Hardware Assignment 2 Report

Our goal was to construct a stopwatch using the 7-segment displays and switches on the Basys 3 board. The display format of the stopwatch is (M:SS:T) i.e.minutes (M) on one LED display, seconds (SS) on two LED displays and tenth of second (T) on one LED display.

We utilised the 4-digit seven segment display created in the last assignment as a component (‘*display.vhd*’) . In addition we created 2 new files to implement a stopwatch.

We created the file ‘*stpwatch.vhd*’ . The signal *enable_watch* is used for starting the counting of time and the signal *reset_watch* is used to reset the watch to 0:00.0 . The watch will be controlled via four switches on the board : start, pause, continue and reset. We defined three processes in this file

The first process allows the use of the 4 switches as follows
• start: When the start switch moves from 0 → 1, then enable_watch is set to HIGH/1 i.e. starts the counting of time.
• pause: When pause switch moves from 0 → 1, then enable_watch is set to LOW/0 so that the watch pauses.
• continue: When continue switch moves from 0 → 1, then enable watch is set to HIGH/1 again the watch continues counting time (continue state should be preceded by pause state)
• reset: On reset from 0 → 1, reset_watch isset to HIGH/1 and the stopwatch counter is reset to 0:00:0.
In our implementation, once the start button is set to HIGH/1, changing it back to low has no effect. The start switch can be used again after we set the reset switch to HIGH and the back LOW again. The continue switch is functional only when the pause switch is set to HIGH, but switching it back to LOW once it has been set to HIGH has no effect. The continue switch can be used again when we have changed pause switch to LOW and then HIGH again .

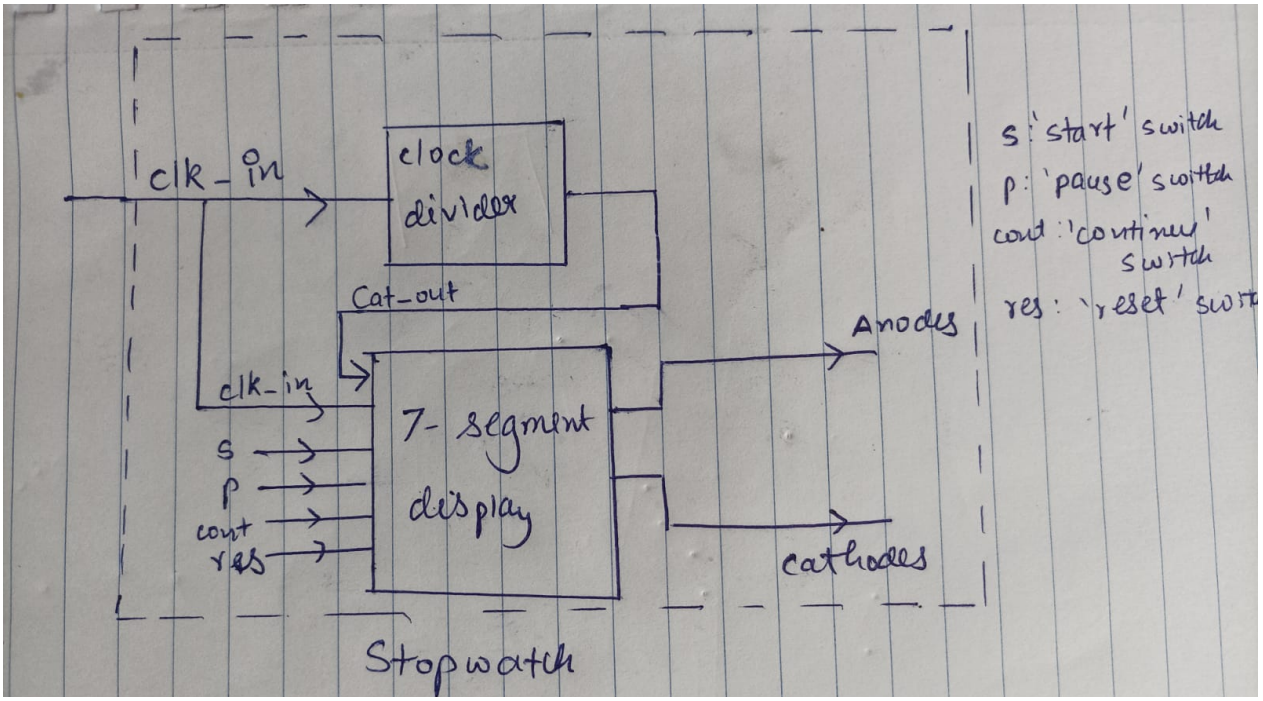
The second process accounts for the no. of cycles using the counter *clk_inpt*. When the stopwatch has reached 10 mins i.e. 10^7 cycles completed it sets the counter *clk_inpt* to 0. The counter keeps counting at every tenth of a second (10Hz). Hence we obtain a 100Mhz clock.

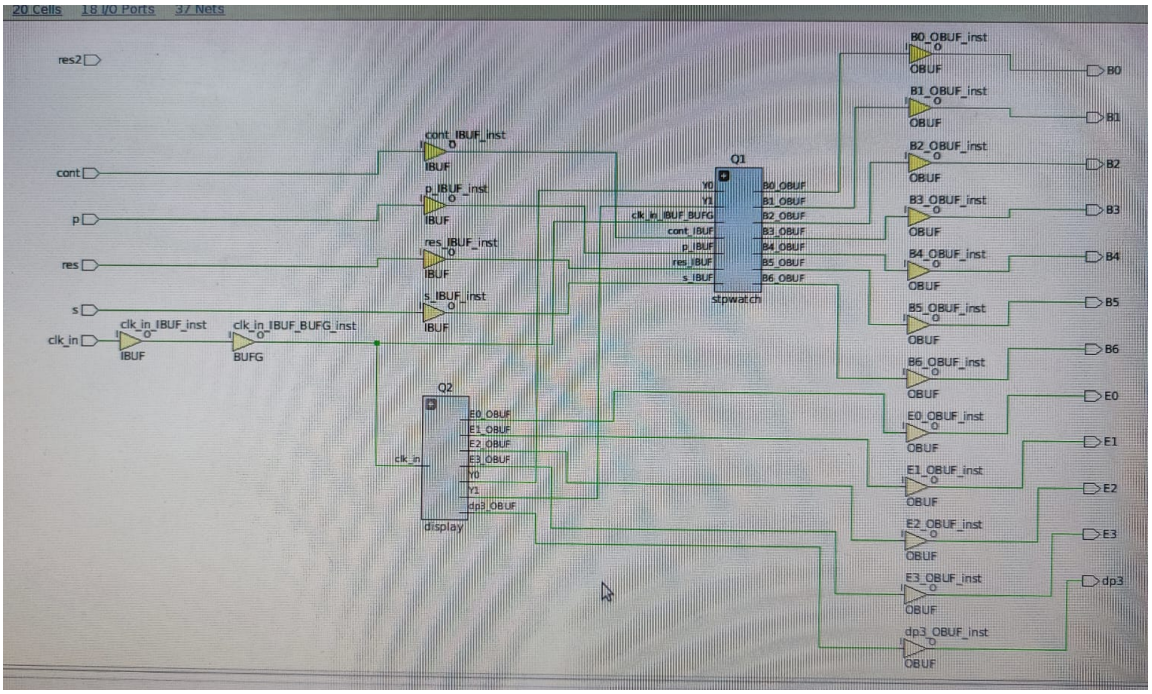
The third process provides the values (16 bit output) derived from the counter to drive the 7-segment display designed previously. If the watch is reset all the output values are assigned 0. Our display format for the stopwatch was M:SS:T. Assume SS as S1 S2. T increases from 0 to 9.After every 10 one-tenth of a second from start pass, S2 increases by one and T becomes 0. S2 goes from 0 till 9. After 10 seconds have passed from start,

S1 increases by one and S2 as well as T becomes 0. S1 goes from 0 to 5. After every 60 seconds from start, M increases by 1 and S1,S2 as well as T becomes 0. M goes from 0 to 9. Once 10 moins have passed all leds display 0.

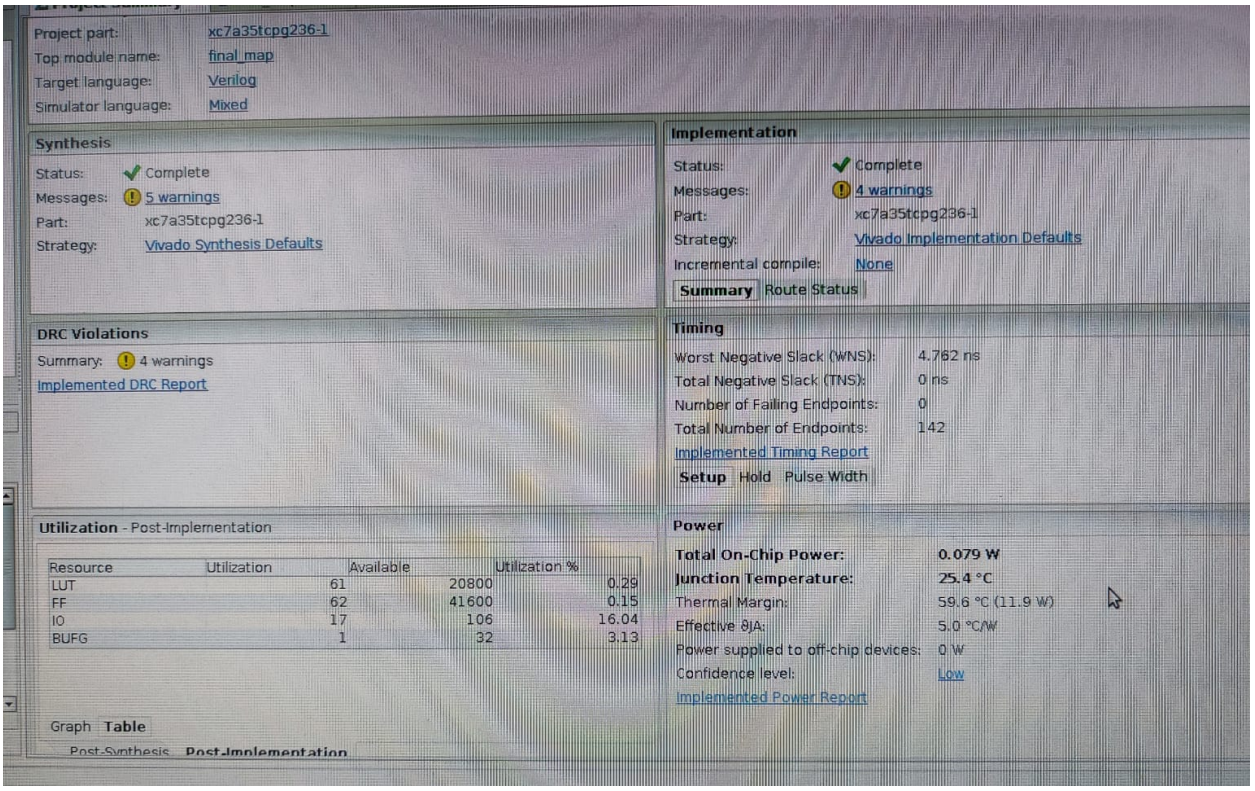
In the file 'final_map.vhd' we combine the utilities of the file 'display.vhd' and 'stpwatch.vhd' via port mapping to get the final desired circuit. This is how we constructed our stopwatch.

Block diagram

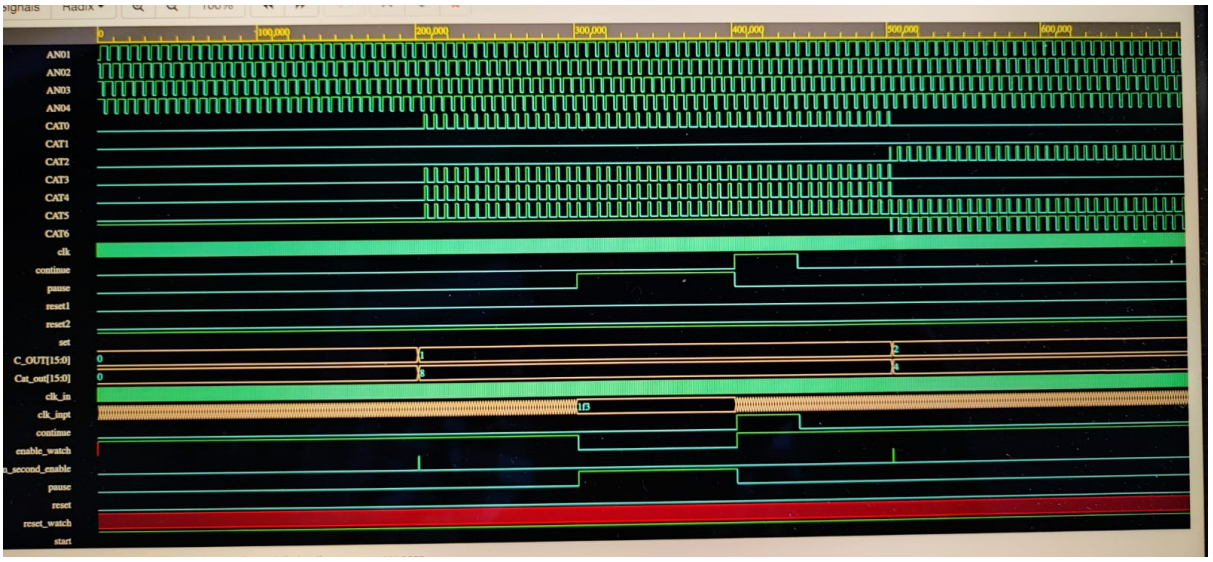




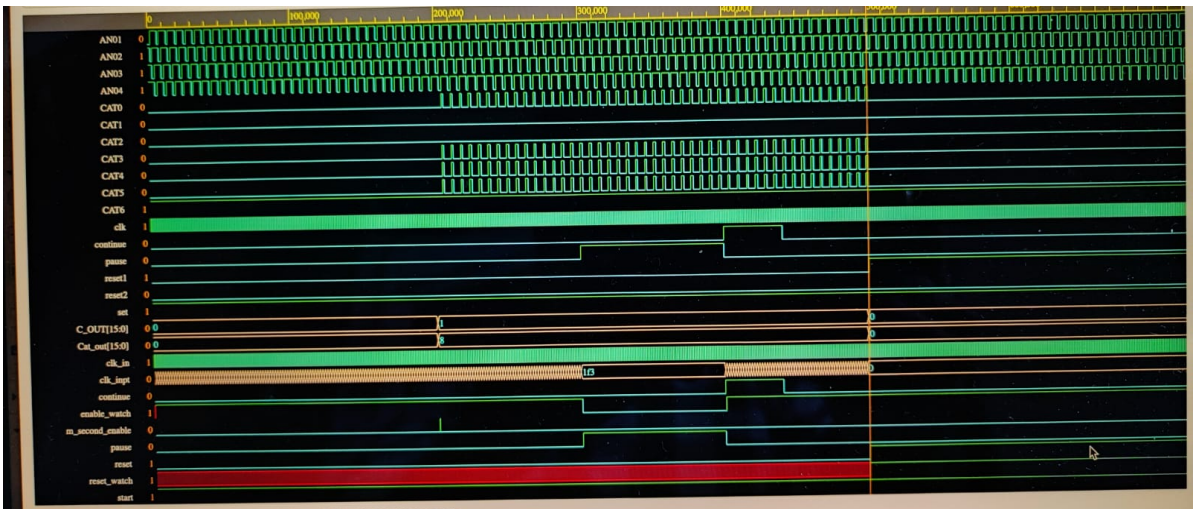
Synthesis Report



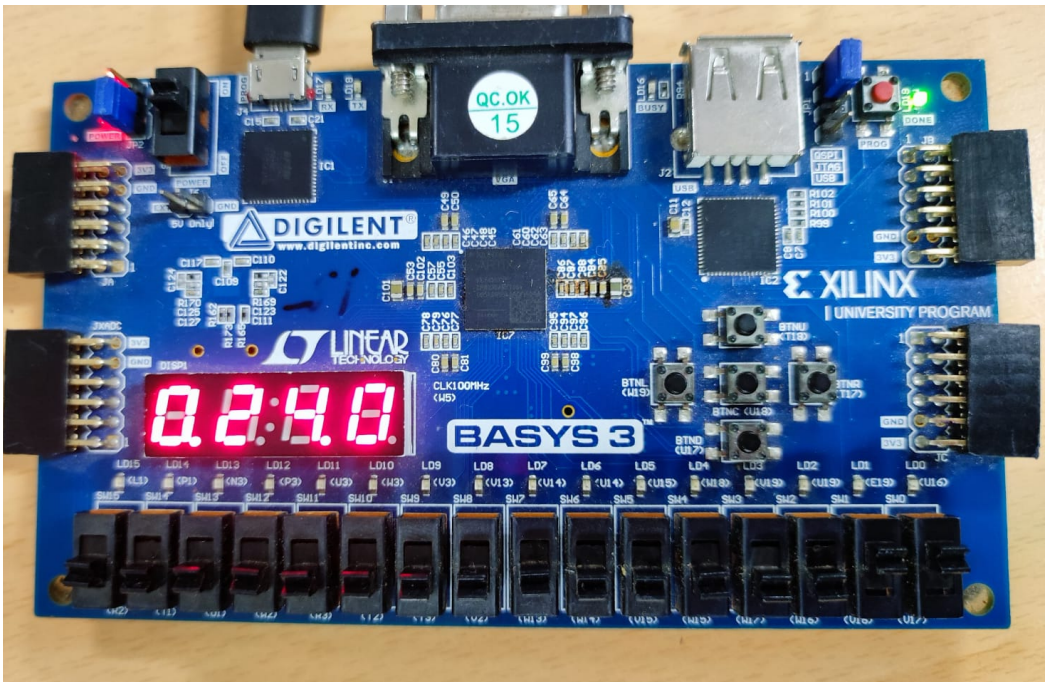
Simulation waveforms



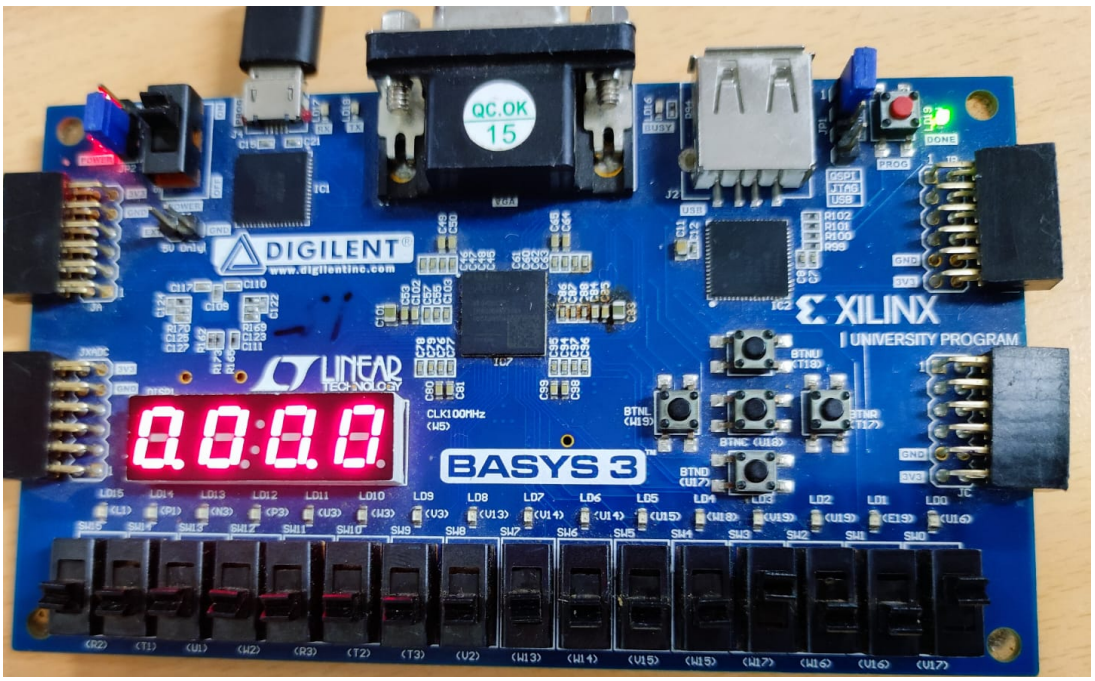
Simulation waveform showing utilisation of pause and continue switches
Pause at 300-400ns
Continue at 400-450ns



Simulation waveform showing utilisation of pause,continue and reset switches
Pause at 300-400ns
Continue at 400-450ns
Reset at 500ns



Implemented design on basys3 board with switches for start and pause set to high
The stopwatch is paused



Implemented design on basys3 board with switches for start and reset set to high
The stopwatch resets

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