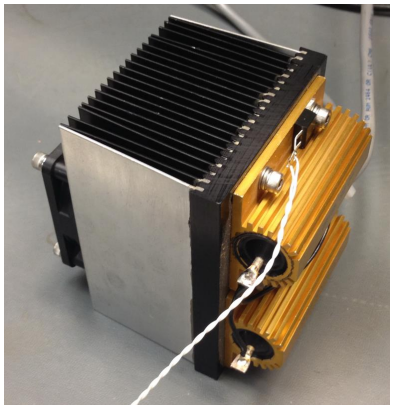


arroyo instruments

APPLICATION NOTE AN-006

Fan Cooling with TEC Controller

October 19, 2015, Rev A

An interesting idea was posed whereby an Arroyo Instruments temperature controller could be used to closed-loop control a fan in an air-cooling application. No TEC was involved… the fan provided the only cooling mechanism, with the intention of cooling a system that is operating above ambient temperature to a point below the normal steady state temperature of the system.

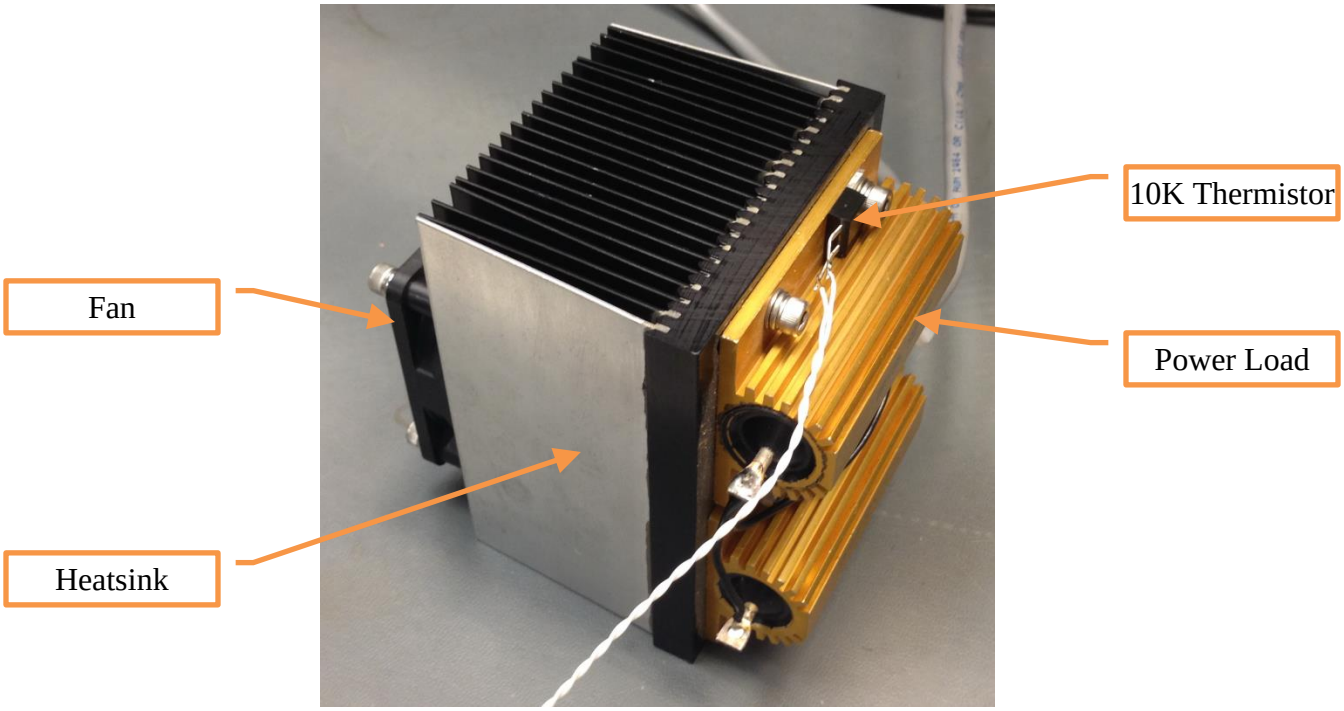
Test Setup

In the test setup, a fan was mounted to a heat sink, which also had a large power resistor. The power resistor was then connected to a bench power supply to provide the heat for the system. The power resistor was a 2Ω 100W Omite resistor with constant 10W of heat generated by it, with 2.5A/5V driven by bench supply. The lower 100W resistor in the photo below was not powered.

The fan was connected to the TE+ and TE- terminals, with the fan positive lead connected to TE+ and the fan ground lead connected to TE-. A 10k thermistor in a TO-220 package was bolted to the load resistor to monitor temperature.

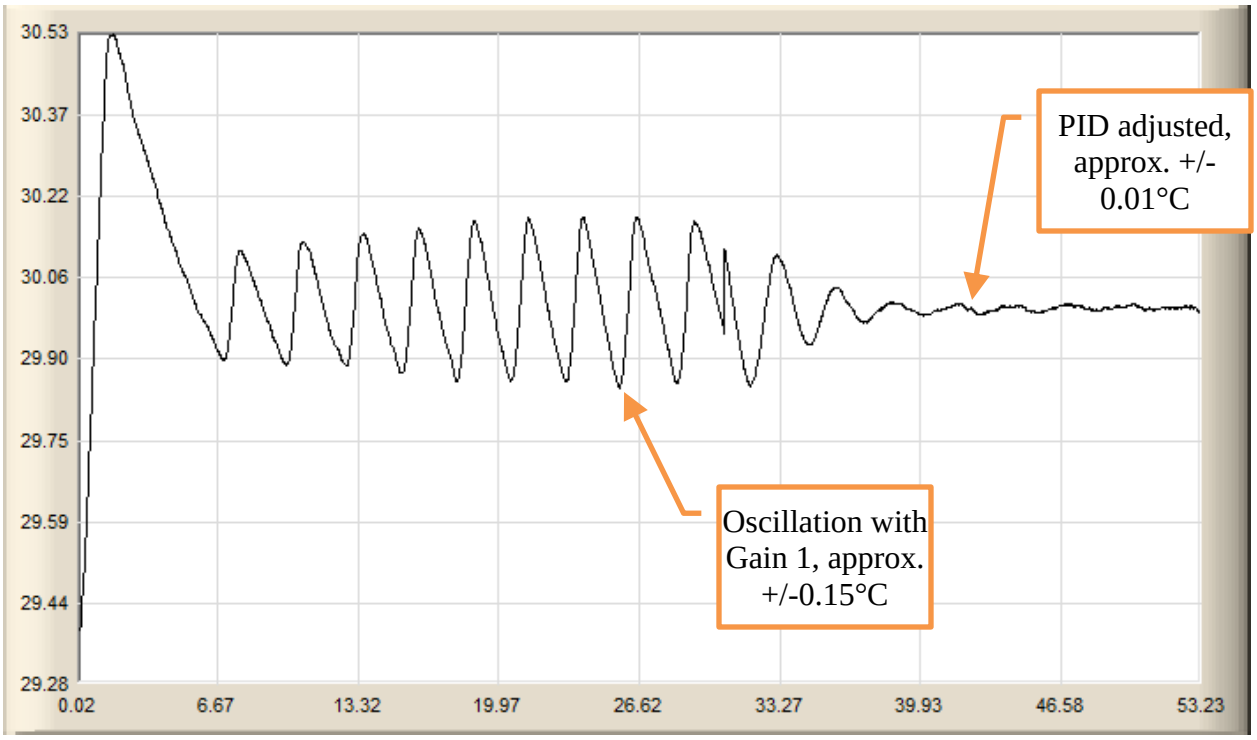
The temperature controller used was the TEC section of a 6305, and capable of delivering 5A/12V. The **ITE Limit** was reduced to 0.15A, which was the rating of the fan. The **H/C Mode** was set to 'Cool' so that the control loop would only activate once the actual temperature rose above the set point.

Temperature set point was 30°C.



Test Results

The **Gain** on the system was initially set to '1', the lowest factory gain setting. It was uncertain if that would be slow enough, considering the large time constant and mass of the system. The system was turned on, and as expected the gain of 1 was not slow enough. The equivalent PID values for a gain of 1 are 0.250, 0.0032, 0.3, respectively. Using these as a starting point, the **Gain** setting was changed to 'PID', and the PID parameters were set to 0.15, 0.001, and 25, respectively. The data plot below shows the performance with both gain settings:



Observations

The ITE current was very small (about 60mA once stable), so the controller is operating very nearly at the bottom of its operating range. Even so, good stability was achieved. No testing was done to evaluate the response to step changes in conditions (suddenly lowering or raising the thermal load, for example), and no further changes to the PID values were made after the first guess, so overall PID performance could likely be improved. As expected, the system moved quite slowly.

Conclusions

While not intended to be used as a fan controller, the instrument does clearly have the ability to perform this function well. Having slightly better resolution on the current control by reducing he current range to something significantly smaller (1A or even 500mA) might provide finer control of the fan speed, but the hardware design of the system already provides better than 16-bit control resolution, so a reduced operating range may not sufficiently improve performance to justify the change.
In this setup, a fan was used to cool a heat sink, but a similar setup can be used anywhere a fan is being used to cool a system, being is air temperature, device temperature, or otherwise.