Temperature Measurement of An FDM 3D Printer Hotend with a PTC Thermistor

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Introduction

An FDM 3D printer can utilize a variety of plastics ranging from PLA to ABS, even TPU. Succesful printing requires a stable temperature at the hotend and build plate. This study will investigate the feasibility of a possible feedback control setup for hotend temperature control.

Setup

Following is the moderately-detailed flow diagram of control of a 3D printer hotend:

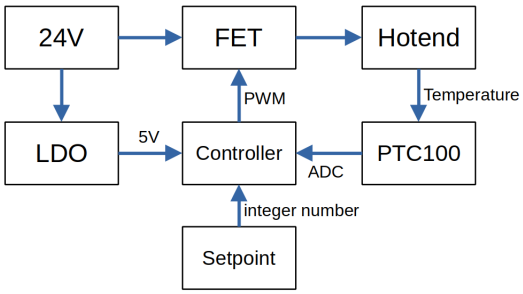

Figure 1: The feedback loop that controls a hotend's temperature

The feedback loop works as follows:

1. The user or the G-Code sets a target temperature for controller.
2. Controller reads the hotend's temperature and calculates the required PWM duty cycle, then applies it to the FET.
3. FET delivers electrical energy to the hotend. This could range from 0 Joules to as many as power supply can withhold. Hotend gains or loses temperature accordingly.
4. Controller reads hotend's temperature again and the loop continues.

Requirement

A successful print requires a stable temperature at hotend. A temperature oscillation within the range of $\pm 2°C$ is acceptable for a stable quality through printing and this is the requirement for this study: Implement a setup where

the data acquisition capability allows a temperature control within $\pm 2°C$ range of setpoint. Also, the budget of the project is 10€.

Approach

Firstly, the material properties of hotend and its thermal behavior will be investigated and required control parameters will be determined. Then, controller and FET will be chosen accordingly.

Outcome Estimation

Given the latest developments in 32-bit controllers and FETs, it is expected that this feasiblity study will return a green light. For example, the latest STM32C0 family MCUs provide 32-bit functionality at 48MHz for as low as 1.6 $/unit, even they may be an overkill for the project.