

Temperature Control with 1050 Series Power Controllers

Overview

Spang Power Electronics' 1051, 1052, and 1053 Series digital SCR power controllers include standard and advanced temperature control features. A thermocouple (T/C) input for Type B, C, E, J, K, N, R, S, or T is provided on the 1050 Series auxiliary I/O option board. For ordering purposes, the option board is specified as part of the 1050 part number.

Within the web browser based configuration tool, the user defines the appropriate thermocouple type that will be physically connected to the option board. The thermocouple input allows for control, limit, and monitoring as well as configurable alarm and fault levels.

Standard Temperature Control Features

Operation Modes: Within Spang's web browser configuration tool, the thermocouple input is set to either not used, monitor only, limit temperature, or control temperature.

- *Not Used* – the actual temperature will read but no alarm, fault, or control / limit is available.
- *Monitor Only* – the actual temperature will read and associated alarms / faults are active, but no control or limit is available.
- *Limit Temperature* – the actual temperature measured is used as a limiting variable. The power controller's output will be reduced using the temperature proportional, integral, and derivative (PID loop) to limit the temperature to a configurable setpoint limit value.
- *Control Temperature* – the actual temperature is used as the master control variable. The power controller's output will be adjusted using the temperature PID loop to regulate to a configurable temperature setpoint.

PID and Ramp Settings: The temperature loop should be tuned to a given application and environment using the 1050's individually settable PID gains as well as ramp up and down settings. The PID and ramp settings allow users to minimize overshoot or target the desired aggressiveness of the temperature loop as it relates to resistance change, thermal mass, and heat transfer.

Automatic / Manual Temp Control: The temperature control loop is controlled automatically using temperature setpoints, ramps, and PID settings or adjusted manually using the temperature loop's output percentage. Setpoint tracking also exists to create a smoother transition from manual back into automatic control.

Alarm and Fault Settings: Configurable alarm and fault settings allow the user to annunciate thermal status as well as take shutdown action to protect product and furnace equipment from run-away conditions. The 1050 Series additionally incorporates time-delayed fault levels, individual enable / disable permissive for alarms, and alarm deadbands to allow for a more customer-specific setup.

Temperature Units: Either degrees Celsius or Fahrenheit may be selected as the default temperature units for the temperature setpoint, target, and actual. The numeric display of these values can be toggled back and forth between units over the configuration tool or display while running with no disruption to the controller's output. Additionally, both sets of values are available for control or monitoring over a network communication platform (e.g. Ethernet, Profinet, etc.).

Advanced Temperature Control Features

Recipe Mode: Within the 1050 Series power controller, recipe mode can be enabled to automatically play through a series of different setpoint levels; holding at each level for a specific period of time. Initially the user will set up a series of ramp and soak segments, thus defining the “recipe”. A segment must first be enabled; establishing a “ramp to” setpoint target as well as the ramp rate and then a soak time duration for that segment. The user may play, pause, stop or reset the recipe from the controls within the configuration tool (below as example), via a Spang color display, over a network communication platform (Ethernet, Profinet, etc.), or via hard-wire digital input contacts.

Temperature Recipe x

Recipe Mode

Enabled

Disabled

Temperature °C

70.0

Target Setpoint

70.0 70.0

Celsius

Segment

6

Ramp Time Remaining: min

Soak Time Remaining: min

Repeat From Seg.

Number Of Repeats

Repeats Remaining

Maximum Outage Time s

Output Action When Finished:

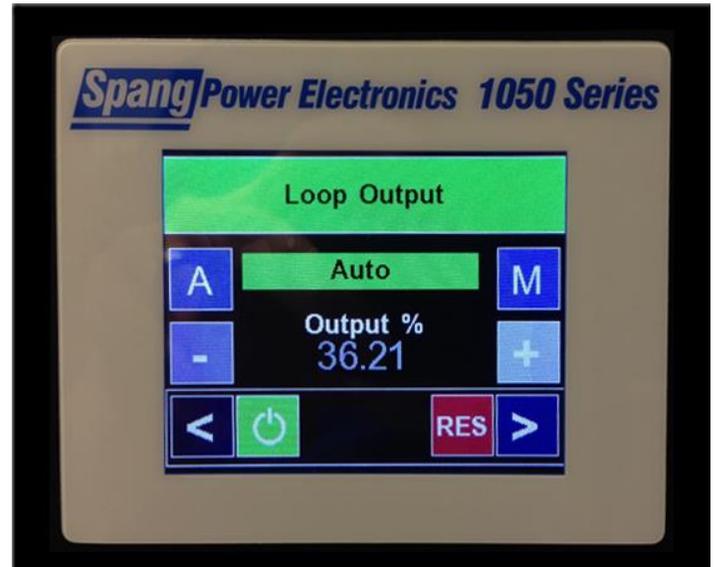
Segment	Enable / Disable	Target (in °C)	Target (in °F)	Ramp Rate (°C / Hr)	Ramp Rate (°F / Hr)	Soak Time (min)	Guaranteed Soak	Segment Status
1	<input checked="" type="checkbox"/>	60.0	140.0	25.0	45.0	15.0	<input checked="" type="checkbox"/>	Completed
2	<input checked="" type="checkbox"/>	100.0	212.0	40.0	72.0	15.0	<input checked="" type="checkbox"/>	Completed
3	<input checked="" type="checkbox"/>	90.0	194.0	25.0	45.0	42.0	<input checked="" type="checkbox"/>	Completed
4	<input checked="" type="checkbox"/>	95.0	203.0	25.0	45.0	45.0	<input checked="" type="checkbox"/>	Completed
5	<input checked="" type="checkbox"/>	100.0	212.0	25.0	45.0	60.0	<input checked="" type="checkbox"/>	Completed
6	<input checked="" type="checkbox"/>	70.0	158.0	50.0	90.0	90.0	<input checked="" type="checkbox"/>	In Process
7	<input checked="" type="checkbox"/>	85.0	185.0	40.0	72.0	15.0	<input checked="" type="checkbox"/>	Pending
8	<input checked="" type="checkbox"/>	100.0	212.0	25.0	45.0	30.0	<input checked="" type="checkbox"/>	Pending
9	<input checked="" type="checkbox"/>	105.0	221.0	25.0	45.0	30.0	<input checked="" type="checkbox"/>	Pending
10	<input checked="" type="checkbox"/>	80.0	176.0	50.0	90.0	15.0	<input checked="" type="checkbox"/>	Pending

Guaranteed Soak and Deviation Limits: Enabling the guarantee soak option for a given segment allows the soak timer to only count down when the actual temperature is within a tolerance range (e.g. the “deviation” from setpoint). This will ensure that the process maintains the actual temperature within a deviation range for a guaranteed minimum amount of time, no less. If the guaranteed soak and / or the deviation limits are not enabled, the soak timer will start counting down as soon the setpoint ramp has reached its target regardless of the actual measured temperature.

Completing the Recipe: The 1050 Series temperature recipe mode includes an option to repeat the defined recipe. Users configure the total number of times the recipe will repeat as well as from what segment number the next repeat attempt will start from. Allowing the user to select the “repeat from segment” provides an option to have a heat up sequence in the early segment stages that is not included in a repeated production run. Upon conclusion of the recipe and any established repeats, the 1050 controller can be set to turn the output off, hold the last segment’s temperature, or reduce its output to a preconfigured safe level in manual mode.

Local Digital Control (LDC) over Spang's Color, Touchscreen Display

Standard Control Features: After temperature control or limit is selected within Spang's web browser configuration tool, the LDC will allow the user to monitor the actual thermocouple temperature reading as well as change the target setpoint for the desired level of control or limit. The LDC provides access to change the displayed temperature units to / from degrees Celsius and Fahrenheit as well as change the temperature control loop from automatic (using the temperature PID gains to control) to manual mode (operating from the temperature loop output percentage). Once in manual output mode, the loop percentage can also be increased or decreased from the display touchscreen.



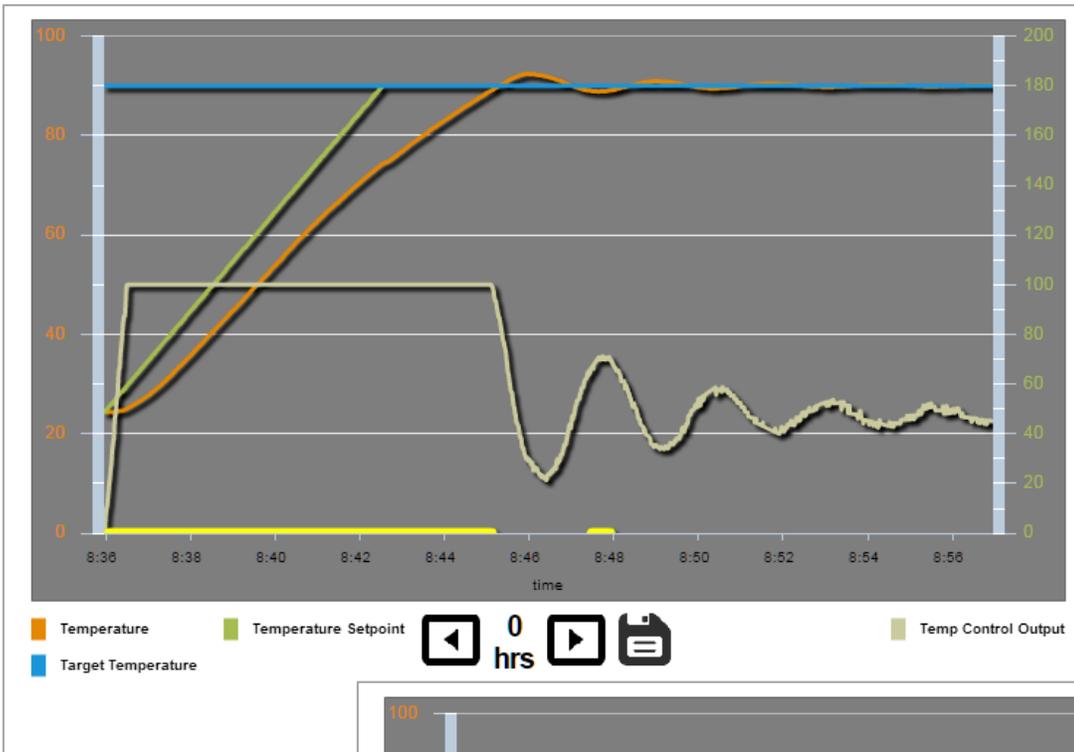
Advanced Control Features: After recipe mode is enabled within Spang's web browser configuration tool, the LDC allows the user to monitor the recipe status. This includes the actual thermocouple temperature, the active segment number and associated target setpoint, ramp or soak status, and how much time is remaining to ramp to the target or soak at the target. Additionally the recipe mode controls are provided to play, pause, stop and reset a recipe. Once paused or stopped, the user can also increment or decrement the active segment before continuing.



Tuning the Temperature Loop

Trending Application: In addition to the individually settable PID gains and ramp up / down settings, the 1050 Series power controllers include a real-time trending application within the web browser configuration tool. The trending application not only allows users to monitor and troubleshoot process related phenomena but also provides a user-friendly platform to tune the temperature loop specific to the installed equipment, maximizing performance and minimizing overshoot.

Before tuning....



After tuning....

