicking the "Add" button and selecting "Report to OPC." This event is shown incorporated into a workflow in Figure 4 on the following page. A value is obtained from a spectrum taken in the process and quantified by a chemometric model. In this case, a value (i.e. concentration, ratio, etc.) is the measurement being reported. When this is accomplished, every value assigned in the measurement section is reported to the OPC client. The data on the client computer shows up regardless of the location of the computer. Another advantage of Ethernet-based protocols like OPC is that the client computer can be linked to the server computer using either an already existing internal network or remotely over the internet using XML protocols. RESULT workflows can also be set up to take commands from the client computer allowing for true two-way interfacing.

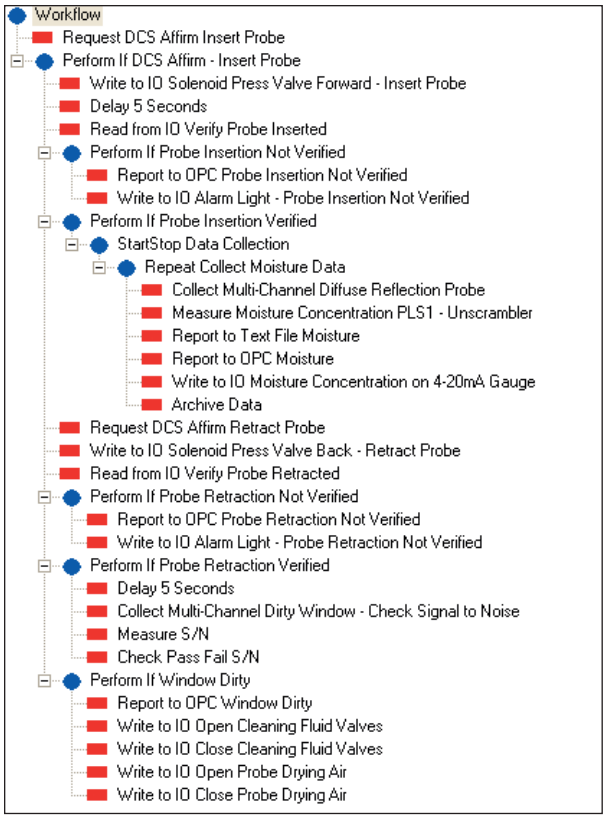


Figure 4: Workflow including Antaris Controller and OPC events

Analog and Digital I/O Communication

Similar to the OPC communication described previously, a similar communication scheme is available using the Antaris Process Communications Controller. Both digital and analog I/O can be added via the "Write to IO" and "Read from IO" events in RESULT workflows. This allows seamless integration of in-process FT-NIR data with existing PLC control schemes. The user can customize the controller channel configuration to correlate to the desired protocol.

An example of this type of interface is the output of an in-process concentration value to an analog gauge on a panel near the instrument. The gauge could be directly wired into the controller using an analog channel (4-20 mA) or it could be wired using an existing PLC into the proper Antaris controller channel. The concentration scale is entered in the "Write to IO" event. The chemometric measurement event in the workflow (the source of the concentration data) is then added to the "Write to IO" event. Once the desired channel number is designated, the process is complete and the desired value will be output on the analog gauge.

Analog I/O is not the only traditional hard-wired option available in RESULT with Antaris process analyzers. Digital output is a convenient and simple way to, as an example, send a pass/fail result or alarm condition to a remote computer or even to a local alarm light or indicator. In addition, solenoids can be automatically controlled in this way. The "Write to IO" is used in this case to report the result of a "Check" event in RESULT which designates a PASS or FAIL condition. This signal will be one of two possibilities (binary) allowing it to be passed using a digital channel on the controller. So, for example, if the concentration of a particular component were to go out of spec during a process run, there would be a FAIL notification sent immediately to either the control center and/or to the local environment using a digital channel on the controller. The end result could be, for example, a red alarm light signaling the need for attention or an alarm signal sent to the control facility.

LIMS Communication

A LIMS system is often used as a centralized data archival system. These systems commonly use text files to pull measurement data from a wide variety of instrument vendors. Input from RESULT software to a LIMS system can take several forms, either an HTML report that the LIMS system will then parse, or text files that contain the necessary information in a delimited format. Either one or both of these options can be executed in RESULT using the "Report" or "Report to Text" events in a workflow. Any of the data available in RESULT like concentrations or PASS/FAIL results can be incorporated into a "Report" or a "Report to Text" event just as with the Antaris controller I/O and OPC.

Output is not the only way for RESULT to communicate with a LIMS system. The "Request" Event in RESULT can be configured to read information from files such as LIMS ID numbers or analysis requests. This event can be used to read sample information provided by a LIMS system. RESULT can automatically incorporate information pushed down from a LIMS demonstrating RESULT's ability to function as part of a 2-way I/O scheme for manufacturing environments.

Conclusion

RESULT software provides a user-friendly environment for implementing various customizable communication protocols within a process environment. The options for using modules to support both digital I/O and/or analog I/O communications are very easy to implement and require no programming knowledge. The only requirement is to know the desired measurement to be reported and where it is to be reported. In addition, OPC and LIMS communications are also fully-integratable options from within a workflow providing a complete process communication solution for any type of manufacturing facility.

In addition to these offices, Thermo Electron Corporation maintains a network of representative organizations throughout the world.

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