Temperature Modulator

Juan Felipe Quiroga
Faculty of electronic Engineering
University of Ibague
Ibague, Colombia
2420192023@estudiantesunibague.edu.co

Jessica Villamizar Suarez
Faculty of electronic engineering
Universit of Ibague
Ibague, Colombia
2420182005@estudiantesunibague.edu.co

***Abstract*— In response to everyday problems, the construction of a temperature modulator was proposed. This modulator has to do a certain job depending on the range of the room temperature that goes from 17 to 30 C grades. Now familiarized with the operation of the elements to be used, through the datasheets. The PIC16F15244 is programm in C language to receive the signal of a LM35 temperature sensor and with it work in a stablished way. With the help of MPLABX and the materials of the design a montage is done to check it's the proper operation whether is turning on a fan, a lightbulb or do nothing given the case.**

https://github.com/2420182005/Temperature-Mod.

***Keywords*— Temperature, sensor, microcontroller, c language, PIC**

I. Introduction

For a long time, the human has required to handle factors around him to carry out common tasks, such as the flame for cooking, the lighting to orient himself at night or in dim environments, up to the temperature of a cave to be able to pass the night protected from the cold. With the passage of time and social, economic and industrial growth, needs were modified, first trying to keep a stable temperature in an industrial oven, a living room or simply in a rest room. With the evolution of technologies, the point of having automatic components that regulate the variables of a structure in order to maintain order in it has been reached. A clear example of the topic that will be discussed next is the use of thermostats, devices that measure a temperature and emit a signal to a closed loop system, where the actual temperature is compared with the desired one and a controller emits a signal to heating, maintaining temperature or cooling depending on the function of the system. All this with the ultimate goal that without the need for man to act, the temperature in the place can be maintained automatically or autonomously.

The Analog-Digital Converter (ADC) transforms analog signals into digital signals, that is, into binary codes. Basically they are used, for example, if we have a signal that comes from a microphone, the sound that the microphone complies with the Analog-Digital Converter, what we do is convert that signal into numerical values that later a digital device, such as a Microcontroller can try and reproduce or modify them.
The analog signal, which varies continuously in time, is connected to the input of the device and is sampled at a fixed rate. Digitization basically consists of periodically carrying out measurements of the amplitude (voltage) of a signal, rounding its values to a finite set of pre-established levels of voltage (known as quantization levels) and recording them as whole numbers in any type of memory or support. The processes that lead to this conversion are sampling, retention, quantification, and encoding.

II. Methodology

As a first instance, a diagram of the circuit and the possible materials to be used was made, this base circuit was subject to modifications as the project progressed. Subsequently, the calculation of the conditioning of the LM35 signal for its connection to the PIC16F15244 began. Two ports were implemented as outputs which originally would be connected to a fan and a light bulb respectively. However, for demonstration purposes under forced conditions, LEDs were replaced in the test circuit. The device in its correct operation must turn on a led or a fan if it is in a temperature range that is considered hot, turn on the other led or what would be a light bulb if it is in a cold temperature or do nothing if it is in an intermediate range. Starting from this idea of operation, a flow chart was made as a guide for building the code.

With the help of the MPLABX program, the code to program the PIC16F15244 was created. For this project, it was necessary to assemble the circuit from the beginning to test the code since there are no simulation programs for this specific PIC. It was important to have the device characteristics datasheet when there were problems on how to proceed with the code programming.

So, for the sensor's working mode, the following temperature ranges were established, from 17 to 21C is considered cold, from 22 to 26C is normal and from 27C to 30C is considered hot. In total, the sensor's working range should be 17 to 30C. Already with the signal conditioning done with operational amplifiers, the most complicated thing was to program the ADC conversion in the PIC to finally formulate conditionals that would work in the already established ranges.

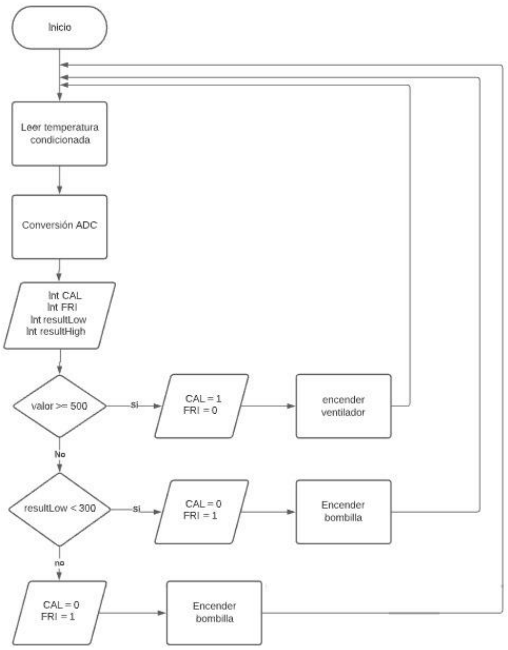

Figure 1. Flowchart

III. RESULTS

Conditioning

First, we must know how many volts the Temperature Sensor delivers for each degree centigrade.

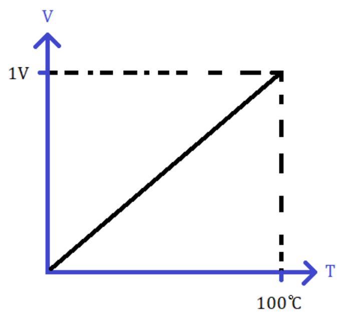

Figure 2. Directly Proportional Graph of Temperature and Voltage

We use the slope formula:

$$m = \frac{y_2 - y_1}{x_2 - x_1}$$

$$m = \frac{1 - 0}{100 - 0}$$

$$m = 0.01$$

The voltage is equal to the slope times the temperature.

Now, we choose the temperature ranges that we are going to use, and then make a rule of 3:

0.01V $\rightarrow$ 1°C

X $\rightarrow$ 17°C

$$X = \frac{0.01V \times 17°C}{1°C}$$

$$X = 0.17V$$

0.01V $\rightarrow$ 1°C

X $\rightarrow$ 30°C

$$X = \frac{0.01V \times 30°C}{1°C}$$

$$X = 0.3V$$

Then, a graph is made that relates the sensor voltage with the voltage of the Microcontroller that we are going to handle:

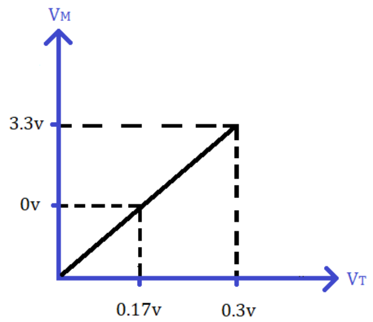

Figure 3. Directly Proportional Graph of Input Voltage and Output Voltage

We calculate the slope again:

$$m = \frac{3.3 - 0}{0.3 - 0.17}$$

$$m = 25.38461538$$

Then, we apply the equation of a linear function:

$$y = mx + b$$

So, since we need that for 0.17V, the voltage of the Micro is 0V and for 0.3V, the maximum that is 3.3V, we replace with the following values:

$$y = 25.38461538(0.17V) + (-4.315384615)$$

$$y = 0V$$

$$y = 25.38461538(0.3V) + (-4.315384615)$$

$$y = 3.3V$$

Therefore, the offset is -4.3115384615 and according to the equation, we must amplify the voltage with a multiplier AOP and a subtractor AOP to obtain the corresponding voltage.

Identify applicable funding agency here. If none, delete this text box.

IV. CONCLUSIONS

Signal conditioning is the most important aspect of an ADC conversion, as the rest of the process is facilitated by the internal settings of the PIC16F15244.

The human has constantly managed its field, as it has promoted new technologies and in terms of temperature, it is one of the agents that over time it has managed to dominate with little human action.

Most modern temperature controllers operate in closed loop control systems.

To prevent human intervention, it is necessary, even if it is a sensor, a controller and an actuator in the system for it to function autonomously.

REFERENCES

[1] "PIC16F15244 curiosity nano hardware user guide (PDF) - Microchip", *Alldatasheet.com*, 2020. [Online]. Available: http://ww1.microchip.com/downloads/en/DeviceDoc/PIC16F15244-Curiosity-Nano-Hardware-User-Guide-DS50003045A.pdf. [Accessed: 22- Nov- 2020].

[2] "PIC16F152 family full-feature (PDF) - Microchip", *Alldatasheet.com*, 2020. [Online]. Available: http://ww1.microchip.com/downloads/en/DeviceDoc/PIC16F15213-14-23-24-43-44-Data-Sheet-DS40002195B.pdf. [Accessed: 27- Nov- 2020].

[3] "LM35 Datasheet(PDF) – Texas Instruments", *ti.com*, 2020. [Online]. Available: https://www.ti.com/lit/ds/symlink/lm35.pdf [Accessed: 22- Nov- 2020].

[4] "LM324 operational amplifiers Datasheet(PDF) – Texas Instruments", *ti.com*, 2020. [Online]. Available: https://www.ti.com/lit/ds/snosc16d/snosc16d.pdf [Accessed: 22- Nov- 2020].