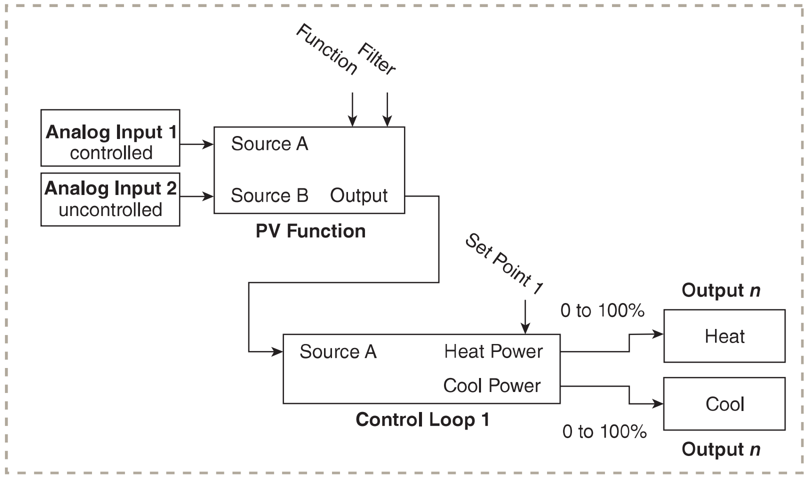
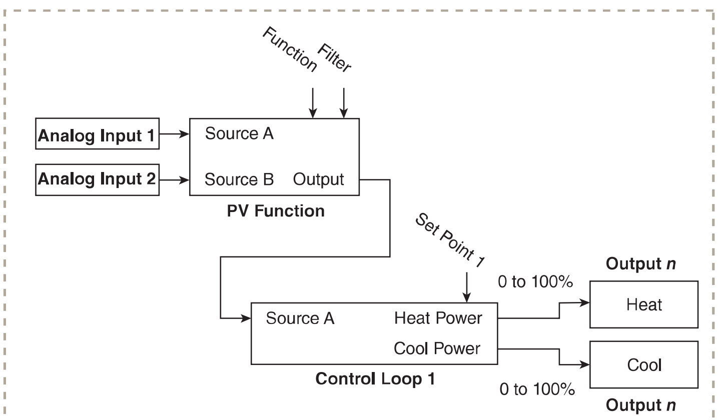
Ratio

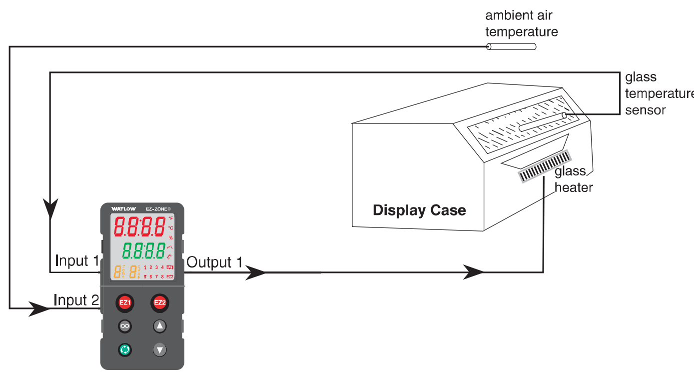


Example 5: Differential

Requirements:
Two analog inputs and the enhanced software option are required and at least one output adjusts the controlled part of the process.
Overview:
Differential control maintains one process at a difference to another process. When function is set for Differential, the PV Function output equals Source A minus Source B. Control loop 1 will control Analog Input 1 difference to Analog Input 2 based on Set Point 1.

Differential



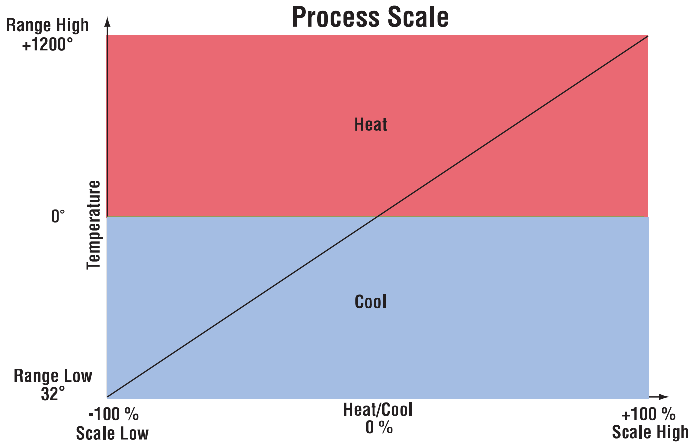


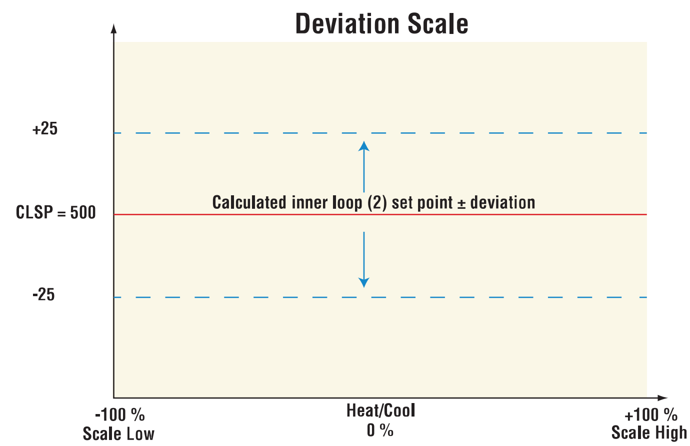
Example 6: Cascade

Requirements:
Two loops of control, two inputs and at least 1 output and the enhanced software option.
Overview: Cascade control can handle a difficult process with minimal overshoot, while reaching the set point quickly. This minimizes damage to system components and allows for over sizing heaters for optimal heat-up rates. Heater life is also extended by reducing thermal cycling of the heater. Systems with long lag times between the energy source (heater, steam, etc.) and the measured process value cannot be controlled accurately or efficiently with a single control loop, because a lot of energy can build up before a response is detected. This can cause the system to overshoot the set point, which could damage the heater, product or heat transfer medium, such as a heat transfer fluid.

The majority of the user configuration is done via the Math function. There are two user selectable settings that will enable Cascade control, Deviation Scale or process Scale. When Process Scale is selected the remote set point will be within the defined Range low/high and Scale low/high settings. As an example, the graph below shows a heat/cool application where the temperature range is between 32° to 1200°. With the scaling set as shown 100% cool will equate to 32°, likewise when the control is calling for 100% heat the temperature equates to 1200°.

When Deviation Scale is selected the Closed Loop Set Point (SP) will not deviate beyond the specified settings. With the settings as shown in the graph below the SP (500°) will not deviate beyond ± 25°.

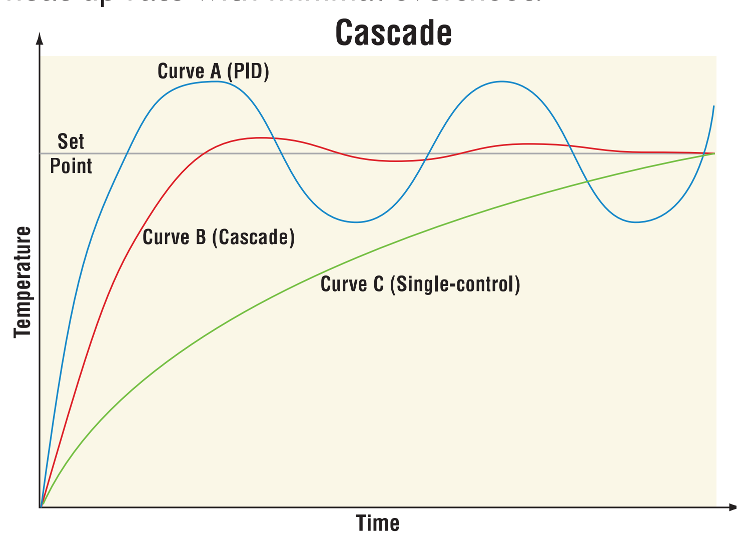




The graph below illustrates a system with a long lag time and the advantages in using cascade control. Curve A represents a single-control system with PID parameters that allow a maximum heat-up rate. Too much energy is introduced and the set point is overshot. In most long-lag-time systems the process value may never settle out to an acceptable error. Curve C represents a single-control system tuned to minimize overshoot. This results in unacceptable heat-up rates, with the final value taking hours to reach. Curve B shows a cascade system that limits the energy introduced into the system allowing an optimal heat-up rate with minimal overshoot.

Note:

When using cascade control, two loops of control are required. Changing the control mode in either loop will affect both loops of control. In other words, if loop one is changed to manual mode, loop two will also be changed to manual mode automatically.



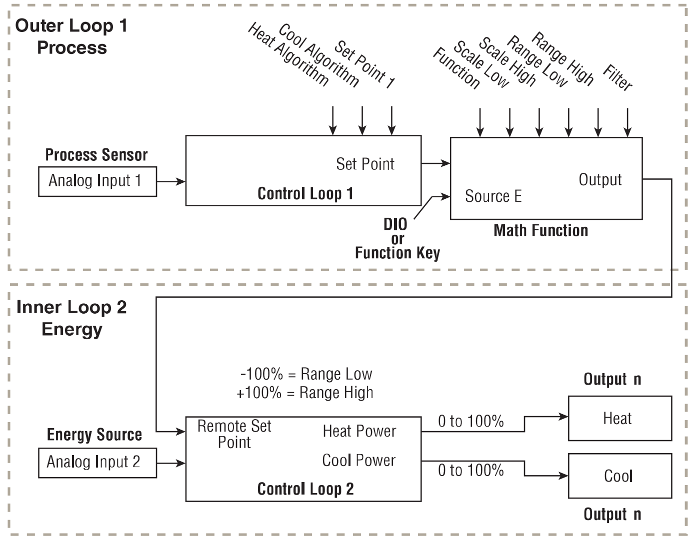
When the Math function is set for Process or Deviation Scale and Source E is not connected or false, cascade control is enabled.

Note:

When the Math function is set for Process or Deviation Scale the PM automatically makes the connections for each Control Loop as shown in the graphic below. Each loop, 1 (process) and 2 (energy) outer and inner respectively, cannot be changed. If it is desired to display the inner loop process variable and set point, the home page must be changed via the Factory Page, Custom Menu.

Cascade control uses two control loops (outer - loop 1 and inner - loop 2) to control the process. The outer loop (Analog Input 1) monitors the process or part temperature, which is then compared to the Set Point. The result of the comparison, the error signal, is acted on by the PID settings and the Range and Scale high/low settings. Ultimately, the outer loop produces a remote set point for the inner loop. The inner loop input (Analog input 2) monitors the energy source (heating and cooling), which is compared to the remote set point generated by the outer loop. The result of the comparison, the error signal, is acted on by the PID settings in the cascade inner loop (2), which generates an output power level between -100% to +100%. If the power level is positive the heat will be on; if the power level is negative the cool will come on. Power from the energy sources are supplied by the outputs of choice always referenced to Control loop 2.

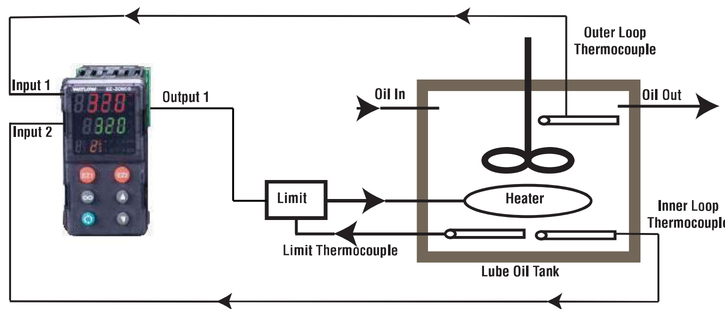
Cascade



When cascade control is disabled (Source E is true), the Math function output will equal Control Loop 1, Set Point.

Note:

If an input sensor on the outer loop fails when using deviation cascade the inner loop will continue to drive the output.



Example 7: Wet Bulb / Dry Bulb

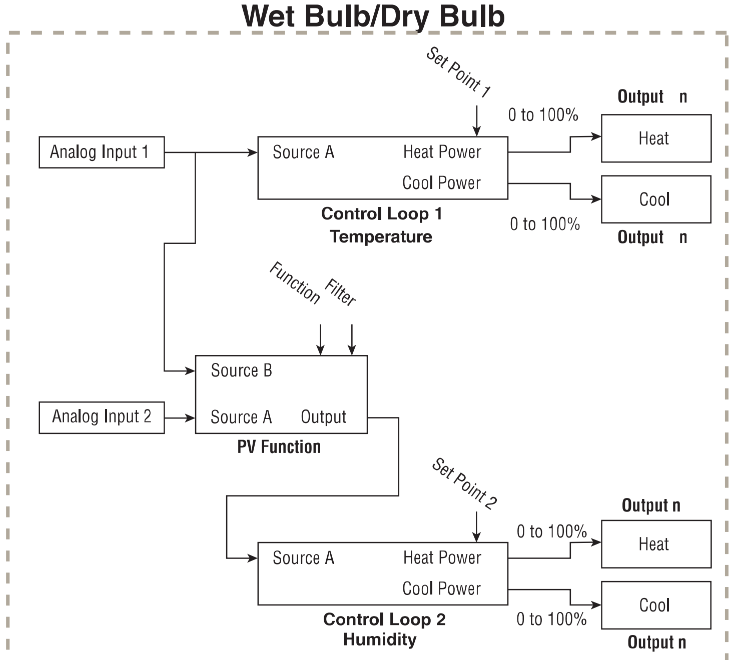
Requirements:

Two analog inputs and at least one output are required to adjust the controlled part of the processes.

Overview:

Wet Bulb/Dry Bulb is a configuration where a dry bulb connected to Analog Input 1 measures temperature on Analog Input 1. A wet bulb sensor that is maintained with moisture has air moved over the sensor. As moisture evaporates from the wet bulb, the temperature drops. A wet bulb input on Analog Input 2, in combination with the dry bulb temperature, senses relative humidity. The controller calculates the temperature difference between the two sensors to determine percent relative humidity.

Wet Bulb/Dry Bulb



The humidify and dehumidify outputs are disabled when Analog Input 1 temperature falls below 32 F/0 C, or goes above 212 F/100 C. When function is set for Wet Bulb/Dry Bulb, the PV Function output equals calculated humidity. Control loop 1 will control Analog Input 1 to Set Point 1. Control loop 2 will control Analog Input 2 to Set Point 2.