Experiment 6

Objective

The objective of this laboratory is to introduce the student to the use of bistable multivibrators (flip-flops), monostable multivibrators (one-shots), and astable multivibrators (Clock-generators). Switch debouncing is also investigated.

Introduction

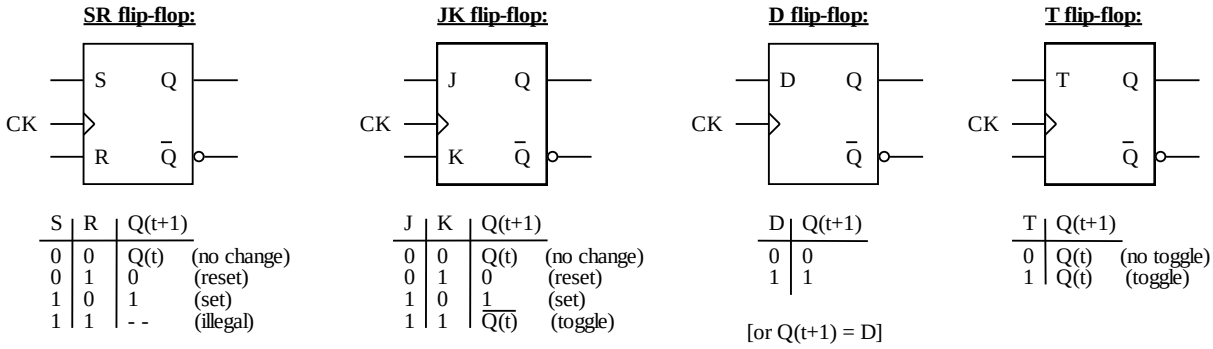
Multivibrators

A multivibrator is a circuit whose output oscillates between logic HIGH and LOW states, either automatically or due to some input. There are three types of multivibrators:

1) **Bistable multivibrators (flip-flops)** - These devices have two stable states (Q = 0 and Q = 1). They can easily be switch from one stable state to the other.
2) **Monostable multivibrators (one-shots)** - These devices have one stable state, but they may enter another unstable state for a certain period of time.
3) **Astable multivibrator (clock generator)** - These devices oscillate between two unstable states, forming a clock (square wave generator).

Flip-Flops

A flip-flop is the simplest type of memory cell. Its output, Q, does not depend solely upon its inputs, but also depends on the order in which they are applied. Thus, the flip-flop is not a combinational circuit, but is a sequential circuit. The flip-flop is the key building block of most synchronous sequential circuits. There are four common types of flip-flops. The symbol and truth table for each is shown below.



S	R	Q(t+1)	
0	0	Q(t)	(no change)
0	1	0	(reset)
1	0	1	(set)
1	1	- -	(illegal)

J	K	Q(t+1)	
0	0	Q(t)	(no change)
0	1	0	(reset)
1	0	1	(set)
1	1	$\overline{Q(t)}$	(toggle)

D	Q(t+1)
0	0
1	1

[or Q(t+1) = D]

T	Q(t+1)	
0	Q(t)	(no toggle)
1	Q(t)	(toggle)

Figure 1: Four common types of flip-flops

Flip-flops are synchronous devices meaning that the output responds to the synchronous inputs (S, R, J, K, D, or T) only on certain clock edges. There are three main types of triggering:

1) **positive-edge triggering** - the output Q can only change on the positive (rising) edge of the clock (due to the values of the synchronous inputs).

2) **negative-edge triggering** - the output Q can only change on the negative (falling) edge of the clock (due to the values of the synchronous inputs).
3) **master-slave triggering** - the synchronous inputs are "read" on the positive edge of the clock, but the output Q does not respond until the negative edge of the clock.

The type of triggering is sometimes indicated by the symbol. Shown below in Figure 2 are JK flip-flops with all three types of triggering.

Positive-edge triggered: **Negative-edge triggered:** **Master-slave triggered:**

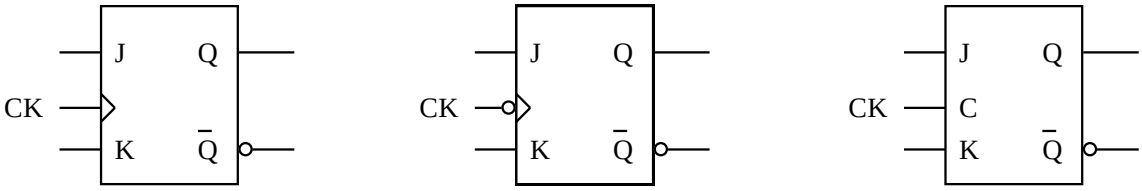


Figure 2: JK Flip-flops with different types of triggering

Flip-flops often have asynchronous inputs available also. These inputs are not synchronized with the clock, therefore, the output may respond immediately to changes in these inputs. There are two types of asynchronous inputs commonly used:
1) **PRESET** (also called **SET**) - used to preset the output Q to 1
2) **CLEAR** (also called **RESET**) - used to clear the output (set Q to 0)

Asynchronous inputs are often active-LOW. Therefore, they are typically tied HIGH for normal flip-flop operation. The PRESET or CLEAR may be momentarily set LOW to initialize the flip-flop to some desired initial value. The symbol for a flip-flop often show the asynchronous inputs as indicated below in Figure 3.

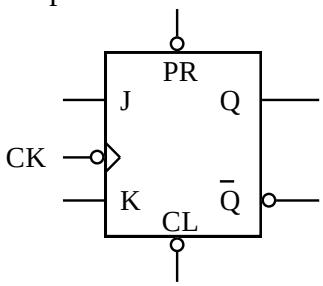


Figure 3: JK Flip-flops with asynchronous PRESET and CLEAR inputs

Experimental Procedure:

Implement S-R flip flop by using minimum amount of logic gates.
Inputs are: S (set)
R (reset)
C (clock).