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Design of a high-resolution PID temperature controller for use in a low-cost thermo-luminescence system

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Abstract content
 (Max 300 words)

The operation of an associated low-cost thermo-luminescence (TL) system necessitated the design and construction of a precision temperature controller. The temperature controller is presented separately since it is a crucial aspect of the TL system. The overarching design condition was a tightly controllable temperature regime with a resolution of about $\pm 0.5^\circ\text{C}$. The system was designed in such a way that an embedded controller formed around the PIC18f2520 heats up a sample holder to a specified temperature in optimal time while monitoring the temperature. The control algorithm was then written to ramp the temperature through the desired range of temperature between 25 and $+700^\circ\text{C}$. The output of the PID controller was made to drive a resistive heater element or plant, modelled as a low-delay component owing to the small size of the sample holder. A mathematical model of the plant was obtained, simulated within MATLAB and the optimal controller found. The results of the simulation were then used to design an algorithm for the PIC controller. It was initially thought that the demands of controlling the temperature necessitated an additional PIC controller separate from one that would handle USB communications and general control. However, the responses of the temperature controller and optimal design of the overall user interface software and PIC firmware eliminated that need. The performance of the constructed PID controller was verified over the temperature range of 100°C to 400°C . While the PID controller has been designed specifically for usage in the TL system, it can be adapted with minimal adjustments to many other laboratory processes where fine temperature control is required.

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