Team Members:
Saveetha Venkatesan (SXV200028), Vishnuvaradhan Moganarengam (VXM210090)

EEDG6302: Microprocessor and Embedded Systems

Wednesday Lab Report

Project_1: - Designing two memories for 8-bit MCU: Program Memory and Data Memory.

Part_1 Task: - Designing and simulating synthesizable MCU memories

- Writing testbench to test the written codes

Week 1 Summary:

The goal of this week's task is to verify the Verilog module program and data memories individually.
As given project specification, Data Memory (RAM) takes 8-bit input data, 8-bit address as input, we have assigned 256 bytes to our Data Memory. When write enable bit is high, it stores the input data at the address received at the positive edge of the clock pulse. To test it, we designed a logic that can test for all the addresses and values. Data is written on Data output lines from Data memory address which is coded by logic.
In a Similar Way we have designed a logic at certain memory locations in Program memory module. To test in a test bench, we call those addresses. As expected, we can read correct instructions for the logic coded in simulations.

We have assigned Opcodes to the given instruction set:

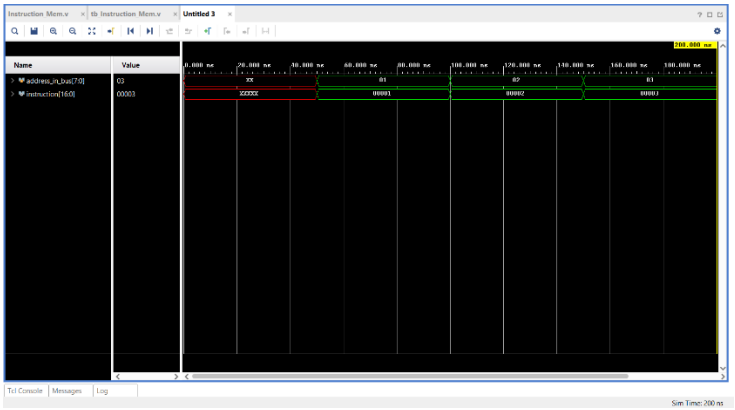
#	Operation	Symbolic Notation	Opcode	Action	ALU/FU requirement
1	No Operation	NOP	"00000"	None	No
2	Input	IN	"00001"	R[DR] <- Input Port	No
3	AND	AND	"00010"	R[DR] <- R[SA] ^ R[SB]	No
4	Move A	MOVA	"00011"	R[DR] <- R[SA]	Yes

Instruction Memory:

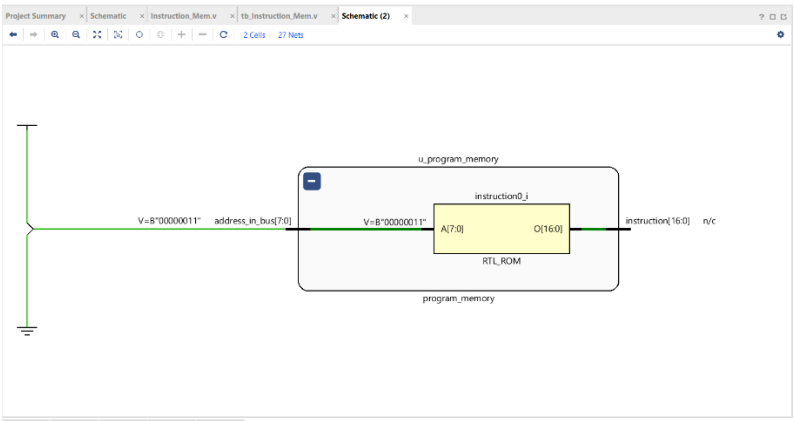
- Also known as Program memory, useful for storing data items which are meant to permanent such as ROM, EEPROM is implemented as "program_memory.v"
- Program memory takes in an 8-bit address as input and outputs a 17-bit instruction bus according to the address given.
- The program will create an array of size 17-bits as mentioned in the bus size provided.
- Since we have an 8-bit address bus, it results in 256 words each of size 17-bits. An 8-bit address with 8 arrays results in 256 words.
- The program assigns the memory locations with values equal to the address bus.
- The testbench "tb_program_memory" then compares the address provided with the memory location values.

Team Members:
Saveetha Venkatesan (SXV200028), Vishnuvaradhan Moganarengam (VXM210090)

Simulation:



Schematic:

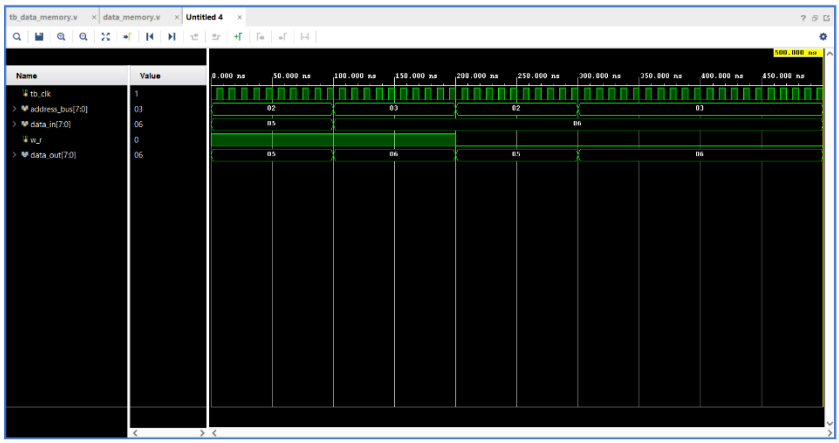


Data Memory:

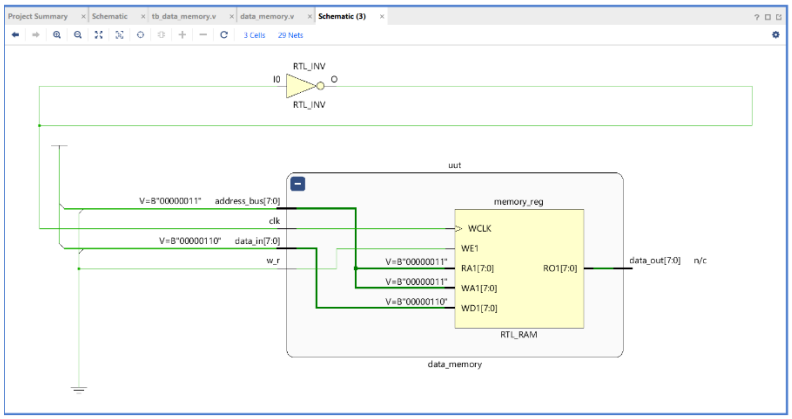
- Data Memory (RAM) is implemented first as module data_memory in "data_memory.v" file
- It takes in 8-bit "address_bus" as input and according to the value of "w_r" it performs either Read or Write operation. Whenever "w_r" is 1 it performs a write operation i.e., takes the value given in "data_in" and updates it according to "address_bus" in that memory block location.
- When "w_r" is 0 then a read operation is performed where "data_out" outputs the data located at "address_bus" given in the testbench.
- Since we have an 8-bit address bus, it results in 256 words each of size 8-bits. An 8-bit address with 8 arrays results in 256 words.
- The program assigns the memory locations with values equal to the address bus.
- The testbench "tb_program_memory" then compares the address provided with the memory location values. Then the data is modified to some random value to test the write operation. We then performed a read operation to verify the functionality of the write operation at a particular memory location.

Team Members:
Saveetha Venkatesan (SXV200028), Vishnuvaradhan Moganarengam (VXM210090)

Simulation:



Schematic:



Problems Encountered During Design:

- To come up with logic that can test all 256 memory locations took a significant amount of time.
- We faced an issue with always block where assign function will not work.

1. What are the long formats of ROM, PROM, EPROM and EEPROM? Explain briefly (2 or 3 lines) their pros, cons and differences in a table. Also consider Flash memory in your comparisons.

ROM	PROM	EPROM	EEPROM	Flash Memory
Read Only Memory	Programmable Read Only Memory	Erasable Programmable Read Only Memory	Electrically Erasable Programmable Read Only Memory	Flash Memory
Large Capacity. Removable. Robust.	Implement functions with large number of inputs and outputs.	Allows changes in the contents of PROM after it is burned. Program and erase it	Erase Instantly. Can select erased byte. Program and erase its contents while it	Light weight and portable. Non Volatile. Data transfer friendly.

		thousands of times.	is still in the system board	
Expensive. Slow access time. Read only.	Large board space requirements. Large power requirements. Lack of security.	Cannot be programmed while in the system board.	Different voltages required for erasing, reading and writing the data. Very Expensive. Data retention period is limited.	Small easy to lost. Can be infected by computer virus. Limited time of use. Flash drive can be physically be worn out.

2. Why is stored data in the Program Memory larger than Data Memory (in this project)?

Program Memory (ROM) is used for permanent saving program being executed, while Data Memory (RAM) is used for temporarily storing and keeping intermediate results and variables. Program memory here is used for storing program code, i.e instructions. Since, we assign each instruction for different opcodes that requires large memory.