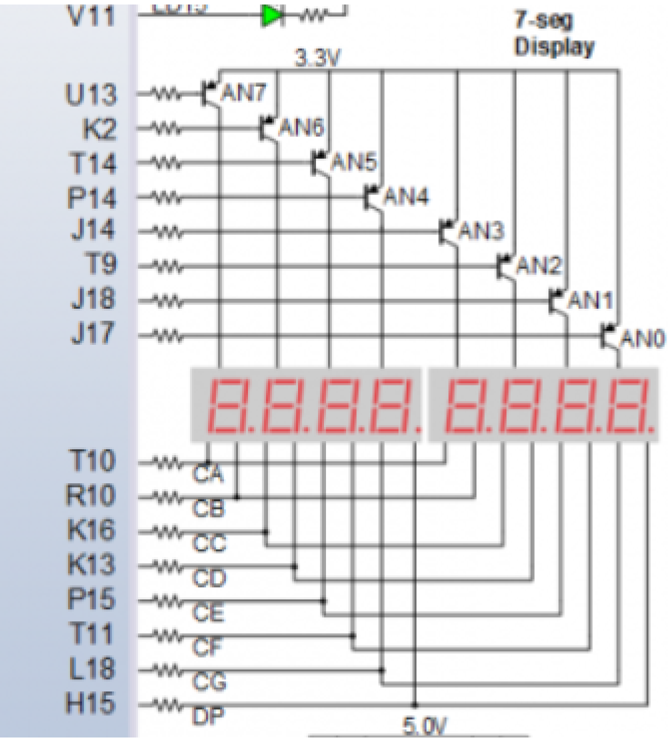
04 - Segment

1. Tables

Table with connection of 7-segment displays:

Pin No. at 0V	func.
U13	Disp. 7 ENABLED
K2	Disp. 6 ENABLED
T14	Disp. 5 ENABLED
P14	Disp. 4 ENABLED
J14	Disp. 3 ENABLED
T9	Disp. 2 ENABLED
J18	Disp. 1 ENABLED
J17	Disp. 0 ENABLED
T10	CA ON
R10	CB ON
K16	CC ON
K13	CD ON
P15	CE ON
T11	CF ON
L18	CG ON
H16	DP ON

Schematic:



Decoder truth table for common anode 7-segment display:

Hex	Inputs	A	B	C	D	E	F	G
0	0000	0	0	0	0	0	0	1
1	0001	1	0	0	1	1	1	1
2	0010	0	0	1	0	0	1	0
3	0011	0	0	0	0	1	1	0
4	0100	1	0	0	1	1	0	0
5	0101	0	1	0	0	1	0	0
6	0110	0	1	0	0	0	0	0
7	0111	0	0	0	1	1	1	1
8	1000	0	0	0	0	0	0	0
9	1001	0	0	0	0	1	0	0
A	1010	0	0	0	1	0	0	0
b	1011	1	1	0	0	0	0	0
C	1100	0	1	1	0	0	0	1
d	1101	1	0	0	0	0	1	0
E	1110	0	1	1	0	0	0	0
F	1111	0	1	1	1	0	0	0

2. Seven-segment display decoder

VHDL architecture from source file hex_7seg.vhd:

```
p_7seg_decoder : process(hex_i)
    begin
        case hex_i is
            when "0000" =>
                seg_o <= "0000001";     -- 0
            when "0001" =>
                seg_o <= "1001111";     -- 1
            when "0010" =>
                seg_o <= "0010010";     -- 2
            when "0011" =>
                seg_o <= "0000110";     -- 3
            when "0100" =>
                seg_o <= "1001100";     -- 4
            when "0101" =>
                seg_o <= "0100100";     -- 5
            when "0110" =>
                seg_o <= "0100000";     -- 6
            when "0111" =>
                seg_o <= "0001111";     -- 7
            when "1000" =>
                seg_o <= "0000000";     -- 8
            when "1001" =>
                seg_o <= "0000100";     -- 9
            when "1010" =>
                seg_o <= "0001000";     -- A
            when "1011" =>
                seg_o <= "1100000";     -- b
            when "1100" =>
                seg_o <= "0110001";     -- C
            when "1101" =>
                seg_o <= "1000010";     -- d
            when "1110" =>
                seg_o <= "0110000";     -- E
            when others =>
                seg_o <= "0111000";     -- F
        end case;
    end process p_7seg_decoder;
```

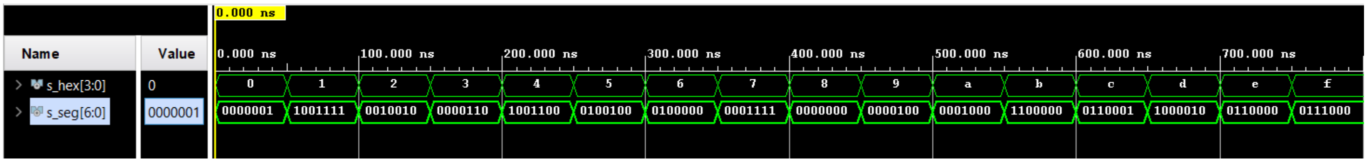
VHDL stimulus process from testbench file tb_hex_7seg.vhd:

```
p_stimulus : process
    begin
        -- Report a note at the begining of stimulus process
        report "Stimulus process started" severity note;

        s_hex <= "0000"; wait for 50 ns;
        s_hex <= "0001"; wait for 50 ns;
        s_hex <= "0010"; wait for 50 ns;
        s_hex <= "0011"; wait for 50 ns;
        s_hex <= "0100"; wait for 50 ns;
        s_hex <= "0101"; wait for 50 ns;
        s_hex <= "0110"; wait for 50 ns;
        s_hex <= "0111"; wait for 50 ns;
        s_hex <= "1000"; wait for 50 ns;
        s_hex <= "1001"; wait for 50 ns;
        s_hex <= "1010"; wait for 50 ns;
        s_hex <= "1011"; wait for 50 ns;
        s_hex <= "1100"; wait for 50 ns;
        s_hex <= "1101"; wait for 50 ns;
        s_hex <= "1110"; wait for 50 ns;
        s_hex <= "1111"; wait for 50 ns;

        -- Report a note at the end of stimulus process
        report "Stimulus process finished" severity note;
        wait;
    end process p_stimulus;
```

Screenshot with simulated time waveforms:



VHDL code from source file top.vhd with 7-segment module instantiation:

```
hex2seg : entity work.hex_7seg
        port map(
            hex_i    => SW,
            seg_o(6) => CA,
            seg_o(5) => CB,
            seg_o(4) => CC,
            seg_o(3) => CD,
            seg_o(2) => CE,
            seg_o(1) => CF,
            seg_o(0) => CG
        );
```

3. LED(7:4) indicators

Truth table for LEDs(7:4):

Hex	Inputs	LED4	LED5	LED6	LED7
0	0000	1	0	0	0
1	0001	0	0	1	1

Hex	Inputs	LED4	LED5	LED6	LED7
2	0010	0	0	0	1
3	0011	0	0	1	0
4	0100	0	0	0	1
5	0101	0	0	1	0
6	0110	0	0	0	0
7	0111	0	0	1	0
8	1000	0	0	0	1
9	1001	0	0	1	0
A	1010	0	1	0	0
b	1011	0	1	1	0
C	1100	0	1	0	0
d	1101	0	1	1	0
E	1110	0	1	0	0
F	1111	0	1	1	0

VHDL code for LEDs(7:4):

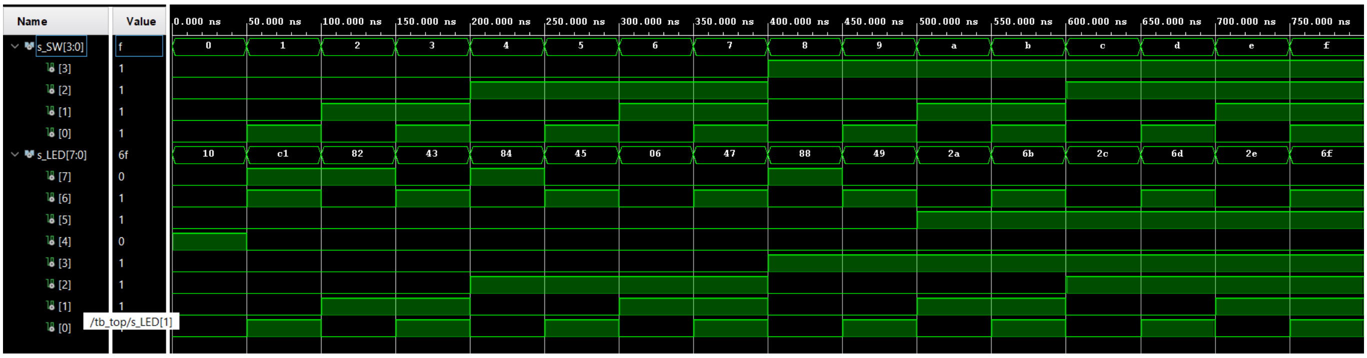
```
-- Display input value on LEDs
    LED(3 downto 0) <= SW;

-- LED(7:4) indicators
    -- Turn LED(4) on if input value is equal to 0, ie "0000"
    LED4 : process (SW)
        begin
            if (SW = "0000") then
                LED(4) <= '1';
            else
                LED(4) <= '0';
            end if;
        end process LED4;

    -- Turn LED(5) on if input value is greater than "1001", ie 9
    LED5 : process (SW)
        begin
            if (SW > b"1001") then
                LED(5) <= '1';
            else
                LED(5) <= '0';
            end if;
        end process LED5;
    -- Turn LED(6) on if input value is odd, ie 1, 3, 5, ...
    LED6 : process (SW)
        begin
            if (SW(0) = '1') then
                LED(6) <= '1';
            else
                LED(6) <= '0';
            end if;
        end process LED6;

    -- Turn LED(7) on if input value is a power of two, ie 1, 2, 4, or 8
    LED7 : process (SW)
        begin
            case SW is
                when "0001" =>
                LED(7) <= '1';
                when "0010" =>
                LED(7) <= '1';
                when "0100" =>
                LED(7) <= '1';
                when "1000" =>
                LED(7) <= '1';
                when others =>
                LED(7) <= '0';
            end case;
        end process LED7;
```

Screenshot with simulated time waveforms:


Name
Value
0.000 ns
50.000 ns
100.000 ns
150.000 ns
200.000 ns
250.000 ns
300.000 ns
350.000 ns
400.000 ns
450.000 ns
500.000 ns
550.000 ns
600.000 ns
650.000 ns
700.000 ns
750.000 ns
s_SW[3:0] f
0 1 2 3 4 5 6 7 8 9 a b c d e f
[3] 1
[2] 1
[1] 1
[0] 1
s_LED[7:0] 6f
10 c1 82 43 84 45 06 47 88 49 2a 6b 2c 6d 2e 6f
[7] 0
[6] 1
[5] 1
[4] 0
[3] 1
[2] 1
[1] 1
[0]
/tb_top/s_LED[1]