

Temp Sensor

The project involves the temperature sensor DS18B20 and FPGA BASYS3. The temp sensor measures temperatures from -55C to 125C.

Tools

1. Basys3
2. Arduino uno
3. Temperature sensor DS18B20
4. Buzzer
5. Leds (1 red and 1 blue)
6. Keypad
7. wires
8. Breadboard
9. 3 cups

Software

1. Vivado- VHDL
2. Arduino

Introduction

For this project, I used FPGA (Basys3 board and program in VHDL) and Arduino. I integrated a DS18B20 temperature sensor, which can read temperatures ranging from -55°C to 125°C. The temperature data, provided in binary format as detailed in the datasheet-

<https://www.analog.com/media/en/technical-documentation/data-sheets/ds18b20.pdf>

It is communicated to the Arduino, which then interfaces with the FPGA.

The FPGA processes the temperature data and displays the temperature in Celsius. Additionally, I connected a buzzer and two LEDs to the FPGA to indicate if the temperature is too hot or too cold. A keypad was also added, allowing the user to set threshold temperatures.

The system operates in four modes, selectable via FPGA switches:

- sw1: Checks if the temperature exceeds 50°C.
- sw2: Checks if the temperature falls below 10°C.
- sw3: Allows the user to set a custom hot temperature threshold via the keypad and checks if the temperature exceeds this value.
- sw4: Allows the user to set a custom cold temperature threshold via the keypad and checks if the temperature falls below this value.

The system also functions when both sw1 and sw2 or sw3 and sw4 are enabled simultaneously.

The project

In this project, three cups are used, each containing:

1. Hot water
2. Room temperature water
3. Ice

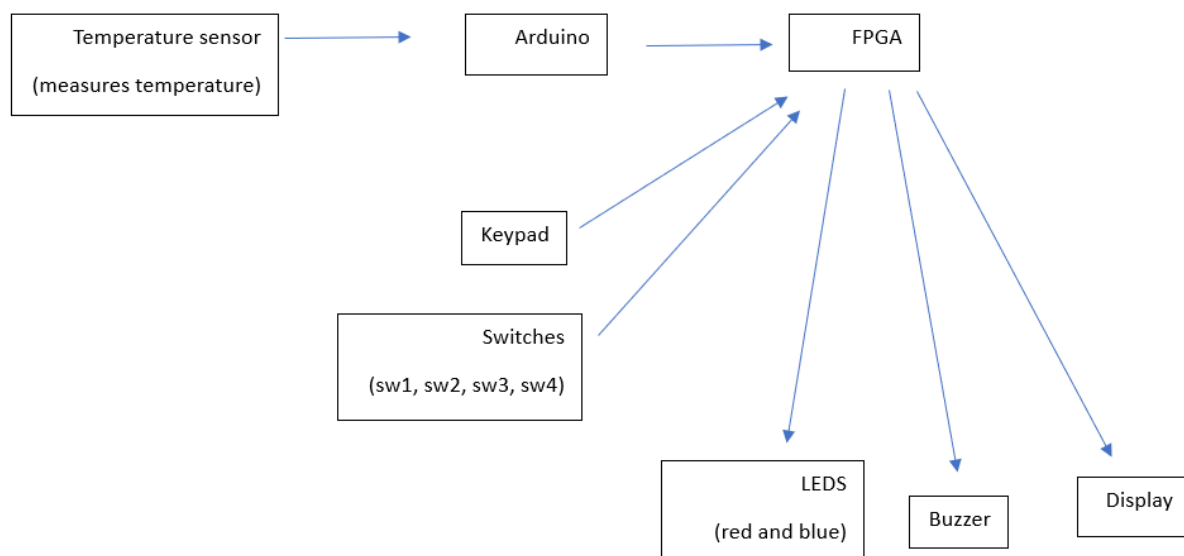
As we measured the temperature of the water in each cup, the FPGA board displayed the corresponding temperature. The different modes are utilized of the system to test the sensor in each cup, allowing us to observe all the functionalities.

- Mode 1 (Checking if the temperature is over 50°C): When in this mode, the buzzer and the red LED successfully activate when the temperature exceeds 50°C.
- Mode 2 (Checking if the temperature is under 10°C): In this mode, the buzzer and the blue LED turn on when the temperature falls below 10°C.
- Mode 3 (Checking if the temperature is over the user-defined threshold): The buzzer and the red LED are triggered when the temperature exceeds the threshold set by the user via the keypad.
- Mode 4 (Checking if the temperature is under the user-defined threshold): The buzzer and the blue LED activate when the temperature is below the user-defined threshold.

Throughout all modes, the temperature is continuously displayed on the FPGA board.

This testing process effectively demonstrates the system's ability to handle varying temperature conditions and accurately display the temperature while engaging the appropriate alerts based on user-defined thresholds.

Block diagram



Here's a description of the block diagram of system:

Temperature Sensor (DS18B20):

- Inputs: Temperature (from the environment/water)
- Outputs: Binary temperature data
- Function: Measures temperature and sends binary data to Arduino.

Arduino Uno:

- Inputs: Binary temperature data from temperature sensor DS18B20
- Outputs: Binary temperature data to FPGA
- Function: Receives binary temperature data from the DS18B20 sensor and sends it to the FPGA.

FPGA (Basys3):

- Inputs: Binary temperature data from Arduino
- Outputs: Control signals to LEDs, buzzer, and temperature display
- Function: Converting temperature data from binary to Celsius and checks it against predefined thresholds. Controls LEDs, buzzer, and displays the temperature.

Keypad:

- Inputs: User-defined temperature thresholds
- Outputs: Threshold values to FPGA
- Function: Allows the user to set custom temperature thresholds for hot and cold.

Switches (sw1, sw2, sw3, sw4 on FPGA):

- Inputs: User-selected mode
- Outputs: Mode selection to FPGA
- Function: Determines the operating mode (checking temperature against 50°C, 10°C, or user-defined thresholds).

LEDs (Red and Blue):

- Inputs: Control signals from FPGA
- Outputs: Visual indication (ON/OFF)
- Function: Indicate if the temperature exceeds the hot threshold (Red LED) or falls below the cold threshold (Blue LED).

Buzzer:

- Inputs: Control signal from FPGA
- Outputs: Sound (ON/OFF)
- Function: Alerts when the temperature exceeds or falls below the set thresholds.

Display (on FPGA):

- Inputs: Processed temperature data from FPGA
- Outputs: Visual temperature readout
- Function: Continuously displays the current temperature in Celsius.

Appendix

Links to the videos in Youtube-

<https://www.youtube.com/watch?v=Jwe6oWMPyZE&list=PLejz4G5i2PCac-pyeZiZoc6fPHPi7-JGv&index=2>

<https://www.youtube.com/watch?v=TRDaP4a6h9g&list=PLejz4G5i2PCac-pyeZiZoc6fPHPi7-JGv&index=1>

