



UTM

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SECR1013-02 DIGITAL LOGIC

LAB 4 + MINI PROJECT

TOPIC: Programmable Logic Device (PLD) Photocopying (Xerox) Machine

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Dedication & Acknowledgement

First and foremost, with our devotion to our lecturer, Dr. Nur Haliza Binti Abdul Wahab, we have finally completed this final project and we would like to express our gratitude to her. She is a brilliant lecturer who taught us about digital logic and how to apply it to our real life. She explained and listened patiently to all the difficulties we encountered and also guided us to find the solution. She provided a lot of help and guidance throughout the project so that we managed to complete the final project on time.

In addition, we would also like to thank our classmates and friends who have assisted us with this final project. To make it more effective, we share information with each other and discuss the 3-bit PLD programme together. In this project, we also shared our ideas with each other to change the Xerox Machine.

Table of Contents

Dedication & Acknowledgement	1
Objective	3
Materials	3
The Problem	4
Proposed Solution	4
Discussion	8
Conclusion	9
Reference	9
Appendix	10

Table of Figures

Figure 1 Block diagram of a complete system of the machine	5
Figure 2 The Drawing of Deeds.	8

Background

In this project, we will implement 3 different components on a single ATMEL device.

These components including:

1. 3-bit Count up Counter
2. 3-bit Comparator
3. Clock Disabler

Objective

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

1. Understand the development of a PLD device.
2. Learn a simple Hardware Description Language.

Materials

The materials of this laboratory are:

1. Breadboard
2. ATMEL 22V10 – 1 unit
3. ETS-5000 Digital Training Kit
4. Wellon or Hi-Lo ALL-11 Universal Programmer & Tester
5. WinCUPL 5.0 Software
6. Handouts:
 - a. “WinCUPL user manual”
 - b. “ATMEL 22V10 Data Sheet”

- c. “How to use Wellon Programmer”
- d. “How to use WinCUPL 5”

The Problem

A switch is required to power the Xerox machine in order to initialise or close the Xerox machine. The user will then be forced to enter a password to enable the xerox part of the machine. This is due to private security in order to avoid unauthorised use of the machine. A part of the output is used to enforce that the password entered is valid. If an invalid password, the machine will not proceed to the next step. The computer will not move to the next stage if an invalid password is entered. Then, the user is expected to select the printing properties. The properties are printing properties, including colour printing and black and white printing, while portrait and landscape are the style properties. After that, users need to enter the number of copies that they want to print, starting from 0 to 7. First, to reset the counter, the user needs to set the PRESET and the CLEAR button. There is a counter in the photocopying system to count the number of copies that have been photocopied. Two 7-segment displays are used to show the amount of required copies and photocopied copies. A comparator will compare the number of required copies and photocopied copies. The machine will stop once the required number of copies is produced.

Proposed Solution

In Figure 1, the block diagram of a necessary part is shown. First of all, the user is expected to turn on the power button to power the components of the photocopy machine to initialise the photocopy machine. Then, before beginning to use this photocopying machine, the user must enter a 4-bit password. This is to protect the computer from unauthorised use. If the password entered is incorrect, the user is unable to proceed to the next level. The LED will light up until the password is right, to show that the computer is ready for use.

Users must then choose the printing properties. The printing characteristics include colour printing, black and white printing, portrait and landscape printing. The characteristics are either portrait or landscape colour printing, or portrait or landscape in black and white. A multiplexer is

used to allow the option of properties to be selected by the user and a demultiplexer is used to indicate the choice chosen by the user. LED light can supplement the arrangement of the printing properties to enforce the selection process of the properties. Three core components used to count the necessary copy are the 3-bit comparator, the 3-bit JK positive edge count up counter and a clock enable. The counter is used to calculate how many copies have been made. The Comparator compares the necessary number of copies with the number of copies printed. Once copied, the number is equal to the number of copies printed. Disabling the clock disables the clock and prevents the counter from counting.

Users have to enter the number of necessary copies using 3 input switches to enforce this. These switches allow the user to enter a 3-bit digit that is between 0 and 7. Next, to reset the counter, the user needs to set PRESET to 1 and follow Simple. In order to display both the number of necessary copies and photocopied copies, two 7-segment LEDs will be connected to the system. If the quantity is different, then photocopying will proceed until all values are the same. The photocopy machine would stop printing and counting after that. The method of printing has been terminated. If the user wants to continue using the xerox machine, he or she just needs to repeat the property selection stage, insert the appropriate number of copies, and reset PRESET and CLEAR to 1.

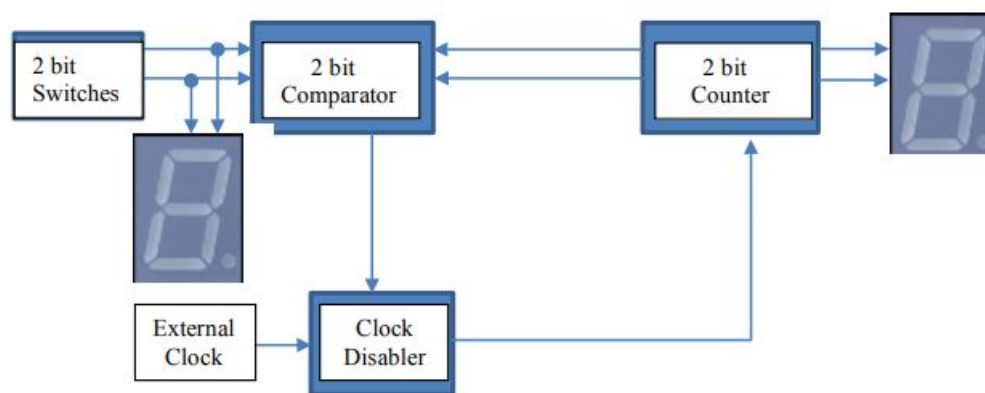


Figure 1 Block diagram of a complete system of the machine

Components & Requirement

1. Input Switches

To get the amount of copies that users want to print.

2. 3-bit JK Positive-edge Count-up Counter

To count the amount of copies that have been printed.

3. 3-bit Comparator

To compare whether the amount of copies input and also the amount of printed copies has been met.

4. Clock Disabler

To stop the counter when the amount of copies input and printed copies has been met.

5. 7-Segment Display

To display the required number of copies and amounts of printed copies.

System Implementation

1. Input Switch

The user has 3 switches to input the amount they need. The switches each represent a single bit, which is CNT0, CNT1, CNT2, respectively. CNT0 represents LSB and MSB is represented by CNT2. The consumer is also only able to input values ranging from 0 to 7. A 7-segment display and comparator are connected to the output of the input switch.

2. 3-bit count-up Counter

The 3-bit counter that we use is a 3-bit JK positive edge count-up counter. The counter starts to count based on the clock enabler. It will start counting if the J and K input are connected to high

input. If the START button is activated, the clock enabler is active. It will stop when the clock pulse is no longer received or reached the number of counts initialised by the user (printing amount).

3. 3-bit Comparator

The comparator uses three 2-input XOR gates to compare value from 2 sources, which are the input switches and the counter. The first XOR gate compares the least significant bit (LSB) of the 2 sources. If they are the same, the output will be 0 and it is sent to the NOT gate and converted into 1. The same principle applies for the second and the third XOR gate. Then the signal from all the three gates will be sent to a NAND gate to convert it into an opposite signal. Therefore, when all the XOR gates receive the same input from input switches and the counter, it will send an output 0 to clock enabler to stop the photocopy process.

4. Clock Enabler

The clock enabler is set up by using a 3-input AND gate. The input of the AND gate is the clock source, signal sent by the properties (START button) and a signal sent by the comparator. The enabler can only be active when all three inputs are high. It used to stop the operation of the counter when the amount of copies and printed copies has been met.

5. 7-Segment Display

This component displays the number by converting the binary code received and into decimal. Two 7-segment displays are used where one of them shows the required copies at input and the other shows printed copies at output. Since we use a 7-segment display but just connected to 3 input thus the 4th input will connect to ground (0).

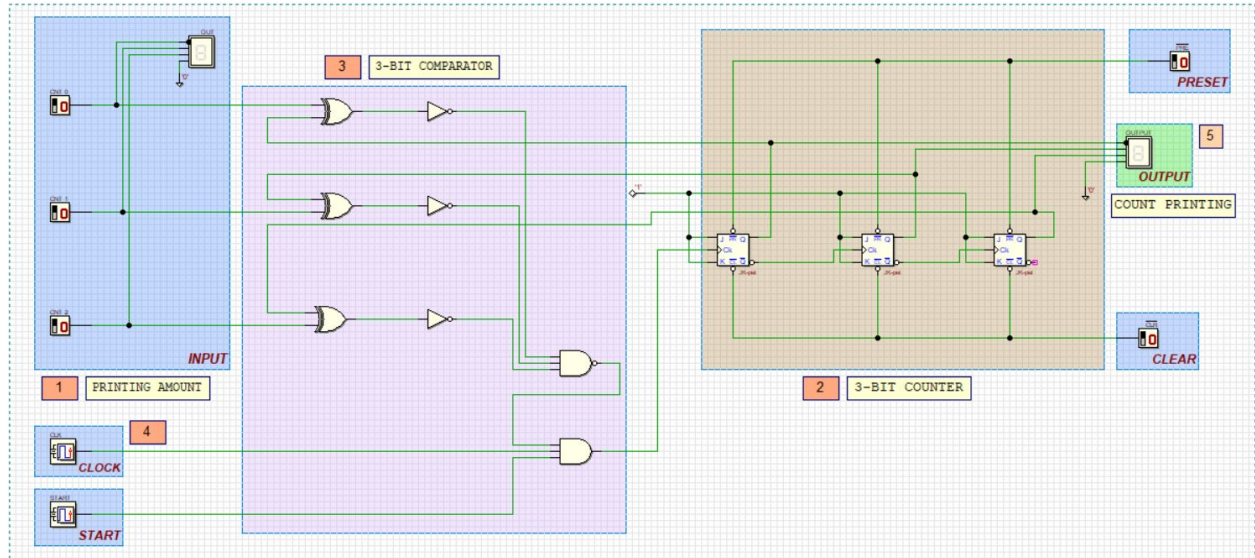


Figure 2 The Drawing of Deeds

Instruction to use deeds:-

1. Set PRESET to 1
2. Make sure CLEAR is 1
3. Enter the printing amount at input
4. Press START to start printing
5. Press CLOCK continuously until reaching the amount of printing in input. The process will stop when the maximum printing amount.
6. Set back START and CLEAR to 0 after finished printing.
7. Repeat the process (step 1 - 6) to print more.

Discussion

This project is about how to build a PLD device and simple Hardware Description Language. The device we build can copy the number of user input to an output. The machine will stop once the output is matched with the user input. After this project, we are able to build a simple 2-bit and 3-bit counter. We also have a very good understanding about how counter, comparator, and clock disablers work. This might be very helpful when it comes to hardware or circuit design.

Although it seems we did the project successfully, we actually face many problems when we are preceding the project. We are facing difficulty in doing discussion in WhatsApp as not all the group members are free at any time. Hence, we have to remind them of our final discussion result one by one. Other than that, when the project is proceeding, the final exam is around the corner. We have to study other subjects while doing our project. This makes us plan our schedule more tightly.

Overall, it is a very fun project that allows us to make the device ourselves. By looking at the counter increase one digit by one digit, we really feel our hard work and time spending are worth it. To further the project, we are thinking we can try to build one of these in Minecraft.

Conclusion

Digital logic is really handy, and we personally think that I was a must-learnt subject for an IT related student. This project has increased our impression of digital logic and the logic gate. Although the high level programming languages are the trends of modern IT companies, the need of computer chips and CPU processors and its design of the circuit are also important.

With this project, we are able to have a skill of communication and have a plan to proceed with the project. Although the group members of this project are far apart from each other, we are still able to do many things due to the convenience of the internet. We now know how to guide others group mates, express and explain the needs of ourselves in a polite way, and we also have good leadership skills after this.

Reference

1. Mohamad, M., Othman, S., Raja Mohd Radzi, R., Yaacob, M., & Kamarudin, C. (n.d.). (2018). Digital Logic (Fifth Edition). Johor, Malaysia. Desktop Publisher.

Appendix

1. Basic Photocopying Machine Coding

```
Name      Xerox3 ;

PartNo     00 ;

Date       6/2/2021 ;

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 6  = a2                 ; /*                */

PIN 7  = b0                 ; /* Comparator B   */

PIN 8  = b1                 ; /*                */

PIN 9  = b2                 ; /*                */

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 */

PIN 23 = q2                                /* output counter */


/***** Function Comparator*****/

sameCmp = !(a0$b0)&!(a1$b1)&!(a2$b2);

diffCmp = !sameCmp ;


/**** Function Clock Enabler *****/

clkEn=startPrt & diffCmp;


/** Function Counter 2 Bit UP *****/

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


/**Define Asynchoronous Input: Asynchronous Input Active High**/

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

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


/**State Counter Sequence**/

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;

}
```