

Biestable S-R asíncrono

Circuitos secuenciales

Electrónica digital

Felipe Machado

Circuitos secuenciales

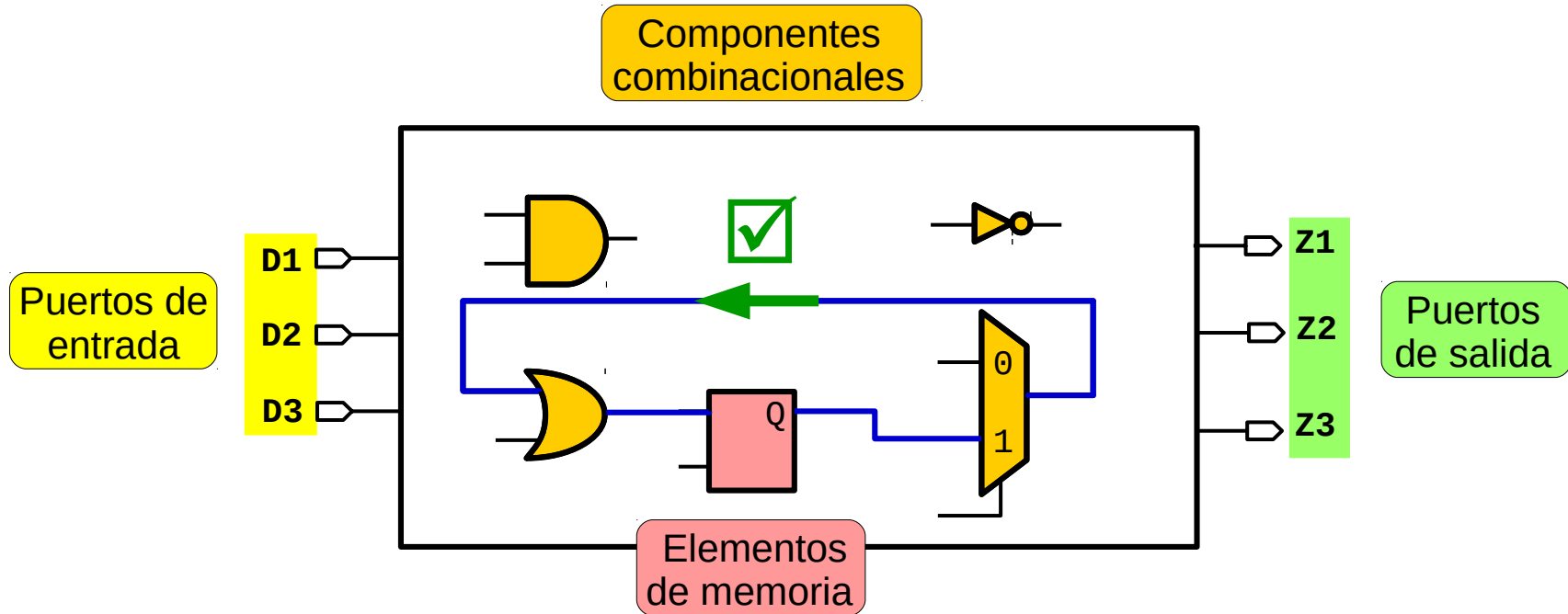
Las salidas dependen

- Entradas actuales
- Entradas en momentos anteriores

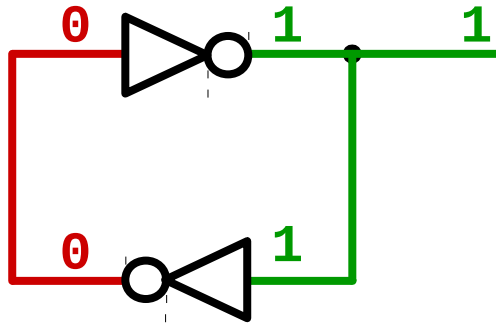
➡ Elementos de memoria

➡ Estado interno

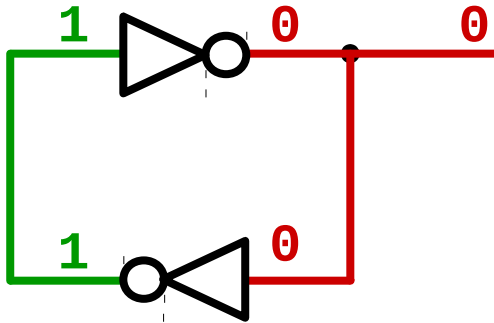
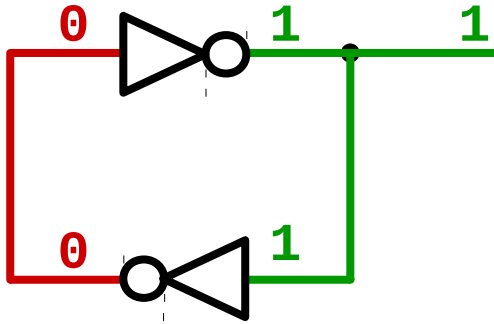
Pueden tener realimentación



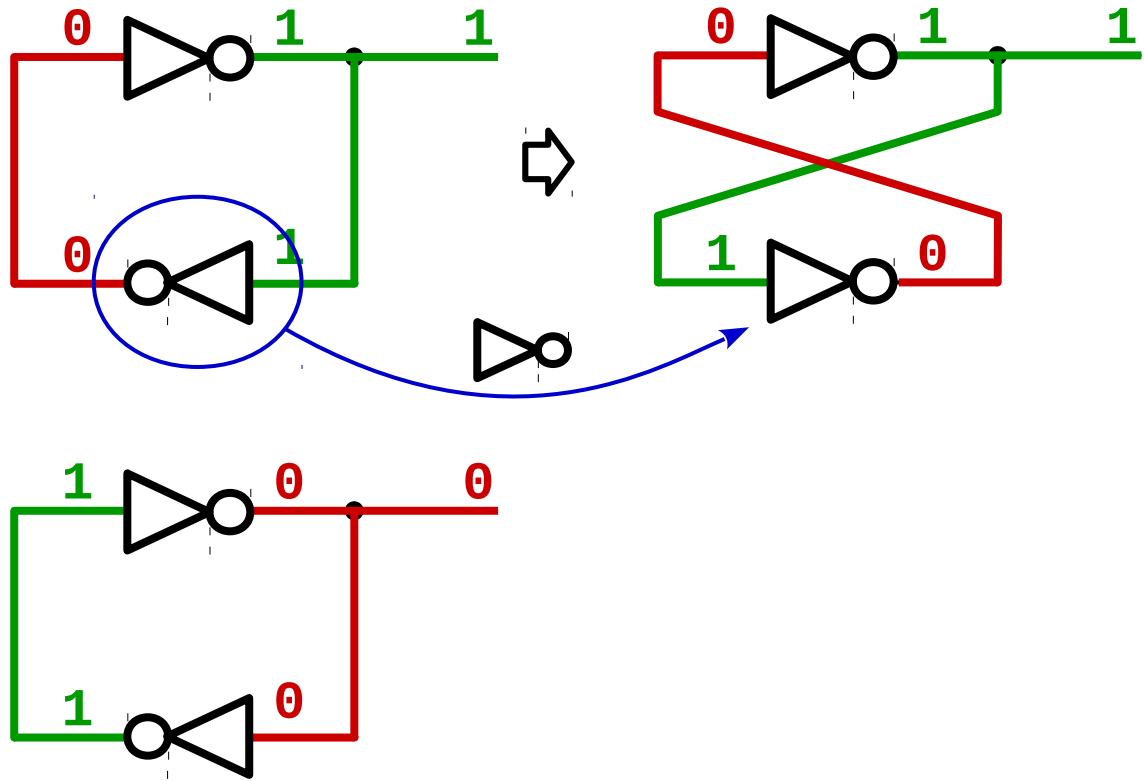
Biestables



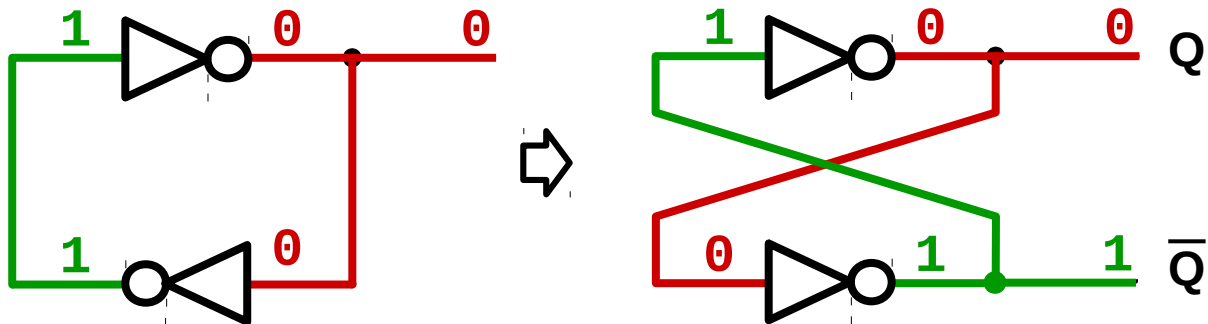
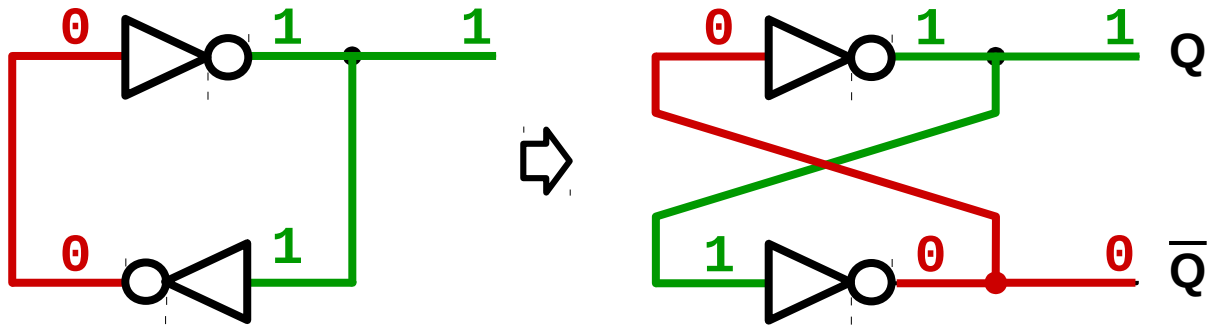
Bistables



Bistables



Biestables

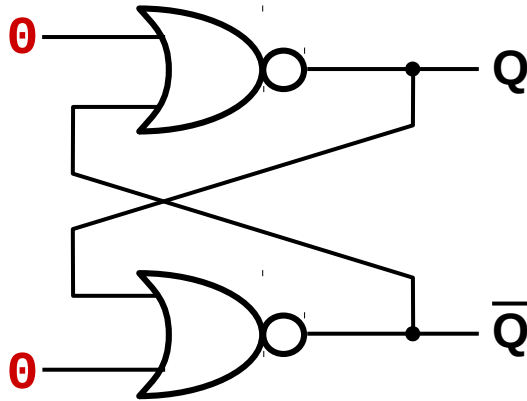
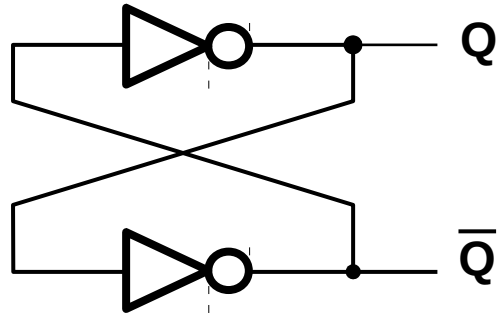


?

¿Cómo puedo cambiar el estado?

Biestables

¿Cómo puedo cambiar el estado?



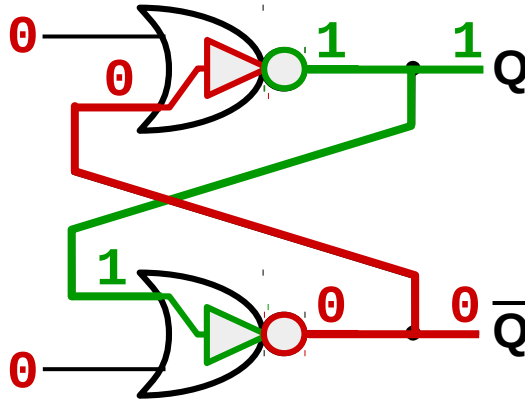
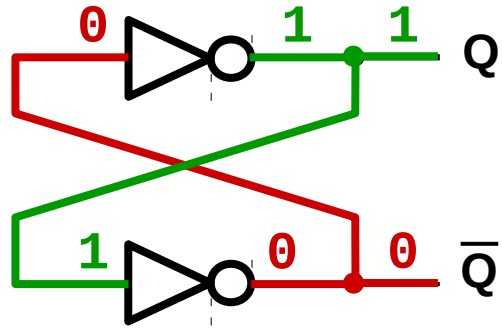
Puerta NOR

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

↴ equivalente

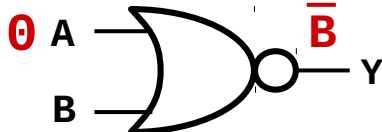
Biestables


¿Cómo puedo cambiar el estado?




Puerta NOR

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

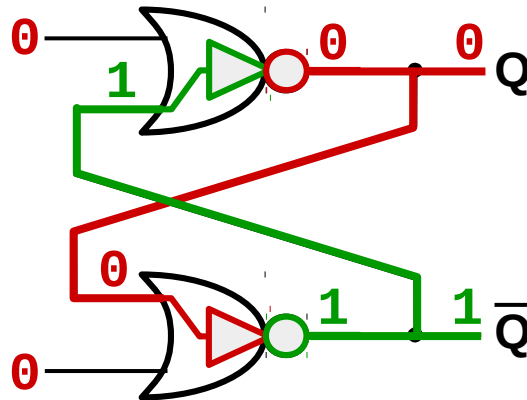
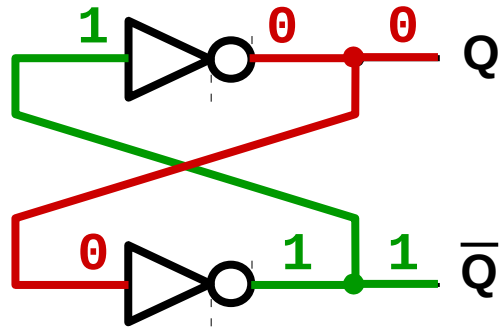
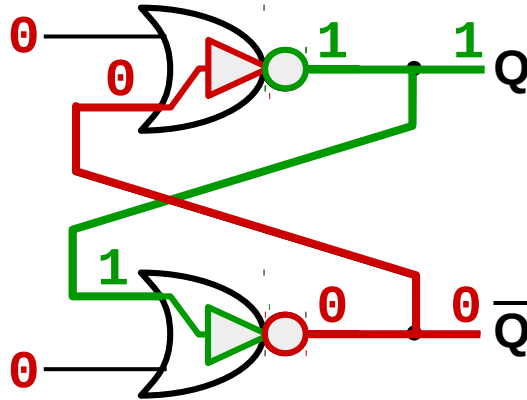
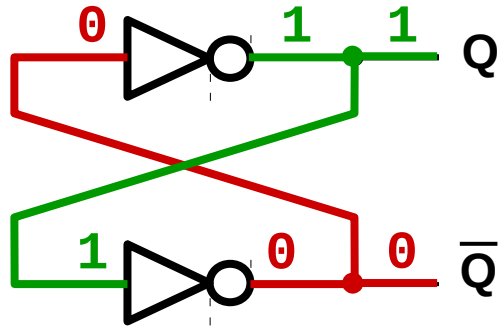
 \bar{B}

 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

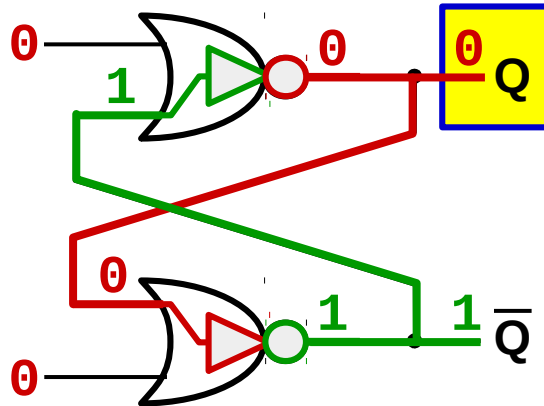
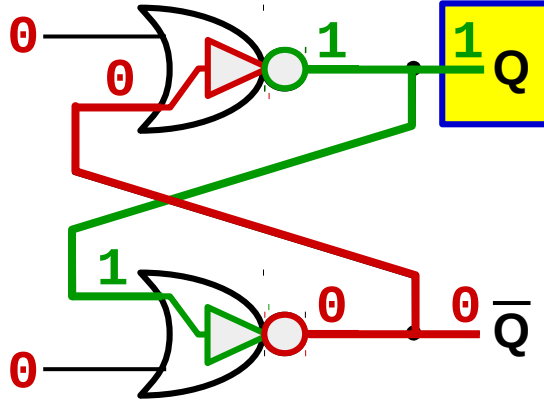
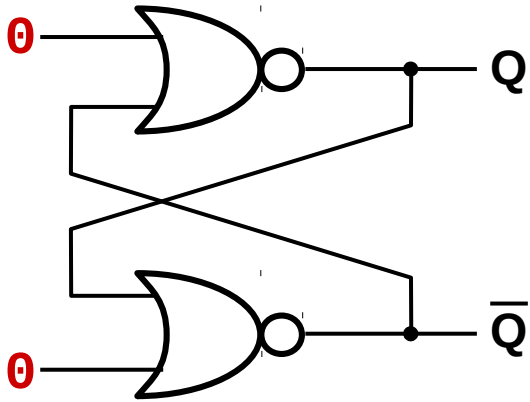
\bar{B}

\bar{B} — \bar{B}

equivalente

Biestables

¿Cómo puedo cambiar el estado?



Puerta NOR

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

$\bar{0}$ A — B — \bar{B} Y

↴ equivalente

B — \bar{B}

Puerta NOR

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

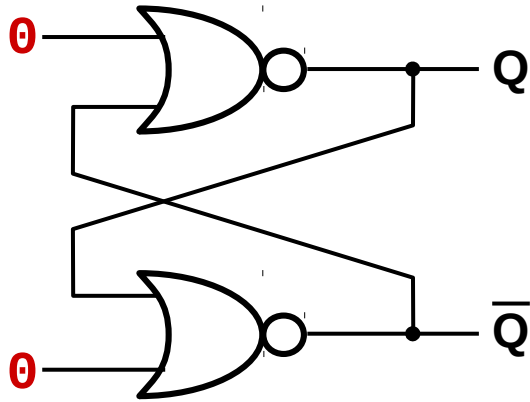
1 A — $\bar{0}$ Y

↴ equivalente

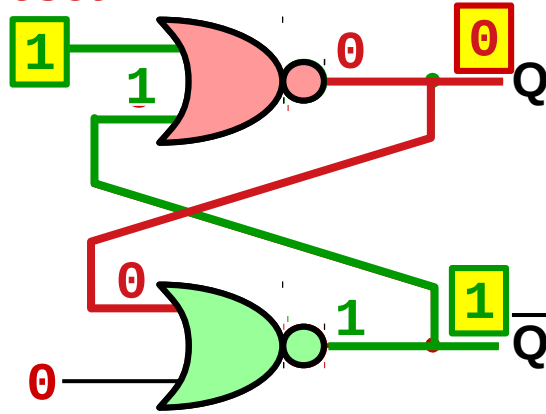
$\bar{0}$ — Y

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

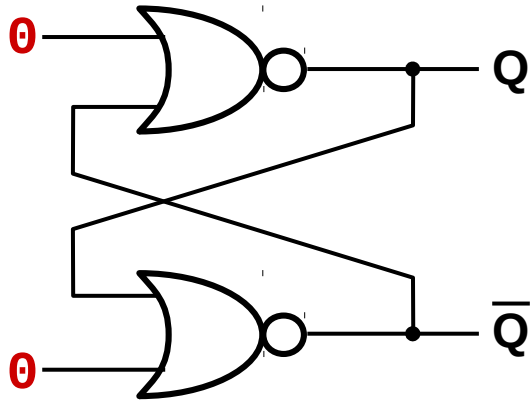
Puerta NOR

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

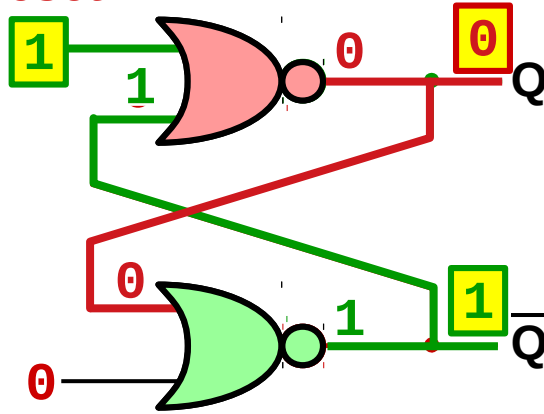
↴ equivalente

Biestables

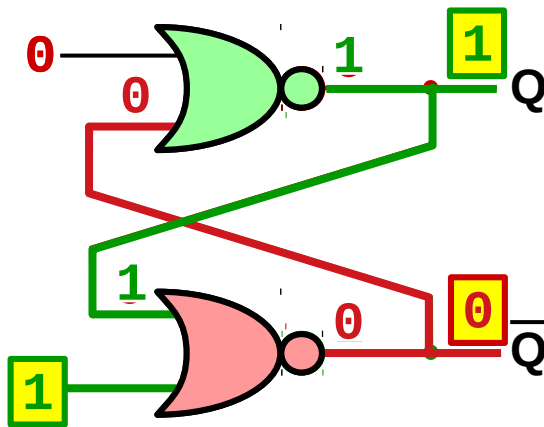
¿Cómo puedo cambiar el estado?



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

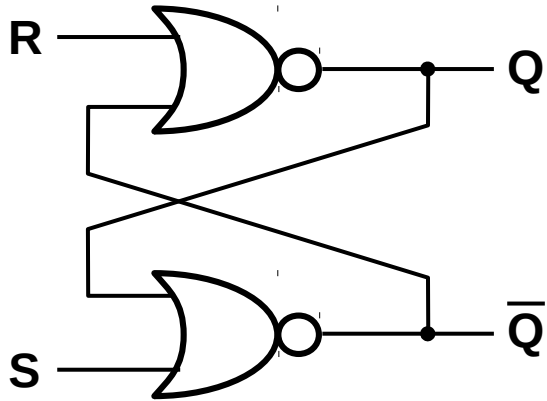
A	B	Y
0	0	1
0	1	0
1	0	0
1	1	0

↓ equivalente

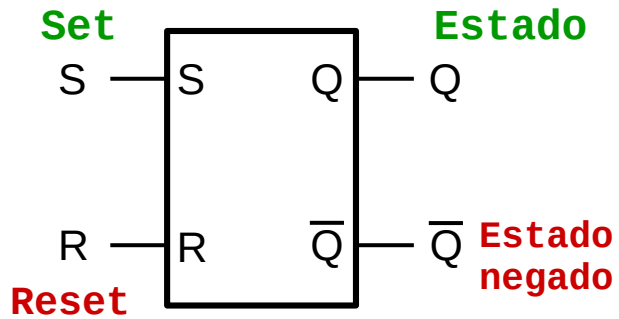
$0 \rightarrow Y$

Biastable S-R asíncrono

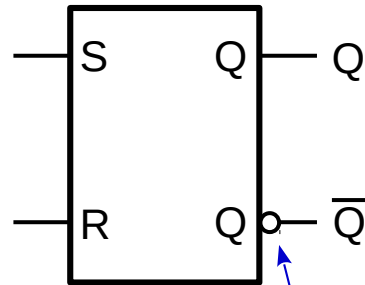
Reset



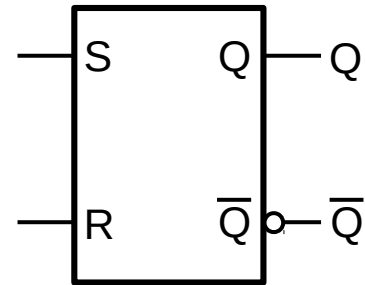
Set



Otras posibles representaciones



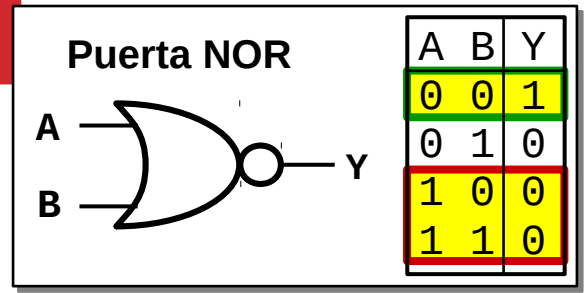
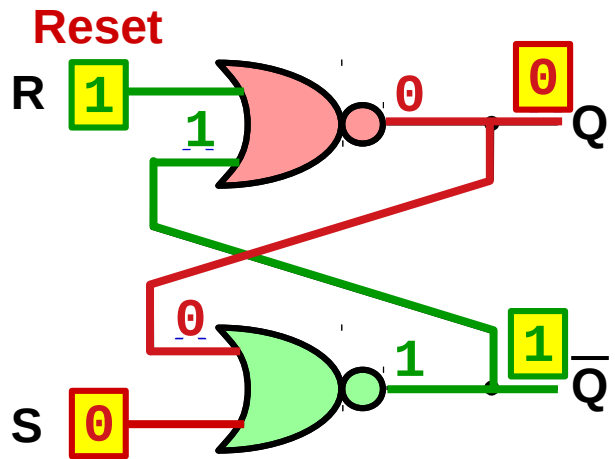
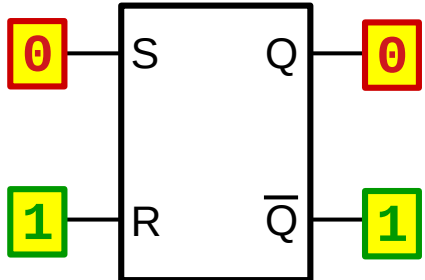
negación



Biastable S-R asíncrono

Transiciones

Set: 0
Reset: 1



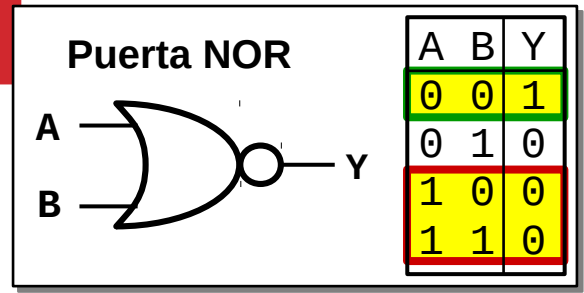
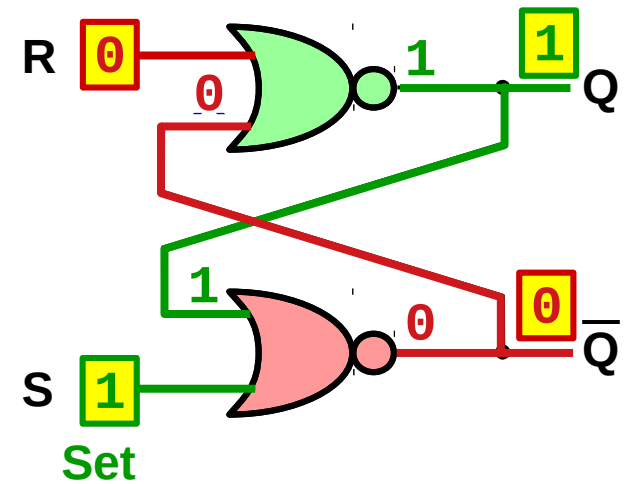
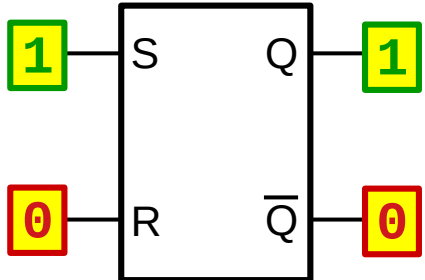
S	R	Q_t	Q_{t+1}	\bar{Q}_{t+1}
0	1	X	0	1

Reset

Biastable S-R asíncrono

Transiciones

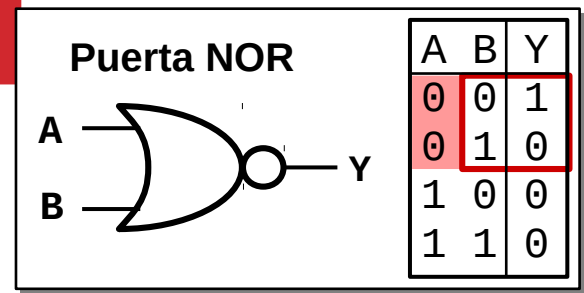
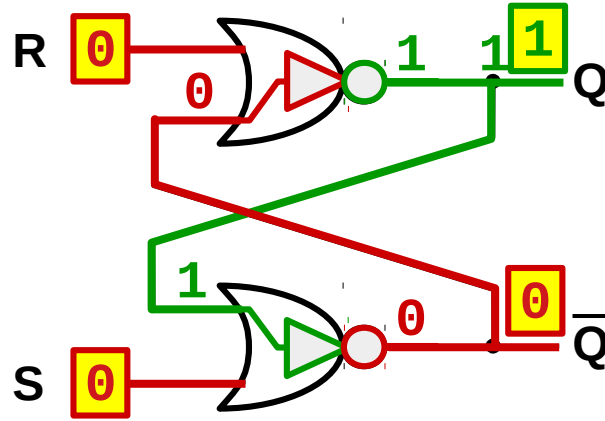
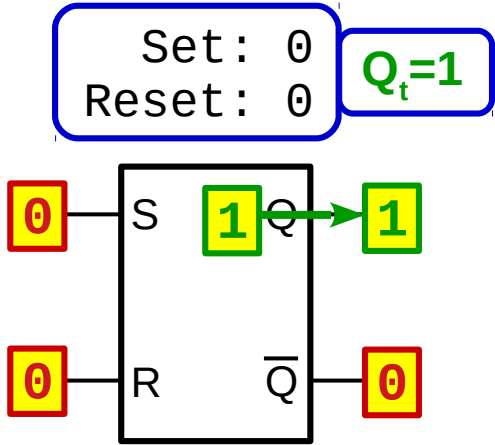
Set: 1
Reset: 0



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

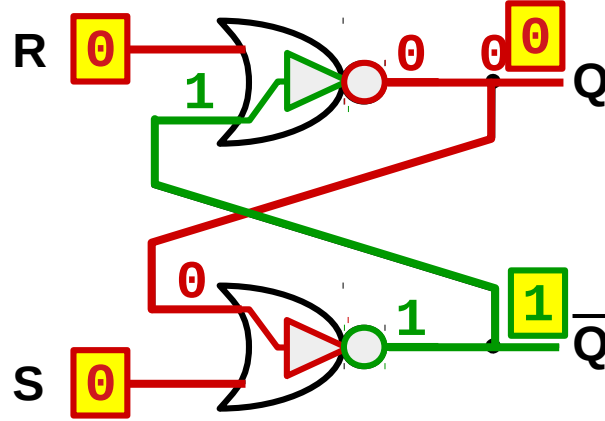
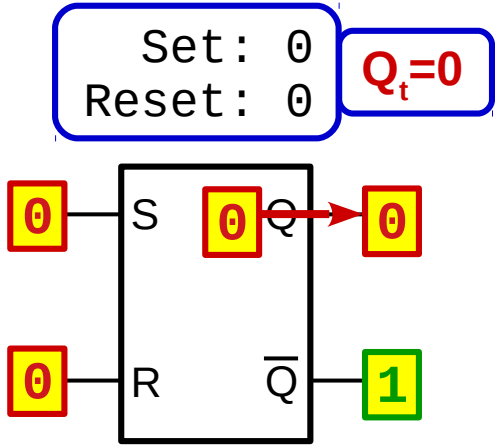
Transiciones



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

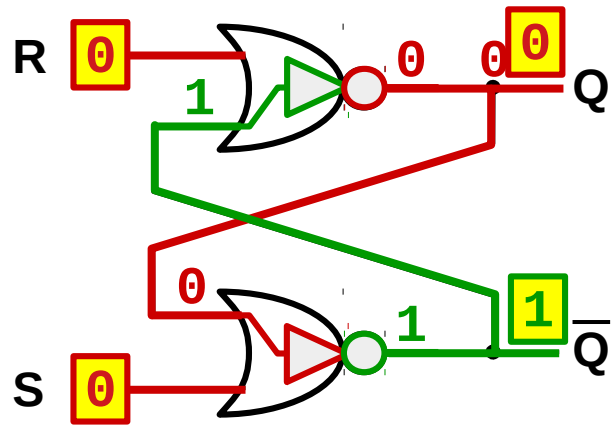
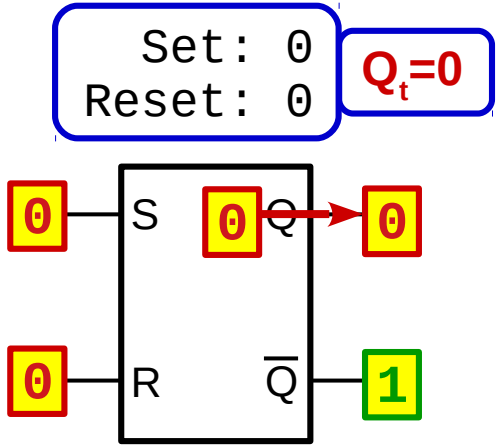
S	R	Q_t	Q_{t+1}	$\overline{Q_{t+1}}$	
0	1	X	0	1	Reset
1	0	X	1	0	Set
0	0	1	1	0	Mantiene
0	0	0	0	1	Mantiene

Biastable S-R asíncrono

Transiciones

Puerta NOR

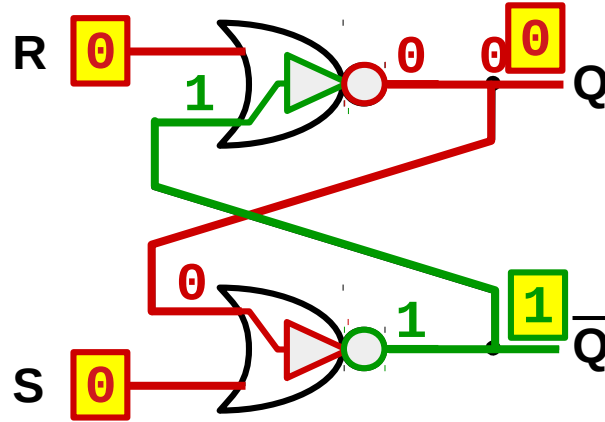
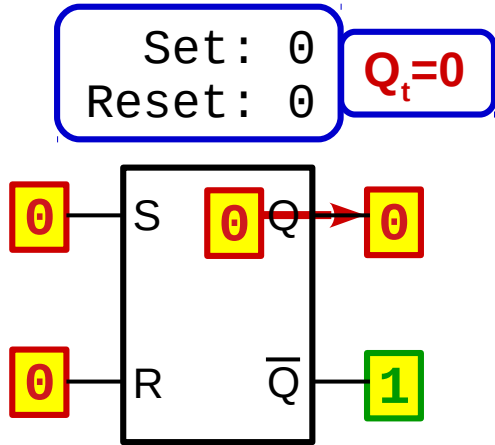
A	B	Y
0	0	1
0	1	0
1	0	0
1	1	0



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

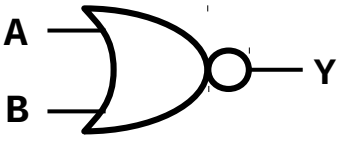
A	B	Y
0	0	1
0	1	0
1	0	0
1	1	0

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

Biastable S-R asíncrono

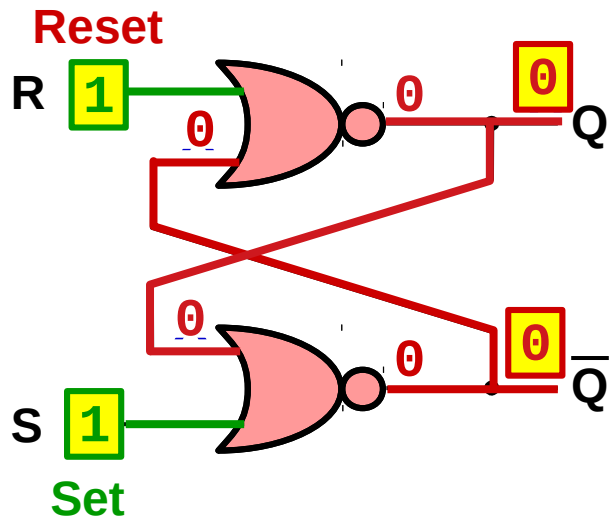
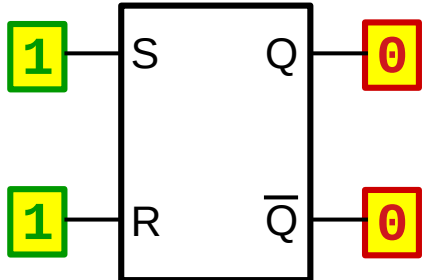
Transiciones

Puerta NOR



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

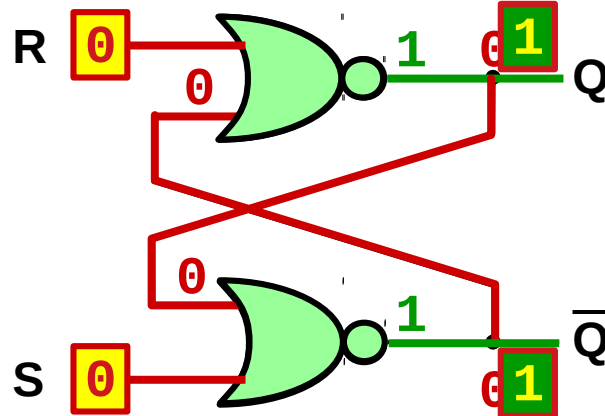
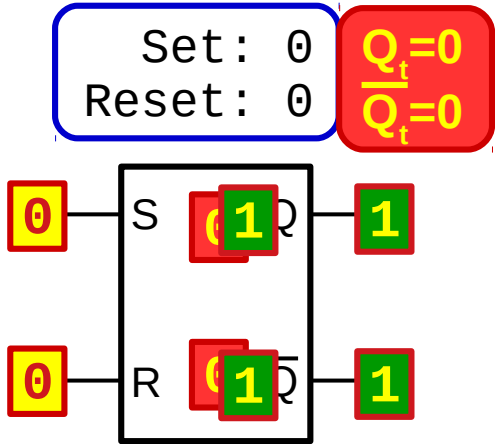
Set: 1
Reset: 1



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

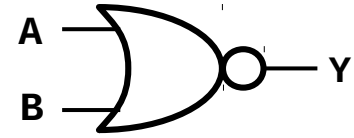
A	B	Y
0	0	1
0	1	0
1	0	0
1	1	0

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

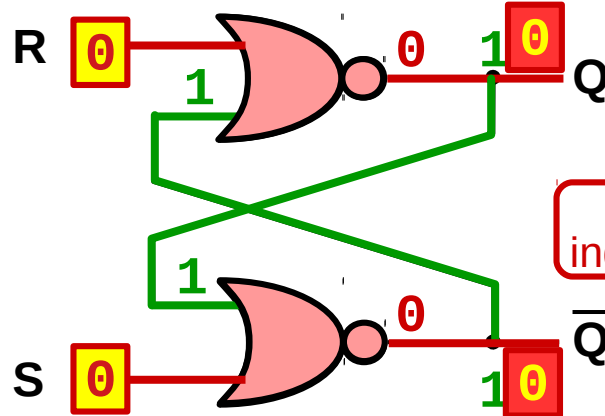
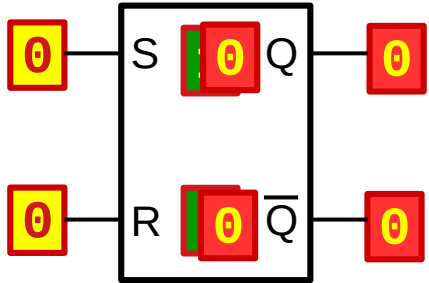
Transiciones

Puerta NOR



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

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

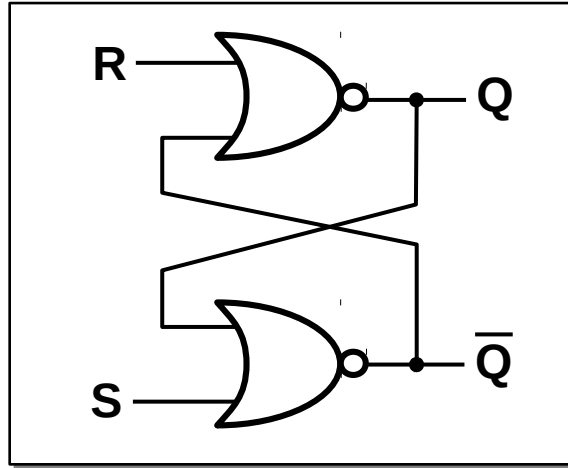
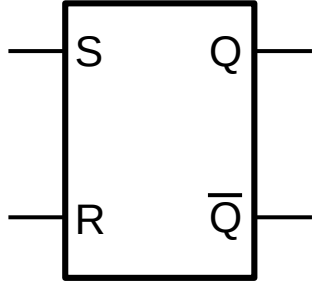


Estado indeterminado

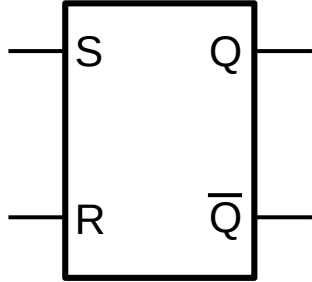
S	R	Q_t	Q_{t+1}	\overline{Q}_{t+1}
0	0	Q_t	Q_t	Q_t
0	1	X	0	1
1	0	X	1	0
1	1	X	0	0

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



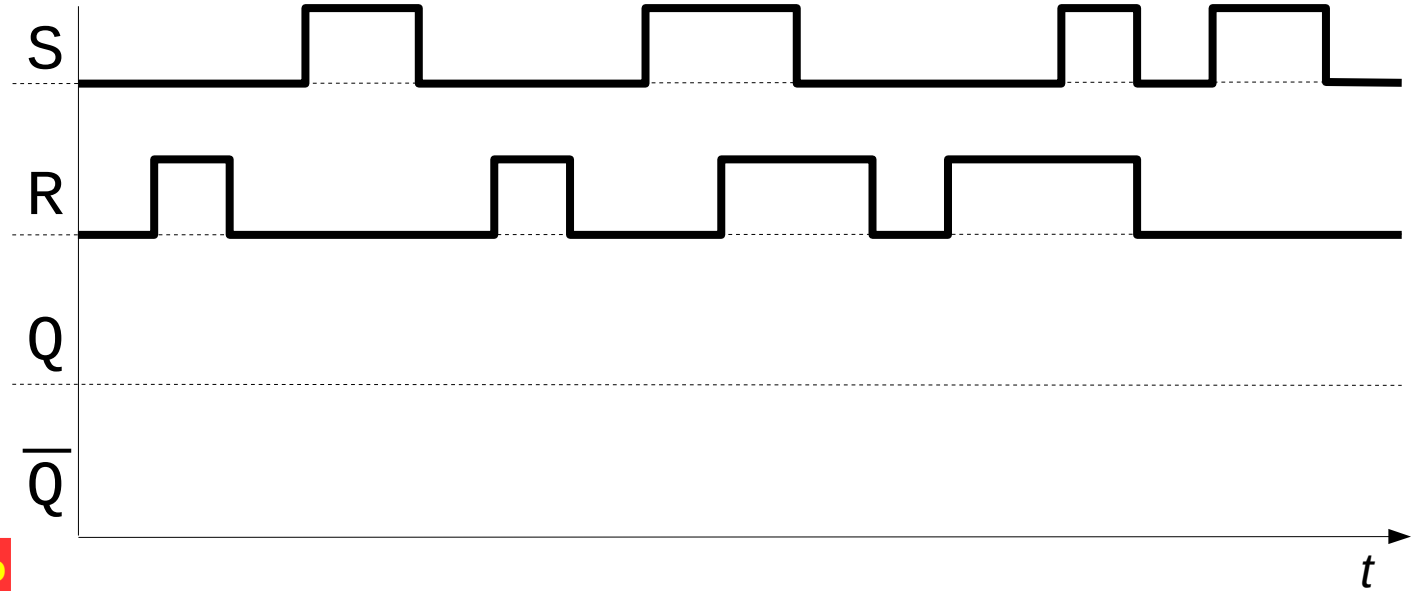
S	R	Q_{t+1}	\overline{Q}_{t+1}
0	0	Q_t	\overline{Q}_t
0	1	0	1
1	0	1	0
1	1	0	0

Mantiene

Reset

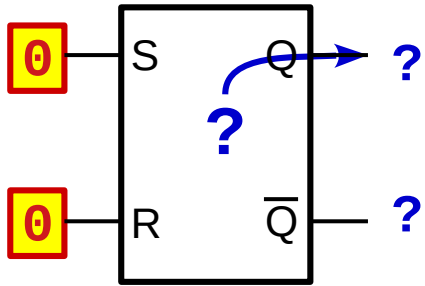
Set

Prohibido

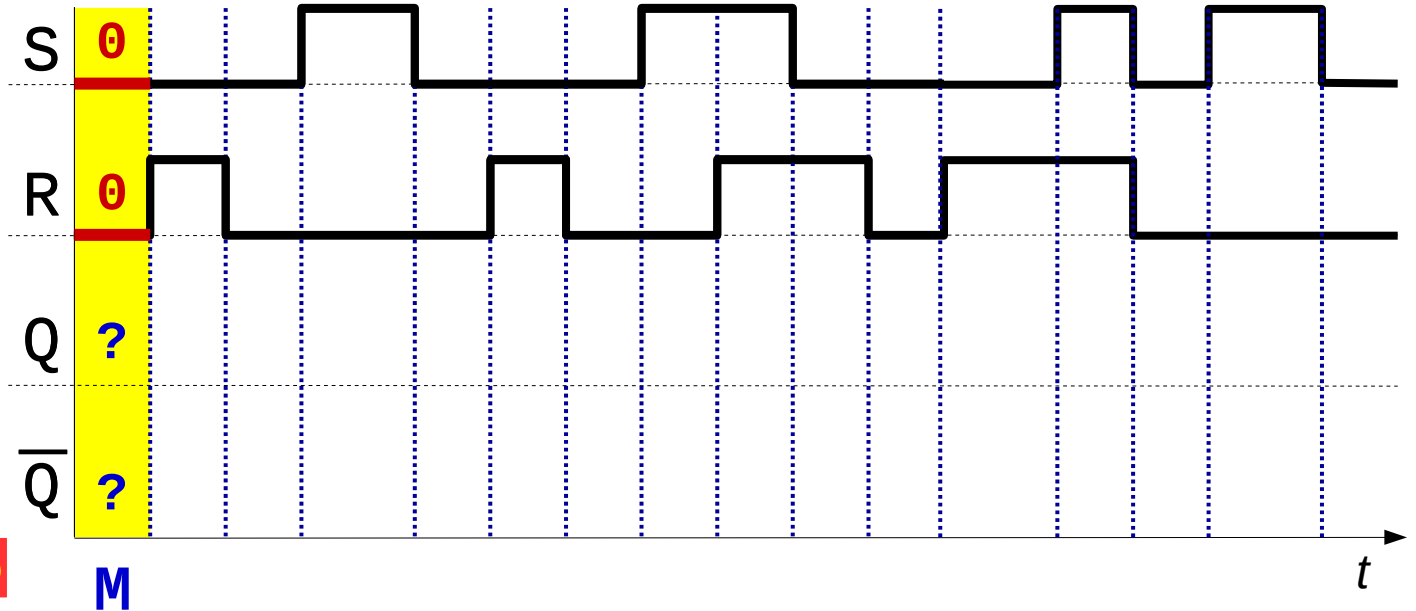


Biastable S-R asíncrono

Cronograma

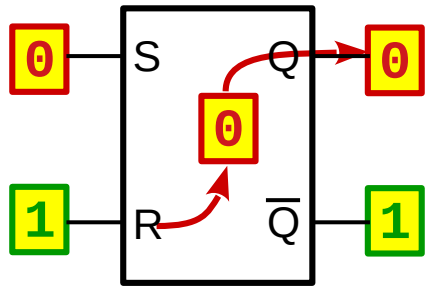


S	R	Q_{t+1}	\overline{Q}_{t+1}	
0	0	Q_t	\overline{Q}_t	Mantiene
0	1	0	1	Reset
1	0	1	0	Set
1	1	0	0	Prohibido



Biastable S-R asíncrono

Cronograma



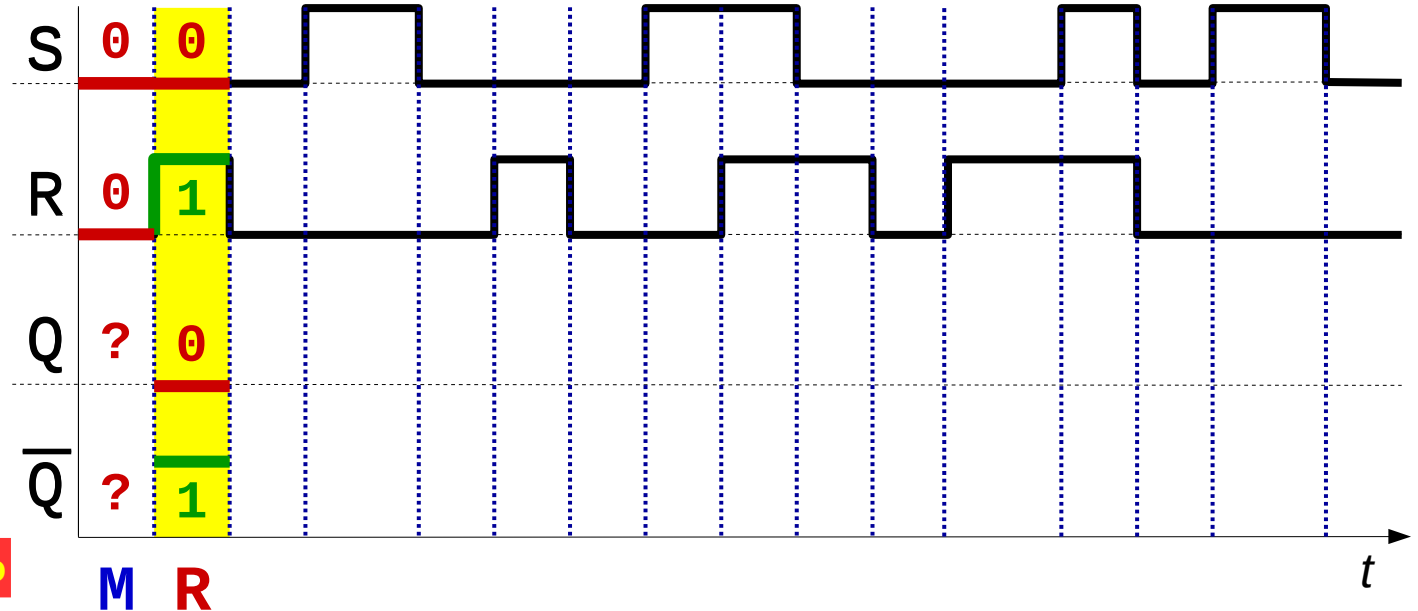
S	R	Q_{t+1}	\overline{Q}_{t+1}
0	0	Q_t	\overline{Q}_t
0	1	0	1
1	0	1	0
1	1	0	0

Mantiene

Reset

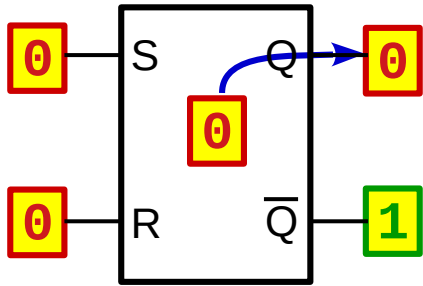
Set

Prohibido

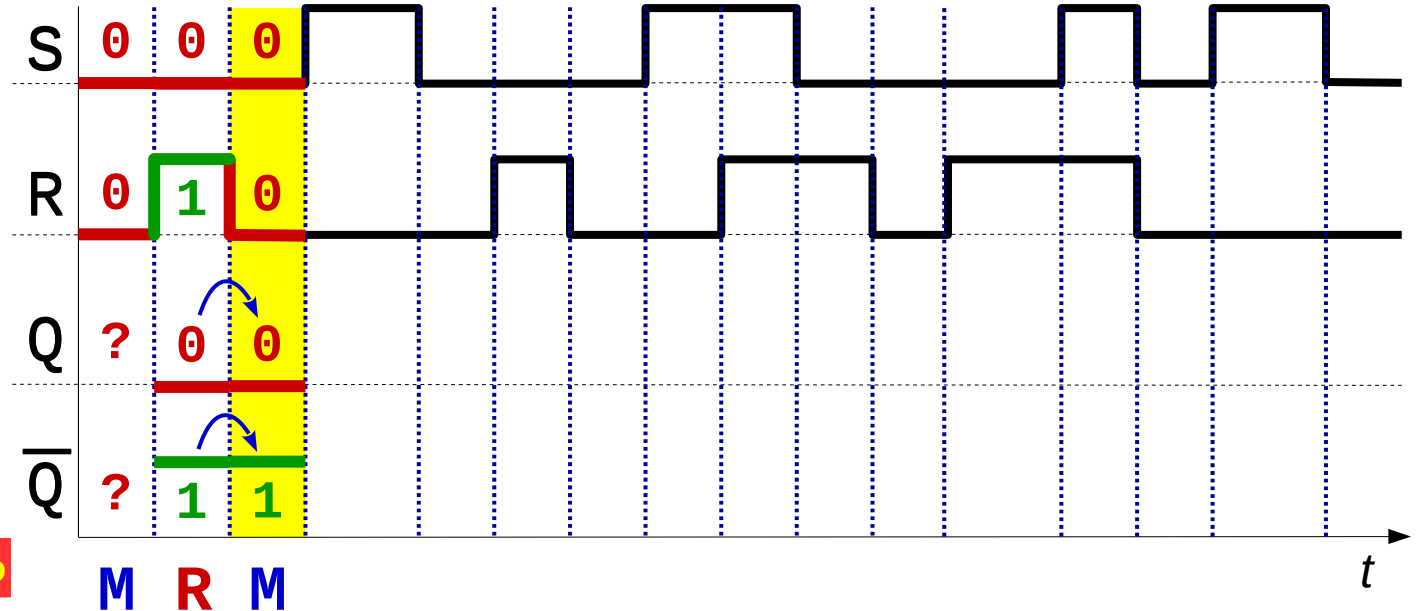


Biastable S-R asíncrono

Cronograma

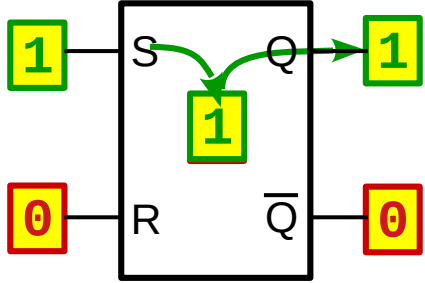


S	R	Q_{t+1}	\overline{Q}_{t+1}	
0	0	Q_t	\overline{Q}_t	Mantiene
0	1	0	1	Reset
1	0	1	0	Set
1	1	0	0	Prohibido



Biastable S-R asíncrono

Cronograma



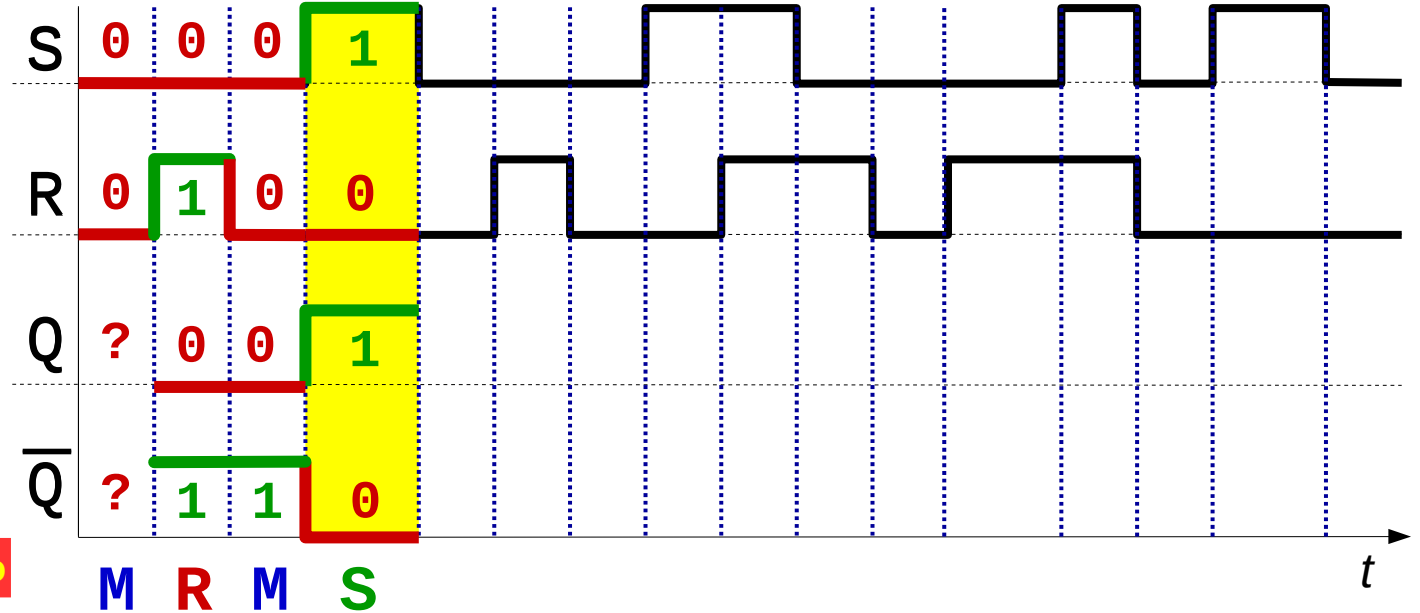
S	R	Q_{t+1}	\overline{Q}_{t+1}
0	0	Q_t	\overline{Q}_t
0	1	0	1
1	0	1	0
1	1	0	0

Mantiene

Reset

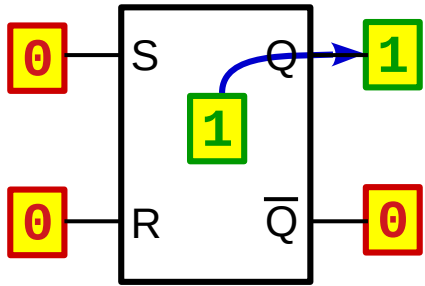
Set

Prohibido



Biastable S-R asíncrono

Cronograma



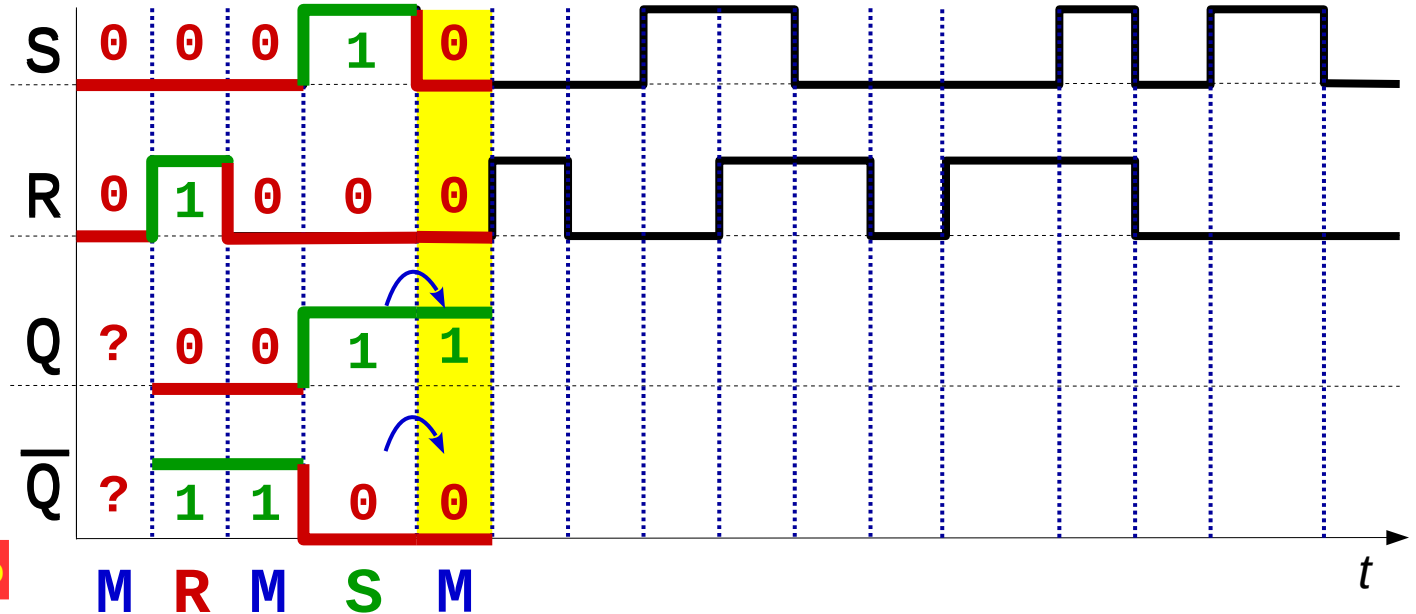
S	R	Q_{t+1}	\overline{Q}_{t+1}
0	0	Q_t	\overline{Q}_t
0	1	0	1
1	0	1	0
1	1	0	0

Mantiene

Reset

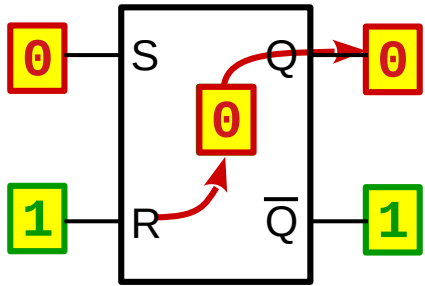
Set

Prohibido



Biastable S-R asíncrono

Cronograma



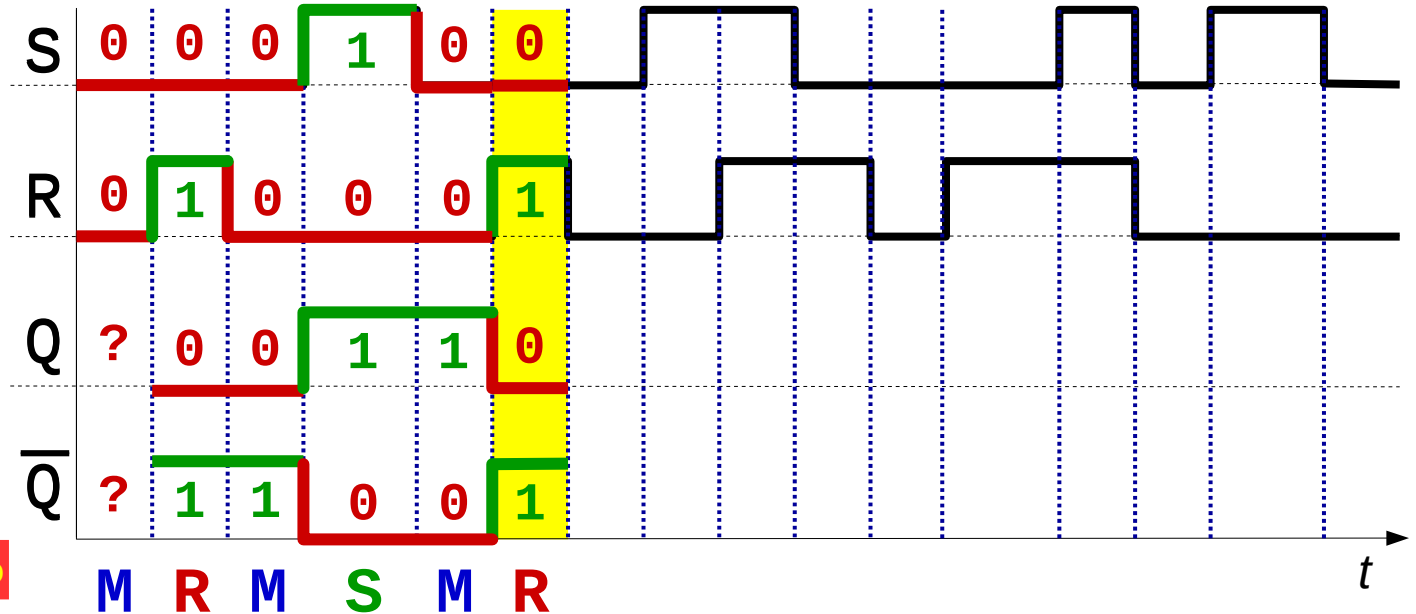
S	R	Q_{t+1}	\overline{Q}_{t+1}
0	0	Q_t	\overline{Q}_t
0	1	0	1
1	0	1	0
1	1	0	0

Mantiene

Reset

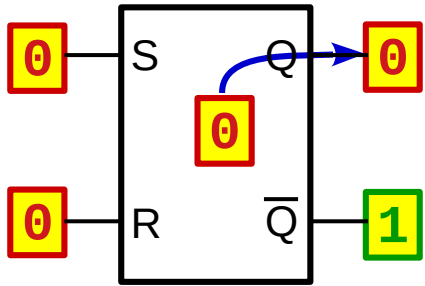
Set

Prohibido



Biastable S-R asíncrono

Cronograma



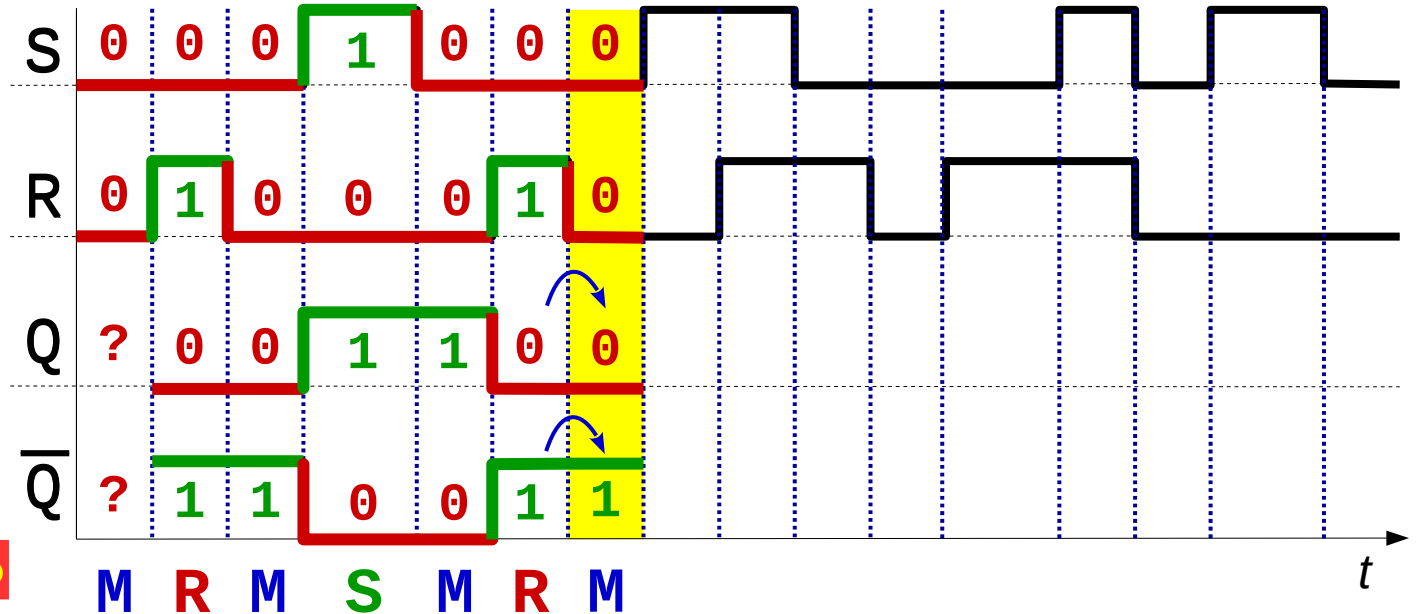
S	R	Q_{t+1}	\overline{Q}_{t+1}
0	0	Q_t	\overline{Q}_t
0	1	0	1
1	0	1	0
1	1	0	0

Mantiene

Reset

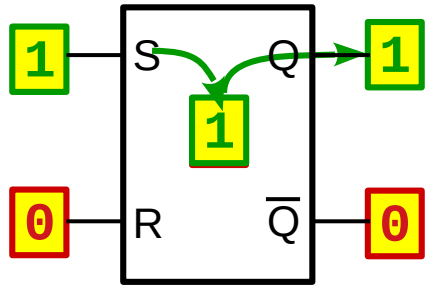
Set

Prohibido



Biastable S-R asíncrono

Cronograma



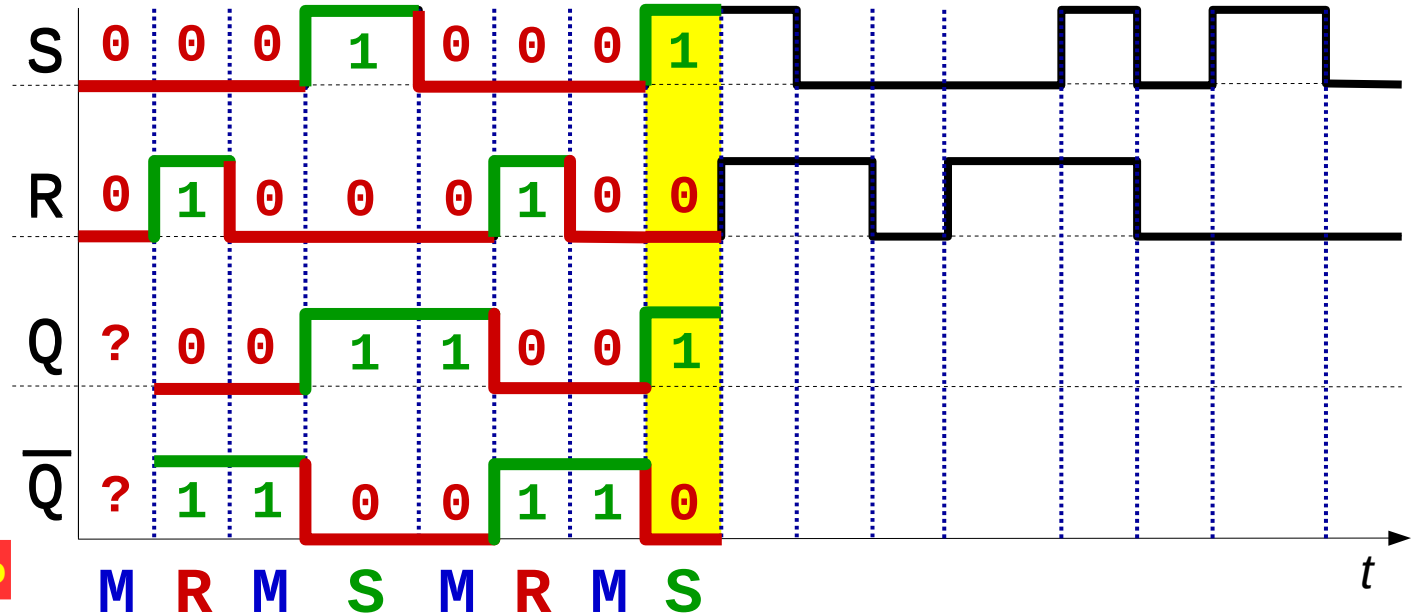
S	R	Q_{t+1}	\overline{Q}_{t+1}
0	0	Q_t	\overline{Q}_t
0	1	0	1
1	0	1	0
1	1	0	0

Mantiene

Reset

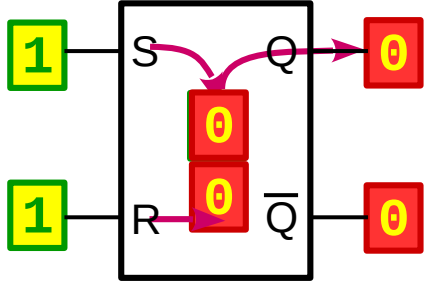
Set

Prohibido

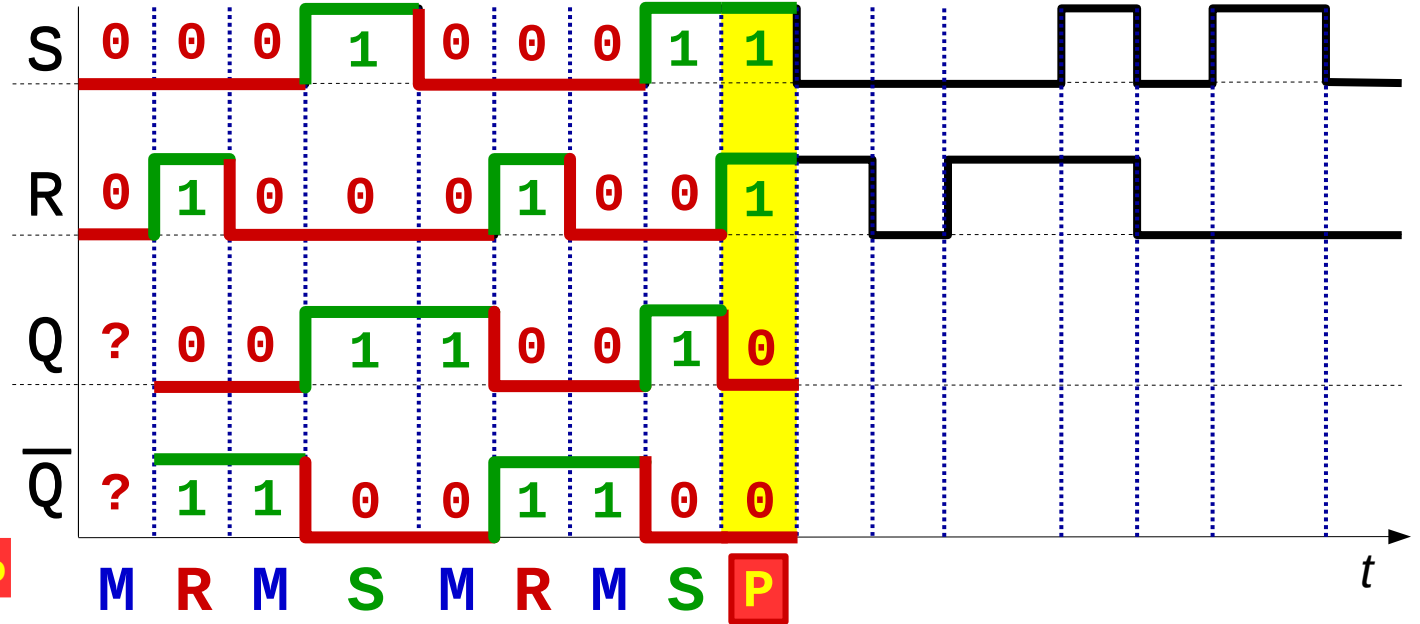


Biastable S-R asíncrono

Cronograma

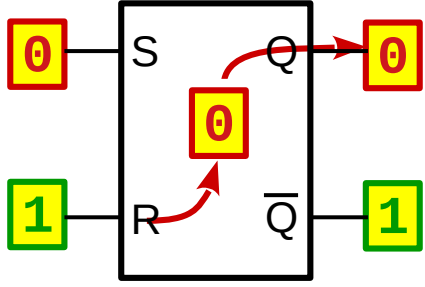


S	R	Q_{t+1}	\overline{Q}_{t+1}	
0	0	Q_t	\overline{Q}_t	Mantiene
0	1	0	1	Reset
1	0	1	0	Set
1	1	0	0	Prohibido



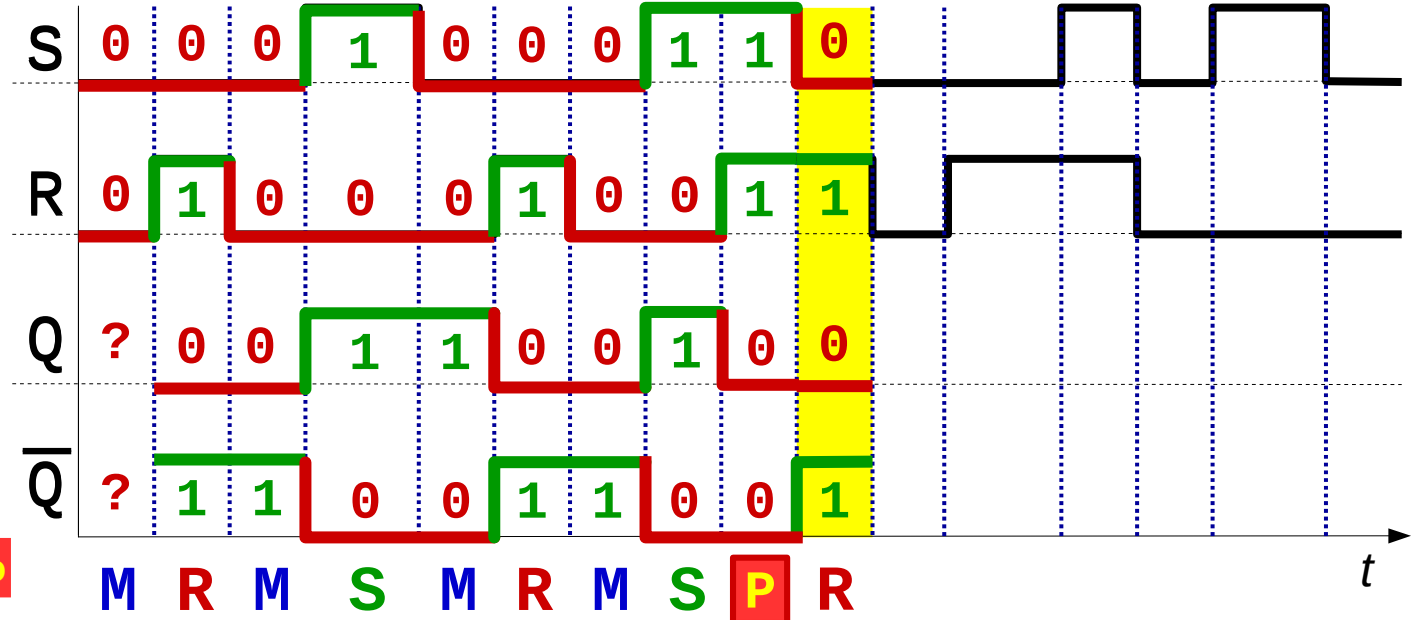
Biestable S-R asíncrono

Cronograma



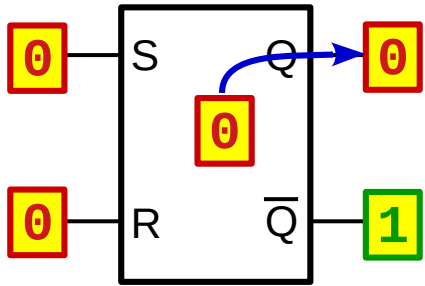
S	R	Q_{t+1}	\overline{Q}_{t+1}
0	0	Q_t	\overline{Q}_t
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1	0	1	0
1	1	0	0

Mantiene
Reset
Set
Prohibido



Biastable S-R asíncrono

Cronograma



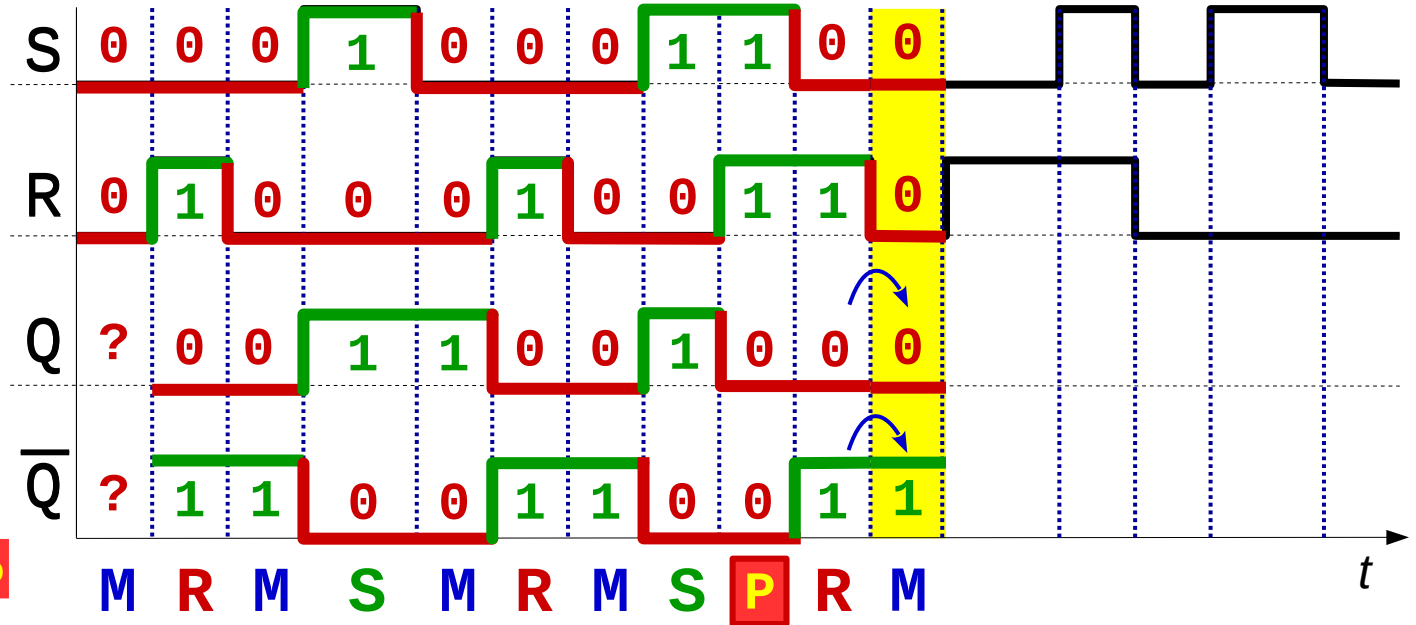
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0	0	Q_t	\overline{Q}_t
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1	0	1	0
1	1	0	0

Mantiene

Reset

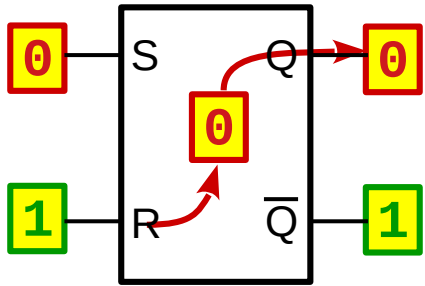
Set

Prohibido



Biastable S-R asíncrono

Cronograma



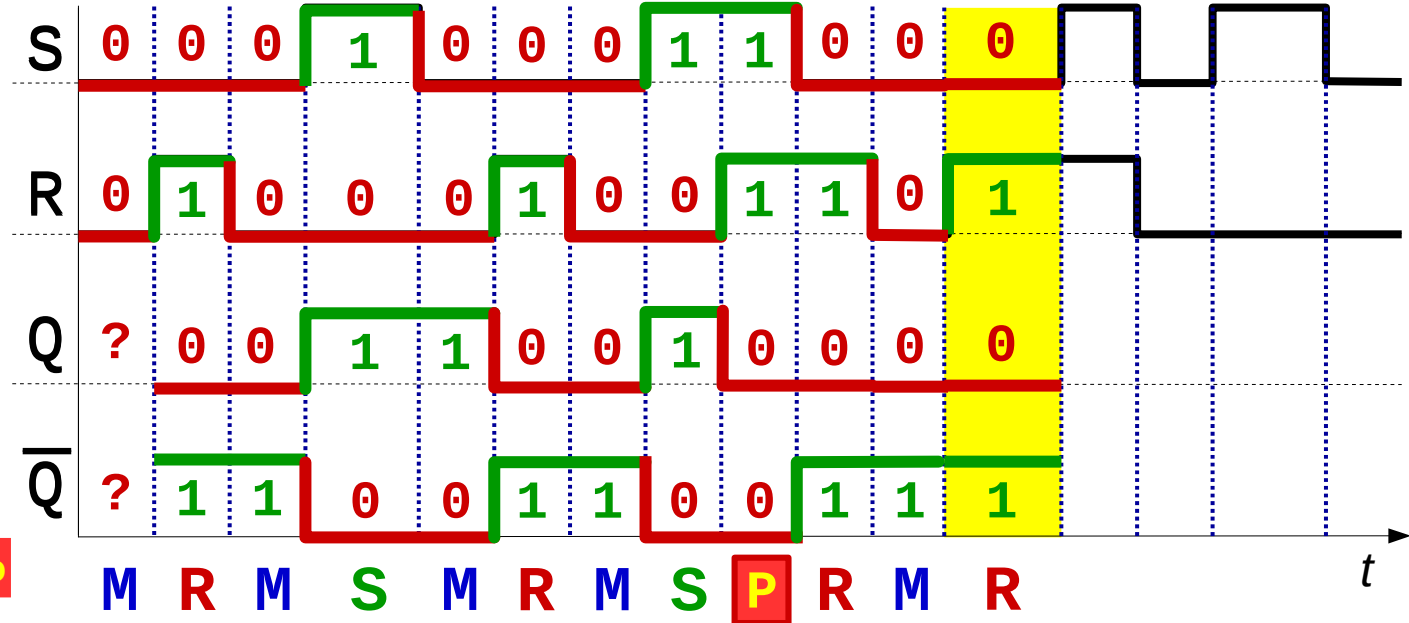
S	R	Q_{t+1}	\overline{Q}_{t+1}
0	0	Q_t	\overline{Q}_t
0	1	0	1
1	0	1	0
1	1	0	0

Mantiene

Reset

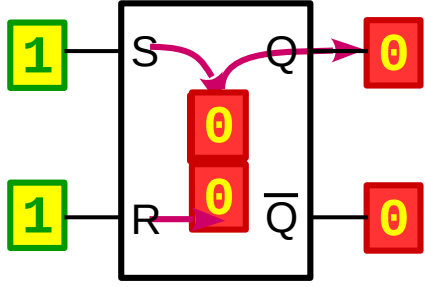
Set

Prohibido

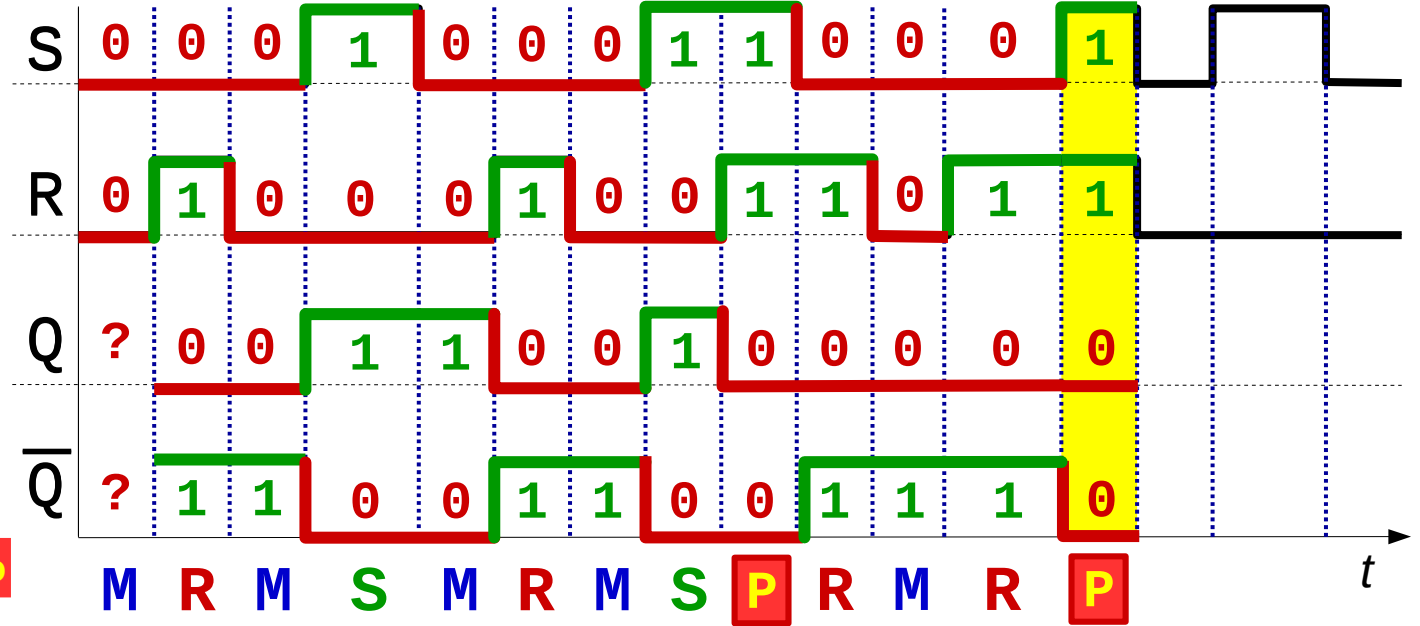


Biastable S-R asíncrono

Cronograma

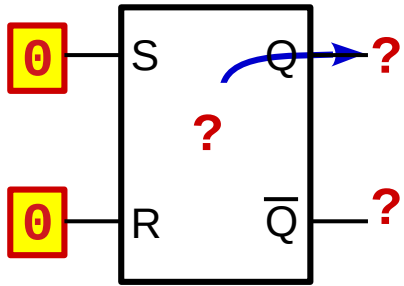


S	R	Q_{t+1}	\overline{Q}_{t+1}	
0	0	Q_t	\overline{Q}_t	Mantiene
0	1	0	1	Reset
1	0	1	0	Set
1	1	0	0	Prohibido



Biestable S-R asíncrono

Cronograma



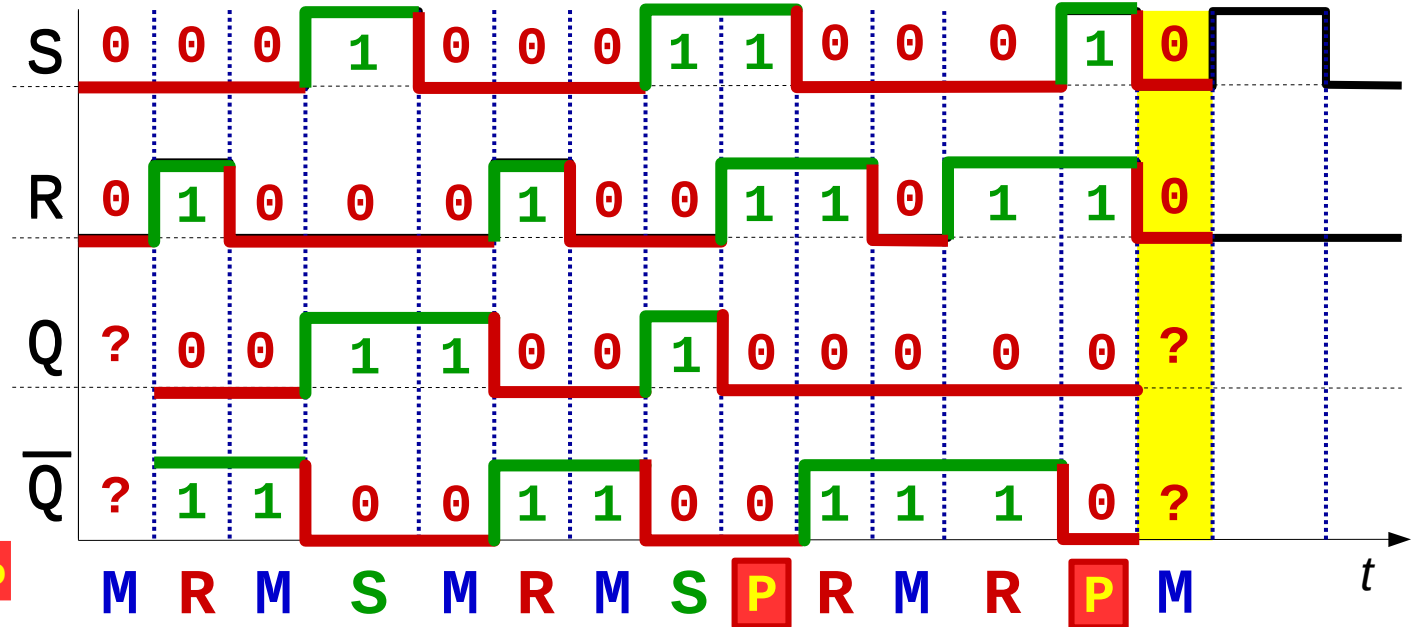
S	R	Q_{t+1}	\overline{Q}_{t+1}
0	0	Q_t	\overline{Q}_t
0	1	0	1
1	0	1	0
1	1	0	0

Mantiene

Reset

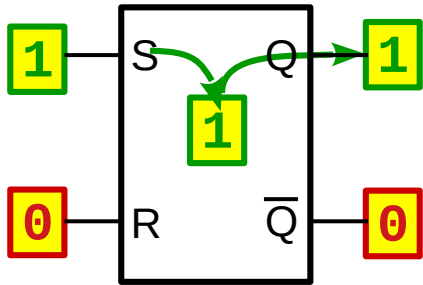
Set

Prohibido



Biastable S-R asíncrono

Cronograma



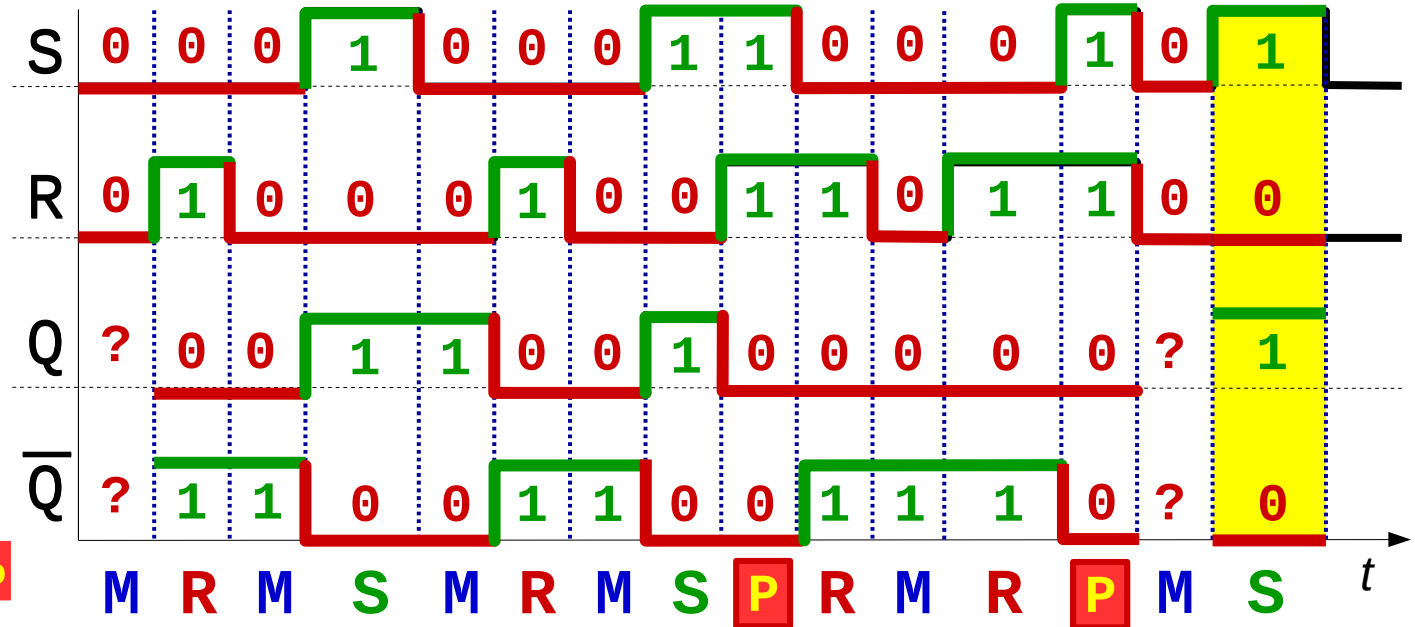
S	R	Q_{t+1}	\overline{Q}_{t+1}
0	0	Q_t	\overline{Q}_t
0	1	0	1
1	0	1	0
1	1	0	0

Mantiene

Reset

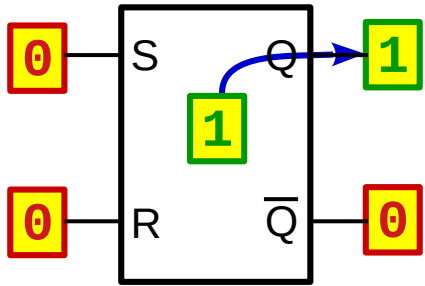
Set

Prohibido



Biestable S-R asíncrono

Cronograma



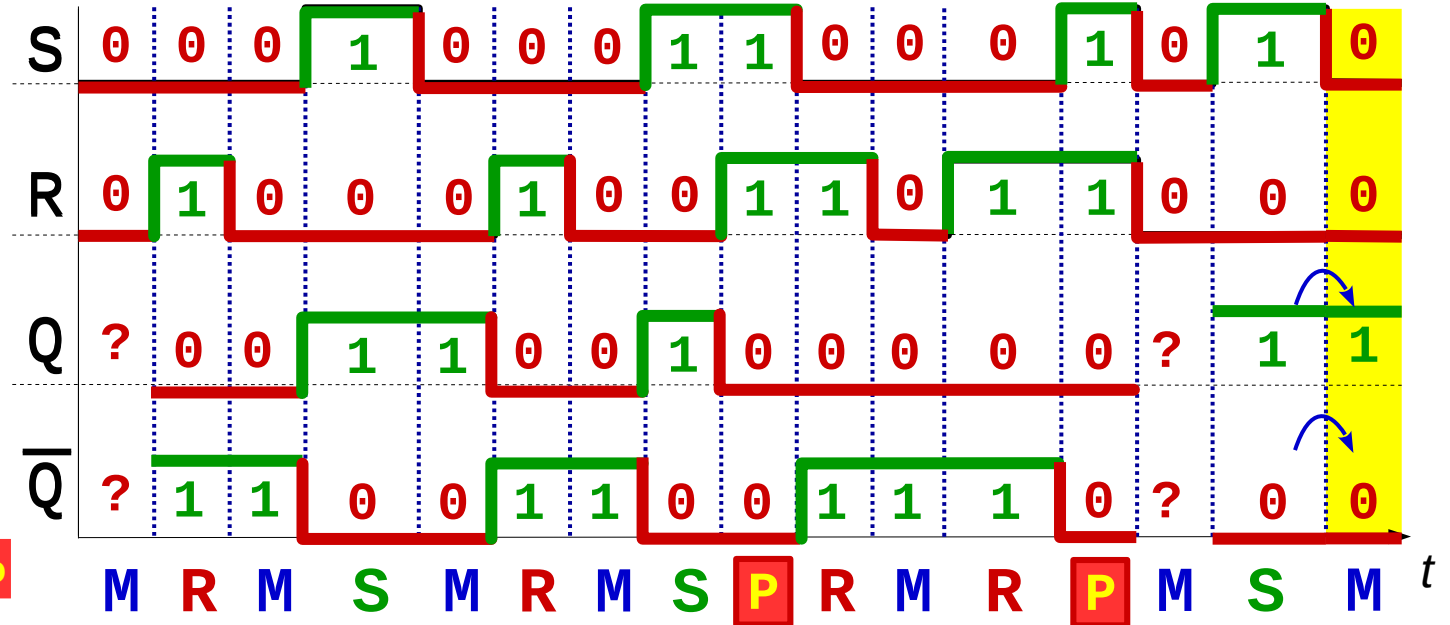
S	R	Q_{t+1}	\overline{Q}_{t+1}
0	0	Q_t	\overline{Q}_t
0	1	0	1
1	0	1	0
1	1	0	0

Mantiene

Reset

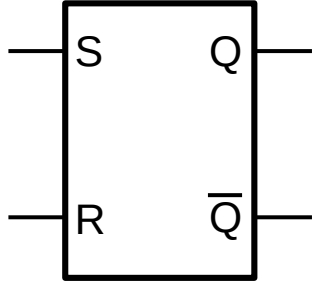
Set

Prohibido



Biastable S-R asíncrono

Cronograma



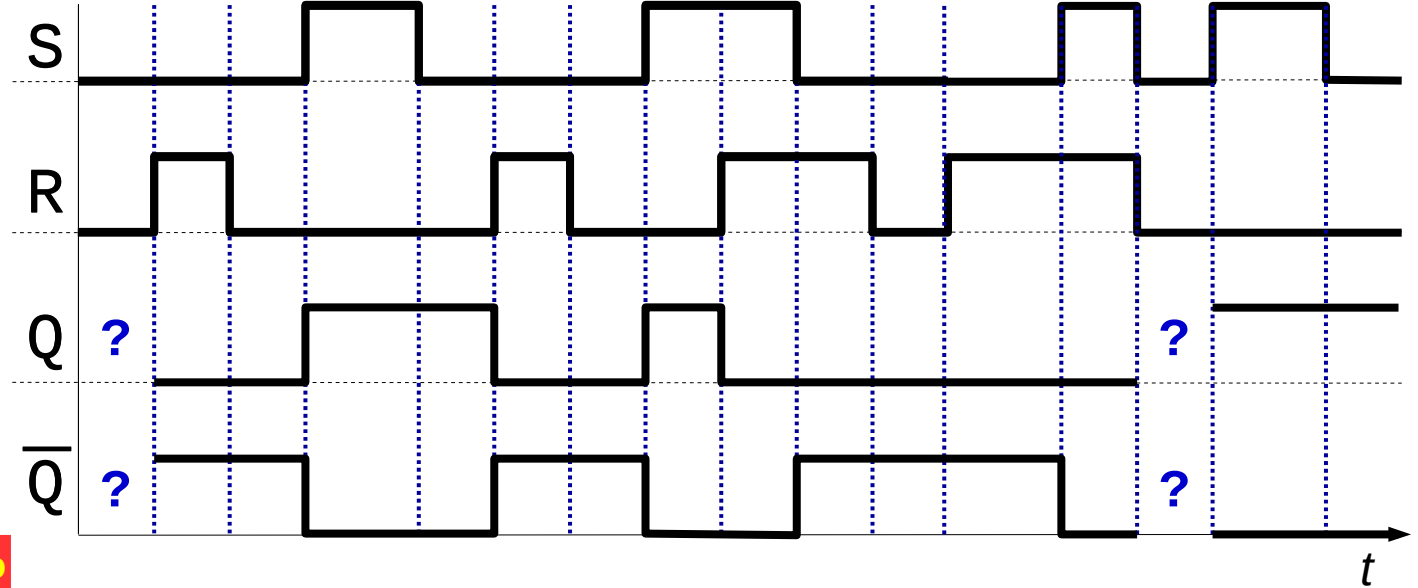
S	R	Q_{t+1}	\overline{Q}_{t+1}
0	0	Q_t	\overline{Q}_t
0	1	0	1
1	0	1	0
1	1	0	0

Mantiene

Reset

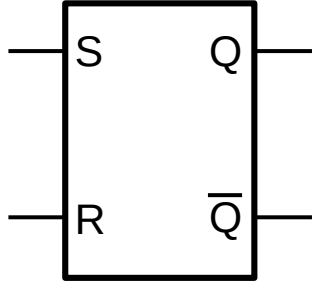
Set

Prohibido



Biastable S-R asíncrono

Cronograma



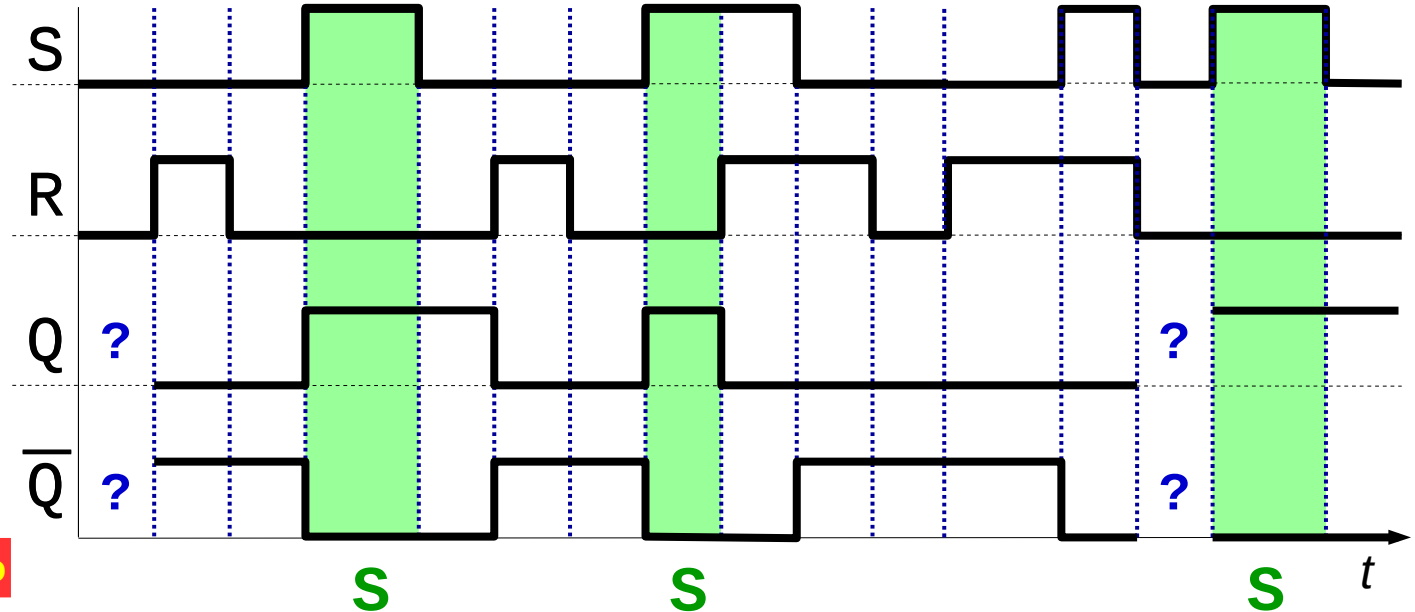
S	R	Q_{t+1}	\overline{Q}_{t+1}
0	0	Q_t	\overline{Q}_t
0	1	0	1
1	0	1	0
1	1	0	0

Mantiene

Reset

Set

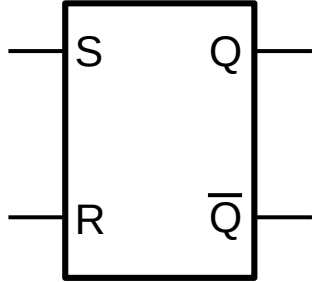
Prohibido



asíncrono

Biastable S-R asíncrono

Cronograma



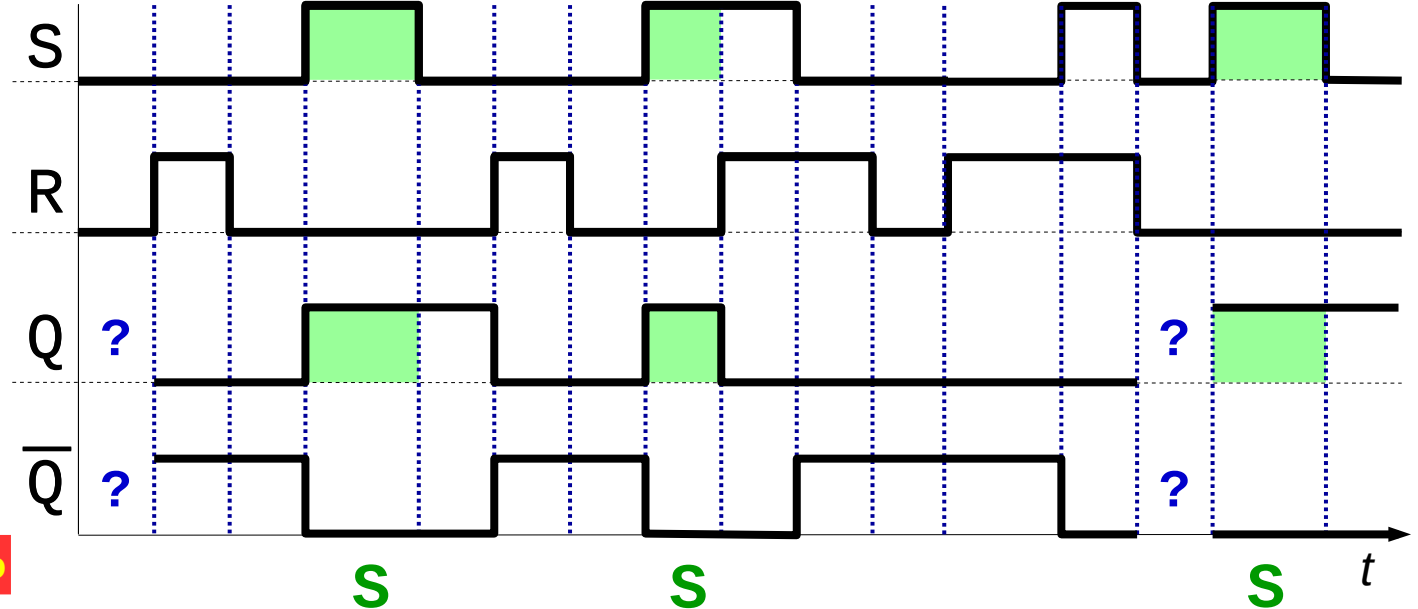
S	R	Q_{t+1}	\overline{Q}_{t+1}
0	0	Q_t	\overline{Q}_t
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1	0	1	0
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Mantiene

Reset

Set

Prohibido

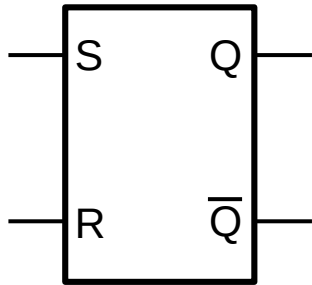


asíncrono

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

Biastable S-R asíncrono

Cronograma



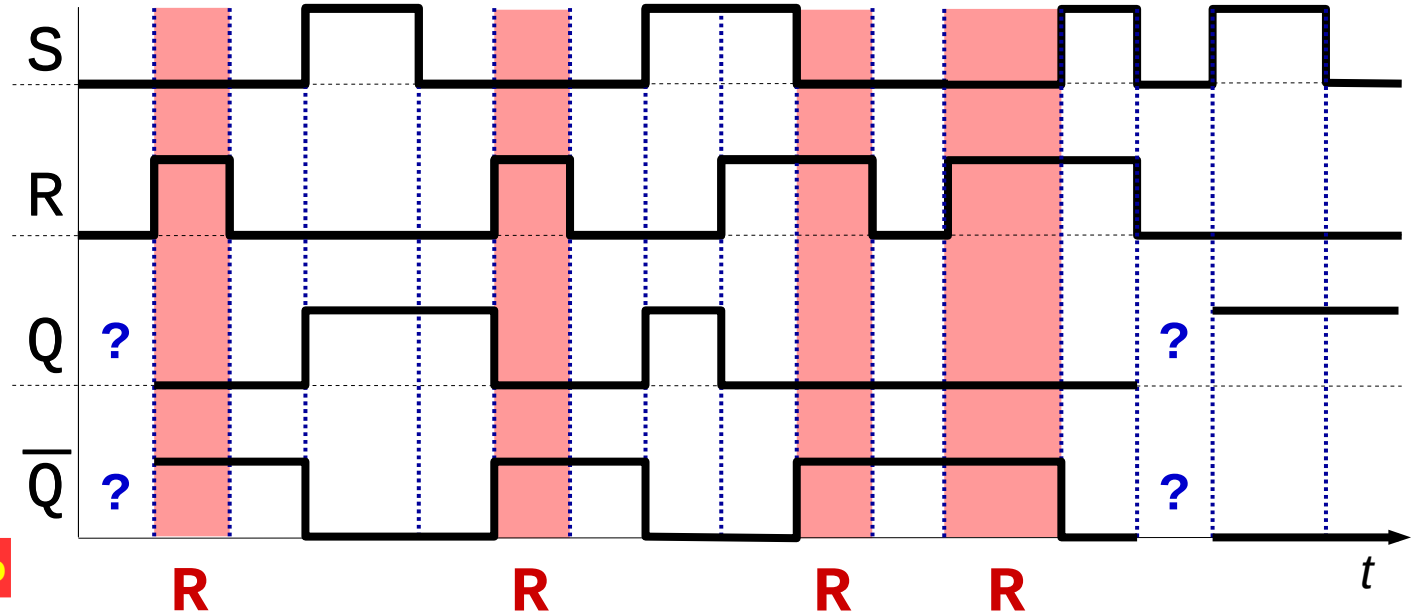
S	R	Q_{t+1}	\overline{Q}_{t+1}
0	0	Q_t	\overline{Q}_t
0	1	0	1
1	0	1	0
1	1	0	0

Mantiene

Reset

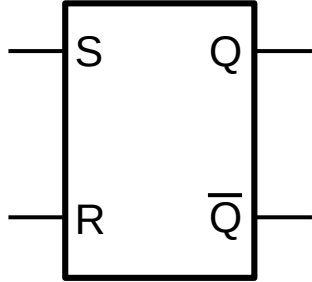
Set

Prohibido



Biastable S-R asíncrono

Cronograma



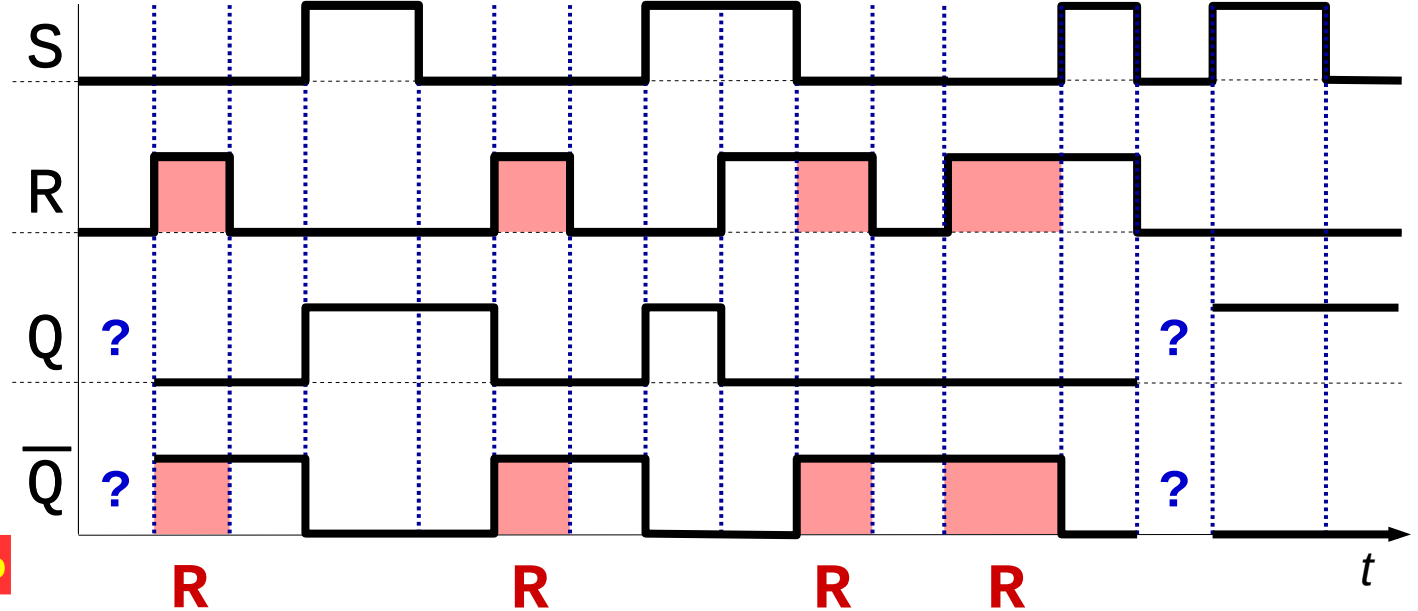
S	R	Q_{t+1}	\overline{Q}_{t+1}
0	0	Q_t	\overline{Q}_t
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Mantiene

Reset

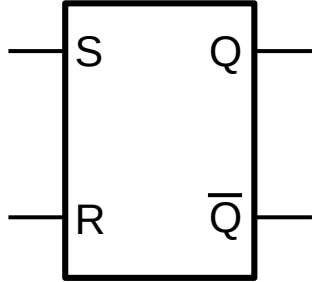
Set

Prohibido



Biastable S-R asíncrono

Cronograma



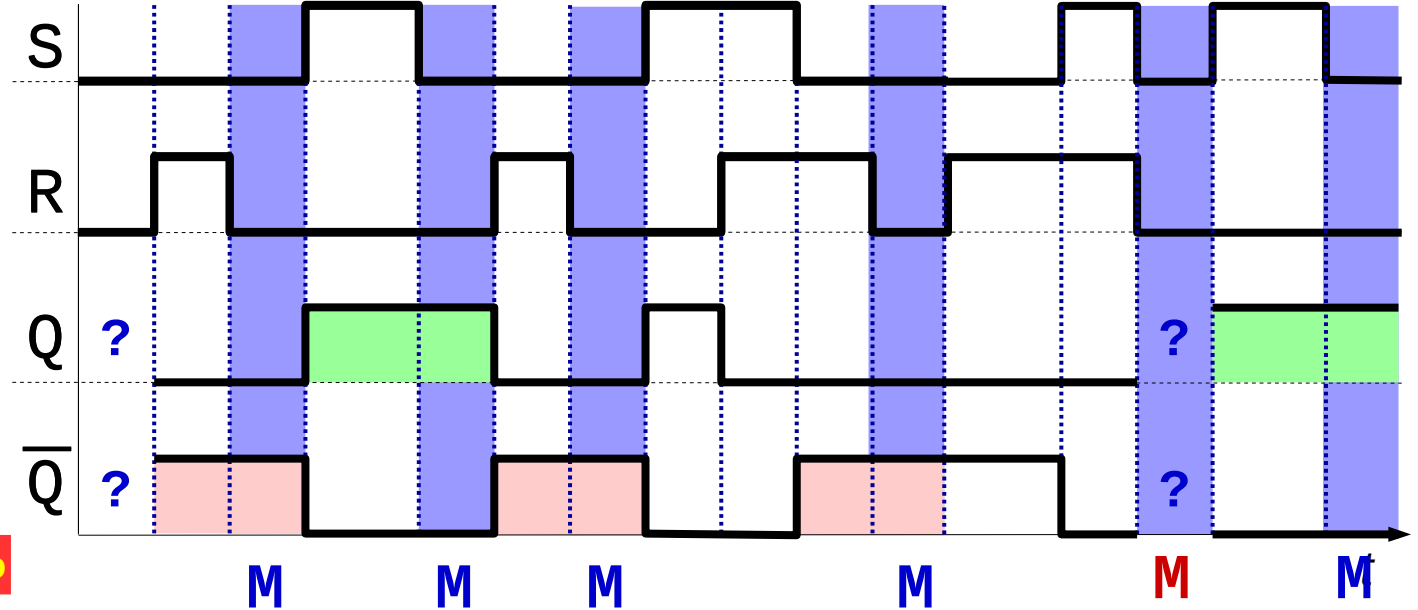
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0	1	0	1
1	0	1	0
1	1	0	0

Mantiene

Reset

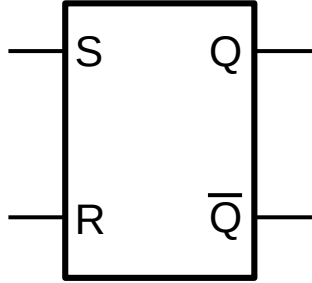
Set

Prohibido



Biastable S-R asíncrono

Cronograma



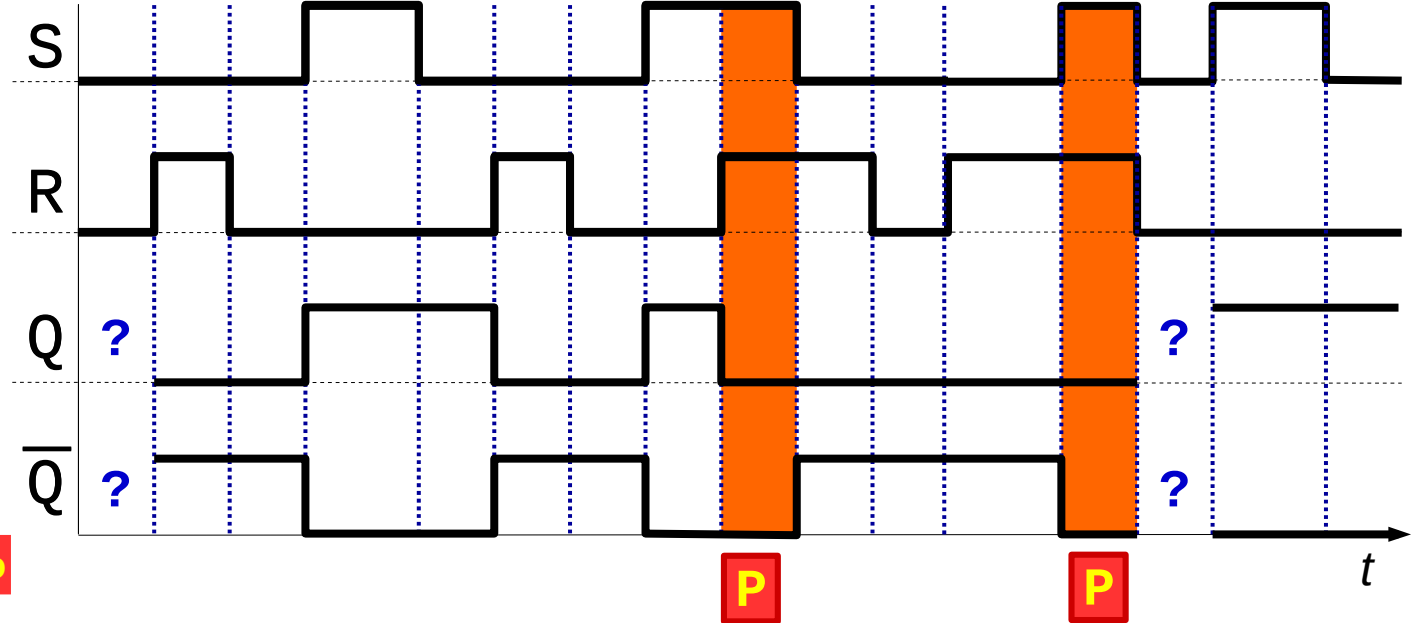
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Mantiene

Reset

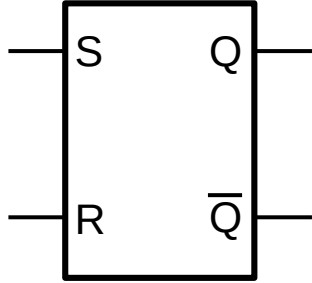
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Prohibido



Biastable S-R asíncrono

Cronograma



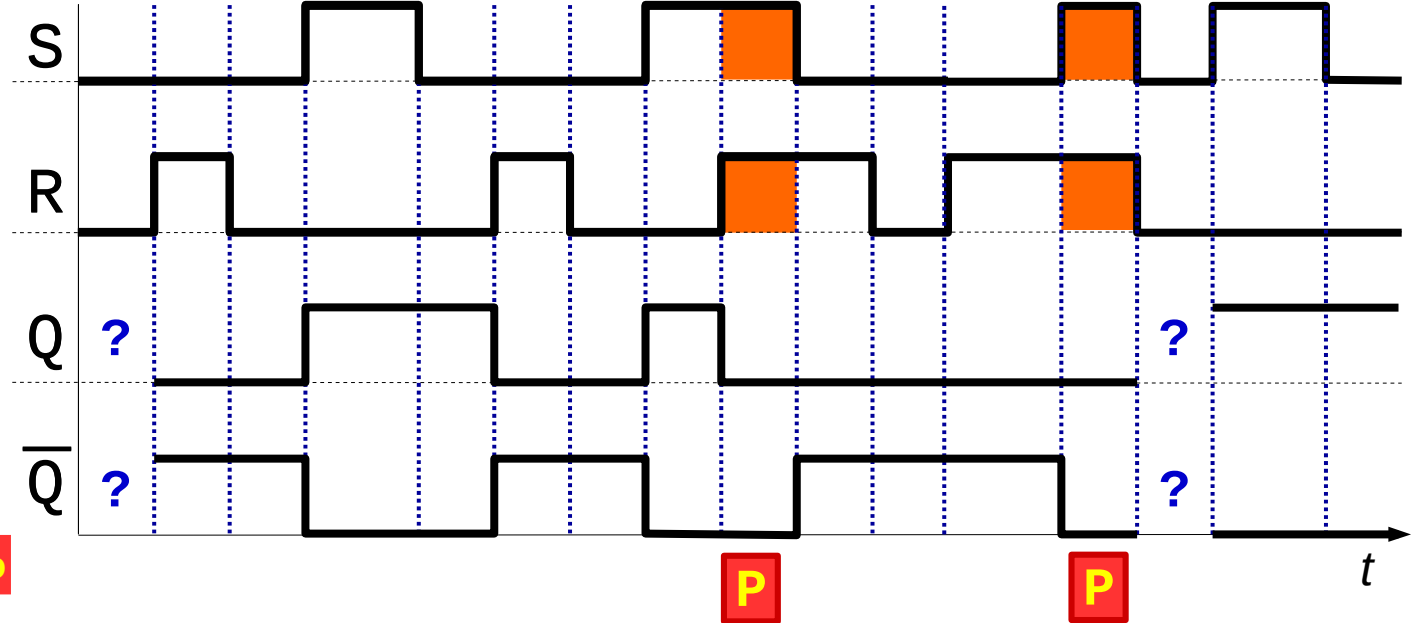
S	R	Q_{t+1}	\overline{Q}_{t+1}
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Mantiene

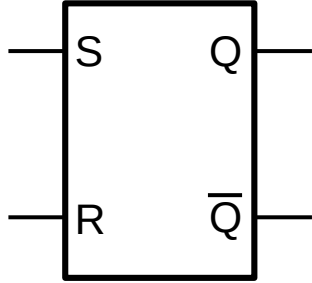
Reset

Set

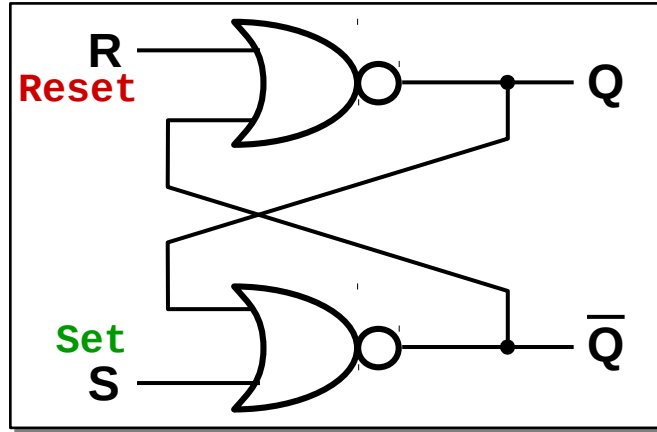
Prohibido



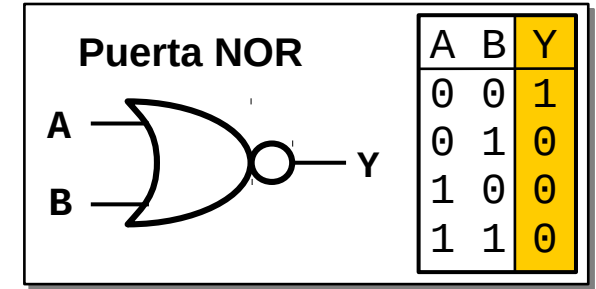
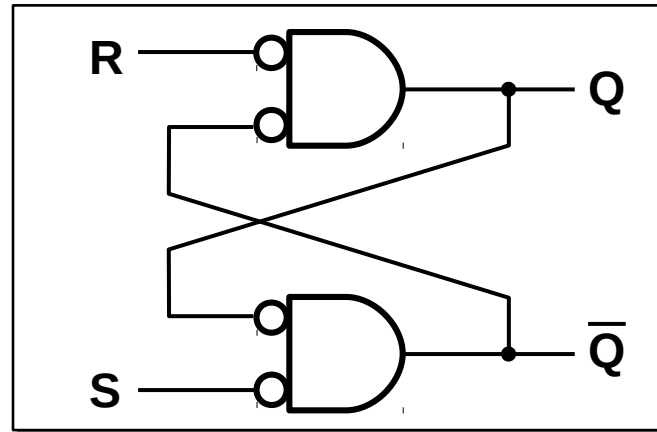
Biastable S-R asíncrono



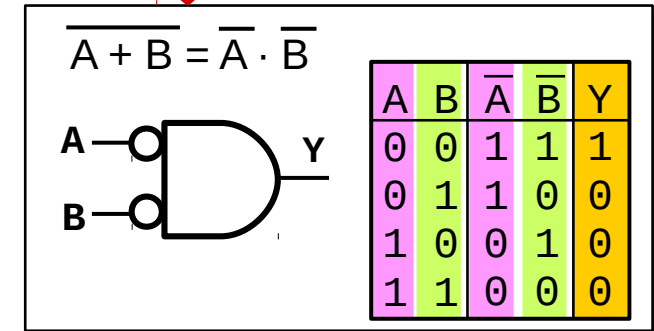
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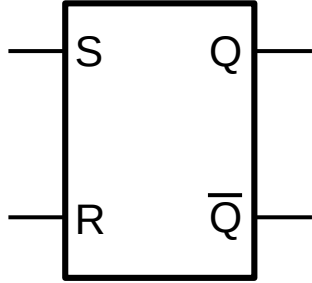
↴ equivalente



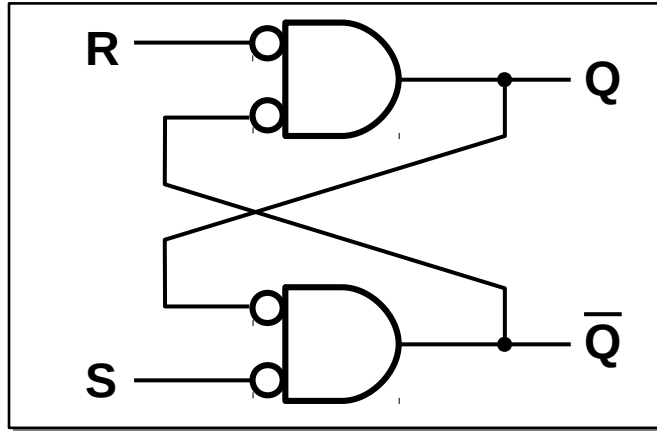
↴ equivalente



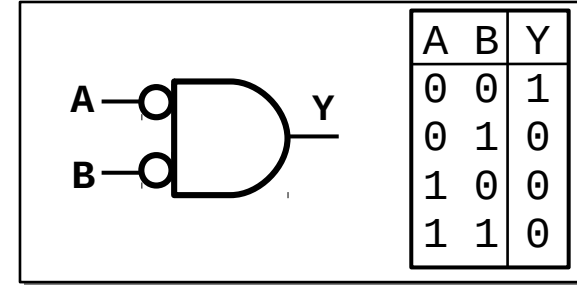
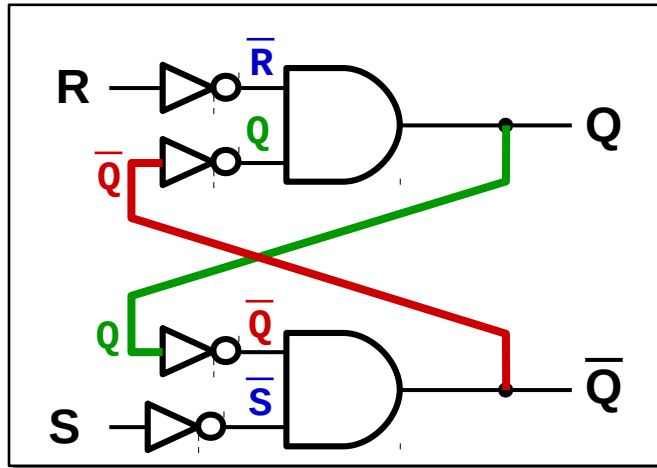
Bistable S-R asíncrono



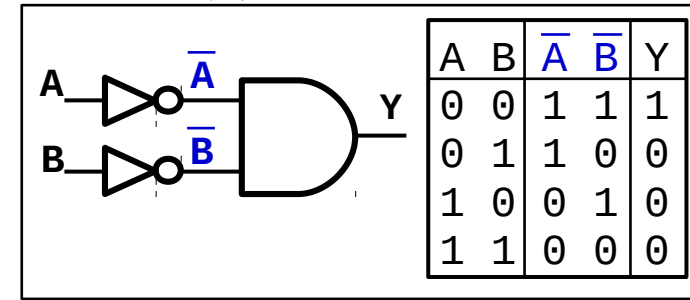
S	R	Q_{t+1}	\overline{Q}_{t+1}
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1	1	0	0



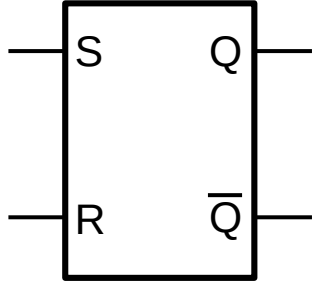
↴ equivalente



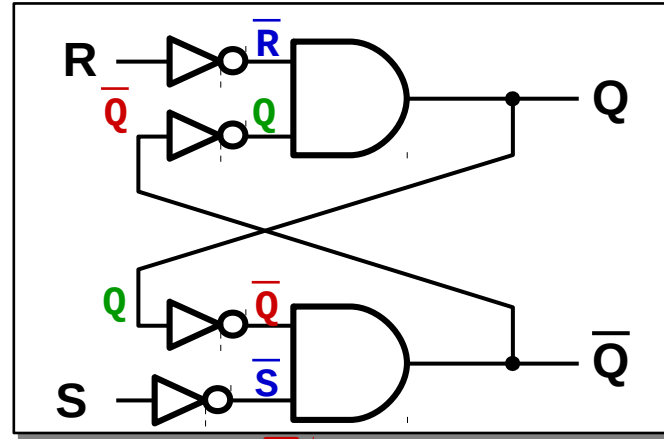
↴ equivalente



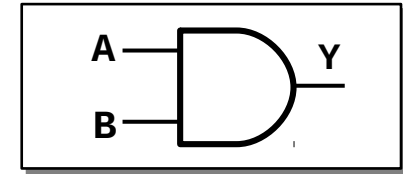
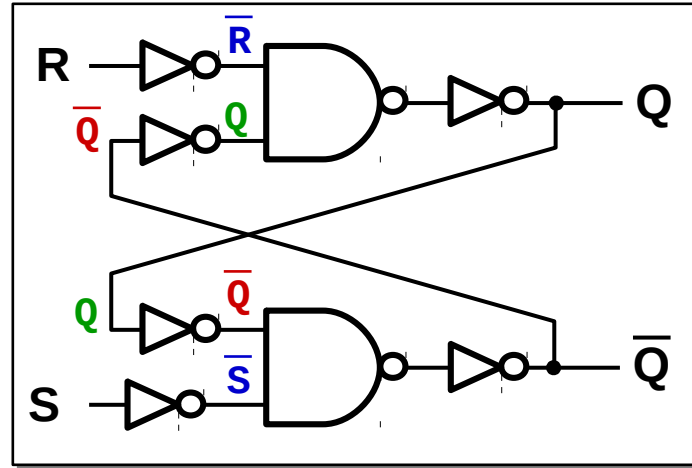
Biastable S-R asíncrono



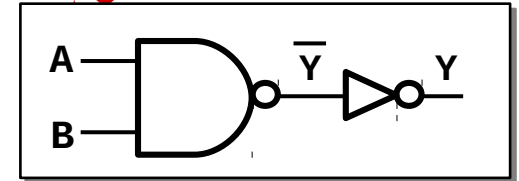
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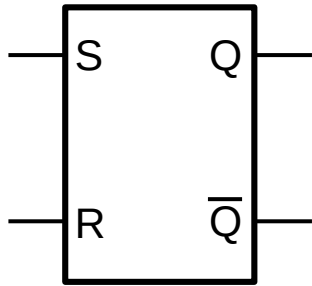
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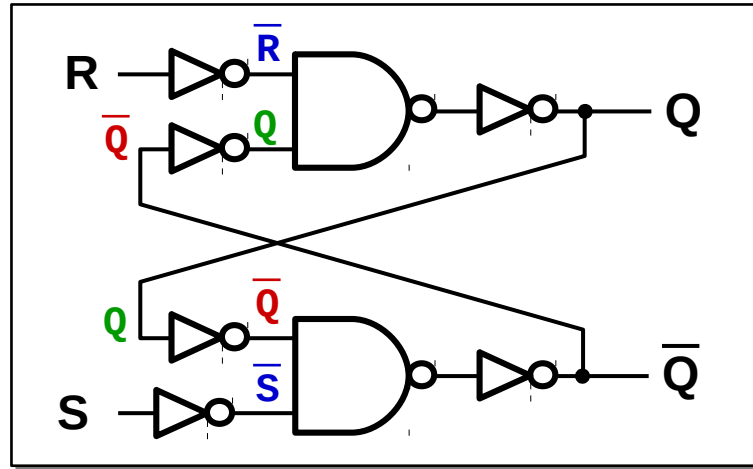
↴ equivalente



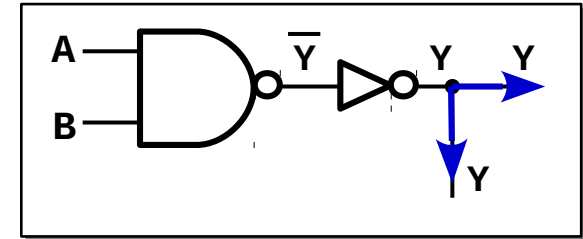
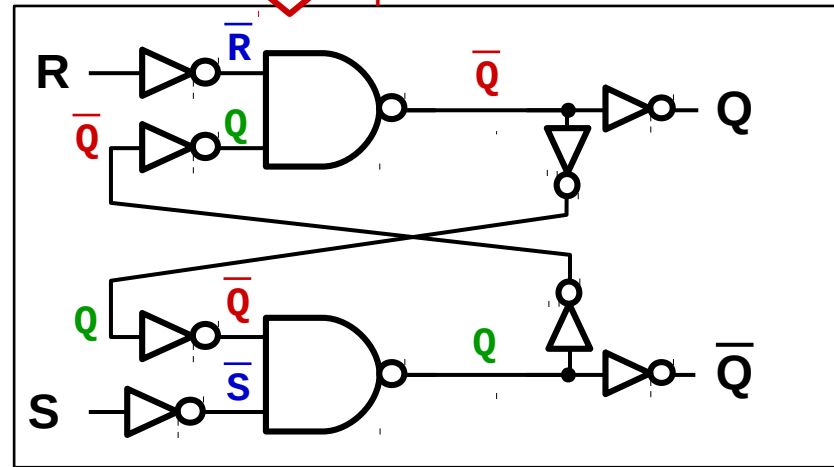
Bistable S-R asíncrono



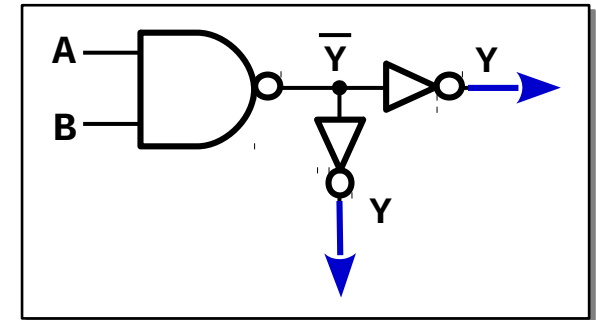
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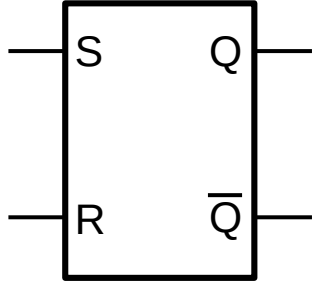
↴ equivalente



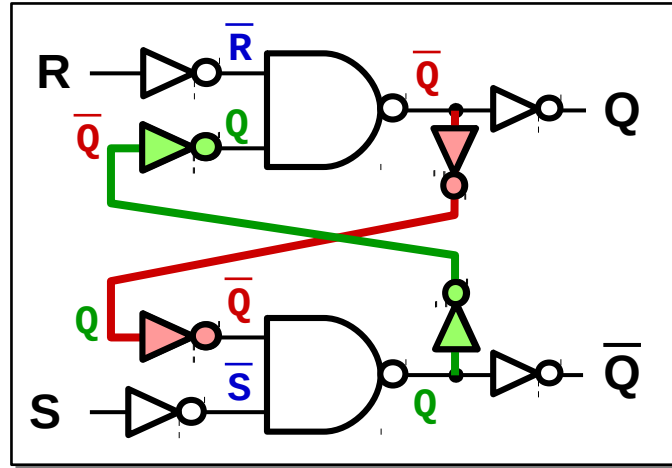
↴ equivalente



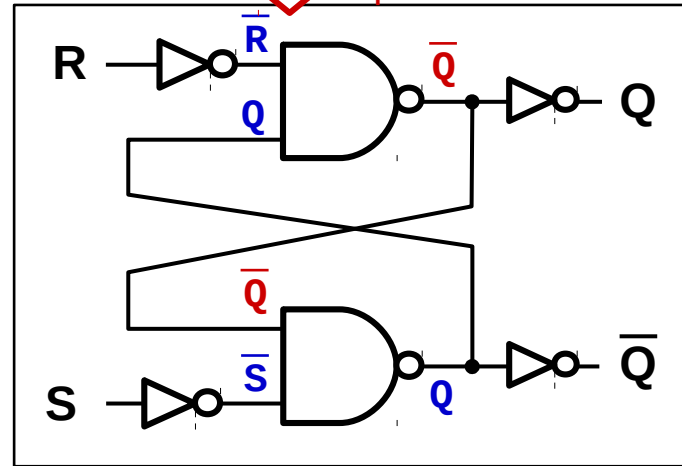
Bistable S-R asíncrono



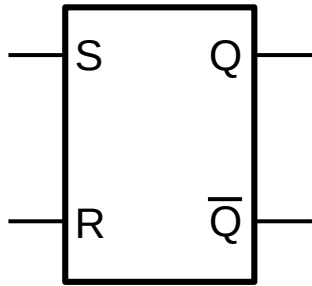
S	R	Q_{t+1}	\overline{Q}_{t+1}
0	0	Q_t	\overline{Q}_t
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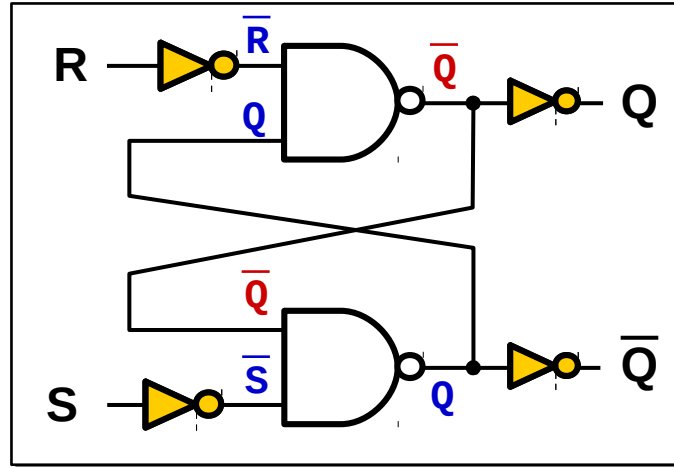
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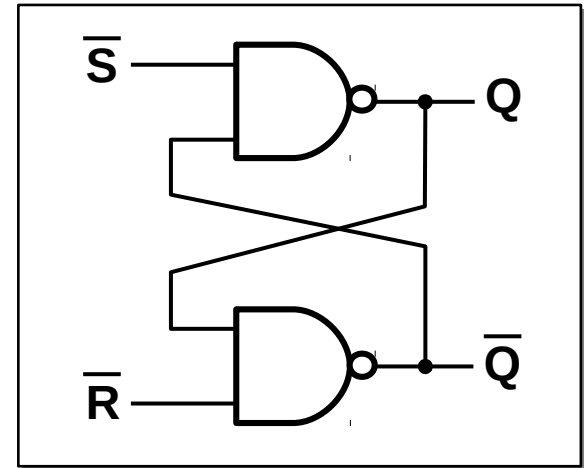
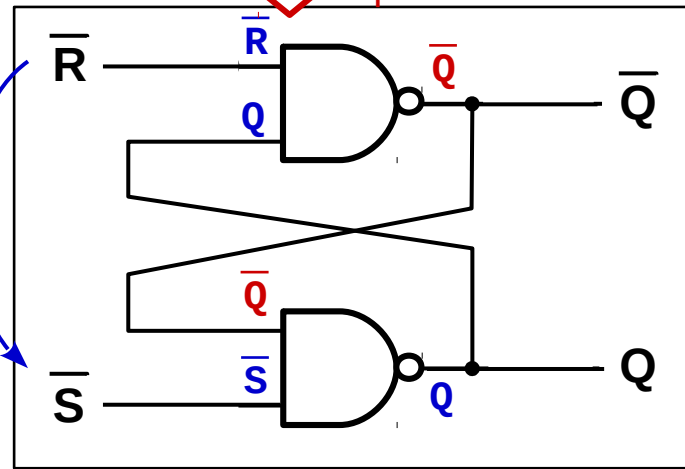
Bistable S-R asíncrono



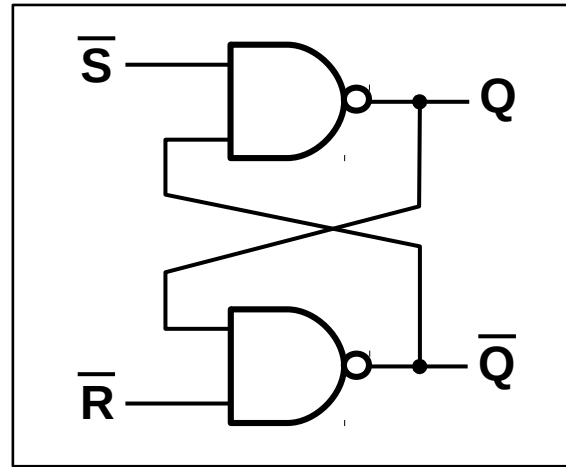
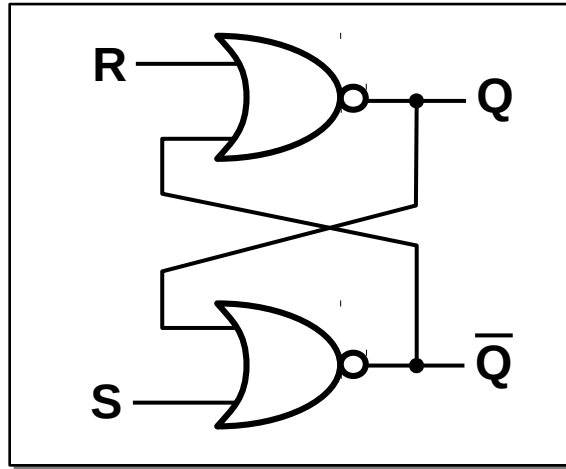
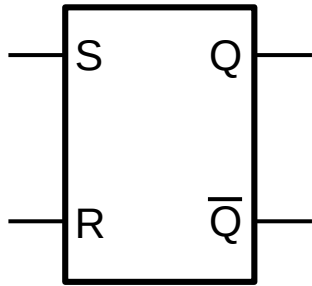
S	R	Q_{t+1}	\overline{Q}_{t+1}
0	0	Q_t	\overline{Q}_t
0	1	0	1
1	0	1	0
1	1	0	0



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	1	1

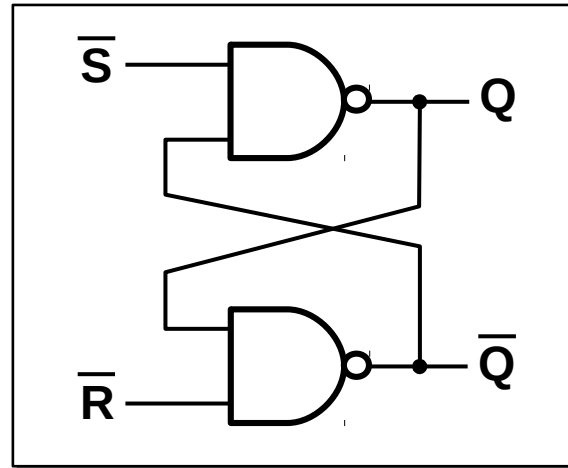
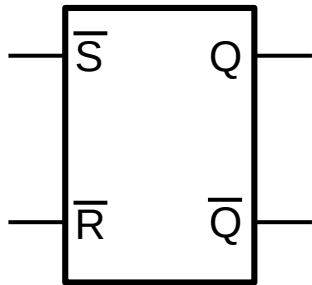
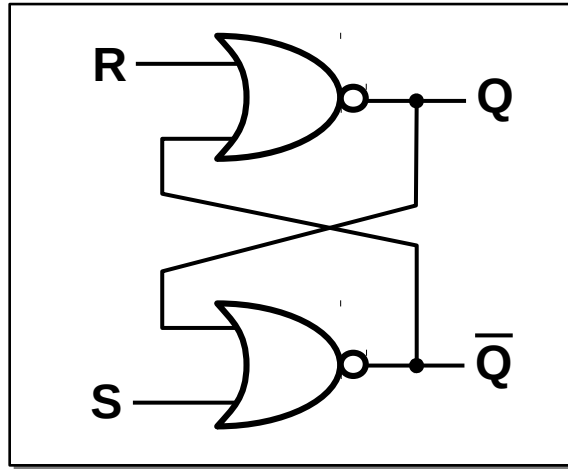
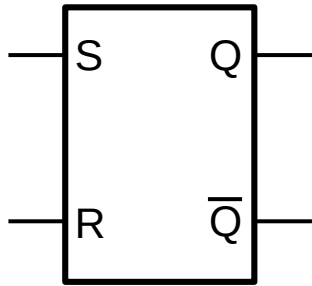
Mantiene

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	1	1

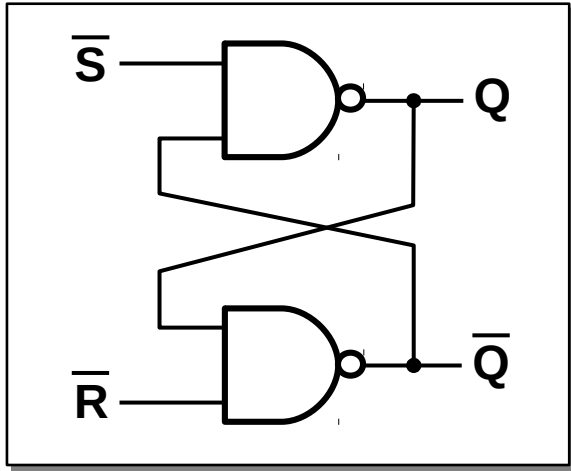
Mantiene

Reset

Set

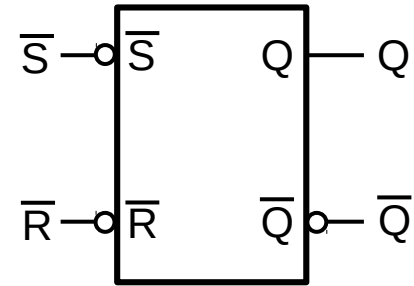
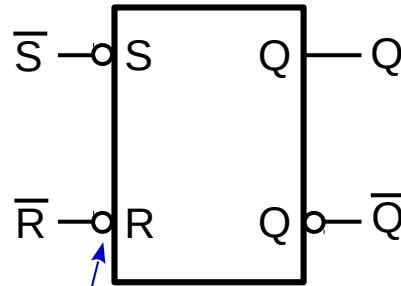
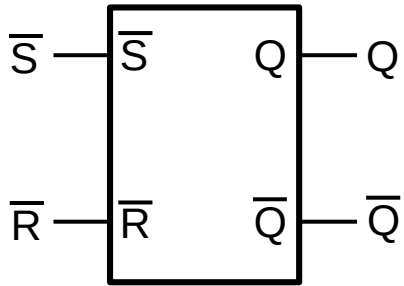
Prohibido

Biastable S-R asíncrono con puertas NAND



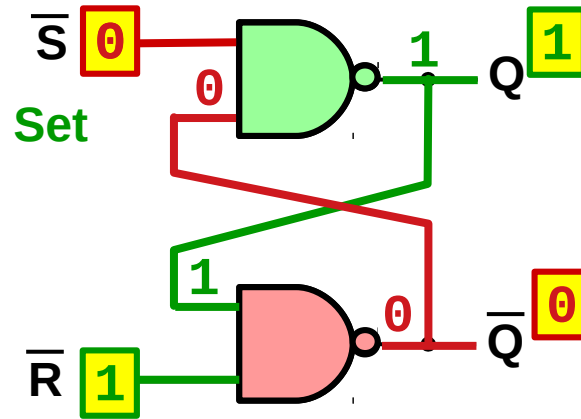
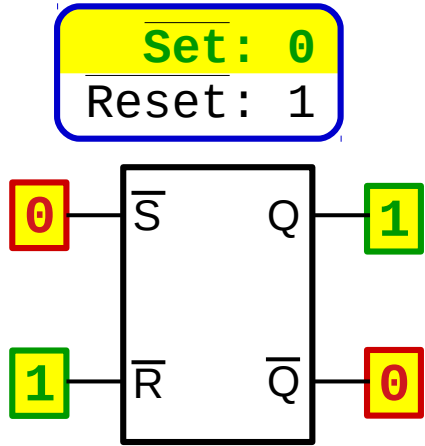
\bar{S}	\bar{R}	Q_{t+1}	\bar{Q}_{t+1}	
1	1	Q_t	\bar{Q}_t	Mantiene
1	0	0	1	Reset
0	1	1	0	Set
0	0	1	1	Prohibido

Otras posibles representaciones



Biestable S-R asíncrono con puertas NAND

Transiciones



Puerta NAND

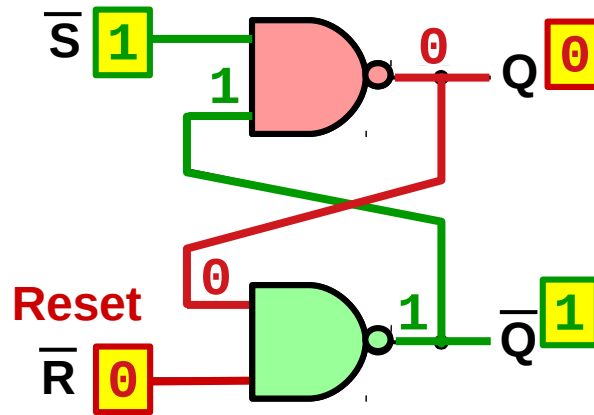
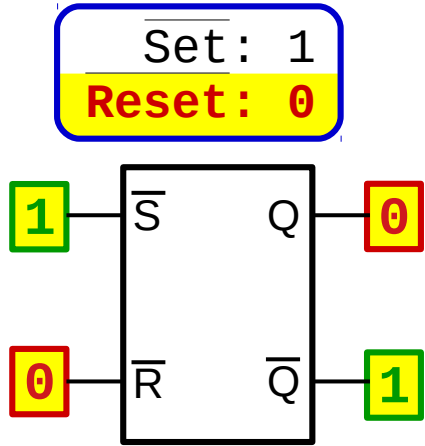
A	B	Y
0	0	1
0	1	1
1	0	1
1	1	0

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

Set

Biestable S-R asíncrono con puertas NAND

Transiciones



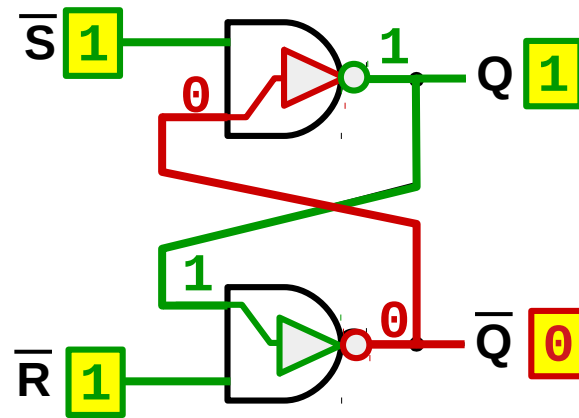
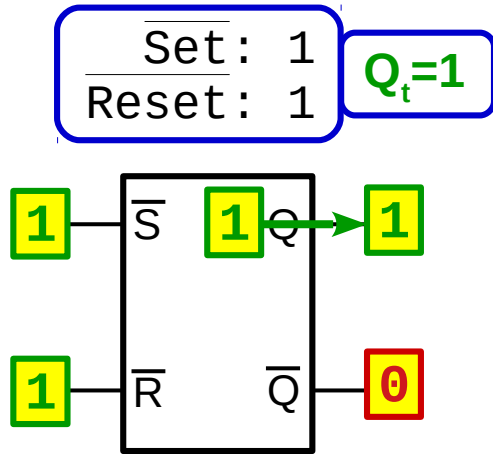
Puerta NAND

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



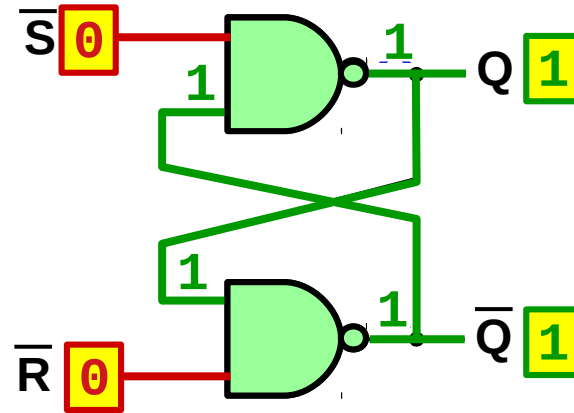
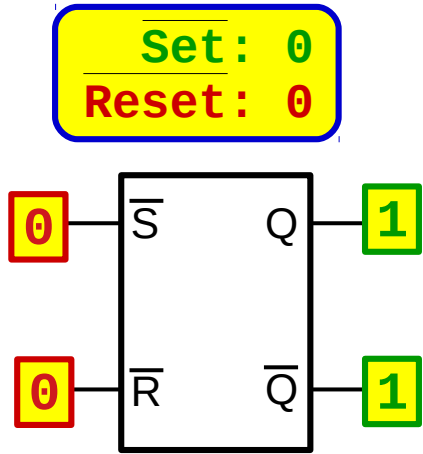
Puerta NAND

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

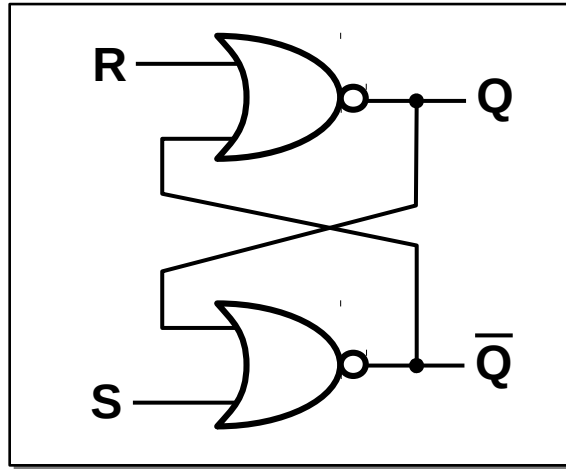
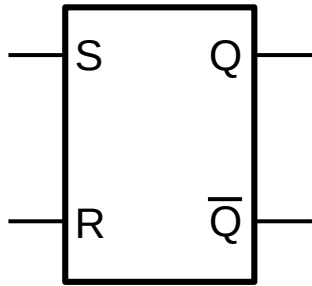


Puerta NAND

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



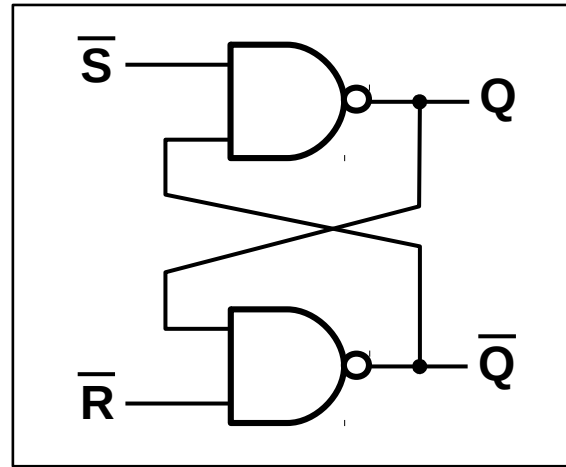
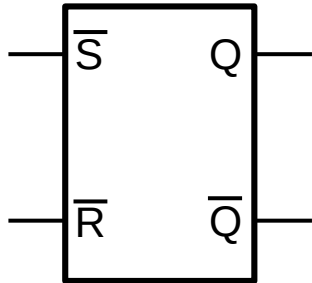
S	R	Q_{t+1}	$\overline{Q_{t+1}}$
0	0	Q_t	$\overline{Q_t}$
0	1	0	1
1	0	1	0
1	1	0	0

Mantiene

Reset

Set

Prohibido



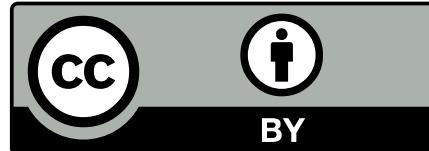
\overline{S}	\overline{R}	Q_{t+1}	$\overline{Q_{t+1}}$
0	0	1	1
0	1	1	0
1	0	0	1
1	1	Q_t	$\overline{Q_t}$

Prohibido

Set

Reset

Mantiene



Esta presentación:

Biestable S-R asíncrono - Circuitos secuenciales

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doi:[10.5281/zenodo.3750172](https://doi.org/10.5281/zenodo.3750172)

versión 1.1

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>

