Lab Assignment 5

Title: Stopwatch

Learning Objective:

Learn (i) use of a pre-designed circuit (4 digit display, in this case) as a building block, (ii) creation of time reference.

Specifications:

Design a stopwatch and implement it on BASYS 3 board, using its 7-segment display and push buttons. Since the display has only 4 digits, assign these as follows - 1 digit for minutes, two digits for seconds and one digit for tenths of a second. Use three push buttons as follows.

- Start/Continue
- Pause
- Reset

Details:

The circuit will consist of a few counters, time reference and display (from assignment 4).

A. Counters : Counters take one input(clock) and give n bit outputs

The design will be centered around an ensemble of four counters described below.

- A modulo 10 counter to count tenths of a second input: 10 Hz clock Output:Q00Q01Q02Q03
- A modulo 10 counter to count unit digits of seconds input:Q03' Output:Q10Q11Q12Q13
- A modulo 6 counter to count tens of seconds input:Q13' Output:Q20Q21Q22Q23
- A modulo 10 counter to count minutes input:Q22' Output:Q30Q31Q32Q33

Appropriate Latch : SR-Latch

The ensemble is driven by a 10 Hz timing reference. Provide for an enable input and a reset input. The enable input comes from a flip-flop/latch that is set to '1' when Start/Continue button is pressed and set to '0' when Pause button is pressed. Reset input comes from a push button.

The counters can be synchronous or asynchronous. In asynchronous counters, various bits may not change simultaneously, but the time delays will not be perceptible to the eye.

B. Time reference

100 MHz clock available on BASYS 3 board needs to be divided by 10^7 to get 10 Hz clock that updates tenths of a second. Note that a modulo N counter divides frequency by N. Recall that the display requires a clock in the range of 250 Hz to 4 KHz. Suppose you use 1 KHz clock for the display. Then you can first divide 100 MHz frequency by 10^5 to get 1 KHz and then divide it by 100 to get 10 Hz.