EER-018 Introduction to Digital Computers
LABORATORY 1
Logic Gates and Circuits

Objectives:

1.To introduce the lab equipment: protoboard, dual in-line package (DIP) integrated circuits, power supply, switches and light emitting diodes (LED's).

2.To learn basic wiring and testing techniques for switches, integrated circuits and LEDs.
3.To understand how switches can be configured to implement logic gates.
4.To implement and analyze logic circuits with TTL gates.

Equipment:

1 Lab Setup:

- Protoboard
- Power Supply
- 2 Single-Pole, Single-Throw (SPST)
- 2 Single-Pole, Double-Throw (SPDT) Switches,
- wires, LED's, resistors

TTL chips:

- 7404 Hex INVERTER (NOT gate)
- 7432 Quad OR (2-input OR gate)
- 7408 Quad AND (2-input AND gate)

Introduction

Two Types of Switches

Single-Pole, Single-Throw (SPST):

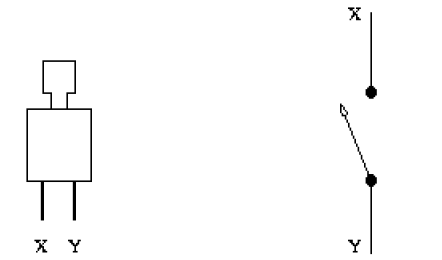


Figure 1. SPST Switch

This is the simplest form of switch. It is sometimes called a "momentary contact switch" in the pushbutton form that we use in this lab. The switch is normally-open, meaning that an open circuit exists between X and Y when the button is **not** depressed (off). When the button is depressed (on), a short circuit exists between X and Y.

Single-Pole, Double-Throw (SPDT):

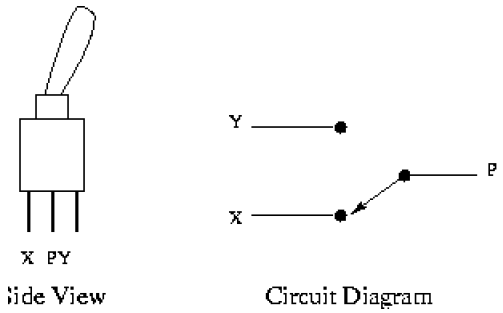
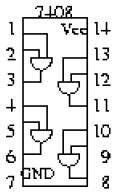


Figure 2. SPDT Switch

This switch has three terminals: a Pole (P), and X and Y. It is sometimes called a "toggle switch". When the switch is "thrown" to the right, as shown, pins P and X are connected as shown in the circuit diagram. When it is thrown to the left, pins P and Y are connected.

Integrated Circuits

The small integrated circuits used in this lab implement basic logic gates. Some of the pins are inputs to the gates, others are outputs, and two of them are the connectors for power (Vcc or +5V) and ground (0V).



7408 Quad AND Gate

Figure 3. 7408 Integrated Circuit Diagram

In the 7408 AND gate chip shown above, pin 14 is where you will apply +5V, and pin 7 will be connected to GND.

Light Emitting Diodes

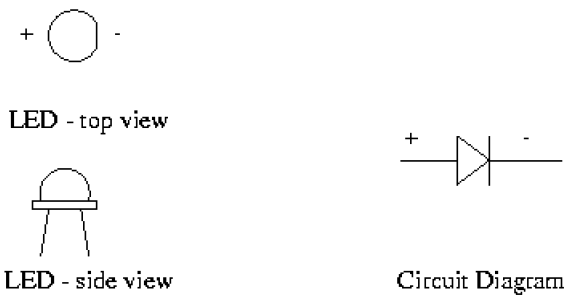
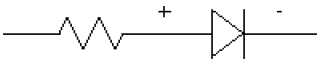


Figure 4. LEDs

Light Emitting Diodes (LEDs) are two-terminal devices that light up (on) when current passes through them. They are often used to indicate logic levels in logic circuits (on = 1, off = 0). If the voltage on the positive side is high, and the voltage on the negative side is low, current will flow and they will light up. Looking at the LED from the top, the negative is indicated by the flat edge in the plastic case.

Usually a resistor is connected in series with the LED (shown below) so that the voltage across the LED is not too high and the LED does not burn out. The resistor value should be between 100 and 1000 Ohms.



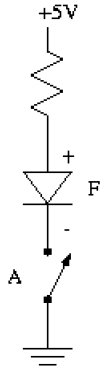
LED in Series with Resistor

Figure 5.

Prelab

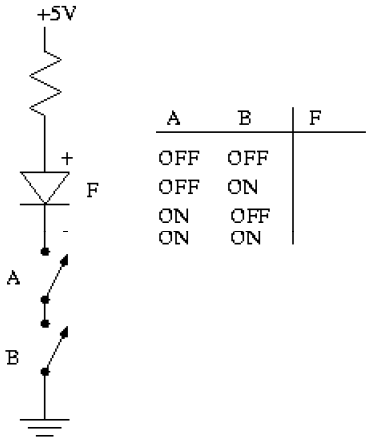
Part 1 - Analysis

Below are some circuits that are constructed from the elements shown above. Analyze each one and determine whether the LED (labeled F) will be ON (lighted) or OFF for the switch positions given. For SPST switches, ON=closed, OFF=open. For SPDT switches, ON=+5, OFF=GND. The first one is done for you.

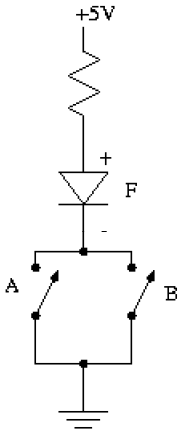


A	F
(closed) ON	ON
(open) OFF	OFF

Figure 6.

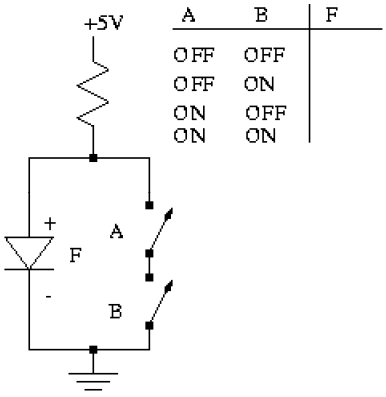


A	B	F
OFF	OFF	
OFF	ON	
ON	OFF	
ON	ON	

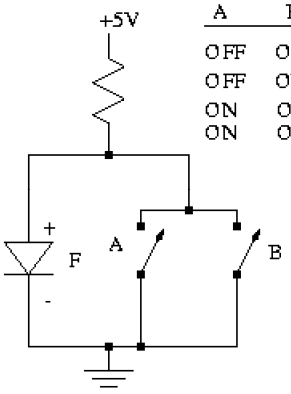


A	B	F
OFF	OFF	
OFF	ON	
ON	OFF	
ON	ON	

Figure 7.

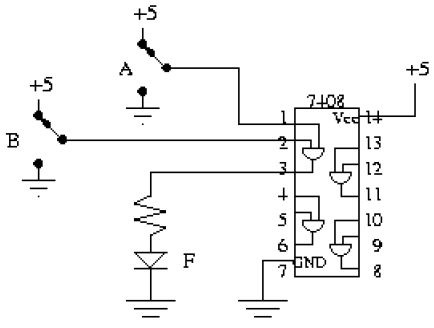


A	B	F
OFF	OFF	
OFF	ON	
ON	OFF	
ON	ON	



A	B	F
OFF	OFF	
OFF	ON	
ON	OFF	
ON	ON	

Figure 8.



A	B	F
OFF	OFF	
OFF	ON	
ON	OFF	
ON	ON	

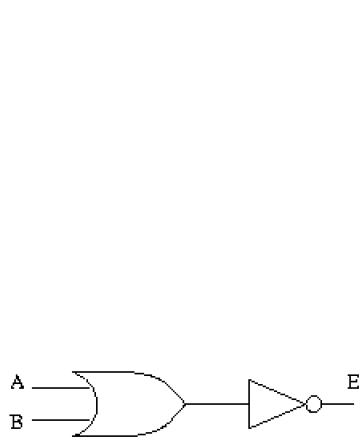
Figure 9.

Part 2 - Implementation

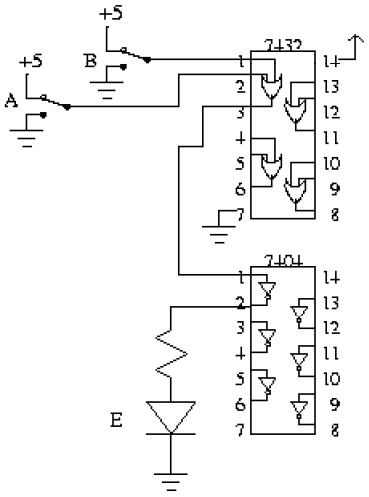
If we need to implement a switching function such as:

$$E=(A+B)'$$

We would first make a circuit of gates (logic diagram) as shown below on the left, and then a pin



Logic Diagram



Pin Diagram

diagram as shown on the right.

Figure 10. Logic and Pin Diagrams for E = (A + B)'

Draw the logic and pin diagrams to implement the following functions:

$$F = A'B + AB'$$

$$G = (A + B)(A' + B')$$

Use the 7408, 7404 and 7432 integrated circuits.

Procedure

Part 1: Analysis

Build each of the circuits given in Part 1 of the prelab. Prepare new tables for each circuit and record the results

that you see. Compare them to the results you wrote in the prelab. Assuming that ON=1 and OFF=0, write the name of the logic gate that is implemented by each circuit.

Part 2: Implementation

Implement each of the functions F and G from the pin diagrams in Part 2 of your prelab. Use truth tables to record the results when you provide the circuit with all possible combinations of switches A and B.

Report

Follow the lab report guidelines. Include all your Prelab and experimental results and tables along with discussions of each result and the answers to the following related questions:

1. Find the logic diagram that corresponds to the pin diagram in Figure 11..

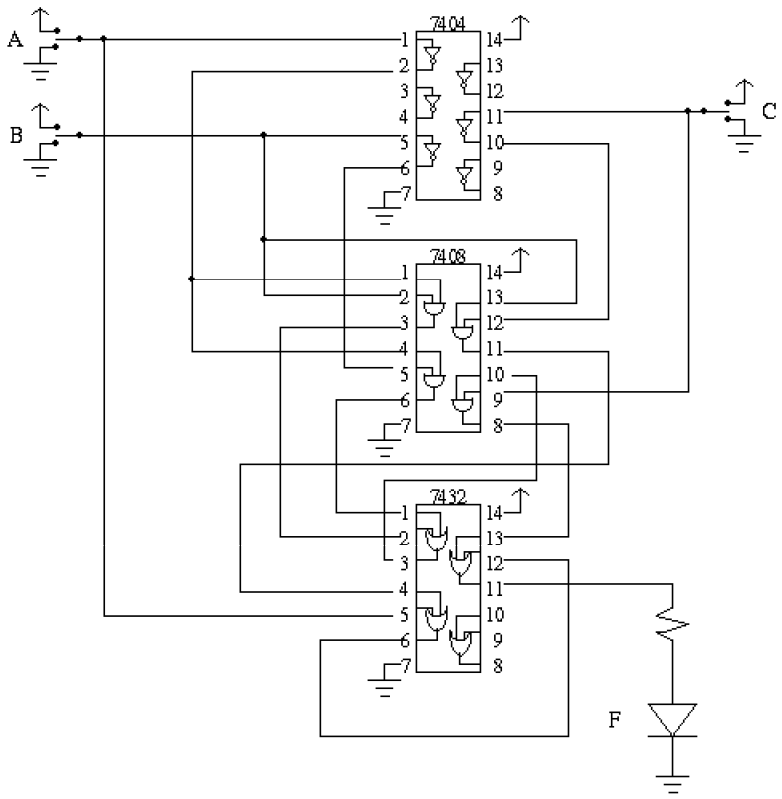


Figure 11. Some Circuit

2. Find the equation for function F in Figure 11. Write this equation in Sum of Product form. Can you simplify this function so that only one gate type is required? Give the equation.

3. Can the equation F, in any of the forms you found in question 2, be implemented with switches and an LED? If so, provide a circuit diagram.