ECNS-414

Lab #7

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Closed Loop Control System

Objective: Program adaptation in response to environmental events is a foundational concept for digital electronics. The purpose of this lab is to construct and demonstrate a closed loop control system that uses pulse width modulation (PWM). Additionally, a DIP switch will be used to transition from automatic control to manual control via POT1. A temperature sensor LM-335 with a ten millivolt per Kelvin transfer characteristic is to be used. The on-chip Analog to Digital (A/D) converter configured for 10-bit resolution with a reference voltage of zero to five volts will be used to read the current temperature from the lamp.

Methods: To accomplish the construction of a closed loop control system a basic timer interrupt was configured to update the lamps condition approximately every 100mS. Within the interrupt PORTB's state was checked to determine the control mode. For automatic mode proportion control algorithm (Output = (32°C – Present_Value) * $14 + $10) was implemented to control the temperature of the lamp. When any DIP switch is not off the program would operate in manual mode by executing a subroutine named "Manual". While in manual mode the lamps brightness can be adjusted using POT1as its state is being read with the on-chip A/D converter using channel 0 set for 8-bit operation. The PWM prescaler used for both modes was 128 with a PWMPER3 value of $FA for a period of 8mS.

Results: The set point selected was 32 degrees Celsius and the lamps brightness initially went to maximum as predicted. The bulbs brightness decreased as it approached the set point and the filament was just barely light when the set point was reached proving the control system was fully functional. When the DIP switch was flipped/not zero the program switched to manual mode operation allowing POT1 to set the lamps brightness as expected. This process was verified by single stepping the CodeWarrior IDE and reading the PWM output using an oscilloscope.

Conclusion: Initially, the programmer experienced strange results and realized the PWMPOL register by default is set to high when the duty count is reached. This caused the bulb to be at maximum brightness when PWMDTY was 0 unless PWMPOL was set to a 1 for channel 3. Splitting up program tasks into subsections resulted in easy implementation for the programmer. The use of subroutines within a timer interrupt is an effective way to achieve multiple task completions at the same time.