Worksheet 4

Objective: Going beyond basic circuits and design some advanced circuits and see their behavior.

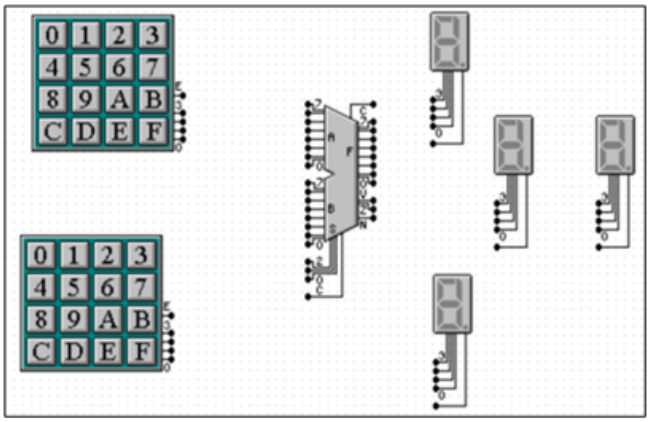
Adder Circuit

The adder uses an arithmetic logic unit to build a circuit capable of summing two 4 bit hexadecimal numbers. The following components are needed to build the adder:

- Arithmetic Logic Unit (ALU)
- 4, 7 Segment LEDs
- 2 Hexadecimal keypads

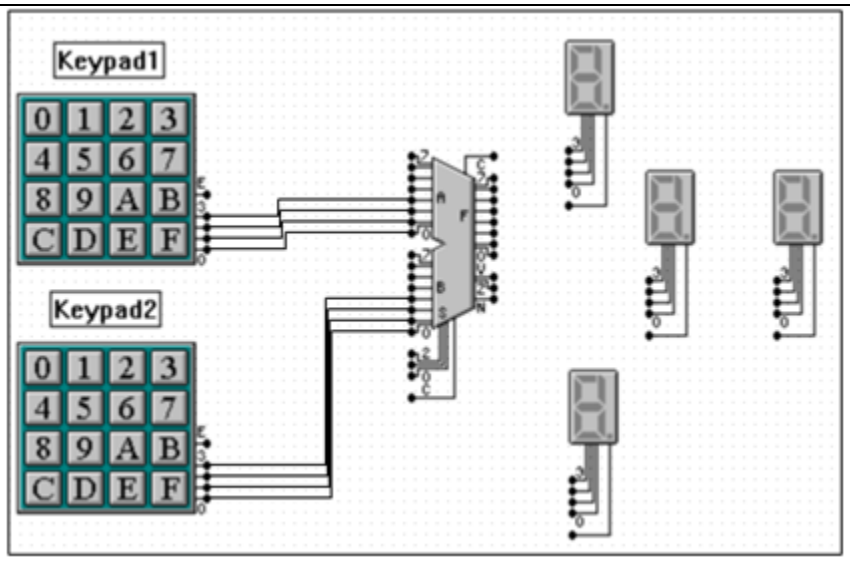
To build the adder:

1. Go to the palette and drag and drop the above components to the workspace



2. Connect the 4 outputs from hexadecimal keypad 1 to the 4 least significant bits of input A of the ALU.
3. Connect the 4 outputs from hexadecimal keypad 2 to the 4 least significant bits of input B of the ALU.

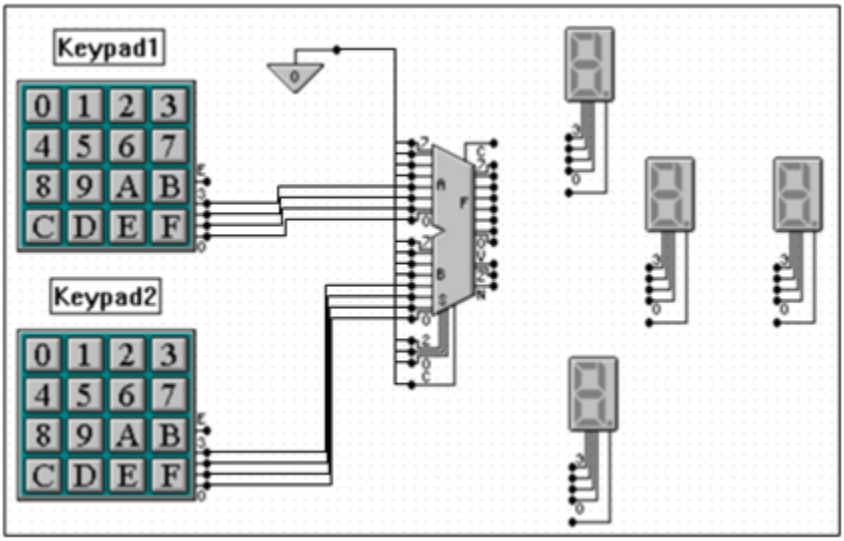
Worksheet 4



4. Using the ground component connect the 4 most significant bits of ALU inputs A and B together. This disables 4 most significant input bits, which are not needed for this tutorial.

5. Connect the C, S0, S1, and S2 pins to the ground as well (the input pins at the bottom of the ALU)

   After all these, the circuit should be as following figure.

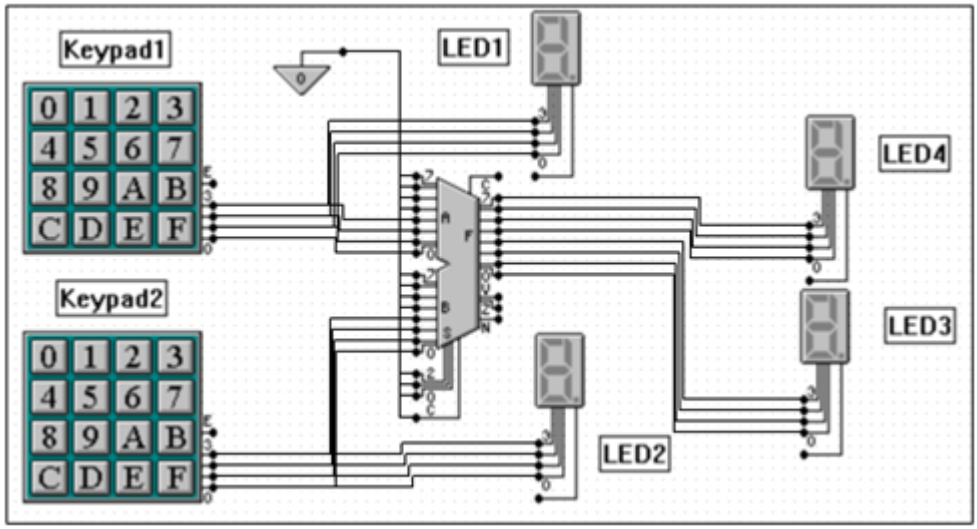


Worksheet 4

6. Connect 1 7 segment LED to the 4 output lines of keypad 1. Connect the second 7 segment LED to the 4 output lines of keypad 2.

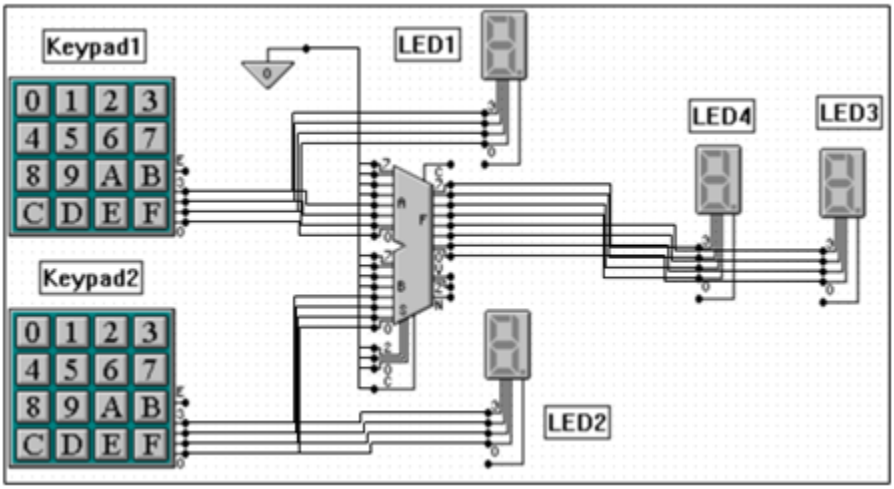
   *This allows you to monitor the output from the hexadecimal keypads.

7. Connect the 4 least significant bit lines from the ALU to the 4 input lines of the 3rd 7 segment LED.
8. Connect the 4 most significant bit lines from the ALU to the 4 input lines of the 4th 7 segment LED.



Worksheet 4

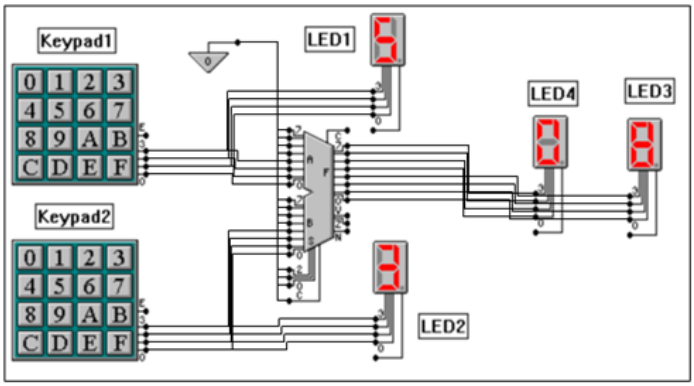
9. Position the 3rd and the 4th 7 segment LEDs next to each other with the 3rd directly to the right of the 4th. The final circuit should be as follows.



You are now ready to run the simulation. Run the simulation by clicking the run button on the toolbar.

To run the adder simulation (the initial conditions before the simulation are 0.):

- Using the hexadecimal keypads enter a number on each. For example, enter a 5 on the first keypad and a 3 on the second keypad.
- The output of the ALU has summed the numbers together and the output is 08.



Worksheet 4

- The hexadecimal adder is capable of adding together two hexadecimal numbers each ranging from 0-F(15). The maximum adder output is, therefore, 1E hexadecimal or 30 decimal (F+F=1E,15+15=30).

Activity

The ALU is capable of performing Addition, Subtraction, Multiplication, Division, Shifting and Comparing which is performed by giving inputs to S0, S1 and S2 pins while the C pin is used to input a carry bit. Connect these pins to switch inputs and try to perform these arithmetic functions.