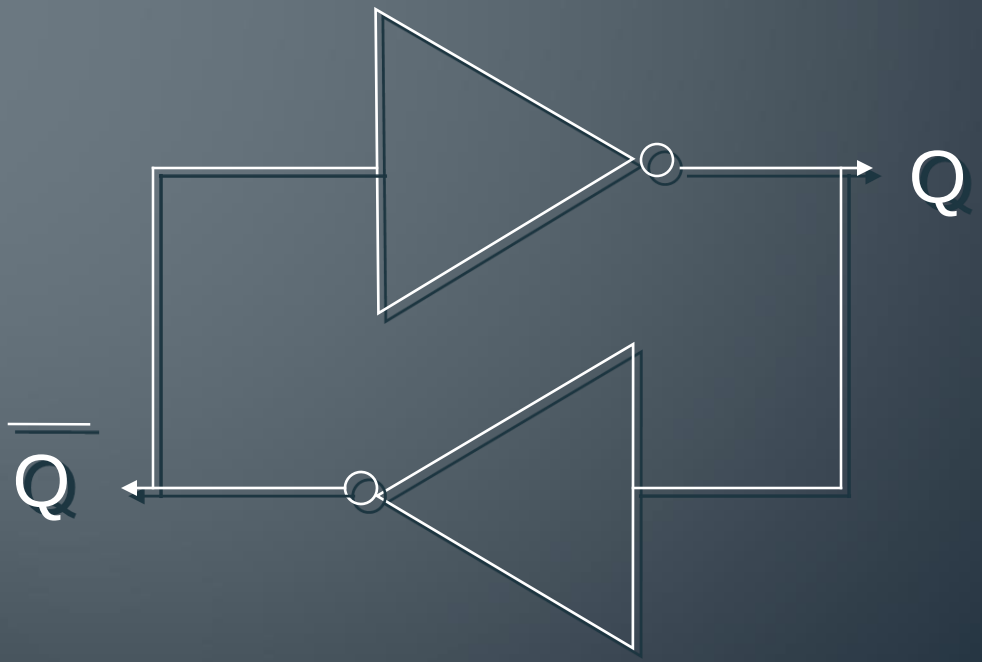
SEL 405
Introdução aos Sistemas Digitais

CIRCUITOS SEQUENCIAIS BIESTÁVEIS

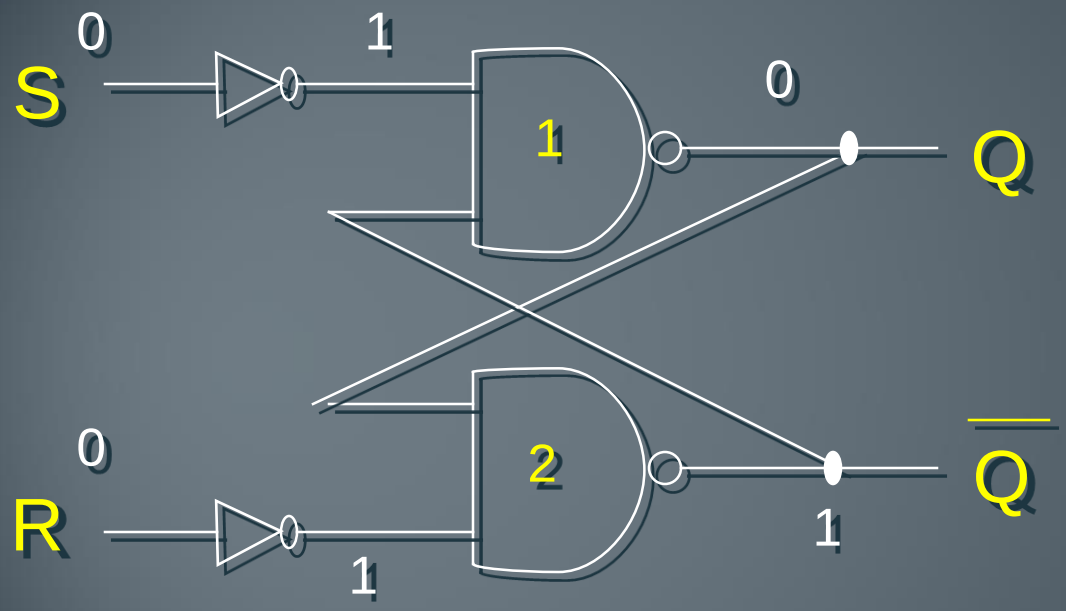
Prof. Homero Schiabel

LATCH RS



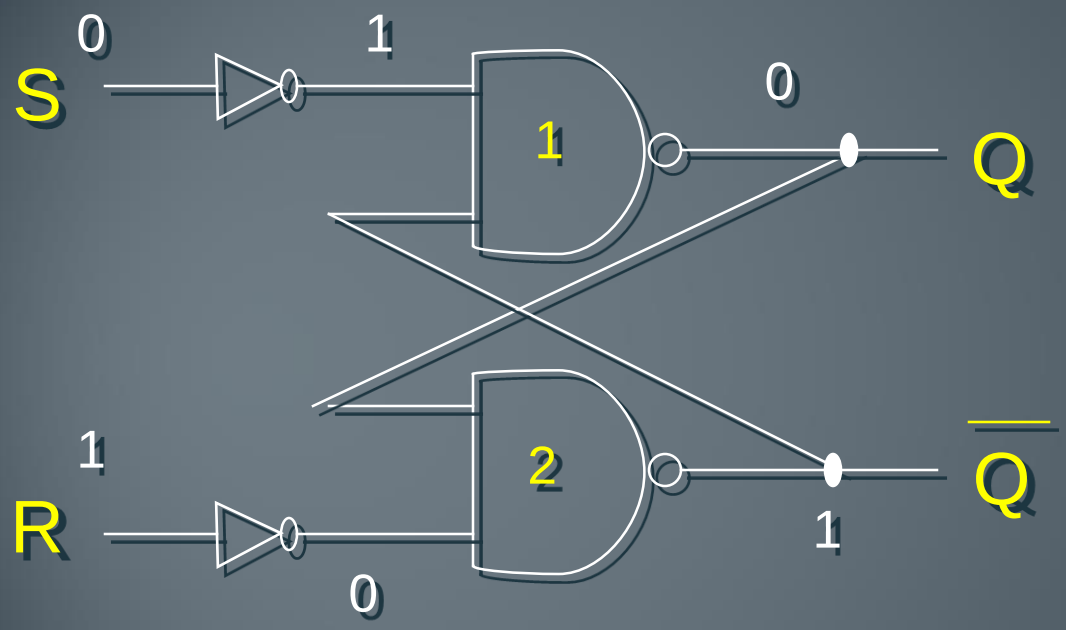
Latch RS

Condição Inicial ➔ Q = 0



S	R	1	2	Q	$\overline{Q}$
0	0	1 1	0 1	0	1

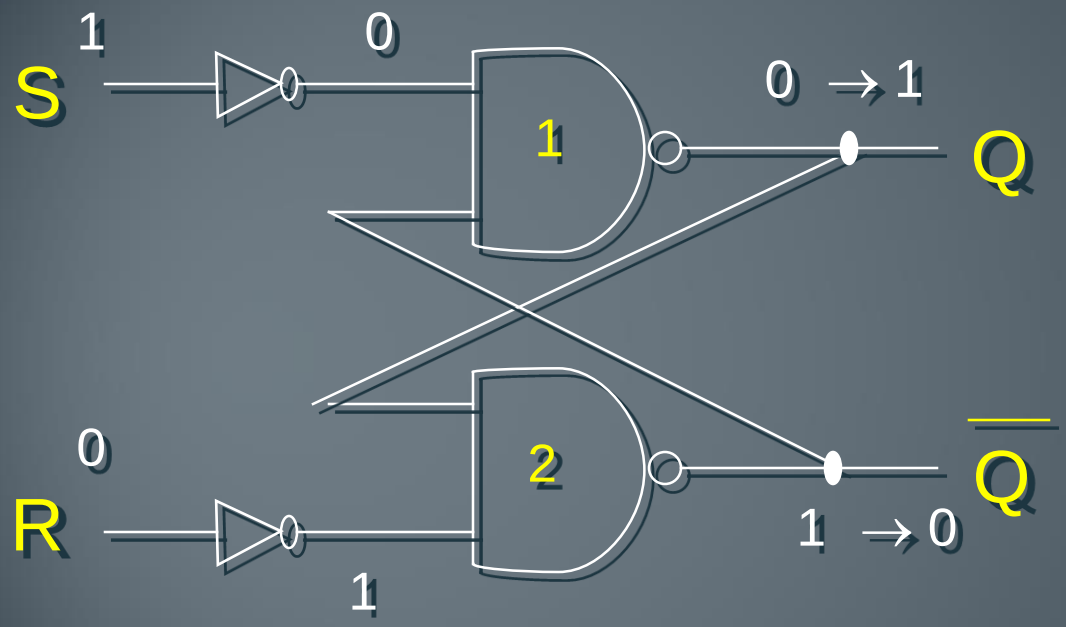
Latch RS



Condição Inicial ➔ Q = 0

S	R	1	2	Q	$\overline{Q}$
0	0	1 1	0 1	0	1
0	1	1 1	0 0	0	1

Latch RS

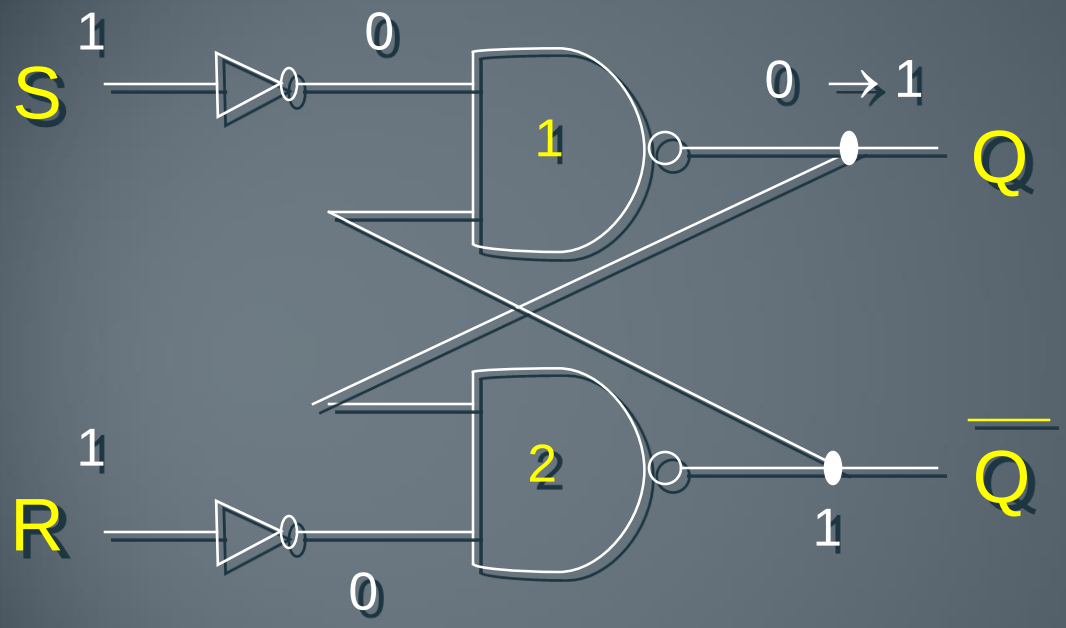


Condição Inicial ➔ Q = 0

S	R	1	2	Q	$\overline{Q}$	
0	0	1 1	0 1	0	1	
0	1	1 1	0 0	0	1	
1	0	0 1	0 1	1	1	*
		0 1	1 1	1	0	

* Estado instável

Latch RS



Condição Inicial ➔ Q = 0

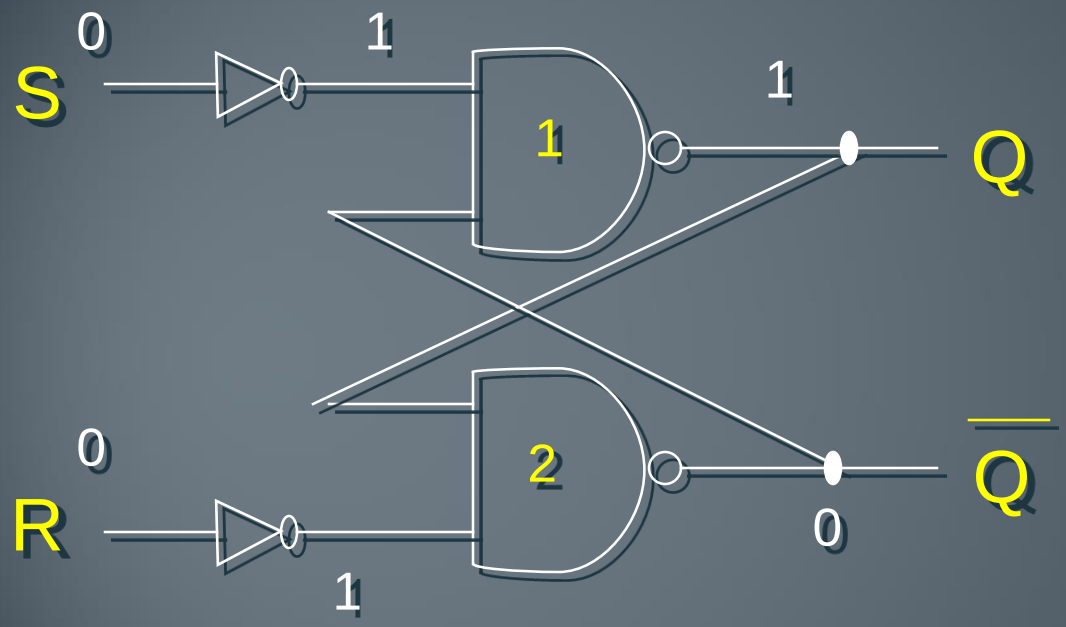
S	R	1	2	Q	$\overline{Q}$	
0	0	1 1	0 1	0	1	
0	1	1 1	0 0	0	1	
1	0	0 1	0 1	1	1	*
		0 1	1 1	1	0	
1	1	0 1	0 0	1	1	
		0 1	1 0	1	1**	

* Estado instável

** “Incompatibilidade”
(Est. “proibido”)

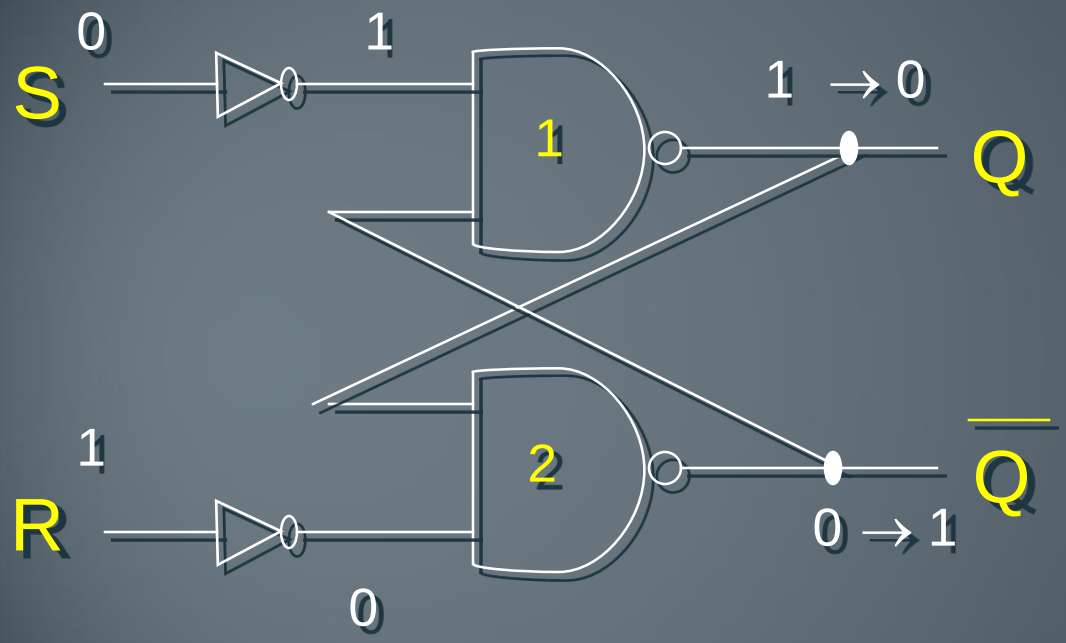
Latch RS

Condição Inicial ➔ Q = 1



S	R	1	2	Q	$\overline{Q}$
0	0	1 0	1 1	1	0

Latch RS

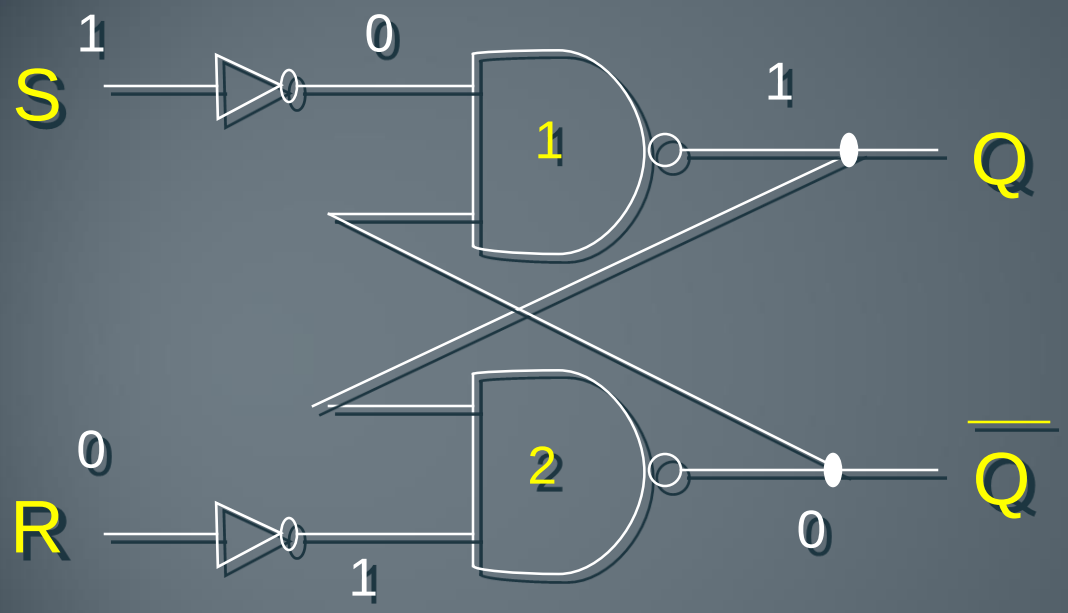


Condição Inicial ➔ Q = 1

S	R	1	2	Q	$\overline{Q}$
0	0	1 0	1 1	1	0
0	1	1 0	1 0	1	1 *
		1 1	1 0	0	1

* Estado instável

Latch RS

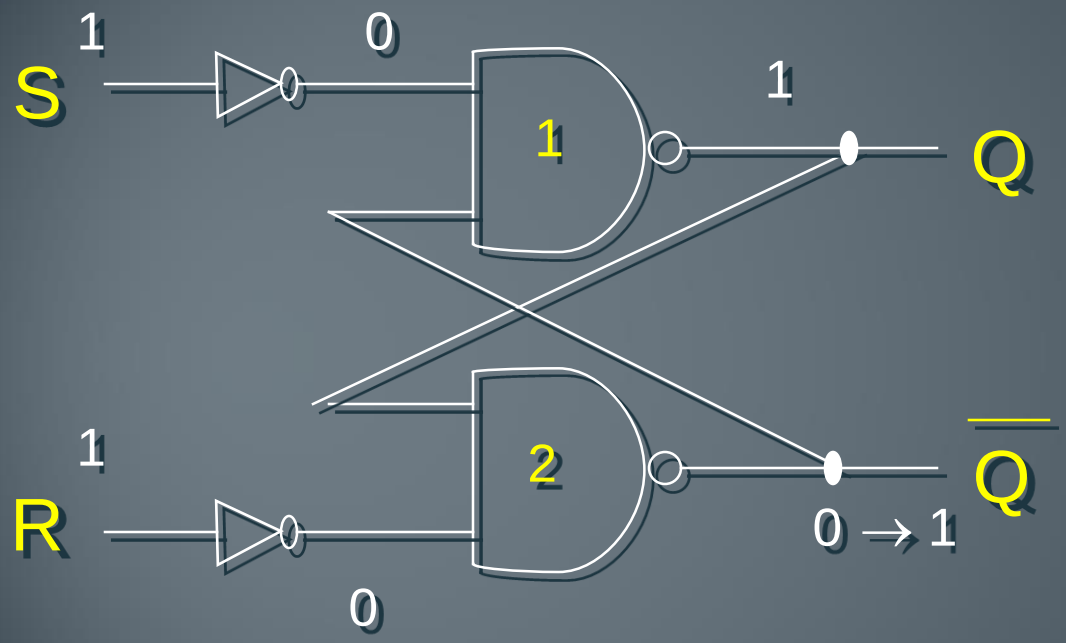


Condição Inicial ➔ Q = 1

S	R	1	2	Q	$\overline{Q}$
0	0	1 0	1 1	1	0
0	1	1 0	1 0	1	1 *
		1 1	1 0	0	1
1	0	0 0	1 1	1	0

* Estado instável

Latch RS



Condição Inicial ➔ Q = 1

S	R	1	2	Q	$\overline{Q}$
0	0	1 0	1 1	1	0
0	1	1 0	1 0	1	1 *
		1 1	1 0	0	1
1	0	0 0	1 1	1	0
1	1	0 0	1 0	1	1
		0 1	1 0	1	1**

* Estado instável

** "Incompatibilidade"
(Est. "proibido")

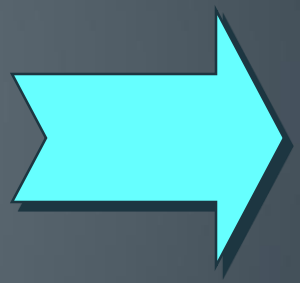
Tabela da verdade:

Q = 0

S	R	Q	$\overline{Q}$
0	0	0	1
0	1	0	1
1	0	1	0
1	1	1	1**

Q = 1

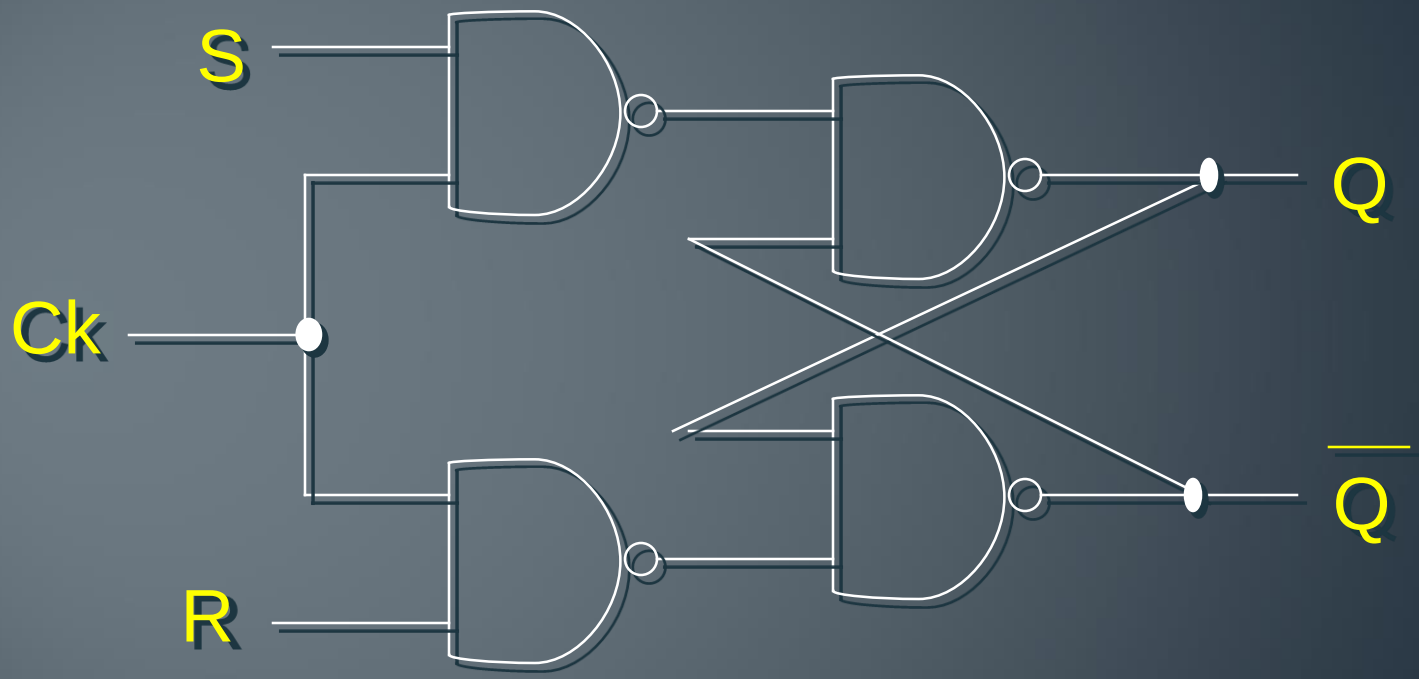
S	R	Q	$\overline{Q}$
0	0	1	0
0	1	0	1
1	0	1	0
1	1	1	1**



S	R	Q*
0	0	Q
0	1	0
1	0	1
1	1	1 **

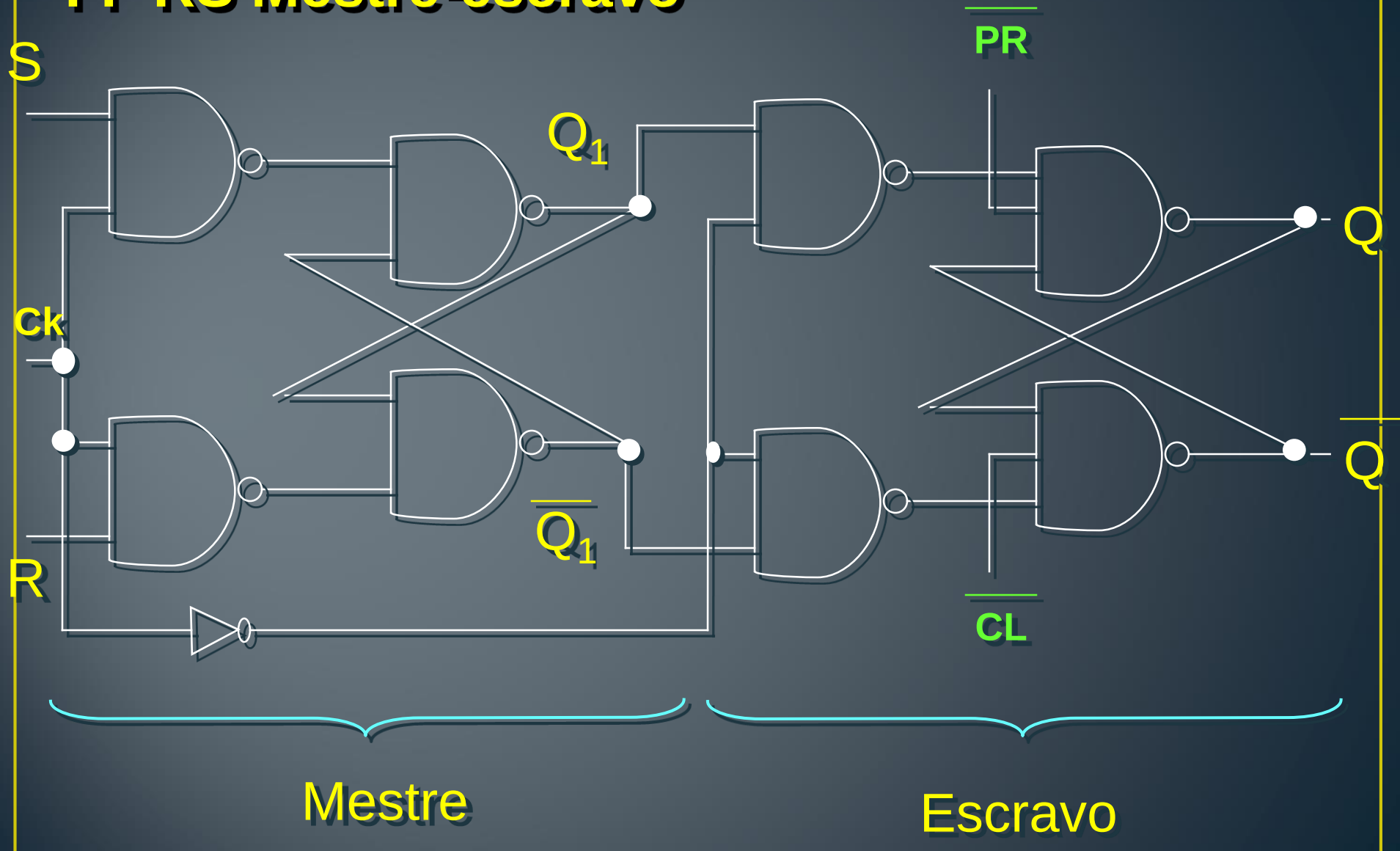
** “Incompatibilidade”
(Est. “proibido”)

RS Síncrono



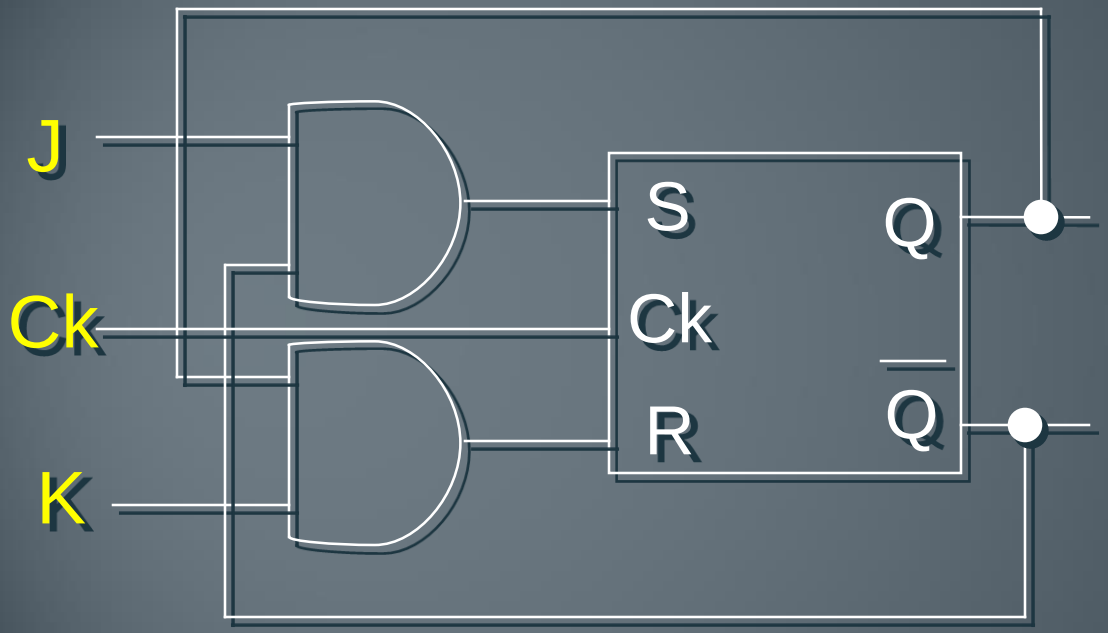
- Para Ck=0 ➔ Q e $\overline{Q}$ não "sentirão" eventuais variações nas entradas
- Para Ck=1 ➔ funcionamento normal (portas de entrada habilitadas)

FF RS Mestre-escravo



FLIP-FLOP JK

Flip-flop JK

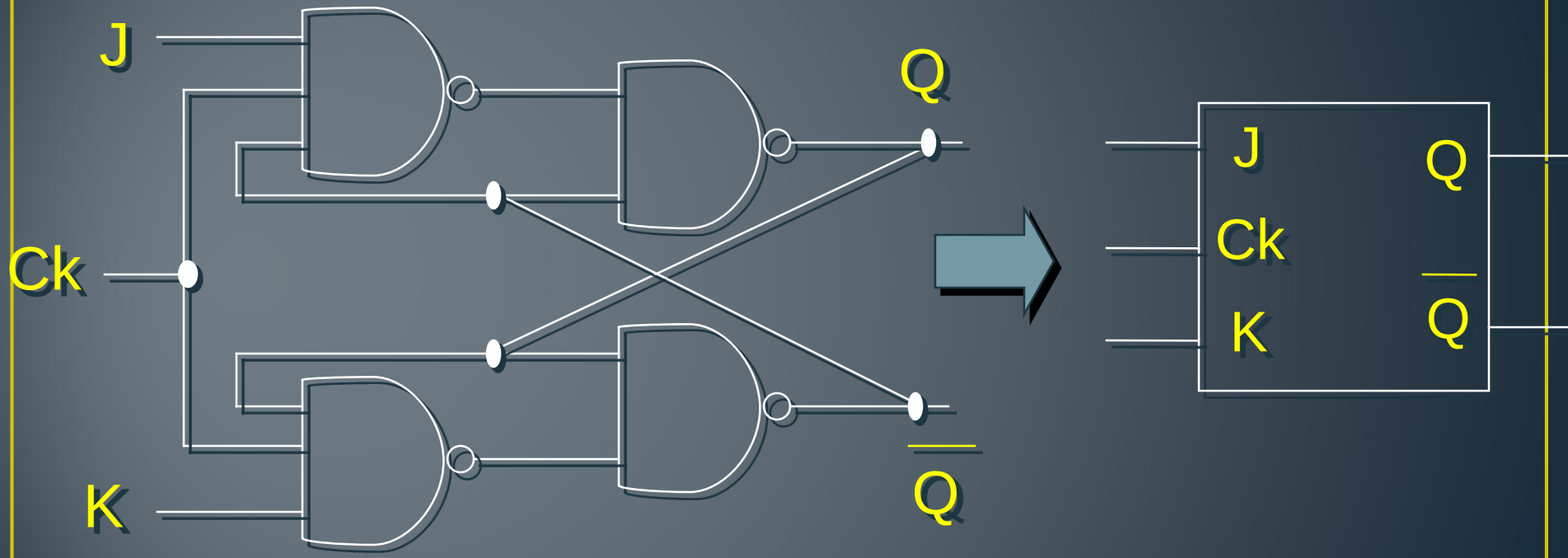


J	K	Q *
0	0	Q
0	1	0
1	0	1
1	1	$\overline{Q}$

Resolve o problema da indeterminação quando as duas entradas são iguais a 1

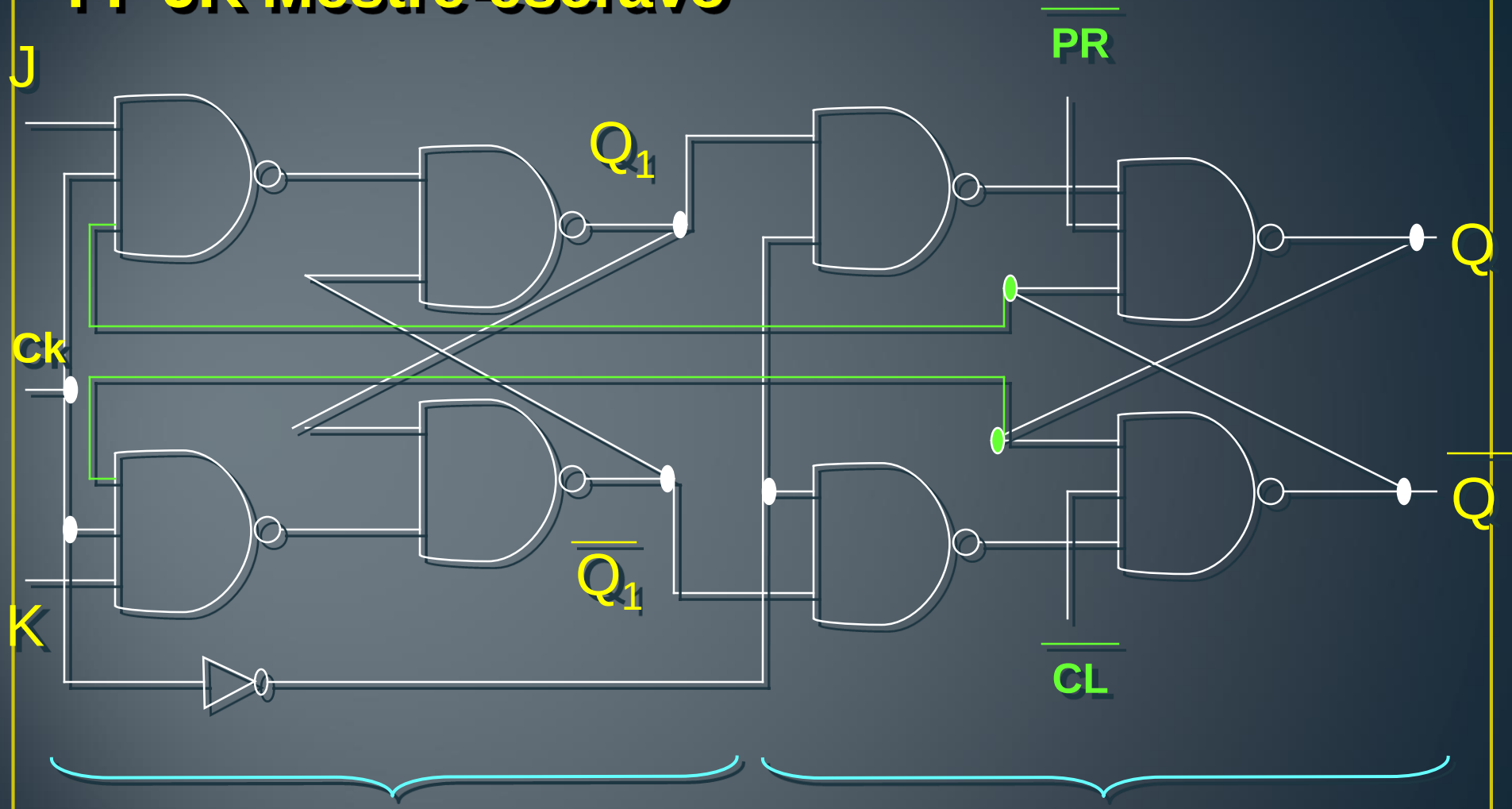
* Após o pulso do Ck

Circuito básico real

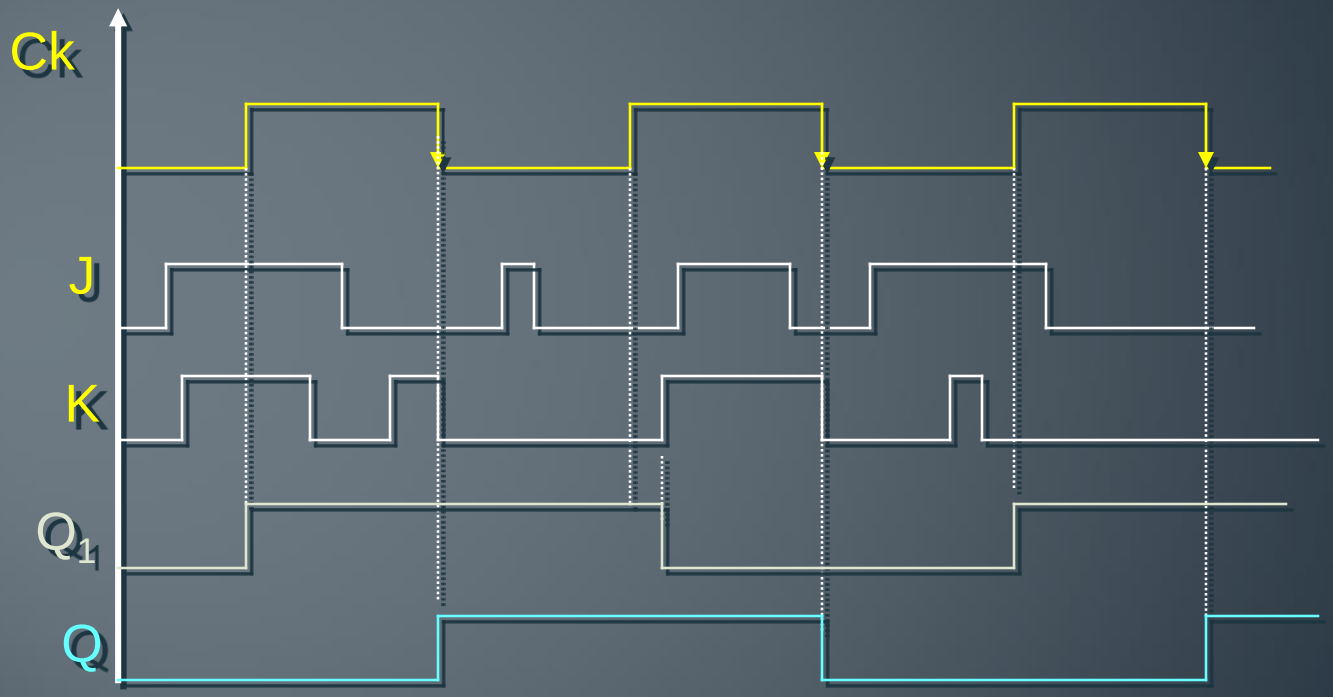


Problema do JK comum: quando o Ck=1, há passagem das entradas e realimentações; se, nesse instante, houver mudança de J e/ou K, haverá nova saída ➔ comutação para outro estado mais de uma vez durante o mesmo pulso de Ck

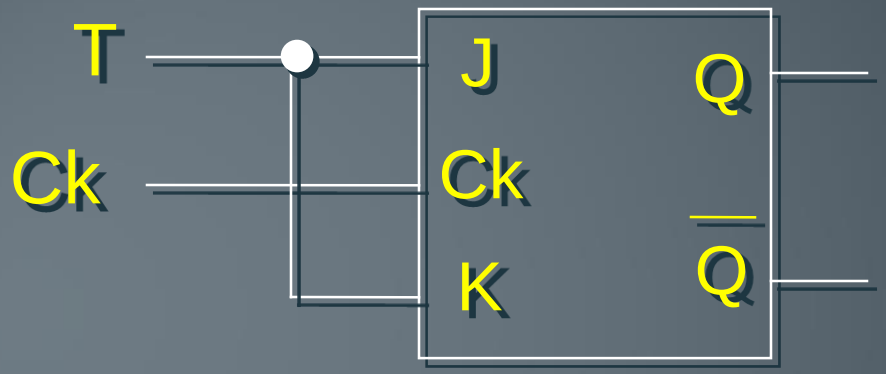
FF JK Mestre-escravo



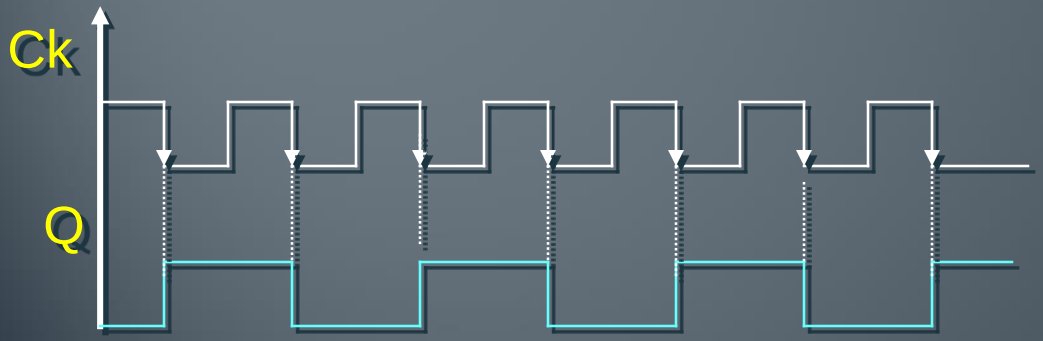
FF JK Mestre-escravo: comportamento



FF Tipo T



T	Q
0	Q
1	$\overline{Q}$

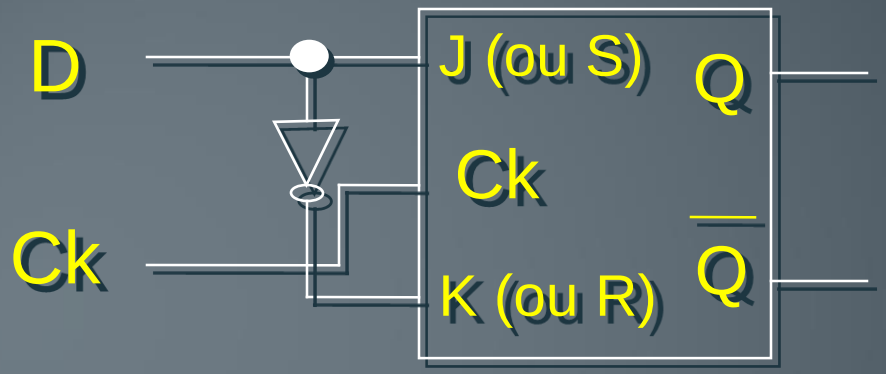


T = 1

$f_Q = f_{Ck} / 2$

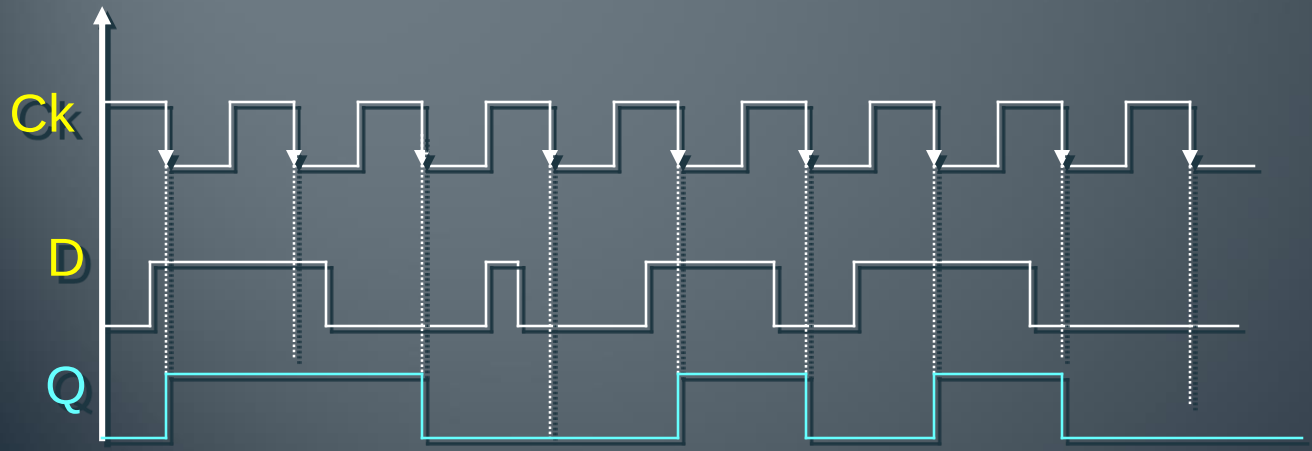
Divisor por 2

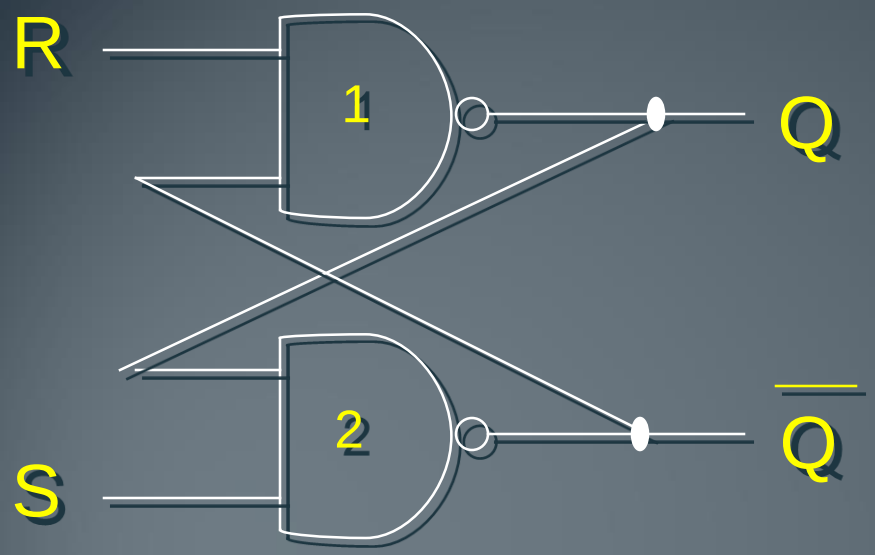
FF Tipo D



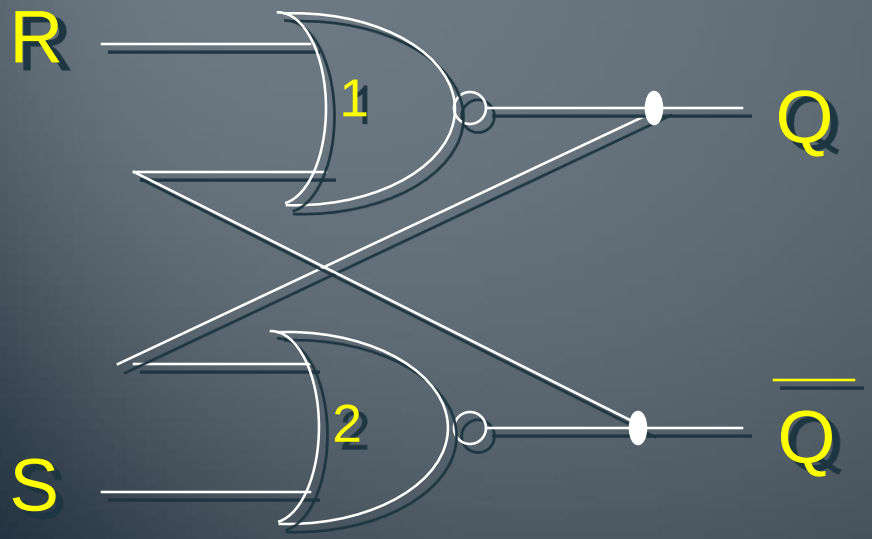
D	Q
0	0
1	1

Ck =↑, ↓ ou nível





R	S	Q
0	0	1 **
0	1	1
1	0	0
1	1	Q_a



R	S	Q
0	0	Q_a
0	1	1
1	0	0
1	1	1 **