UTM
UNIVERSITI TEKNOLOGI MALAYSIA

GROUP REPORT

Mini Project: Programmable Logic Device (PLD) Photocopying (Xerox) Machine

Year: 2020/2021 Semester 1

Course: Bachelors of Computer Science (Data Engineering)

Subject: SECR 1013-02 (Digital Logic)

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Video Presentation for part 2: https://drive.google.com/file/d/1t26lhuFhZ-GVrNC9R_ngngZe5aLa4ROR/view?usp=sharing

Deeds:
https://drive.google.com/file/d/1tbrSUZtffYoi5Y7BKhKdRTDbLgvd1DKs/view?usp=sharing

Dedication & Acknowledgement

First of all, we would like to express our gratitude toward our Digital Logic lecturer, Dr. Nur Haliza for her unconditional guidance throughout our mini project which is very complex and difficult. We are very grateful because our lecturer was always there when we needed her for her consultation. Without her advice and knowledge, we would not be able to complete the mini-project as we are still not familiar with the topic very well.

Next, we would like to appreciate our family's members supporting us emotionally and also physically for us to complete our mini-project. Thanks to them we are able to complete our task with full of motivation and determination. Without them, we would not have the strength to continue our mini-project as we will have the final exam for the following week.

Last but not least, we would like to say a big thank you to our classmate. They are really angels in disguise as we can discuss the questions together. We are very grateful to have them in life and we also want to express our gratitude to our group members for the support and willingness to spend valuable time to finish this project.

Table of Content

Report Content

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

1. Breadboard
    - A breadboard is a solderless device for temporary prototype with electronics and test circuit designs. Connections are made when the wires are inserted into the holes and all the holes in selected column are interconnected.

2. ATMEL 22V10 – 1 unit
    - A high-performance electrically erasable CMOS programmable logic device (PLD) with proven Microchip electrically erasable flash memory. The device supports speeds down to 5ns and power dissipation as low as 10. All speed ranges are specified over the full 5V ± 10% range for military and industrial applications and 5V ± 5 percent for commercial applications. Each of several low-power options can significantly reduce total system power and enhance system reliability.

3. ETS-5000 Digital Training Kit
    - Is where the breadboard home. Contains 2 digits of 7-segment LED display, 8 bit LED display when the mode selector switch was set to ‘TTL’ and so on.

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4. Wellon Universal Programmer & Tester
    - Is the software used for programming the IC circuit. The IC is inserted and .JED file is open inside the application. The IC then can be programmed using the coding or content inside of the .JED file.

5. WinCUPL 5.0 Software
    - Is the software used for writing the coding to program one IC. .JED file and .PLD file will be generated once the coding is compiled.

6. Handouts:

    a. “WinCUPL user manual”

    b. “ATMEL 22V10 Data Sheet"

    c. “How to use Hi-Lo Programmer”

    d. “How to use Wellon Programmer”

    e. “How to use Win CUPL 5”

Background

In this project, we will implement 8 different components on a single ATMEL device.

These components including:

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

5. Multiplexer
6. Demultiplexer
7. Adder
8. Input switches

The Problem

To initialize or close the Xerox machine, a switch is required to power on the Xerox machine. Then, the user is required to input a password to activate the Xerox machine component. This is due to private safety to prevent unauthorized usage of the machine. An output component is used to implement that the entered password is true. If entered an invalid password, the machine will not proceed to the next step.

Next, the user is required to choose the properties of printing, whether it is colour printing or black and white printing and landscape or portrait, there is a 7-segment display used to show number of colour copies that already printed out besides of 7-segment display which showed the photocopied copies no matter colour or black and white.

Then, the user has to input the number of copies he wants to print in the range of 0 until 7, the counter will count the number of copies that have been photocopied, two 7-segment display is used to show the number 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.

In addition, the subtractor component in this machine is to count the number of copies that still have not been printed out. The number of copies displayed on the 7-segment display in hexadecimal number.

Proposed Solution

A power button is used to turn on the photocopy machine which powers on all its components. The user is required to switch the machine on for the very first step in using this photocopy machine. Next, the user is required to input 8-bits binary password as authorization step. The password for this photocopy machine is 01100110 which is divided into two parts with 4-bits binary password. The password entered by the user will show in hexadecimal by using two 7-segment display. Thus, the password is 2-digit (88) if translate to hexadecimal number. If an incorrect password is entered, the user needs to enter the password again until he or she got the password right.

Then, the user has to select the properties of printing which include colour printing, black and white printing, whereas the layouts of printing are portrait and landscape. The combinations of properties chosen can be either colour printing with portrait or landscape or black and white printing with portrait or landscape. To implement this, a multiplexer is used to enable selection of the choice of properties by the user and a demultiplexer is used to indicate the choice selected by the user. Once the selection process for the printing properties has done, the LED light will be lightened up complement to the arrangement of printing properties.

The three core components that are used for counting the copies required are a 3-bit positive edge count up counter, 3-bit comparator and a clock disabler. The counter is used for determining the number of copies that had been printed. The comparator is used to compare the number of copies required with the number of printed copies. The clock disabler is used in disabling the clock and stopping the counter from counting when the number of printed copies equal to the number of required copies.

After choosing the printing properties, the user is required to input the number of required copies by using 3 input switches which allow the user to enter 3 bits digit (from 0 to 7). This step is then followed by setting the PRESET and CLEAR to 1 to reset the counter. The amount of required copies and photocopied copies will be shown by the two 7-segment display which are connected to the device. A parallel subtractor is used to count the difference between the number of printed copies and required copies by performing arithmetic operation and the result will show in a 7-segment display. When both the amounts are found different, the machine will continue to photocopy until both values reach the same number. The photocopying process has now ended. The process of printing can be repeated by choosing again the printing properties, entering the number of copies and resetting the PRESET and CLEAR to 1.

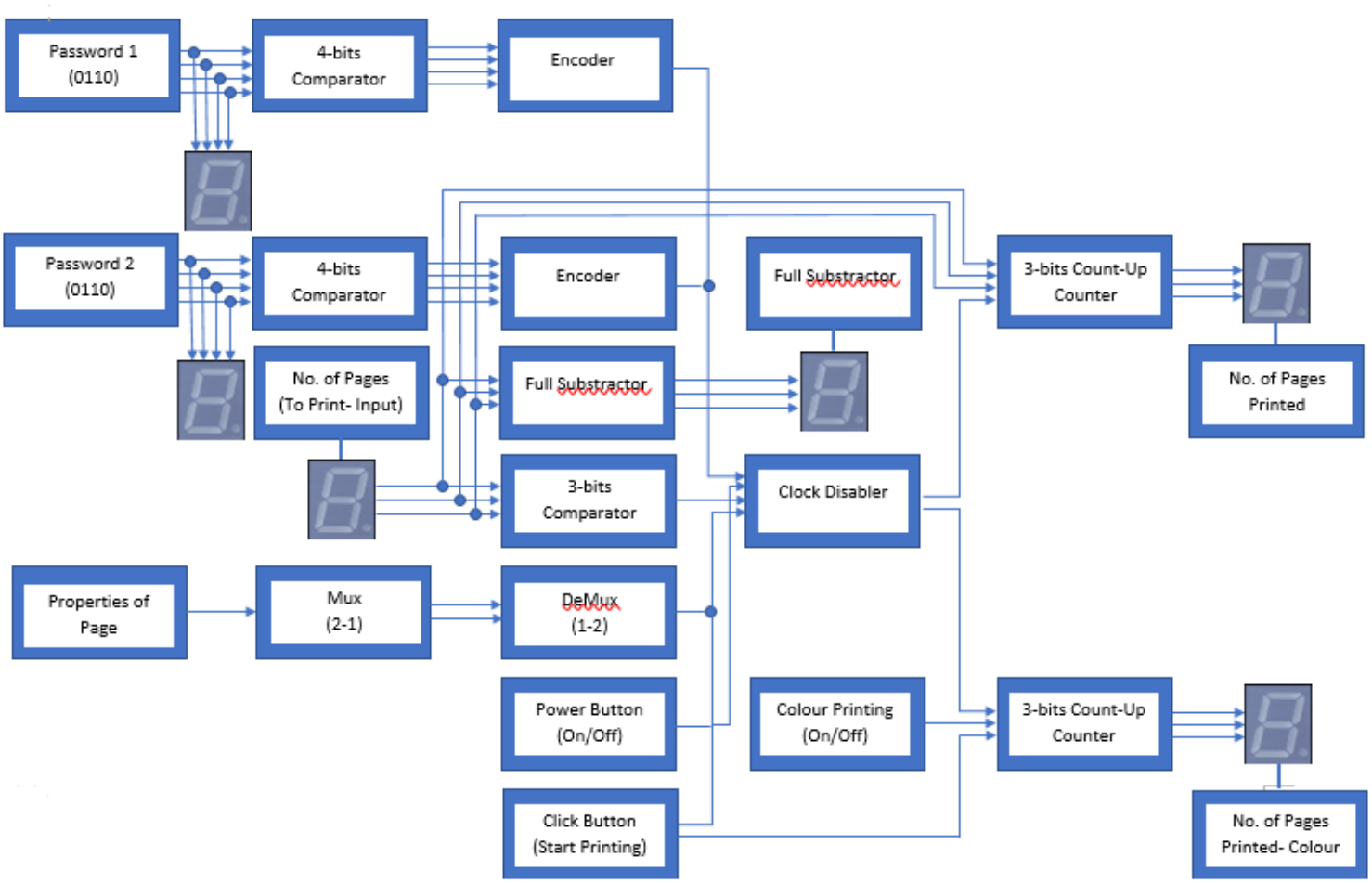

Figure 1: Block diagram of a complete Xerox machine

Components & Requirement

1. **On/Off switch**

· To turn on and off photocopy machine.

2. **4-bit Decoder**

· A type of security to determine whether the password entered is correct or not.

3. **Multiplexer**

· To allow the user select the printing properties.

4. **Demultiplexer**

· To determine which properties of printing that user had selected.

5. **Input Switches**

· To set the initial amount of copies that user want to print.

6. **3-bit JK positive edge count-up Counter**

· To count the amount of copies that had been printed.

7. 3-bit Comparator

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

8. Clock Disabler

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

9. Input Colour

· To choose the printed copies to be black or colour.

10. Full subtractor (Full Adder)

· To display the remaining of copies to print.

11. 7-Segment Display

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

System Implementation

1. **On/Off switch – (function suggested by Pei Geok)**

   To turn on the photocopy machine when the user wants to use it and turn off when it is no longer in use or has finished using it.

2. **4-bit decoder – (function suggested by Junyi)**

   The 4-bit decoder function is to determine the password entered by the user whether is correct or not. This is a type of security on this machine to prevent unauthorized user from use this machine. We use four 4-bit decoders to implement 4-digit password and each decoder represents each digit of the password. The outputs from decoder components are connected to XNOR gate and it will only activate when PASSWORD 1 and PASSWORD 2 is equal to 0110. Then, the XNOR gate will be connected to AND gate at the clock disabler part. So, once the password from decoder is true, the disabler clock will be activated.

3. **Multiplexer (2-1) – (function suggested by Eddie)**

   Mux connected with S0 input and power source 1 in I0 and I1 as input. When the S0 input is 0, the printing properties will be landscape and when the input is 1, the printing properties will be portrait.

4. **Demultiplexer (1-2) –(function suggested by Kai Zhe)**

   Demux input is connected with the output of the Mux while the output connected to two LED and OR gate. When the S0 = 0, the LED connected to Q0 will active, when the S1=1, the LED connected to Q1 will active.

5. **Input switch**

   This photocopy machine has 8 switches for the user enter the number of pages that want to print. Each of these 8 switches represents a single bit which are A, B, C and D where A is MSB and D is LSB in both PASSWORD 1 and PASSWORD 2. So, the user able to enter the range input from 0000 until 1111 which is 0 until 15 in both PASSWORD.

6. **3-bit JK positive edge count-up Counter**

   In the deeds simulator, we have 2 parts of 3-bit JK positive edge count-up Counter. The upper part for the amount of printed copies while the lower part is for amount of colour printed copies. The counter will start counting the pages when it accepts the signal from the clock disabler. The clock disabler will be active when the user turns on the machine and enter the correct password. When the clock enabler is active, the counter will start counting until it stops when clock pulse is no longer received any signal or reached the number of pages required by the user. On this machine, we use WINCUPL code, we program the condition on it. By using Wellon Universal Programmer, the PLD program is the burnt into PLD ATMEL22V10.

7. **3-bit Comparator**

   On this photocopy machine, we use three 2-input XOR gates and three not gate act as a comparator. This comparator function is to compare 2 input from 2 sources which are the counter and the switch input. On the deeds diagram shown in figure 2 shows that the first XOR gate compare the most significant bit (MSB) of the two sources. If these 2 sources are same, the output will be 0, then it will send to the NOT gate and convert it into output 1. The next XOR gates use the same concept of the first XOR gate. Then, the signal from the comparator will be send to NAND gate at the clock disabler part to convert it into the opposite signal. When all the XOR gates accept the same input from the counter and input switches, it will send to clock disabler as a 0 output so that it can stop the photocopy machine.

8. **Clock Disabler**

   In this part, we using 3-input NAND gate and 4-input AND gate. The 3-input NAND gate receive the signal from the comparators while the 4-input AND gate receive signal from the

clock source, two 4-bit decoders and NAND gate. The disabler clock will only be active when these four inputs are high.

9. **Input colour – (function suggested by Vincent)**

   In this part, there is only an input switch. Input 0 to print the copies in black and input 1 to print the copies with colour.

10. **Full Subtractor (Full Adder) – (function suggested by Zhi Yan)**

    In this part, there are three full adder that input connected with input switches and JK flip flop output Q with the NOT gate in between. The display will minus 1 once the start printing button (CLK) is being pressed and become 0 when the amount of printed copies is equal to the amount of required printed copies.

11. **7-Segment Display**

    This component displays the input of the number of pages entered by the user and display the output of the number of pages has been printed and number of set of copies.

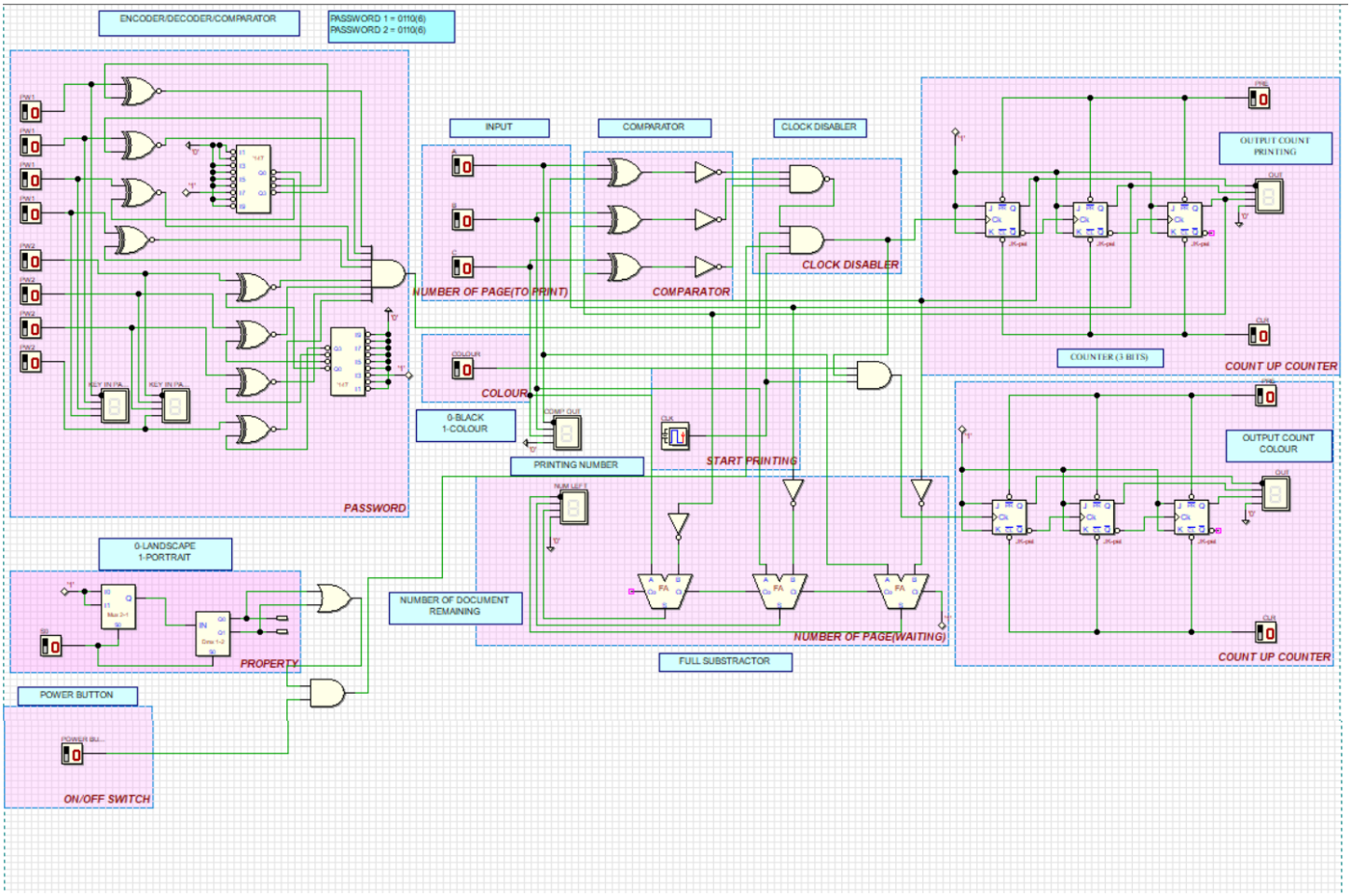

Figure 1: The Drawing of Deeds

CONCLUSION

In conclusion, our reflection is that Xerox machine had increase our understanding and strengthen knowledge throughout the project. We also learned how to program the logic gate by using our basic coding skills. Besides, I also get to know the importance of communication between team members to avoid miscommunication happening as we're now doing the meeting to set up deeds and block diagram which is not that difficult if we doing in lab but virtually doing this mini project is really challenging. Although we don't have the opportunity to contact a real machine, but we can simulate the circuit by using deeds simulator which introduced by our lecturer Dr. Nur Haliza. Furthermore, this is a group project, it is necessary to strengthen relationship with our course mates as we need to be a strong team in the upcoming semesters. We also know that the importance of teamwork and leadership because we have to work together on not only reports but also Deeds circuit simulator and also video as the leader will lead and guide us to finish the report in the shortest time. As always, communication always the most importance when working in a team, we will be a burden if we do not communicate well with each other. We should always do more exercises and study more before the incoming lab or project is given. That's all for our group reflection.

For achievement part, we are able to get this mini project done successfully. We had achieved all the mini project's objectives, which are to understand a PLD device's development and learn a simple Hardware Description Language. Other than that, we had also proposed some solutions based on the problems that we had figured out in order to enhance the circuit for better functioning which we have 6 function in total from each of the group members.

The strength we had throughout this mini project was that each and every member in the group communicated well and had good teamwork. When we encountered problems, we discussed together, suggested different kinds of ideas and solutions and came into one conclusion together. Even though we cannot meet each other physically due to the pandemic, but we tried our best in conducting virtual discussion through WhatsApp. We also have teammates that give a lot effort especially in the deeds software part which she study a lot before the mini project is given to us.

The weakness of us in this mini project was ignorance regarding the physical circuit. This was because we only learnt about the theories but did not had any chances to handle the physical circuit in the lab as we cannot went back the campus due to current pandemic situations. Therefore, it was quite a challenge for us to picture how the circuit worked in real life. We also faced connection problem as not all of us have a good network to support the Google Meet so as Zoom.

We will continue strengthen our understanding about combination logic circuit because we are not fully master it. This limited us in adding the function of Xerox machine. In future, we will keep the effort to enhance our design to make it become a more perfect and innovative system. The target of us is build a system that multifunctional but easy for everyone to use. Thus, skills and knowledge are important things for us to apply in this.

Video Presentation for part 2: https://drive.google.com/file/d/1t26lhuFhZ-GVrNC9R_ngngZe5aLa4ROR/view?usp=sharing

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Appendices

- **3-BIT SOURCE CODE**

```
Name     Xerox3B;
PartNo   00 ;
Date     02/02/2021 ;
Revision 01 ;
Designer Engineer ;
Company  UTM ;
Assembly None ;
Location Lab 4 Digital Logic;
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            ; /* Comparator B */
PIN 7 = b0            ; /* */
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           ;

/***** 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
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 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;
}
```

. HOUR SPENT

Eddie	Prepare report	5 days
Junyi	Draw Block Diagram	2 days
Kai Zhe	Prepare video	1 days
Pei Geok	-Draw Circuit in Deeds	3 days
Vincent	Prepare video	1 days
Zhi Yan	Prepare report	5 days

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