# Dedication and Acknowledgement

First of all, we would like to dedicate our thanks and gratitude to our lecturer, Madam Rashidah for teaching and giving us guidance at every step of the way in learning this subject. She has taught us a lot of thing about the basics of electronics and the application of this electronical knowledge in real life. Madam Rashidah has also been very patient in explaining the various and complicated ideas in the progress of this project. Thanks to her guidance we are able to complete the project successfully.

We would also like to extend out appreciation to the lab assistants that also helped us during the time we were doing the practical section of this course. They have prepared the prerequisite items and tools to accomplish the tasks, such as the Wellon programmer and the additional software needs.

Finally, we would like to note our appreciation to the friends and comrades in 1SECP that assisted in doing this project, without their teamwork this project would have not been possible, the expertise in both coding and wiring the chips at that point of time was very crucial in completing the program in the given time.

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# DESIGN OF A XEROX MACHINE

## Background

In this project, we will be implementing 2 separate components in a single ATMEL chip.

## Problem Statement

In order to start printing in the XEROX machine, the user is required to input the number of copies of paper that he wishes to print, ranging from 0 to 3 or 0 to 7, for the 2-bit counter and 3-bit counter respectively. After doing so, the user is required to activate the printing switch. The XEROX machine should be capable of counting the number of papers that it has successfully printed. Two 7-segment LEDs are used to provide the digit display in this project, one to show the number of papers wished to be printed, and the other to show the number of papers already printed. The comparator implemented in the code will compare the number of papers printed and the total amount of papers needed to be printed. If said values differ, the printer will continue printing. If they are the same, the printer stops printing and counting.

## Objectives

The objective of this lab practical is to expose the students to:

1. Understanding the development of a PLD device
2. The implementation of a simple Hardware Description Language

## Flowchart

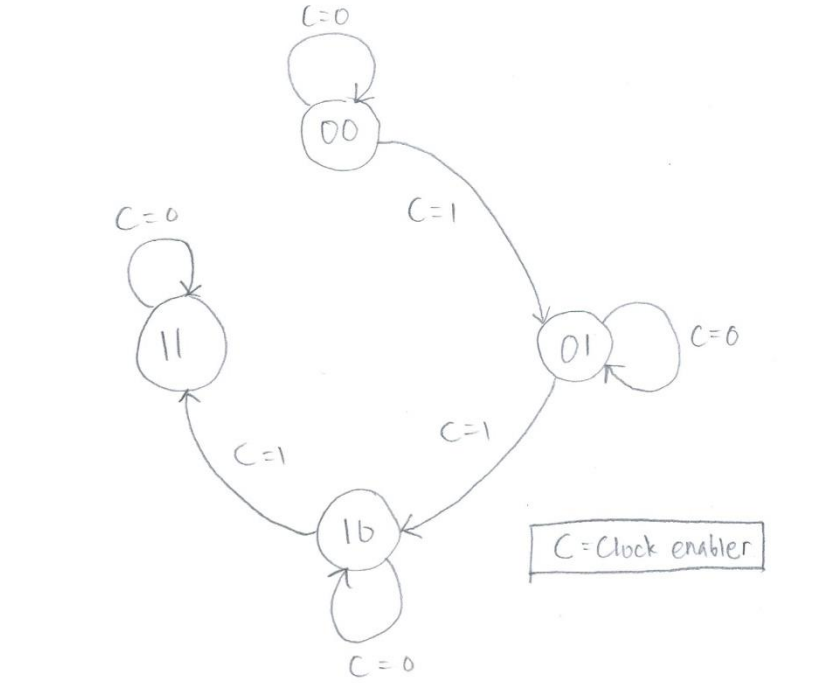



*Figure 1*

*2-bit Comparator Flowchart*

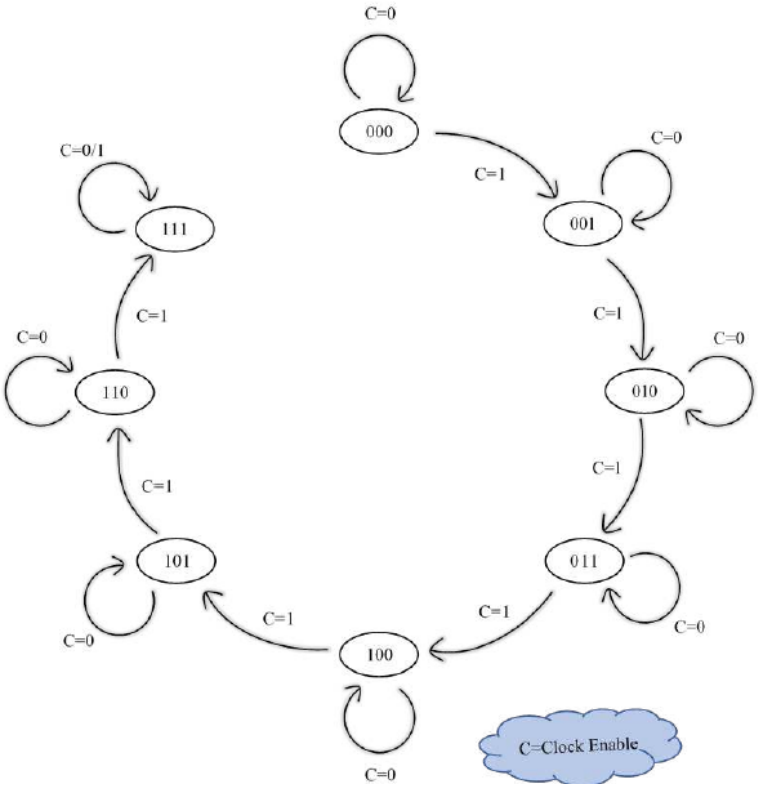



*Figure 2*

*3-bit Comparator Flowchart*

## Component

These components implemented in this lab include:

1. 2-bit Saturated Counter
2. 3-bit Saturated Counter

## Materials

The Materials and Software used in this laboratory are as stated as below:

1. Breadboard
2. ATMEL 22V10 chip
3. ETS-500 Digital Training Unit
4. Wellon Universal Programmer
5. WinCUPL 5.0

## Circuit Implementation

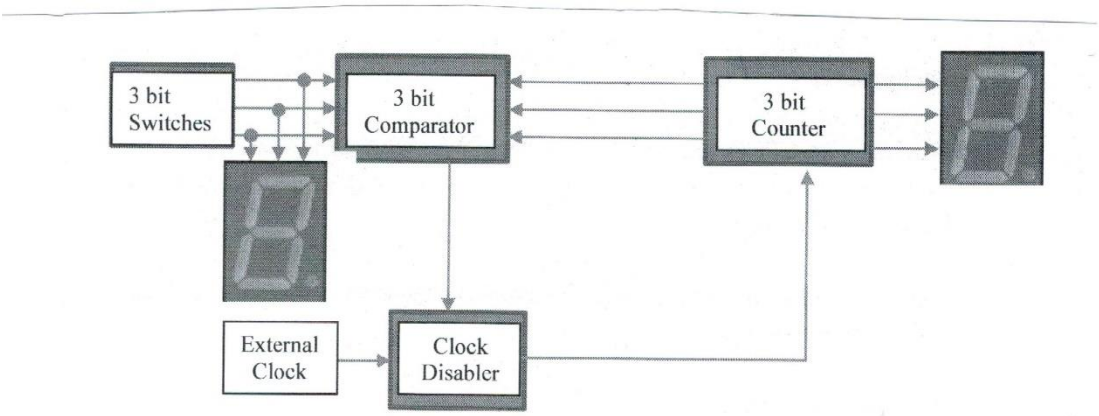
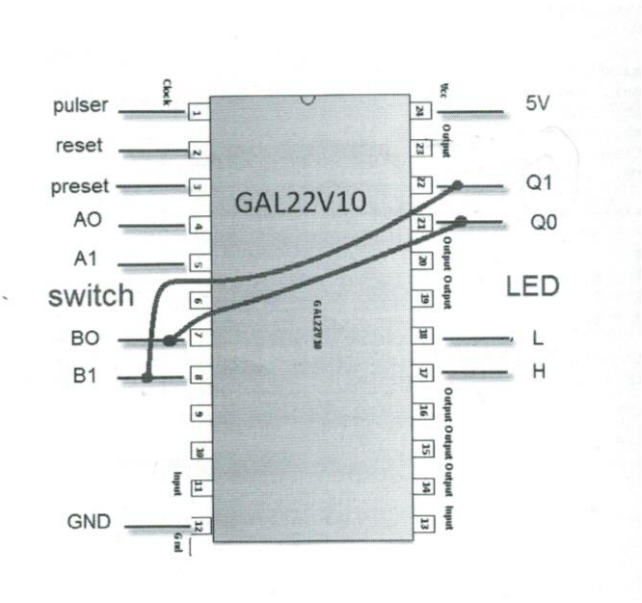



**Figure 1** A block diagram of a complete system

## Physical System Implementation




## Discussion

In short, this project need both programming and digital logic knowledge to solve the problems. Our strength is we are able to create the new 3-bit saturated counter program by ourselves and success at the first try with no error. The problem faced is when solving the 2-bit saturated counter. We confused with what source must be connected by each pin. Other than that, we also received the unwanted outputs for the counter as an example the counter did not count but directly follow the input. We solve that by rearranging the wires and it works. The new function suggestion for this system is we need to improve the amount of the pages we want to print and not limit until 8 pages only. Because in real life, people usually print hundreds or thousands of page in one time and this system are not capable of it. Maybe we need the 16-bit saturated counter for commercial unit.

## Conclusion

It can be said that we have completed the project successfully to the stated goals. Every component worked perfectly as planned and functioned flawlessly in the lab. The solution produced by the circuit has also made the XEROX machine possible.

Throughout this project, we have encountered many problems, nevertheless we have solved them successfully. We have gained a lot of experience in programming and implementing a chip in this lab practical. This knowledge may also be used in our further studies as we progress through other courses in UTM. For example, we managed to learn on how to use Wellon Universal Programmer and the ATMEL chip.

We would also like to voice out our appreciation to Madam Rashidah again for showing us the way of building this circuit, teaching Digital Logic and guiding us at every step of the way. More thanks are extended to other lab assistants and friends that also assisted us in making this lab possible.

## References

Abd. Bahrim Yusoff, M. S. (2018). *Digital Logic 5th Edition.* Johor: Desktop Publisher.

# Appendix

## Code Snippets

### *2-bit Comparator*

```
Name XeroxMachine2BIT ;
PartNo 00 ;
Date 07/12/2017 ;
Revision 01 ;
Designer Engineer ;
Company UTM ;
Assembly None ;
Location ;
Device G22V10 ;

/* *************** INPUT PINS *********************/
PIN 1 = clk ;         /* clock */
PIN 2 = reset ;               /* reset */
PIN 3 = preset ;              /* preset */
PIN 4 = a0 ;                  /* Comparator A */
PIN 5 = a1 ;                  /* */
PIN 7 = b0 ;                  /* Comparator B */
PIN 8 = b1 ;                  /* */
PIN 10 = startPrt ;           /* Start Printing */

/* *************** OUTPUT PINS *********************/
PIN 17 = diffCmp ;            /* XOR (A B not equal HIGH) */
PIN 18 = sameCmp ;            /* XNOR (A B equal HIGH) */
PIN 21 = q0 ;         /* output counter */
PIN 22 = q1 ;         /* output counter */

/***** Function Comparator************************/
sameCmp = !(a0$b0)&!(a1$b1);
diffCmp = !sameCmp ;

/**** Function Clock Enabler *********************/
clkEn=startPrt & diffCmp;

/*** Function Counter 2 Bit UP ******************/
field count =[q1..0];
$define s0 'b' 00
$define s1 'b' 01
$define s2 'b' 10
$define s3 'b' 11

count.ar=reset;       /* connect reg AR to reset (Asyn Mode) */
count.sp=preset;      /* connect reg AR to preset (Syn Mode) */

sequence count{
       present s0 if clkEn next s1;
              default next s0;
       present s1 if clkEn next s2;
              default next s1;
       present s2 if clkEn next s3;
              default next s2;
       present s3 if clkEn next s3;
              default next s3;
}
```

## *3-bit Comparator*

```
Name     Ariff Fansuri ;
PartNo   00 ;
Date     17/12/2019 ;
Revision 01 ;
Designer Engineer ;
Company  UTM ;
Assembly None ;
Location Digital Logic Lab ;
Device   G22V10 ;

/* members in group : Ariff Fansuri
                      Irfan Daniel */

/* Input Pins */

PIN 1 = clk ;
PIN 2 = reset ;
PIN 3 = preset ;
PIN 4 = A0;
PIN 5 = A1;
PIN 6 = A2;
PIN 7 = B0;
PIN 8 = B1;
PIN 9 = B2;
PIN 10 = startPrint;

/* output pins */

PIN 17 = H;
PIN 18 = L;
PIN 21 = Q0;
PIN 22 = Q1;
PIN 23 = Q2;

H = !(A0$B0)& !(A1$B1)&!(A2$B2);
L = !H;

field count=[Q2..0];
$define S0 'b' 000
$define S1 'b' 001
$define S2 'b' 010
$define S3 'b' 011
$define S4 'b' 100
$define S5 'b' 101
$define S6 'b' 110
$define S7 'b' 111

count.ar = reset;
count.sp = preset;
clkEn= L & startPrint ;

sequence count{
       present S0 if clkEn next S1;
              default next S0;
       present S1 if clkEn next S2;
              default next S1;
       present S2 if clkEn next S3;
              default next S2;
       present S3 if clkEn next S4;
              default next S3;
       present S4 if clkEn next S5;
              default next S4;
       present S5 if clkEn next S6;
              default next S5;
       present S6 if clkEn next S7;
              default next S6;
       present S7 if clkEn next S7;
              default next S7;
}
```

## Lab Pictures