

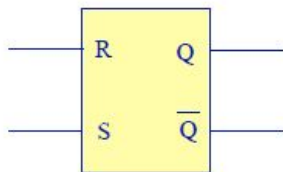
Sistemas Digitais

Flip-Flop, Latches e Registradores.

Latches, Flip-Flops e Registradores

O Latch RS

símbolo



circuito com portas nor

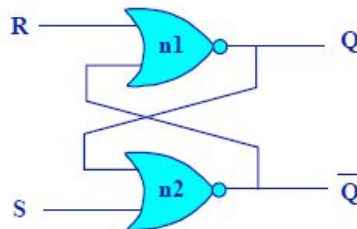


tabela de transição
de estados

R	S	Q_{t+1}	comentário
0	0	Q_t	mantém estado anterior
0	1	1	estado set
1	0	0	estado reset
1	1	-	proibido

Latches, Flip-Flops e Registradores

O Latch RS Controlado

símbolo

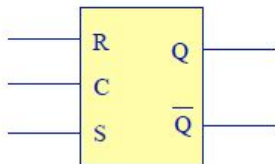
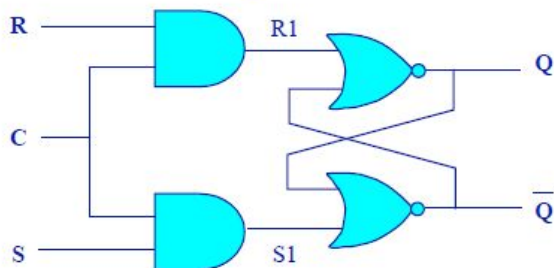


tabela de transição
de estados

circuito com portas nor e and

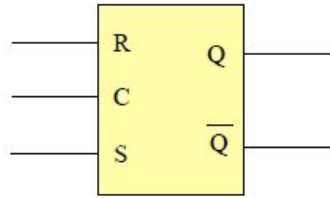


C	R	S	Q_{t+1}	comentário
0	X	X	Q_t	mantém estado anterior
1	0	0	Q_t	mantém estado anterior
1	0	1	1	estado set
1	1	0	0	estado reset
1	1	1	-	proibido

Latches, Flip-Flops e Registradores

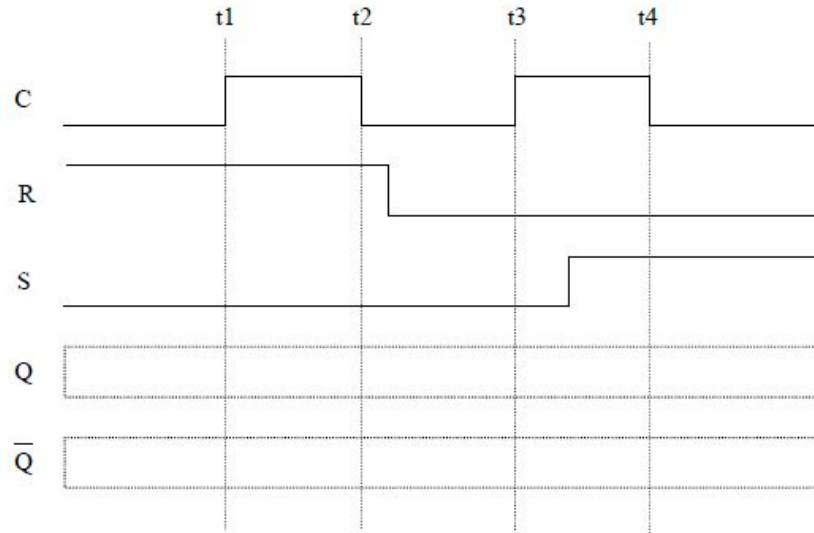
O Latch RS Controlado

Exemplo



C	R	S	Q_{t+1}
0	X	X	Q_t
1	0	0	Q_t
1	0	1	1
1	1	0	0
1	1	1	-

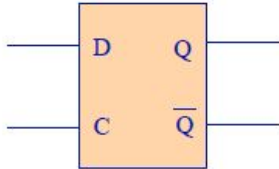
tabela de transição
de estados



Latches, Flip-Flops e Registradores

O Latch D

símbolo



circuito a partir do latch RS controlado

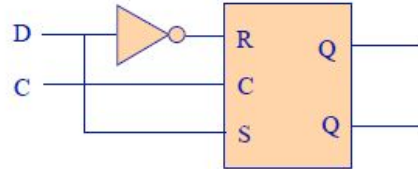


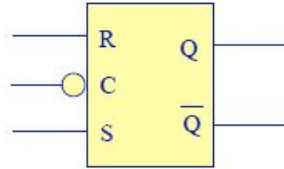
tabela de transição
de estados

C	D	Q_{t+1}	comentário
0	X	Q_t	mantém estado anterior
1	0	0	estado reset
1	1	1	estado set

Latches, Flip-Flops e Registradores

Latches com ativação em lógica complementar

Latch RS

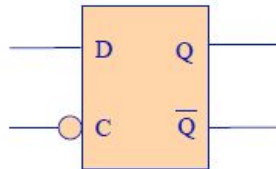


símbolo

C	R	S	Q_{t+1}
1	X	X	Q_t
0	0	0	Q_t
0	0	1	1
0	1	0	0
0	1	1	-

tabela de transição
de estados

Latch D



símbolo

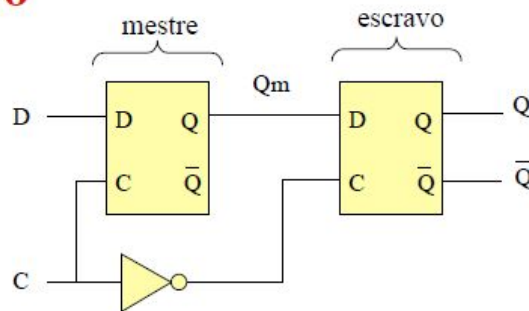
C	D	Q_{t+1}
1	X	Q_t
0	0	0
0	1	1

tabela de transição
de estados

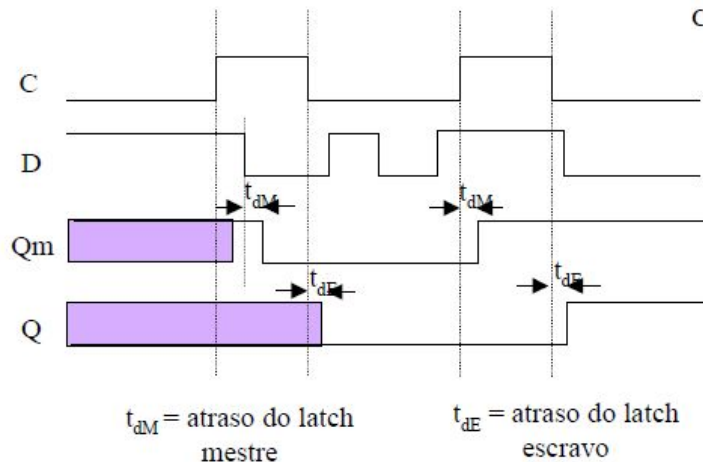
Latches, Flip-Flops e Registradores

O Flip-flop D mestre-escravo

circuito



análise dinâmica
(exemplo de funcionamento)



Latches, Flip-Flops e Registradores

O Flip-flop D disparado pela borda ascendente (ou Flip-flop D sensível à borda ascendente)

símbolo

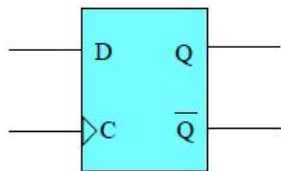
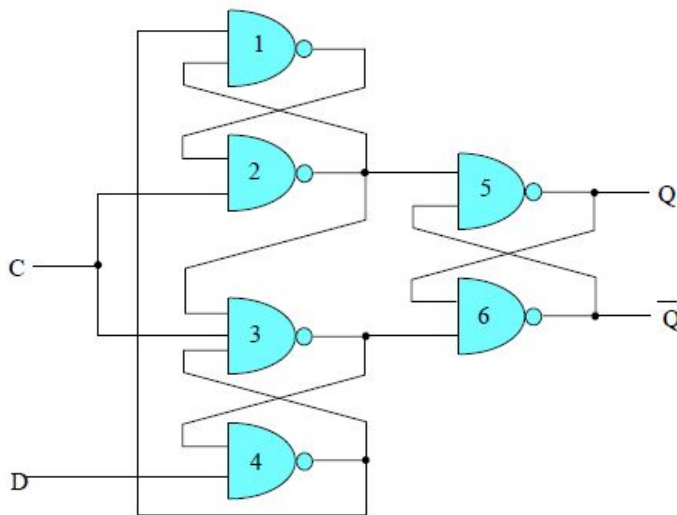


tabela de transição de estados

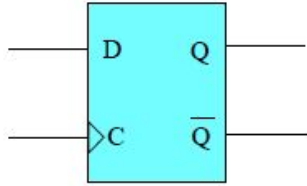
C	D	Q_{t+1}
$\neq \uparrow$	X	Q_t
\uparrow	0	0
\uparrow	1	1

circuito com portas nand



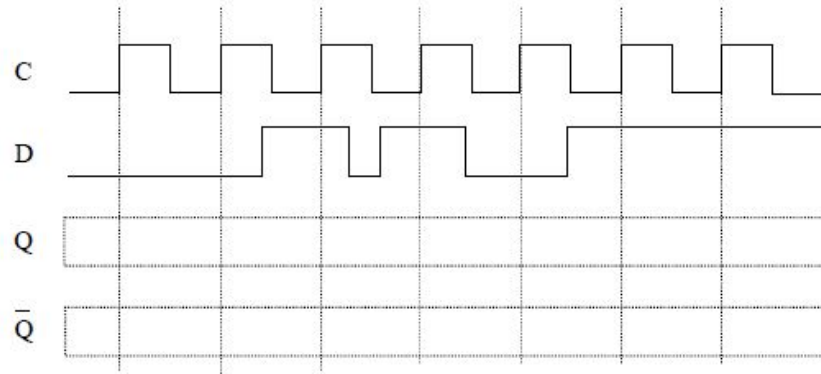
Latches, Flip-Flops e Registradores

O Flip-flop D disparado pela borda ascendente



C	D	Q_{t+1}
$\neq \uparrow$	X	Q_t
\uparrow	0	0
\uparrow	1	1

tabela de transição
de estados



Latches, Flip-Flops e Registradores

O Flip-flop JK (disparado pela borda ascendente)

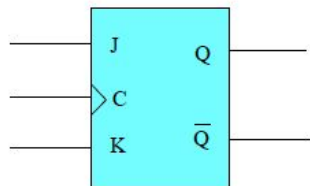
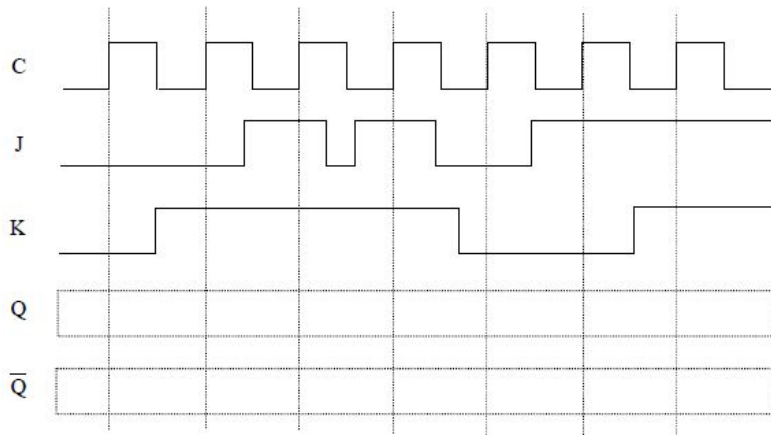


tabela de transição
de estados

C	J	K	Q_{t+1}
$\neg \uparrow$	X	X	Q_t
\uparrow	0	0	Q_t
\uparrow	0	1	0
\uparrow	1	0	1
\uparrow	1	1	$\overline{Q_t}$

Exemplo

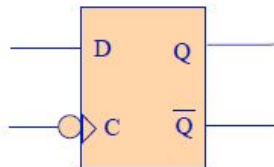


Latches, Flip-Flops e Registradores

Flip-flops disparados pela borda descendente

(ou Flip-flops sensíveis à borda descendente)

Flip-flop D

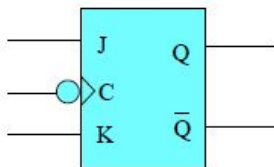


símbolo

C	D	Q_{t+1}
$\neq \downarrow$	X	Q_t
\downarrow	0	0
\downarrow	1	1

tabela de transição
de estados

Flip-flop JK



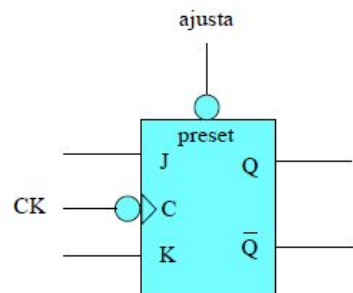
símbolo

C	J	K	Q_{t+1}
$\neq \downarrow$	X	X	Q_t
\downarrow	0	0	Q_t
\downarrow	0	1	0
\downarrow	1	0	1
\downarrow	1	1	$\overline{Q_t}$

tabela de transição
de estados

Latches, Flip-Flops e Registradores

Flip-flops com set e reset assíncronos



C	J	K	Q_{t+1}
$\neq \downarrow$	X	X	Q_t
\downarrow	0	0	Q_t
\downarrow	0	1	0
\downarrow	1	0	1
\downarrow	1	1	\bar{Q}_t

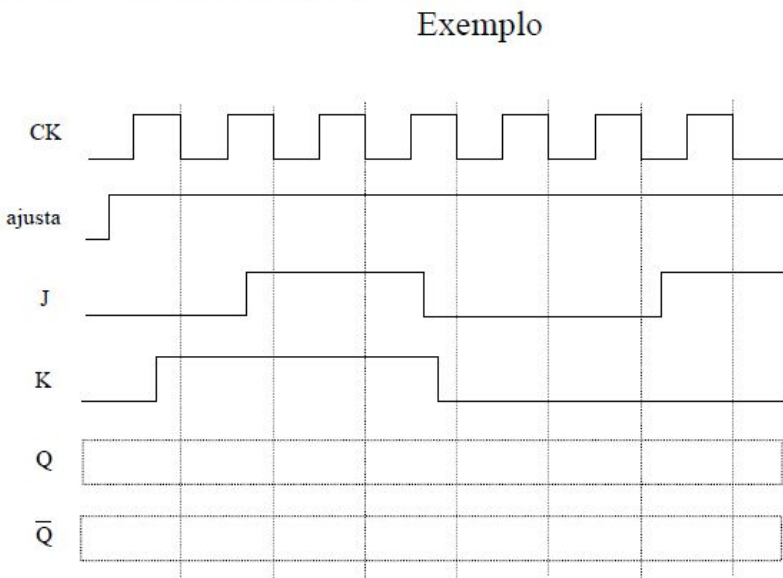


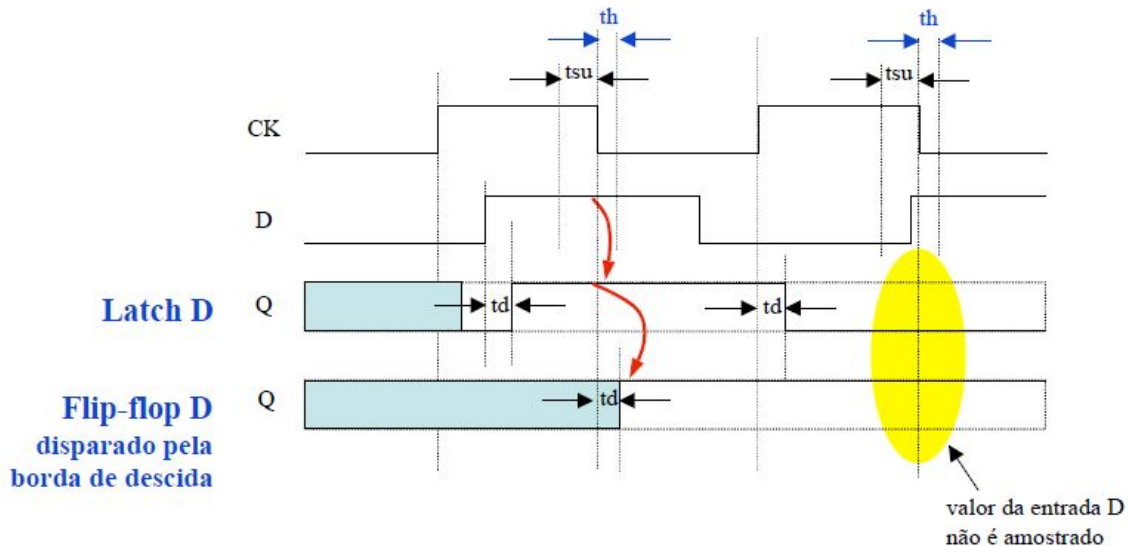
tabela de transição
de estados

Latches, Flip-Flops e Registradores

Tempo de Preparação - t_p (*setup time*)

Tempo de Manutenção - t_{su} (*hold time*)

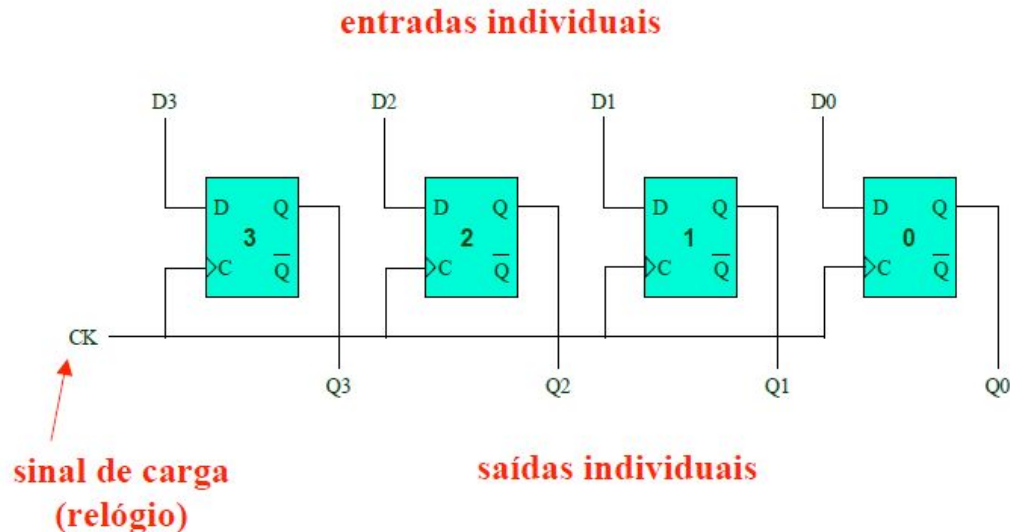
Atraso de Propagação - t_d ou t_p (*propagation delay*)



Latches, Flip-Flops e Registradores

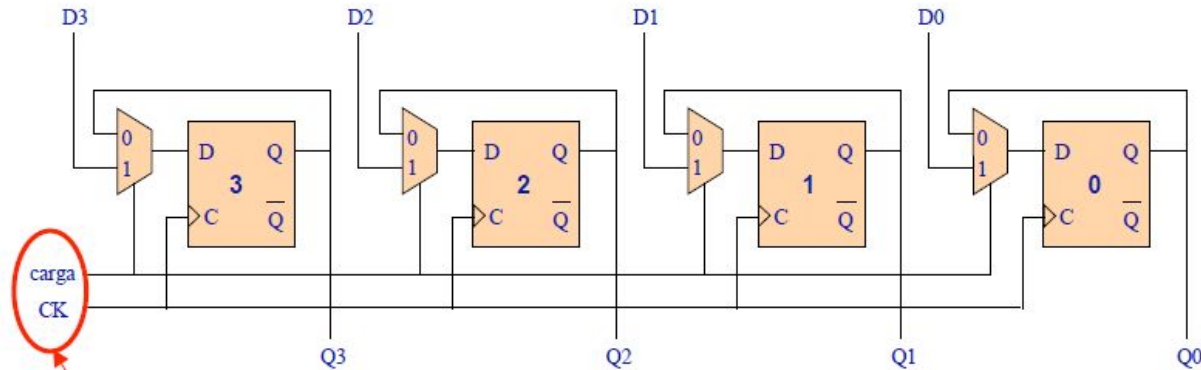
Registradores

Registrador com carga paralela (versão 1)



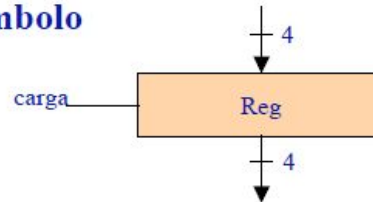
Latches, Flip-Flops e Registradores

Registrador com carga paralela (versão 2)



sinal de carga
separado do relógio

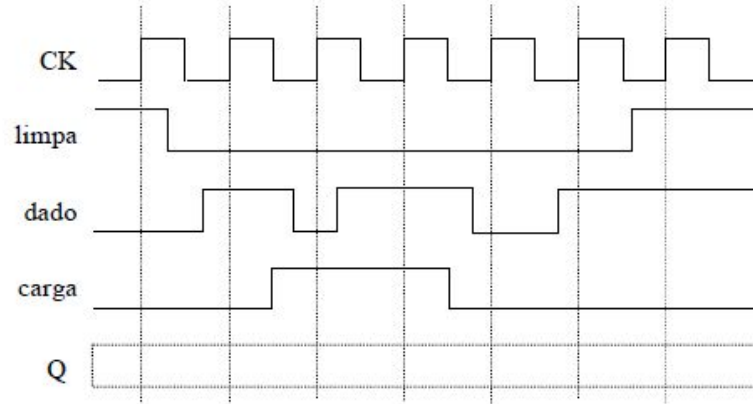
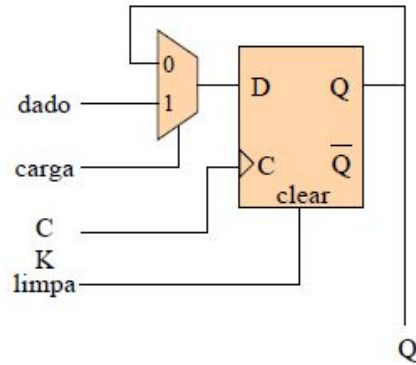
símbolo



Latches, Flip-Flops e Registradores

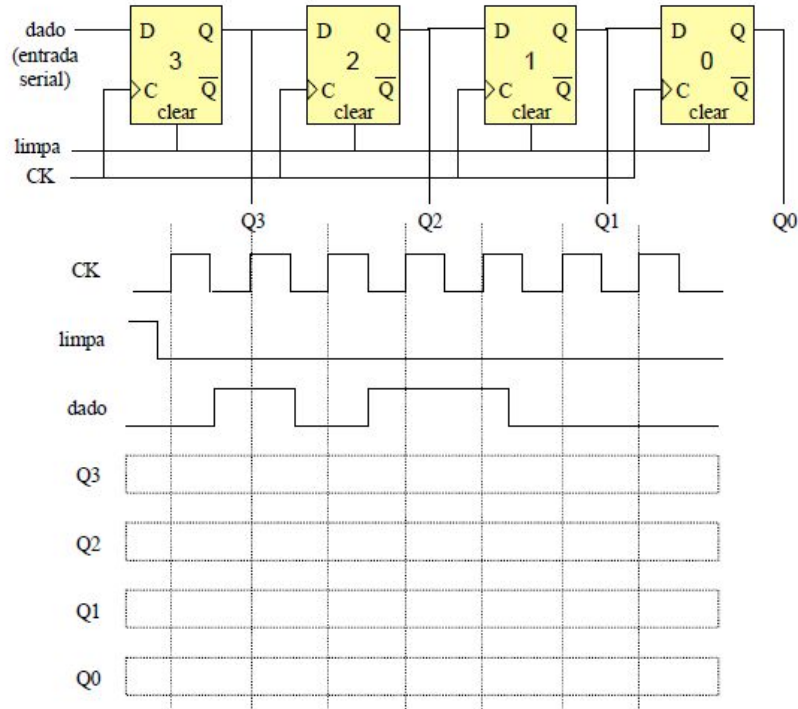
Registrador com carga paralela (versão 2)

Exemplo



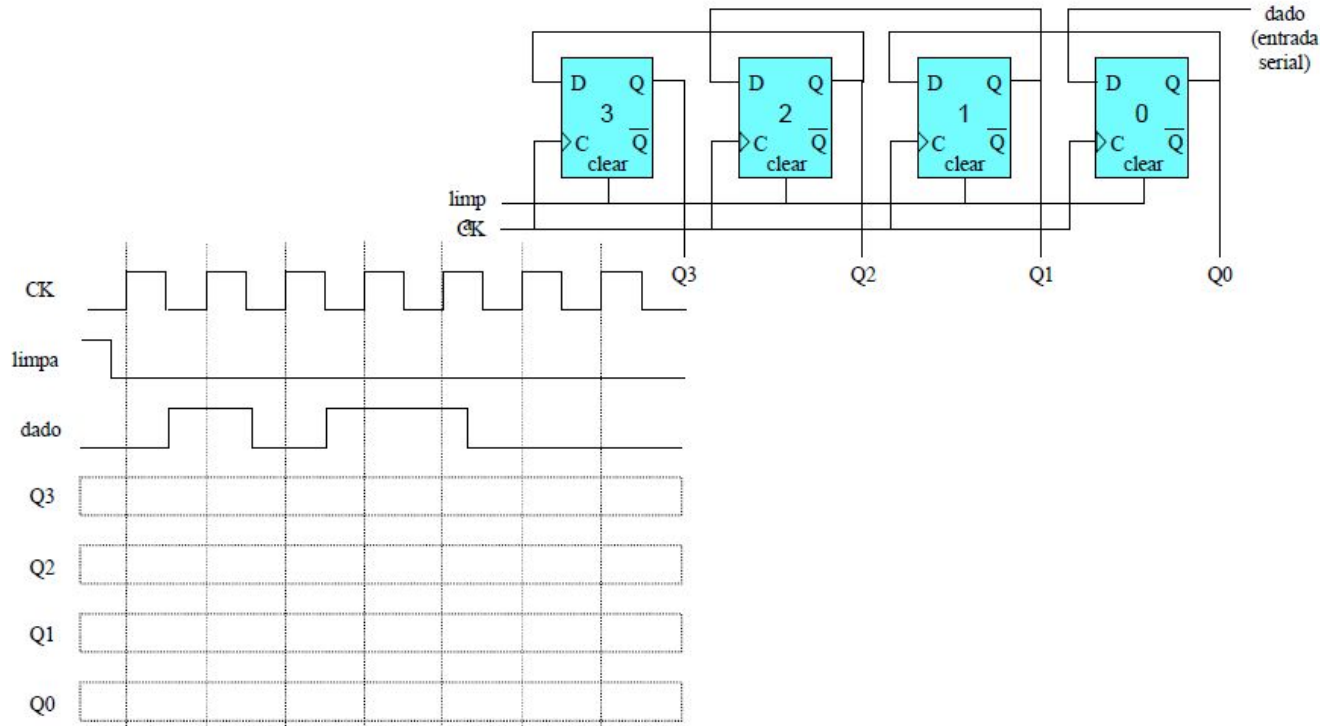
Latches, Flip-Flops e Registradores

Registrador de deslocamento (à direita)



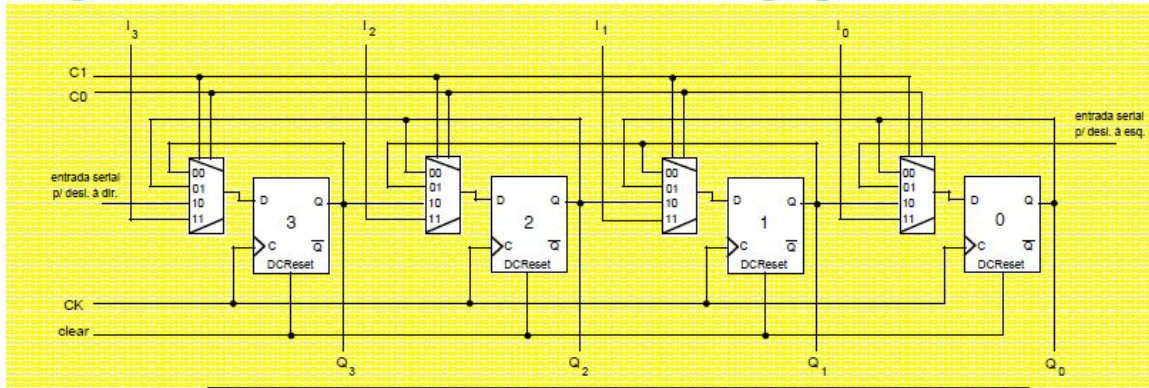
Latches, Flip-Flops e Registradores

Registrador de deslocamento (à esquerda)



Latches, Flip-Flops e Registradores

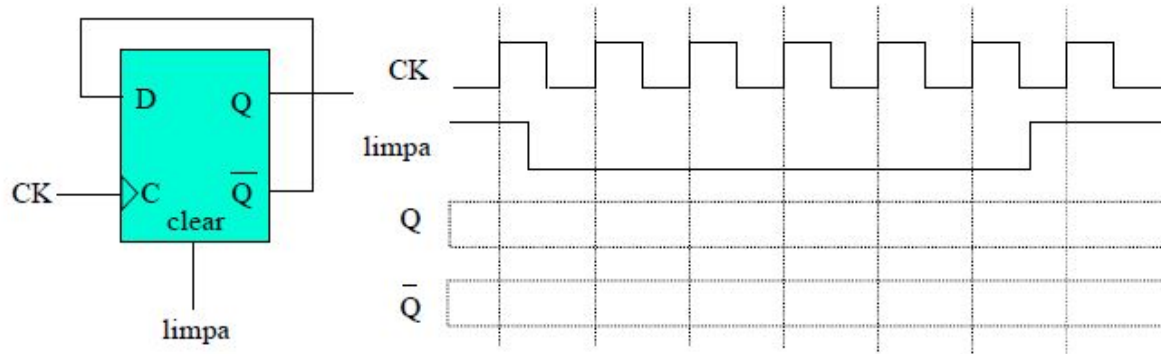
Registrador de deslocamento com carga paralela



clear	CK	C1	C0	operação
0	$\neq \uparrow$	X	X	mantém conteúdo
0	\uparrow	0	0	mantém conteúdo
0	\uparrow	0	1	desloca à esquerda
0	\uparrow	1	0	desloca à direita
0	\uparrow	1	1	carga paralela
1	X	X	X	zera conteúdo

Latches, Flip-Flops e Registradores

Registrador contador (1 bit)



Latches, Flip-Flops e Registradores

Registrador contador (3 bits)

