Temperature Control

Application Note LC-129

One of TSI's greatest strengths is flexibility. Whether your laboratory control solution requires monitors, a direct pressure control approach, a flow tracking approach or a flow tracking with pressure reset solution, TSI is able to offer an instrument to meet your needs.

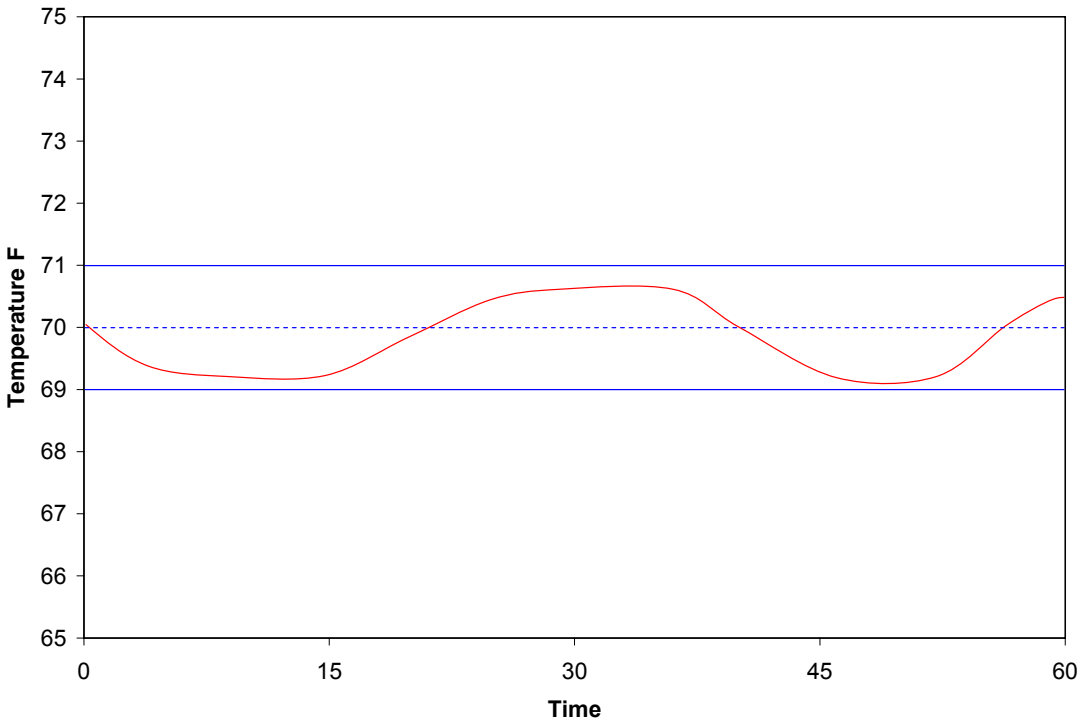
The primary concern for a laboratory is, of course, the protection of those people working in the lab. Another concern for the people working in the lab is comfort. TSI is able to offer laboratory control solutions that work to satisfy both safety and comfort.

To meet the needs of both safety and comfort TSI is proud to offer integral space temperature control as part of the standard features on the Model 8636 Direct Pressure Controller, as well as the Models 8681 and 8682 Flow Tracking with Pressure Reset Controllers.

These controllers now offer industry standard temperature control features. Specifically, these controllers now feature an adjustable Temperature Dead Band range, an adjustable Temperature Set Point Throttling Range, an adjustable Temperature Set Point Integral Value and an adjustable Reheat Valve Control Direction. These adjustable parameters allow you to field tune the TSI controller to provide excellent space temperature control while maximizing the safety and energy efficiency of the lab.

What Are These Features?

The Temperature Set Point Dead Band range (TEMP DB) determines the controller's temperature control deadband, which is defined as the temperature range above *and* below the temperature set point (TEMP SETP), where the controller will not take corrective action.

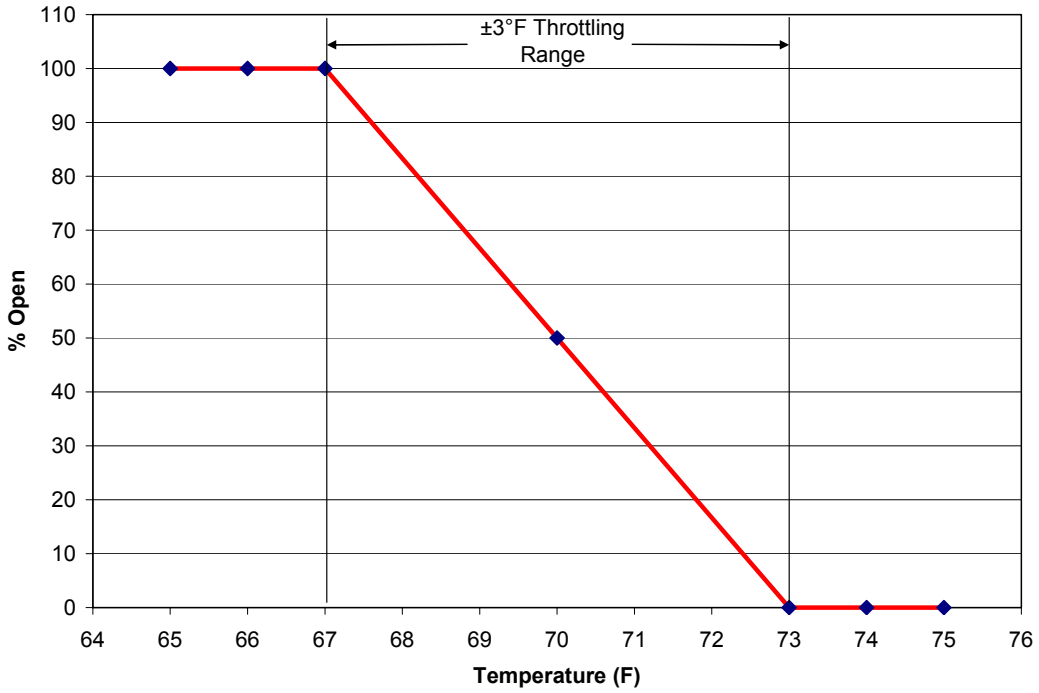


If TEMP DB is set to 1.0°F, and the TEMP SETP is set to 70.0°F, the controller will not take corrective action unless the space temperature is below 69.0°F or above 71.0°F.

Simply put, the Temperature Set Point Dead Band, allows you to define how sensitive the controller needs to be to changes in space temperature above and below the space temperature set point. If the TEMP DB is set to its maximum value, which is ±1.0°F, the controller will not react to changes or fluctuations in space temperature unless the temperature rises above the set point by 1.0°F, or if the space temperature falls below the set point by 1.0°F. Similarly, if the TEMP DB is set to its minimum value, ±0.1°F, the controller will react to space temperature changes 0.1°F above or below set point.

Increasing the Temperature Set Point Dead Band decreases the controller's sensitivity to temperature fluctuations above and below the temperature set point. Dead band control enhances the performance of the controller; it improves stability control and extends actuator life.

The Temperature Set Point Throttling Range (TEMP TR) item determines the controller's temperature control throttling range, which is defined as the temperature range for the controller to fully open and fully close the reheat valve.



If TEMP TR is set to ±3.0°F, and the TEMP SETP is set to 70.0°F, the reheat valve will be fully open when the space temperature is 67°F. Similarly, the reheat valve will be fully closed when the space temperature is 73.0°F.

The Temperature Set Point Throttling Range allows you to define how the magnitude of changes in space temperature, both above and below the space temperature set point, will affect the reheat valve control output, i.e., fully opens or fully closes the reheat valve. The TEMP TR item has a minimum value of ±2.0°F and a maximum value of ±20.0°F.

Changing the Temperature Set Point Throttling Range (TEMP TR), changes (increases or decreases) the temperature at which the reheat valve is fully closed (or open), effectively defining the range of reheat valve movement with a temperature range above and below the space temperature set point. The smaller the Temperature Set Point Throttling Range (TEMP TR), the more precise the control will be. The larger the value for TEMP TR, the more stable the control will be. The goal is to be able to adjust or tune the Throttling Range such that a perfect balance between precision and stability is achieved.

The Temperature Set Point Integral Value (TEMP Ti VAL) item provides you with the ability to manually change the temperature control PI integral control loop variable. The TEMP Ti VAL item is used to read and change the integral control coefficient. Increasing TEMP Ti VAL will slow the control system which will increase stability. Decreasing TEMP Ti VAL will speed up the control system which may cause system instability.

The purpose of integral control is to eliminate the “droop” that is inherent in proportional control. Proportional control provides a good “starting point” for the actuator, at which point the integral function will start to have an impact on the controller’s output.

The integral function is a result of a combination of proportional error and time. Over time, a running sum of the error value is calculated and added to or subtracted from the proportional error to determine the control loop output. As the control output value changes, the temperature is brought closer to set point, which reduces the proportional error, which eventually drives the integral error term to 0. At this point, no

change is made to the control output since set point has been achieved. Abrupt changes in temperature will cause the control system to act more aggressively.

The Temperature Setpoint Integral Value has units of seconds. This is based on the delay of temperature change in the space after a change of control output. Longer integral times are necessary for a slow process such as temperature control.

TSI has taken extra precautions to avoid a condition known as "integral wind-up". Integral wind-up is a condition where a fully open or fully closed position has been achieved without obtaining the desired change in temperature. For instance, if hot water has been shut off to a reheat coil in a VAV box, it would be impossible to heat a space. The temperature control algorithm would have the reheat actuator in a fully open position trying to heat the space (which will not be achieved until hot water is fed to the coil). In this situation, it is possible that the integral value would continue to be calculated and added to the proportional error with no effect…the term effectively "winds up" to a point that can cause problems in the controller software. TSI's temperature control algorithm can detect this situation and has the added precautions to completely eliminate it.

The Reheat Valve Control Direction (REHEAT DIR) item determines the temperature control signal's output direction. As an example; if the control system closes the reheat valve instead of opening the valve, this option will reverse the control signal to now open the valve.

How Does This All Work?

A Model 8636, Model 8681 or Model 8682 controller receives a temperature input from a temperature sensor (1000 Ω Platinum RTD). The controller maintains temperature control by:

(1) Controlling supply and general exhaust for ventilation and cooling
(2) Controlling the reheat coil for heating

The controllers have three supply flow minimum set points. The ventilation set point (VENT MIN SET) is the minimum flow volume required to meet ventilation needs of the laboratory (ACPH). The temperature supply set point (COOLING FLOW) is the theoretical minimum flow required to meet cooling flow needs of the laboratory. The unoccupied set point (UNOCC SETP) is the minimum flow required when the lab is not occupied. All of these set points are configurable. If the controller is in the Unoccupied Mode, the controller will control the supply air flow to the UNOCCUPY SET ventilation rate, the supply flow will not be modulated for space cooling; space temperature control will be maintained by modulating the reheat coil.

The controller continuously compares the temperature set point to the actual space temperature. If set point is being maintained, no changes are made. If set point is not being maintained, and the space temperature is rising, the controller will first modulate the reheat valve closed. Once the reheat valve has been fully closed for three minutes, the controller will then gradually begin increasing the supply volume by 1 CFM/second up to the COOLING FLOW set point.

The controller, when controlling supply flow for cooling, will not increase the supply flow above the COOLING FLOW ventilation rate. If the space temperature decreases below the set point, the controller will first reduce the supply volume. Once the supply volume reaches its minimum (VENT MIN SET), the controller will then start a 3 minute time period. If, after 3 minutes the supply flow is still at the VENT MIN SET flow rate, the controller will begin modulating the reheat coil open to meet the heating demand.

What Does This Mean To Me?

These new temperature control features will allow you to field program and tune the Model 8636, Model 8681 and Model 8682 controllers to provide excellent temperature control as well as excellent pressure and ventilation control, which make the lab safe and comfortable for its users. This means satisfied customers.

And satisfied customers mean more business for you and TSI.

On The Horizon

These new temperature control features will now be part of the standard Model 8636, Model 8681 and Model 8682. We will also be updating many of the existing special controllers with these features as well. This means that many of the "special" controllers you have used in the past will now be even more effective.

As you have upcoming orders with an existing "special" controller, contact TSI and let us know about it, so that we can prioritize the updating of existing special controllers.

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