數位系統實驗

Thu 9:00 am – 12:00 am

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Information Engineering

Digital Integrated Circuit

Outline

- Video preview for 數位系統簡介+邏輯閘+布林代數
- Lab I--Boolean Algebra
- Lab II--XOR
- Lab III--Half Adder
- Lab IV(practice)--Comparator

Three representations for a circuit

1. Boolean Algebra

$F_1 = x + y'z$

2. Truth Table

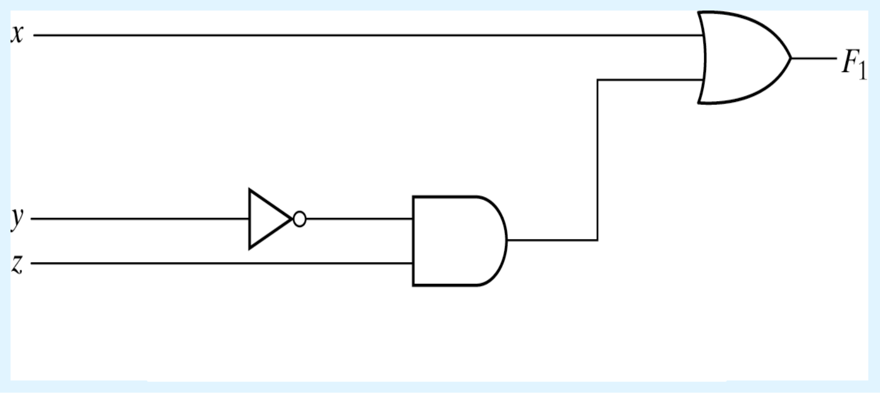
真值表

n input variables ➔ 2^n combinations

Inputs

x	y	z	y'	$y'z$	F_1
0	0	0	1	0	0
0	0	1	1	1	1
0	1	0	0	0	0
0	1	1	0	0	0
1	0	0	1	0	1
1	0	1	1	1	1
1	1	0	0	0	1
1	1	1	0	0	1

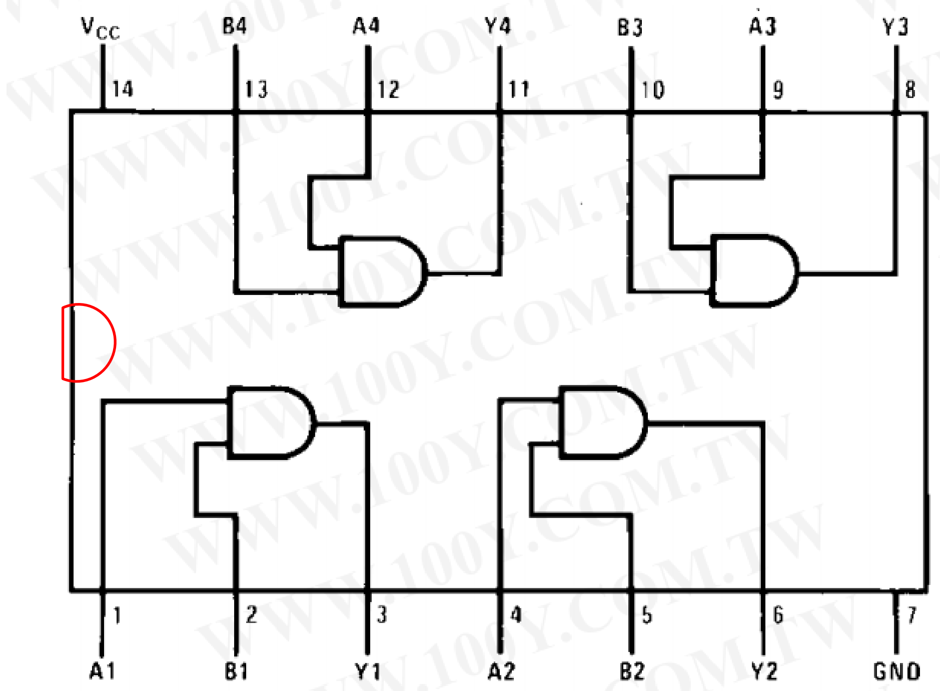
3. Circuit Diagram



74LS08

AND gate

Connection Diagram



Function Table

Y = AB

Inputs		Output
A	B	Y
L	L	L
L	H	L
H	L	L
H	H	H

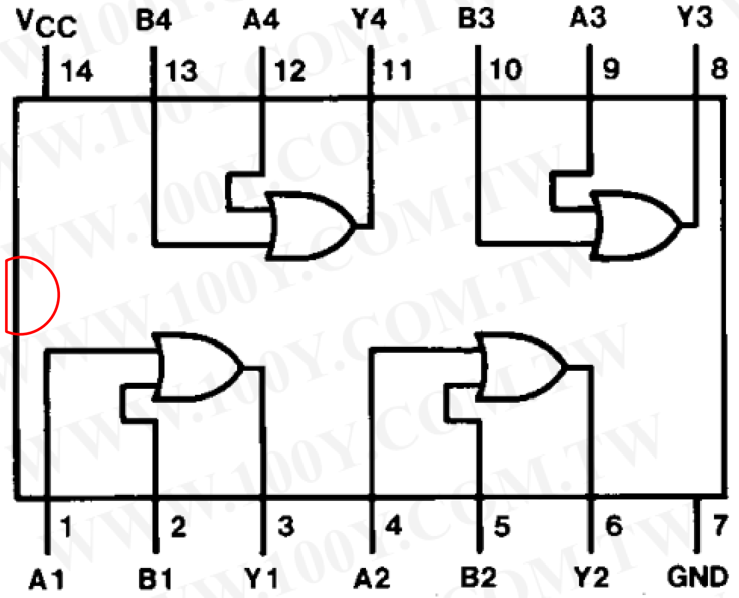
H = HIGH Logic Level
L = LOW Logic Level

Boolean Algebra *F=xy*

74LS32

OR gate

Connection Diagram



Function Table

Y = A + B

Inputs		Output
A	B	Y
L	L	L
L	H	H
H	L	H
H	H	H

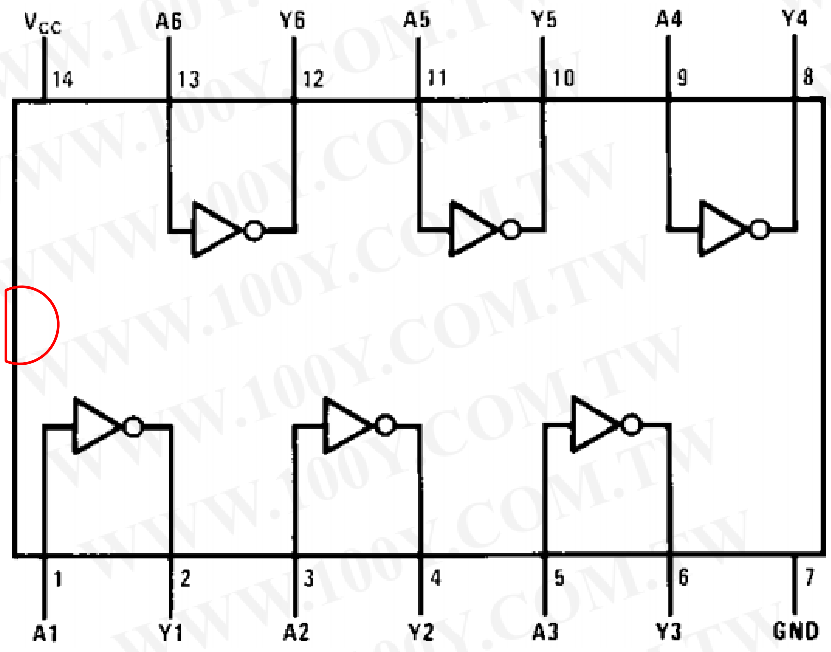
H = HIGH Logic Level
L = LOW Logic Level

Boolean Algebra *F=x+y*

74LS04

NOT gate

Connection Diagram



Function Table

$Y = \overline{A}$

Input	Output
A	**Y**
L	H
H	L

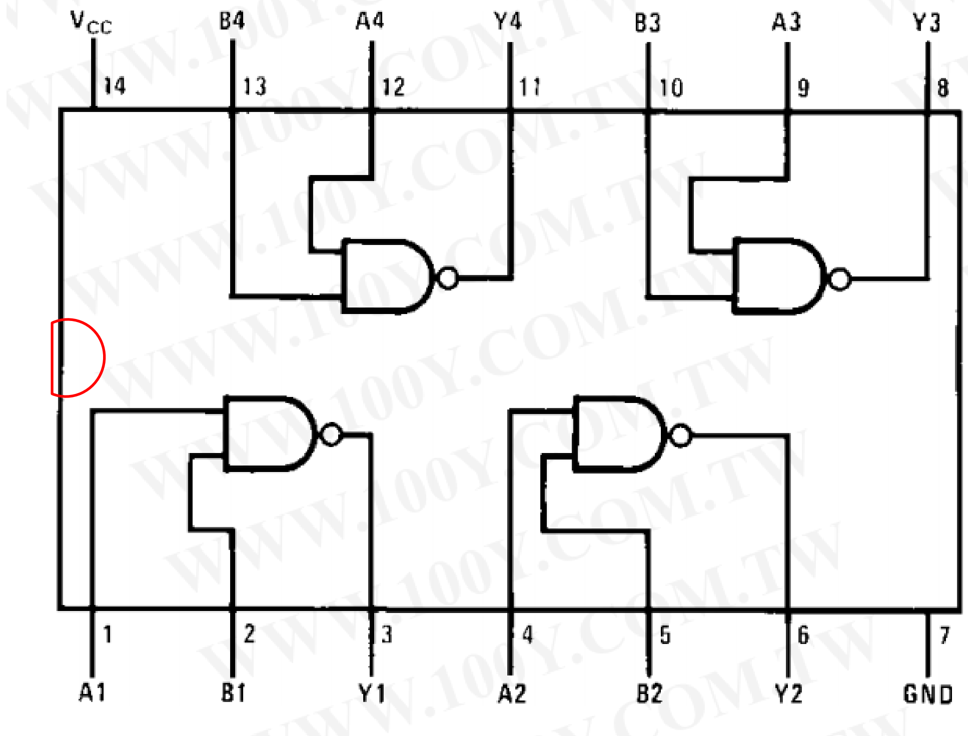
H = HIGH Logic Level
L = LOW Logic Level

Boolean Algebra *F=x'*

74LS00

NAND gate   Not - AND

Connection Diagram



Function Table

$Y = \overline{AB}$

Inputs		Output
A	B	Y
L	L	H
L	H	H
H	L	H
H	H	L

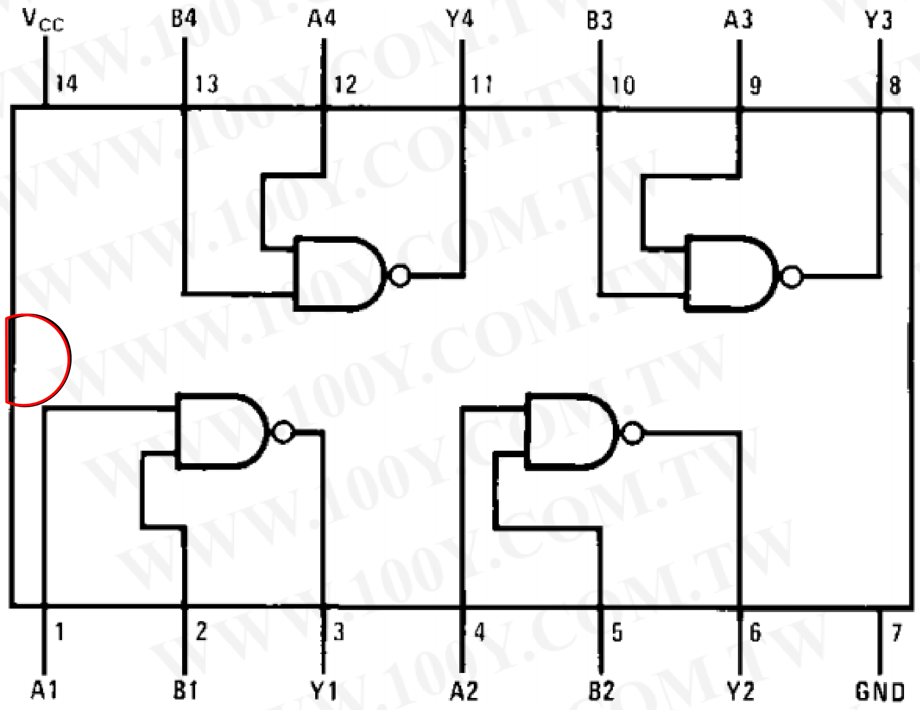
H = HIGH Logic Level
L = LOW Logic Level

Boolean Algebra   *F=(xy)’*

74LS00

NAND gate

Connection Diagram



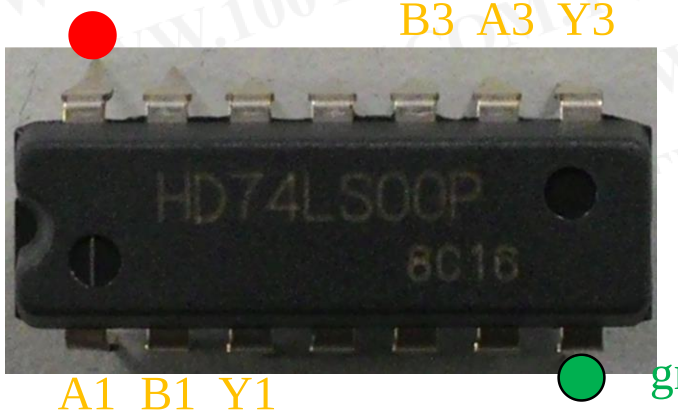
Function Table

$Y = \overline{AB}$

Inputs		Output
A	B	Y
L	L	H
L	H	H
H	L	H
H	H	L

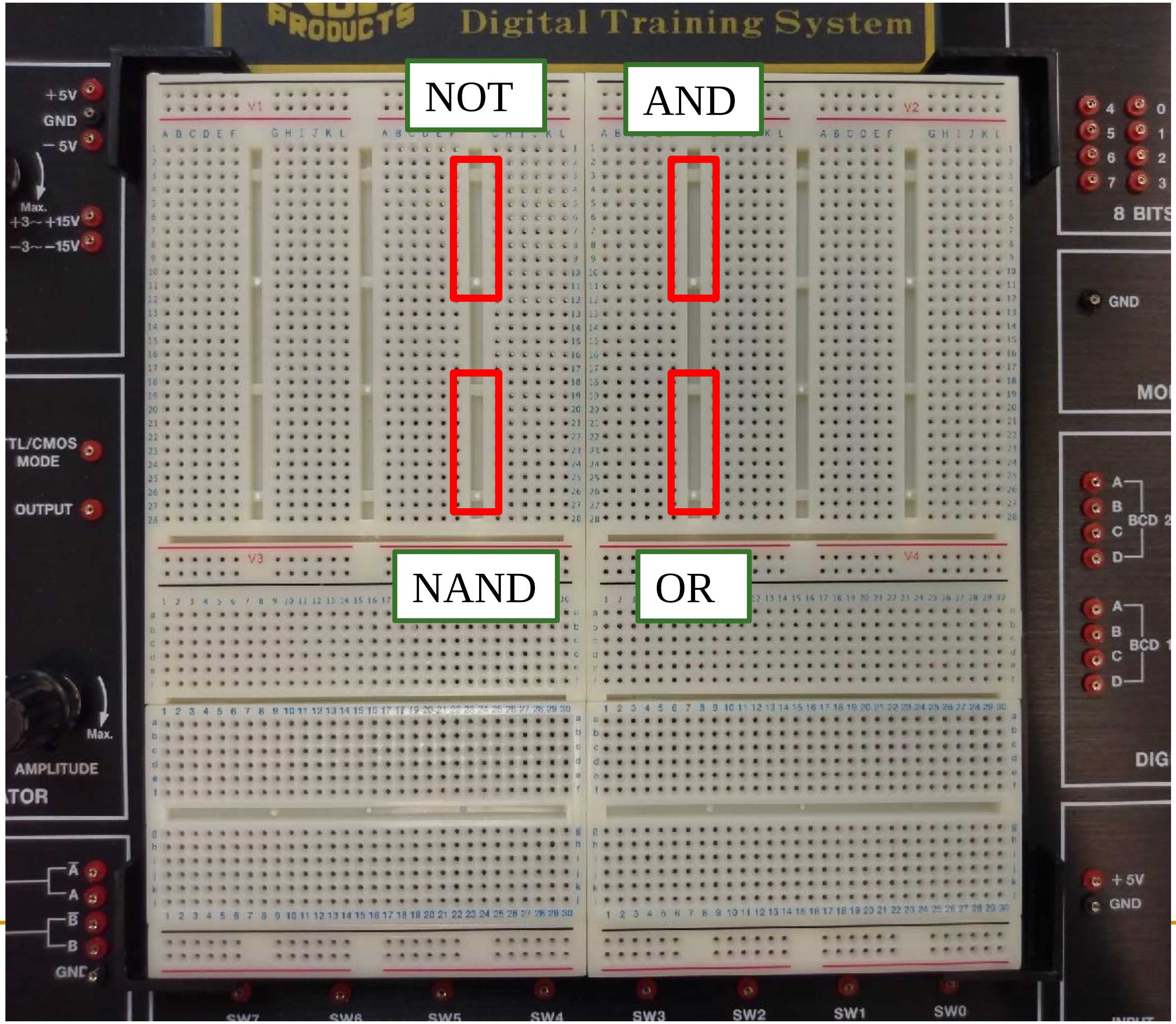
H = HIGH Logic Level

L = LOW Logic Level



The Solderless Breadboard in CSIE NCKU

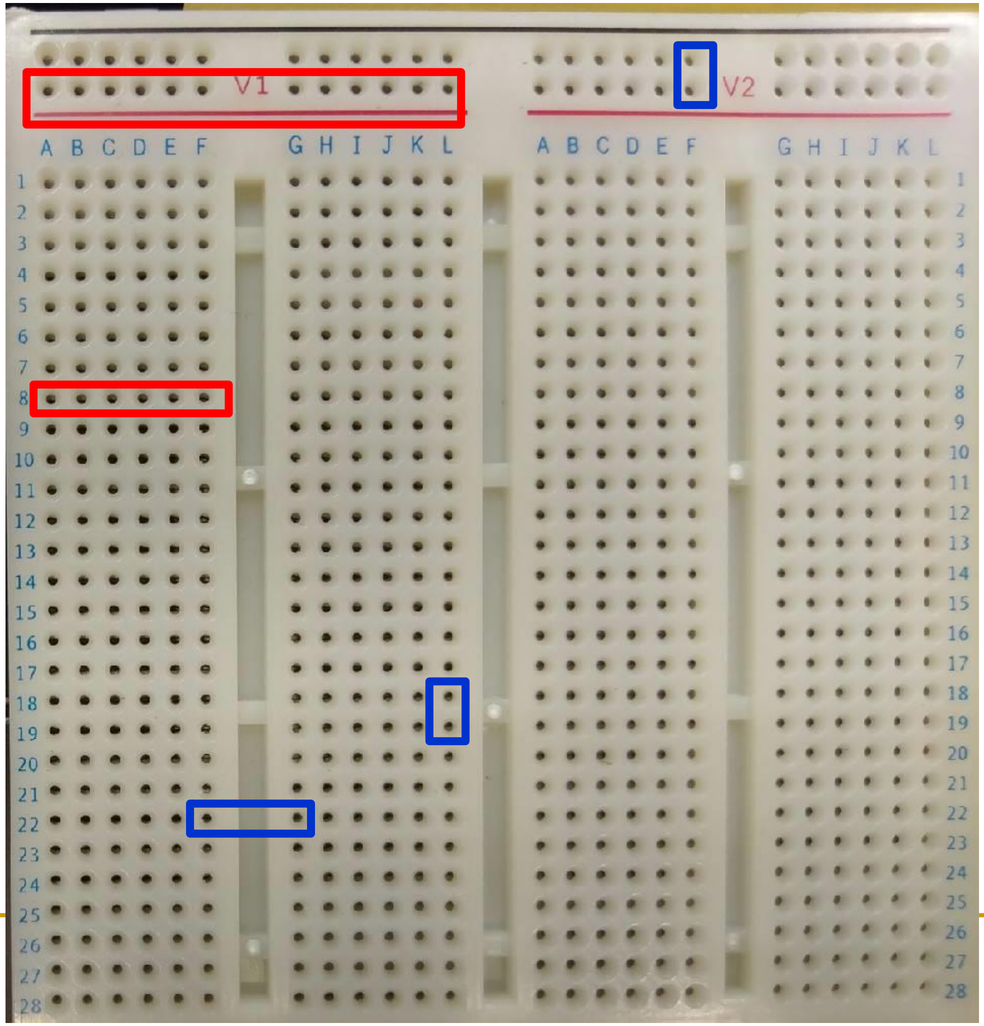
- **Top view of the breadboard**

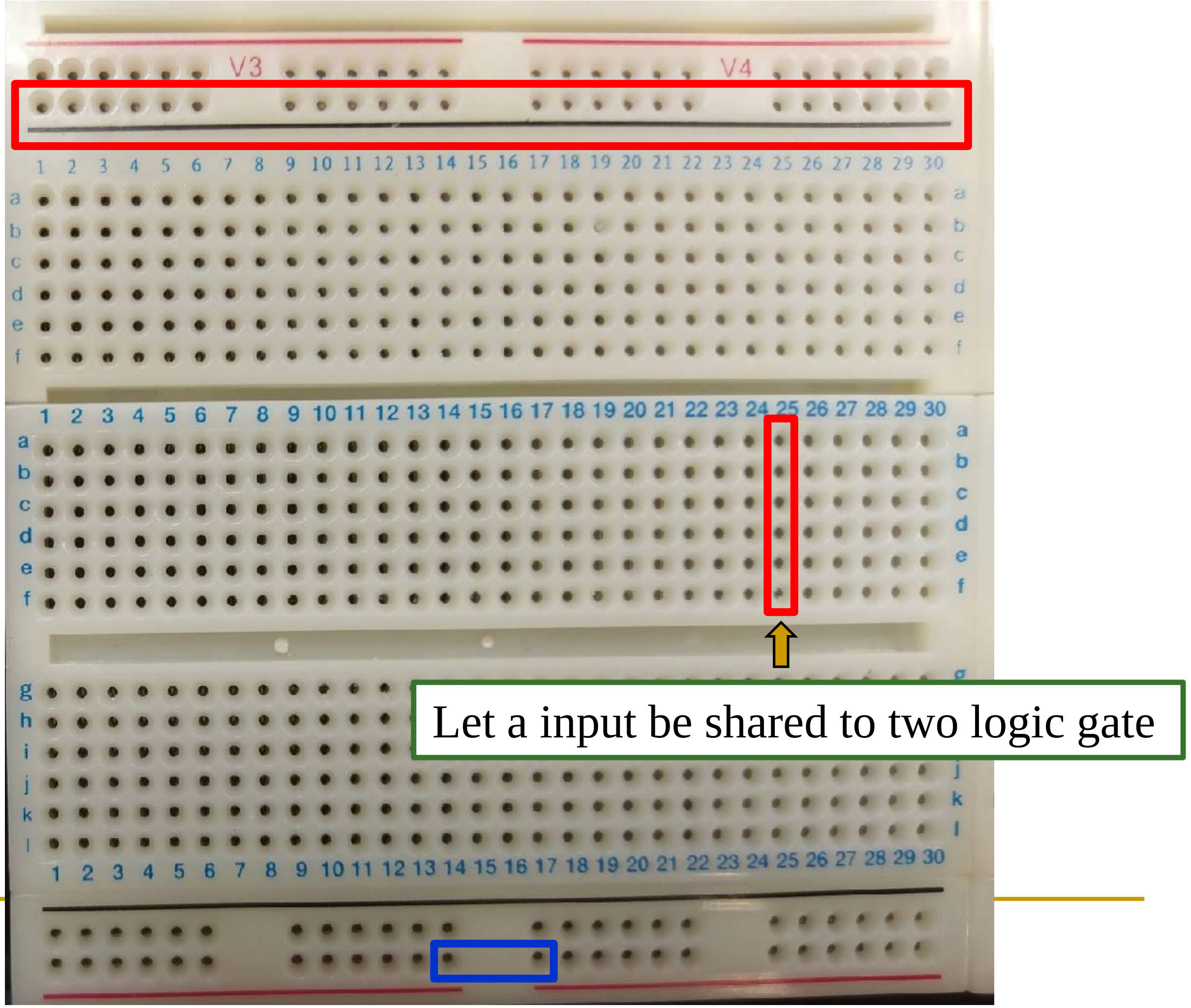


Top View of the Solderless Breadboard

: connected

: disconected



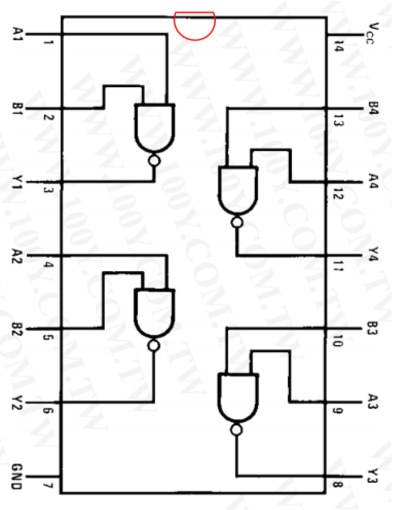


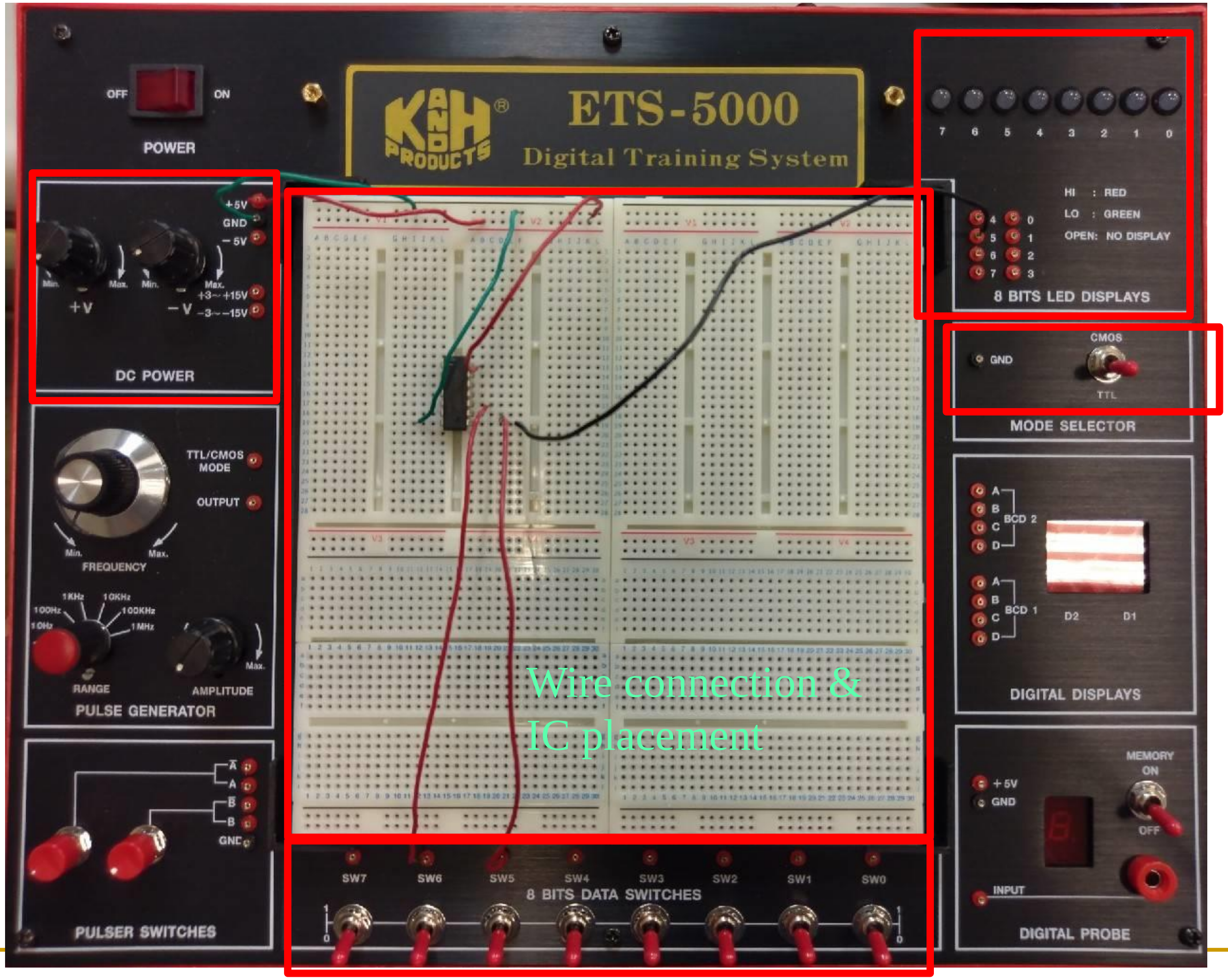
Example: Connection with 74LS00 Chip(1/7)

- **Board**

power supply

Chip(NAND)





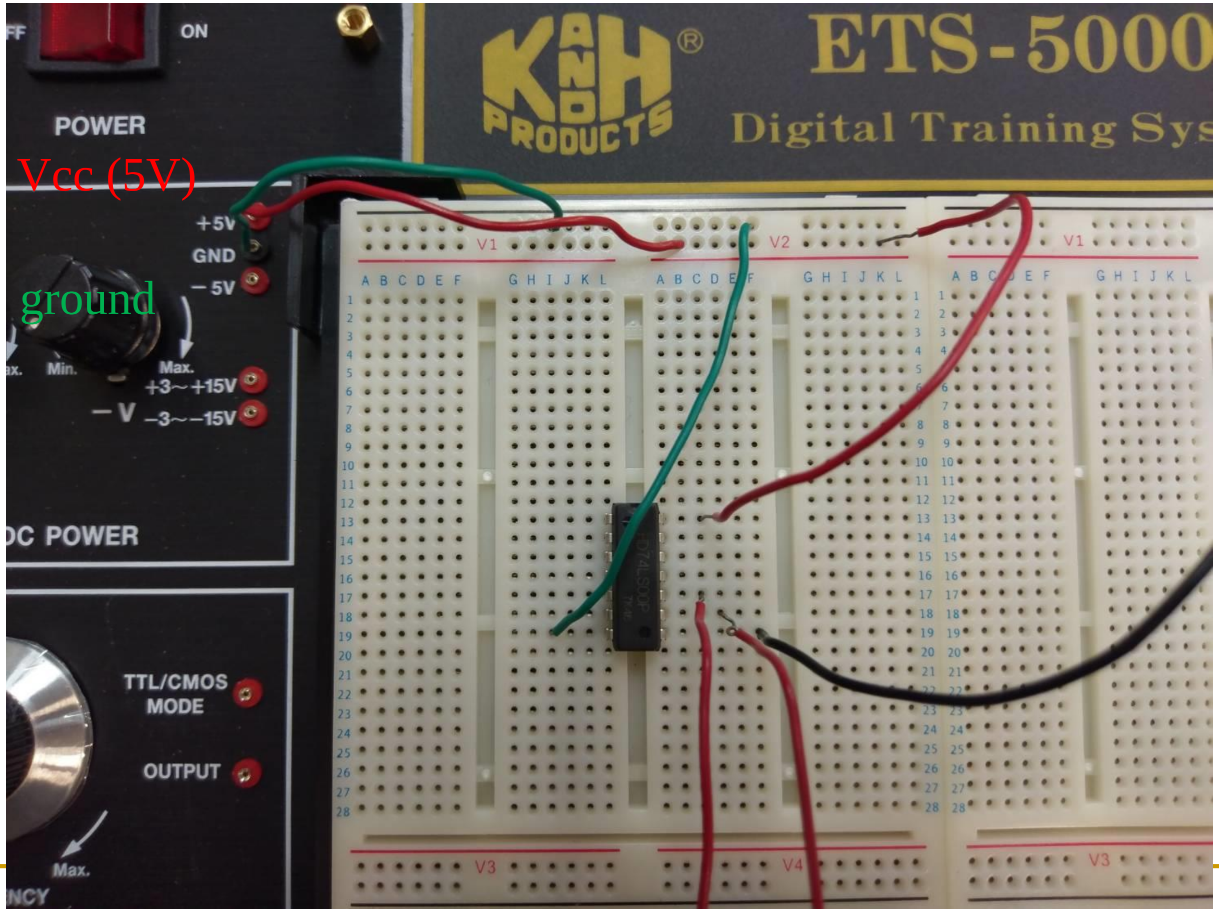
output

TTL mode

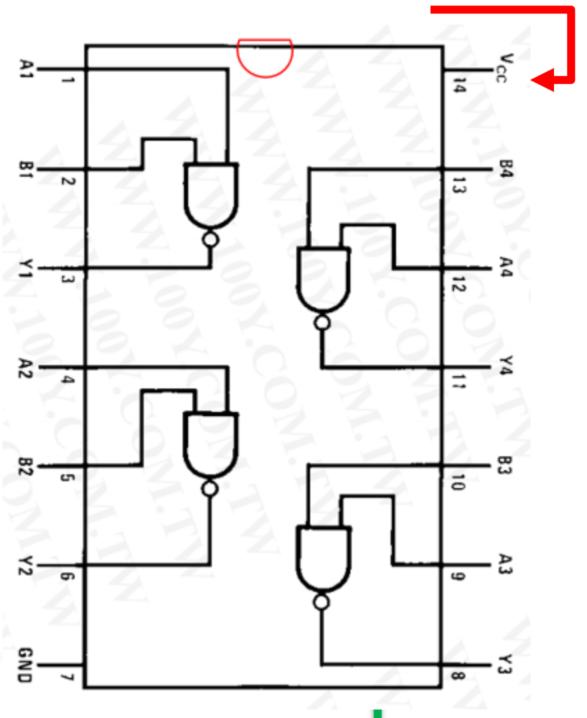
input

Example: Connection with 74LS00 Chip(2/7)

- **Board : wire connection**



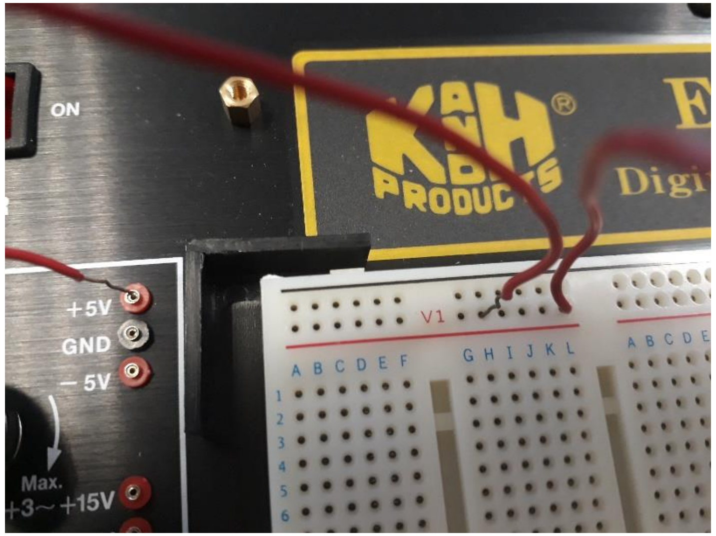
Chip(NAND)



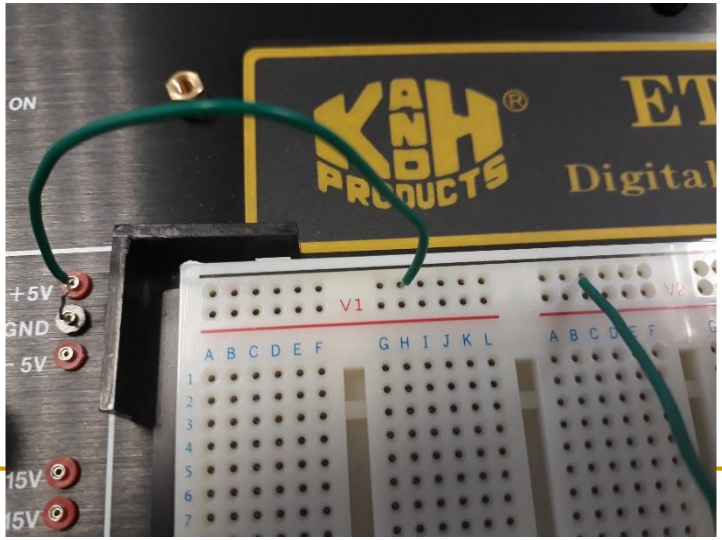
Example: Connection with 74LS00 Chip(3/7)

- **Power supply**

VCC

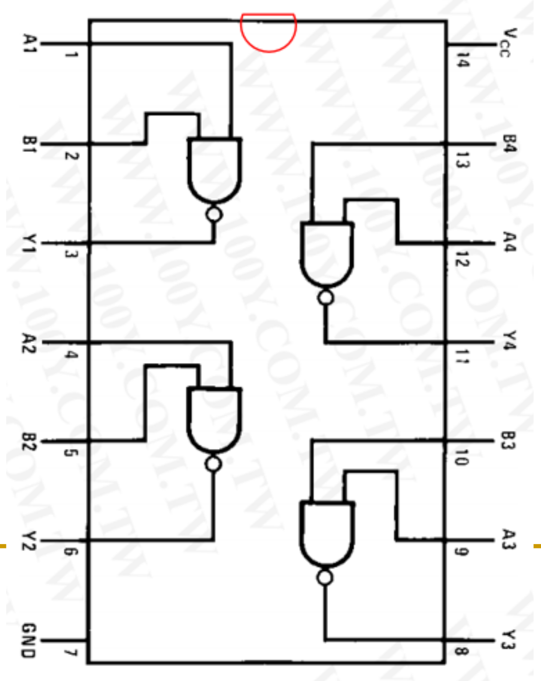


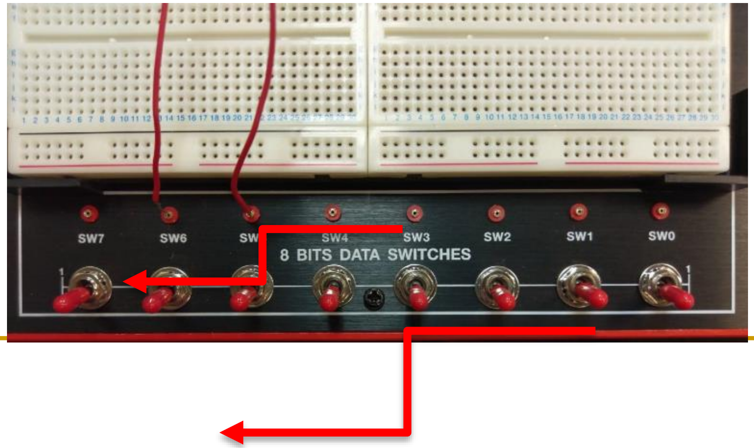
GND



Example: Connection with 74LS00 Chip(4/7)

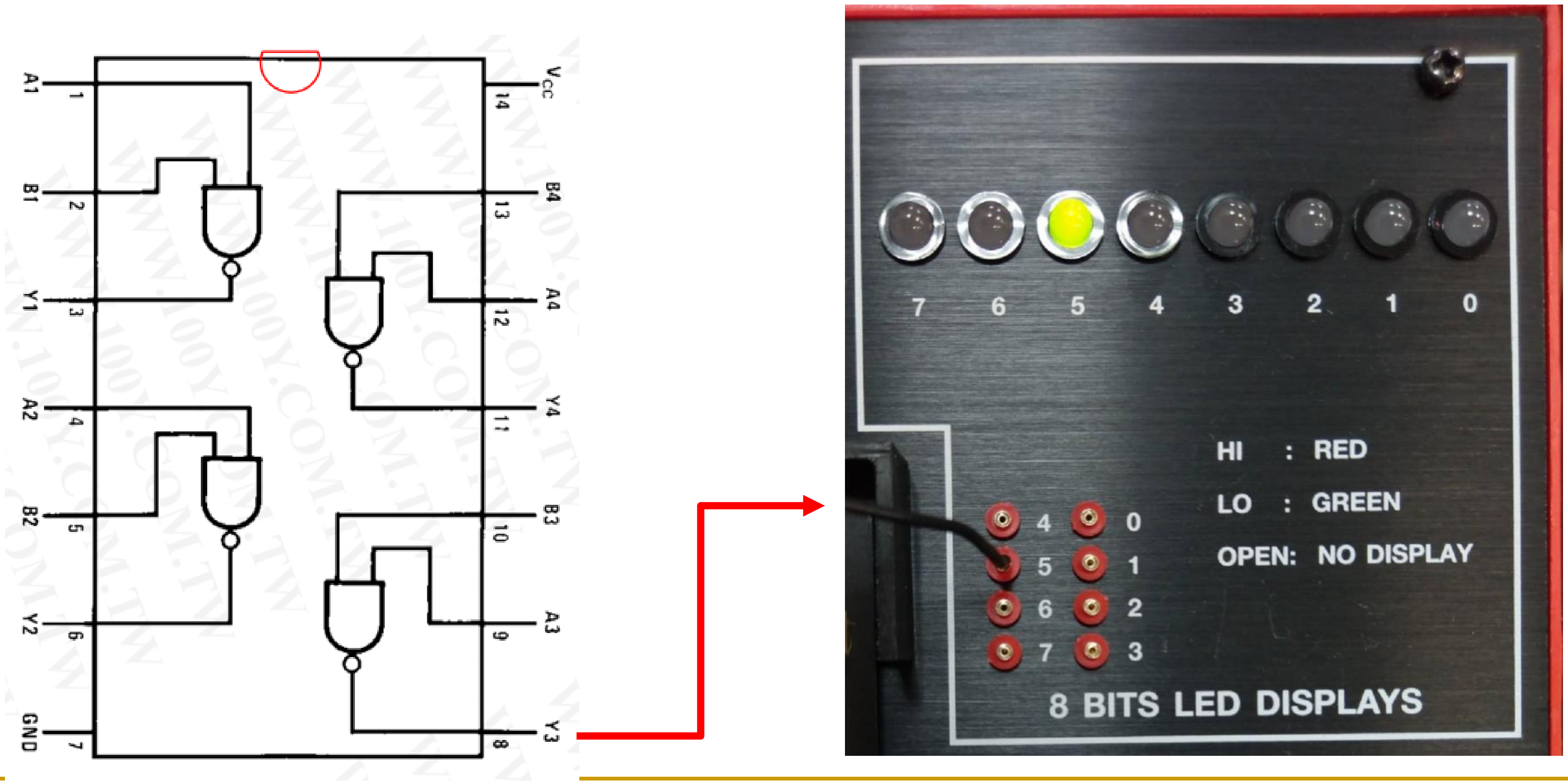
- Signal input





Example: Connection with 74LS00 Chip(5/7)

- Signal output

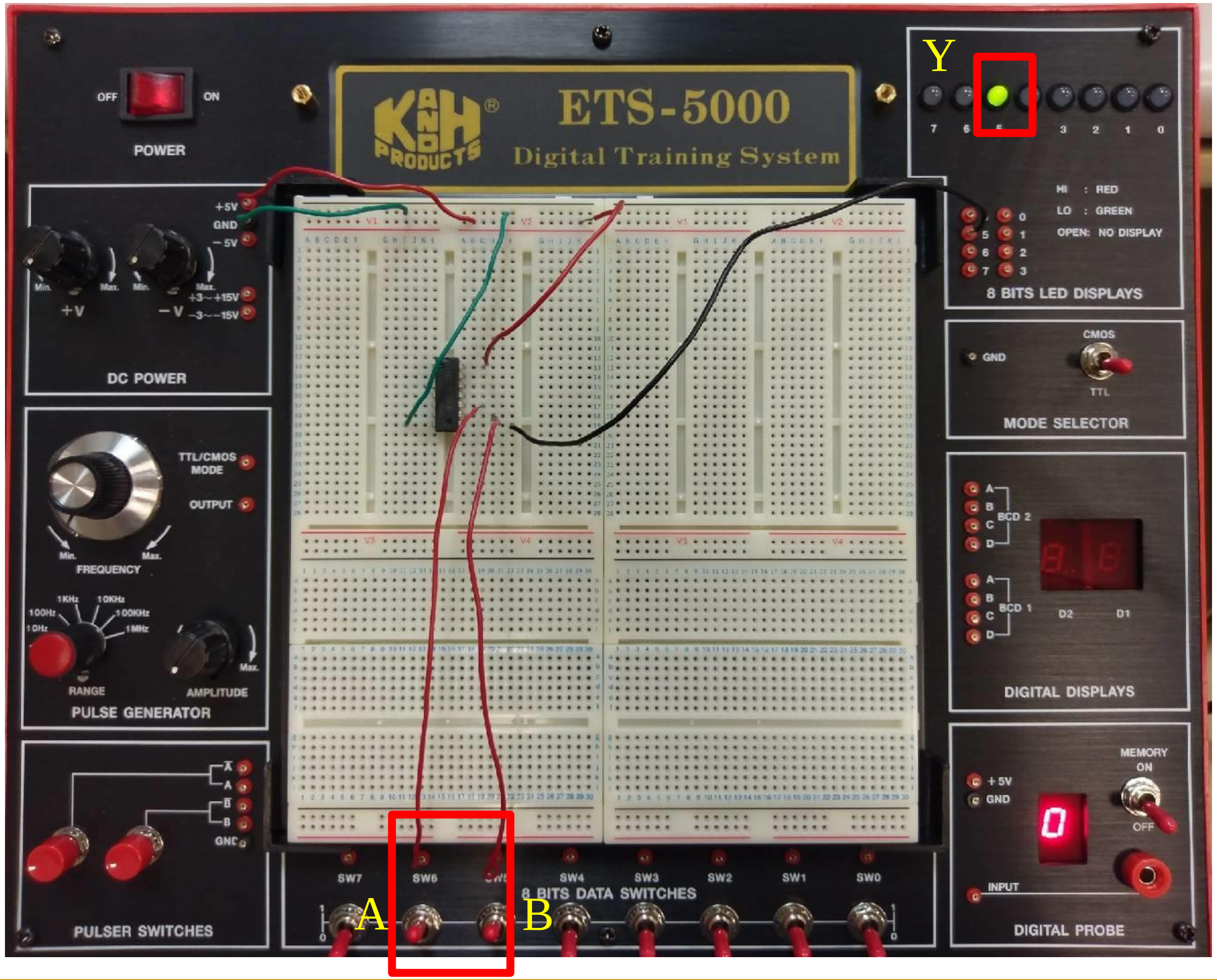


Example: Connection with 74LS00 Chip(6/7)

- **Input 11**
- **Output 0**

74LS00 truth table

Input		Output
A	B	Y
0	0	1
1	0	1
0	1	1
1	1	0

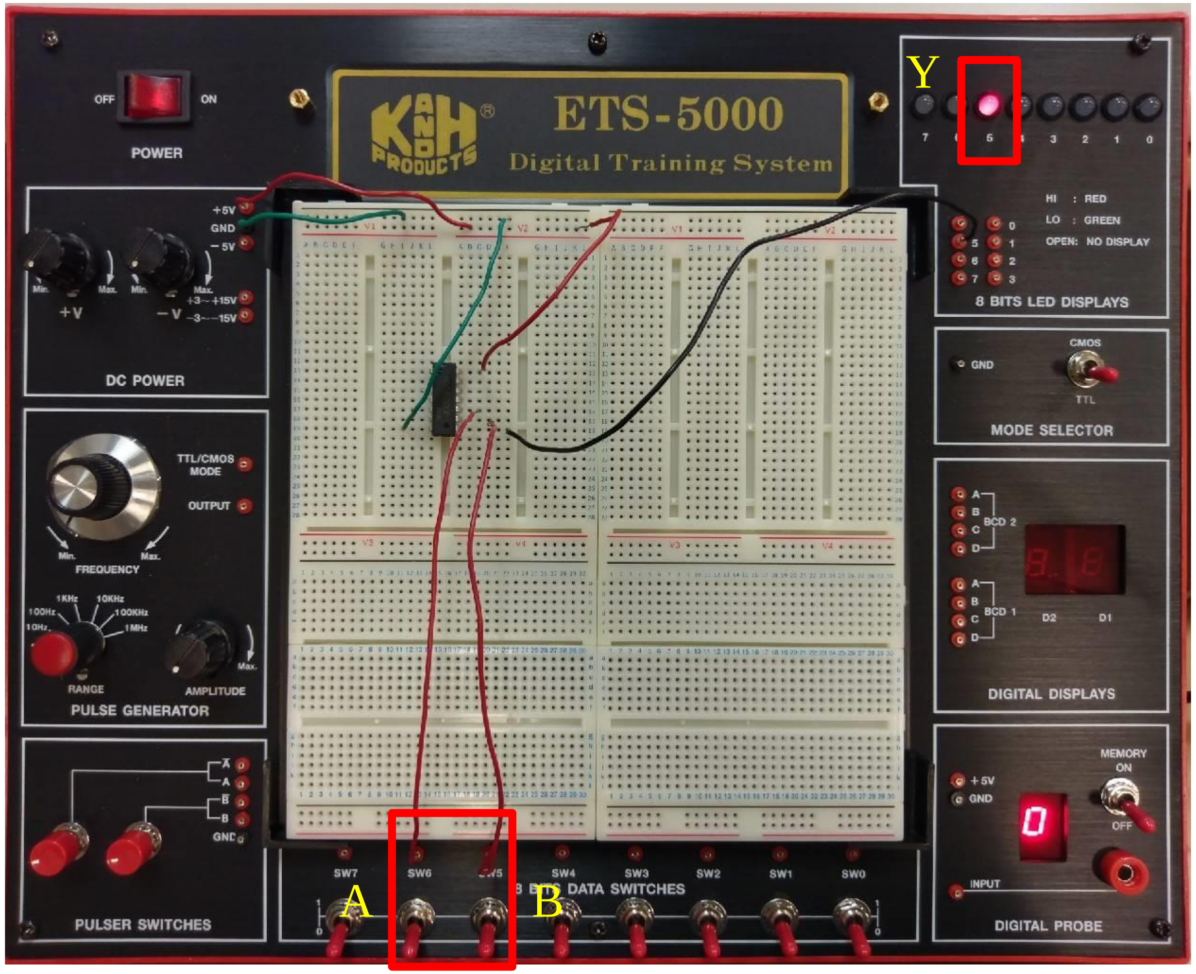


Example: Connection with 74LS00 Chip(7/7)

- **Input 00**
- **Output 1**

74LS00 truth table

Input		Output
A	B	Y
0	0	1
1	0	1
0	1	1
1	1	0



Lab I

- **Please draw their Truth Tables and implement the circuits with breadboard.**
  - $F_1(A, B) = (A+B')(A'+B)$
  - $F_2(A, B) = (AB)'(A + B)$

Components needed for LAB I

Names	Amount
Solerless Breadboard	×1
74LS00	×1
74LS04	×1
74LS08	×1
74LS32	×1

Lab II – XOR (1/2)

1. Boolean Algebra

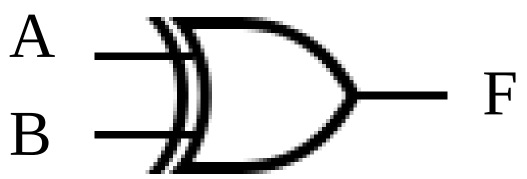
$F = A \oplus B$

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

2. Truth Table

A	B	F
0	0	0
0	1	1
1	0	1
1	1	0

3. Circuit Diagram



LAB II -- XOR (2/2)

Please

(a) implement the circuit on the breadboard.

Components needed for LAB II

Names	Amount
Solerless Breadboard	×1
74LS04	×1
74LS08	×1
74LS32	×1

LAB III -- Half Adder (1/5)

- A half adder (HA) consists of two inputs (A and B) and two outputs (Sum and Carry). "A" denotes the summand and "B" is the addend. Sum and Carry mean the output sum and carry for input "A" and "B". The truth table and Boolean algebra for the half adder are as follows.

A	B	Carry	Sum
0	0	0	0
0	1	0	1
1	0	0	1
1	1	1	0

$$\text{Carry} = A \cdot B$$

$$\text{Sum} = \overline{A} \cdot B + A \cdot \overline{B}$$

Example:

$$\begin{array}{rrr} & & A \\ + & & B \\ \hline & \text{Carry} & \text{Sum} \end{array}$$

LAB III -- Half Adder (2/5)

Please

(a) implement the circuit on the breadboard and show the result on LED.

(b) show the result with decimal format (0, 1, 2, …..,9) on Digital Display in the breadboard.

LAB III -- Half Adder (3/5)

- **A half adder (HA) consists of two inputs (A and B) and two outputs (Sum and Carry). “A” denotes the summand and “B” is the addend. Sum and Carry mean the output sum and carry for input “A” and “B”. The truth table and Boolean algebra for the half adder are as follows.**

A	B	Carry	Sum	Decimal
0	0	0	0	0
0	1	0	1	1
1	0	0	1	1
1	1	1	0	2

$$\text{Carry} = A \cdot B$$

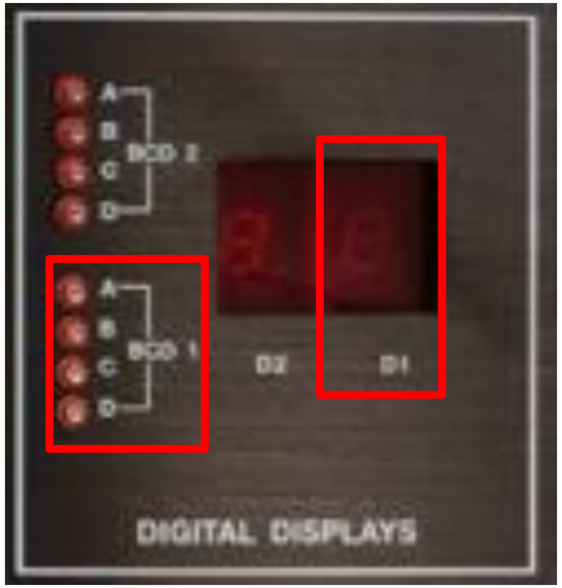
$$\text{Sum} = \overline{A} \cdot B + A \cdot \overline{B}$$

Example:

		A
+		B
	Carry	Sum

Digital Display in the breadboard

Function of the Digital Display in the breadboard is as follows.



D	C	B(Carry)	A(Sum)	DIGITAL DISPLAY
0	0	0	0	0
0	0	0	1	1
0	0	1	0	2
0	0	1	1	3
0	1	0	0	4
0	1	0	1	5
0	1	1	0	6
0	1	1	1	7
1	0	0	0	8
1	0	0	1	9

Components needed for LAB III

Names	Amount
Solerless Breadboard	×1
74LS04	×1
74LS08	×1
74LS32	×1

Lab IV – Comparator (1/2)

- There are two inputs denoted as A and B. Both A and B are 1-bit value. A comparator is designed to determine whether A is equal to B or not. The output results are represented with E .
- The function and truth table of the comparator is described as follows.

$$E = \begin{cases} 1 & , if\ A\ is\ equal\ to\ B \\ 0 & , else \end{cases}$$

A	B	F
0	0	1
0	1	0
1	0	0
1	1	1

Lab IV – Comparator (2/2)

Please

(a) Write boolean algebra and implement the circuit on the breadboard.

Components needed for LAB IV

Names	Amount
Solerless Breadboard	×1
74LS04	×1
74LS08	×1
74LS32	×1