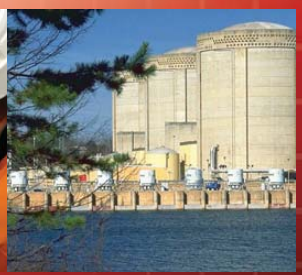
Fieldbus Foundation

FOUNDATION™ Fieldbus

The Power of Digital for your Process Devices

www.fieldbus.org





What is Foundation Fieldbus?

Foundation fieldbus is a real-time digital communication network designed specifically for process control applications. It replaces analog 4-20 mA and on/off signals for connecting instruments like transmitters, analyzers, control valve positioners, and on/off valves to distributed control systems (DCS), programmable logic controllers (PLC), remote terminal units (RTU), and other automation systems.

Foundation fieldbus has the smallest hardware footprint of any technology in process automation. It provides an all-digital solution from the sensor to actuator, completely eliminating the need for analog 4-20 mA signals and significantly reducing the overall amount of equipment needed. It also takes the place of proprietary protocols previously used with electric actuators/motor-operated valves (MOV), gas chromatographs, and tank gauging systems. Communication is time-synchronized and scheduled to ensure deterministic closed-loop digital control. Multiple devices, each with multiple I/O signals, share the same bus.

Foundation fieldbus supports long cable lengths to junction boxes far into the field, as well as long spurs for devices. Fieldbus-based control systems employ two-wire twisted pair cable and provide intrinsically safe or non-incendive device power suitable for all hazardous areas. Unrestricted access to field device intelligence enables centralized configuration/setup and diagnostics for all field instruments, including discrete sensors and actuators. This solution also supports temporary masters such as handheld field communicators, laptops/tablets, and documenting calibrators.

Unlike other digital architectures, Foundation fieldbus was designed from the ground up to enable control-in-the-field (CIF) strategies across the plant.

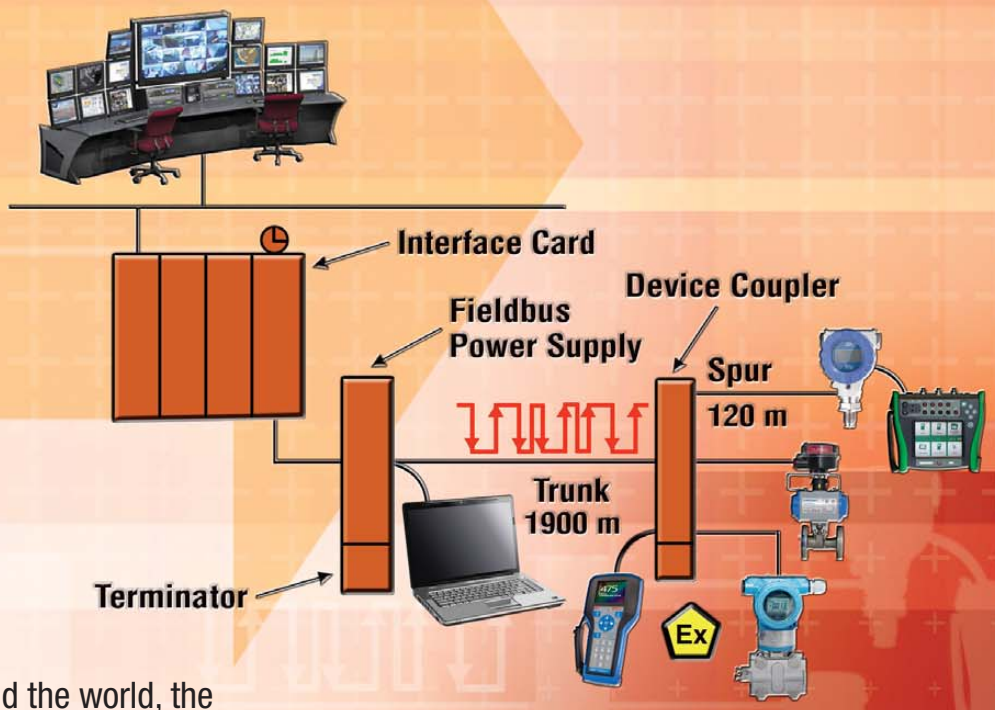
Fieldbus
Foundation

All-digital Infrastructure for Plant Automation

Breaking the Limits of Analog Technology

FOUNDATION fieldbus started with a few simple ideas:

- Reduce cabling
- Simplify marshalling
- Enable real-time digital closed-loop control
- Ensure multi-vendor interoperability
- Expand device intelligence
- Allow diagnostics-based maintenance
- Liberate plants from proprietary protocols



As demonstrated at plants around the world, the benefits of completely digital automation without the limitations of 4-20 mA and on/off signals are enormous.

FOUNDATION fieldbus takes automation to the next level by making control loops entirely digital from end-to-end—from transmitter to positioner—without intermediate analog signals, and by communicating multiple signals from multiple devices on the same pairs of wires. Range setting is reduced, if not eliminated, for most transmitters, and there is no signal distortion like traditional analog systems. The technology also enables new, more powerful devices, including intelligent two-wire on/off devices with predictive diagnostics.

Reduced Hardware Requirements

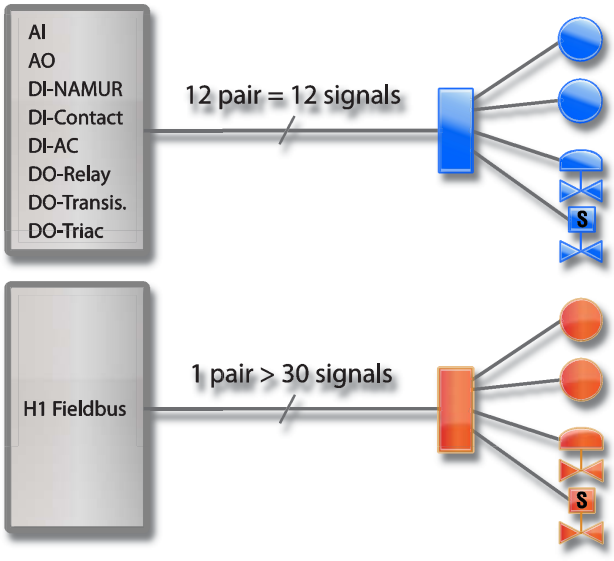
Today, some automation projects are adopting various alternatives to traditional I/O and marshalling technology. But why make physical marshalling smarter or better when you can eliminate it entirely? Many of the functions provided by physical hardware in conventional control systems are no longer necessary in a FOUNDATION fieldbus system since they are now handled through software, which has proven more robust and reliable by eliminating failure points.

FOUNDATION technology was developed to provide a solution for *Virtual*Marshalling™—software-based distributed I/O connectivity—in which devices provide multiple signals over the same two terminals. Instead of relying on custom hardware configurations to accomplish the functions of traditional marshalling, FOUNDATION fieldbus performs these tasks through a software-based structure. All signal linking (block to block) is done in software without hardwiring. This approach allows late addition of feedback and auxiliary measurement and control signals without the need for additional wiring, as well as change of devices without switching I/O cards. Burnt shunt resistors are also eliminated. More devices can be added without laying more cable.

FOUNDATION fieldbus is particularly well suited for expansions at existing sites, which are running out of tray capacity.

Smaller System Footprint

Rather than use individual wires for each device signal, FOUNDATION fieldbus connects multiple devices in parallel on the same pair of wires recognized by address. A single pair provides both power and communication, and can be intrinsically safe or non-incendive if required. Long distance is also possible. Field junction box hardware is rugged and encapsulated for harsh outdoor field conditions, some even passive and optionally Zone 1 certified.



FOUNDATION technology reduces the need for cable, cable trays, I/O cards, and associated labor for installation, as well as the effort of cutting, stripping, crimping, labeling and connecting at every intermediate point. For example, a bus with 10 instruments—and an average of three signals per device—can take the place of 30 pairs of wires and I/O channels. The resulting cost is even lower than remote I/O and local mounting.

In addition, FOUNDATION fieldbus simplifies integration of devices with multiple signals for operation and feedback. This includes electric actuators/MOVs and discrete devices such as intelligent two-wire intrinsically safe on/off valve actuators. In the past, these devices required one pair of wires and one I/O channel for each signal, meaning as many as 3, 6, 12 or more pairs per device. In comparison, FOUNDATION fieldbus enables a single pair of wires to support multiple devices, resulting in drastic wiring reduction. The reduced number of I/O cards for auxiliary signals also translates into fewer I/O cabinets, a smaller footprint, less weight and drastically reduced maintenance labor. No more “bird’s nest” of wires!

Since all device signals can now be employed at lower cost, plants can fully utilize device capabilities without being limited to a subset of signals and functionality. Continuous feedback and bumpless transfer on hand-operation also becomes available for all valves.

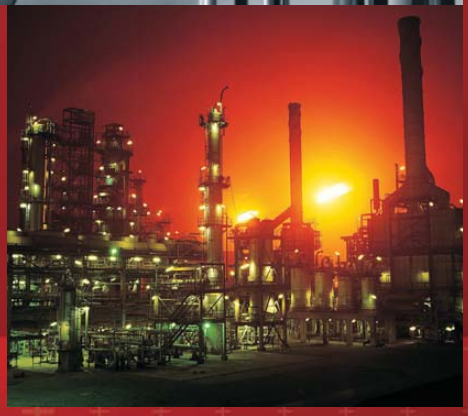
Thanks to FOUNDATION technology, transmitters, control valves, and two-wire on/off valves are able to share the same bus. As a result, there is no need to select I/O card or barrier types, since all devices use the same single type of interface card and barrier, and have the same entity parameters—simplifying selection. At design time, it is not necessary to know the exact type and quantity of signal for each device to determine I/O requirements.

Proven Benefits in Projects Worldwide

Reduced Device Count

FOUNDATION fieldbus instruments are not limited to transmitting single values in real-time. Instead, the technology supports multi-point devices such as multi-channel temperature transmitters with eight sensor inputs, which are ideal for temperature profiling applications, as well as multi-point indicators. For dual sensor temperature transmitters, both channels can be used for control loops.

The fieldbus solution allows eight-channel temperature transmitters to take the place of many hardwired transmitters, thus reducing the overall device count as well as associated wiring and I/O card points. These and other innovations offering installation cost benefits are not possible with hardwired signals.



An Open Network Standard

Proprietary protocols were eliminated years ago for simple transmitters and valve positioners. Now, FOUNDATION fieldbus can also eliminate these protocols for electric actuators/MOVs, gas chromatographs and tank gauging systems.

These fieldbus devices integrate with intelligent device management software for setup/configuration and diagnostics just like transmitters and valve positioners, enabling predictive maintenance and doing away with special software. Devices also share the same bus infrastructure, eliminating the need for separate networks, gateways, and drivers.

Anyone can purchase the FOUNDATION fieldbus specification. As an open network standard, the technology eliminates single vendor dependency, which limits the ability to interchange or replace existing instruments with third-party solutions. This means different brand equipment can share the same network or serve as second-source replacement devices. End users can choose the best available instruments for their application and replace them as needed to accommodate the process.

Faster Commissioning

With FOUNDATION fieldbus, time-consuming manual commissioning tasks and their associated errors are no longer a concern. The same is true of 4-20 mA ranging and signal distortion; traditional five-point loop tests are replaced by a simple plausibility check. Technicians can automatically confirm the correct device type (model and manufacturer) has been installed, and are not required to spend time re-ranging it. This not only applies to transmitters and positioners, but also discrete devices such as intelligent two-wire on/off valves and electric actuators.

High Signal Integrity

FOUNDATION fieldbus' pure digital signals eliminate the digital-to-analog (D/A) and analog-to-digital (A/D) conversion required in devices and systems utilizing 4-20 mA technology. Fewer conversions lead to higher resolution and accuracy. Errors due to current calibration differences between transmitter output and DCS input are also eliminated. This is particularly important in flow and level applications such as tank gauging, where small percentages correspond to significant revenue.

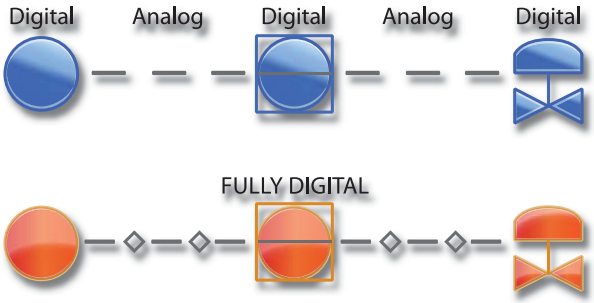
Using fieldbus, measurement values transmitted digitally cannot be distorted and integrity errors are immediately detected. This compares with "on-scale" errors associated with 4-20 mA signals, which are often due to undetected ground loop or current restriction issues. Unlike discrete signals where open or short circuits may not be recognized, bus communication errors are easily identified.

Greater Signal Fidelity

FOUNDATION fieldbus devices are designed to transmit measurements as a real number in engineering units (not scaled by range), which are received—unaltered—by a control system at the other end.

Transmitter configuration download from the DCS is done as part of the device replacement process, thus ensuring the units, range, and other settings are correct. This approach eliminates the process variable value skew that sometimes results from mismatched 4-20 mA range settings between transmitters and the control system. Operators gain confidence that the reading, controls, and alarms in the system are correct.

With fieldbus, measurement values are also transmitted over the full sensor limit with greater precision and are not limited to a narrow 4-20 mA portion. As such, they do not saturate at the normal control range, but go beyond, providing valuable information during abnormal conditions.



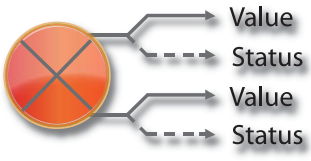
Tighter Control

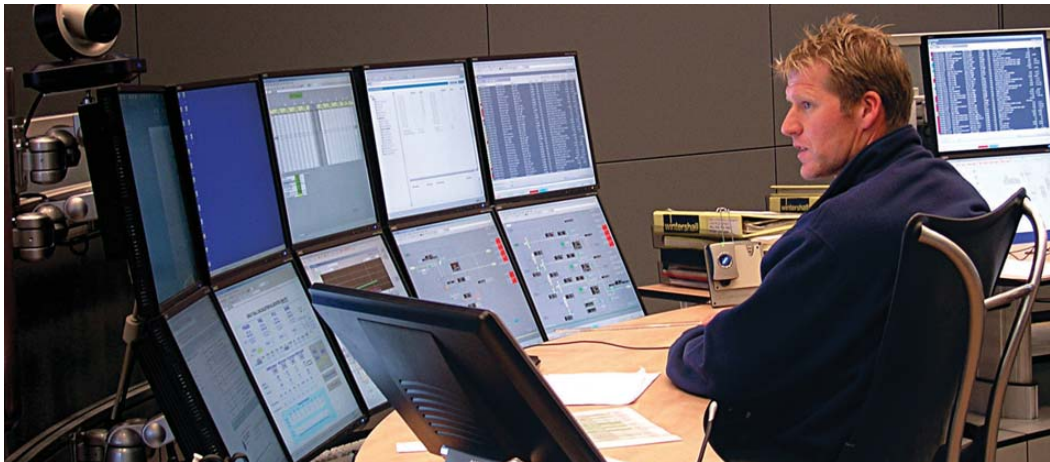
Transmitters, controllers, and valve positioners are digital—so it only makes sense to have pure digital signals between them. A digital bus running 25 times faster than earlier hybrids of analog and digital allows a closed loop that is digital and time-synchronized from end to end, from sensor to valve. Fieldbus communication is deterministic and real-time, offering control response times faster than 150 ms in some cases.

Elimination of analog input (AI) and analog output (AO) cards and their associated scan delays and jitter also improves control response time, particularly compared to remote I/O with additional network and link delays. Reductions in process variability allow set points to be moved closer to the optimal point of operation, with less "comfort margin." Improvements for each transmitter and valve, loop, and process unit contribute to better plant performance.

Real-time Signal Status & Data Quality

FOUNDATION fieldbus delivers real-time signal validity indicating if the value is good for control, uncertain, or bad (fault). The status is then propagated as part of the same data structure as the value, eliminating the need for separate data





Enhanced Operations and Maintenance

mapping. This enables process problems to be distinguished from device problems, thereby minimizing nuisance trips of the control loop on sensor failure and increasing availability.

The valve status includes limit conditions for override windup protection, fault state, bumpless transfer and more—further improving control.

More Powerful Devices

The electronics in FOUNDATION fieldbus two-wire devices are not restricted to operation on 4 mA. The result: bus-powered instruments are able to consume more power, enabling new and more powerful functionality.

Examples of such devices include two-wire radar level transmitters with frequency modulated continuous wave modulation, two-wire eight-channel process temperature transmitters, two-wire tank gauging multi-spot temperature transmitters with water bottom level measurement, two-wire intelligent on/off valves, and two-wire field indicators.

Powerful function blocks in fieldbus instruments provide computation and arithmetic capabilities whenever there is a need to calculate or compensate a value in the device so that it may be shown on a local display.

Enhanced Diagnostics

The digital nature of FOUNDATION fieldbus supports centralized device configuration/setup, diagnostics, and viewing of internal variables. The technology also allows two-wire devices to drive more powerful electronics and firmware, ensuring more sophisticated self-diagnostics. This includes statistical process monitoring (SPM) for multiple variables across the bus and continuous valve performance diagnostics not found in 4-20 mA devices.

Faster communication also means diagnostics and configuration/setup pages load faster.

Status Signal	Color	Symbol
Normal; valid output signal		
Maintenance required; still valid output signal		
Out of specification; signal out of the specified range		
Function check; temporary non-valid output signal		
Failure; non-valid output signal		

NAMUR NE107 Diagnostic Categories

Predictive diagnostics with fieldbus are available from two-wire intrinsically safe intelligent on/off valves and other discrete devices not digitally integrated in the past. In addition, the technology employs NAMUR NE107-compliant device alarm rationalization to notify the right person without alarm flooding.

Simple Online Upgrades

FOUNDATION fieldbus instruments not only communicate faster than older hybrid analog/digital devices, but they also have the speed necessary to allow firmware download from the system while continuing to run the process. Devices with dual memory banks switch bumplessly to new firmware without any downtime on the segment.

Modern fieldbus devices are easily upgraded to take advantage of features and other improvements in new versions. These upgrades can be performed without going into the field to replace the entire circuit board or connect a laptop.

Ease of Use

FOUNDATION technology is continuously improving based on feedback from our strong end user advisory council. The FOUNDATION specification now includes NAMUR NE107-compliant role-based and prioritized device diagnostic alarms; backwards compatibility and easy device replacement; and graphically enhanced, device-level electronic device description language (EDDL) user interface and wizards. Constantly improved device interoperability testing kits (ITK) and host profile registration processes ensure that new devices and systems meet or exceed our specifications.

Certified Training: Expert Technology Instruction

Getting started with FOUNDATION technology is easy: the Fieldbus Foundation offers a wide range of technology instruction opportunities across the globe. Our FOUNDATION Certified Training Program (FCTP) establishes uniform standards for fieldbus educational curriculum and instructors, and defines acceptable levels of learning for students of the technology.

Certified training ensures professionals with a strong knowledge of FOUNDATION principles, a consistent understanding of fieldbus fundamentals, and a proven ability to implement fieldbus-based control systems. All FCTP sites offer certificates showing a student's competency within that certification level.

FCTP-approved training facilities have a close working relationship with the Fieldbus Foundation, and as such, continually receive updates on FOUNDATION fieldbus as it continues to improve and develop capabilities. These sites are always on the leading edge of the technology.

Through the FCTP, training facilities, curriculum, and instructors are all audited to ensure they meet program requirements. Certified sites are required to maintain multiple FOUNDATION fieldbus hosts and devices onsite in order to demonstrate competence with fieldbus technology. They must also demonstrate to auditors that their course material adheres to set instructional standards.

The FCTP currently offers three types of certification: FOUNDATION Certified Professional, FOUNDATION Certified Support Specialist, and FOUNDATION Certified Technical Specialist. Students completing a certified training program are listed in the Student Registry Catalog on the foundation's web site.

Certified training is currently available at the following sites:

King Mongkut's Institute of Technology Ladkrabang
Bangkok, Thailand

Lee College
Baytown, Texas, USA

Waseda University
Tokyo, Japan

SAIT
Calgary, Alberta, Canada

Sinopec Yanshan
Beijing, China

STC-Group, Brielle
The Netherlands

Trine University
Angola, Indiana, USA

University of Miskolc
Hungary

"The Fieldbus Foundation, in response to end user input via the EUAC, has implemented many useful products and features, including FOUNDATION for Safety Instrumented Functions, Remote Operations Management, and enhancements to EDDL. This confirms that fieldbus technology will continue to be the right choice for the control systems of today and the future."

John Rezabek
Chairman
Fieldbus Foundation End User Advisory Council
(Contact: john.rezabek@fieldbus.org)

End User Councils: Let Your Voice Be Heard

You can have a voice in the future of the Fieldbus Foundation by participating in an End User Council (EUC). Regional EUCs, established worldwide, provide an open forum for the exchange of information about the application and development of FOUNDATION technology in a wide range of industries.

Current EUC locations include:

Americas
South America
United States
Western Canada
(Contact: americas_euc@fieldbus.org)

EMEA
Europe
Middle East
Africa
(Contact: emea_euc@fieldbus.org)

Asia/Pacific
China
Japan
Singapore
India
(Contact: asia_euc@fieldbus.org)

Oceania
Australia
New Zealand
(Contact: oceania_euc@fieldbus.org)

Educational Seminars: Hands-on Experience for End Users

FOUNDATION technology seminars are offered in key locations around the world — from North America and Europe/Middle East/Africa (EMEA), to Latin America and Oceania.

Oriented towards process industry end users and engineering firms, the one-day seminars cover all aspects of FOUNDATION technology business value, project execution and system design. Leading end users, systems integrators, and trainers discuss successful installation and commissioning practices, control strategies, and operational and maintenance practices.

Foundation Membership: Gain a Competitive Edge

The Fieldbus Foundation offers a significant number of benefits through membership. Whether you are a manufacturer, systems integrator, educational institution, end user or other professional in the business, join the foundation and gain a competitive edge!

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