

Binary comparator truth table:

Dec. equivalent	B[1:0]	A[1:0]	B is greater than A	B equals A	B is less than A
0	0 0	0 0	0	1	0
1	0 0	0 1	0	0	1
2	0 0	1 0	0	0	1
3	0 0	1 1	0	0	1
4	0 1	0 0	1	0	0
5	0 1	0 1	0	1	0
6	0 1	1 0	0	0	1
7	0 1	1 1	0	0	1
8	1 0	0 0	1	0	0
9	1 0	0 1	1	0	0
10	1 0	1 0	0	1	0
11	1 0	1 1	0	0	1
12	1 1	0 0	1	0	0
13	1 1	0 1	1	0	0
14	1 1	1 0	1	0	0
15	1 1	1 1	0	1	0

2-bit Comparator

Karnaugh's maps and simplified functions for their respective previous functions:

4-bit Comparator

design.vhd

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-----  
  
library ieee;
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use ieee.std_logic_1164.all;

-----
-- Entity declaration for 4-bit binary comparator
-----
entity comparator_4bit is
    port(
        a_i          : in  std_logic_vector(4 - 1 downto 0);
        b_i          : in  std_logic_vector(4 - 1 downto 0);
        -- vektor dvou vodicu

        B_less_A_o    : out std_logic;      -- B is less than A
        B_equals_A_o   : out std_logic;     -- B equals A
        B_greater_A_o  : out std_logic      -- B is greater than A
    );
end entity comparator_4bit;

-----
-- Architecture body for 4-bit binary comparator
-----
architecture Behavioral of comparator_4bit is
begin

    B_less_A_o    <= '1' when (b_i < a_i) else '0';
    B_equals_A_o   <= '1' when (b_i = a_i) else '0';
    B_greater_A_o  <= '1' when (b_i > a_i) else '0';

end architecture Behavioral;

```

testbench.vhd

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library ieee;
use ieee.std_logic_1164.all;

-----
-- Entity declaration for testbench
-----
entity tb_comparator_4bit is
    -- Entity of testbench is always empty
end entity tb_comparator_4bit;

-----
-- Architecture body for testbench
-----
architecture testbench of tb_comparator_4bit is

    -- Local signals
    signal s_a      : std_logic_vector(4 - 1 downto 0);

```

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signal s_b      : std_logic_vector(4 - 1 downto 0);
signal s_B_greater_A : std_logic;
signal s_B_equals_A  : std_logic;
signal s_B_less_A    : std_logic;

begin
-- Connecting testbench signals with comparator_4bit entity (Unit Under Test)
uut_comparator_4bit : entity work.comparator_4bit
    port map(
        a_i      => s_a,
        b_i      => s_b,
        B_greater_A_o => s_B_greater_A,
        B_equals_A_o  => s_B_equals_A,
        B_less_A_o    => s_B_less_A
    );

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

    -- First test values
    s_b <= "0000"; s_a <= "0000"; wait for 100 ns;
    -- Expected output
    assert ((s_B_greater_A = '0') and (s_B_equals_A = '1') and (s_B_less_A = '0'))
    -- If false, then report an error
    report "Test failed for input combination: 0000, 0000" severity error;

    s_b <= "0000"; s_a <= "0001"; wait for 100 ns;
    -- Expected output
    assert ((s_B_greater_A = '0') and (s_B_equals_A = '0') and (s_B_less_A = '1'))
    -- If false, then report an error
    report "Test failed for input combination: 0000, 0001" severity error;

    s_b <= "0000"; s_a <= "0010"; wait for 100 ns;
    -- Expected output
    assert ((s_B_greater_A = '0') and (s_B_equals_A = '0') and (s_B_less_A = '1'))
    -- If false, then report an error
    report "Test failed for input combination: 0000, 0010" severity error;

    s_b <= "0000"; s_a <= "0011"; wait for 100 ns;
    -- Expected output
    assert ((s_B_greater_A = '0') and (s_B_equals_A = '0') and (s_B_less_A = '1'))
    -- If false, then report an error
    report "Test failed for input combination: 0000, 0011" severity error;

    s_b <= "0000"; s_a <= "0100"; wait for 100 ns;
    -- Expected output

```

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assert ((s_B_greater_A = '0') and (s_B_equals_A = '0') and (s_B_less_A = '1'))
-- If false, then report an error
report "Test failed for input combination: 0000, 0100" severity error;

s_b <= "0000"; s_a <= "0101"; wait for 100 ns;
-- Expected output
assert ((s_B_greater_A = '0') and (s_B_equals_A = '0') and (s_B_less_A = '1'))
-- If false, then report an error
report "Test failed for input combination: 0000, 0101" severity error;

s_b <= "0000"; s_a <= "0110"; wait for 100 ns;
-- Expected output
assert ((s_B_greater_A = '0') and (s_B_equals_A = '0') and (s_B_less_A = '1'))
-- If false, then report an error
report "Test failed for input combination: 0000, 0110" severity error;

s_b <= "0000"; s_a <= "0111"; wait for 100 ns;
-- Expected output
assert ((s_B_greater_A = '0') and (s_B_equals_A = '0') and (s_B_less_A = '1'))
-- If false, then report an error
report "Test failed for input combination: 0000, 0111" severity error;

s_b <= "0000"; s_a <= "1000"; wait for 100 ns;
-- Expected output
assert ((s_B_greater_A = '0') and (s_B_equals_A = '1') and (s_B_less_A = '0'))
-- If false, then report an error
report "Test failed for input combination: 0000, 1000" severity error;

s_b <= "0000"; s_a <= "1001"; wait for 100 ns;
-- Expected output
assert ((s_B_greater_A = '0') and (s_B_equals_A = '0') and (s_B_less_A = '1'))
-- If false, then report an error
report "Test failed for input combination: 0000, 1001" severity error;

-- WRITE OTHER TESTS HERE

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

end architecture testbench;

```

Console error:

```

[2021-02-17 08:53:38 EST] ghdl -i design.vhd testbench.vhd && ghdl -m tb_comparator_4bit
analyze design.vhd
analyze testbench.vhd
elaborate tb_comparator_4bit

```

```
testbench.vhd:51:9:@0ms:(report note): Stimulus process started
testbench.vhd:105:9:@900ns:(assertion error): Test failed for input combination: 0000, 1000
testbench.vhd:119:9:@1us:(report note): Stimulus process finished
Finding VCD file...
./dump.vcd
[2021-02-17 08:53:39 EST] Opening EPWave...
Done
```

EDA playground link:

<https://www.edaplayground.com/x/EQTE>
