1 0print name (first last): \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

course: ECET 229 2018-09-14

lab date (mo/day/yr): \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

lab section (day time): \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

instructor: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Lab 5**

**Latches and Flip-Flops**

Performance Checks

\_\_\_\_\_ 1. SN RN Latch

\_\_\_\_\_ 2. D Latch

\_\_\_\_\_ 3. D FF

Lab Performance Scoresheet

***Prelab*** initial submission (on time, complete) …………………………10%……… \_\_\_\_\_\_\_\_\_\_

All required signed ***Performance check offs*** ……………………60%………… \_\_\_\_\_\_\_\_\_\_

Writeup will be worth 30 points.

***Final Performance Grade*** \_\_\_\_\_\_\_\_\_\_

**Prelab Activity**

1. Review the material in your text sections 5-1, 5-2, 5-4, 5-8, 5-9, 5-10
2. Open the Prelab 5 Exercise Document and complete all tasks. Upload it to BB when done

PASTE YOUR COMPLETED PRELAB5 ACTIVITY HERE as Figures 1 – 4 with captions and citations.

**Objectives**

**1.** Identify the purpose and active level of any input to a latch or FF

2. Given the initial conditions of all the inputs and the initial state of the Q output, predict the state of the Q output resulting from a change on any input,

**Approach and Results**

1. Load your NAND gate Latch into your DE0 board. Determine the active state of each input and put them both in their inactive position. Fill in Table 1 below. Note the rows are a sequence of inputs. Explain why the results occur. Work with the latch until you can ALWAYS predict what any change on an input will cause to happen on the output. When you are confident ask your instructor to quiz you.

Table 1 Response of the SR latch to a sequence of inputs.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | | Sequence of inputs | SN | RN |  |  | Q | Qnot | EXPLAIN | | Inputs Inactive | 1 | 1 |  |  | 0 | 1 |  | | Set the latch | 0 | 1 |  |  | 1 | 0 | Latch keeps output the same as it was, no change in SN | | Both inputs inactive | 1 | 1 |  |  | 1 | 0 | Latch set, output stays the same as reset is off | | Reset the latch | 1 | 0 |  |  | 0 | 1 | Latch reads SN and outputs Q as 0 | | Activate both inputs | 0 | 0 |  |  | 1 | 1 | Illegal state, both set to 1 | | Deactivate SN | 1 | 0 |  |  | 0 | 1 | Read SN as low, output Q as low | | Activate both | 0 | 0 |  |  | 1 | 1 | Illegal state, both set to 1 | | Deactivate RN | 0 | 1 |  |  | 1 | 0 | Read SN , set Q accordingly | | Deaactivate SN | 1 | 1 |  |  | 1 | 0 | Keep same output, no reset | |  |  |  |  |  |

1. Load your D\_test project into the DE0 board. **NOTE: KEY3 is a debounced, active low, momentary contact push button. Button up (not pressed) = 1, Button down(pressed) = 0.**

Determine the active state of each input and put them all in their inactive position. Fill in Tables 2 and 3 below. Work with the latch and FF until you can ALWAYS predict what any change on an input will cause to happen on the output under all initial conditions. Validate your prelab timing by testing it. When you are confident ask your instructor to quiz you.

Table 2. Response of the D latch to a sequence of inputs

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | | Sequence of inputs | PRN | CLRN | D | EN | QLatch | EXPLAIN | | Inputs Inactive | 1 | 1 | 0 | 0 | 0 | Doesn’t read, sets to low | | Enable latch | 1 | 1 | 0 | 1 | 0 | Latch enabled, reads D = 0 | | Change data to1 | 1 | 1 | 1 | 1 | 1 | Latch enabled, reads D = 1, sets QLatch accordingly | | disable latch | 1 | 1 | 1 | 0 | 1 | Latch disabled, keeps QLatch | | change data to 0 | 1 | 1 | 0 | 0 | 1 | Data not read, so QLatch stays as 1 | | activate asynch reset | 1 | 0 | 0 | 0 | 0 | Reset, QLatch sets to 0 | | deactivate reset | 1 | 1 | 0 | 0 | 0 | Deactivate reset, no change in latch or D so QLatch still 0 | | change data 1 | 1 | 1 | 1 | 0 | 0 | Latch not set, data not read, QLatch = 0 | | enable latch | 1 | 1 | 1 | 1 | 1 | Latch enabled, Data read as 1, QLatch = 1 | | *actvate asynch reset* | *1* | *0* | *1* | *1* | *0* | *QLatch reset by asynch reset, QLatch = 0* | | activate asynch set | 0 | 0 | 1 | 1 | 0 | Asynch set active but reset enabled, reset takes priority | | deactivate set | 1 | 0 | 1 | 1 | 0 | Set deactivated, reset still active | | deactivate reset | 1 | 1 | 1 | 1 | 1 | Reset deactivated, EN is on so D is read as 1 and QLatch = 1 |   Table 3. Response of the DFF to a sequence of inputs   |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | | Sequence of inputs | PRN | CLRN | D | CLK | QFF | EXPLAIN | | Inputs Inactive, | 1 | 1 | 0 | 0 | 0 | No Input read | | rising edge on clk | 1 | 1 | 0 | 1 | 0 | Input read as 0 | | Change data to 1 | 1 | 1 | 1 | 1 | 0 | Data changed, but no input read | | falling edge on clk | 1 | 1 | 1 | 0 | 0 | No input read | | rising edge on clk | 1 | 1 | 1 | 1 | 1 | Input read as 1, QFF set to 1 | | Change data to 0 | 1 | 1 | 0 | 1 | 1 | Data changed to 0, no input read | | falling edge on clk | 1 | 1 | 0 | 0 | 1 | No input read, QFF still 1 | | rising edge on clk | 1 | 1 | 0 | 1 | 0 | Rising edge so data is read, QFF set to 0 accordingly | | change data to 1 | 1 | 1 | 1 | 1 | 0 | Data changed to 1 | | activate Asynch set | 0 | 1 | 1 | 1 | 1 | Sets regardless of clock, so QFF is set to 1 | | actvate asynch reset | 0 | 0 | 1 | 1 | 0 | Reset takes priority, QFF set to 1 | | deactivate reset | 0 | 0 | 1 | 1 | 1 | Reset disabled, set still active | | deactivate set | 1 | 1 | 1 | 1 | 1 | Set deactivated but no new rising edge, no different reading | |  |  |  |  |  |  |  |

**Analysis and Conclusions**

1. **Explain the operation of the SR Latch in terms of activating inputs or not and the effect on the latch (set, reset, or invalid).**
2. **Explain the operation of the DFF, and the Dlatch, including the preset and clear inputs. Discuss active levels and which controls have precedence over each other when multiple inputs are activated.**

Upload this document with all tables filled in and analysis and conclusions completed.