Experiment 1: (Part A)
Prototyping of Logic Circuits using Discrete Components

Objectives

- Introduction to ICs, logic families, 74xx, 54xx
- Learn how to read Data sheets, IC diagrams etc.
- Partial familiarization with bread board, pins, switches, LEDs and power supply connections.
- Implementation of a simple combinational circuit using ICs

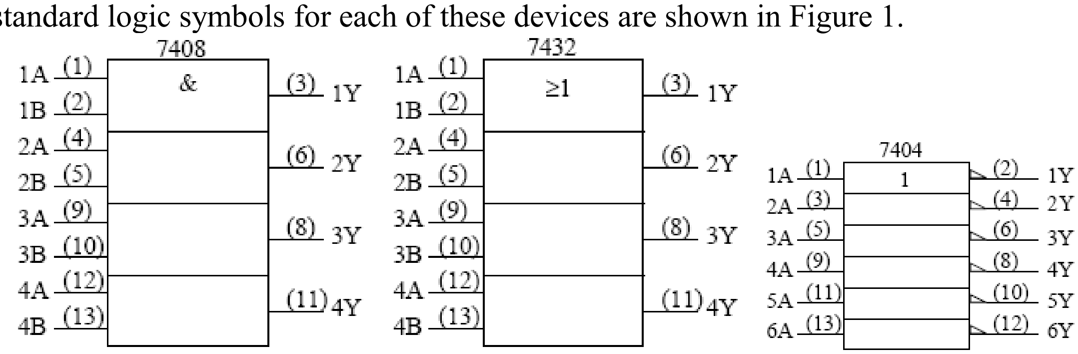
Material

- ICs – 7400, 7432, 7408 etc
- Wire Stripper
- Prototyping board with power and ground connections

Logic Gates and Integrated Circuits

In COE 203, you are required to work on digital circuits. Digital circuits are hardware components that are implemented using transistors and interconnections in complex semiconductor devices called *integrated-circuits*. Digital circuits work in binary logic domain which uses two discrete values, **TRUE** (High) and **FALSE (Low)**. We can also refer to these values as **1(High)** and **0 (Low)**.

Logic-Gates are basic building blocks of digital circuits. Using these building blocks, complex functions or larger digital circuits can be built. Examples of the basic logic gates are **AND, OR, NOT, NAND and NOR**. A complex gate such as an **XOR** gate can be built out of these basic gates. Each logic gate is actually implemented in part of an integrated circuit (IC), with each gate made using several transistors. For the most part we do not need to concern ourselves with the actual circuitry inside each gate, only the interconnections between individual gates. Usually each IC package contains several individual gates. The 7408 chip implements 4 two input AND gates and is commonly referred to as a “Quad two input AND” chip. Similarly the 7432 chip is a “Quad 2 input OR” chip while the 7404 chip is a “Hex Inverter” since it contains 6 inverters. The IEEE standard logic symbols for each of these devices are shown in Figure 1.



Y=A.B   Y=A+B   Y=A’

Figure 1: Standard Logic Symbols

Each of the chips in Figure 1 is available in 14 pin Dual-In-Line packages or DIPs. In a popular logic family called TTL (Transistor-Transistor Logic), the low logic level is assigned to 0V and the high logic level is assigned to 5V. Each IC or chip has an ID number that can be referenced in IC Data Book. From the book, you can get the pin configuration of that chip. The pin numbers assigned to each logic signal are shown inside brackets in the figure. The pins are numbered as shown in Figure 2. Pin 1 is usually identified as the pin to the left of an indentation or cutout in one end of the chip that is visible when the chip is viewed from the top. Occasionally, it is also identified by a printed or indented dot placed just next to it.

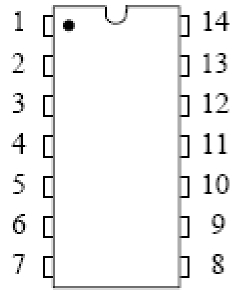


Figure 2: Identifying Pin 1

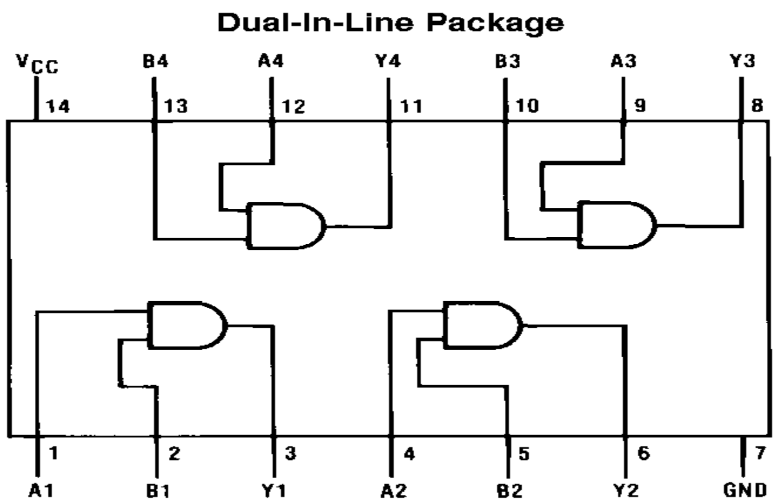


Figure 3: A Quad 2-input AND gate chip

Figure 3, shows an IC which contains four 2-input AND gates. You will notice that pins 7 and 14 show no connections. In 14 pin DIP packages, pin 7 is usually connected to ground (Gnd), and pin 14 is usually connected to the power supply (Vdd). These connections must be made or the chip will not work. Take care not to connect pin 7 to power and pin 14 to ground, or to connect the outputs of two or more gates together. In complex ICs more than one pin can be dedicated for power (VDD) as well as ground. In the simpler gates that we will be using in this experiment, the ICs require only one pin for power (VDD) and another for ground (GND). The power supply (VDD) voltage is typically +5Volts, 3.3 Volts or 2.5 Volts. The ground is typically connected to 0 Volts.

The Prototyping Board

The circuit is constructed on the breadboard section of the prototyping board. A breadboard is used to rapidly create an experimental or prototype circuit. It consists of an array of holes in which wires or component leads can easily be inserted. Rows of five or six holes are electronically connected to form a single node as shown in Figure 4. When a component lead is inserted into one of the holes, anything inserted into any of the remaining four holes will be connected to that lead. Nodes can be connected to each other using wires with 1/4” of insulation stripped from both ends. The holes are spaced 100 mms(.1 inch) apart, which is the standard spacing of the pins on a DIP package. The breadboard has a groove down the center separating one side from the other. When inserting a chip into the breadboard, make sure it fits into the central groove as shown in the figure; otherwise the pins on opposite sides of the chip will be connected. Press the chip down until it touches the surface of the breadboard. Devices inserted on the breadboard can be connected to components on the prototyping board by using wires between the device and the J1 connector.

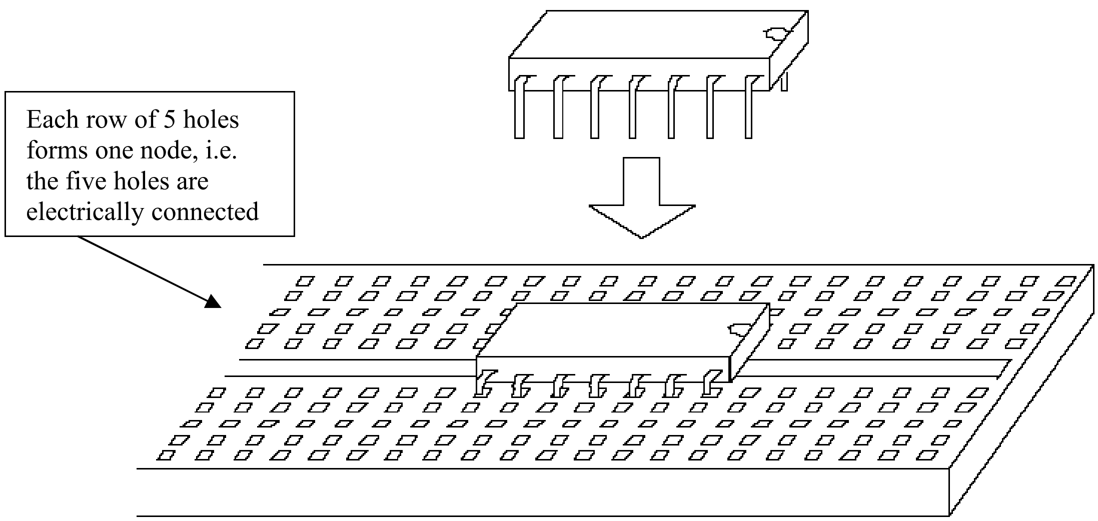


Figure 4: Placing DIP devices on a breadboard

Lab Procedure

In this lab, you will have a chance to test the functionality of some logic gates.

1. Check the datasheet in the lab and find the part number of a chip that implements a logic function (AND, NAND, OR, XOR, etc…). Choose at least two.
2. Pick the chips from the shelf and test them using the IC tester.
3. Place the chips on the bread board carefully and connect Vcc and GND.
4. Use two switches and an LED to verify the functionality of the selected gates.

Lab Report

- The report is required when part B is completed.

Data Sheets

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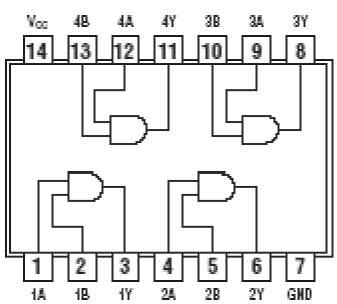
QUADRUPLE 2-INPUT POSITIVE-AND GATES

positive logic:

$Y = A \cdot B$



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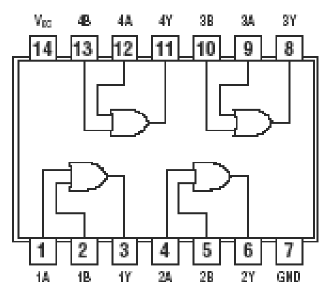
QUADRUPLE 2-INPUT POSITIVE OR GATES

positive logic:

$Y = A + B$



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QUADRUPLE 2-INPUT EXCLUSIVE-OR GATES

positive logic:

$Y = A \oplus B$ or $Y = \overline{A}B + \overline{A}B$