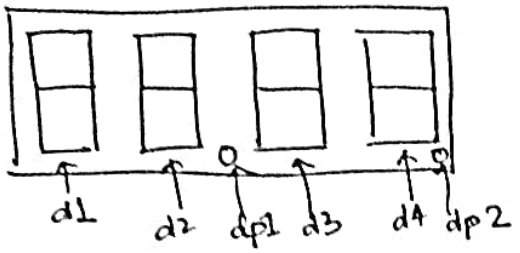
PRATEEK CHAUDHURY
2019CS10384

COL 215 – ASSIGNMENT-II
DIGITAL CLOCK

Display design



This is the display where 4 digits will be displayed as HH:MM or MM:SS as per current state/mode and decimal point will be blinking also with some dependence on current state. (explained ahead).

In my design,
I have basically 4 states and 4 buttons.

States/Modes

S_1: In this state, the normal clock runs and time is displayed in HH:MM. Both the decimal points blink in speed of a second's clock.

S_2: In this state, the normal clock runs and time is displayed in MM:SS. Both the decimal points blink at the speed of second's clock.

S_3: In this mode, the clock enters timesetting mode. In this the minute value is set by the user. Clock displays HH:MM.
dp2 { Decimal point, right to the minutes digits blinks whereas the one on right of hours' digits stops blinking indicating that user is currently changing ~~seconds~~ minutes' digits.

S_4: Similarly, this is also a time setting mode, here Hours digits are changed. Similar to above explanation, only dp1 blinks, dp2 is off indicating that user is in mode for changing digits of Hours'.

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Now, there are 4 buttons en, sw, in, dn. First we will see the specifications of button, then the state transition or finite state diagram.

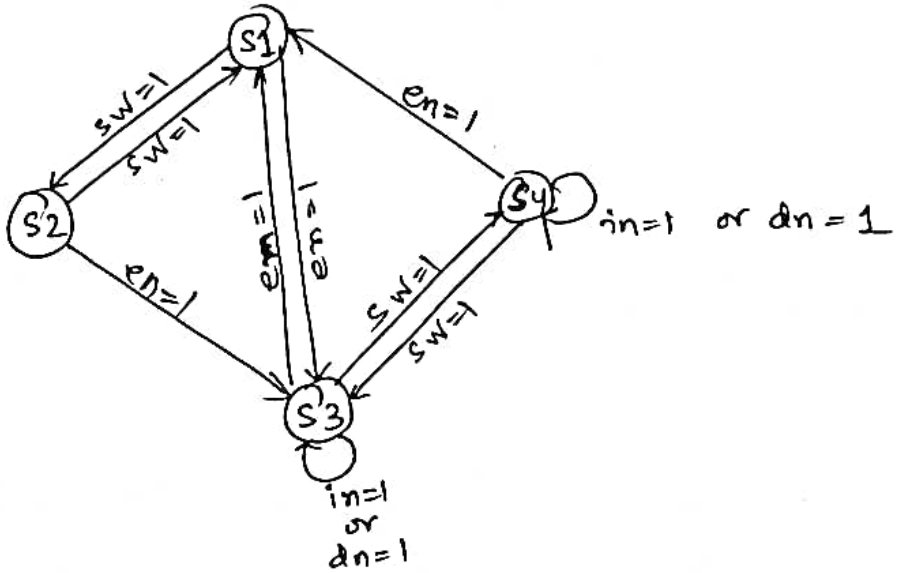
① en → 'Enable' ;; This button switches ~~between~~ ~~S_1 and S_2~~ from ~~On pressing, this button [illegible] normal time setti~~ normal clock modes (S_1 and S_2) to time setting mode S_3. It also switches from time setting mode (S_3 and S_4) to S_1.
By default, the button sends us to S_1 or S_3 (never S_2 or S_4) depending on initial state.

(II) sw → 'Switch' : This button switches between S_1 and S_2. (S_1 to S_2 and S_2 to S_1) So, this switches from HH:MM to MM:SS in normal clock mode. (& vice versa) ~~It also swit~~
It also switches between S_3 and S_4. (Minute setting to hour setting and vice versa are in S_3 or S_4)

(III) in → 'Increase' : This button works only when we are in S_3 or S_4 (time setting modes). If this button is pressed for less than 1 sec, it increases the value of hour or minute (depending on S_3 or S_4) by 1. When this is pressed for more the 1sec continuously, then after 1 sec, the value of hour or minute (S_3 or S_4) increases at rate of 4 per second.

(IV) dn → 'decrease' : This button is totally similar to 'in' button. It works when we are S_3 or S_4, has no effect in S_1 or S_2.
If it is pressed less than second, the digit decreases by 1. Else if, it is pressed for more than one second then after 1 sec, the value of hour or minute (S_3/S_4) increases at 4 per second.

Now, let us see the state transition diagram, 4 buttons en, sw, in and dn as inputs.



CIRCUIT DIAGRAM

I have basically 8 4 components in my final entity.

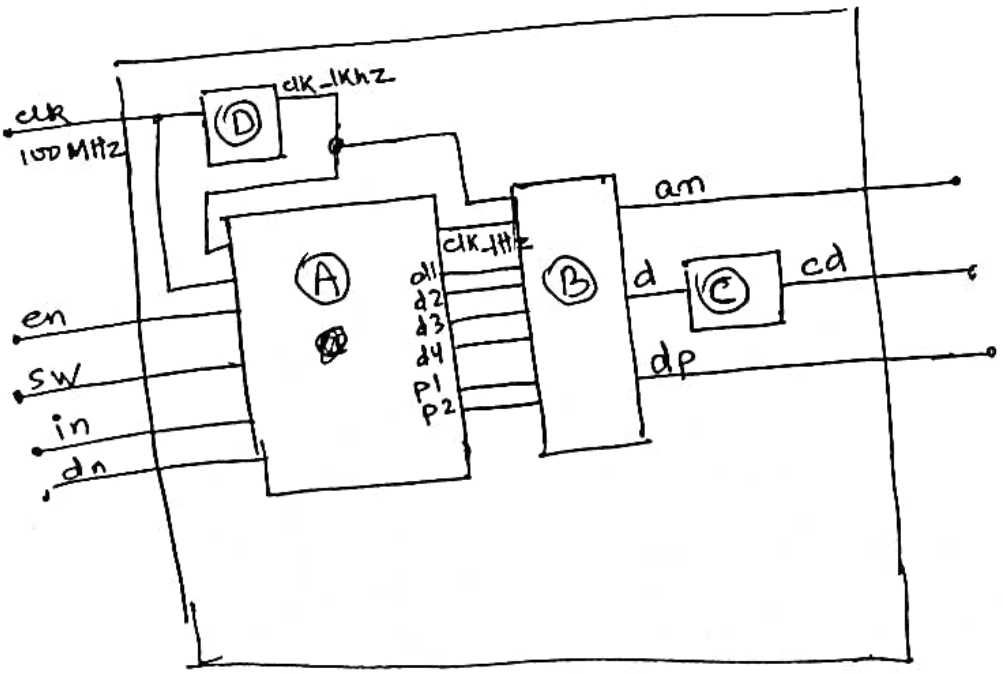
(i) Clock and time setting (main) → (A)

(ii) Seven segment display (sevensegment) → (B)

(iii) Encoder (encoder) → (C)

(iv) 1000Hz clock (clk_1Khz) → (D)

← In bracket, I have mentioned the name of the entity in my VHDL code.



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an, cd, dp are the outputs of the whole circuit.

an → This is a 4 bit vector (anode) and has 3 '0's and 1 '1', indicating which digit of the 4 is to be displayed.

cd → This is the 7 bit vector cathode which has some '0's and some '1's according to value of the digit to be displayed.

dp → This is the 2 bit vector having '0' or '1' indicating whether decimal point has to blink or not. If any bit of dp is '0' then that decimal point will blink.

Basically, if the cathode bit is '0', and anode bit of the then that segment gets displayed in the digit for which anode bit is '1'.

Explaining my design decisions

Firstly, I have used a 1KHz clock to trigger processes in which button changes are considered.

I have used a 1Hz clock to for the normal clock time counting.

For, blinking the decimal point, I have used a 1Hz clock, as the decimal point should blink at the rate of a second's clock. Whichever bit of 'dp' is '0', that means it is 'on'.

Now, refresh rate of my display of digits.

I have used a clock of 1000Hz (1KHz). So, each digit is displayed for 10^3 seconds. So, displaying the 4 digits for one cycle will take 4×10^{-3} seconds.

So, the screen basically refreshes after 4×10^{-3} sec or 4ms.

Refresh rate is 4ms.

I have also ensured that 'en' has higher priority than 'sw' and 'in' has higher priority than 'dn'.