**Fieldbus 404**

# Segment design

- Overview
- Designing for loop criticality
- Mission-critical loops
- Highly important loops
- Normal-importance loops
- View-only or data acquisition loops
- Process modularity
- Multivariable devices
- Host system considerations
- Design resources

## Overview

**Which devices — and how many — go on each segment?**

The answer to this question depends on the situation.

Using proven segment design tools and good installation practices, it's easy to design and implement a highly reliable and functional fieldbus segment. However, loops and processes differ in criticality and functional requirements.

This course covers how those factors may affect your segment design.

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

- *Is there an optimum number of devices to put on a segment?*
- *Can fieldbus handle critical loops?*
- *What is process modularity?*

## Designing for loop criticality

Designing a fieldbus segment that's both reliable and easy to maintain depends to a large degree on **segmentation**. This means putting common elements on the same fieldbus segment and dissimilar elements on separate segments.

One of the most important criteria for segmentation is **loop criticality**: how much impact a loop failure would have on the process or on the entire plant.

- With **mission-critical** loops, the loss of automatic control will result in a shutdown.
- In **highly important** loops, a loss of automatic control will require a near-superhuman effort from the operator to sustain operations.
- For **normal-importance** loops, loss of automatic control or operator visibility could be tolerated during normal mean-time-to-repair.
- Finally, loss of automatic control or the operator's ability to view a loop would not have any detrimental affect on **view-only or data acquisition** loops.

Let's look at some design guidelines for loops at each of these four criticality levels.

## Mission-critical loops

Initially, a mission-critical loop may be the only loop on a segment. That way problems with another loop, such as accidentally shorting the segment during maintenance on the non-critical loop, can't cause loss of the segment with the mission-critical loop. With time and experience, you may discover that more loops can safely exist on this segment.

If two mission-critical loops are interacting or cascaded, you can put both on the same segment. But if the process can be kept running with only one of the loops active, consider separate segments.

**Redundancy.** On segments with mission-critical loops, it's a good idea to use redundant segment infrastructure. That includes using redundant H1 interface cards and power supplies. One of the devices on the loop should also have a backup LAS. (Don't use redundant terminators on the same segment. Doing so can cause signal problems.)

If loops also include redundant field devices and process piping, put these redundant components and loops on separate segments and bring the two segments into separate H1 field interface cards.

**Control in the field.** Consider using control in the field for critical loops. As long as the segment retains power (and one device has backup LAS), automatic control can be maintained in the field devices even if the H1 interface card and all other host components are lost.

Remember that critical loops may have supervisory control, operator visibility, or regulatory reporting requirements that require the host to be connected to the loop for the loop to remain operational. Control in the field will not address these needs.

**Non-fieldbus control.** Although FOUNDATION fieldbus is quite capable of handling critical loops, sometimes plant practices dictate that specific loops be controlled using other technologies. That's okay — there's no harm in using both traditional and fieldbus technologies on the same project. But as experience and confidence with fieldbus grows, you'll likely want to use it more often for your critical loops.

## Highly important loops

If a highly important loop loses automatic control, an operator will typically go to the loop's physical location and operate the valve manually, receiving instructions by radio from the control room.

Grouping and loading of such loops is therefore guided by how many loops an operator can control this way, without control room visibility to the final control element.

**Loops and devices.** As a rule of thumb, two related loops will share a segment. You can also put critical operator monitoring information on the same segment.

Consider six devices per segment as a maximum for these loops. The right number for your plant will be determined by the nature of your process.

**System interface.** The number of highly important loops that should be brought into a single H1 field interface card depends on how many loops an operator can handle via manual control at the valve — without visibility through the host system — if the card fails. If you have redundant H1 cards, you may be able to bring in more loops on a segment.

**Control in the field.** If it's okay for a loop to operate in automatic control without operator control, then control in the field can be a good idea for highly-important loops. Even if the H1 card and all other host components are lost, automatic control can continue as long as the segment has power and one of the devices has backup LAS.

(That's why you shouldn't run power through the H1 card if removing the card would interrupt power to the segment.)

## Normal-importance loops

Although it's tempting to use higher loading on normal-importance loops, there are still practical limits. Generally, no more than 4 to 6 normal-importance control loops, and 12 to 16 devices, should be on a single segment.

These limits will help ensure a stable, reliable operation. Here's why:

**Communication.** As the total number of devices and loops increases, communication loading also increases. If you have several very fast loops, the total amount of communication on the segment might be more than the segment can reliably handle.

A properly optimized communication schedule can give devices plenty of time to communicate. But automatic scheduling tools don't necessarily produce optimized schedules. If you use such a tool, keep an eye on the total communication loading for each segment.

**Power.** Different devices take different amounts of power. Make sure the total current draw for all devices on the segment is well within the capacity of the segment power supply — typically about 400 mA.

## View-only or data acquisition loops

These kinds of loops are generally not very fast, nor do they place a tremendous load on the segment.

In general, for view-only or data acquisition applications, a segment can be loaded with sixteen or more devices.

However, you still need to make sure that total current draw of all devices on a segment is well within the power supply's capacity.

In some cases, the number of devices and blocks your host system can support will also be a limiting factor.

## Process modularity

It's generally a good idea to group devices, loops, and segments along process lines.

Besides providing structure for the design task, this modular approach offers both maintenance and performance benefits.

**Use separate segments for unrelated equipment units or process areas.** That way, maintenance of the devices or network for one unit — during a shutdown, for example — won't affect the operation of other units.

**Use separate segments for parallel process streams.** That way one process stream can be shut down while parallel streams remain online.

**Put all devices for the same loop on the same segment.** This includes closely integrated or cascaded loops.

Although multi-segment loops will work, they increase maintenance complexity and the number of components required to close the loop.

Timing of control execution and communications also becomes a bit less precise. For fast or time critical loops, this can degrade performance.

**Leave room for growth.** You may decide to add more devices to a loop in the future. When that happens, the extra capacity you build in now will help you keep all devices for the loop on same segment.

**Know your "comfort level."** Traditional analog input or output cards typically have at least 8 to 16 points and are usually non-redundant. Since loop integrity of a FOUNDATION fieldbus implementation is comparable to or better than a traditional analog solution, it's reasonable to use similar risk levels for a first fieldbus implementation

## Multivariable devices

Multivariable devices can make segment design easier and more cost-effective by letting you acquire multiple measurements with a single instrument.

For example, one mass flow device may provide values for real-time mass flow, total mass flow, process temperature, density, and viscosity. You get the functionality of five or six instruments — without the maintenance and reliability issues that can come with adding that many devices to your segment.

Cost is also much lower for a multivariable device than for multiple individual devices, especially when you include the costs for design and for multiple process penetrations.

Capacity restrictions in some host systems may limit the number of multivariable devices you can put on one segment. And if the inputs from a multivariable device are used in controlling valves or other final control elements on more than one segment, it may be better to use separate measurement devices on each segment.

## Host system considerations

As explained in the previous course, different hosts provide different levels of support for FOUNDATION fieldbus. Those differences can affect your segment design.

**Capacity limits.** All hosts have capacity limits of some sort. Some have limits on the total number of devices for a segment. Some limit the number of devices or function blocks for an H1 interface card. Some even have a fixed capacity for parameters.

Keep those limits in mind as you design your segments.

**Outages for repairs.** Ideally, a failed system component, such as an H1 card, can be removed under power, its replacement installed, and the configuration of the card downloaded automatically — all without affecting segment power. This capability is available in some fieldbus hosts shipping today.

There are host implementations, however, that require the H1 card, or even the entire controller card cage, to be shut down for repair, affecting a large part of the process. And there are instances where a partial download isn't possible. In this case, the entire card cage must be downloaded.

In either of these circumstances, a failure generally requires a shutdown. Keep that in mind as you plan how many segments— and which ones — will be connected to each H1 card. More important, select a host that doesn't have these limitations.

Note that both of the issues covered here — capacity limits and repair time — are limitations of some host systems and not FOUNDATION fieldbus. Careful host selection can minimize

## Design resources

Designing a fieldbus segment isn't hard — but it is different. Here are some additional ways to make your first project a success:

- **Use design tools.** A segment design tool can help prevent errors because much of the work is automated and has already been debugged. You can find good tools from fieldbus product vendors. Just call them or go to their web site to see what's available.
- **Get training.** The Fieldbus Foundation, Southern Alberta Institute of Technology (SAIT), ISA, and various process-automation suppliers (including Emerson) offer classes ranging from fieldbus basics to engineering design to commissioning. Learning from the experts can help you avoid costly and unnecessary mistakes.
- **Consult an experienced fieldbus solutions provider.** Especially on your first project, working with someone who's "been there" is probably the best way to rapidly absorb the do's and don'ts of fieldbus segment design. Some fieldbus solutions providers have experience on hundreds of projects — or more. They can bring you up to speed quickly.
- **Contact the Fieldbus Foundation at www.fieldbus.org.** The Foundation has a wealth of information on all sorts of issues relating to fieldbus. Their mission includes educating people like you on the best ways to implement fieldbus.