

Arquitectura de Computadores

CC4301

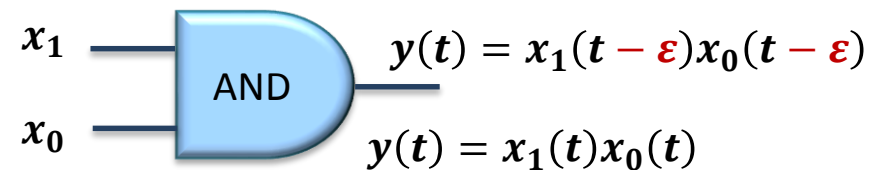
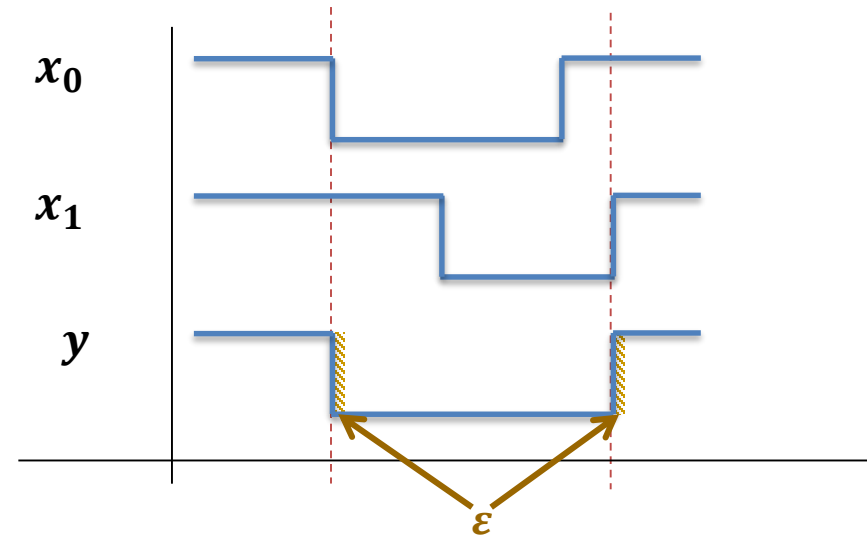
Clase 5: Biestables. Latch y Flip Flop

Semestre Primavera 2013

Profesor: Pablo Guerrero

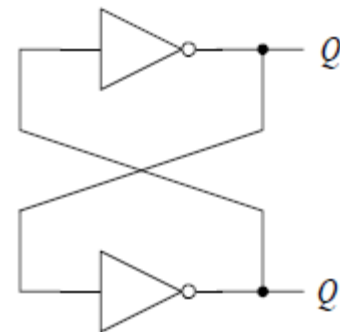
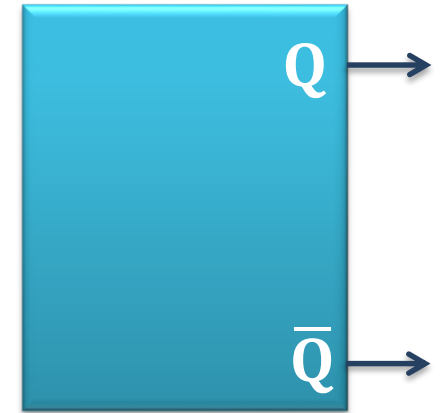
Tiempo de retardo

- Hemos supuesto que las compuertas no introducen retardo
- En realidad hay un retardo ε
- El retardo varía pero lo asumiremos constante $\Rightarrow T = n\varepsilon$



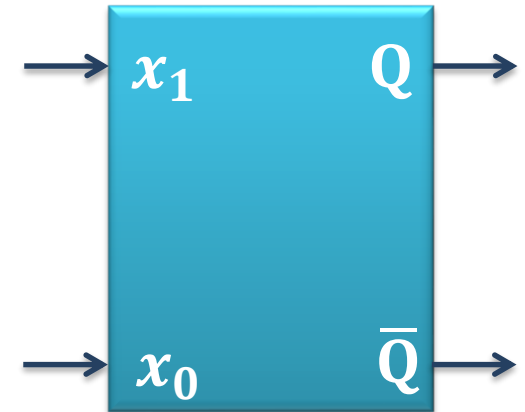
Elementos Biestables

- Tienen 2 salidas:
 - Q
 - \bar{Q}
- Tienen 2 estados estables
 - $Q = 0 (\Rightarrow \bar{Q} = 1)$
 - $Q = 1 (\Rightarrow \bar{Q} = 0)$
- Implementación:



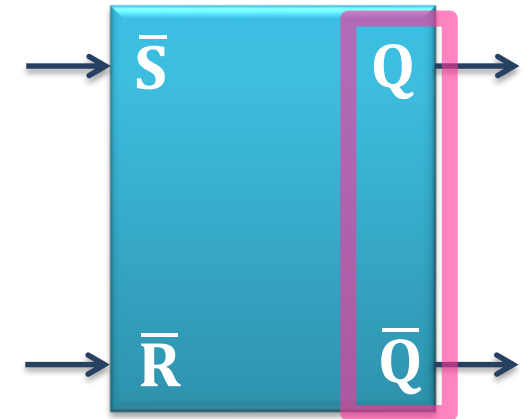
Elementos Biestables con Entradas

- Las entradas permiten controlar el estado.
- Hay dos tipos:
 - **Latch** (asíncronos): las salidas pueden cambiar en cualquier momento
 - **Flip-Flop** (síncronos): las salidas sólo pueden cambiar en los pulsos de bajada del reloj

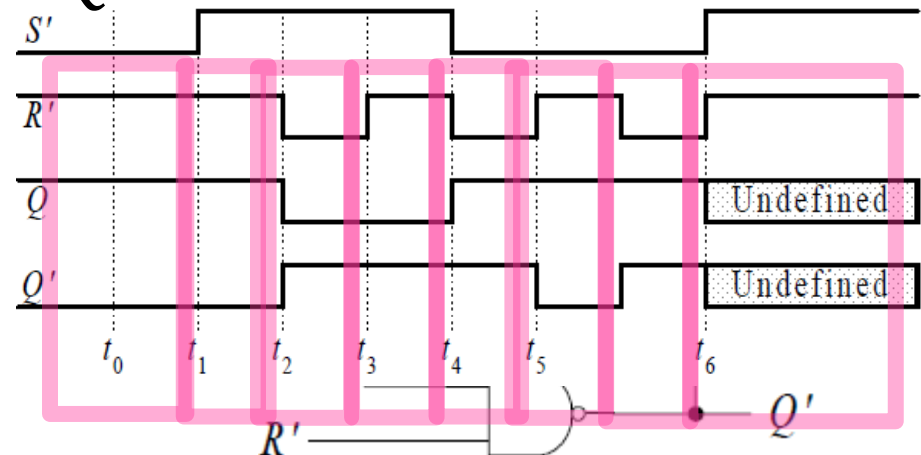


Latch SR

- Permite controlar una salida, Q , y su negado, \bar{Q}
- $S = 1, R = 0$ (set) $\Rightarrow Q \leftarrow 1$
- $S = 0, R = 1$ (reset) $\Rightarrow Q \leftarrow 0$
- $S, R = 1 \Rightarrow Q, \bar{Q} \leftarrow 1$
- $S, R = 0$ (hold) $\Rightarrow Q \leftarrow Q$



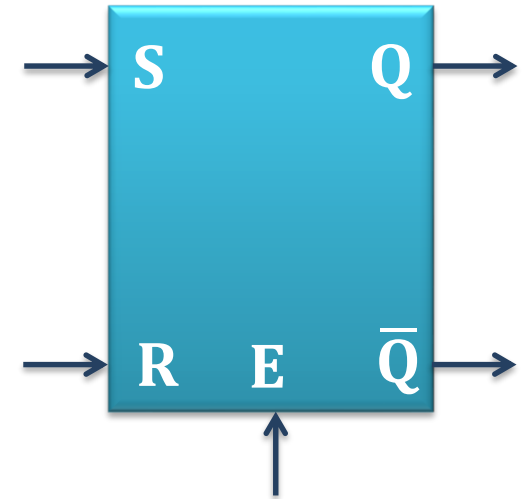
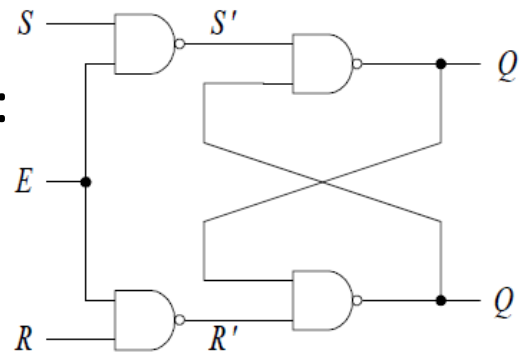
| \bar{S} | \bar{R} | Q_{next} | \bar{Q}_{next} | Desc. |
|-----------|-----------|-------------------|-------------------------|-------|
| 0 | 0 | 1 | 1 | - |
| 0 | 1 | 1 | 0 | set |
| 1 | 0 | 0 | 1 | reset |
| 1 | 1 | Q | \bar{Q} | hold |



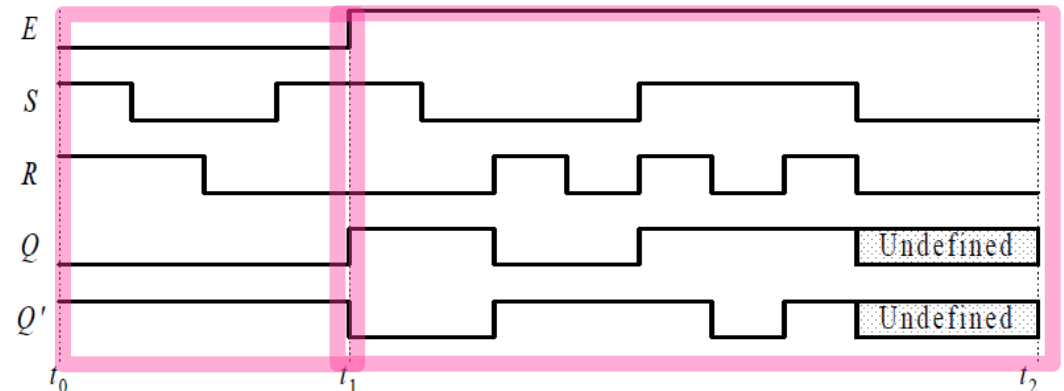
Latch SR con compuerta

- $E = 0 \Rightarrow Q \leftarrow Q$
- $E = 1 \Rightarrow$ Comportamiento de SR

Implementación con NANDs:



| E | S | R | Q_{next} | \bar{Q}_{next} | Desc. |
|---|---|---|------------|------------------|----------|
| 0 | X | X | Q | \bar{Q} | disabled |
| 1 | 0 | 0 | Q | \bar{Q} | hold |
| 1 | 0 | 1 | 0 | 1 | reset |
| 1 | 1 | 0 | 1 | 0 | set |
| 1 | 1 | 1 | 1 | 1 | — |

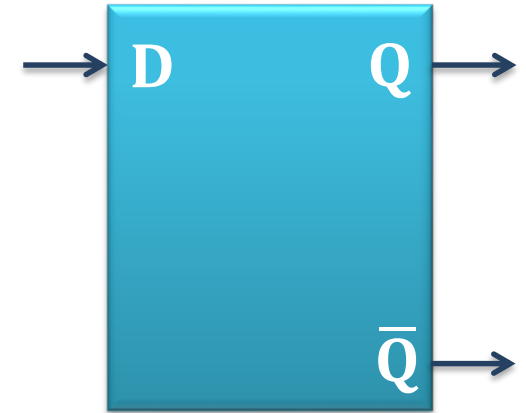
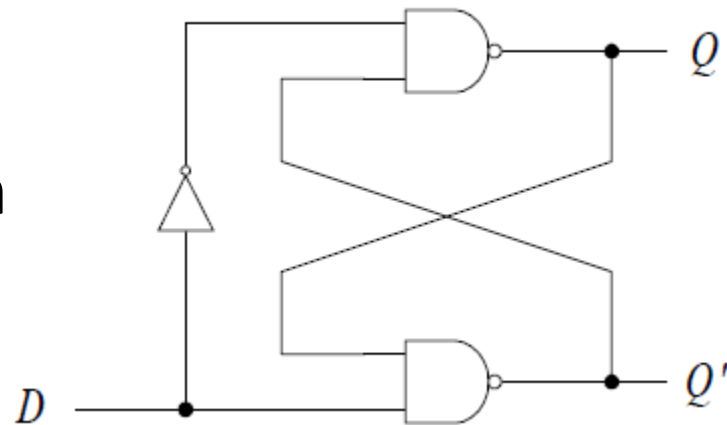


Latch Data

- Permite olvidarse del problema de la simultaneidad de S y R coordinando ambas entradas.

| D | Q_{next} | \bar{Q}_{next} |
|---|-------------------|-------------------------|
| 0 | 0 | 1 |
| 1 | 1 | 0 |

Implementación
con NANDs:

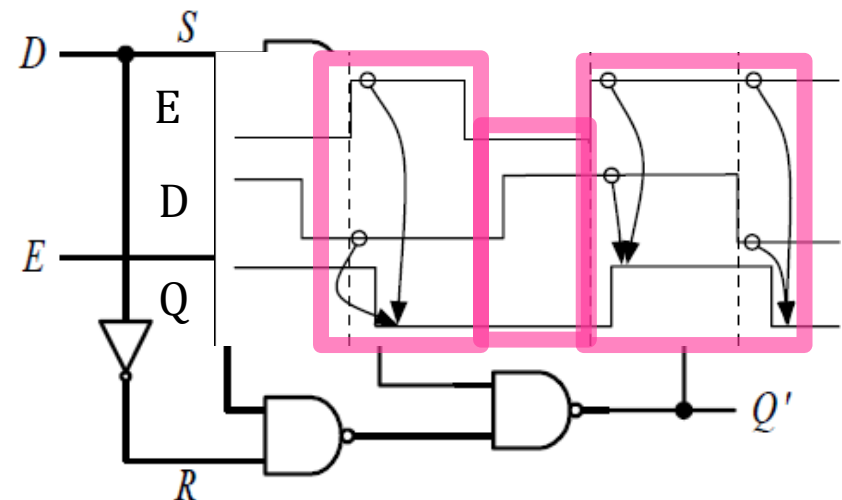
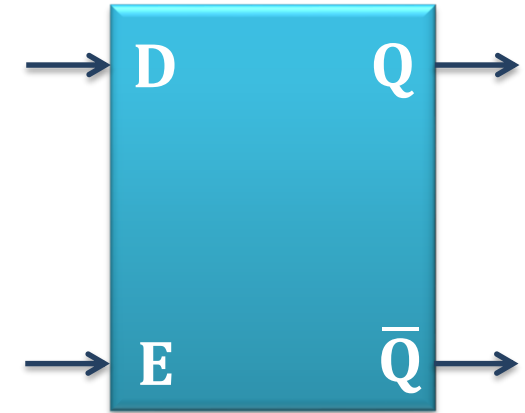


Latch Data con Compuerta

- Mientras $E = 1$, $Q = D$
- Cuando $E = 0$, Q no cambia

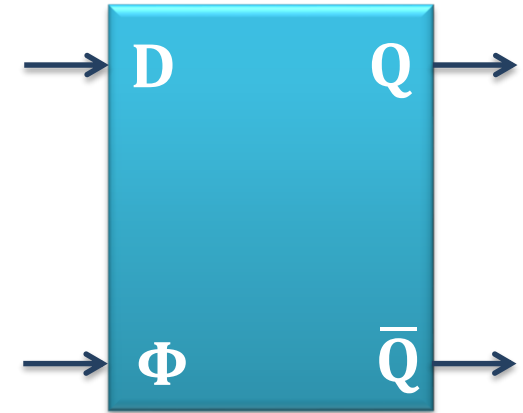
| E | D | Q_{next} | \bar{Q}_{next} |
|---|---|-------------------|-------------------------|
| 0 | X | Q | \bar{Q} |
| 1 | 0 | 0 | 1 |
| 1 | 1 | 1 | 0 |

Implementación:

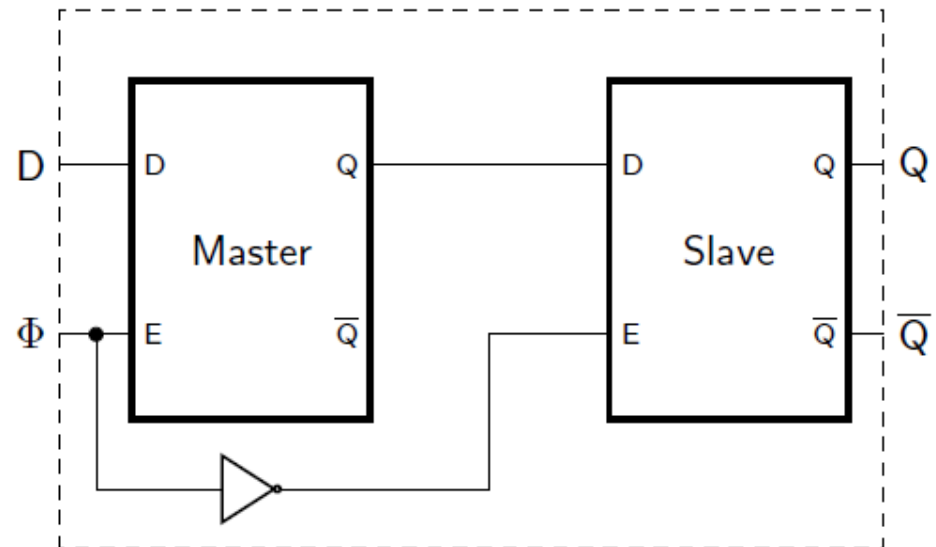


Flip Flop Data

- Copia D en el ciclo de bajada del reloj



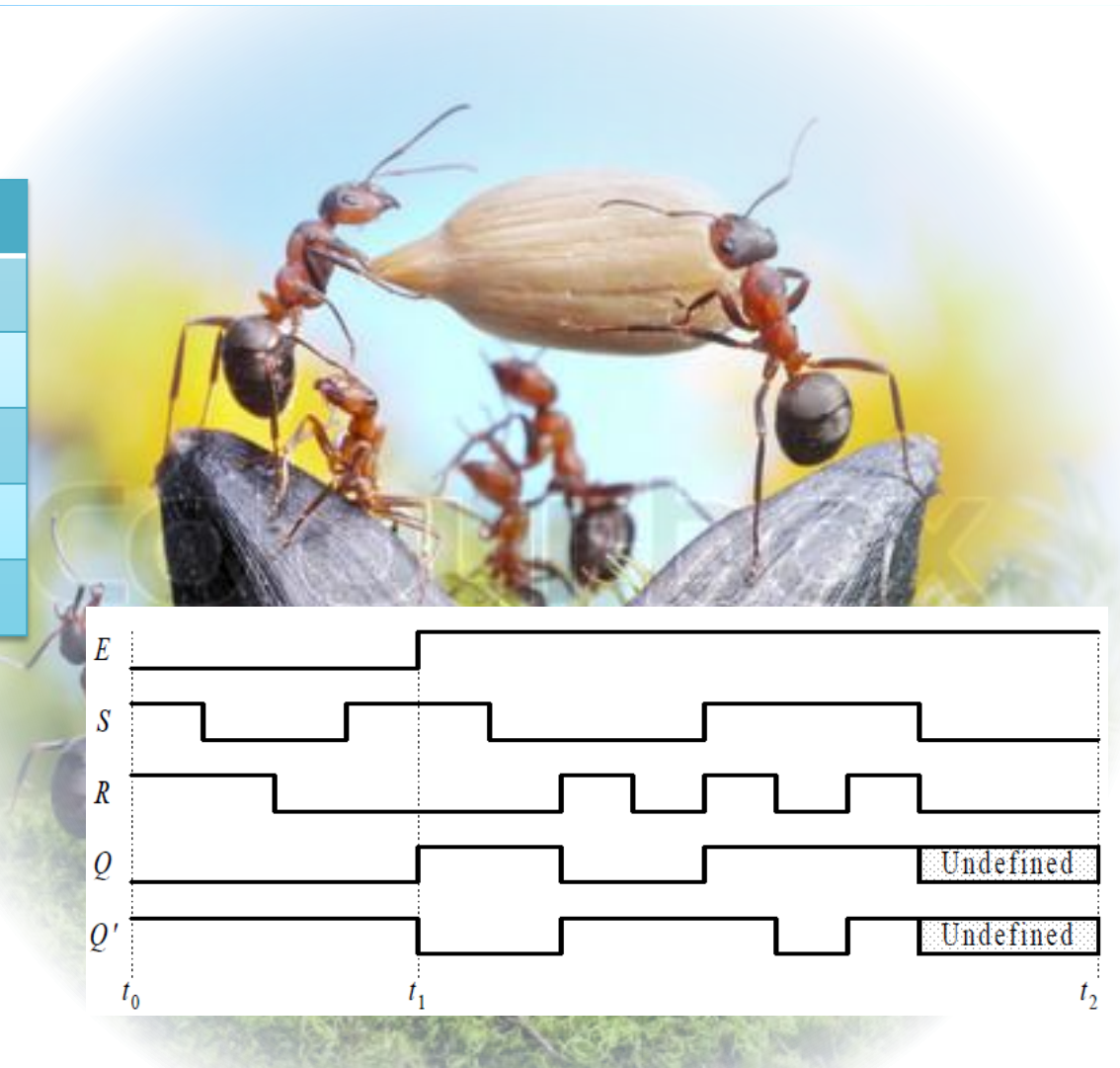
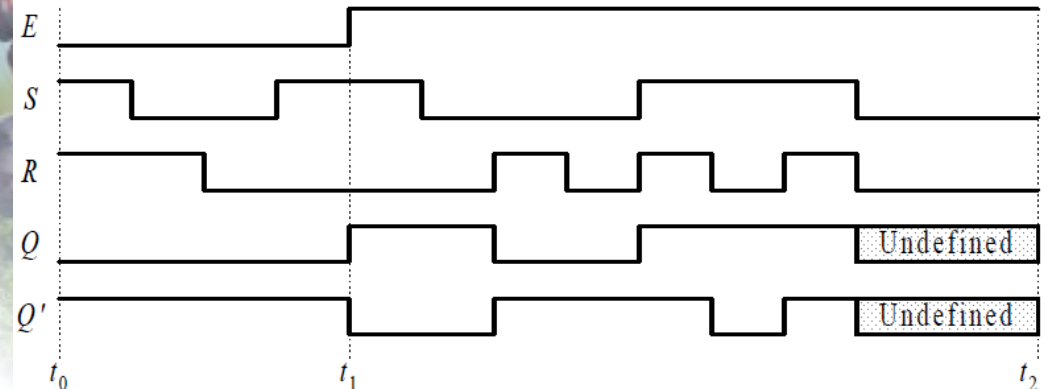
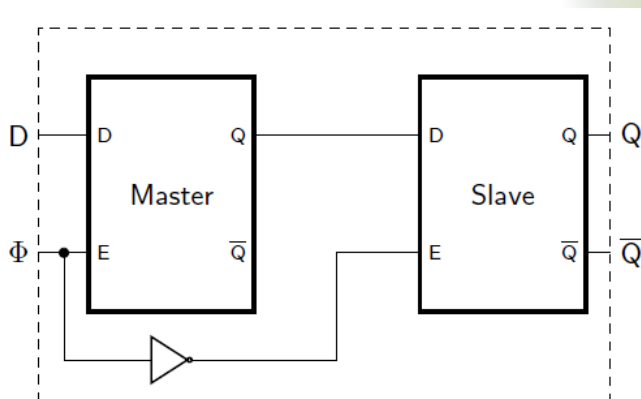
Implementación en
base a Latch Data
(Maestro-Esclavo):



Trabajo Grupal 1

- Recordar:

| E | S | R | Q_{next} | \bar{Q}_{next} | Desc. |
|---|---|---|-------------------|-------------------------|----------|
| 0 | X | X | Q | \bar{Q} | disabled |
| 1 | 0 | 0 | Q | \bar{Q} | hold |
| 1 | 0 | 1 | 0 | 1 | reset |
| 1 | 1 | 0 | 1 | 0 | set |
| 1 | 1 | 1 | 1 | 1 | — |

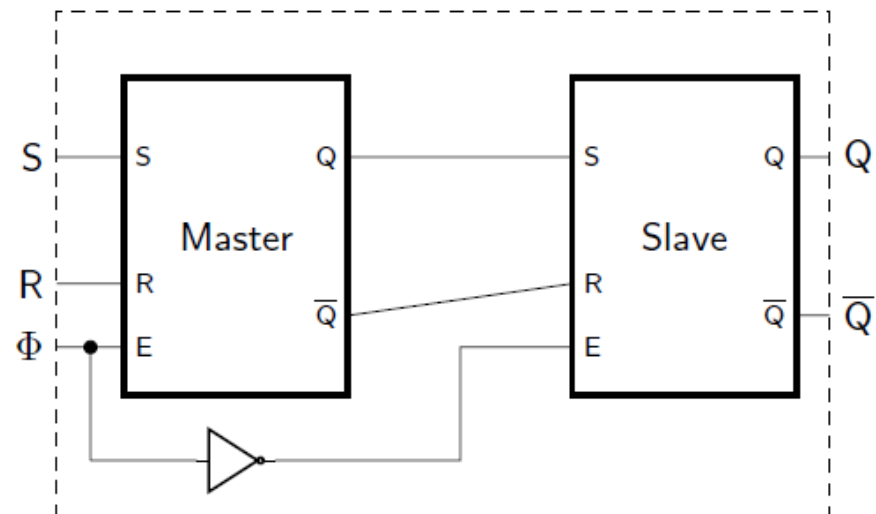
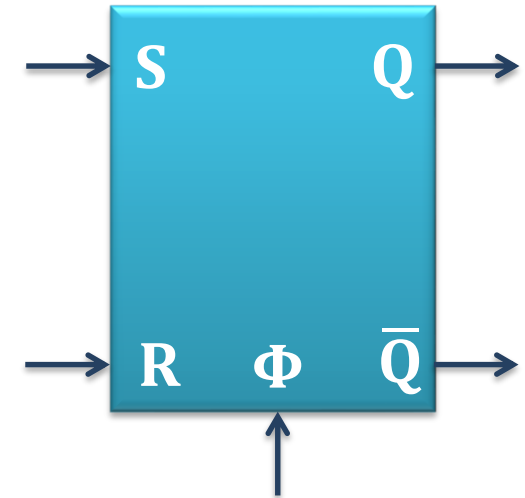


Flip Flop SR

- Sólo toma en cuenta S y R en los ciclos de bajada del reloj

| S | R | Q_{next} | \bar{Q}_{next} | Desc. |
|---|---|------------|------------------|-------|
| 0 | 0 | Q | \bar{Q} | hold |
| 0 | 1 | 0 | 1 | reset |
| 1 | 0 | 1 | 0 | set |
| 1 | 1 | X | X | — |

Implementación en base a Latch SR (Maestro-Escravo):

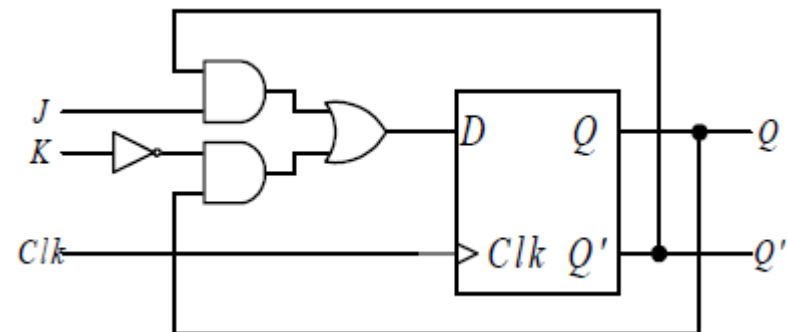
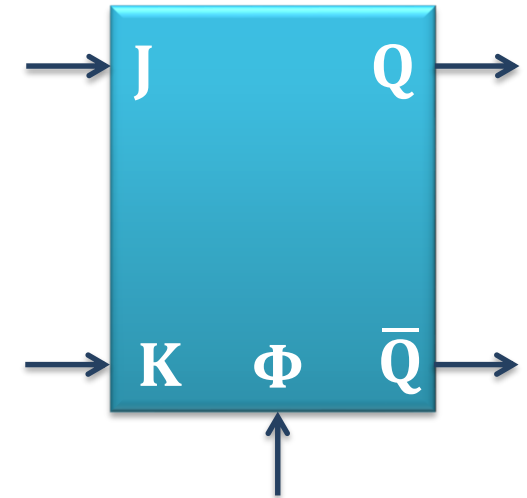


Flip Flop JK

- Muy similares a FF SR pero permiten hacer toggle con ambas entradas en 1

| J | K | Q_{next} | \bar{Q}_{next} | Desc. |
|---|---|------------|------------------|--------|
| 0 | 0 | Q | \bar{Q} | hold |
| 0 | 1 | 0 | 1 | reset |
| 1 | 0 | 1 | 0 | set |
| 1 | 1 | \bar{Q} | Q | toggle |

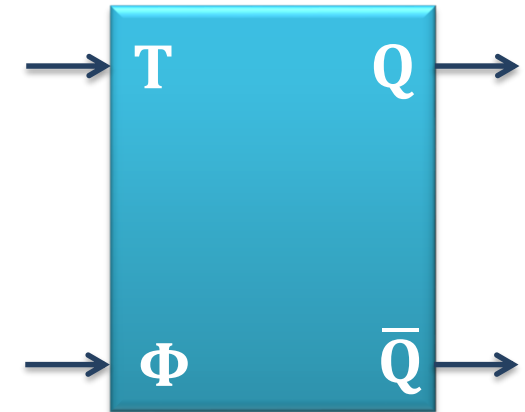
Implementación en
base a Flip Flop Data:



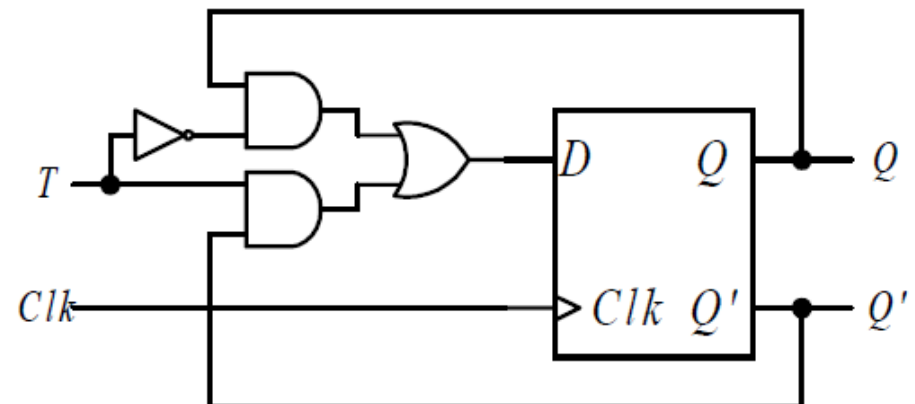
Flip Flop T

- Cambia (toggle) el valor de Q cuando $T=1$

| T | Q_{next} | \bar{Q}_{next} | Desc. |
|---|------------|------------------|--------|
| 0 | Q | \bar{Q} | hold |
| 1 | \bar{Q} | Q | toggle |



Implementación en
base a Flip Flop Data:



Trabajo Grupal 2

- Recordar:

| J | K | Q_{next} | \bar{Q}_{next} | Desc. |
|---|---|------------|------------------|--------|
| 0 | 0 | Q | \bar{Q} | hold |
| 0 | 1 | 0 | 1 | reset |
| 1 | 0 | 1 | 0 | set |
| 1 | 1 | \bar{Q} | Q | toggle |

| T | Q_{next} | \bar{Q}_{next} | Desc. |
|---|------------|------------------|--------|
| 0 | Q | \bar{Q} | hold |
| 1 | \bar{Q} | Q | toggle |

