Thermal Controller Lab

The thermal controller exercise will examine the functionality of the thermal controller device emulated within the PIC microcontroller. The exercise will use the System Management GUI to modify the I^2C device registers. A thermal system will be simulated by turning on the heating element and modifying temperature set points while monitoring output.

Lab Setup Procedures

[ ] Find JP200 labeled “Heater Enable.” Make sure that JP200 is open.

[ ] Find JP202 and ensure that shunt connects middle pin and pin labeled MCP9700.

[ ] Find JP201 and ensure that shunt connects middle pin and pin labeled TACH.

[ ] Connect the +12V power supply to J100 labeled “+12VDC.”

[ ] Verify that the fan is spinning and that the DS104 Power Led is on.

[ ] Connect the PICkit Serial Analyzer to the PC using the provided USB cable.

[ ] Ensure that the “Power” LED on the PICkit Serial Analyzer is on.

[ ] Connect the PICkit Serial Analyzer to the PICDEM System Management Board connector P104 labeled “PICkit Serial.”

[ ] Start the PICDEM System Management Software. (Click Start<Programs<Microchip System Management Board

Understanding the Thermal Management GUI

[ ] Click on the Temperature Management Tab of the System Management GUI.

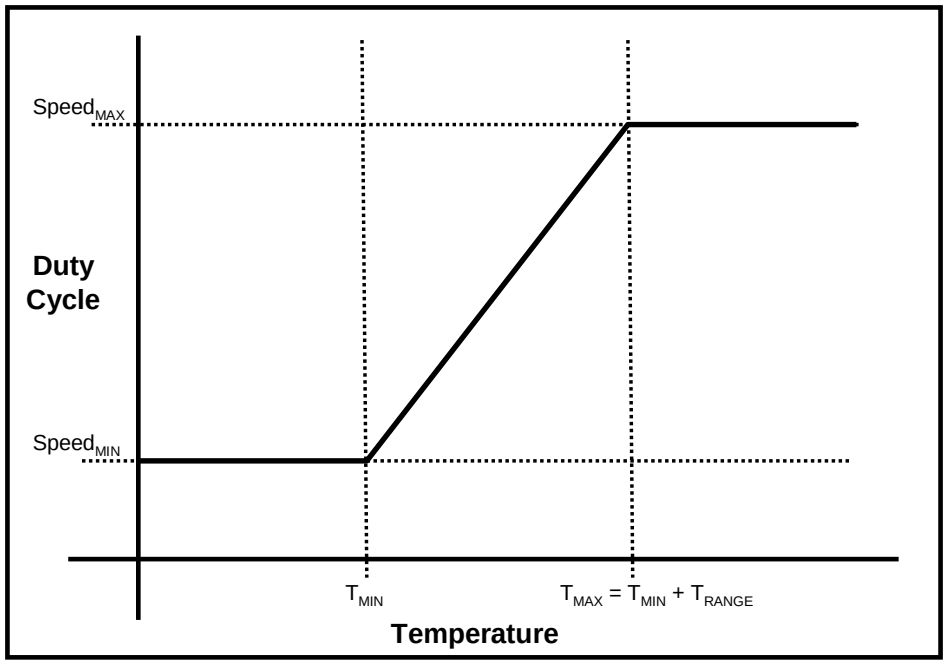
[ ] The Temperature (Degrees C) bar graph shows the temperature value calculated from the voltage output of the MCP9700 temperature sensor.

[ ] The Max Temperature (Degrees C) bar graph shows an arrow which Indicates the T_{MAX} point shown in the figure below. By dragging the Max Temperature arrow to various temperatures, you will notice that this changes the speed of the fan. Increasing Max Temperature should lower the speed of the fan while lowering Max Temperature should increase the speed of the fan.

The tachometer speed is shown in both an analog display on the upper left of the GUI and a digital value labeled “RPM.” Duty cycle is also shown on a analog display on the bottom left.

[ ] The Min Temperature (Degrees C) bar graph also shows an arrow which Indicates the T_{MIN} point shown in the figure below. By dragging the Min Temperature arrow to various temperatures, you will notice that this changes the speed of the fan. Increasing Min Temperature should increase the speed of the fan, while lowering Min Temperature should lower the speed of the fan.

The fan controller firmware calculates a duty cycle on the line shown in the figure below based on the current temperature. The duty cycle output between T_{MIN} and T_{MAX} is linear. Above and below T_{MIN} and T_{MAX}, duty cycle is set at constant minimums and maximums. In the case of this exercise they are programmed for 10% minimum and 99% maximum.



Simulating a Thermal System Using the Heating Element

The PICDEM System Management Board has a heating element circuit on board controlled by a digital I/O pin on the PIC16F886. The heating element causes resistor "R200" to become very hot. The resistor is located in close proximity to the MCP9700 temperature sensor, which allows a thermal system to be simulated.

[ ] Find JP200 labeled "Heater Enable." Make sure that JP200 is closed. When the "Heater Enable" jumper is in place, do not touch the resistor as it will become very hot.

[ ] Find JP202 and ensure that shunt connects middle pin and pin labeled MCP9700. This connects the MCP9700 temperature sensor to the analog input line of the microcontroller.

[ ] Set the Max Temperature to 40 by dragging the arrow in the Max Temperature box.

[ ] Set the Min Temperature to 20 by dragging the arrow in the Min Temperature box.

[ ] Make sure that the "Heater On" checkbox on the bottom left of the screen is checked. Removing the check from this box will turn the heating element off.

As the temperature rises, the speed of the fan will change with temperature and speed relationship shown in the figure on the previous page. This is because the duty cycle increases linearly with temperature until the maximum and minimum set points are reached.

[ ] Move the JP202 shunt to connect to the middle pin and pin labeled "POT." This connects the potentiometer to the analog input line of the microcontroller. The circuit has been designed so that the potentiometer sweeps the entire temperature range of the MCP9700.

[ ] Turn the potentiometer and vary the maximum and minimum set points in the GUI to understand how the thermal control algorithm works.

This concludes the thermal controller lab. We have modified the I^2C device registers for the thermal controller emulated in the PIC microcontroller and simulated a thermal system using the heating element and potentiometer.