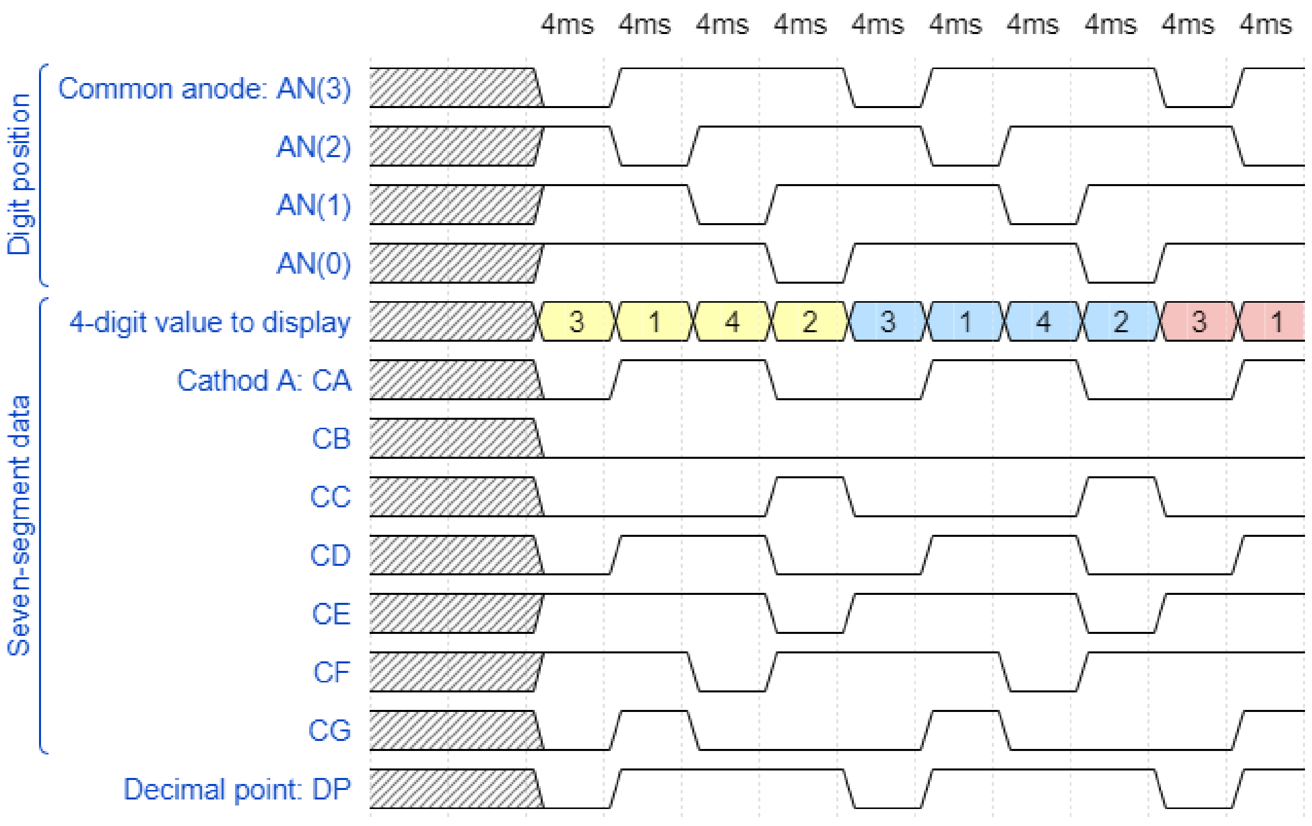
Digital electronics 1 - 06 display driver

Driver for multiple seven-segment displays

Timing diagram figure



Source code of process `p_mux`

```
p_mux : process(s_cnt, data0_i, data1_i, data2_i, data3_i, dp_i)
    begin
        case s_cnt is
            when "11" =>
                s_hex <= data3_i;
                dp_o  <= dp_i(3);
                dig_o <= "0111";

            when "10" =>
                s_hex <= data2_i;
                dp_o  <= dp_i(2);
                dig_o <= "1011";

            when "01" =>
                s_hex <= data1_i;
                dp_o  <= dp_i(1);
                dig_o <= "1101";

            when others =>
```

```
                s_hex <= data0_i;
                dp_o  <= dp_i(0);
                dig_o <= "1110";
        end case;
    end process p_mux;
```

Source code of VHDL testbench file

```
------------------------------------------------------------------------
--
-- Template for 4-digit 7-segment display driver testbench.
-- Nexys A7-50T, Vivado v2020.1.1, EDA Playground
--
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--
------------------------------------------------------------------------

library ieee;
use ieee.std_logic_1164.all;

------------------------------------------------------------------------
-- Entity declaration for testbench
------------------------------------------------------------------------
entity tb_driver_7seg_4digits is
    -- Entity of testbench is always empty
end entity tb_driver_7seg_4digits;

------------------------------------------------------------------------
-- Architecture body for testbench
------------------------------------------------------------------------
architecture testbench of tb_driver_7seg_4digits is

    -- Local constants
    constant c_CLK_100MHZ_PERIOD : time    := 10 ns;

    --Local signals
    signal s_clk_100MHz : std_logic;
    --- WRITE YOUR CODE HERE

    signal s_reset      : std_logic;

    signal s_data0      : std_logic_vector(4 - 1 downto 0);
    signal s_data1      : std_logic_vector(4 - 1 downto 0);
    signal s_data2      : std_logic_vector(4 - 1 downto 0);
    signal s_data3      : std_logic_vector(4 - 1 downto 0);

    signal s_dp_i       : std_logic_vector(4 - 1 downto 0);
    signal s_dp_o       : std_logic;
    signal s_seg_o      : std_logic_vector(7 - 1 downto 0);
    signal s_dig        : std_logic_vector(4 - 1 downto 0);

begin
    -- Connecting testbench signals with driver_7seg_4digits entity
    -- (Unit Under Test)
    --- WRITE YOUR CODE HERE

    uut_driver_7seg_4digits : entity work.driver_7seg_4digits
        port map(
            clk => s_clk_100MHz,
            reset => s_reset,
            -- 4-bit
            data0_i => s_data0,
            data1_i => s_data1,
            data2_i => s_data2,
            data3_i => s_data3,

            dp_i => s_dp_i,

            dp_o  => s_dp_o,
            seg_o => s_seg_o,
            dig_o => s_dig
        );

    --------------------------------------------------------------------
    -- Clock generation process
    --------------------------------------------------------------------
    p_clk_gen : process
    begin
        while now < 750 ns loop         -- 75 periods of 100MHz clock
            s_clk_100MHz <= '0';
            wait for c_CLK_100MHZ_PERIOD / 2;
            s_clk_100MHz <= '1';
            wait for c_CLK_100MHZ_PERIOD / 2;
        end loop;
        wait;
    end process p_clk_gen;

    --------------------------------------------------------------------
    -- Reset generation process
    --------------------------------------------------------------------
    p_reset_gen : process
    begin
        s_reset <= '0';
        wait for 28 ns;

        -- Reset activated
        s_reset <= '1';
        wait for 53 ns;

        s_reset <= '0';
        wait;
    end process p_reset_gen;
    --------------------------------------------------------------------
    -- Data generation process
    --------------------------------------------------------------------
    p_stimulus : process
    begin
        report "Stimulus process started" severity note;

        s_data3 <= "0011";
        s_data2 <= "0001";
        s_data1 <= "0100";
        s_data0 <= "0010";

        s_dp_i <= "0111";


        report "Stimulus process finished" severity note;
        wait;
    end process p_stimulus;
end architecture testbench;
```
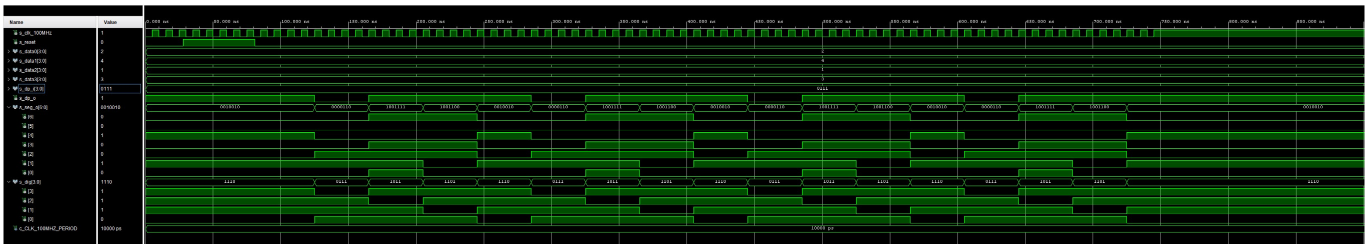
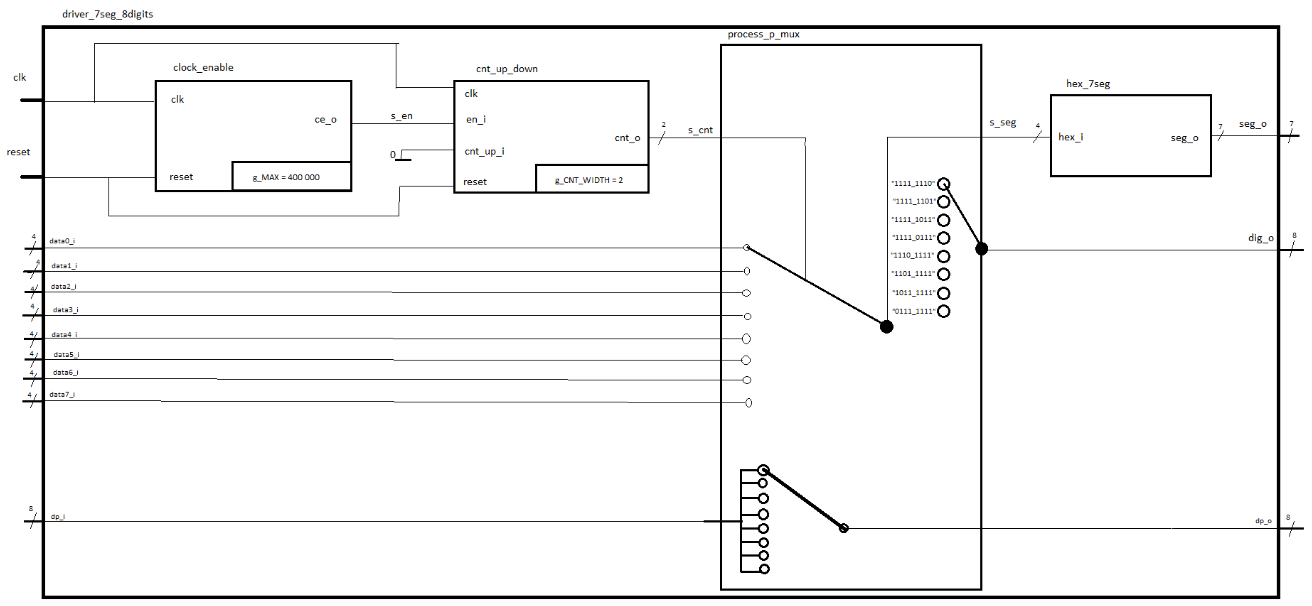

Simulated waveforms



Source code of architecture of the top layer

```
architecture Behavioral of top is

    -- Internal clock enable
    signal s_en  : std_logic;
    -- Internal counter
    signal s_cnt : std_logic_vector(4 - 1 downto 0);

begin
    driver_seg_4 : entity work.driver_7seg_4digits
        port map(
            clk        => CLK100MHZ,
            reset      => BTNC,

            data0_i(3) => SW(3),
            data0_i(2) => SW(2),
            data0_i(1) => SW(1),
            data0_i(0) => SW(0),

            data1_i(3) => SW(7),
            data1_i(2) => SW(6),
            data1_i(1) => SW(5),
            data1_i(0) => SW(4),

            data2_i(3) => SW(11),
            data2_i(2) => SW(10),
            data2_i(1) => SW(9),
            data2_i(0) => SW(8),

            data3_i(3) => SW(15),
            data3_i(2) => SW(14),
            data3_i(1) => SW(13),
            data3_i(0) => SW(12),

            dp_i => "0111",
            dp_o => DP,

            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,

            dig_o => AN(4 - 1 downto 0)
        );

    -- Disconnect the top four digits of the 7-segment display
    AN(7 downto 4) <= b"1111";

end architecture Behavioral;
```

Image of the driver schematic



GitHub repository