

LAB #1 Introduction to Logic Gates

LAB OBJECTIVES

1. Familiarization with the [breadboard](#)
2. Use of switches as inputs and light emitting diodes (LEDs) or LCD (liquid crystal display) as outputs
3. Acquiring design experience in using a truth table to implement a logic circuit
4. Experience in designing a circuit using the 7400 series logic gates
5. Using Boolean algebra to reduce a logic equation (and hardware)
6. Using K-maps as a reduction method for logic equations
7. Learning to create schematics and logic diagrams

LAB PROCEDURE

Lab 1 Part 1 Examine the [breadboard](#). The breadboard can be set up with both switches (for inputs) and Light Emitting Diodes, LEDs (for outputs). This board is used when for testing circuit designs. The circuit designs and programs should be created prior to coming to lab. Investigate the breadboard and determine where the lines of continuity are (what lines of holes are connected to other lines of holes).

Lab 1 Part 2 Identify the [7400 Series TTL gates](#) and look up their data sheets; 7400, 7404, 7408 and 7432 find the [gate pin outs](#) for each chip. Describe in your lab report each of their functions. Also show their logic symbol, use the function in an equation and show the Truth Table for one gate in each of the integrated circuits. This needs to be done for each of the four integrated circuits (ICs) (chips).

Lab 1 Part 3 Gate testing: Test each gate in the [simulator](#) (MultiSim). Verify the truth table of each gate. Create a truth table base on the information gathered in part 2, have a columns for both inputs (count in binary), a column for the output based on gate specification, another for the simulator results, and the last output column for the lab results.

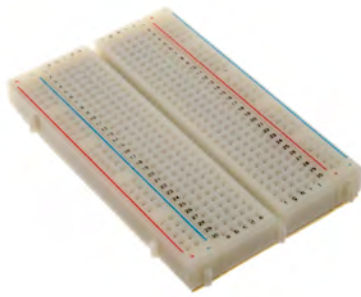
After testing each gate in the simulator, [build up each gate](#) on the breadboard. Use the components from the lab kit. Select the 7404 (a package of six INVERTERS – usually called a hex INVERTER package). Place the 7404 chip across the center line (horizontal line) of your white breadboard and seat the device firmly (push down) on the breadboard. Find the dot that marks Pin 1 (most device have a notch at one end – if so, Pin 1 is to the left of the notch and on the corner of the device.) Viewed from the top, pin numbers always go counter-clockwise. Using RED wire, connect Pin 14 to +5 volts. Using BLACK wire, connect Pin 7 to GROUND. One of the six INVERTERS has its input pin on Pin 1, and its corresponding output on Pin 2. Connect the INVERTER's input to a switch and the output to an LED. Test to see if the function works properly. Compare this output data to the truth table for this device. Go on and test to the other five “gates” as we call them. When you complete the 7404 IC, continue testing the other three Integrated Circuits (ICs). The 7400 is a quad NAND gate, the 7408 is a quad AND gate, and the 7432 is a quad OR gate. Test each gate of each Integrated Circuit (IC). Record your results for your lab report. Since each gate had two inputs, you must use two switches for each gate. You still only need one LED for the one output of each gate.

Lab1 Part 4 Test all [four chips together](#), there should be two inputs and four outputs, there should be an output for each function or gate type. Before building the circuit on the breadboard test the circuit in the simulator (MultiSim).

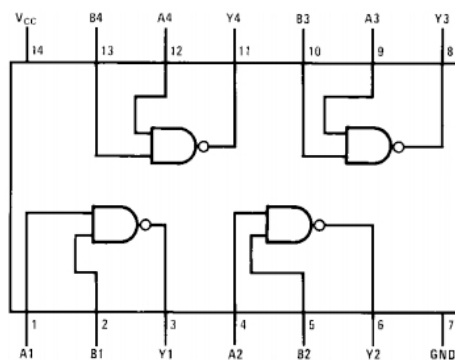
Wire up one LED to each of the gate function's output. ALL the LEDs are connected at the same time. There should be 4 LEDs used: one for the NAND (7400), one for the NOT or Inverter (7404), one for the AND (7408), and one for the OR (7432). That takes care of the outputs. For the inputs you only need two switches that will connect to each gate. {note: the 7404 (inverter) only needs one switch connected to the input}. Your complete the circuit; it will have a total of 4 LEDS, and 2 switches (along with 4 ICs).

[Test and record](#) the functions by observing the 4 outputs when you place the 4 possible input patterns – 00, 01, 10, 11 on the switches. Create a schematic for this Part and put it in your lab report.

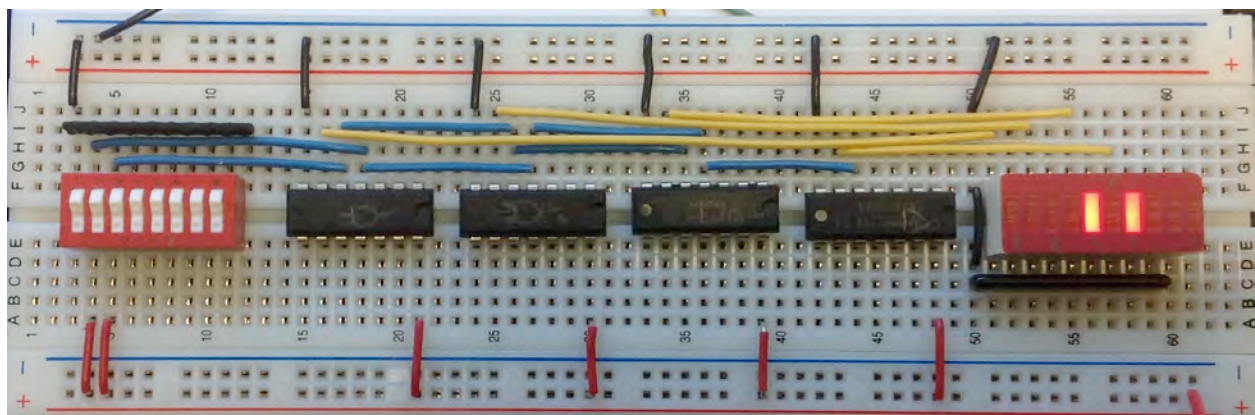
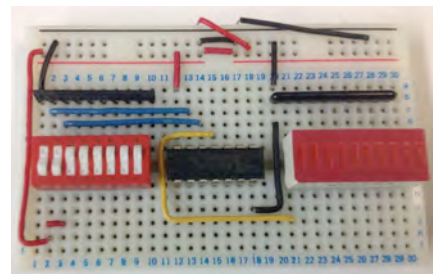
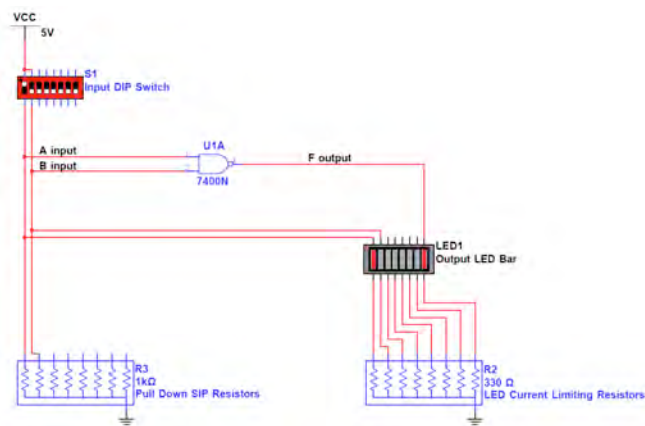
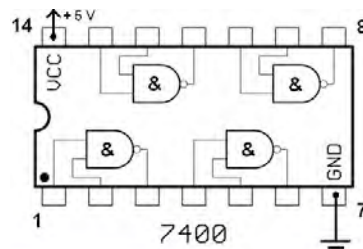
Breadboard example



7400 IC Chip Circuit Diagram showing pin outs

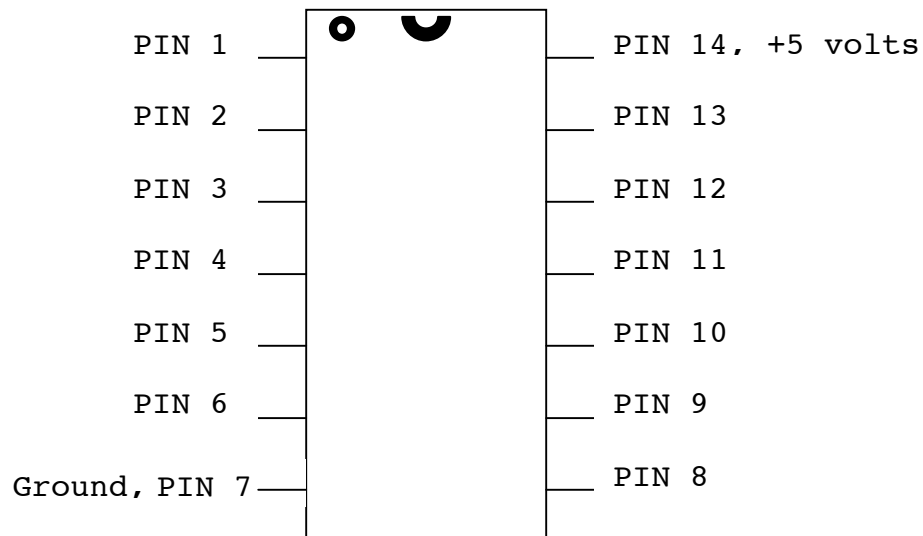


7400 package and pins

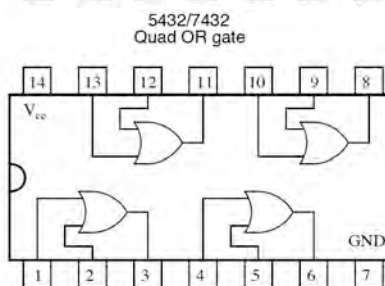
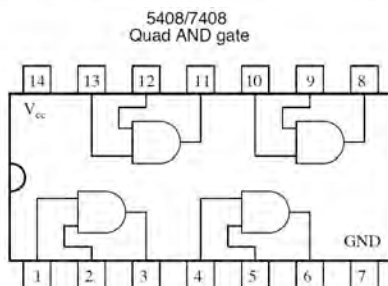
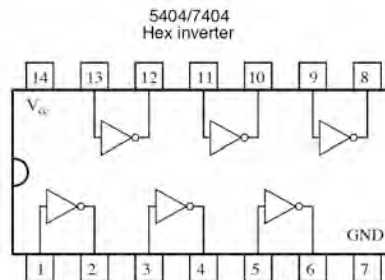
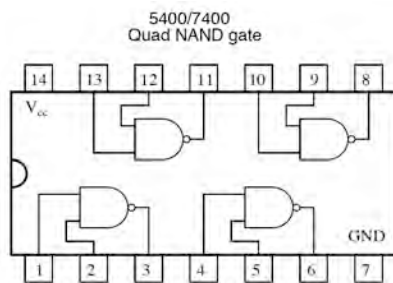
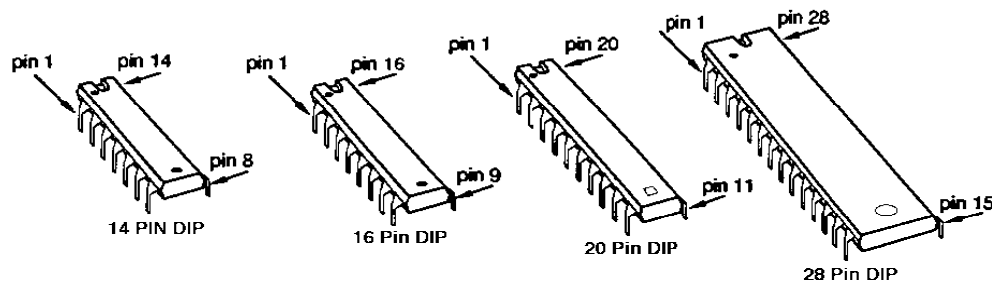


Here is some information about the 7400 Series TTL Integrated Circuits:

Dot near pin 1 or Notch at top center



**Top View of a 14 pin 74xx device
Dual In-Line Package (DIP)**



1. The transistor and inverter

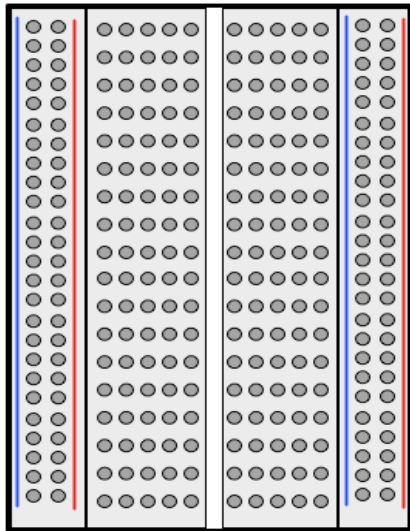


Exhibit 1.2: Breadboard

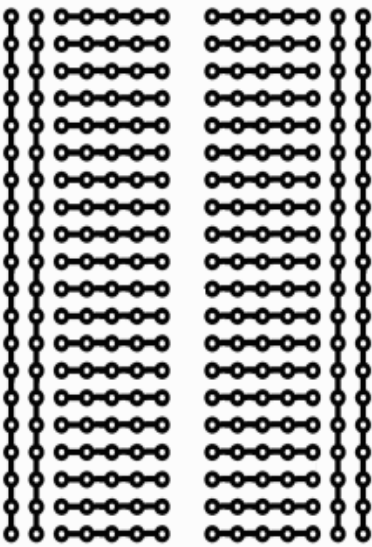


Exhibit 1.3: Common connections

The breadboard

In order to build the circuit, a digital design kit that contains a power supply, switches for input, light emitting diodes (LEDs), and a breadboard will be used. Make sure to follow your instructor's safety instructions when assembling, debugging, and observing your circuit. You may also need other items for your lab such as: logic chips, wire, wire cutters, a transistor, etc. Exhibit 1.2 shows a common breadboard, while Exhibit 1.3 shows how each set of pins are tied together electronically. Exhibit 1.4 shows a fairly complex circuit built on a breadboard. For these labs, the highest voltage used in your designs will be five volts or +5V and the lowest will be 0V or ground.

A few words of caution regarding the use of the breadboard:

- Keep the power off when wiring the circuit.
- Make sure to keep things neat, as you can tell from Exhibit 1.4, it is easy for designs to get complex and as a result become difficult to debug.
- Do not strip more insulation off of the wires used than is necessary. This can cause wires that are logically at different levels to accidentally touch each other. This creates a short circuit.
- Do not push the wires too far into each hole in the breadboard as this can cause two different problems.
 - The wire can be pushed so far that only the insulation of the wire comes into contact with the breadboard, causing an open circuit.
 - Too much wire is pushed into the hole; it curls under and ends up touching another component at a different logical level. This causes a short circuit.
- Use the longer outer rows for for +5V on one side and ground on the other side.
- Wire power to the circuit first using a common color (say red) for +5V and another (black) for ground.
- Always make sure to have a clearly documented circuit diagram before you start wiring the circuit.

An Example Truth Table for sim and lab results

Inputs		Expected Outputs				Simulated Outputs				Actual Outputs			
In1	In2	and	or	nand	not	and	or	nand	not	and	or	nand	not
0	0	0	0	1	1	0	0	1	1	0	0	1	1