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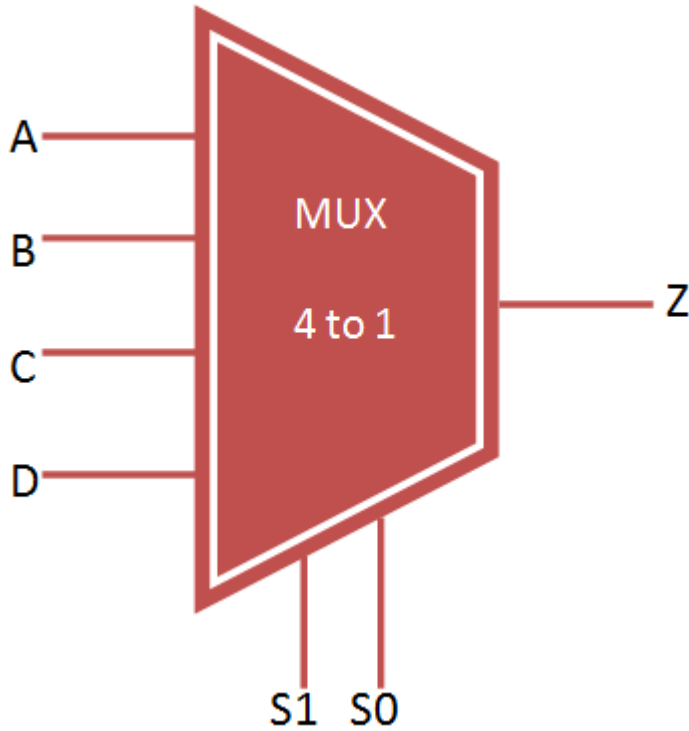
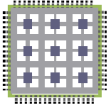
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## Multiplexer

Multiplexer (MUX) select one input from the multiple inputs and forwarded to output line through selection line. It consist of  $2^n$  power n input and 1 output. The input data lines are controlled by n selection lines.

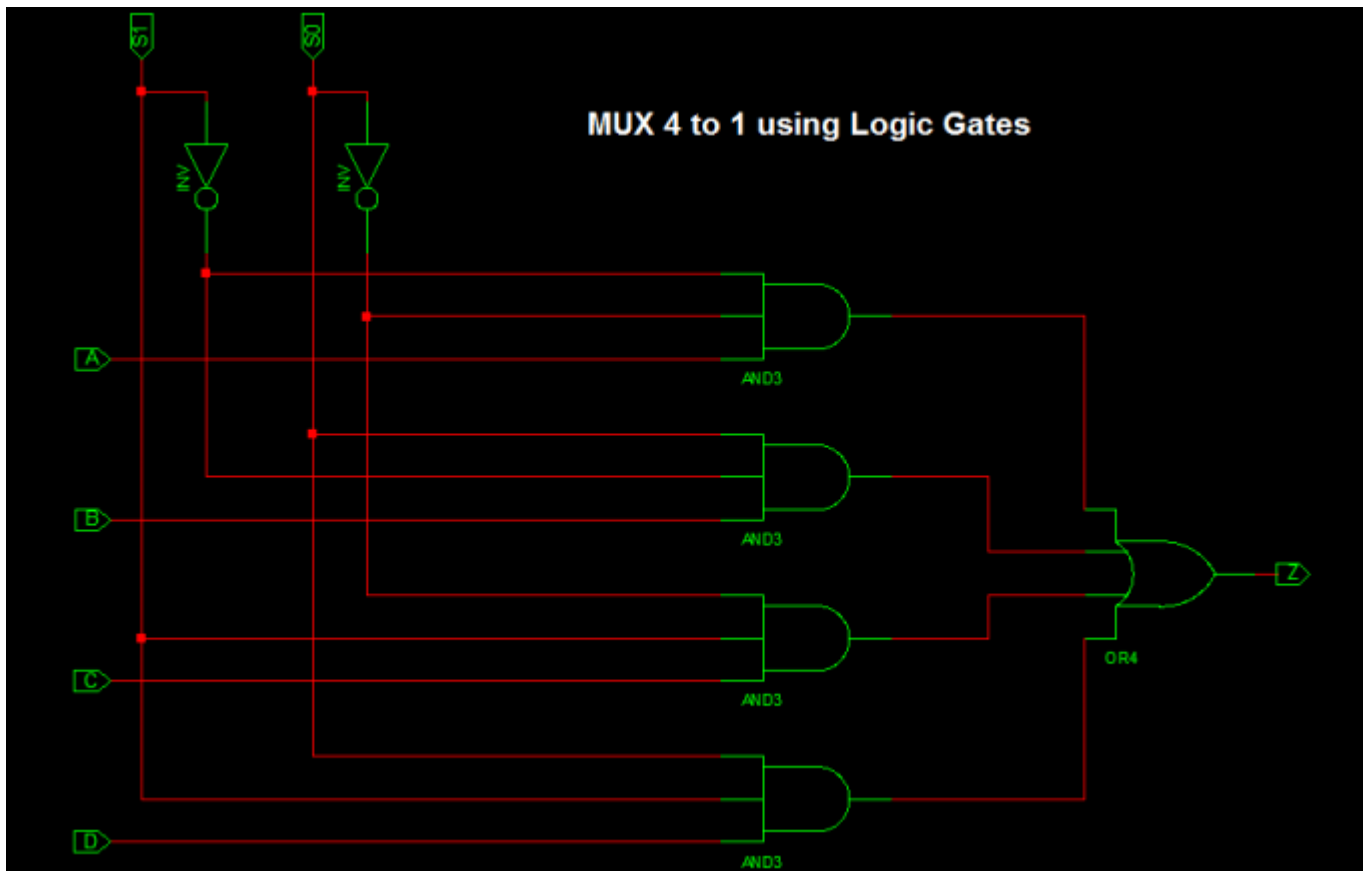
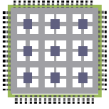
For Example, if  $n = 2$  then the mux will be of 4 to 1 mux with 4 input, 2 selection line and 1 output as shown below.



### Truth Table for Multiplexer 4 to 1

Input		output
S1	S0	Z
0	0	A
0	1	B
1	0	C
1	1	D

### Mux 4 to 1 design using Logic Gates

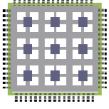


## VHDL Code For 4 to 1 Multiplexer

```
library IEEE;
use IEEE.STD_LOGIC_1164.all;

entity mux_4to1 is
port(

    A,B,C,D : in STD_LOGIC;
    S0,S1: in STD_LOGIC;
    Z: out STD_LOGIC
);
end mux_4to1;
```



```
architecture bhv of mux_4to1 is
begin
process (A,B,C,D,S0,S1) is
begin
    if (S0 = '0' and S1 = '0') then
        Z <= A;
    elsif (S0 = '1' and S1 = '0') then
        Z <= B;
    elsif (S0 = '0' and S1 = '1') then
        Z <= C;
    else
        Z <= D;
    end if;

end process;
end bhv;
```

## VHDL TestBench Code for 4 to 1 Multiplexer

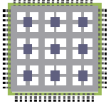
```
LIBRARY ieee;
USE ieee.std_logic_1164.ALL;

ENTITY tb_mux IS
END tb_mux;

ARCHITECTURE behavior OF tb_mux IS

    -- Component Declaration for the Unit Under Test (UUT)

    COMPONENT mux_4to1
    PORT(
        A : IN  std_logic;
```



```
        B : IN  std_logic;
        C : IN  std_logic;
        D : IN  std_logic;
        S0 : IN  std_logic;
        S1 : IN  std_logic;
        Z : OUT  std_logic
    );
END COMPONENT;

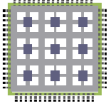
--Inputs
signal A : std_logic := '0';
signal B : std_logic := '0';
signal C : std_logic := '0';
signal D : std_logic := '0';
signal S0 : std_logic := '0';
signal S1 : std_logic := '0';

--Outputs
signal Z : std_logic;

BEGIN

    -- Instantiate the Unit Under Test (UUT)
    uut: mux_4to1 PORT MAP (
        A => A,
        B => B,
        C => C,
        D => D,
        S0 => S0,
        S1 => S1,
        Z => Z
    );

    -- Stimulus process
```



```
stim_proc: process
begin
  -- hold reset state for 100 ns.
  wait for 100 ns;

  A <= '1';
  B <= '0';
  C <= '1';
  D <= '0';

  S0 <= '0'; S1 <= '0';

  wait for 100 ns;

  S0 <= '1'; S1 <= '0';

  wait for 100 ns;

  S0 <= '0'; S1 <= '1';

  wait for 100 ns;

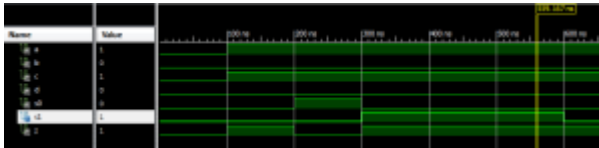
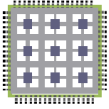
  S0 <= '0'; S1 <= '1';

  wait for 100 ns;

  end process;

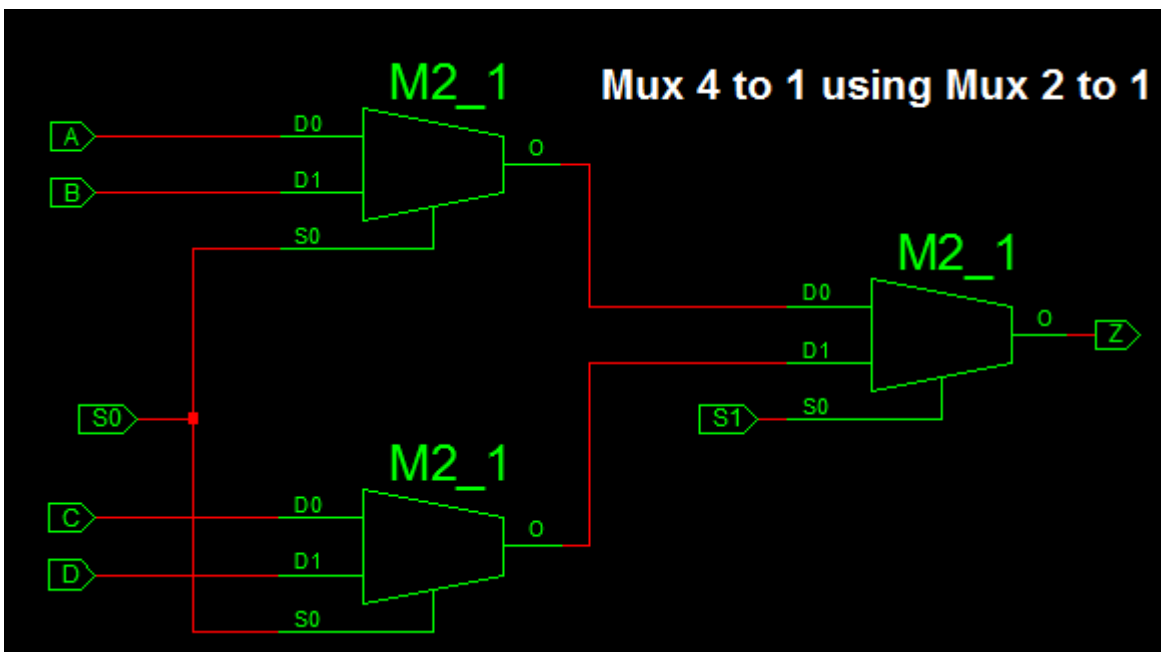
END;
```

## Output Waveform for 4 to 1 Multiplexer



Another Method of Constructing VHDL 4 to 1 mux is by using 2 to 1 Mux. For that implementation first we have write VHDL Code for 2 to 1 Mux and Port map 3 times 2 to 1 mux to construct VHDL 4 to 1 Mux.

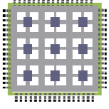
### 4 to 1 Mux Implementation using 2 to 1 Mux



### VHDL Code for 2 to 1 Mux

```
library IEEE;
use IEEE.STD_LOGIC_1164.ALL;

entity mux2_1 is
port(A,B : in STD_LOGIC;
S: in STD_LOGIC;
```



```
Z: out STD_LOGIC);
end mux2_1;

architecture Behavioral of mux2_1 is

begin

process (A,B,S) is
begin
if (S ='0') then
Z <= A;
else
Z <= B;
end if;
end process;

end Behavioral;
```

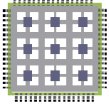
## VHDL 4 to 1 Mux using 2 to 1 Mux

```
library IEEE;
use IEEE.STD_LOGIC_1164.ALL;

entity mux4_1 is
port(

A,B,C,D : in STD_LOGIC;
S0,S1: in STD_LOGIC;
Z: out STD_LOGIC
);
```





```
end mux4_1;

architecture Behavioral of mux4_1 is
  component mux2_1
  port( A,B : in STD_LOGIC;
  S: in STD_LOGIC;
  Z: out STD_LOGIC);
  end component;
  signal temp1, temp2: std_logic;

  begin
  m1: mux2_1 port map(A,B,S0,temp1);
  m2: mux2_1 port map(C,D,S0,temp2);
  m3: mux2_1 port map(temp1,temp2,S1,Z);

  end Behavioral;
```

VHDL Testbench and Simulation Waveform for 4 to 1 mux using 2 to 1 mux is same as the above implementation.