

Class: CECS 201, Section 7

Lab: 8

Title: Latches and Flip-Flops

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Introduction. We investigate the functions of an S-R Latch, a D Flip-Flop, a T Flip-flop and a J-K Flip-Flip, and the differences between them.

Project Description. S-R Latch's Truth Table

| S | R | Q_1 |
|---|---|-------|
| 0 | 0 | Q_1 |
| 0 | 1 | 0 |
| 1 | 0 | 1 |
| 1 | 1 | ?? |

For the S-R latch, we notice that if the clock rises from 0 to 1, then

- Q_1 will be set to 1 if $S = 1$ and $R = 0$.
- Q_1 will be set to 0 if $S = 0$ and $R = 1$.
- Q_1 's state will be unchanged if $S = R = 0$.
- indeterminate if $S = R = 1$.

Also the state of Q_1 does not change if the clock is not set.

D Flip-Flop's Truth Table

| D | Q |
|---|-----|
| 0 | 0 |
| 1 | 1 |

On a positive clock edge, Q will attain the value of input D. If the clock is not set, then varying the input D will have no effect on Q , as evidenced in the lab.

T Flip-Flop's Truth Table

| T | Q | Q_{next} | Operation |
|---|-----|------------|-----------|
| 0 | 0 | 0 | Hold |
| 0 | 1 | 1 | Hold |
| 1 | 0 | 1 | Toggle |
| 1 | 1 | 0 | Toggle |

The T Flip-Flops stores the value of its output if T is 0. But if T is 1, it negates the value in Q . The Q_{next} columns holds the future value of Q on a positive clock edge.

J-K Flip-Flop's Truth Table

| J | K | Q | Q _{next} | Operation |
|---|---|---|-------------------|-----------|
| 0 | 0 | 0 | 0 | Hold |
| 0 | 0 | 1 | 1 | Hold |
| 0 | 1 | 0 | 0 | Reset |
| 0 | 1 | 1 | 0 | Reset |
| 1 | 0 | 0 | 1 | Set |
| 1 | 0 | 1 | 1 | Set |
| 1 | 1 | 0 | 1 | Toggle |
| 1 | 1 | 1 | 0 | Toggle |

As the lab and Truth Table showed us, a J-K Flip-Flop is a combination of a D Flip-Flop and a T-Flip Flop. We can select particular values for J and K so that it can mimic the behavior of a D Flip-Flop or a T-Flip Flop.

Schematic.

