Indian J.Sci.Res. 17(2): 442 - 445, 2018

ISSN: 0976-2876 (Print)
ISSN: 2250-0138(Online)

DESIGN OF GENERAL PURPOSE PROCESSOR USING VHDL

[1]Kurella Saikumar, [2]Devarakonda Vandana, [3] Vangara Poornachandar Reddy
[1,2]Electronics and Communication Engineering-Communication system, Aurora's Engineering college,Bhongir
[3]Electronics and Communication Engineering, Aurora's Engineering college,Bhongir

Abstract:This paper presents the design of general purpose processor using VHDL. The Control Processing Unit is divided into 2 main parts - Processor and Memory. The Processor executes most of the instructions in a single machine cycle which provides high speed. The processor has been designed using VHDL and it can be implemented on an FPGA. The major components of micro-processor like ALU, comparator, shift register, control unit and registers are designed and implemented. The memory unit consists of all the data stored in the processor and the data to be stored, while the operations are being done in the processor are also stored into the memory unit. All the modules in the design are coded in VHDL (Very High Speed Integrated Circuit Hardware Description Language) to ease the description, verification and simulation. The processor is developed using Top-Down design approach. The design entry, synthesis and simulation of the processor are done by using XILLINX ISE 12.2 software.

Keywords: VHDL, FPGA, XILLINX

I. Introduction

A microprocessor is a computer processor which incorporates the functions of a computer's central processing unit (processor) on a single integrated circuit (IC), or at most a few integrated circuits.

The microprocessor is a multipurpose, clock driven, register based, digital-integrated circuit which accepts binary data as input, processes it according to instructions

stored in its memory, and provides results as output. Microprocessors contain both combinational logic and sequential digital logic. Microprocessors operate on numbers and symbols represented in the binary numeral system.

The integration of a whole processor onto a single chip or on a few chips greatly reduced the cost of processing power, increasing efficiency. Integrated circuit processors are produced in large numbers by highly automated processes resulting in a low per unit cost. Single-chip processors increase reliability as there are many fewer electrical connections to fail. As microprocessor designs get better, the cost of manufacturing a chip (with smaller Components built on a semiconductor chip the same size) generally stays the same.

VHDL stands for very high-speed integrated circuit hardware description language. This is one of the programming languages used to model a digital system by dataflow, behavioral and structural style of modeling. This language was first introduced in 1981 for the Department of Defense (DOD) under the VHSIC program. In 1983 IBM, Texas instruments and Inter metrics started to develop this language. In 1985 VHDL 7.2 version was released in 1987 IEEE standardized the language.

A field-programmable gate array (FPGA) is an integrated circuit designed to be configured by a designer after manufacturing, hence "field-programmable". The FPGA configuration is generally specified using ahardware description language (HDL), similar to that used for an application-specific integrated circuit (ASIC). (Circuit diagrams were previously used to specify the configuration, as they were for ASICs, but this is increasingly rare.)

The objective of this paper is like that writing a VHDL behavioral model. Developing test bench and simulating the behavior and synthesizing it using the Xilinx ISE. In this paper we used Spartan-3 family of FPGA. The Spartan®-3E family of Field-Programmable Gate Arrays (FPGAs) is specifically designed to meet the needs of high volume, cost sensitive consumer electronic applications.

II. Design Of Micro Processor

1. Top Level Design

The top-level design consists of the processor block and a memory block communicating through a bidirectional data bus, an address bus, and a few

[1]**Corresponding Author**

control lines. The processor fetches instructions from the external memory and executes these instructions to run a program. These instructions are stored in the instruction register and decoded by the control unit.

The control unit causes the appropriate signal interactions to make the processor unit execute the instruction.If the instruction is an Add of two registers, the control unit would cause the first register value to be written to register OpReg for temporary storage. The second register value would then be placed on the data bus.

The ALU would be placed in add mode and the result would be stored in register OutReg. Register OutReg would store the resulting value until it is copied to the final destination. When executing an instruction, a number of steps take place.

The program counter holds the address in memory of the current instruction. After an instruction has finished execution, the program counter is advanced to the location of next instruction to be fetched. If the processor is executing a linear stream of instructions, this is the next instruction. If a branch was taken, the program counter is loaded with the branch instruction location directly.

The control unit copies the program counter value to the address register, which outputs the new address on the address bus. At the same time, the control unit sets the R/W (read write signal) to a ‘0’ value for a read operation and sets signal VMA (Valid Memory Address) to a ‘1’, signaling the memory that the address is now valid.

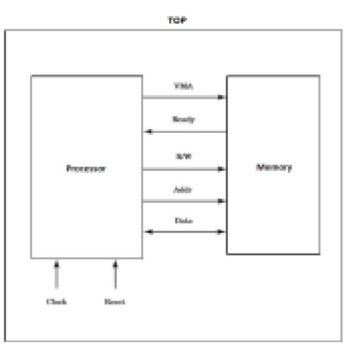

Fig 2.1 Top Level Design of MicroProcessor

The memory decodes the address and places the memory data on the data bus. When the data has been placed on the data bus, the memory has set the READY signal to a ‘1’ value indicating that the memory data is ready for consumption.

The control unit causes the memory data to be written into the instruction register. The control unit now has access to the instruction and decodes the instruction. The decoded instruction executes, and the process starts over again.

A. Processor Unit

The processor contains a number of basic pieces. There is a register array of eight 16-bit registers, an ALU (Arithmetic Logic Unit), a shifter, a program counter, an instruction register, a comparator, an address register, and a control unit. All of these units communicate through a common, 16-bit tristate data bus.

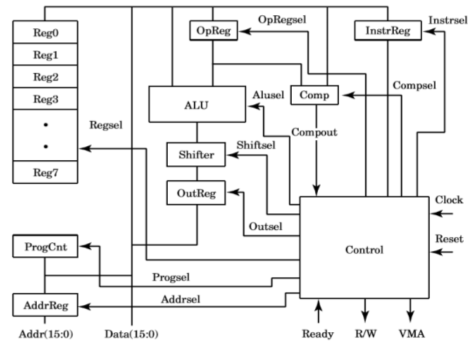

Fig 2.2 Block Diagram of Processor Unit

B. Memory Unit

The Memory Unit is required in general to hold data and instructions for processing. This unit in the designed processor has 8 address lines which make it to support 28=256 memory locations and also it is made to resemble ROM (Read Only Memory) as the data and instructions can be read from the unit but can’t be written back into the memory.

III. Results

In this section, the synthesis outputs of all the blocks of processor and simulation output of ALU is verified.

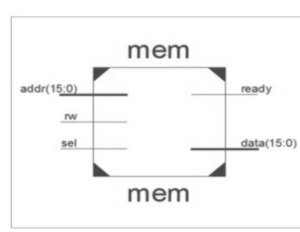

Fig 3.1 Memory Synthesis Output

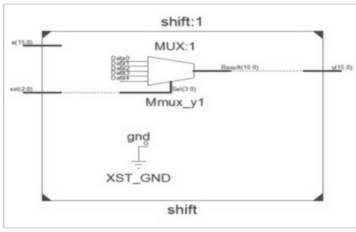

Fig 3.2 Shifter Synthesis Output

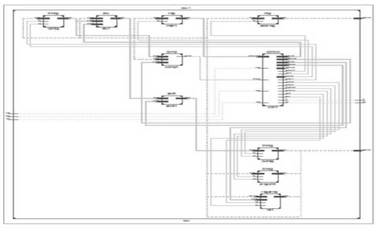

Fig 3.3CPU Synthesis Output

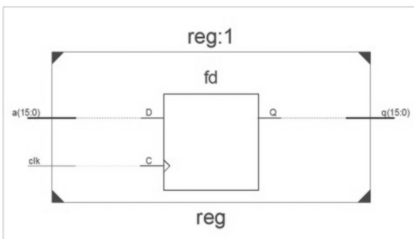

Fig 3.4 Address Register Synthesis Output

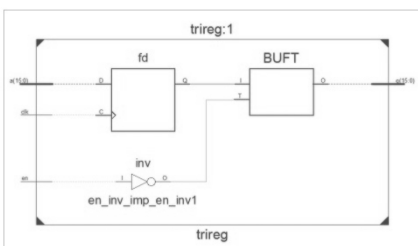

Fig 3.5 Output Register Synthesis Output

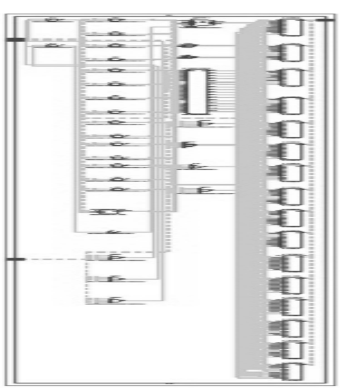

Fig 3.6 ALU Synthesis Output

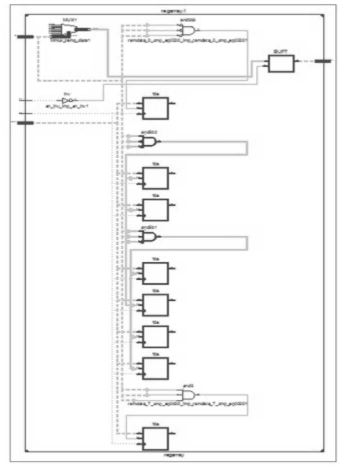

Fig 3.7 Control Unit Synthesis Output

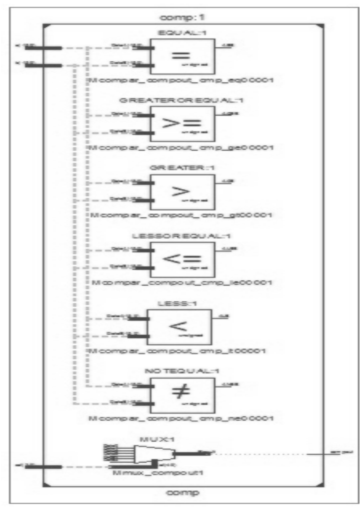

Fig 3.8 Comparator Synthesis Output

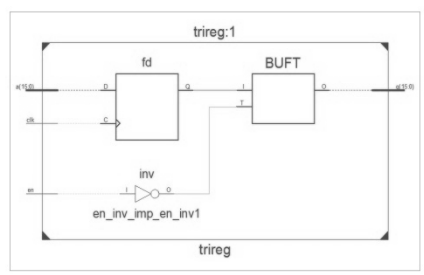

Fig 3.9 Op Code Register Synthesis Output

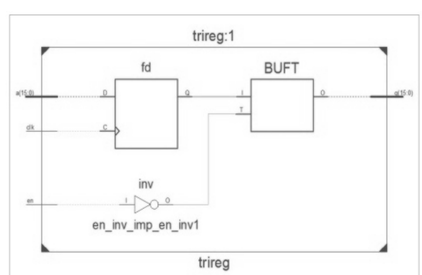

Fig 3.10 Program Counter Synthesis Output

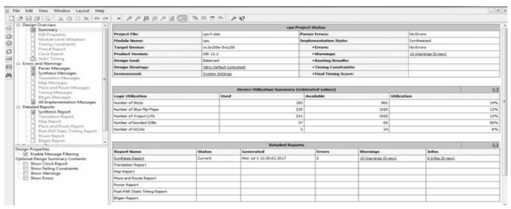

Fig 3.11 Design Summary

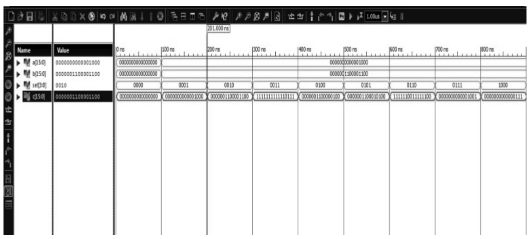

Fig 3.12 ALU Simulation Output

The simulation result of ALU shows that the processor is capable of implementing the given arithmetic and logical operations. It is also possible to test all the modules of the CPU. The RTL description of all the modules of CPU is simulated with a standard VHDL simulator Xilinx design tool.

IV. Conclusion

This paper, design of a 16 bit processor is described by a number of lower-level components that are instantiated to form the CPU design. In the project, the VHDL coding of the CPU and simulation is done successfully. The design architecture of the 16-bit processor is written in Very High Speed Integrated Circuit Hardware Description Language (VHDL) code using Xilinx ISE 12.2 design tool for synthesis and simulation and synthesis of all the modules of the CPU is successfully done. After the programming andsynthesis is done in VHDL, a VHDL simulator is used to verify the functionality of the CPU.

Acknowledgement

We are extremely thankful to our Head of Department Mr.GaddamSrujan for helping us and Mr. VangaraPoornaChandar Reddy for giving us helpful guidelines and helping us throughout the paper work. He has always supported us and guided us. He gave us very valuable suggestions, whenever we faced any problem. and also very grateful to Dr. ShubhroChakrabartty, Associate Professor, Dept. of Electronics and Communication Engineering, and Head (Research and Development) Aurora's Engineering College, Bhongir for motivating us towards the research.

References

[1] TessyNinan, "Design and Analysis of 16-Bit Micro Processor Using Xilinx Tool", International Journal of Scientific Research Engineering & Technology (IJSRET), Volume 4, Issue 9, September 2015.

[2] ManoranjanPradhan, "Control Unit Design of a 16-bit Processor Using VHDL" , International Journal of Advanced Research in Computer Science and Software Engineering , Volume 3, Issue 12, December 2013.

[3] ShailyGoyal, "16 Bit Microprocessor -Design and Simulations in VHDL", International Journal of Innovative Research and Development, Volume 3, Issue 1, January 2014.

[4] Enoch O. Hwang, "Digital Logic and Microprocessor Design With VHDL", La Sierra University, Riverside.

[5] Douglas L Perry, "VHDL Programming", fourth edition, McGraw Hill publications.

[6] Weijun Zhang, "VHDL Tutorial: Learn by Example"(http://esd.cs.ucr.edu/labs/tutorial)