Construction of a 4 Bit Adder

Tyler Sengia January 1st, 2018

Introduction

Creating a 4 Bit Adder means creating a complete schematic from scratch and fragmented logic diagrams, selecting and ordering components, building the circuit on a bread board, losing your sanity while fixing issues in the breadboard circuit, and then repeating the time consuming process transferring the breadboard circuit onto a PCB prototype board.

But in the end you are rewarded with a circuit that can take two 4 bit integers and add them to a result of 5 bits in length. A very simple piece of our modern computers.

Schematic

The schematic to the right was created myself, by having an understanding of a 1 Bit Adder and chaining multiple 1 Bit Adders together to create a 4 Bit Adder. A 1 Bit Adder consists of XOR gates, an AND gate, and an OR gate all interlinked to take 3 logical inputs (bit A, bit B, carry) and turn it into 2 logical outputs (output, carry).

This complex circuit should only built by those who are determined, experienced with circuits, have knowledge of low-level computer logic, and/or insane. There is a heavy amount of jumper-wires and soldering in the final product.

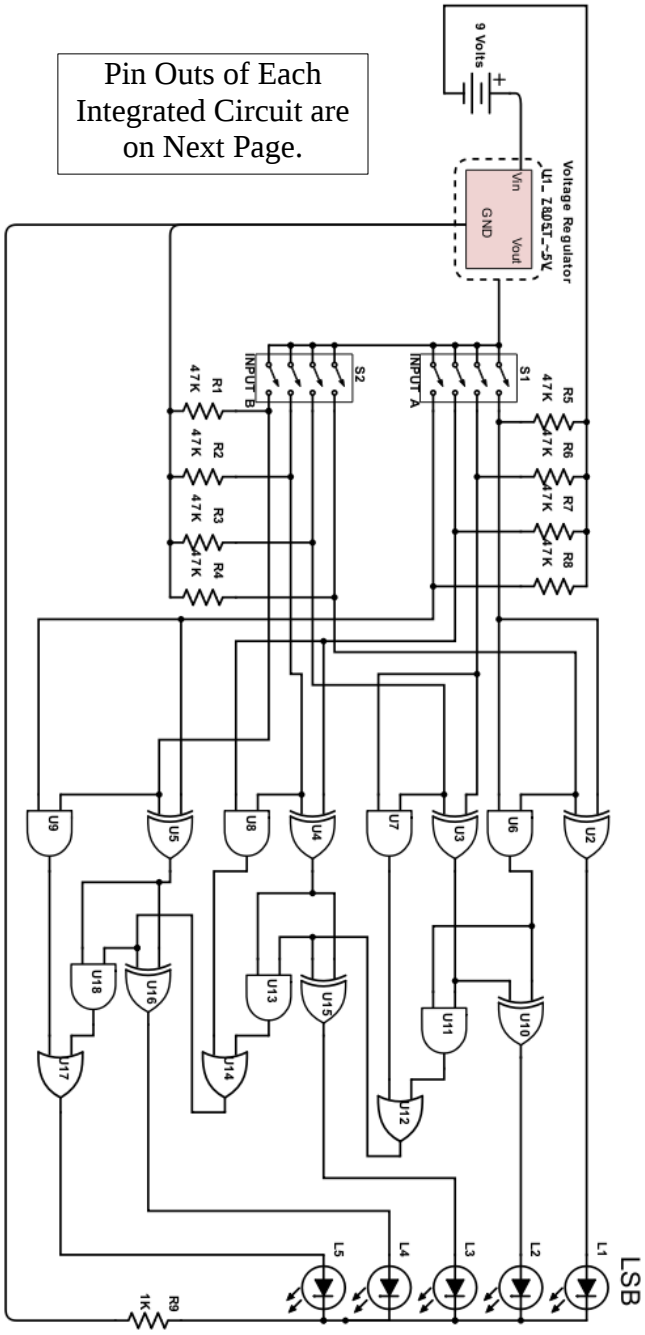
The reason that I dedicated myself to this complex circuit was my interest in computers. I am a computer programmer and I like to know my layers of abstraction from top to bottom, so I've made a small, extremely, small portion of what a modern computer is made up of. Additionally, I was terrible at soldering, but I wanted to get good at it, so I challenged myself. Now after soldering this behemoth, I am confident in my soldering skills.

Amazingly, the schematic to the right works completely. It was redrawn in a logic gate simulator and worked, and it then worked in real life too.

Construction

When prototyping and later soldering the circuit, it will come in handy to have an index

Pin Outs of Each Integrated Circuit are on Next Page.



(Continued from Construction) card with a short diagram/sketch of where each integrated circuit is. If you take a break and come back the next day, you may forget which IC was which, and It is a pain to sift through the jumper-wires to read the finely printed IDs on each integrated circuit.

While soldering, have a multimeter handy to test for solder bridges between the IC pins. Test using a continuity setting, and test after you solder a wire or pin that is next to an already soldered pin. Then test again once you are finished for good measure.

After soldering or prototyping and you are ready to test the circuit, make sure you have a multimeter, a penny or marker, an XOR truth table (or a logic simulator with this circuit in it), and this circuit schematic. If an LED is off/on when it shouldn't be off/on, start from that LED and trace the wires back to the input. Is the pin from the LED in the same state as the pin on the IC circuit that should go directly to the LED? If not, there is a soldering error. If they are in the same state, then you must check the states of the inputs of that gate and continue working back until you have found the issue. Good luck.

Results

For me, this project went very well. I was impressed that it worked, and that I did not make many mistakes in prototyping and soldering the circuit. In fact, I made no mistakes soldering the circuit! The only reason it did not work the first time was because I placed the ICs in the wrong sockets, whoops.

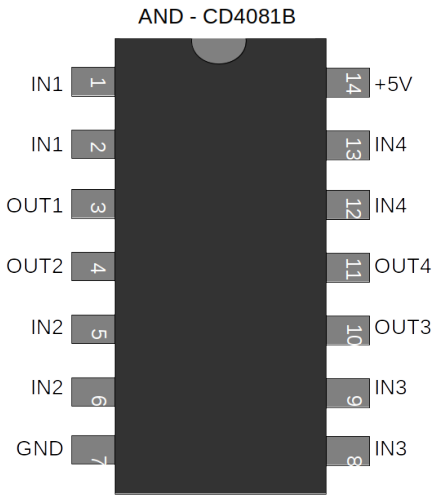
The project works well, and the DIP switches are nice. They are compact and secure, and seem to be holding up well.

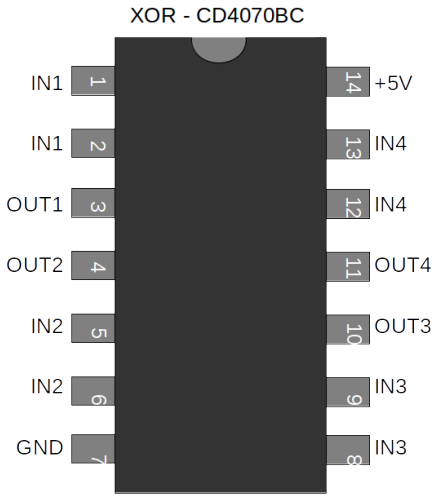
I wish I had organized my circuit/schematic better. Having my wires labeled/numbered helped with prototyping and soldering, but it was very disorganized and only I understood the organization.

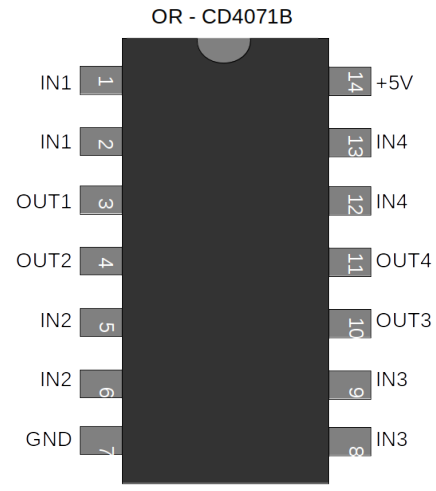
If you would like to challenge yourself and add more to this project (add, ha, pun not intended), you could attach a 7 segment display driver to the output. This way, the output could be displayed in our familiar decimal format and you would not need to know binary to understand the output. Making the input decimal based is a completely different undertaking and much more complex.

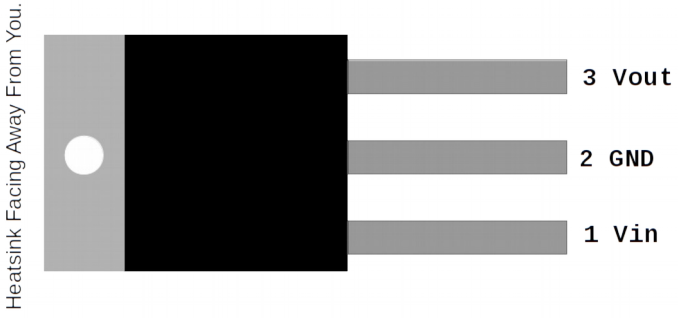
Parts List

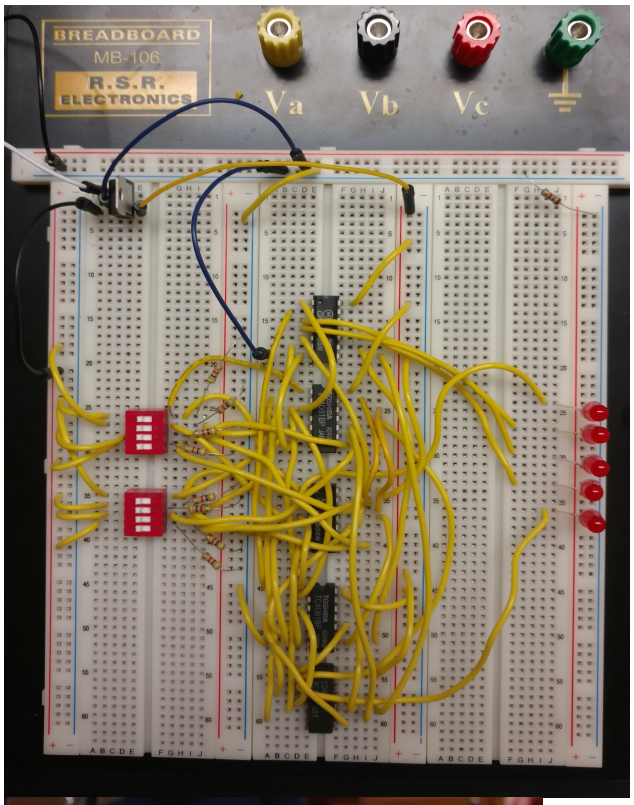
The last page of this article contains a parts list, corresponding to schematic label, and containing name, description, part number, and cost when I built the circuit. Be careful when buying the logic gates. Double check they are AND, OR, or XOR gates and not something fancy/more complex.

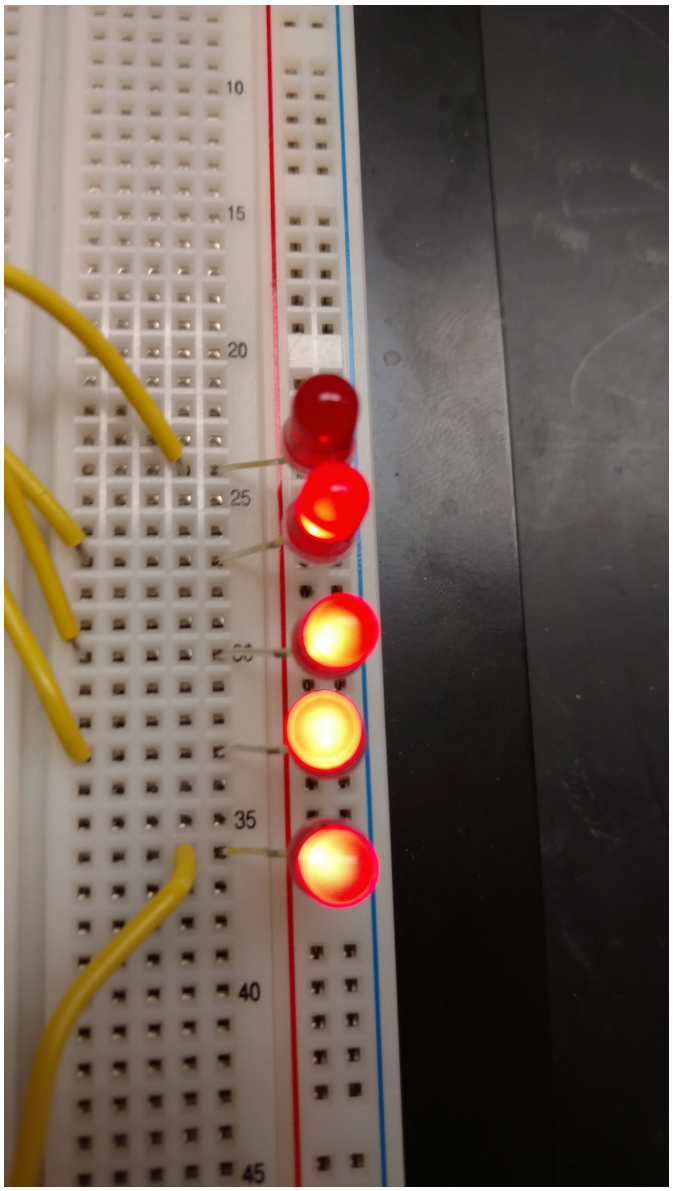









BREADBOARD
MB-106
R.S.R.
ELECTRONICS
Va
Vb
Vc


10
15
20
25
30
35
40
45