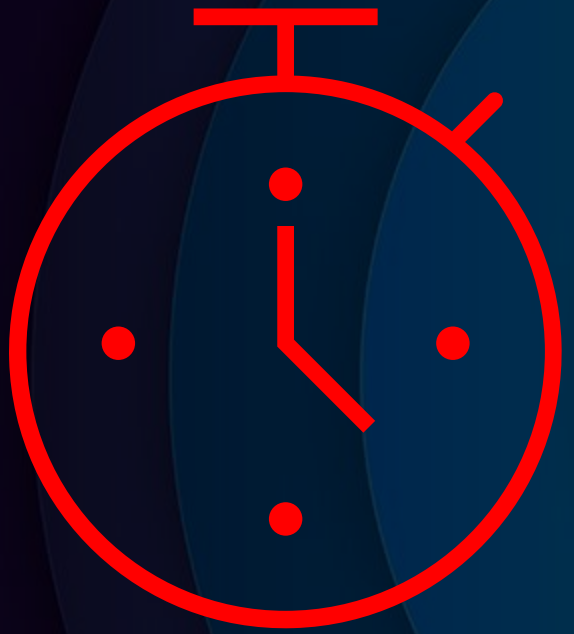
VHDL Digital Stopwatch

ECE2700 Final Project



By Colin Steed, Eduardo Garcia, David Dzierzawski, Muhammad Imtiaz

ECE2700 - Digital Logic Design

Presented on 12/6/21

Our Objective

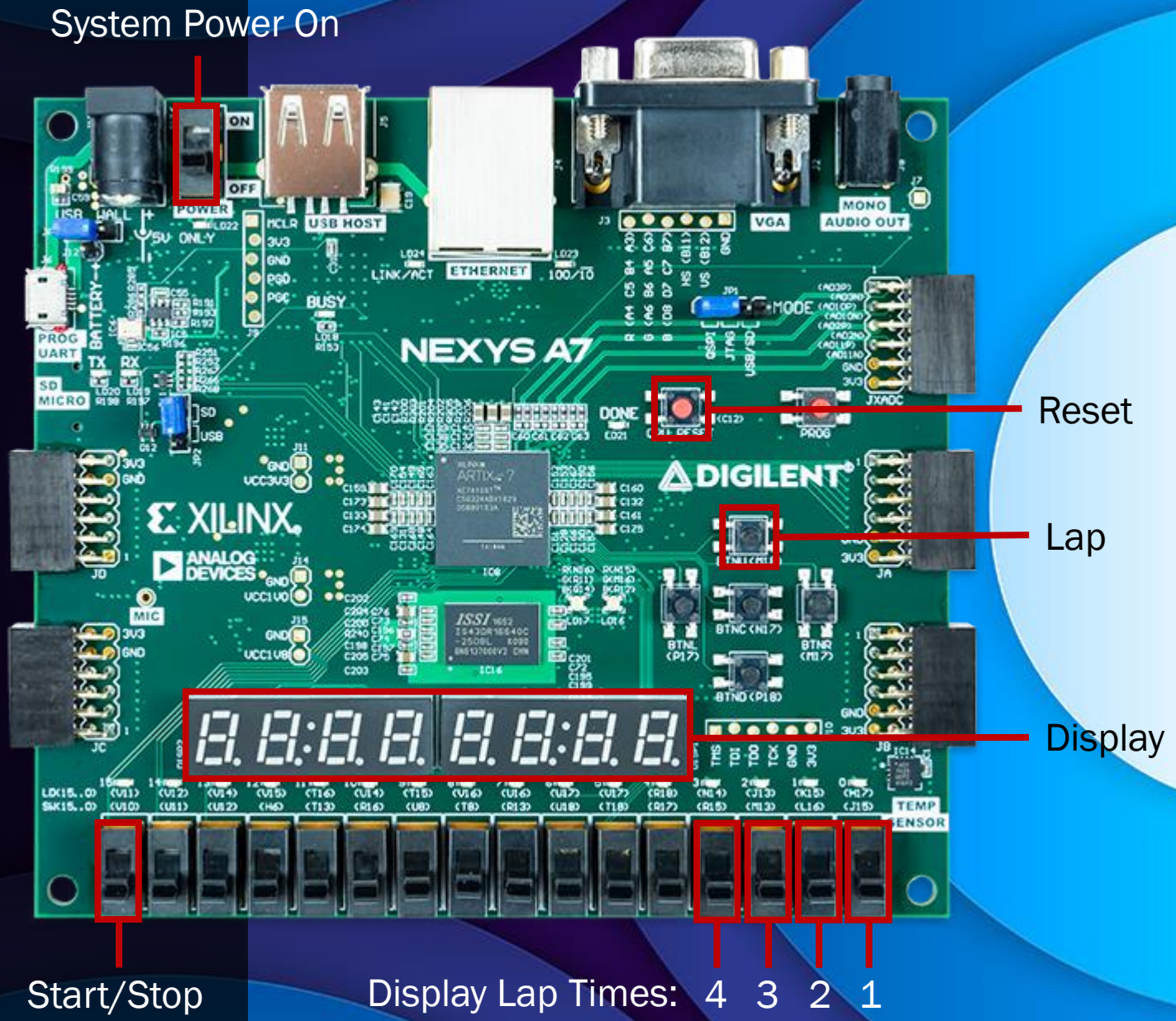
- We wanted to create a fully functional Digital Stopwatch
- We will be using the Nexys A7 Programmable Board

- Our Stopwatch can Display:
  - Hours
  - Minutes
  - Seconds
  - Hundredths of Second
  - Tenths of Second

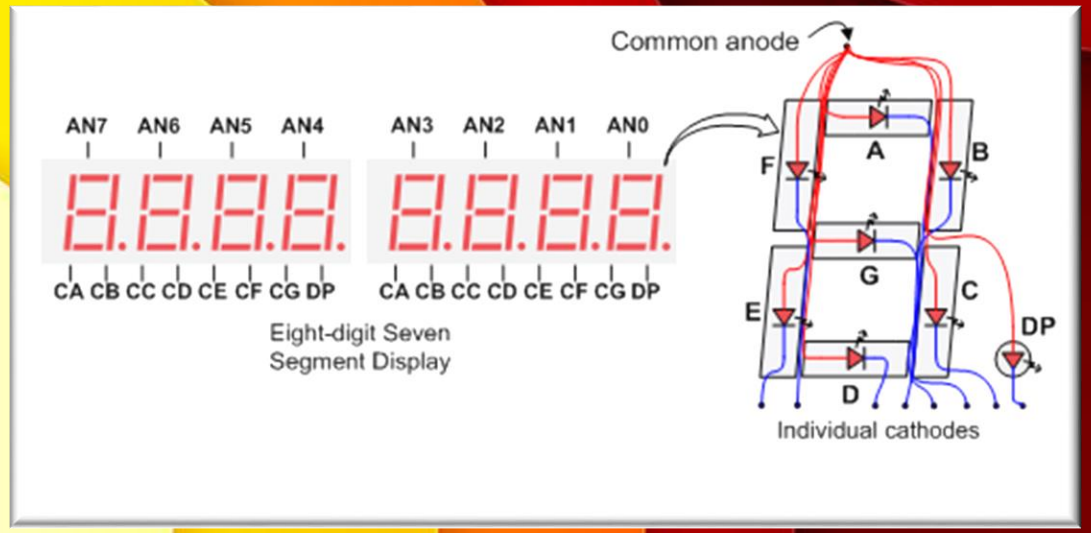
- Watch Features Include:
  - Start
  - Pause
  - Reset
  - Lap
- Our Stopwatch is able to Store up to Four Lap Times

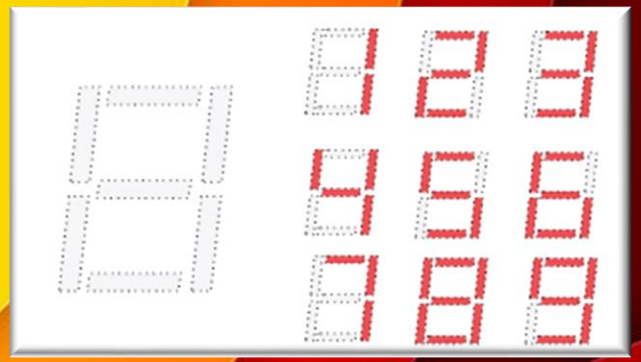
Board Layout & Controls

- Our Stopwatch will utilize the Pushbuttons and Switches for the Watch Controls
- Switch #0 - Switch #3 (SW0-SW3) are utilized to display its designated Lap Time
- Switch #15 (SW15) is utilized for the Start/Stop Feature
- The Up Button (BNTU) is utilized to toggle and record the lap times
- The Reset Button (CPU RESET) is utilized to Reset the Stopwatch

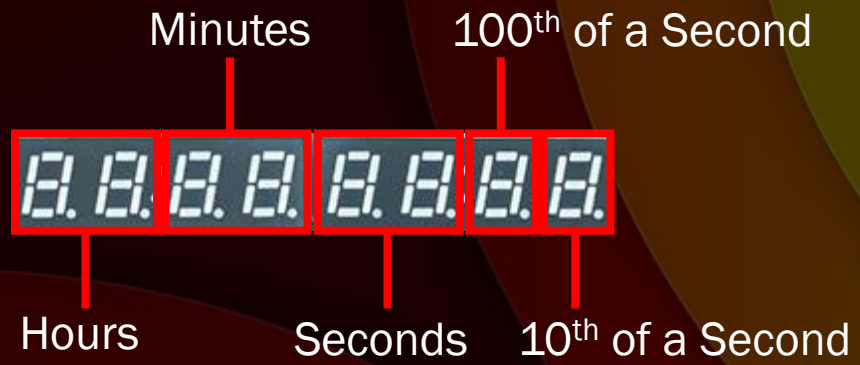


The Display

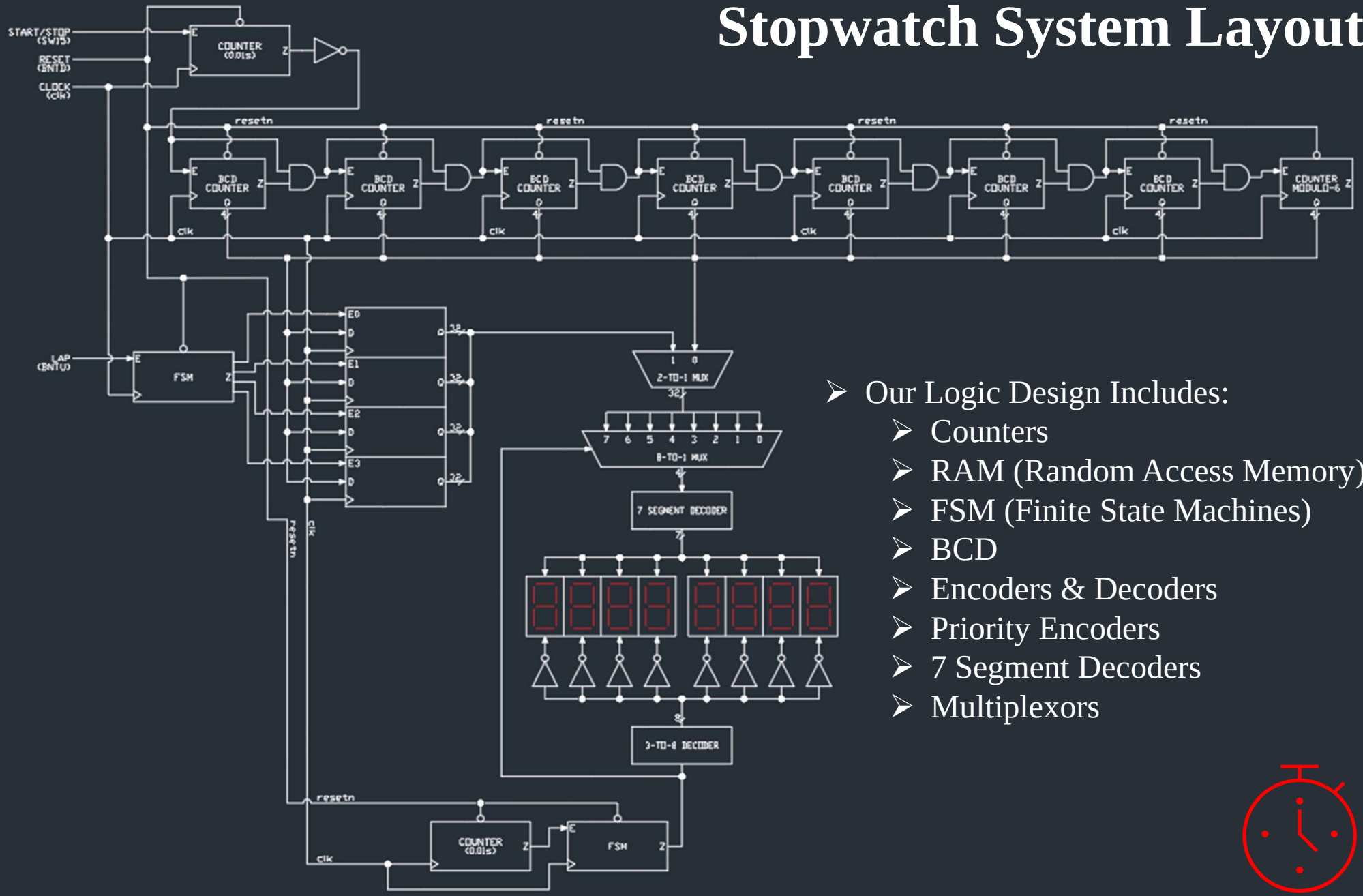




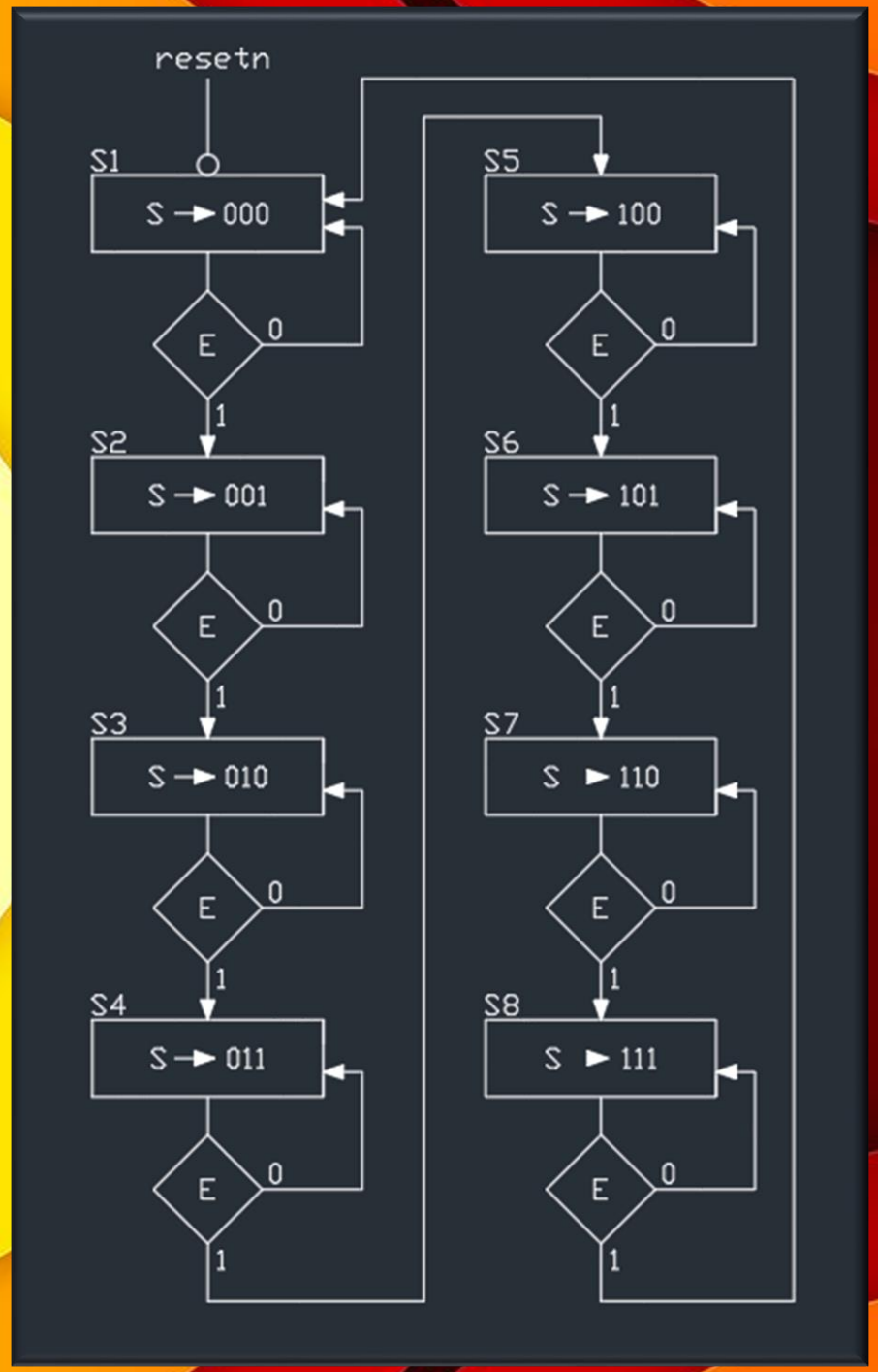
- The Nexys A7 board contains two four-digit common anode seven-segment LED displays
- They are configured to behave like a single eight-digit display
- On the left is an example of illuminated numbers 1-9 being displayed on a seven-segment LED display
- The diagram below shows the configuration of the display inputs



Stopwatch System Layout



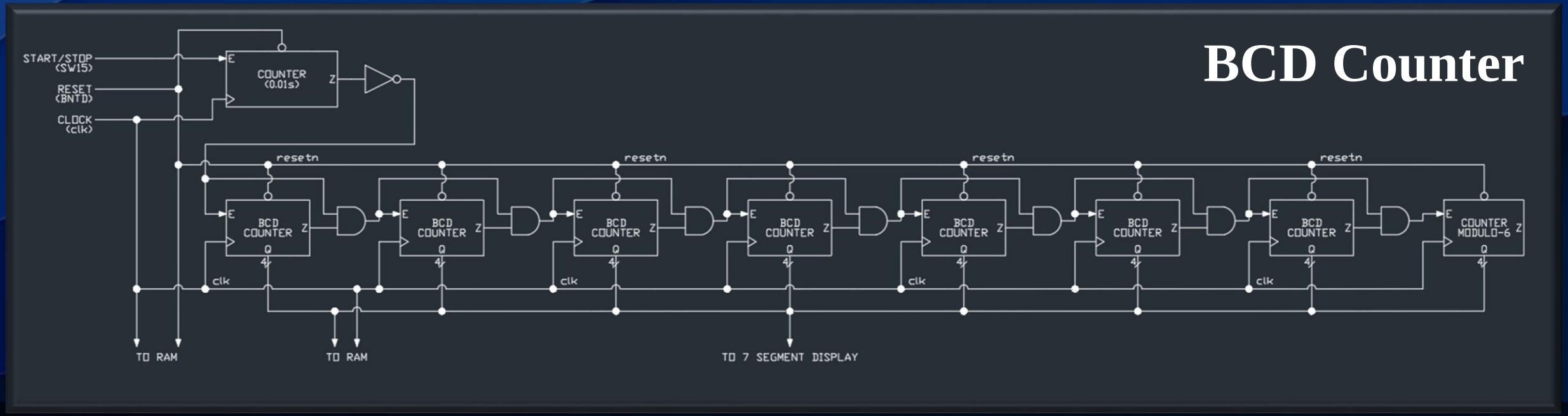
- Our Logic Design Includes:
  - Counters
  - RAM (Random Access Memory)
  - FSM (Finite State Machines)
  - BCD
  - Encoders & Decoders
  - Priority Encoders
  - 7 Segment Decoders
  - Multiplexors



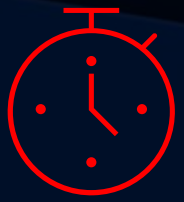
Finite State Machine

- Our FSM has eight states
- Each state is associated to a specific Seven Segment Display
- The FSM is controlled by a 1ms counter
- The FSM shifts between states in coordination with the counter and sends its values to the output ‘S’

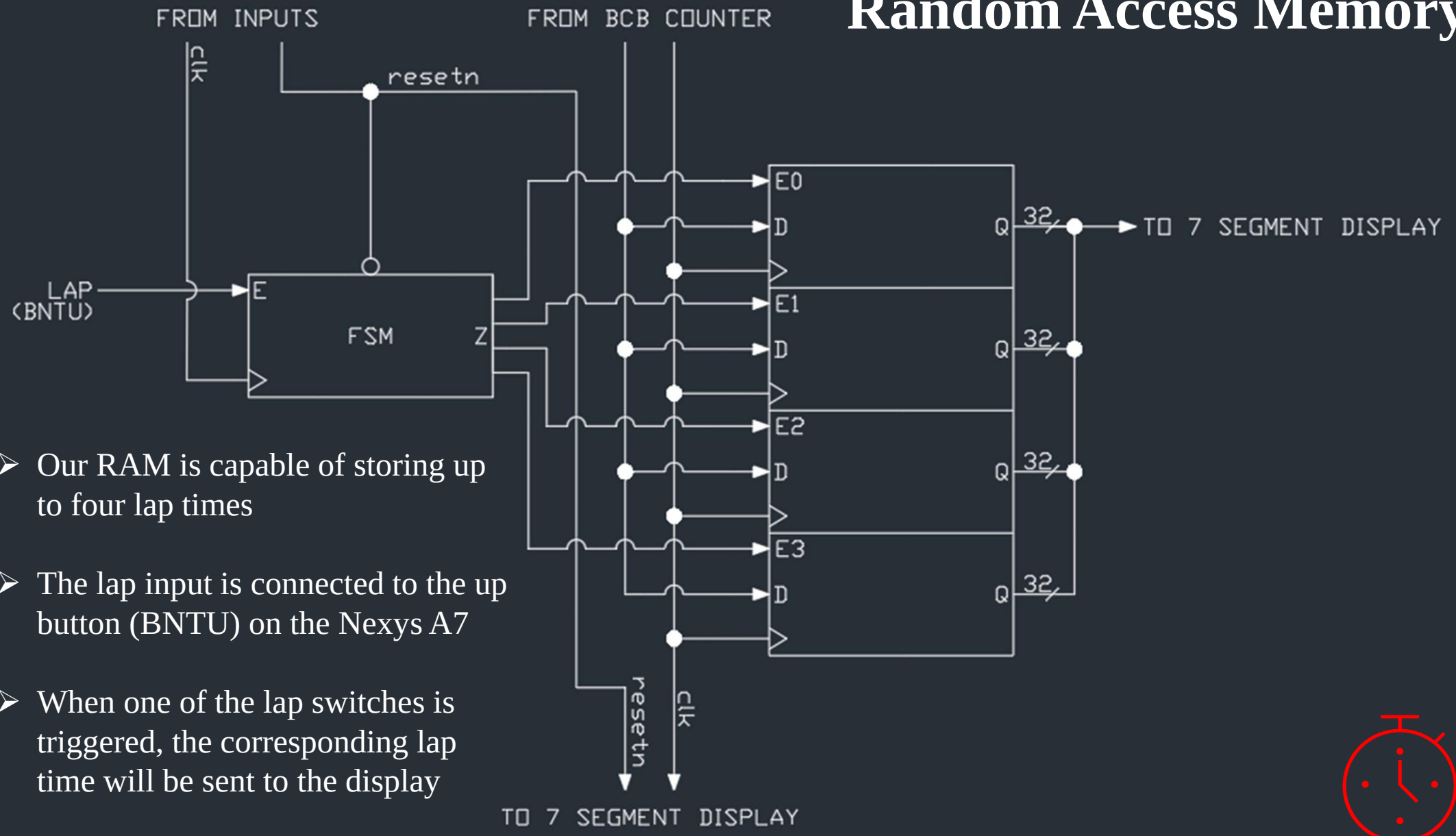
BCD Counter



- Our Logic utilizes Nine counters
- The lead counter increments by a hundredth of a second (0.01s) and feeds into the rest of the counters
- Switch #15 (SW15) is utilized for the Start/Stop Feature
- The Counters then feed into the RAM system and the Seven Segment Display System



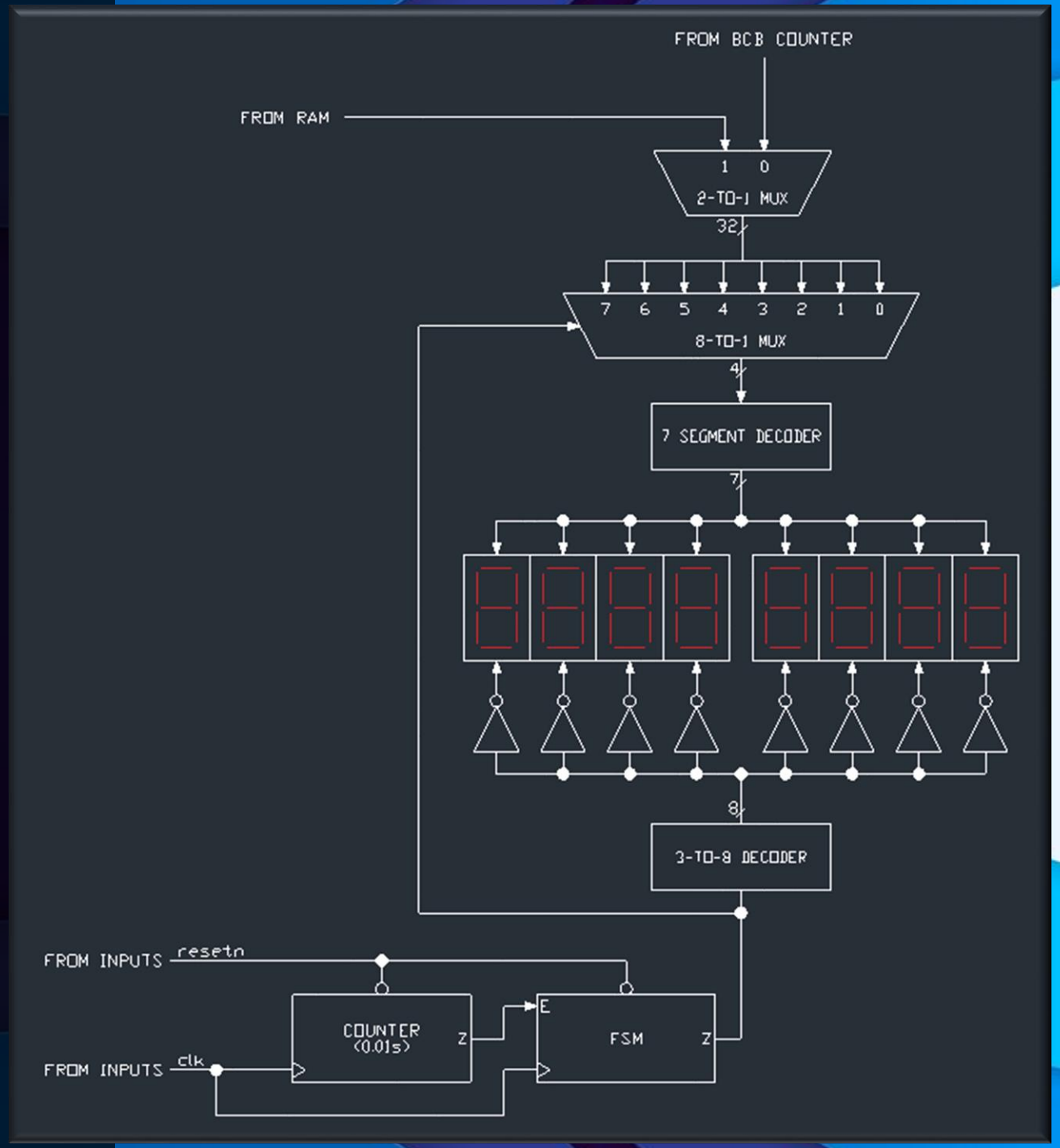
Random Access Memory



- Our RAM is capable of storing up to four lap times
- The lap input is connected to the up button (BNTU) on the Nexys A7
- When one of the lap switches is triggered, the corresponding lap time will be sent to the display

Seven Segment Display

- The display is controlled by a 2-to-1 Mux to determine whether a lap time will be displayed, or the current watch time is displayed
- Following the 2-to-1 Mux is an 8-to-1 Mux and a 7 Segment Decoder
- The Up Button (BNTU) is utilized to toggle and record the lap times
- The First Four Switches: (SW0-SW3) are utilized to display its designated Lap Time



Thank You For Listening

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References

https://digilent.com/reference/programmable-logic/nexys-a7/reference-manual
http://www.secs.oakland.edu/~llamocca/index.html