ENGR 2323 Digital Design Lab
Seven-Segment Displays

Seven-Segment Displays

Seven-segment (7-segment) LED displays are found in digital clocks, calculators, many other home appliances. They are primarily used to display decimal numbers, but they can also display some letters and characters.

A 7-segment display consists of a rectangular arrangement of seven LEDs. Six of the LEDs form the outline of the rectangular; one LED at the top and bottom, and two LEDS on the left and right sides. The remaining LED is connected to the middle of the left and right sides. Seven-segment displays may also have an eighth LED at the bottom right for a decimal point. See Figure 1. By individually turning the segments on or off, numbers from 0 to 9 and some letters can be displayed.

Figure 1. Layout of7-Segment Display

The segments on a 7-segment display are commonly named a – g (with a corresponding to 0 in Figure 1, b to 1, c to 2, d to 3, e to 4, f to 5, and g to 6).

The LEDs in the display can be arranged with a common anode or common cathode configuration. For a common cathode configuration, the cathodes of all the LEDs are tied together and connected to a common ground. The anode of the LED is the positive lead, and the cathode of the LED is the negative lead. The LED current flows from anode to cathode in typical operation. To turn on a segment of a common cathode connected display, a high voltage (logic 1) is applied to the anode of the segment,

For a common anode configuration, the anodes of all the LEDs are tied together and connected to common supply voltage (3V to 5V for most common LEDs). To turn on a segment of a common anode connected display, a low voltage (logic 0) is applied to the cathode of the segment.

DE10-Standard Board 7-Segment Displays

The DE10 Standard board has six 7-segment displays (numbered 0 through 5). The DE10-Standard board 7-segment displays are common anode configurations with pull down resistors connected between the LED and the driving signal as shown in Figure 2 (Figure 2 shows the signals for display 0). The segments are numbered from 0 to 6 with an additional LED for the decimal point (DP).

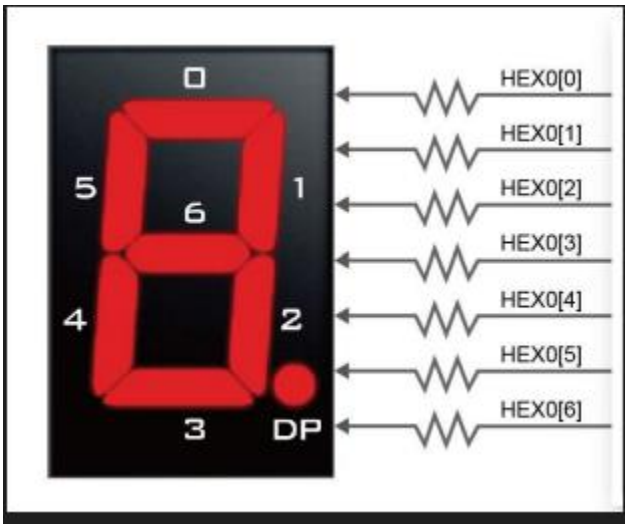

Figure 2: DE10-Standard Board 7-Segment Display (Common Anode)

To display the number one on the display, segments 1 and 2 need to be lit and the other segments unlit. The inputs HEX0[1] and HEX0[2] would be set low (logic 0) and the remaining inputs HEX0[0], HEX0[3], HEX0[4], HEX0[5], and HEX0[6] would be set high (logic 1). The decimal point (DP) would also be set high.

BCD to 7-Segment Decoders

A BCD (binary coded decimal) to 7-segment decoder converts a 4-bit binary coded decimal digit to the seven signals (8 if there is a decimal point) needed to display the digit on a 7-segment display.

The VHDL behavioral design of Figure 3 illustrates the decoding of a 2-bit binary coded number for display on one of the DE10-Standard board 7-segment displays (display decimal 0 to 3 corresponding to binary 00 to 11). The output vector is seven bits with the most significant bit corresponding to HEX[6] and the least significant bit corresponding to HEX[0]. To display 0 for binary input 00, HEX[6] is set to 1 and the remaining HEX signal values are set to 0.

When assigning pins for the output signals for the display, all 7-bits of the output need assigned pins. The exact pin assignment depends on which of the six 7-segment displays (HEX0 to HEX5) is being used.

```
LIBRARY ieee;
USE ieee.std_logic_1164.all;

ENTITY displaydecoder IS
PORT(BA : IN STD_LOGIC_VECTOR(1 DOWNTO 0);
     HEX : OUT STD_LOGIC_VECTOR(6 DOWNTO 0));
END displaydecoder;

ARCHITECTURE behavior of displaydecoder IS
BEGIN
-- segments for DE10-Standard are active low
     HEX <= "1000000" WHEN BA = "00" ELSE
          "1111001" WHEN BA = "01" ELSE
          "0100100" WHEN BA = "10" ELSE
          "0110000" WHEN BA = "11" ELSE
          "1111111";
END behavior;
```

Figure 3. VHDL Display Decoder Design

References

[1] DE10-Standard User Manual, Terasic Inc., 2017

Last modified Monday, October 3, 2022

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