

Lab 8 - ad-hoc Design

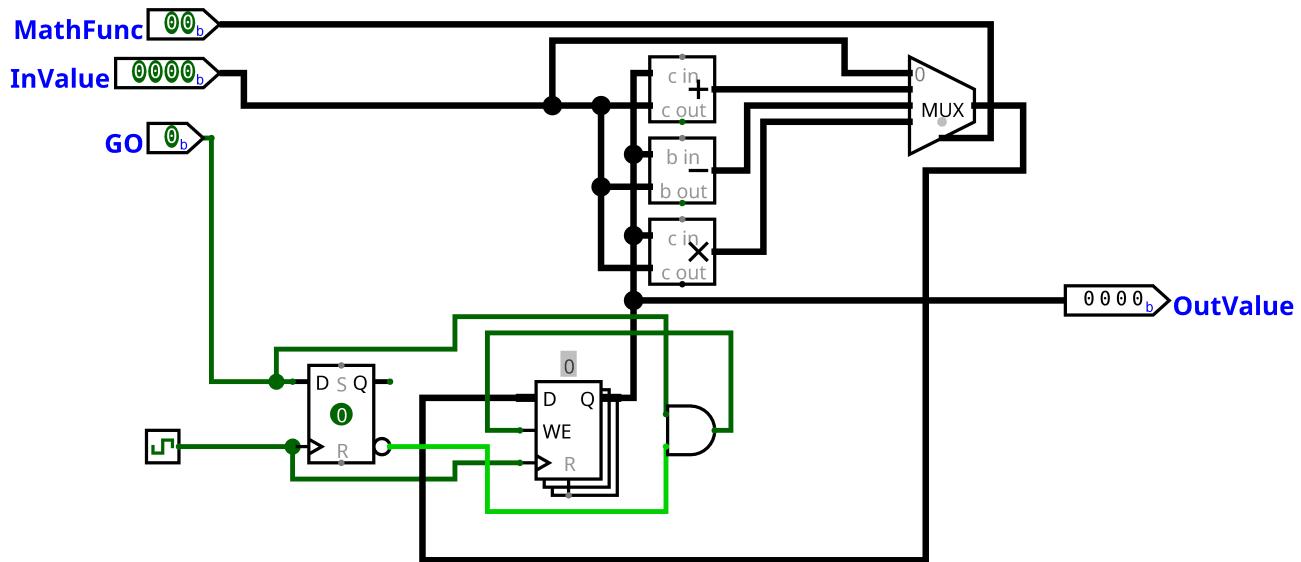
- Objective:
 - Design and implement a 4-bit calculator using existing modules in logisim
- Device Specifications:
 - I/O
 - 4-bit input IN | Value to be manipulated by circuit
 - 2-bit input F | Function selector
 - 1-bit input GO | Triggers device to perform calculation
 - 4-bit output OUT | Outputs calculated value
 - Calculator has an accumulator "A" that holds 4-bits of memory
- Function Bit Mapping

F0F1	Function	Operation
00	Set Data	A = IN
01	Add	A = A + IN
10	Subtract	A = A - IN
11	Multiply	A = A * IN

- Design:
 - Triggering a calculation:
 - There is a need to control when the device performs a calculation
 - The register which stores the A value used for performing calculations must be updated by a clock signal
 - If the clock was connected directly to the register, the register would update its value on every cycle, which is undesirable
 - So the clock cycle is instead ANDed with the output of a D flip-flop so that when the GO pin is switch to TRUE the register only updates its value ONCE and will no do so again until the GO pin switches back to FALSE and then to TRUE again
 - The logic used for this relies on GO being TRUE and GO the previous clock cycle being FALSE, in order for the register to update
 - Selecting functions:
 - This circuit will perform all functions every time using the same INPUT and A values for said functions

- The F (Function) pin which is responsible for determining the math function to be performed will control a MUX device
 - 4 Data bits to handle the 4 bit values
 - 2 Select bits to select between the 4 possible inputs
- Each function will be paired to a MUX pin corresponding to its F0F1 value
- The output of the MUX device connects to the D input of the register
- Register
 - The output of the Register splits and terminates to:
 - The 4 bit output pin which displays the value that was calculated based upon the function desired
 - One of the two input pins for the 3 arithmetic devices:
 - Add
 - Subtract
 - Multiply
 - A data terminal on the MUX corresponding to the Function 00
 - Sets the value of A
- Arithmetic Functions:
 - Each of the mathematical functions are performed by:
 - Terminating the 4 bit Q outputs from the register to the one input of the arithmetic device
 - Note: For the subtract function this is the Minuend input, as A is the value to be subtracted from
 - Terminating the 4 bit IN to the other input pin
 - Note: For the subtract function this is the Subtrahend pin
 - The outputs of these devices are then terminated to their corresponding pins on the MUX device

- Figure #1: Circuit Diagram



- Results:

- All functions work as intended the circuit is able to:
 - Load a value to the register using the Load function
 - Add a value to the value stored in the register with the Add function
 - Subtract a value from the value stored in the register with the Subtract function
 - Multiply a value with the value stored in the register with the Multiply function
- All resulting values are correctly stored in the Register and displayed on the OUT pin