A Project Report
On
DIGITAL ALARM CLOCK

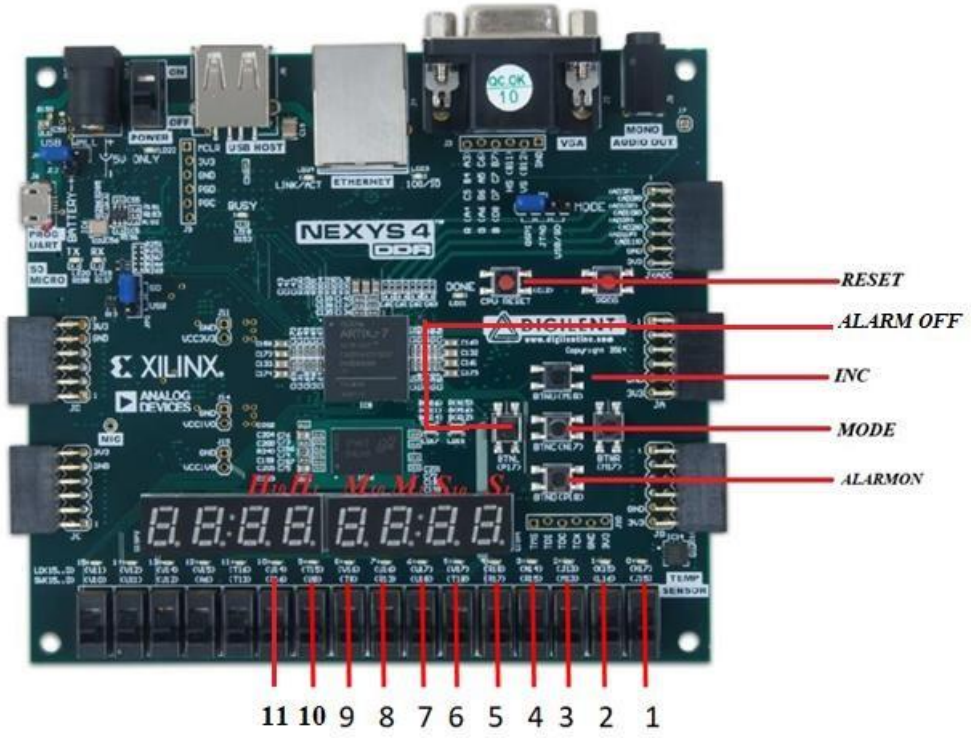
Introduction:

This design is of digital alarm clock that displays time in hours, minutes and seconds. The goal of this design is to implement all of the basic features that one would normally expect to find on a standard digital alarm clock. Features like 24 hour time, alarm setting and time setting functionality.

List of features implemented:

1. Clock setting functionality
2. Alarm time setting functionality
3. Alarm indicating LED

The design has been implemented on a Nexys4 DDR FPGA development board. The following diagram shows the physical alarm clock interface:



1. **Reseti**: LED for Reset button.
2. **seti:** LED glows when we set the time or alarm.
3. **inc_ledi:** LED glows when we increment by pressing INC button.
4. **inc_houri:** LED glows when we increase the hours.
5. **inc_mini:** LED glows when we increase the minutes.
6. **inc_seci:** LED glows when we increase the seconds.
7. **stopi:** LED glows when stops the clock.
8. **runi:** LED glows when clock is running.
9. **inc:** LED glows when we increase the time.
10. **alarmled:** LED glows when current time and alarm time matches means it is showing alarm.
11. **alarmSLi:** LED glows when we enter in the alarm module.

Design Description:

This design is implemented on a Digilent Nexys4 DDR development board.
Below is the VHDL entity that describes the design I/O that is in the constraint file (.xdc file).

TOP ENTITY:

Inputs:

clk100M: It is the system clock of 100M Hz. **reset:**
It is the reset button, for resetting the board.
Mode: It is the Mode button for entering from seconds to minutes or minutes to hours. **inc:** It is the increment button for incrementing the seconds or minutes or hours. **alarmon:** It is the alarm button for entering in the alarm mode.
alarm_off: It is the alarm off switch.

Outputs:

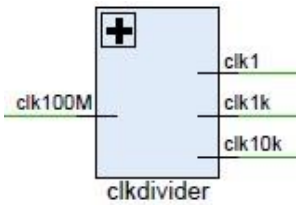
disp_seg_o: It is connected to the displays.
disp_an_o: It is connected to the anode of the displays.
led : It is connected to the LEDs of the board.

Design Details:

There are following modules in the top entity:

Clock divider Unit:

This module divides the 100M Hz clock into 1 Hz, 10K Hz and 100 Hz clock.



Inputs:

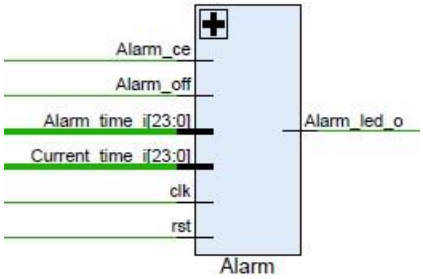
clk100M: It is the system clock of 100M Hz.

Outputs:

Clk1: It is the 1Hz clock.
Clk1k: It is the 1K Hz clock.
Clk10K: It is the 10K Hz clock.

Alarm Unit:

In Alarm module, Current time and Alarm time is compared when chip enable is 0. When current time and alarm time matches, Alarm led glows. And with the Alarm_off switch we can turn off the LED.



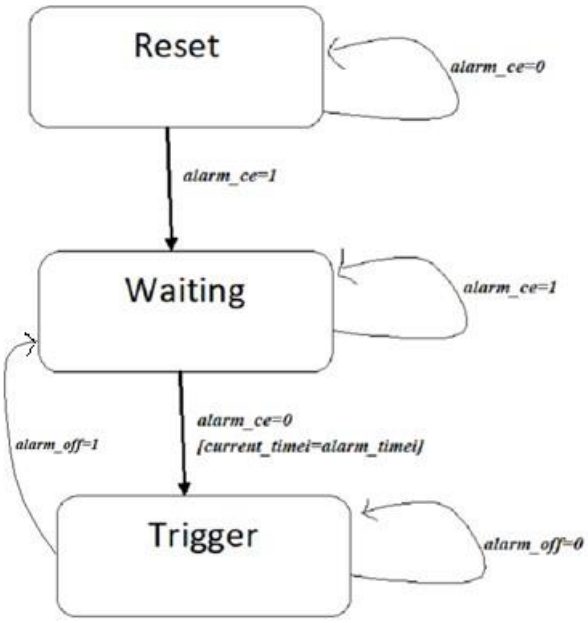
Inputs:

Alarm_ce: It is the chip enable for the alarm and it is active low.
Alarm_off: It is a button for alarm off.
Alarm_time_i: It is the time which we set for alarm. It is of 24 bits.
current_time_i: It is the time on the main clock. It is of 24 bits.
clk: It is connected to the system clock of 100M Hz. **rst:** It is the reset and connected to the reset of controller.

Outputs:

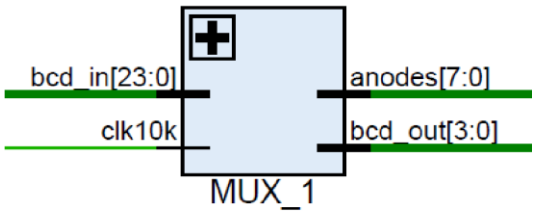
Alarm_led_o: It is connected to alarm led, which glows when current time and alarm time matches.

State Machine of the Alarm:



Multiplexer_1 Unit:

These modules have inputs as clock clk10K and the outputs of the MUX_2 as bcd_in which is used when we are working with alarm. Output goes to the anodes of the 7 segment display which helps to identify which number will be displayed on the display and bcd_out to the decoder module which help to identify which display will work as we are using 6 displays from our board.



Inputs:

bcd_in: It is the inputs from the MUX_2. It is of 24 bits.

clk10k: It is the 10k clock on which multiplexer is working.

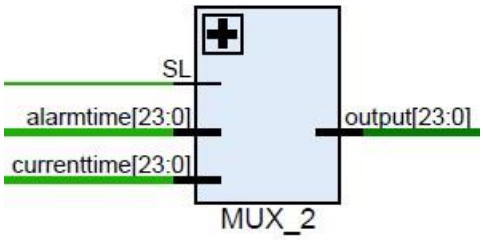
Outputs:

anodes: It is connected to the anodes of the displays. It is of 7 bits.

bcd_out: It is connected to the decoder module. It is of 4 bits.

Multiplexer_2 Unit:

This module selects which output to be shown, either current time or alarm time. It has inputs as SL which is selecting line having values 0 or 1. When SL value is 1 it shows the alarm time on display and when its value is 0 it shows current time on display. So the other inputs are current time and alarm times which are of 24 bits.



Inputs:

SL: It is the select line for the Multiplexer which have value 0 and 1. **alarmtime:** It is the alarm time which we can set. It is of 24 bits.

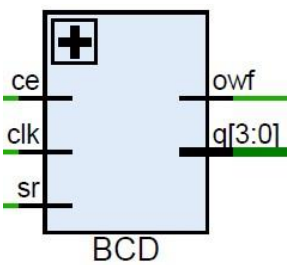
currenttime: It is the current time running on the main clock. It is of 24 bits.

Outputs:

outputs: It shows either the alarm time or current time as per the SL (select line).

BCD Unit:

This is a simple counter which counts from 0 to 9. And gives the overflow when the number reaches to 9.It is used at one's place of seconds, minutes and hours.



Inputs:

ce: It is the chip enable.

clk: It is the clock which works on 1 Hz. **sr:**

It is the set reset.

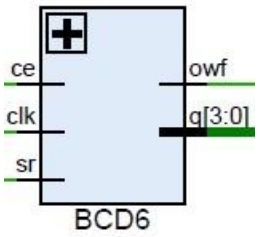
Outputs:

owf: It is the overflow which sends the signal to the next display when it reaches to 9.

q: It is the output of 4 bits.

BCD6 Unit:

This is a counter which counts from 0 to 5. And gives the overflow when the number reaches to 5. It is used at ten's place of seconds and minutes.



Inputs:

ce: It is the chip enable.

clk: It is the clock which works on 1 Hz.

sr: It is the set reset.

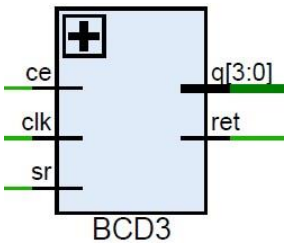
Outputs:

owf: It is the overflow which sends the signal to the next display when it reaches to 5.

q: It is the output of 4 bits.

BCD3 Unit:

This is a counter which counts from 0 to 2. And gives the return signal to the one's position of the hour when 2 comes on it (one's position).



Inputs:

ce: It is the chip enable.

clk: It is the clock which works on 1 Hz.

sr: It is the set reset.

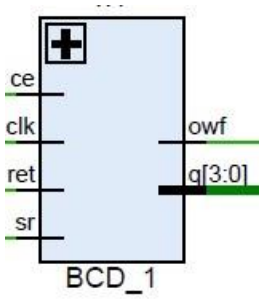
Outputs:

ret: It returns the signal to the BCD_1 when it reach 2, so that BCD_1 should run up to 3.

q: It is the output of 4 bits.

BCD_1 Unit:

This module counts from 0 to 9 but also when 2 come on the tenth's position of the hour it counts from 0 to 3.



Inputs:

ce: It is the chip enable. **clk:** It is the clock which works on 1 Hz. **ret:** It is the signal received from the BCD3.
sr: It is the set reset.

Outputs:

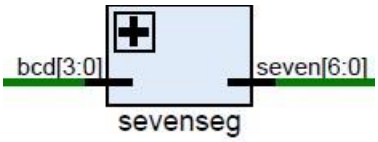
owf: It is the overflow which sends the signal to the next display when it reaches to 9. **q:** It is the output of 4 bits.

Summary of BCDs:

h10	*h1*	*m10*	*m1*	*s10*	*s1*
0-2	9 and 3	5	9	5	9
BCD3	BCD_1	BCD6	BCD	BCD6	BCD

Decoder Unit:

This unit is the seven segment decoder which decodes 4 bits to the 7 bits.



Inputs:

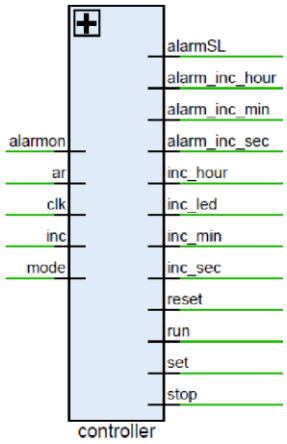
bcd: It is the input from the counters. It is of 4 bits.

Outputs:

seven: It is connected to the display.

Controller Unit:

This unit is the most important unit of the project. It controls all the functionality.



Inputs:

clk : It is connected to the clock of 1K Hz.
ar : It is the asynchronous reset.
mode : It is the Mode button for entering from seconds to minutes or minutes to hours.
inc: It is the increment button for incrementing the seconds or minutes or hours. **alarmon:** It is the alarm button for entering in the alarm mode.

Outputs:

run : It is connected to the LED and glows clock is running. **reset :** It is connected to the LED and glows when we reset the clock. **set :** It is connected to the LED and glows when we come to the setting mode of time. **inc_led :** It is connected to the LED and glows when we increment hours or minutes or seconds. **stop :** It is connected to the LED and glows when clock stops. **alarmSL:** It is connected to the MUX_2 as the select line of it. **inc_sec :** It is connected to the LED and glows when we increase the seconds. **inc_min :** It is connected to the LED and glows when we increase the minutes. **inc_hour :** It is connected to the LED and glows when we increase the hours.
alarm_inc_sec: It is for incrementing in the seconds when we are in alarm mode.
alarm_inc_min: It is for incrementing in the minutes when we are in alarm mode.
alarm_inc_hour: It is for incrementing in the hour when we are in alarm mode.

State Machine:

The state machine is shown in the below diagram: