

Lab 8 - ad-hoc Design

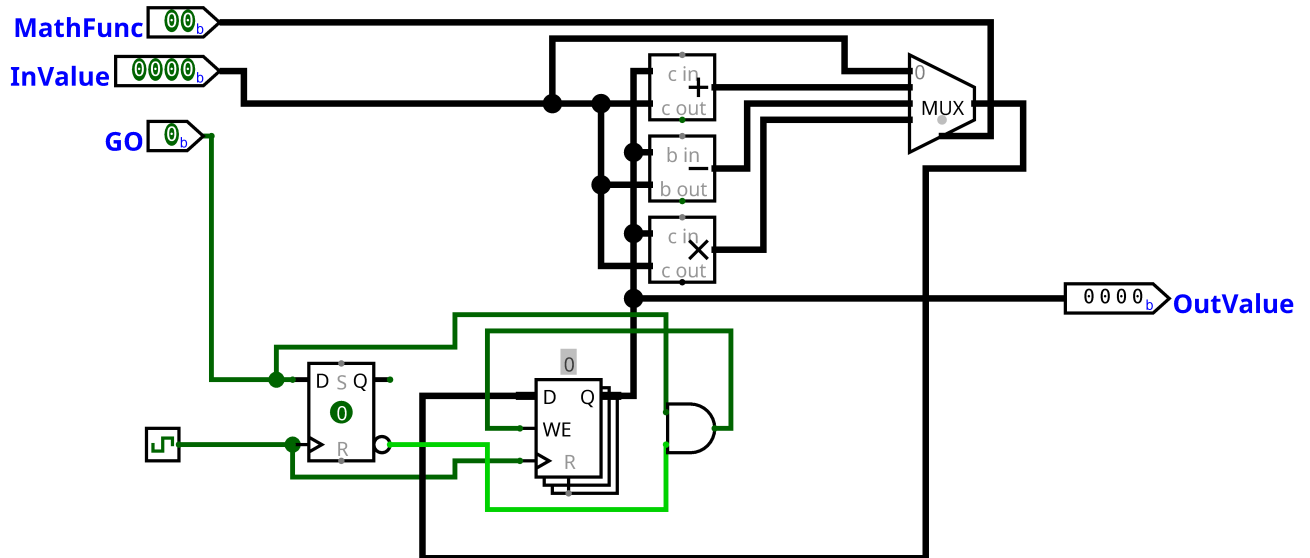
- Objective:
 - Design and implement a 4-bit calculator using existing modules in logisim
- Device Specifications:
 - I/O
 - 4-bit input IN | Value to be manipulated by circuit
 - 2-bit input F | Function selector
 - 1-bit input GO | Triggers device to perform calculation
 - 4-bit output OUT | Outputs 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