MEEC/MIEEC

Electronics for Micro-Systems

Lab#1
A Temperature Meter System with 3 Sensors, Relay and GUI

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1 Introduction

explain the requirements and the main objectives of the project Se calhar dizer aqui quais sao as metricas por onde podemos avaliar a nossa solucao Linearidade de output para conseguir aproveitar melhor a resolucao do adc Consumo erro

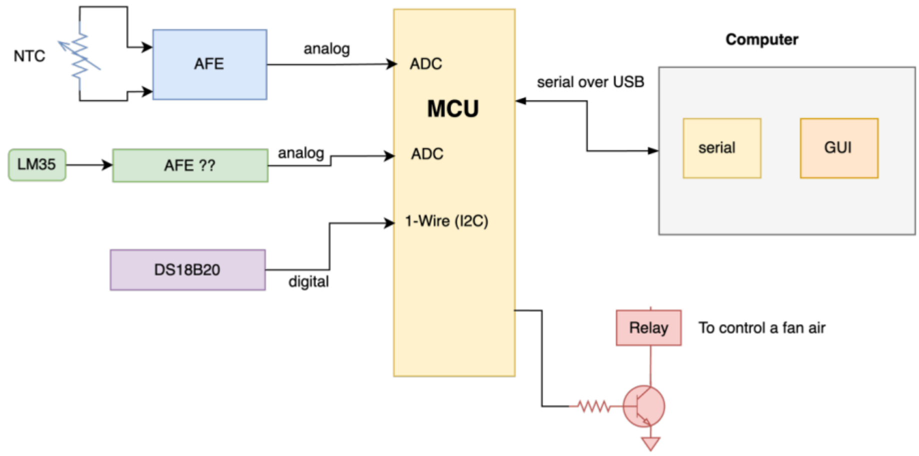

Figure 1: Temperature sensing system with 3 three types of sensors.

2 Temperature Sensors

2.1 NTC - Negative Temperature Coefficient

2.2 LM35 - Precision Centigrade Temperature Sensor

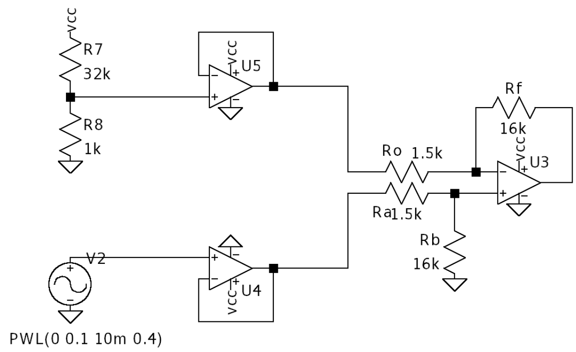

Figure 2: AFE for the LM35 sensor.

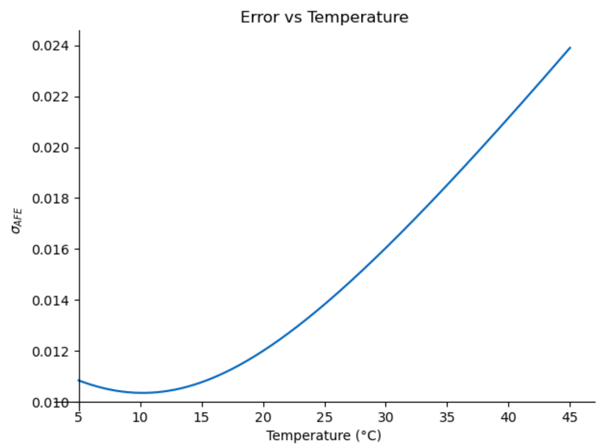

Figure 3: AFE error curve.

2.3 DS18B20 - Digital Thermometer

3 System Design

3.1 Analog FrontEnd (AFE) NTC

A parte onde definimos o intervalo de temperatura nao devia estar aqui pq é para todos os circuitos

In order to design the $NTF\ AFE$ first it's necessary to define the temperature interval in which this circuit will work, thus it was define as $T \in [10°; 40°]$. Through the NTC's datasheet the interval of its resistance values is $R_{NTC} \in [\ 5,282k\ ;\ 19,98k\ ]$

For an accurate reading of the temperature it was used the *Steinhart-Hart* equation.

$$\frac{1}{T} = A + B \cdot \ln(R_{NTC}) + C \cdot [\ln(R_{NTC})]^3 \tag{1}$$

In order to find the parameters A, B and C, its necessary to use 3 points from the datasheet. The points chosen were the two extremes and the middles point.

$$\begin{cases} R(283,15) = 1,998 \cdot 10^4 \ \Omega \\ R(298,15) = 10^4 \ \Omega \\ R(313,15) = 0,5282 \cdot 10^4 \ \Omega \end{cases} \Leftrightarrow \begin{cases} A = 1,2 \cdot 10^{-3} \\ B = 2,1 \cdot 10^{-4} \\ C = 1,3 \cdot 10^{-7} \end{cases} \tag{2}$$

Para poder dimensionar o AFE do NTC primeiro é necessario definir o intrevalo de temperaturas em que o circuito irá operar. Foi então decidido que seria adequado um temperatura $T \in [10°; 40°]$. E pelo datasheet do NTC foi obtido o intrevalo da sua resistencia $R_{NTC} \in [\ 5,282k\ ;\ 19,98k\ ]$

Para usar equacao Steinhart-Hart $\frac{1}{T} = A + B \cdot \ln(R) + C \cdot [\ln(R)]^3$, precisamos de usar 3 pontos para encontrar as constantes A, B e C. $R(T) = R_{NTC}$ onde T é a temperatura em kelvin e R_{NTC} é o valor da resistencia do thermistor NTC

The simplest way to convert the resistance to voltage, is to use a voltage divider circuit.

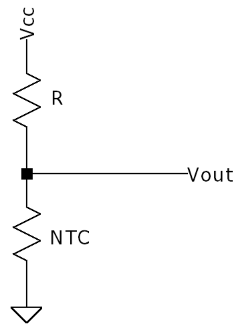

Figure 4: NTC voltage divider.

This approach has a few problems:

· The output resistance is really high $R \parallel NTC$,

· The output voltage is higly non linear, which is a problem because this way some ADC resolution is lost.

The first problem is solved through a buffer at the entrance of the AFE, and the second is somewhat mitigated by using a resistor $R >> NTC$, because, as seen in the equation a value for R will lead to small variation in the output voltage, making it closer to a straight curve.

aqui acho que se vê pela segunda derivada, quanto menor a segunda derivada mais reta é a curva certo ??

With $R =$ ... the output signal is $V_{out} \in [...]$. But the ADC as resolution of 12 bits and a voltage range of $3.3V$, meaning that to have the best resolution possible the signal needs an offset and a gain of ... and ... respectively. This is achieved using a differential amplifier.

3.2 LM35

This integrated-circuit temperature sensor,generates an output voltage linearly proportional to the Centigrade temperature

$$V_{out} = 10^{-2} \cdot T$$

Thus in the specified conditions $V_{out} \in [0.1; 0.4]$, as done in the last section we will be using a differential amplifier to fit this interval in the ADC's range.

3.3 DS18B20 ??(Este tem Dimensionamento?)

3.4 Relé de saída

4 Simulations

5 Implementation and Experimental Tests

6 Results Analysis

7 Conclusion