

Lab. 02

Logic Design Lab.

Spring 2022

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Announcement

- **SNUCSE Account**

- If you registered for 'Logic Design Student',
you can use a PC with your account.
(Please make sure you can sign in to PC)

Announcement

- **Double check your e-mail/file**
 - **LDLAB_Yymmdd_class#_team#_NAME_studentID**
 - YYMMDD : Lab class date. **Not the submission date**

ex) e-mail : LDLAB_220328_001_team1_HaejooJeon_2000-00000

File : LDLAB_220328_001_team1_HaejooJeon_2000-00000.pdf

File : LDLAB_220328_001_team1_전해주_2000-00000.zip

(Name format doesn't matter)

Wrong submission examples)

[LDLAB] LDLAB_210324_001_team1_HaejooJeon_2000-00000 (No [LDLAB] X)

LDLAB_210324_class1_team1_HaejooJeon_2000-00000 (No "class" X)

LDLAB_210327_001_team1_HaejooJeon_2000-00000 (Not submission date X)

LDLAB_210327_001_team1_2000-00000 (Name omitted X)

LDLAB report submission Jeon Haejoo 2000-00000 (Absolutely different format X)

Announcement

- **Double check your e-mail/file**
 - Do not forget to attach your report file!
 - If you submitted incorrectly, **point can be deducted.**
 - Re-submission before the deadline is permitted without deduction.
(We will score the most recent one)

Xilinx ISE

Xilinx ISE Design Suite

- Integrated Synthesis Environment(ISE)
- Release 14.7, 2013
- Features
 - Synthesis(compile) and analysis of HDL¹⁾ designs.
 - Timing analysis, RTL diagram
 - Xilinx FPGA programmer



Creating New Project

New Project Wizard

← Create New Project
Specify project location and type.

Enter a name, locations, and comment for the project

Name: Comparator

Location: C:\Xilinx\Comparator ...

Working Directory: C:\Xilinx\Comparator ...

Description:

Select the type of top-level source for the project

Top-level source type:
Schematic

More Info Next > Cancel

- Select **File -> New Project**
- Specify **Name, Location, Working Directory**. Select **Top-level source type as Schematic**.

Project Settings

New Project Wizard

Project Settings

Specify device and project properties.

Select the device and design flow for the project

Property Name	Value
Evaluation Development Board	None Specified
Product Category	All
Family	Spartan3A and Spartan3AN
Device	XC3S50AN
Package	TQG144
Speed	-4
Top-Level Source Type	Schematic
Synthesis Tool	XST (VHDL/Verilog)
Simulator	ISim (VHDL/Verilog)
Preferred Language	Verilog
Property Specification in Project File	Store all values
Manual Compile Order	<input type="checkbox"/>
VHDL Source Analysis Standard	VHDL-93
Enable Message Filtering	<input type="checkbox"/>

More Info < Back Next > Cancel

New Project Wizard

Project Summary

Project Navigator will create a new project with the following specifications.

Project:

Project Name: Comparator
Project Path: C:\Xilinx\Comparator
Working Directory: C:\Xilinx\Comparator
Description:
Top Level Source Type: Schematic

Device:

Device Family: Spartan3A and Spartan3AN
Device: xc3s50an
Package: tqg144
Speed: -4

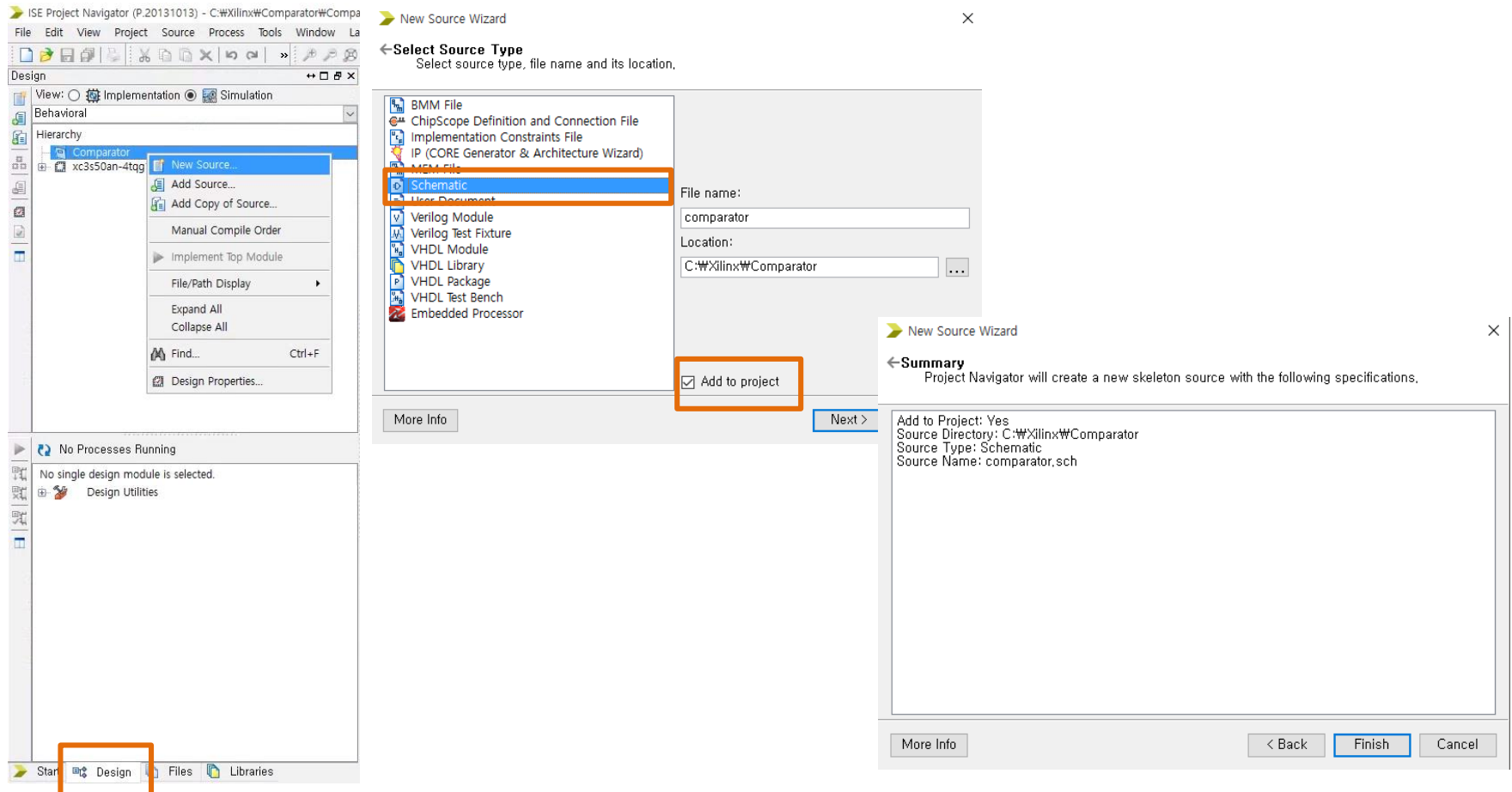
Top-Level Source Type: Schematic
Synthesis Tool: XST (VHDL/Verilog)
Simulator: ISim (VHDL/Verilog)
Preferred Language: Verilog
Property Specification in Project File: Store all values
Manual Compile Order: false
VHDL Source Analysis Standard: VHDL-93

Message Filtering: disabled

More Info < Back Finish Cancel

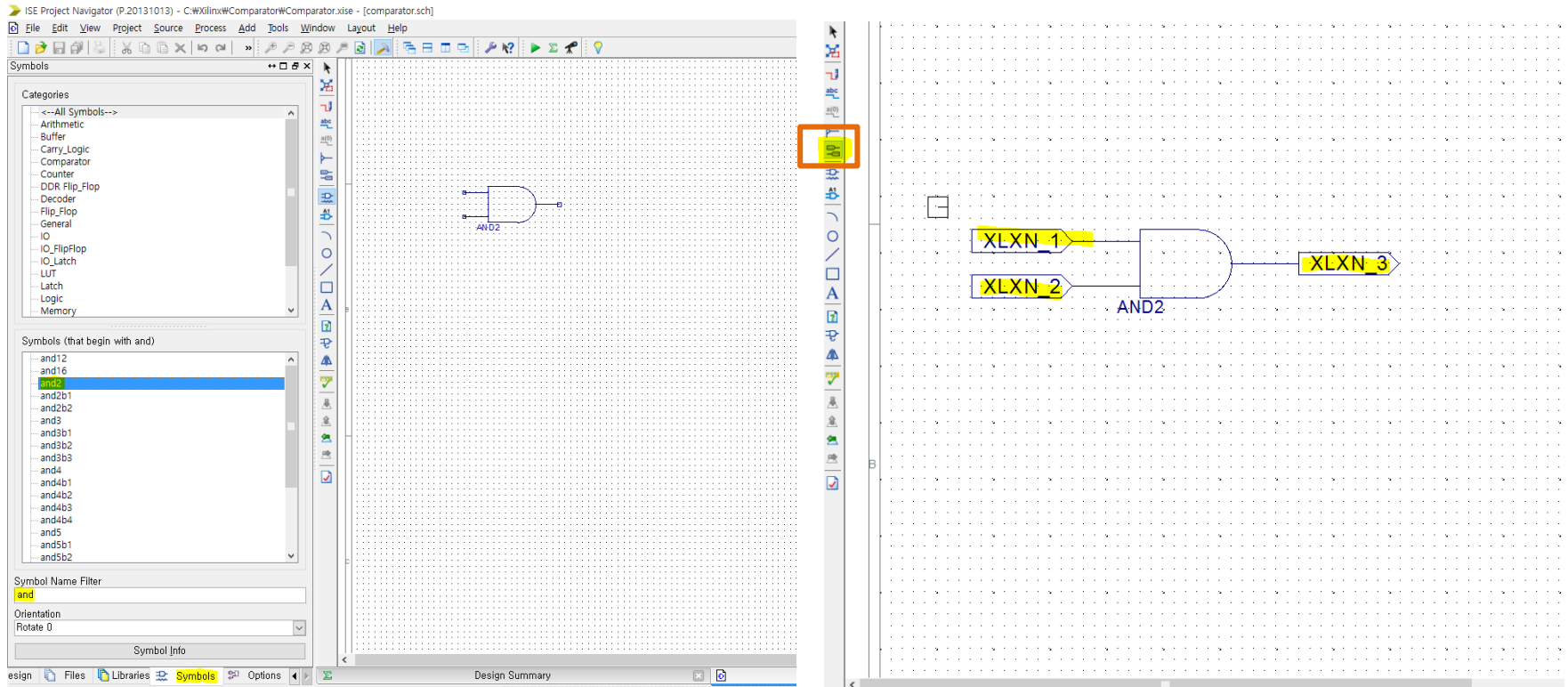
- Set **Project Settings** as **above**
- Click **Next** → **Finish**

Creating Schematic



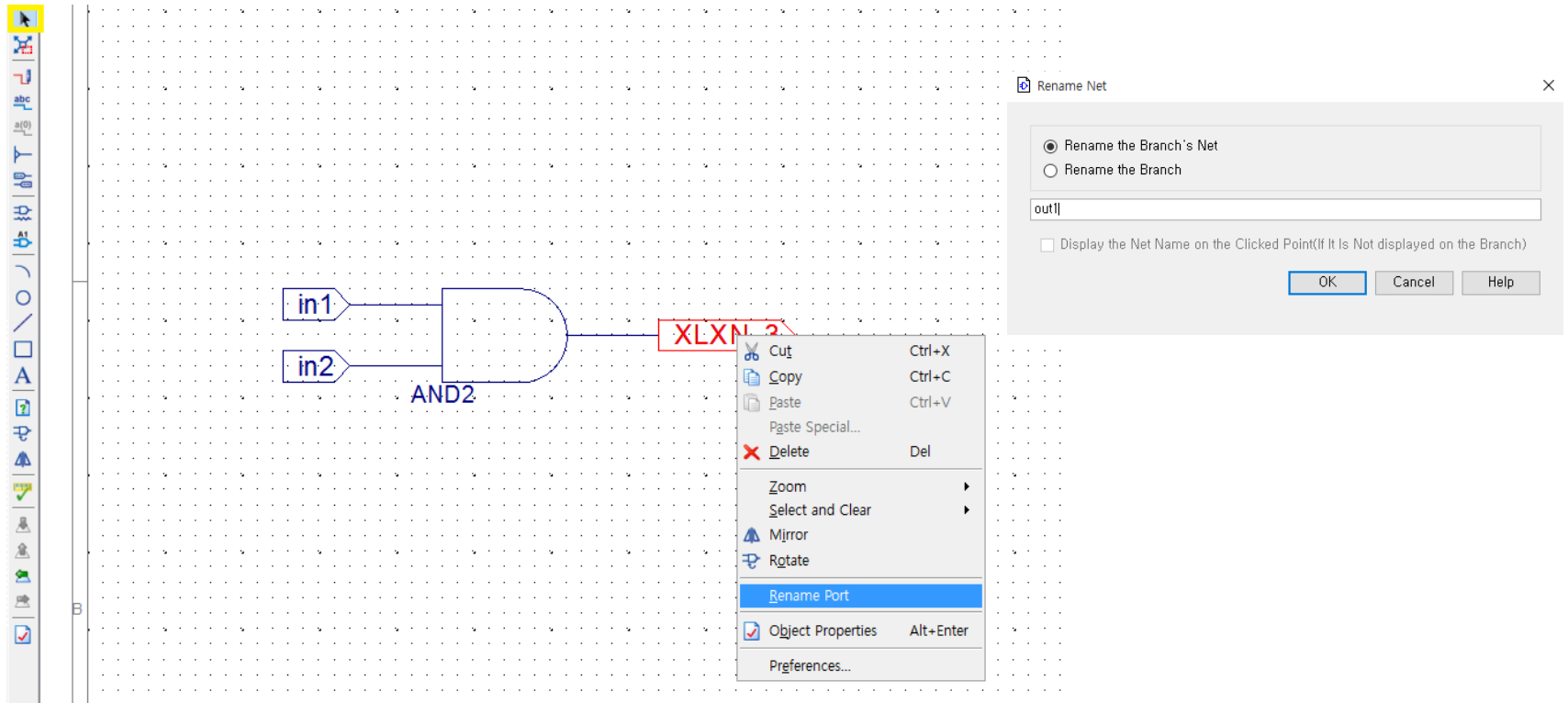
- Right-Click anywhere in Hierarchy in **Design tab**, select New Source.
- New Source Wizard window appears. Select Source Type window, select **Schematic** and type the File name. Ensure **Add to project is checked**.

2-input-AND gate circuit (1)



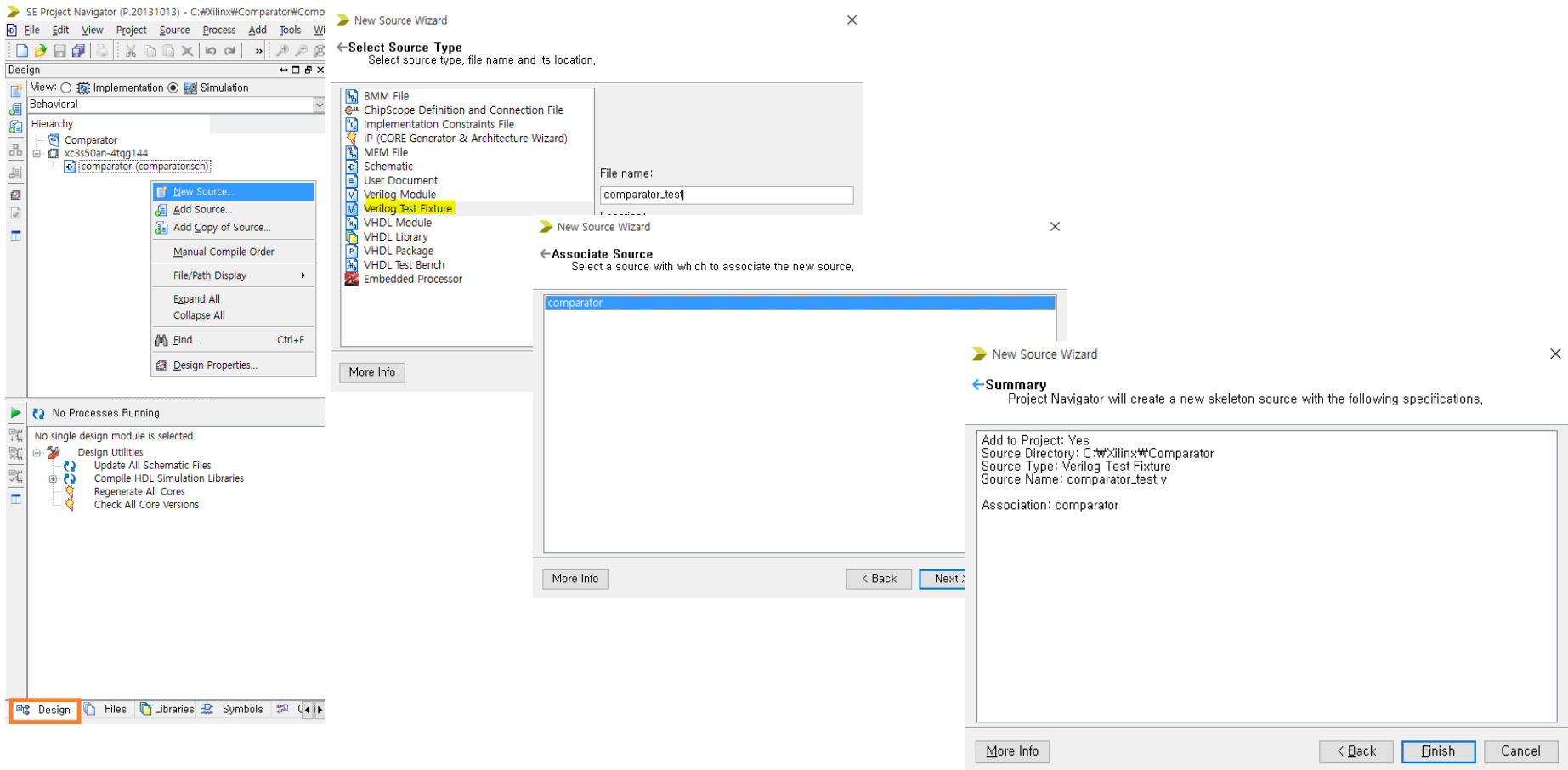
- In Symbols tab, type "and" under Symbol Name Filter.
- Select and2 under Symbols, and place it on board.
- Click **I/O Marker button** and you can add input/output markers to your circuit.

2-input-AND gate circuit (2)



- Change the names of input/output symbols.
- Save to apply changes

Creating Verilog Test Bench



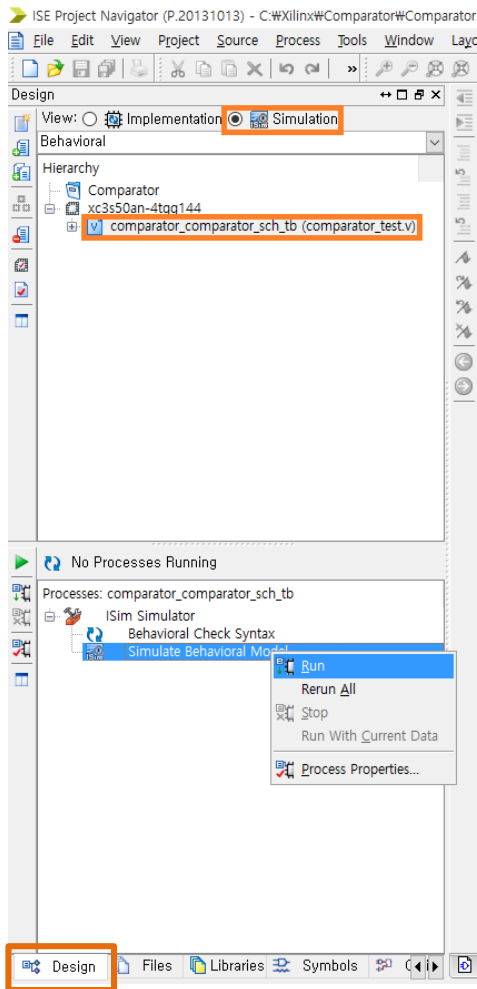
- Select New Source by right clicking inside **Design tab**.
- Select Verilog Test Bench. Type the file name as above.

Schematic Simulation Code

```
1 // Verilog test fixture created from schematic
2
3 `timescale 1ns / 1ps
4
5 module comparator_comparator_sch_tb();
6
7 // Inputs
8 reg in1;
9 reg in2;
10
11 // Output
12 wire out1;
13
14 // Bidirs
15
16 // Instantiate the UUT
17 comparator UUT (
18     .in1(in1),
19     .in2(in2),
20     .out1(out1)
21 );
22 // Initialize Inputs
23
24 initial begin
25     in1 = 0;
26     in2 = 0;
27     #100;
28
29     in1 = 0;
30     in2 = 1;
31     #100;
32
33     in1 = 1;
34     in2 = 0;
35     #100;
36
37     in1 = 1;
38     in2 = 1;
39 end
40 endmodule
41
```

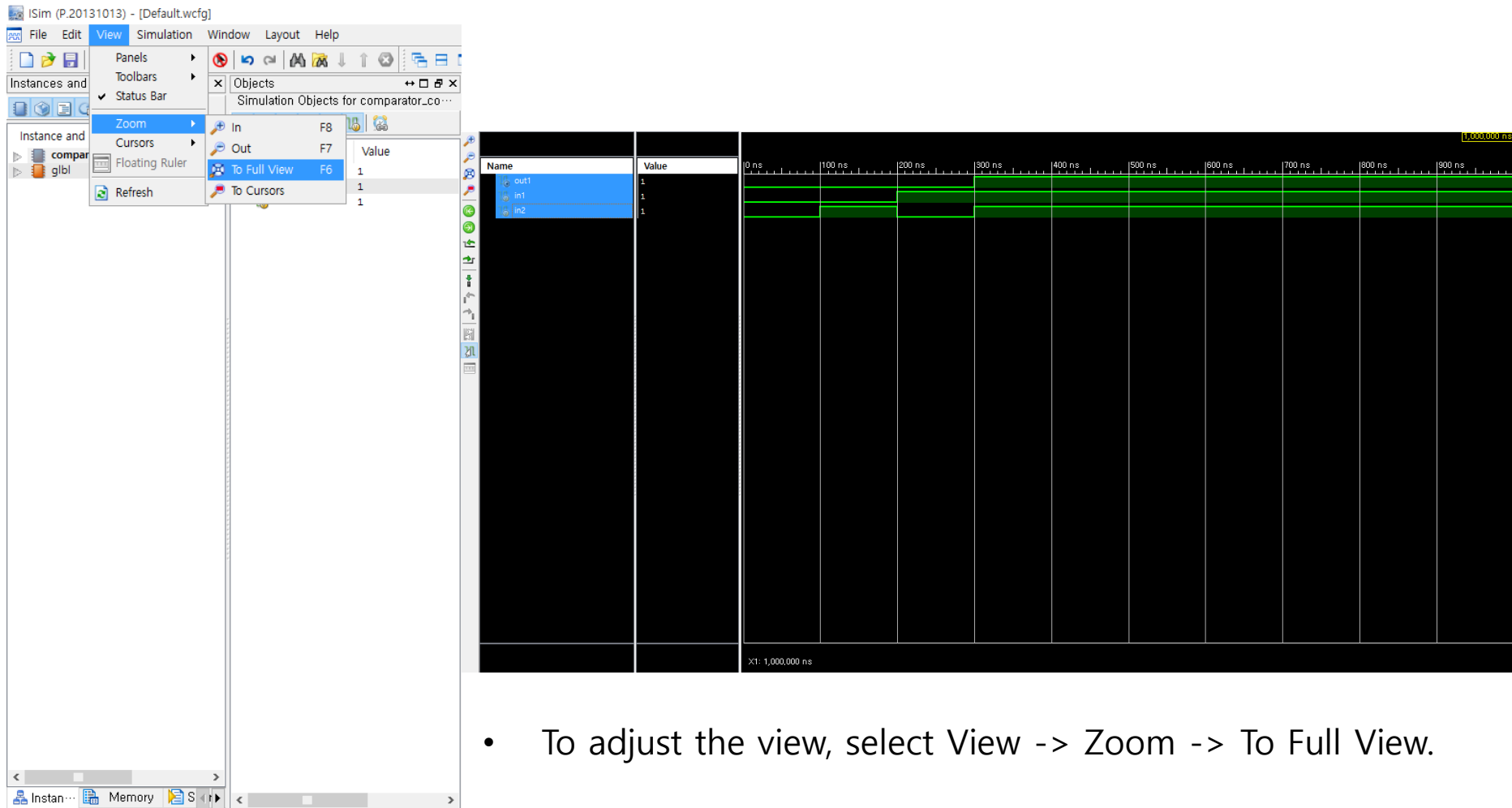
Wait for 100 ns

Simulate Behavioral Model



- Save the project
- Ensure that **Design tab** is selected, View is set to **Simulation**, and your **simulation source code is clicked**
- Double click Behavioral Check Syntax for syntax check
- Double click Simulate Behavioral Model

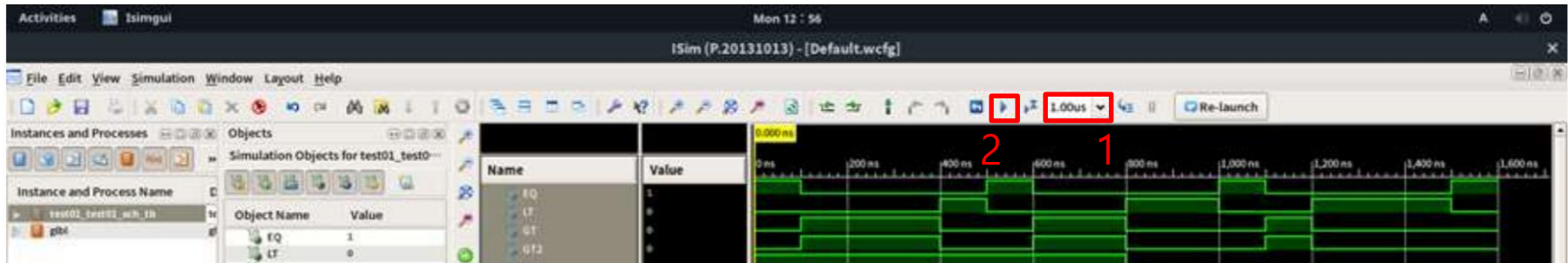
Simulation Result



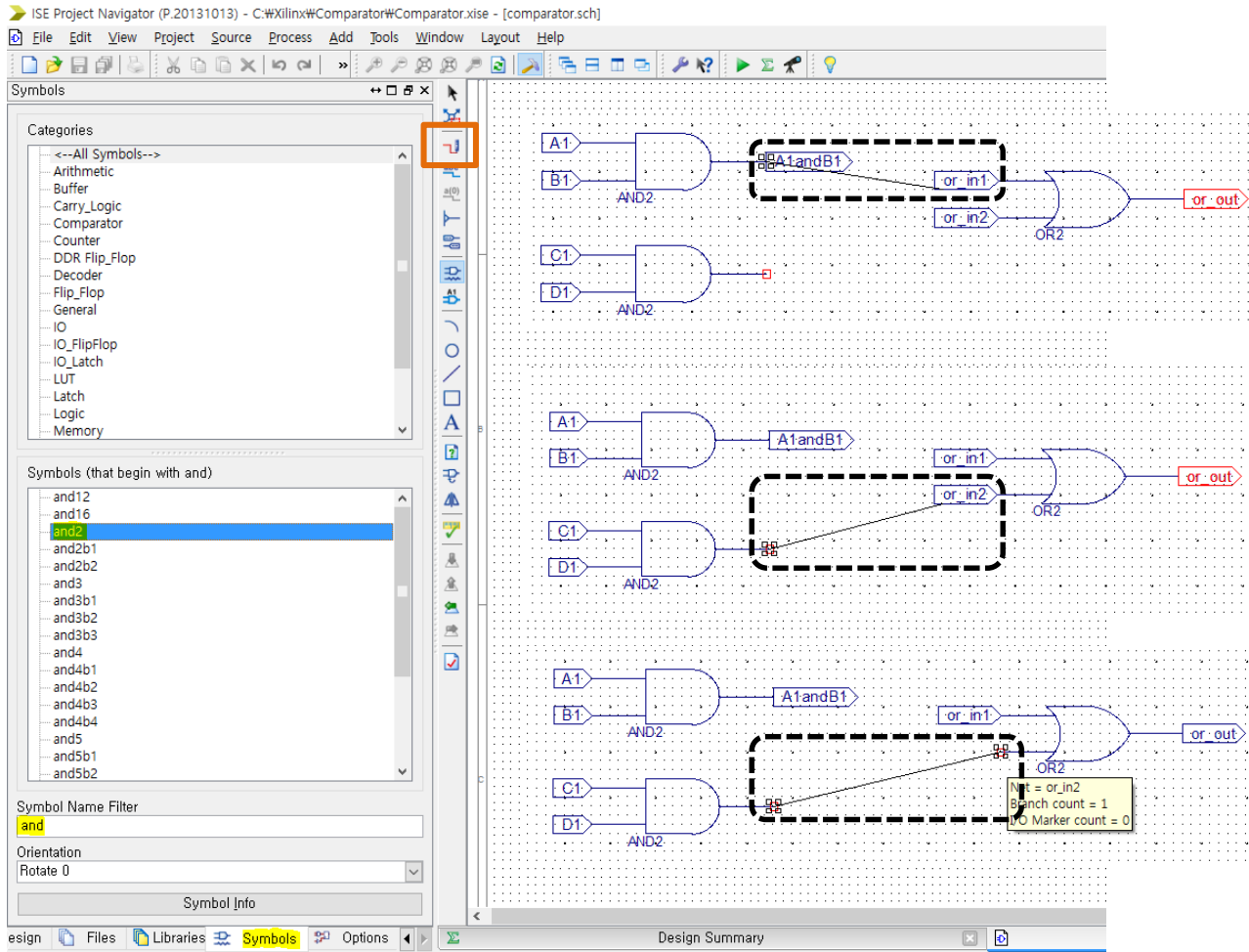
- To adjust the view, select View -> Zoom -> To Full View.

Tips : Adjust Simulation Time

- You can adjust simulation time (default : 1 us)



Tips: Connecting multiple gates



- When connecting multiple gates using **'Add Wire' button**, make sure that **both two ends don't have I/O markers**

Today's lab

- Implement 2-bit comparator LT, EQ, GT using Xilinx ISE Schematic. Simulate its behavior using Xilinx test bench.
- You may need to adjust simulation time to see every result.
- You should add result in report

Some problems with Xilinx

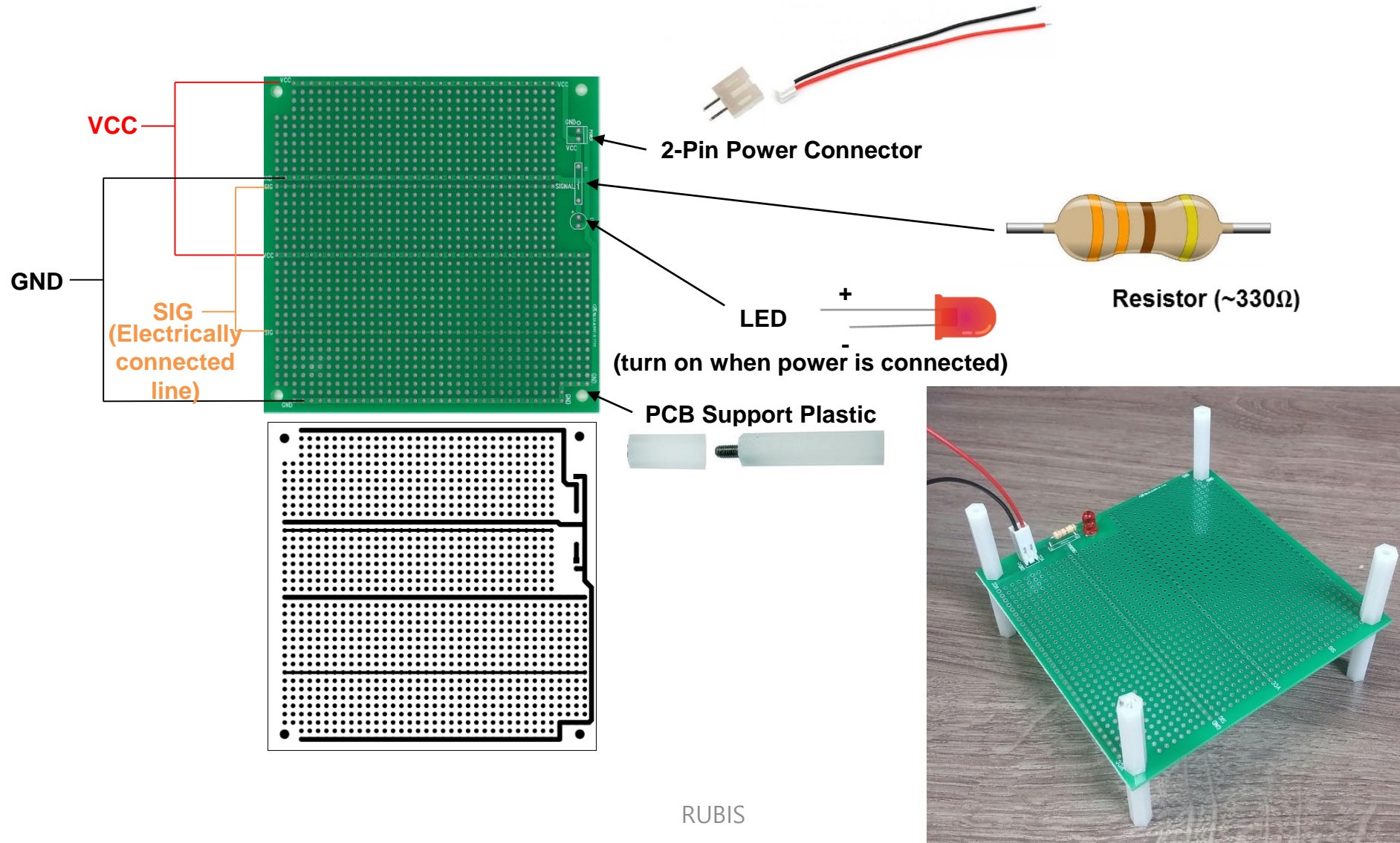
- Xilinx ISE program generates log file *.wdb
 - Sometimes, the file size grows hugely.
 - It makes disk size full, and the disk often fails to boot.
- Don't open multiple simulation windows.
- Before terminating Xilinx ISE program ...
 - Exit your simulation window.
 - Clean up your temp file with Project > Cleanup Project Files

```
ohasno@310-2-26:~/Comparator$ ls -al
total 156
drwxr-xr-x  6 ohasno cseusers  4096 Mar 27 15:43 .
drwx----- 19 ohasno cseusers  4096 Mar 27 15:35 ..
-rw-r--r--  1 ohasno cseusers   125 Mar 27 15:43 comparator_comparator_sch_tb_beh.prj
-rwxr-xr-x  1 ohasno cseusers 21792 Mar 27 15:43 comparator_comparator_sch_tb_isim_beh.exe
-rw-r--r--  1 ohasno cseusers  4709 Mar 27 15:43 comparator_comparator_sch_tb_isim_beh.wdb
-rw-r--r--  1 ohasno cseusers  4359 Mar 27 15:43 Comparator.gise
-rw-r--r--  1 ohasno cseusers   18 Mar 27 15:39 comparator.jhd
-rw-r--r--  1 ohasno cseusers  1908 Mar 27 15:39 comparator.sch
-rw-r--r--  1 ohasno cseusers    0 Mar 27 15:39 comparator.schlog
-rw-r--r--  1 ohasno cseusers  2517 Mar 27 15:43 comparator_summary.html
```

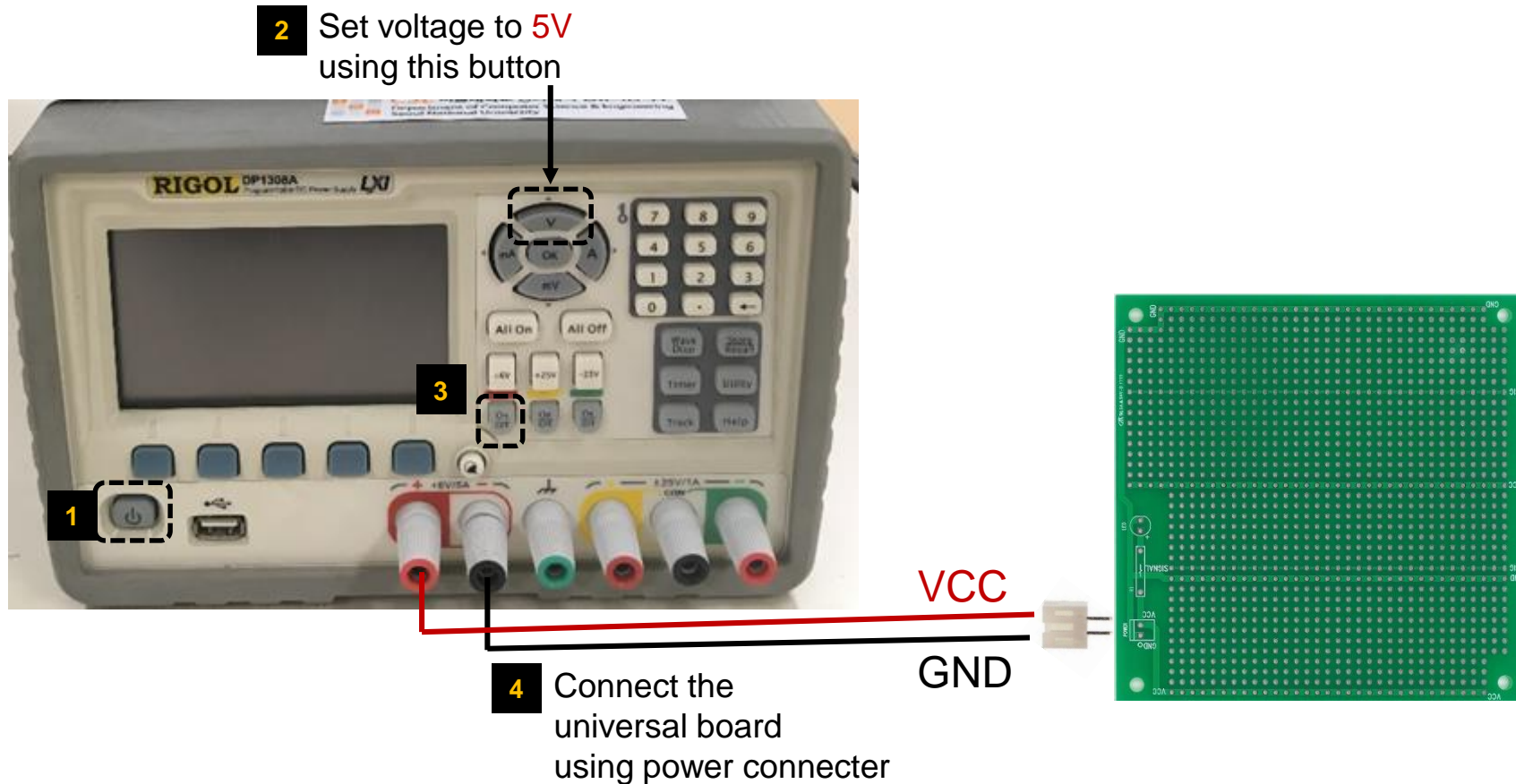
로그 파일

Universal Board

Custom-Made Universal Board

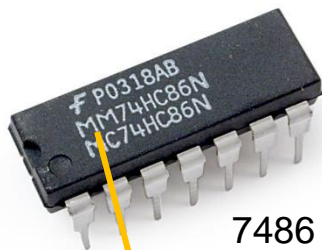


Turning it on using power supply

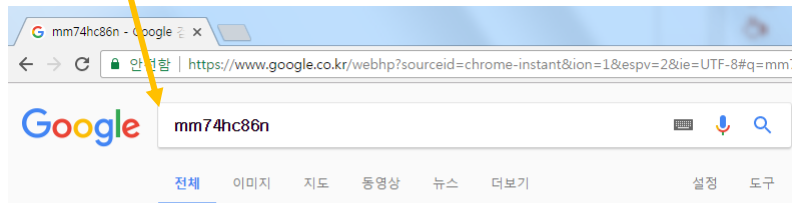


Tips: Look up the datasheet!

- NEVER trust the sorted device boxes... Always check the product name to confirm that you picked the right one.
- Always look up the datasheet online, double check its pin mapping.



7486 XOR gate



[MM74HC86N Datasheet\(PDF\) - Fairchild Semiconductor](#)
[www.alldatasheet.com/datasheet-pdf/pdf/.../MM74HC86N.html](#) ▼ 이 페이지 번역하기
MM74HC86N datasheet, MM74HC86N circuit, MM74HC86N data sheet : FAIRCHILD - Quad 2-Input Exclusive OR Gate, alldatasheet, datasheet, Datasheet ...

[MM74HC86N Fairchild/ON Semiconductor | Integrated Circuits \(ICs ...](#)
[www.digikey.com/product.../MM74HC86N/MM74HC86N.../543...](#) ▼ 이 페이지 번역하기
Order Fairchild/ON Semiconductor MM74HC86N (MM74HC86N-ND) at DigiKey. Check stock and pricing, view product specifications, and order online.

FAIRCHILD
SEMICONDUCTOR™

September 1983
Revised January 2005

MM74HC86

Quad 2-Input Exclusive OR Gate

General Description

The MM74HC86 EXCLUSIVE OR gate utilizes advanced silicon-gate CMOS technology to achieve operating speeds similar to equivalent LS-TTL gates while maintaining the low power consumption and high noise immunity characteristic of standard CMOS integrated circuits. These gates are fully buffered and have a fanout of 10 LS-TTL loads. The 74HC logic family is functionally as well as pin out compatible with the standard 74LS logic family. All inputs are protected from damage due to static discharge by internal diode clamps to V_{CC} and ground.

Features

- Typical propagation delay: 9 ns
- Wide operating voltage range: 2-6V
- Low input current: 1 μ A maximum
- Low quiescent current: 20 μ A maximum (74 Series)
- Output drive capability: 10 LS-TTL loads

Ordering Code:

Order Number	Package Number	Package Description
MM74HC86M	M14A	14-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-012, 0.150" Narrow
MM74HC86MX_NL	M14A	Pb-Free 14-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-012, 0.150" Narrow
MM74HC86SJ	M14D	Pb-Free 14-Lead Small Outline Package (SOP), EIAJ TYPE II, 5.3mm Wide
MM74HC86MTC	MTC14	14-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 4.4mm Wide
MM74HC86N	N14A	14-Lead Plastic Dual-In-Line Package (PDIP), JEDEC MS-001, 0.300" Wide
MM74HC86NX_NL	N14A	Pb-Free 14-Lead Plastic Dual-In-Line Package (PDIP), JEDEC MS-001, 0.300" Wide

Devices also available in Tape and Reel. Specify by appending the suffix letter "X" to the ordering code.
Pb-Free

Connection Diagram

Pin Assignments for DIP, SOIC, SOP and TSSOP

Truth Table

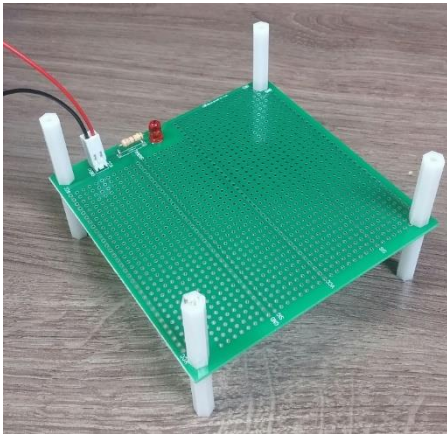
Inputs		Outputs
A	B	Y
L	L	L
L	H	H
H	L	H
H	H	L

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

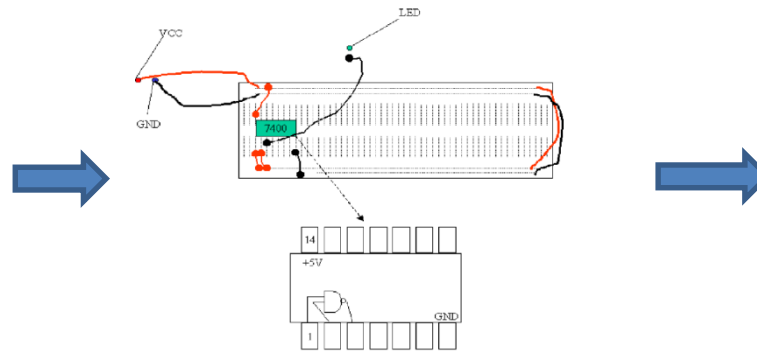
MM74HC86 Quad 2-Input Exclusive OR Gate

Insight

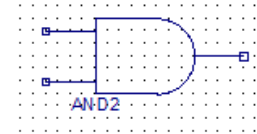
- Xilinx to the rescue!
 - Thanks to Xilinx, you don't need to solder or use a breadboard when implementing the circuit.
 - In the past, without Xilinx, hardware design was much more challenging than now.



Soldering



Breadboard

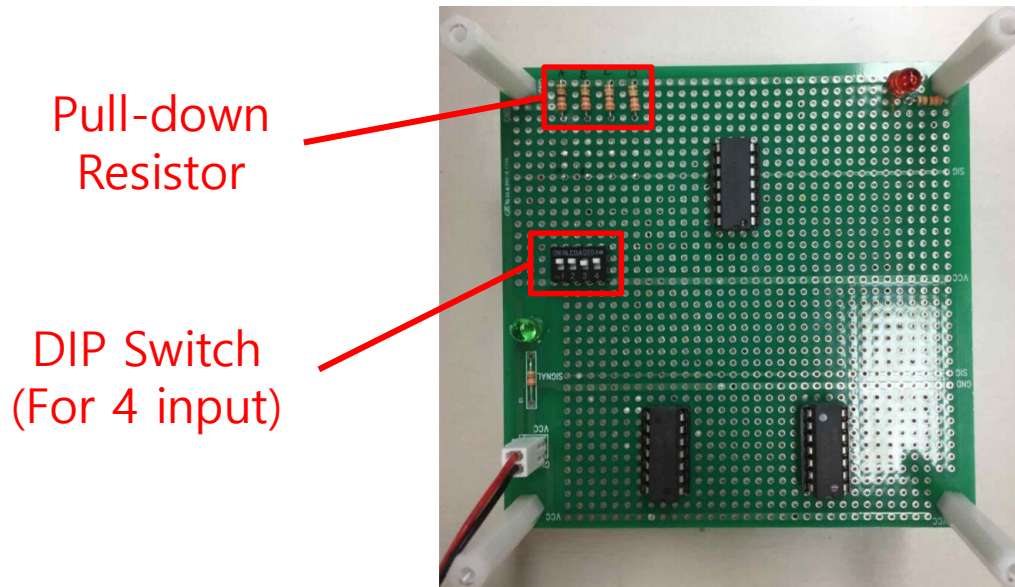


Xilinx

Homework

1. [TEAM]

Implement 2-bit comparator GT logic on the universal board, using DIP switch and primitive logic gates(INV, AND, OR, XOR, NAND...). Try your best to minimize the number of logic gates/chips used.

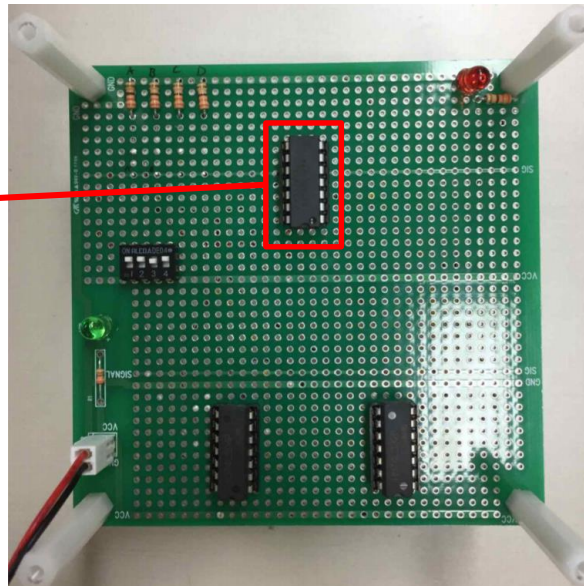


Homework

Tips

- You should solder chip socket, not on gate directly!
- Remove the sheath from the wire and use it.

Chip Socket
+
Gate



Homework

2. [Individual]

Draw a circuit diagram for the below formula using **ONLY NOR and NOT gates**. You can draw it by hand or using any of a computer program.

- $Y = A(B+CD)$

3. [Individual]

$$Y = AB + ABC + A'B + AB'C$$

- (1) Make a truth table
- (2) Minimize # of operators
- (3) Draw a circuit diagram

Homework

4. How can we reduce more costs in GT circuit on a universal board?
(Optional)

- This question is for discussion.
(If you don't have any discussion, think about this)

Homework

- Write a report
 - Either in Korean or in English
 - **Your report should include:**
 - Lab result (Not only homework)
 - Through discussion
 - Homework (if there is any)
 - # of pages doesn't matter
 - Documents should be submitted as PDF file.
 - **Due :**
 - Class 001 – April, 4th (Before class begin at 7:00pm)**
 - Class 002 – April, 5th (Before class begin at 7:00pm)**
 - Class 003 – April, 6th (Before class begin at 7:00pm)**

Questions
