Documentation
Smart Weather Monitoring System
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1 Team members

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2 Introduction

In Chip design IP-Cores and IP-design in general is a really useful technology to save development time and costs by packaging integrated circuits or parts of ICs into smaller IP cores that can be interconnected for full functionality. These IP-Cores can be memory modules, processor modules, cache or interface modules of a bigger system. Companies can also produce IPs for specific functions and license and sell those to other manufacturers or people. With all that being said, IP-Cores are used in a vast amount of modern chip designs and also in FPGA development. Especially the usage in FPGA prototyping is really useful since it is an programmable logic device. Using an FPGA and a library of IPs, one can develop almost every system they have in mind. For our project, we wanted to develop a smart weather monitoring system which can primarily measure the outside temperature and display it for the user and secondarily also the humidity and a possible connection to the internet as a IoT device. All this will be implemented using the Microblaze processor IP and more IP blocks for the advanced functionality.

3 Concept description

A smart weather monitoring system that is designed to be an Internet of things (IoT) application on an FPGA board. For this project, the NEXYS A7 FPGA board is used. The finalized project should be able to measure the room temperature using a PMOD TMP 3 external sensor and display it on the internal seven segment display. Further functionality can be added to advance the system using switches or buttons on the fpga. The initial block diagram for the first concept includes humidity measuring through a different sensor and a esp32 wifi module as seen in the block diagram.

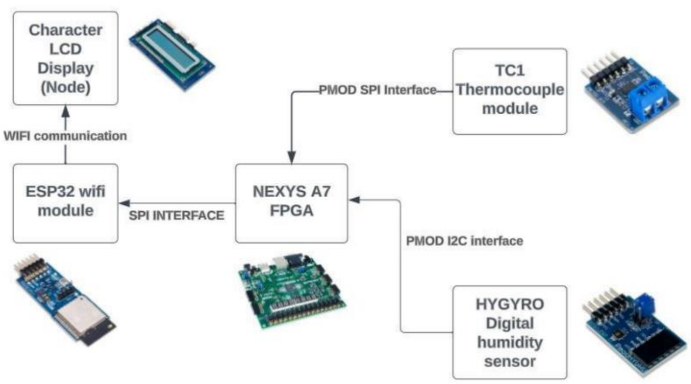

Figure 1 Block design of the system concept

4 Project/Team management

To realize our project concept we had to coordinate by dividing tasks into doable with the FPGA board and doable without the FPGA board since there is only 1 board to work with. Tasks like creating diagrams for the system concept, creating an initial block design in Vivado without testing and documenting progress would be done by group members who don't have the board. Tasks like testing C code and work with the sensors would be distributed to the group member who currently had the FPGA or be done at a meetup at the university together.

Divided tasks for each member:

1. Moataz: Connecting sensors to the FPGA board and linking them correctly with the Microblaze processor to obtain the data.

2. Yashodhan: Creating a block design and most part of the concept design, working at the general block design creation and improvement, Seven segment display IP

3. Emirkan: Working on microblaze block design, testing and writing C code to use obtained data for user feedback on display

5 Technologies

For our project, different technologies were used to implement the system on an FPGA:

- VHDL: VHDL is a hardware description language (HDL), which makes it possible to describe digital systems on transistor level. Together with the Verilog HDL it is one of the most used HDLs in the world. VHDL mostly describes the behavior of certain electronic modules that its user wants to create. Furthermore, it allows for testing and simulation and synthesis into a netlist to create actual electronic systems from. However, it is important to note that not every VHDL code is not synthesizable. VHDL was used to create custom IP-Cores to be added into our final microblaze design.

- FPGA: FPGA, short for Field Programmable Gate Array is a device often used in prototyping, containing a vast amount of digital building blocks with which many different circuits can be realized. It also contains, depending on the board, different onboard sensors, displays,interfaces and I/Os to aid in prototyping and development by providing potentially needed hardware in one programmable package.

- PMOD TMP3: The Digilent PmodTPM3 (Revision A) is a temperature sensor module built around the Microchip TCN75A. With a resolution of up to 0.0625°C, users can effortlessly measure a broad spectrum of ambient temperatures, ranging from -40°C to +125°C.

- Xilinx Vivado Design Suite: The design program for AMD adaptive SoCs and FPGAs is called Vivado. Design Entry, Synthesis, Place and Route, and Verification/Simulation

Tools are among its features.With system-to-IC level tools and a shared scalable data model, it is an integrated design environment (IDE) with a common debug environment. Vivado comprises standards-based IP stitching and systems integration of all kinds of system building blocks; standards-based IP packaging of both algorithmic and RTL IP for reuse; electronic system level (ESL) design tools for synthesizing and verifying C-based algorithmic IP; and the verification of blocks and systems. Designers have access to a constrained version of the design environment with Vivado's WebPACK Edition, which is available for free.

6 FPGA Implementation

For our project, we first had to create a microblaze microprocessor in the Vivado IDE as a foundation to handle all the code and data that needs to be handled. We installed some Ram from the internal memory of the FPGA to our board and a clocking Wizard that can output differently paced clock signals if we need them for later components as seen in figure 2.

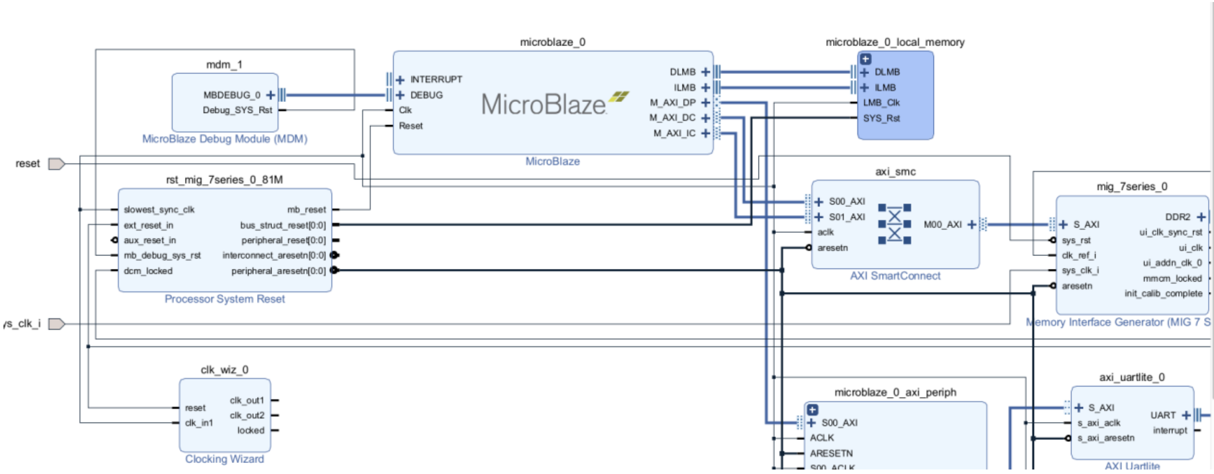

Figure 2 Microblaze block design in our project

The most important part in our microblaze design was the AXI peripheral controller, since it is necessary to connect internal and external devices to our microprocessor and also control them with C code. Generally we needed to more IPs to connect the external temperature sensor to the microblaze and the internal seven segment display. This is showcased in figure 3.

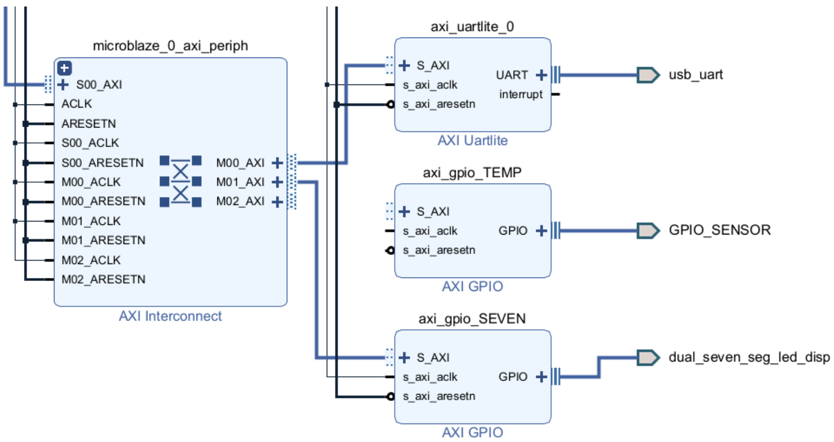

Figure 3 Peripheral controller for microblaze with the needed devices

…More will follow…

7 Sources/References

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