Use Smart Power Control to Improve Temperature Control

By: Sean Wilkinson - December 16, 2021

A smart power controller is smart because it has a microprocessor, memory and sophisticated programming and because it has sensing (voltage and current) that can allow it to adapt and make decisions as conditions change within the parameters of the application for which it is configured.

There are many types of power switches that have been used in commercial and industrial applications. Mechanical relays and contactors are good for applications where they are not switched very often because they are relatively inexpensive and do not produce much heat, but for precise control of electric heating they are a poor choice because they wear out and fail quickly if switched frequently. They also cause electrical noise that can interfere with temperature measurements. To reduce failures and mitigate noise solid-state power switches such as the Watlow® DIN-A-MITE® family are often selected for temperature control applications.

Watlow's ASPYRE power controller (/en/products/controllers/power-switching-devices/aspyre-intelligent-power-controller) is a smart controller that is utilized by industries around the globe. The specialized product comes with a mark of assurance with a UL 508 rating. This is a standard of the industrial control equipment industry that is linked to safety and can reduce labor and project costs.

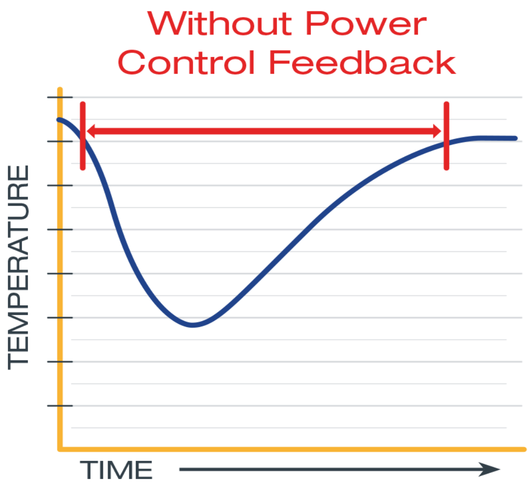
ASPYRE controllers are applied by heavy duty industrial companies in petrochemicals, heat treatment and power generation. For starters, the model is available between a range of 35-2100 amps to complement a wide variety of applications. A single high amp ASPYRE unit can serve as a cost-effective solution. This is ideal for applications utilizing multiple small units with low range amps.

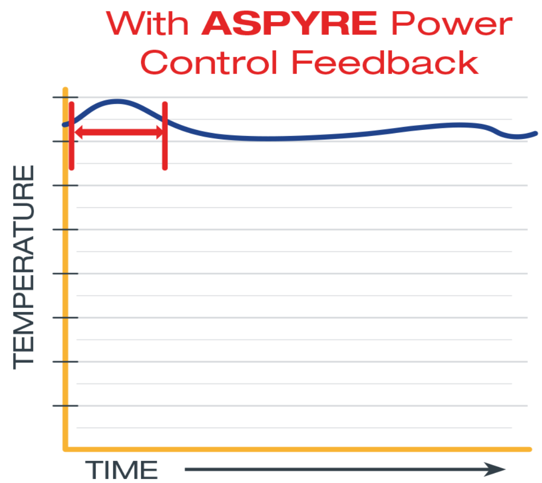
Watlow's ASPYRE® family of smart power controllers have the beneficial characteristics of solid-state power switches allowing them to last a long time, switch frequently to control heaters precisely and generate minimal electrical noise, but why do we call them "smart power controllers?" The key features that distinguish smart power controllers from other solid-state power switching products are:

- On-board measurement of the load current and voltage
- Ability to calculate the power delivered to the load and the load resistance
- Closed-loop control of the output based on the measured current and/or voltage
- Option to limit the load current
- Option to integrate with other automation equipment via modern communication protocols such as EtherNet/IP™ and Profinet

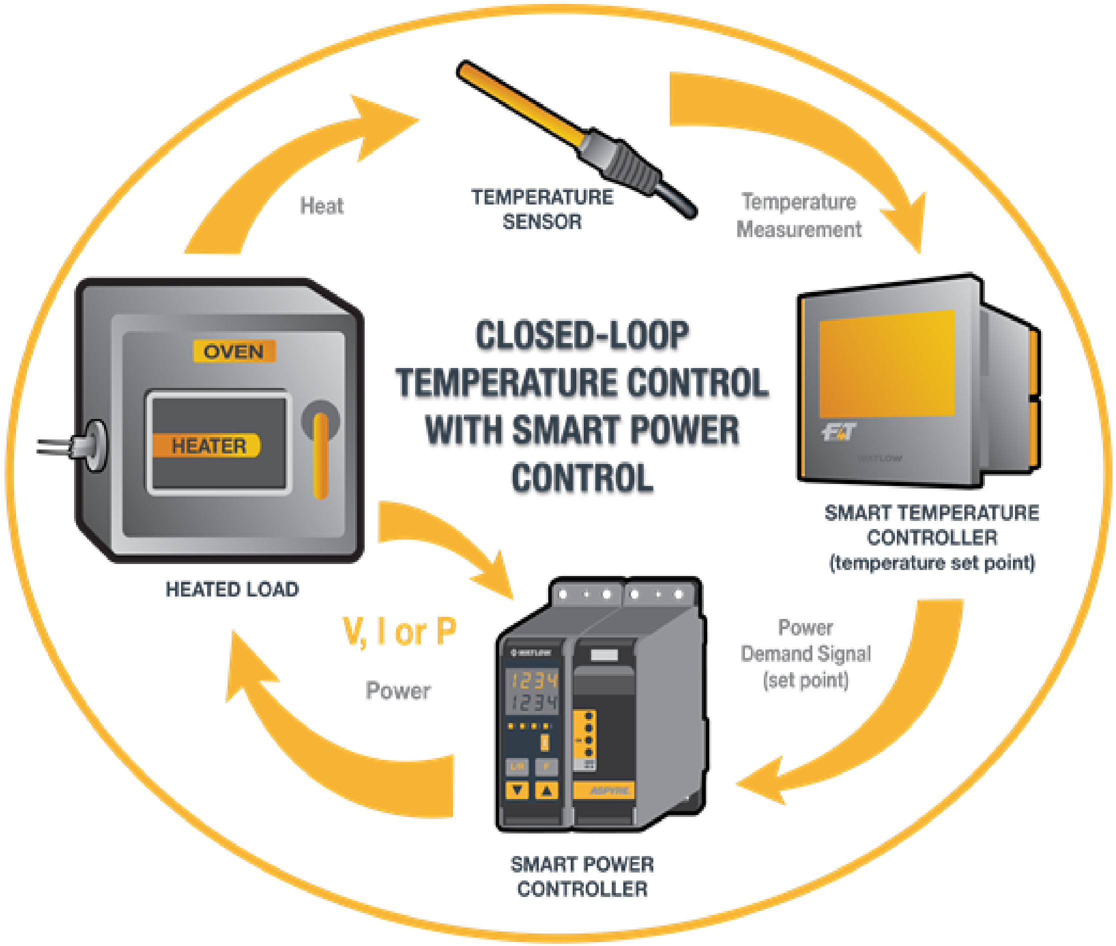
Improved Performance

Being able to control the output based on the measurement of power delivered to the load improves temperature control performance because it compensates for line voltage fluctuations or even partial load failures faster and, therefore, with significantly less deviation from the temperature set point than would occur with the same temperature controller paired with a traditional solid-state power switching product.





The temperature controller and power controller work together. The temperature controller measures temperature with a sensor and determines how much of the available power (from zero to 100%) is necessary to achieve set point. The power controller interprets the output from the temperature controller as a power set point and controls the delivered power accordingly. The power controller adjusts the power delivered for voltage fluctuations and to the best of its ability when there is a partial failure of the heater.



What is meant by “closed loop control of the power” is not always immediately obvious even to people familiar with closed-loop temperature control. It is worth walking through step-by-step:

1. The signal from the temperature controller is the set point for the power controller.
2. The power feedback is measured/calculated by the power controller (measures line voltage and load current and calculates power P = V x I delivered to heaters).
3. The power controller adjusts its output (turns on for more or less time) to make the feedback equal the set point, i.e., it closes the loop.

Process and Equipment Characterization

The smart power controller measures the line voltage and the current through the load. With that information it can calculate the load resistance and how much power is being delivered by the heater. Equipment manufacturers can use this information during commissioning as an indicator of whether there is a problem, or all is well. For example, abnormally high resistance could indicate a poor connection that might eventually cause a premature failure or even a fire if not corrected.

One Watlow customer, a supplier of large, high volume equipment for baking, monitors the load parameters during equipment installation and compares the profile with previous known good startups. They get early warning of issues localized to the heated zone and can take corrective action before a failure occurs.

End users can similarly monitor these parameters overtime and correlate them to good and bad production results. A supplier of foamed sheet packing material reduced product returns and increased customer satisfaction by being able to quickly identify when their curing process is out of tolerance because they can detect when the resistance of the zone increases indicating a failed IR lamp.

Integrated Communication

Integrating the smart power controller with other automation equipment allows process variables to be monitored remotely and allows operators and line maintenance personnel to quickly locate problems. A large manufacturer of power transmission and other cables relied on people to periodically check the current gauges visually for each zone on each of extruders that coat the cables. On shifts with lower staffing, bad product was often the first indication of a problem. They replaced the solid-state power controllers in the extruders with ASPYRE DT power controllers so they could quickly determine if a failed heater would result in cable that would have to be scrapped or reworked or whether production could continue until the scheduled maintenance. The design of the equipment is such that they can continue to produce good product with one element failed in a zone. The power measurements allow them to determine how much power is being delivered per zone which allows them to plan for maintenance and reduce scrap rather than experiencing unexpected downtime.

Integration with Temperature Controller

Traditionally, temperature controllers and other automation equipment signal the power controller with a discrete time-proportioning signal or a process signal such as 4 to 20mADC. Once an industrial protocol is being used to extract data such as line voltage and load current from the smart power controller leveraging that feature for setting the power demand set point is the next logical step. This can reduce system complexity and footprint especially in multi-zone systems.

Adaptable for Application

This article has alluded to, but has not focused on, the capabilities of a *smart* power controller enabled by its microprocessor and sophisticated programming. It is highly configurable and has various functions to support a wide range of applications. More on this in future articles, but in brief two configurable aspects are firing type and feedback.

Smart Firing Increases Heater Life

Having a user-selectable firing type should be familiar to people who frequently set up temperature controllers, which can be configured for on-off, fixed time-base or variable time-based switching. The firing type is an order option for traditional power controllers but is user-selectable in the field for smart power controllers. Beyond that it can even switch automatically based on application needs. For example, you can configure the ASPYRE DT to perform variable time-based burst firing normally to minimize electrical noise but use phase angle to enforce a limit on current to minimize in-rush current in heater that has low resistance when cold such as a Tungsten lamp.

Feedback Appropriate to Application

Most applications use power feedback (V x I), but during start up furnaces with silicon carbide heaters use voltage feedback until the elements are hot and then switch to power feedback. The smart power controller can be configured to do this automatically.

Recap

Smart power controllers can improve temperature controller performance by controlling power delivered to the heater and responding to changes to the line voltage and heater resistance rather than mindlessly switching on and off according to the signal from the temperature controller. This delivers consistent heat through source voltage variations, faster recovery and less severe temperature deviations from partial heater failures.

Smart power controllers can measure current and voltage providing process performance characterization and early warning of issues during system commissioning and operation and provide alarms for short circuit, load failure (heater break) and partial break detection.

Smart power controllers have field configurable firing and feedback appropriate for protecting and extending the life of various heater types.

Ultimately smart power controllers offer features and functionality designed to help users minimize scrap and unscheduled down time.

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