

# MC542

## Organização de Computadores Teoria e Prática

2006

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**MC542**

## **Circuitos Lógicos**

**Flip-Flops, Registradores, Contadores**

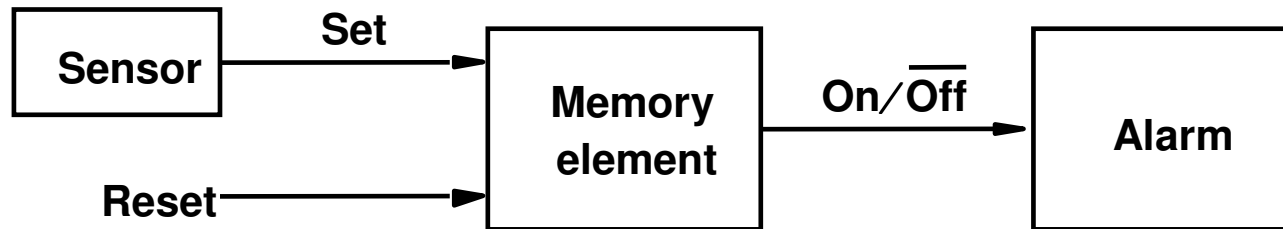
**“Fundamentals of Digital Logic with VHDL  
Design” - (Capítulo 7)**

# Flip-Flops, Registradores, Contadores

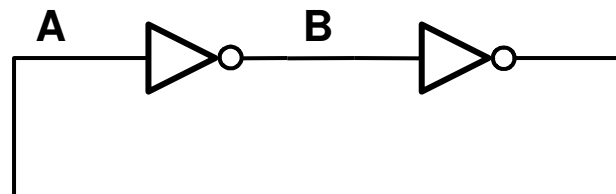
## Sumário

- Latch Básico
- Latch RS
- Latch D
- Flip-Flops
  - D, T e JK
- Registradores
- Registradores de Deslocamento
- Contadores
  - Assíncronos
  - Síncronos
  - Módulo m

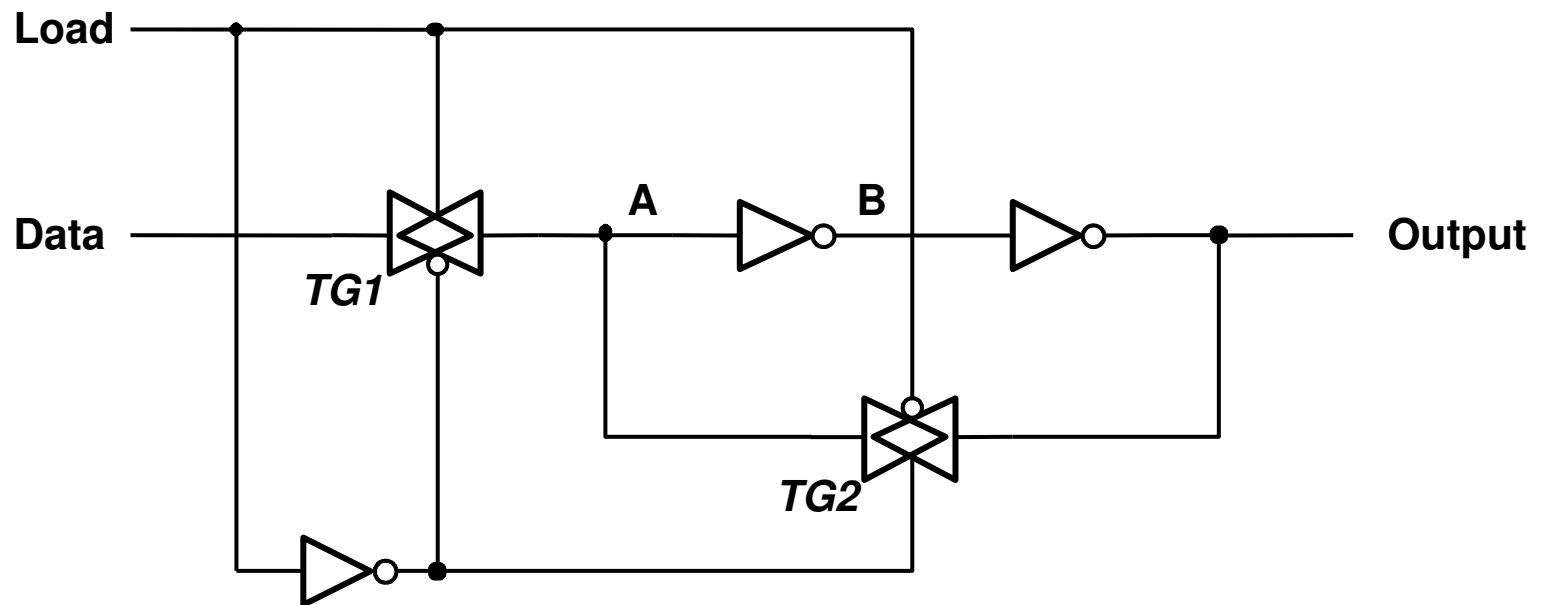
# Circuito de Alarme



## Elemento de Memória Simples

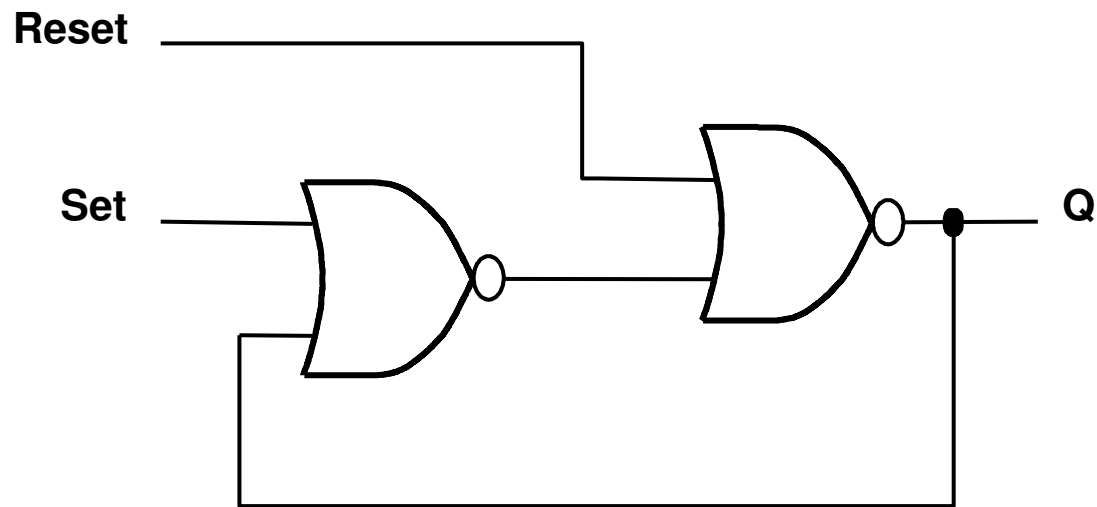


# Elemento de Memória com controle



# Latch Básico

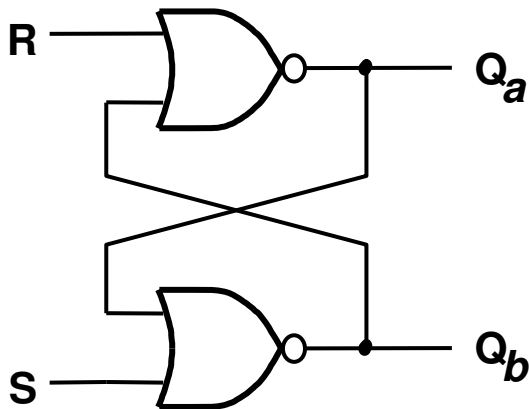
## Elemento de Memória com NOR



Qual a tabela verdade?

# Latch Básico

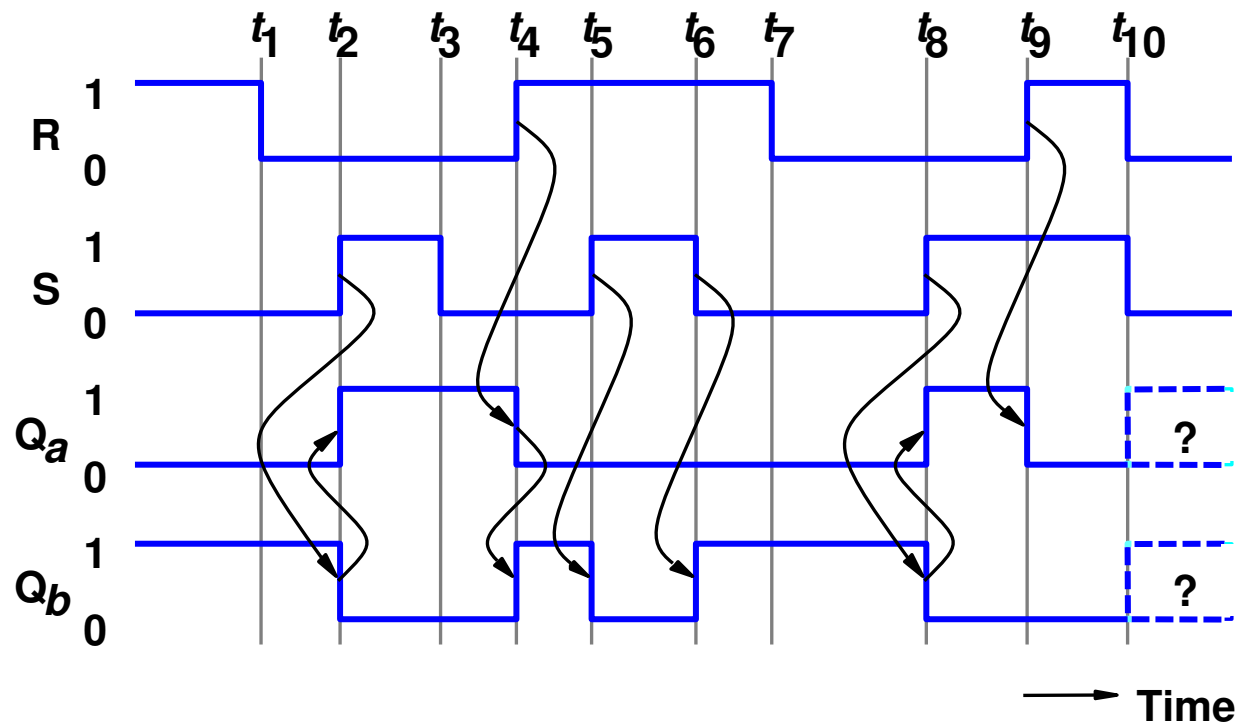
## Elemento de Memória com NOR



S	R	Q <sub>a</sub>	Q <sub>b</sub>
0	0	0/1	1/0 (no change)
0	1	0	1
1	0	1	0
1	1	0	0

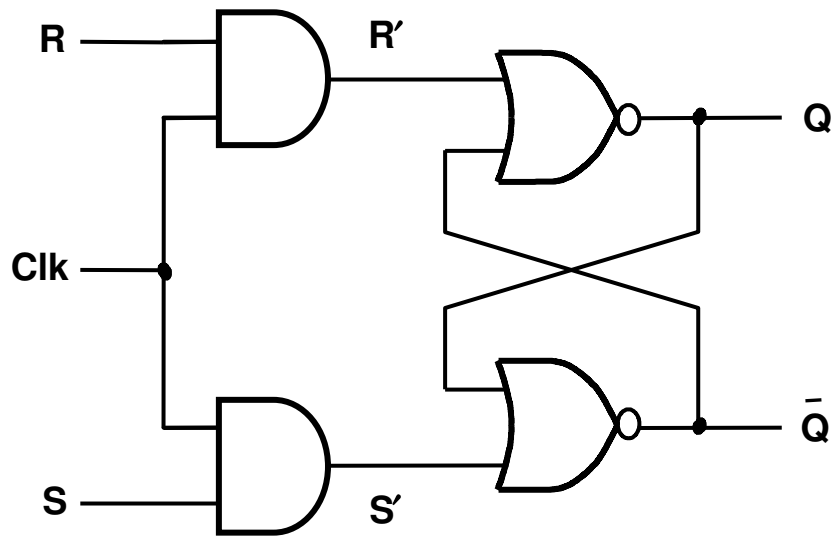
# Latch Básico

## Elemento de Memória com NOR



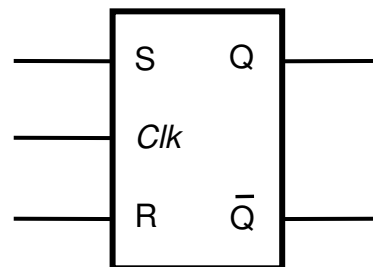
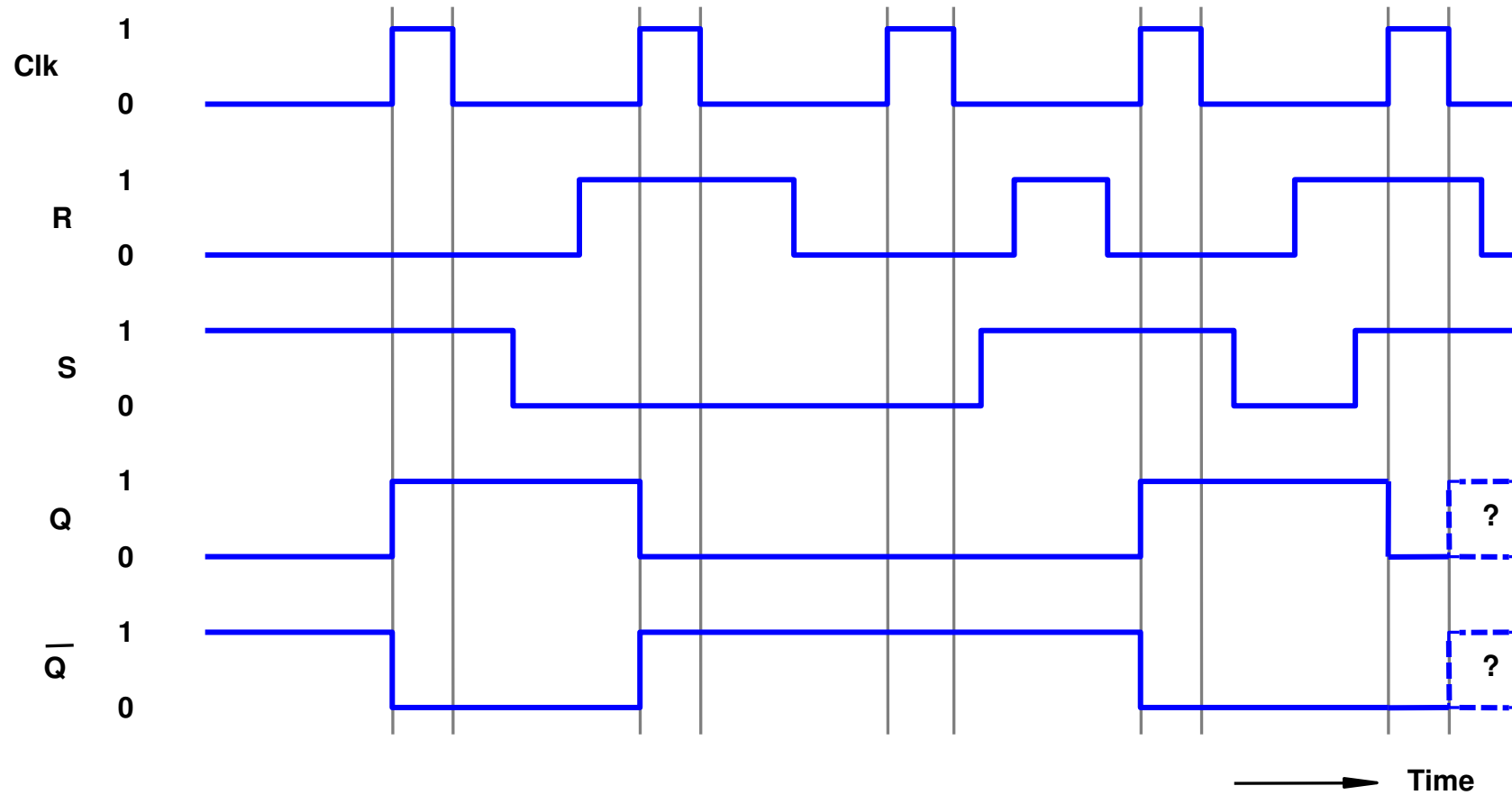


# Gated SR Latch

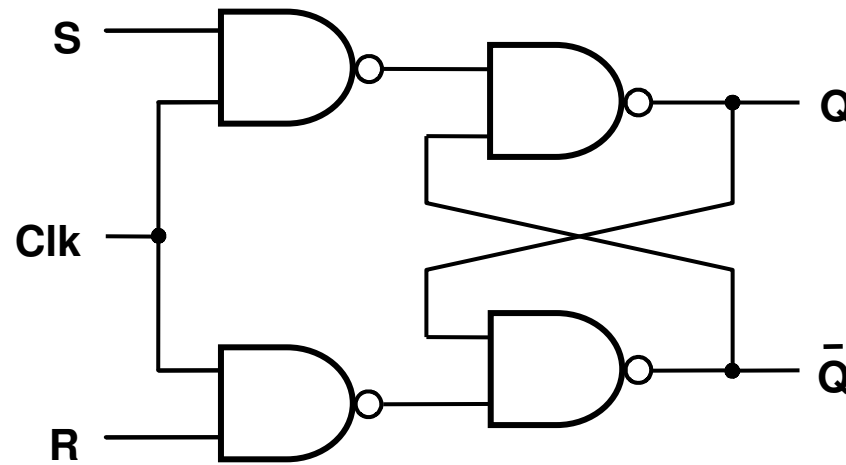


Clk	S	R	Q(t+1)
0	x	x	Q(t) (no change)
1	0	0	Q(t) (no change)
1	0	1	0
1	1	0	1
1	1	1	x

# Gated SR Latch

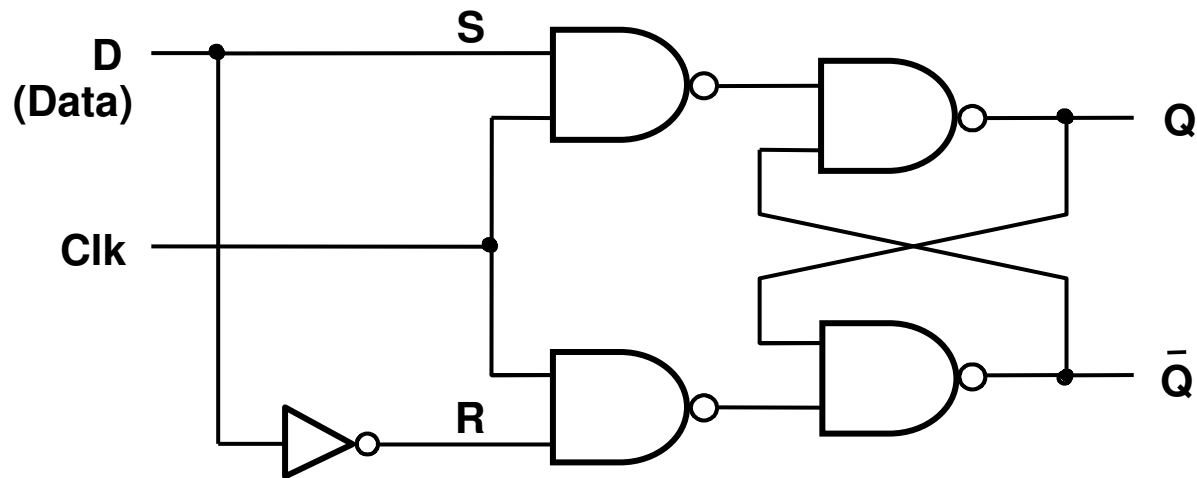


# Gated SR Latch com NAND

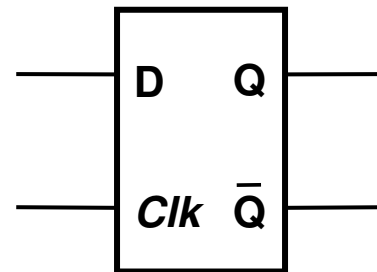


Qual a tabela verdade?

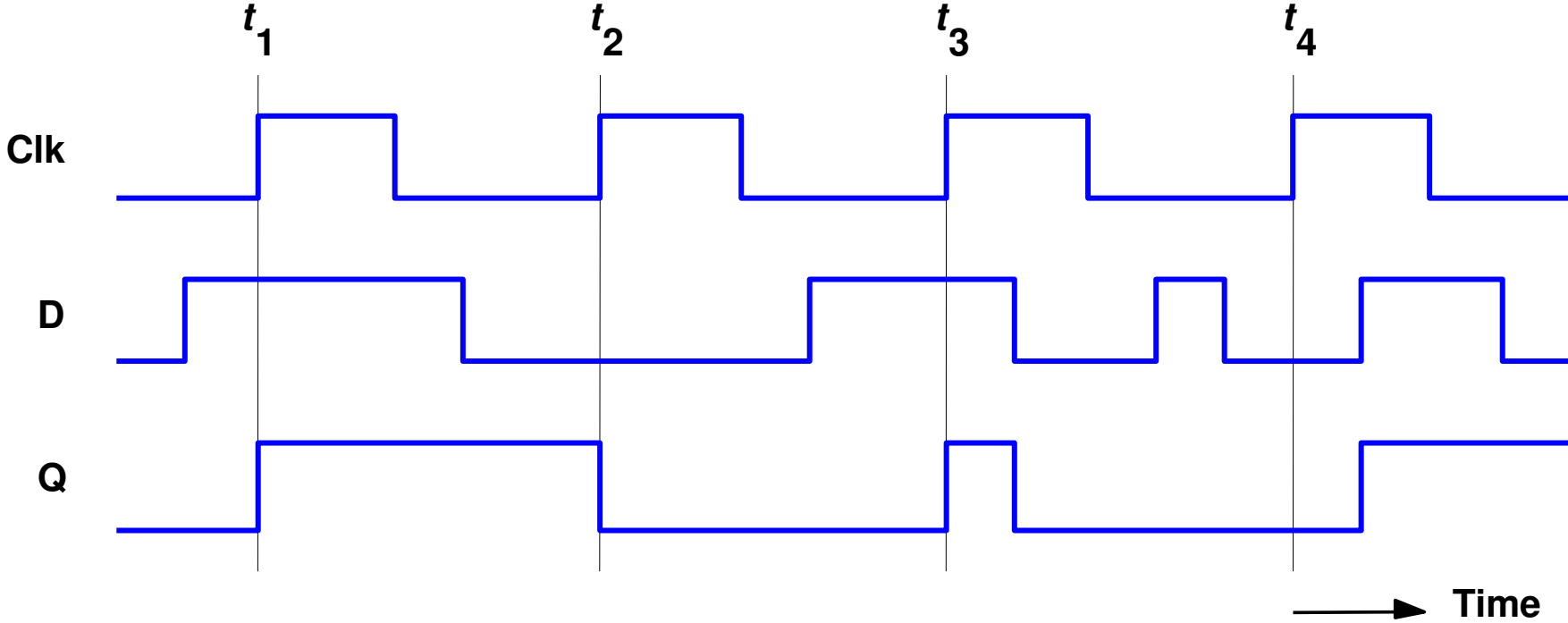
# Gated D Latch



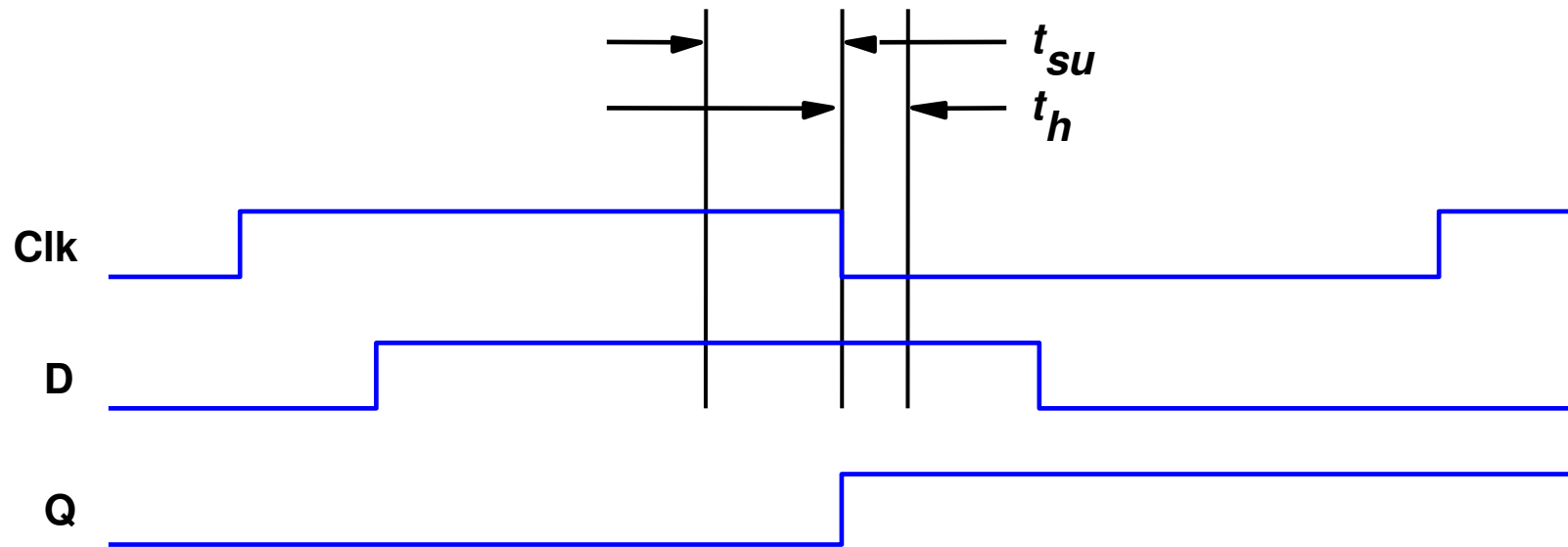
Clk	D	Q(t+1)
0	x	Q(t)
1	0	0
1	1	1



# Gated D Latch

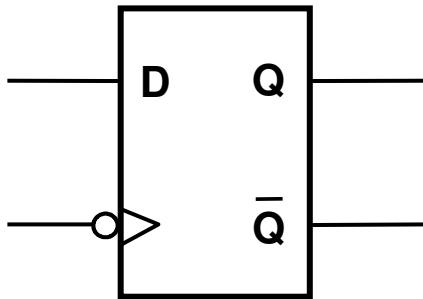
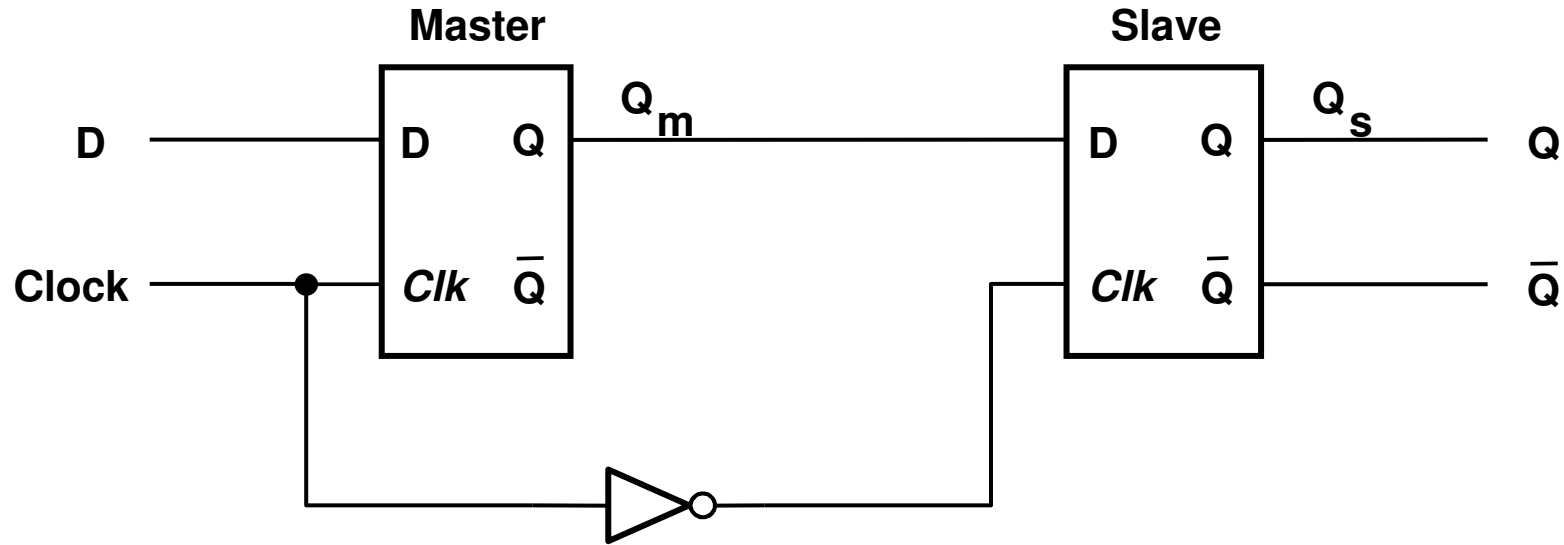


# Efeito do tempo de Propagação

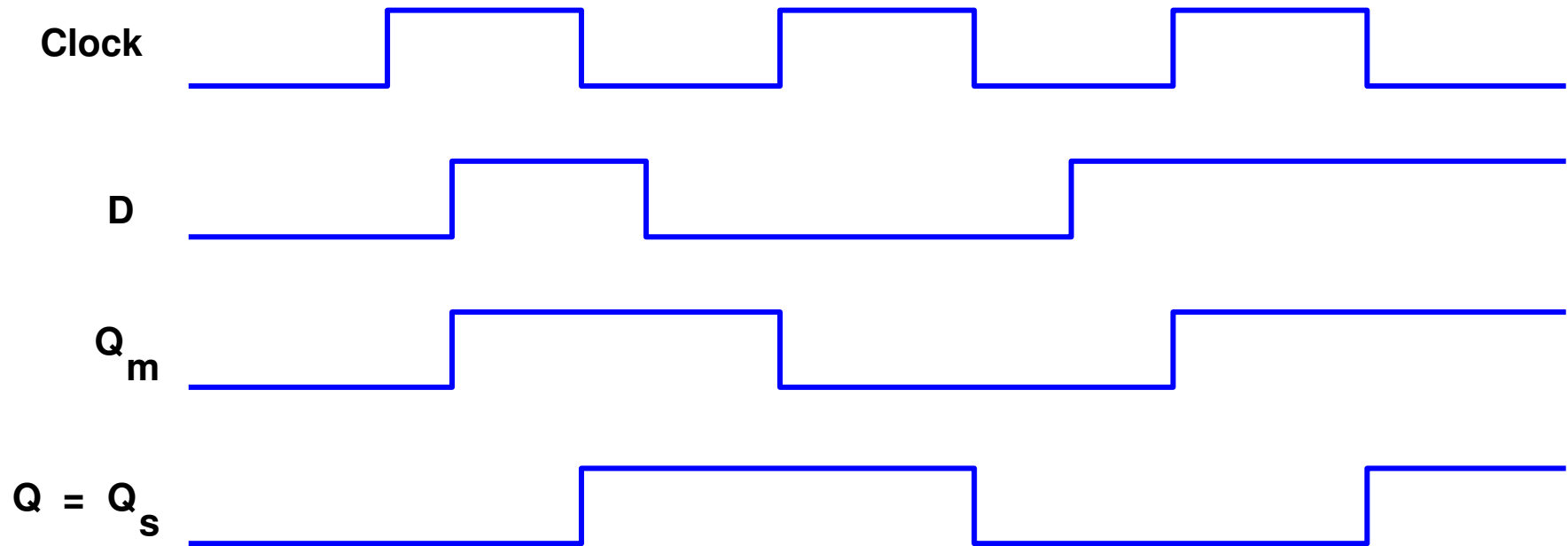


$t_{su}$  - tempo de setup  
 $t_h$  - tempo de hold

# Flip-Flop D Mestre-Escravo

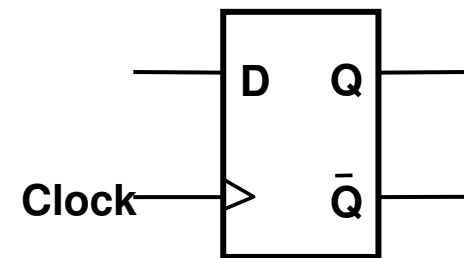
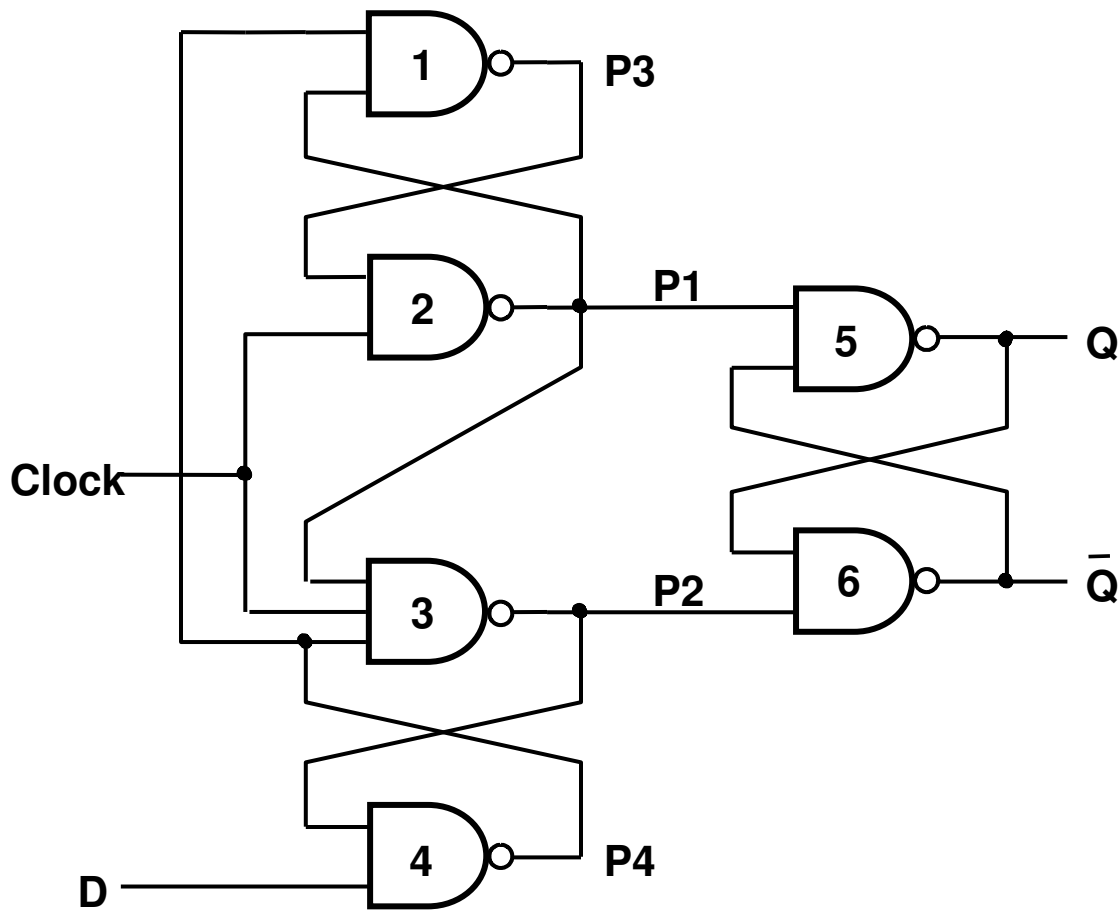


# Flip-Flop D Mestre-Escravo

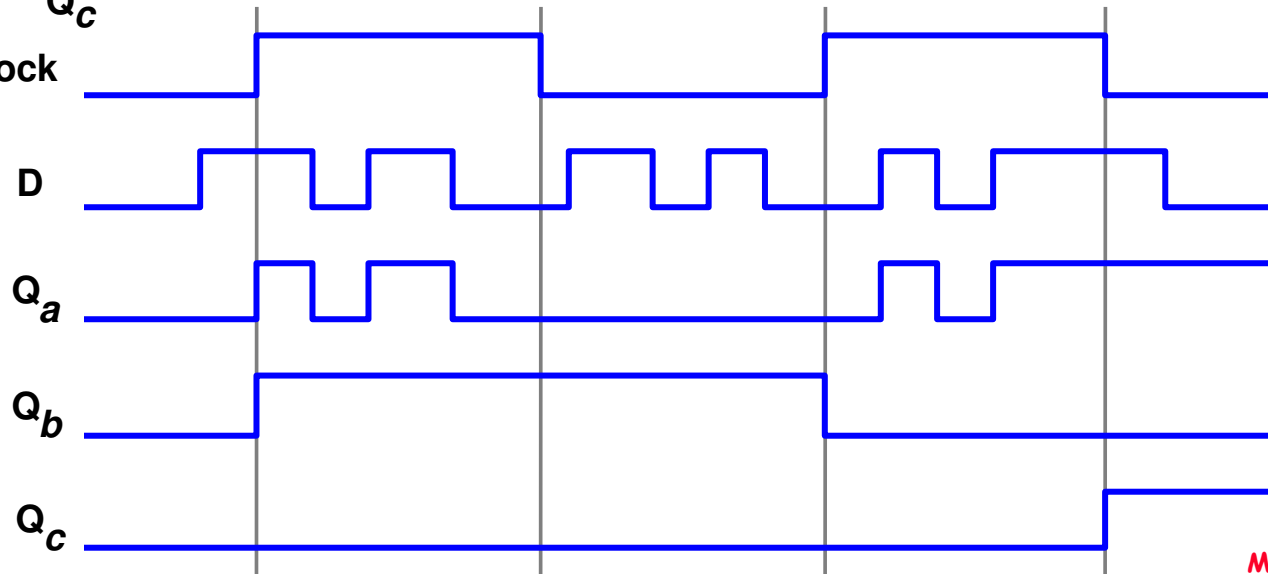
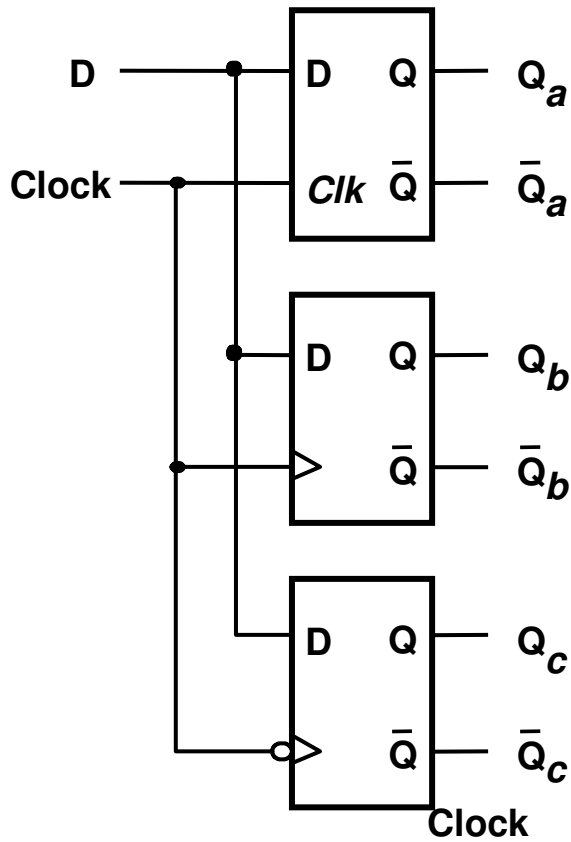




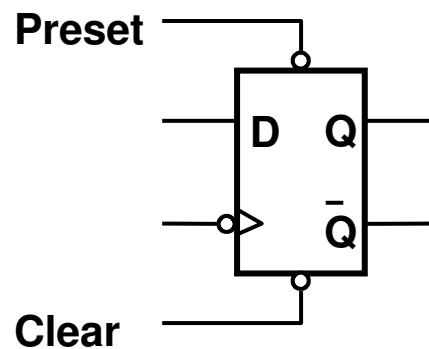
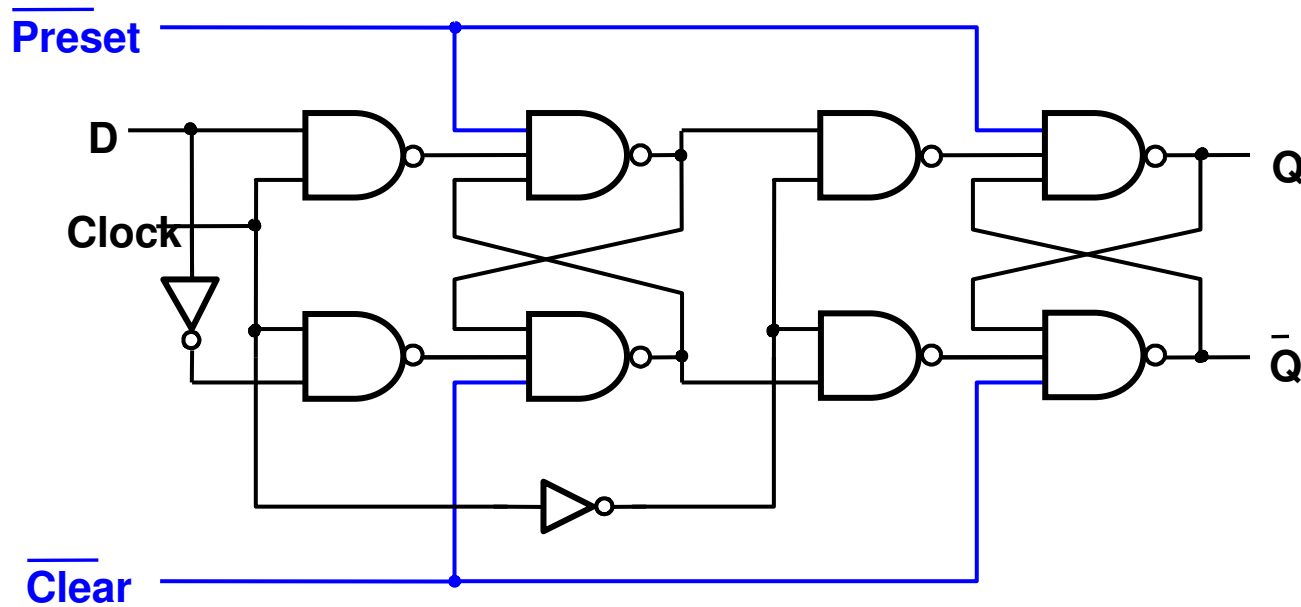
# Flip-Flop D Sensível à Borda de Subida



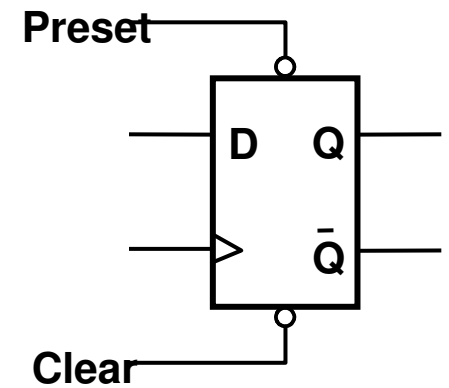
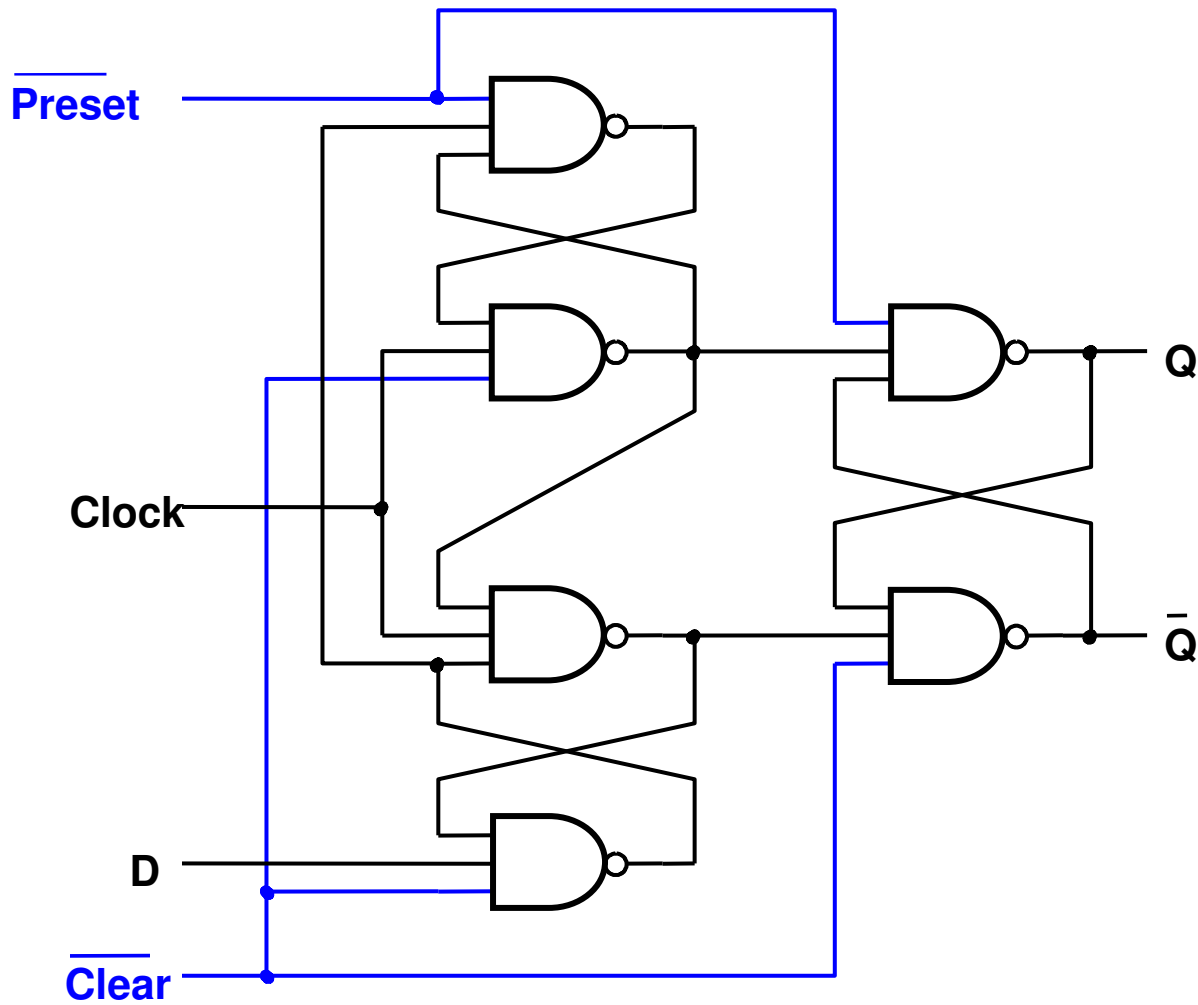
# Comparação entre sensível a nível e a borda



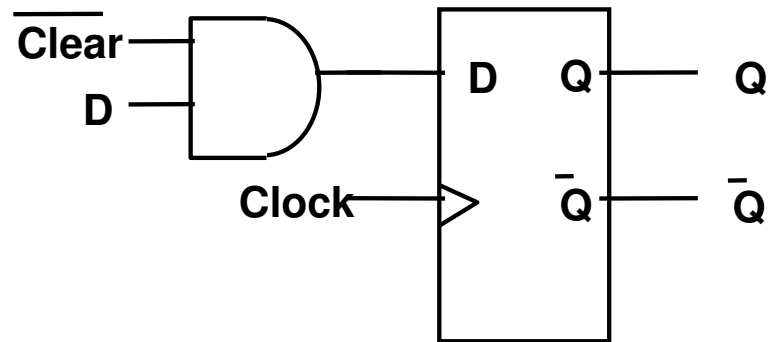
# FF D Mestre-Escravo com Preste e Clear



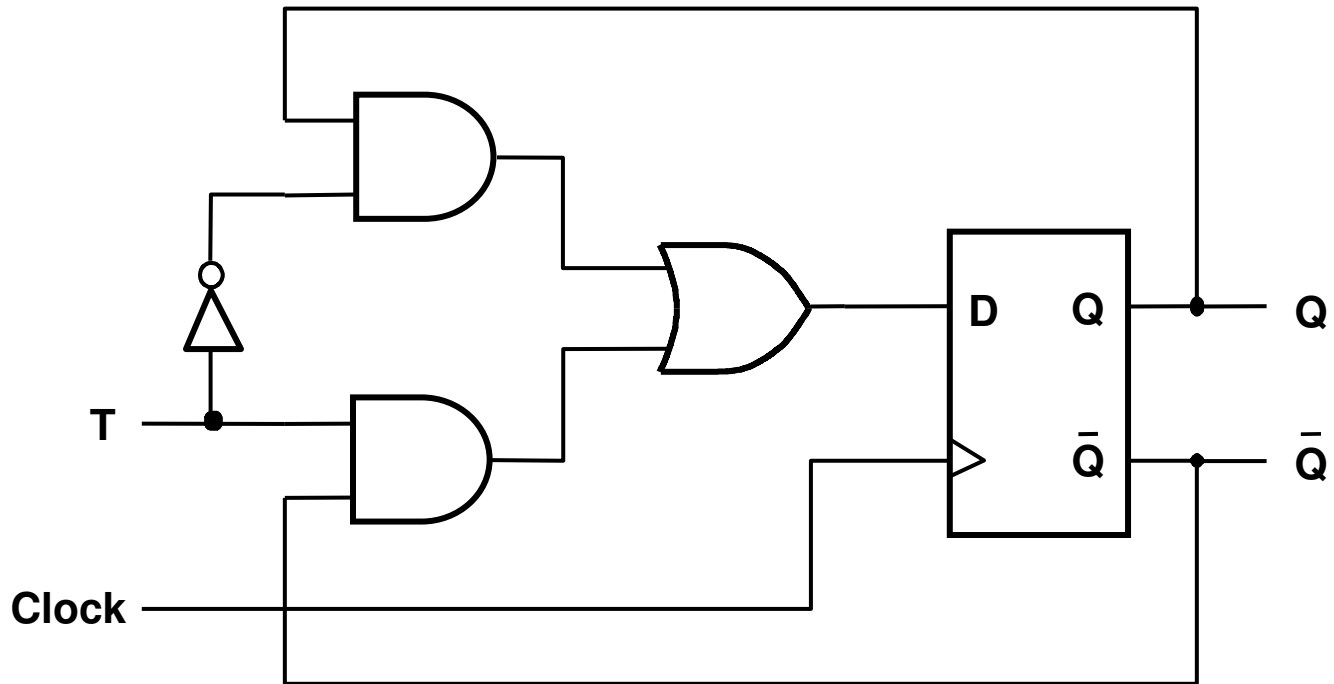
# FF D Sensível à Borda com Preste e Clear



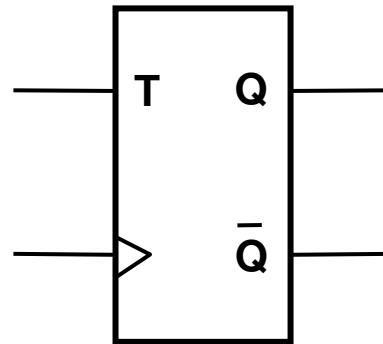
# Reset Síncrono



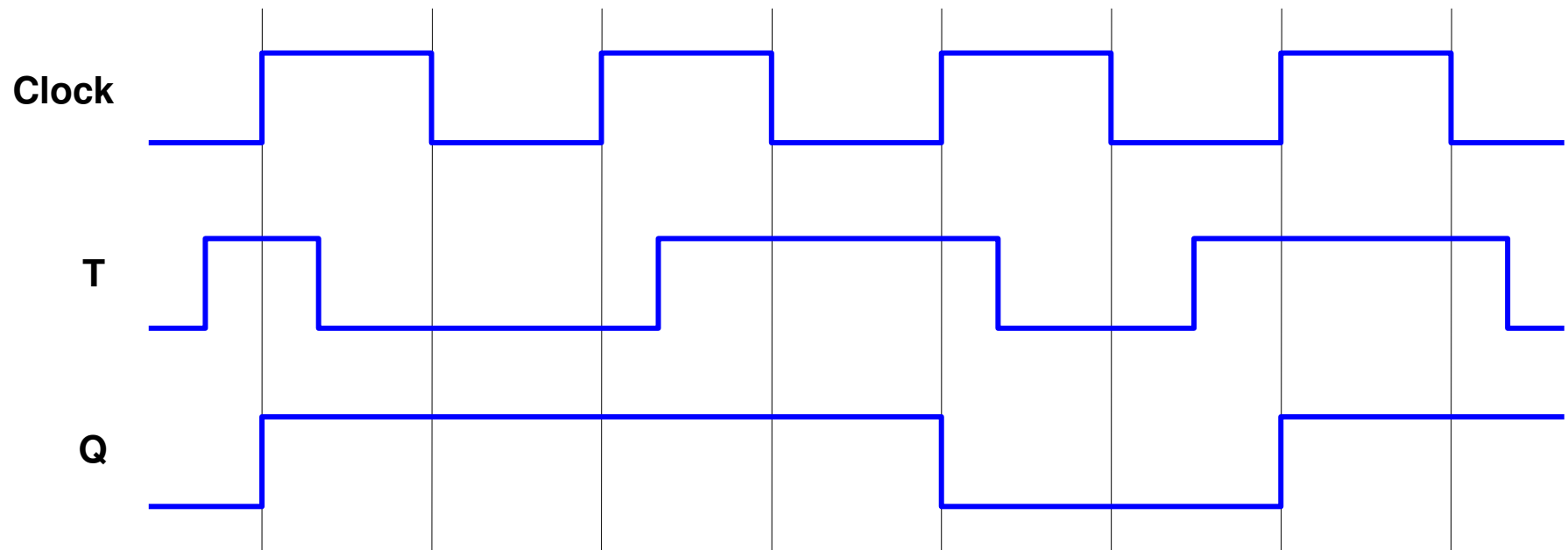
# Flip-Flop Tipo T



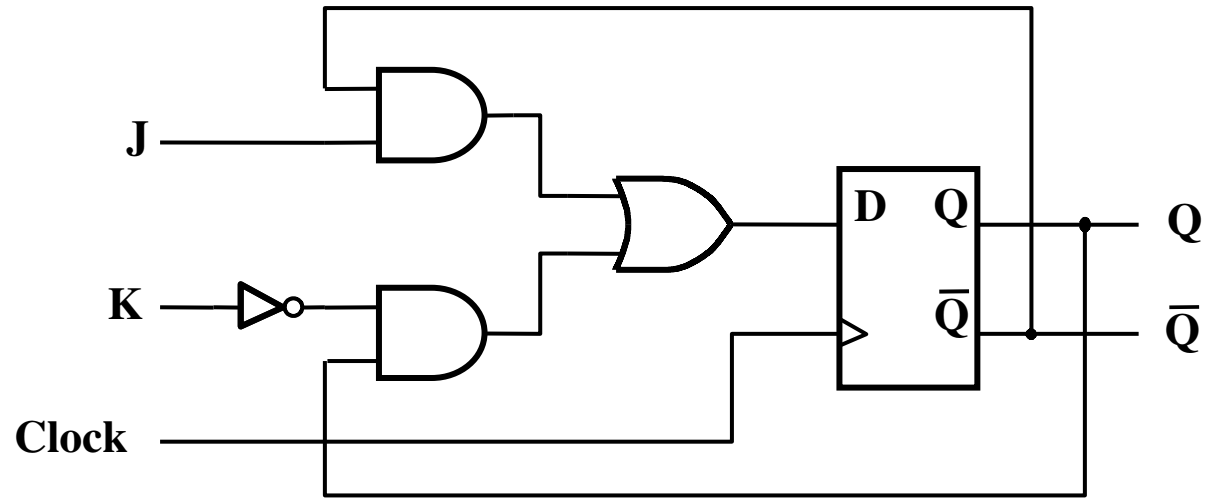
T	$Q(t+1)$
0	$Q(t)$
1	$\bar{Q}(t)$



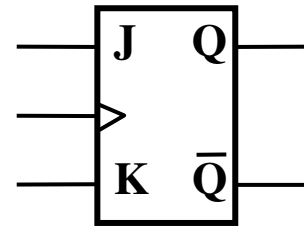
# Flip-Flop Tipo T



# Flip-Flop Tipo JK



J	K	Q(t+1)
0	0	Q(t)
0	1	0
1	0	1
1	1	$\bar{Q}(t)$





# Registradores

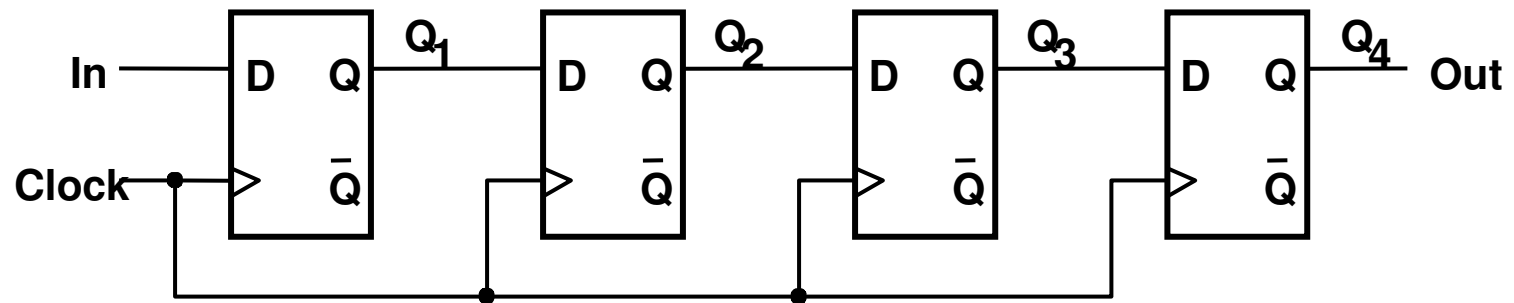
- Conjunto de elementos de memória (flip-flops) utilizados para armazenar  $n$  bits.
- Utilizam um único sinal de clock

# Shift Register

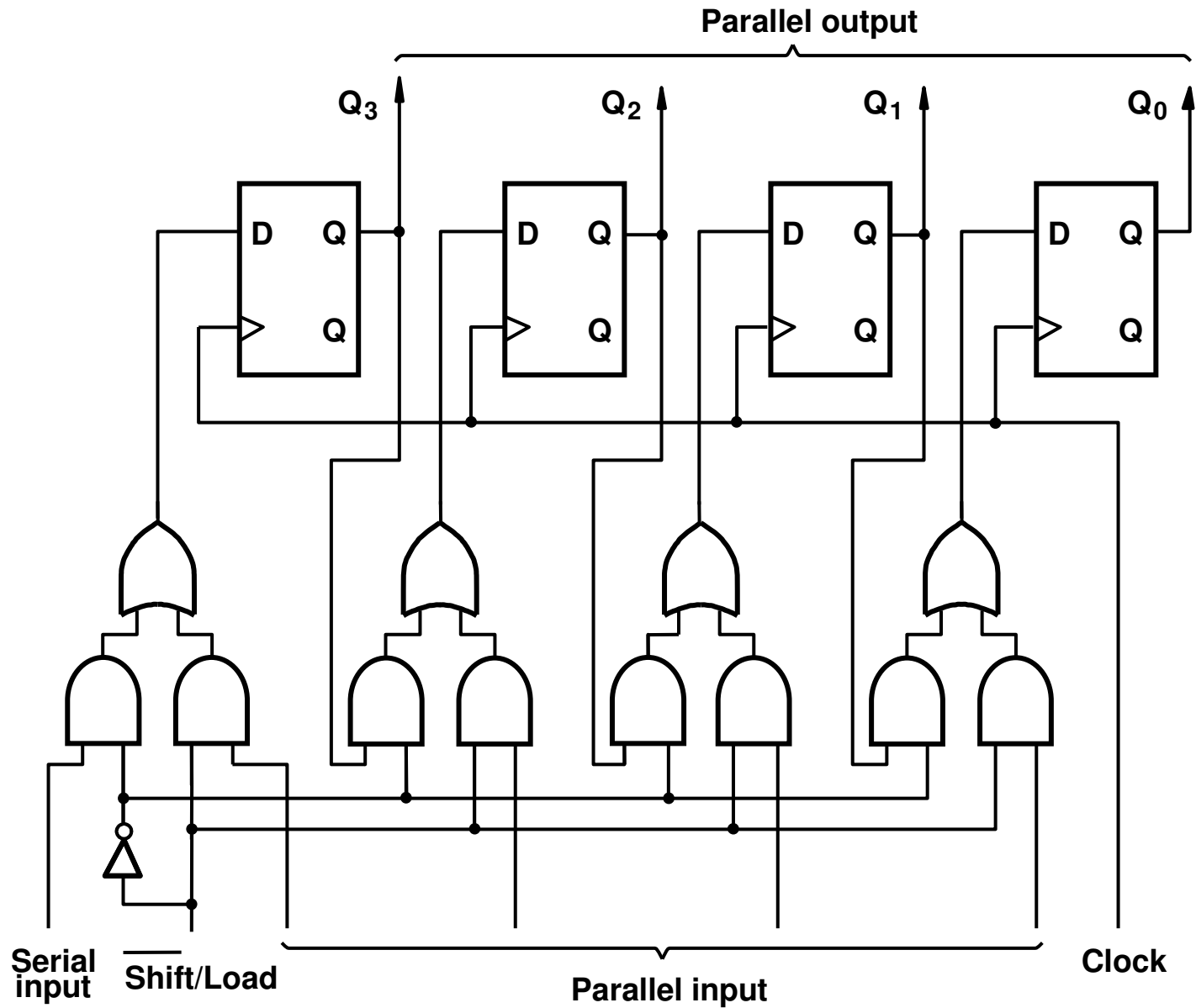
Apresenta o seguinte comportamento:

	In	Q <sub>1</sub>	Q <sub>2</sub>	Q <sub>3</sub>	Q <sub>4</sub> = Out
$t_0$	1	0	0	0	0
$t_1$	0	1	0	0	0
$t_2$	1	0	1	0	0
$t_3$	1	1	0	1	0
$t_4$	1	1	1	0	1
$t_5$	0	1	1	1	0
$t_6$	0	0	1	1	1
$t_7$	0	0	0	1	1

# Shift Register



# Shift Register com Carga Paralela



# Shift Register Universal

- Entrada Serial
    - Deslocamento a Esquerda
    - Deslocamento a Direita
  - Carga Paralela
  - Saída Paralela
- 
- Exercício: Desenhe o Diagrama do Shift Register Universal de 4 bits.

# Contadores

- **Assíncronos**
- **Síncronos**

# Contadores

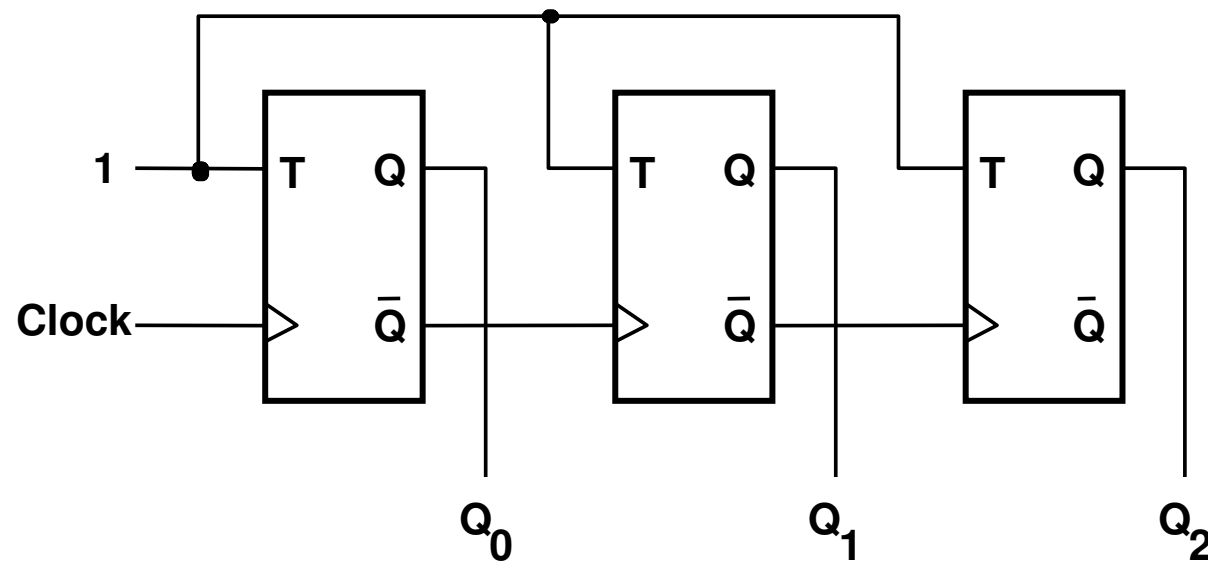
## Contador Binário

	clk	Q <sub>2</sub>	Q <sub>1</sub>	Q <sub>0</sub>
<i>t</i> <sub>0</sub>	↑	0	0	0
<i>t</i> <sub>1</sub>	↑	0	0	1
<i>t</i> <sub>2</sub>	↑	0	1	0
<i>t</i> <sub>3</sub>	↑	0	1	1
<i>t</i> <sub>4</sub>	↑	1	0	0
<i>t</i> <sub>5</sub>	↑	1	0	1
<i>t</i> <sub>6</sub>	↑	1	1	0
<i>t</i> <sub>7</sub>	↑	1	1	1



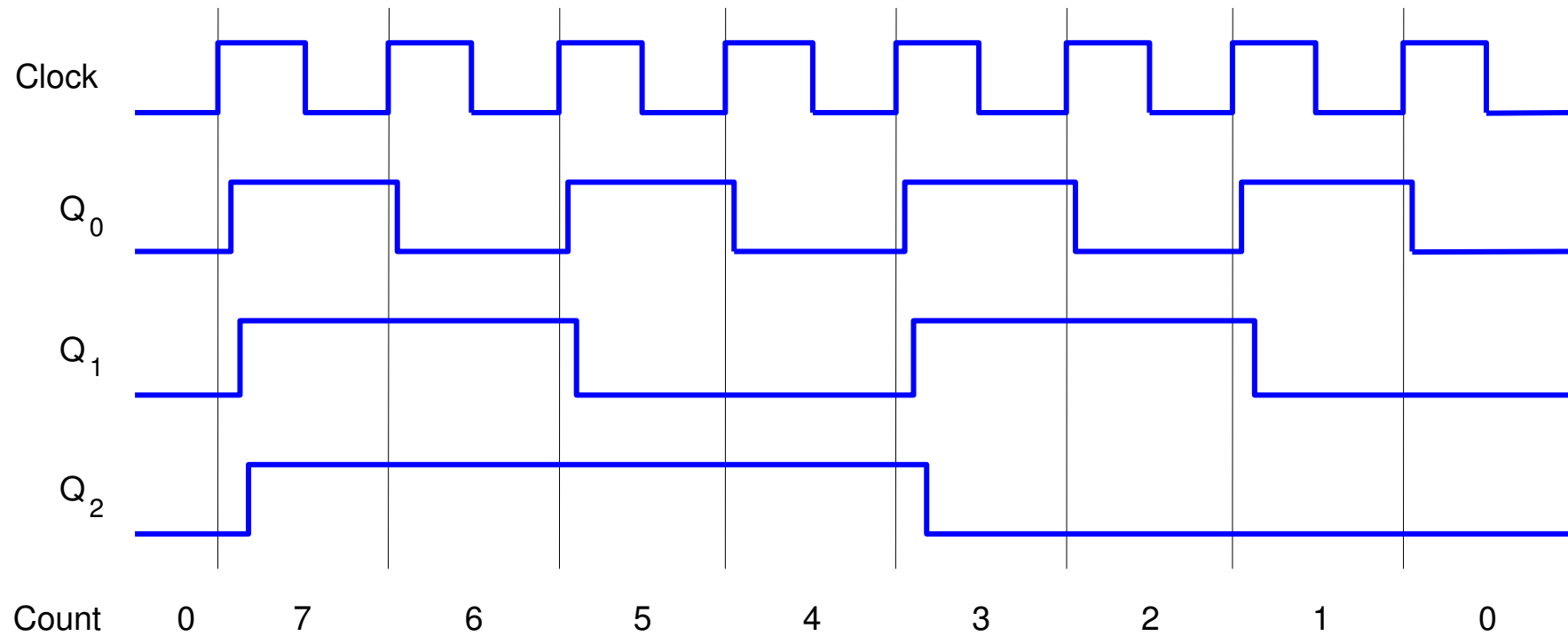


# Contador Binário - FF tipo T

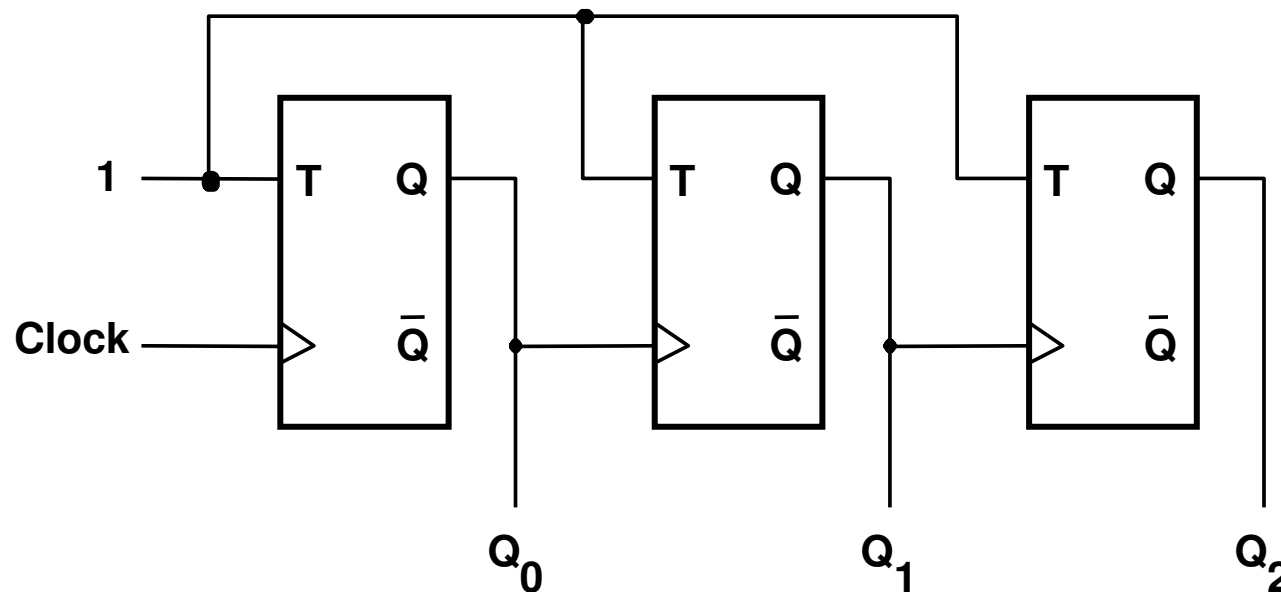


## Contador Binário Assíncrono (up-counter)

# Contador Binário - FF tipo T (down-counter)

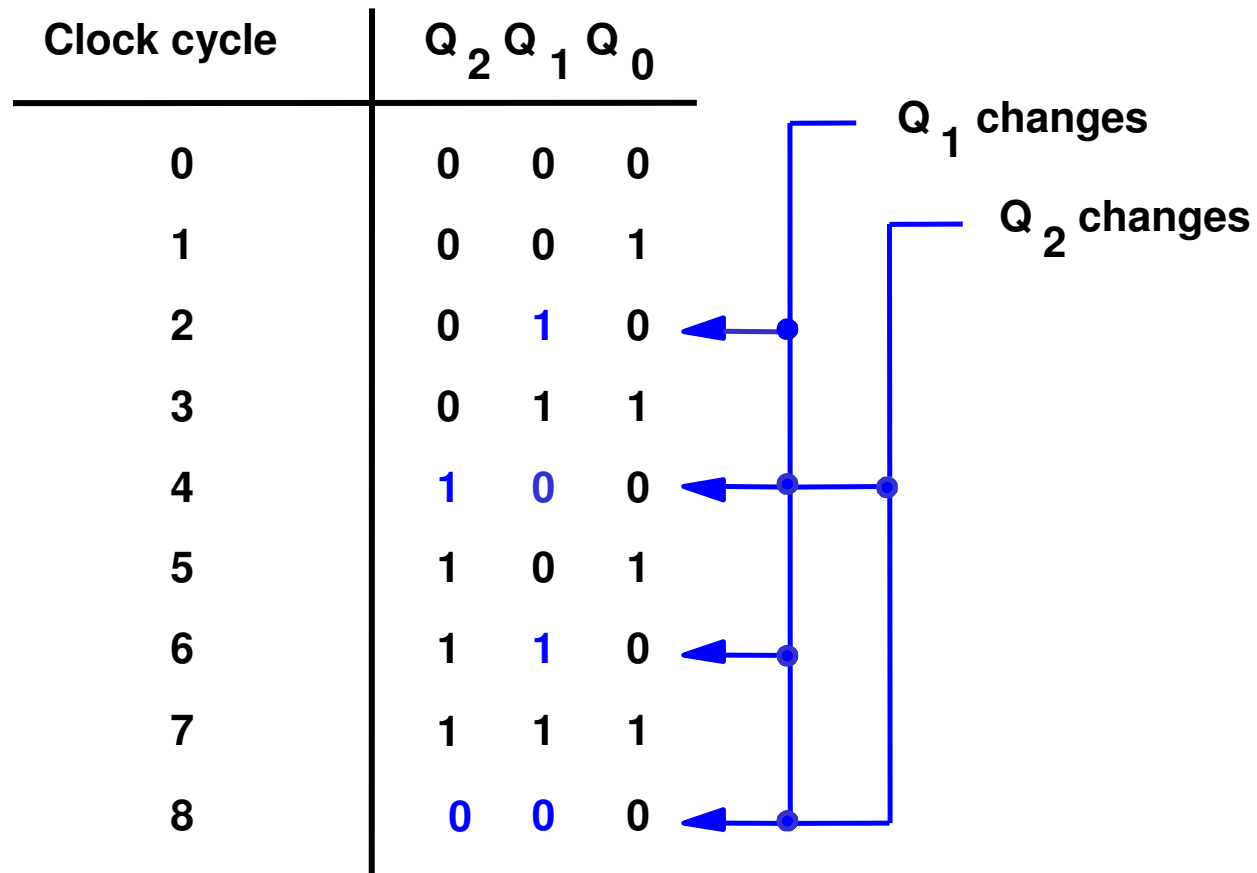


## Contador Binário - FF tipo T (down-counter)

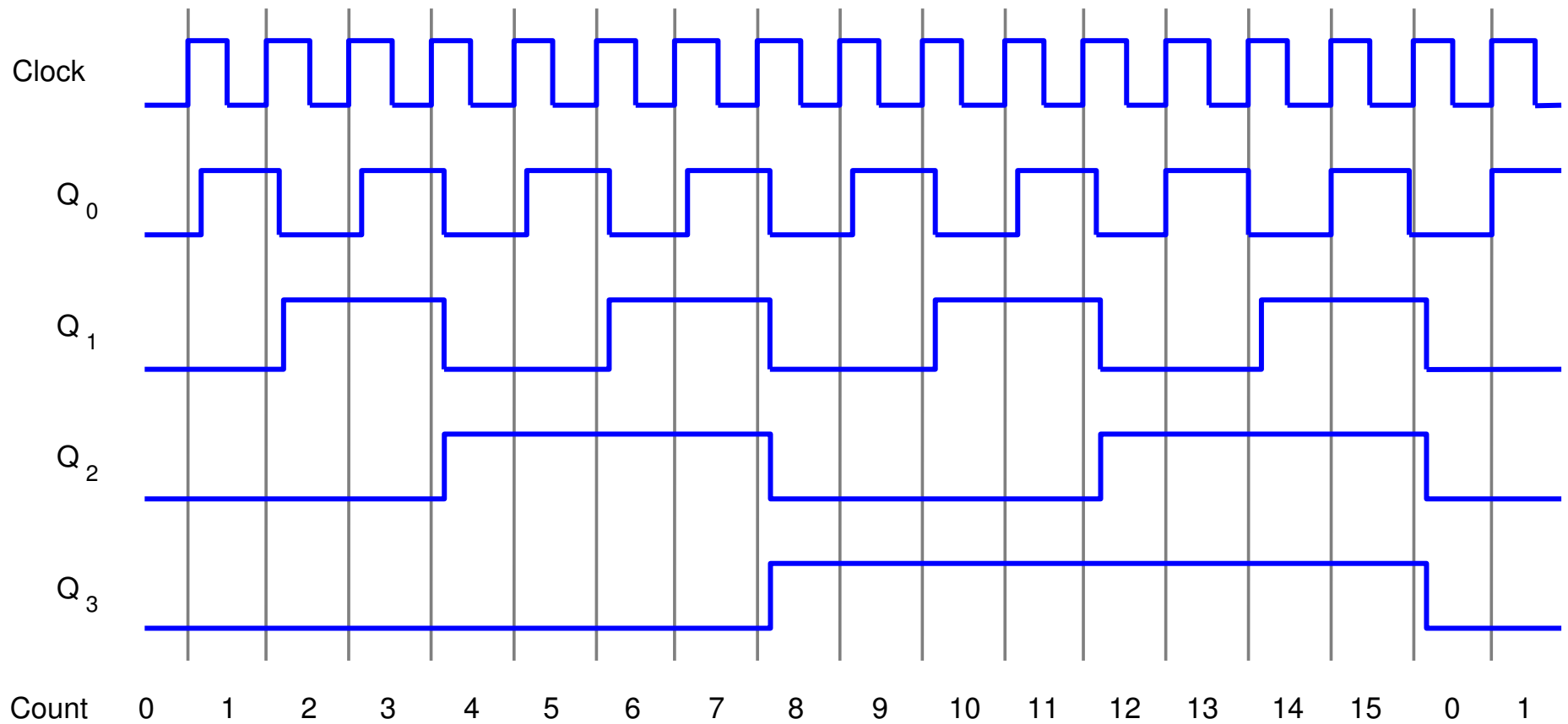


## Contador Binário Assíncrono (down-counter)

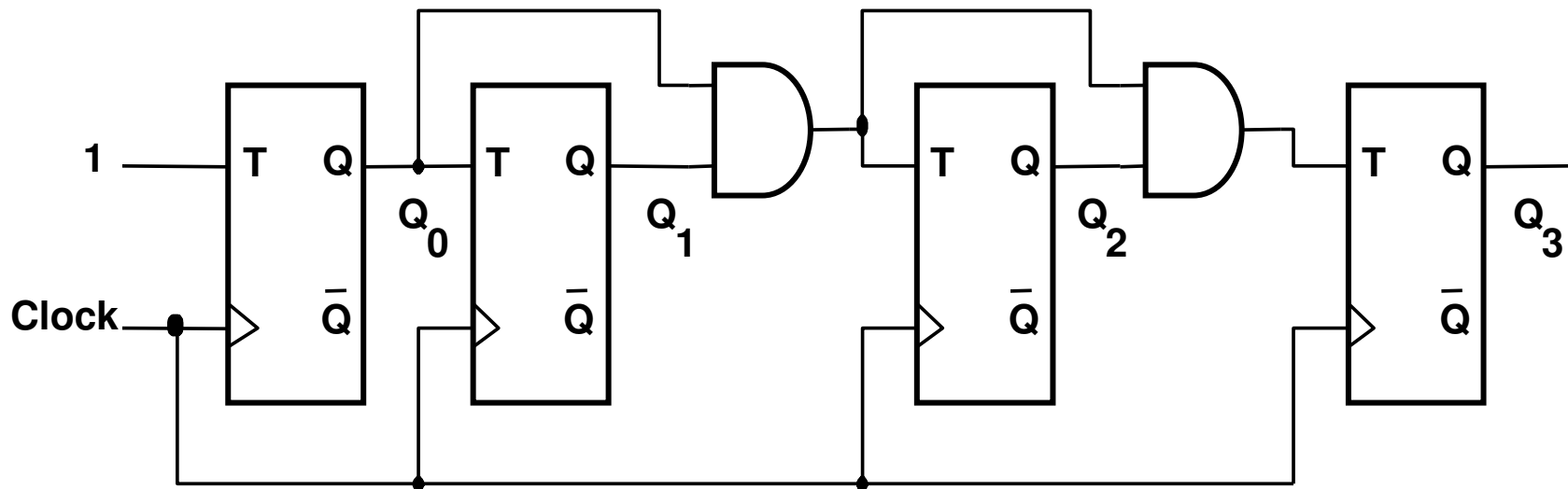
# Contadores Síncronos



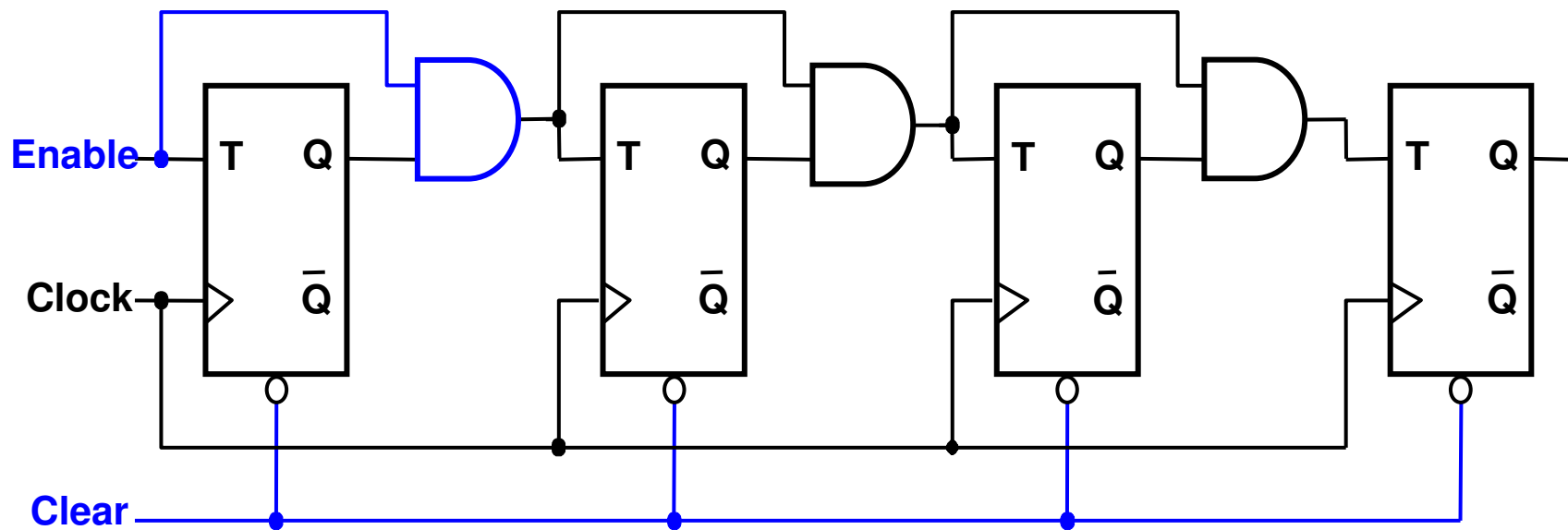
# Contador Binário Síncrono



# Contador Binário Síncrono



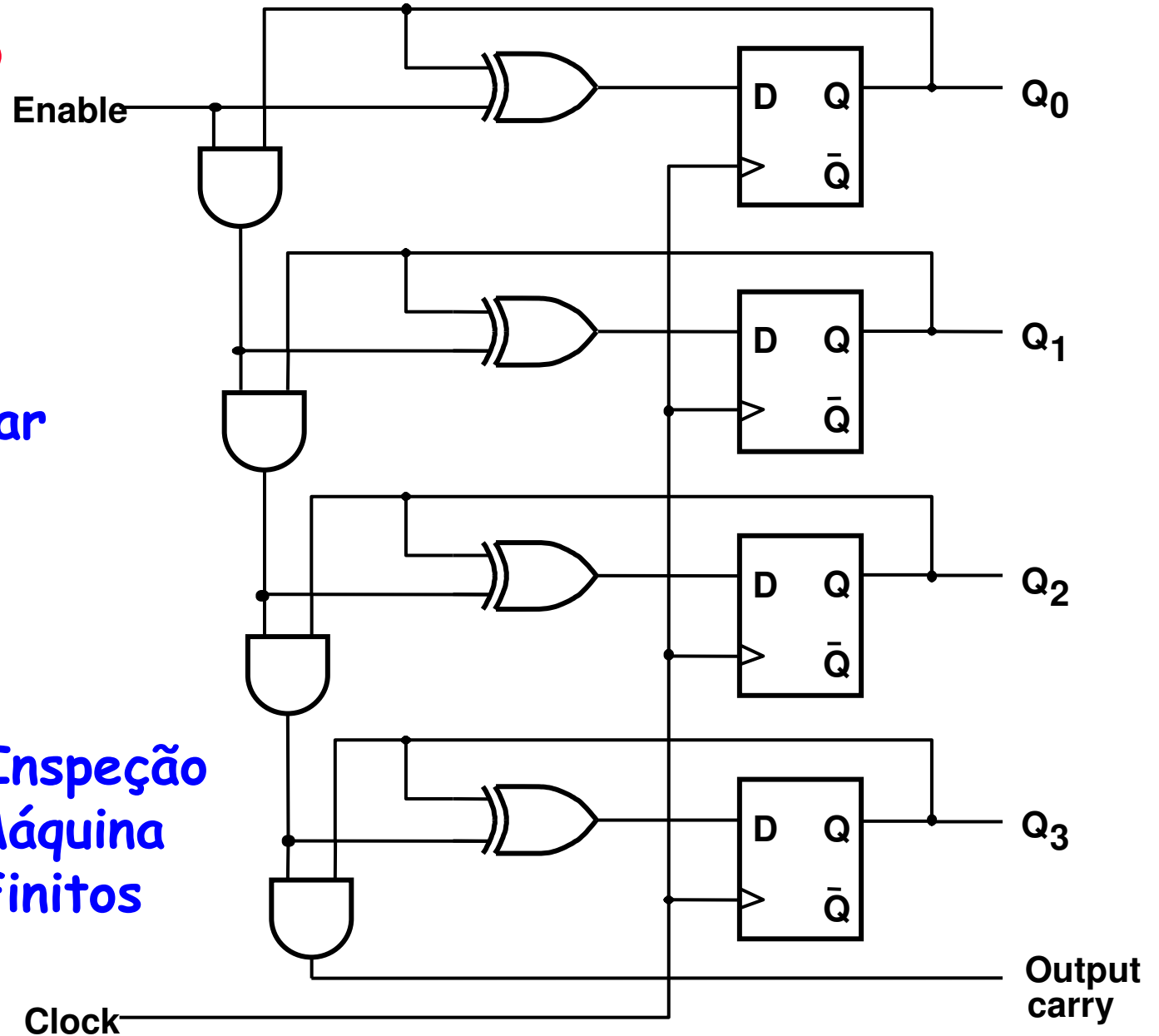
# Contador Binário Síncrono com enable e clear



# Contador de 4 bits com FF D

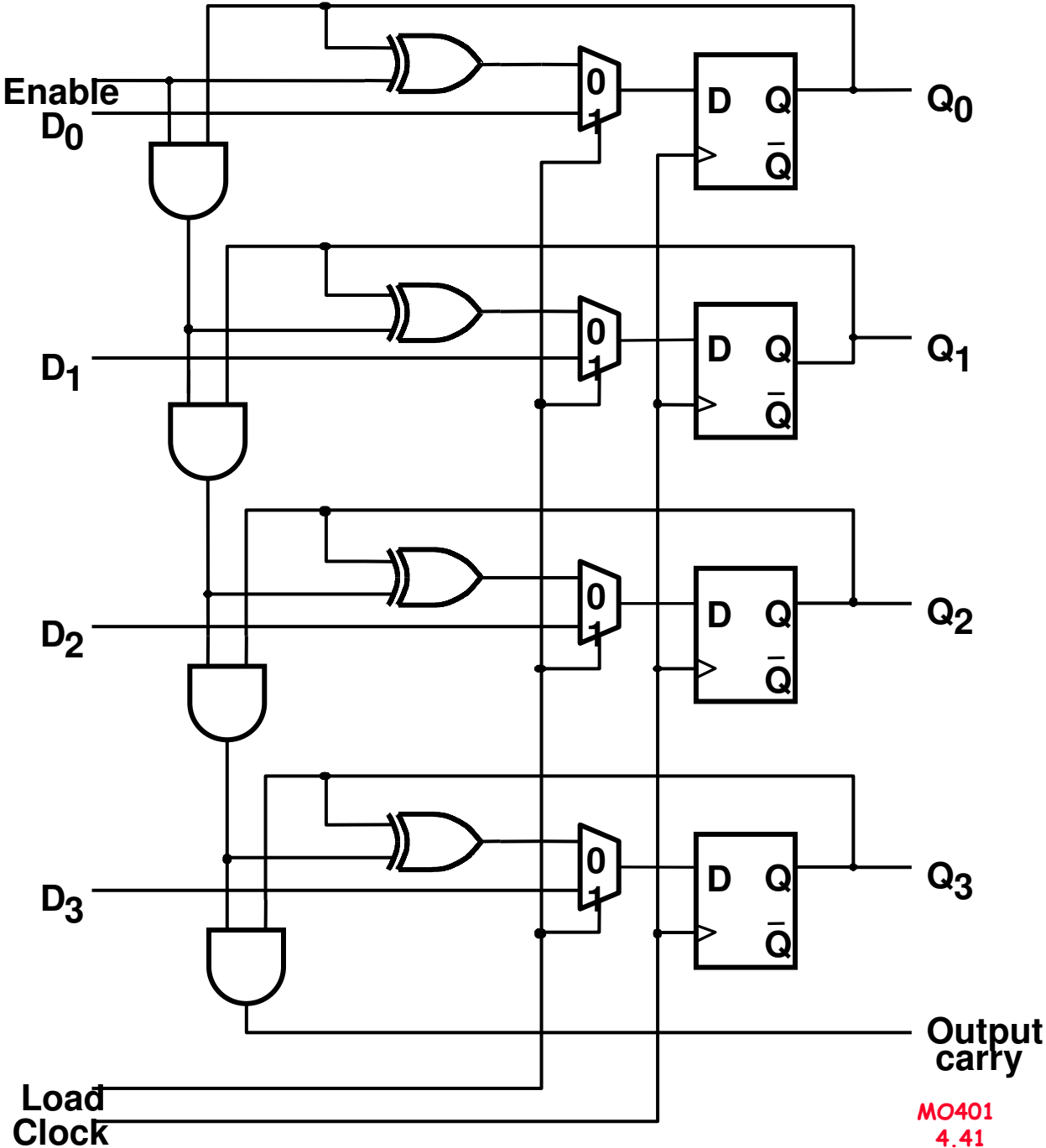
Como determinar as funções de excitação de cada FF?

1. Projeto por Inspeção
2. Projeto de Máquina de Estados Finitos (FSM)

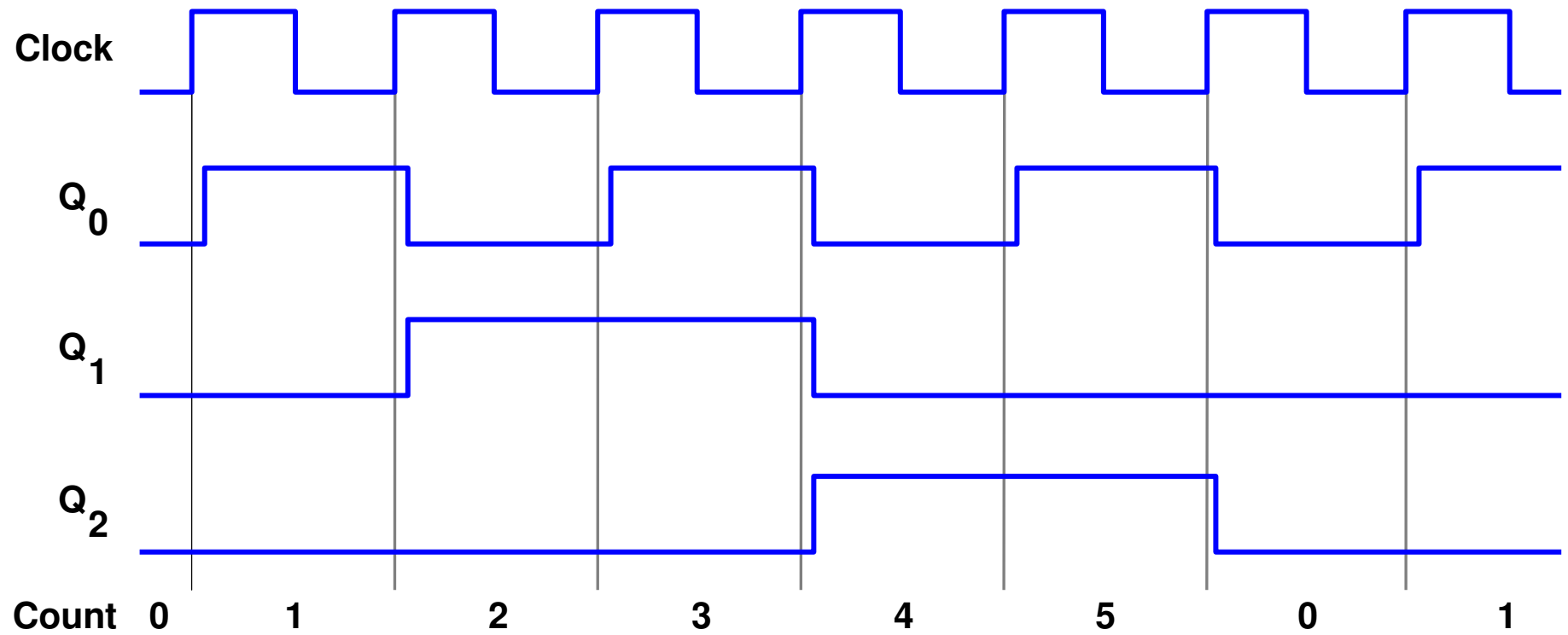




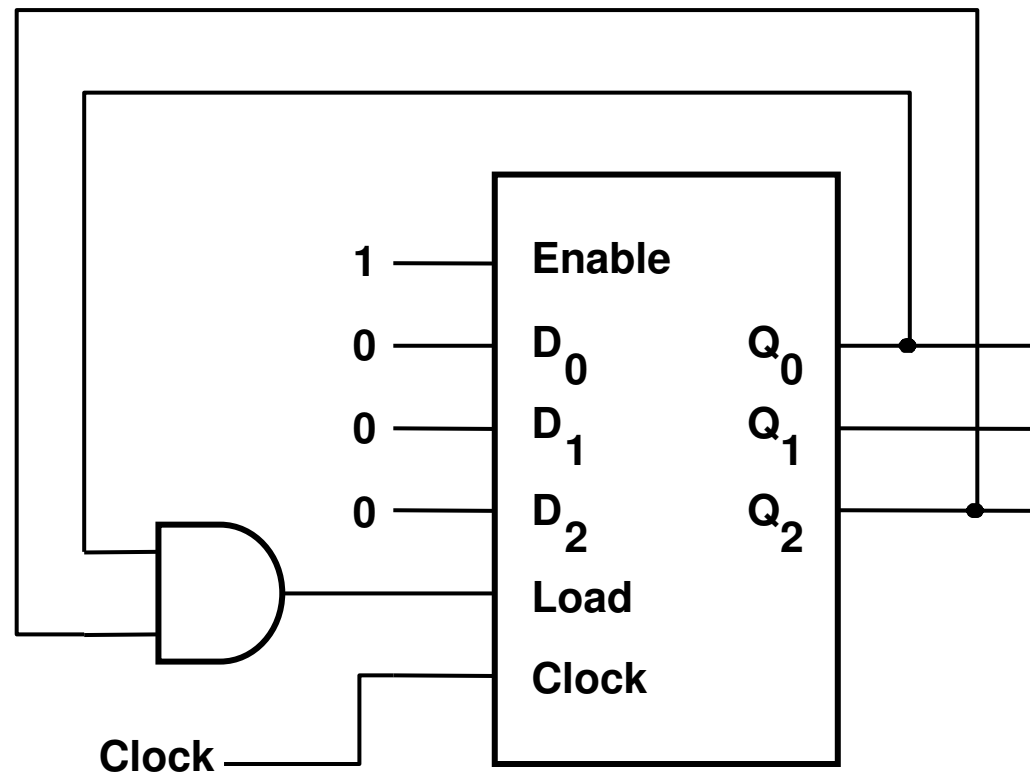
Contador de 4 bits com FF D com carga paralela



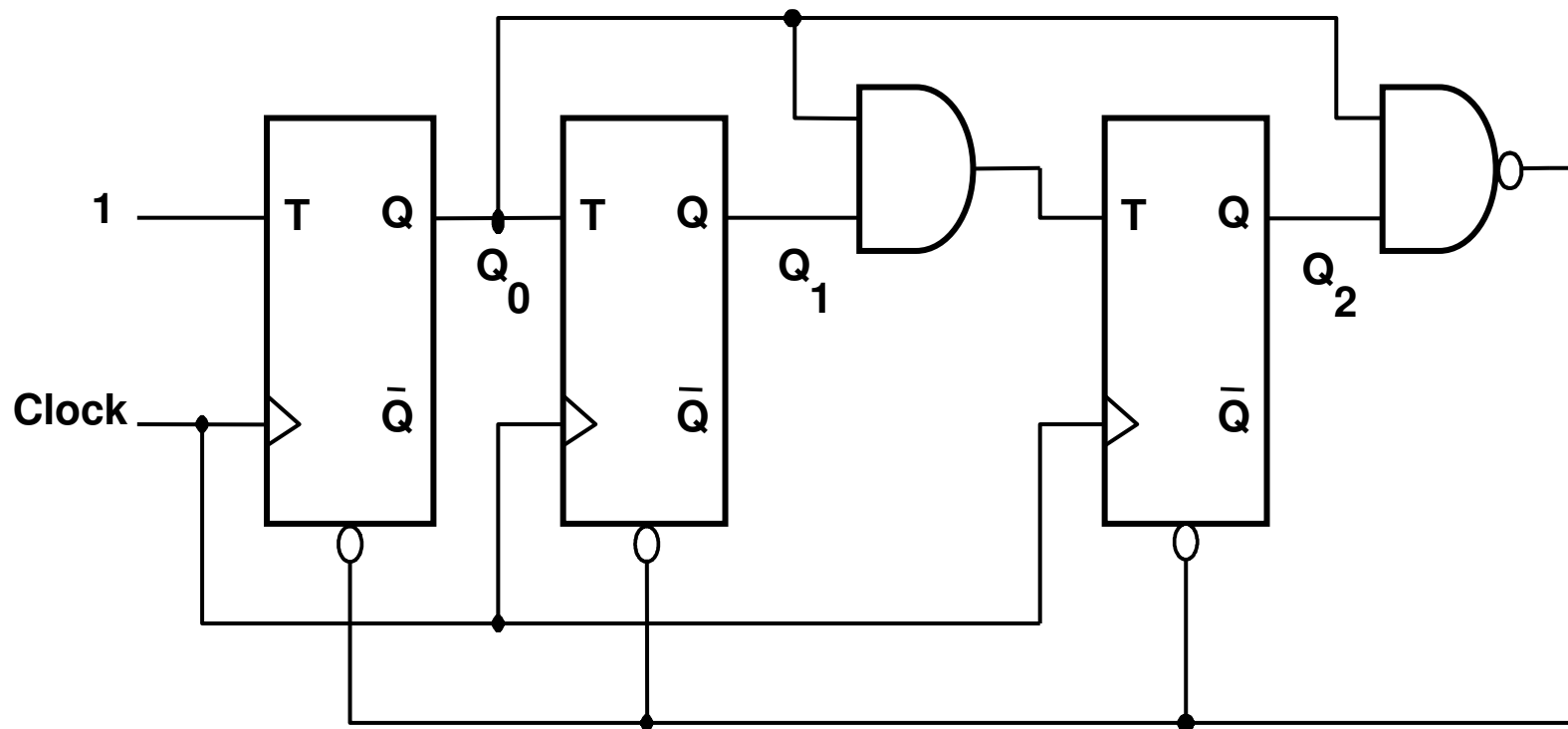
# Contador Módulo (exp. Módulo 6)



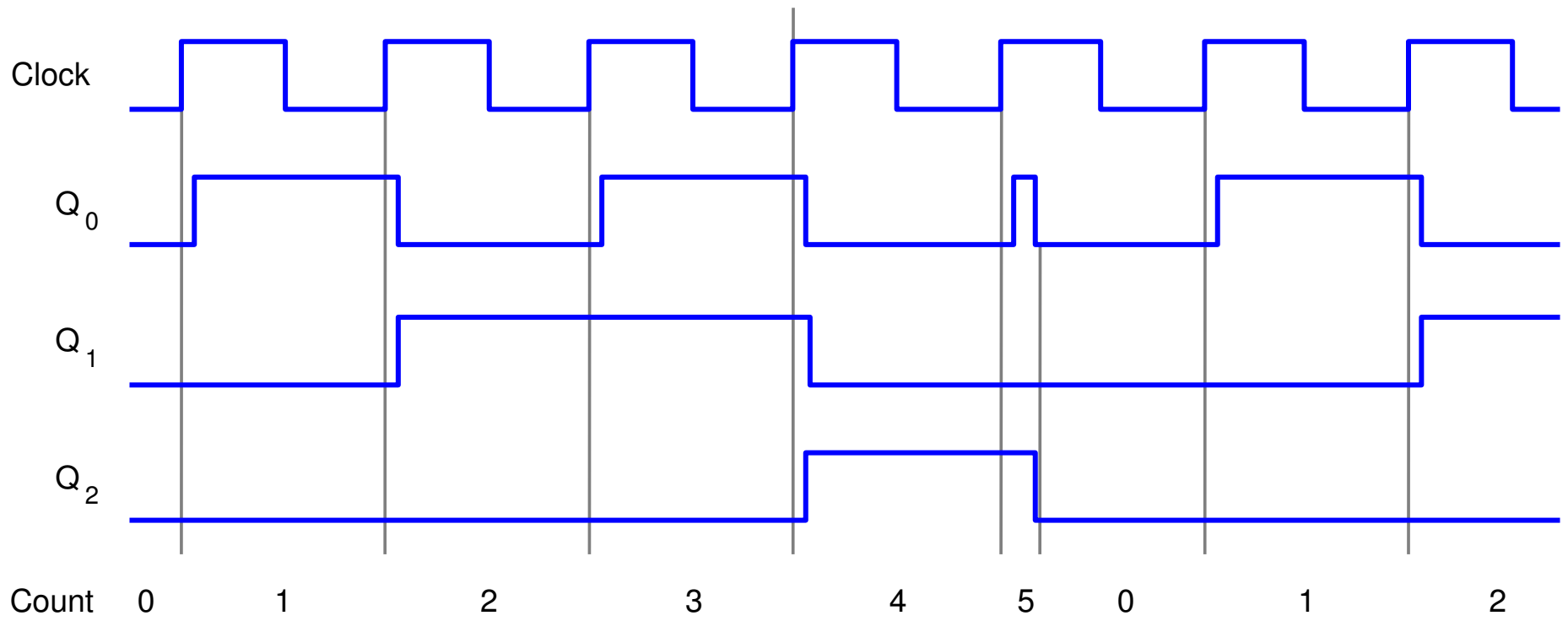
# Contador Módulo (exp. Módulo 6)



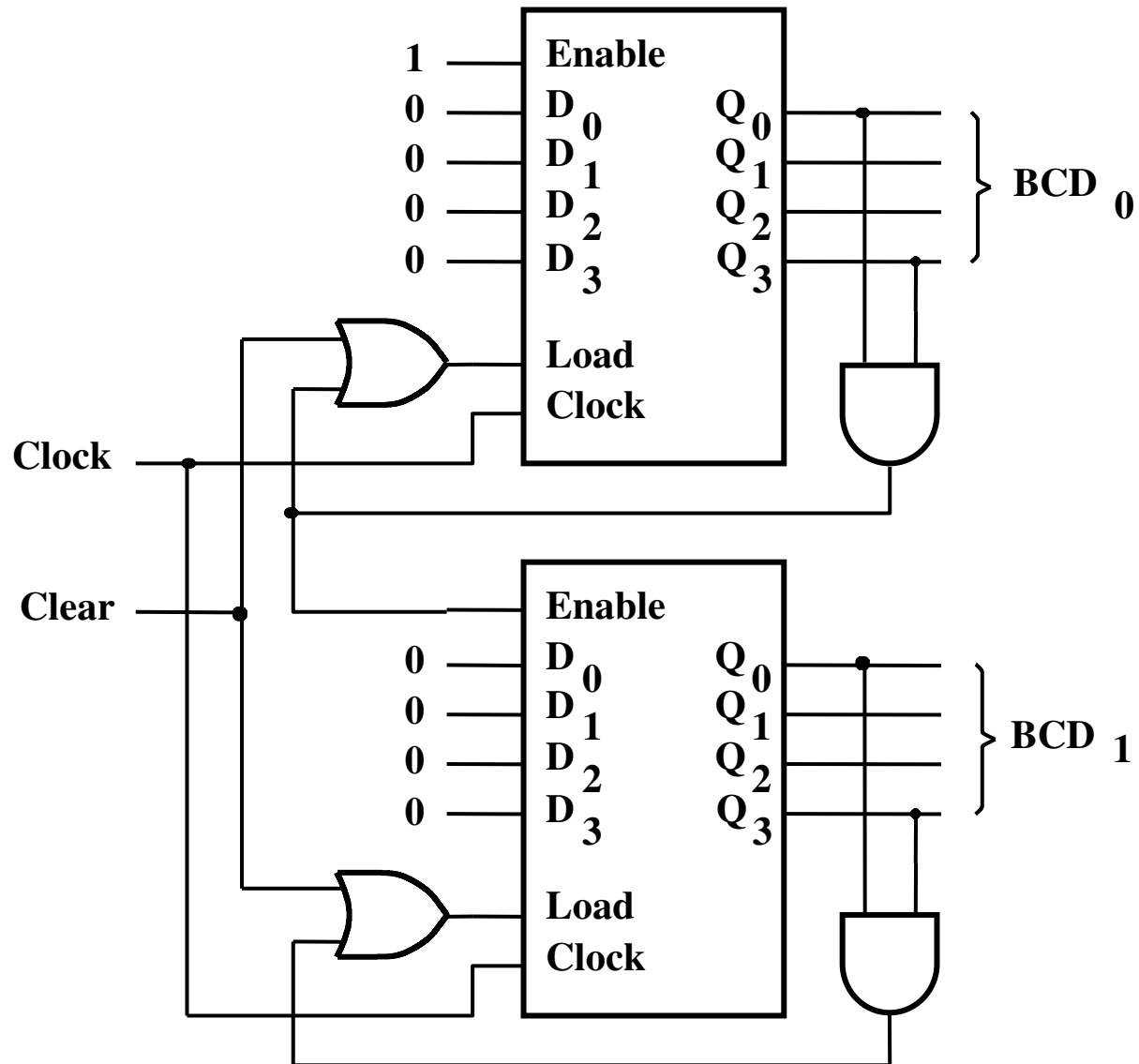
# Contador Módulo 6 com Reset Assíncrono



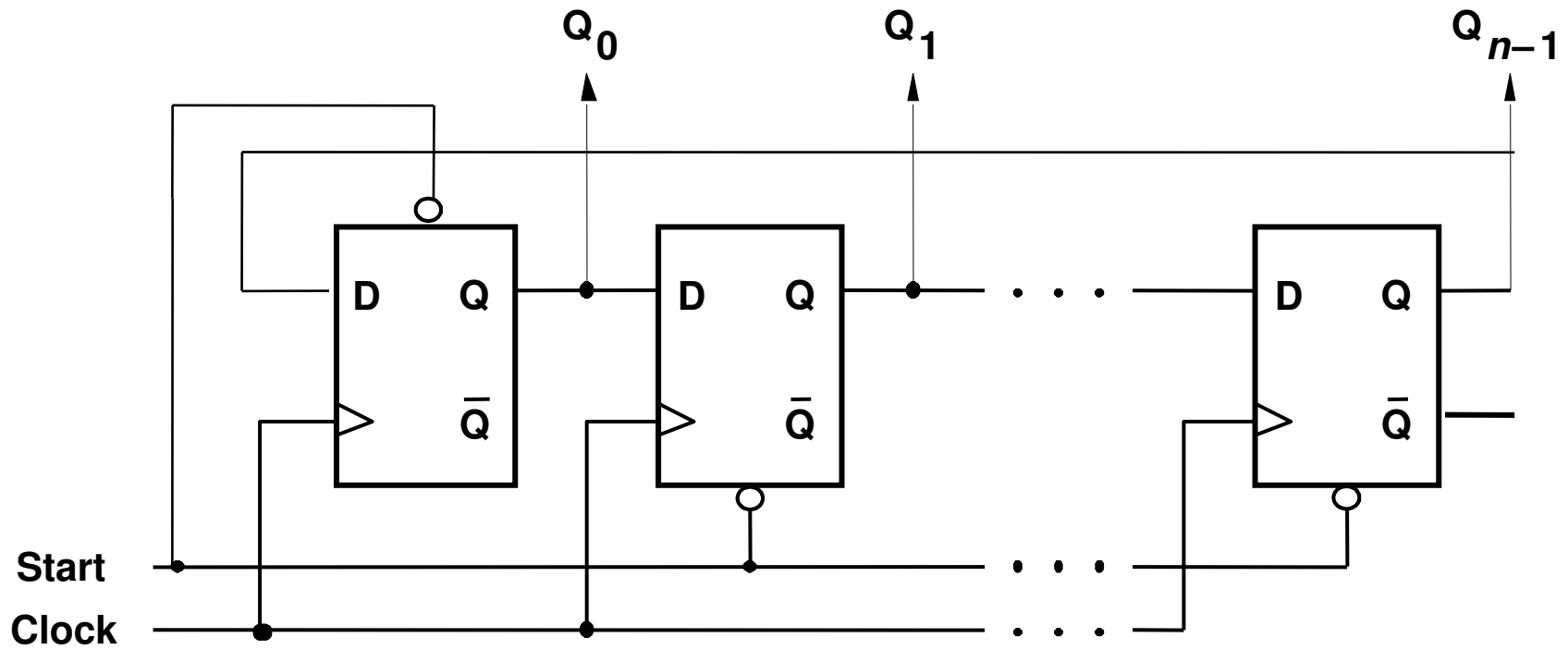
# Contador Módulo 6 com Reset Assíncrono



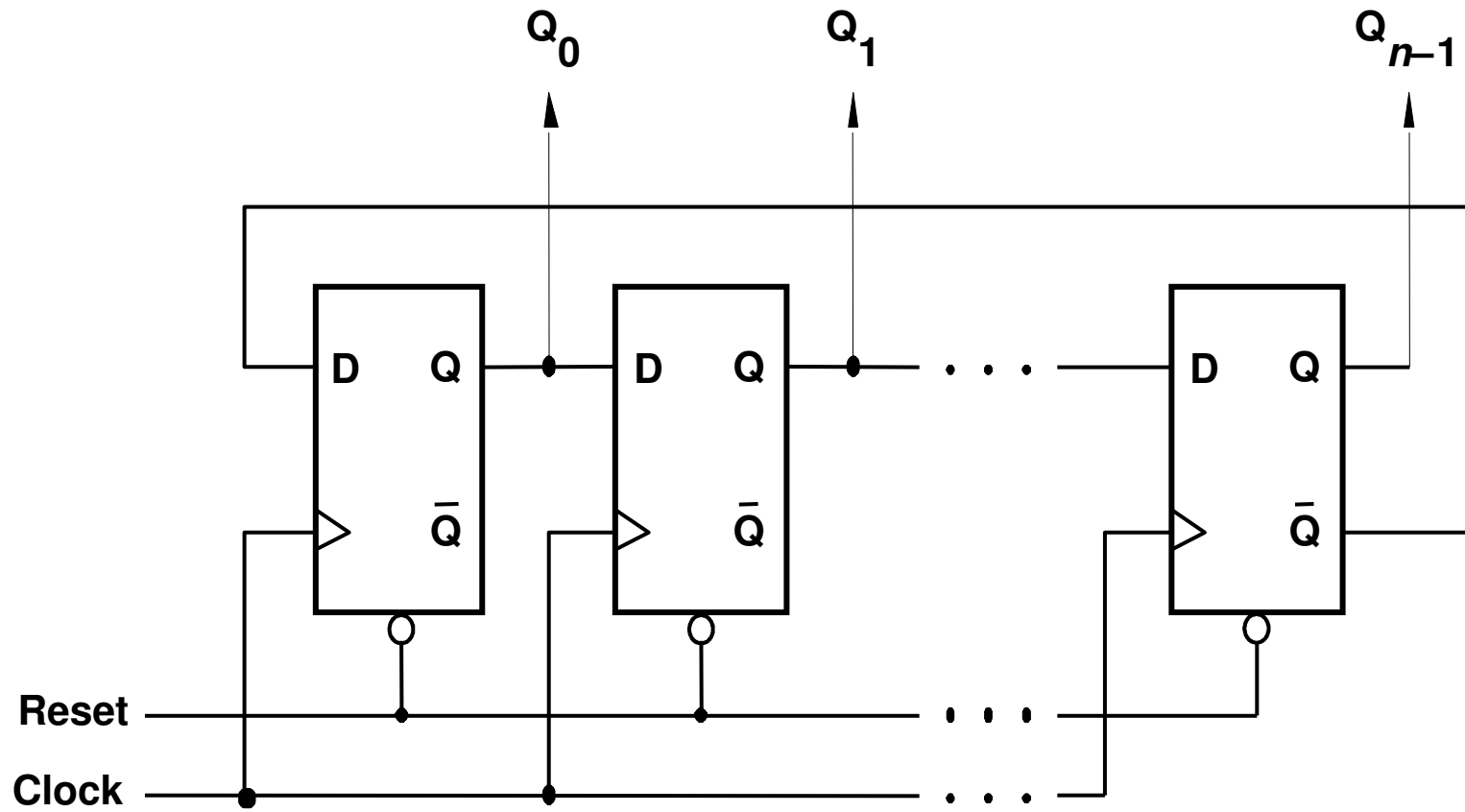
# Contador BCD de 2 Dígitos



# Contador em Anel

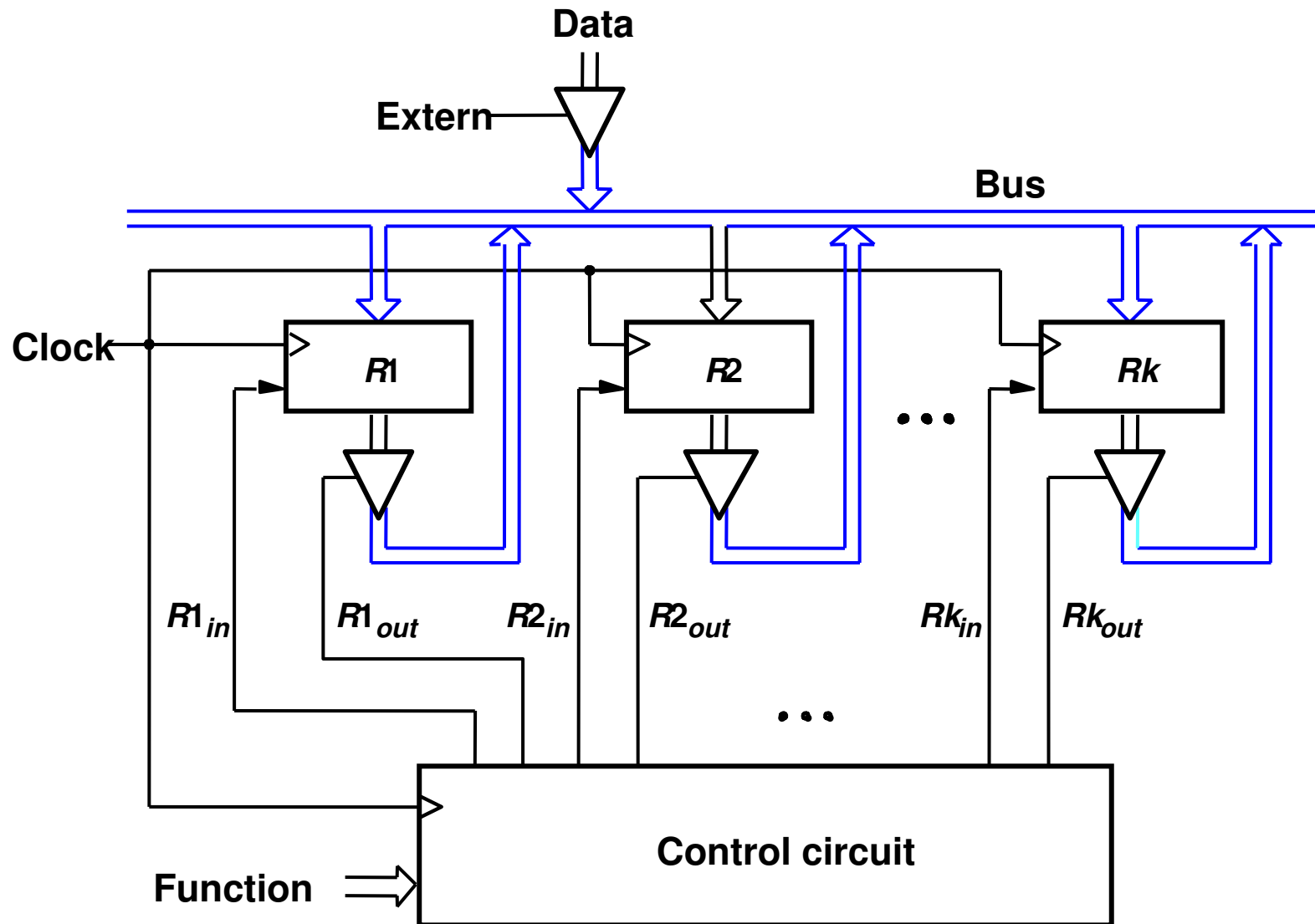


# Contador Johnson

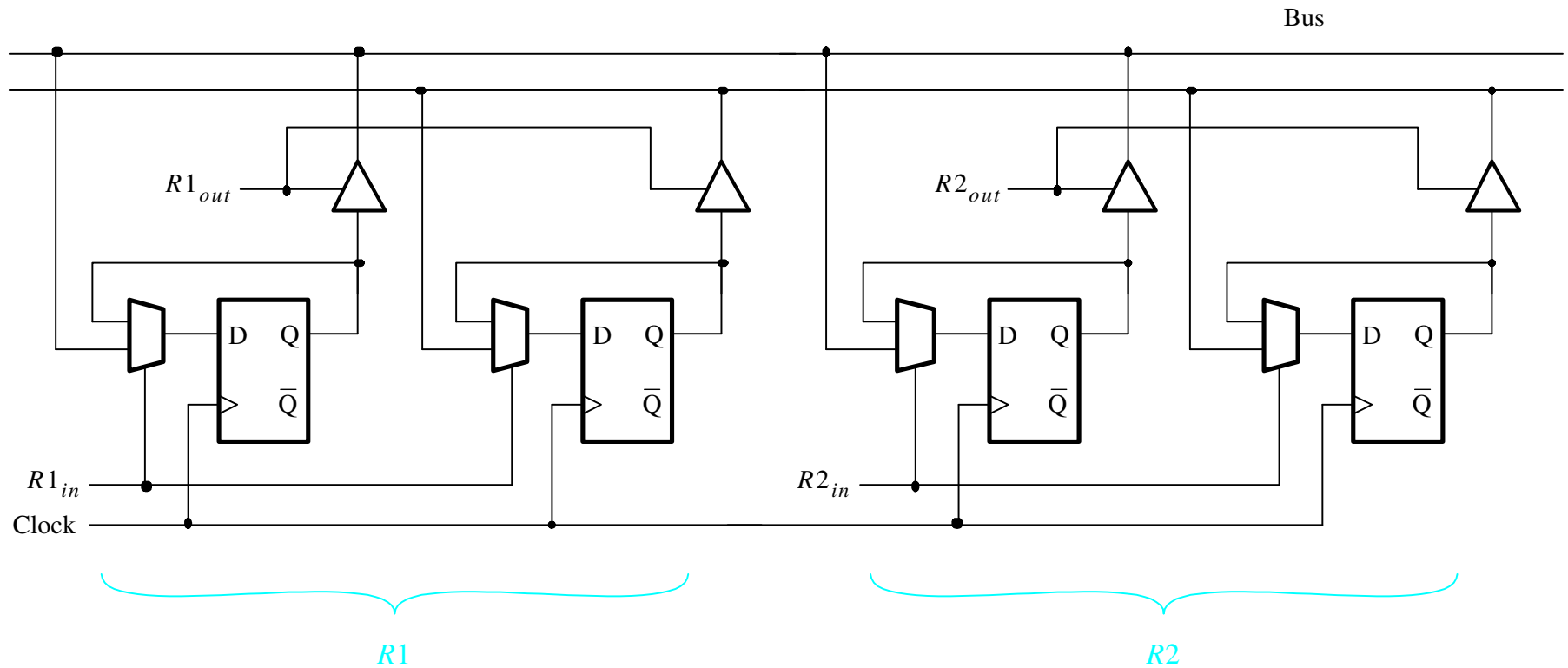




# Registadores em um Barramento



# Registadores em um Barramento



# Registadores em um Barramento implementado com mux

