Digital Stopwatch

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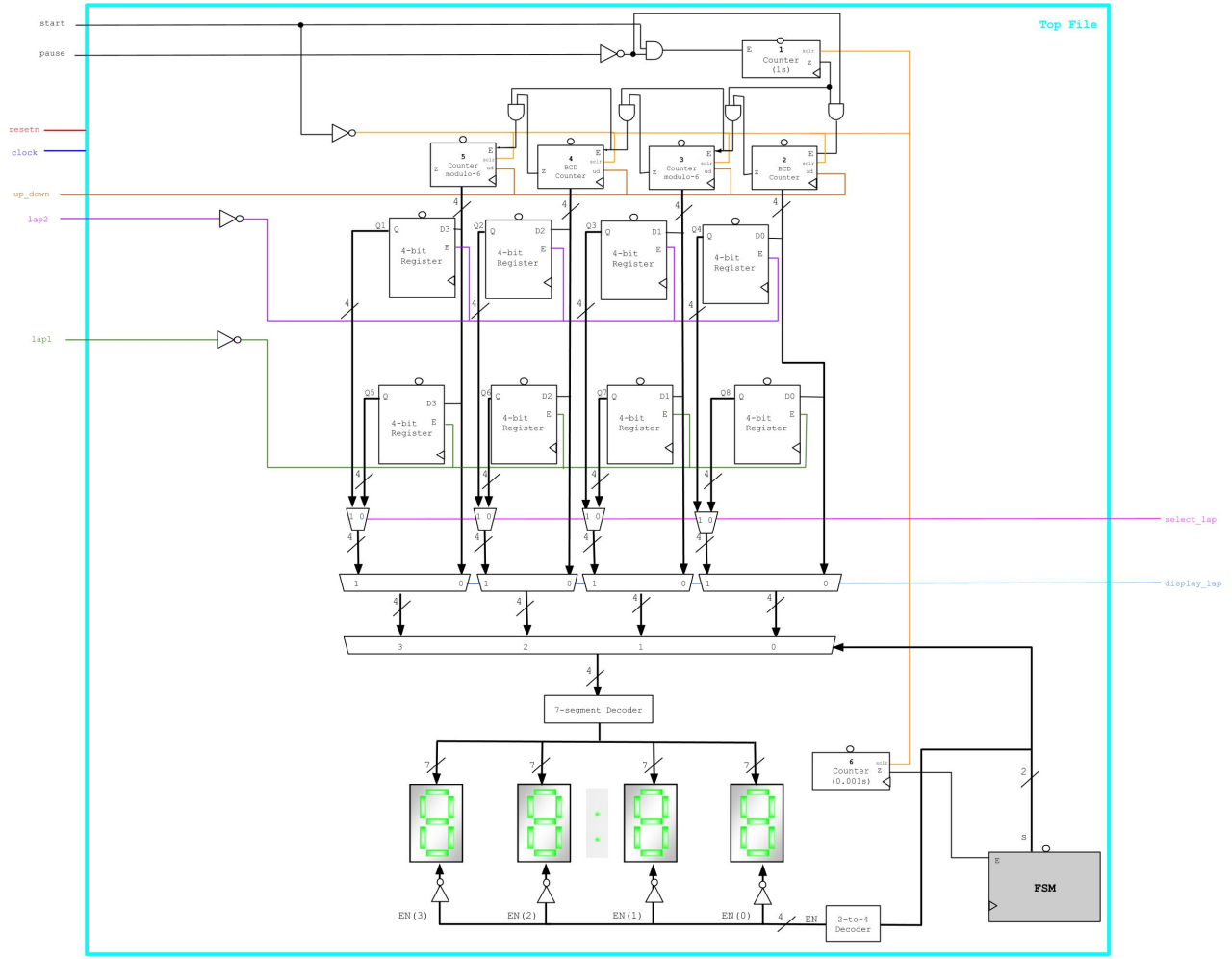
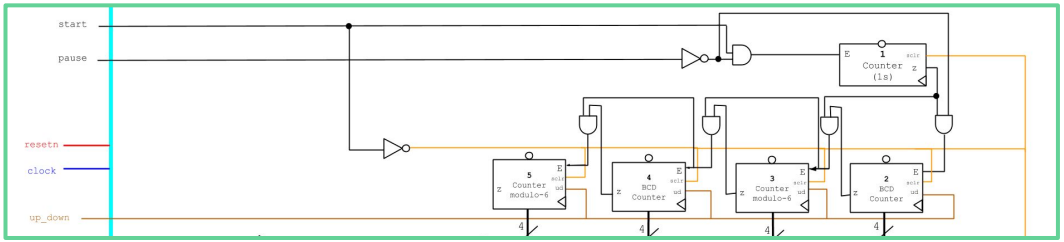
Functionality of Stopwatch

- Counts minutes and seconds
- Can count up or down in time
- Lap capabilities
    - Records up to two lapped values
- Displays current or lapped time on seven-segment displays
    - Possible through implementation on Basys-3 board


Top File
start
pause
resetn
clock
up_down
lap2
lap1
1 Counter (1s)
5 Counter modulo-6
4 BCD Counter
3 Counter modulo-6
2 BCD Counter
4-bit Register
select_lap
display_lap
7-segment Decoder
6 Counter (0.001s)
FSM
2-to-4 Decoder
EN (3)
EN (2)
EN (1)
EN (0)
EN

Main Components of Digital System

Main Counters



Up/Down Switch:

- Counts up when *up_down* is high
- Counts down when *up_down* is low

Counter 1:

- Counter generates a pulse every 1 s
  - Enable controlled by *start* AND NOT(*pause*)
- Output serves as an enable for the next counters

Counters 2 & 4:

- BCD (0 to 9) counters
- Counter 2:
  - Enable controlled by NOT(*pause*) AND counter 1's output *z*
- Counter 4:
  - Enable controlled by counter 3's enable *E* AND counter 3's output *z*

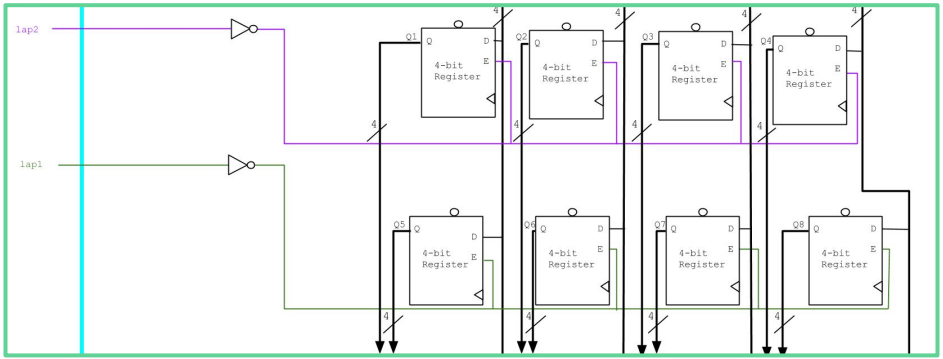
Counters 3 & 5:

- Modulo-6 (0 to 6) counters
- Counter 3:
  - Enable controlled by counter 2's output *z* AND counter 1's output *z*
- Counter 5:
  - Enable controlled by counter 4's enable *E* AND counter 4's output *z*

Laps and Lap Displays

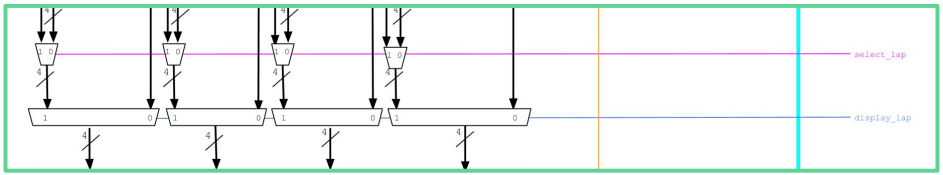
Lapping of Time

- Two sets of four four-bit registers
- Register enables controlled by a NOT gate and a switch
  - *lap2* = ‘1’ ➔ activates memory state of first set of registers
  - *lap1* = ‘1’ ➔ activates memory state of second set of registers



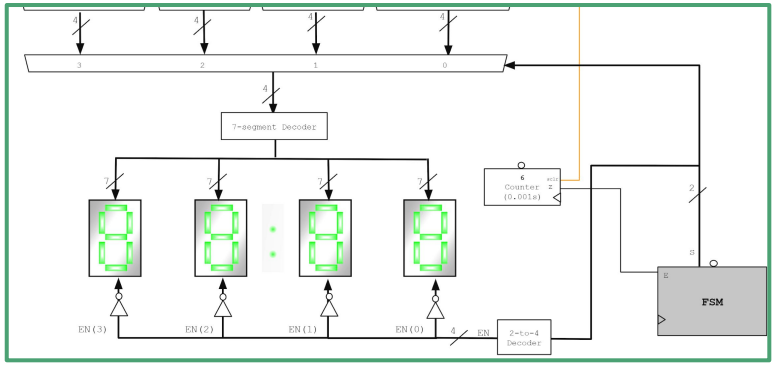
Displaying of Lap

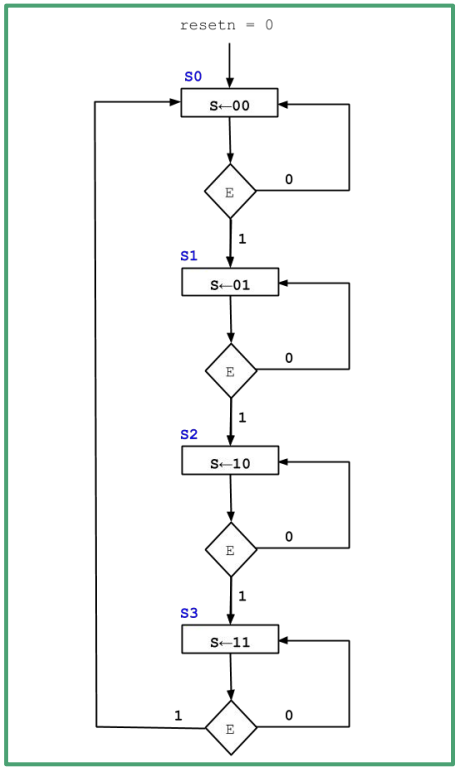
- *select_lap*
  - Selects the first or second lap
- *display_lap*
  - Displays current time or lapped time



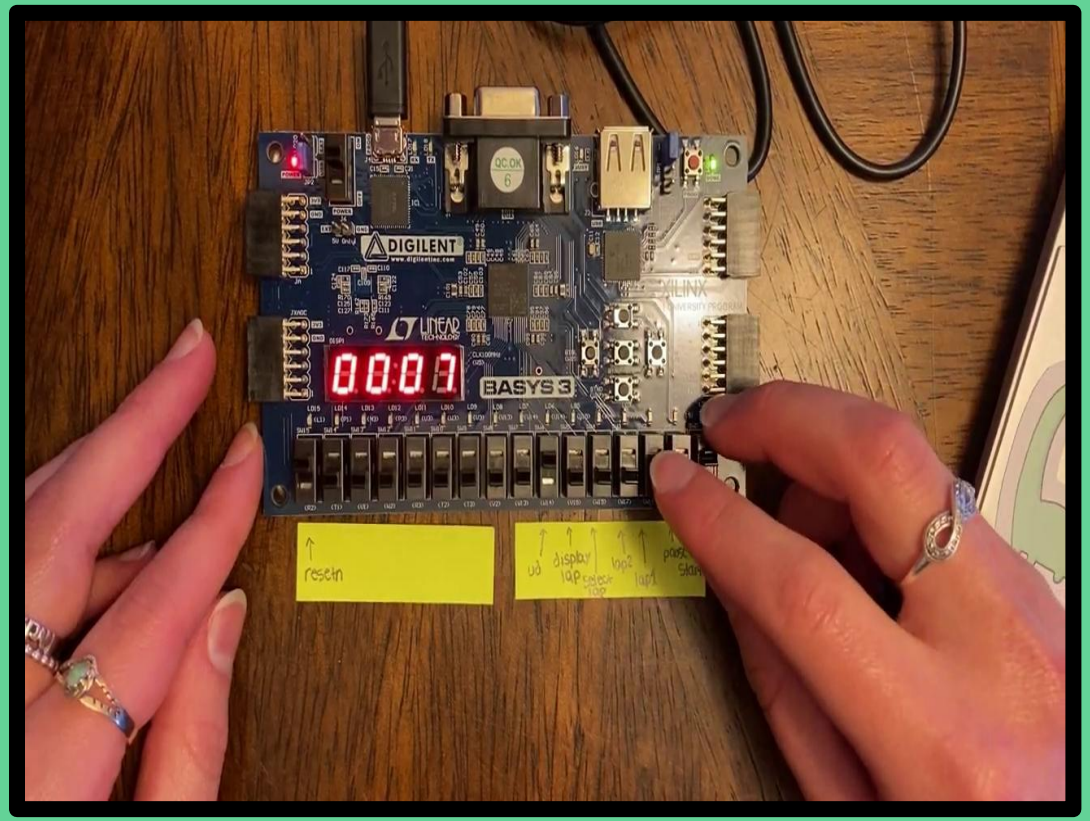
FSM

- **ASM Chart**
  - Functionality of FSM
  - State *S* is used as:
    - Selector in 4-to-1 Mux
    - Input to 2-to-4 decoder
- **Displays current count or lapped time**
  - *E_fsm* wired to *z* of counter to display every 0.001s





Our Stopwatch at Work



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