Fast Control Response Requirement

This document describes how fast loop control is achieved by using FOUNDATION™ Fieldbus with Control in the Field.

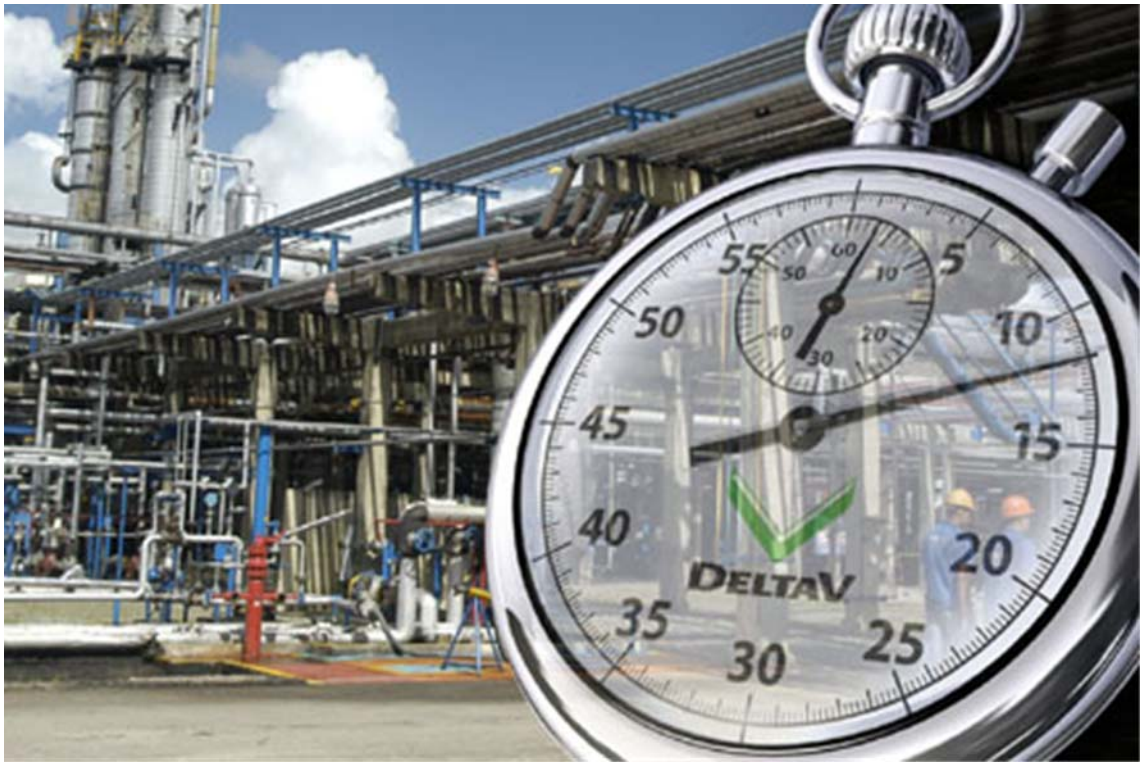

Table of Contents

Introduction

There are projects in which a control response period of 300ms is specified for fast loops such as flow, liquid pressure and differential pressure by the process licensor. The control response period is the length of time elapsed from a change in the process measurement to the change in controller output to the control valve. This specification is to provide the licensee with a process unit that is responsive to set point changes and to disturbances in a stable manner over the life of the process unit. While this is certainly achievable, to meet the control response requirement, one must consider the specification of each component of the control loop: the configuration of the control algorithm within the process automation system, the field transmitters, and final control element.

Traditional DCS Approach to Implementing FOUNDATION™ Fieldbus

A traditional Distributed Control System (DCS) with FOUNDATION™ Fieldbus would have the control algorithm executed in the DCS (referred to as the host for Fieldbus installations). This requires three communication links within the macrocycle: AI to PID, PID to AO and AO feedback to PID. Each communication link consumes approximately 30ms of the available macrocycle time.

The minimum segment macrocycle is determined by the execution time of the AI and AO blocks in the field devices, the number of communication links, and the PID execution time.

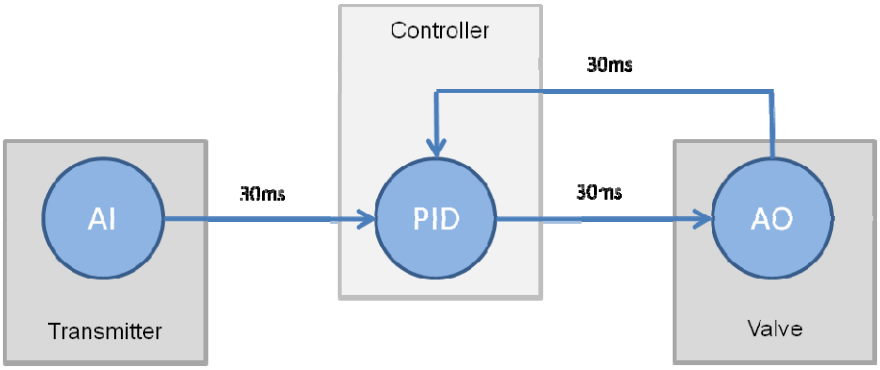

Figure 1 – AI and AO blocks run in Fieldbus devices; PID run in controller

While not shown in the figure above, one must also be aware that the execution of the PID algorithm in the host is typically not synchronized with the macrocycle execution on the Fieldbus segment. This means that a change in output to the control valve may not be sent until the following macrocycle. Hence, the overall control response period, which is a composite of bus macrocycle time and DCS controller module execution cycle, will often exceed the 300ms specification.

Implementing FOUNDATION™ Fieldbus with Control in the Field

By implementing Control in the Field, as before, the AI block is executed in the transmitter and the AO block is executed in the control valve positioner. However, now the PID block can be executed in either the transmitter or the control valve positioner, although it is often preferred to execute the PID in the control valve positioner, because fewer communication links will be required. With this configuration, only one communication link is required on the segment, compared with the three communication links that are required when the PID block is executed in the DCS controller. This will considerably reduce the control response period.

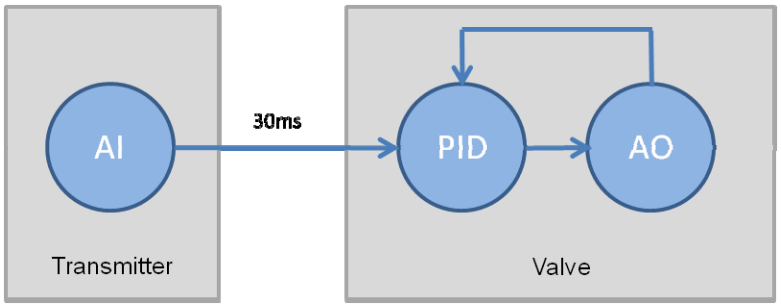

Figure 2 – AI,AO and PID blocks run in Fieldbus devices

The user should exercise caution in the selection of field devices because although Fieldbus devices are interoperable, they are not necessarily interchangeable in any given installation. This is because the products from different supplier can vary considerably in their features (both diagnostic and function blocks), power consumption, and speed of execution of their function blocks. A transmitter or positioner from one company may execute function blocks in the field devices at considerably different rates, as illustrated below.

	Emerson		Other	
	3051S	DVC6000f	Pressure	Positioner
AI	20 ms		100 ms	
PID		30 ms		120 ms
AO		25 ms		95 ms

Figure 3 – Comparison of Device Function Block Execution Rates

When using Control in the Field, the control response period is determined solely by the segment macrocycle. By specifying Emerson's high performance field devices, fast control response can be assured. Using the numbers in Figure 3, the total execution and communication time for one control loop executed in the field will be of the order of 105ms (20ms for AI, 30ms for communication, 30ms for PID, 25ms for AO), allowing plenty of additional time for other communication with a segment macrocycle of 250ms. (The minimum macrocycle for any one segment depends on the process automation system capabilities, and the user configuration.)

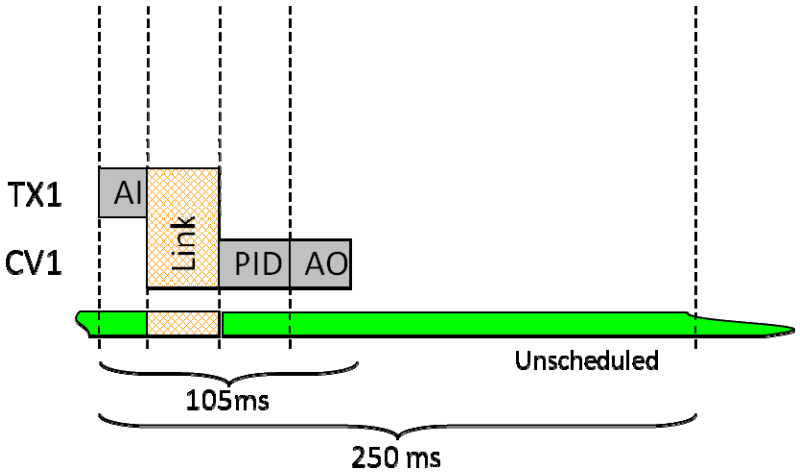

Figure 4 – Control in the Field Macrocycle with One Loop

In addition, it is possible to execute more than one control loop in a segment and still meet the 300ms control response requirement. In fact four separate loops can be configured to run on one Fieldbus segment and still meet the 300ms control response period specification.

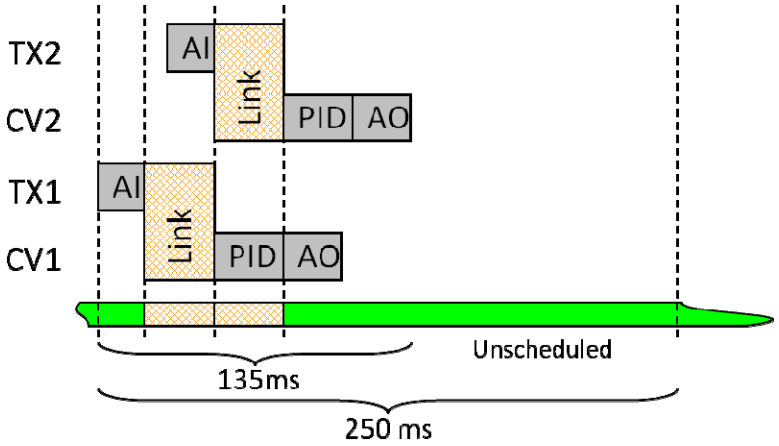

Figure 5 – Control in the Field Macrocycle with Two Loops

Additional Benefits

The examples shown are simple control loops using basic function blocks. However, there are cases for needing to execute more complex loops. Devices may also support blocks for arithmetic, selection, etc., which allow more complex loops to benefit from the speed of Control in the Field. A unique advantage of the DeltaV™ Process Automation System is that function blocks can also be assigned to run in the DeltaV H1 Interface Card, which is synchronized with the field devices on the segment. This provides more powerful function blocks than what is available within the devices, because the H1 Cards do not have the power limitations of the field devices.

When using DeltaV, no customized special software is needed to meet the dynamic performance specification. As a result, any modifications to the control strategy after the plant startup will be much easier compared with system architectures with additional software, data mapping, etc. Furthermore, Control in the Field is transparent to the operators. All loops are operated the same way, regardless of where the PID algorithm is executed.

Finally, there are numerous benefits to the use of FOUNDATION Fieldbus, besides being able to achieve fast control response. There are cost advantages by being able to add more devices per segment thus reducing the cost of interface cards, wiring and installation hardware, safety barriers, control room foot print, as well as the labor associated with cable pulling and termination. For more information on PlantWeb® FOUNDATION Fieldbus solutions, please visit www.EmersonProcess.com.

Summary

Control in the Field, coupled with the execution time of function blocks makes FOUNDATION Fieldbus a good solution when fast control response periods are specified. However, consideration of the process automation system, transmitters and final control element must be reviewed to ensure that all three components enable the specification to be met.

The DeltaV Process Automation System is able to seamlessly implement Control in the Field to meet the fast control response specifications. Emerson Process Management has successful implementations with control strategies that met the 300ms control response specification using FOUNDATION Fieldbus. The results have been tested and verified by the process licensor and the end user.

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