Design and Implementation of 64-bit ALU using VHDL

Priyanka Vanjare¹, Prabhat Pandey²
¹Student, Department of E.C.E, A.I.T.R, Indore, Madhya Pradesh, INDIA
²Assistant Professor, Department of E.C.E, A.I.T.R, Indore, Madhya Pradesh, INDIA

ABSTRACT

In this work a 64-bit ALU is designed and implemented using VHDL and simulated on Xilinx simulator. The ALU is a basic building block of a processor. The ALU performs logical, arithmetic and shifting operation onto data in processor. The proposed design may find application where automobile and control is required.

Keywords: ALU (Arithmetic Logic Unit), LU (Logic Unit), RTL (Register Transistor View), Shift Unit, VHDL, Xilinx

I. INTRODUCTION

A 64-bit ALU implemented using VHDL and verified on Xilinx ISE simulator. The approach used here is to split the ALU into three modules, one Arithmetic, one Logic and one Shift module. The arithmetic, logic and shift units can be combined into ALU with common selection lines. The shift micro-op operations are often performed in a separate unit, but sometimes the shift unit made part of overall ALU. For 64-bit ALU, 4:1 MUX is needed to perform particular operation. These operations arithmetic, logic, shift operation is selected according to the selection inputs. The final output of the ALU is determined by the set of multiplexers with selection lines.

An Arithmetic unit does the following task:
- Addition
- Multiplication
- Subtraction
- Division
- Decrement
- Increment
- Transfer function

A Logic unit does the following task:
- Logical AND
- Logical OR
- Logical XOR
- Logical NOT operation

A Shift unit does the following task:
- Right shift
- Left shift

Here, ALU is implemented and designed using VHDL (VH-SIC hardware description language) is hardware Description language used to design electronic circuit for automation to describe digital and mixed signal systems for example FPGA and integrated circuit. The key advantage of VHDL, when used for systems design, is that it allows the behavior of the required system to be described (modeled) and verified (simulated) before synthesis tools translate the design into real hardware (gates and wires). Another benefit is that VHDL allows the description of a concurrent system. VHDL is a data flow language, unlike procedural computing languages such as BASIC, C, and assembly code, which all run sequentially, one instruction at a time. VHDL project is multipurpose and portable. Being created for one element base, a computing device project example VLSI with various technologies

II. ARCHITECTURAL DESIGN AND IMPLEMENTATION

A. 64-bit Logic Unit

A Logic Unit perform AND, OR, XOR and Complement of data. We design a logic unit that can perform these basic operation. From these all other logic micro operations can be derived. We design a logic unit having four gate and a 4:1 mux. Gate performed operation, their output
feed as input of multiplexer. All gates are designed to perform operation on 64 bit. By the selection line of multiplexer can select one out of four inputs of mux.

**B. 64-bit Shift Unit**

Shift Unit performs shifting of input data. The bits are shifted either right or left side. A shift unit having right and left shift unit separately. A 4:1 mux in Shift unit select one output as a final output of shift unit according to selection line. Shift Unit is designed to shift a 64-bit input data.

**C. 64-bit Arithmetic Logic Unit**

An Arithmetic unit does the following task: Addition, Subtraction, Subtraction with borrow. First we start with making one bit Full Adder, then a 4-bit Carry Adder using four numbers of Full Adder and then a 32-bit Ripple Carry Adder using eight numbers of 4-bit Ripple Carry Adder. And at last a 64-bit Ripple Carry Adder. Same approach will be used in designing a 64-bit Subtract or.

### III. BLOCK DIAGRAM OF MODULES OF ALU

![Fig 1 BLOCKSDIAGRAM OF ALU](image1)

### IV. RTL OF ALU

![Fig 2 RTL View of ALU](image2)

### V. APPLICATION

The proposed design may find applications, where Automobile and Control is required. Typical use of our processor in Bottling plants and control of robotic movements using exhaust simulations.

Future application may include its use in vending machines, ATM, Mobile phones and Portable Gaming kits.

### VI. SIMULATION RESULTS

**A. Simulation of ALU**

![Fig 3 Simulation waveform of ALU](image3)
VIII. CONCLUSION

In this work “Design And implementation of a 64-bit ALU” on Xilinx using VHDL language that will perform all arithmetic operation, logical operation, and shifting operation. Arithmetic operation will perform operation like Addition, subtraction, multiplication, division. A logical operation that are AND, OR, XOR, NOT etc. A shift operation that is right shifting and left shifting also perform.

REFERENCES

[2] VHDL Primer by J. Bhasker
[3] https://www.google.co.in