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COL215: Assignment 2

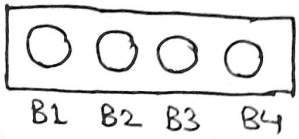
DIGITAL CLOCK

→ The digital clock is designed using VHDL

→ The format of clock is HH:MM or MM:SS dependent on the display mode selected.

→ Specifications of Buttons:

There are 4 buttons on the clock.



(1) Button 1: Display Mode

⊗ This button is primarily used to change the display mode from HH:MM to MM:SS and vice versa (Default is HH:MM) The display mode HH:MM also has a decimal point (Fourth on BASYS3 Board) flashing at the frequency of 1 Hz. MM:SS has no such flashing decimal point.

⊗ This button is also used to change from minute to hour in timesetting mode and vice versa (Default is minute setting)

(2) Button 2: Timesetting / Normal Mode

⊗ If this button is pressed then the clock from normal mode to timesetting mode. If we are done changing minutes and hours, this button is also used to go back to normal mode.

⊗ Whenever this button is pressed, the clock goes into the default HH:MM display mode.
By default, 4th decimal point will turn on indicating that we can now change minute by using button 3 and button 4.
If we press button 1, we can now change hour indicated by 2nd decimal point turning on and 4th one off.

(3) Button 3: Increase Button

If, we are in timesetting mode, this button is used to increase the current quantity (Hours/Minutes) indicated by the decimal point currently on. (4th → Min, 2nd → Hour)
If this button is pressed for more than 1s, then the current quantity will increase by four in every 1/4th seconds. Otherwise, it would increase by 1 in every 1/4th seconds.

(4) Button 4: Decrease Button

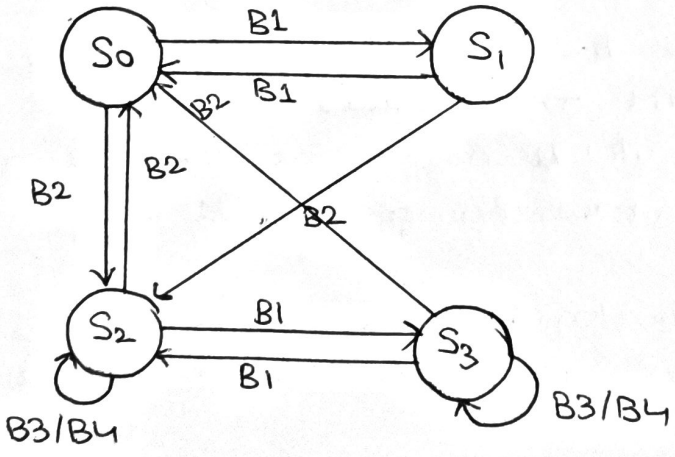
Similar to Button 3, if this button is pressed in timesetting mode, we can decrease the current quantity by 1 if pressed between $1/4^{th}$ of second to 1 second in every $1/4^{th}$ of second.
If pressed longer than 1S, the current quantity would decrease by 4 in every $1/4^{th}$ of second.

DESIGN CONSIDERATIONS:

- The normal clock and button change process are triggered by the main clock of 100 MHz.
- To display the flashing decimal point, a clock of 1Hz is made using a separate process which is triggered by the main clock.
- I have assumed until a button is not pressed for more than $1/4^{th}$ of a second, it will not trigger any action on the device.
- As mentioned earlier, for long press of B3 and B4, I have considered that it will be pressed for more than 1 second.
- I have used a priority order if more than one button is pressed. That order is B2 > B1 > B3 > B4

STATE DIAGRAM:

B1 → Button 1 (D.M.)
B2 → Button 2 (T.S.)
B3 → Button 3 (Inc.)
B4 → Button 4 (Dec.)



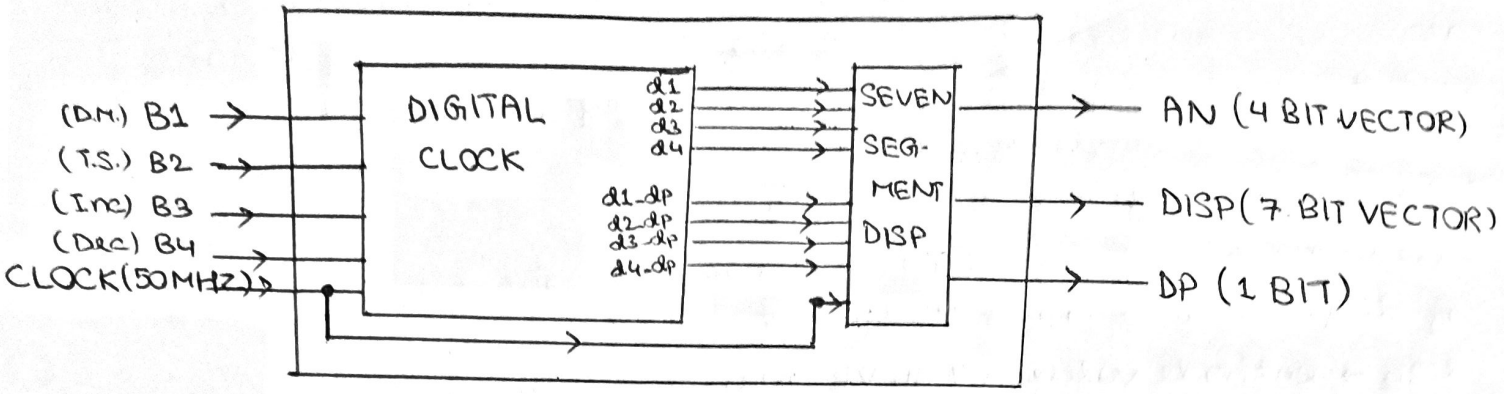
S_0: Clock is in Normal Mode and Time is displayed in MM:MM Format (Flashing decimal point)

S_1: Normal Mode, Display: MM:SS

S_2: Timesetting Mode, Minutes can be changed (4^{th} decimal point is ON)

S_3: Timesetting Mode, Hours can be changed (2nd decimal point is ON)

DIAGRAM:



DESIGN:

The clock is divided into two components:

(1) Digital clock

(2) Seven Segment Display

Digital clock:

The user interacts with digital clock only. Based on the user's demand, there are state changes in the clock. Otherwise, the normal clock will keepon running.

Based on the current state of the component, the output is sent to next component.

INPUT: dm (BIT): To change Display Mode

ts (BIT): To change to Time Setting Mode

inc (BIT): To increase the pointed quantity by clock

dec (BIT): To decrease the pointed quantity

OUTPUT: d1, d2, d3, d4: Digits to be displayed on SSD as $D_1 D_2 : D_3 D_4$

d1_dp, d2_dp, d3_dp, d4_dp (Bit): To be displayed by decimal point

$D_1 \circ \; D_2 \circ \; D_3 \circ \; D_4 \circ$

Seven Segment Display:

Since there is only one anode thus, it is necessary to keep rotating between different digits of display by a rate such that it is ignorable to human eyes and all digits are visible at same time.

I have used refresh rate of 10ms.

Based on the current position of the counter, the value of disp, an and dp is outputed.

disp → cathode values (7 BIT VECTOR)

an → anode values (4 BIT VECTOR)

↳ 0111 → D1 is displayed
1011 → D2 is displayed
1101 → D3 is displayed
1110 → D4 is displayed

dp → decimal point(1 WHEN ON)