CIRCUITOS DIGITAIS

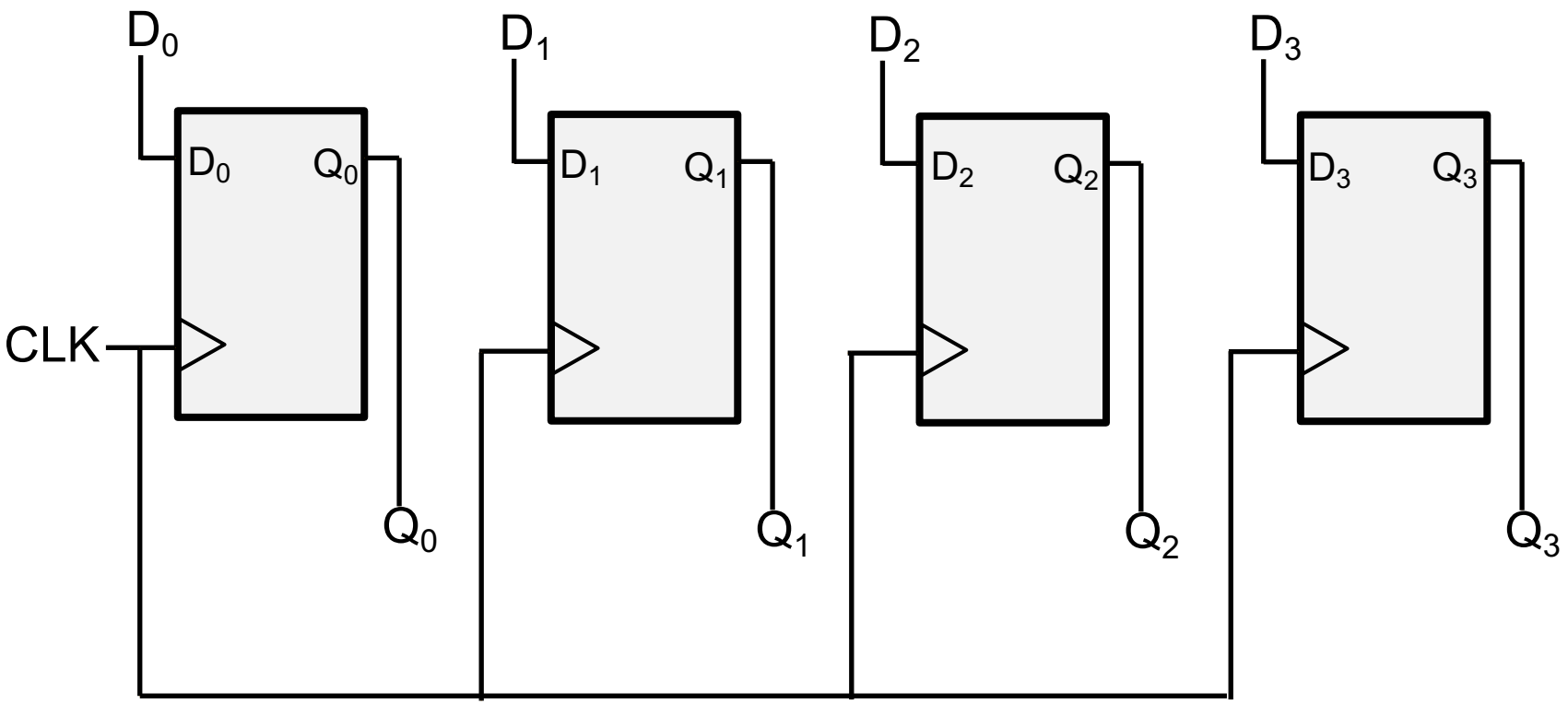
CIRCUITOS SEQUENCIAIS

Prof. Marcelo Grandi Mandelli

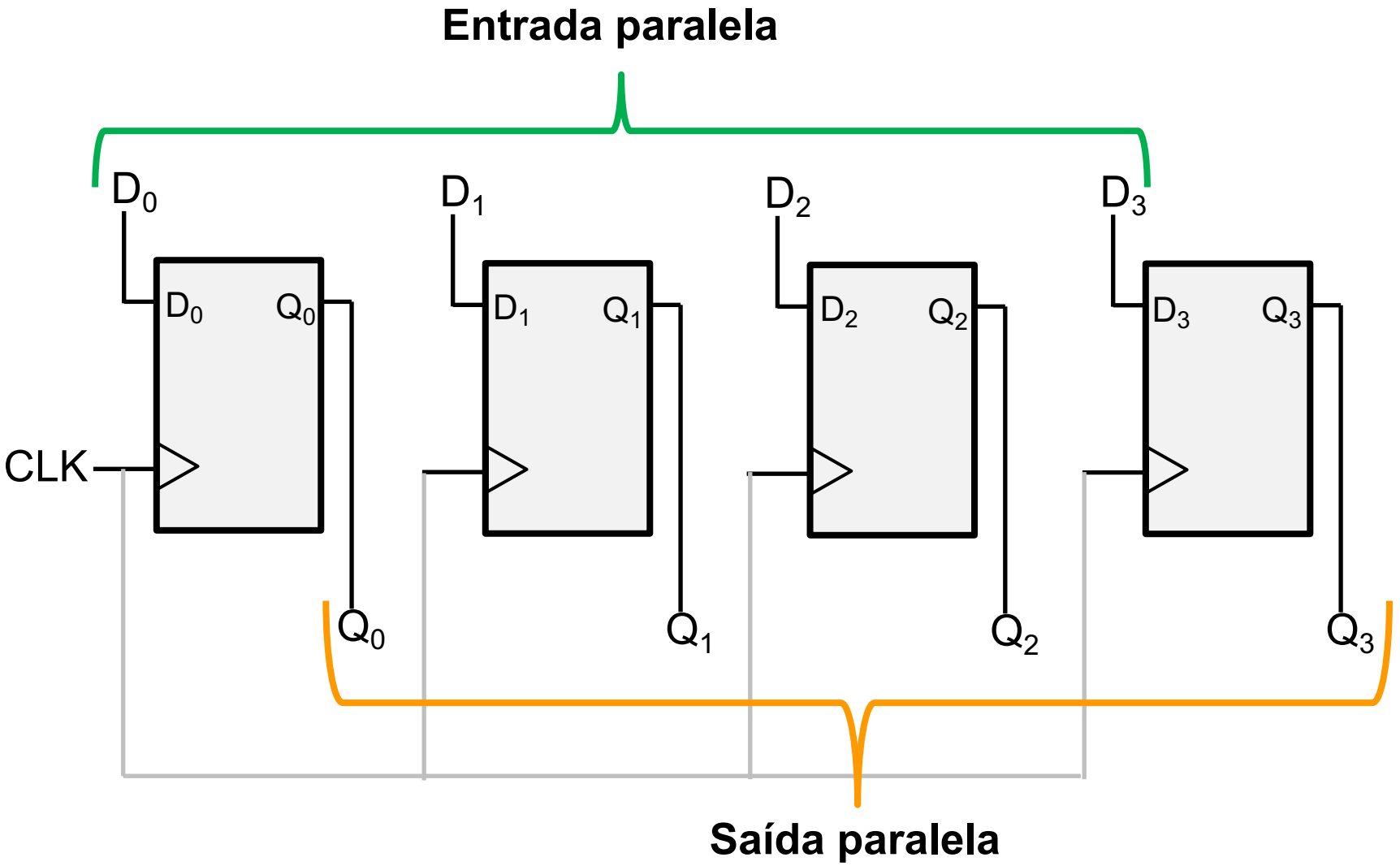
mgmandelli@unb.br

Registrador de Armazenamento

Registrador de 4 bits

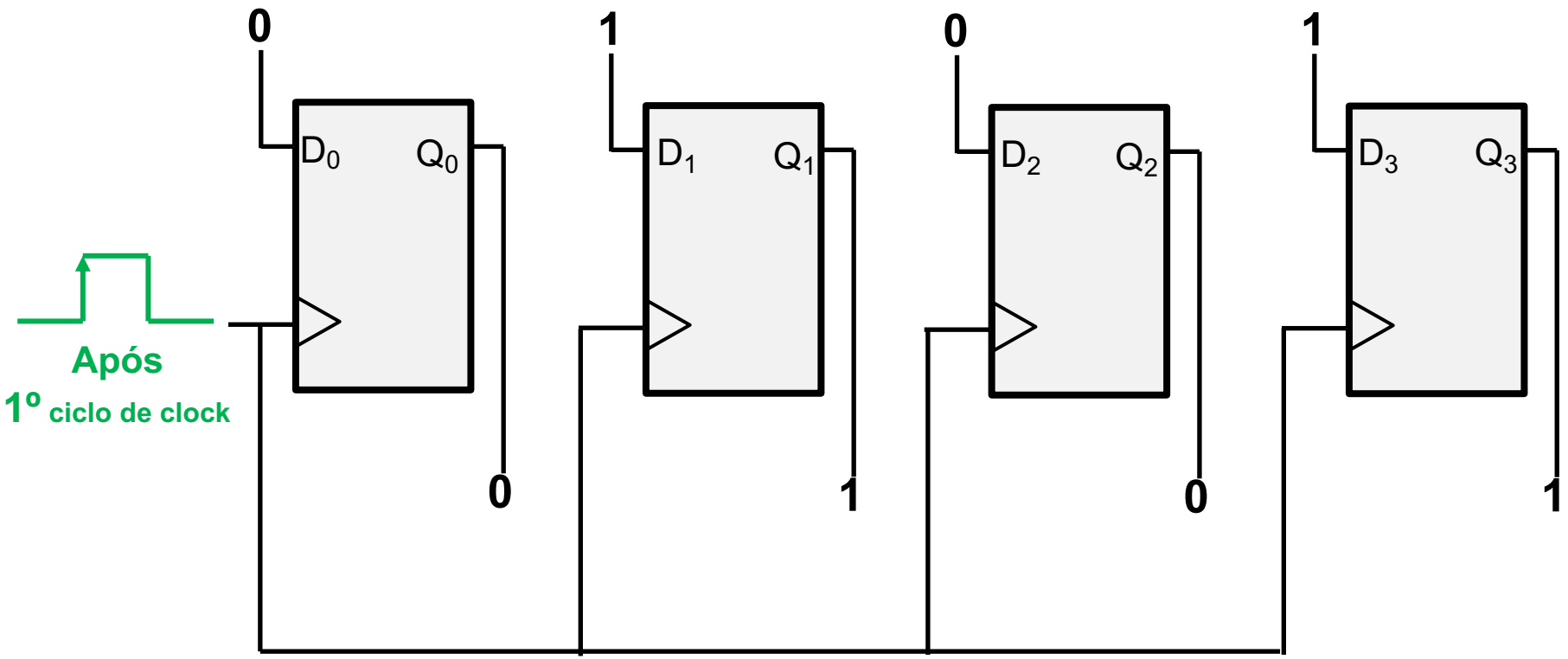


Registrador de Armazenamento



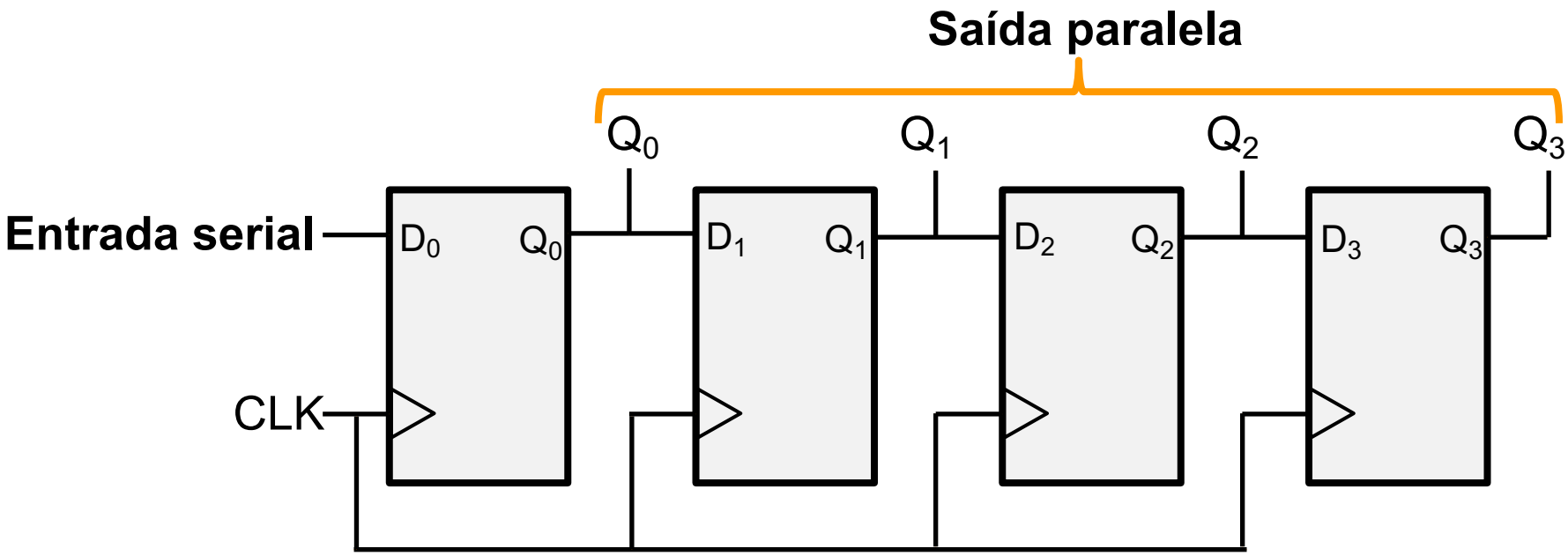
Registrador de Armazenamento

Registrador de 4 bits



Registrador de Deslocamento

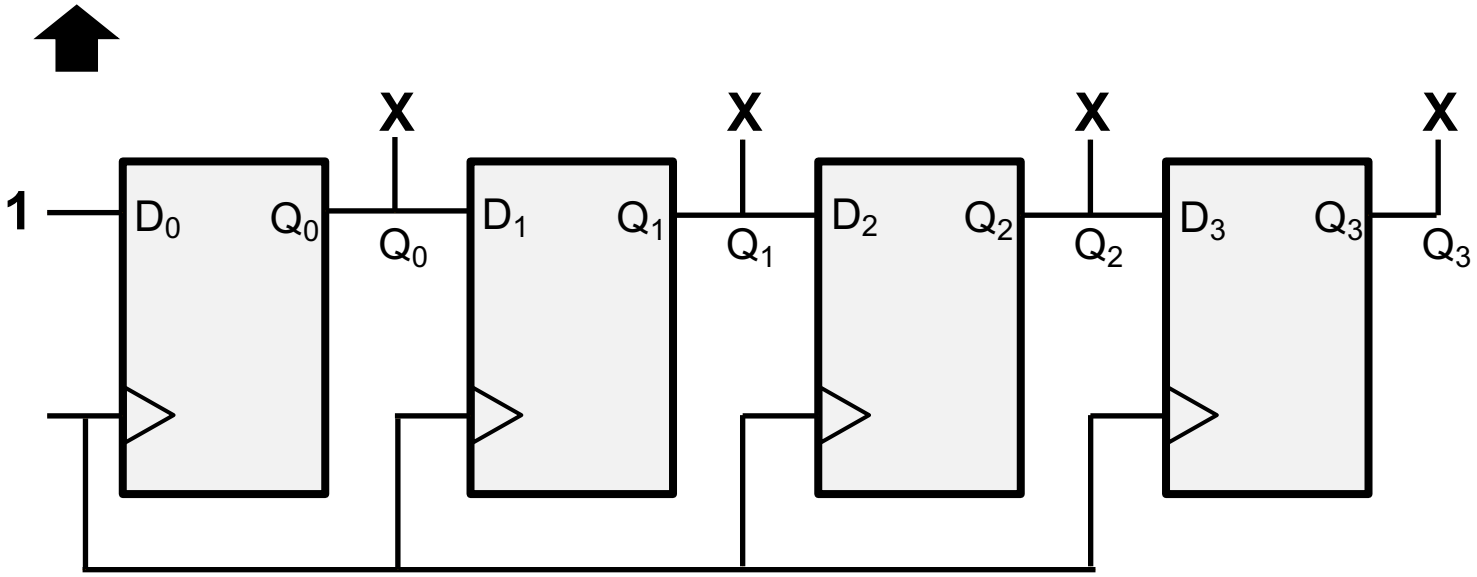
Entrada Serial / Saída Paralela



Registrador de Deslocamento

Entrada Serial / Saída Paralela

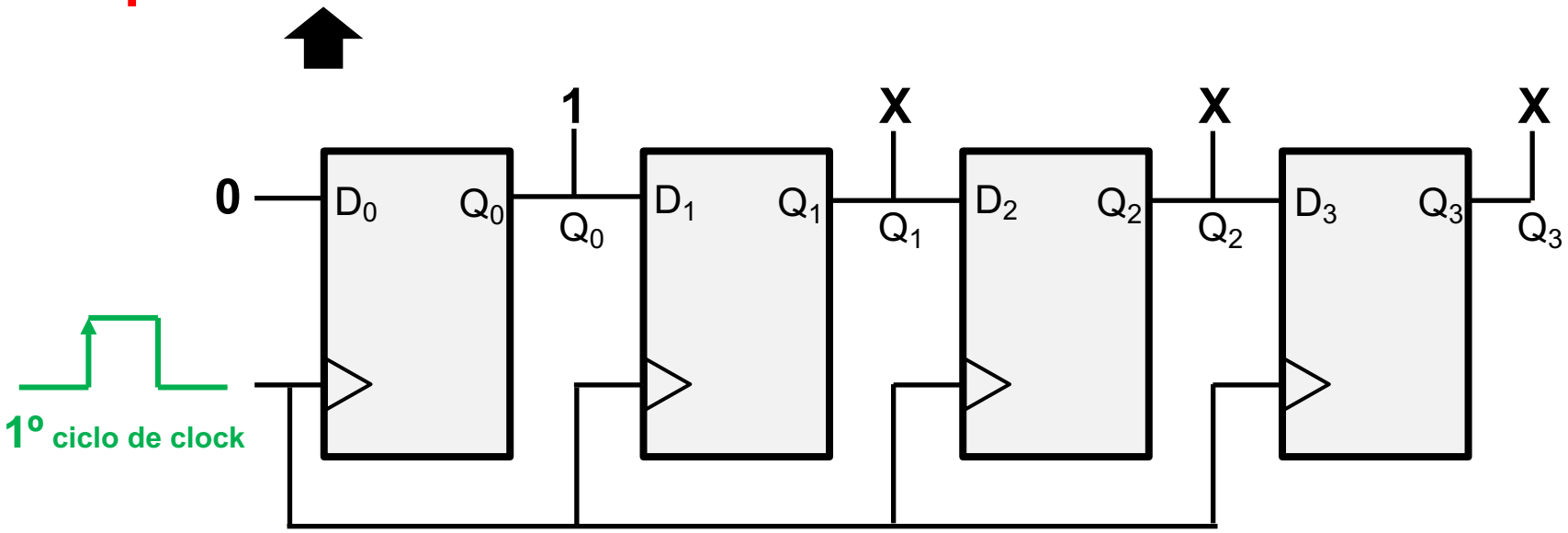
Exemplo : 1 0 1 0



Registrador de Deslocamento

Entrada Serial / Saída Paralela

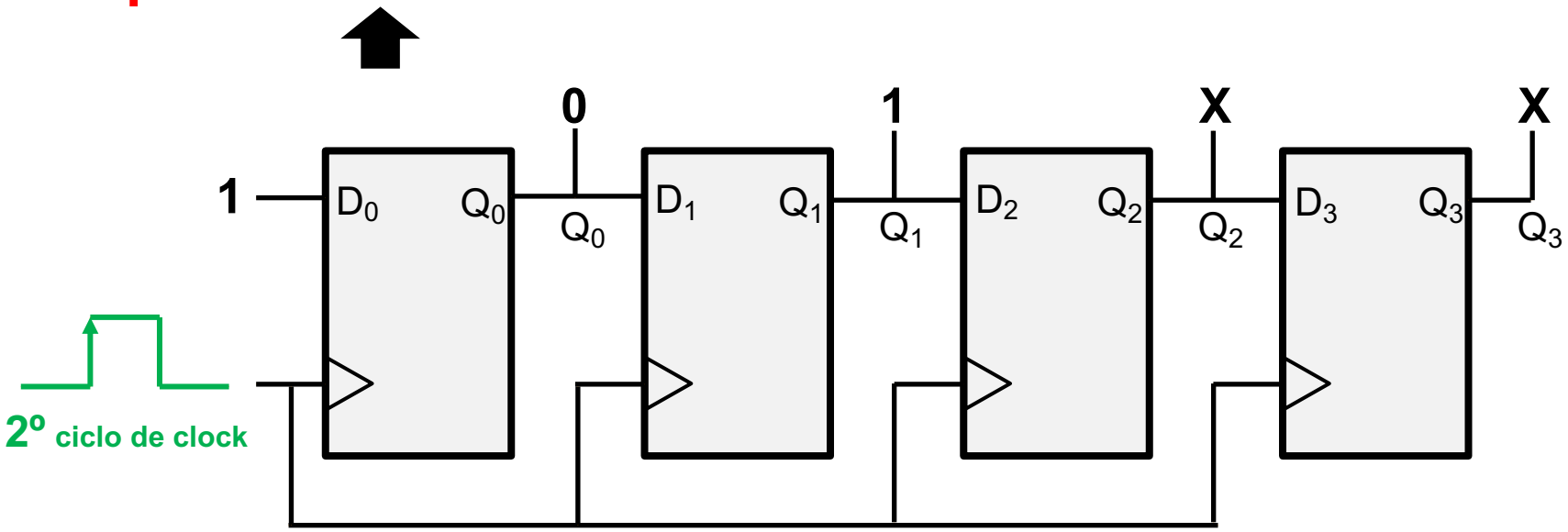
Exemplo : 1 0 1 0



Registrador de Deslocamento

Entrada Serial / Saída Paralela

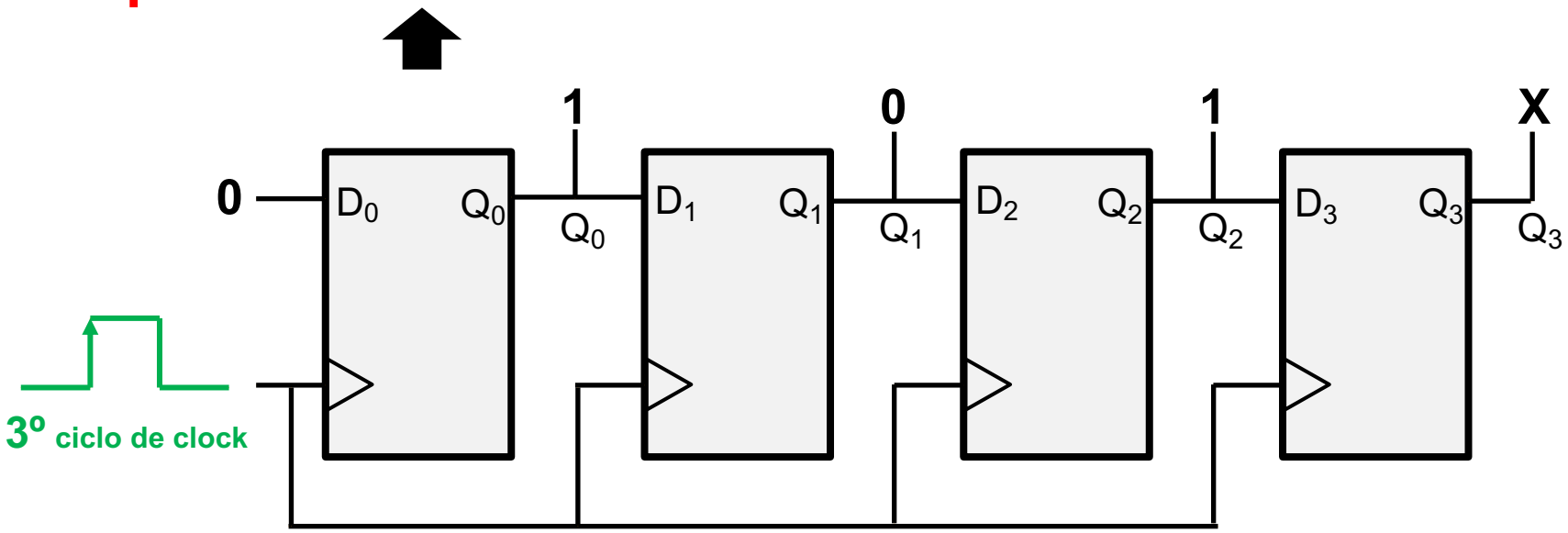
Exemplo : 1 0 1 0



Registrador de Deslocamento

Entrada Serial / Saída Paralela

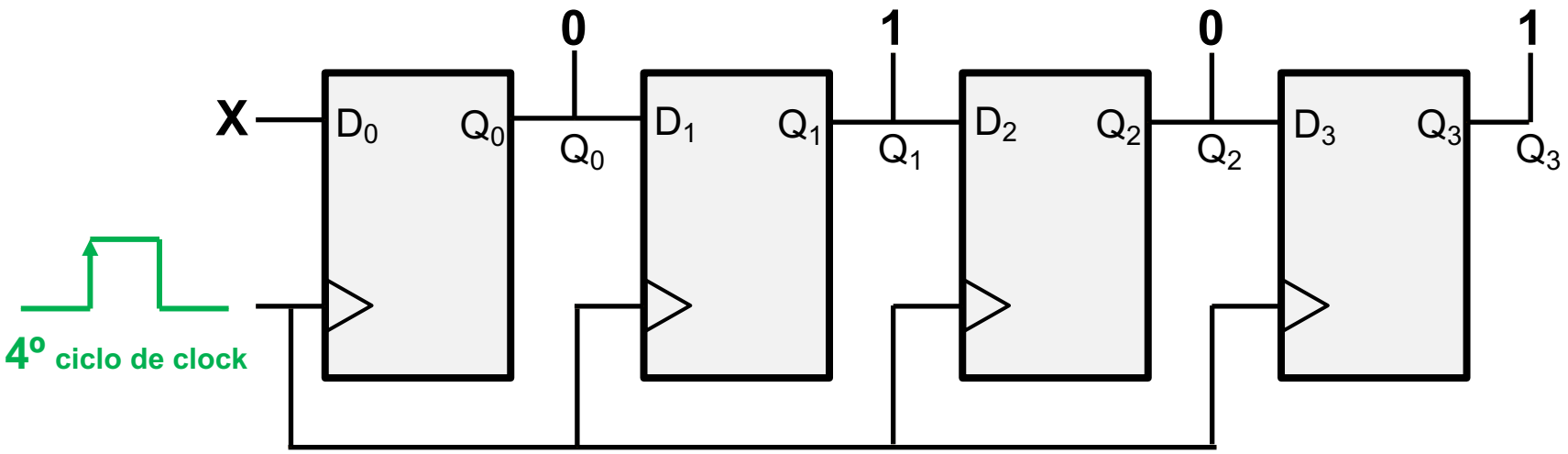
Exemplo : 1 0 1 0



Registrador de Deslocamento

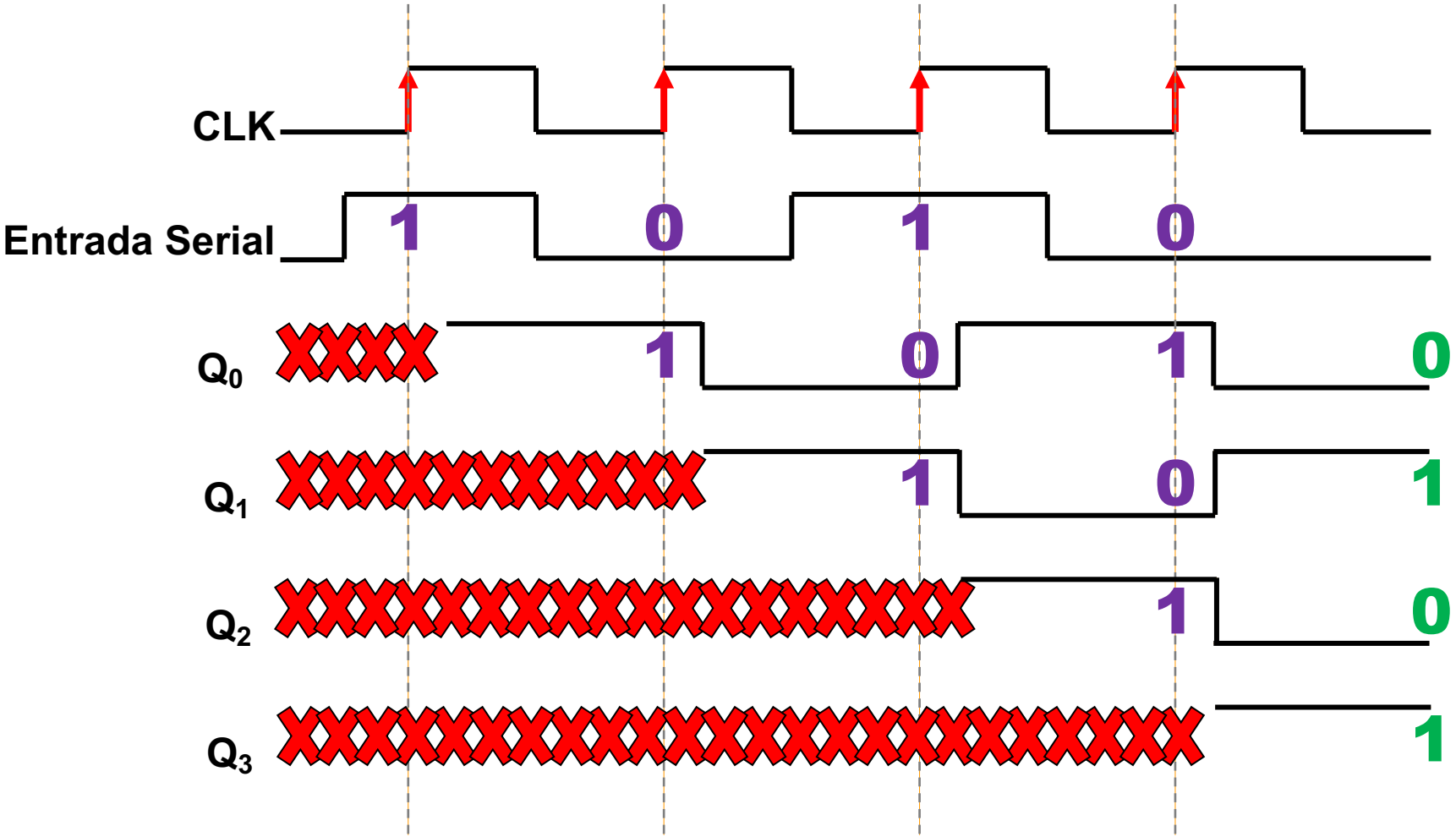
Entrada Serial / Saída Paralela

Exemplo : 1 0 1 0



O valor é armazenado no registrador após 4 ciclos de clock

Registrador de Deslocamento

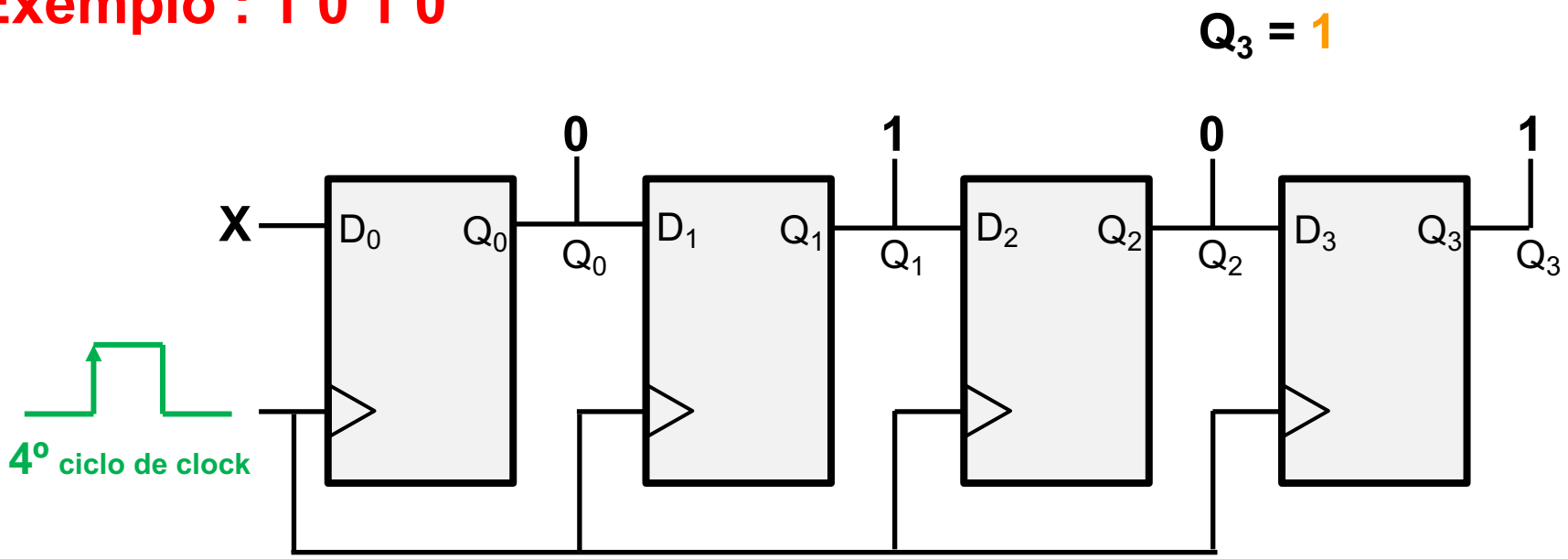


FORMA DE ONDA COM ATRASO

Registrador de Deslocamento

Entrada Serial / Saída Serial

Exemplo : 1 0 1 0

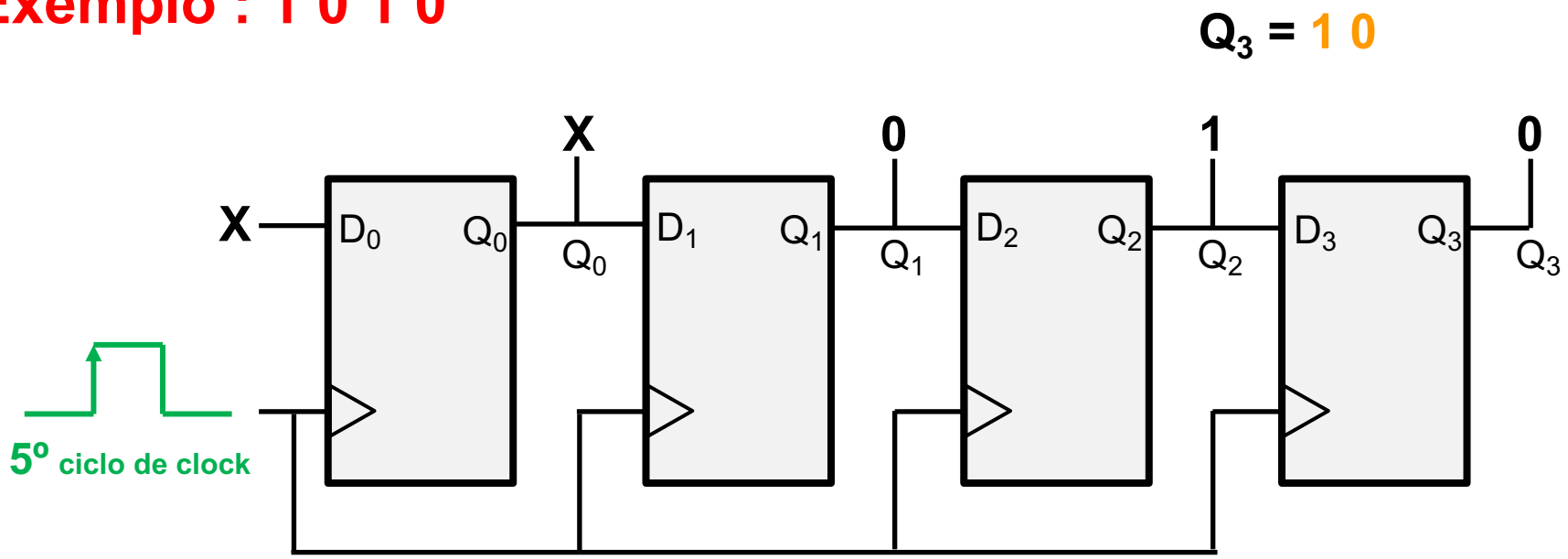


A partir do 4º ciclo de clock o valor começa a sair de forma serial em Q_3

Registrador de Deslocamento

Entrada Serial / Saída Serial

Exemplo : 1 0 1 0

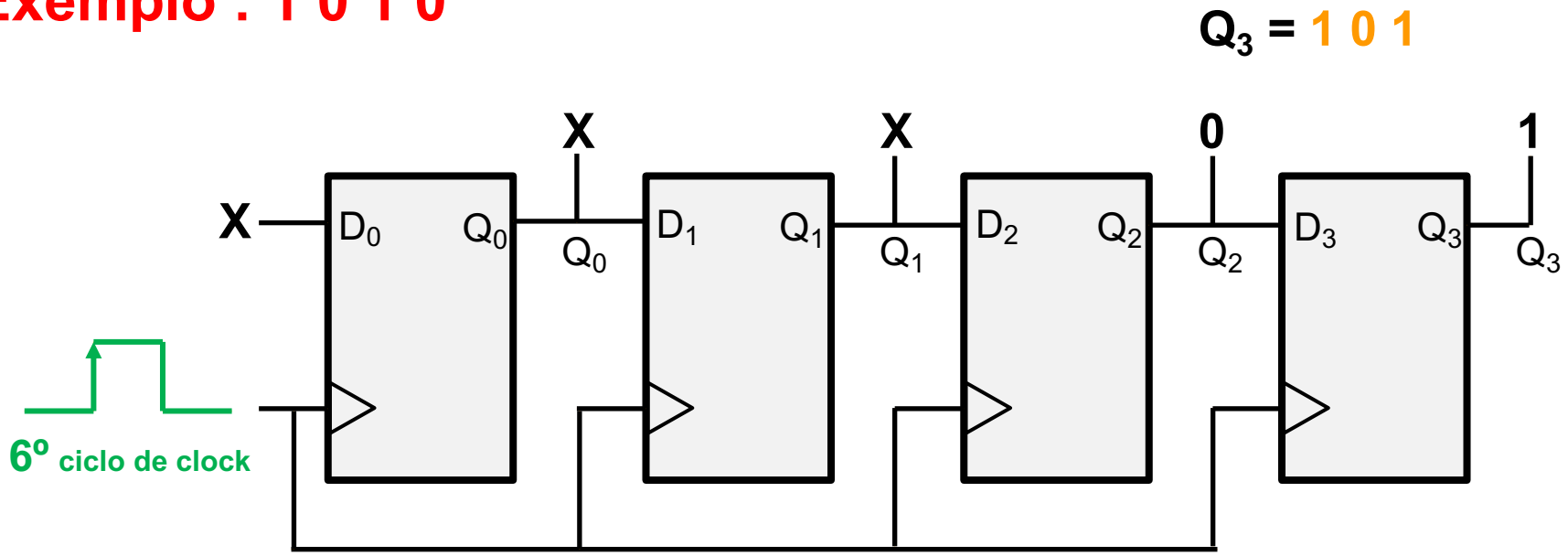


A partir do 4º ciclo de clock o valor começa a sair de forma serial em Q_3

Registrador de Deslocamento

Entrada Serial / Saída Serial

Exemplo : 1 0 1 0

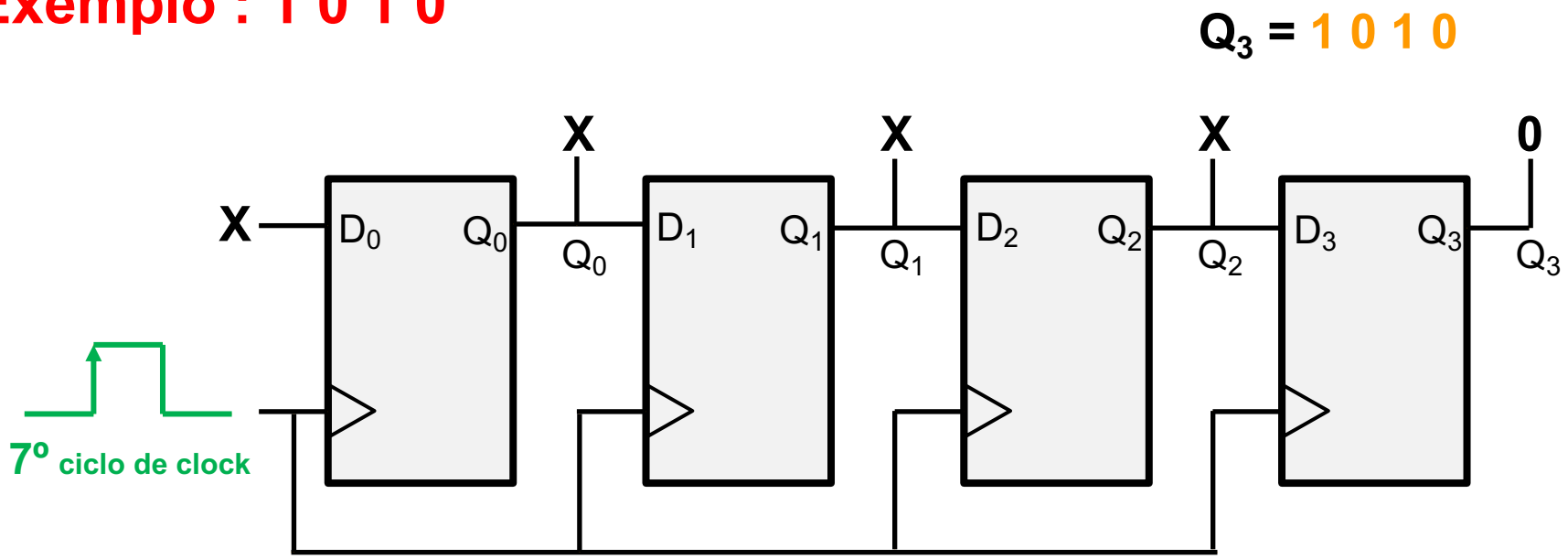


A partir do 4º ciclo de clock o valor começa a sair de forma serial em Q_3

Registrador de Deslocamento

Entrada Serial / Saída Serial

Exemplo : 1 0 1 0

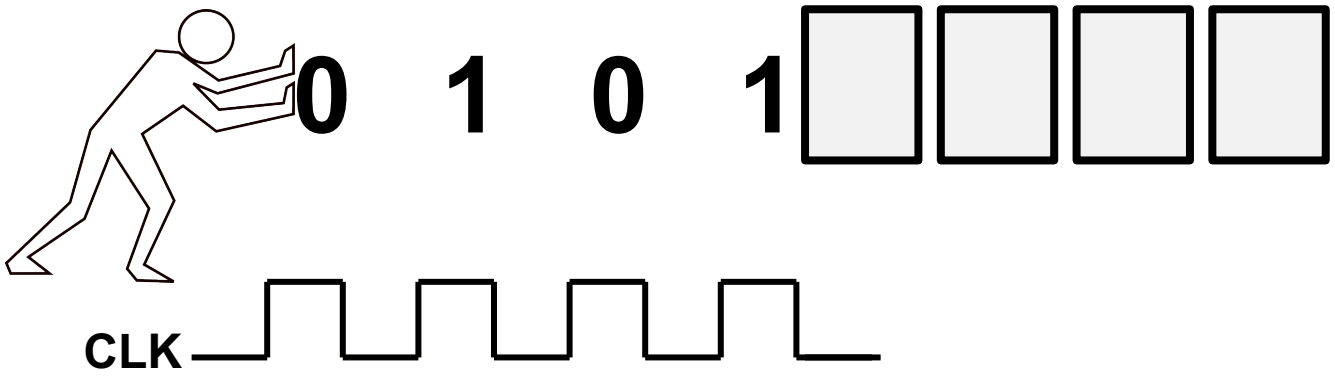


A partir do 4º ciclo de clock o valor começa a sair de forma serial em Q_3

Registrador de Deslocamento

Entrada Serial / Saída Paralela

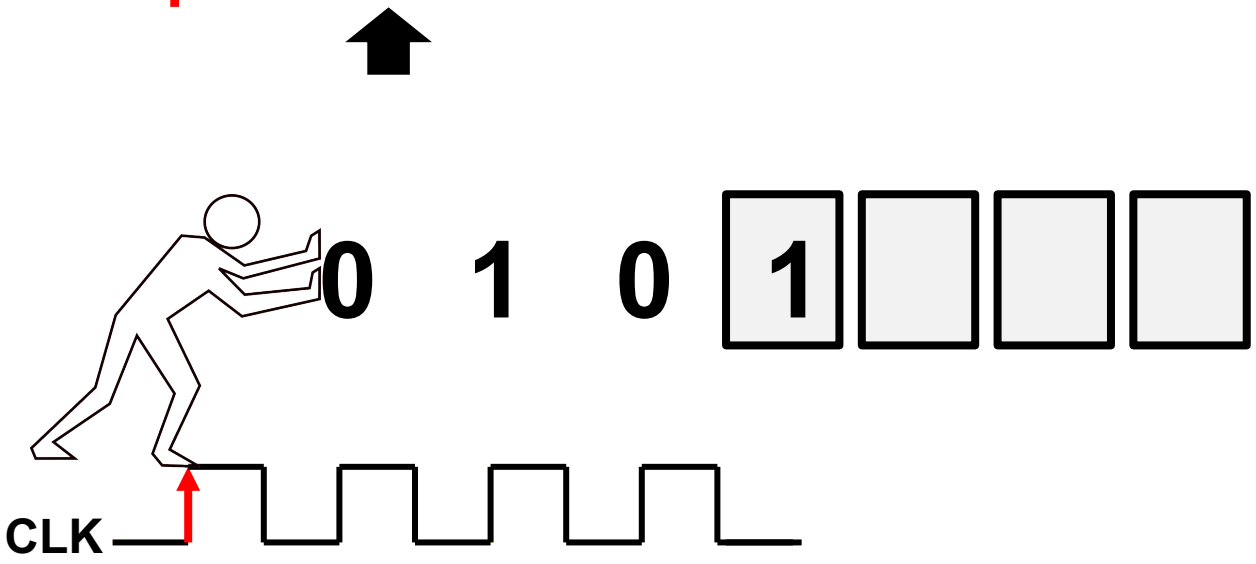
Exemplo : 1 0 1 0



Registrador de Deslocamento

Entrada Serial / Saída Paralela

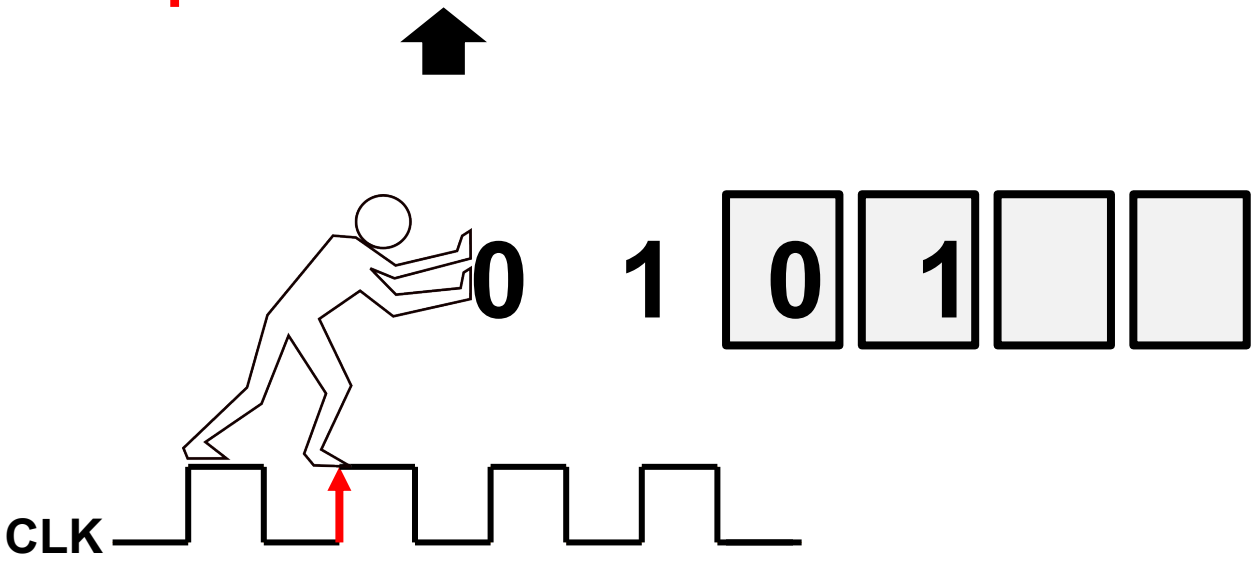
Exemplo : 1 0 1 0



Registrador de Deslocamento

Entrada Serial / Saída Paralela

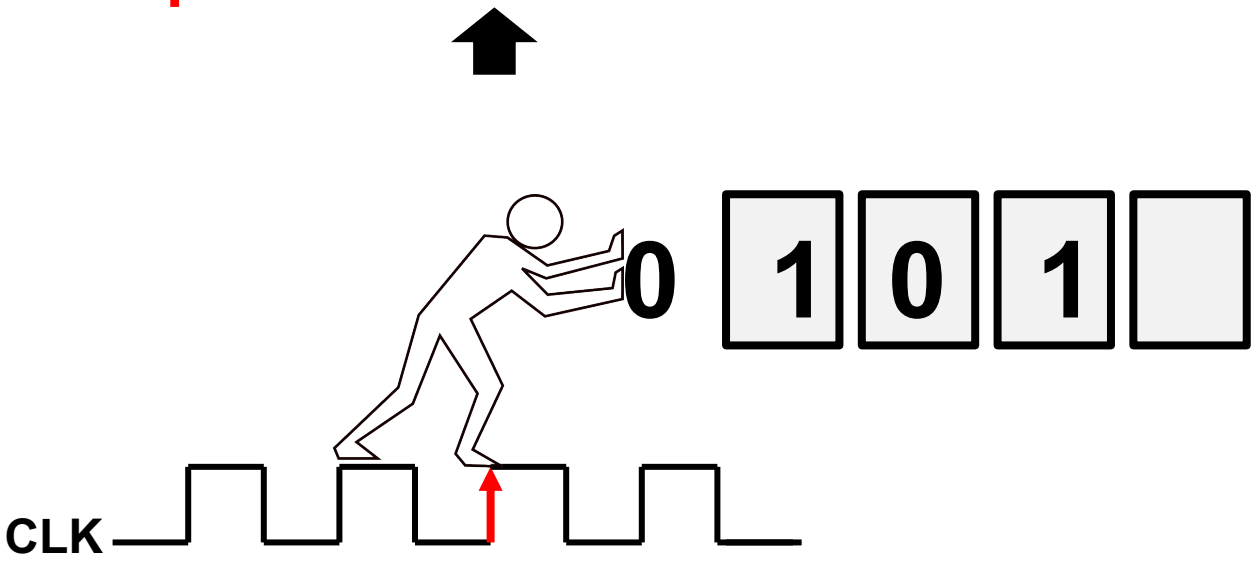
Exemplo : 1 0 1 0



Registrador de Deslocamento

Entrada Serial / Saída Paralela

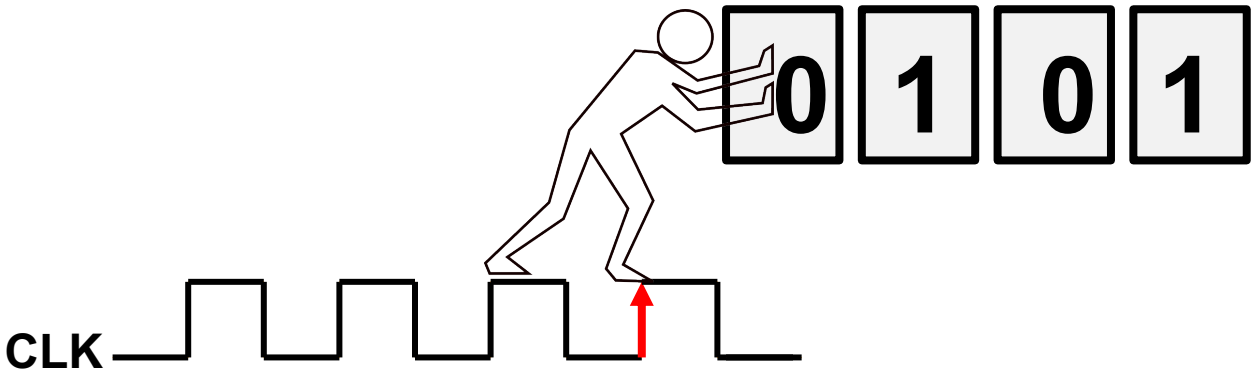
Exemplo : 1 0 1 0



Registrador de Deslocamento

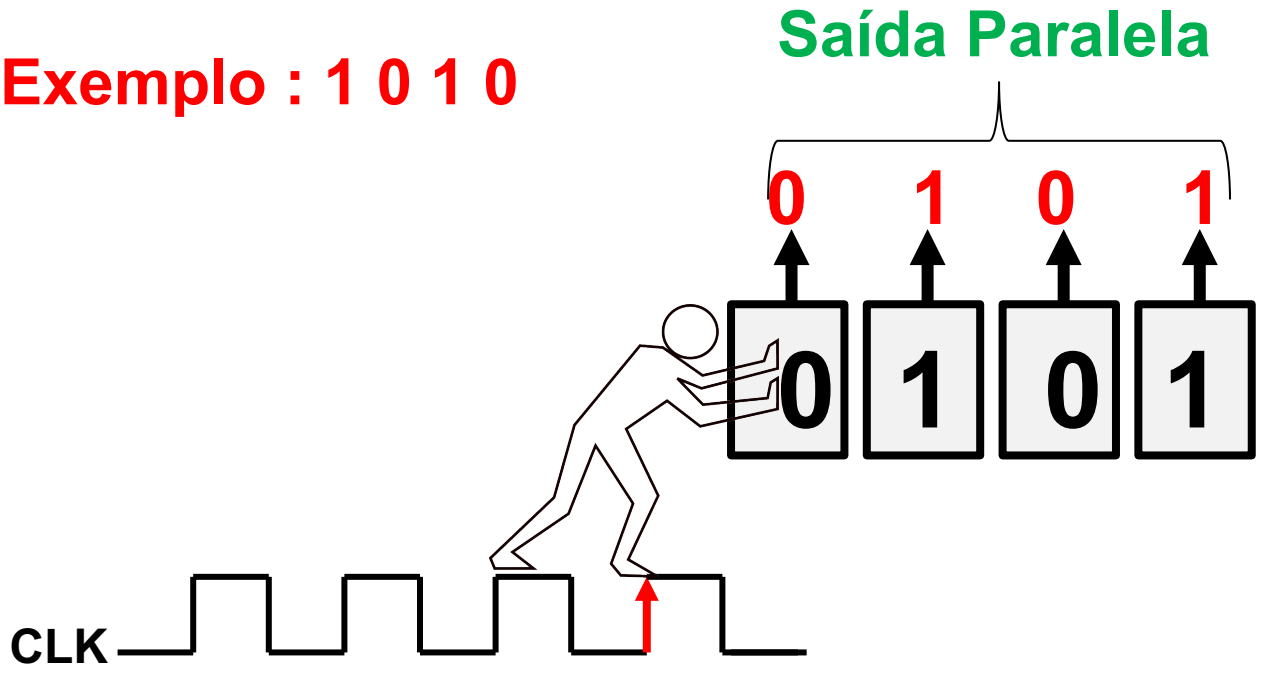
Entrada Serial / Saída Paralela

Exemplo : 1 0 1 0



Registrador de Deslocamento

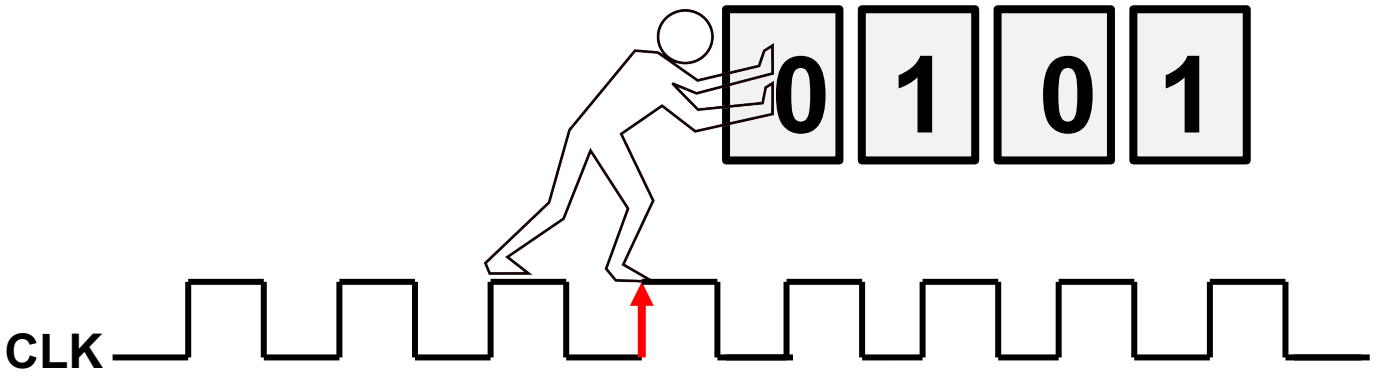
Exemplo : 1 0 1 0



Registrador de Deslocamento

Saída Serial

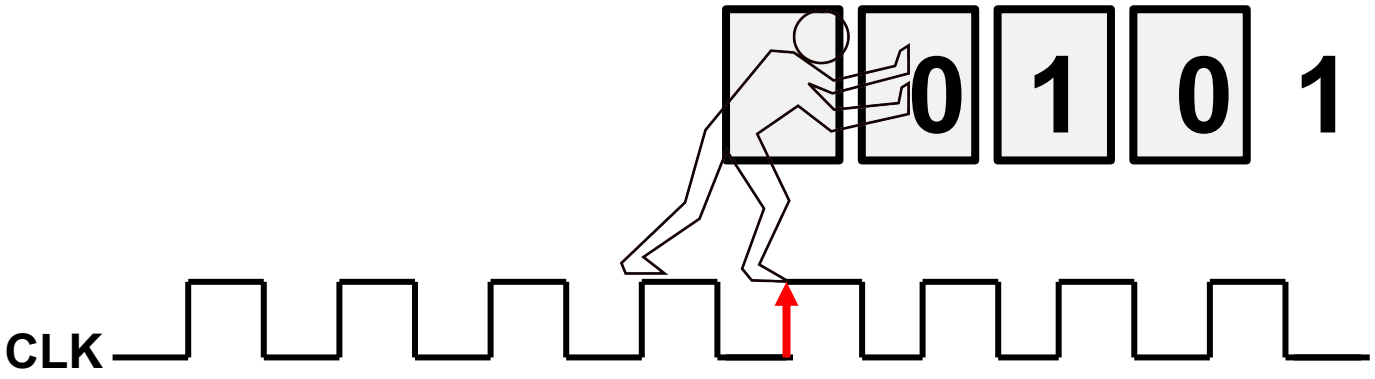
Exemplo : 1 0 1 0



Registrador de Deslocamento

Saída Serial

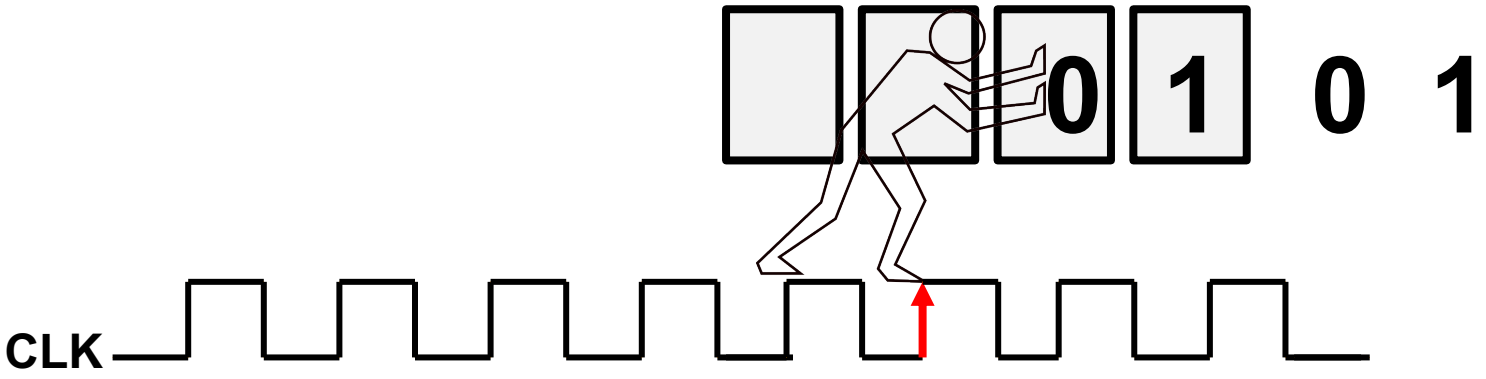
Exemplo : 1 0 1 0



Registrador de Deslocamento

Saída Serial

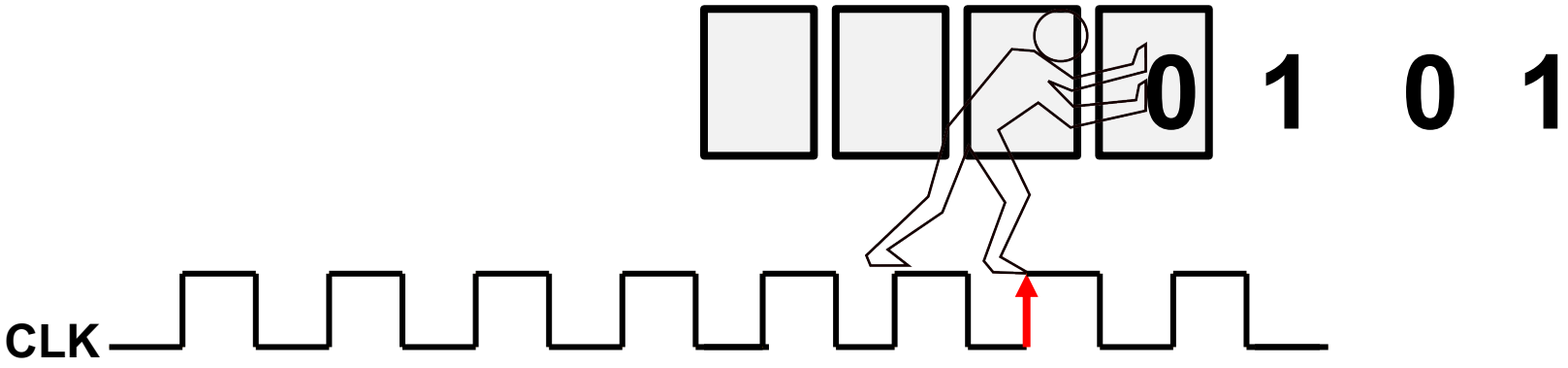
Exemplo : 1 0 1 0



Registrador de Deslocamento

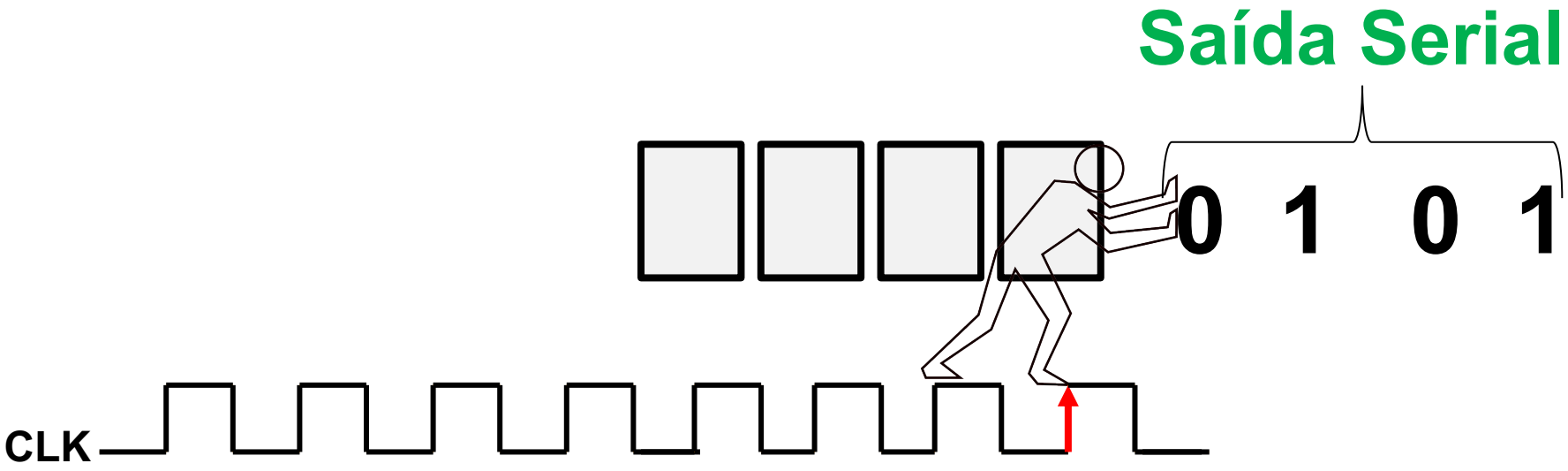
Saída Serial

Exemplo : 1 0 1 0



Registrador de Deslocamento

Exemplo : 1 0 1 0

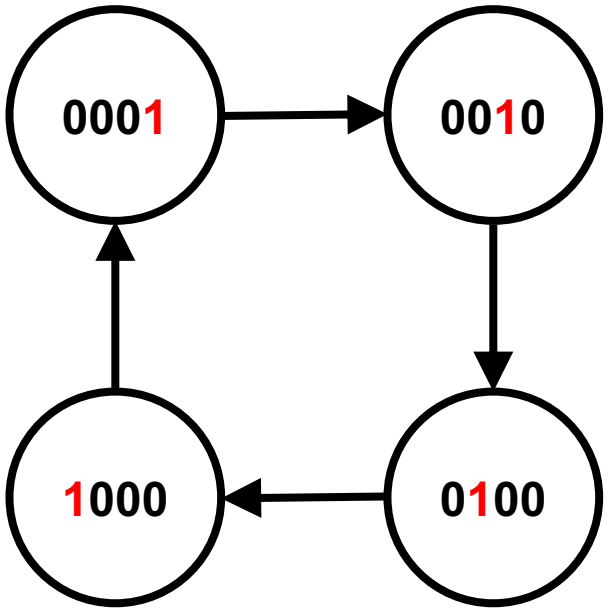


Registrador de Deslocamento

- **Dado armazenado é deslocado para esquerda ou para a direita (shift de bits)**
  - Multiplicação ou divisão por 2 :
    - 1010 → 1 bit deslocado para esquerda → 10100 → **multiplicação**
    - 1010 → 1 bit deslocado para direita → 0101 → **divisão**
- Executar operações um bit por vez
  - Adição, Complemento 2, paridade,...
- Atraso de tempo do clock
- Conversor Serial → Paralelo e Paralelo →Serial
- Contadores – Anel e Johnson

Contador em Anel

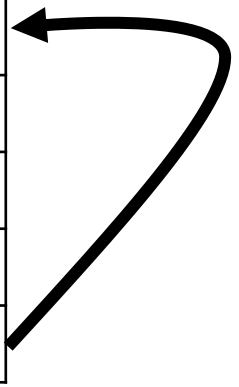
- **Exemplo –** Contador em Anel de 4 bits



Contador em Anel

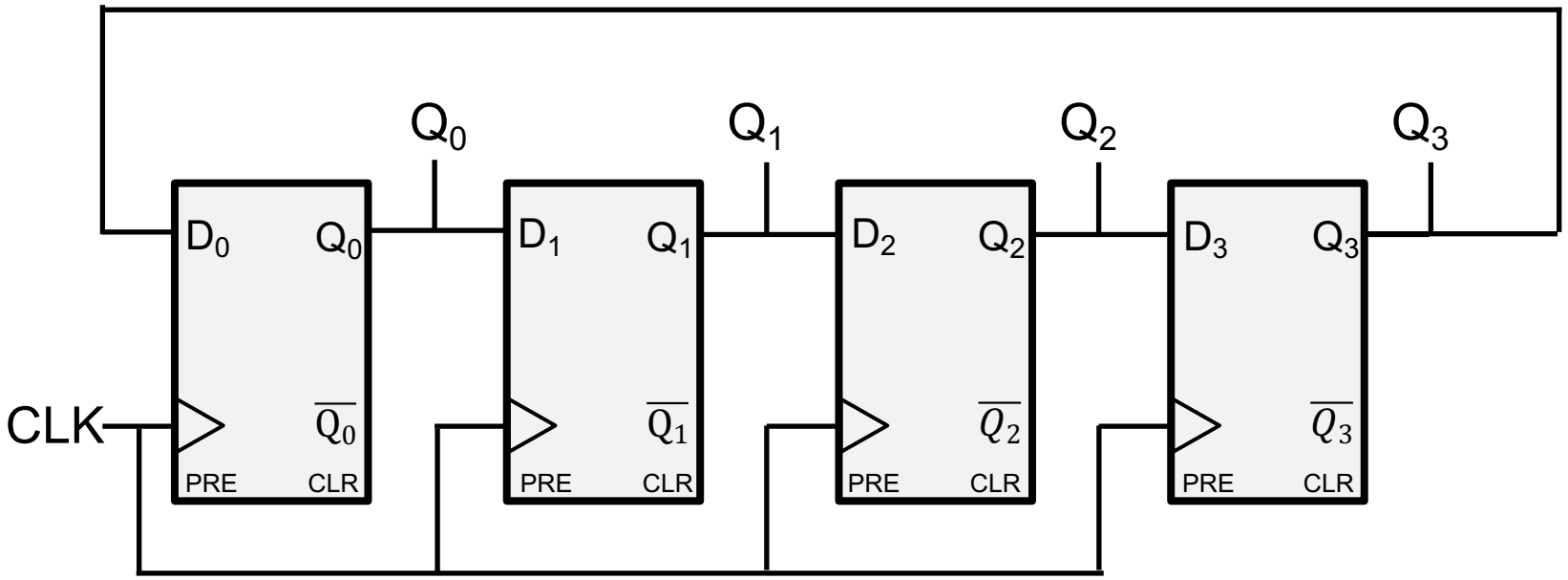
- **Exemplo –** Contador em Anel de 4 bits

Pulso de Clock	Q_3	Q_2	Q_1	Q_0
Valor inicial	0	0	0	1
1º	0	0	1	0
2º	0	1	0	0
3º	1	0	0	0
4º (reciclagem)	0	0	0	1



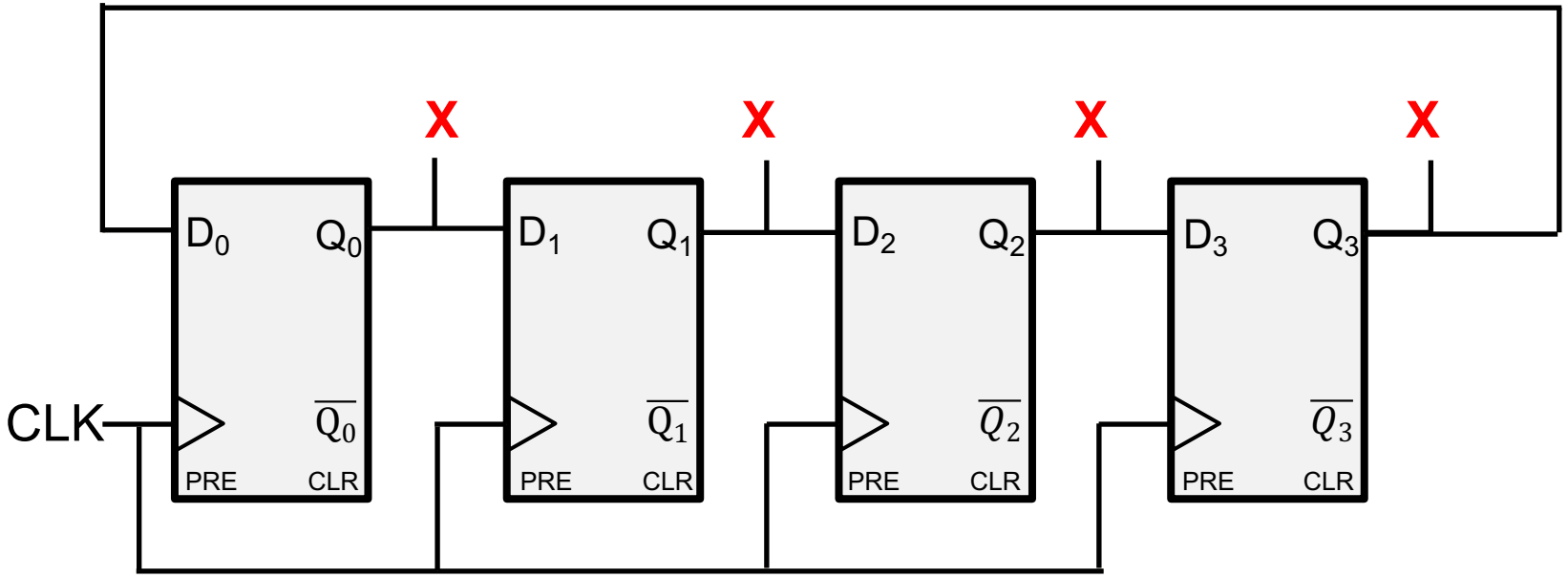
Contador em Anel

- **Exemplo –** Contador em Anel de 4 bits



Contador em Anel

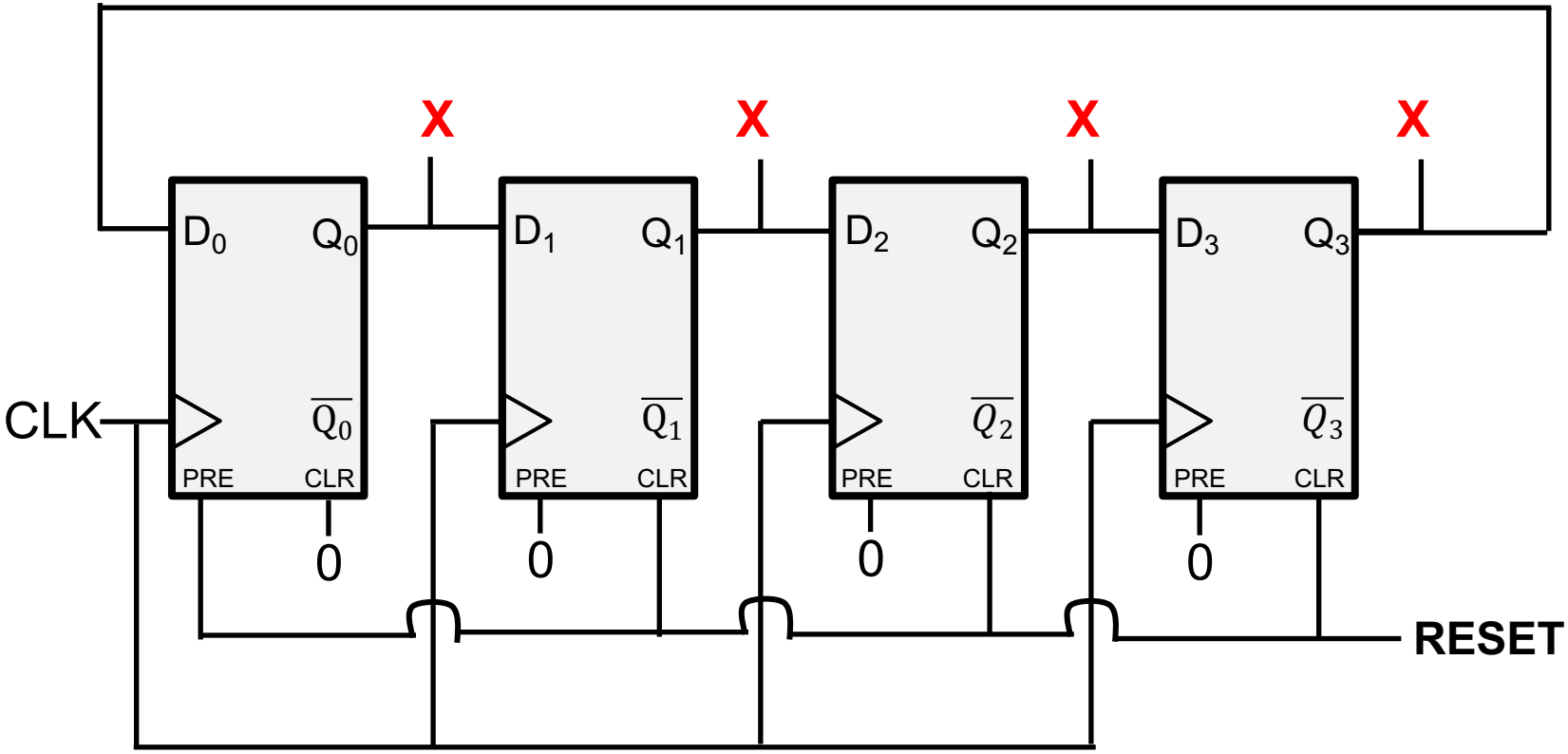
- **Exemplo –** Contador em Anel de 4 bits



COMO INICIALIZAR O CONTADOR?

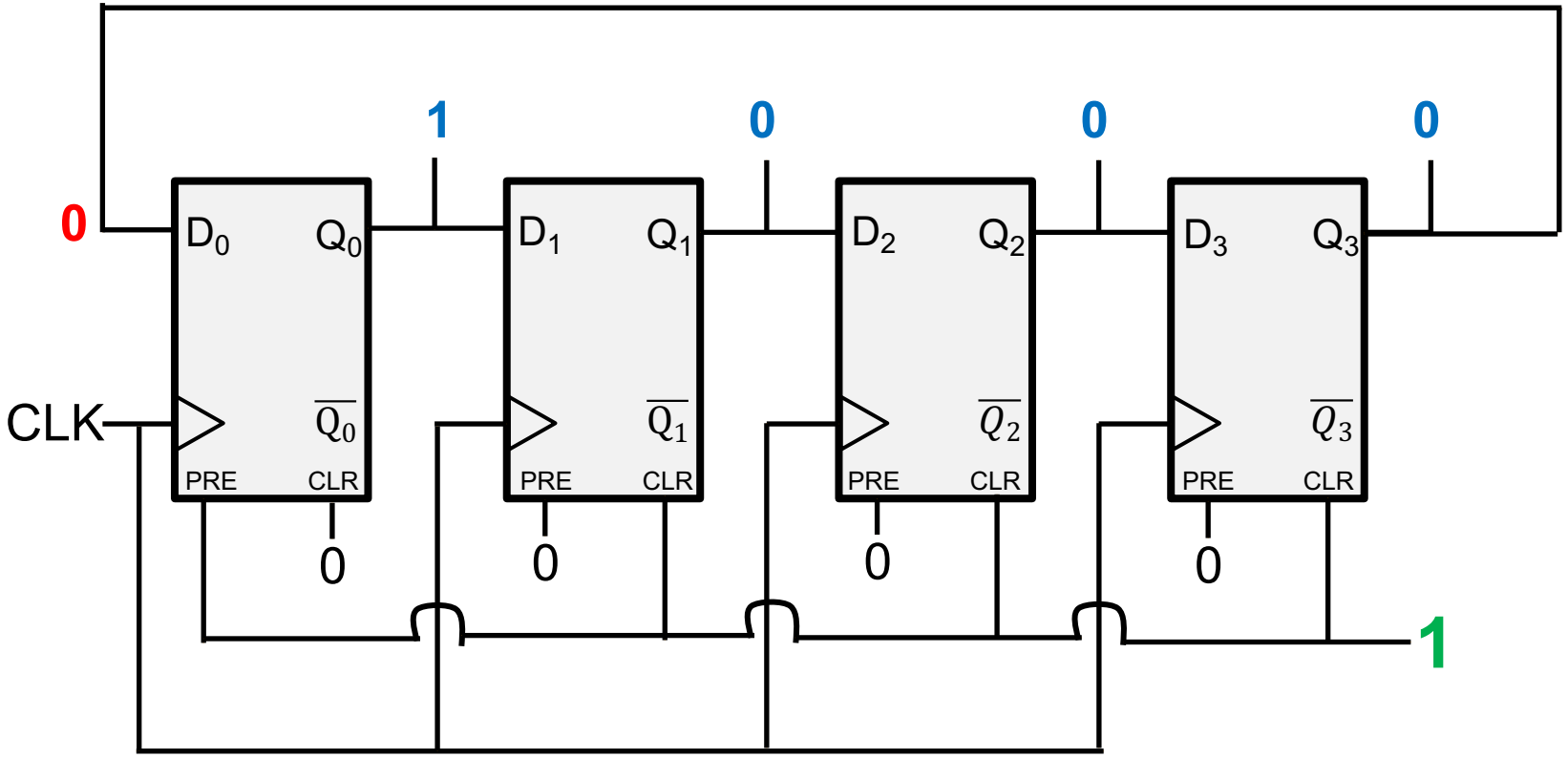
Contador em Anel

- **Exemplo –** Contador em Anel de 4 bits



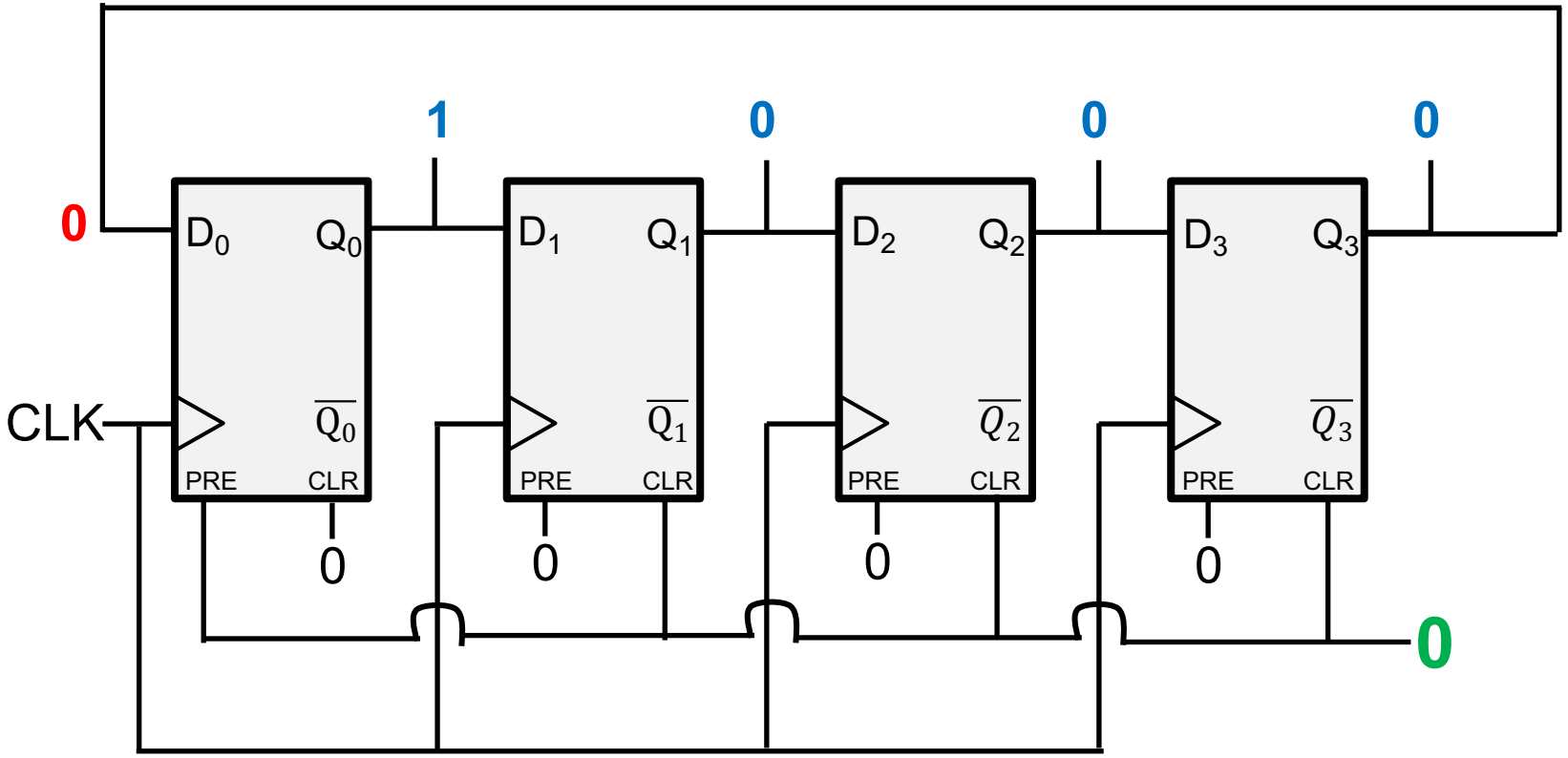
Contador em Anel

- **Exemplo –** Contador em Anel de 4 bits



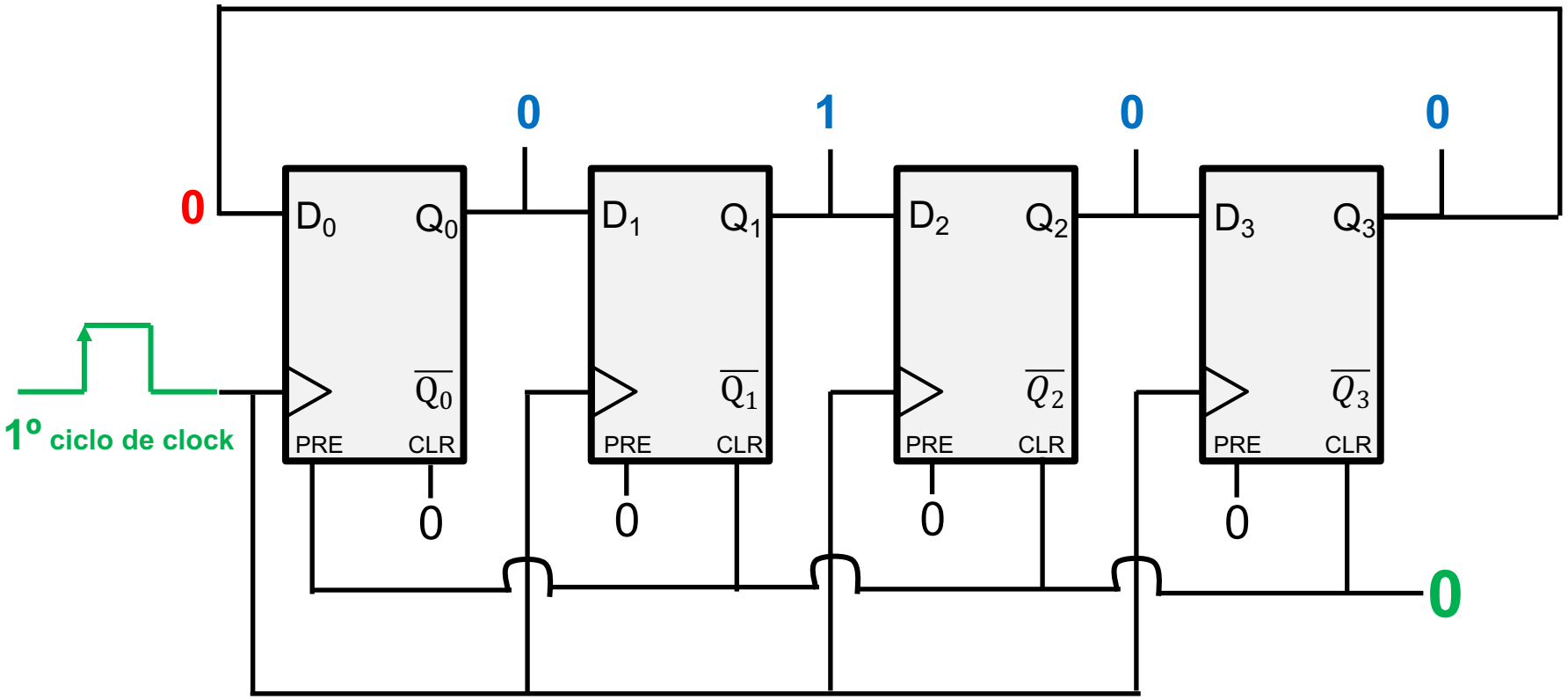
Contador em Anel

- **Exemplo –** Contador em Anel de 4 bits



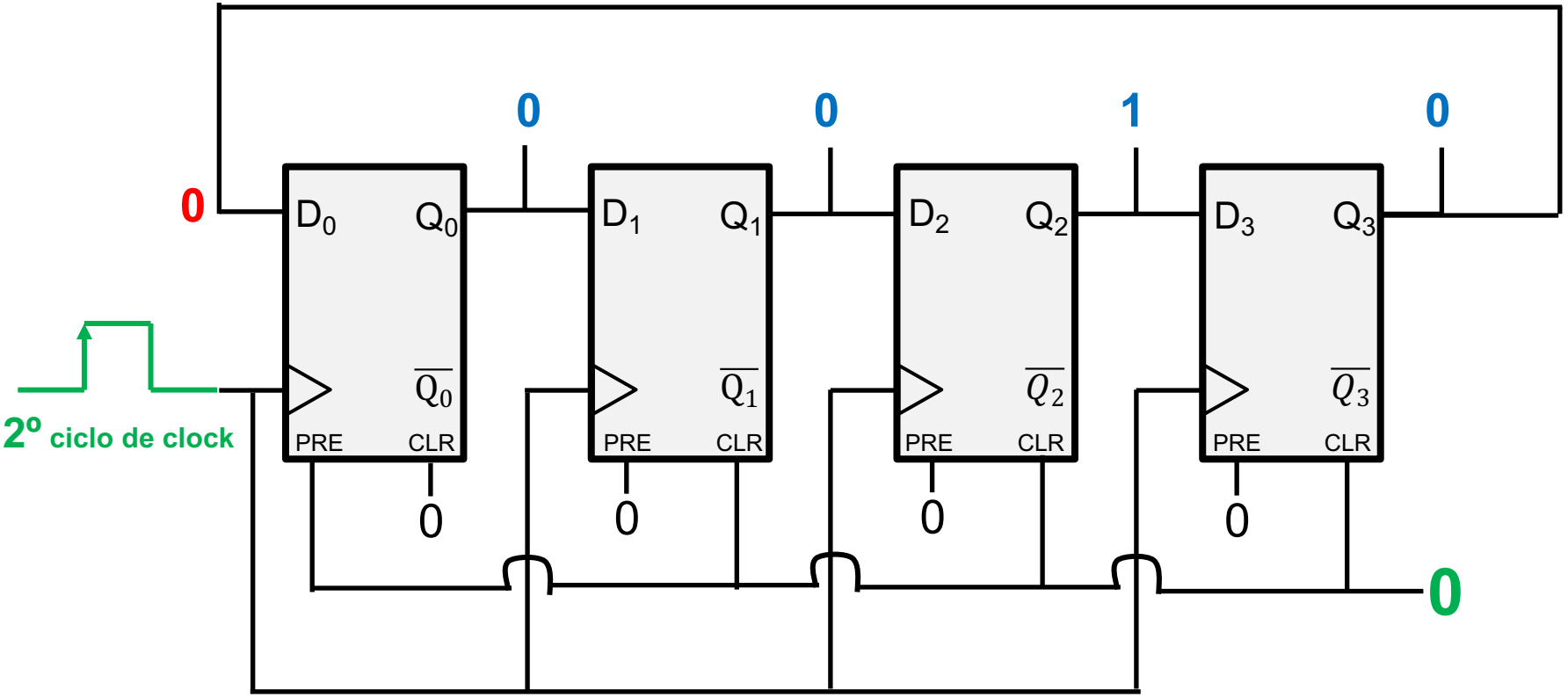
Contador em Anel

- **Exemplo –** Contador em Anel de 4 bits



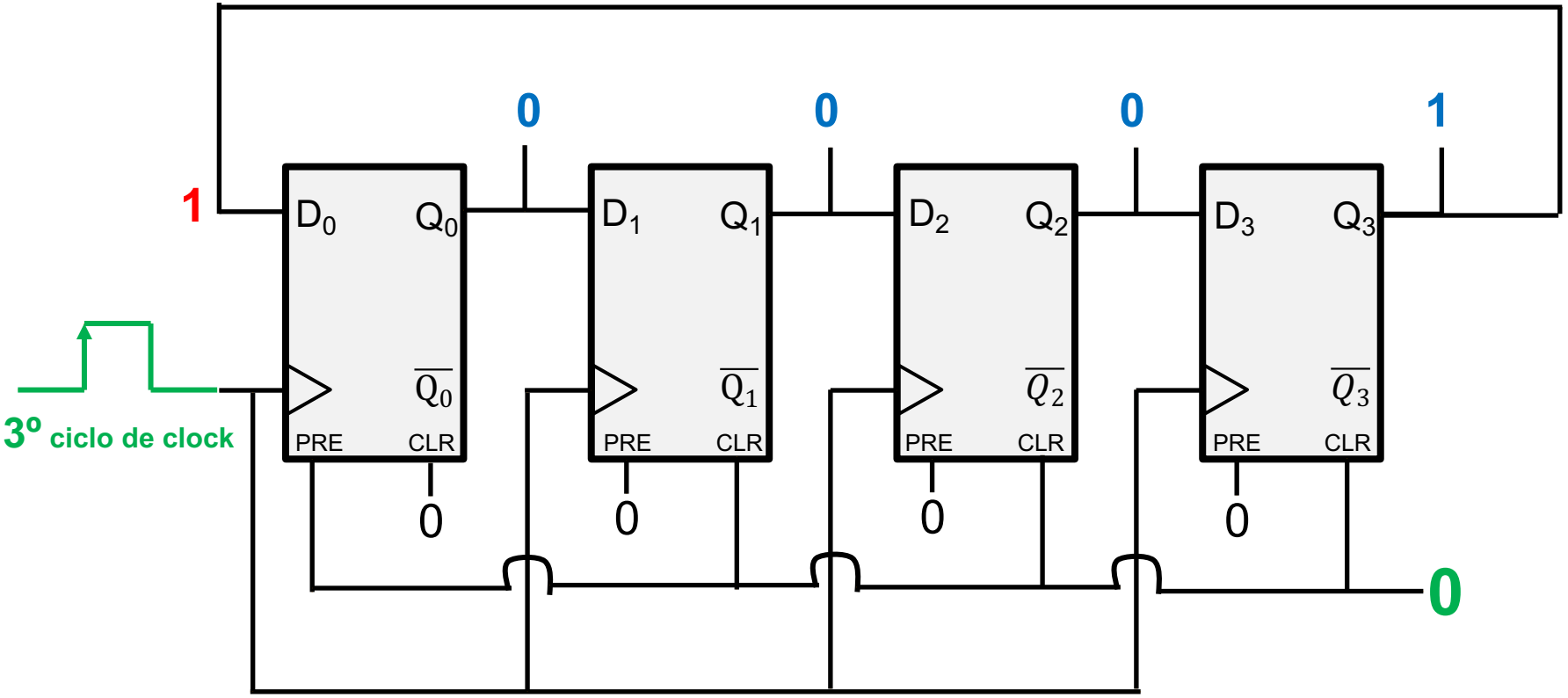
Contador em Anel

- **Exemplo –** Contador em Anel de 4 bits



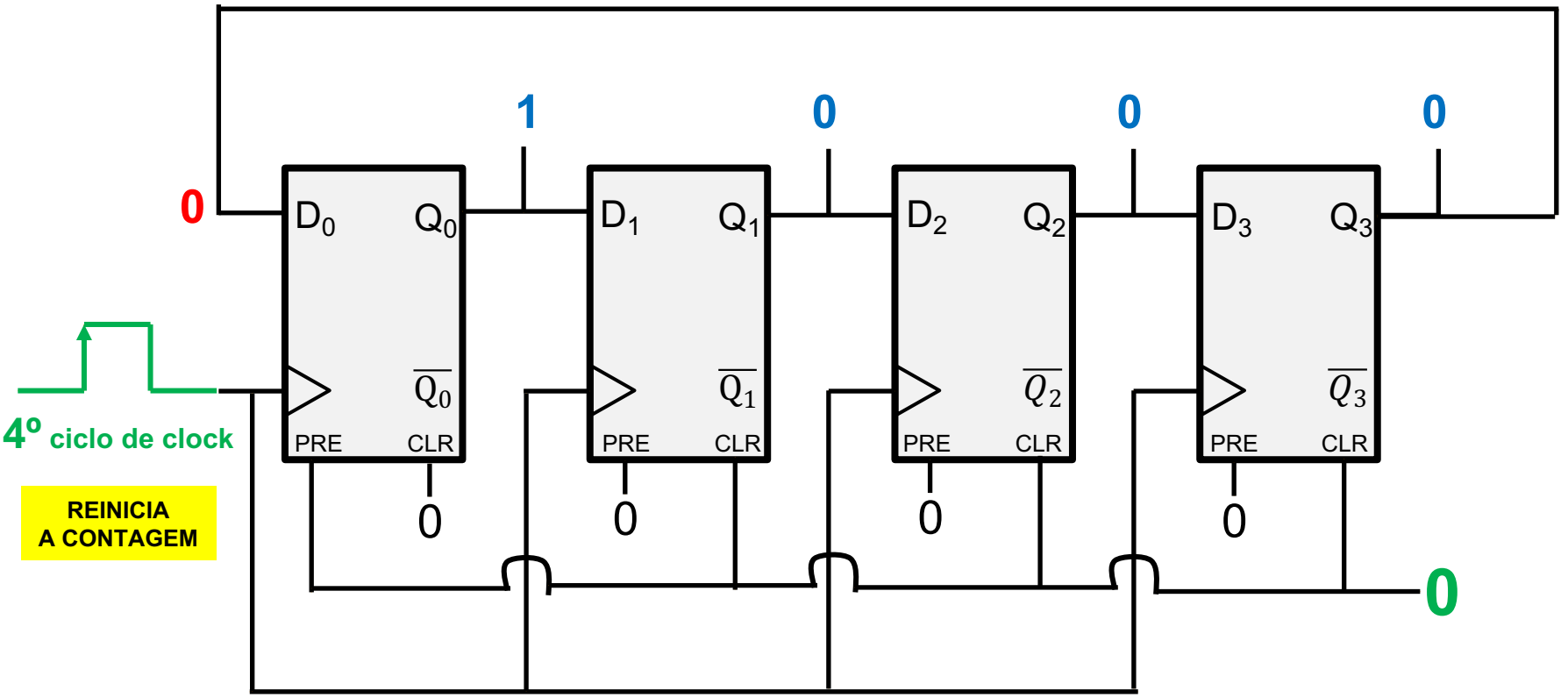
Contador em Anel

- **Exemplo –** Contador em Anel de 4 bits



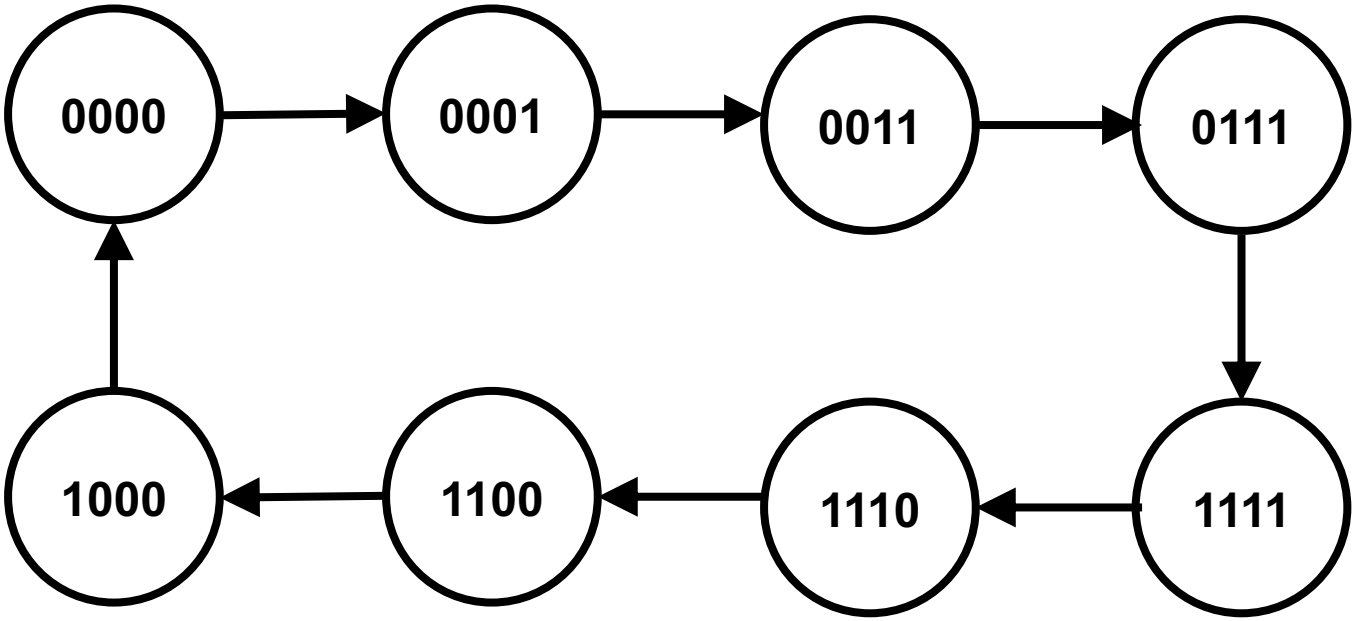
Contador em Anel

- **Exemplo –** Contador em Anel de 4 bits



Contador de Johnson

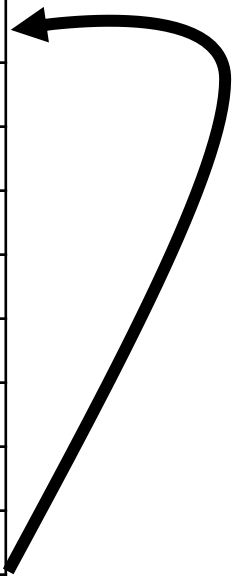
- **Exemplo –** Contador de Johnson de 4 bits



Contador de Johnson

- **Exemplo –** Contador de Johnson de 4 bits

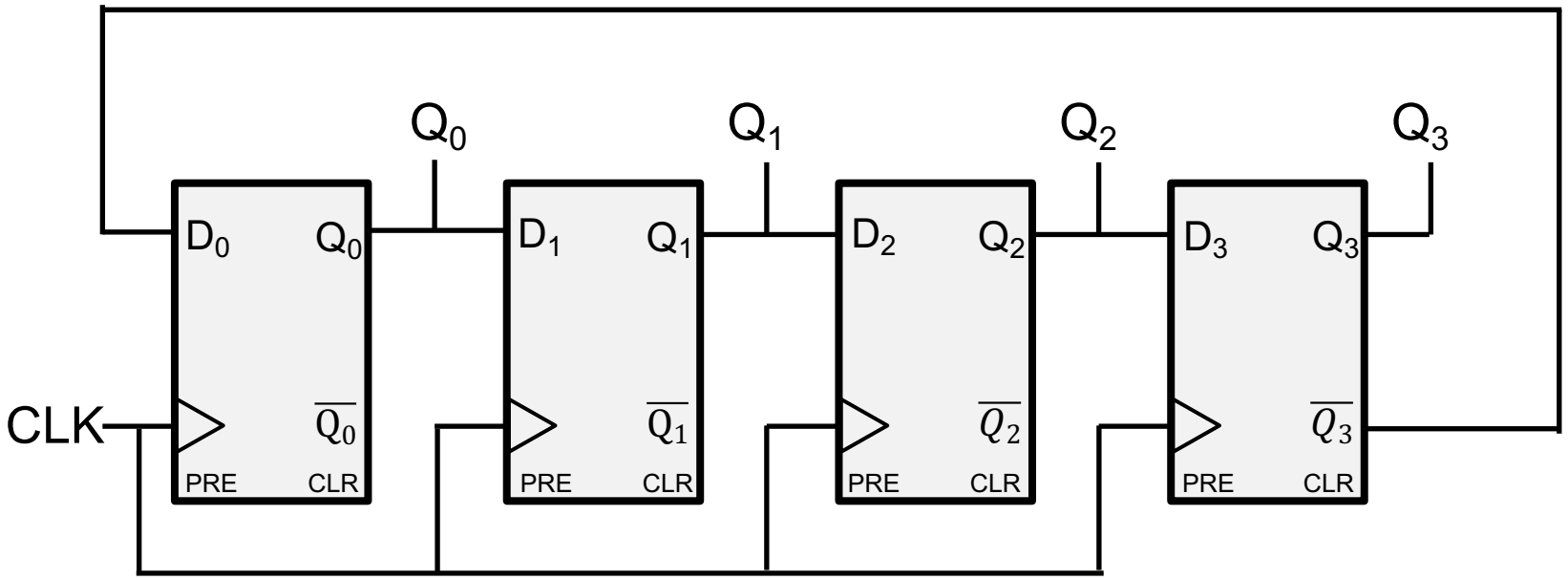
Pulso de Clock	Q_3	Q_2	Q_1	Q_0
Valor inicial	0	0	0	0
1º	0	0	0	1
2º	0	0	1	1
3º	0	1	1	1
4º	1	1	1	1
5º	1	1	1	0
6º	1	1	0	0
7º	1	0	0	0
8º (reciclagem)	0	0	0	0



Só muda um bit entre um estado e outro

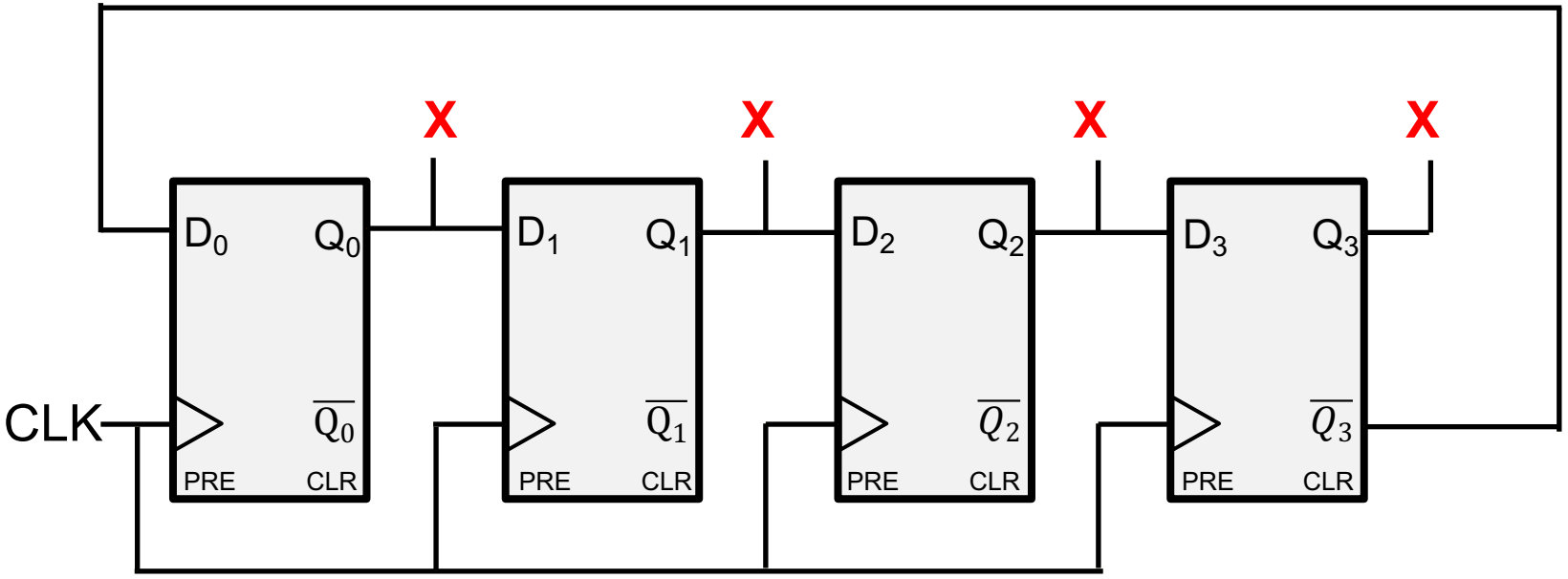
Contador de Johnson

- **Exemplo –** Contador de Johnson de 4 bits



Contador de Johnson

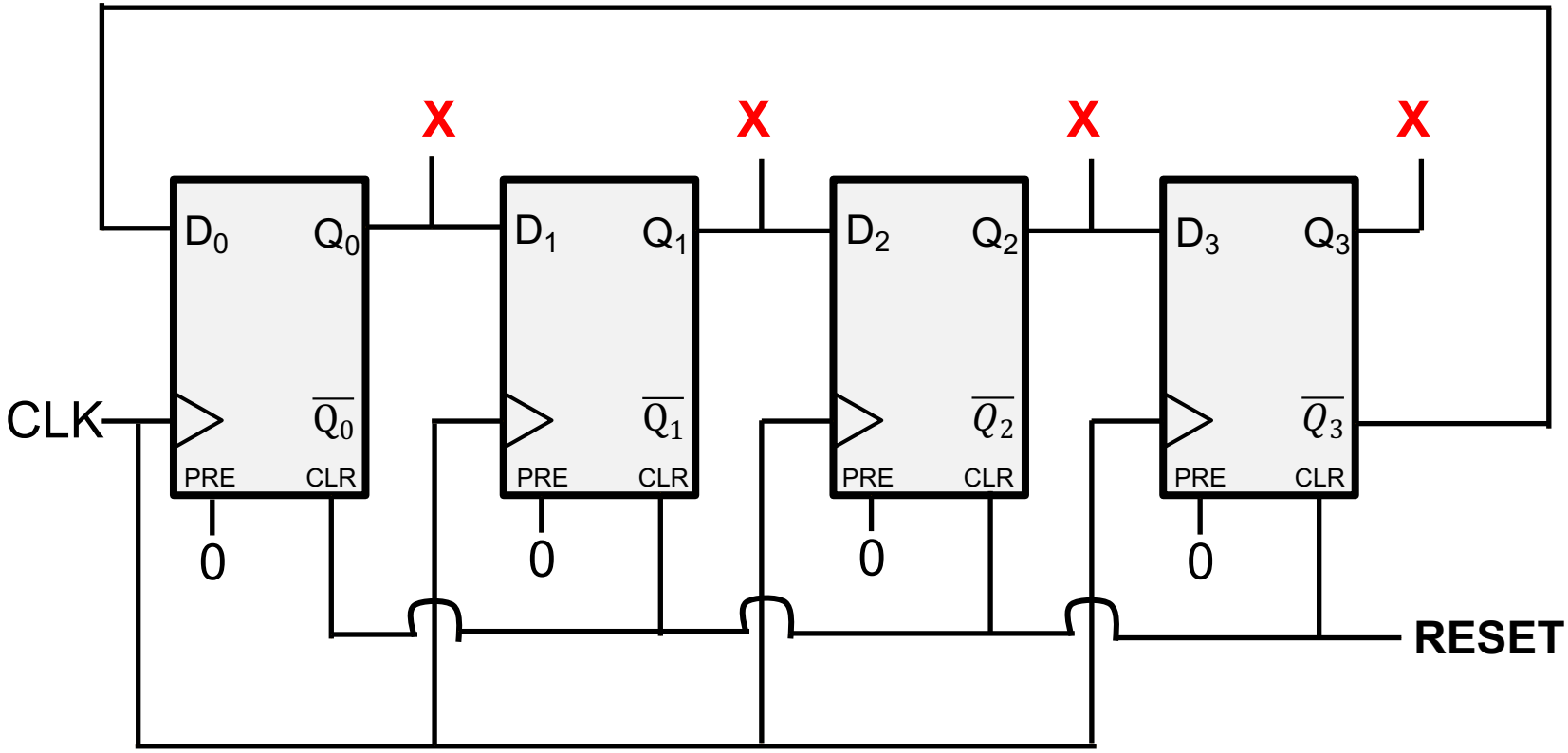
- **Exemplo –** Contador de Johnson de 4 bits



COMO INICIALIZAR O CONTADOR?

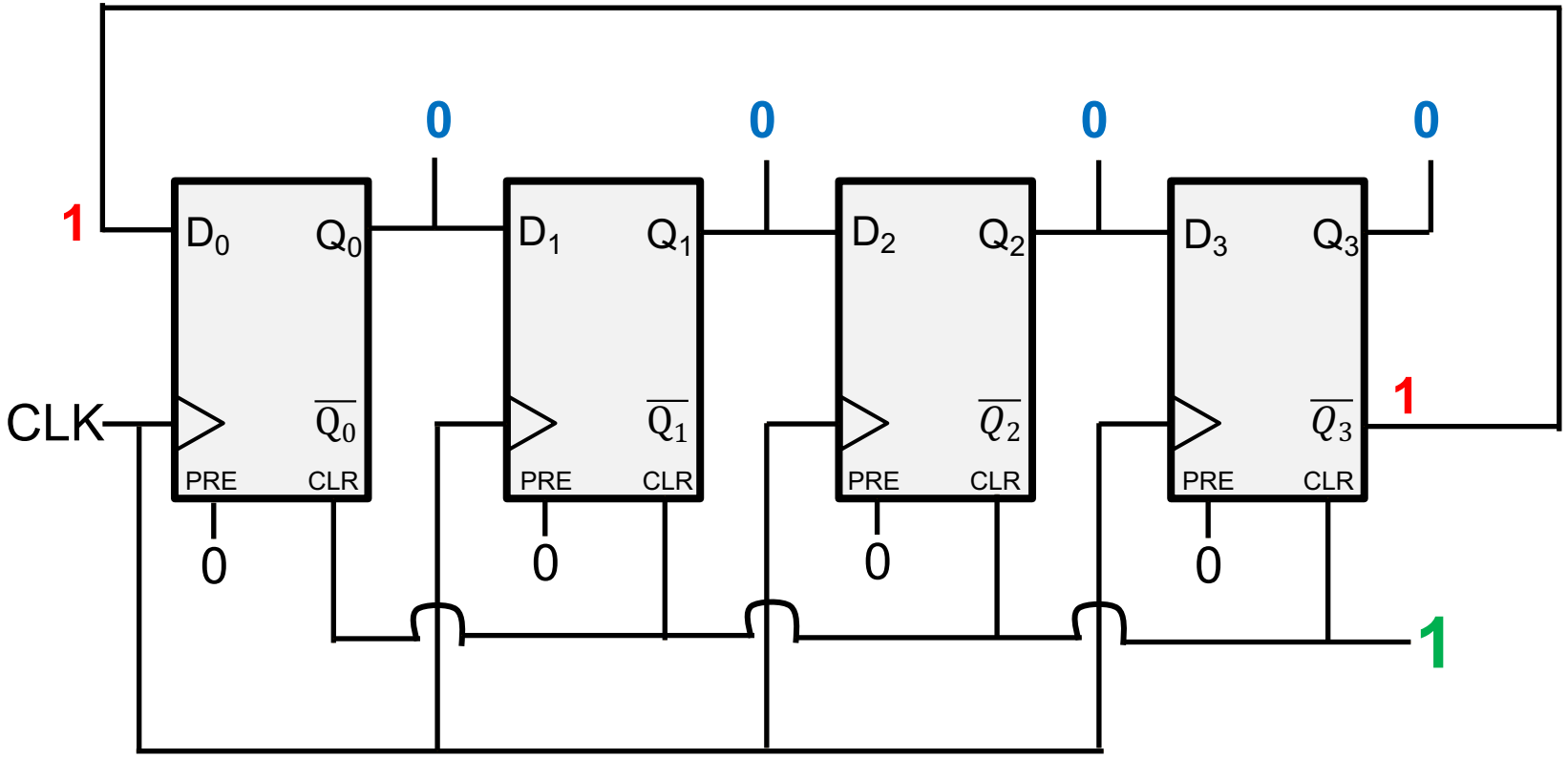
Contador de Johnson

- **Exemplo –** Contador de Johnson de 4 bits



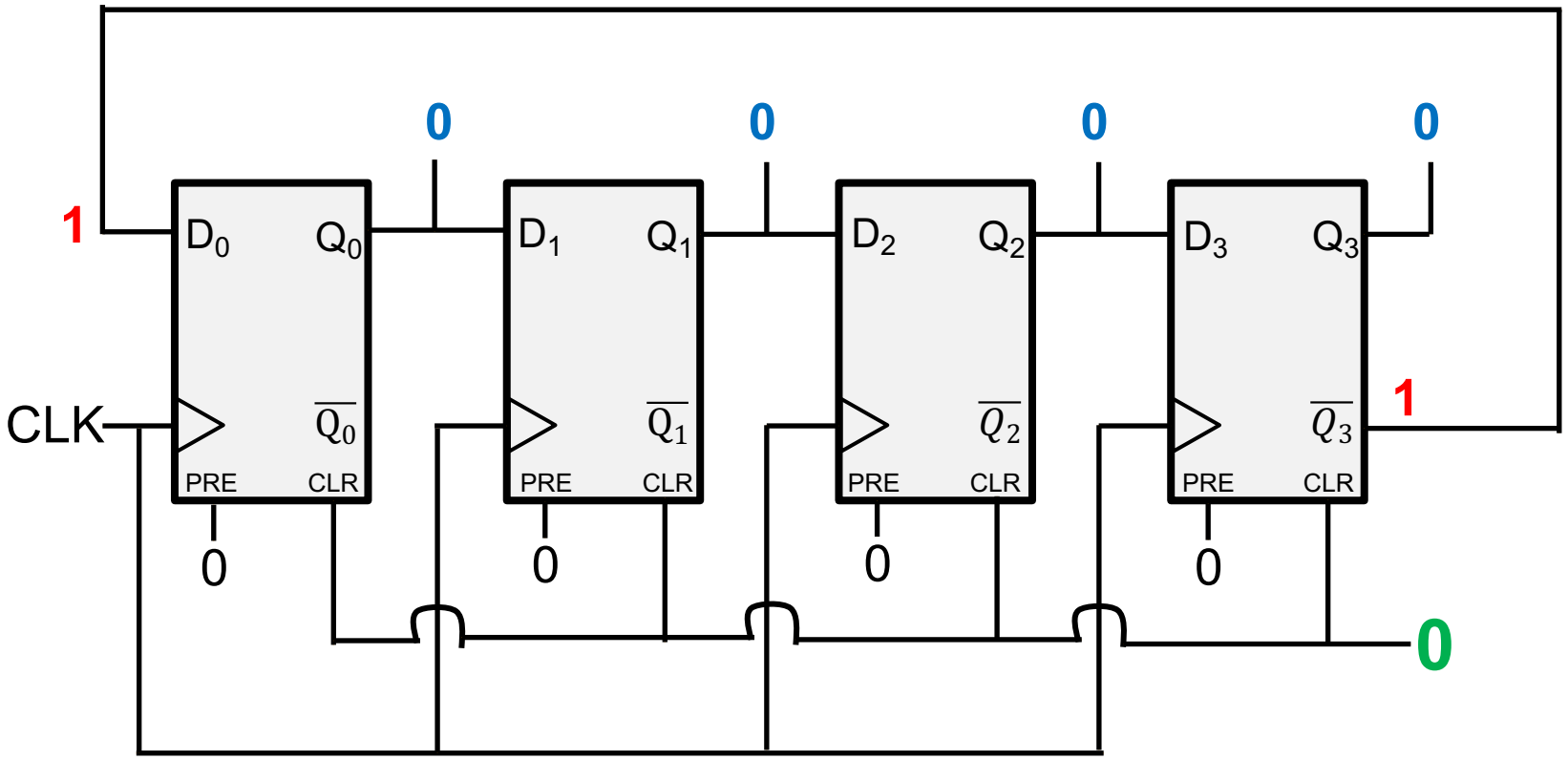
Contador de Johnson

- **Exemplo –** Contador de Johnson de 4 bits



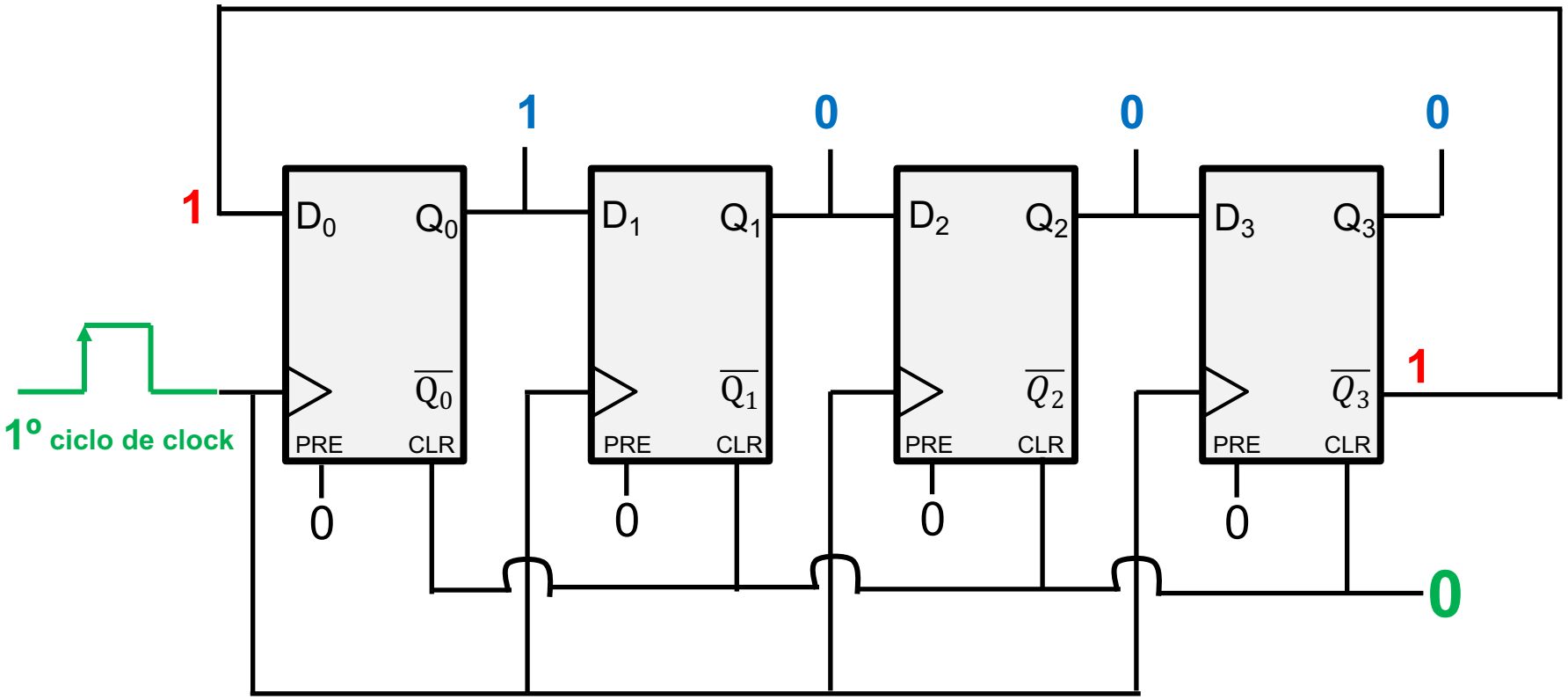
Contador de Johnson

- **Exemplo –** Contador de Johnson de 4 bits



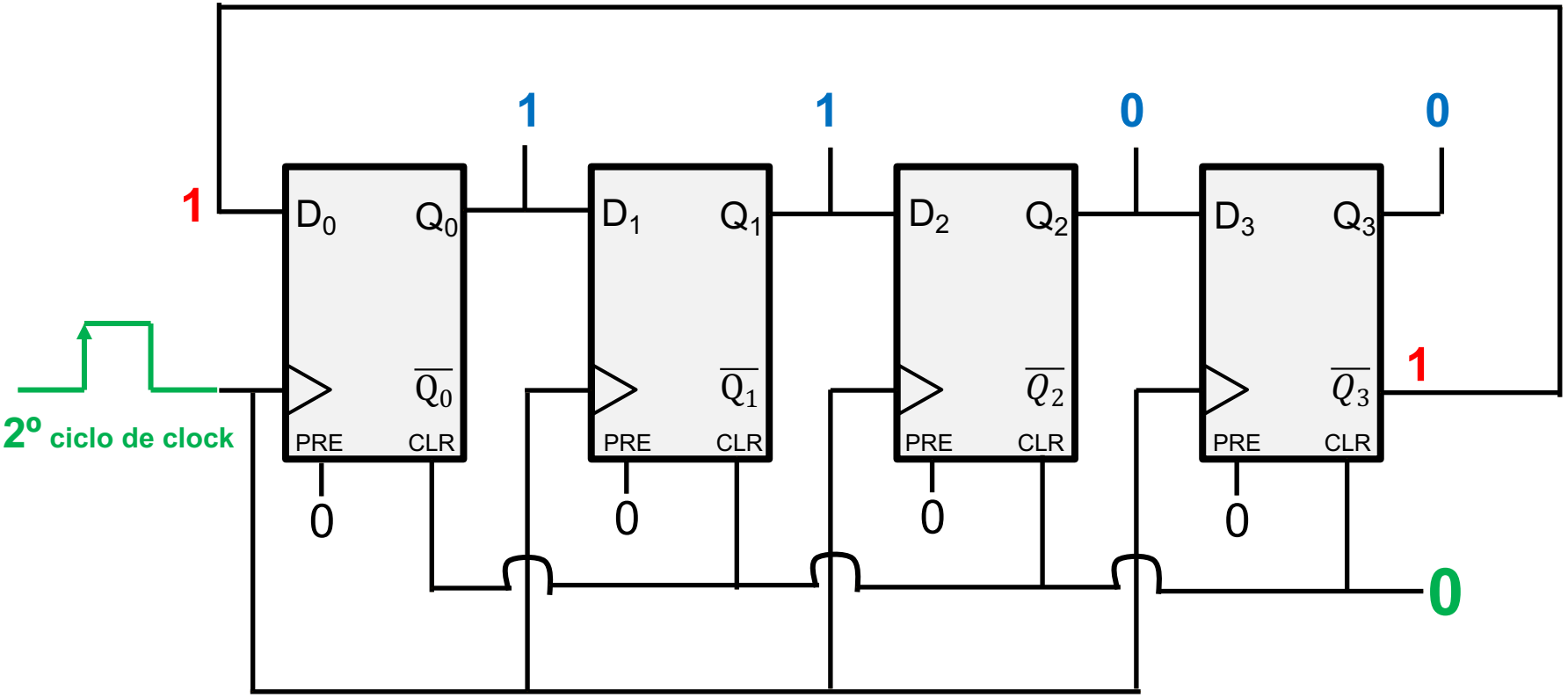
Contador de Johnson

- **Exemplo –** Contador de Johnson de 4 bits



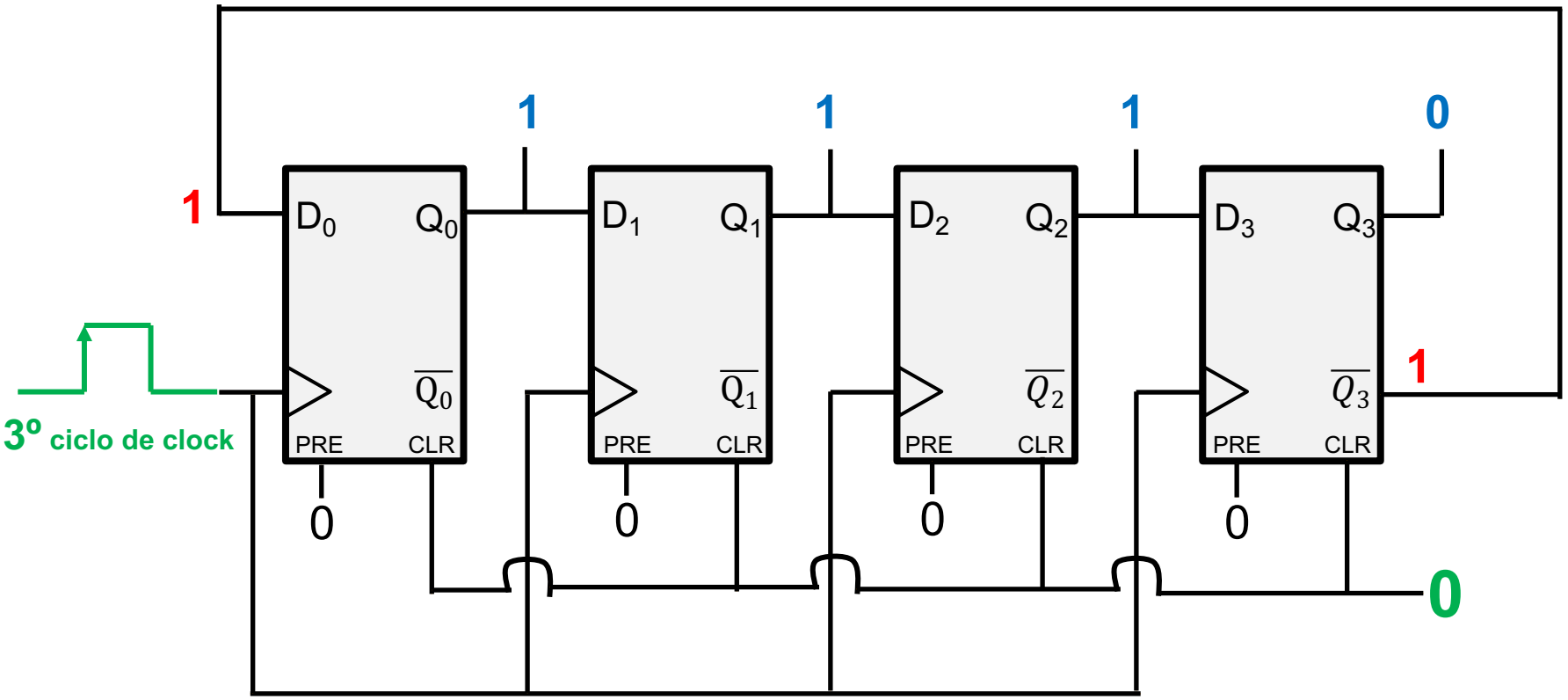
Contador de Johnson

- **Exemplo –** Contador de Johnson de 4 bits



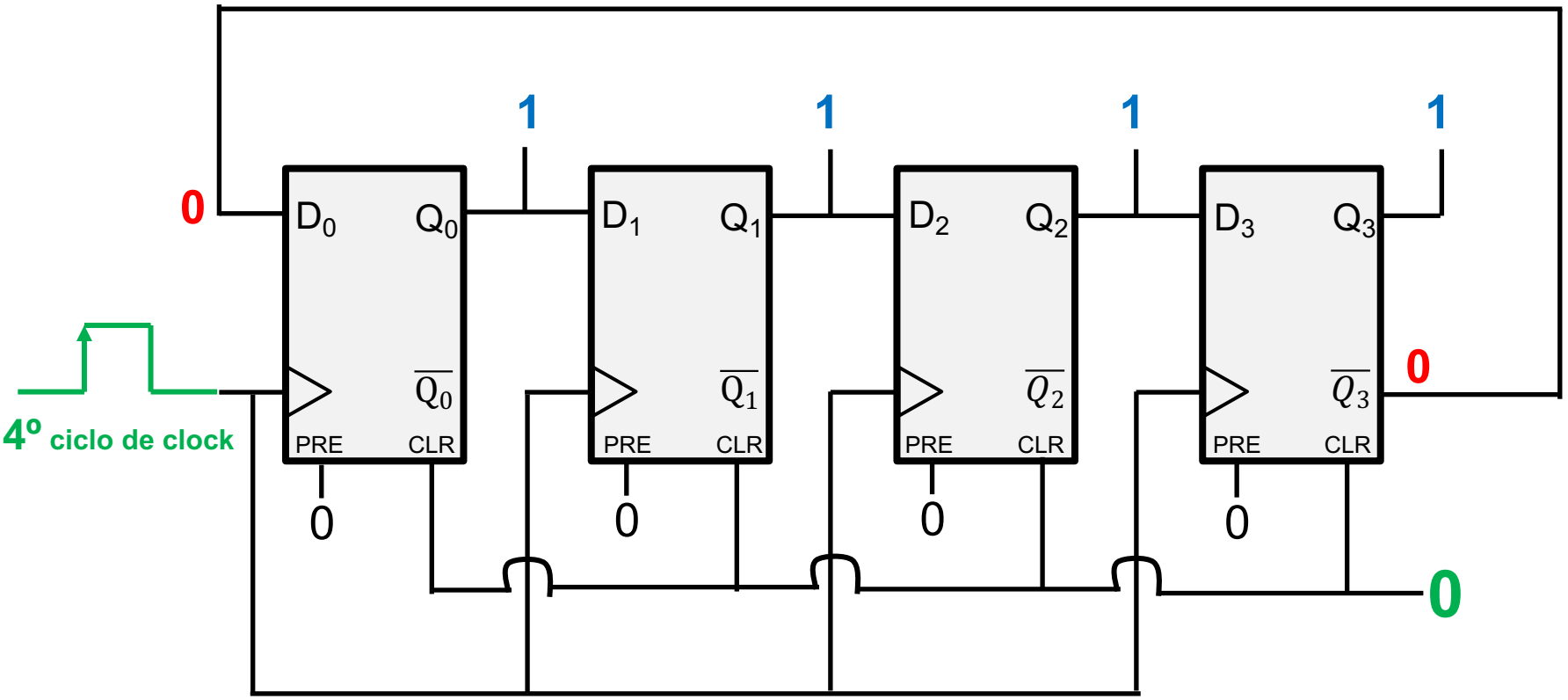
Contador de Johnson

- **Exemplo –** Contador de Johnson de 4 bits



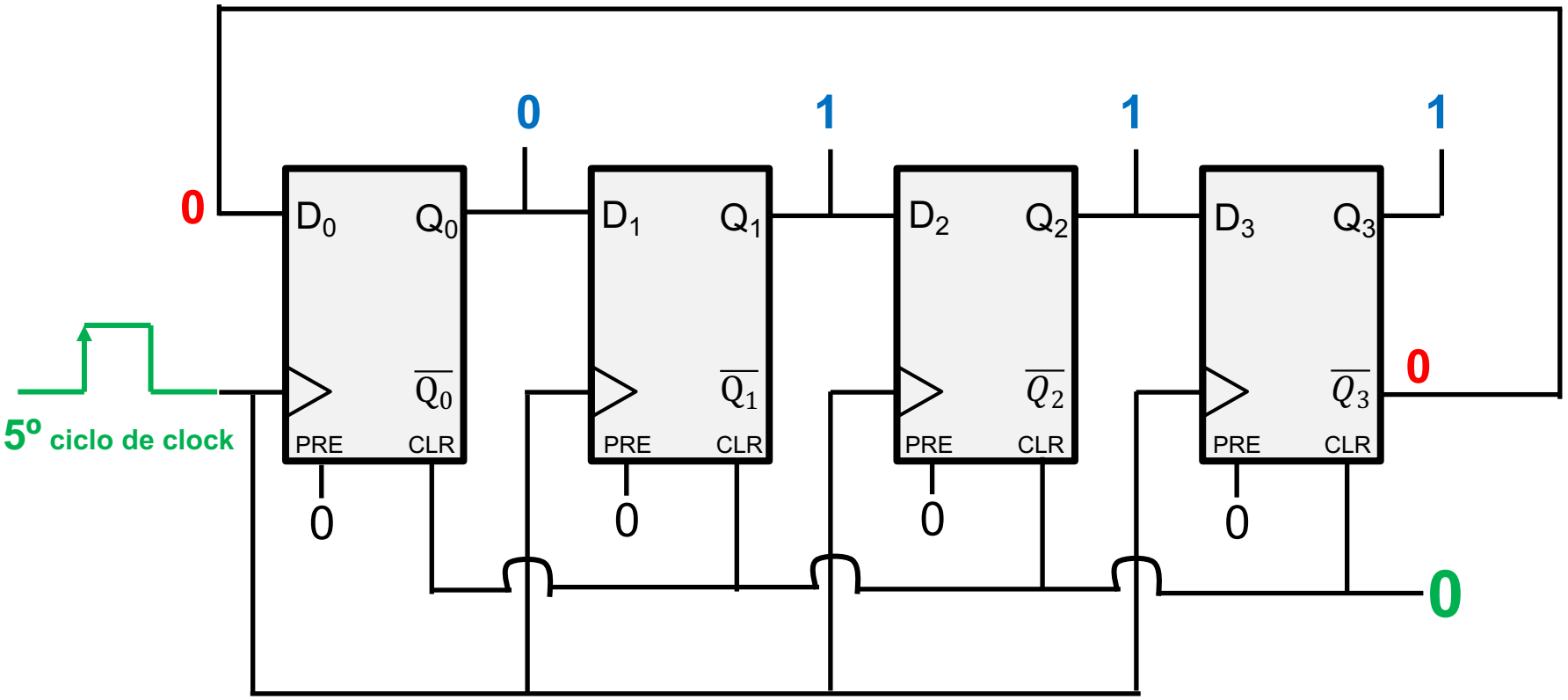
Contador de Johnson

- **Exemplo –** Contador de Johnson de 4 bits



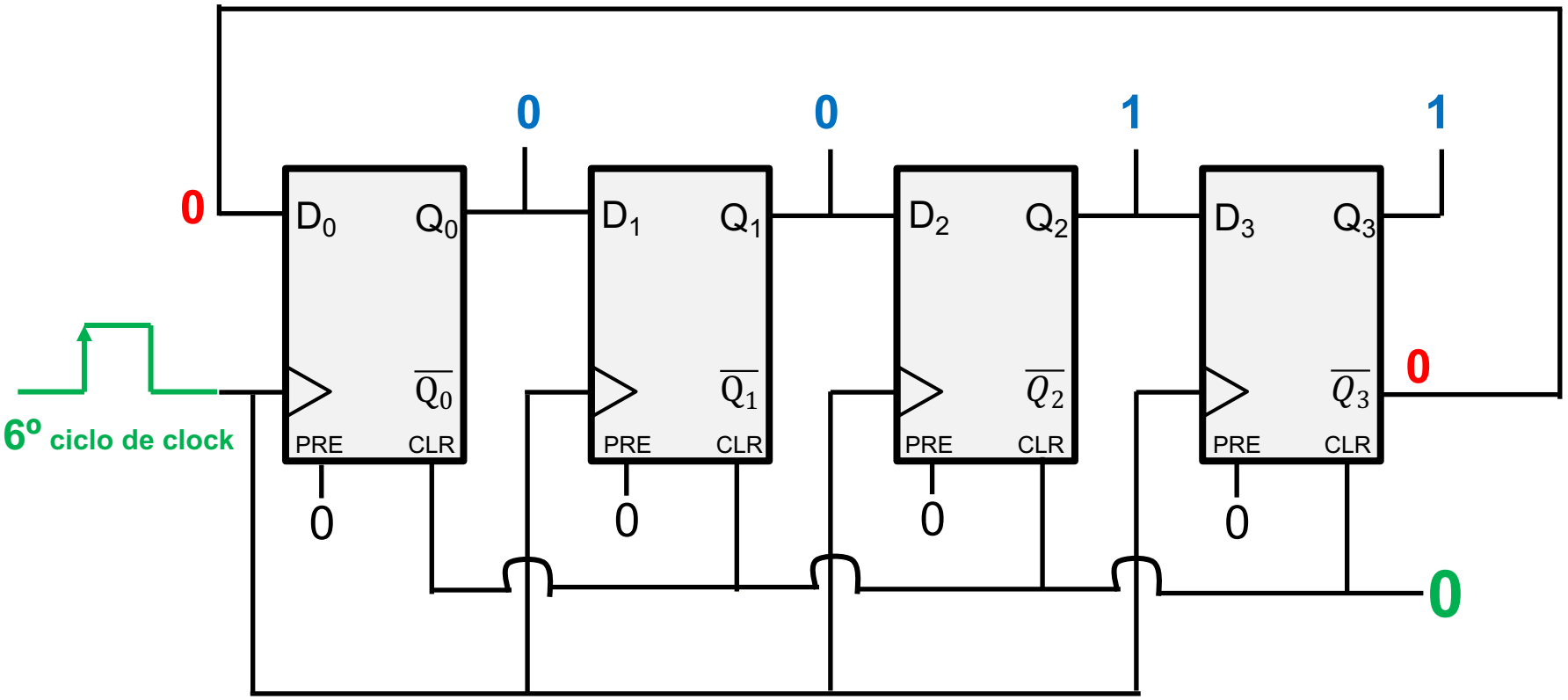
Contador de Johnson

- **Exemplo –** Contador de Johnson de 4 bits



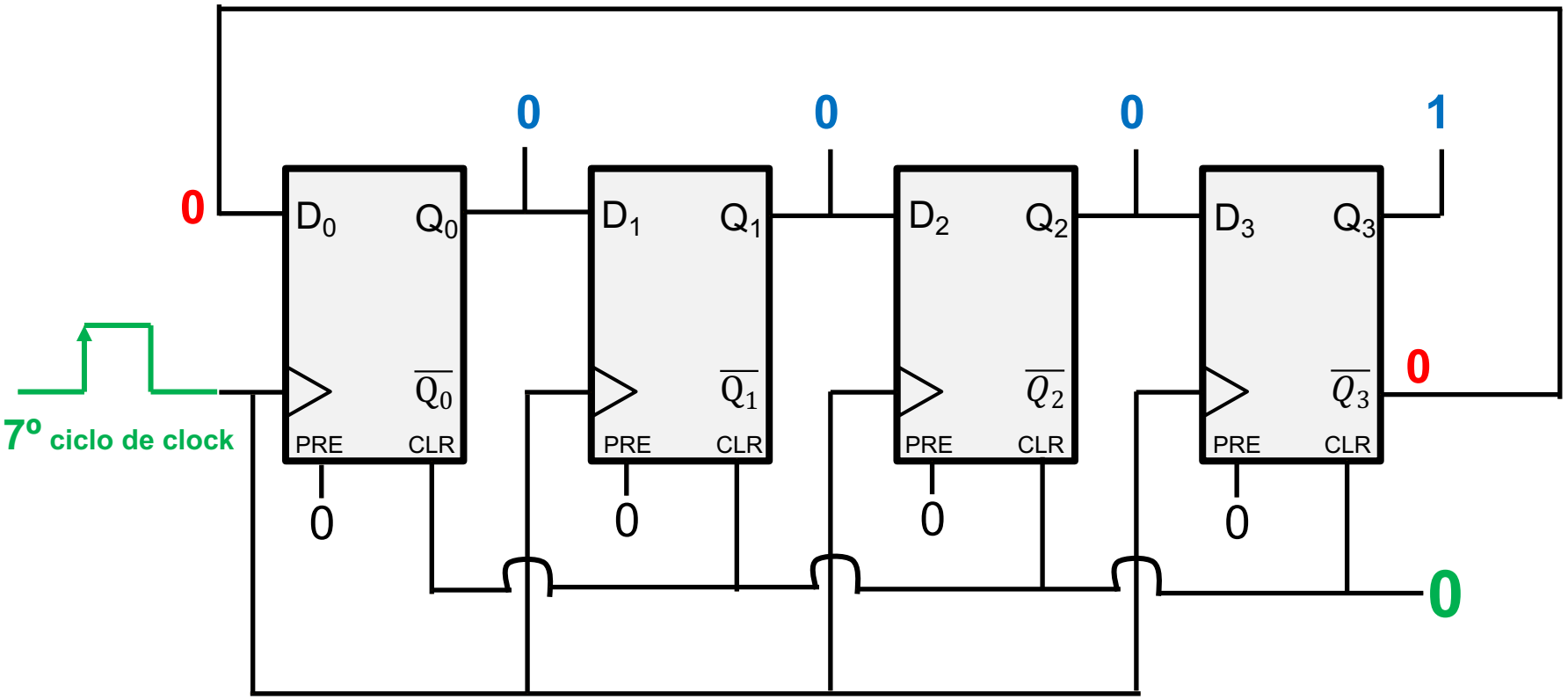
Contador de Johnson

- **Exemplo –** Contador de Johnson de 4 bits



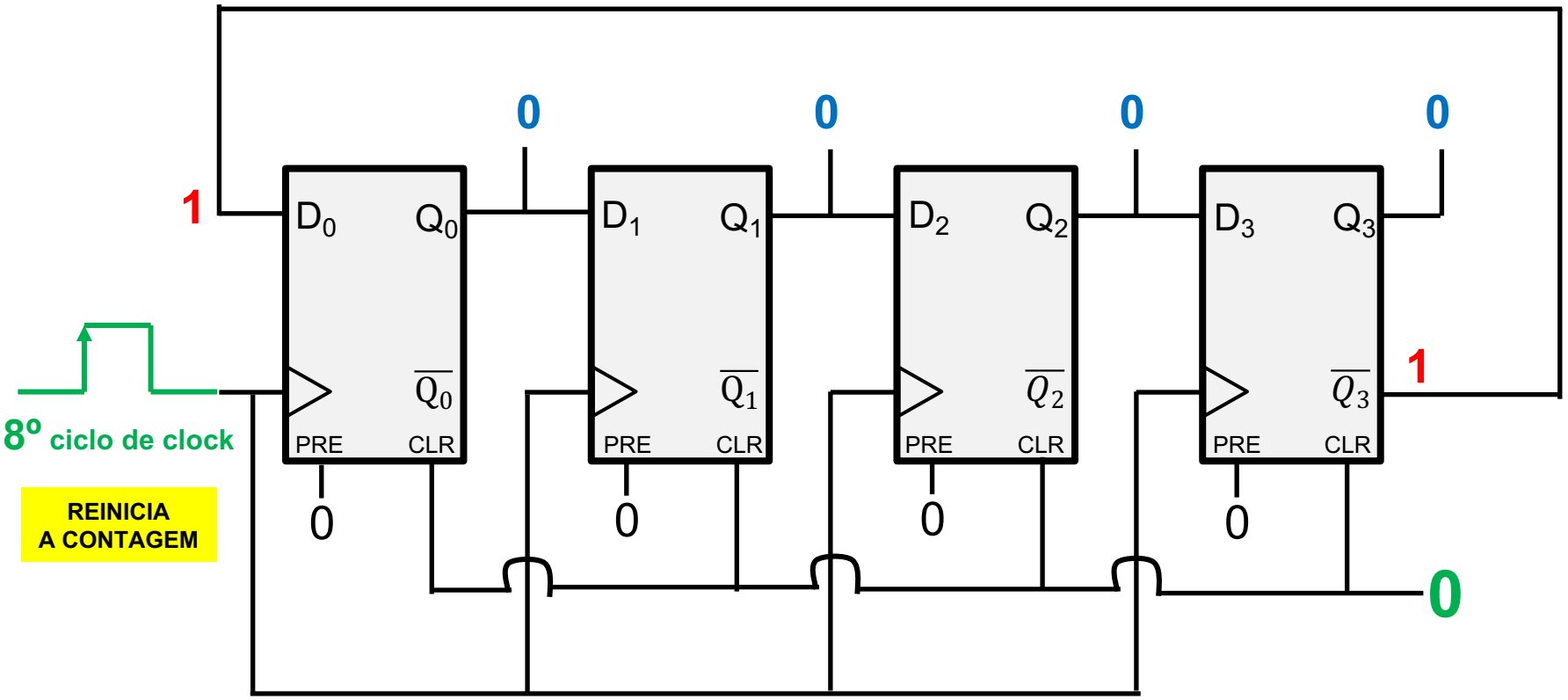
Contador de Johnson

- **Exemplo –** Contador de Johnson de 4 bits



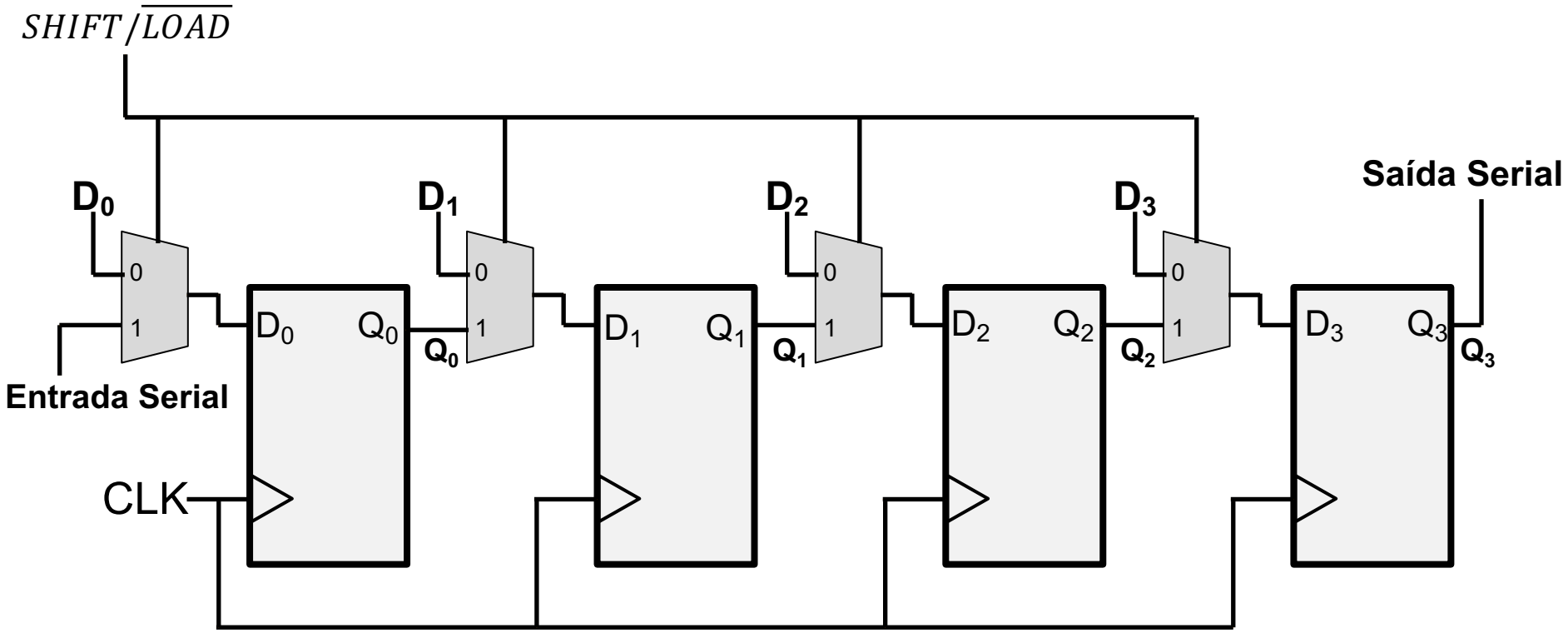
Contador de Johnson

- **Exemplo –** Contador de Johnson de 4 bits



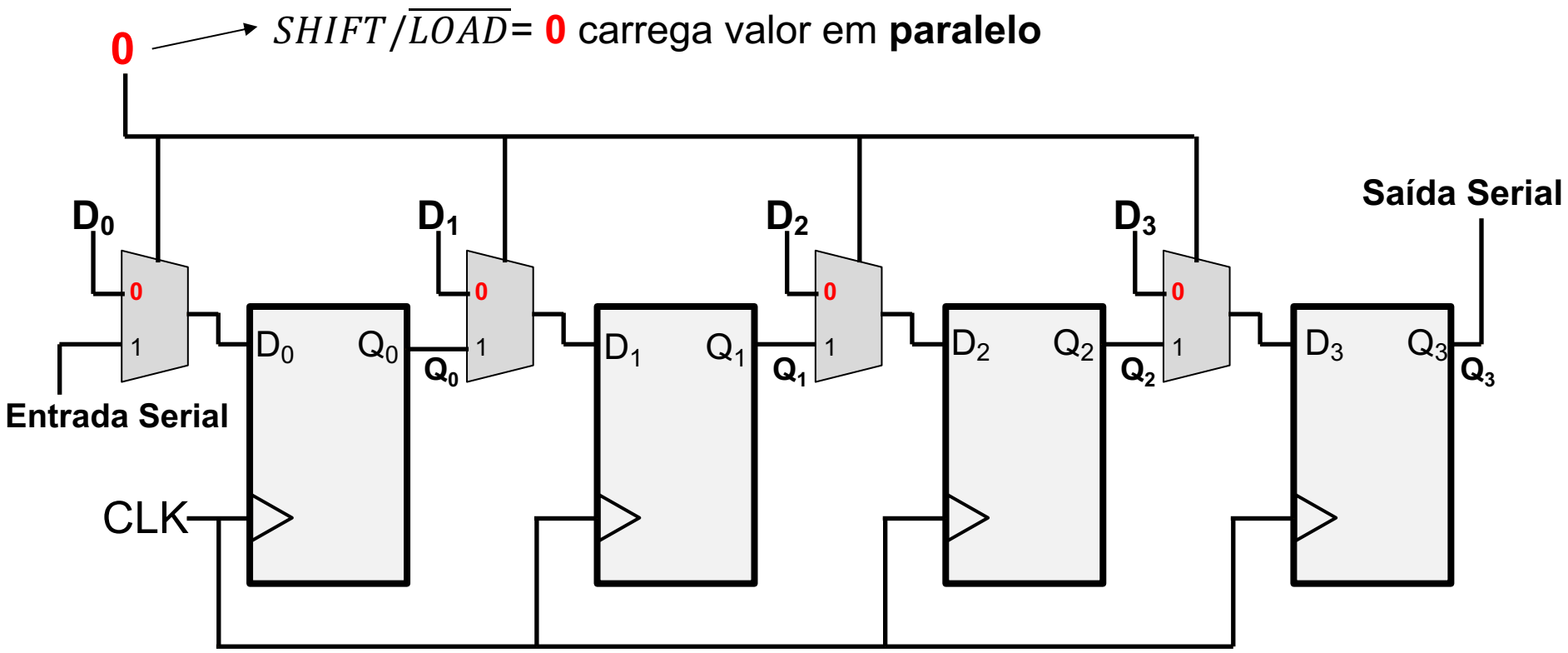
Registrador de Armazenamento/Deslocamento

Entrada Paralela / Saída Serial



Registrador de Armazenamento/Deslocamento

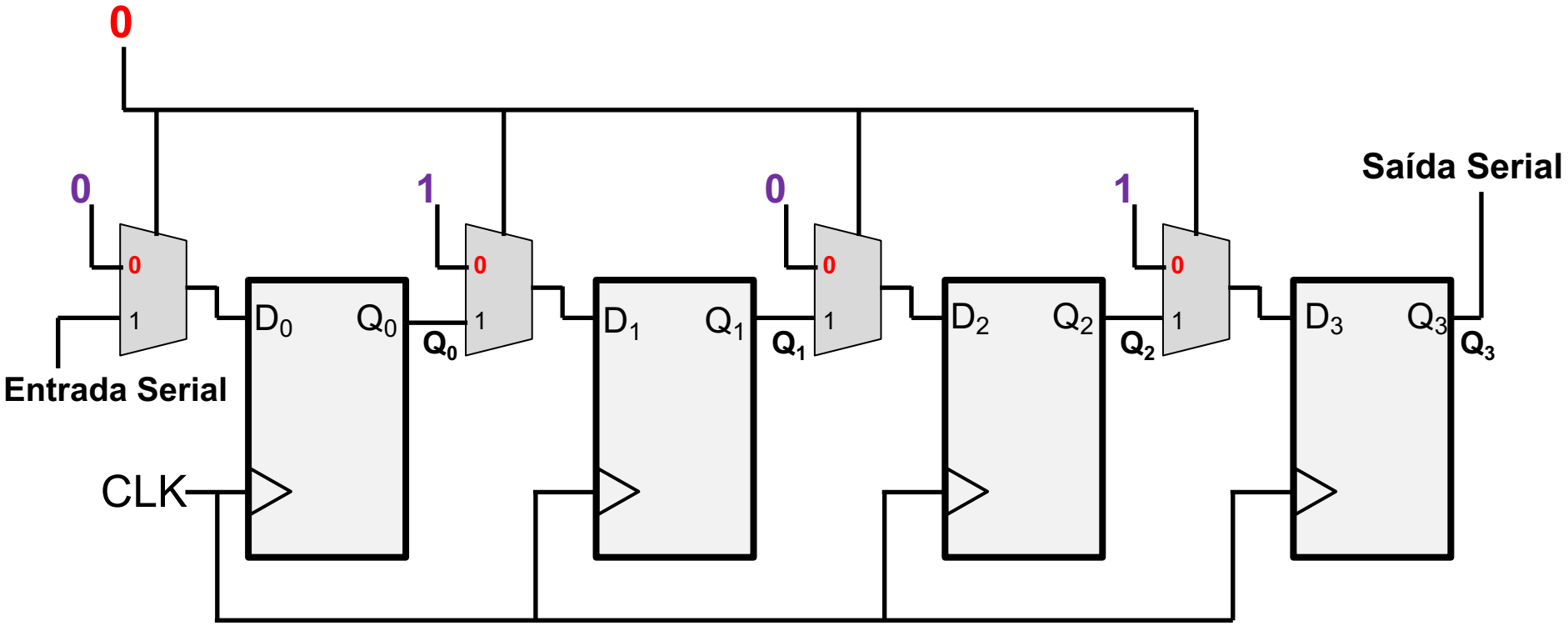
Entrada Paralela / Saída Serial



Registrador de Armazenamento/Deslocamento

Entrada Paralela / Saída Serial

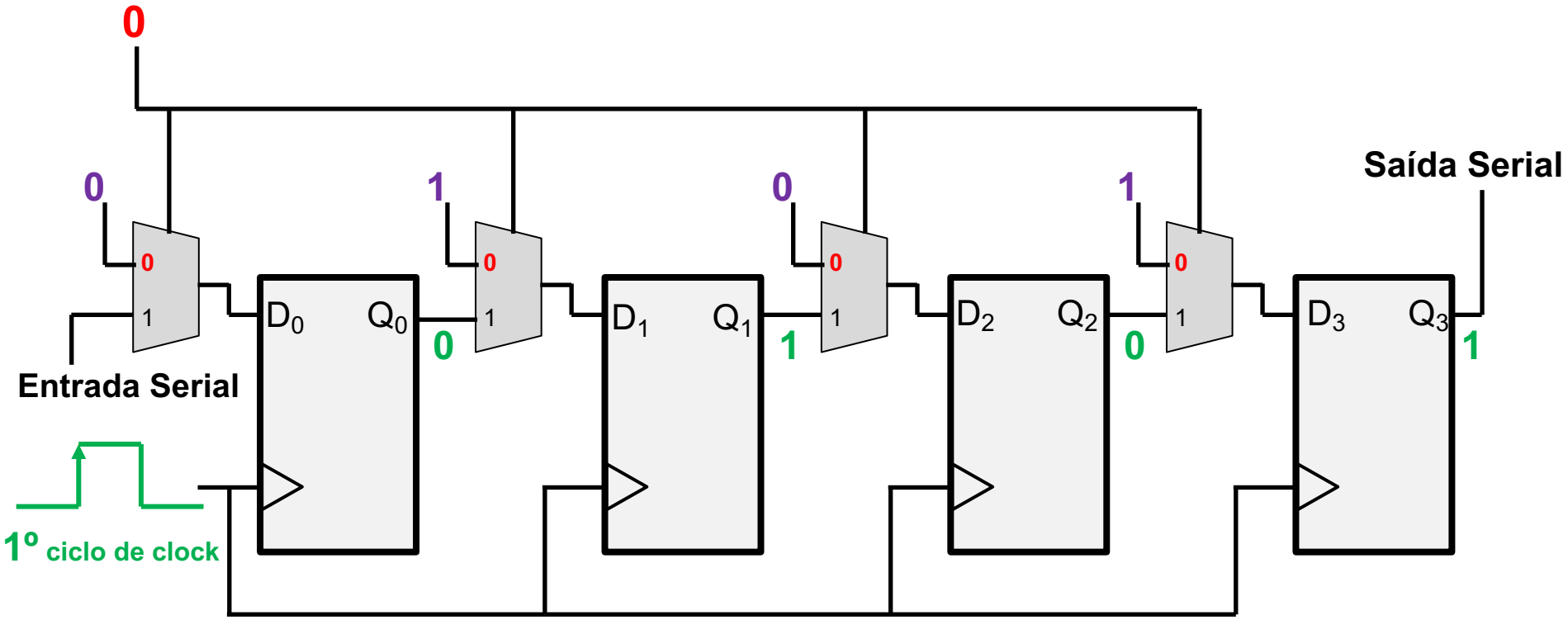
Exemplo : 1 0 1 0



Registrador de Armazenamento/Deslocamento

Entrada Paralela / Saída Serial

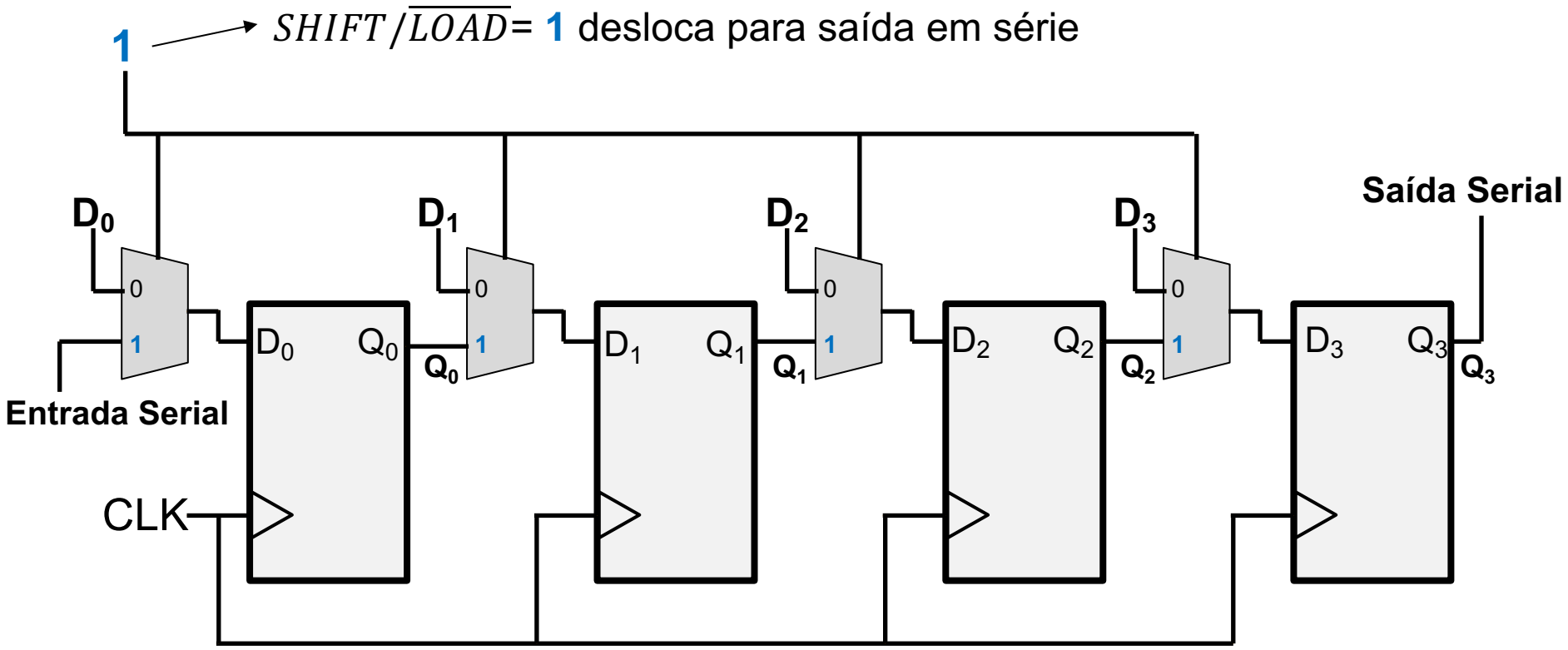
Exemplo : 1 0 1 0



Registrador de Armazenamento/Deslocamento

Entrada Paralela / Saída Serial

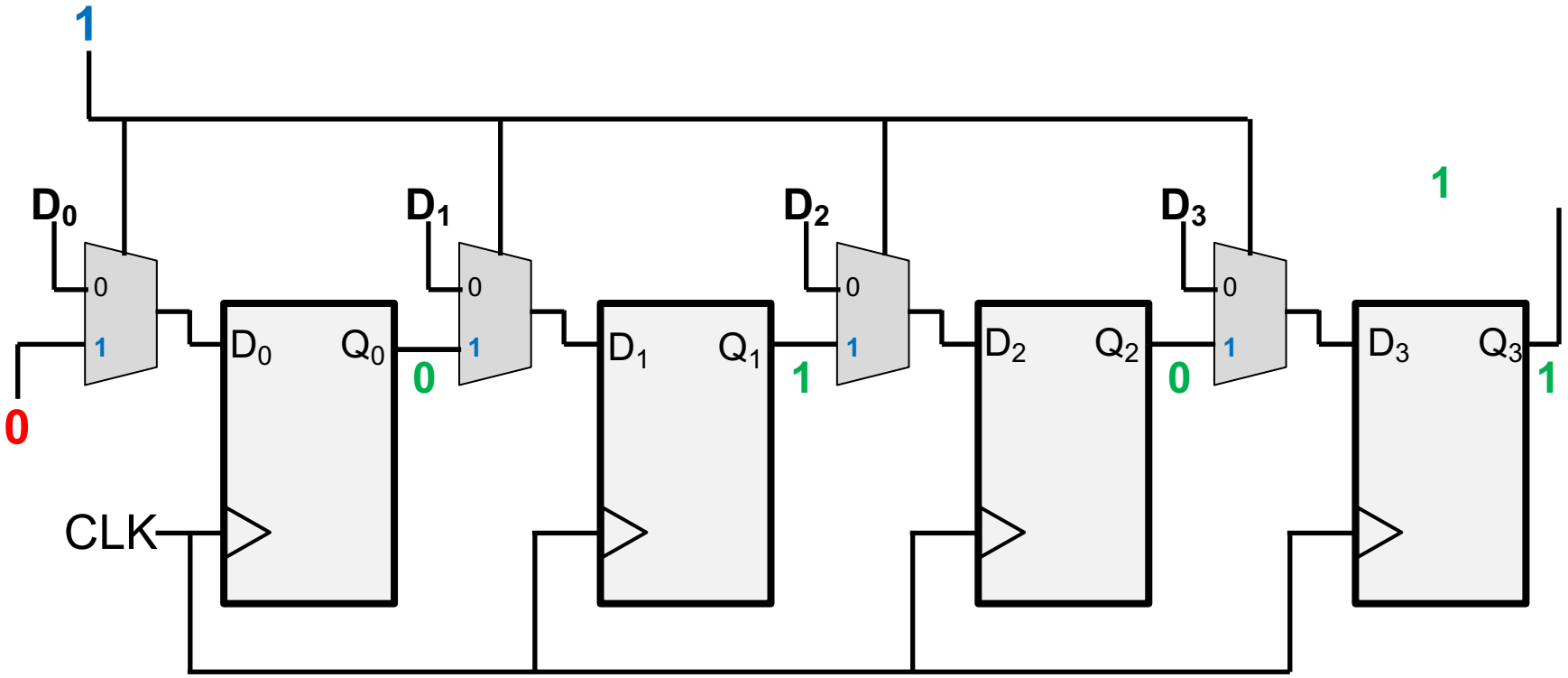
No modo SHIFT
D_0 = Entrada Serial



Registrador de Armazenamento/Deslocamento

Entrada Paralela / Saída Serial

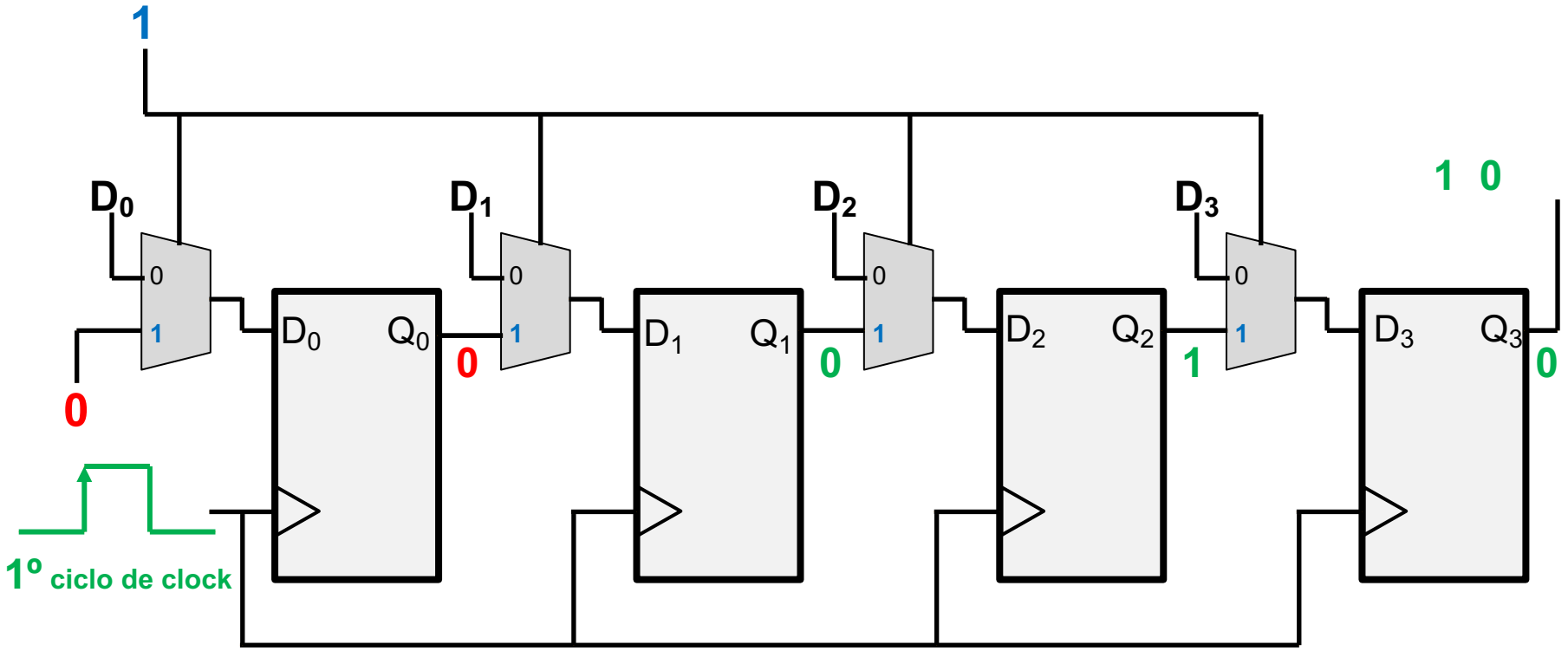
Exemplo : 1 0 1 0 → após carregar em paralelo



Registrador de Armazenamento/Deslocamento

Entrada Paralela / Saída Serial

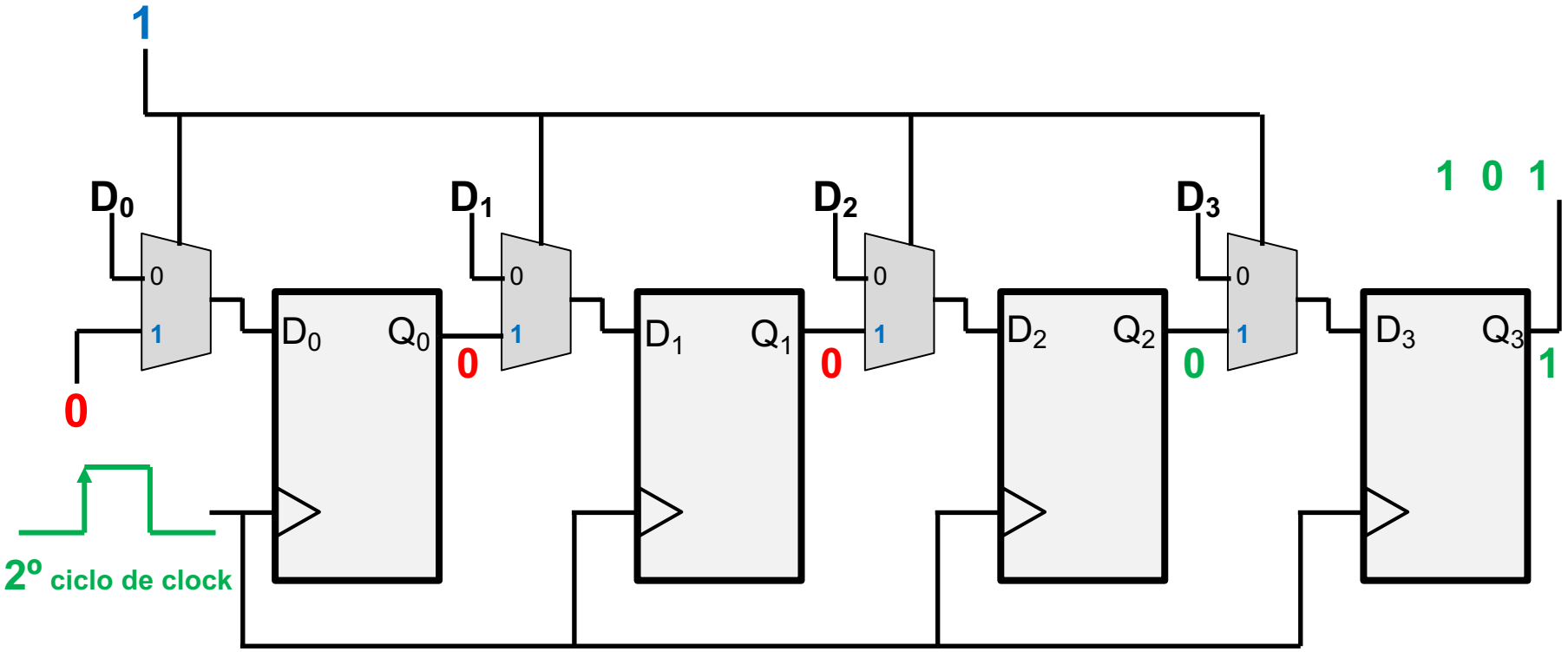
Exemplo : 1 0 1 0 → após carregar em paralelo



Registrador de Armazenamento/Deslocamento

Entrada Paralela / Saída Serial

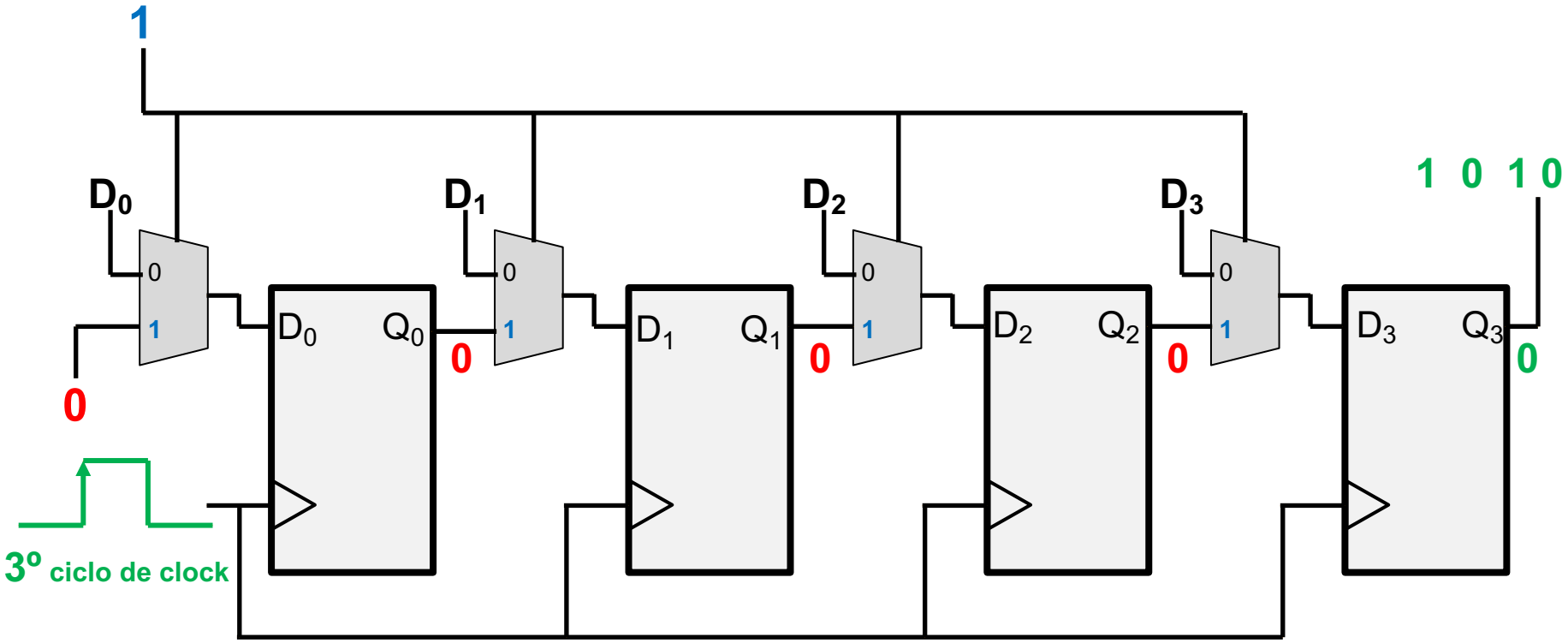
Exemplo : 1 0 1 0 → após carregar em paralelo



Registrador de Armazenamento/Deslocamento

Entrada Paralela / Saída Serial

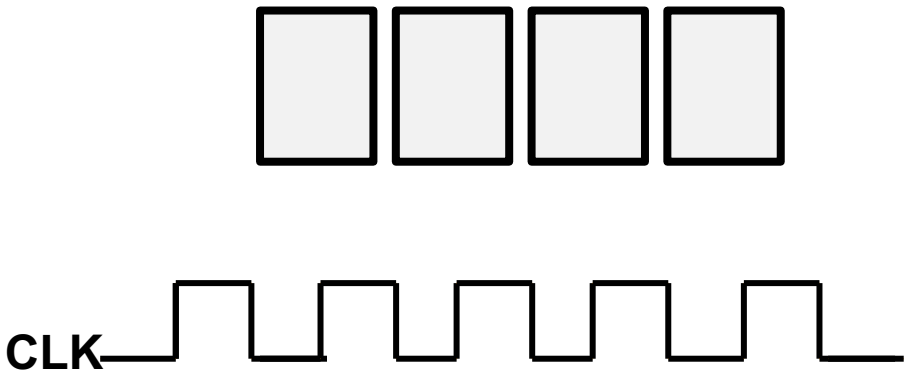
Exemplo : 1 0 1 0 → após carregar em paralelo



Registrador de Armazenamento/Deslocamento

Load → carrega valor em paralelo

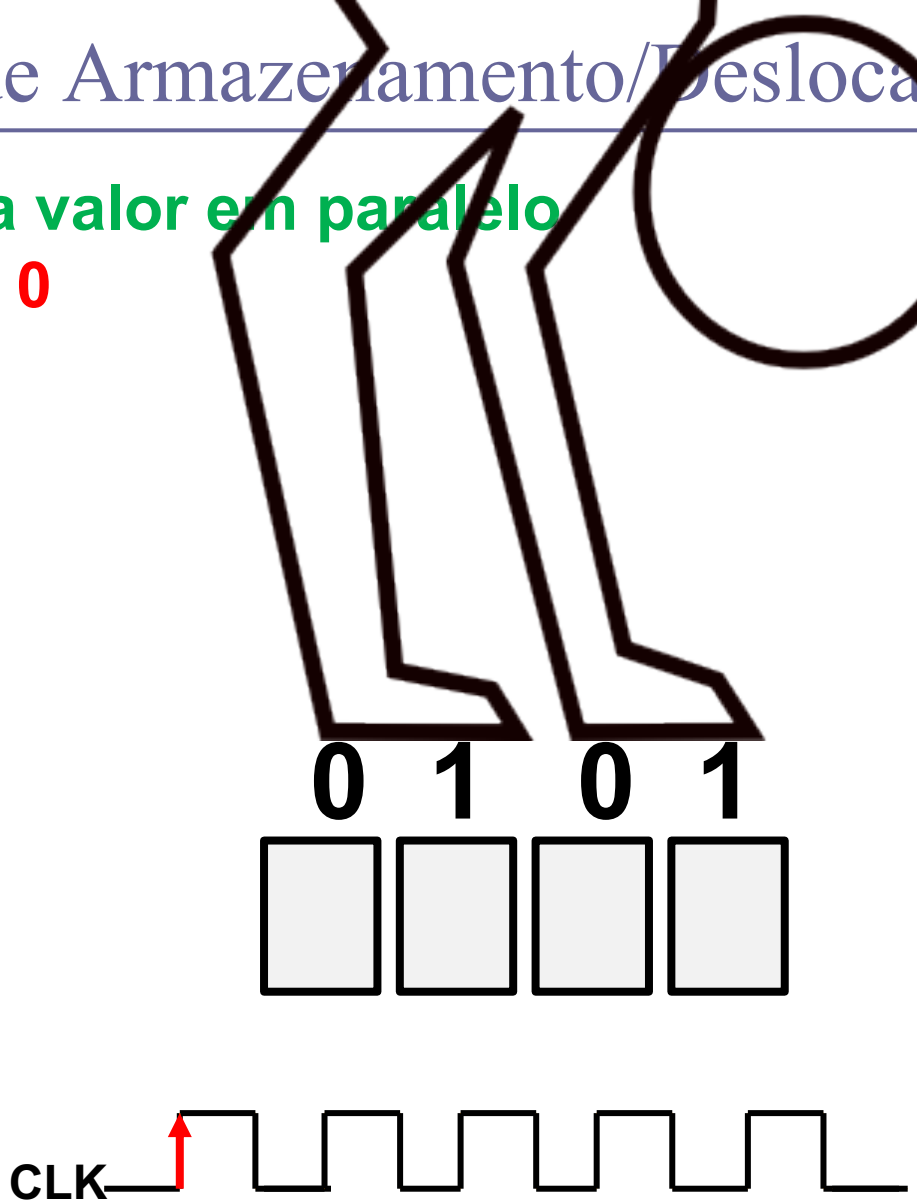
Exemplo : 1 0 1 0



Registrador de Armazenamento/Deslocamento

Load → carrega valor em paralelo

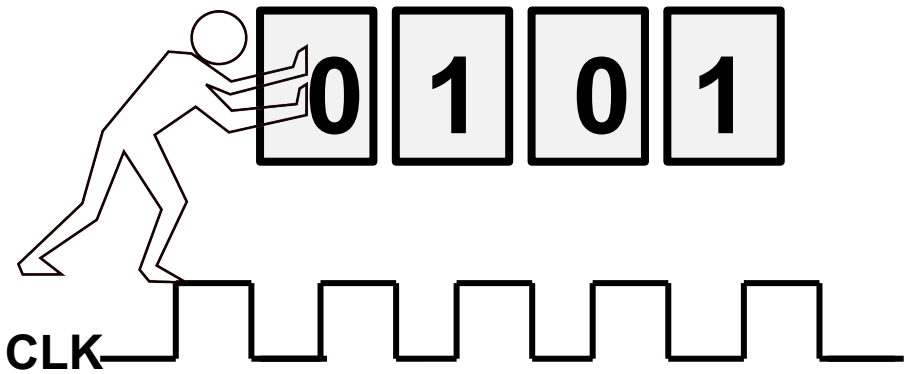
Exemplo : 1 0 1 0



Registrador de Armazenamento/Deslocamento

Shift → desloca para saída serial

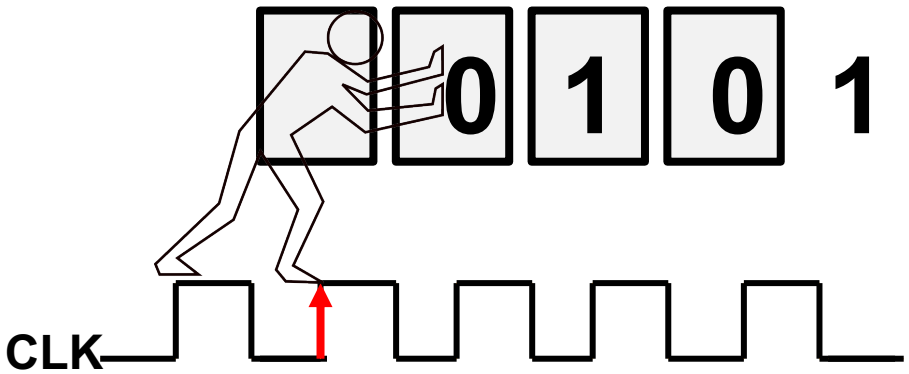
Exemplo : 1 0 1 0



Registrador de Armazenamento/Deslocamento

Shift → desloca para saída serial

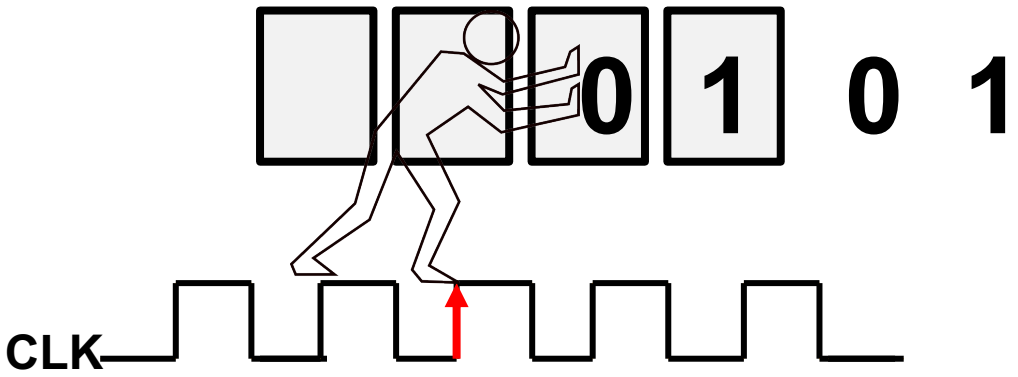
Exemplo : 1 0 1 0



Registrador de Armazenamento/Deslocamento

Shift → desloca para saída serial

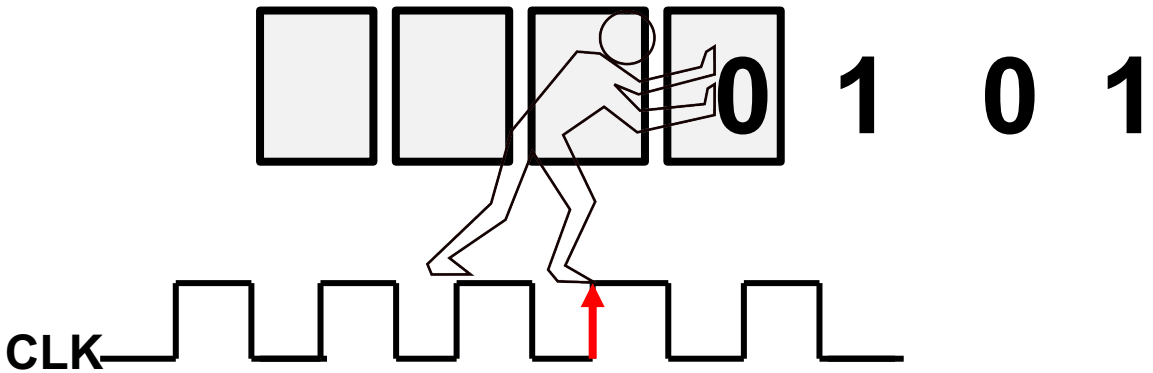
Exemplo : 1 0 1 0



Registrador de Armazenamento/Deslocamento

Shift → desloca para saída serial

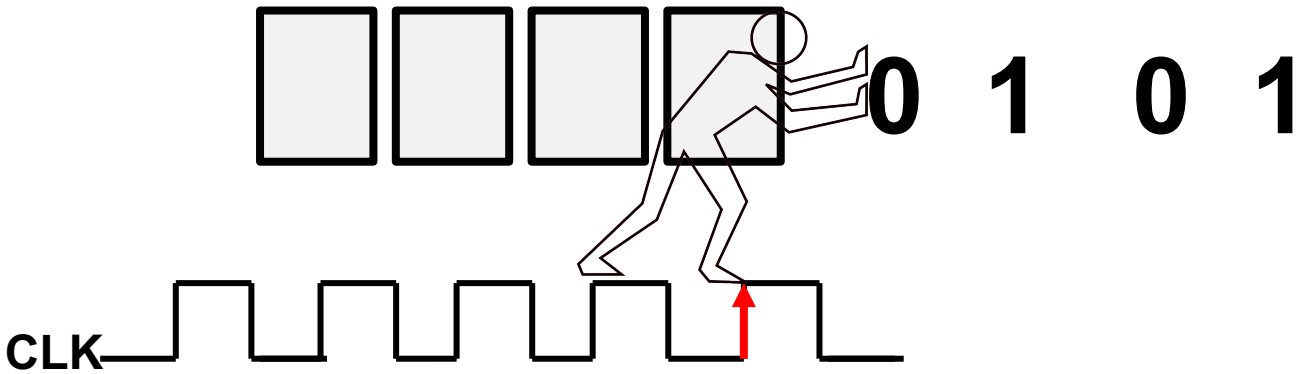
Exemplo : 1 0 1 0



Registrador de Armazenamento/Deslocamento

Shift → desloca para saída serial

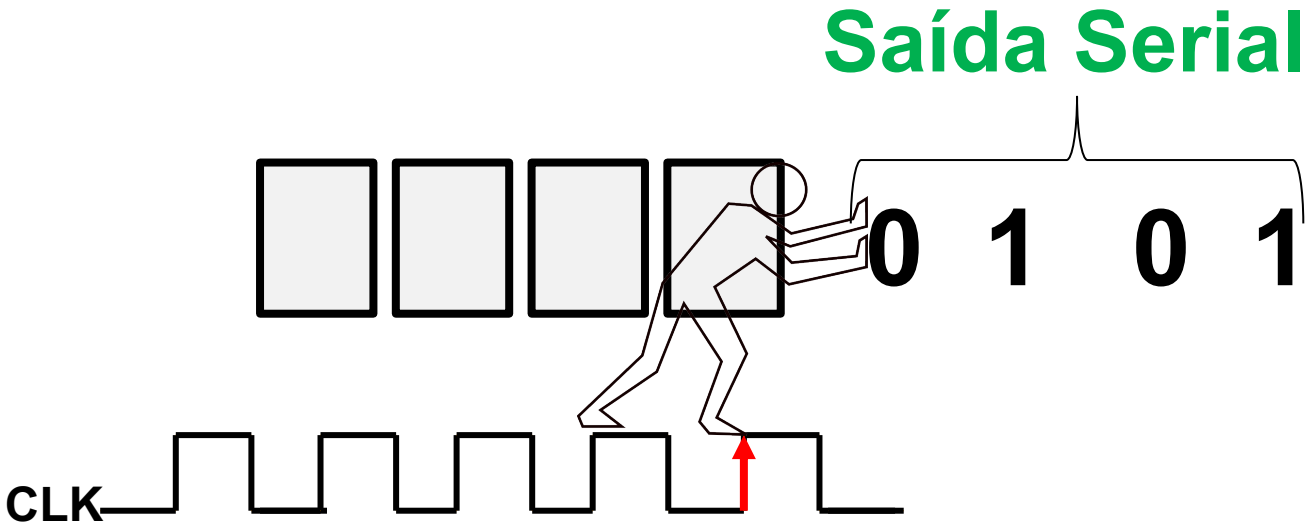
Exemplo : 1 0 1 0



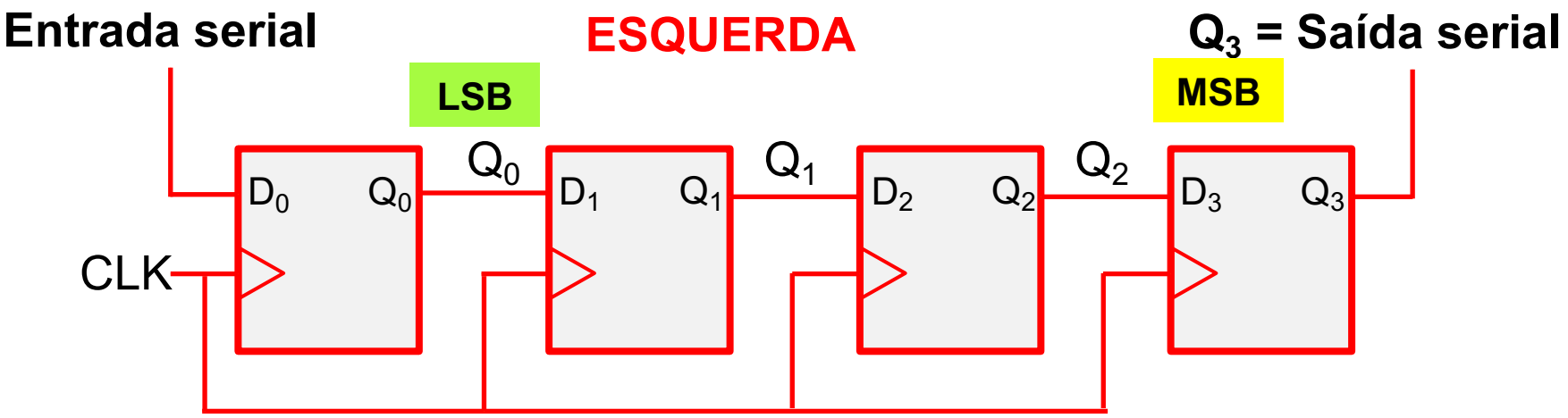
Registrador de Armazenamento/Deslocamento

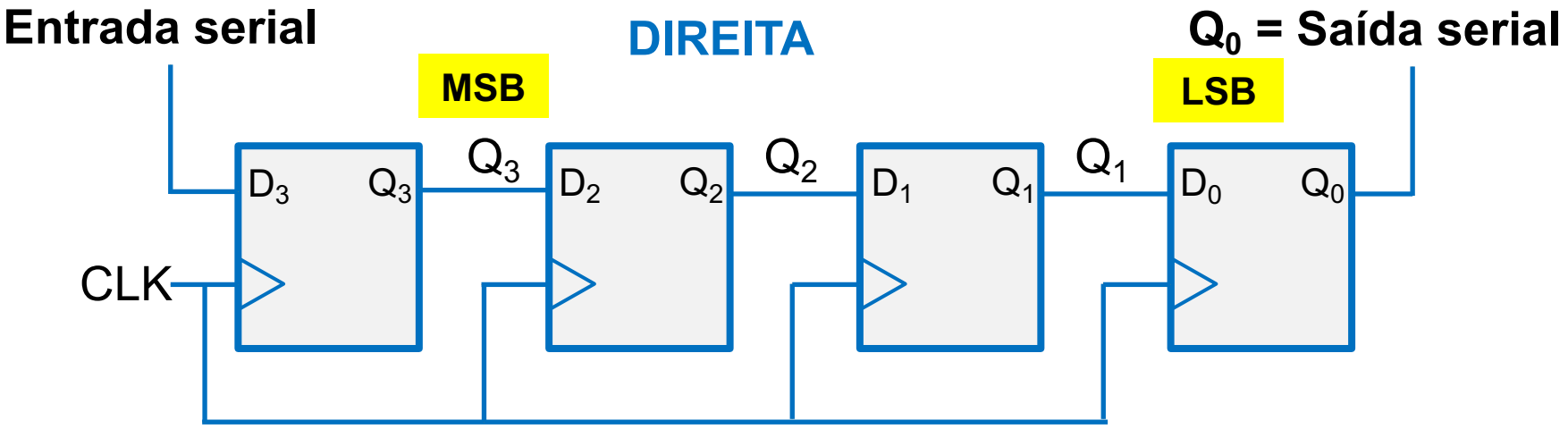
Shift → desloca para saída serial

Exemplo : 1 0 1 0

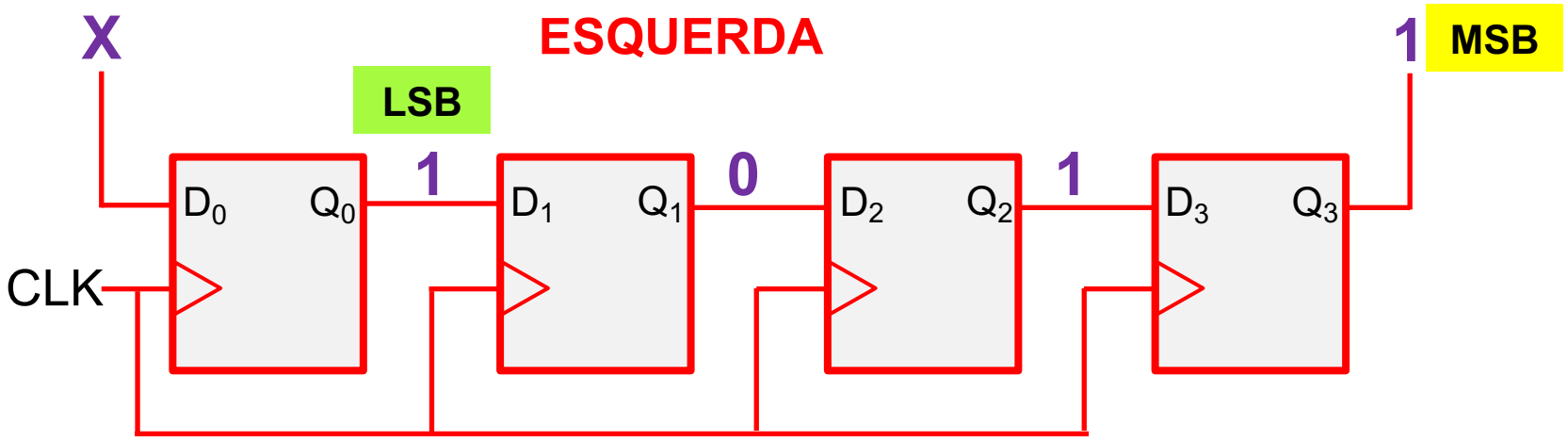


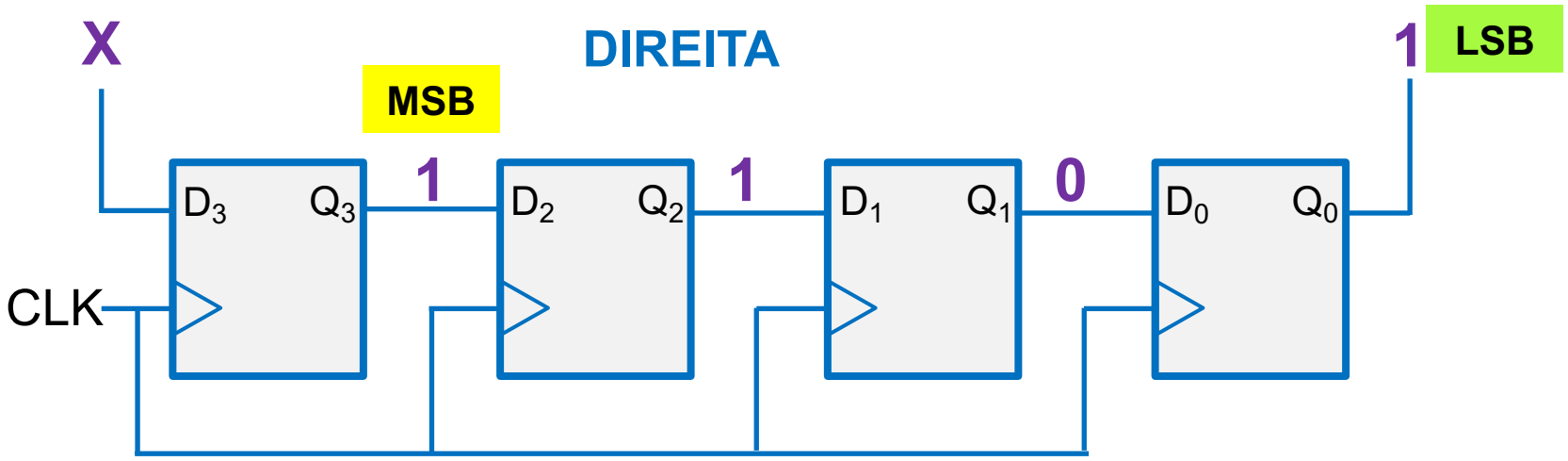
Registrador Bidirecional



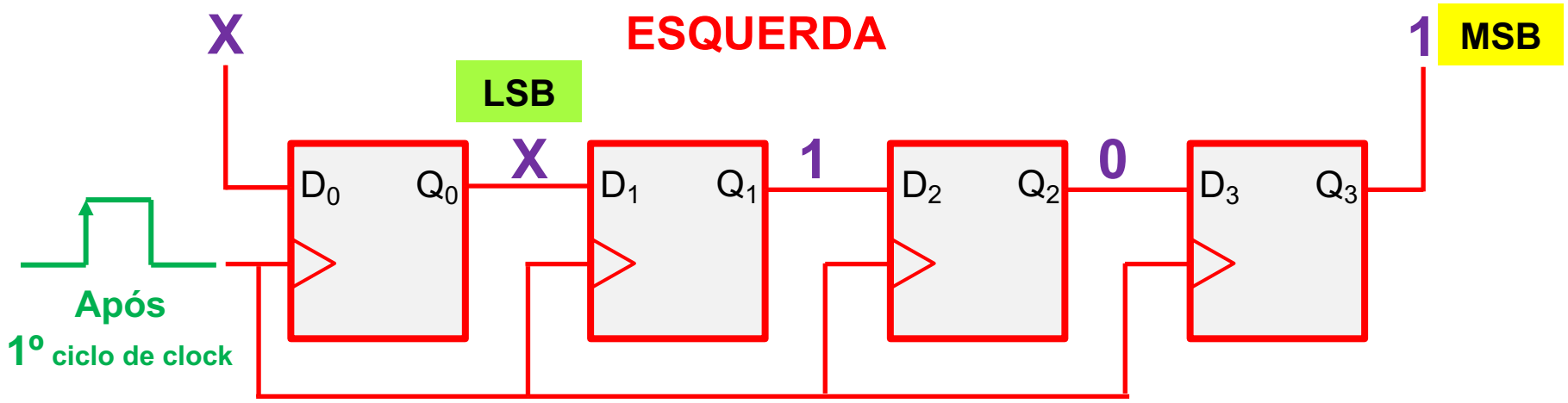


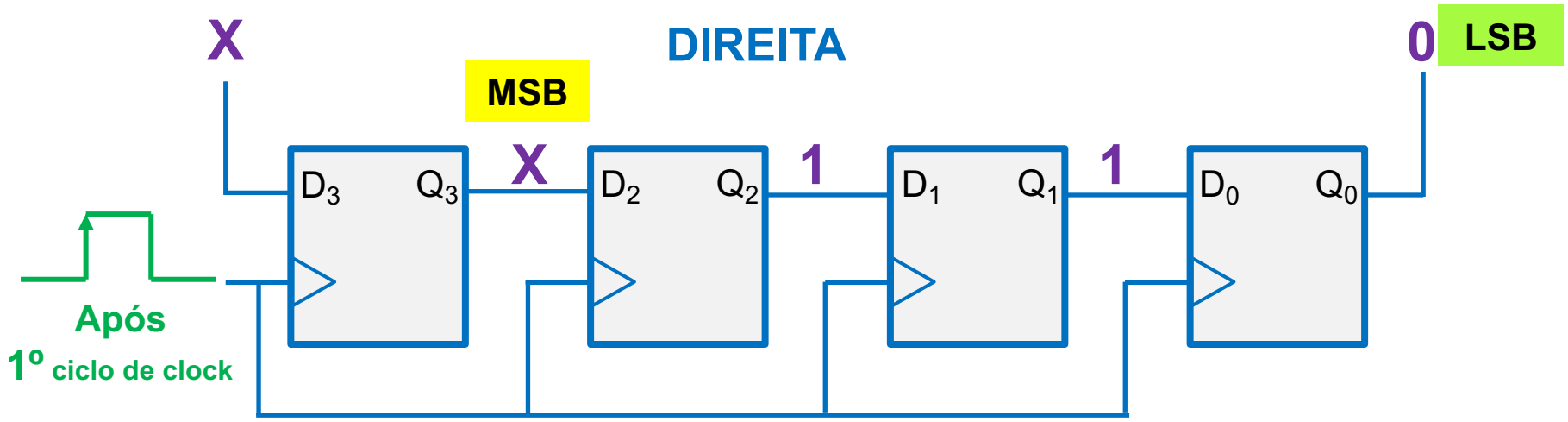
Reg. Bidirecional – Exemplo 1101





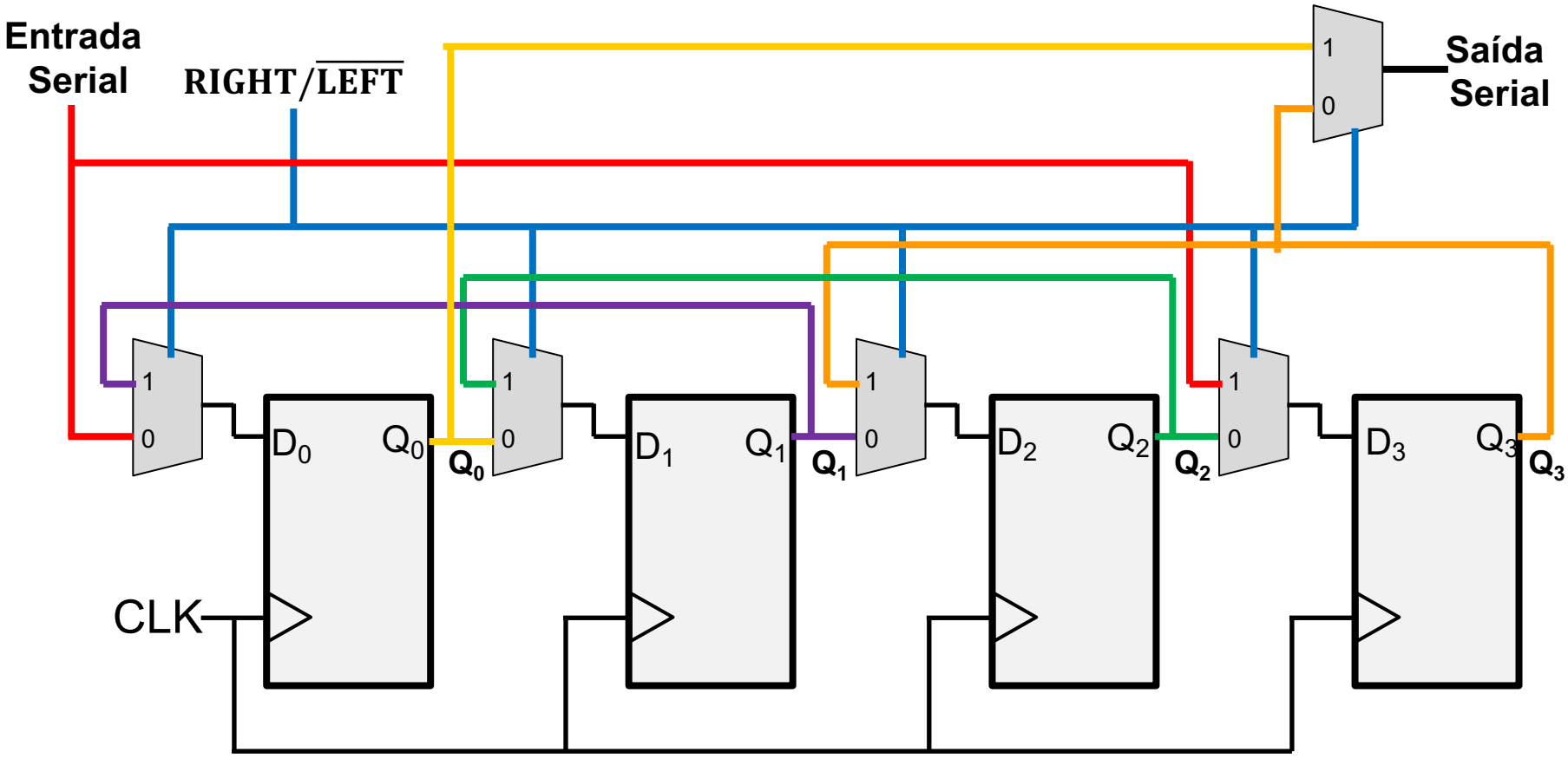
Reg. Bidirecional – Exemplo 1101



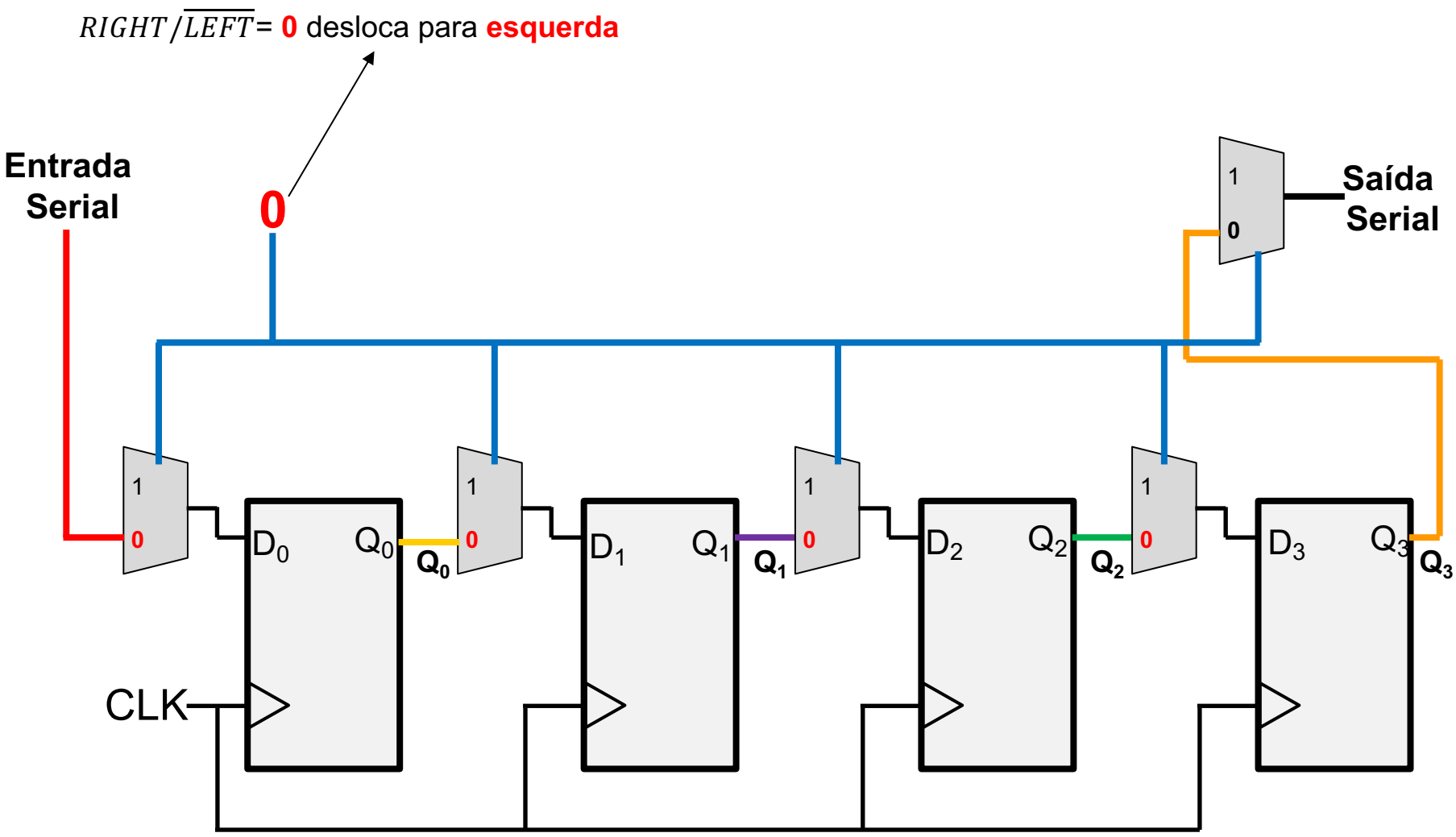


Registrador Bidirecional

Entrada Serial / Saída Serial

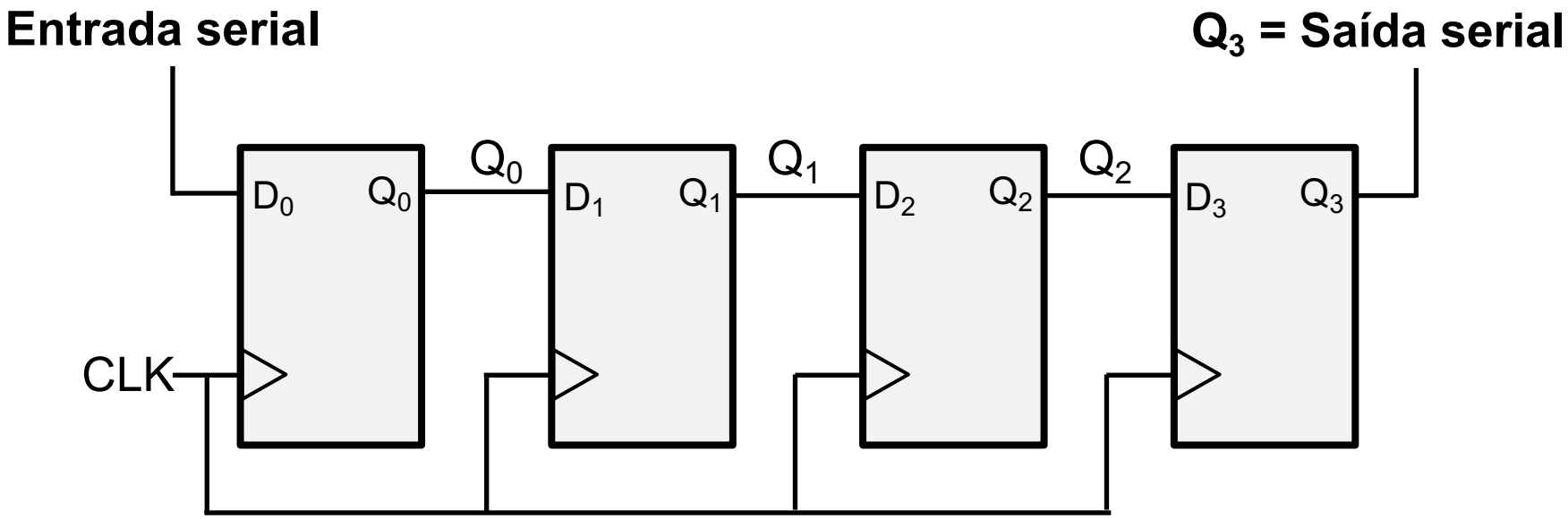


Registrador Bidirecional

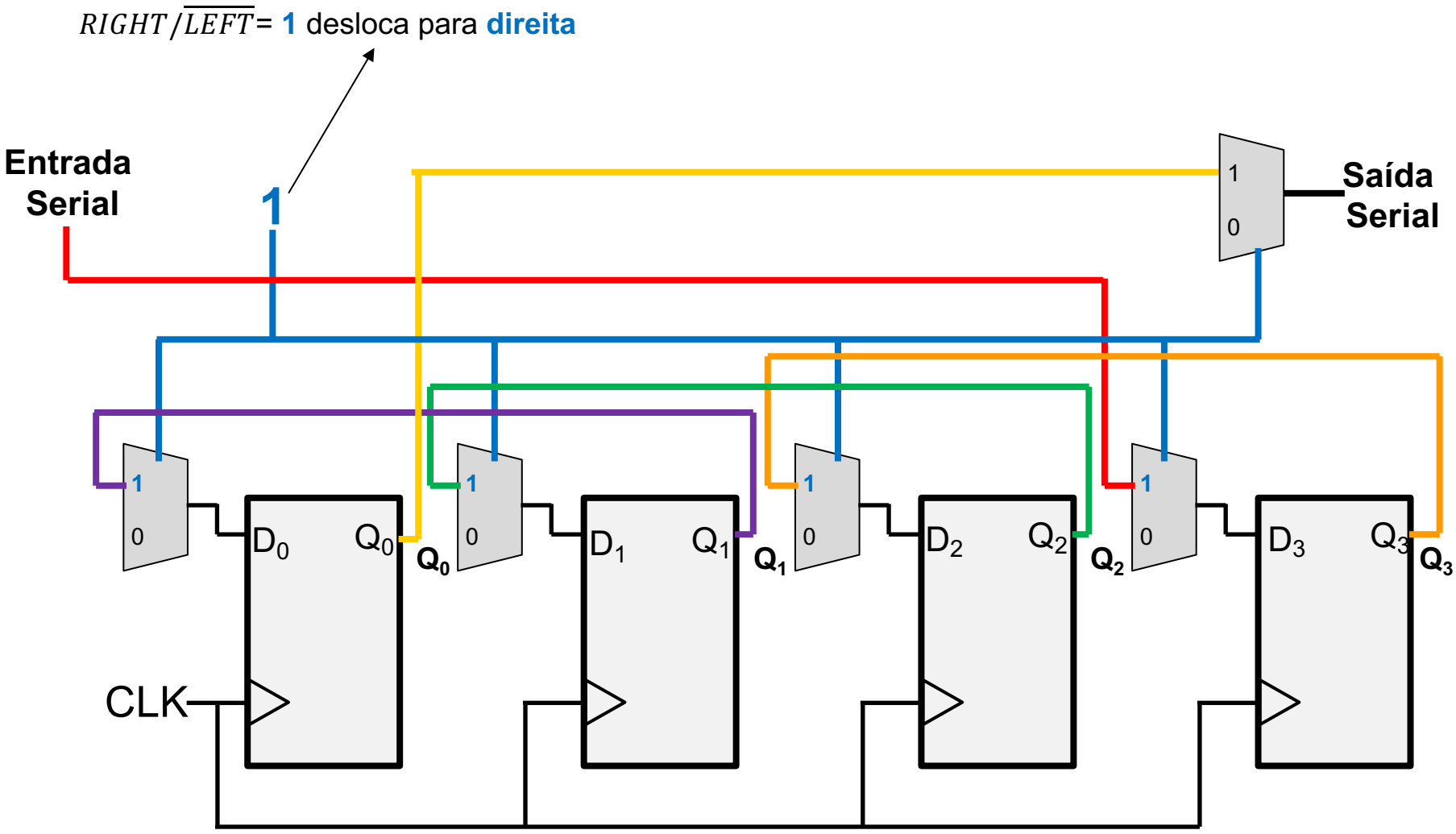


Registrador Bidirecional

Entrada Serial / Saída Serial

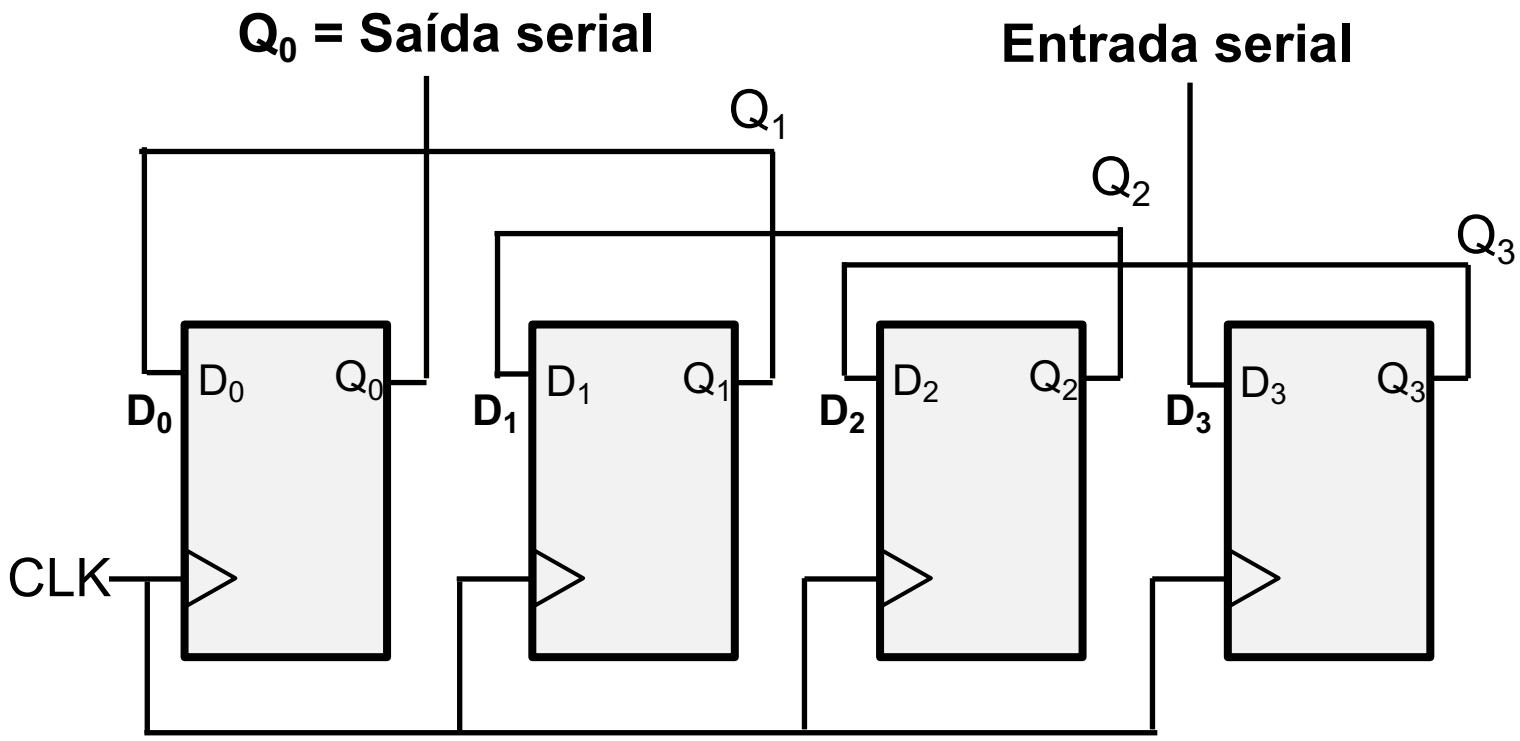


Registrador Bidirecional



Registrador Bidirecional

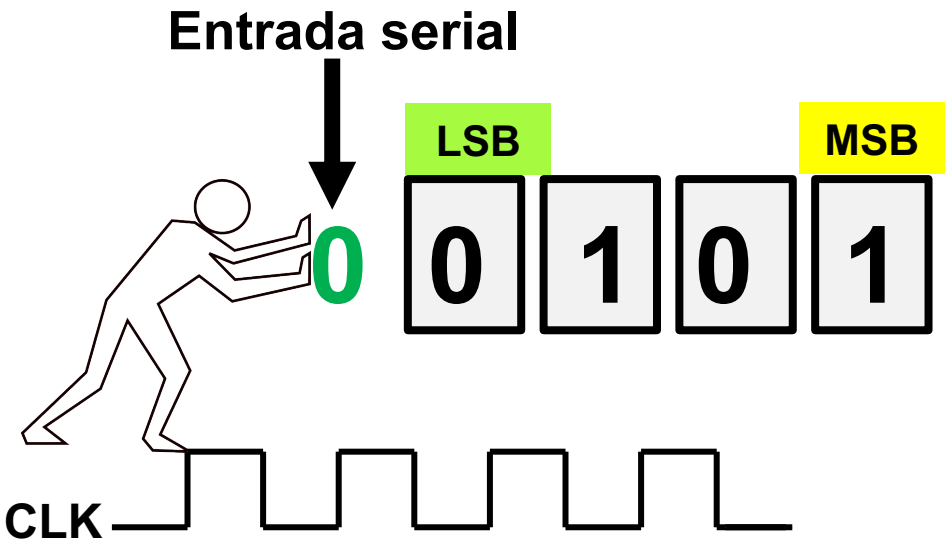
Entrada Serial / Saída Serial



Registrador Bidirecional

Esquerda

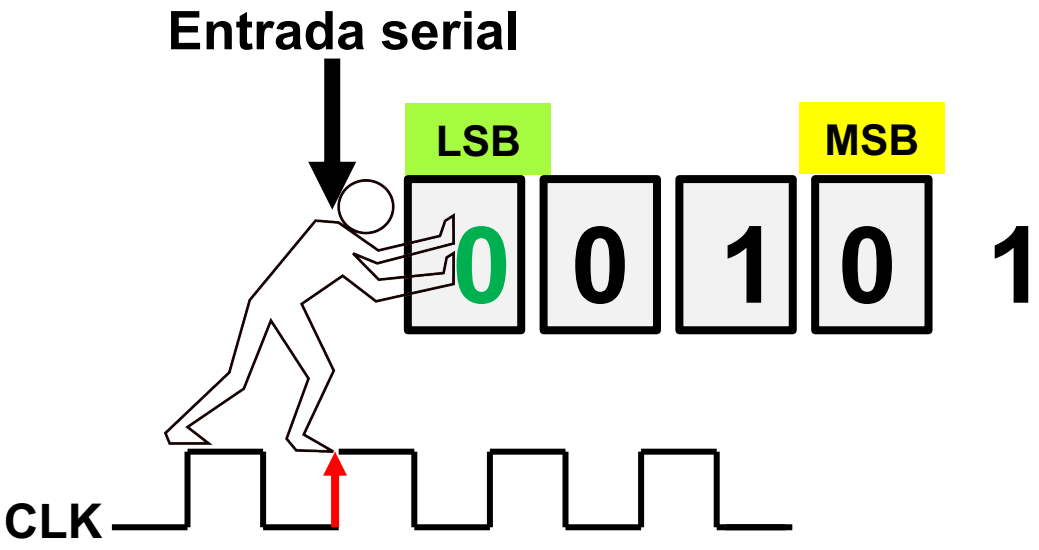
Exemplo : 1 0 1 0



Registrador Bidirecional

Esquerda

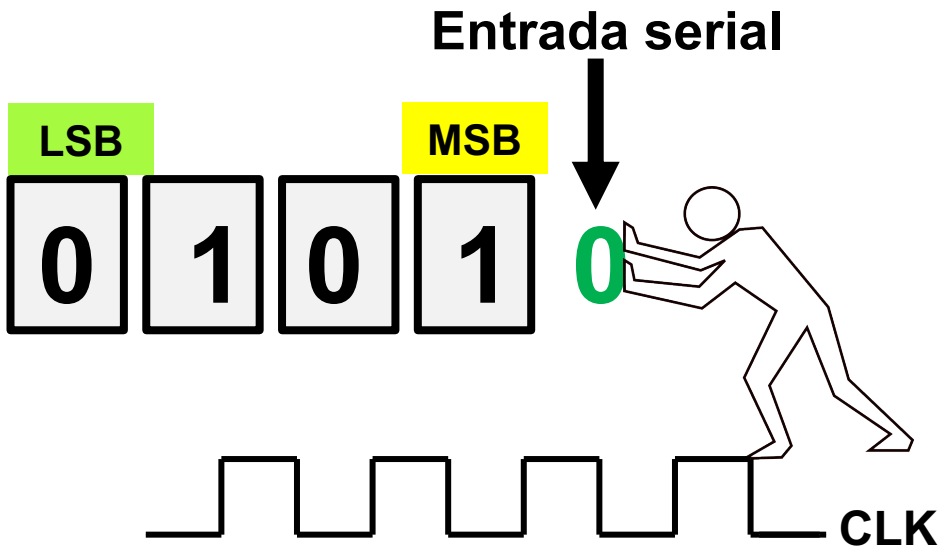
Exemplo : 1 0 1 0



Registrador Bidirecional

Direita

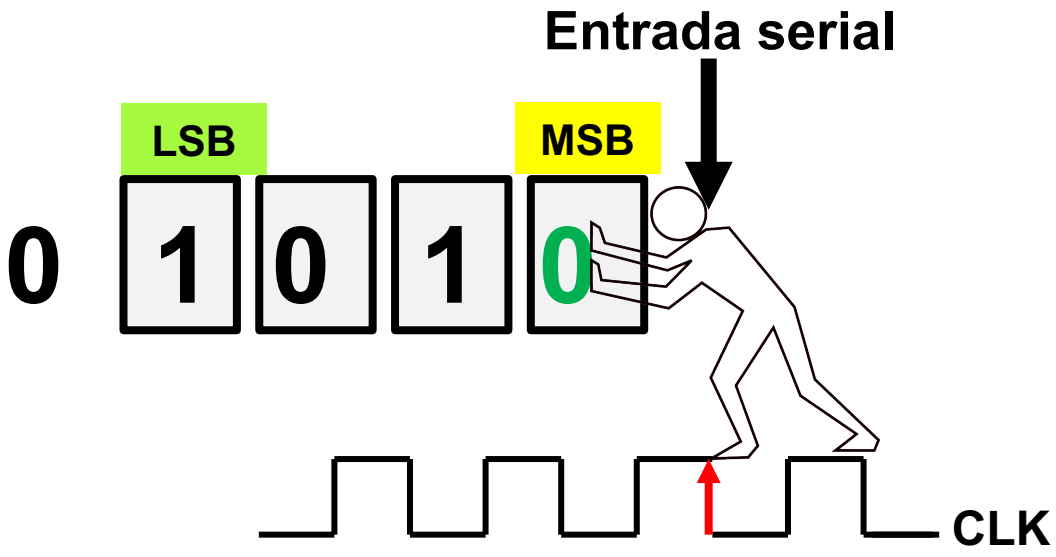
Exemplo : 1 0 1 0



Registrador Bidirecional

Direita

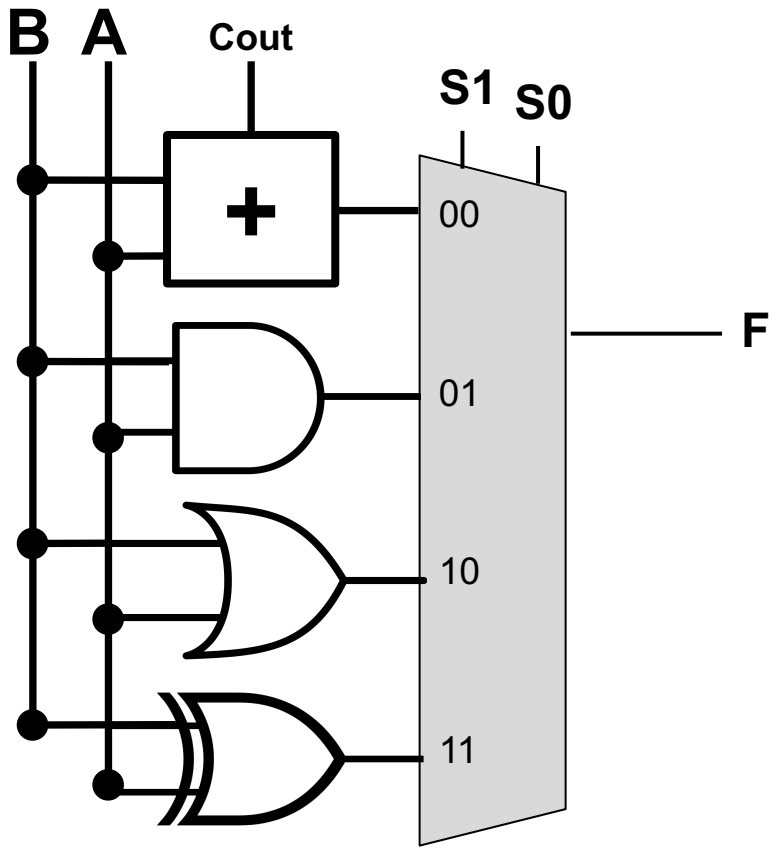
Exemplo : 1 0 1 0



Exemplo

UNIDADE LÓGICA E ARITMÉTICA

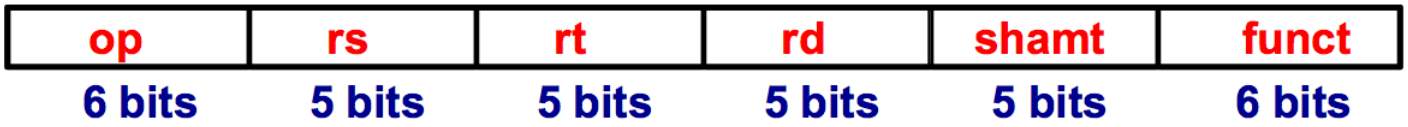
S1	S0	F
0	0	A + B
0	1	A AND B
1	0	A OR B
1	1	A XOR B



Exemplo - MIPS

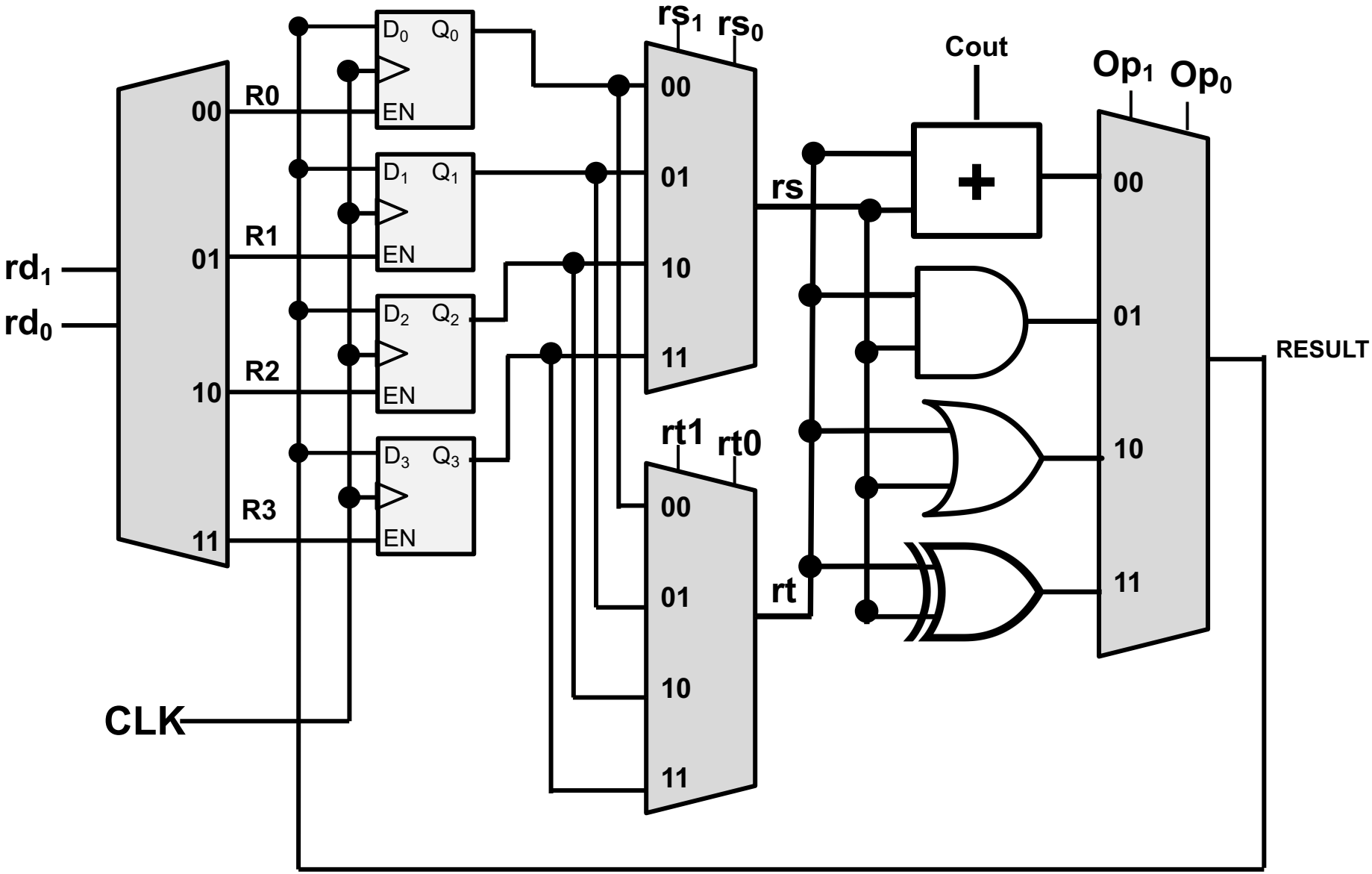
Instruções Lógico-Aritméticas

- Formato de uma instrução tipo R no MIPS:



- Semântica:
  - $rd ← op($rs, $rt)
- Estrutura de suporte: banco de registradores

Exemplo


rd1
rd0
CLK
00
01
10
11
R0
R1
R2
R3
D0 Q0
D1 Q1
D2 Q2
D3 Q3
EN
rs1 rs0
rt1 rt0
rs
rt
Cout
+
Op1 Op0
RESULT

Exemplo - R2 = R1 AND R0