University of North Texas
Department of Electrical Engineering
EENG 2910 Project III – Digital System Design
Design Project 5

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Introduction:

Sequential logic circuits are circuits whose outputs depend not only on the present value of their input signals but also on the sequence of past inputs, the input history. Most sequential circuits we design are **synchronous**, or **clocked**. They use a rising or falling edge of a clock, or a level of an enable signal, to control their state or storage of data.

For this project, you are required to **design**, **implement**, **and test** a **4-bit universal shift register**.

A **universal shift register** is a sequential logic circuit that can be used as either serial-to-serial, left shifting, right shifting, serial-to-parallel, parallel-to-serial, or as a parallel-to-parallel shift register. A representation of a universal shift register is shown in Figure-1 below.

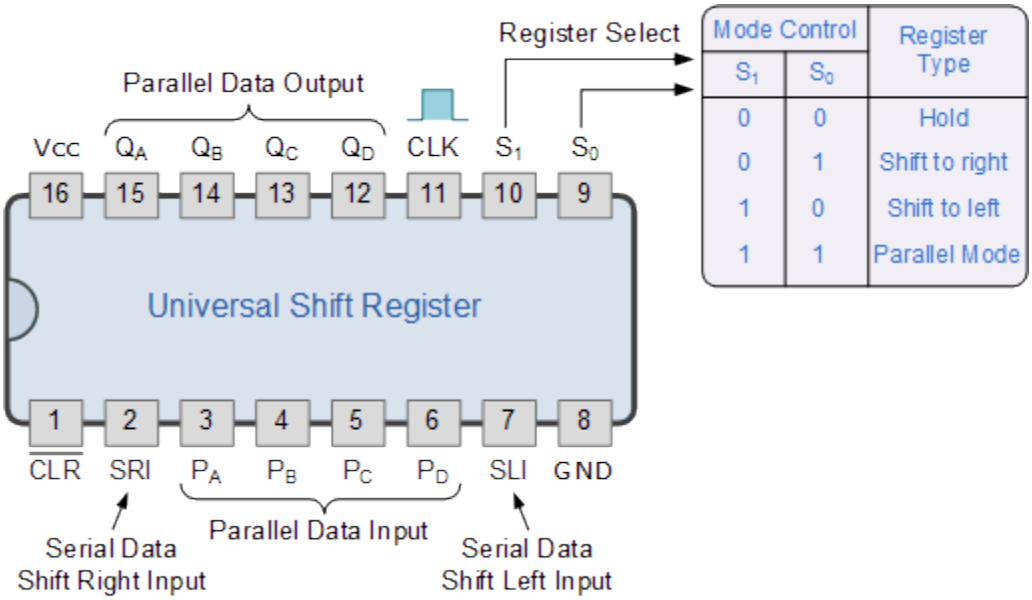

Figure-1: Schematic of a Universal Shift Register.

Recommended Design Procedure:

1. Find the number of input variables, the number of required output variables, and assign them meaningful names.
2. Create a truth table that defines a relationship between inputs and outputs.
3. Obtain a characteristic equation for each output.
4. Draw the logic diagram (use the diagram generated by your program).
5. Implement your design using VHDL
6. Test your design by creating a test bench
7. If possible, load your circuit to the board and test it (not required but could be a good practice – extra credit could be given).

Report:

Submit a soft copy of your report on BlackBoard and hand in hard copy at the beginning of class on the due date (**10/19/2016**). Make sure that your report includes the following:

1. A **cover page** with your name, the name of the project, date, etc. (**5 pts**)
2. An **introduction** – what are the goals of the project? What is a program counter? What is it used for? These are sample questions that you should attempt to answer in the introduction.(**10 pts**)
3. **Theory of operation and explanation of the design**
   Give a brief discussion of the theory of operation, including schematics and equation used, etc. This is of particular importance for the design oriented labs and mini-projects. You should also explain the schematics involved in your design.
4. **Experimental results**: (**70 pts** including the section on "Theory of Operation")
   - Brief description of the lab experiment.
   - Schematics of the circuit (from Xilinx schematic entry tool). Put your name and date on each page.
   - Simulated waveform.
   - Discussion of the results indicating that the circuit functions properly. **It is not good enough to just give the simulated waveform**. It is up to you to show that this waveform correspond to what you expect (do not say "the simulation shows that the circuit works properly"). **You need to make it clear to the reader that the circuit works properly!** One convenient way is to use some of the entries in the truth table in your test bench, indicating that for each entry/inputs the corresponding values/outputs given by the logic simulator correspond to what is displayed in the table.
   - **All figures/schematics in the report must have a figure number, title, and referenced in the body of your report**.
5. **Conclusion:** (**10 pts**)
   The conclusion should contain a summary of the results. Are the goals of the lab fulfilled? If not, explain why. What were your experiences? What did you learn?
6. **References:** (**5 pts**)
   List all the references used for the project and refer to them in the body of your report.