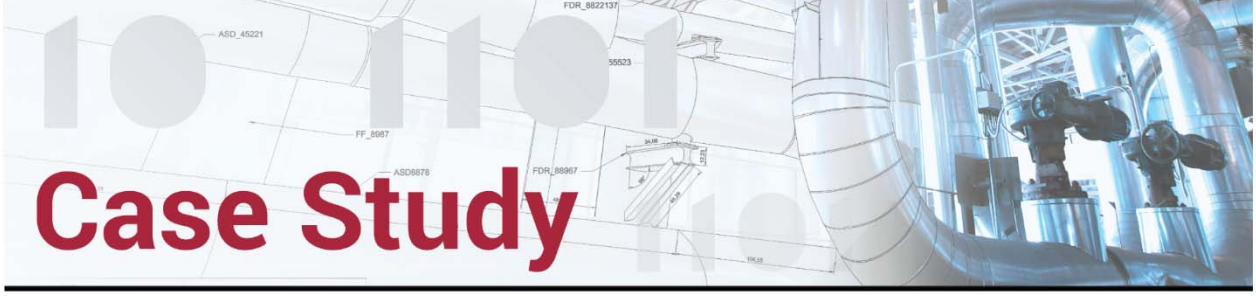


Making your Fieldbus Project as Painless as Possible

District heating company realizes advantages of reliable fieldbus control solution

Having entered the digital era many years ago in nearly every aspect of our lives, it's a wonder that the process industries still struggle with the adoption of digital solutions. Whether users install Modbus, HART, PROFIBUS, FOUNDATION™ Fieldbus or some other digital protocol, the common issue faced across all of them is underutilization of the digital information. These are systems and devices with a lot of engineered smarts inside chattering away to anyone that will listen, yet the process industries on the whole haven't lent an ear. With the Industrial Internet of Things (IIoT) and Industrie 4.0 poised to be the process industry's modern day renaissance, digital integration of instrumentation into systems is a must. It is a profoundly different approach meant to revolutionize how we think about our industry. People have begun understanding that integrating information into systems doesn't just save money; it saves resources, it saves environments, it saves lives. There is no reason we should continuously send humans into extremely hazardous locations to diagnose problems that can be done from the safety of a keyboard.

How can the IIoT and Industrie 4.0 be successful without such utilization? Certainly there is no shortage of benefits in digitally transforming our industry. In much the same way, engineers and end users alike must keep in mind that FOUNDATION Fieldbus is a digital technology and to truly realize the vast benefits, it must be integrated.

Certainly by now, the industry is aware of the upfront savings of FOUNDATION Fieldbus like reduced hardware, reduced instrumentation, reduced wiring, more power, real-time control etc., but the real payback that separates an OK refinery from an industry leader is the one taking advantage of the digital data. And if you are used to analog networks and do not have the proper degree of training, it could be a painful "learning" experience. Fortunately, however, FieldComm Group has developed many resources that can help first time users avoid rookie mistakes. Here are some key pieces of information and advice you should know before embarking on a fieldbus project.

Best Practices

Qualified Engineering Partner is Essential

We cannot emphasize enough, if you do not have an engineering partner that has had some training and knows how to implement a fieldbus network, your costs will go up. Many engineering firms believe that there are no great differences between 4-20 analog and fieldbus

installations, but if you do not know what you are doing you can end up in the weeds pretty quickly.

FieldComm Group offers certified training courses through our FOUNDATION Certified Training Program (FCTP), with eight certified training institutions around the world. You can look at your existing engineering partner and see what kind of training staff engineers have. Even if they do not have people that have taken a certified training course, they could still have successful reference projects. FOUNDATION Fieldbus has almost 20,000 systems installed around the world, and the pool of engineers with fieldbus experience is growing. Checking references, expertise, and training does not take too much time and will provide a quick payoff.

Not surprisingly, engineering partners that do not have experience in fieldbus installations will try to steer you away from the technology. Our advice is not to let engineering companies dictate your automation strategy, but to form a coherent strategy beforehand and find a partner that can fulfill your requirements. There are plenty of engineering service providers on the market today who will do a fine job. You may also want to consider retaining the services of a fieldbus consultant, who can provide years of experience and guidance on your project.

Project Requirements

Having a good understanding of project requirements is fundamental. The AG 181 System Engineering Guide is a free resource that the FieldComm Group provides free of charge. It can be downloaded at fieldcommgroup.org. AG 181 provides a lot of good guidance throughout the project lifecycle, starting with project requirements. The guide points out five fundamental differences between conventional projects and FOUNDATION Fieldbus projects. If you remember these differences, you will be on your way to a successful project:

- With FOUNDATION Fieldbus, field devices and segments become an integral part of the DCS. This requires an integrated configuration, data management, and system architecture approach to field network design. You can no longer treat devices and process automation systems as separate islands of automation.

- System integration aspects of FOUNDATION Fieldbus require some design activities to be performed earlier and with greater detail in the project lifecycle.

- You can achieve more advanced functions with FOUNDATION Fieldbus designs compared to traditional technologies. These advanced functions offer considerable opportunities for operating cost-savings and improved commissioning and start-up.

- System, field device, and segment component testing capabilities are more advanced than for simple analog connections.

- Traditional lines of authority between crafts and legacy-derived practices should be reviewed to determine if they are a suitable “fit” for FOUNDATION Fieldbus. In other words, it will require a few different work processes than you have done before.

Especially if you want to practice true predictive and proactive maintenance, which is where a lot of your operational cost savings will occur.

Use Registered Devices and Hosts

It may seem obvious, but it is always preferable to use a host system or device that has gone through the FieldComm Group testing and registration process. The FOUNDATION Fieldbus "check mark" symbol is an obvious indicator that a product has been tested and registered, but you should go beyond that to determine which version of the Interoperability Test Kit or Host Profile Registration process the host or device conforms to. The FieldComm Group has greatly strengthened its testing and registration requirements. Devices tested under the latest Version 6.0 of the Interoperability Test Kit (ITK) will provide more advanced diagnostic functionality, including the NAMUR NE 107 recommendations for presenting diagnostic data. Our latest iteration of host profile registration has made many previously optional requirements mandatory, such as support of enhanced function blocks and DD V5.1 Device-Level Access.

You Need a Good Plant Asset Management System

It does not matter which process fieldbus you are installing. If you don't have some kind of plant asset management application (PAM) to deal with all the new diagnostic data you are going to get from your intelligent devices, you will not realize the significant operational and maintenance cost benefits that come with the technology. A PAM system will help you manage your data and will be a valuable tool for maintenance personnel. Examples of current PAM systems include Emerson's AMS Suite, Honeywell Field Device Manager, and Yokogawa PRM. The PAM system is the core application that will allow you to develop a predictive and proactive maintenance strategy. Remember how we mentioned earlier that some aspects of the fieldbus project must be planned earlier in the lifecycle? The plant asset management system is one of these items. You should start early in the front end engineering and design phase to determine how the PAM system will be used and who will need to use it.

Screen Shot of a FOUNDATION Fieldbus PAM System

A Word about Work Processes

You should define any new or revised work processes that may be required because of the use of FOUNDATION Fieldbus. This is one of the most often overlooked aspects of a fieldbus project. If you do not pay attention to proper work processes, the people that need the data from fieldbus devices may not be able to get it, or you could remain stuck in traditional maintenance processes that are transformed by fieldbus. Fieldbus is essentially a data pipeline, and users must plan where that flood of data is going to go and how it will be transformed into useful

information. In most cases today, this is a secondary consideration that is only addressed after the system is up and running. Having a team in place consisting of personnel from all areas of the plant that are affected will expedite this process. What kinds of information are your maintenance personnel looking for? What about data storage and validation concerns for companies that must undergo regulatory compliance in industries such as pharmaceuticals and food & beverage?

The information flow from the device level to the associated applications that need it must be mapped out prior to startup to achieve maximum benefits. Intelligent field devices are really data servers, and much of the information in these data servers is not appropriate for the control system operator. If you are dealing with a supplier that has an effective fieldbus configuration tool integrated with a good Plant Asset Management (PAM) application, it should be a minimal effort to get the right information to the right people at the right time.

Many end users may lack sufficient knowledge to implement these work processes. There is currently a new ISA standards effort underway to develop recommended work processes for managing the data from your intelligent devices. The ISA 108 standard will define work processes for different roles in the organization and provide best practices for the project lifecycle.

System Capabilities

FOUNDATION Fieldbus and Redundancy

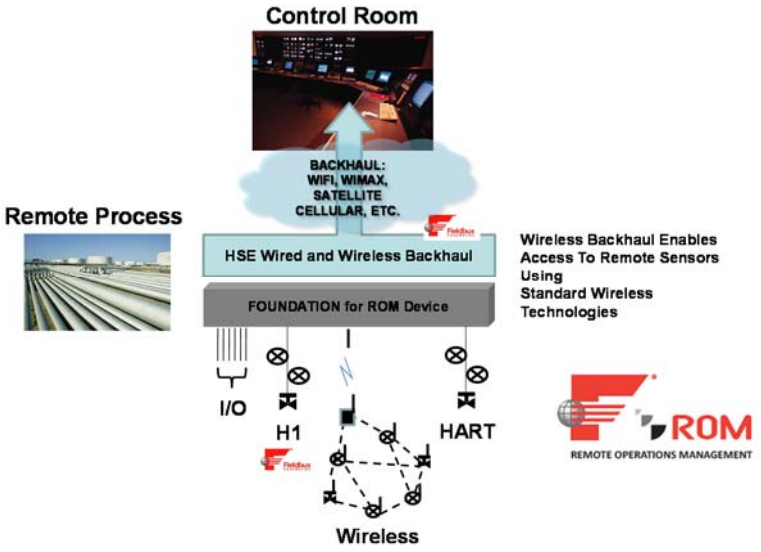
Today, FOUNDATION Fieldbus is used in critical applications and can support key functions for demanding applications, including redundancy. FOUNDATION Fieldbus support redundancy on many levels if that is one of your requirements. Redundant power supplies, redundant H1 (device level) fieldbus interface cards, and redundant controllers are the most comment ways to do this. With redundant H1 cards, it is possible to replace either H1 card under power with no impact on the H1 segments associated with the redundant cards. It is also possible to upgrade H1 card software/firmware without affecting communications on the related H1 segments.

FOUNDATION Fieldbus is comprised of the H1 network at the device level, and the HSE standard Ethernet-based network addresses high-speed application and devices such as motor operated valves (MOVs), drives, remote I/O. FOUNDATION HSE is based on unmodified IEEE 802.3 Ethernet and, therefore, is compatible with standard Ethernet equipment. Unlike mere "ring topology," FOUNDATION HSE provides complete "DCS style" redundancy with redundant network switches, redundant devices, and redundant communication ports for extremely high availability.

Integration of Wireless Devices and Remote I/O

The HSE network also provides integration with wireless networks such as ISA 100.11a and *Wireless*HART through FOUNDATION for Remote Operations Management (ROM). HSE can also serve as a wireless or wired backhaul network for remote applications such as pipeline SCADA and offshore platform automation. FOUNDATION for ROM provides for direct access to

information and diagnostics in wireless and remote I/O devices. Conversely, FOUNDATION for ROM can take the data from those devices and place into the FOUNDATION Fieldbus environment for data management and quality.



FOUNDATION for ROM

FOUNDATION Fieldbus Function Blocks

One key thing to consider at the device level, aside from buying products that have been tested and registered, is the support of advanced diagnostic functions and function blocks. The support of function blocks is unique to FOUNDATION Fieldbus and is the enabler for control in the field and many of the advanced diagnostic functions that we offer. Function blocks were really the first instances of object-oriented programming, and enable FOUNDATION Fieldbus to take a comprehensive, object-oriented approach to process control. FOUNDATION Fieldbus supports a series of standard function blocks, as well as advanced function blocks and additional function blocks such as flexible function blocks (FFBs). The ten standard Function Blocks are as follows:

- AI - Analog Input
- AO - Analog Output
- B - Bias
- CS - Control Selector
- DI - Discrete Input
- DO - Discrete Output
- ML - Manual Loader
- PD - Proportional/Derivative Control
- PID - Proportional/Integral/Derivative Control
- RA – Ratio

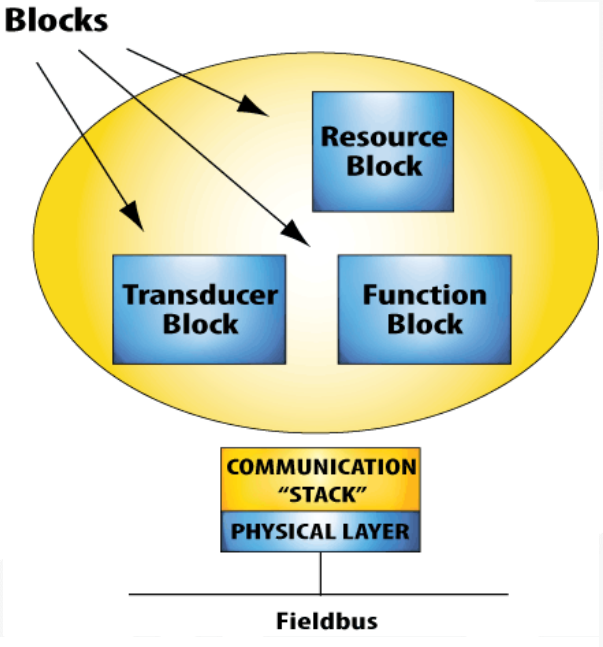
Advanced Function Blocks include:

- Device Control
- Set Point Ramp
- Splitter
- Input Selector
- Signal Characterizer
- Dead Time
- Calculate
- Lead/Lag
- Arithmetic
- Integrator
- Timer
- Analog Alarm

Additional Function Blocks:

Additional function blocks include Multiple Analog Input and Output and Multiple Discrete Input and Output.

It can be seen from this list that not all function block types are suitable or available for all instruments. It is, therefore, essential to make a considered choice when specifying the function blocks to be included in various field device types. Although it is appropriate to host most of these blocks in controllers, their use in field devices on H1 networks/segments may be limited (due to the availability of devices), to the following blocks: AI for transmitters, AO and PID for valves, and DI/DO for discrete devices. Additional function blocks are likely to be added in the future, therefore, it is wise to check function block availability with the instrument manufacturer and ensure that the Host system will allow the use of the desired function blocks at the time of purchase, thus ensuring that the features desired are available for use. It should be noted that there is seldom a need to have all function blocks available in all field devices. The user should also verify that functionality in the Host and field device is compatible, should it be necessary to revise the functionality location.



FOUNDATION Fieldbus Block

User Application Blocks

Where function blocks allow the user to create control strategies, user application blocks allow the user to configure devices and applications. The Resource Block (RB) describes characteristics of the FOUNDATION device, such as the device name, manufacturer, and serial number. The Transducer Block (TB) contains information such as calibration date and sensor type. Field Devices require at least one Transducer Block to make the device useful. TBs decouple FBs from the local Input/Output (I/O) functions required to read sensors and command output hardware (i.e., this is where parameterization, calibration and diagnostics for the device are carried out).

Power Requirements

Power requirements for fieldbus are different from analog systems. FOUNDATION Fieldbus devices may be powered either from the segment (bus), or locally powered, depending on the device design. Bus-powered devices typically require 10-30 mA of current at between 9 and 32 volts. Any network/segment designed to operate at less than 2 volts above the minimum required voltage at any device or wiring component should normally carry a warning about additional loads in the network documentation. Minimum network/segment voltage should always be shown in the network documentation. The total current draw from all devices on the network must not exceed the rating of the FOUNDATION Fieldbus power supply. The network/segment design must take into account:

- Total maximum device quiescent current draw
- One spur short-circuit fault (i.e., ~50 mA additional current draw)
- 15 - 25% additional current load above the two (2) previous requirements (for inrush current and expansion, etc.)
- Current consumption of wiring components
- Test equipment (typically 12 mA per device)

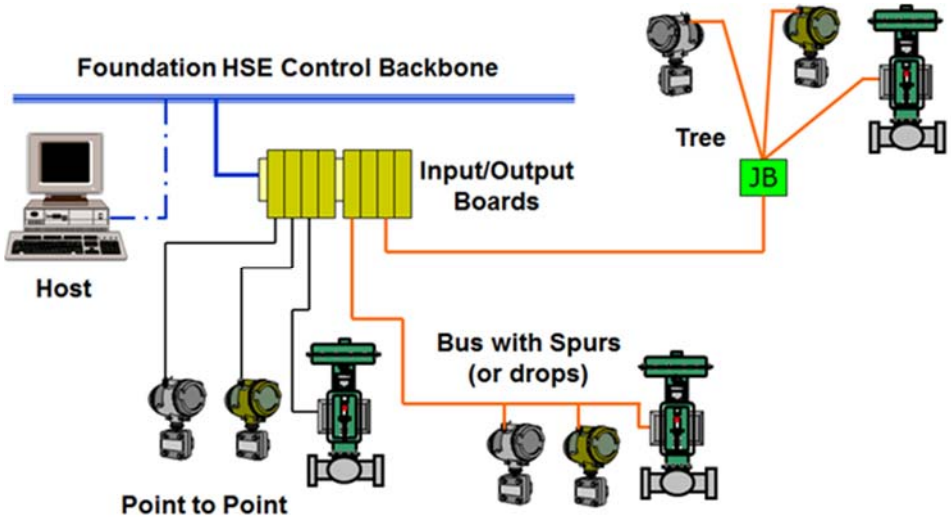
Cable

Just as we provide testing and registration services for field devices and host systems, there is a wide range of registered FOUNDATION Fieldbus cable to choose from. In November 2007, the Fieldbus Foundation (now FieldComm Group) released its H1 Cable Test Specification (Document FF-844) for use by manufacturers developing cables for Foundation Fieldbus H1 (31.25 kbit/s) installations. The specification test cases, based upon the IEC 61158-2:2003 standard for Type A cable, include (but are not limited to) impedance, capacitive unbalance, connector pin-outs, and attenuation. Cable manufacturers submit their test reports to the foundation, which provides official cable registration.

There are many choices today for registered cable, but there are also ways to test your installed instrument cable to see if it would be compatible with a FOUNDATION Fieldbus installation. Suppliers such as Relcom offer automated tools that can test your existing cable.

Network Topology

Components of fieldbus segments can be connected together in various topologies. The topology selected is often, though not always driven by the physical device location in order to reduce installation costs. Hence, control narratives, plot plans and risk management considerations are used in addition to P&IDs and instrument indexes in the design of a fieldbus segment. FOUNDATION Fieldbus installation use the tree, spur or combination topologies. Other topologies are not recommended.



FOUNDATION Fieldbus Network Topologies

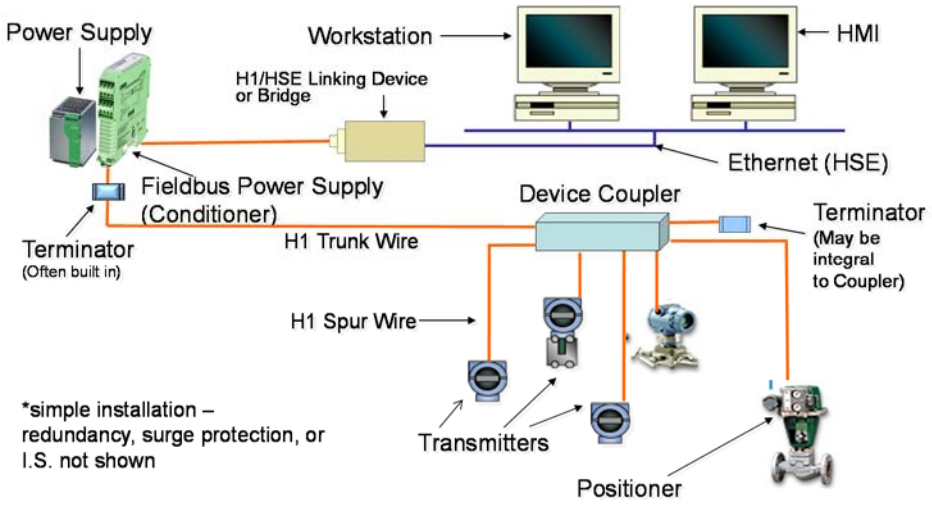
Point-to-Point topology consists of a network having a maximum of only two devices. The network could be entirely in the field (e.g., a transmitter and valve, with no connection beyond the two) or it could be a field device connected to a Host system (doing control or monitoring). This topology is illustrated below and should not be used. It is not an economical design except as shown in the attached figure.

Tree topology consists of a single fieldbus segment connected to a common junction box to form a network. This topology can be used at the end of a home run cable, and is practical if the devices on the same segment are well separated but in the general area of the junction box.

Spur topology consists of fieldbus devices connected to a multi-drop bus segment through a length of cable called a spur. This technology is technically acceptable, but generally not a good economical choice when there is a high density of devices.

Combinations of the above topologies must follow all the rules for maximum fieldbus network/segment length, and include the length of spurs in the total length calculation. These types of topologies are preferred for designs using bricks with tray cable. Spurs are permitted to extend only from trunk lines and not from other spur lines.

What is a Segment?



FOUNDATION Fieldbus Physical Layer Components

A FOUNDATION Fieldbus segment is a network or part of a network that serves as the primary communication highway for the connected fieldbus devices. It includes the fieldbus network card interface, the power supply, and the power conditioner. The cable serves as the principal link between the fieldbus network and fieldbus devices. It can be a part of the fieldbus network wiring that is electrically independent from other parts and may or may not have an associated power supply (as in the use of repeaters).

Trunks, Spurs, and Terminators

Trunks, spurs, and terminators are all fundamental parts of a FOUNDATION Fieldbus installation. A **Trunk** is the main communication highway acting as a source for other lines (spurs) from the control room. Generally, the longest cable path between any two devices on a segment.

A **Spur** is a fieldbus branch line that connects to the segment. A spur does NOT have terminators at either end of the spur cable. A Spur can vary in length from 1 m (3.28 ft.) to 120 m (394 ft.), depending on the number of devices on the Spur.

A **Terminator** is an impedance-matching module used at each end of a segment. A Terminator is required at each end of the longest cable path between any two devices on a segment to prevent distortion and signal errors. Only two terminators can be used on a single fieldbus segment.

Segment Isolation

Segment isolation is a basic requirement for FOUNDATION Fieldbus design. Where devices are installed in areas that are considered to be at a high risk of lightning strikes, segment segregation shall be considered as an additional measure of protection. High-risk applications

include tank farms where transmitters are located on top of tanks, remote areas in open spaces, devices requiring more than two wires (temperature), unprotected structures with little or no surrounding steel, and transmitters that are located on the top of columns or in the open on top of structures.

Number of Devices per Segment

Many end users are under the misconception that only a small number of devices can be placed on a fieldbus segment. As a rule of thumb, the AG 181 System Engineering guide recommends the maximum number of devices on any segment (including future devices) should be no greater than 12, but there are situations where more than 12 is possible. Students at some of our training facilities routinely overload segments with as many as 16 devices and they continue to function. Of course, we don't recommend overloading your segments. The advice that AG-181 gives is that project staff shall set a design standard for the maximum number of devices per segment for that project if less than 12. This design standard should be used as the basis for voltage drop calculations and should include spare capacity for future expansion.

Further Reading

These are some of the key recommendations facts for designing and implementing a successful fieldbus project, all of which can be seen in our AG-181 System Engineering guide available for free download from the Technical References section of this website.

FieldComm Group also offers a free automated segment design tool called DesignMate. DesignMate automatically audits segment layouts for conformance with the FOUNDATION physical layer specification, which is based on the international IEC 61158-2 (Type 1) standard. This assures end users their fieldbus infrastructure will work with desired parameters such as cable length, number and type of installed devices, and selected power supplies. You can download DesignMate from the Technical References section as well. Aside from our FCTP certified training partners, FieldComm Group offers many free end user seminars around the world year round. These seminars can provide even the experienced user with valuable tips and information.