

Department of Electronic Engineering
City University of Hong Kong

EE 1001 Foundations of Digital Techniques
Laboratory Manual

Aims:

1. To practice skills in designing simple logic circuits
2. To get acquaintance with logic ICs (integrated circuits)
3. To implement logic circuits with bread board

Laboratory Sessions:

LAB1 Design and implement a 2-bit comparator

LAB2 Implementation a 4-bit comparator with 7-segment LED display

Notes:

1. Each Student will work on your own experiment
2. Student is required complete the experiment within 3 weeks.

Components (per Group):

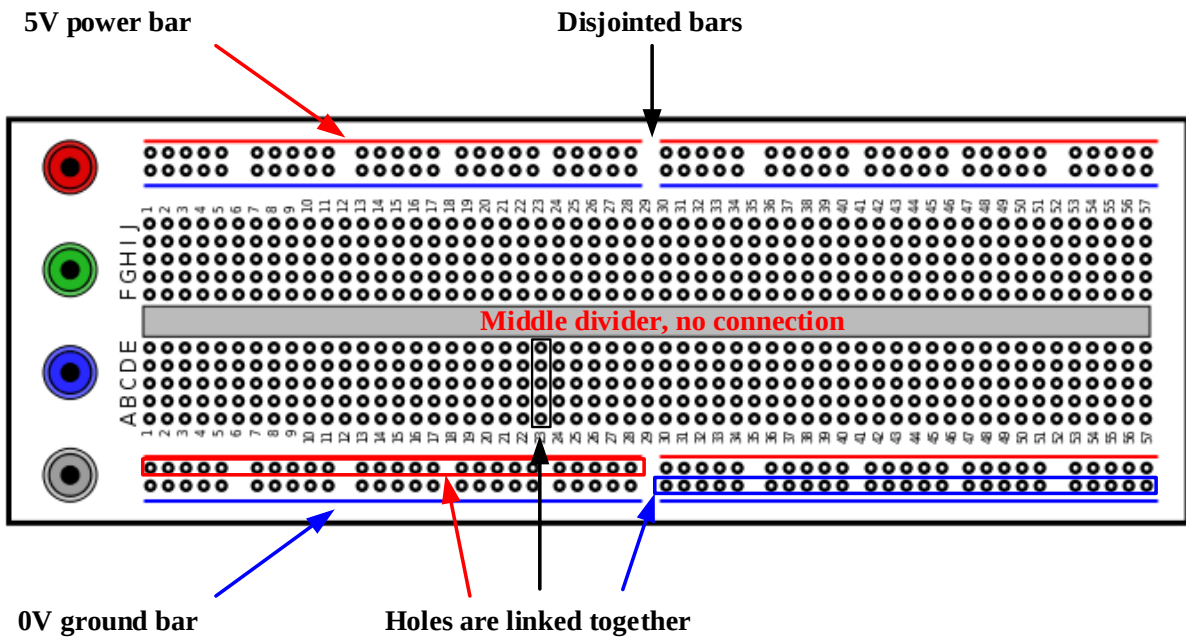
Breadboard		1
Inverter	74LS04	1
2-input AND gate	74LS08	1
3-input AND gate	74LS11	2
2-input OR gate	74LS32	1
7-segment display driver	74LS47	2
4-bit comparator	74LS85	1
LEDs		3
7-segment LED display (Common Anode)		2
1 k Ω resistor		5
470 Ω resistor		14
5V power supply (on bench)		1

Submit your work to laboratory supervisor

Experiment 1: pages 6-8

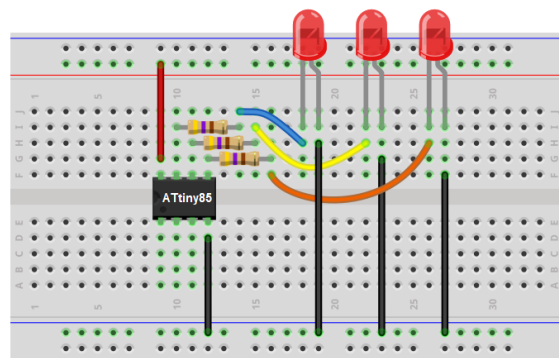
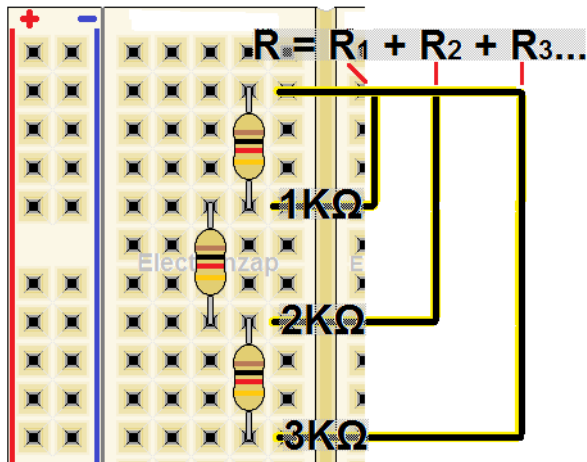
Experiment 2: Pages 12-13

Introduction to bread board:



Examples of circuit connection:

Series three 1K Ω resistors to obtain 3 K Ω resistance



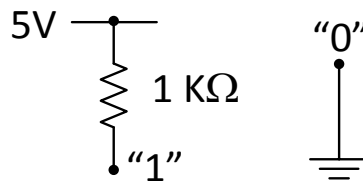
Tutorial on how use bread board is available on youtube:

<https://www.youtube.com/watch?v=6WReFkfrUIk>

A few tips for logic circuit implementation:

1. Logic "1" & "0"

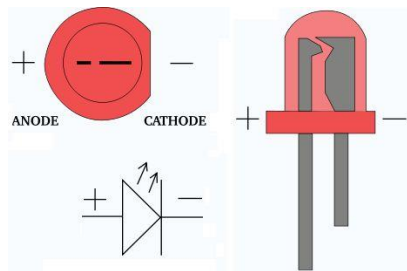
Use the following circuit to produce logic "1" and logic "0" as input to the logic circuit.



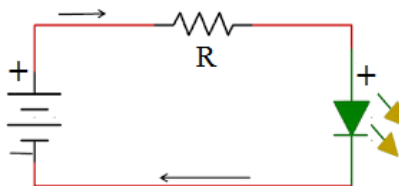
IMPORTANT: NEVER directly connect to 5V to obtain logic "1", the logic gate IC may easily be damaged.

2. Use LED to indicate Logic "1" & "0"

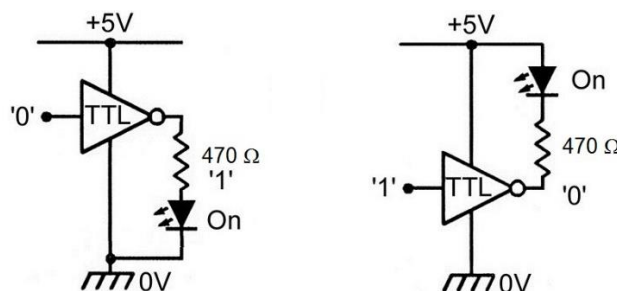
LED is with polarity, with long leg representing anode and short leg representing cathode.



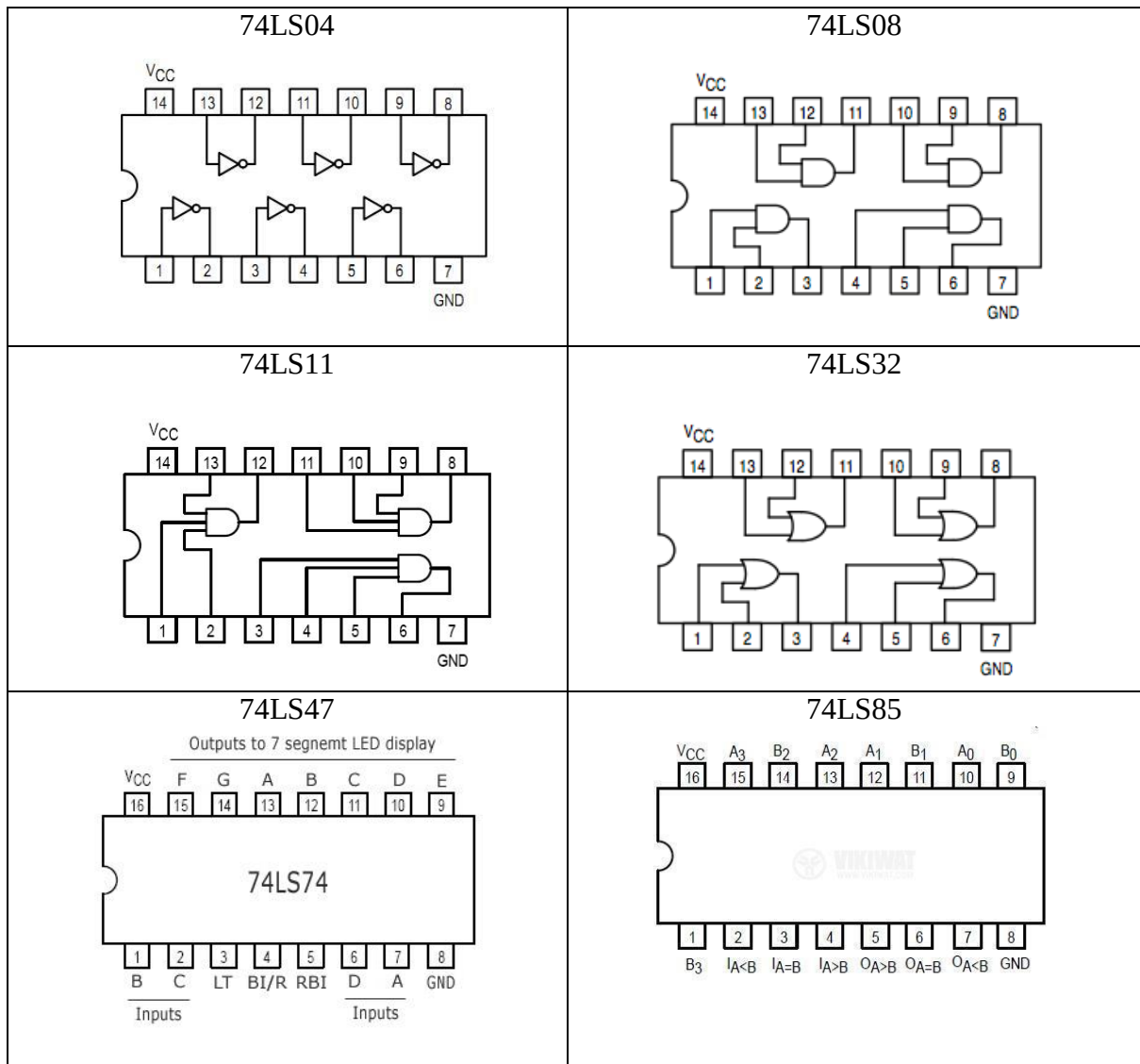
To turn a LED, the LED should be forward-biased as shown below:



The following circuit shows the TTL output circuits for turning on the LED with either logic "1" output or logic "0" output. The function of the resistor is to limit the current passing through the LED to avoid damage.



TTL Logic IC Pin assignment:



For detail data sheet, search from Google to obtain on-line.
 For example: Type “74LS85 datasheet pdf” to search for detail information for 74LS85 IC.

Name: _____ .SID: _____.

Experiment 1: Design and implement a 2-bit comparator

Objective: Design and implement a 2-bit comparator with discrete logic gates.

A 2-bit comparator is used to compare the magnitude of two 2-bit numbers, x (x_1x_0) and y (y_1y_0). Three different outputs will be generated to indicate the result: $x < y$, $x = y$ and $x > y$. Three LEDs are used to illustrate the results. When a LED lights up, it indicates that the corresponding result is met.

Step 1: Fill in the truth table for the 2-bit comparator circuit

Input: x & y				Output ($x - y$)		
x_1	x_0	y_1	y_0	S ($x < y$)	E ($x = y$)	G ($x > y$)
0	0	0	0			
0	0	0	1			
0	0	1	0			
0	0	1	1			
0	1	0	0			
0	1	0	1			
0	1	1	0			
0	1	1	1			
1	0	0	0			
1	0	0	1			
1	0	1	0			
1	0	1	1			
1	1	0	0			
1	1	0	1			
1	1	1	0			
1	1	1	1			

Name: _____ .SID: _____ .

Step 2: Use K-maps to design the Boolean function for three output conditions, S , E and G .

Output “S”

	$y_1 y_0$				
$x_1 x_0$					

Output “G”

	$y_1 y_0$				
$x_1 x_0$					

Write the Boolean functions for different outputs:

$S =$

$G =$

E (derived from S and G) =

Step3: Draw the circuit diagram

Hint: Use two 2-input OR gate to form a 3-input OR gate.

Name: _____ .SID: _____ .

Step 4: Implement the 2-bit comparator with logic gates using bread board

NOTE: Make sure 5V and ground are connected to the circuit; see page 4 for tips.

Comments on your experimental results:

Show your results to Laboratory Supervisor.

Items	Grade
Attitude and progress (1 – 10)	
Quality of implementation (1 – 10)	
Completion % (0% – 100%)	
Supervisor Signature	

Name: _____ .SID: _____.

Experiment 2: Design and implement a 4-bit comparator with display

Objective: Design and implement a 4-bit comparator with module ICs and numeric display.

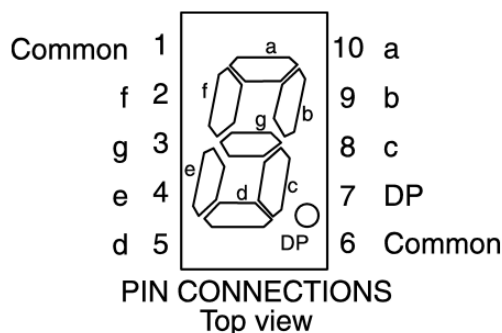
74LS85 is 4-bit magnitude comparator TTL IC for comparing two 4-bit number A ($A_3 A_2 A_1 A_0$) and B ($B_3 B_2 B_1 B_0$). This module can be used to comparing binary number with more bits. It accepts the comparison results from previous stage and also generate comparison results for next stage. It's truth table is shown below:

Comparing Inputs				Cascading Inputs			Outputs		
A_3, B_3	A_2, B_2	A_1, B_1	A_0, B_0	$A > B$	$A < B$	$A = B$	$A > B$	$A < B$	$A = B$
$A_3 > B_3$	X	X	X	X	X	X	H	L	L
$A_3 < B_3$	X	X	X	X	X	X	L	H	L
$A_3 = B_3$	$A_2 > B_2$	X	X	X	X	X	H	L	L
$A_3 = B_3$	$A_2 < B_2$	X	X	X	X	X	L	H	L
$A_3 = B_3$	$A_2 = B_2$	$A_1 > B_1$	X	X	X	X	H	L	L
$A_3 = B_3$	$A_2 = B_2$	$A_1 < B_1$	X	X	X	X	L	H	L
$A_3 = B_3$	$A_2 = B_2$	$A_1 = B_1$	$A_0 > B_0$	X	X	X	H	L	L
$A_3 = B_3$	$A_2 = B_2$	$A_1 = B_1$	$A_0 < B_0$	X	X	X	L	H	L
$A_3 = B_3$	$A_2 = B_2$	$A_1 = B_1$	$A_0 = B_0$	H	L	L	H	L	L
$A_3 = B_3$	$A_2 = B_2$	$A_1 = B_1$	$A_0 = B_0$	L	H	L	L	H	L
$A_3 = B_3$	$A_2 = B_2$	$A_1 = B_1$	$A_0 = B_0$	L	L	H	L	L	H
$A_3 = B_3$	$A_2 = B_2$	$A_1 = B_1$	$A_0 = B_0$	X	X	H	L	L	H
$A_3 = B_3$	$A_2 = B_2$	$A_1 = B_1$	$A_0 = B_0$	H	H	L	L	L	L
$A_3 = B_3$	$A_2 = B_2$	$A_1 = B_1$	$A_0 = B_0$	L	L	L	H	H	L

H: Logic High ("1"), L: Logic Low ("0"), X: Don't Care

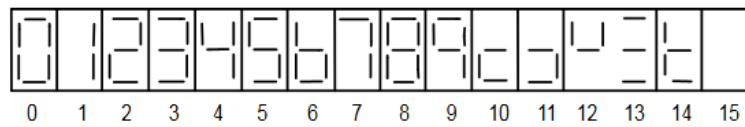
7-Segment LED:

There are two types of 7-Segment LED: common anode (with common pin is connect 5V) and common cathode (with common pin is connect ground). The common anode one is used in this experiment and the pin assignment is shown below.



74LS47 is a BCD to 7-Segment Decoder/Driver. It accepts 4-bit input and generates seven outputs to drive a 7-Segment LED to indicate its corresponding decimal digit. Since the output

“0” when a segment is “ON”, a common anode 7-Segment LED is used for the circuit implementation. For digital above 9, the outputs are invalid as shown below:



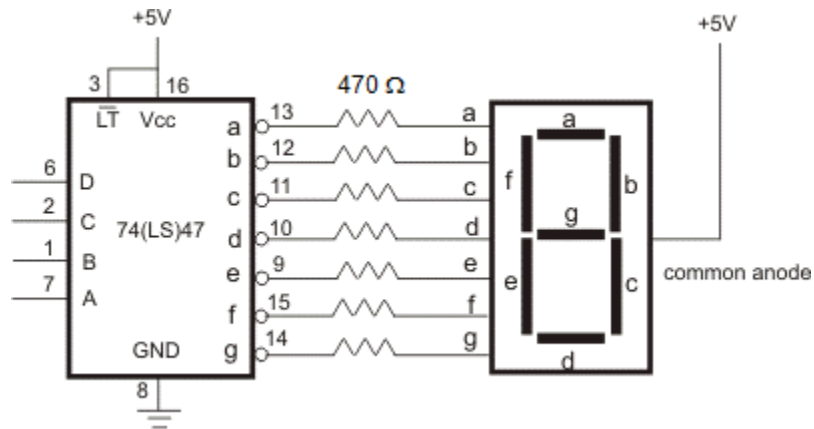
The truth table of &4LS47 is shown below:

TRUTH TABLE

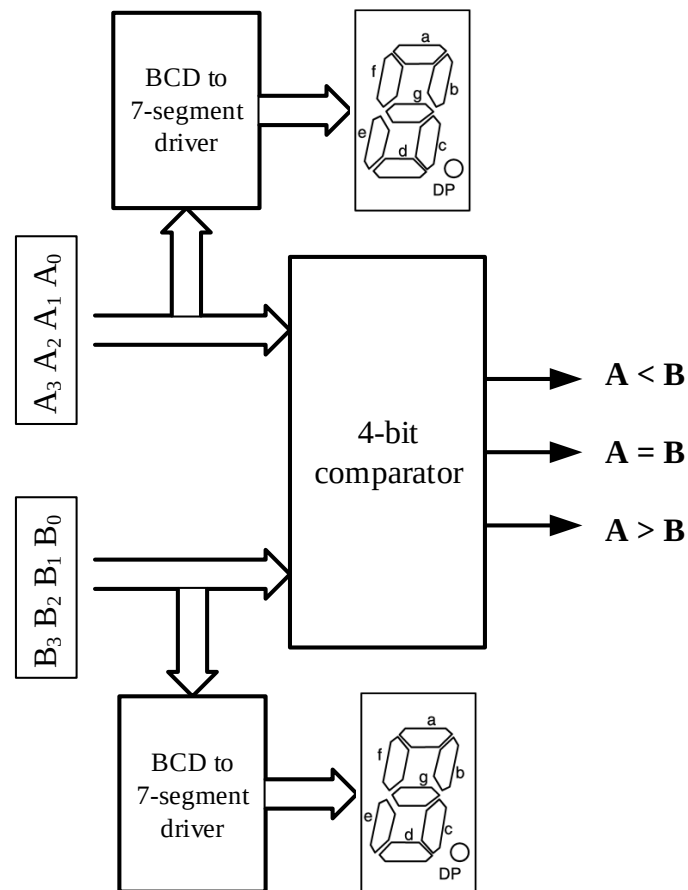
DECIMAL OR FUNCTION	INPUTS							OUTPUTS						
	$\overline{\text{LT}}$	$\overline{\text{RBI}}$	D	C	B	A	$\overline{\text{BI/RBO}}$	$\overline{\text{a}}$	$\overline{\text{b}}$	$\overline{\text{c}}$	$\overline{\text{d}}$	$\overline{\text{e}}$	$\overline{\text{f}}$	$\overline{\text{g}}$
0	H	H	L	L	L	L	H	L	L	L	L	L	L	H
1	H	X	L	L	L	H	H	H	L	L	H	H	H	H
2	H	X	L	L	H	L	H	L	L	H	L	L	H	L
3	H	X	L	L	H	H	H	L	L	L	L	H	H	L
4	H	X	L	H	L	L	H	H	L	L	H	H	L	L
5	H	X	L	H	L	H	H	L	H	L	L	H	L	L
6	H	X	L	H	H	L	H	H	H	L	L	L	L	L
7	H	X	L	H	H	H	H	L	L	L	H	H	H	H
8	H	X	H	L	L	L	H	L	L	L	L	L	L	L
9	H	X	H	L	L	H	H	L	L	L	H	H	L	L
10	H	X	H	L	H	L	H	H	H	H	L	L	H	L
11	H	X	H	L	H	H	H	H	H	L	L	H	H	L
12	H	X	H	H	L	L	H	H	L	H	H	H	L	L
13	H	X	H	H	L	H	H	L	H	H	L	H	L	L
14	H	X	H	H	H	L	H	H	H	H	L	L	L	L
15	H	X	H	H	H	H	H	H	H	H	H	H	H	H
BI	X	X	X	X	X	X	L	H	H	H	H	H	H	H
RBI	H	L	L	L	L	L	L	H	H	H	H	H	H	H
LT	L	X	X	X	X	X	H	L	L	L	L	L	L	L

Name: _____ .SID: _____.

The schematic diagram for connecting 74LS47 to 7-Segment LED is shown below:



The schematic diagram will show the corresponding BCD value on the 7-segment LEDs for both 4-bit input numbers and the comparison results indicated by three LEDs.



Name:_____.SID:_____.

Step 1: Draw the detail circuit diagram for implementing the circuit

Name:_____.SID:_____.

Step 2: Implement the 4-bit comparator with 7-segment LEDs using bread board

NOTE: Make sure 5V and ground are connected to the circuit; see page 4 for tips.

Comments on your experimental results:

Question: Draw a block diagram to illustrate a 8-bit comparator with two 74LS85.

Show your results to Laboratory Supervisor.

Items	Grade
Attitude and progress (1 – 10)	
Quality of implementation (1 – 10)	
Completion % (0% – 100%)	
Supervisor Signature	

WH Lau 24.10.2017