

# Biestable S-R asíncrono

*Circuitos secuenciales*

Electrónica digital

Felipe Machado

# Circuitos secuenciales

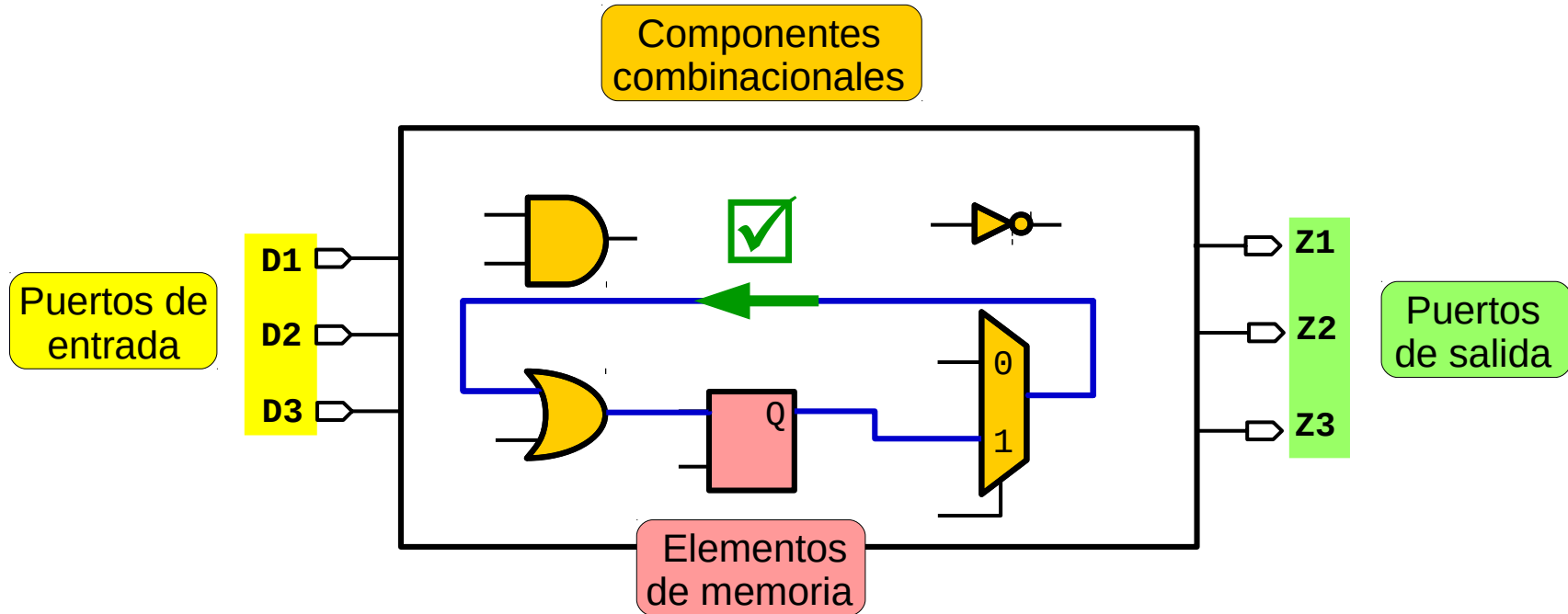
Las salidas dependen

- Entradas actuales
- Entradas en momentos anteriores

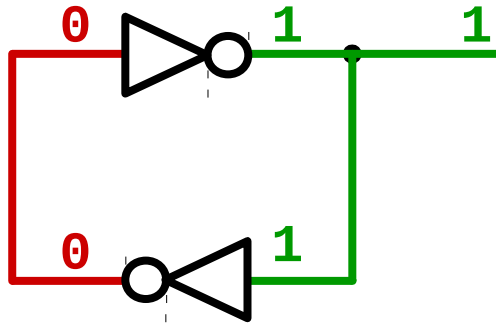
⇒ Elementos de memoria

⇒ Estado interno

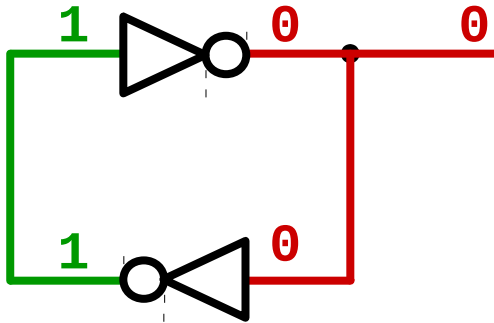
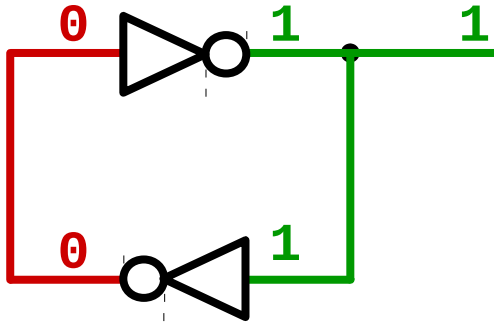
Pueden tener realimentación



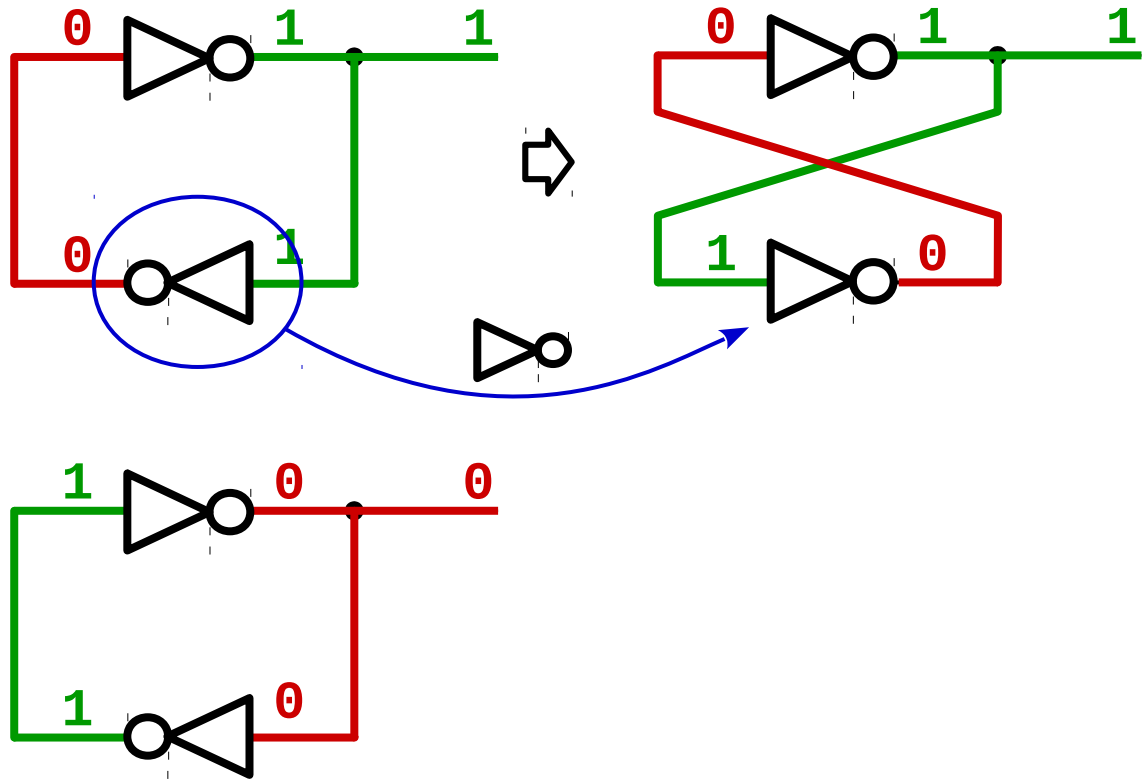
# Biestables



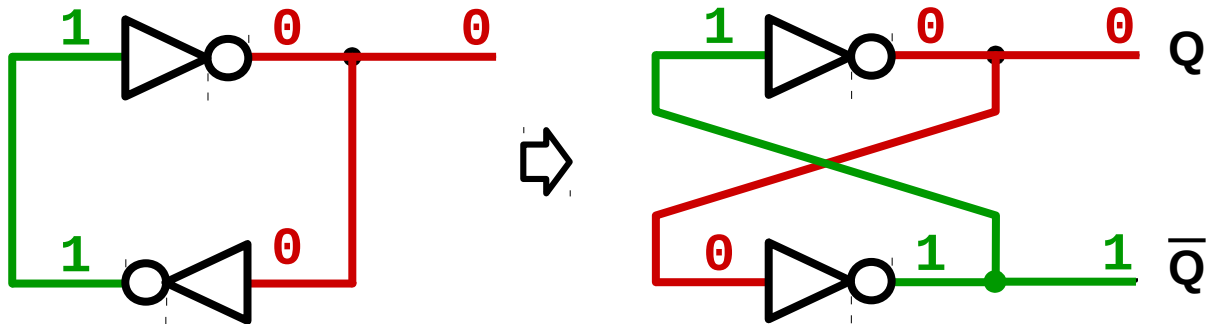
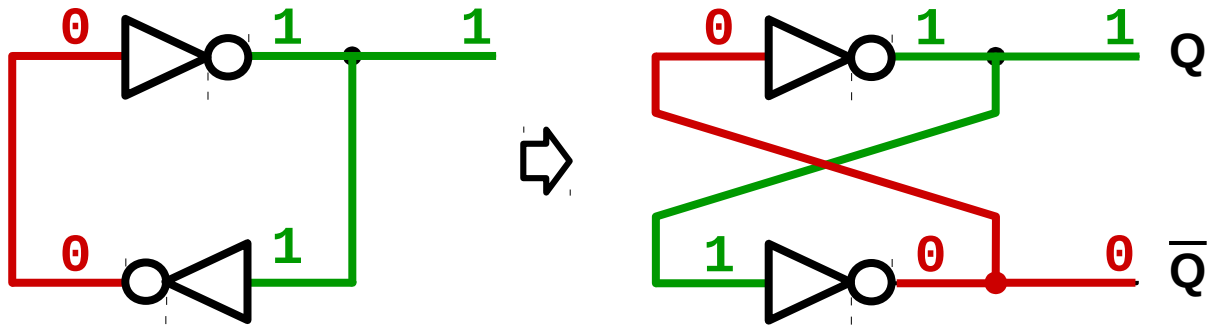
# Biestables



# Bistables



# Biestables

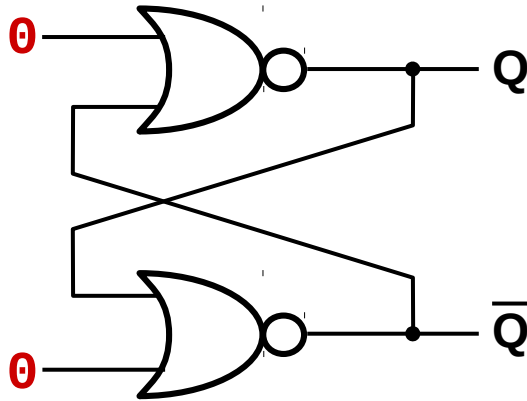
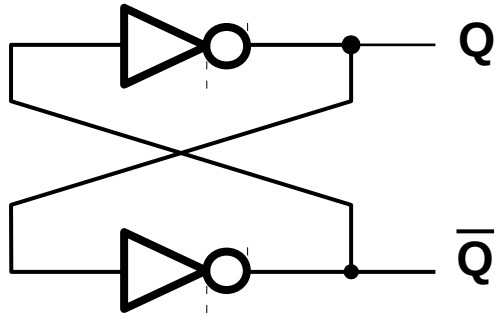


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¿Cómo puedo cambiar el estado?

# Biestables

¿Cómo puedo cambiar el estado?



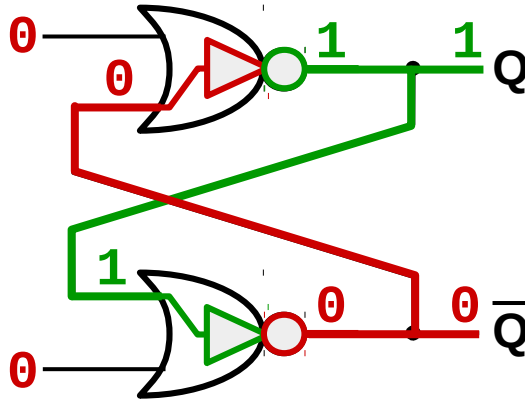
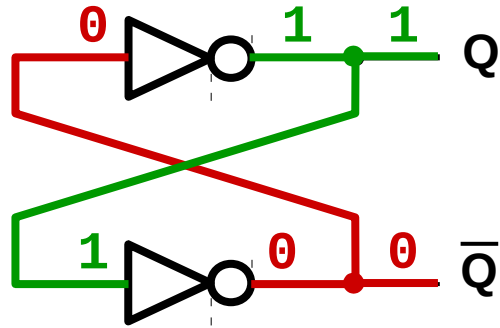
**Puerta NOR**

A	B	Y
0	0	1
0	1	0
1	0	0
1	1	0

↴ equivalente

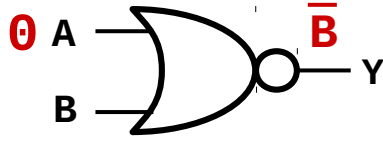
# Biestables

¿Cómo puedo cambiar el estado?




**Puerta NOR**

A	B	Y
0	0	1
0	1	0
1	0	0
1	1	0



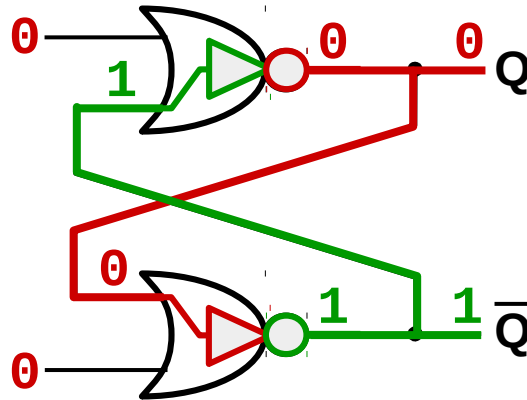
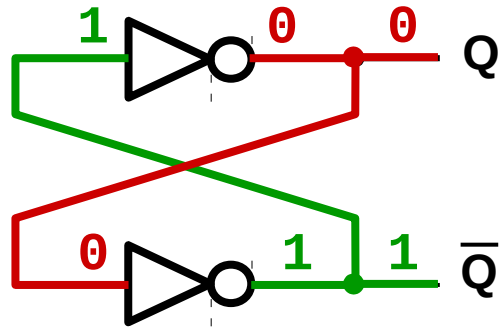
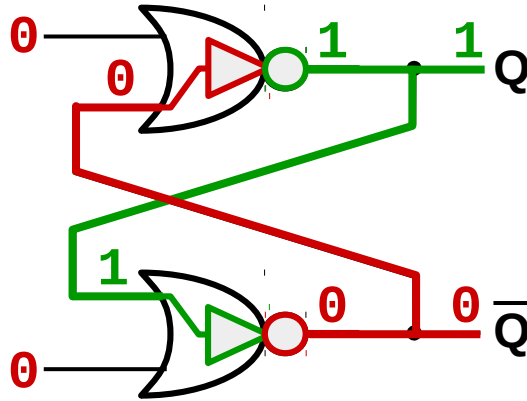
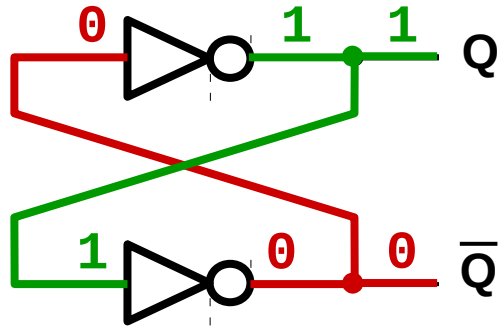
**↴ equivalente**





# Biestables

¿Cómo puedo cambiar el estado?



**Puerta NOR**

$\bar{B}$

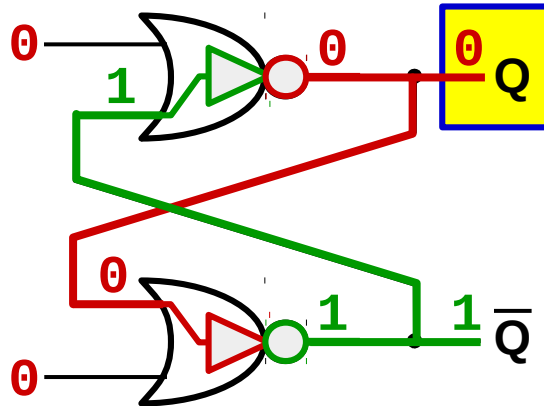
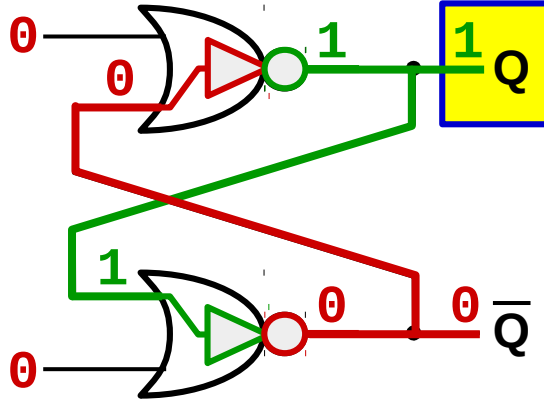
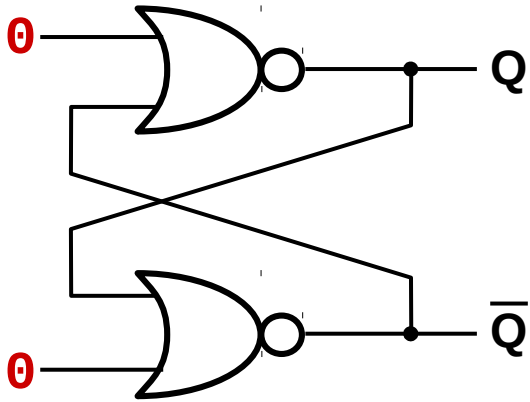
A	B	Y
0	0	1
0	1	0
1	0	0
1	1	0

equivalente

$\bar{B}$

# Biestables

¿Cómo puedo cambiar el estado?



**Puerta NOR**

A	B	Y
0	0	1
0	1	0
1	0	0
1	1	0

$\bar{B}$

⇓ equivalente

$\bar{B}$

**Puerta NOR**

A	B	Y
0	0	1
0	1	0
1	0	0
1	1	0

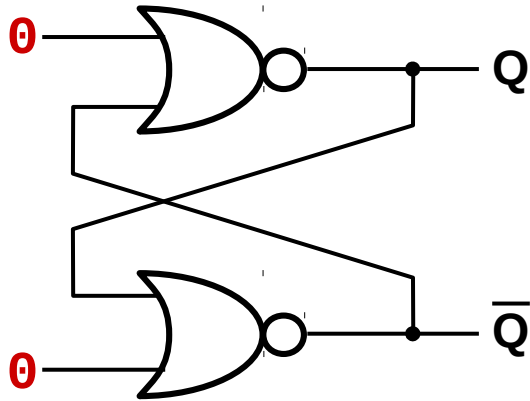
$\bar{0}$

⇓ equivalente

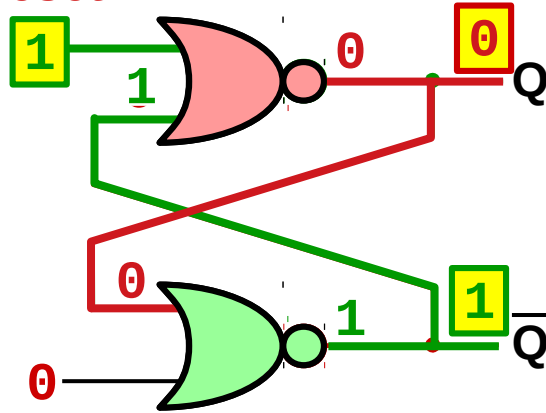
$\bar{0}$

# Biestables

¿Cómo puedo cambiar el estado?



Reset



**Puerta NOR**

A	B	Y
0	0	1
0	1	0
1	0	0
1	1	0

↓ equivalente

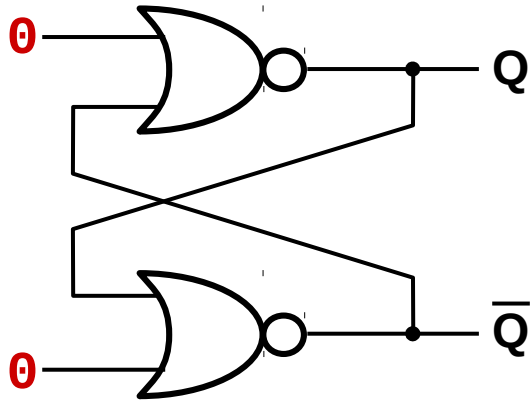
**Puerta NOR**

A	B	Y
0	0	1
0	1	0
1	0	0
1	1	0

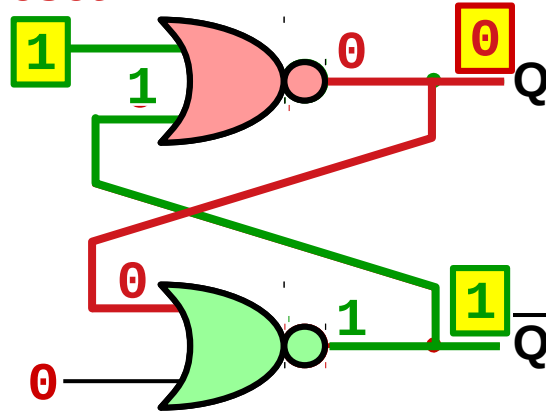
↓ equivalente

# Biestables

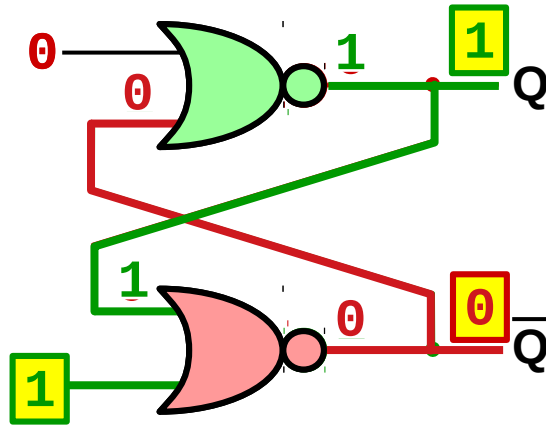
¿Cómo puedo cambiar el estado?



Reset



Set



**Puerta NOR**

A	B	Y
0	0	1
0	1	0
1	0	0
1	1	0

↓ equivalente

$B \rightarrow \bar{B}$

**Puerta NOR**

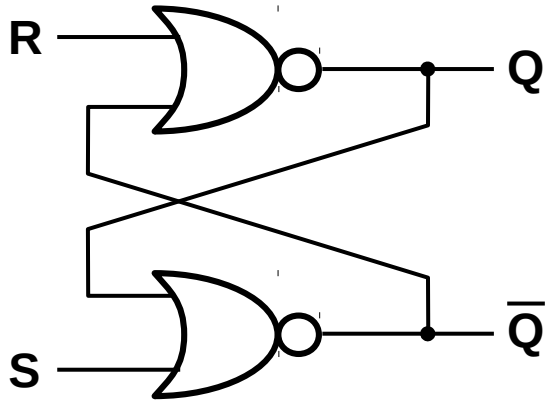
A	B	Y
0	0	1
0	1	0
1	0	0
1	1	0

↓ equivalente

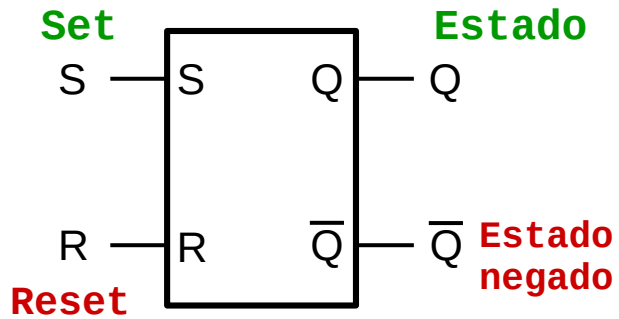
$0 \rightarrow Y$

# Biastable S-R asíncrono

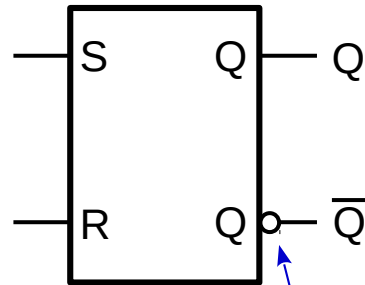
Reset



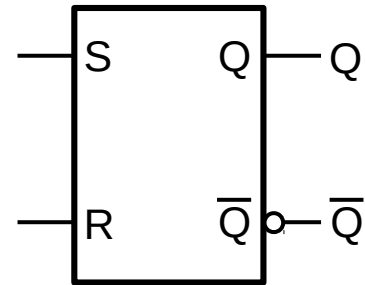
Set



Otras posibles representaciones



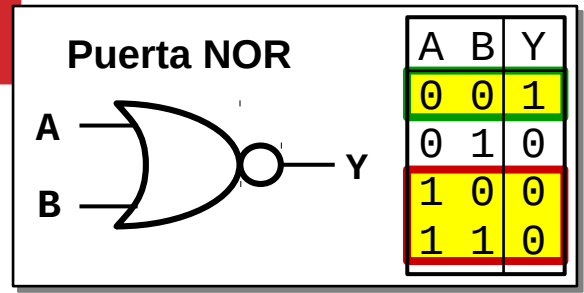
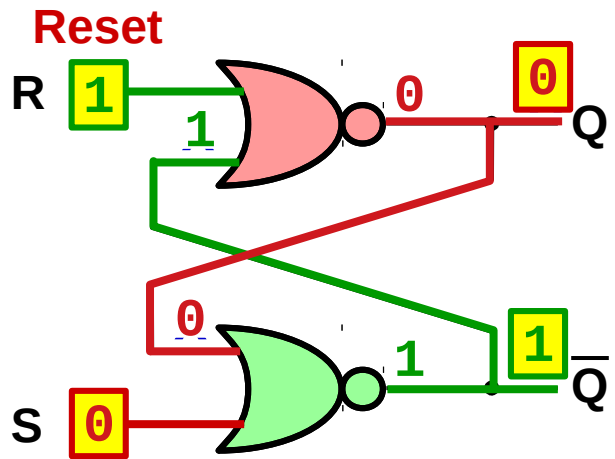
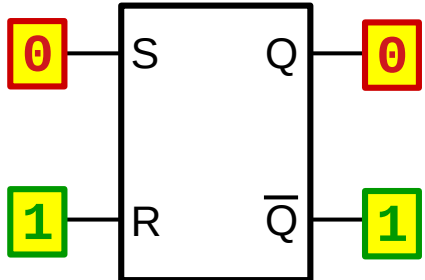
negación



# Biastable S-R asíncrono

## Transiciones

Set: 0  
Reset: 1



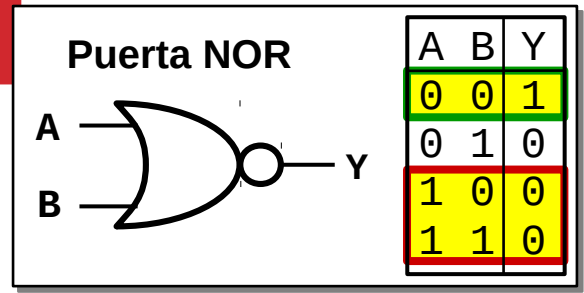
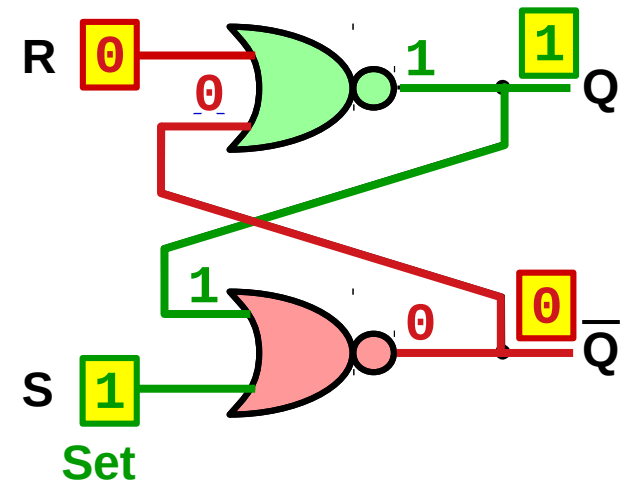
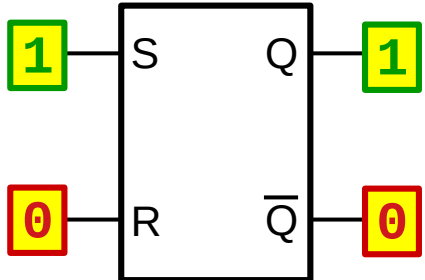
S	R	$Q_t$	$Q_{t+1}$	$\overline{Q}_{t+1}$
0	1	X	0	1

**Reset**

# Biastable S-R asíncrono

## Transiciones

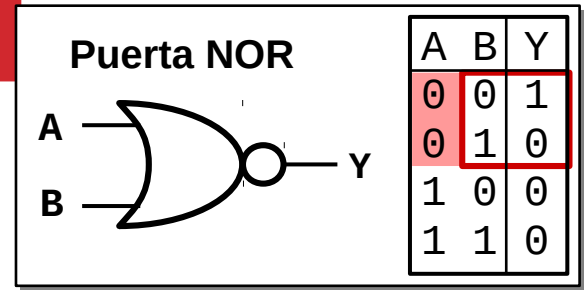
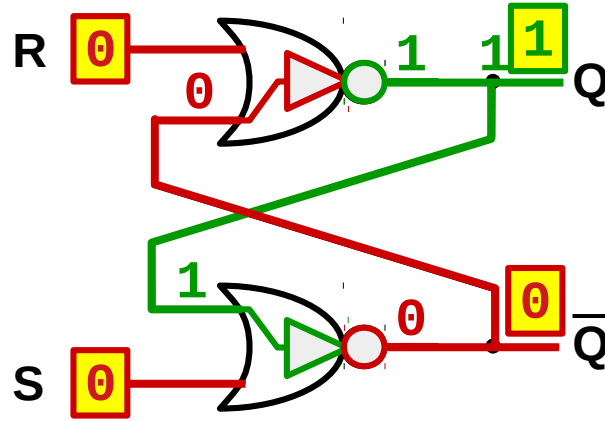
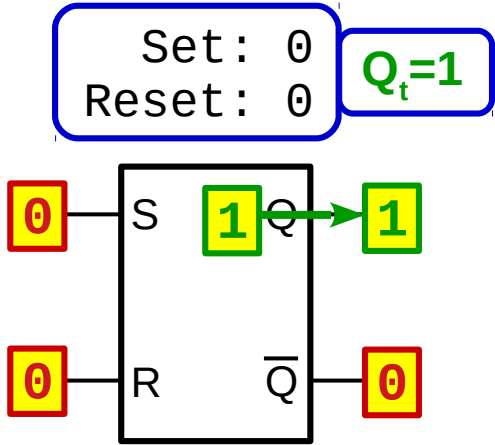
Set: 1  
Reset: 0



S	R	$Q_t$	$Q_{t+1}$	$\overline{Q_{t+1}}$	
0	1	X	0	1	Reset
1	0	X	1	0	Set

# Biastable S-R asíncrono

## Transiciones

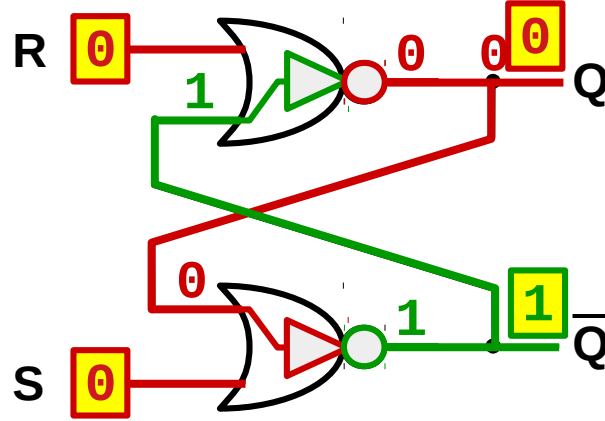
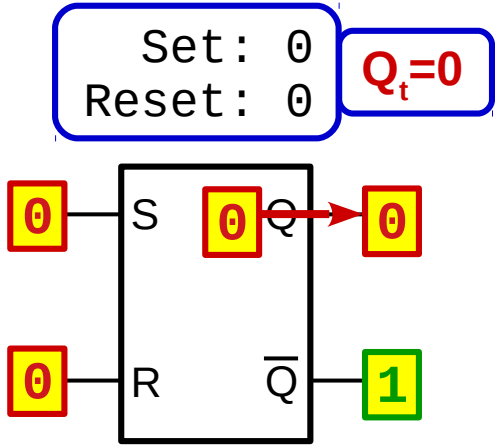


S	R	$Q_t$	$Q_{t+1}$	$\overline{Q_{t+1}}$	
0	1	X	0	1	Reset
1	0	X	1	0	Set
0	0	1	1	0	Mantiene



# Biastable S-R asíncrono

## Transiciones



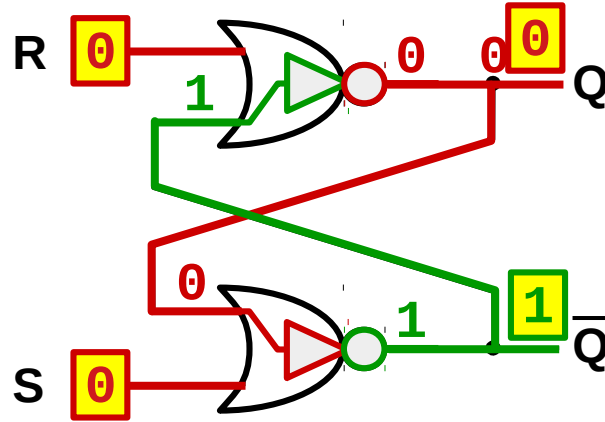
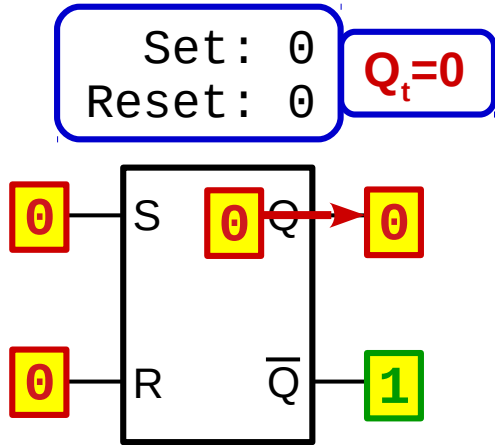
Puerta NOR

A	B	Y
0	0	1
0	1	0
1	0	0
1	1	0

S	R	$Q_t$	$Q_{t+1}$	$\overline{Q_{t+1}}$	
0	1	X	0	1	Reset
1	0	X	1	0	Set
0	0	1	1	0	Mantiene
0	0	0	0	1	Mantiene

# Biastable S-R asíncrono

## Transiciones



Puerta NOR

A	B	Y
0	0	1
0	1	0
1	0	0
1	1	0

S	R	$Q_t$	$Q_{t+1}$	$\overline{Q_{t+1}}$	
0	1	X	0	1	Reset
1	0	X	1	0	Set
0	0	1	1	0	Mantiene
0	0	0	0	1	Mantiene

# Biastable S-R asíncrono

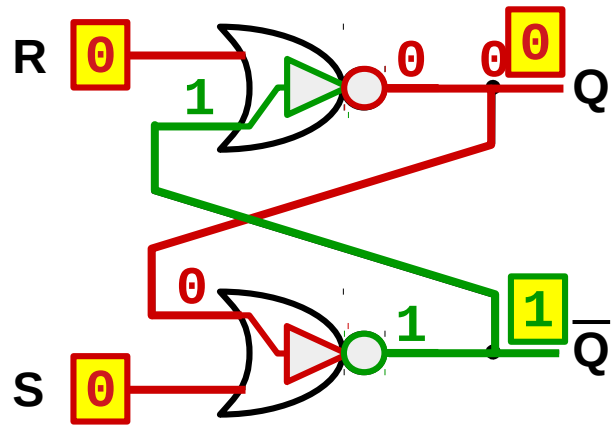
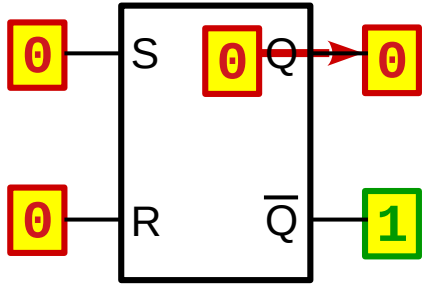
## Transiciones

**Puerta NOR**

A	B	Y
0	0	1
0	1	0
1	0	0
1	1	0

Set: 0  
Reset: 0

$Q_t = 0$

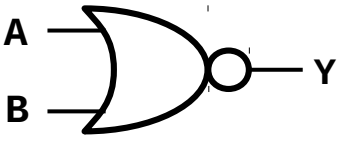


S	R	$Q_t$	$Q_{t+1}$	$\overline{Q_{t+1}}$	
0	1	X	0	1	Reset
1	0	X	1	0	Set
0	0	$Q_t$	$Q_t$	$\overline{Q_t}$	Mantiene

# Biastable S-R asíncrono

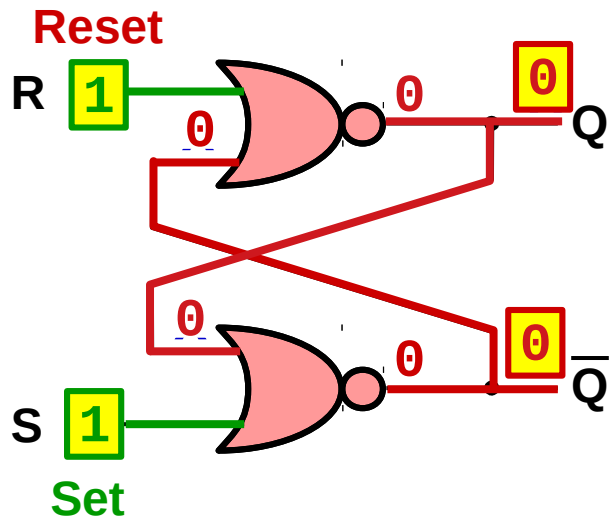
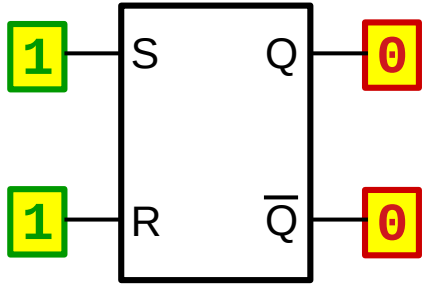
## Transiciones

**Puerta NOR**



A	B	Y
0	0	1
0	1	0
1	0	0
1	1	0

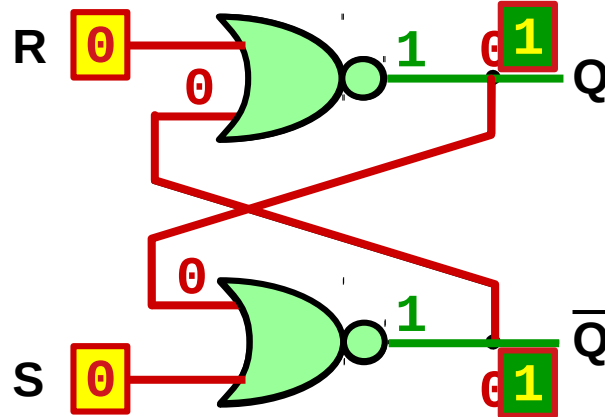
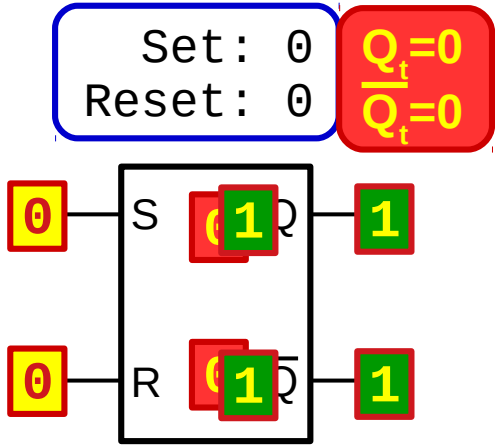
**Set: 1**  
**Reset: 1**



S	R	$Q_t$	$Q_{t+1}$	$\overline{Q_{t+1}}$	
0	0	$Q_t$	$Q_t$	$\overline{Q_t}$	Mantiene
0	1	X	0	1	Reset
1	0	X	1	0	Set
1	1	X	0	0	Prohibido

# Biastable S-R asíncrono

## Transiciones



Puerta NOR

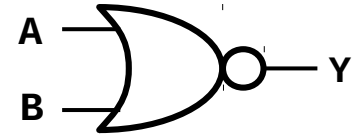
A	B	Y
0	0	1
0	1	0
1	0	0
1	1	0

S	R	$Q_t$	$Q_{t+1}$	$\overline{Q}_{t+1}$	
0	0	$Q_t$	$Q_t$	$Q_t$	Mantiene
0	1	X	0	1	Reset
1	0	X	1	0	Set
1	1	X	0	0	Prohibido

# Biastable S-R asíncrono

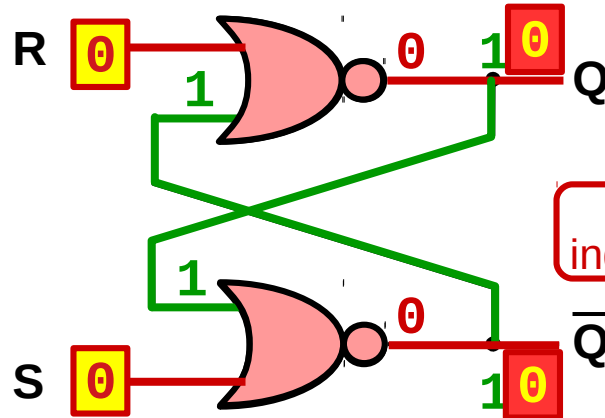
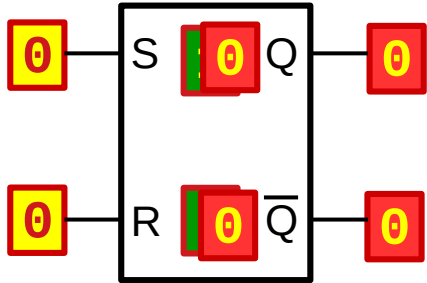
## Transiciones

### Puerta NOR



A	B	Y
0	0	1
0	1	0
1	0	0
1	1	0

Set: 0  $Q_t=1$   
 Reset: 0  $\overline{Q}_t=1$

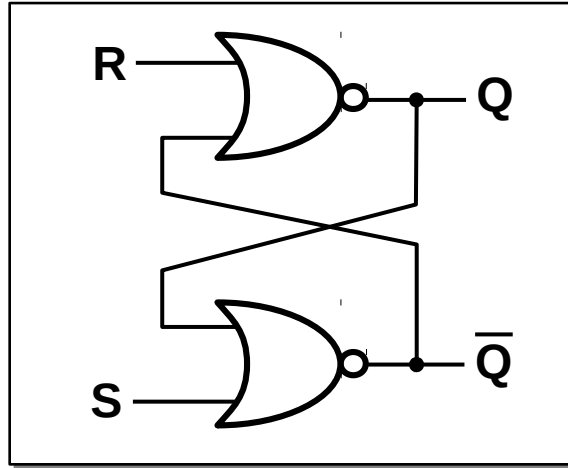
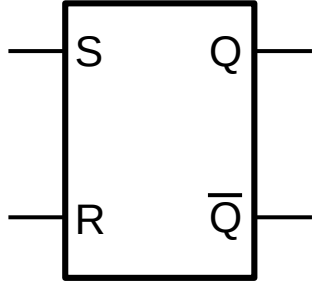


Estado indeterminado

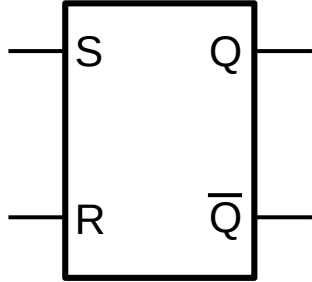
S	R	$Q_t$	$Q_{t+1}$	$\overline{Q}_{t+1}$
0	0	$Q_t$	$Q_t$	$Q_t$
0	1	X	0	1
1	0	X	1	0
1	1	X	0	0

Mantiene  
 Reset  
 Set  
 Prohibido

# Biastable S-R asíncrono



S	R	$Q_{t+1}$	$\overline{Q_{t+1}}$	
0	0	$Q_t$	$\overline{Q_t}$	Mantiene
0	1	0	1	Reset
1	0	1	0	Set
1	1	0	0	Prohibido



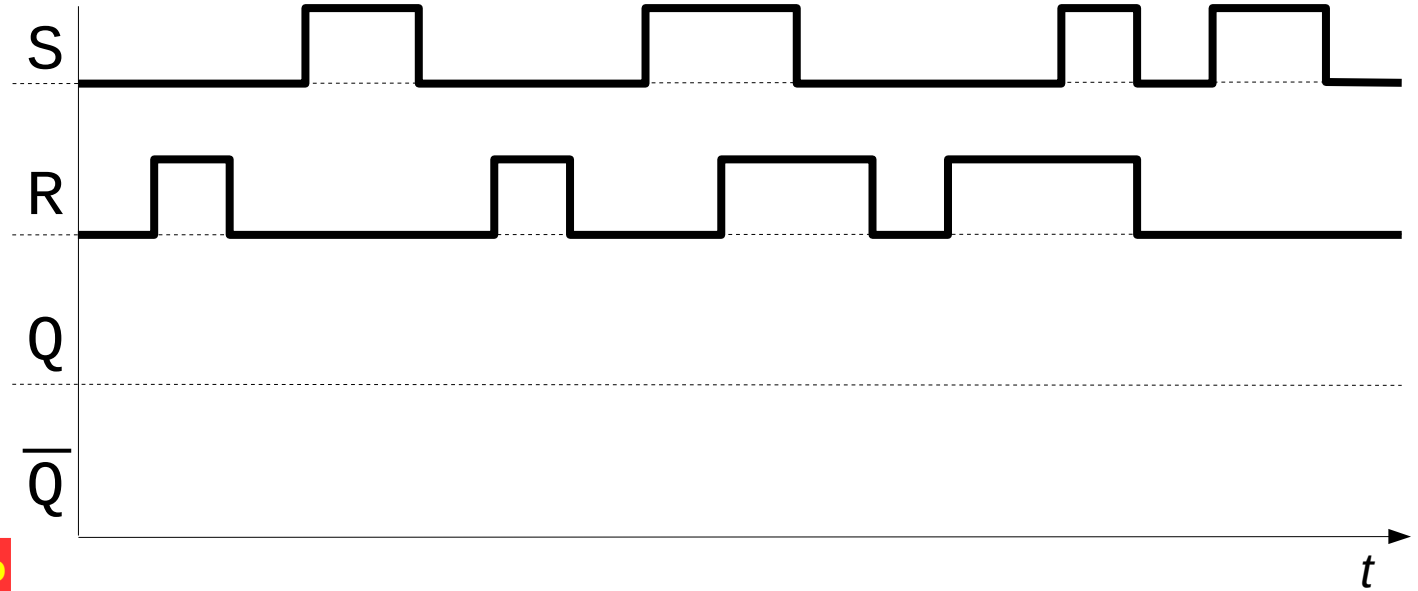
S	R	$Q_{t+1}$	$\overline{Q}_{t+1}$
0	0	$Q_t$	$\overline{Q}_t$
0	1	0	1
1	0	1	0
1	1	0	0

Mantiene

Reset

Set

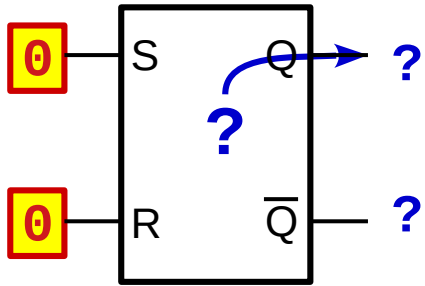
Prohibido



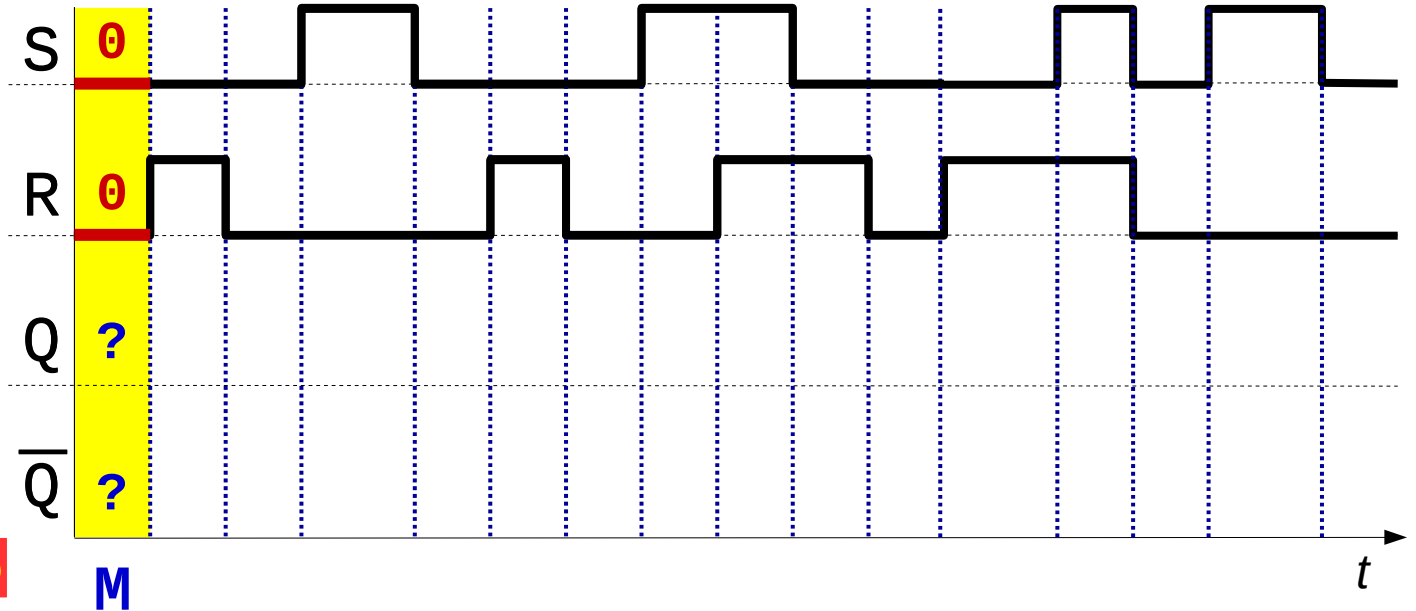


# Biastable S-R asíncrono

## Cronograma

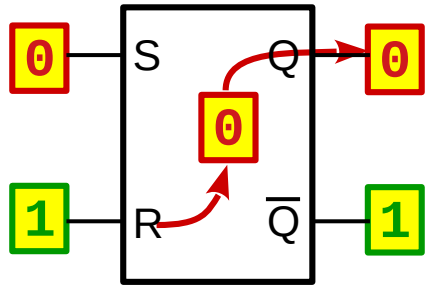


S	R	$Q_{t+1}$	$\overline{Q}_{t+1}$	
0	0	$Q_t$	$\overline{Q}_t$	Mantiene
0	1	0	1	Reset
1	0	1	0	Set
1	1	0	0	Prohibido



# Biastable S-R asíncrono

## Cronograma



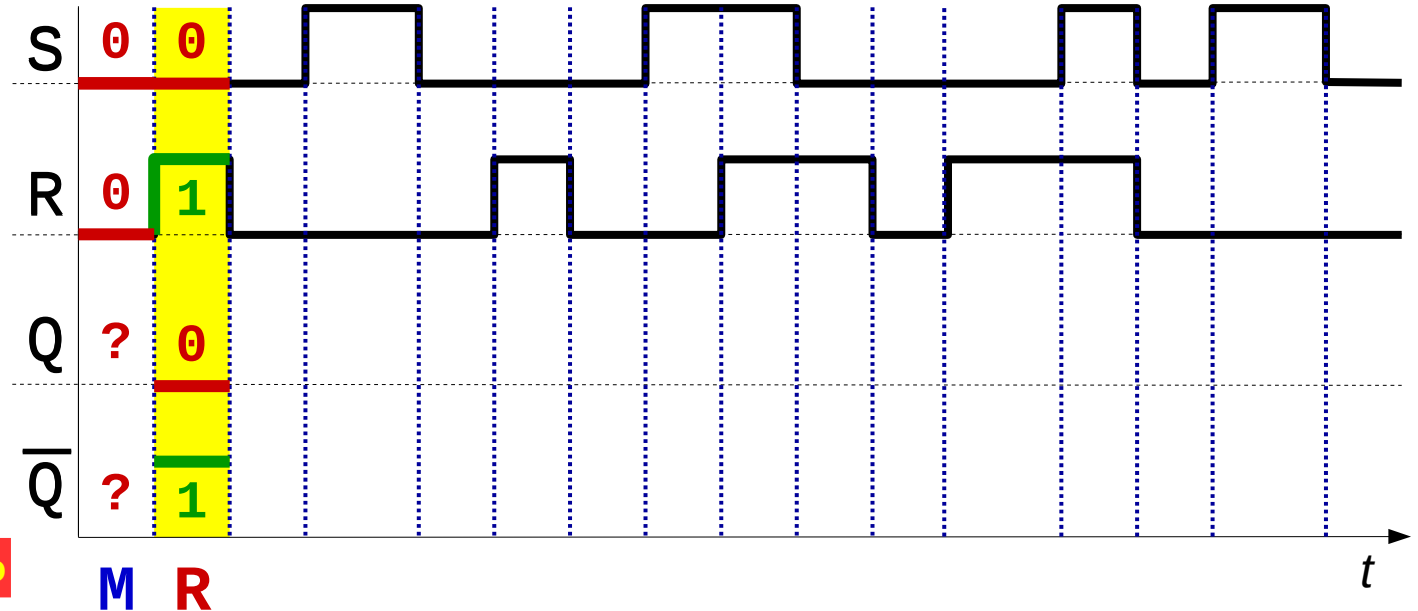
S	R	$Q_{t+1}$	$\overline{Q}_{t+1}$
0	0	$Q_t$	$\overline{Q}_t$
0	1	0	1
1	0	1	0
1	1	0	0

Mantiene

Reset

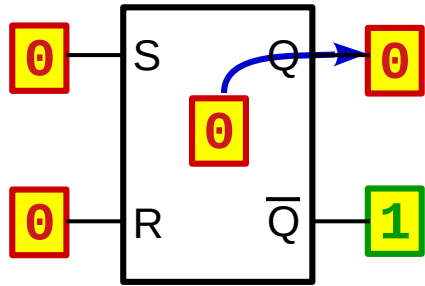
Set

Prohibido

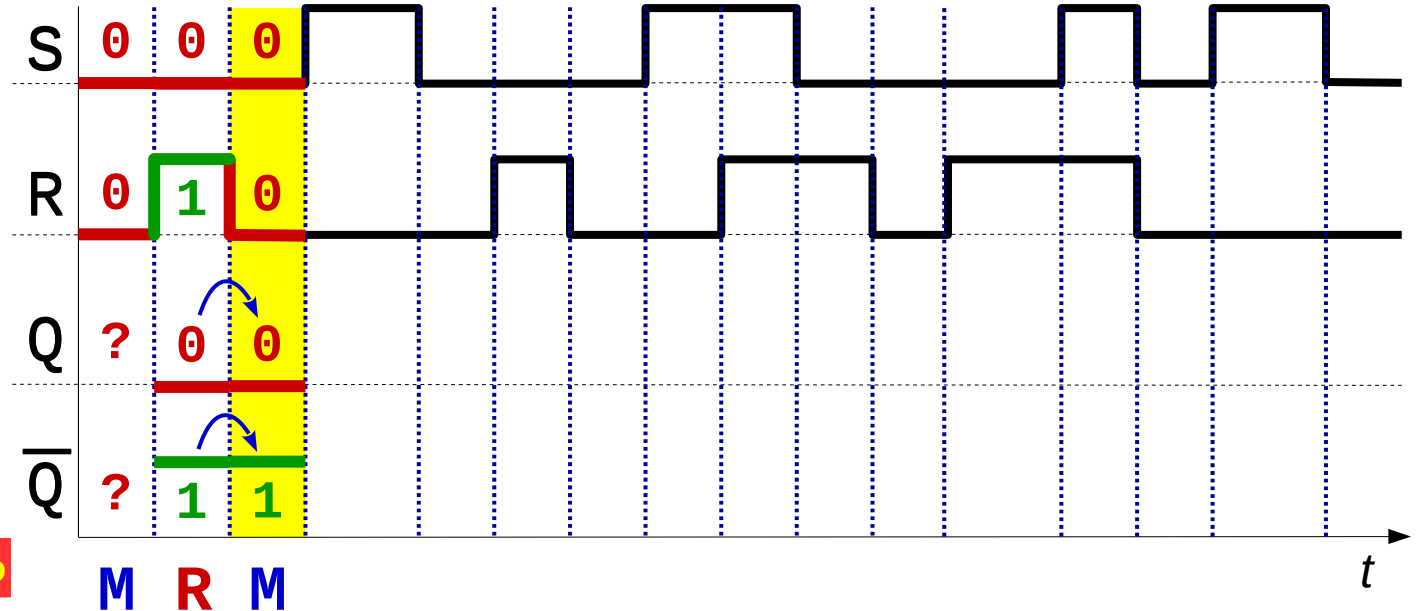


# Biastable S-R asíncrono

## Cronograma

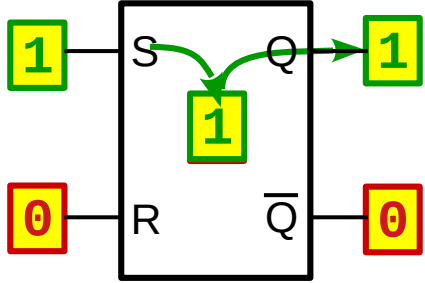


S	R	$Q_{t+1}$	$\overline{Q}_{t+1}$	
0	0	$Q_t$	$\overline{Q}_t$	Mantiene
0	1	0	1	Reset
1	0	1	0	Set
1	1	0	0	Prohibido

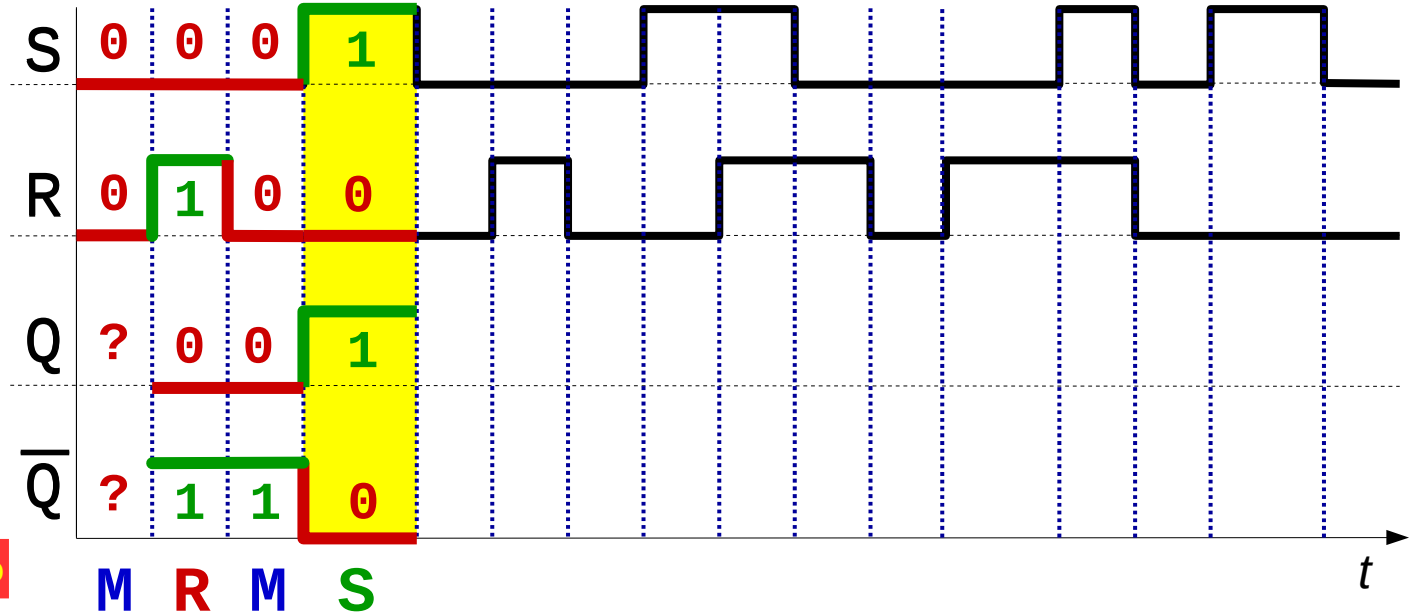


# Biastable S-R asíncrono

## Cronograma

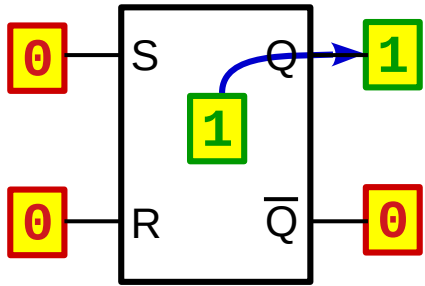


S	R	$Q_{t+1}$	$\overline{Q}_{t+1}$	
0	0	$Q_t$	$\overline{Q}_t$	Mantiene
0	1	0	1	Reset
1	0	1	0	Set
1	1	0	0	Prohibido



# Biastable S-R asíncrono

## Cronograma



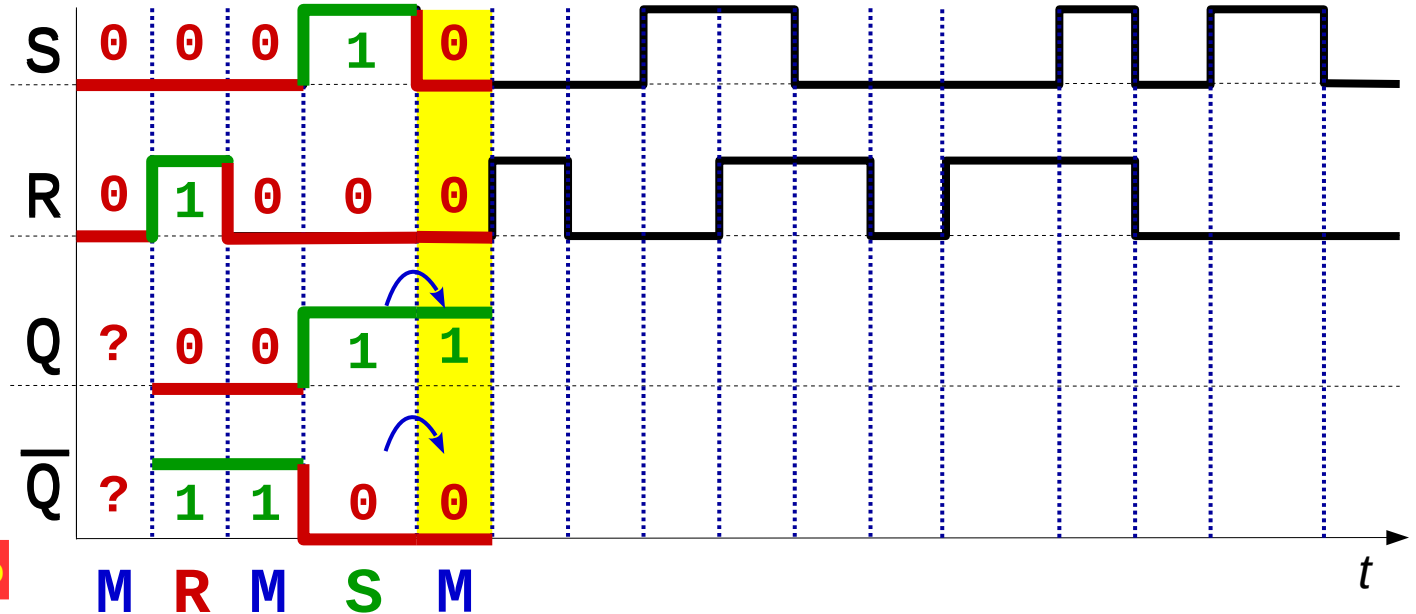
S	R	$Q_{t+1}$	$\overline{Q}_{t+1}$
0	0	$Q_t$	$\overline{Q}_t$
0	1	0	1
1	0	1	0
1	1	0	0

Mantiene

Reset

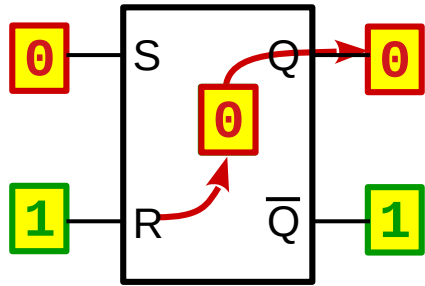
Set

Prohibido



# Biastable S-R asíncrono

## Cronograma



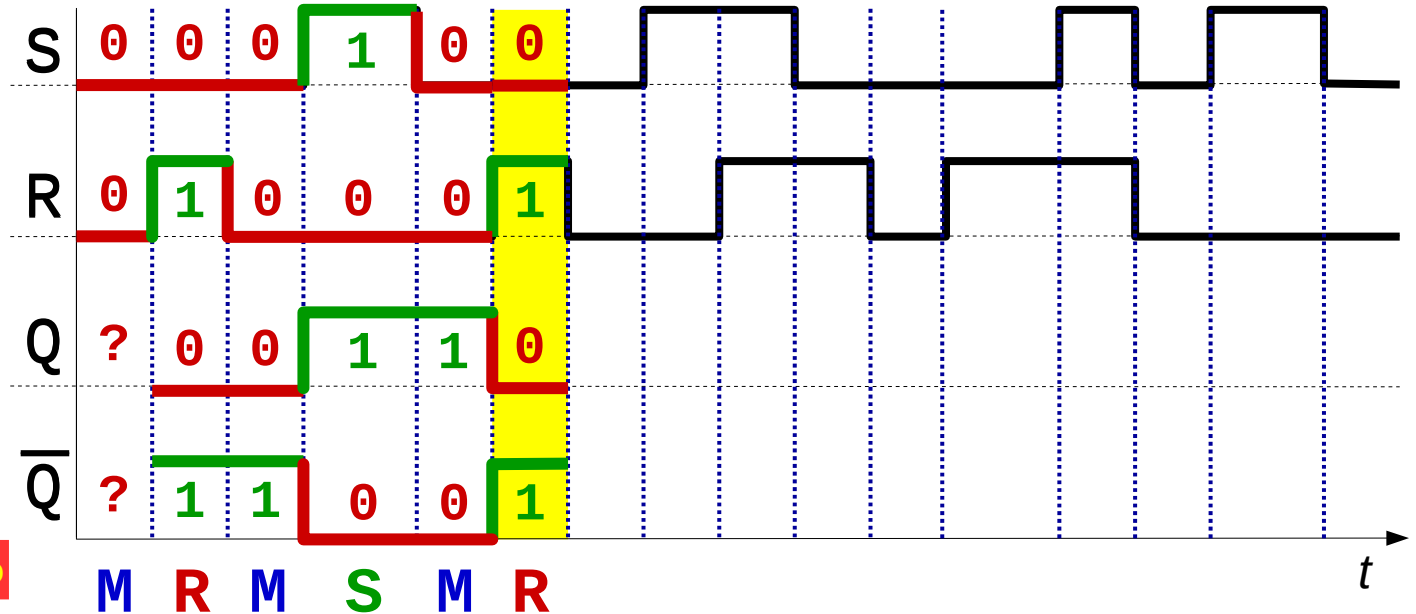
S	R	$Q_{t+1}$	$\overline{Q}_{t+1}$
0	0	$Q_t$	$\overline{Q}_t$
0	1	0	1
1	0	1	0
1	1	0	0

Mantiene

Reset

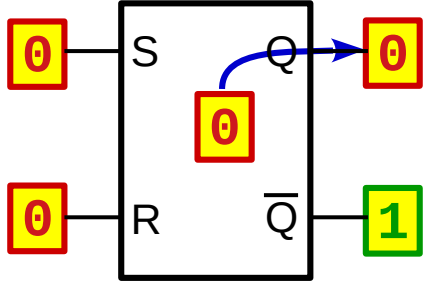
Set

Prohibido



# Biastable S-R asíncrono

## Cronograma



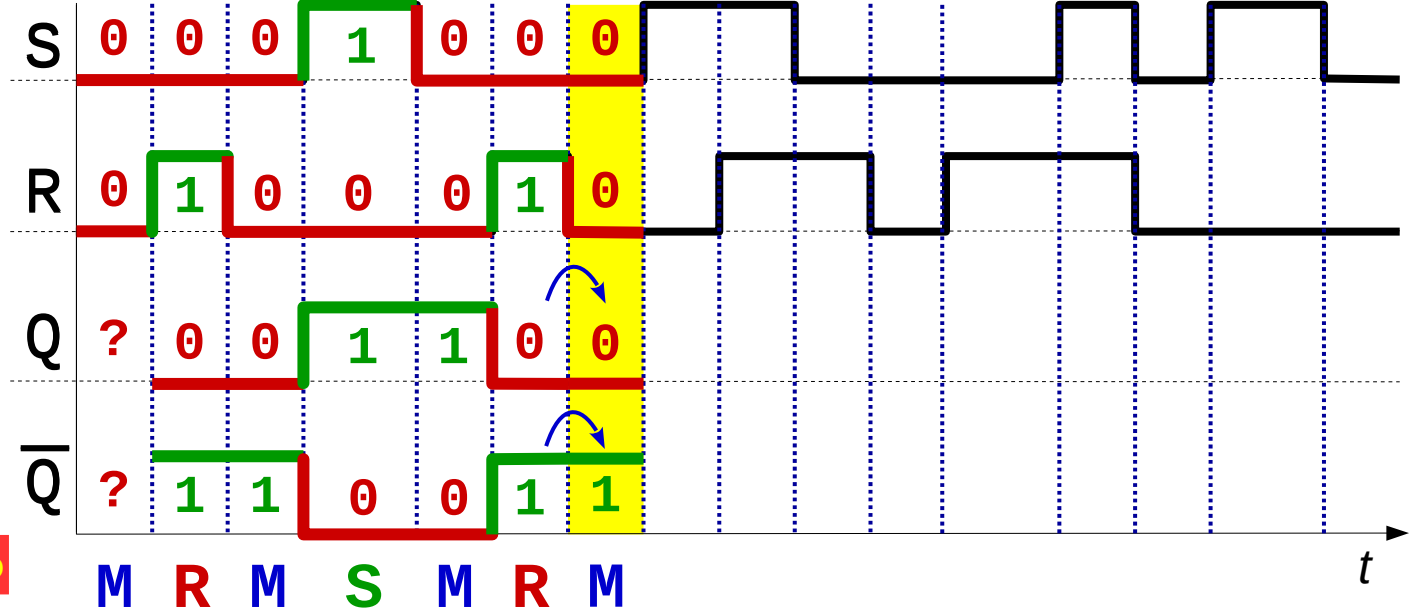
S	R	$Q_{t+1}$	$\overline{Q}_{t+1}$
0	0	$Q_t$	$\overline{Q}_t$
0	1	0	1
1	0	1	0
1	1	0	0

Mantiene

Reset

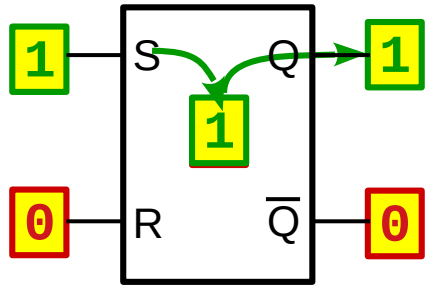
Set

Prohibido



# Biastable S-R asíncrono

## Cronograma



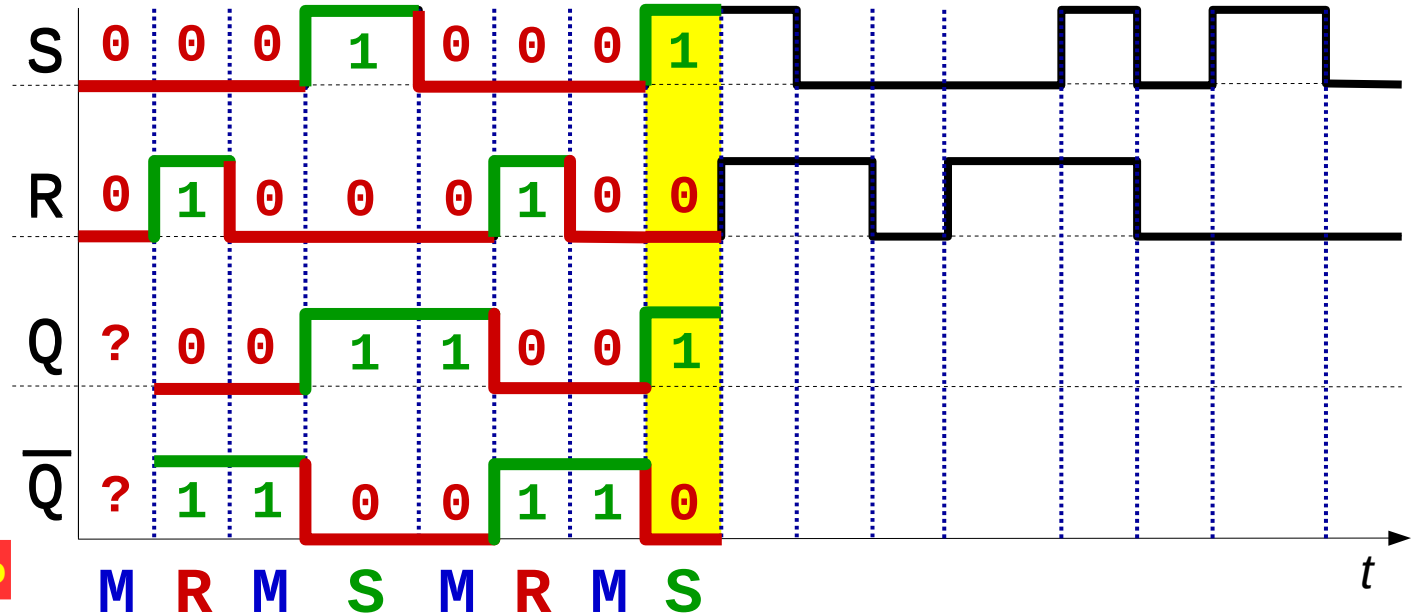
S	R	$Q_{t+1}$	$\overline{Q}_{t+1}$
0	0	$Q_t$	$\overline{Q}_t$
0	1	0	1
1	0	1	0
1	1	0	0

Mantiene

Reset

Set

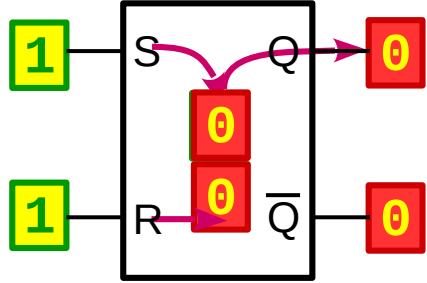
Prohibido



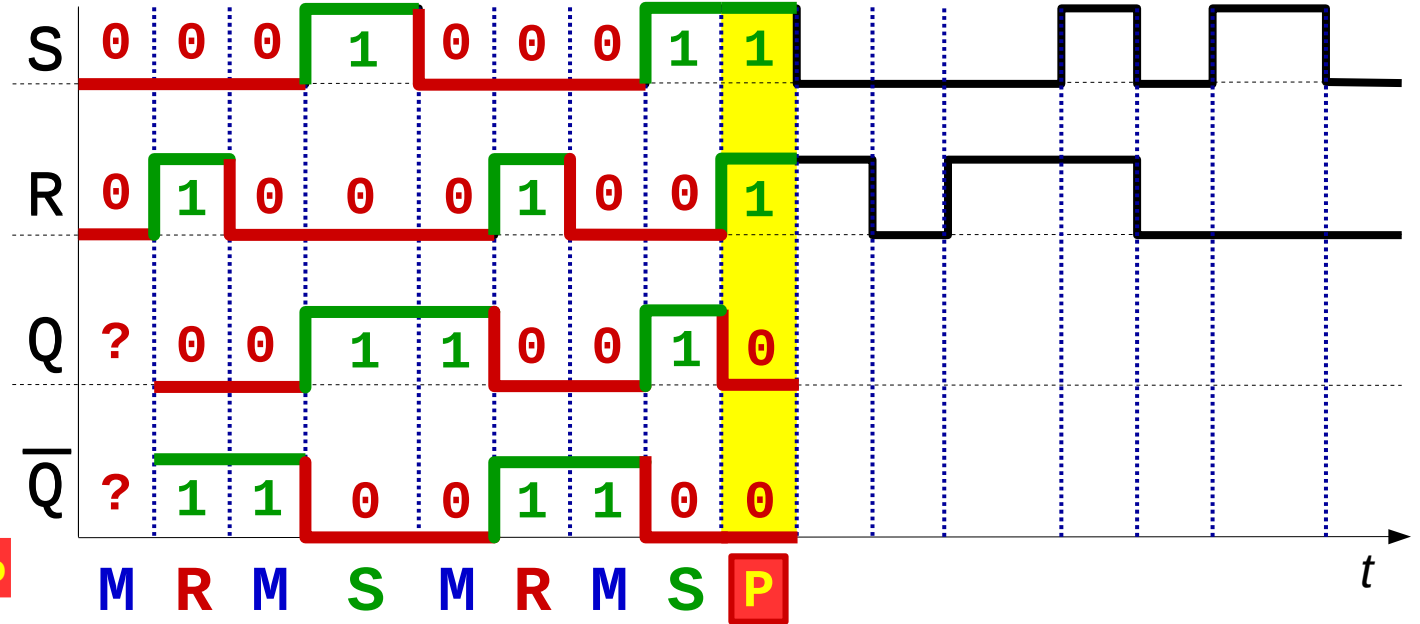


# Biastable S-R asíncrono

## Cronograma

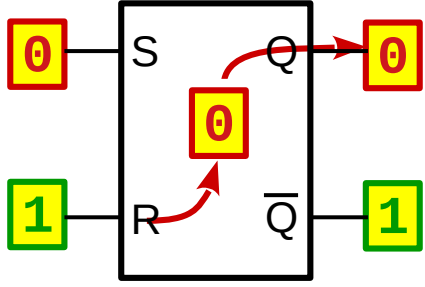


S	R	$Q_{t+1}$	$\overline{Q}_{t+1}$	
0	0	$Q_t$	$\overline{Q}_t$	Mantiene
0	1	0	1	Reset
1	0	1	0	Set
1	1	0	0	Prohibido



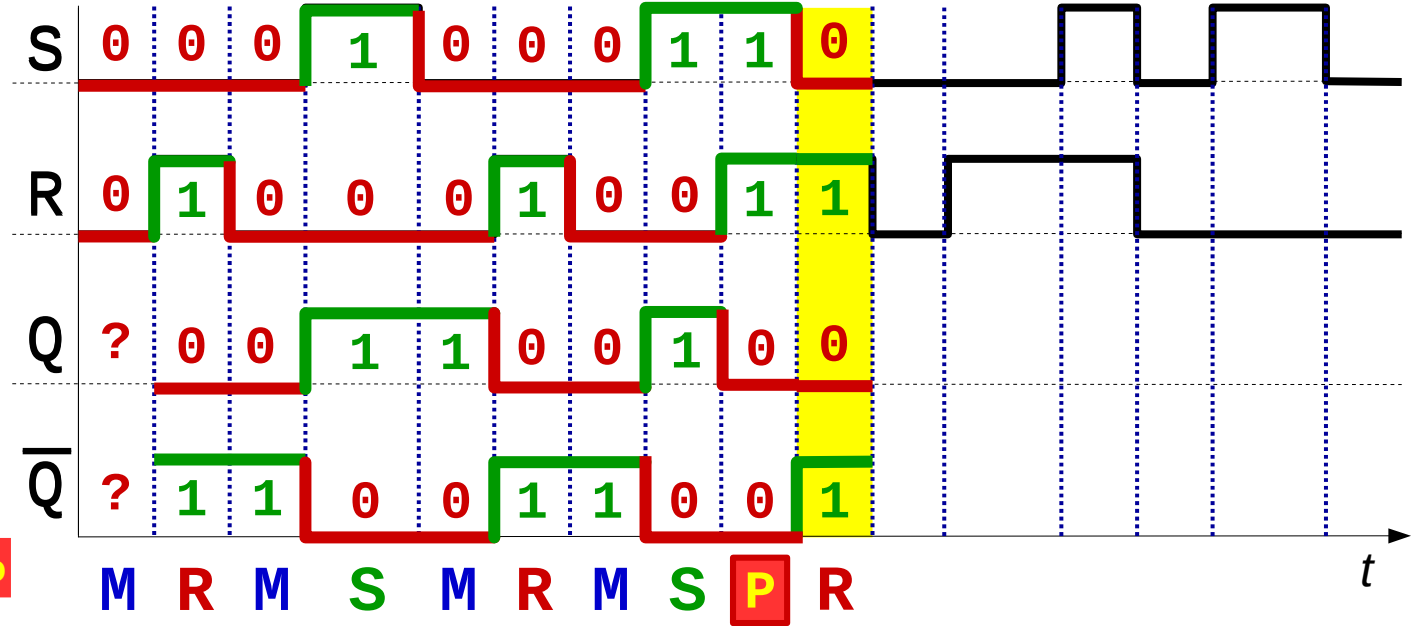
# Biestable S-R asíncrono

## Cronograma



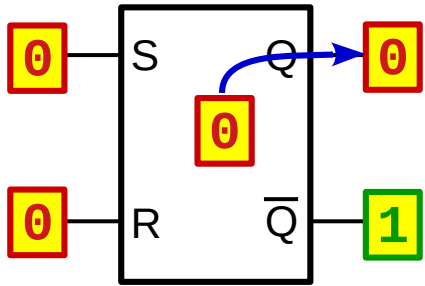
S	R	$Q_{t+1}$	$\overline{Q}_{t+1}$
0	0	$Q_t$	$\overline{Q}_t$
0	1	0	1
1	0	1	0
1	1	0	0

Mantiene  
 Reset  
 Set  
 Prohibido



# Biastable S-R asíncrono

## Cronograma



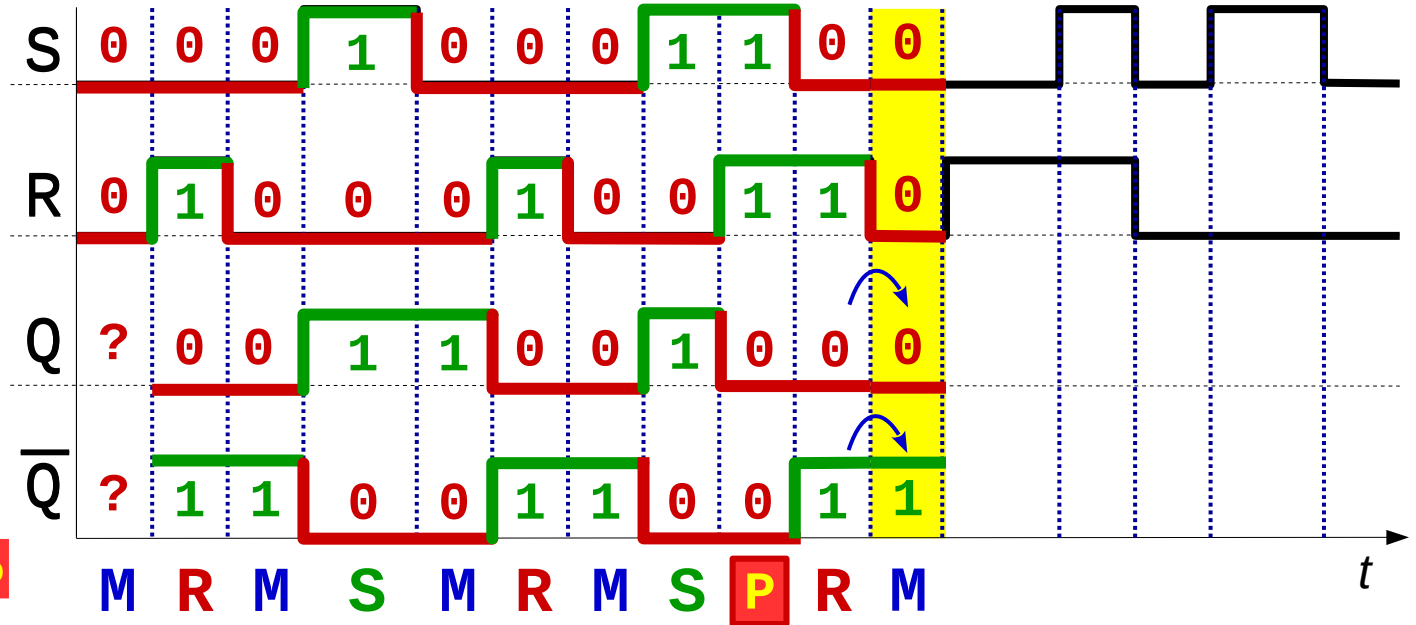
S	R	$Q_{t+1}$	$\overline{Q}_{t+1}$
0	0	$Q_t$	$\overline{Q}_t$
0	1	0	1
1	0	1	0
1	1	0	0

Mantiene

Reset

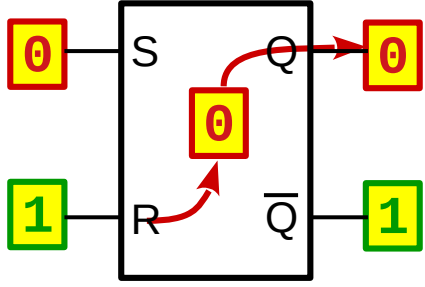
Set

Prohibido



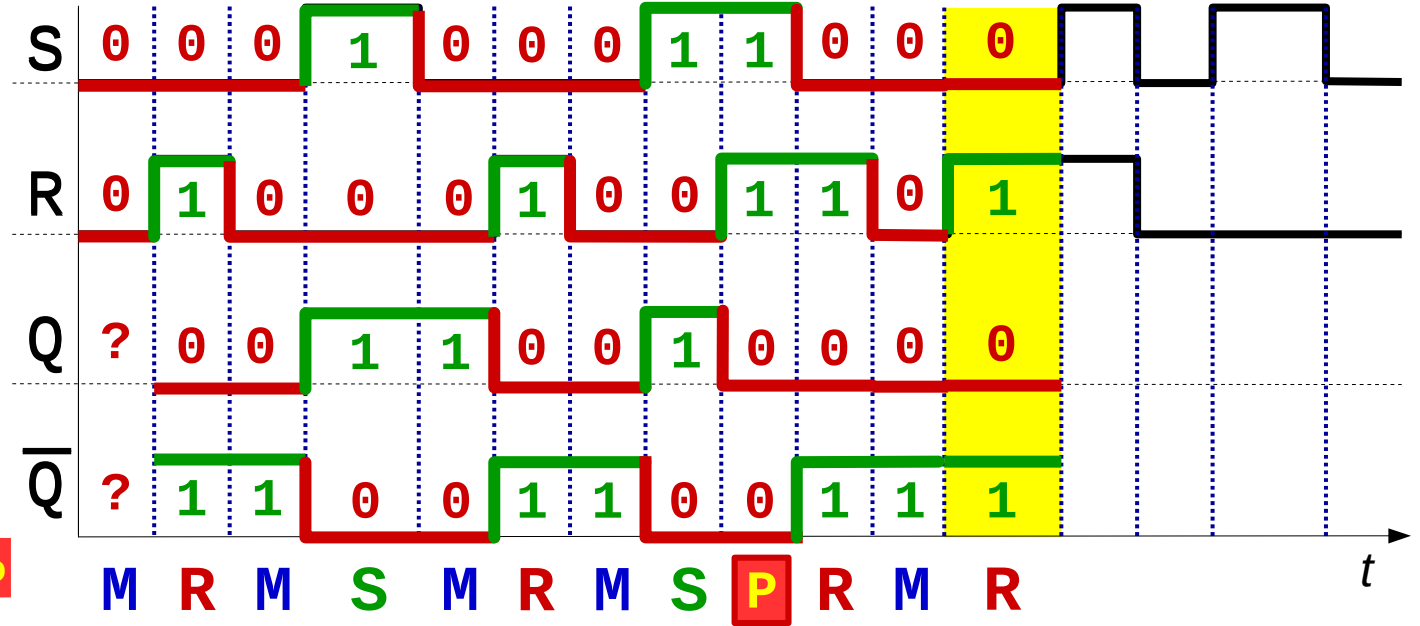
# Biastable S-R asíncrono

## Cronograma



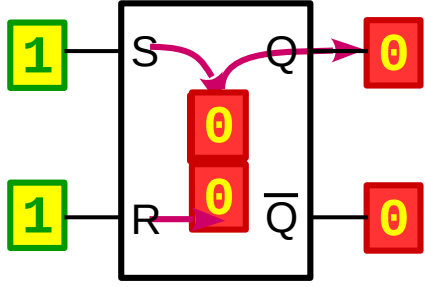
S	R	$Q_{t+1}$	$\overline{Q}_{t+1}$
0	0	$Q_t$	$\overline{Q}_t$
0	1	0	1
1	0	1	0
1	1	0	0

Mantiene  
 Reset  
 Set  
 Prohibido



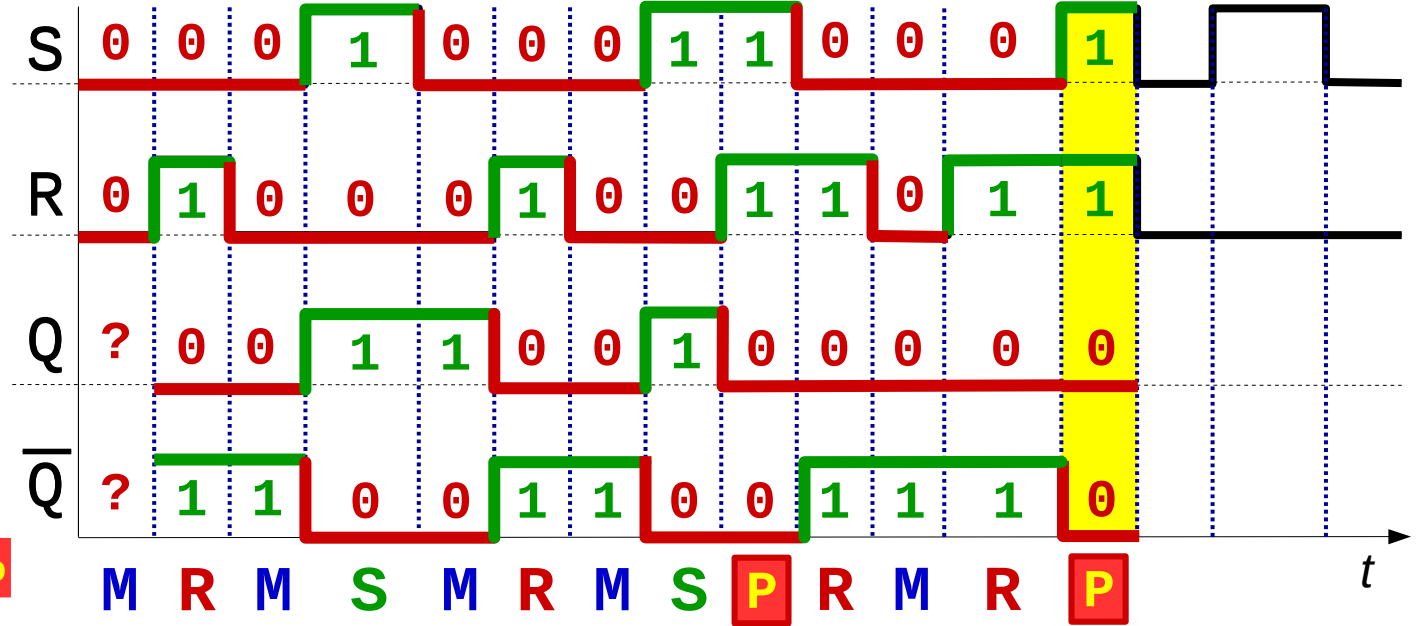
# Biastable S-R asíncrono

## Cronograma



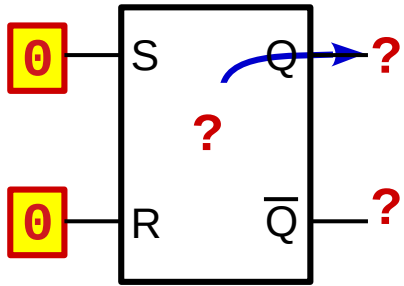
S	R	$Q_{t+1}$	$\overline{Q}_{t+1}$
0	0	$Q_t$	$\overline{Q}_t$
0	1	0	1
1	0	1	0
1	1	0	0

Mantiene  
 Reset  
 Set  
 Prohibido



# Biestable S-R asíncrono

## Cronograma



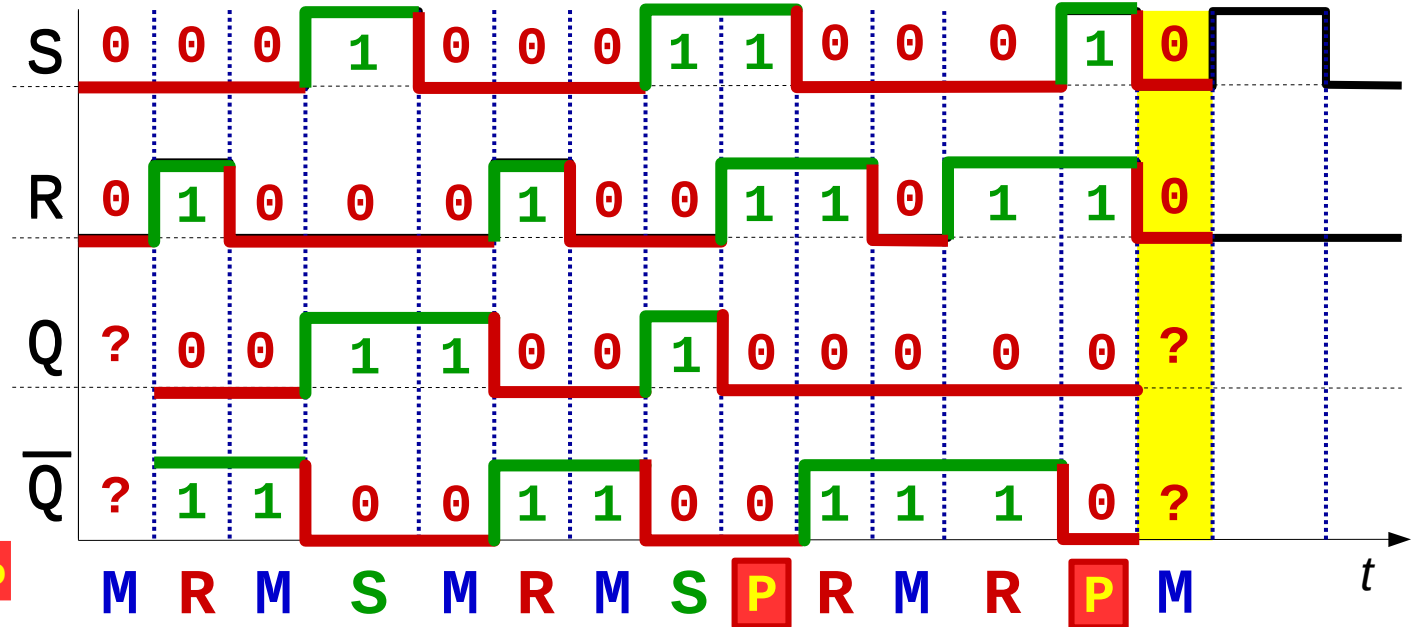
S	R	$Q_{t+1}$	$\overline{Q}_{t+1}$
0	0	$Q_t$	$\overline{Q}_t$
0	1	0	1
1	0	1	0
1	1	0	0

Mantiene

Reset

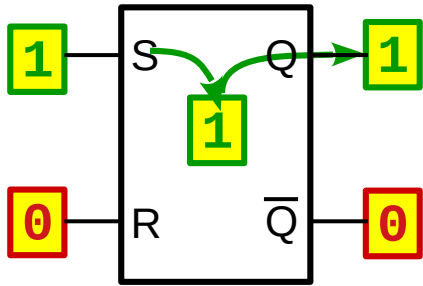
Set

Prohibido



# Biastable S-R asíncrono

## Cronograma



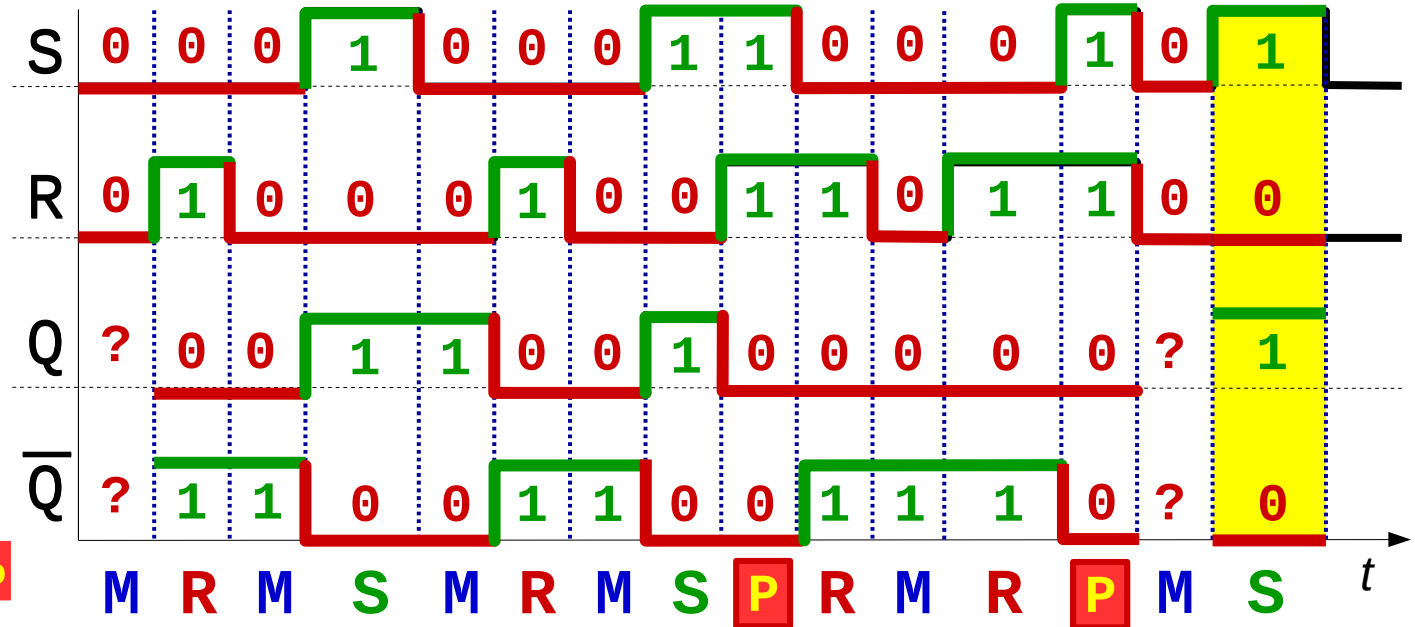
S	R	$Q_{t+1}$	$\overline{Q}_{t+1}$
0	0	$Q_t$	$\overline{Q}_t$
0	1	0	1
1	0	1	0
1	1	0	0

Mantiene

Reset

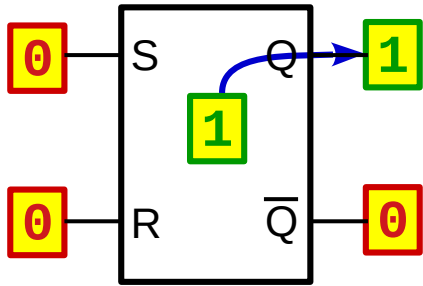
Set

Prohibido



# Biestable S-R asíncrono

## Cronograma



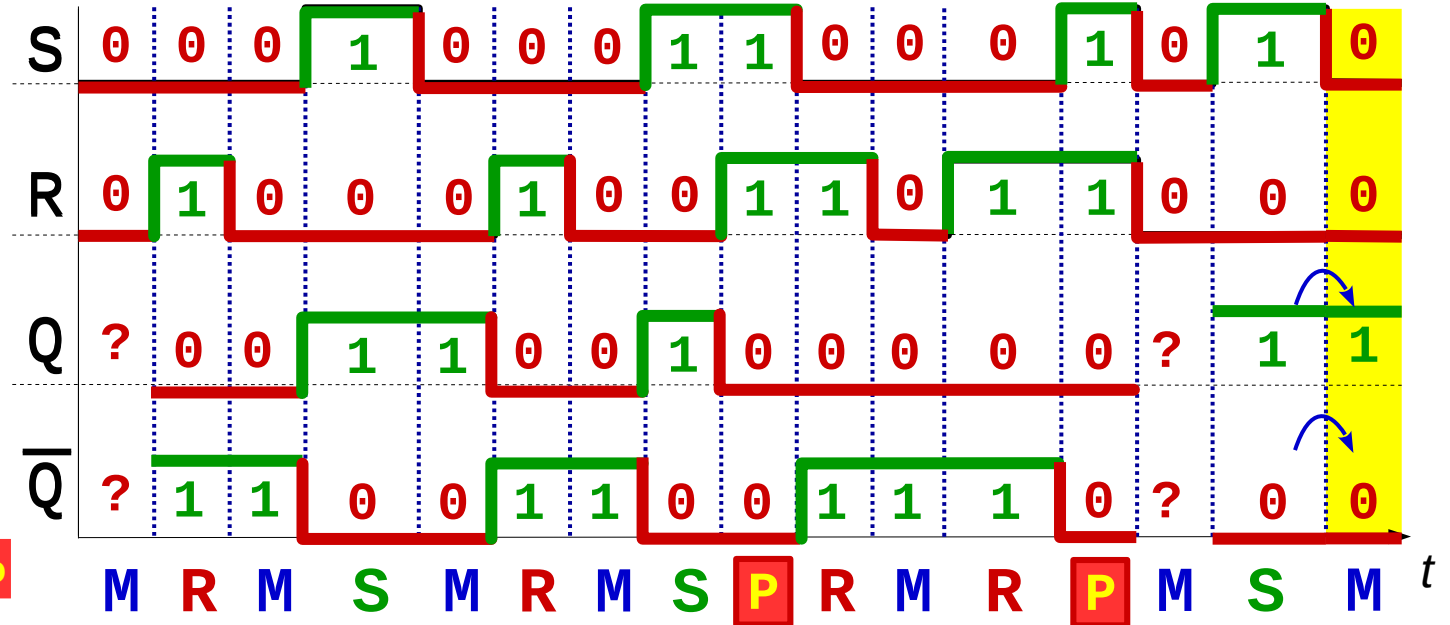
S	R	$Q_{t+1}$	$\overline{Q}_{t+1}$
0	0	$Q_t$	$\overline{Q}_t$
0	1	0	1
1	0	1	0
1	1	0	0

Mantiene

Reset

Set

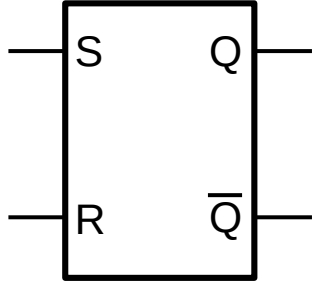
Prohibido





# Biastable S-R asíncrono

## Cronograma



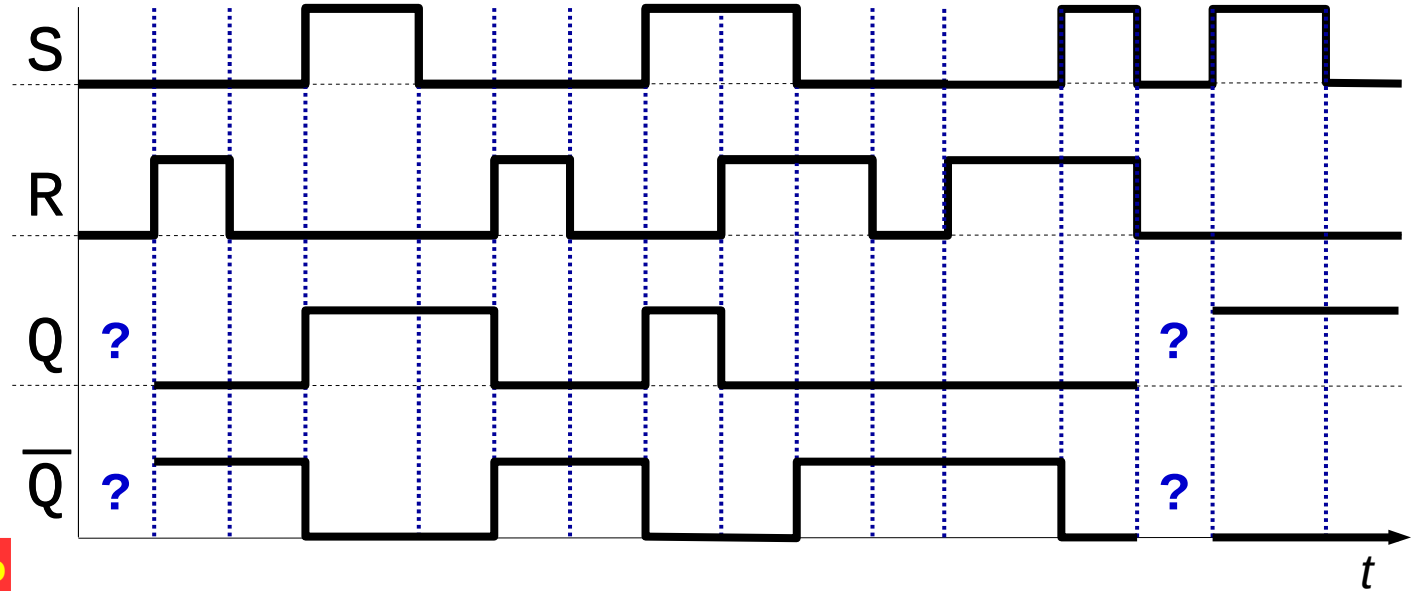
S	R	$Q_{t+1}$	$\overline{Q}_{t+1}$
0	0	$Q_t$	$\overline{Q}_t$
0	1	0	1
1	0	1	0
1	1	0	0

Mantiene

Reset

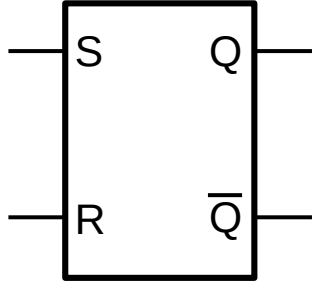
Set

Prohibido



# Biastable S-R asíncrono

## Cronograma



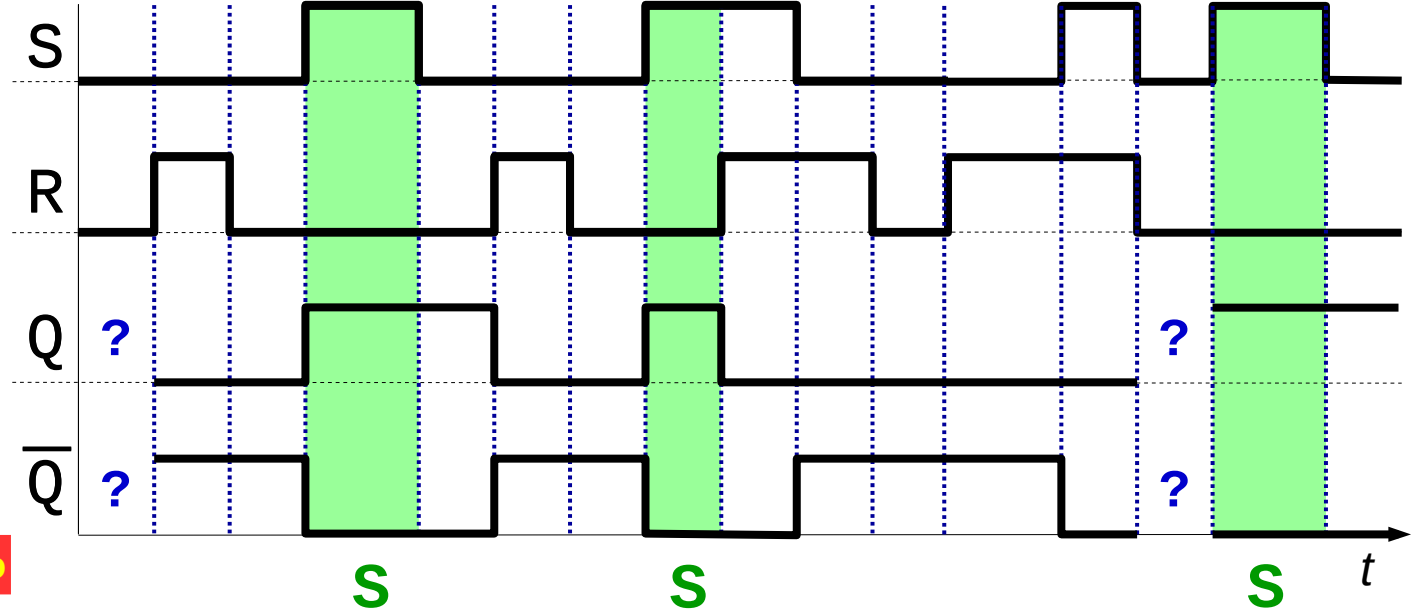
S	R	$Q_{t+1}$	$\overline{Q}_{t+1}$
0	0	$Q_t$	$\overline{Q}_t$
0	1	0	1
1	0	1	0
1	1	0	0

Mantiene

Reset

Set

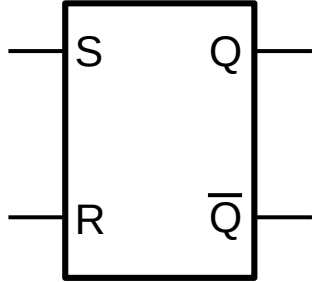
Prohibido



asíncrono

# Biastable S-R asíncrono

## Cronograma



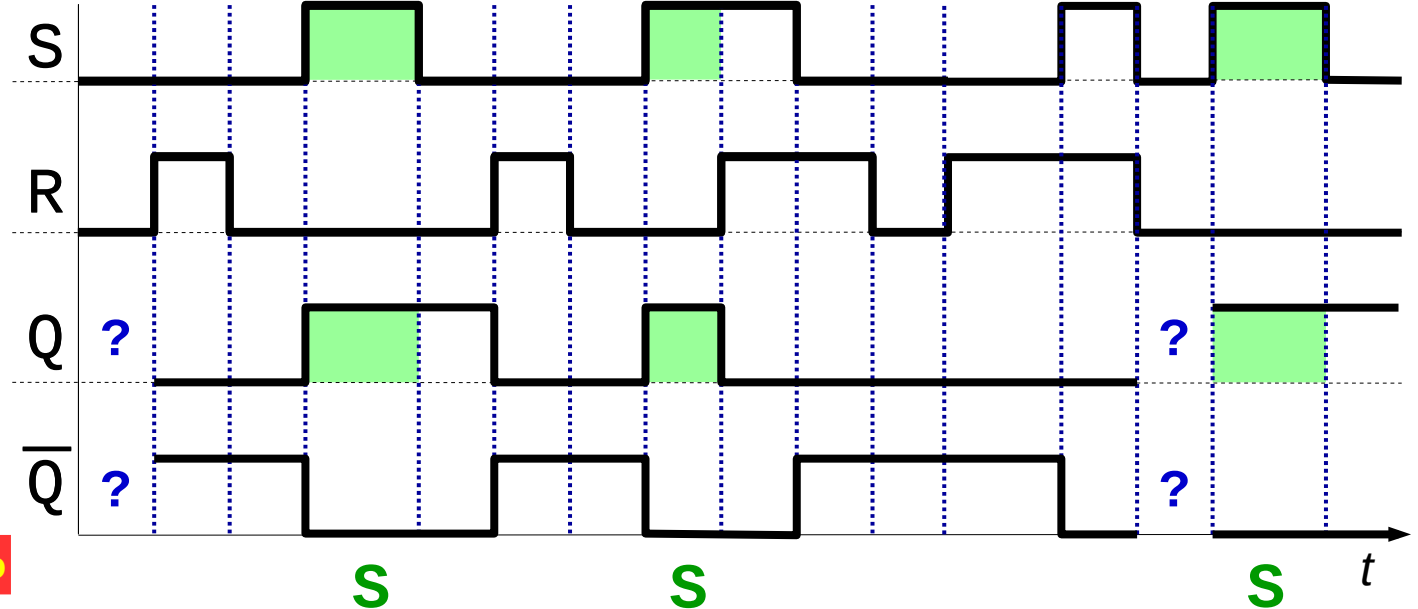
S	R	$Q_{t+1}$	$\overline{Q}_{t+1}$
0	0	$Q_t$	$\overline{Q}_t$
0	1	0	1
1	0	1	0
1	1	0	0

Mantiene

Reset

Set

Prohibido

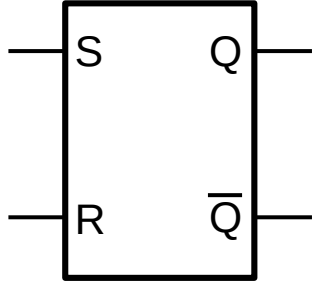


asíncrono

En cualquier instante, cambios en las entradas pueden modificar el estado

# Biastable S-R asíncrono

## Cronograma



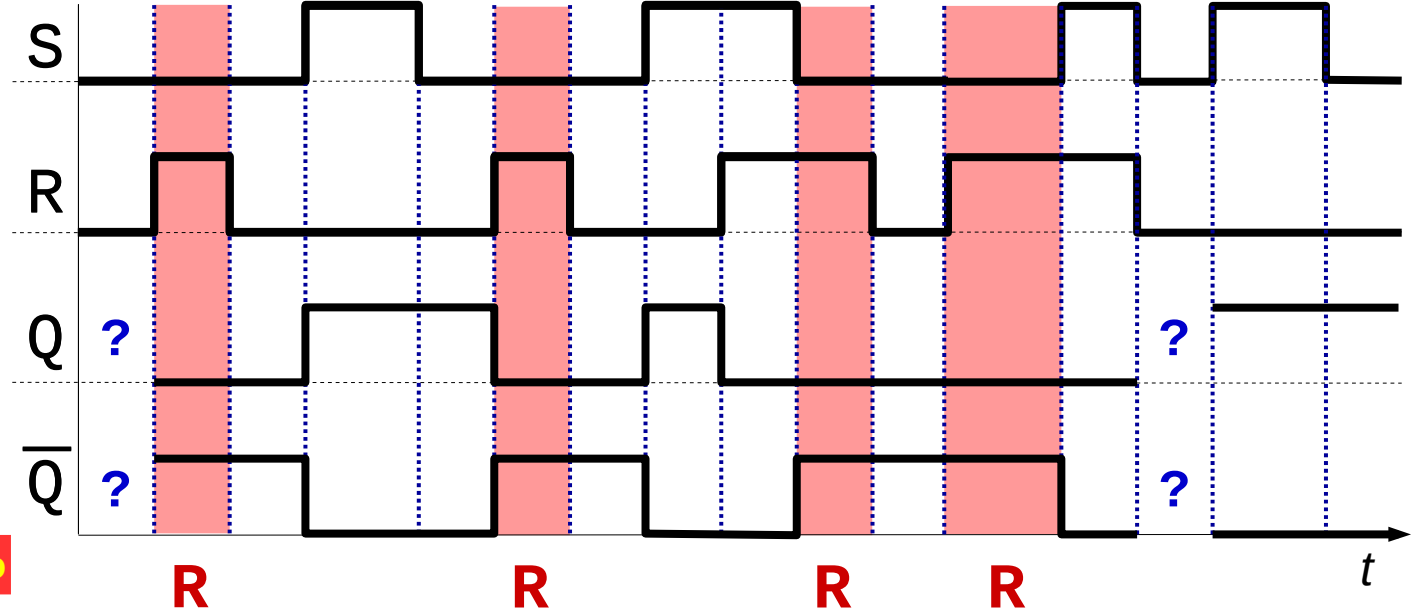
S	R	$Q_{t+1}$	$\overline{Q}_{t+1}$
0	0	$Q_t$	$\overline{Q}_t$
0	1	0	1
1	0	1	0
1	1	0	0

Mantiene

Reset

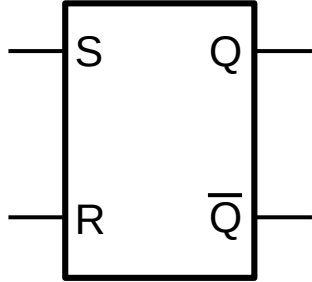
Set

Prohibido



# Biastable S-R asíncrono

## Cronograma



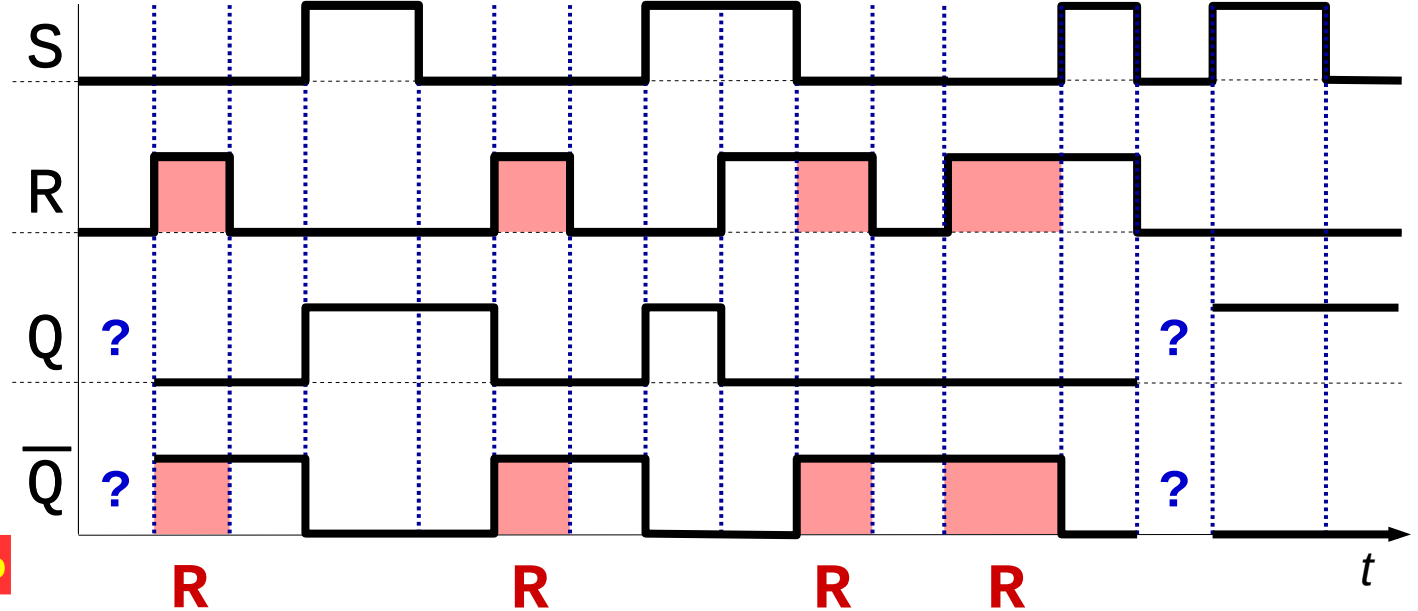
S	R	$Q_{t+1}$	$\overline{Q}_{t+1}$
0	0	$Q_t$	$\overline{Q}_t$
0	1	0	1
1	0	1	0
1	1	0	0

Mantiene

Reset

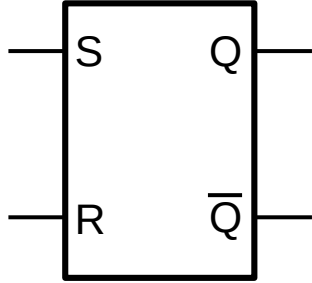
Set

Prohibido



# Biastable S-R asíncrono

## Cronograma



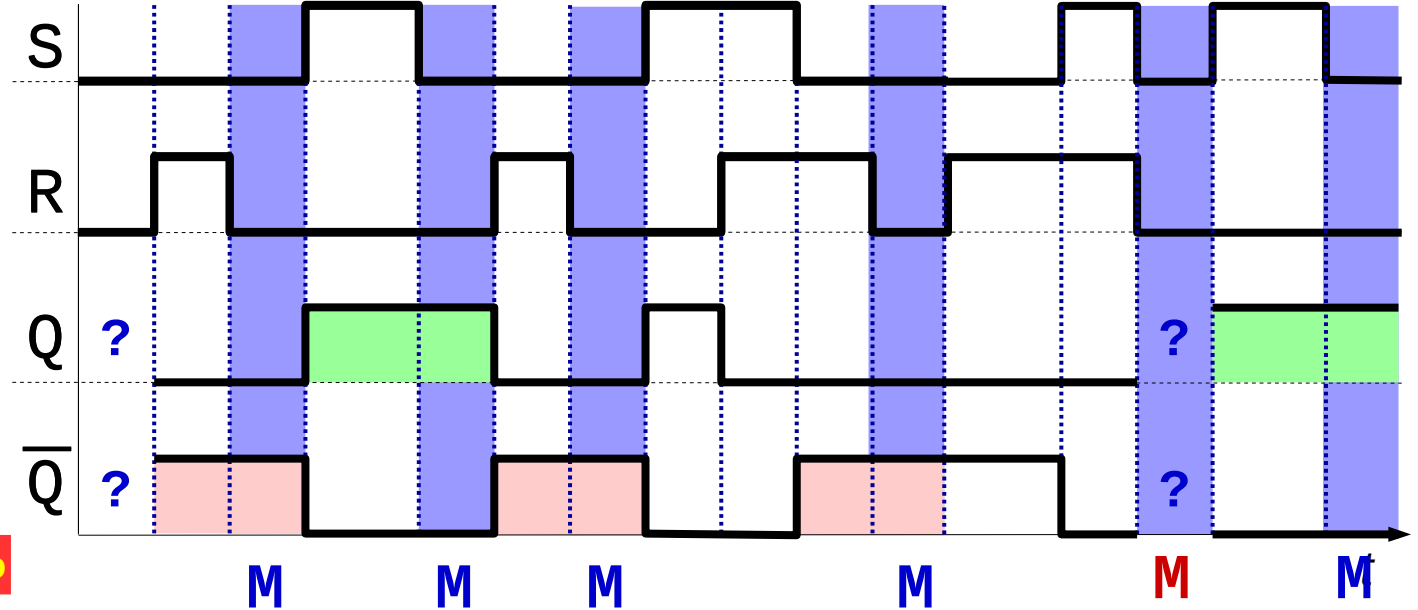
S	R	$Q_{t+1}$	$\overline{Q}_{t+1}$
0	0	$Q_t$	$\overline{Q}_t$
0	1	0	1
1	0	1	0
1	1	0	0

Mantiene

Reset

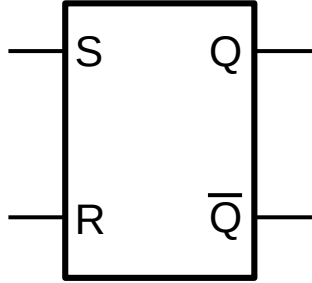
Set

Prohibido



# Biastable S-R asíncrono

## Cronograma



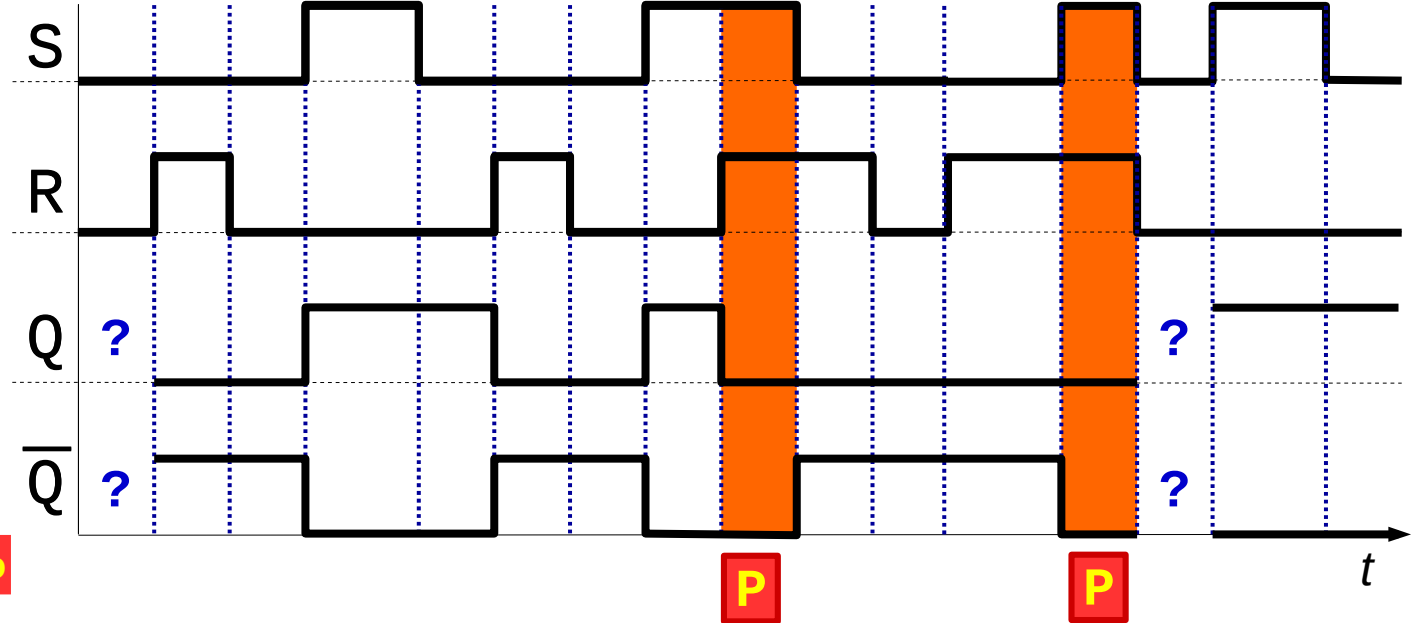
S	R	$Q_{t+1}$	$\overline{Q}_{t+1}$
0	0	$Q_t$	$\overline{Q}_t$
0	1	0	1
1	0	1	0
1	1	0	0

Mantiene

Reset

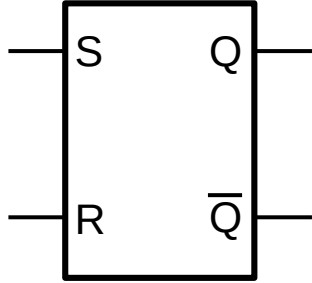
Set

Prohibido



# Biastable S-R asíncrono

## Cronograma



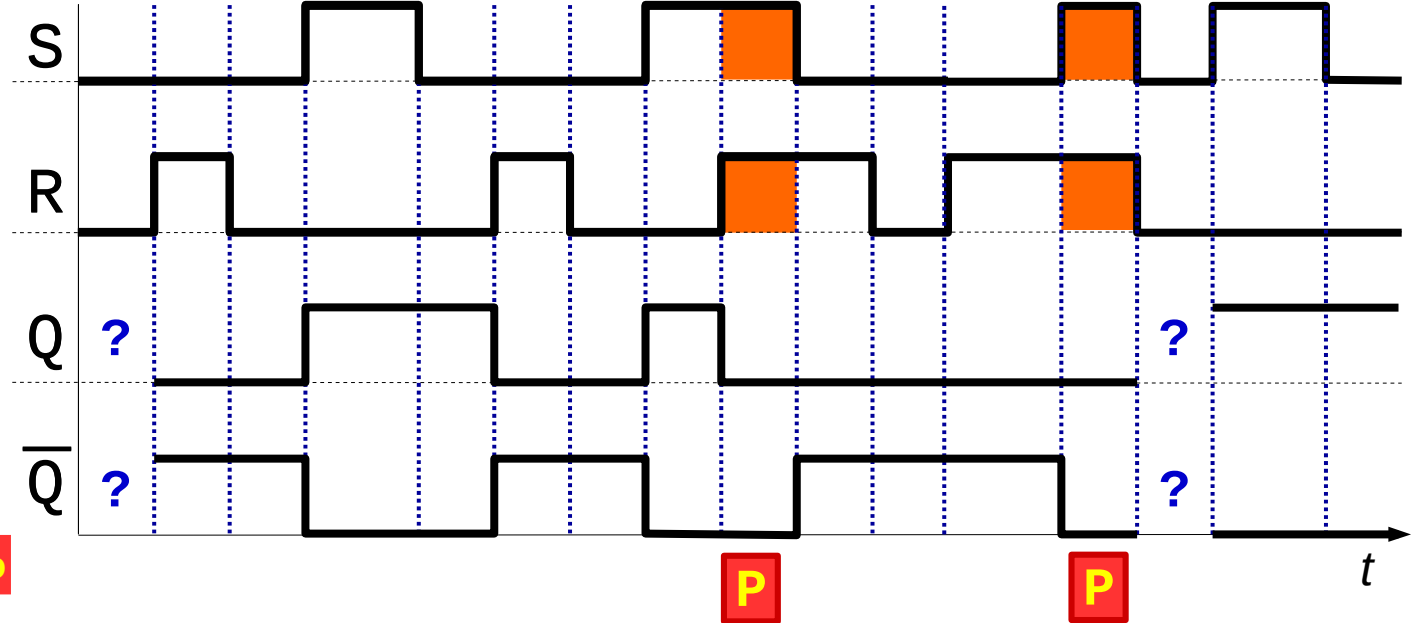
S	R	$Q_{t+1}$	$\overline{Q}_{t+1}$
0	0	$Q_t$	$\overline{Q}_t$
0	1	0	1
1	0	1	0
1	1	0	0

Mantiene

Reset

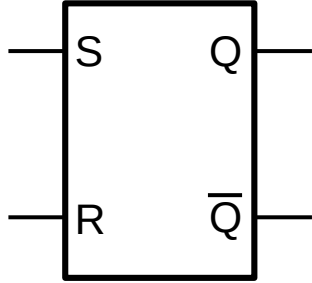
Set

Prohibido

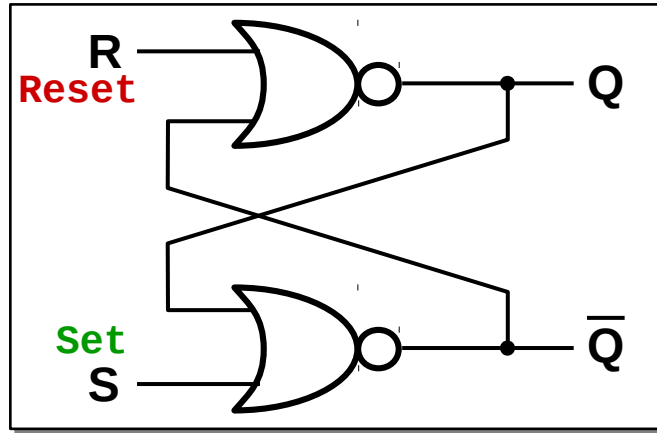




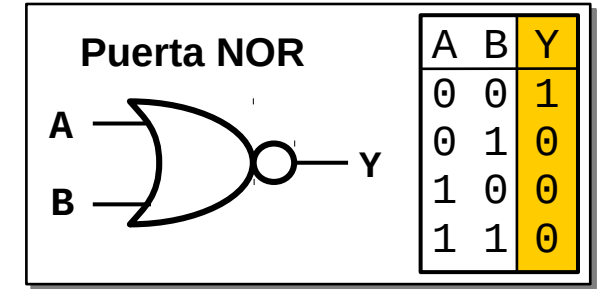
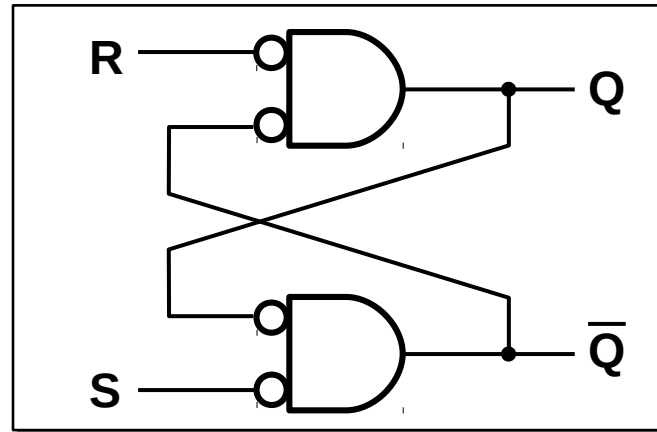
# Biastable S-R asíncrono



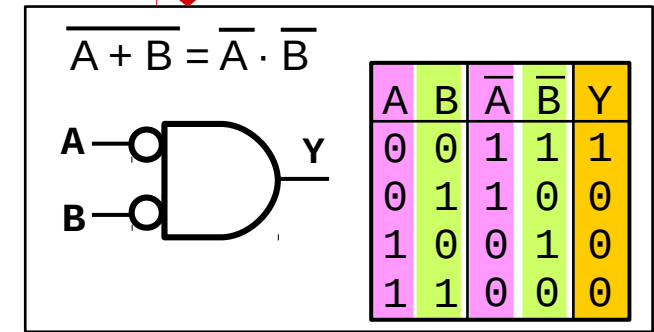
S	R	$Q_{t+1}$	$\overline{Q}_{t+1}$
0	0	$Q_t$	$\overline{Q}_t$
0	1	0	1
1	0	1	0
1	1	0	0



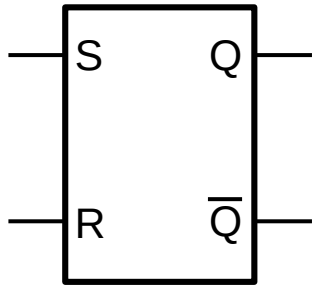
↴ equivalente



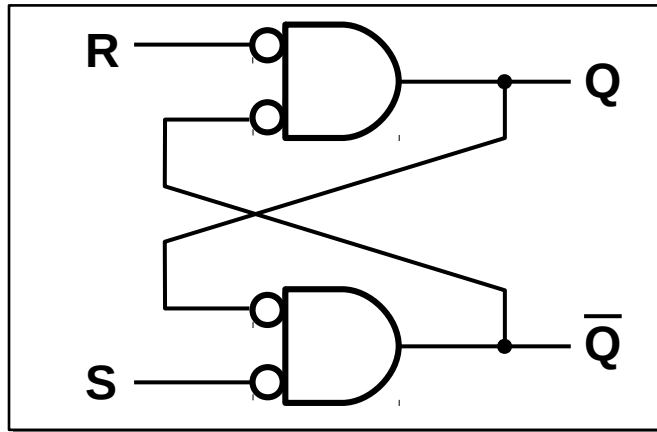
↴ equivalente



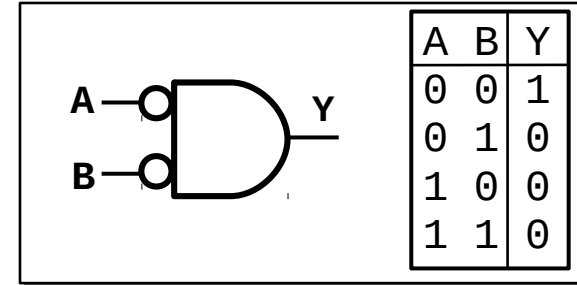
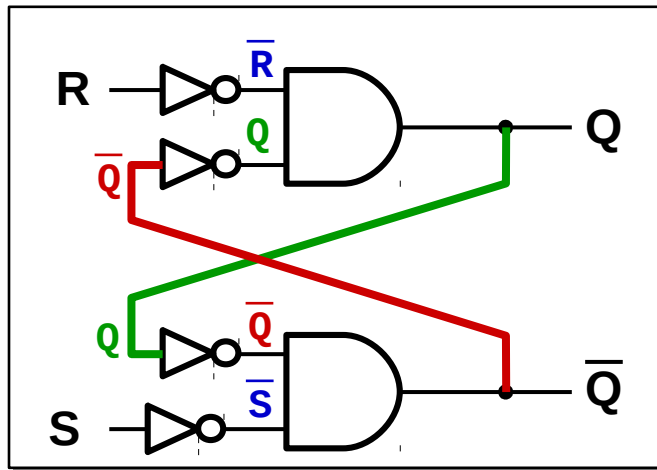
# Biastable S-R asíncrono



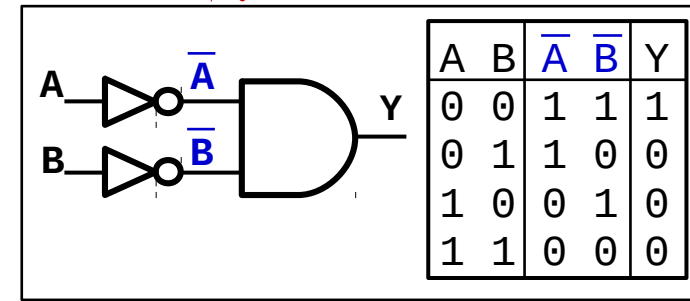
S	R	$Q_{t+1}$	$\overline{Q}_{t+1}$
0	0	$Q_t$	$\overline{Q}_t$
0	1	0	1
1	0	1	0
1	1	0	0



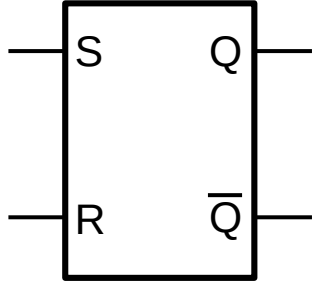
↴ equivalente



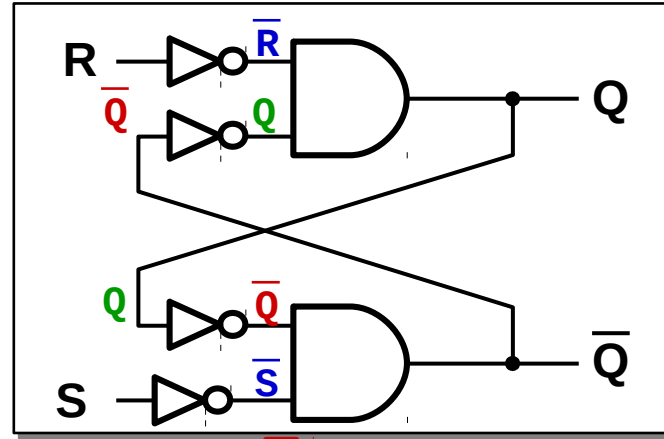
↴ equivalente



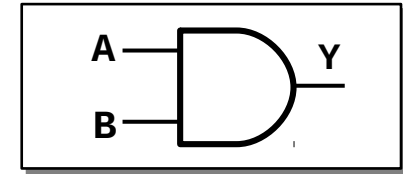
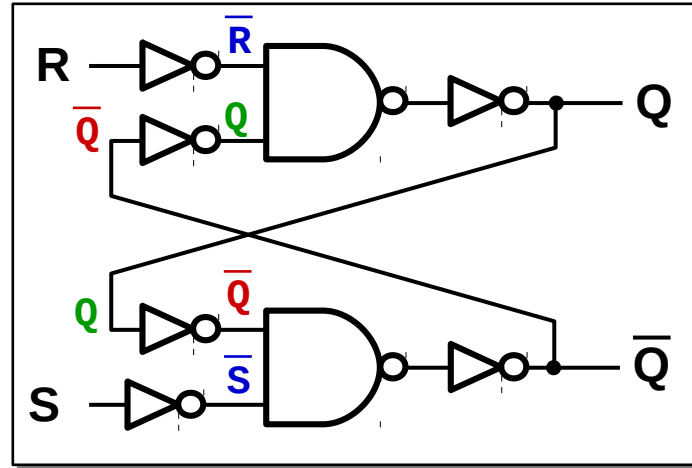
# Bistable S-R asíncrono



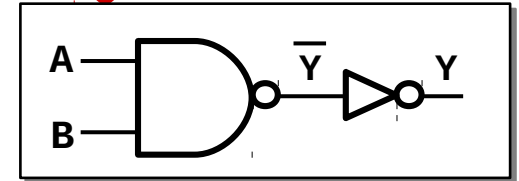
S	R	$Q_{t+1}$	$\overline{Q}_{t+1}$
0	0	$Q_t$	$\overline{Q}_t$
0	1	0	1
1	0	1	0
1	1	0	0



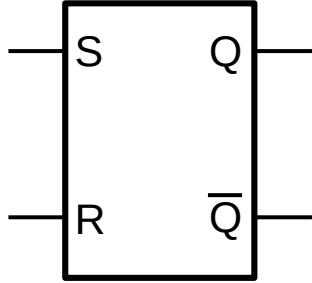
↴ equivalente



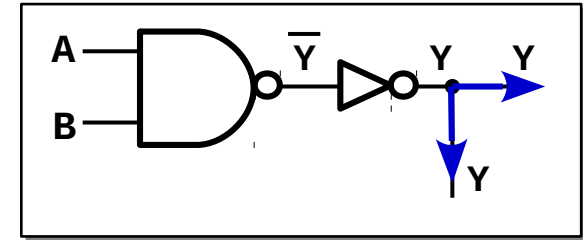
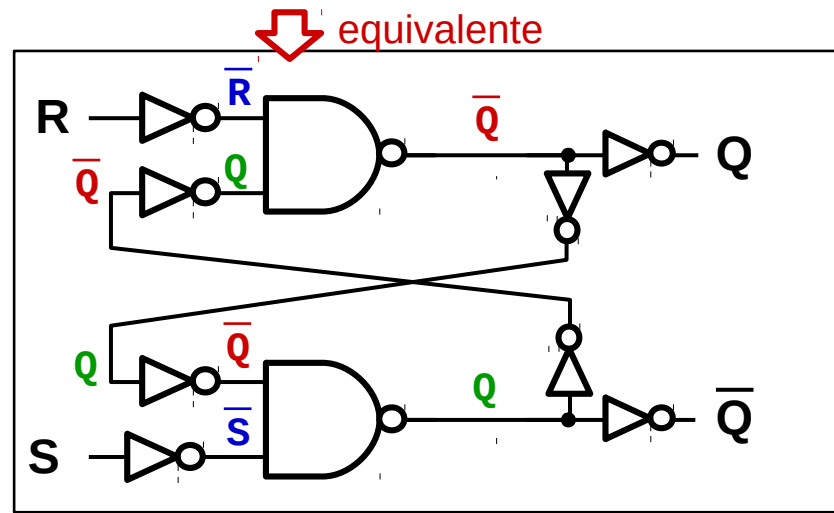
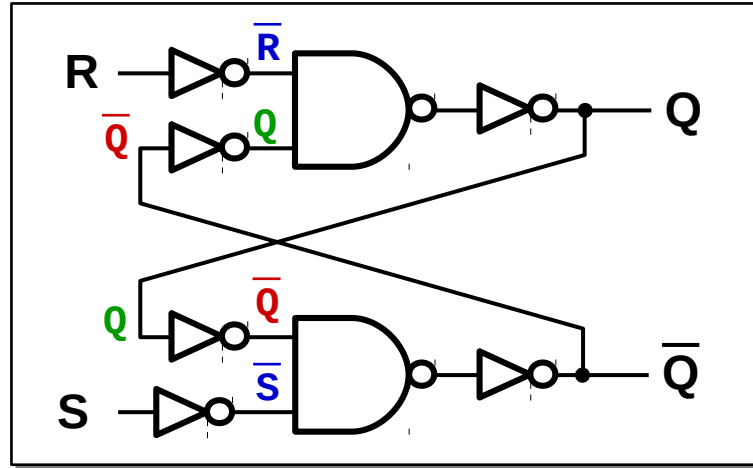
↴ equivalente



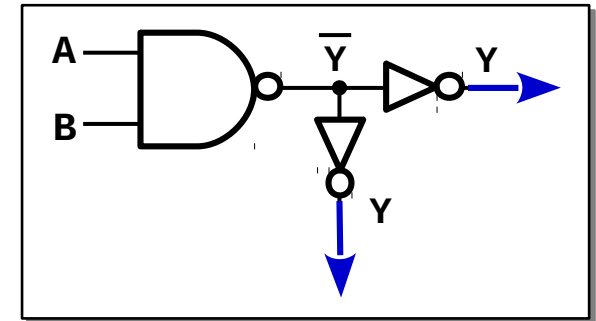
# Biastable S-R asíncrono



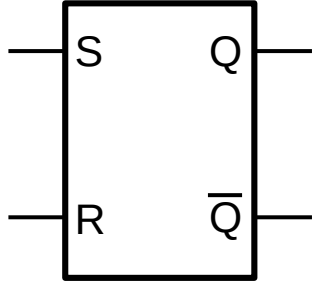
S	R	$Q_{t+1}$	$\overline{Q}_{t+1}$
0	0	$Q_t$	$\overline{Q}_t$
0	1	0	1
1	0	1	0
1	1	0	0



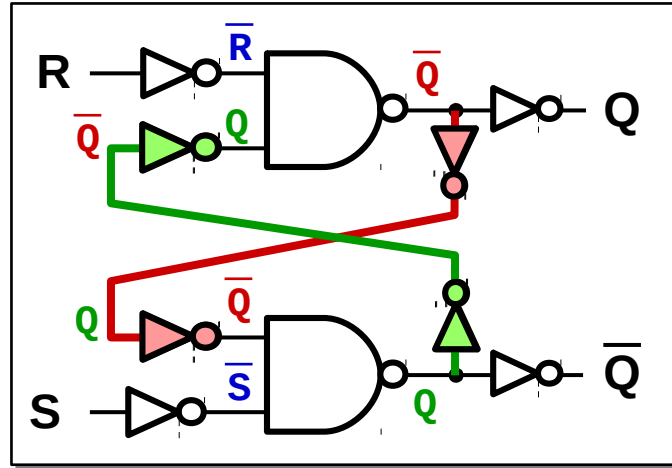
↴ equivalente



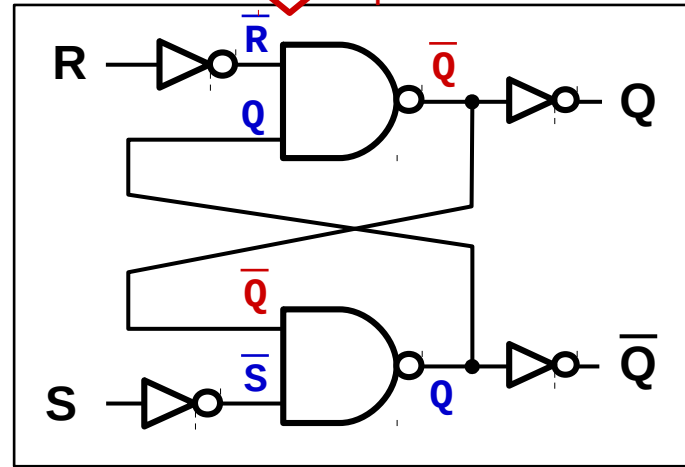
# Bistable S-R asíncrono



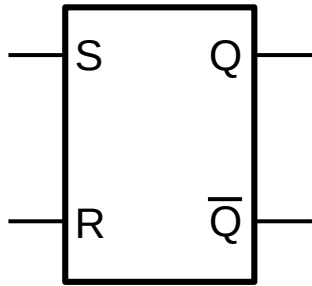
S	R	$Q_{t+1}$	$\overline{Q}_{t+1}$
0	0	$Q_t$	$\overline{Q}_t$
0	1	0	1
1	0	1	0
1	1	0	0



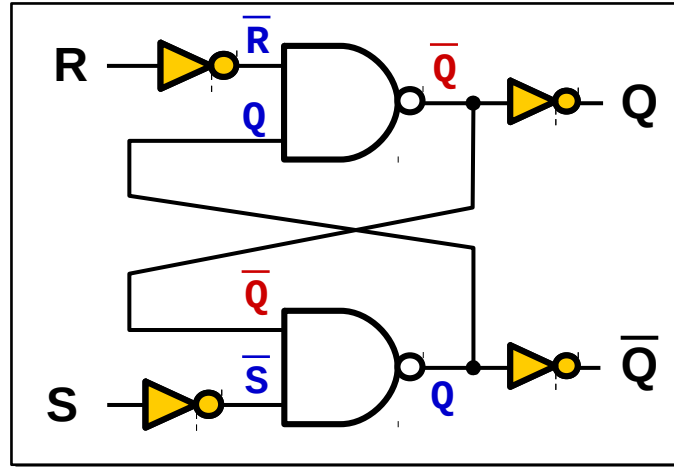
↴ equivalente



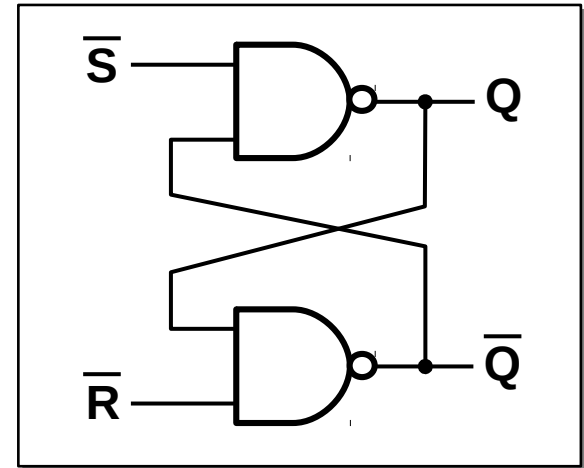
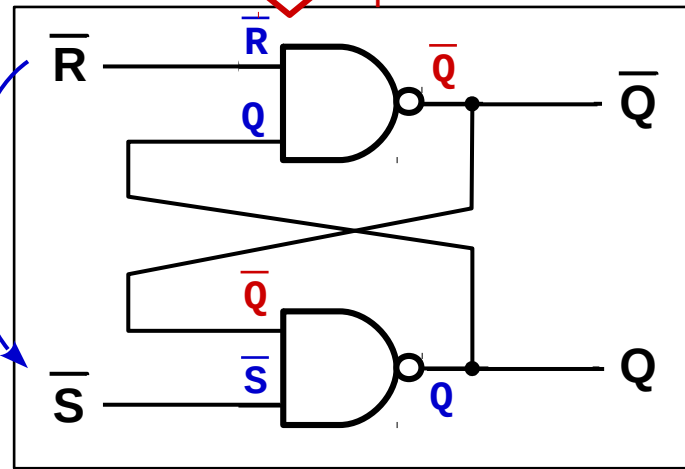
# Bistable S-R asíncrono



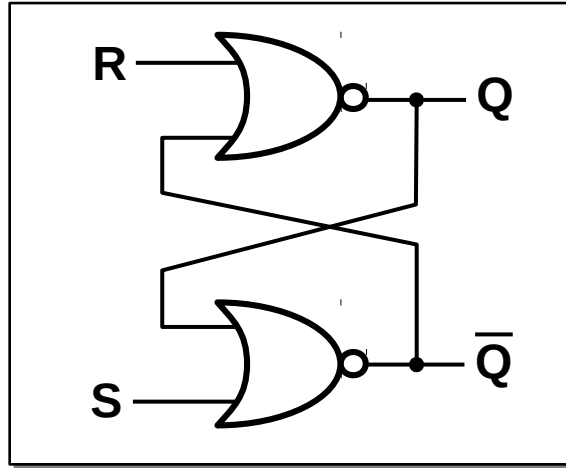
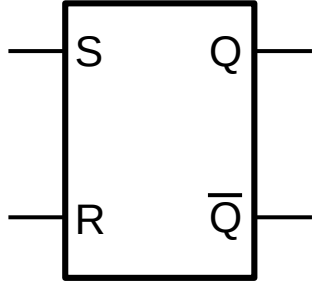
S	R	$Q_{t+1}$	$\overline{Q}_{t+1}$
0	0	$Q_t$	$\overline{Q}_t$
0	1	0	1
1	0	1	0
1	1	0	0



equivalente



# Biestable S-R asíncrono con puertas NAND



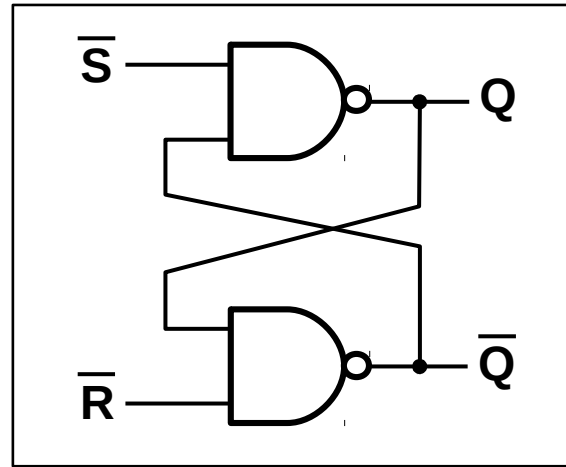
S	R	$Q_{t+1}$	$\overline{Q_{t+1}}$
0	0	$Q_t$	$\overline{Q_t}$
0	1	0	1
1	0	1	0
1	1	0	0

Mantiene

Reset

Set

Prohibido



S	R	$\overline{S}$	$\overline{R}$	$Q_{t+1}$	$\overline{Q_{t+1}}$
0	0	1	1	$Q_t$	$\overline{Q_t}$
0	1	1	0	0	1
1	0	0	1	1	0
1	1	0	0	0	0

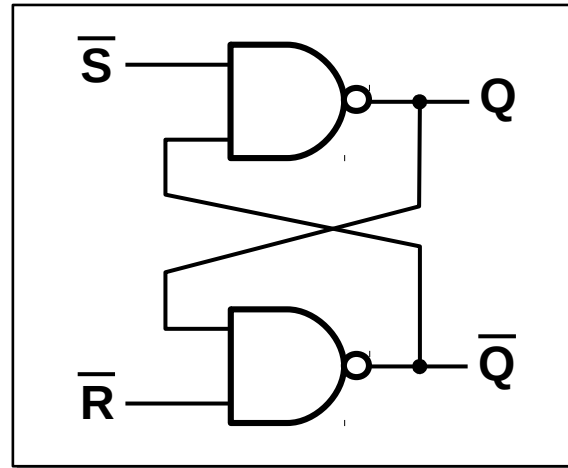
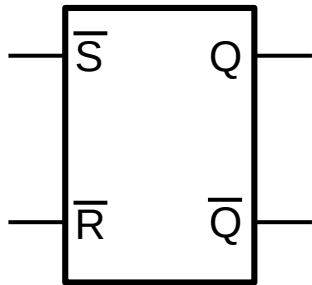
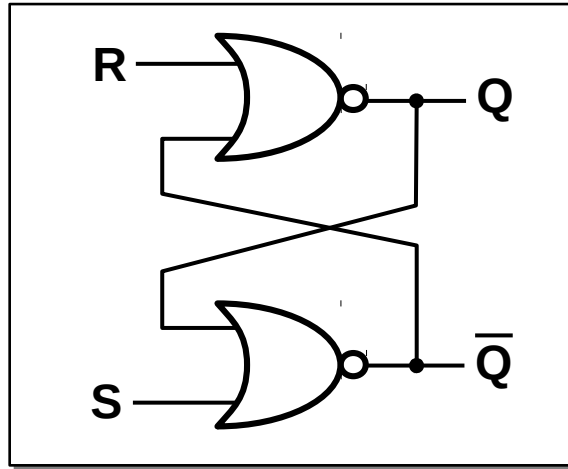
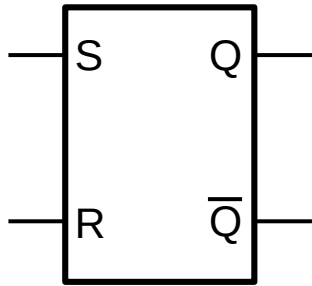
Mantiene

Reset

Set

Prohibido

# Biestable S-R asíncrono con puertas NAND



S	R	$Q_{t+1}$	$\overline{Q}_{t+1}$
0	0	$Q_t$	$\overline{Q}_t$
0	1	0	1
1	0	1	0
1	1	0	0

Mantiene

Reset

Set

Prohibido

Activas a nivel bajo

$\overline{S}$	$\overline{R}$	$Q_{t+1}$	$\overline{Q}_{t+1}$
1	1	$Q_t$	$\overline{Q}_t$
1	0	0	1
0	1	1	0
0	0	0	0

Mantiene

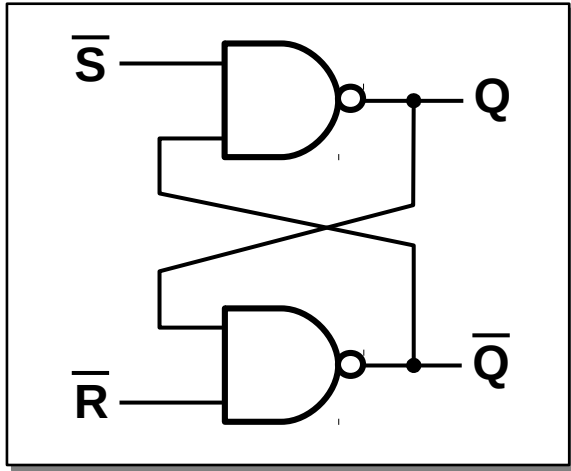
Reset

Set

Prohibido

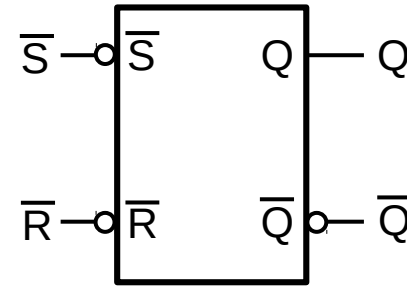
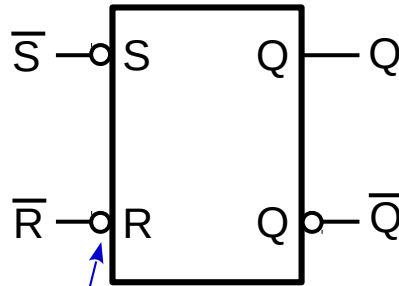
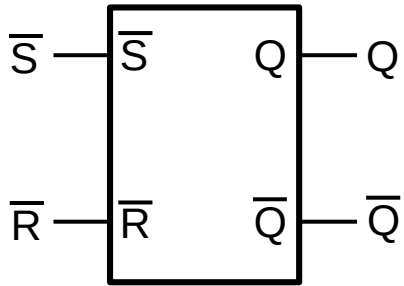


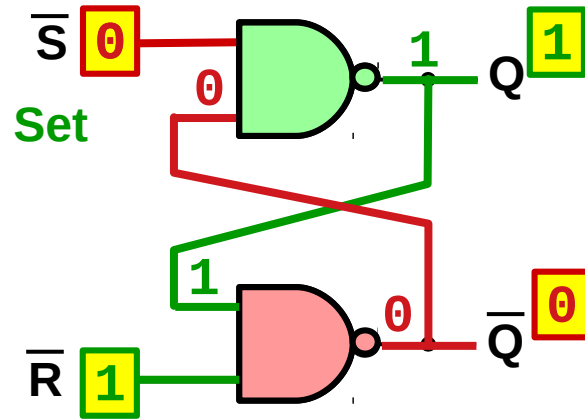
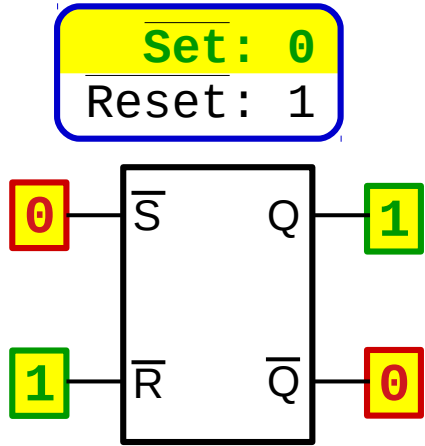
# Biestable S-R asíncrono con puertas NAND



$\bar{S}$	$\bar{R}$	$Q_{t+1}$	$\bar{Q}_{t+1}$	
1	1	$Q_t$	$\bar{Q}_t$	Mantiene
1	0	0	1	Reset
0	1	1	0	Set
0	0	0	0	Prohibido

Otras posibles representaciones





Puerta NAND

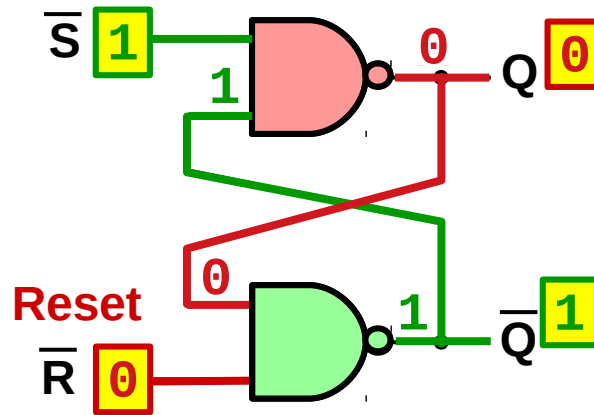
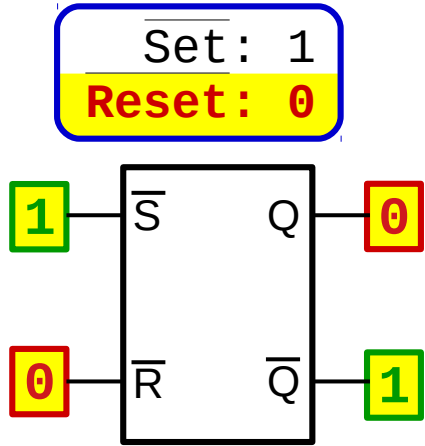
A	B	Y
0	0	1
0	1	1
1	0	1
1	1	0

$\bar{S}$	$\bar{R}$	$Q_t$	$Q_{t+1}$	$\bar{Q}_{t+1}$
0	1	X	1	0

Set

# Biestable S-R asíncrono con puertas NAND

## Transiciones



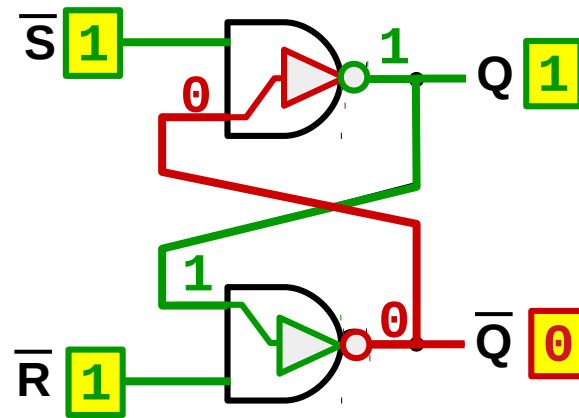
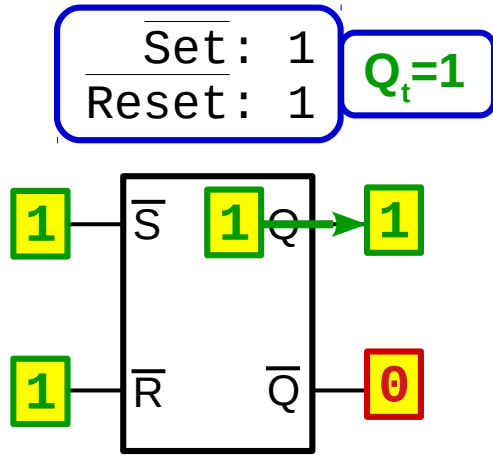
Puerta NAND

A	B	Y
0	0	1
0	1	1
1	0	1
1	1	0

$\bar{S}$	$\bar{R}$	$Q_t$	$Q_{t+1}$	$\bar{Q}_{t+1}$	
0	1	X	1	0	Set
1	0	X	0	1	Reset

# Biestable S-R asíncrono con puertas NAND

## Transiciones



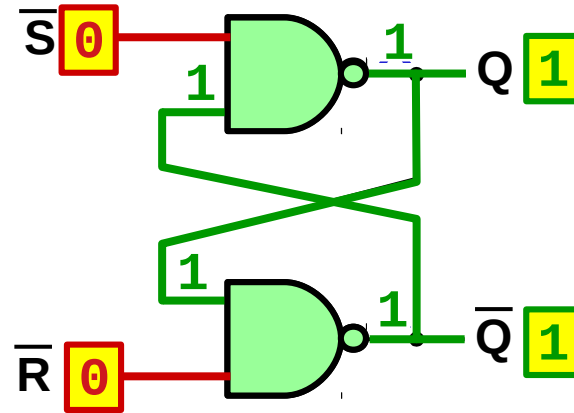
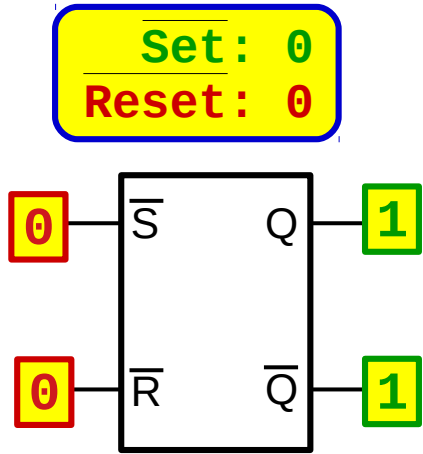
Puerta NAND

A	B	Y
0	0	1
0	1	1
1	0	1
1	1	0

$\bar{S}$	$\bar{R}$	$Q_t$	$Q_{t+1}$	$\bar{Q}_{t+1}$	
0	1	X	1	0	Set
1	0	X	0	1	Reset
1	1	1	1	0	Mantiene

# Biestable S-R asíncrono con puertas NAND

## Transiciones

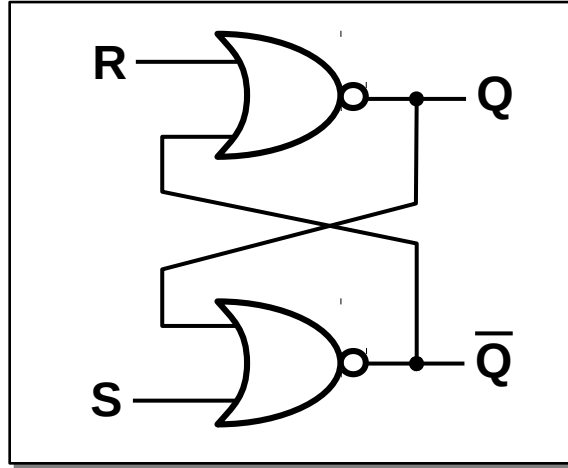
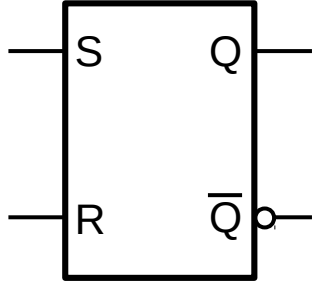


**Puerta NAND**

A	B	Y
0	0	1
0	1	1
1	0	1
1	1	0

$\bar{S}$	$\bar{R}$	$Q_t$	$Q_{t+1}$	$\bar{Q}_{t+1}$	
0	1	X	1	0	Set
1	0	X	0	1	Reset
1	1	$Q_t$	$Q_t$	$\bar{Q}_t$	Mantiene
0	0	X	1	1	Prohibido

# Biastable S-R asíncrono



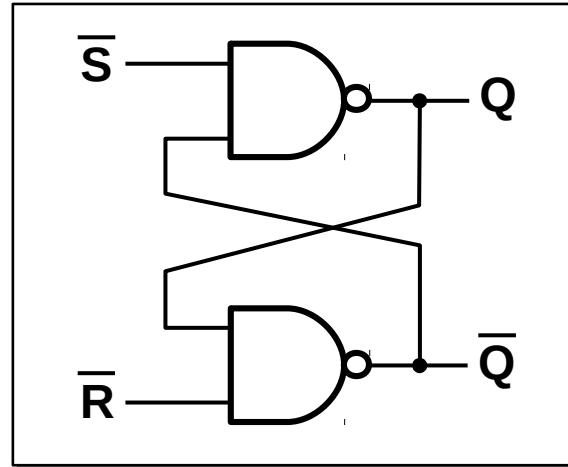
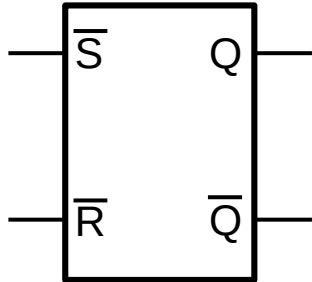
S	R	$Q_{t+1}$	$\overline{Q_{t+1}}$
0	0	$Q_t$	$\overline{Q_t}$
0	1	0	1
1	0	1	0
1	1	0	0

Mantiene

Reset

Set

Prohibido



S	R	$Q_{t+1}$	$\overline{Q_{t+1}}$
0	0	1	1
0	1	1	0
1	0	0	1
1	1	$Q_t$	$\overline{Q_t}$

Prohibido

Set

Reset

Mantiene



Esta presentación:

***Biestable S-R asíncrono - Circuitos secuenciales***

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Videos disponibles:

Parte 1 de 3. Implementación con puertas NOR <https://youtu.be/Y3B1UKwQ7G8>

Parte 2 de 3: Cronograma <https://youtu.be/KdRcHo1msxl>

Parte 3 de 3: Implementación con puertas NAND <https://youtu.be/ipsJB2MKqvU>

