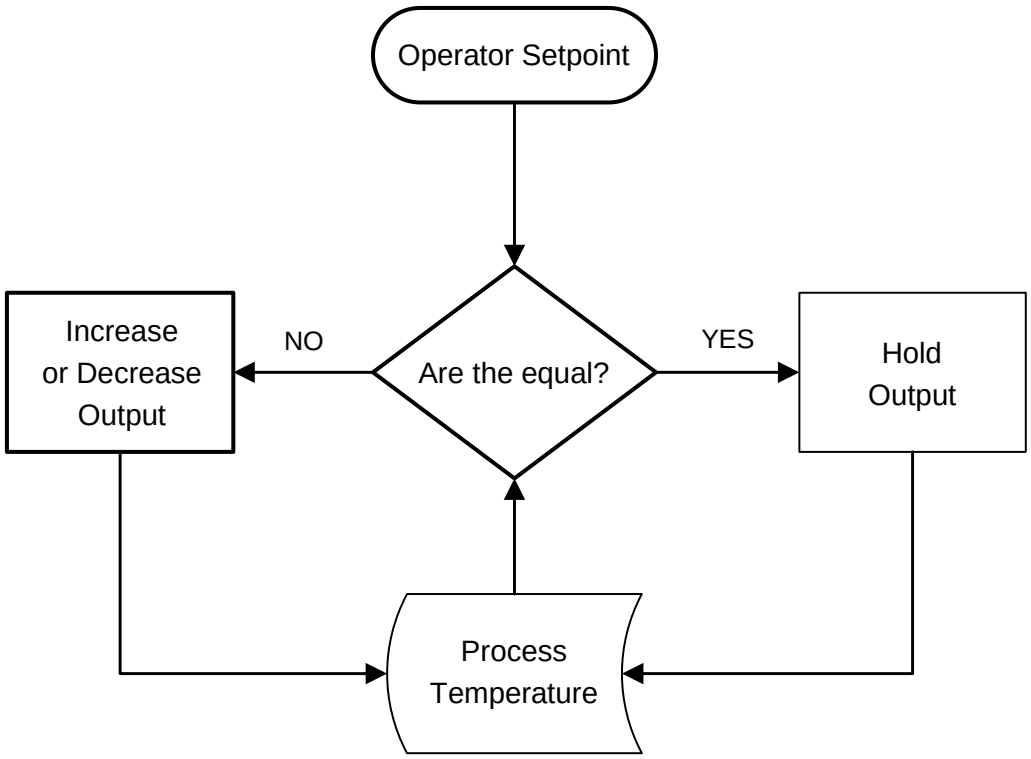
Spang Power Electronics

Technical Note

Temperature Control Topologies using 1050 Series Power Controllers

Overview

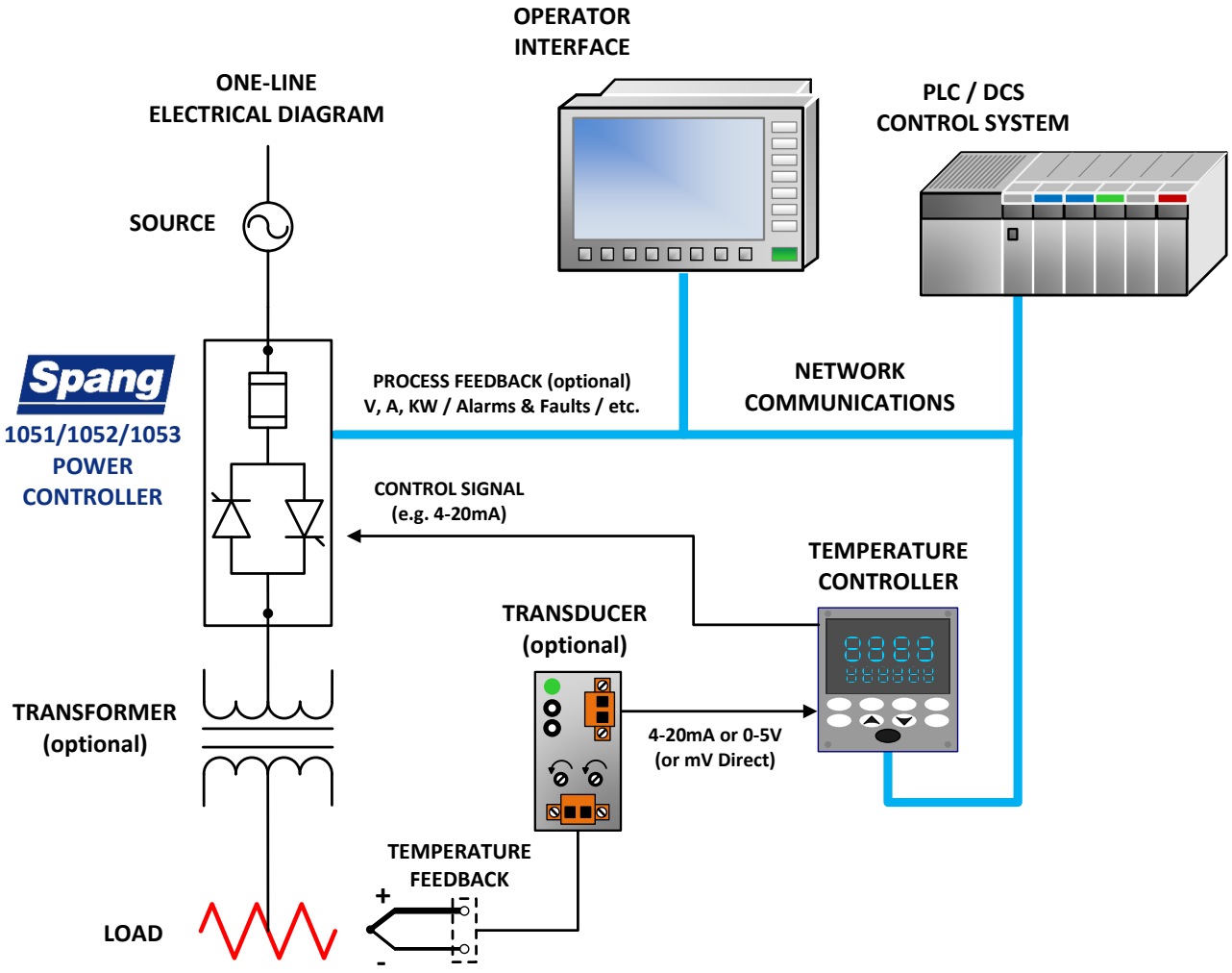
Industrial customers continue to use temperature control loops to more precisely guarantee product quality and repeatability. Outside of the exact nature of the control loop strategy, temperature ranges, and heating / cooling characteristics, the simplistic view of this function is as follows.



The diagram shows an operator setpoint being compared against the actual measured process temperature. If the two values are equal, the output is held constant and another temperature measurement is taken to compare once again to the setpoint. This repetitive process however does not become an infinite sub-loop as the operator setpoint could change or external process conditions could affect and alter the measured temperature (external influence is not shown for simplicity). If the operator setpoint does not equal the actual measured process temperature, the output is increased or decreased to reduce the deviation and another temperature measurement is taken to compare. The complete process is repeated continuously at a predetermined sampling interval.

Equipment required to execute temperature control loops will vary relative to the intelligence analyzing, processing and commanding the loop as well as controllers to increase, decrease or hold the output. This document will further review some of those equipment options establishing advantages and disadvantages for multiple control topologies.

Temperature Control using a PLC, Temperature Controller & Network Communications

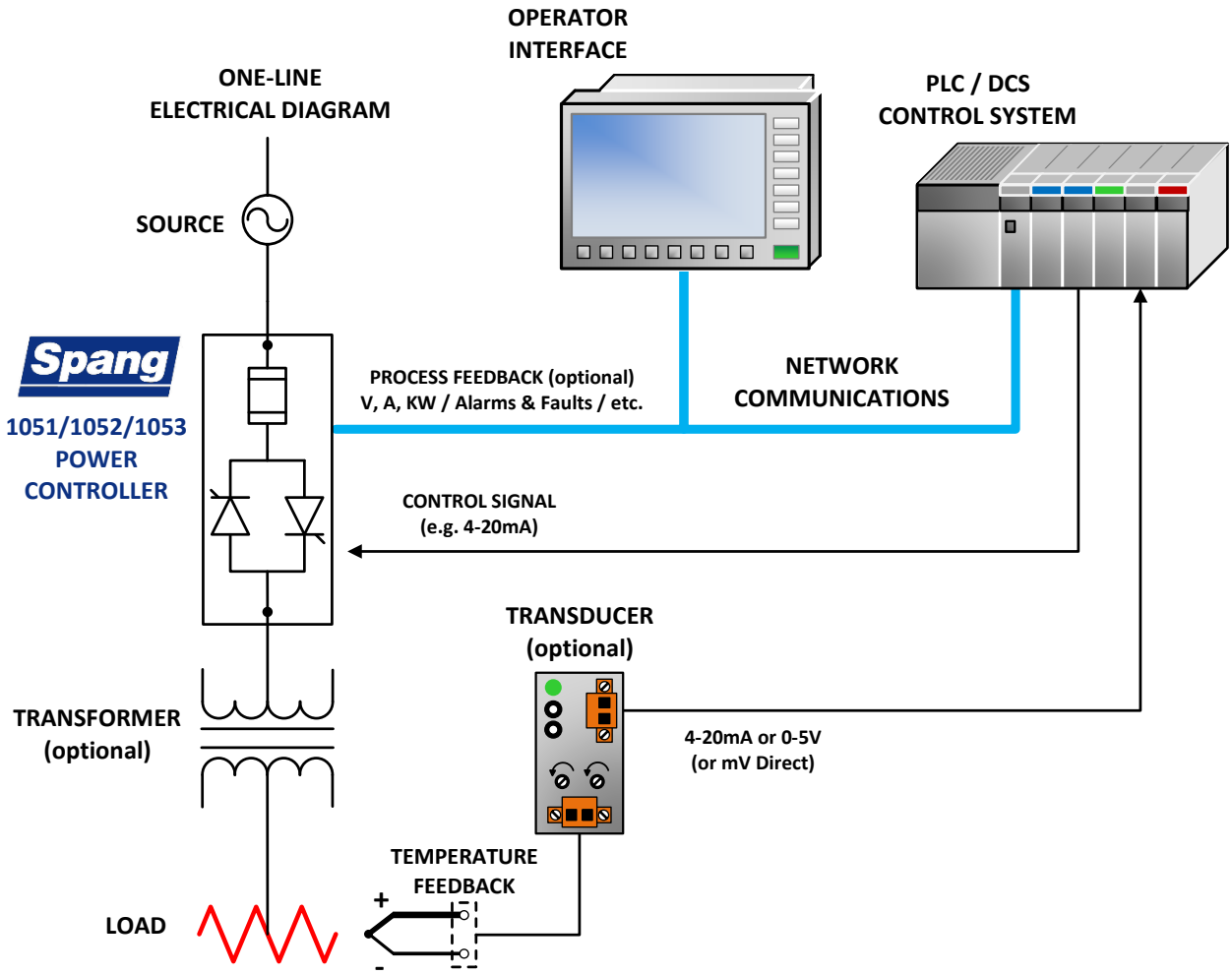


Circuit Description. The one-line electrical schematic above illustrates an SCR-based power system in which the temperature control loop is driven through a separate, stand-alone temperature controller. The temperature controller is receiving the temperature feedback either direct from a thermocouple or through an additional transducer module, analyzing and internally processing the feedback, comparing the feedback against the customer-defined settings and operator inputs, and supplying an updated setpoint command to the SCR controller via analog, control signal. The system also includes network communications from a master control system (PLC / DCS) to the temperature controller, an operator interface, and Spang's 1050 Series Digital SCR Controller.

Advantages. The control system (PLC / DCS) in this circuit can collect data, monitor fault and alarm status, manage sub-process controls and more. A single thermocouple approach is shown for simplicity, but could be expanded to monitor multiple thermocouples within the control system architecture by adding averaging algorithms in the PLC / DCS code as well as more external hardware components (consequently adding more cost).

Disadvantages. In the circuit above, higher cost results from using unnecessary components like the stand-alone temperature controller and transducers to monitor temperature feedback and drive the analog control signal to the SCR power controller. Each subcomponent in the processing loop contains some level of additional filtering, response delay, and retransmit calibration error causing performance inefficiencies. The process parameter setup and data gathering functions of the of the stand-alone temperature controller are not user-friendly and require the constant use of a user manual to understand brief setting abbreviations and the menu structure on the display.

Temperature Control using a PLC with Thermocouple Input Cards

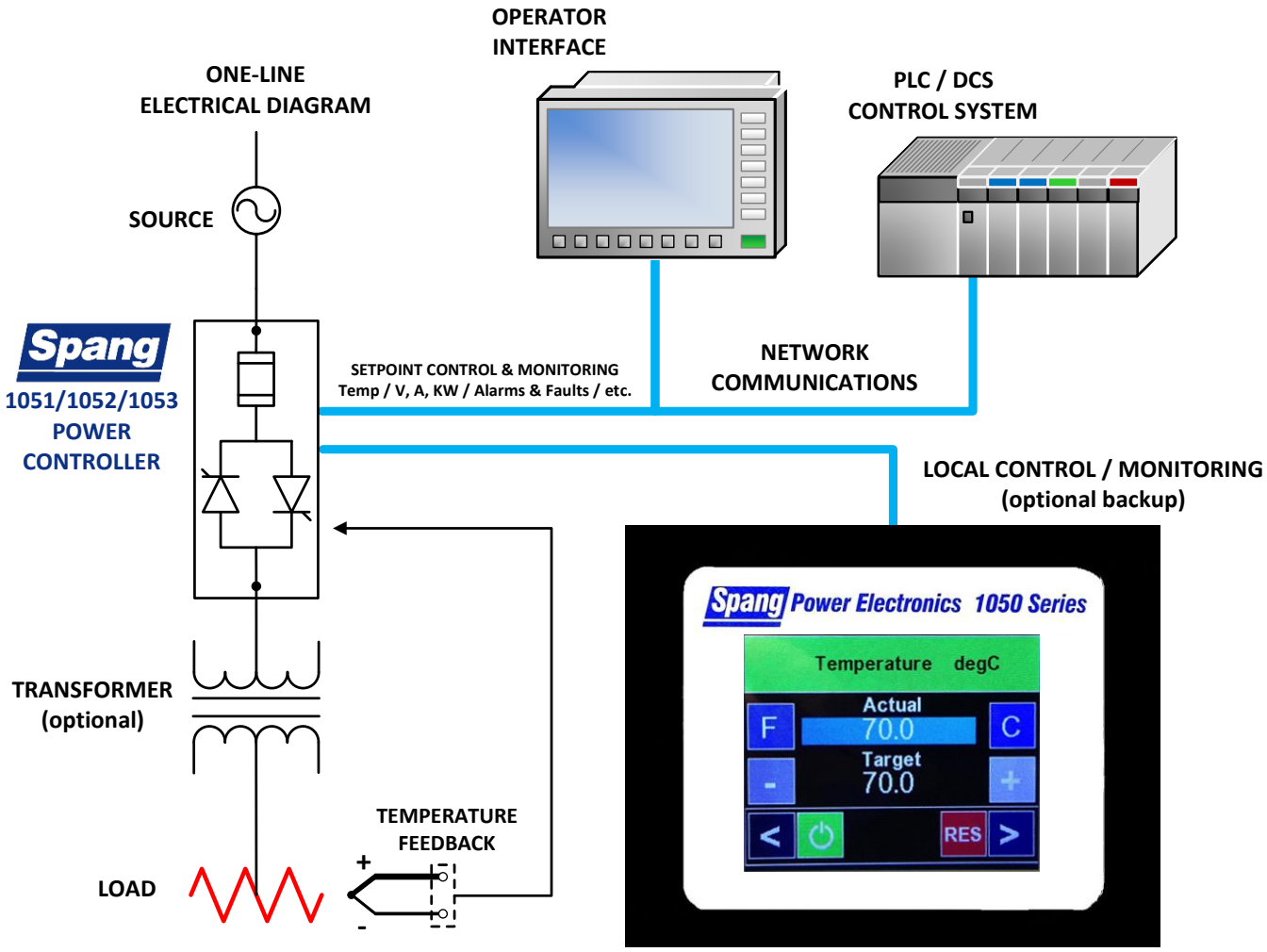


Circuit Description. The one-line electrical schematic above illustrates an SCR-based power system in which the temperature control loop is driven through an additional input module in the master control system (PLC / DCS). The input module is receiving the temperature feedback either direct from a thermocouple or through an additional transducer module, analyzing and internally processing the feedback, comparing the feedback against the customer-defined settings and operator inputs, and supplying an updated setpoint command to the SCR controller via analog, control signal. The system also includes network communications from a master control system (PLC / DCS) to an operator interface and Spang's 1050 Series Digital SCR Controller.

Advantages. The control system (PLC / DCS) in this circuit allows for ease of use for the operator after initial configuration, data collection, fault and alarm monitoring, sub-process control and more. A single thermocouple approach is shown for simplicity, but could be expanded to monitor multiple thermocouples within the control system architecture by adding averaging algorithms in the PLC / DCS code as well as more external hardware components (consequently adding more cost). The analog control signal to the SCR power controller could be replaced by direct setpoint control over the network communication protocol from the control system to the SCR power controller.

Disadvantages. The cost of the circuit topology above is a disadvantage considering unnecessary components like the additional PLC / DCS input modules and transducers to monitor temperature feedback as well as the analog output cards to drive the control signal to the SCR power controller. Also, each subcomponent in the processing loop contains some level of additional filtering, response delay, and retransmit calibration error causing performance inefficiencies.

Temperature Control direct from Spang's 1050 Series using Network Communications

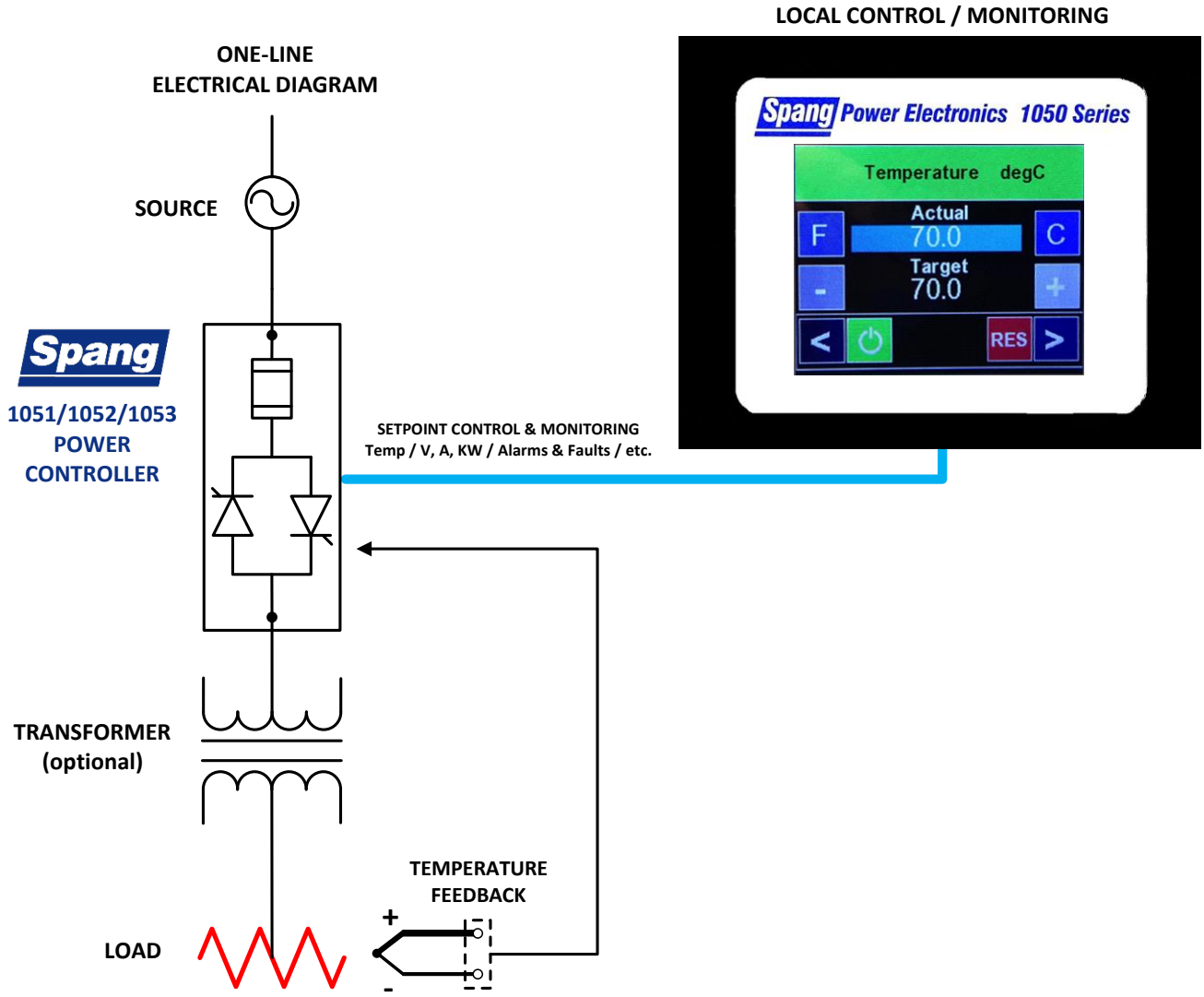


Circuit Description. The one-line electrical schematic above illustrates an SCR-based power system in which the temperature control loop is driven directly through the 1050 Series power controller. The power controller is receiving the temperature feedback direct from a thermocouple, analyzing and internally processing the feedback, comparing the feedback against the customer-defined settings and operator inputs, and internally adjusting the output to track the temperature setpoint. The system also includes network communications from a master control system (PLC / DCS) to an operator interface and Spang's 1050 Series Digital SCR Controller as well as Spang's 1050 Series color display. This approach is intended for a single thermocouple instead of multiple thermocouples and averaging algorithms.

Advantages. An advantage to this circuit topology is cost reduction through the elimination of unnecessary external hardware while maintaining control functionality. The PLC / DCS with input modules or the stand-alone temperature controller and the additional transducer module are eliminated by this direct approach. The 1050 Series display is also available for Local Digital Control backup should the control system fail. Additionally, the temperature feedback processing and control direct from a common "brain" improves overall performance minimizing processing stages, loops, and time as well as provides an easy to use platform for operators to configure and manage. Maintaining the control system (PLC / DCS) in this circuit allows for data collection, fault and alarm monitoring, sub-process control and more.

Disadvantages. A single thermocouple approach could be a disadvantage if the application requires more.

Temperature Control direct from Spang's 1050 Series using Local Digital Control



Circuit Description. The one-line electrical schematic above illustrates an SCR-based power system in which the temperature control loop is driven directly through the 1050 Series power controller. The power controller is receiving the temperature feedback direct from a thermocouple, analyzing and internally processing the feedback, comparing the feedback against the customer-defined settings and operator inputs, and internally adjusting the output to track the temperature setpoint. Spang's 1050 Series color display is connected to the power controller as the primary means of operator control, monitoring, and temperature setpoint adjustment. This approach is intended for a single thermocouple instead of multiple thermocouples and averaging algorithms.

Advantages. The major advantage to this circuit topology is dramatically reducing the external hardware cost while maintaining control functionality. The PLC / DCS with input modules or network communications, the Operator Interface, the additional transducer module, and the stand-alone temperature controller are all eliminated by this direct approach. Additionally, the temperature feedback processing and control direct from a common "brain" improves overall performance minimizing processing stages, loops, and time as well as provides an easy to use platform for operators to configure and manage.

Disadvantages. A disadvantage to this approach is the lack of data collection without the use of network communications. Additionally, without a control system (PLC / DCS) the number of sub-processes that can be controlled solely from the power controller's inherent I/O is limited.

Summary

Although none of the circuit topologies will fit the needs for every industrial application, each circuit example discussed has individual advantages and disadvantages that should considered for optimizing the control system design.

A collective summary of the key points outlined in this document are included in the table below.

Circuit Description	Reduces Cost	Temperature Loop Processing Improvement	Process Data Collection	Ease of Use	# of Thermocouples
Temperature Controller using Operator Interface & PLC / DCS			✓		Single or Multiple
PLC / DCS with Operator Interface using input and output modules			✓	✓	Single or Multiple
Spang 1050 – direct temperature control using network communications	✓	✓	✓	✓	Single
Spang 1050 – direct temperature control using LDC display	✓ ✓	✓		✓	Single

The direct temperature control ability of Spang's 1050 Series SCR power controller is a truly unique, integrated feature that possesses real process benefit to the customer; not only in terms of installation cost, but also in terms of performance and ease of use.

For more information about the standard and advanced capabilities of Spang's 1050 Series direct temperature control and recipe mode, please visit www.spangpower.com to download our latest tech notes, reference our product manuals or contact a Spang representative direct with application questions.