

Experiment 1

Introduction To Logic Design Lab : AND, OR, NOT NAND And NOR GATES

Objective

The purpose of this laboratory is to introduce the use and features of the logic lab unit (ETS-7000 DIGITAL ANALOG TRAINING SYSTEM) and to introduce the TTL integrated circuit AND, OR and NOT (inverter) gates.

References

Donald P. Leach : Experimental in Digital Principles, 3rd Edition
Malvino/Leach : Digital Principles and Applications
Bartee : Digital Computer Fundamentals, 6th Edition
John F. Wakerley : Digital Design , Principle and Practice, 2nd Edition
Ronald A Reis : Digital Electronics Through Project Analysis, 1st Edition

Component

1-74LS04 hex-inverter (NOT) TTL IC
1-74LS08 Quad-two input AND TTL IC
1-74LS32 Quad-two input OR TTL IC

About the ETS- 7000

The ETS-7000 DIGITAL ANALOG TRAINING SYSTEM is equipped with all features needed for digital experiments. It has the following specifications :

- 1) Solderless breadboard
 - provided with 2712 tie points. Used to connect the different leads of the digital IC's and other components without soldering.
- 2) DC Power Supply :
 - fixed +5 VDC , 1 A, -5 VDC , 300 mA
 - Variable 0V to + 15 VDC, 500 mA, 0 V to -15 VDC, 500 mA
- 3) Potentiometers:
 - VR1-1 K
 - VR2 -100K
- 4) Function Generator can generate the following functions:
 - sine wave output [Amplitude 0-8 V_{pp}, Frequency 1- 1000 Hz]
 - square wave output [Amplitude 0-8 V_{pp}, Frequency 1- 1000 Hz]
 - triangle wave output [Amplitude 0-6 V_{pp}, Frequency 1- 1000 Hz]
- 5) 8 bit data switches : used to generate either high or low level
- 6) 8 bit LED display
- 7) Two Pulses Switches With 2 Sets Of Outputs A', A ; B' , B
- 8) Speaker : To Be Used For Load.

Proⁱcedure

- 1) Connect the unit to an appropriate power source and turn it ON.
- 2) Wire one data switch connector (SW0-SW7) to one on the LED (light emitting diode) connectors (L0-L7)
- 3) Verify HIGH and LOW operations of the data switch by first setting the data switch to LOW and noting the indicator

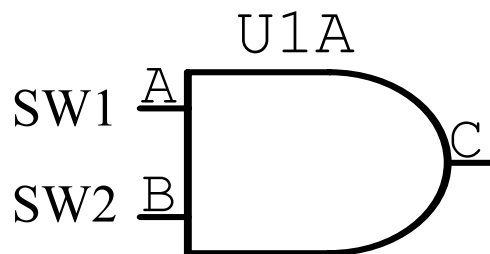
illumination level, then setting the data switch to HIGH and noting the indicator illumination level. The LED's are on for a HIGH logic level and off for the LOW level.

- 4) Repeat step 3 for all the switches and LED's.
- 5) Wire 1 Hz oscillator output to one of the LED's. note the output indication.
- 6) Wire a 100 kHz output connector to one of the LED's. How does this output appears with respect to :
 - a) that of the 1 Hz oscillator ?
 - b) a normally lit LED ?
- 7) Set the variable power supply to minimum (turn the potentiometer counterclockwise), measure the voltage using a voltmeter. Now turn the potentiometer clockwise slowly letting the heads of your voltmeter connected to the output voltage. You will notice that the reading of your voltmeter increases as you rotate the potentiometer clockwise and decreases as you rotates counterclockwise.
- 8) Measure the voltage at the fixed output voltage. You should get +5VDC. This voltage is used for the digital experiment.

Part A :

AND Gate Familiarization

1. Insert a 7408 quad (4 in 1 package) two inputs AND gate IC into the logic Lab breadboard
2. Wire one of the AND gates as shown below. Refer to the datasheet for further IC information.

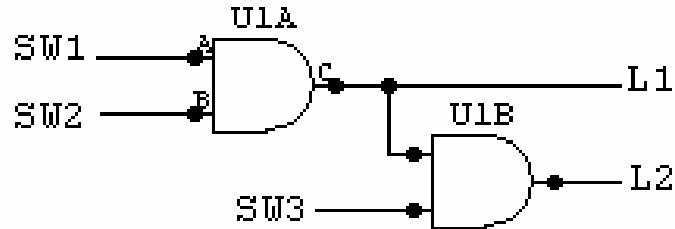


3. Experimentally verify that your AND gate is working properly by listing all input combination s and resulting outputs in truth table form.

LOW switch state = 0, HIGH switch state = 1

- **AND Dynamic propagation**

1. With the same network configuration as above, set data switch SW1 to HIGH
2. Connect Pin 2 of the IC to 1 Hz oscillator output instead of SW2
3. Construct the two level 3-input AND gate which implements the function $F = ABC$ as shown



- Experimentally verify that the 3-input gate working properly by determining its truth table. List both L1 and L2 states for the various input combinations in truth table.

Part B : OR Gate Familiarization

- Insert a quad 2-input Or gate into the breadboard.
- Wire one of the OR gates such that its inputs can be entered from SW1 and SW2 and such that output state will be displayed on L1.
- Experimentally verify that this OR gate is working properly as you have done previously by determining its truth table.
- Construct a 3 -pin Or gate to implement the function $F=A+B+C$. Experimentally verify that this network is working properly as you did for the 3-input AND gate network above.

Part C : NOT Gate Familiarization

- Insert a Hex inverter (6 in 1 package) into the breadboard.
- Connect the input of one inverter to a switch and the output to a LED and verify the operation of the gate using a truth table.

Part D : A Network of Gates

Realizing the following Boolean function using a network of the above gates

$$F=(A+B)C + A'B + A'C'$$

Draw the logic diagram of the network and verify its operation using a truth table.

Part E : Universality of NAND and NOR Gates

Objectives:

To demonstrate the operation and characteristics of NAND and NOR gates and to show how any of these gates can be used to perform any of the three basic logic functions.

Procedure :

- Verify the functionality of the NAND and NOR gates by developing their truth table .
- How can you replace a NOT function by using NAND gate.
- How can you replace an AND function by using multiple NAND

gates.

4. How can you replace the NOT and OR functions by using NOR gates.
5. Draw the pin diagrams for the above logic circuits.
