WATLOW

Products
CLS20X, CLS216, MLS3XX

Category
Cascade Control

Title
Setting up for Cascade Control

Body
The Enhanced Feature option or option number 3 for CLS200 and MLS300 series controllers used in cascade control applications have proved to be somewhat demanding in setting up this feature. There are some extra items in the setup menu not normally seen which are utilized in cascade control. These cascade menu items along with the cascade parameter setup labels have occasionally been the source of some confusion when setting up cascade control.

Typical Cascade Application Data:

Let's say that **Loop #3** is measuring the process inlet air temperature using a Type J TC and will provide the actual PID control output to the final control element. This is the secondary loop of cascade control and maximum air temperature desired is 400, therefore the **SP range** will be **100 to 400**. From the front panel display, Go to Loop #3.

The primary loop for measuring the process mold temperature and adjusting the SP of the secondary control will be Loop # 7. The desired temperature of the mold temperature is 270 and **Loop #7 SP** will be set to **270**.

Go into the programming menu and go to the Cascade Menu.

Explanation of Cascade Menu setup parameters:

Setup Loop 03 for Cascade ? Select **YES**. This is setting Loop #3 to be the cascaded control loop also known as the Secondary Loop. This is the loop that will measure the process inlet BTU such as air temperature inside a furnace and will provide the PID control output to a final control element such as a Din-a-mite. This loop SP range is set by cascade parameters and is adjusted by the output of the Primary Loop.

03 Cascade Prim. Loop ? 07 This is the loop that is providing the temperature of the process load such as a mold temperature inside of the furnace. We are using Loop #7 as the Primary Loop and this is where we **select Loop #7**. This loop TC for instance would be the TC actually mounted on the mold for measuring mold temperature. Loop #7 input should be set correctly for the type of sensor used.

03 Cascade Base SP? 100 This is the low end of the desired SP range of the Secondary Loop and the factory default value is 25, so we must adjust it to 100. When Loop #7 PID output is at 0% (above Loop #7 SP), it will set Loop #3 SP to 100. This is also known as the Zero setting.

03 Cascade Min SP ? -350 The factory default value is 25. This is a redundant SP function providing the same function as the Base SP. In order to avoid confusion, it is recommended to set this to the lowest

value of the input range of Loop #3 and for a Type J TC it would be -350. This parameter has no value for most uses of cascade control and is best set to the input range lowest limit.

03 Cascade Max SP ? 1400 The factory default value is 25. This is a redundant SP function providing the same function as the HT Span. In order to avoid confusion, it is recommended to set this to the highest value of the input range of Loop #3 and for a Type J TC it would be 1400. This parameter has no value for most uses of cascade control and is best set to the input range highest limit.

03 Cascade HT Span? 300 This is the high end value of the SP range of Loop #3. This value is obtained by subtracting the Base SP value of 100 (SP low end value) from the SP high end parameter of 400. HT Span = HT Hi SP - HT Lo SP. Adjust the factory default value of 0 to 300.

03 Cascade CL Span ? 0 This is the low end value of the Cooling SP range, if cooling is to be used. The Base SP would be the high end of the cool SP range. CL Span = CL Lo SP + CL Hi SP (Base SP). Factory default value is 0. If the cooling output is not to be used, allow factory default to stay at 0.

Example: Cool SP range for Loop #3 is -40 to 40. Add the two values to obtain the total value of the range, this is the CL Span parameter. Base SP = 40 and CL Span = -80.

This concludes the setup for cascade control. Now the PID operating parameters must be set to correct values in order for cascade to work correctly.

Setting PID Parameters:

The control loop or secondary loop will control as a normal PID control loop. The primary loop will only use P and I control modes.

Place the Primary Loop #7 in Manual Mode and set the output level to 0%. This should set Loop #3 SP to 100. Set the output level to 100%. Loop #3 SP should be at 400. If these two end points are not obtained, please recheck the Cascade Menu parameters. If end values are good then set the output level to 50%. Loop #3 SP should be at 250.

With Loop #3 SP at 250 the tuning of the control loop can now take place. The autotuning function may be used or manual tuning of the PID may be used to obtain the necessary correct PID values for Loop #3 to control the process temperature.

The P and I values for Primary Loop #7 are set differently from normal PID control tuning procedures used for process control loop #3. The Pb parameter is used to provide for a proportional change of Loop #3 SP over it's SP range with respect to the change in process temperature of Loop #7. This proportional change of the control loop SP may be based upon empirical data of the process or it may be based upon the desired rate of change of the primary loop PV to the change in the process control temperature range. If nothing is known about the process change effect of the primary loop change then it is suggested that the Pb value obtained when tuning Loop #3 is used as the Pb for the Primary Loop #7 Pb as a first step method.

Example: To have a proportional change of primary loop PV starting at 200 with a span of 70 (up to 270), set the Pb to 70. This will provide a proportional change of Loop #3 SP starting when the process load temperature reaches 200, decreasing the temperature of the control loop from 400. The proportional

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change will decrease the control loop SP to 100 by the time Loop #7 PV has reached 270. This means that for every 1° change of Loop #7 PV from 200 to 270, Loop #3 SP will change 4.3°.

There are processes where only the P mode would or could be used for changing the control loop SP. In that case, for most processes the PV of Loop #7 would remain below the SP. The I mode is used to bring the PV to SP. The recommended initial TI value to use is the TI parameter of the control Loop #3. When Loop #7 PV is at SP and the output level is not changing by more then 1-2% then the TI value is correct. It the output is cycling above a 5% level change when the PV is at SP or if the PV is cycling, increase TI in steps of 30 until the output stops changing while at SP. To see if optimum TI setting has been obtained with the PV at SP and the output level is holding steady (<1-3% change), reduce the TI in steps of 30. When the output level starts changing add to the TI in steps of 30 until the output stops changing. This should be the optimum TI parameter for the primary loop.

Do not use the Derivative Mode for the Primary Loop.