Buses 301

FOUNDATION fieldbus H1 or Profibus PA?

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Overview

Does it really matter whether I use Profibus PA or FOUNDATION fieldbus?

Fieldbuses are the most appropriate type of field networks for control and diagnostics in process operations. That's because fieldbuses provide highly reliable two-way communications between "smart" devices and systems in time-critical applications.

But different fieldbus technologies have different attributes. To maximize fieldbus benefits, you have to choose the right one.

The two most widely used fieldbuses for process automation are FOUNDATION fieldbus and Profibus PA. This course can help you decide which is right for you.

Hint: As you go through the topics in this course, watch for answers to these questions:

- *How does physical layer of FOUNDATION fieldbus compare to that of Profibus PA?*

- *Where is control executed in FOUNDATION fieldbus? in Profibus PA?*

- *How does each achieve interoperability?*

Different origins, different attributes

Some of the differences between Profibus PA and FOUNDATION fieldbus reflect their different origins.

The Profibus family of protocols was designed to provide a communications hierarchy for a PLC system, primarily in discrete manufacturing and building automation. It includes three different protocols that have different capabilities and applications:

- **Profibus FMS** provides a backbone for PLC systems, connecting user interfaces, PLCs, CNC machines, and so on.
- **Profibus DP** is used for primarily discrete processes such as assembly lines, packaging lines, building automation, motor control, and material handling systems.
- Built on top of these two earlier protocols, **Profibus PA** is intended to extend the use of Profibus to the process industry. The greatest differences between Profibus PA and DP are in the physical layer.

FOUNDATION fieldbus, on the other hand, was designed specifically to address the needs of process automation — including providing safe and effective real time process control on the bus.

Because both Profibus PA and FOUNDATION fieldbus are digital buses, they have the potential to provide certain advantages over traditional point-to-point wiring. Some of the advantages are determined by the **physical characteristics** of the bus, and some by the **software implementation** of the bus.

Let's compare the ways Profibus PA and FOUNDATION fieldbus deal with these potential advantages — including differences that can affect your choice of bus.

Physical layer

Profibus PA and FOUNDATION fieldbus H1 use the same physical layer as defined in ANSI/ISA-50.02, Part 2-1992, which is the same as IEC 1158-2. This means the media (twisted pair), electrical signaling, and other physical layer issues are the same.

Advantages brought by the physical characteristics of the bus include reduced wiring due to multi-drop, and reduced control room space due to fewer I/O cards.

Both FOUNDATION fieldbus and Profibus PA support the requirements of intrinsic safety, including the new FISCO model.

Master slave or peer-to-peer

Profibus PA is a master-slave protocol. A field device is a slave that can only respond to a command from a master. That means if a Profibus PA device experiences a problem, it can't report the problem unless the host specifically asks.

FOUNDATION fieldbus is a peer-to-peer protocol. Devices can communicate with each other without a host, and they can initiate communications without a specific host command. For example, if a FOUNDATION fieldbus device experiences a problem, it can send an alarm.

This peer-to-peer communication also enables FOUNDATION fieldbus devices with the appropriate function blocks to execute control in the field, independent of a host system.

Control in the field

With Profibus PA, control can currently reside only in the host. The Profibus Users Organization has work under way to distribute control to field devices.

However, since Profibus PA is a master-slave protocol, a host will still be required to tell the device to process the function block and communicate the results. The host must also forward the results to other devices, since peer-to-peer communications is not supported. This means the host must be present for control to function.

With FOUNDATION fieldbus, control can be in the field device, or the host, or partially in both. That includes both basic and advanced regulatory control, as well as discrete and sequential control. While control in the field devices runs independently of the host, its execution is synchronized with that of the host.

When you run control in field devices using FOUNDATION fieldbus, you can disconnect the host without halting the loop — or your plant. That's because the devices can maintain real time deterministic control over the bus.

Control function blocks can also run in the host with only I/O blocks in the fieldbus devices. Or you can combine control function blocks in the host and in the field devices. For example, one of the PIDs in a cascade loop can run in the field device and the other in the host. Careful planning can result in graceful degradation of control strategies when the host is not operative.

The PlantWeb advantage

Because all Emerson Process Management fieldbus devices and the DeltaV and Ovation automation systems use a common set of function blocks, your control strategy operates the same way — with the same dynamic response —- no matter where you choose to locate these control functions.

You can also move control simply by reassigning it to a different location — no reconfiguration, no re-mapping, no changing the engineering environment.

Interoperability

Interoperability enables you to interconnect and operate devices from different manufacturers on the same fieldbus, without loss of functionality.

By design, Profibus PA allows a host system to use a standard set of basic functionality for a device (called a **standard profile**). If you want to use a field device that has additional vendor-specific functionality, this functionality may be available to the control host only through a vendor-specific extension of the profile, and require vendor-specific engineering tools.

As a result, controllers can't use vendor-specific advanced functionality in the field device without special software. And you may need several different tools to cover every device or every vendor in the plant.

Work is under way to address these issues. But until a universal solution is defined and implemented, you should carefully evaluate the functionality available using your specific host system, as well as the cost and complexity of using multiple tools.

FOUNDATION fieldbus addresses interoperability by a combination of device descriptions and function blocks. If a host can understand a FOUNDATION fieldbus device description, all of the functionality of all the devices is available. And a single host application can configure and access all device information and functionality.

Information integration

Getting the full benefits of a digital bus requires that information be available wherever it's needed.

Profibus PA uses two different technologies to make device information available:

- The **device configuration and management host** uses **device descriptions** to configure and interact with the device.
- The **control host** uses **profiles** to access device information in the control environment.

The information available through these two techniques is very different.

With Profibus PA devices it's important to know the capabilities of the devices that are available using device descriptions, and the capabilities of the device and control host combination using profiles. A configuration and management host must implement a set of revisions to the Profibus protocol, called the **V1 enhancements**, to co-exist with the control host on the same DP segment.

Device-related information not in the standard profile, such as diagnostics or quality information, isn't available to a control host that only uses the standard profile. Often this non-standard device information is available only in control host systems from the same vendor as the device. In such situations, the only way to extract and use all device information may be to use multiple hosts.

Information integration: Linking devices or couplers

Most Profibus control hosts don't accept Profibus PA inputs directly. Instead, a **linking device** or **coupler** converts the Profibus PA protocol into Profibus DP protocol, and the host accepts Profibus DP.

The linking device. Most linking devices can only pass information contained in the standard Profibus PA device profiles, so the host doesn't have access to vendor-specific device information.

To access non-profile information such as device configuration information contained in the device description, the configuration tool must be attached at the PA segment. This means a centralized, device-description-based device configuration and management tool can only be used with a linking device if the tool implements the V1 enhancements to the Profibus DP protocol.

The linking device has the advantage of allowing the PA segment to run at 31.25 Kbits/sec, while allowing the Profibus DP bus, which attaches the PA segment to the host, to run at a

much higher speed. A typical installation technique is to connect several PA segments to one DP segment and have that DP segment bring the information into the host at high speed.

The linking device may require configuration to map the device profile parameters from the PA segment to the DP bus. This is usually a register mapping exercise and may require significant design, engineering, and testing.

The coupler. A coupler converts the physical layer between Profibus PA and Profibus DP. It has no knowledge of the message content.

This allows a centralized device management host to configure PA devices through a coupler using device descriptions. However, the entire Profibus DP network is limited to the converted speed. The fastest is about 92 Kbits/sec.

This means the host may require many Profibus DP networks to connect the PA segments to the host. The centralized device management host still must implement the V1 enhancements to the Profibus DP protocol.

The link vs. coupler tradeoff. These differences leave the Profibus user with an architectural choice when considering Profibus PA:

- higher data throughput by using a linking device and fewer DP interfaces, or
- lower communications throughput and higher bus cost by using the coupler and more DP buses to connect PA to the host.

Information integration: FOUNDATION fieldbus approach

FOUNDATION fieldbus uses device description technology to make all the information available to other devices, host systems, and applications.

The PlantWeb advantage

PlantWeb with FOUNDATION fieldbus offers a single configuration tool for device and control configuration. System management tools provide auto-recognition, auto-addressing, and drag-and-drop commissioning.

Address assignment

In Profibus PA, device addresses are set using several different methods, including setting DIP switches or user-entered software addresses. The device addresses must be entered into the host for the host to locate and recognize the attached devices.

To add a new device to a Profibus PA segment, the segment is shut down and the device address and other configuration parameters are configured in the host. Then the segment is restarted.

FOUNDATION fieldbus uses a special message to detect and identify new devices added to a running bus. The device address can be manually or automatically assigned. (If the host automatically assigns the address, all reserved and used addresses should be protected against use or reuse.)

FOUNDATON fieldbus devices can be added, commissioned, and used while the rest of the segment remains in operation.

Device tags and tag search

FOUNDATION fieldbus supports both device and function block tags in the field devices. This means that any FOUNDATION fieldbus device can be located by asking for it by its tag. It also means that configurations for FOUNDATION fieldbus devices can be compared with the host database based on tag.

Profibus PA supports tags in the host. The tag database is manually entered into the host. Profibus devices are accessed by bus address. The connection between the host tag and the device address must be entered manually. Configuration errors may not be detected until segment startup, and the segment must be taken offline to correct errors.

Real-time clock

FOUNDATION fieldbus provides a distributed real-time clock on the bus. All devices on a segment have the same real time, enabling highly deterministic communications, time stamping, and control execution.

Profibus PA does not provide a real-time distributed clock. This is one reason why all bus communications and future control execution are directed by the host.

The net result is that FOUNDATION fieldbus is appropriate for real-time control on the bus with or without a host. Profibus PA is appropriate for host-based control only.