

YS100 APPLICATION NOTE

General Cascade Configuration PIDs, CASCADEG

Overview

The most common process control configuration using two process variables is cascade. Many of these applications can be adequately controlled using the YS170 program "CASCADEG". This program is a programmable, hence changeable, version of the pre-configured "CASCADEG" control algorithm available in the YS150 and YS170 controllers. The pre-configured version does not require programming. See TI 1B7C1-01E, Control Functions and Applications YS150/170 Single-Loop Controller for a description of the pre-configured "CASCADE" algorithm.

The programmable "CASCADEG" has two advantages over the pre-configured version. First, the programmable version can be changed to satisfy specific plant applications. Secondly, the programmable version permits the entire program including parameters and tuning constants to be entered from a computer and data stored on a disk. This saves time compared to making all entries from the front panel and documenting the entries.

Basic Operation

The secondary loop PID Algorithm, loop 2, uses the signal from input X3 after signal conditioning as its PV. The output to the valve, Y1, is the secondary loop output. When loop 2 is in the cascade mode, the set point for loop 2 is the output from the primary controller, loop 1. The process variable for loop 1 is the X1 input after signal conditioning. For both inputs X1 and X3 signal conditioning consists of filtering, optional square root extraction and optional characterization using a look-up table. The transfers from manual mode to automatic mode and from automatic mode to cascade mode are bumpless without any need for the operator to proceed through any special balancing procedure.

Optional features

While most of the options of the pre-configured and programmable "CASCADE" control algorithms are the same, this application note is written for the programmable version.

Options for remote set point, and feedforward use inputs X2, and X4. Each of these options is discussed in more detail below.

Many features are built into the PID algorithm. These include process high/low alarms, velocity alarms, gap gain, self-tuning, sample and hold algorithm, batch control algorithm, I-PD, PD, PI-D forms of the PID algorithm, and set point filter. For details concerning these options refer to TI 1B7C1-01E.

When options are not needed

Generally, optional features are not processed until the appropriate parameters are set to activate the desired option. Thus, options can generally be ignored until needed. If the program is to be a single application, the unneeded options can be removed from the configuration. If the program is to be used as a general program, with the same program used many times, the optional parts of the program are usually left in the program, and parameters left so they do not activate the options.

Feedforward

Feedforward can improve control. Examples include:

- Three element boiler feedwater, drum level control (figure 2)
- Temperature control on heaters and heat exchangers

Three element boiler feed-water, drum level control can be implemented by bringing steam flow into input X4, feedforward, level into input X1, and boiler feed-water into input X3. The feedforward signal path provides filtering and if necessary square root extraction for the steam flow signal. The steam flow signal should be filtered, typically with a 15 second filter (lag) on the steam flow signal. The steam flow filter provides some compensation for shrink and swell. The steam flow signal is added to the output of the level controller to become the set point for the boiler feed-water control loop, loop 2. A gap gain may be useful on the drum level controller.

Cascade Set Point

Typical applications for the Cascade Set Point include:

- Set point from another controller
- Remote set point sent through an RTU or from a PLC

The operator selects the remote set point by changing the loop 1 mode from automatic to cascade. Loop 2 uses a remote set point, loop 1 output when loop 2 is in cascade. When loop 1 is in the cascade mode, a signal external to the controller, X2, after conditioning, becomes the loop 1 set point. The control parameters can be set to allow an external signal (DI1) to change the loop 1 mode from automatic to cascade. Signal

conditioning includes optional square root extraction, filter (lag), and optional ratio and bias.

Input Signal Conditioning

Each input, X1 to X4 has an adjustable input filter. Note, the term filter and lag can be treated as synonymous in this context. If the filter time constant is set to 0.0, no filtering is done. All four inputs X1-X4 have optional square root extraction. Inputs X1 and X3, PV for loops 1 and 2, have look-up tables, FX1 and FX2, to characterize the input. Inputs X2 and X4, remote set point and feedforward have optional ratio and bias.

In applications which require a signal conditioning card, such as thermocouple and pulse inputs, input X5 is used. The thermocouple, pulse, RTD etc is wired to pins 19-21 as per IM 1B7C1-01E or GS 1B7C2-01E. The optional signal conditioning card processes the input and provides a 1-5 volt signal at the X5 input terminals. Ranging is done from the front of the YS-170. If the program is to use the conditioned signal at the X5 terminals, the program must be modified to use X5 or a jumper wire used to connect the signal from pin 9 to pin 1 (for X1), pin 3 (for X2), pin 5 (for X3), or pin 9 (for X4).

Summary

The general cascade loop control program, CASCADEG, satisfies the control necessary for most cascade loop applications. Inputs are provided for feedforward, and remote set point. As necessary, the program can be altered to quickly satisfy specific plant requirements.

