EXPERIMENT 9

9. An Alarm Clock – Phase 2

9.1 Objectives

- More practice on time multiplexing.
- To implement the alarm behavior.
- To finalize the alarm clock project.

9.2 Overview

In this lab, you will finalize the alarm clock project. You will also implement the alarm behavior by using a comparator.

9.3 Design Specifications

The alarm should be on for 60 seconds once the alarm time equals the current time. For illustration purpose, we will use an LED instead of a Buzzer. Checking the equality of the current time and the alarm time requires checking the equality of every bit in the current time with its corresponding bit in the alarm time. A 16-bit magnitude comparator is used for this purpose.

In Spartan Library, COMPM16 is a 16-bit magnitude comparator. This component takes two 16-bit buses as inputs and outputs two signals: a Less Than (LT) signal, and a Greater Than (GT) signal. Refer to www.xilinx.com software manuals to find out how this component is used.

COMPM16 has no output that tells whether its two inputs are equal or not. However, two numbers A and B are equal if and only if A is not greater than B and A is not less than B. Thus, feeding these two outputs to a NOR gate produces the EQ (Equality) output signal.

9.4 Pre-Lab

Bring the following from the previous labs:

- Bring the 1 &2 Hz clock schematic.
- Bring the schematic of the phase 1 (experiment 8) with you.
- Review magnitude comparators.

9.5 In-Lab

Note: In the following steps, the purpose of the labeling is to combine Time0– Time15 and Alarm0– Alarm15 into buses Time[15:0] and Alarm[15:0], respectively. These two buses will be the inputs of the COMPM16 component.

1. Open the schematic of the phase 1.
2. Zoom in around the minutes counter of the current time. Label the seven outputs of the minutes counter as Time0, Time1 … Time6.
3. Now zoom in around the hours counter of the current time. Label the six outputs of the hours counter as Time8, Time9 … Time13.
4. In the same way and order label the seven outputs of the minutes counter as Alarm0, Alarm1 … Alarm6. Label the six outputs of the hours counter as Alarm8, Alarm9 … Alarm13.
5. Connect six wires to GND and label them Time7, Time14, Time15, Alarm7, Alarm14, and Alarm15 (this is needed to display the time correctly on the seven-segment displays).
6. Instantiate a COMPM16 component.
7. Connect a bus to the A input of the COMPM16 and label it as Time.
8. Connect a bus to the B input of the COMPM16 and label it as Alarm.
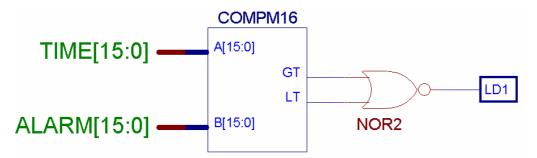9. Connect the outputs of the COMPM16 to a NOR gate. See Figure 9.1.

Figure 9.1: Magnitude Comparator

10. Constraint the output of the NOR gate to LD1.
11. Constraint the seven outputs of the seconds counter to LD2, LD3 … LD8. Note that LD8 should be connected to the least significant output of the seconds counter.
12. Constraint the BTN1, BTN2, and SW8 to AH, AM, MODE respectively.

13. Now add the macro of multiplexed seven-segment display you built in a previous lab to your design.
14. This macro has four input buses that allow you to display either the current or alarm time. To be able to selectively display either of them you need to add a quad two-to-one multiplexer at every bus to select between current or alarm time counters, with the select lines connected to MODE signal as shown in Figure 9.2.
15. Download & test your circuit. Note when you adjust the current time, the seconds counter will not increment.
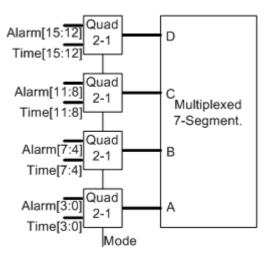16. Demonstrate it to your instructor.

Figure 9.2: Selecting Between the Current and Alarm Times

9.6 Post-Lab

In case you have not completed the project, you have to document all the problems you faced, what are possible causes, and possible solutions.