Assignment Activity Unit 5

Department of Computer Science, UoPeople

CS 1105-01 - AY2025-T1

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### Assignment: Designing a Simple Digital Circuit with a Programmable Logic Device (PLD)

#### Introduction

In this project, we explore the design and development of a simple digital circuit using a programmable logic device (PLD). PLDs are essential components in modern digital systems, allowing flexibility in design and implementation. This project demonstrates how a PLD can enhance the functionality and adaptability of a digital circuit, making it easier to implement complex logic with fewer components.

#### Project Design and Components

The circuit we designed is a 4-bit binary counter that increments its value with each clock pulse. The major components of the circuit include the following:

1. **Programmable Logic Device (PLD):**
   * The PLD we use is a Complex Programmable Logic Device (CPLD) that contains multiple logic gates and flip-flops, configurable to implement the required counter logic.
   * It provides the core functionality of the counter, replacing traditional discrete logic gates and enabling the integration of more complex operations.
2. **Clock Generator:**
   * The clock generator provides a periodic signal used to synchronize the operations of the circuit. Each rising edge of the clock pulse causes the counter to increment its value.
3. **4-bit Output Register:**
   * The output register stores the current count and displays it using LEDs. Each LED represents a single bit of the 4-bit counter (ranging from 0000 to 1111 in binary).
4. **Reset Button:**
   * A reset button is added to the design to allow the counter to return to zero, resetting the entire circuit.

#### Role of the PLD in Enhancing Circuit Functionality

PLDs like CPLDs and Field Programmable Gate Arrays (FPGAs) are critical in modern digital design due to their flexibility and ability to be reprogrammed to fit different applications. In our circuit, the PLD enhances functionality by simplifying the design process. Instead of wiring multiple individual logic gates, we configure the PLD to implement the counter logic using software. This reduces the number of physical components needed and minimizes wiring complexity.

Additionally, the PLD allows for easy future modifications. For instance, if we wanted to expand the circuit to an 8-bit or 16-bit counter, we could reprogram the PLD without changing the physical layout of the circuit. This adaptability makes PLDs invaluable in prototyping and developing complex digital systems.

#### Why PLDs are Valuable in Digital Circuit Design

PLDs are highly valuable in digital circuit design for several reasons:

1. **Flexibility:** PLDs can be reprogrammed, making it easy to modify the circuit design without rebuilding the hardware.
2. **Integration:** They allow the integration of complex logic into a single chip, reducing the number of discrete components.
3. **Scalability:** As requirements change, PLDs can be easily updated, making them ideal for prototyping and iterative design processes.
4. **Efficiency:** They reduce power consumption and space by consolidating multiple logic functions into a single programmable device (Volnei, 2018).

In summary, the use of a PLD in our 4-bit binary counter design demonstrates how PLDs simplify circuit design while offering flexibility and scalability. These features make PLDs essential tools in digital electronics.

#### Conclusion

In this project, we successfully designed and implemented a 4-bit binary counter using a programmable logic device (PLD). The PLD enhanced the circuit's functionality, allowing for a more streamlined and flexible design. This project highlights the importance of PLDs in modern digital electronics, where flexibility and scalability are critical to the success of circuit designs.

#### References

Volnei, A. (2018). Digital Systems: Principles and Applications. Pearson Education.