

#100daysofrtl

4-BIT COMPARATOR:

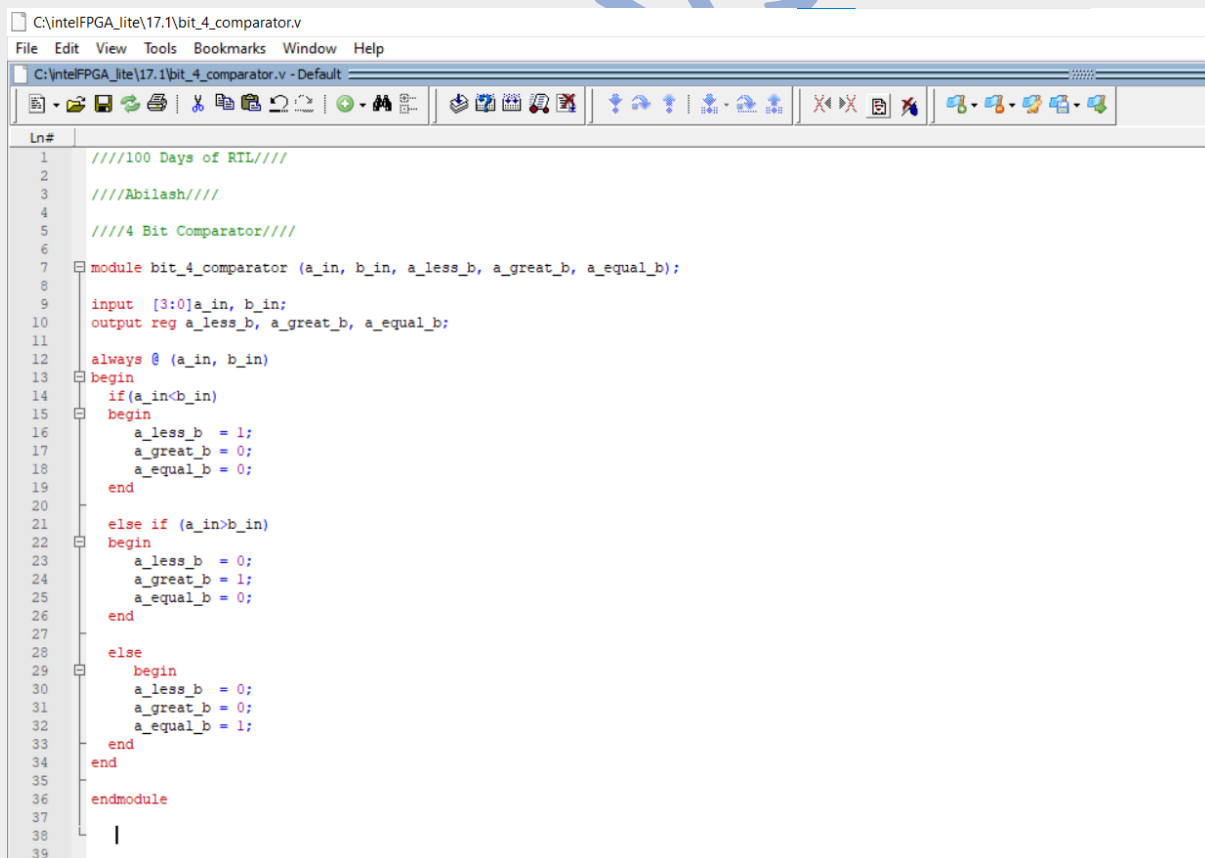
AIM:

To design a four-bit comparator using Modelsim and Verilog HDL

TOOLS:

Modelsim

MAIN CODE:

A screenshot of the Modelsim IDE interface. The title bar shows the file path: C:\intelFPGA_lite\17.1\bit_4_comparator.v. The menu bar includes File, Edit, View, Tools, Bookmarks, Window, and Help. The toolbar contains various icons for file operations, simulation, and debugging. The main text area displays Verilog code for a 4-bit comparator module. The code includes comments for '100 Days of RTL', 'Abilash', and '4 Bit Comparator'. The module signature is 'module bit_4_comparator (a_in, b_in, a_less_b, a_great_b, a_equal_b);'. It defines inputs 'a_in' and 'b_in' as 4-bit buses [3:0], and outputs 'a_less_b', 'a_great_b', and 'a_equal_b' as single-bit signals. An 'always' block is triggered by 'a_in' and 'b_in', containing an 'if-else' structure to compare the two inputs. If 'a_in' is less than 'b_in', 'a_less_b' is set to 1, 'a_great_b' to 0, and 'a_equal_b' to 0. If 'a_in' is greater than 'b_in', 'a_less_b' is 0, 'a_great_b' is 1, and 'a_equal_b' is 0. Otherwise, all three outputs are set to 1. The code ends with 'endmodule' and a cursor at the bottom.

```
1  //100 Days of RTL//
2
3  //Abilash//
4
5  //4 Bit Comparator//
6
7  module bit_4_comparator (a_in, b_in, a_less_b, a_great_b, a_equal_b);
8
9      input  [3:0]a_in, b_in;
10     output reg a_less_b, a_great_b, a_equal_b;
11
12     always @ (a_in, b_in)
13     begin
14         if(a_in<b_in)
15         begin
16             a_less_b = 1;
17             a_great_b = 0;
18             a_equal_b = 0;
19         end
20
21         else if (a_in>b_in)
22         begin
23             a_less_b = 0;
24             a_great_b = 1;
25             a_equal_b = 0;
26         end
27
28         else
29         begin
30             a_less_b = 0;
31             a_great_b = 0;
32             a_equal_b = 1;
33         end
34     end
35 endmodule
36
37
38
39 |
```

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TESTBENCH CODE:

```
C:/intelFPGA_lite/17.1/bit_4_comparator_tb.v
File Edit View Tools Bookmarks Window Help
C:/intelFPGA_lite/17.1/bit_4_comparator_tb.v - Default

Ln#
1  ///100 Days of RTL Challenge///
2
3  ///Abilash P///
4
5  ///4 bit comparator///
6
7  module bit_4_comparator_tb ();
8
9  reg [3:0]a_in,b_in;
10 wire a_less_b, a_great_b, a_equal_b;
11
12 bit_4_comparator DUT (.a_in(a_in), .b_in(b_in), .a_less_b(a_less_b), .a_great_b(a_great_b), .a_equal_b(a_equal_b));
13
14 integer i;
15
16 initial
17 begin
18     a_in = 4'b 0000;
19     b_in = 4'b 0000;
20 end
21
22 initial
23 begin
24     for(i=0; i<256; i=i+1)
25     begin
26         {a_in,b_in} = i;
27         if(b_in == 0)
28             $display("-----");
29         #20;
30     end
31 end
32
33 initial
34 $monitor("Input A = %b, Input B = %b, A<B = %b, A>B = %b, A==b = %b", a_in,b_in,a_less_b,a_great_b, a_equal_b);
35 endmodule
36
37
```

Results:

```
Transcript
File Edit View Bookmarks Window Help
Transcript
# Reading C:/intelFPGA_lite/17.1/modelsim_ase/tcl/vsim/pref.tcl
# project open C:/intelFPGA_lite/17.1/bit_4_comparator.mgd
# Loading project bit_4_comparator
# Compile of bit_4_comparator.v was successful.
# Compile of bit_4_comparator_tb.v was successful.
# 2 compile, 0 failed with no errors.
ModelSim> vsim -gui work.bit_4_comparator_tb
# vsim -gui work.bit_4_comparator_tb
# Start time: 16:51:29 on Oct 06, 2023
# Loading work.bit_4_comparator_tb
# Loading work.bit_4_comparator
add wave sim:/bit_4_comparator_tb/*
VSI4b> run -all

#
# Input A = 0000, Input B = 0000, A<B = 0, A>B = 0, A==b = 1
# Input A = 0000, Input B = 0001, A<B = 1, A>B = 0, A==b = 0
# Input A = 0000, Input B = 0010, A<B = 1, A>B = 0, A==b = 0
# Input A = 0000, Input B = 0011, A<B = 1, A>B = 0, A==b = 0
# Input A = 0000, Input B = 0100, A<B = 1, A>B = 0, A==b = 0
# Input A = 0000, Input B = 0101, A<B = 1, A>B = 0, A==b = 0
# Input A = 0000, Input B = 0110, A<B = 1, A>B = 0, A==b = 0
# Input A = 0000, Input B = 0111, A<B = 1, A>B = 0, A==b = 0
# Input A = 0000, Input B = 1000, A<B = 1, A>B = 0, A==b = 0
# Input A = 0000, Input B = 1001, A<B = 1, A>B = 0, A==b = 0
# Input A = 0000, Input B = 1010, A<B = 1, A>B = 0, A==b = 0
# Input A = 0000, Input B = 1011, A<B = 1, A>B = 0, A==b = 0
# Input A = 0000, Input B = 1100, A<B = 1, A>B = 0, A==b = 0
# Input A = 0000, Input B = 1101, A<B = 1, A>B = 0, A==b = 0
# Input A = 0000, Input B = 1110, A<B = 1, A>B = 0, A==b = 0
# Input A = 0000, Input B = 1111, A<B = 1, A>B = 0, A==b = 0
# -----
# Input A = 0001, Input B = 0000, A<B = 0, A>B = 1, A==b = 0
# Input A = 0001, Input B = 0001, A<B = 0, A>B = 0, A==b = 1
# Input A = 0001, Input B = 0010, A<B = 1, A>B = 0, A==b = 0
# Input A = 0001, Input B = 0011, A<B = 1, A>B = 0, A==b = 0
# Input A = 0001, Input B = 0100, A<B = 1, A>B = 0, A==b = 0
# Input A = 0001, Input B = 0101, A<B = 1, A>B = 0, A==b = 0
# Input A = 0001, Input B = 0110, A<B = 1, A>B = 0, A==b = 0
# Input A = 0001, Input B = 0111, A<B = 1, A>B = 0, A==b = 0
# Input A = 0001, Input B = 1000, A<B = 1, A>B = 0, A==b = 0
# Input A = 0001, Input B = 1001, A<B = 1, A>B = 0, A==b = 0
# Input A = 0001, Input B = 1010, A<B = 1, A>B = 0, A==b = 0
# Input A = 0001, Input B = 1011, A<B = 1, A>B = 0, A==b = 0
# Input A = 0001, Input B = 1100, A<B = 1, A>B = 0, A==b = 0
# Input A = 0001, Input B = 1101, A<B = 1, A>B = 0, A==b = 0
# Input A = 0001, Input B = 1110, A<B = 1, A>B = 0, A==b = 0
# Input A = 0001, Input B = 1111, A<B = 1, A>B = 0, A==b = 0
#
```


#100daysofrtl

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Transcript
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Transcript
# -----
# Input A = 0110, Input B = 0000, A<B = 0, A>B = 1, A==B = 0
# Input A = 0110, Input B = 0001, A<B = 0, A>B = 1, A==B = 0
# Input A = 0110, Input B = 0010, A<B = 0, A>B = 1, A==B = 0
# Input A = 0110, Input B = 0011, A<B = 0, A>B = 1, A==B = 0
# Input A = 0110, Input B = 0100, A<B = 0, A>B = 1, A==B = 0
# Input A = 0110, Input B = 0101, A<B = 0, A>B = 1, A==B = 0
# Input A = 0110, Input B = 0110, A<B = 0, A>B = 0, A==B = 1
# Input A = 0110, Input B = 0111, A<B = 1, A>B = 0, A==B = 0
# Input A = 0110, Input B = 1000, A<B = 1, A>B = 0, A==B = 0
# Input A = 0110, Input B = 1001, A<B = 1, A>B = 0, A==B = 0
# Input A = 0110, Input B = 1010, A<B = 1, A>B = 0, A==B = 0
# Input A = 0110, Input B = 1011, A<B = 1, A>B = 0, A==B = 0
# Input A = 0110, Input B = 1100, A<B = 1, A>B = 0, A==B = 0
# Input A = 0110, Input B = 1101, A<B = 1, A>B = 0, A==B = 0
# Input A = 0110, Input B = 1110, A<B = 1, A>B = 0, A==B = 0
# Input A = 0110, Input B = 1111, A<B = 1, A>B = 0, A==B = 0
# -----
# Input A = 0111, Input B = 0000, A<B = 0, A>B = 1, A==B = 0
# Input A = 0111, Input B = 0001, A<B = 0, A>B = 1, A==B = 0
# Input A = 0111, Input B = 0010, A<B = 0, A>B = 1, A==B = 0
# Input A = 0111, Input B = 0011, A<B = 0, A>B = 1, A==B = 0
# Input A = 0111, Input B = 0100, A<B = 0, A>B = 1, A==B = 0
# Input A = 0111, Input B = 0101, A<B = 0, A>B = 1, A==B = 0
# Input A = 0111, Input B = 0110, A<B = 0, A>B = 1, A==B = 0
# Input A = 0111, Input B = 0111, A<B = 0, A>B = 0, A==B = 1
# Input A = 0111, Input B = 1000, A<B = 1, A>B = 0, A==B = 0
# Input A = 0111, Input B = 1001, A<B = 1, A>B = 0, A==B = 0
# Input A = 0111, Input B = 1010, A<B = 1, A>B = 0, A==B = 0
# Input A = 0111, Input B = 1011, A<B = 1, A>B = 0, A==B = 0
# Input A = 0111, Input B = 1100, A<B = 1, A>B = 0, A==B = 0
# Input A = 0111, Input B = 1101, A<B = 1, A>B = 0, A==B = 0
# Input A = 0111, Input B = 1110, A<B = 1, A>B = 0, A==B = 0
# Input A = 0111, Input B = 1111, A<B = 1, A>B = 0, A==B = 0
# -----
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Transcript
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Transcript
# -----
# Input A = 1000, Input B = 0000, A<B = 0, A>B = 1, A==b = 0
# Input A = 1000, Input B = 0001, A<B = 0, A>B = 1, A==b = 0
# Input A = 1000, Input B = 0010, A<B = 0, A>B = 1, A==b = 0
# Input A = 1000, Input B = 0011, A<B = 0, A>B = 1, A==b = 0
# Input A = 1000, Input B = 0100, A<B = 0, A>B = 1, A==b = 0
# Input A = 1000, Input B = 0101, A<B = 0, A>B = 1, A==b = 0
# Input A = 1000, Input B = 0110, A<B = 0, A>B = 1, A==b = 0
# Input A = 1000, Input B = 0111, A<B = 0, A>B = 1, A==b = 0
# Input A = 1000, Input B = 1000, A<B = 0, A>B = 0, A==b = 1
# Input A = 1000, Input B = 1001, A<B = 1, A>B = 0, A==b = 0
# Input A = 1000, Input B = 1010, A<B = 1, A>B = 0, A==b = 0
# Input A = 1000, Input B = 1011, A<B = 1, A>B = 0, A==b = 0
# Input A = 1000, Input B = 1100, A<B = 1, A>B = 0, A==b = 0
# Input A = 1000, Input B = 1101, A<B = 1, A>B = 0, A==b = 0
# Input A = 1000, Input B = 1110, A<B = 1, A>B = 0, A==b = 0
# Input A = 1000, Input B = 1111, A<B = 1, A>B = 0, A==b = 0
# -----
# Input A = 1001, Input B = 0000, A<B = 0, A>B = 1, A==b = 0
# Input A = 1001, Input B = 0001, A<B = 0, A>B = 1, A==b = 0
# Input A = 1001, Input B = 0010, A<B = 0, A>B = 1, A==b = 0
# Input A = 1001, Input B = 0011, A<B = 0, A>B = 1, A==b = 0
# Input A = 1001, Input B = 0100, A<B = 0, A>B = 1, A==b = 0
# Input A = 1001, Input B = 0101, A<B = 0, A>B = 1, A==b = 0
# Input A = 1001, Input B = 0110, A<B = 0, A>B = 1, A==b = 0
# Input A = 1001, Input B = 0111, A<B = 0, A>B = 1, A==b = 0
# Input A = 1001, Input B = 1000, A<B = 0, A>B = 1, A==b = 0
# Input A = 1001, Input B = 1001, A<B = 0, A>B = 0, A==b = 1
# Input A = 1001, Input B = 1010, A<B = 1, A>B = 0, A==b = 0
# Input A = 1001, Input B = 1011, A<B = 1, A>B = 0, A==b = 0
# Input A = 1001, Input B = 1100, A<B = 1, A>B = 0, A==b = 0
# Input A = 1001, Input B = 1101, A<B = 1, A>B = 0, A==b = 0
# Input A = 1001, Input B = 1110, A<B = 1, A>B = 0, A==b = 0
# Input A = 1001, Input B = 1111, A<B = 1, A>B = 0, A==b = 0
# -----
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Transcript
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Transcript
# -----
# Input A = 1010, Input B = 0000, A<B = 0, A>B = 1, A==b = 0
# Input A = 1010, Input B = 0001, A<B = 0, A>B = 1, A==b = 0
# Input A = 1010, Input B = 0010, A<B = 0, A>B = 1, A==b = 0
# Input A = 1010, Input B = 0011, A<B = 0, A>B = 1, A==b = 0
# Input A = 1010, Input B = 0100, A<B = 0, A>B = 1, A==b = 0
# Input A = 1010, Input B = 0101, A<B = 0, A>B = 1, A==b = 0
# Input A = 1010, Input B = 0110, A<B = 0, A>B = 1, A==b = 0
# Input A = 1010, Input B = 0111, A<B = 0, A>B = 1, A==b = 0
# Input A = 1010, Input B = 1000, A<B = 0, A>B = 1, A==b = 0
# Input A = 1010, Input B = 1001, A<B = 0, A>B = 1, A==b = 0
# Input A = 1010, Input B = 1010, A<B = 0, A>B = 0, A==b = 1
# Input A = 1010, Input B = 1011, A<B = 1, A>B = 0, A==b = 0
# Input A = 1010, Input B = 1100, A<B = 1, A>B = 0, A==b = 0
# Input A = 1010, Input B = 1101, A<B = 1, A>B = 0, A==b = 0
# Input A = 1010, Input B = 1110, A<B = 1, A>B = 0, A==b = 0
# Input A = 1010, Input B = 1111, A<B = 1, A>B = 0, A==b = 0
# -----
# Input A = 1011, Input B = 0000, A<B = 0, A>B = 1, A==b = 0
# Input A = 1011, Input B = 0001, A<B = 0, A>B = 1, A==b = 0
# Input A = 1011, Input B = 0010, A<B = 0, A>B = 1, A==b = 0
# Input A = 1011, Input B = 0011, A<B = 0, A>B = 1, A==b = 0
# Input A = 1011, Input B = 0100, A<B = 0, A>B = 1, A==b = 0
# Input A = 1011, Input B = 0101, A<B = 0, A>B = 1, A==b = 0
# Input A = 1011, Input B = 0110, A<B = 0, A>B = 1, A==b = 0
# Input A = 1011, Input B = 0111, A<B = 0, A>B = 1, A==b = 0
# Input A = 1011, Input B = 1000, A<B = 0, A>B = 1, A==b = 0
# Input A = 1011, Input B = 1001, A<B = 0, A>B = 1, A==b = 0
# Input A = 1011, Input B = 1010, A<B = 0, A>B = 1, A==b = 0
# Input A = 1011, Input B = 1011, A<B = 0, A>B = 0, A==b = 1
# Input A = 1011, Input B = 1100, A<B = 1, A>B = 0, A==b = 0
# Input A = 1011, Input B = 1101, A<B = 1, A>B = 0, A==b = 0
# Input A = 1011, Input B = 1110, A<B = 1, A>B = 0, A==b = 0
# Input A = 1011, Input B = 1111, A<B = 1, A>B = 0, A==b = 0
```

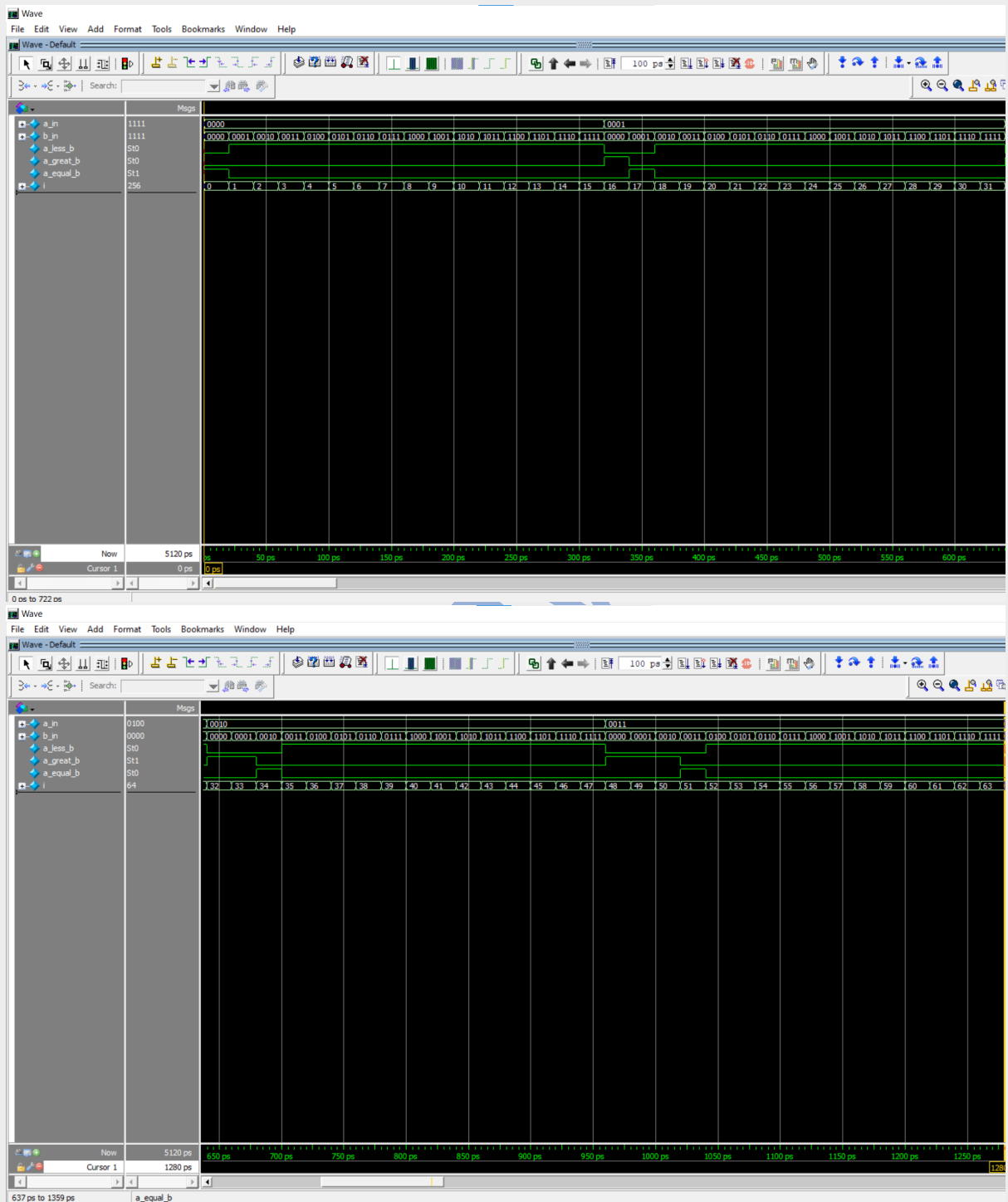
#100daysofrtl

```
Transcript
File Edit View Bookmarks Window Help
Transcript
# -----
# Input A = 1100, Input B = 0000, A<B = 0, A>B = 1, A==B = 0
# Input A = 1100, Input B = 0001, A<B = 0, A>B = 1, A==B = 0
# Input A = 1100, Input B = 0010, A<B = 0, A>B = 1, A==B = 0
# Input A = 1100, Input B = 0011, A<B = 0, A>B = 1, A==B = 0
# Input A = 1100, Input B = 0100, A<B = 0, A>B = 1, A==B = 0
# Input A = 1100, Input B = 0101, A<B = 0, A>B = 1, A==B = 0
# Input A = 1100, Input B = 0110, A<B = 0, A>B = 1, A==B = 0
# Input A = 1100, Input B = 0111, A<B = 0, A>B = 1, A==B = 0
# Input A = 1100, Input B = 1000, A<B = 0, A>B = 1, A==B = 0
# Input A = 1100, Input B = 1001, A<B = 0, A>B = 1, A==B = 0
# Input A = 1100, Input B = 1010, A<B = 0, A>B = 1, A==B = 0
# Input A = 1100, Input B = 1011, A<B = 0, A>B = 1, A==B = 0
# Input A = 1100, Input B = 1100, A<B = 0, A>B = 0, A==B = 1
# Input A = 1100, Input B = 1101, A<B = 1, A>B = 0, A==B = 0
# Input A = 1100, Input B = 1110, A<B = 1, A>B = 0, A==B = 0
# Input A = 1100, Input B = 1111, A<B = 1, A>B = 0, A==B = 0
# -----
# Input A = 1101, Input B = 0000, A<B = 0, A>B = 1, A==B = 0
# Input A = 1101, Input B = 0001, A<B = 0, A>B = 1, A==B = 0
# Input A = 1101, Input B = 0010, A<B = 0, A>B = 1, A==B = 0
# Input A = 1101, Input B = 0011, A<B = 0, A>B = 1, A==B = 0
# Input A = 1101, Input B = 0100, A<B = 0, A>B = 1, A==B = 0
# Input A = 1101, Input B = 0101, A<B = 0, A>B = 1, A==B = 0
# Input A = 1101, Input B = 0110, A<B = 0, A>B = 1, A==B = 0
# Input A = 1101, Input B = 0111, A<B = 0, A>B = 1, A==B = 0
# Input A = 1101, Input B = 1000, A<B = 0, A>B = 1, A==B = 0
# Input A = 1101, Input B = 1001, A<B = 0, A>B = 1, A==B = 0
# Input A = 1101, Input B = 1010, A<B = 0, A>B = 1, A==B = 0
# Input A = 1101, Input B = 1011, A<B = 0, A>B = 1, A==B = 0
# Input A = 1101, Input B = 1100, A<B = 0, A>B = 1, A==B = 0
# Input A = 1101, Input B = 1101, A<B = 0, A>B = 0, A==B = 1
# Input A = 1101, Input B = 1110, A<B = 1, A>B = 0, A==B = 0
# Input A = 1101, Input B = 1111, A<B = 1, A>B = 0, A==B = 0
# -----
```

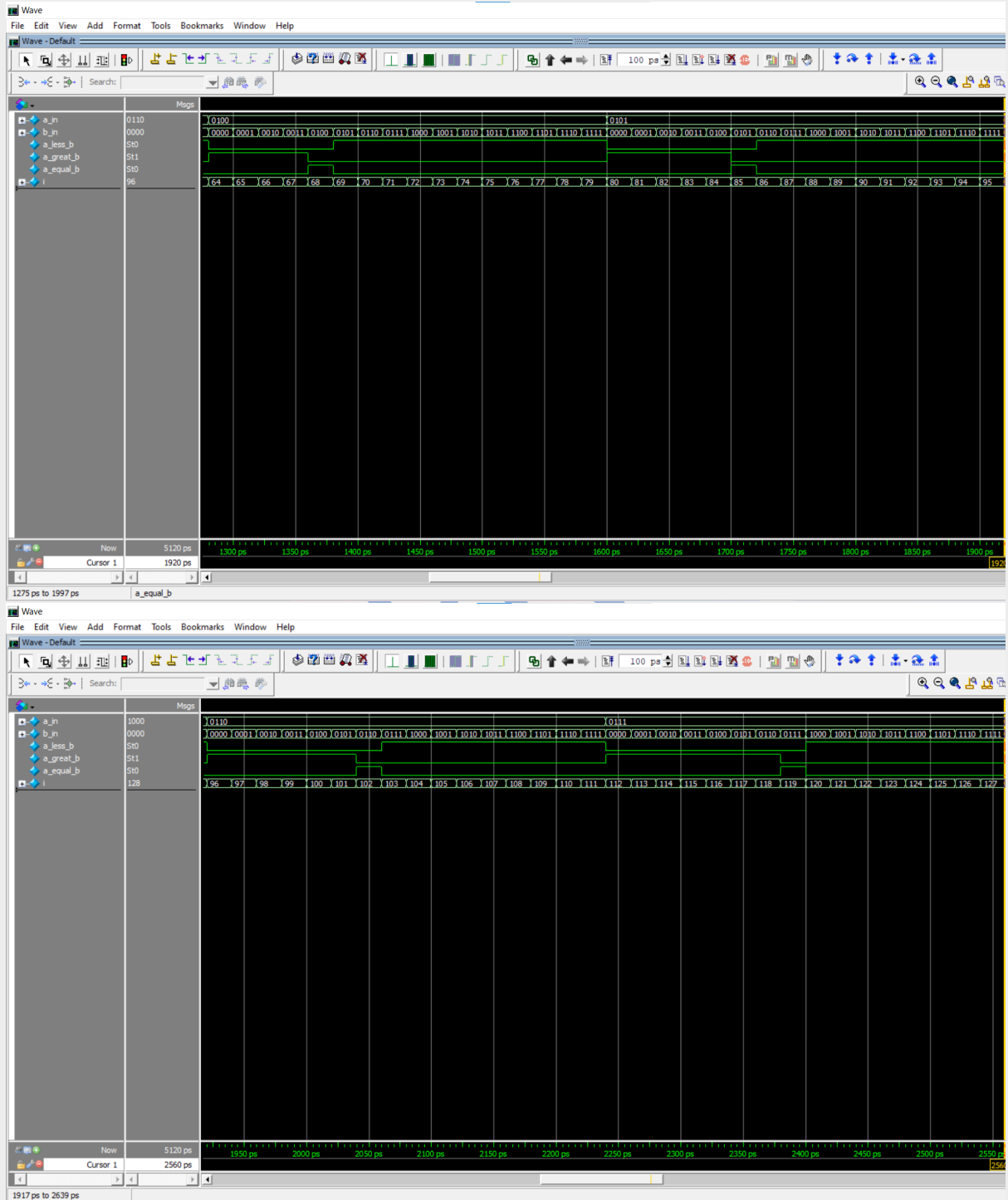
[illegible]

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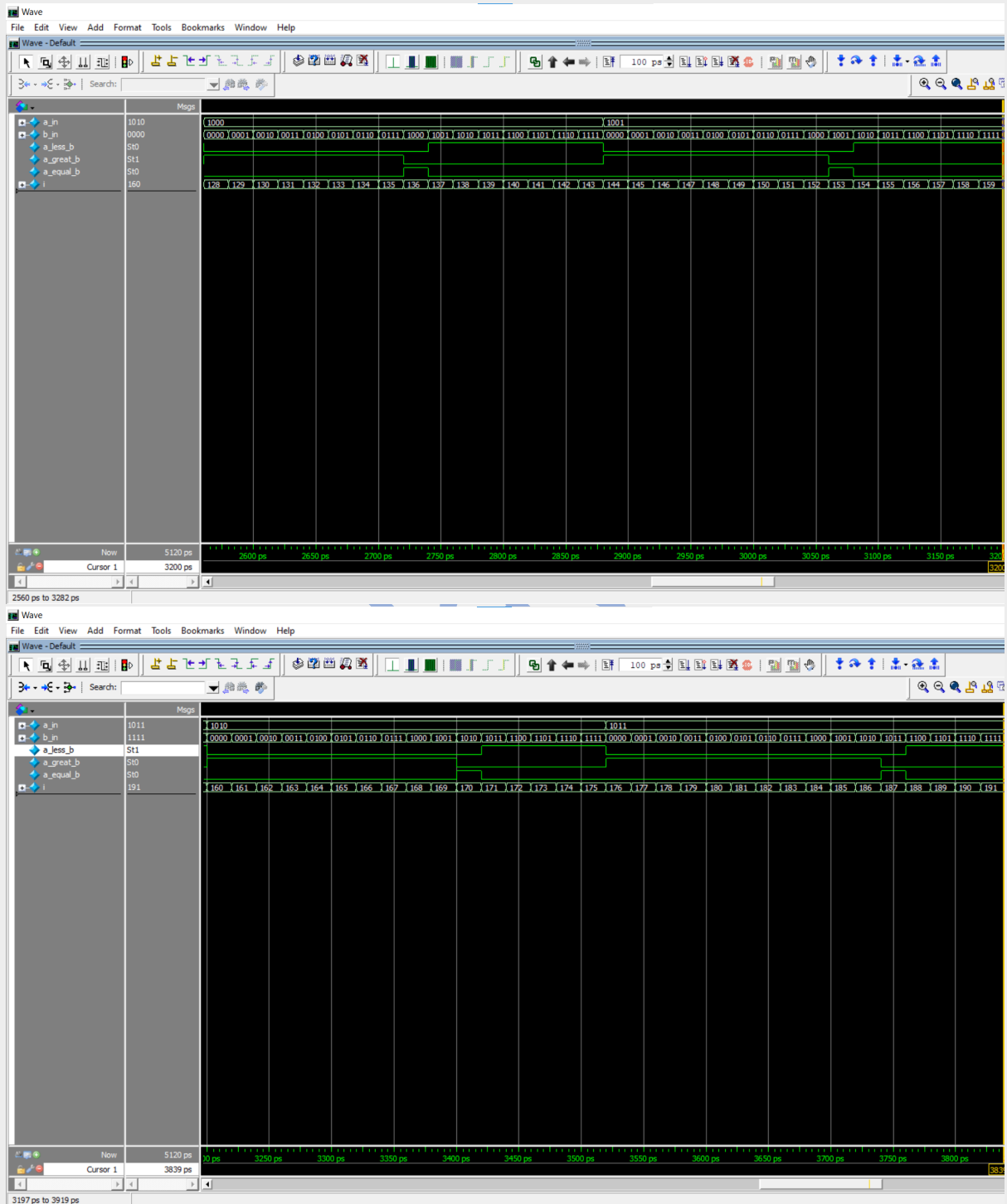
Waves:



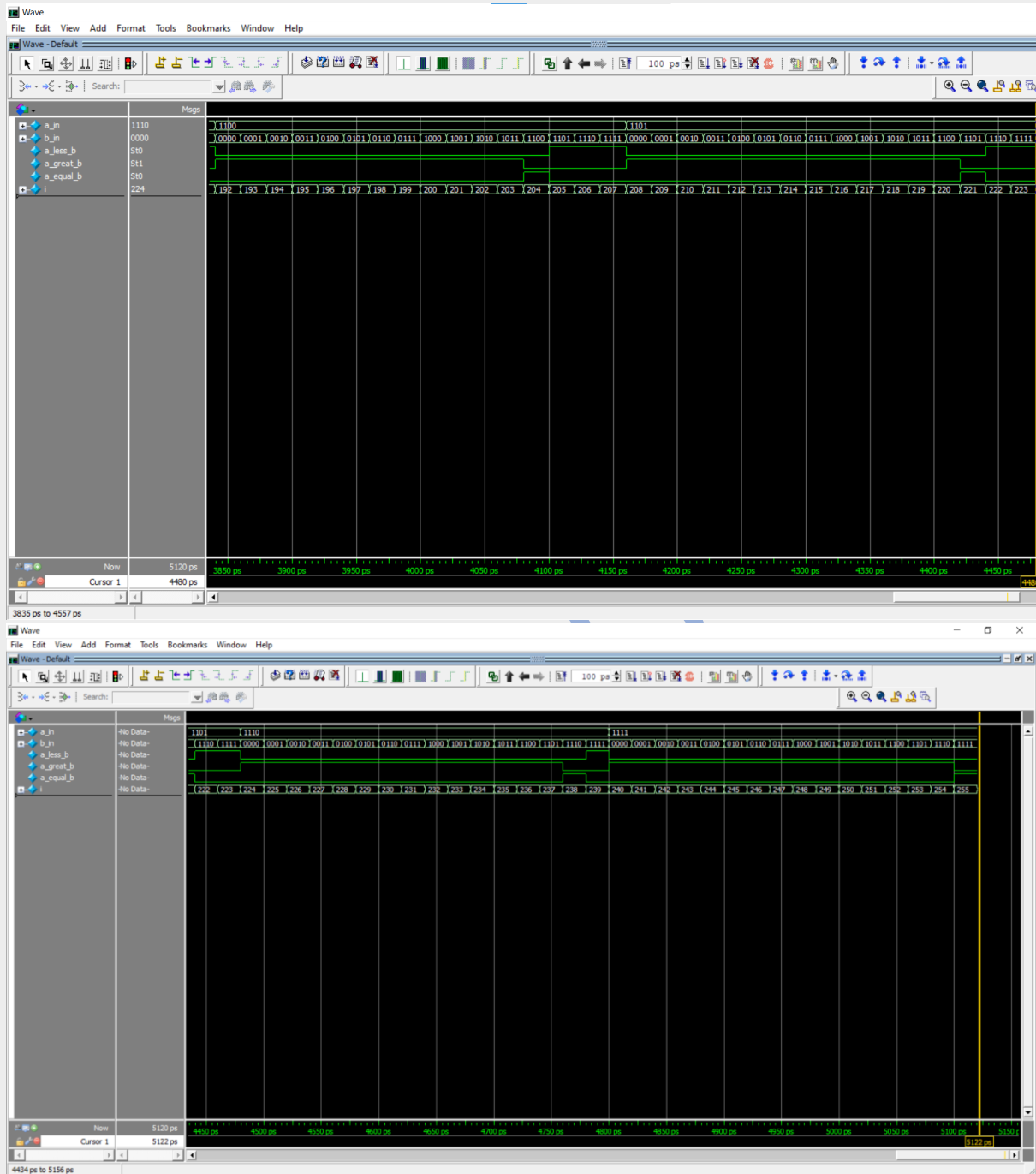
#100daysofrtl



#100daysofrtl



#100daysofrtl



By,
Abilash P