



**School of Computing  
Faculty of Engineering  
UNIVERSITI TEKNOLOGI MALAYSIA**

SUBJECT : SECR1013 DIGITAL LOGIC

SESSION/SEM : 2020/2021 - 1

**LAB 4 : 2-BITS PHOTOCOPYING XEROX  
MACHINE**

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## Photocopying (Xerox) Machine

### A. Objectives

The objectives of this laboratory are to introduce the students to:

- The development of a PLD device
- A simple Hardware Description Language

### B. Materials

Breadboard

ATMEL 22V10

- 1 unit

ETS-5000 Digital Training kit

Wellon or Hi-Lo ALL-11 Universal Programmer & Tester

WinCUPL 5.0 Software

Handouts:

***“WinCUPL user manual”***

***“ATMEL22V10 Data Sheet”***

***“How to use Hi-Lo Programmer”***

***“How to use Wellon Programmer”***

***“How to use Win CUPL 5”***

As an appendix in your Lab Book

### C. Mini Project : Photocopying (Xerox) Machine

#### Background

*Read the appendix in your lab book to familiarize yourself with the WinCUPL compiler and the universal programmer. If you need any help please ask your lecturer or the teaching assistants.*

This mini project will implement 3 different components on a single ATMEL device, those components are

1. Count Up Counter
2. Comparator
3. Clock Disabler

#### Problem:

User will initially enter amount of copies, the counter will count the number of copies that has been photocopied. The machine will stop once the required number of copies produced.

### Proposed Solution:

A block diagram of a component required is shown in Figure1. Three core components are counter, comparator and clock disabler. Counter will determine the number of copies that has been made while the comparator will determine whether the required number of copies has been met. Once the number of copies has been met, the clock disabler will disable the clock and stop the counter from counting. The machine will display the required number of copies and the amount that has been produced.

To implement this, the user has to key in the required number of copies by using 2 switches, which allow the required number from 0 to 3 (don't ask me why so few, if you can produce a zillion copies by using the kit in the lab then I will give you an A+ for this subject). He/she will reset the counter (assuming pressing a START button), the counter will count and its output will be compared with the value of the switches, if the value is not the same it will continue counting up. A signal will be generated to stop the counting if the output of the counter has the same value as the digital value of the switches.

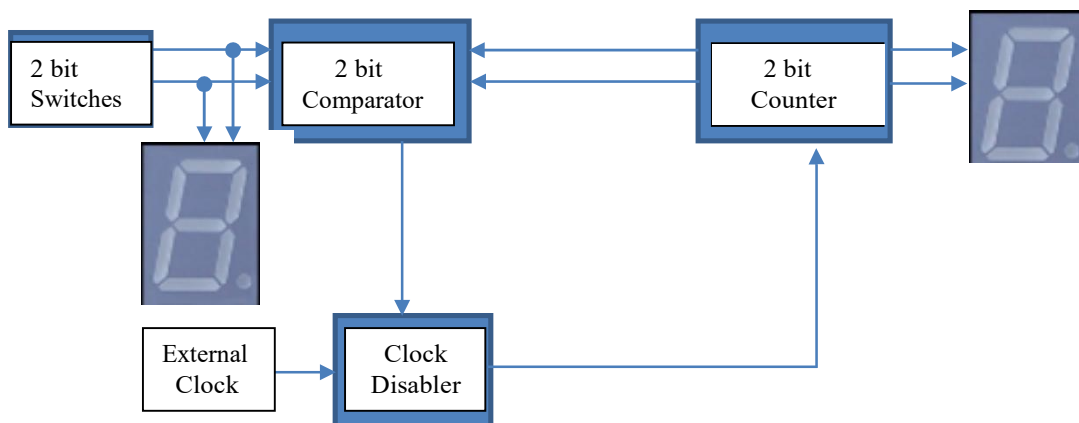


Figure 1. A block diagram of a complete system

### Components & Requirement:

- ✓ **Switches:** to set the required no of copies
- ✓ **Counter:** to count the number of copies that has been made
- ✓ **Comparator:** to compare the number of copies required with the number of copies produced
- ✓ **Clock Disabler:** to stop the operation of the counter

*If Copies produced < Required Copies, Counter will count up  
Else  
Counter will stop counting*

## Implementation

### Comparator

A comparator is a combinational circuit that can be designed using *XNOR* gate. Figure 3 shows a 2 bit equality Comparator, you need to modify this circuit to suit the requirement of your design

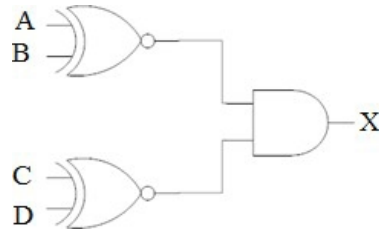


Figure 3. 2bits Equality Comparator

**COMPARATOR Testing steps:**

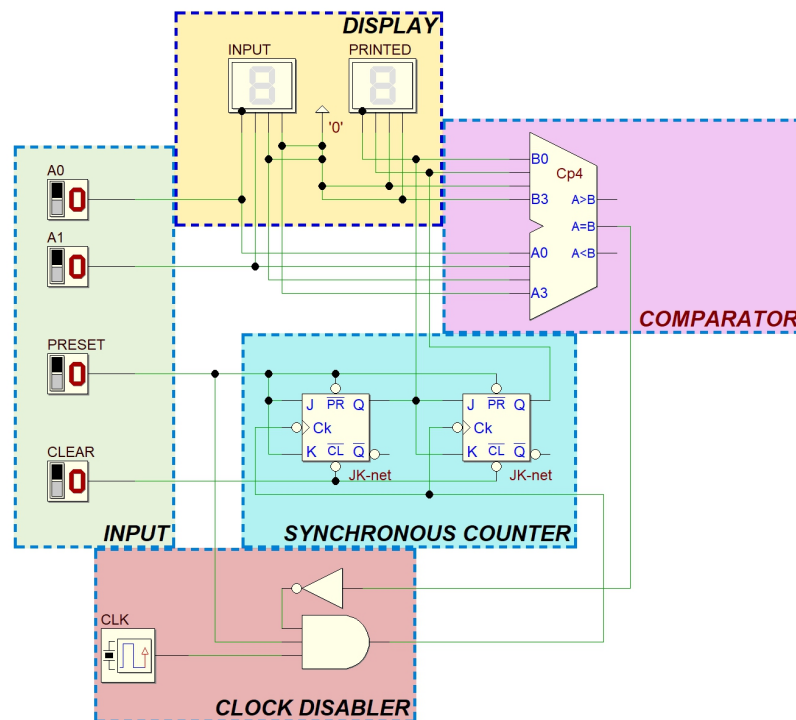
- Set the number of required copies by flipping the switch (eg:  $A_1A_0 = 10$  ; 2 copies)
- Set different value of  $B_1B_0$  and compare the value in  $A_1A_0$  . What is the value of L and H.

$A_1$	$A_0$	$B_1$	$B_0$	diffCmp	sameCmp
0	0	0	0	0	1
0	1	0	1	0	1
1	0	1	0	0	1
1	1	1	1	0	1

**COUNTER Testing steps:**

- Set the Asynchronous/Synchronous pin switch input to the correct setting.  
Make sure the initial output of the counter in ZERO.
- Press the pulser switch, it will increment the counter ( $00 \rightarrow 01 \rightarrow 10$ )
- Counter output equals comparator will change as count up counter.

## Final Circuit



2 bits Xerox photocopying machine with comparator component

## **Appendix**

Demonstration video:

[https://www.youtube.com/watch?v=L\\_w2T\\_s8sXg&feature=youtu.be](https://www.youtube.com/watch?v=L_w2T_s8sXg&feature=youtu.be)