Simon Fraser University
School of Mechatronic Systems Engineering
MSE352 Digital Logic and Microcontrollers
Lab 1 Handout

Logic Gates

Objectives

1. Determine experimentally the truth tables for OR, AND, NAND, NOR
2. Wire and operate 2-input AND, NAND, OR, NOR gates.
3. Wire and operate the Inverter.
4. Use the logic gates to implement Boolean functions.

Reference reading

- Fundamentals of Digital Logic with VHDL Design, chapter 2.

Materials Needed

- ICs: 7400,7402,7405,7408,7432
- Other components: DIP switch, 11 resistors

Basic Information

Logic deals with only two normal conditions: logic “1” or logic “0.” These conditions are like the yes or no answers to a question. either an event has occurred (1) or it hasn’t (0); and so on.

In Boolean logic, 1 and 0 represent conditions. In positive logic, 1 is represented by the term HIGH and 0 is represented by the term LOW. In positive logic, the more positive voltage is 1 and the less positive voltage is 0. Thus, for positive TTL logic, a voltage of 2.4 V is 1 and a voltage of 0.4 V is 0.

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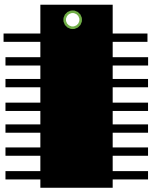
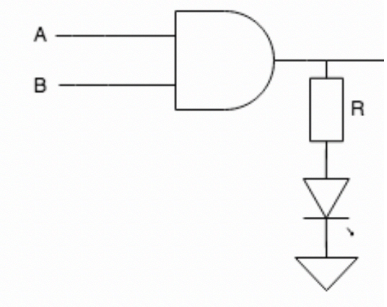
Pre-lab Assignment

1. Read the sections: “Logic Gate”, “Practical TTL Logic Gates” and “Integrated circuit Gates” to familiarize yourself with the theory before doing the Tasks.

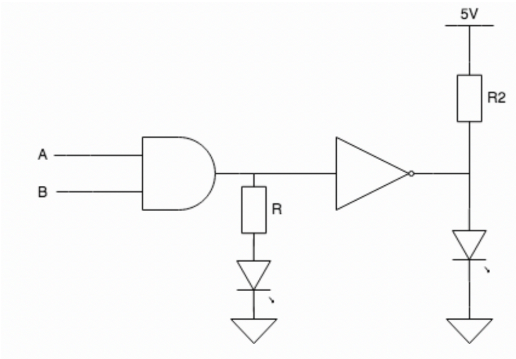
2. Find the datasheet of a 7408 IC (part number SN74LS08) online. Label the pins corresponding to VCC, Ground, Input A, Input B, and Output on this diagram.



3. From the datasheet, find the output high voltage (V_{OH}) of the IC. Next, find the maximum current of a standard LED and voltage drop across it. Use these to calculate an appropriate value for R.



4. What could be a good value for pull-up resistor R2? Your constraints are that it should be able to drive the LED but dissipate as little power as possible.



Check your values for R and R2 with a TA before starting the lab

END OF PRE-LAB

Logic Gate

a. The NOT gate (Inverter)

The inverter (NOT circuit) performs the operation called inversion or complementation. The inverter changes one logic level to the opposite level. In terms of bits it changes a 1 to a 0 and a 0 to a 1. Standard logic symbols for the inverter are shown in Figure 1. Part (a) shows the distinctive shape symbols, and part (b) shows the rectangular outline symbols. In the logic circuits lab, distinctive shape symbols are used.

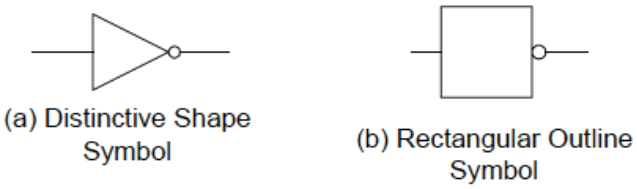


Figure 1: Standard Logic Symbols For The Inverter

b. The AND gate

The AND gate is one of the basic gates from which all logic functions are constructed. The term gate is used to describe a circuit that performs a basic logic operation. The AND gate is composed of two or more inputs and a single output, as indicated by the standard logic symbols in Figure 2. Inputs are on the left, and the output is on the right in each symbol.

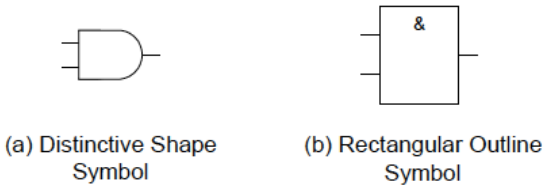


Figure 2: Standard Logic Symbols For The AND Gate Showing Two Symbols

c. The OR gate

An OR gate can have two or more inputs and performs what is known as logical addition.

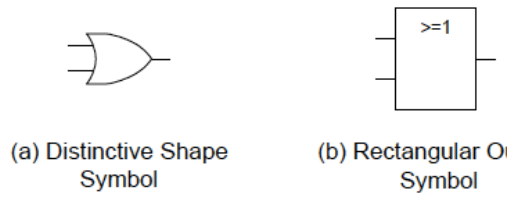


Figure 3: Standard Logic Symbols For The OR Gate Showing Two Symbols

d. The NAND gate

The NAND gate is a popular logic element because it can be used as a universal gate; that is, NAND gates can be used in combination to perform the AND, OR, and inverter operations.

Figure 4: Standard Logic Symbols For The NAND Gate Showing Two Symbols

e. The NOR gate

The NOR gate, like the NAND gate, is a useful logic element because it can also be used as a universal gate; that is, NOR gates can be used in combination to perform AND,OR, and inverter operations.

Figure 5: Standard Logic Symbols For The NOR Gate Showing Two Symbols

f. The EXCLUSIVE-OR gate

The EXCLUSIVE-OR gate are actually formed by a combination of other gates already discussed, because of their fundamental importance in many applications, these gates are treated as basic logic elements with their own unique symbols.

Figure 6: Standard Logic Symbols For The XOR Gate Showing Two Symbols

Practical TTL Logic Gates

A popular type of IC is illustrated in Figure 8. This case style is referred to as a dual inline package (DIP) by IC manufacturers. This particular IC is called a 14-pin DIP IC. Just counterclockwise from the notch on the IC is pin 1. A dot on the top of the DIP IC is another method used to locate pin 1.

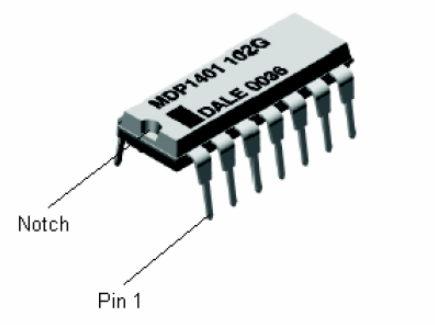


Figure 8

Part Number

Part number is divided into three sections:
- The prefix: the manufacturer's code.
- Core part number: which determine the technology "TTL or CMOS" the device series and the function of a digital IC.
- The trailing letter(s) "the suffix" which is a code used by several manufacturers to designate the DIP.

For example, the Part Number of:

SN 74 LS 08 J

SN: stand for the manufacturer "Texas Instruments"
74: 7400 TTL series
LS: Low schottky type
08: function of a digital IC
J: Ceramic dual in line package

Integrated-circuit Gates

Hex Inverter:
The 74LS05 hex inverter is consisting of six inverters in a 14-pin package.

AND Gates:
The 74LS08 has four 2-input AND gates (it is called a quad 2-input AND).

NAND Gates:
The 74LS00 has four 2-input gates.

OR Gates:
The 74LS32 has four 2-input OR gates.

NOR Gates:
74LS02 has four 2-input gates.

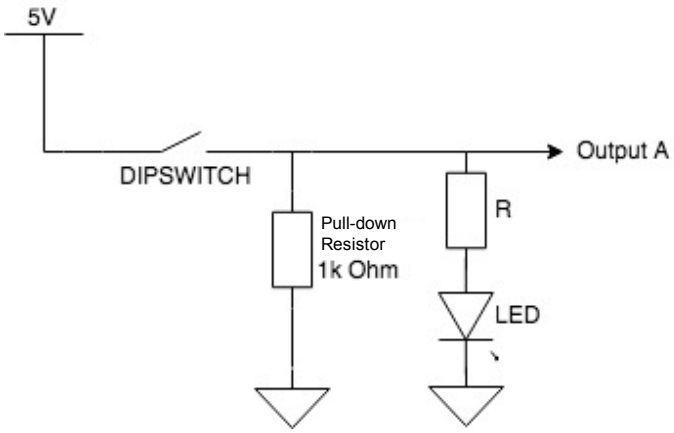
Exclusive-OR Gates:
74LS86 has four 2-input XOR gates.

Tasks

Task 1

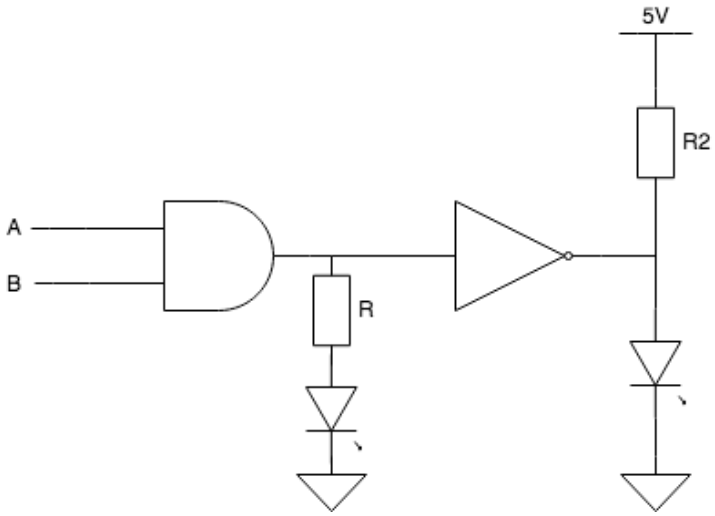
Using a dipswitch build the circuit below to obtain the output A. The LED indicates whether A is "ON" or "OFF". Repeat the exact same circuit to obtain an output B. A and B will be used as inputs to the logic gates.

The value of R and R2 in the following sections should have been calculated in the pre-lab.



Task 2

Using the 74LS08 IC and the 74LS05 IC, build the circuit below. Refer to the datasheets for pin allocation.

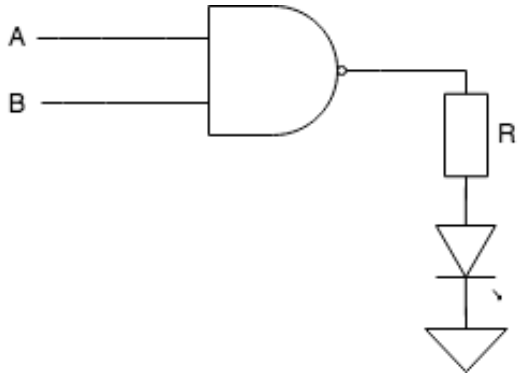


Task 3

Repeat Task 2 but swap the AND gate for an OR gate. You may use the same circuit as Task 2 and simply swap the IC, however get the TA to approve you Task 2 first.

Task 4

Build the circuit below using a NAND gate.



Task 5

Repeat Task 4, swap the NAND gate for a NOR gate. You may use the same circuit as Task 4 and simply swap the IC, however get the TA to approve you Task 4 first.

Task 6

Check that all your circuits agree with the truth table for that component.

Ask a TA to check your results.

END OF LAB