8-bit ALU

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Overview

Project Outline

- Design an 8-bit ALU in verilog.
- Run the verilog code on Icoboard using the icestorm toolchain.
- To get a clear view of work flow for the Icoboard.
- Interface the icoboard running the verilog module with Arduinos to send and receive inputs and outputs.
- Display the outputs on a 16x2 LCD display.

ALU implementation

- The ALU is implemented as an FSM.
- The inputs and outputs of the ALU are as follows:
  - Input - 1-bit clock
  - Input - 5-bit opcode
  - Input - 8-bit data operand A
  - Input - 8-bit data operand B
  - Input - 1-bit enable
  - Input - 1-bit input-ready
  - Input - 1-bit carry-in
  - Output - 8-bit result Y
  - Output - 1-bit result ready
  - Output - 1-bit carry-out
  - Output - 1-bit zero
  - Output - 1-bit negative
  - Output - 1-bit overflow

ALU implementation

The list of operations performed by the ALU are as follows:

- ADD
- ADD WITH CARRY
- SUB
- SUB WITH BORROW
- NEGATE
- INCREMENT
- DECREMENT
- PASS THROUGH
- AND
- OR
- Exclusive-OR

ALU implementation

- One's COMPLIMENT
- Arithmetic SHIFT LEFT
- Arithmetic SHIFT RIGHT
- Logical SHIFT LEFT
- Logical SHIFT RIGHT
- ROTATE LEFT
- ROTATE RIGHT
- ROTATE Through carry LEFT
- ROTATE Through carry RIGHT

Wrapper for the ALU module

- The ALU module has multiple set of inputs and outputs and we have a physical constraint, the number of IO pins on the ICOboard.
- To solve this issue, we use a wrapper module which serially takes in the inputs, calculates the outputs and gives the outputs back serially.
- Also, the clock signal for the verilog design needs to be such that the frequency at which the results are being generated should be equal to the frequency at which Arduino samples them and the wrapper module takes care of this.

Interfacing the ICOboard

- The inputs are given to the Arduino using the serial monitor. These inputs are then converted to binary by Arduino and are sent to the ICOboard.
- The input format in the serial monitor are as follows : opcode operandA operandB carryIn borrowIn. Each of the inputs are integers followed by spaces in the order mentioned above.
- Once the inputs are processed by the ICOboard, the outputs are sampled by the Arduino and are displayed on the serial monitor as well as the 16x2 LCD display using the LiquidCrystal library.

Resources

- Download link and instructions for flashing the SD card with raspberry image : `https://www.raspberrypi.org/downloads/raspbian/`
- IceStorm toolchain description and installation instructions : `http://www.clifford.at/icestorm/`
- Link for downloading the Arduino software : `https://www.arduino.cc/en/Main/Software`
- Link for LCD connections with Arduino and instructions for displaying data : `https://www.instructables.com/id/Connecting-an-LCD-to-the-Arduino/`

Thank You