Automation Infrastructure
For Operational Excellence.

In This Issue:
- Reliance Fieldbus Installation
- Field Diagnostics Technology
- Product Registration Overview
- Lab Integration Effort
- Fieldbus Technical Tip
- FDI Project Report
- New Application Note
- Abengoa Case Study
- Fieldbus Product Highlights
"Your clear path to Asset Excellence"

Introducing:
VigilantPlant Asset Excellence
for asset availability and utilization

Is your plant asset reliable and available?
Is your asset condition predictable and performance sustainable?
Applying the VigilantPlant philosophy to plant asset management,
Yokogawa helps you build sustainable asset performance from the ground up. Yokogawa will be your partner in the clear path to asset excellence.

Asset Excellence = Reliability + Availability + Predictability + Performance

www.yokogawa.com/vigilantplant/ae/
President’s Letter

FOUNDATION technology:
Charting a course out of recessionary times

Around the world, manufacturing is one of the worst hit market segments in today's economic downturn. What at first appeared to be a financial meltdown was deep enough to stay, spread and affect the industrial sector as a whole. Organizations of all sizes reduced inventory levels, shut down plants, and slashed workforces.

Despite its impact, however, the current recession creates new opportunities for improvement. Many companies are using this period to retool, update outdated systems, and prepare for what will undoubtedly be a different global business climate when recovery occurs.

Increasingly, industrial organizations are focusing on improved plant performance and asset reliability strategies. Cost analysis of unscheduled shutdowns shows that a large percentage of lost production relates to a lack of equipment availability and reliability. Asset integrity management, therefore, is an avenue to enhanced productivity and better cost control in process plants.

This is where the Fieldbus Foundation steps in. As a true enabling technology, FOUNDATION fieldbus provides industrial end users with the means to optimize their operations for greater efficiency, improved safety and better business results. FOUNDATION technology enables an automation infrastructure supporting process integrity, business intelligence, and open scalable integration in a managed environment.

Automation equipment suppliers are increasing their investments in the Fieldbus Foundation's technology because it delivers productivity tools allowing customers to drive down production costs and improve their return-on-assets (ROA). Even during recessionary times, the foundation is continuing to attract new members, register new fieldbus products, and launch important development projects.

For example, we are working closely with leading industry organizations such as NAMUR to identify digital control system requirements for process end users. This collaboration has led to the development of a new profiles specification, which builds upon the robust diagnostic features already provided by FOUNDATION fieldbus devices. Field diagnostics supports a structured approach to asset management, which simplifies operators' tasks and increases their confidence in utilizing asset software. At the same time, end users can harness enhanced Electronic Device Description Language (EDDL) technology to achieve true, actionable diagnostics.

The Fieldbus Foundation has also partnered with major industrial companies such as Shell, BP, Chevron and Saudi Aramco to develop FOUNDATION-based Safety Instrumented Functions (SIFs) for the process industries. FOUNDATION for SIF enables plants to realize significant CAPEX and OPEX benefits by extending fieldbus benefits into safety systems. It offers new opportunities to optimize asset lifecycle initiatives and reduce plant operating expenses.

These technology developments, along with other key initiatives involving wireless networking, fieldbus remote I/O and Field Device Integration (FDI), promise to help manufacturers realize new levels of performance throughout their plants and factories. This represents a “win-win” situation for the industrial community and consumers alike.

All the best,

Richard J. Timoney
President & CEO
Fieldbus Foundation
RuggedCom is a leading manufacturer of Industrial Ethernet products specifically tailored for real-time process control and mission critical applications that require high levels of reliability, availability, and performance. High MTBFs, fast network fault recovery, immunity to harsh environments, and integrated cyber security features are standard across all product lines.

- Network Routers
- Ethernet Switches
- Secure Wireless
- Serial Device Servers
- Media Converters
- Network Management Software

www.RuggedCom.com
Introducing flexible expandability for fieldbus segment protection

Now it's easier than ever to expand Foundation Fieldbus and PROFBUS PA with the new, modular Process Fieldbus Infrastructure System from Phoenix Contact.

While other fieldbus infrastructure systems are rigid and make expansion difficult, our breakthrough technology makes additions simple — never over-engineer your system again. Just design to your current needs and expand with ease using this modular approach.

With our Process Fieldbus Infrastructure System, you get:
- Hot-swappability – Expand your system without disrupting communication
- Pluggable Termination – For error-free mechanical termination
- Modularity – Save space and lose the brick

For more information or to specify modular segment protection on your next fieldbus project call 1-800-322-3225 or visit www.phoenixcontact.com/fieldbus

FIELDBUS APPLICATION GUIDES AVAILABLE

The Fieldbus Foundation offers a selection of comprehensive Application Guides that can help end users get on the “Fast Track to Fieldbus.” These documents provide valuable information regarding fieldbus installation procedures, wiring guidelines, network isolation techniques, and more.

To download the Application Guides, visit: www.fieldbus.org/About/FoundationTech/Resources

© 2009 PHOENIX CONTACT

FIELDBUS REPORT is written and produced by Industrysource – The Industrial Marketing Resource (www.indsource.com).
FIELDBUS REPORT is published by the Fieldbus Foundation, 9005 Mountain Ridge Drive, Bowie Bldg. – Suite 200, Austin, TX 78759 (Phone 512-794-8890, Fax 512-794-8893). Address all correspondence to Editorial at the same address. Printed in the United States. © 2009 Fieldbus Foundation. All rights reserved. The contents of this publication may not be reproduced in whole or part without consent of the copyright owner.
Recognized as the world’s largest refinery installation of FOUNDATION technology to date, the new Reliance Industries Ltd. complex in Jamnagar, Western India, is also India’s largest private sector enterprise, with businesses in the energy and materials value chain.

In this issue of Fieldbus Report, B. R. Mehta, Reliance’s senior vice president, takes an in-depth look at this remarkable project, describing the installation, its mission, and its purpose in this exclusive interview.
Mr. Mehta, please describe Reliance Industries’ FOUNDATION fieldbus installation at part of the Jamnagar Export Refinery Project (JERP).

B. R. Mehta: Reliance built the world’s most modern refinery in the late 1990s and operated it most efficiently over the last 10 years, accumulating huge domain knowledge and operation expertise. When Reliance management decided to build a new refinery in Jamnagar, Western India, under Reliance Petroleum Ltd., the aim of the automation technology was to create next-generation control systems using rich intelligence property of the refining process and the latest in technology to achieve operational excellence which will have no parallel in the world.

The mission of the automation was to provide:

• Operational excellence in monitoring, controlling, and managing the process and the business;
• Optimum level of integration between process control, operation support, and business support systems; and
• Showcase the corporate image of Reliance Industries providing next-generation control systems.

The new refinery, with a capacity of 580,000 barrels-per-day (bpd), together with Reliance’s neighboring 660,000 bpd existing refinery, form the world’s largest refining complex with a 1.24 million bpd capacity. With the commissioning of the new refinery, Jamnagar becomes the “refining hub” of the world.

After the successful commissioning of our new refinery, Reliance will focus on achieving the highest standards of safety and reliability at the facility.

The new Jamnagar refinery deploys the latest state-of-the-art technologies, and FOUNDATION fieldbus is one of them. Project highlights include:

• Crude processing capacity of 580,000 bpd;
• A polypropylene plant with a capacity of 0.9 mtpa (million tons per annum);
• Completion target of 36 months;
• Highest health, safety, and environment standards;
• First and largest project in India to implement FOUNDATION technology;
• More than 13,000 tags connected to Fieldbus;
• More than 3,600 segments in the project;
• 1,200 temperature multiplexers on Fieldbus;
• All selected devices carrying the FOUNDATION “checkmark” logo;
• Type testing done for all devices and function blocks used on the project; and
• Host system using FDT/DTM technology.

FR: What were the key considerations in Reliance’s selection of FOUNDATION technology?

B. R. Mehta: We looked at three major aspects in the selection of automation technology for JERP. These included:

• Future of process automation;
• Proven technology; and
• Openness.

Our team of experts from operation, maintenance, and projects visited all major DCS vendor tech laboratories as well as various sites in China. We had references from other large end users like Shell in terms of technology advancement. Based on feedback from our supplier visits and
”Fieldbus technology was applied to all major loops going to the DCS in various units.”

Reliance Industries standardized on a two-type combination of field barrier boxes.

references, as well as the experience of other major users, we concluded that Foundation fieldbus technology is well proven.

We also learned that Foundation fieldbus is non-proprietary, open, and interoperable, and involves continuous vendor innovation. The infrastructure is neutral and standards-based, and provides end users with a common framework to implement and manage the latest advanced control strategies.

We also considered the market availability of Fieldbus devices and products. We asked ourselves, “Are there enough suppliers supporting this technology?” “Are all required device types covered?” “Are there devices registered in compliance with the Foundation standard?” “Will this technology be supported in the Indian market in due course?”

In terms of interoperability, we asked, “How easy is it to activate devices on the system (such as connecting and powering up devices, establishing communications with the host, configuration from the host engineering tool, recognition in the system structure, and host access to measured values and diagnostics)?” In addition, we asked, “How easy is it to interchange field devices of the same type from different suppliers?” And “how easy it is to remove, insert, and commission devices on line?”

Based on all of these considerations, our team of highly experienced engineers decided to go for Foundation fieldbus technology.

**FR:** Did your company have previous experience with Fieldbus-based controls?

**B. R. Mehta:** We had first implemented Foundation technology on a Reliance Life Sciences project on a small scale, with about 800 devices. Our engineering contractor had implemented the technology on a much larger scale. We are also implementing Fieldbus on Reliance’s KGD-6 project, which has approximately 200 segments and 1,200 devices.

**FR:** Did you consider other solutions, such as Profibus and HART, and if so, why were they not chosen?

**B. R. Mehta:** No other solutions were considered.

**FR:** Describe how the Fieldbus system will be implemented for plant automation (that is, number of segments, nodes, etc).

**B. R. Mehta:** The challenges we faced were many, as Foundation fieldbus is relatively new to India as well as were detail engineering contractors. Our engineering is carried out by Bechtel from many different engineering centers, including London, Houston, Toronto, China, Delhi, Mumbai, and Jamnagar. We also have other contractors, such as Foster Wheeler for coker and Aker Kvaerner for PP, carrying out engineering from separate engineering centers.

The engineering methodology adopted by Reliance included:

- **Early involvement of all parties, including operations and maintenance;**
- **Dedicated specification for Foundation fieldbus implementation;**
- **System and device selection/evaluation team with engineering contractor;**
- **Fieldbus device HIST test carried out on each type of device used on the project;**
- **Fieldbus system design training for all involved personnel;**
- **Fieldbus template development on IA system and testing of each device;** and
- **FAT of Fieldbus devices and system by connecting available devices on a segment and loading each segment to its full capacity.**

In addition, Reliance employed a dedicated Foundation fieldbus specification for JERP to:

- Ensure consistency across the entire JERP;
- Minimize design effort at various design centers;
- Simplify the overall Fieldbus implementation process across various engineering contractors and engineering centers;
- Minimize testing- and commissioning-related problems; and
- Ensure project-common Foundation fieldbus hardware components, including junction boxes, power supplies, and field barriers.

Fieldbus technology was applied to all major loops going to the DCS in various units. We standardized on a two-type combination of field barrier boxes. This included a 1-off-4 channel barrier box for segments limited to 4 devices maximum, and a 3-off-4 channel barrier box for segments limited to 12 devices maximum. JERP used a design with up to 8 devices per segment.

Reliance has adopted a tree topology. The current refinery is using the I.S. concept for all field devices. To be very near to the current system for design, we have used a high-power trunk up to the field barriers, with all spurs being I.S. The high-power trunk allows us to install more instruments per segment. Our project maximum is 8 devices per segment. This will provide
for maintainability with power for all devices and spurs.

All trunks have surge protection at both ends (that is, in the marshaling cabinet and the Fieldbus spur junction box). Surge protection for each instrument is considered in areas with a high susceptibility to lightning strikes. This includes tank farms, columns, jetties, etc., as well as any area where instrumentation is not significantly shielded by the plant stealwork and pipe racks.

Segment design considerations include:

- **Level 1**
  
  *Definition*: Failure of a Level 1 loop will result in a shutdown of an entire unit, damage to non-spared vital or essential equipment. Level 1 valves and their associated measurement devices should reside on a segment that is only used for Level 1 control. The segment will have one Level 1 valve and associated transmitter, or a maximum of two valves and associated transmitter if they are part of the same loop. Necessary consideration will be given to assigning valves to different barriers in the junction box.

- **Level 2**
  
  *Definition*: Failure of a Level 2 loop will result in an entire unit shutdown, but process dynamics will allow for quick unit recovery. Level 2 valves are used only for Level 2 control. The segment will have one Level 2 valve and associated transmitter, or a maximum of three valves (split range valves of a single loop) and associated transmitters if they are part of the same loop. Necessary consideration will be given to assigning valves to different barriers in the junction box.

- **Level 3**
  
  *Definition*: Failure of a Level 3 loop will not result in any short-term risk of total unit shutdown. Level 3 valves can reside on segments with up to two other Level 3 valves, but not on a segment with a Level 1 or Level 2 valve. Reasonable reliability can be achieved with backfilling, particularly on Level 3 segments with miscellaneous monitoring loops and local indicators.

- **Level 4 (no control)**
  
  Level 4 (monitoring only) segments containing monitoring devices are not used for control across segments. Reliance did not consider the use of FOUNDATION technology in seven areas:
  
  - Emergency shutdown systems;
  - Fire and gas control systems;
  - Fast loops such as compressor controls (anti-surge);
  - Various packages such as heaters and compressors;
  - Loops with execution time faster than 300 ms;
  - Burner management systems; and
  - Analyzer systems.

More than 3,600 segments are distributed across the refinery and PP units, with more than 13,000 connected devices. We have also used more than 1,200 temperature MUX in the system, where 8 TC/RTD elements per MUX are connected to the system.

---

**FR:** What are the expected benefits from this FOUNDATION fieldbus installation?

**B. R. Mehta:** Our expectations for FOUNDATION technology include:

- Interoperable products and systems;
- Elimination of proprietary protocols;
- Technology innovation by manufacturers;
- Device diagnostics;
- Lower installation costs;
- More information from valves;
- Multiple inputs from one device;
- New instrumentation that is easier to add to later;
- Reduced wiring;
- Fewer terminations;
- Reduced commissioning time;
- Ability to implement control in the field;
- Reduced control room space; and
- Improved instrument diagnosis.

**FR:** What are your future plans for adopting FOUNDATION technology?

**B. R. Mehta:** Our specifications are based on FOUNDATION fieldbus, and so far our experience in handling the technology is very good. Based on feedback received from other plants worldwide, we believe the major benefit is in asset management, which we are yet to derive as we have commissioned the plants very recently. Our next goal will be to get maximum benefit out of our installation and take full advantage of our FOUNDATION fieldbus system. We will also be using this technology in our future plants based on our success rate in current applications.
Do you have any advice for other process industry end users considering the use of Fieldbus?

B. R. Mehta: I have just listed some of the important benefits realized from a comparison of legacy systems versus FOUNDATION technology. These include, for example:

- Fieldbus signals are digital, and therefore more immune to noise;
- The requirement for damping to filter out noise is eliminated;
- Fieldbus automatically detects all connected devices and includes them on a live list, and addresses are automatically assigned, eliminating any possibility of duplicate addressing;
- Traditional I/O uses 16- or 32-channel cards, thus are costly and a weak point. Module failure can cause all associated loops to crash;
- Accidental removal during fault-finding will affect all 16 or 32 I/O; minimizing the components reduces failure probability;
- Fieldbus has no requirement to manually configure alarms to detect transmitter failure or broken signal cable; the technology builds in this automatic safety function;
- Fieldbus uses engineering units, not scaled ranges, thereby measuring actual process variables, not scaled or a percentage of 4–20 mA; this eliminates the need for range configuration;
- With fieldbus, conflict in ranges is not possible;
- Analog-to-digital conversion is eliminated, thus improving accuracy and reliability;
- Dual measurement of parameters is possible from a single instrument; and
- Fieldbus enables failure prediction due to increased data availability.

When we adopt new technology, there are always unresolved points that must be looked into at various stages of the project. We also are closely watching points in the development of Fieldbus systems, such as:

- How to achieve faster commissioning of Fieldbus loops on site;
- Mismatches in device files tested at the lab versus devices supplied;
- Untested device type delivered to the site;
- Alarm management implementation;
- How to realize maximum value from asset management;
- OPC stability of many connected systems to the DCS; and
- Training staff members in commissioning of Fieldbus systems.

B.R. Mehta has more than 36 years experience in the refinery and petrochemicals industries. He has worked on engineering projects in the field of control systems and instrumentation for the Patalganga, Hazira, and Jamnagar Refinery & Petrochemicals complexes during his 24 years with the Reliance group. Before joining Reliance, he spent two years at the Agro Chemical & Food Co. in Kenya as chief instrumentation engineer, and 11 years at Indian Petrochemicals Ltd. in Vadodara, India, as an instrumentation engineer. Mehta is the nominated pro-temp chairman of the Fieldbus Foundation End User Council — India, and a member of the foundation’s End User Advisory Council (EUAC) worldwide. He has been chairman of the Instrumentation Experts Club in Mumbai, India, for the past seven years, and he sits on the Board of Governors for Automation 2010.
Field Diagnostics Optimizes Plant Asset Management

Advancements improve reliability, increase uptime and reduce operating costs

Stephen Mitschke, Manager – Fieldbus Products
Fieldbus Foundation

New developments in fieldbus diagnostics technology support a structured approach to plant asset management, which simplifies operators’ tasks and increases their confidence in utilizing equipment diagnostics and asset software.
Since May 2006, the Fieldbus Foundation has been collaborating with NAMUR, an international process industry end user association based in Germany, on fieldbus performance enhancements such as device diagnostics, which both parties identified as requiring further clarification and guidance for the user community.

New field diagnostics profiles resulting from this collaboration will benefit a wide range of automation stakeholders, including process engineers, maintenance technicians and operators. This technology will optimize plant asset management programs and enable improved process performance, greater reliability, increased uptime and lower operating costs.

Background

In order to maximize the output of an industrial facility, all assets need to be maintained at certain intervals — i.e. monitored, serviced, refurbished or replaced. Plant asset management assists in determining these intervals through continual asset condition monitoring, which predicts time-to-service; detailed diagnostics with guidance of required service actions; and system-supported planning and execution of service tasks.

The goal of an asset management solution is proactive rather than reactive maintenance wherever possible. Condition-Based Monitoring (CBM) focuses on optimizing the timing of maintenance. It seeks to avoid unexpected equipment failures on the one hand (too late maintenance) and unnecessary maintenance on the other (too early maintenance). To achieve this goal, individual assets either require embedded intelligence or specific condition monitoring techniques at a higher level.

Due to demands for increased availability and uptime, various techniques for monitoring plant assets have been developed. These include using control equipment for monitoring field devices (e.g., electro-pneumatic positioners monitoring control valves, electrical drives monitoring conveyors, etc.); installing specialized sensors, measuring and diagnostic equipment; and process modeling at a higher system level.

Many process industry end users configure their asset management software for predictive maintenance. By using the diagnostic features built into intelligent instrumentation, they track indications of impending failure. Some applications can produce a notice resulting in a work order when repair is required. This is significantly more economical than crisis repair, which is waiting for the failure and repairing the device on an emergency basis.

Understanding industry requirements

Today, the field device revolution is centered on reducing process variable uncertainty and enhancing device functionality and diagnostics while providing more integrated solutions around the desired process measurement.

Over the years, plant constructors and operators have consistently pursued two main goals: to lower installation costs and to optimize production conditions. This has led to the widespread use of digital bus technologies in the process and manufacturing industries, as well as development of intelligent automation devices. But, in many cases, the savings potential from fieldbus wiring reductions and digital device communications have already been exhausted.

Intelligent maintenance concepts, on the other hand, still offer tremendous potential for added value. This potential must now be tapped. In addition to increasing plant availability, diagnostics-driven maintenance strategies reduce fixed and variable maintenance costs and extend useful asset life by reducing the interval between maintenance events, reducing the cost of failures, and making it easier to plan maintenance and service work.

With the advance of intelligent automation components, an extensive amount of data is being generated on all levels of the automation hierarchy and, increasingly, in the field devices themselves (See Figure 1 at right). Many of these components provide parameterization options, and some include diagnostic and analytic functions — but usually only in proprietary formats. Vendor-specific software is therefore often needed to access these functions and the information they generate.

If modern methods of preventive or condition-based maintenance are to gain more widespread acceptance, the available information must be centrally collated, evaluated and given to maintenance providers in an understandable form.

Asset or lifecycle management systems can only be used consistently and effectively if there is easy access to parameterization, status and diagnostic data from the field.
What today’s end users need

As the ability to self-diagnose device health and integrity improves, available information is too valuable to ignore. For example, standard temperature measurement options offering hot backup redundancy are being expanded into detecting sensor drift and predicting when a temperature sensor will fail. Pressure transmitters now detect plugged impulse lines and inform the operator when an apparently good measurement is, in fact, not valid.

Control valve diagnostics and the ability to generate valve signatures for online diagnostics allow many valve problems to be easily isolated and remedied without the cost associated with pulling a valve out of service and unnecessarily rebuilding it.

All of these developments in device diagnostics help processing facilities practice more preventive and less reactive maintenance. With approximately 50% of the work accomplished in most organizations being reasonably preventable maintenance, potential cost savings from utilizing device diagnostics data are tremendous.

As part of its work on behalf of process industry end users, NAMUR has published recommendations describing the functions and features that should be provided by modern plant asset management systems (NE 91, “Requirements for Online Plant Asset Management Systems”) and the types of diagnostic functions and status reports they should offer (NE 107, “Self-Monitoring and Diagnosis of Field Devices”).

Development of the NE107 recommendation was driven by automation end users seeking greater consistency in their installed field device networks. Many plants utilize a variety of technologies for different applications, including FOUNDATION fieldbus, PROFIBUS and HART. However, diagnostic information is often represented amongst these networks in different ways. This can include different data structures, different parameter names, etc. Even within the same protocol, there are areas where vendors can add additional diagnostic information that is presented in many different formats.

As part of the NE107 guidelines, NAMUR members expressed the need for a common set of asset management tools ensuring important information regarding device
status and operating condition gets to the appropriate person within the plant. In turn, the organization proposed a common structure for representing all instrument diagnostics. This would allow device developers, as well as industry organizations such as the Fieldbus Foundation, Profinet User Organization and HART Communications Foundation, to write specifications mapping their particular technology into a standardized group of diagnostic categories.

According to the NE107 document, fieldbus diagnostic results should be reliable and viewed in the context of a given application. Plant operators should only see status signals, with detailed information viewable by device specialists. The NAMUR guidelines further recommend categorizing internal diagnostics into four standard status signals, and stipulate configuration should be free, as reactions to a fault in the device may be very different depending upon the user’s requirements.

NE107 proposes diagnostic signals/categories be identified as follows:

- **Maintenance Required**: Although the device is still able to provide a valid output signal, it is about to lose functionality or capability due to some external operational condition. Maintenance can be needed short-term or mid-term.

- **Failure**: The instrument provides a non-valid output signal due to a malfunction at the device level.

- **Check Function**: The device is temporarily non-valid due to some type of maintenance activity.

- **Off Specification**: The device operates out of the specified measurement range. Diagnostics indicate a drift in the measurement, internal problems in the device, or the consequence of some process influence (i.e., cavitations, empty pipe, etc.).

NE107 further recommends the classification and association of a diagnostic event to one of these four levels of diagnosis be configurable by the user. The configuration would depend on the process constraints (e.g., loop criticality) and the role of the addressee, such as an operator, maintenance technician, etc. (See Figure 2 above).

**New profiles specification released**

During a press briefing on April 25, 2006, at the INTERKAMA Trade Fair in Hannover, Germany, the Fieldbus Foundation announced the establishment of a liaison relationship with Working Group 2.6 Fieldbus of NAMUR. This cooperation has focused on two key issues: grounding and shielding, and device diagnostics profiles.

Key to the foundation’s liaison with NAMUR was the establishment of a dedicated working group to investigate standard end user work processes for employing field device diagnostics. This initiative was critical to ensuring FOUNDATION instruments are consistent with the NE107 guideline requiring field devices deliver extensive diagnostics, which help ensure optimum plant efficiencies are achieved.

The Fieldbus Foundation/NAMUR working group analyzed specific requirements for device diagnostics in developing a field diagnostics profile specification. These included:

- Common view of instrument-specific diagnostics
- Common configuration environment
- Extensibility
- Leverage of existing “push” technologies (e.g. alerts and alarms)
- Flexible configuration to meet user applications
- Simulation for FAT/SAT activities
- Ease of understanding and implementation
- Adoption by system and instrument vendors

Using the power of FOUNDATION fieldbus, and considering the NAMUR NE107 recommendations, the Fieldbus Foundation developed a profiles specification enhancing the organization and integration of device diagnostics within FOUNDATION fieldbus systems. The new diagnostic profile includes a standard and open interface for reporting all device alarm conditions, and provides a means of categorizing alert conditions by severity. The technology facilitates routing of alerts to appropriate consoles based on user-selectable severity categories. In addition, it provides recommended corrective actions and detailed help, as well as an indication of the overall health of the device.

The **FOUNDATON fieldbus Diagnostics Profile Specification (FF-912)** was defined to allow any Electronic Device Description (EDD)-based system to access and configure the diagnostics in fieldbus devices. The field diagnostics profile makes no
changes to the existing FOUNDATION fieldbus stack specifications. However, the profile does introduce a new field diagnostic alert type. System updates will provide more extensive integration capabilities (such as Wizards for configuration) that will enhance diagnostics performance.

Rather than introduce significant changes to the current FOUNDATION protocol, the new diagnostic profile specification builds upon the existing, powerful diagnostic capabilities of FOUNDATION fieldbus equipment, and at the same time, adds a greater degree of organization so field instruments can represent their diagnostics in a more consistent way.

FOUNDATION fieldbus has always utilized “push” diagnostics, which allows the user to receive alerts much faster, instead of the traditional “polling” method of requesting diagnostic information from devices. Every fieldbus function block has a standard block alarm parameter providing 16 standardized diagnostic conditions. Current control systems scan field devices and may receive diagnostic event information once per day. This process requires a considerable amount of time to scan a large population of installed instruments. With the FOUNDATION fieldbus push method, diagnostic information is obtained within seconds instead of days.

The FOUNDATION fieldbus Diagnostics Profile Specification provides common, network-visible parameter names that go into fieldbus device resource blocks. The parameter names will all have the same data types and the same behaviors. In this way, device vendors can map their current equipment diagnostics to a common structure for presenting diagnostic information via the host system and plant asset management tools.

The diagnostic profile specification also allows for common tools and engineering procedures, which will reduce costs and deliver actionable intelligence from the field level to the end user.

As part of the field diagnostics solution, individual device vendors will define which diagnostics are available in their instrument, with the end user modifying these diagnostics based upon their specific process requirements. Each device will come with a default mapping of the field diagnostics developed by the supplier, and active diagnostic conditions will have a recommended course of action.

For example, Yokogawa’s EJX 910 (multi-variable) transmitter supports advanced diagnostic functions to detect abnormalities like an impulse line blockage and heat tracing problems. The configuration tool for the EJX 910, which is based on FDT/DTM Technology, provides customers a graphical interface with a simple look and feel to configure and enable these advanced diagnostic functions.

Implementing role-based diagnostics

Field diagnostics technology per the NE107 recommendation offers a robust solution for implementing role-based diagnostics, meaning the right information is sent to the appropriate person — when they need it — without flooding others in alarms (See Figure 3 on the next page).

Fieldbus devices offer greater value than older analog 4–20 mA devices through their ability to indicate data quality — i.e., whether signals communicating setpoints, PVs, etc. have good, bad or uncertain quality. This improves diagnosis of equipment problems and also helps validate measurement or control actions by field instrumentation.

It is helpful to think of a field diagnostics alert as a “check engine” light on an automobile. The diagnostic features of FOUNDATION fieldbus provide an indication that something is wrong with a particular device, as well as a standardized way to interpret and apply this information for maintenance and repair purposes. Once an alert is acknowledged, the first step is to determine the nature of the abnormal condition. Next, field diagnostics provides a clear recommended action. The third step is the detailed EDD screen, which helps to back up the operator action. Diagnostic information offered via enhanced EDDL features such as charts and graphs is available to assist troubleshooting.

Field diagnostics enhances user control and distribution of messages between field devices and host/asset management systems. This allows for faster response times as each message is presorted according to criticality, whether it is a process alarm or a maintenance alarm. Users can map alerts (in any of the four categories) based on their particular device situation and its importance to the overall process line. This, in turn, builds a standardized diagnostic system across all sorts of devices and creates a common way to structure, filter and deliver diagnostics to controllers. Using this technology, industrial facilities have the ability to specify the diagnostics most important for a given operation or process area. They can also determine the priority of the
diagnostic information and identify all appropriate recipients for particular data.

For example, device diagnostics like those for thermocouple degradation, temperature tracking, and statistical process monitoring can be prioritized and categorized according to the NAMUR NE107 recommendation.

In the past, operators were frequently overwhelmed by nuisance alarms and alerts that distracted their attention from running the process. This situation can result in unnecessary shutdowns, or cause operators to disregard online asset management tools, which, in turn, leads to valid alarms being ignored. Now, thanks to field diagnostics, plants can avoid wasting money and resources on irrelevant diagnostics, and can take the appropriate control or maintenance actions when they are truly needed. Plant personnel are able to make better decisions, in less time, and potentially save or extend the life of valuable assets.

Help available for device developers

The Fieldbus Foundation is recognized as one of the few automation industry organizations that has implemented a rigorous procedure for control equipment registration. The foundation is now paving the way for adoption of field diagnostics technology per NE107 by developing a comprehensive tool kit, which assists in the registration of devices implementing new diagnostic profiles.

The Fieldbus Foundation 5.1 Interoperability Tool Kit (ITK) has been updated from previous versions with field diagnostics profiles enhancing the organization and integration of device diagnostics within Foundation fieldbus systems. The test kit verifies the functionality of an H1 (31.25 kbit/s) device and its conformity with the Foundation fieldbus Function Block and Transducer

**Fig. 3**

Role-based diagnostics means the right information is sent to the appropriate person — when they need it.
Block specifications. An excellent tool for troubleshooting and debugging devices, the test kit includes all hardware and software required to ensure a manufacturer's complete device interoperability as specified by the foundation's official registration testing procedure.

By using the H1 ITK 5.1, device developers can run tests identical to those used by the Fieldbus Foundation before submitting their device for official registration. The H1 ITK now includes support for the FF-912 Field Diagnostics Profile Specification. The kit also provides a Resource Block parameter set to implement the field diagnostics profile, as well as various other software enhancements.

Additionally, the Fieldbus Foundation will test for field diagnostics support as part of the standardized host features verified during its host registration procedure. This feature will become mandatory for all registered hosts starting in late 2010.

**Conclusion**

Cooperation between the Fieldbus Foundation and NAMUR has enabled the global process automation industry to develop a greater understanding of end user requirements for adopting fieldbus technology. It has also helped pave the way for process plants to implement better and more useful asset management strategies.

Asset management based on end user requirements, with a consistent and structured approach to information, gives plant personnel a meaningful tool to achieve operational excellence. To be effective, it is essential that the right information gets to the right people in the right form — and at the right time. Ultimately, plant owners will benefit from field diagnostics advancements thanks to easier diagnostic configuration, greater application flexibility, and fewer spurious alarms.

**References**

1. NAMUR-Geschäftsstelle, NE107, “Requirements to Self-Monitoring and Diagnosis of Field Devices” (October 2006).
Fieldbus Product Registration: What it Means to End Users

Rigorous testing verifies interoperability and integration of fieldbus systems

The Fieldbus Foundation initiated its Product Registration Program to meet the global automation community’s demand for tested, proven fieldbus instrumentation providing all of the robust features of FOUNDATION technology. End users were seeking assurance of interoperability among fieldbus products with known characteristics, supplied by different manufacturers. This approach would simplify selection of best-in-class solutions from the user’s supplier-of-choice.

The Fieldbus Foundation is one of the only automation industry organizations with a registration program requiring mandatory testing of critical elements of its technology. This rigorous effort encompasses all of the components required to build a FOUNDATION fieldbus system, including host systems and field devices, as well as physical layer equipment such as power supplies, device couplers and cable.

Within the Fieldbus Foundation’s automation infrastructure, interoperability is made possible by the fact that devices and software must conform to the same standard. Registered FOUNDATION fieldbus products have undergone a series of common tests audited by the Fieldbus Foundation. This provides the freedom to select the best device for a specific measurement or control task — regardless of the manufacturer.

The FOUNDATION Registration “mark” is the manufacturer’s representation that a sample of the product has successfully completed all test protocols specified in the Fieldbus Foundation’s Device Registration Process.

The Fieldbus Foundation’s testing program provides independent, third party validation of product conformance to the open, non-proprietary FOUNDATION fieldbus specifications. The testing process documents that products have met those requirements, and test results are available for public access.

Why register fieldbus products?

Fieldbus Foundation Product Specialist Mike Stathopoulos believes registration testing reduces interoperability and integration risks for end users getting started with fieldbus, or expanding their implementation of the technology. This is critical because the FOUNDATION solution is more than just a network protocol — it is a complete automation system architecture.

“Fieldbus users are dealing with intelligent devices that not only measure...
parameters like temperature and flow, but also perform complex PID control functions,” said Stathopoulos. “The fieldbus system environment involves multiple host and device suppliers, each utilizing a different tool set. So the goal of our registration program is make sure users have a good experience with integration of this equipment.”

He continued, “The registration program’s interoperability testing broadens the availability of options for industrial applications that need a varied level of products from different manufacturers. Also, with EDD interoperability testing through host profile testing and registration, end users are more assured of a common “look and feel” for device user interfaces from various vendors in a host system. This commonality leads to reduced learning curves by those operating and working with the equipment. In the end, this amounts to savings.”

The Fieldbus Foundation began its registration program in 1998 with H1 (31.25 kbit/s) stack and field device testing. High Speed Ethernet (HSE) stack and H1/HSE linking device testing were added in 2001. Host interoperability support testing (HIST) started in 2000, and was subsequently upgraded to host registration testing. Power supply and conditioner testing began in 2004, and cable testing followed in 2008. Coupler and HSE field device testing have not yet been used for registration purposes.

The introduction of host registration testing in 2008 enhanced the foundation’s overall product registration solution by supporting a new level of consistency in a multi-vendor FOUNDATION fieldbus environment. It also highlighted the significance of enhanced Electronic Device Description Language (EDDL), because Device Description (DD) Version 5 visualizations, methods and persistent data features became mandatory in this testing.

In order to be registered under the Host Profile Registration Process, host systems must support a clear set of required features. Suppliers now have access to standardized test requirements and test cases for all hosts within a profile tested to the same requirements; standardized Device Descriptions (DDs) and Capability Files (CFs) assuring hosts can parse files; and standardized test devices for all basic I/O function blocks and specialized test transducer blocks.

Both automation suppliers and end users benefit from host registration. Like the original H1 device registration process, host registration strengthens fieldbus interoperability and system integration.

How is the testing done?

The Fieldbus Foundation’s registration testing program encompasses all critical components of the FOUNDATION fieldbus system architecture. Test procedures are designed to address unique aspects of the FOUNDATION user layer, which includes function blocks for process control and transducer blocks for device configuration, set-up and maintenance.

The H1 device registration process defines a series of test protocols, summarized as a set of specification features, for a particular device profile. The test protocols include test campaigns performed either by the manufacturer, an approved third-party testing facility, or the Fieldbus Foundation’s laboratory in Austin, Texas. The device-under-test must pass all required test cases related to a specific feature.

For registration, each H1 device must pass three separate test campaigns. The first campaign addresses electrical characteristics of the fieldbus network. The second campaign concerns the device communications stack. The third campaign includes extensive interoperability tests.

H1 physical layer tests are performed to ensure that a submitted device can properly function on a fieldbus segment. Stack testing confirms the ability of the device to package and control communication. Application layer testing ensures the device can be linked, handles modes, and is interoperable on the segment.

Each test case can have a verdict of Device and host registration testing provides an extra measure of confidence that fieldbus products incorporate the robust functionality of FOUNDATION technology.
MTL has made a major enhancement to its class-leading range of Fieldbus Intrinsically Safe Concept (FISCO) power supplies for FOUNDATION™ Fieldbus networks.

With the introduction of power supply redundancy, FISCO can now be specified for even the most critical hazardous area applications, while retaining the key benefits of intrinsic safety such as the ability to conduct 'live maintenance' on the entire field network. The redundancy scheme eliminates the risk of network failure in the event of the loss of a single power supply unit. Such redundancy is routinely specified by end users and engineering companies where failure could result in down-time and lost production.

To find out how MTL can help you with your next Fieldbus project, visit our website at: www.mtl-fieldbus.com or email: enquiry@mtl-inst.com

Highest levels of system availability
Fully live-workable trunk and spurs
Compliant with IEC 60079-27 FISCO standard

SEAMLESS WIRELESS INTEGRATION.
Smart Wireless lets you start anywhere and go everywhere.

Whether you start with a handful of nodes or hundreds, Emerson Smart Wireless gives you the first truly scalable wireless network that seamlessly integrates with your wired one. Thanks to open, interoperable WirelessHART™ and industrial Wi-Fi standards, Emerson Smart Wireless incorporates directly into your existing automation architecture — without any need for upfront engineering, site surveys or special commissioning. And to your operators and maintenance staff, each Smart Wireless device looks and behaves like a wired one, no matter how many you install. So not only is it self-organizing, Emerson Smart Wireless plays well with others too.
PASS, FAIL, INCONCLUSIVE or NOT RUN. INCONCLUSIVE results are analyzed by the test administrator and given a final verdict of PASS, FAIL or NOT RUN. A device successfully completes a test campaign when all test cases of a test schedule result in a verdict of PASS or NOT RUN.

Specific test procedures

Individual testing and registration programs have been developed for each class of FOUNDATION fieldbus product. Specific test procedures include:

H1 DEVICE
- Test physical layer
  - Device adheres to the required physical characteristics for H1 segments
- Test communications stack
  - Device communicates when it should and stays silent when it should
  - Device packages messages properly
- Test application layer
  - Ensures that device contains required parameters
  - Checks for blocks and adherence to the requirements of those blocks
  - Examines system links, schedules, mode and status handling, and other block behavior

H1/HSE LINKING DEVICE
- Testing establishes that a linking device can transfer messages from HSE to H1 and from H1 to HSE
  - Checks timing, retransmission, scheduling
  - Behavior is observed on both the H1 and HSE parts of the device
  - Tests are run by connecting the device-under-test via HSE to a computer running the test system, and via H1 to a test box

HSE FIELD DEVICE
- Test communication stack
  - Device can communicate over Ethernet

HOST SYSTEM
- Ensures compliance to host profile requirements
- Profiles indicate intended use of host system:
  - Class 61 – Integrated Host
  - Class 62 – Visitor Host
  - Class 63 – Bench Host
  - Class 64 – Bench Host, limited access to device parameterization
- Testing involves hands-on checking of compliance with listed requirements for registered host profile
  - H1 and HSE device support
  - Distributed application support
  - DD support
- Includes standardized test requirements and test cases
  - All hosts within a profile are tested to the same requirements
  - EDD requirements implemented in cooperation with Profibus and HART
- Requires standardized DD and CF file(s)
  - Assures host can parse files
  - Verifies EDD and CF interpreter
- Incorporates standardized test device
  - All basic I/O blocks and function blocks
  - Specialized test transducer blocks

POWER SUPPLIES AND CONDITIONERS
- Includes physical layer tests
  - Checks for compliance with IEC 61158-2: 2003
  - Checks for compliance with FF-816 power requirements

- Examines output voltage, ripple and noise, jitter, resonance, start-up, short-circuit recovery, device addition and isolation

CABLE
- Includes physical layer tests
  - Ensures registered cable adheres to specified requirements
  - Examines impedance, attenuation, wire, resistance, shielding and jacketing

Selecting registered products

The Fieldbus Foundation audits each manufacturer’s product as it completes the formal testing procedures, and issues a certificate identifying registered features for equipment meeting all requirements of the registration process. Registration is only valid for the product identified on the certificate. If the manufacturer modifies a registered device, system or component, it must fulfill all the registration requirements in order to maintain the product’s registration status.

Registered FOUNDATION fieldbus products are listed in an online catalog at www.fieldbus.org/registered. This catalog provides a detailed profile for each registered device, including standard blocks tested for interoperability, the presence of untested Function Blocks (if any), and additional useful information.
Technology Experts Share Knowledge Through Lab Integration

Project enables fieldbus developers to leverage common experiences

The Fieldbus Foundation and its members worldwide have embarked on a lab integration project that will enable continuous fieldbus technology quality improvement through collaboration. This endeavor will bring together different vendor-specific test labs as a means to share information and continuously enhance the user experience with Foundation fieldbus.

Scope of lab integration effort

Darie Dreptate, Fieldbus Foundation product marketing team leader, believes the new lab integration program will help to continuously improve the device integration user experience based on products complying with the Foundation fieldbus Technical Specifications (FF-007). He said, “The Lab Integration Team is made up of highly skilled engineers who have first-hand experience with the integration of multi-vendor Foundation fieldbus devices within one or more host applications.”

According to Dreptate, the first step in the lab integration effort is to define a process for collecting interoperability and usability experiences with the integration of Foundation fieldbus devices and systems from all participants. Project team members will then perform root cause analysis on these issues, and forward their findings to other fieldbus labs as Action Requests (ARs).

Dreptate indicated the lab integration project will also define common integration test requirements and test cases for fieldbus instrumentation and host systems. The work will identify standardized procedures for testing the Foundation fieldbus physical layer, function blocks, Device Definitions and Link Active Schedulers.

Current working group status

The lab integration team has its procedures in place, and this effort will be a continuing process for team members. Experiences identified as part of the project will be shared through a series of lab integration reports.

Future updates of the lab integration project will be available on the Fieldbus Foundation’s website at www.fieldbus.org.
Technical Tip:
Importance of Training To Project Success

Technology instruction can help ensure successful fieldbus installation

John Rezabek, Chairman, Fieldbus Foundation End User Advisory Council
David Lancaster, Fieldbus Instructor, Trine University

Certainty of outcome is important on any plant automation project, but delivering it isn’t free. This is especially true on projects involving FOUNDATION fieldbus. What are some of the key areas where effort and/or investment are needed to obtain sufficient certainty of outcome for even the smallest project? Training, for one.

During the execution of a fieldbus project, stakeholders requiring training include a wide range of engineering and design disciplines, including I&E, controls, and process specialists. The installer/constructor may need training as well. What this accomplishes, among other things, is ensuring that everyone speaks the same language, understands how to apply the rules or guidelines of the job, and has an opportunity to express their concerns about delivering certainty of outcome for their scope of work.

Engineers and designers need guidance from process specialists earlier in a fieldbus job to understand where sensors and valves are likely to end up on the plot plan. Process specialists also can give guidance on loop criticality, so end users’ guidelines for segregating highly critical loops can be accommodated. Clients can dream of saving money by eliminating a junction box drawing for fieldbus, but it may end up costing them when the installer needs daily guidance to interpret segment drawings.

Training can also bring to light diagnostics capability. Users can save a lot of effort by having alarms and alerts delivered with the preferred settings preset by the factory, conceivably saving weeks or months of implementing the proper settings on every device.

Field Device Integration Working Group: Status Report

Cooperative effort incorporates best aspects of EDDL and FDT solutions

Increasingly, protocols and processes are converging in the automation industry. The divide between discrete, factory, batch, and process control is closing, and end users face important decisions about the operation of their facilities.

The integration of Electronic Device Description Language (EDDL) and Field Device Technology (FDT) promises to unify industrial automation. The combined EDDL/FDT solution aims to present real-time data in a consistent format that makes plants operate efficiently and safely without confusion.
Originally announced at the 2007 Hanover Fair in Germany, the joint development agreement between the EDDL Cooperation Team (ECT) and the FDT Group resulted in a combined effort on Field Device Integration (FDI) that is compatible with both technologies.

EDDL and FDT have traditionally served in different markets with respect to device configuration, diagnostics and runtime operation. EDDL was primarily targeted toward the process industries, whereas FDT was largely intended for discrete automation.

The FDI concept integrates the advantages of both EDDL and FDT/DTM (Field Device Tool/Device Type Manager) in a structured client-server architecture. This solution also incorporates the positive system aspects of EDDL and FDT, including robust interpretation or “nested communication” — the open communication within heterogeneous hierarchical networks.

FDI is intended to apply to a full range of device applications; from a simple single-variable device to a complex multivariable transmitter and valve positioner or motor controller. The basis for FDI was developed at the “itm” Institute of Munich’s Technical University and first presented to the public at the NAMUR (International User Association of Automation Technology in Process Industries) 2006 Annual General Meeting under the name FDD UA.

Ultimately, FDI will ensure compatibility with all existing EDDL- and DTM-based Device Descriptions (DDs). The technology will eliminate redundancies by automation vendors and customers where they may exist, as well as preserve backward compatibility and operating system independence. It will be applicable to any field device communication technology, as well as all hierarchical and heterogeneous network topologies.

Regardless of the model, the vendor, the age of the device, the communication protocol at work, or the complexity of the measurement, the output display will be consistent graphically and in content when successful device integration is at work.

The integrated FDI solution will appeal to both end users and automation suppliers. For users, this approach will permit them to focus on purchasing the hardware of their choice without worrying about the compatibility with their control host. For vendors, FDI will focus investment, development, and support efforts on one solution.

The FDI working group has devoted considerable time and resources to identifying use cases encompassing all facets of plant operations: from startup and commissioning to ongoing maintenance activities and plant operations. The group has drafted an FDI architecture concept that meets the needs of each technology as they are migrated to a common standard.

The FDI working group includes representatives of leading automation industry companies. For example, two experts from Yokogawa are contributing to the development of the Client specification of FDI. Yokogawa considers this a key technology for its host systems in order to provide end users a single window for easy field device configuration and maintenance.

Another major supplier, Rockwell Automation, has contributed to the FDI effort by authoring several works for the project as well as serving as host for several working group sessions. Rockwell PlantPAx System users can have confidence that involvement in FDI will provide insight into this emerging technology.

ABB is also a highly involved participant on the FDI team, contributing time from three experienced knowledge specialists plus resources for prototyping and technology verification.

Recent FDI working group activities have focused on fulfilling functional specification requirements. Validation of technical specifications is scheduled for early next year, with release of the final FDI functional specification planned for the middle of 2010.

Major control equipment suppliers and user organizations are cooperating on an FDI framework supporting the growth of intelligent instrumentation technology around the world.
The Fieldbus Foundation has announced the availability of a new technical document (AN-007) describing application guidelines for deploying FOUNDATION fieldbus devices and hosts, and identifying specification enhancements that improve the end user experience when replacing or upgrading a wide range of fieldbus instrumentation.

The FOUNDATION fieldbus Device Replacement Application Note was developed to complement the Fieldbus Foundation’s H1 technical specifications with respect to the topic of replacing a field device in a running system. It helps to simplify the functionality of reproducing an existing FOUNDATION fieldbus device configuration (including all function blocks and parameters) in a new device.

The document also minimizes the need for end users to understand the intricacies of FOUNDATION technology, and at the same time, helps to ensure that fieldbus device replacement can be performed quickly and easily without disturbing network operations.

According to the Fieldbus Foundation’s manager, fieldbus products, Stephen Mitschke, the Device Replacement Application Note provides valuable guidance for FOUNDATION system and device suppliers on how to implement backwards compatibility in their fieldbus product offerings. He said, “In essence, this application note defines the contract between fieldbus systems and devices as it relates to the replacement of complex automation equipment. The document will ultimately make it easier for end users to perform routine tasks like substituting older devices with newer instrumentation.”

With a typical FOUNDATION fieldbus system, there are numerous situations where it may be necessary to replace an existing field device with a new or different instrument. These include:

- Substituting an existing device with a new, similar device (same brand and model) that represents an updated version
- Replacing an existing device with a new device that has identical communication and software implementation features, but utilizes a different hardware setup such as process connections, sensors, etc.
- Replacing an existing device with a new device that has the same hardware features, but is manufactured by a different vendor
- Replacing an existing device with a new device that has different features (e.g., different capability levels, completely different block set, etc.), which requires re-engineering the fieldbus network and/or device configuration.

The FOUNDATION fieldbus Device Replacement Application Note addresses examples of fieldbus device replacement having practical relevance for developing guidelines for current device and host implementations. In each of the aforementioned scenarios, device replacement can be accomplished in a number of different ways.

The new application note is available to all Fieldbus Foundation members with a FOUNDATION specification license and maintenance agreement. The document can be downloaded from the “Fieldbus Forums” section of the foundation’s website at http://forums.fieldbus.org.
Abengoa Bioenergy Optimizes Greenfield Fieldbus Installation

Innovative segment termination solution holds key to project success

Tim Wilson, Chief Operating Officer, Abengoa Bioenergy
Jeff Marsh, Senior Project Manager, FeedForward

Many process plants are embarking on real fieldbus applications for the first time. Fieldbus is a truly enabling technology, but its installation involves some additional considerations over and above traditional 4–20 mA systems. Upfront engineering is key to the success of any fieldbus project, and end users must be mindful of physical layer requirements such as power conditioning and segment termination.
Like other process industry operations, bio-fuel production plants seek state-of-the-art automation technology in order to reduce raw material costs, increase yields, comply with regulatory standards and maximize revenues. However, plant managers must ensure control systems provide reliable operation and a low cost of ownership over the life of installed assets.

Although modern, fieldbus-based process control systems offer many operational benefits, ethanol producers need effective measures protecting the fieldbus physical layer against short circuits, improper termination and other problems that can adversely affect system performance and reliability. They also need solutions enabling a quick ramp-up from installation to operation of the control system in order to improve their time to market.

Background

Industrialized nations dependent on other countries for fossil fuels have been severely impacted by declining oil reserves, coupled with an uncertain worldwide economic and political outlook. As a result, the U.S. government, along with leading energy producers, is ramping up support for alternative energy sources. A tough challenge for bio-fuel producers. To ensure business success, ethanol plants must tightly control their production processes.

Achieving consistent profitability can be a tough challenge for bio-fuel producers. To ensure business success, ethanol plants must tightly control their production processes.

Abengoa Bioenergy has more than 340 MGY of total installed capacity worldwide. In addition to the Ravenna site, the company operates ethanol facilities in Colwich, Kansas; York, Nebraska; and Portales, New Mexico. Its parent corporation, Abengoa Bioenergy, S.A. is one of the world’s leading bio-fuels manufacturers and the largest ethanol producer in Europe.

In Abengoa’s dry mill process, corn starch is hydrolyzed into sugar and then fermented into alcohol. The major steps in the dry mill operation are: milling, liquefaction, saccharification, fermentation, distillation, dehydration and denaturing.

When launching its ethanol plant project in late 2006, Abengoa Bioenergy enlisted Fru-Con, a large industrial engineering firm, to handle the plant design, project planning, procurement and construction. FeedForward, Inc., a control systems integrator serving the processing industries, was awarded the contract for control system design and installation.

Abengoa challenged its project team to achieve the lowest total cost of plant ownership through automation and integration from an operational and maintenance standpoint. Plant optimization required a state-of-the-art automation architecture connecting “smart” field instrumentation into a Distributed Control System (DCS) using digital networks with a high degree of diagnostics and troubleshooting information.

With the right automation technology, Abengoa could reduce the number of people involved in controlling and maintaining the ethanol plant, while at the same time, optimizing production by minimizing downtime and maximizing margins.

After considering alternative solutions for plant enterprise automation, Abengoa decided upon Yokogawa’s CENTUM CS3000 DCS. This system enables true distributed control throughout the ethanol plant. It distributes control strategies to field instruments, enables flexible device networking, and allows free access to the process and devices by system software.

The Yokogawa DCS takes full advantage of open, digital network standards to provide a secure control platform for the future. The system employs the FOUNDATION fieldbus H1 protocol for use with analog devices, and AS-i bus with a Profibus-DP gateway for all motor control centers (MCCs). The major advantage of fieldbus technology, and the one most attractive to end users, is its reduction of capital expenses (CAPEX) and operating expenses (OPEX) through reduced wiring and greater information availability from field instruments. Remote configuration and asset manage-
Avoid the number one pitfall of FOUNDATION fieldbus™ networks: All power and communications are vulnerable to a single broken twisted wire pair.

Designed for plant-critical fieldbus segments, TRUNKSAFE™ maintains all process communications without interruption, even if the network cable is broken or shorted.

With TRUNKSAFE, now you can take full advantage of fieldbus technology without worrying about simple cable failures.

Learn more at: www.miinet.com/moorehawke
ment are two further benefits of fieldbus installations in process plants.

**FOUNDATION fieldbus** is an all-digital, two-way communications system interconnecting interoperable field equipment from different suppliers, such as sensors, actuators and controllers, on a single network. The fieldbus system infrastructure reduces the amount and complexity of wiring throughout a plant (See Figure 1 above).

**FOUNDATION fieldbus** also transmits multiple variables, enabling a reduction in process variability as well as device identification information. The technology allows collection and transmission of robust instrument diagnostics, thus reducing unnecessary shutdowns and improving safety and regulatory compliance.

For motor control centers, Profibus-DP offers simplified control, increased diagnostics and reduced cabling. The Profibus network allows centralized control to be connected to widely distributed I/O as part of the MCC. Profibus cabling functions as a replacement for the bundles of hard-wiring typically interconnecting operating units. Functionally, each MCC device connected to the system becomes a node on the network.

**Fieldbus design considerations**

Without correct connection of wiring and field devices, any anticipated ROI from fieldbus technology can be wiped out as technical complications can delay setting up a plant and take a long time to recoup in operational savings.

It has been estimated that wiring malfunctions are responsible for about 90 percent of the challenges on fieldbus projects; the biggest causes of performance and reliability problems are bad termination, short-circuits, interference and inadequate earthing. Under/over termination, in particular, can be a significant issue during plant startup and commissioning. Simply put, technicians sometimes set segment terminators incorrectly for a given installation.

All fieldbus segments need proper termination to prevent communication errors through uncontrolled signal reflections. In some cases, multiple terminators are placed on an individual segment — creating major complications on large installations. Physical inspection of junction boxes and field enclosures is often the only way to locate and correct the terminator position, which is a significant delay to the commissioning process.

Short-circuits are another common problem in fieldbus installations. Maintenance technicians can jostle cables, corrosion can weaken connections, and vibration from pumps and motors can loosen cables and connectors. Plant operators must be concerned about what might happen to an entire fieldbus segment if any single instrument shorts out.

Engineers designing fieldbus systems are faced with incorporating some form of spur short-circuit protection, which may be either active or passive in design. A “current limiting” approach, employed by many conventional fieldbus device couplers, restricts the amount of power short-circuits can draw to between 40 and 90 mA. However, it also holds the fault on the segment continuously. The additional current draw can deprive other instruments on the segment of power, overload the segment power supply, and cause an entire segment to have a catastrophic failure.

For example, a segment may have 10 measuring devices plus two valves connected via 1000 m of 50 Ohm nominal cable. In this case, the trunk voltage drop equals 12.5 V, which allows 12.5 V at the farthest device. However, if a short occurs at a spur and an additional 60 mA load is “locked in” to the segment, this takes away enough power so that devices receive less than 9 V, and some will drop off the segment. If two shorts occur, all the devices could drop off, and an entire process unit might go down.

**Physical layer solution**

Industrial plants can avoid many fieldbus physical layer problems from the beginning, simply by specifying the latest generation of device couplers with automatic segment terminators and short-circuit protection. These devices simplify fieldbus installation and significantly reduce the time required to install and troubleshoot devices in the field.

The new breed of fieldbus device couplers
greatly assist in segment commissioning by eliminating errors associated with manual termination, including failures resulting from over/under termination. They also address the problem of excess current on a fieldbus spur; rather than limiting the fault current to a fixed (and always higher) level, the spur current is switched to a nominal trickle-level. With removal of the short, the spur is automatically reconnected to the fieldbus segment.

On Abengoa’s Greenfield project, FeedForward, acting as control system designer, installed the MooreHawke TRUNKGUARD system — the first FOUNDATION fieldbus and Profibus physical layer solution providing fully automatic fieldbus segment termination. The control system architecture incorporated 72 individual fieldbus segments with over 650 nodes. The device segments were installed utilizing MooreHawke field device couplers, redundant fieldbus power supplies and segment power conditioners.

From FeedForward’s perspective, TRUNKGUARD provided seamless “plug and play” connection with the Yokogawa DCS. The control system’s H1 cards connected directly to the power conditioner boards, eliminating the need to manually wire each fieldbus segment.

Unlike the older current limiting technique, TRUNKGUARD’s revolutionary short-circuit protection method prevents segment failure caused by single device faults. Its unique “fold-back” technique automatically removes the faulted device from the segment, and does not permit any current flow to the device until the fault is corrected. The fold-back technique employs a logic circuit on each spur, which detects a short in an instrument, disconnects that spur from the segment, and illuminates an LED visible to maintenance personnel. The auto-termination capability assures local parts of a segment will continue to function even if remote parts of the segment are accidentally disconnected, preventing costly downtime and hazardous situations — a matter of critical concern in both process and discrete manufacturing.

Tests by Evaluation International, an independent instrumentation testing and evaluation service, confirm the advantages of the fold-back technique: When a spur is short-circuited, segment voltage actually increases, because the device coupler removes the shorted device from the segment. This means multiple short-circuits on a segment cannot deprive other instruments of power and cause a complete segment failure, as with conventional device couplers (See Figure 2 on the next page).

With fold-back device couplers, users are also free to place more devices on fieldbus segments. A large industrial process operation may have hundreds if not thousands of devices. If the “safety margin” approach is implemented, where the entire capability of fieldbus is not used, the cost of all the extra fieldbus segments can become substantial.

CONTINUED ON NEXT PAGE
End user benefits

For Abengoa Bioenergy, the fieldbus-based DCS employing TRUNKGUARD technology will deliver long-term competitive benefits. Fieldbus provided a “leaner” automation architecture containing less wiring and hardware than a traditional control system. Loop and wiring diagrams, panel drawings and cable schedules were greatly simplified. Plus, installation was easier than with a traditional system since several devices could be multi-dropped on a single pair of wires.

The flexibility of the fieldbus architecture also allows the Ravenna plant to reconfigure its process automation scheme to meet product and sales demands without major reinvestments. It reduces I/O subsystem requirements and makes the plant control system very scalable. The system can be expanded or modified loop-by-loop as needed.

Thanks to the fold-back device couplers, which do not allow any excess current per spur under fault conditions, FeedForward’s control system designers were free to configure fieldbus segments at their maximum capacity. Unlike the current limiting approach, which places additional load on the fieldbus segment upon detecting a short, the fold-back technique removes the failed device from the segment and utilizes a “trickle current” to determine when the short is eliminated. This, in turn, enables voltage on the segment to actually increase — minimizing the possibility of other devices dropping off the network.

The TRUNKGUARD solution also expedited unit startup at the Abengoa facility by providing increased fieldbus status information. Green and red LEDs on device couplers helped technicians determine if there was proper voltage on the fieldbus spurs. The indicator lights also showed whether terminators had been applied at specific device couplers.

Lessons learned

Abengoa’s Greenfield ethanol plant project provided valuable insights for process industry end users installing their first fieldbus control systems. Engineers face new challenges when designing fieldbus segments, which potentially can be brought down by a single short. For most process plants, this is unacceptable; they cannot afford an unexpected shutdown that would immediately affect their bottom line.

Specific “lessons learned” from the Abengoa project include:

1. Don’t become confused by the choice of fieldbus technologies. Rather, choose a solution that provides a satisfactory and functional control system for your particular application. In continuous operation process plants, FOUNDATION fieldbus and Profibus-PA are the dominant fieldbus protocols. Most installations will use multiple fieldbus technologies to accomplish the many tasks required.

2. FOUNDATION fieldbus and Profibus systems carry both DC power and the digital communications signal on the same wire pair. Thus, the segment power supply requires low pass “conditioning” to filter out that signal. This conditioning may be “active” (notch filters, etc.) or “passive” (series inductance).

3. Terminators are required at each end of the segment cable to prevent line reflection, which may otherwise result from open-ended cables, and also to source/sink the communications current. Careful installation management to ensure the correct number of terminators is essential, or the issue can be completely avoided by using device couplers that automatically provide correct signal termination.

4. Short-circuit faults on individual spurs will drag down the entire fieldbus segment. Hence, device couplers need to incorporate some form of spur short-circuit protection, which again may be active or passive in design. The best approach is auto-setting fold-back overcurrent protection, where any faulty spur is switched off and that load completely removed from the segment. This approach also allows system designers to use the maximum available power supply capacity without worrying about “headroom.”

5. Do not ground the shield in the field. This can result in unnecessary complications and noise issues. Instead of grounding in multiple locations using a capacitive technique, installers should ground the bus one time only at the power conditioner level.

Conclusion

Thanks to a well-engineered fieldbus automation solution, Abengoa’s Ravenna, Nebraska, ethanol production facility has achieved optimal process operating conditions that increase yields, while also cutting the amount of energy needed per gallon of ethanol produced.

Abengoa ensured the fieldbus installation was simple, practical and reliable by utilizing the TRUNKGUARD physical layer solution. On its Greenfield plant project, these innovative fieldbus device couplers spelled the difference between quick up-time and low maintenance, versus delayed start-up and frequent downtime.
Fieldbus Solution Highlights

**SMART PRESSURE MEASUREMENT WITH ENDRESS+HAUSER**

- Cerabar S and Deltabar S for pressure/differential pressure, level and flow
- Deltapilot S for hydrostatic level measurement
- Totalizer for flow measurement
- Comprehensive diagnosis information
- Output limit and sensor alarming

**EJX MULTIVARIABLE TRANSMITTER**

The EJX multivariable transmitter precisely measures differential pressure, static pressure, and process temperature, and has dynamic mass flow calculation based on full compensation by these measurement values. Dynamic flow compensation allows the EJX multivariable transmitter to eliminate errors in the differential flow calculations and to optimize the flow.

Other key features for Foundation fieldbus include the following:

- **Advanced diagnostic** — The multi-sensing technology provides the advanced diagnostic function to detect such abnormalities as an impulse line blockage or heat trace breakage.
- **10 variables display on LCD** — Up to 10 process variables and inputs from other devices are cyclically displayed.

The transmitter, with a maximum working pressure of 32 MPa, is also ideal for high pressure applications.

**YOKOGAWA**

http://www.yokogawa.com/fld/PRESSURE/EJX/fld-ejx-group-01en.htm

**FREE FIELDBUS JARGON BUSTER**

If you mix up HIST and host, can’t tell a chicken foot from a backbone, or wonder what Kermit has to do with fieldbus technology, then the ABB Fieldbus Jargon Buster is the publication for you. It contains a clear explanation of dozens of fieldbus technical terms and can be downloaded from the web address below.

**ABB**

http://instrumentation.request-center.com/8

**EMERSON ANNOUNCES NEW CONTROL MODULE TO EXPAND THE APPLICATION SCOPE OF FieldQ™ ACTUATORS AND CONTROLS**

Emerson Process Management announces a new FieldQ™ control module for use in conventionally wired applications. The new module significantly expands the application scope and scalability of the FieldQ range of fully integrated pneumatic actuators and controls for on/off and modulating control valves. FieldQ now covers multiple applications from simple switching to high end buses with diagnostic capability.

The new module enables on/off control and provides all the FieldQ benefits of a field proven, rack and pinion pneumatic actuator with controls, in a compact, reliable and robust, modular package. The FieldQ integrated solution is suitable for both new and retrofit installation. The “plug and play” control modules provide an easy upgrade path to a Smart module, which features integrated local On/Off controls and Status/Position LEDs or bus control, providing feedback and advanced diagnostics.

**EMERSON PROCESS MANAGEMENT**

http://www.emersonprocess.com/valveautomation/fieldq/

**WHITE PAPER GIVES FIELDBUS BASICS**

MooreHaweke, a division of Moore Industries-International, Inc., has released a white paper called “Introduction to Fieldbus.” This concise 8-page bulletin explains, in terms any engineer, technician or operator can understand, how fieldbus works. It explains: the advantages of using fieldbus networks; the elements of fieldbus (H1 cards, power conditioners, segments, spurs, device couplers and segment terminators) and much more. To get your copy, go to the web address below.

**MOORE HAWKE**

www.minet.com/moorehaweke
NEW MTL FIELDBUS COMPONENTS

Whether you are planning your first fieldbus project or your 20th, it pays to know what is available. And MTL knows a thing or two about fieldbus networks, having been involved in defining the early standards right up to supplying the power supplies, wiring hubs, and components for the world’s largest fieldbus projects. So before you commit your hard-won budget, check out what’s available from the leading source of:

- Fieldbus power supplies
- Field test equipment
- Fieldbus I/O and displays
- Surge protection devices
- Process junction boxes
- Wiring hubs and components
- Integrated fieldbus diagnostics
- FISCO and FNICO supplies
- Fieldbus Barriers

For more information, request a copy of the latest product overview by e-mailing fieldbus.info@mti-inst.com and read up on application stories that outline why MTL is the world’s leading supplier of fieldbus components.

MTL  www.mtl-fieldbus.com

DATACELL FOUNDATION FIELDBUS CABLE FOR H1 NETWORKS

Northwire’s third-generation designs include 16 and 18 AWG, single- and multi-pair cables with alternate color, shielding and ground; and easy-to-strip, round, smooth jackets for effortless installation in cable glands. All are ITC-ER (no need for conduit), meet/exceed FF-844 for “Type A”, approved for Class I & II, Div. 2 locations, UL-listed ITC/PLTC-ER and CSA CMX-Outdoor-CMG-compliant. Dual-rated ITC and artic-grade marine-shipboard (to -60°C) versions offered.

Complimentary Sample!
Call 1-715-294-2121 or 1-800-468-1576.

NORTHWIRE  www.northwire.com/buscable

PEPPERL+FUCHS’ AWARD WINNING ADVANCED DIAGNOSTICS MODULE NOW AVAILABLE IN MOBILE CONFIGURATION FOR MAXIMUM FLEXIBILITY

The Mobile Advanced Diagnostic Module from Pepperl+Fuchs is a comprehensive physical layer measurement tool for Foundation fieldbus H1 and Profinbus-PA installations that can be used in Zone 2/Class I, Div. 2 areas. The Mobile ADM creates a visual picture of the fieldbus communication signal to facilitate faster commissioning work and easy, efficient troubleshooting. Diagnostic data is easily integrated directly into DCS/PLC device configuration and asset management tools. For more information, call (330) 486-0002 or e-mail sales@us.pepperl-fuchs.com.

PEPPERL+FUCHS  www.fieldconnex.info

PHOENIX CONTACT PHYSICAL LAYER OFFERS NUMEROUS BENEFITS

A modular approach to Fieldbus physical layer components from Phoenix Contact provides infrastructure connection between the process Fieldbus controller and field devices. The new concept, says the company, combines industrial electronic packaging and data communications competencies to deliver a high-value Fieldbus infrastructure solution. It provides a number of benefits:

- The fieldbus is expanded without disrupting communication
- Modular segment protection enables flexibility within the fieldbus network
- Valuable enclosure space is saved because only the needed number of device couplers are installed
- Scalability for fieldbus segment protection boosts control
- Fieldbus integrity equals a hot swappable modular design

For more details, visit the Phoenix Contact Website.

PHOENIX CONTACT  www.phoenixcontact.com/fieldbus

ROCKWELL AUTOMATION INTRODUCES THE PlantPax PROCESS AUTOMATION SYSTEM TO AWARDS

Rockwell Automation is delivering a unified automation control platform that delivers unmatched capabilities for process and other plant-wide applications, culminating with the PlantPax Process Automation System which features full support of FOUNDATION fieldbus technology. After the results of this year’s CONTROL Magazine Readers’ Choice Awards, it’s evident that the pros recognize the performance and reduced costs this unified platform provides. The Rockwell system scored a total of 31 first place Readers’ Choice finishes. The company’s wins came in the vertical markets, where systems were rated on their industry capabilities rather than on particular components. Preference was shown in several process industries: beverage, food, electric/power generation, pharma/life sciences, metals/minerals/mining, plastics/rubber, pulp & paper, water/waste water. View the full results at http://www.controlglobal.com/digital_edition/2009/0901/flash.html#I1


NEW FIELDBUS POWER SUPPLY SYSTEM FOR H1 SECTIONS

R. STAHL has expanded the HBus range, adding a new modular Fieldbus Power Supply System which provides up to 28 V and 500 mA for FOUNDATION fieldbus H1 segments, and also allows for redundant supply. In “Boost” mode, a parallel connection of two Power Supplies enables users to continuously supply the bus with up to 1 A, thus providing sufficient power reserves even for special fieldbus applications. An integrated Basic Diagnosis function monitors each segment for line faults, reporting these via a potential-free relay contact and indicating them via a red ERROR LED. Likewise, the activation of the integrated switchable fieldbus terminator is clearly indicated by a yellow LED.

The basic Fieldbus Power Supply version monitors the bus for cable breaks and short circuits. The Advanced Fieldbus Power Supply, which will be available shortly, additionally provides advanced diagnostic features concerning physical layer parameters such as signal level, noise, asymmetries and jitter, thus rendering costly diagnosis modules unnecessary.

R. STAHL  www.stahl.de

“RUGGEDIZED” COMMUNICATIONS NETWORKING EQUIPMENT AVAILABLE FROM RUGGEDCOM

RuggedCom designs and manufactures “ruggedized” communications networking equipment for harsh environments and has established itself as a global leader in the area of industrial Ethernet and communications technologies. Our industry-leading products can be found in mission-critical networks where high reliability and maximum uptime are of paramount importance, including the “Smart Grid” for electric utilities, intelligent transportation, process control and manufacturing automation.

RuggedCom developed the world’s first Ethernet switch designed specifically for electric utilities, as well as the world’s first error-free communications device under severe EMI conditions. RuggedCom has the industry’s fastest network fault recovery, and introduced the world’s first fully managed waterproof Ethernet switch.

RUGGEDCOM  www.ruggedcom.com

SOFTING ANNOUNCES THE WORLD’S SMALLEST COMMUNICATION MODULE FOR FOUNDATION FIELDBUS AND PROFIBUS PA

The Fieldbus Kit 2 (FBK-2) from Softing is an off-the-shelf, field-proven solution for the rapid development of FOUNDATION Fieldbus H1 field devices for Intrinsically Safe (IS) and non-Intrinsically Safe environments. The FBK-2 provides a serial Modbus/RTU interface and a HART interface to seamlessly integrate with an existing analog/HART slave device to create a complete fieldbus product. The FBK-2 is small enough (40x60 mm) to fit into most existing device housings. Since the hardware is ready-to-use, no additional costs for fieldbus physical-layer testing are incurred. The board is designed according to the specifications of the Fieldbus Foundation and is ready to pass all necessary conformance testing. For more information, please visit us online or call (978) 499-9650.

Foundation Fieldbus – we put the pieces in place.

The right skills to optimize your projects.

It's powerful and versatile, but getting the most from your FOUNDATION™ fieldbus architecture is a major challenge. At Endress+Hauser, we complement our wide product offering with top industry expertise and experience. This enables you to realize your project’s potential and achieve the return on investment you expect.

Independent of the DCS we offer solutions integration for condition monitoring, asset management and control in the field. We deliver improved plant performance and better business results and reduce hassle and risk. Nothing puzzling about that.

www.automation.endress.com/fieldbus
Automation Infrastructure For Operational Excellence.

The Fieldbus Foundation is “Changing the Playing Field” in industrial automation. The scope of Foundation technology makes it a process automation infrastructure—one of the most advanced and scalable solutions available.

This infrastructure is supplier-neutral and standards-based, providing end users with a common framework to implement and manage strategies for operational excellence and continuous improvement in process manufacturing.

Today, Foundation Fieldbus dominates the worldwide process automation market—and is a growing solution for the hybrid industries. It’s the “technology of choice” for both early adopters and new end users around the globe, especially in developing markets such as Asia-Pacific, Latin America and Eastern Europe. Find out more.


Fieldbus Foundation
9005 Mountain Ridge Drive, Bowie Bldg. – Suite 200
Austin, Texas USA 78759
Tel: 512.794.8890 • Fax: 512.794.8893
E-mail: info@fieldbus.org