Final System

SYS CTRL States:

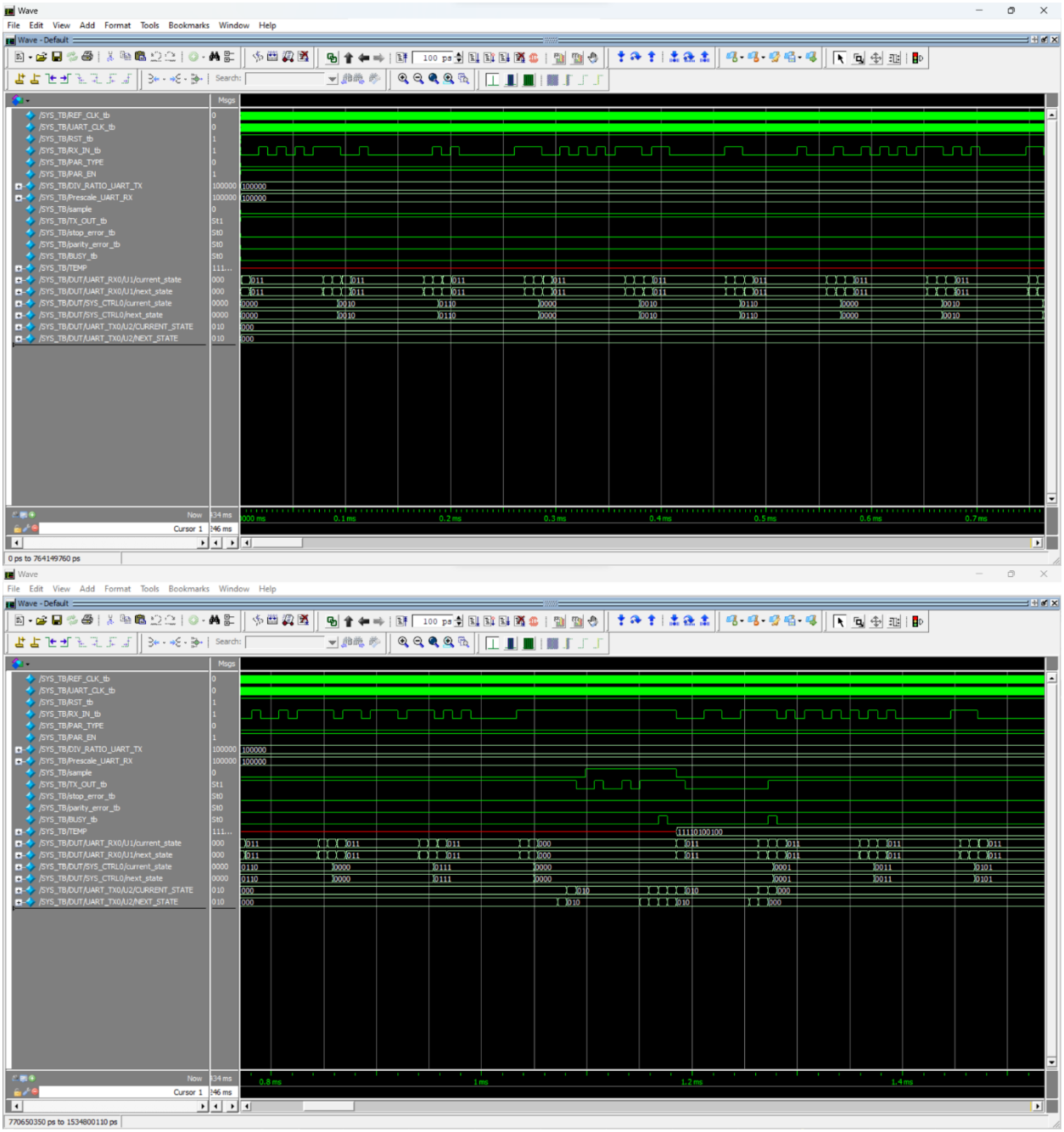
```
//////////////////////////////// FSM Gray Encoding ////////////////////////////////

localparam IDLE                                 = 4'b0000;
localparam OPERAND_A_state                      = 4'b0001;
localparam OPERAND_B_state                      = 4'b0011;
localparam RF_Wr_Addr_state                     = 4'b0010;
localparam RF_Wr_Data_state                     = 4'b0110;
localparam RF_Rd_Addr_state                     = 4'b0111;
localparam ALU_FUN_state                        = 4'b0101;
localparam send_ALU_output_least_state          = 4'b0100;
localparam send_ALU_output_most_state           = 4'b1100;
localparam receive_data_reg_file_state          = 4'b1110;
```

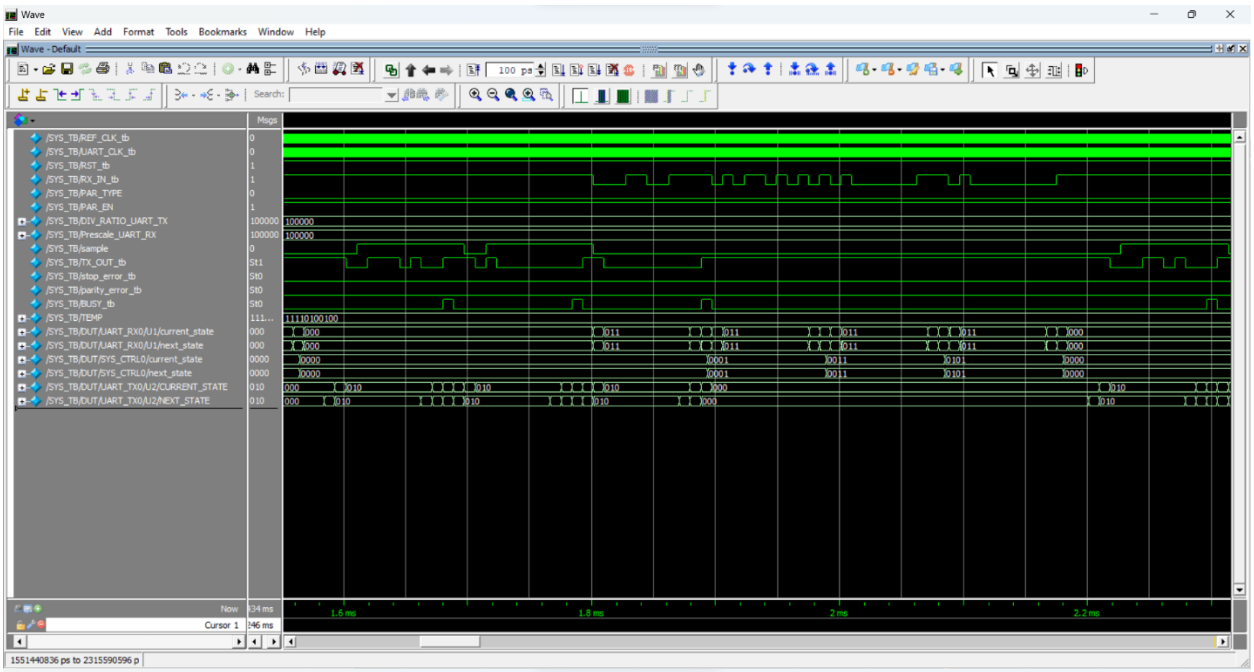
UART RX states:

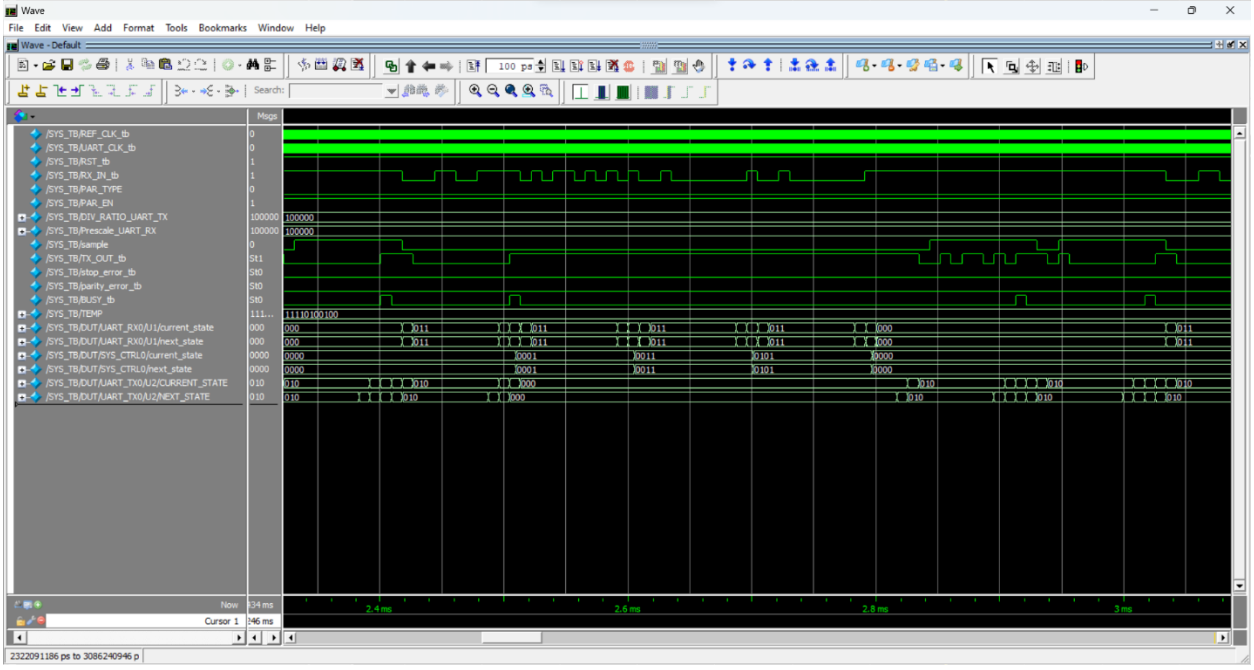
```
 ////////////////////////////////state  Gray encoding////////////////////////////////
 localparam IDLE                  = 3'b000;
 localparam strt_bit_state        = 3'b001;
 localparam data_bits_state       = 3'b011;
 localparam stp_bit_state         = 3'b010;
 localparam parity_bit_state      = 3'b110;
```

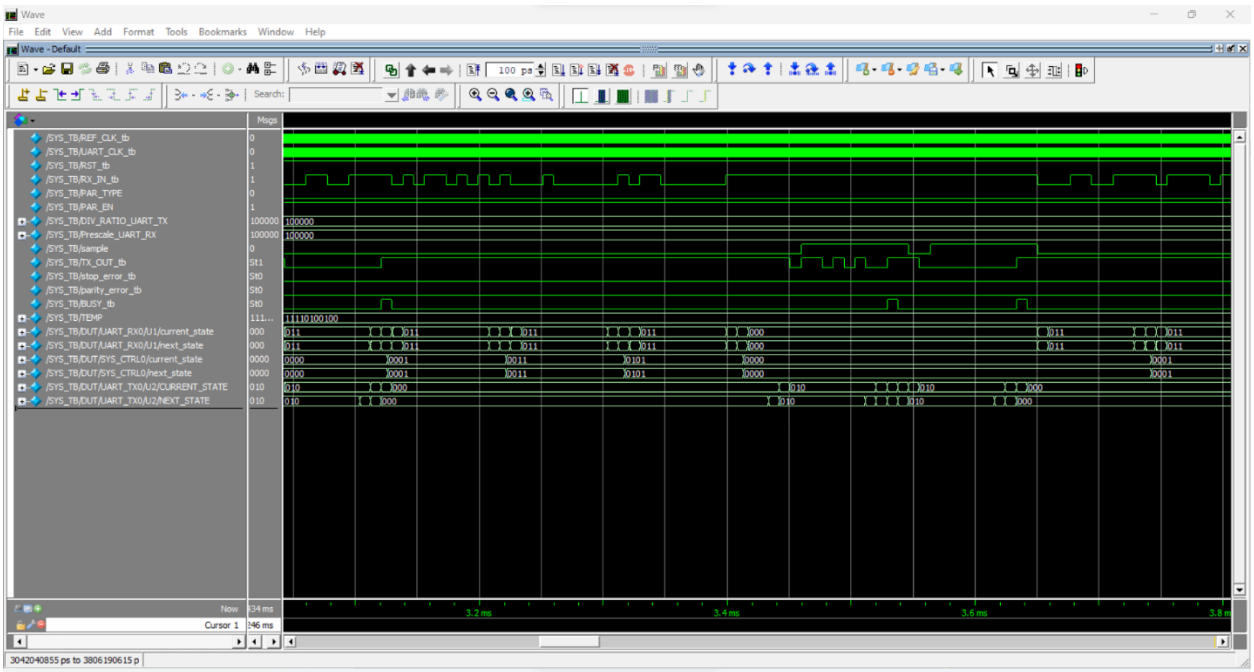
UART TX state:

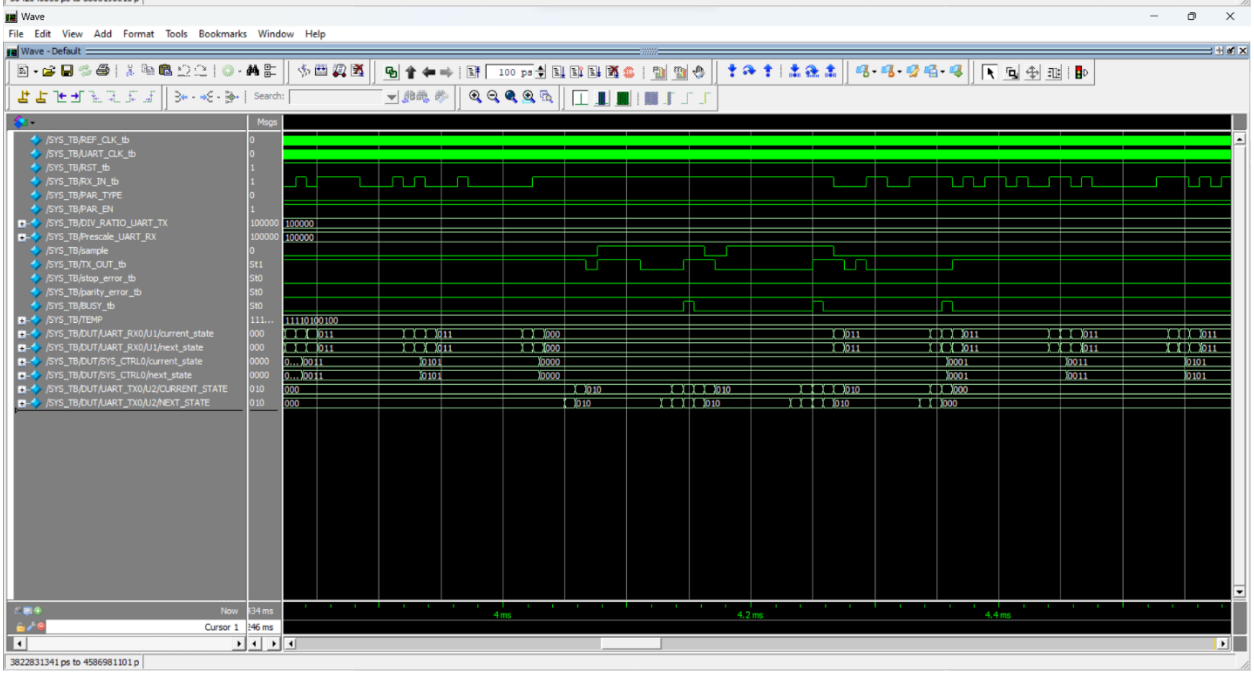
```
//FSM DECODING
localparam       IDLE= 3'b000;
localparam       start_bit_state= 3'b001;
localparam       data_bits_state= 3'b010;
localparam       stop_bit_state= 3'b011;
localparam       parity_bit_state= 3'b111;
```

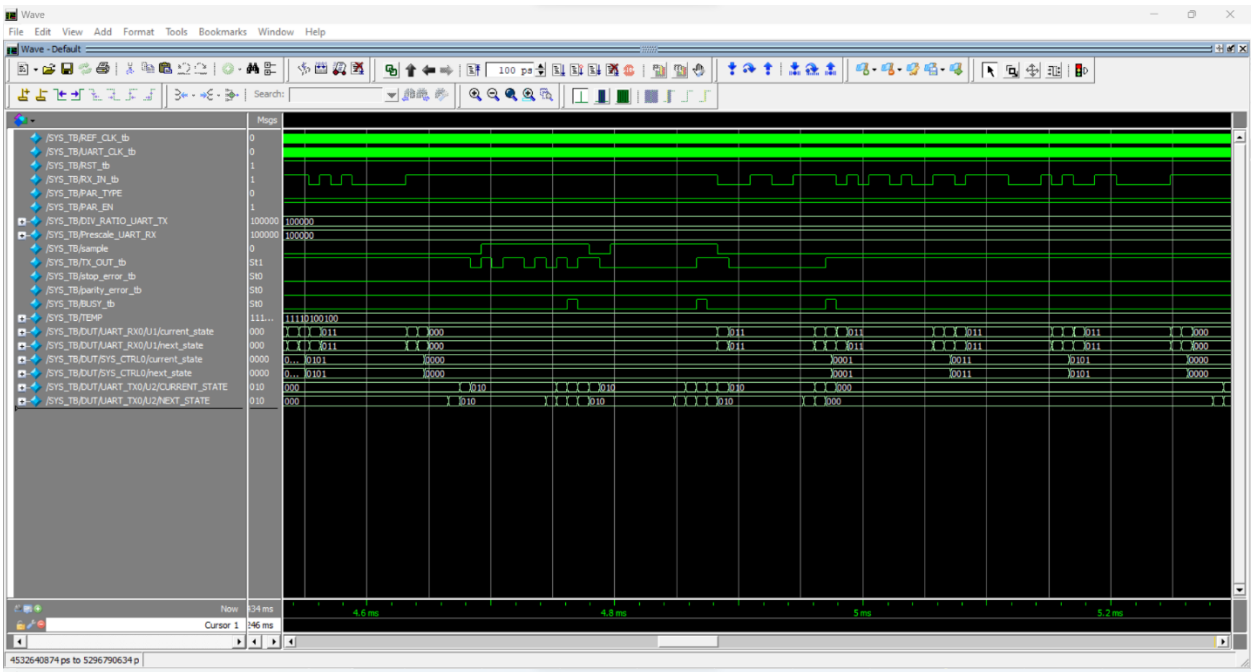

Wave
File Edit View Add Format Tools Bookmarks Window Help
Wave - Default
/SYS_TB/REF_CLK_tb
/SYS_TB/UART_CLK_tb
/SYS_TB/RST_tb
/SYS_TB/RX_IN_tb
/SYS_TB/PAR_TYPE
/SYS_TB/PAR_EN
/SYS_TB/DIV_RATIO_UART_TX
/SYS_TB/Prescale_UART_RX
/SYS_TB/sample
/SYS_TB/TX_OUT_tb
/SYS_TB/stop_error_tb
/SYS_TB/parity_error_tb
/SYS_TB/BUSY_tb
/SYS_TB/TEMP
/SYS_TB/DUT/UART_RX0/U1/current_state
/SYS_TB/DUT/UART_RX0/U1/next_state
/SYS_TB/DUT/SYS_CTRL0/current_state
/SYS_TB/DUT/SYS_CTRL0/next_state
/SYS_TB/DUT/UART_TX0/U2/CURRENT_STATE
/SYS_TB/DUT/UART_TX0/U2/NEXT_STATE
Now
Cursor 1
0 ps to 764149760 ps
Wave
File Edit View Add Format Tools Bookmarks Window Help
Wave - Default
/SYS_TB/REF_CLK_tb
/SYS_TB/UART_CLK_tb
/SYS_TB/RST_tb
/SYS_TB/RX_IN_tb
/SYS_TB/PAR_TYPE
/SYS_TB/PAR_EN
/SYS_TB/DIV_RATIO_UART_TX
/SYS_TB/Prescale_UART_RX
/SYS_TB/sample
/SYS_TB/TX_OUT_tb
/SYS_TB/stop_error_tb
/SYS_TB/parity_error_tb
/SYS_TB/BUSY_tb
/SYS_TB/TEMP
/SYS_TB/DUT/UART_RX0/U1/current_state
/SYS_TB/DUT/UART_RX0/U1/next_state
/SYS_TB/DUT/SYS_CTRL0/current_state
/SYS_TB/DUT/SYS_CTRL0/next_state
/SYS_TB/DUT/UART_TX0/U2/CURRENT_STATE
/SYS_TB/DUT/UART_TX0/U2/NEXT_STATE
Now
Cursor 1
770650350 ps to 1534800110 ps

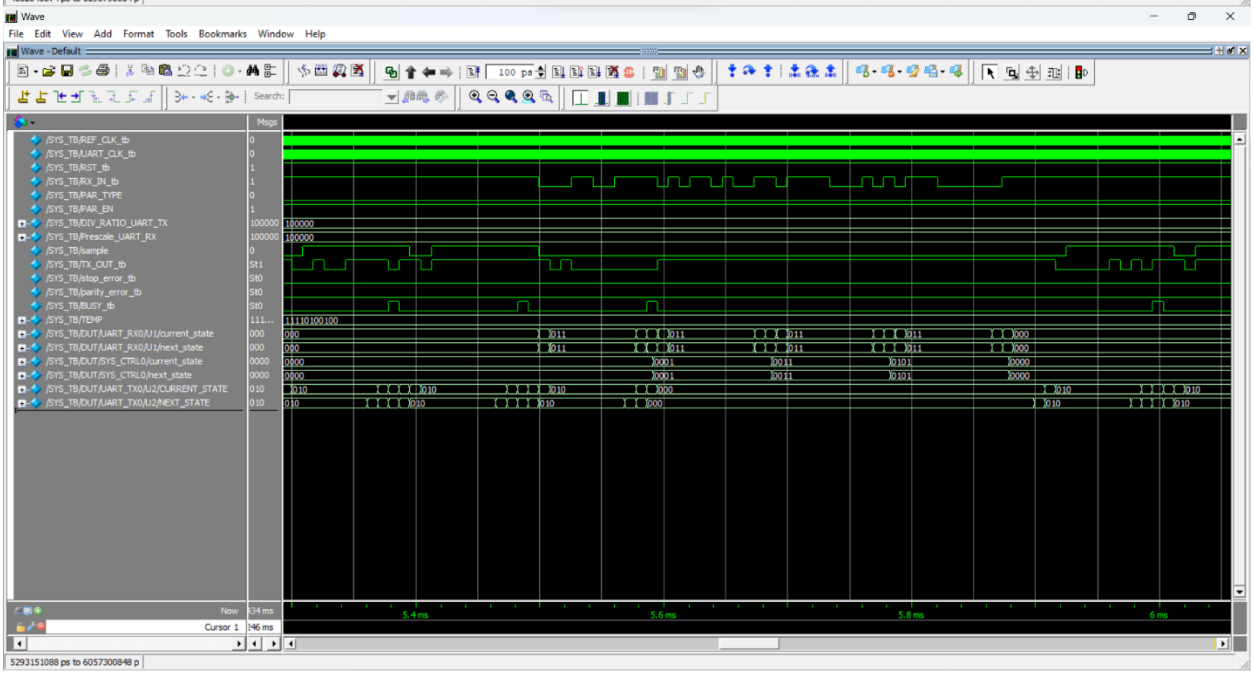

Wave
File Edit View Add Format Tools Bookmarks Window Help
Wave - Default
/SYS_TB/REF_CLK_tb
/SYS_TB/UART_CLK_tb
/SYS_TB/RST_tb
/SYS_TB/RX_IN_tb
/SYS_TB/PAR_TYPE
/SYS_TB/PAR_EN
/SYS_TB/DIV_RATIO_UART_TX
/SYS_TB/Prescale_UART_RX
/SYS_TB/sample
/SYS_TB/TX_OUT_tb
/SYS_TB/stop_error_tb
/SYS_TB/parity_error_tb
/SYS_TB/BUSY_tb
/SYS_TB/TEMP
/SYS_TB/DUT/UART_RX0/U1/current_state
/SYS_TB/DUT/UART_RX0/U1/next_state
/SYS_TB/DUT/SYS_CTRL0/current_state
/SYS_TB/DUT/SYS_CTRL0/next_state
/SYS_TB/DUT/UART_TX0/U2/CURRENT_STATE
/SYS_TB/DUT/UART_TX0/U2/NEXT_STATE
Now
Cursor 1
1.6 ms
1.8 ms
2 ms
2.2 ms
1551440836 ps to 2315590596 p

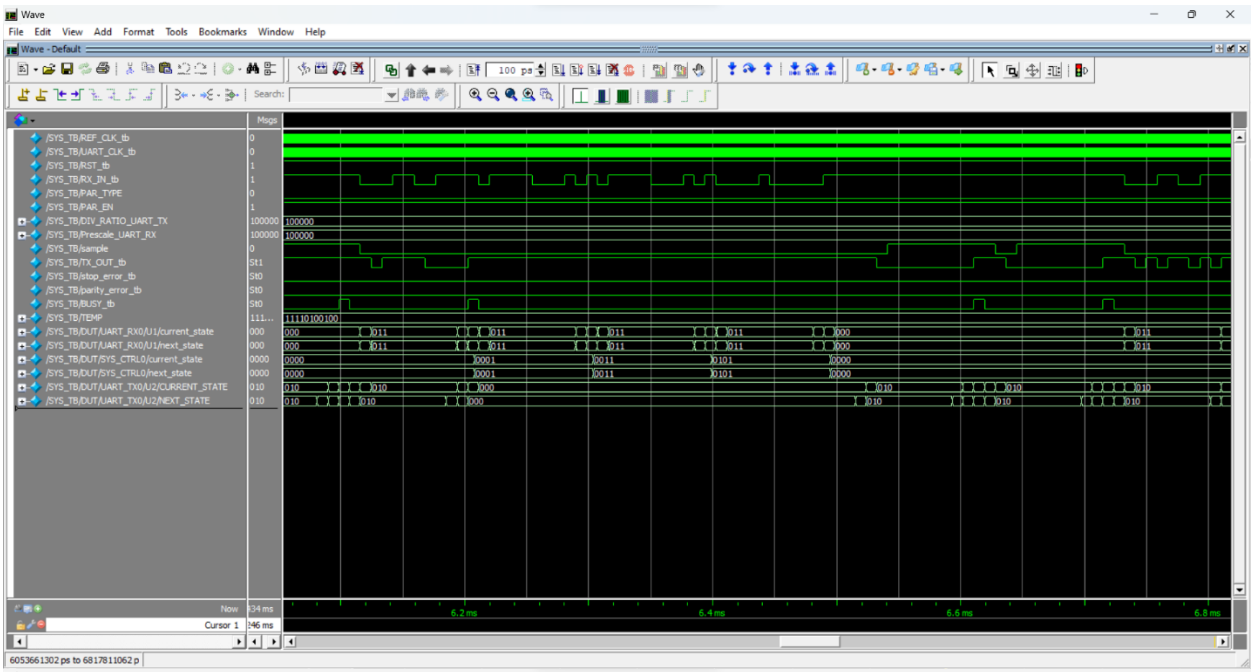

Wave
File Edit View Add Format Tools Bookmarks Window Help
Wave - Default
/SYS_TB/REF_CLK_tb
/SYS_TB/UART_CLK_tb
/SYS_TB/RST_tb
/SYS_TB/RX_IN_tb
/SYS_TB/PAR_TYPE
/SYS_TB/PAR_EN
/SYS_TB/DIV_RATIO_UART_TX
/SYS_TB/Prescale_UART_RX
/SYS_TB/sample
/SYS_TB/TX_OUT_tb
/SYS_TB/stop_error_tb
/SYS_TB/parity_error_tb
/SYS_TB/BUSY_tb
/SYS_TB/TEMP
/SYS_TB/DUT/UART_RX0/U1/current_state
/SYS_TB/DUT/UART_RX0/U1/next_state
/SYS_TB/DUT/SYS_CTRL0/current_state
/SYS_TB/DUT/SYS_CTRL0/next_state
/SYS_TB/DUT/UART_TX0/U2/CURRENT_STATE
/SYS_TB/DUT/UART_TX0/U2/NEXT_STATE
Now
Cursor 1
2.4 ms
2.6 ms
2.8 ms
3 ms
2322091186 ps to 3086240946 p

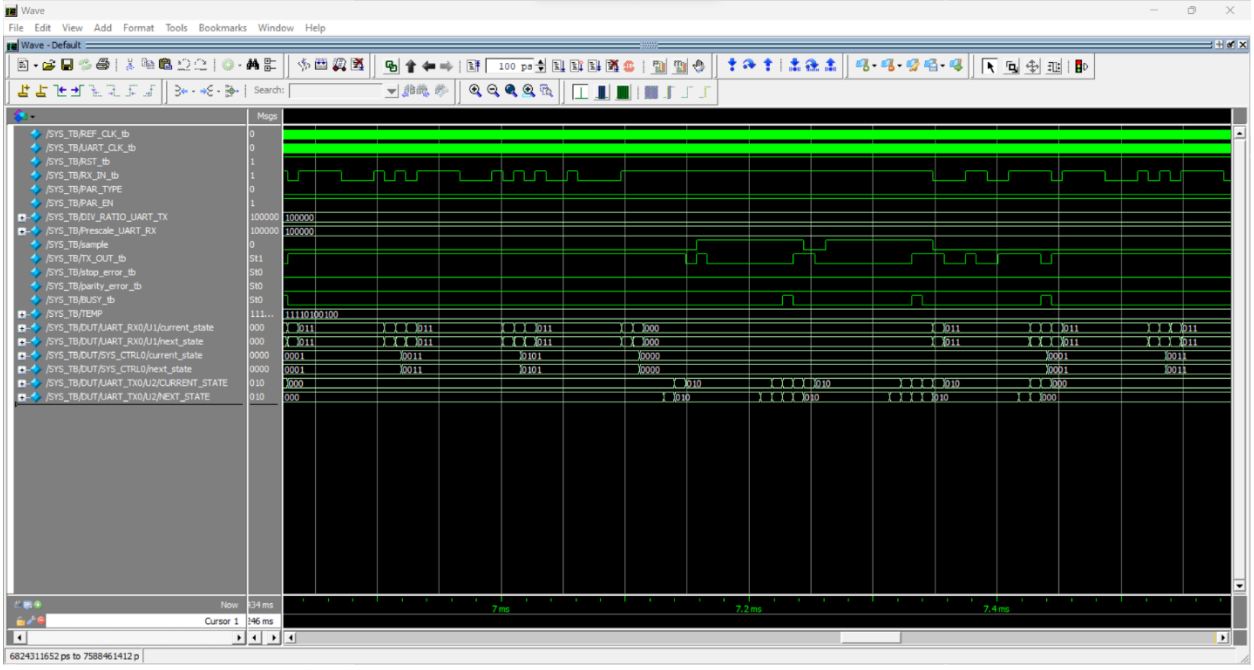

Wave
File Edit View Add Format Tools Bookmarks Window Help
Wave - Default
/SYS_TB/REF_CLK_tb
/SYS_TB/UART_CLK_tb
/SYS_TB/RST_tb
/SYS_TB/RX_IN_tb
/SYS_TB/PAR_TYPE
/SYS_TB/PAR_EN
/SYS_TB/DIV_RATIO_UART_TX
/SYS_TB/Prescale_UART_RX
/SYS_TB/sample
/SYS_TB/TX_OUT_tb
/SYS_TB/stop_error_tb
/SYS_TB/parity_error_tb
/SYS_TB/BUSY_tb
/SYS_TB/TEMP
/SYS_TB/DUT/UART_RX0/U1/current_state
/SYS_TB/DUT/UART_RX0/U1/next_state
/SYS_TB/DUT/SYS_CTRL0/current_state
/SYS_TB/DUT/SYS_CTRL0/next_state
/SYS_TB/DUT/UART_TX0/U2/CURRENT_STATE
/SYS_TB/DUT/UART_TX0/U2/NEXT_STATE
Now
Cursor 1
3.2 ms
3.4 ms
3.6 ms
3042040855 ps to 3806190615 p

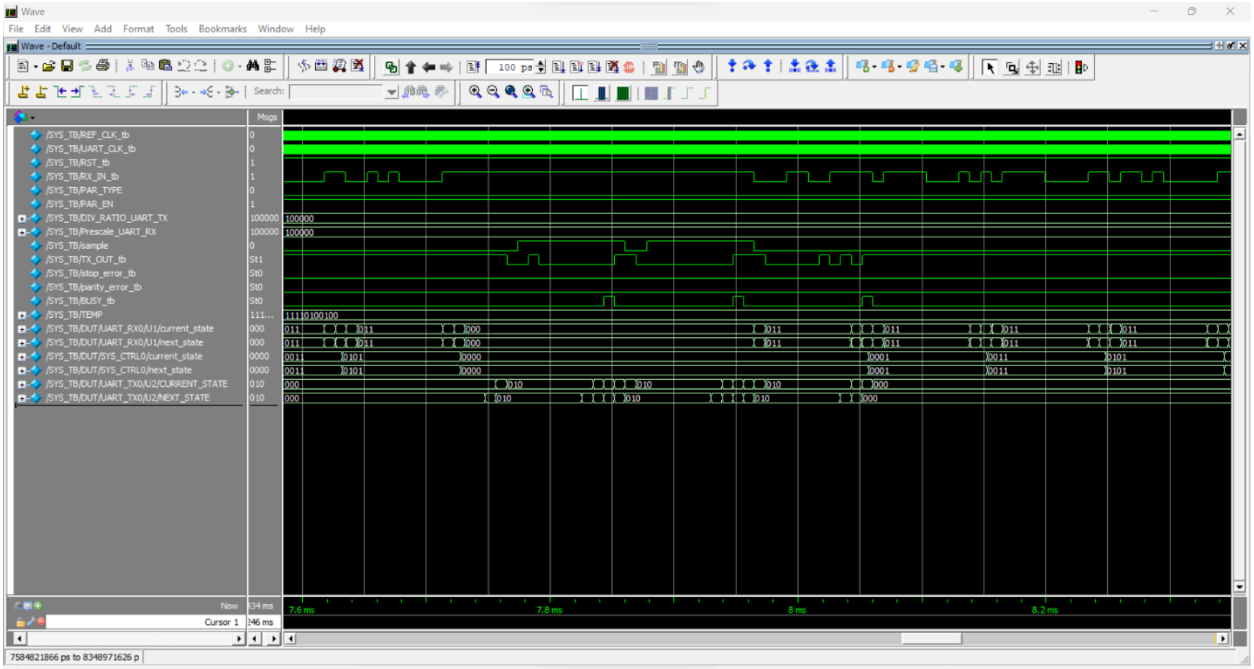

Wave
File Edit View Add Format Tools Bookmarks Window Help
Wave - Default
/SYS_TB/REF_CLK_tb
/SYS_TB/UART_CLK_tb
/SYS_TB/RST_tb
/SYS_TB/RX_IN_tb
/SYS_TB/PAR_TYPE
/SYS_TB/PAR_EN
/SYS_TB/DIV_RATIO_UART_TX
/SYS_TB/Prescale_UART_RX
/SYS_TB/sample
/SYS_TB/TX_OUT_tb
/SYS_TB/stop_error_tb
/SYS_TB/parity_error_tb
/SYS_TB/BUSY_tb
/SYS_TB/TEMP
/SYS_TB/DUT/UART_RX0/U1/current_state
/SYS_TB/DUT/UART_RX0/U1/next_state
/SYS_TB/DUT/SYS_CTRL0/current_state
/SYS_TB/DUT/SYS_CTRL0/next_state
/SYS_TB/DUT/UART_TX0/U2/CURRENT_STATE
/SYS_TB/DUT/UART_TX0/U2/NEXT_STATE
Now
Cursor 1
4 ms
4.2 ms
4.4 ms
3822831341 ps to 4586981101 p

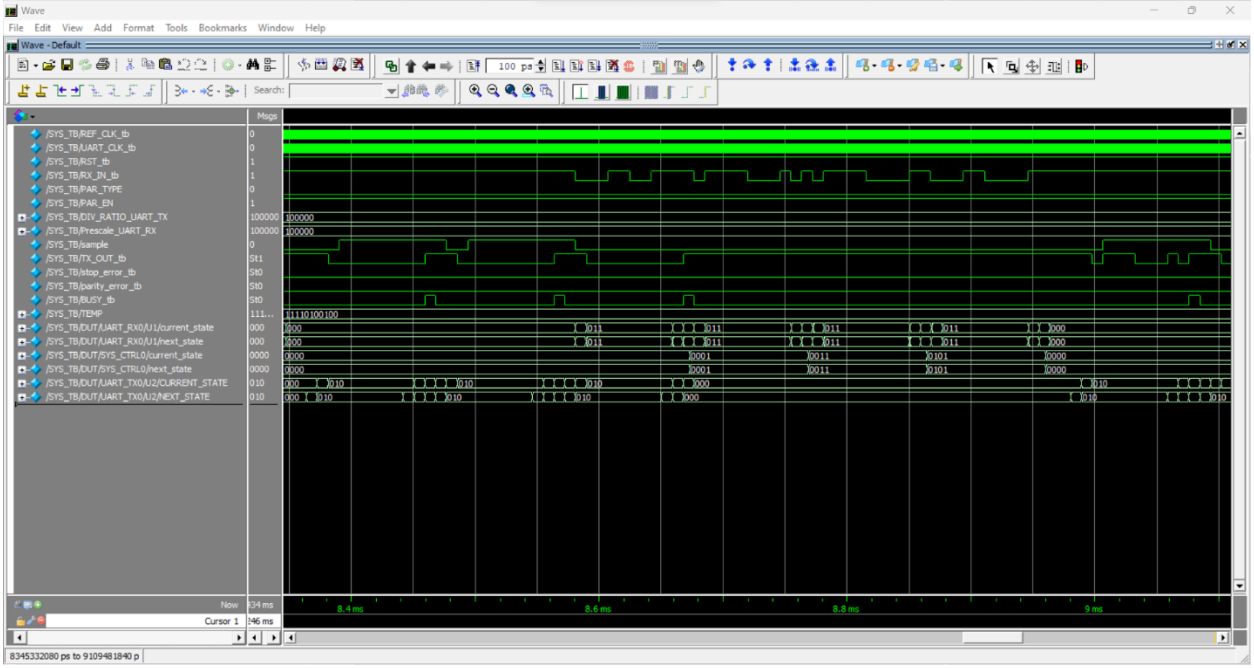

Wave
File Edit View Add Format Tools Bookmarks Window Help
Wave - Default
/SYS_TB/REF_CLK_tb
/SYS_TB/UART_CLK_tb
/SYS_TB/RST_tb
/SYS_TB/RX_IN_tb
/SYS_TB/PAR_TYPE
/SYS_TB/PAR_EN
/SYS_TB/DIV_RATIO_UART_TX
/SYS_TB/Prescale_UART_RX
/SYS_TB/sample
/SYS_TB/TX_OUT_tb
/SYS_TB/stop_error_tb
/SYS_TB/parity_error_tb
/SYS_TB/BUSY_tb
/SYS_TB/TEMP
/SYS_TB/DUT/UART_RX0/U1/current_state
/SYS_TB/DUT/UART_RX0/U1/next_state
/SYS_TB/DUT/SYS_CTRL0/current_state
/SYS_TB/DUT/SYS_CTRL0/next_state
/SYS_TB/DUT/UART_TX0/U2/CURRENT_STATE
/SYS_TB/DUT/UART_TX0/U2/NEXT_STATE
Now
Cursor 1
4.6 ms
4.8 ms
5 ms
5.2 ms
453264087 ps to 5296790634 p

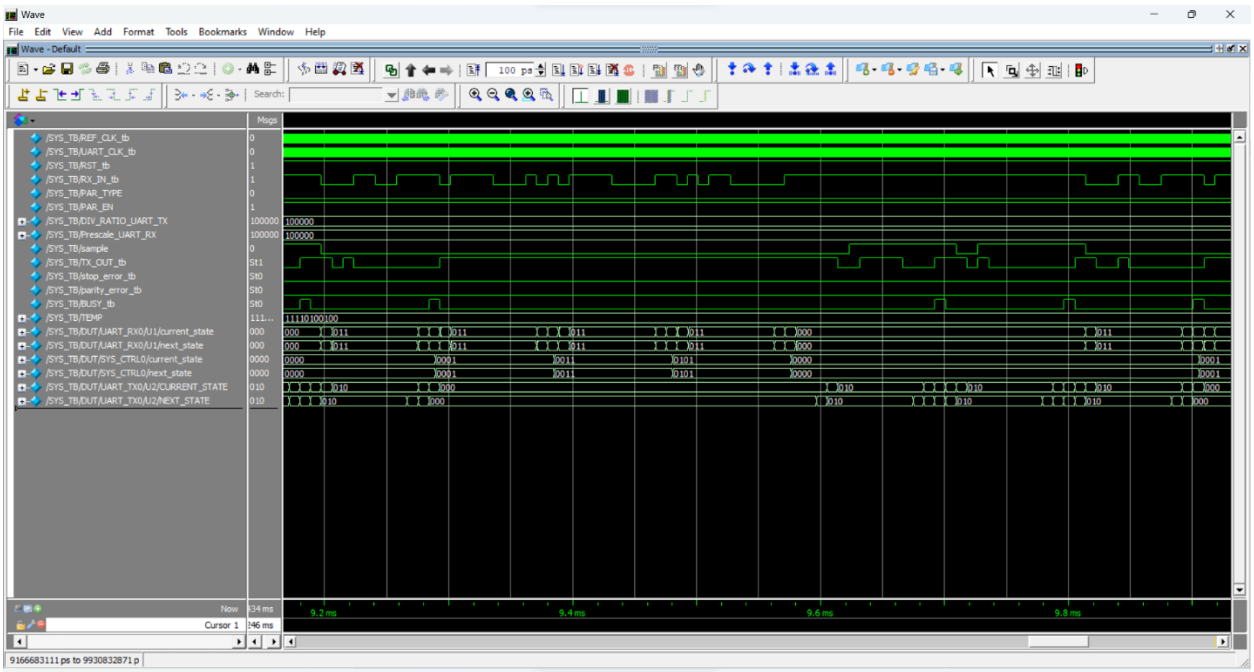

Wave
File Edit View Add Format Tools Bookmarks Window Help
Wave - Default
/SYS_TB/REF_CLK_tb
/SYS_TB/UART_CLK_tb
/SYS_TB/RST_tb
/SYS_TB/RX_IN_tb
/SYS_TB/PAR_TYPE
/SYS_TB/PAR_EN
/SYS_TB/DIV_RATIO_UART_TX
/SYS_TB/Prescale_UART_RX
/SYS_TB/sample
/SYS_TB/TX_OUT_tb
/SYS_TB/stop_error_tb
/SYS_TB/parity_error_tb
/SYS_TB/BUSY_tb
/SYS_TB/TEMP
/SYS_TB/DUT/UART_RX0/U1/current_state
/SYS_TB/DUT/UART_RX0/U1/next_state
/SYS_TB/DUT/SYS_CTRL0/current_state
/SYS_TB/DUT/SYS_CTRL0/next_state
/SYS_TB/DUT/UART_TX0/U2/CURRENT_STATE
/SYS_TB/DUT/UART_TX0/U2/NEXT_STATE
Now
Cursor 1
5.4 ms
5.6 ms
5.8 ms
6 ms
5293151088 ps to 6057300848 p

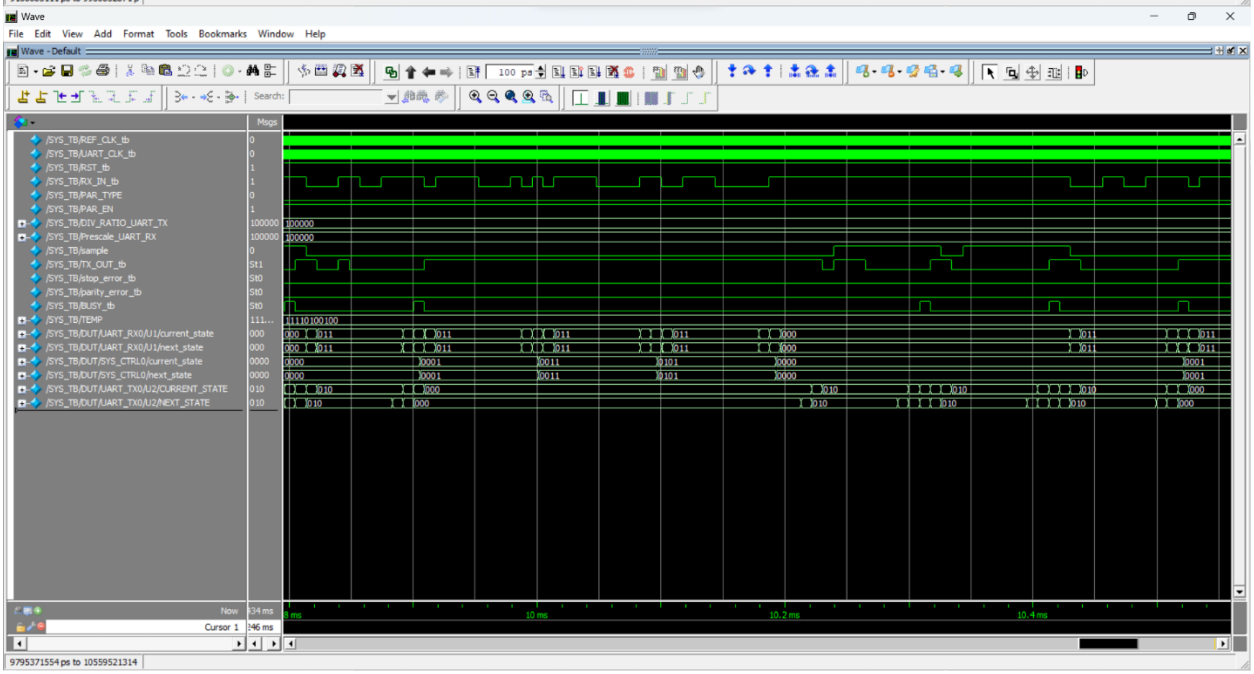

Wave
File Edit View Add Format Tools Bookmarks Window Help
Wave - Default
/SYS_TB/REF_CLK_tb
/SYS_TB/UART_CLK_tb
/SYS_TB/RST_tb
/SYS_TB/RX_IN_tb
/SYS_TB/PAR_TYPE
/SYS_TB/PAR_EN
/SYS_TB/DIV_RATIO_UART_TX
/SYS_TB/Prescale_UART_RX
/SYS_TB/sample
/SYS_TB/TX_OUT_tb
/SYS_TB/stop_error_tb
/SYS_TB/parity_error_tb
/SYS_TB/BUSY_tb
/SYS_TB/TEMP
/SYS_TB/DUT/UART_RX0/U1/current_state
/SYS_TB/DUT/UART_RX0/U1/next_state
/SYS_TB/DUT/SYS_CTRL0/current_state
/SYS_TB/DUT/SYS_CTRL0/next_state
/SYS_TB/DUT/UART_TX0/U2/CURRENT_STATE
/SYS_TB/DUT/UART_TX0/U2/NEXT_STATE
Now
Cursor 1
6.2 ms
6.4 ms
6.6 ms
6.8 ms
6053661302 ps to 6817811062 p

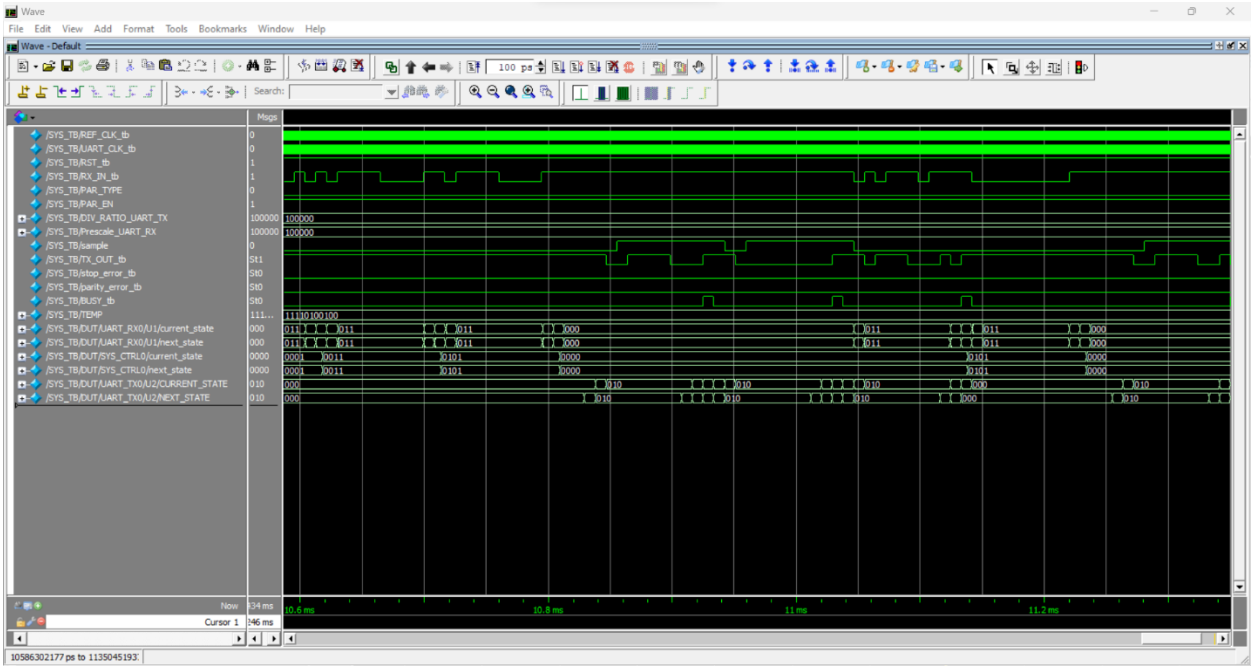

Wave
File Edit View Add Format Tools Bookmarks Window Help
Wave - Default
/SYS_TB/REF_CLK_tb
/SYS_TB/UART_CLK_tb
/SYS_TB/RST_tb
/SYS_TB/RX_IN_tb
/SYS_TB/PAR_TYPE
/SYS_TB/PAR_EN
/SYS_TB/DIV_RATIO_UART_TX
/SYS_TB/Prescale_UART_RX
/SYS_TB/sample
/SYS_TB/TX_OUT_tb
/SYS_TB/stop_error_tb
/SYS_TB/parity_error_tb
/SYS_TB/BUSY_tb
/SYS_TB/TEMP
/SYS_TB/DUT/UART_RX0/U1/current_state
/SYS_TB/DUT/UART_RX0/U1/next_state
/SYS_TB/DUT/SYS_CTRL0/current_state
/SYS_TB/DUT/SYS_CTRL0/next_state
/SYS_TB/DUT/UART_TX0/U2/CURRENT_STATE
/SYS_TB/DUT/UART_TX0/U2/NEXT_STATE
Now
Cursor 1
7 ms
7.2 ms
7.4 ms
6824311652 ps to 7588461412 p

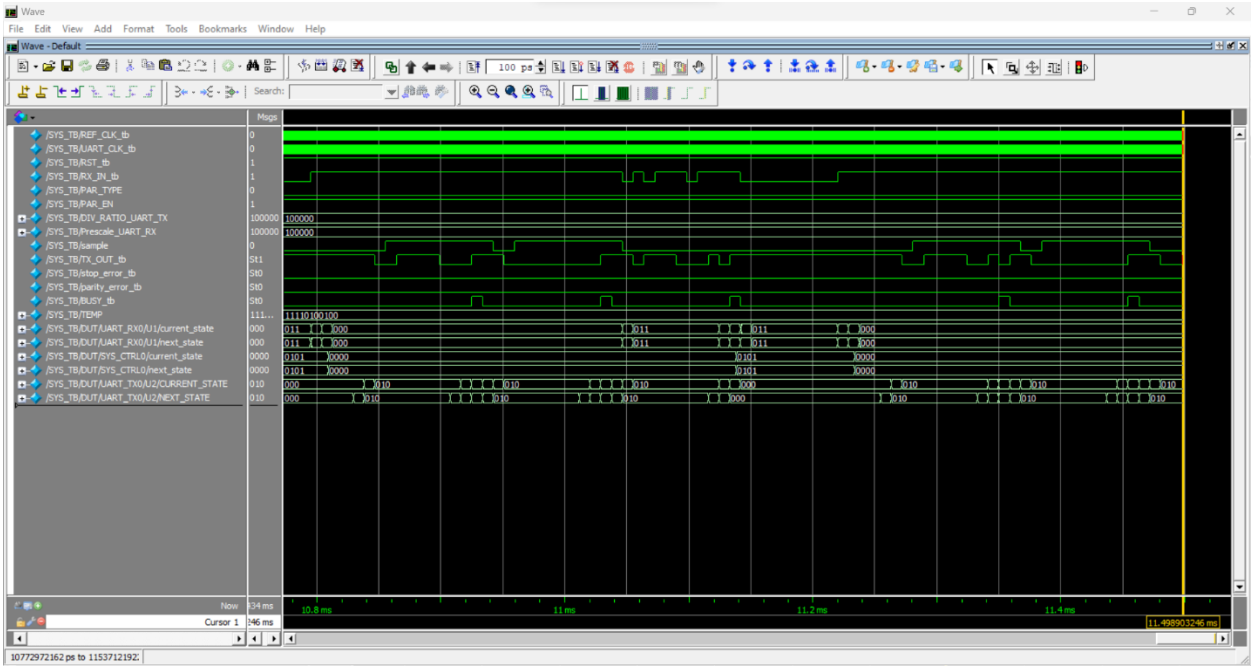

Wave
File Edit View Add Format Tools Bookmarks Window Help
Wave - Default
/SYS_TB/REF_CLK_tb
/SYS_TB/UART_CLK_tb
/SYS_TB/RST_tb
/SYS_TB/RX_IN_tb
/SYS_TB/PAR_TYPE
/SYS_TB/PAR_EN
/SYS_TB/DIV_RATIO_UART_TX
/SYS_TB/Prescale_UART_RX
/SYS_TB/sample
/SYS_TB/TX_OUT_tb
/SYS_TB/stop_error_tb
/SYS_TB/parity_error_tb
/SYS_TB/BUSY_tb
/SYS_TB/TEMP
/SYS_TB/DUT/UART_RX0/U1/current_state
/SYS_TB/DUT/UART_RX0/U1/next_state
/SYS_TB/DUT/SYS_CTRL0/current_state
/SYS_TB/DUT/SYS_CTRL0/next_state
/SYS_TB/DUT/UART_TX0/U2/CURRENT_STATE
/SYS_TB/DUT/UART_TX0/U2/NEXT_STATE
Now
Cursor 1
7.6 ms
7.8 ms
8 ms
8.2 ms
7584821866 ps to 8348971626 p


Wave
File Edit View Add Format Tools Bookmarks Window Help
Wave - Default
/SYS_TB/REF_CLK_tb
/SYS_TB/UART_CLK_tb
/SYS_TB/RST_tb
/SYS_TB/RX_IN_tb
/SYS_TB/PAR_TYPE
/SYS_TB/PAR_EN
/SYS_TB/DIV_RATIO_UART_TX
/SYS_TB/Prescale_UART_RX
/SYS_TB/sample
/SYS_TB/TX_OUT_tb
/SYS_TB/stop_error_tb
/SYS_TB/parity_error_tb
/SYS_TB/BUSY_tb
/SYS_TB/TEMP
/SYS_TB/DUT/UART_RX0/U1/current_state
/SYS_TB/DUT/UART_RX0/U1/next_state
/SYS_TB/DUT/SYS_CTRL0/current_state
/SYS_TB/DUT/SYS_CTRL0/next_state
/SYS_TB/DUT/UART_TX0/U2/CURRENT_STATE
/SYS_TB/DUT/UART_TX0/U2/NEXT_STATE
Now
Cursor 1
8.4 ms
8.6 ms
8.8 ms
9 ms
8345332080 ps to 9109481840 p


Wave
File Edit View Add Format Tools Bookmarks Window Help
Wave - Default
/SYS_TB/REF_CLK_tb
/SYS_TB/UART_CLK_tb
/SYS_TB/RST_tb
/SYS_TB/RX_IN_tb
/SYS_TB/PAR_TYPE
/SYS_TB/PAR_EN
/SYS_TB/DIV_RATIO_UART_TX
/SYS_TB/Prescale_UART_RX
/SYS_TB/sample
/SYS_TB/TX_OUT_tb
/SYS_TB/stop_error_tb
/SYS_TB/parity_error_tb
/SYS_TB/BUSY_tb
/SYS_TB/TEMP
/SYS_TB/DUT/UART_RX0/U1/current_state
/SYS_TB/DUT/UART_RX0/U1/next_state
/SYS_TB/DUT/SYS_CTRL0/current_state
/SYS_TB/DUT/SYS_CTRL0/next_state
/SYS_TB/DUT/UART_TX0/U2/CURRENT_STATE
/SYS_TB/DUT/UART_TX0/U2/NEXT_STATE
Now
Cursor 1
9.2 ms
9.4 ms
9.6 ms
9.8 ms
9166683111 ps to 9930832871 p


Wave
File Edit View Add Format Tools Bookmarks Window Help
Wave - Default
/SYS_TB/REF_CLK_tb
/SYS_TB/UART_CLK_tb
/SYS_TB/RST_tb
/SYS_TB/RX_IN_tb
/SYS_TB/PAR_TYPE
/SYS_TB/PAR_EN
/SYS_TB/DIV_RATIO_UART_TX
/SYS_TB/Prescale_UART_RX
/SYS_TB/sample
/SYS_TB/TX_OUT_tb
/SYS_TB/stop_error_tb
/SYS_TB/parity_error_tb
/SYS_TB/BUSY_tb
/SYS_TB/TEMP
/SYS_TB/DUT/UART_RX0/U1/current_state
/SYS_TB/DUT/UART_RX0/U1/next_state
/SYS_TB/DUT/SYS_CTRL0/current_state
/SYS_TB/DUT/SYS_CTRL0/next_state
/SYS_TB/DUT/UART_TX0/U2/CURRENT_STATE
/SYS_TB/DUT/UART_TX0/U2/NEXT_STATE
Now
Cursor 1
10 ms
10.2 ms
10.4 ms
9795371554 ps to 10559521314


Wave
File Edit View Add Format Tools Bookmarks Window Help
Wave - Default
/SYS_TB/REF_CLK_tb
/SYS_TB/UART_CLK_tb
/SYS_TB/RST_tb
/SYS_TB/RX_IN_tb
/SYS_TB/PAR_TYPE
/SYS_TB/PAR_EN
/SYS_TB/DIV_RATIO_UART_TX
/SYS_TB/Prescale_UART_RX
/SYS_TB/sample
/SYS_TB/TX_OUT_tb
/SYS_TB/stop_error_tb
/SYS_TB/parity_error_tb
/SYS_TB/BUSY_tb
/SYS_TB/TEMP
/SYS_TB/DUT/UART_RX0/U1/current_state
/SYS_TB/DUT/UART_RX0/U1/next_state
/SYS_TB/DUT/SYS_CTRL0/current_state
/SYS_TB/DUT/SYS_CTRL0/next_state
/SYS_TB/DUT/UART_TX0/U2/CURRENT_STATE
/SYS_TB/DUT/UART_TX0/U2/NEXT_STATE
Now
Cursor 1
10.6 ms
10.8 ms
11 ms
11.2 ms


Wave
File Edit View Add Format Tools Bookmarks Window Help
Wave - Default
/SYS_TB/REF_CLK_tb
/SYS_TB/UART_CLK_tb
/SYS_TB/RST_tb
/SYS_TB/RX_IN_tb
/SYS_TB/PAR_TYPE
/SYS_TB/PAR_EN
/SYS_TB/DIV_RATIO_UART_TX
/SYS_TB/Prescale_UART_RX
/SYS_TB/sample
/SYS_TB/TX_OUT_tb
/SYS_TB/stop_error_tb
/SYS_TB/parity_error_tb
/SYS_TB/BUSY_tb
/SYS_TB/TEMP
/SYS_TB/DUT/UART_RX0/U1/current_state
/SYS_TB/DUT/UART_RX0/U1/next_state
/SYS_TB/DUT/SYS_CTRL0/current_state
/SYS_TB/DUT/SYS_CTRL0/next_state
/SYS_TB/DUT/UART_TX0/U2/CURRENT_STATE
/SYS_TB/DUT/UART_TX0/U2/NEXT_STATE
Now
Cursor 1
10.8 ms
11 ms
11.2 ms
11.4 ms
11.49893246 ms

Test Bench:

Test cases:

1. Write in register File
2. Read form Register file
3. All ALU operation
4. ALU operation with no operands