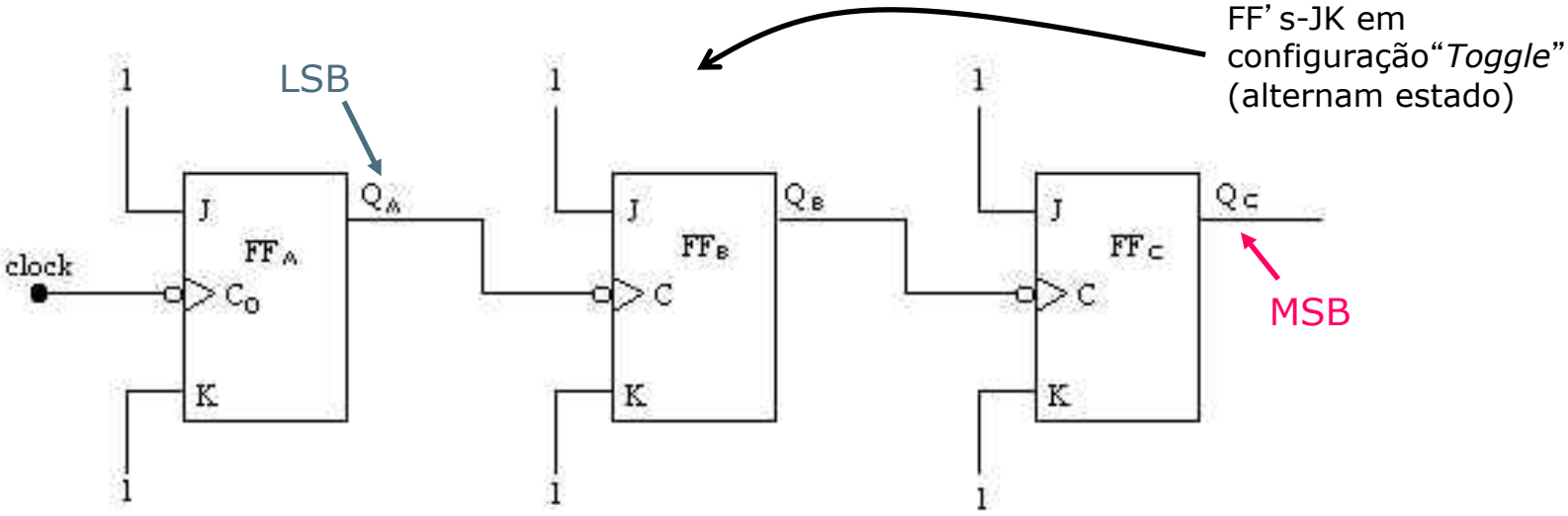
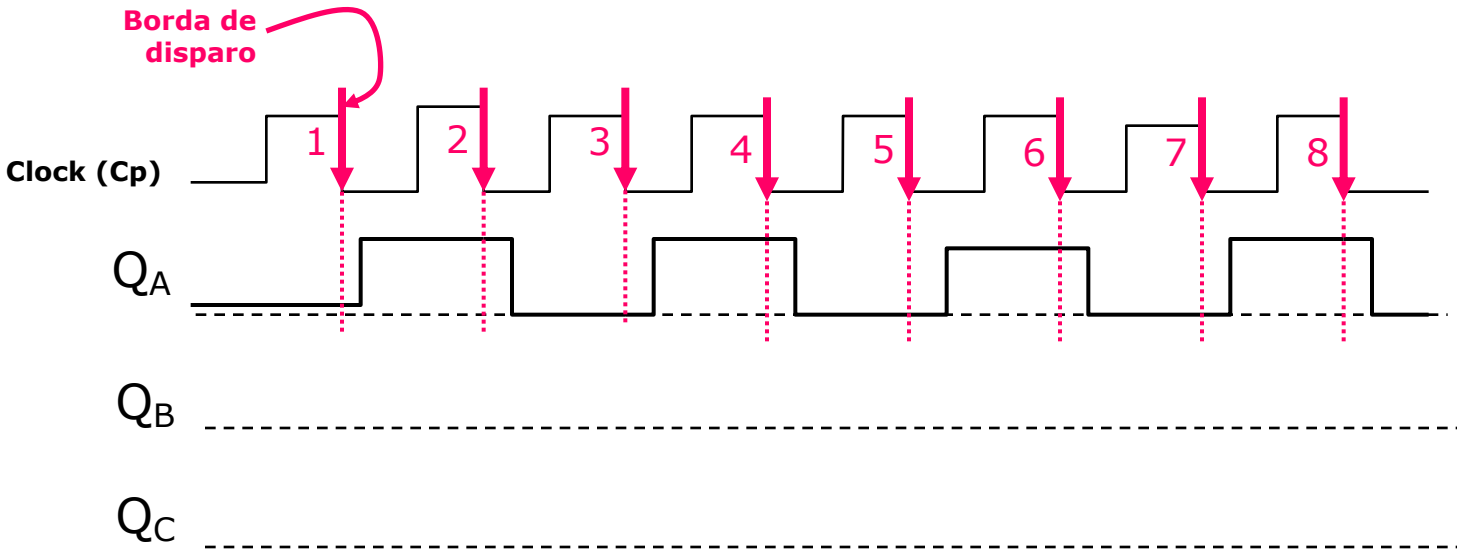
Contadores assíncronos

Circuitos Digitais II

Prof. Fernando Passold

Exemplo1) Contador assíncrono crescente de módulo 8 (2^3): conta de 0 até 7:





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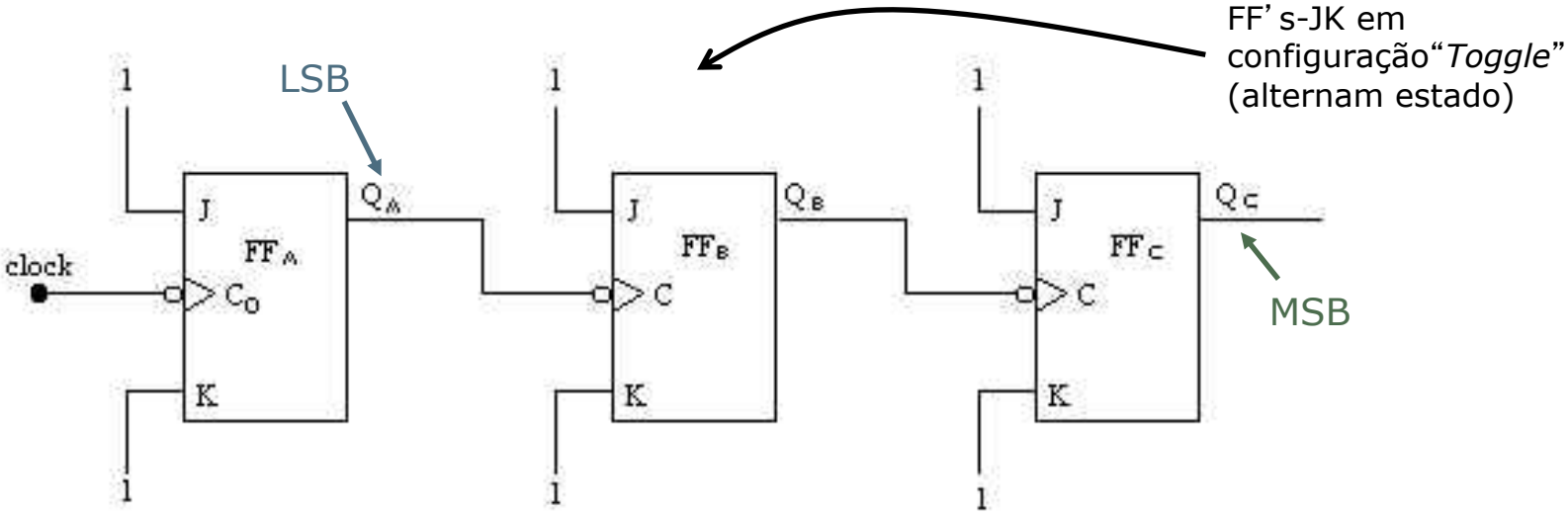

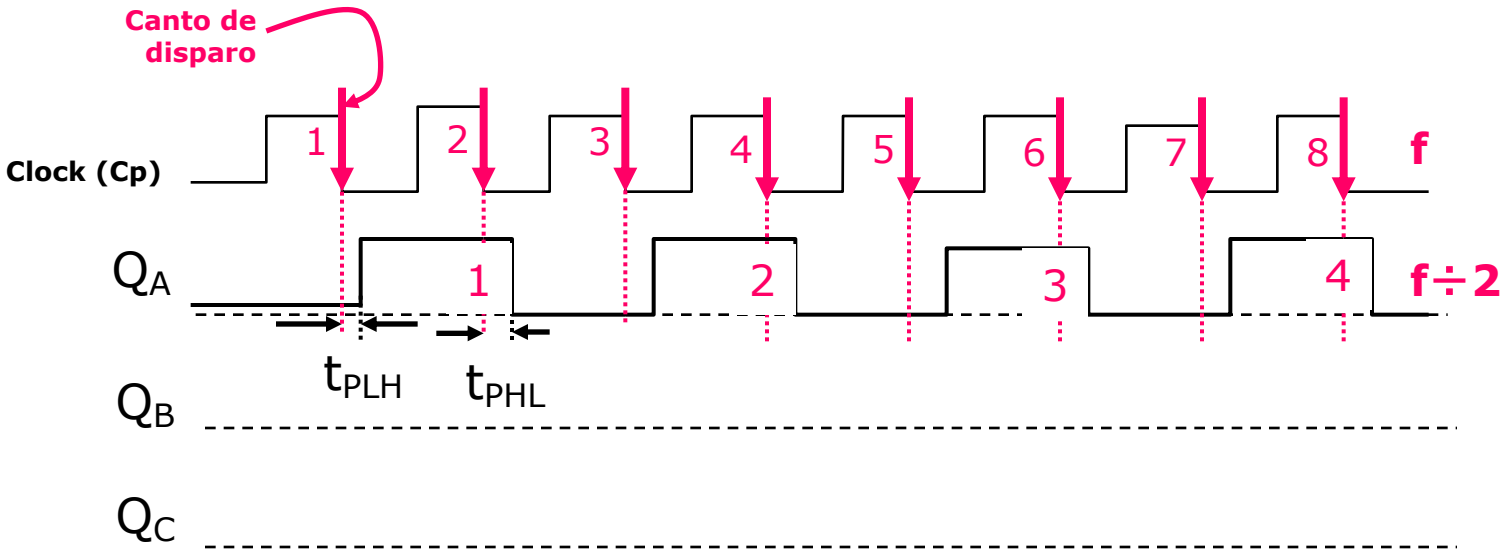

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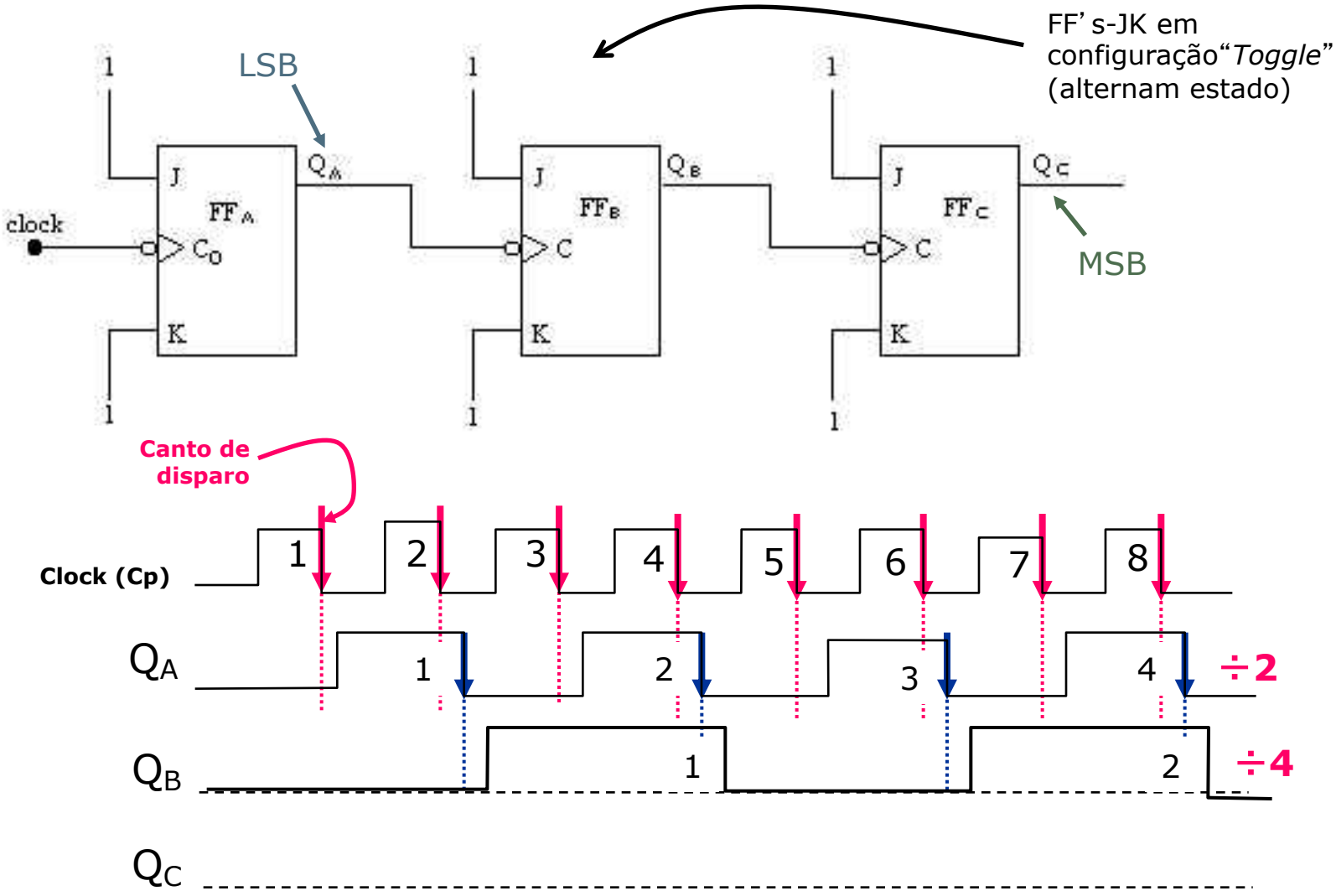

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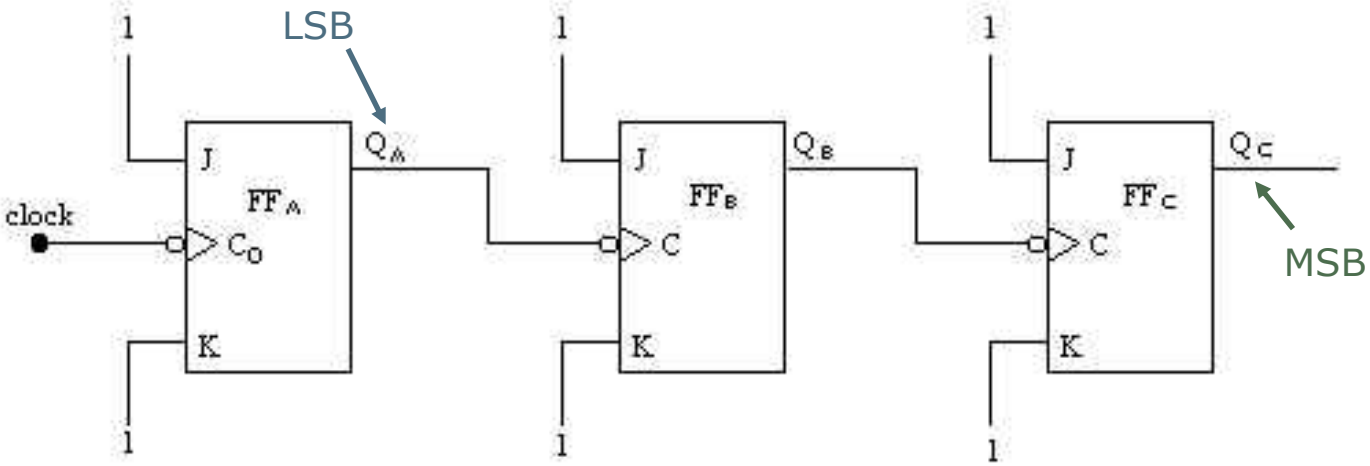

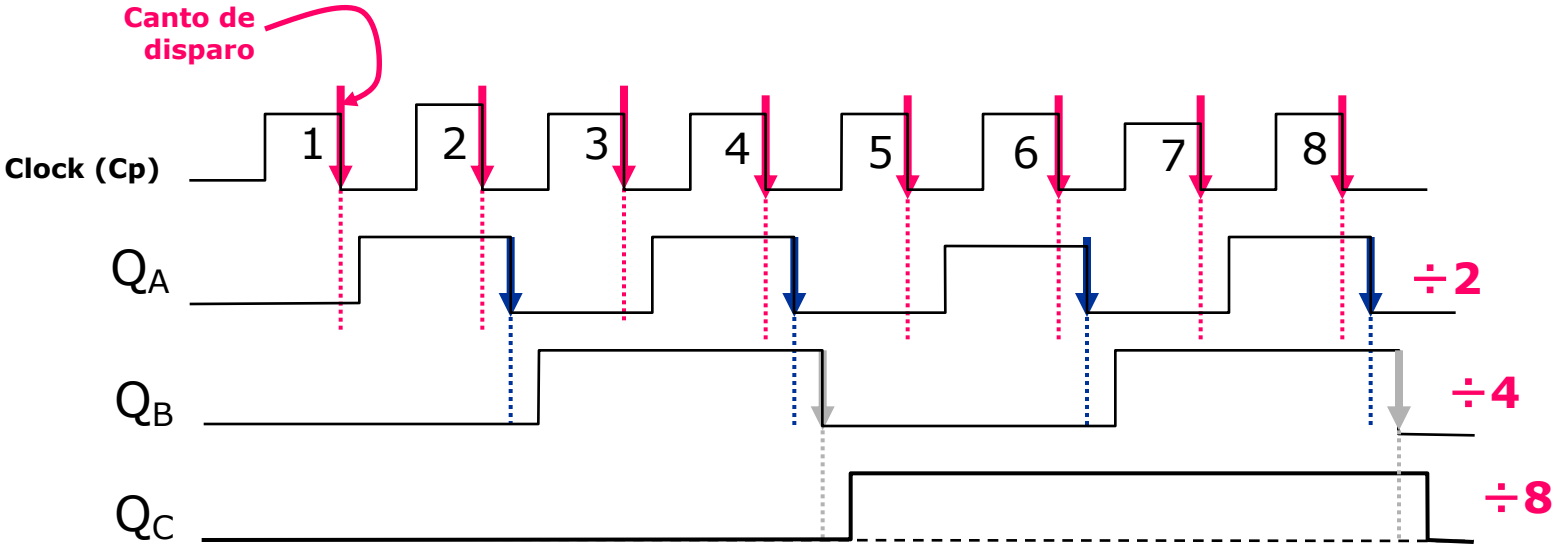

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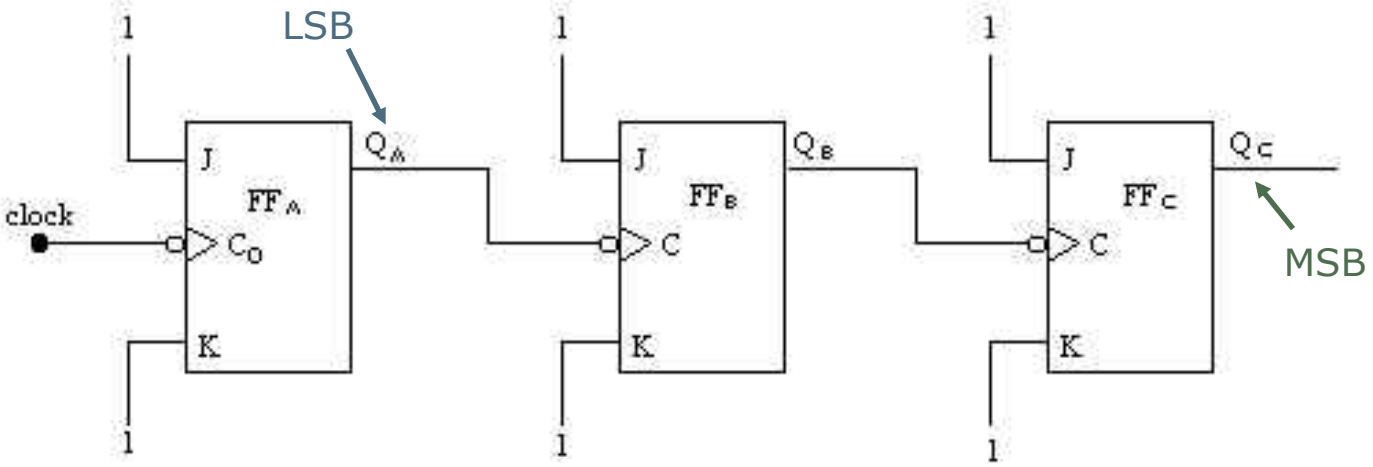

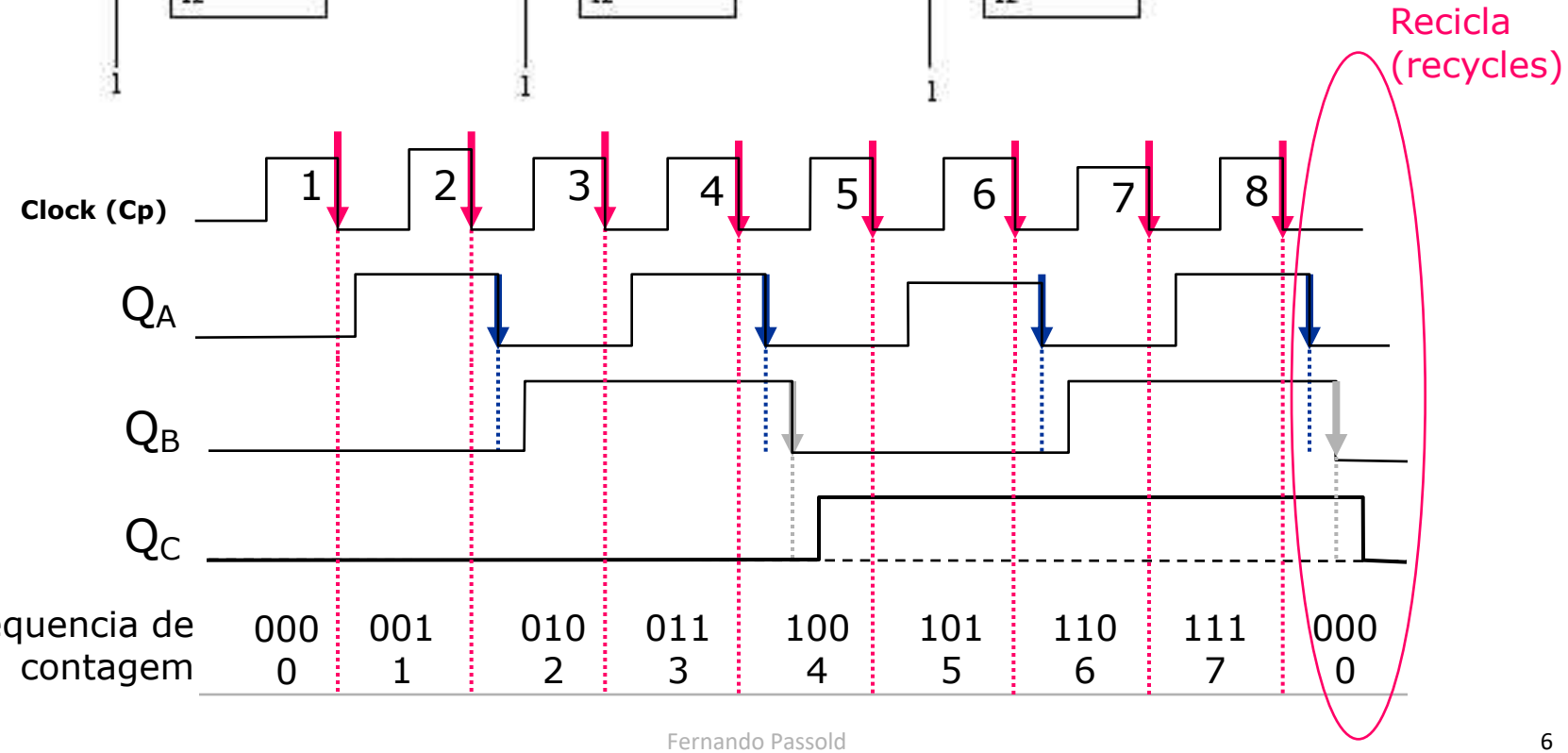

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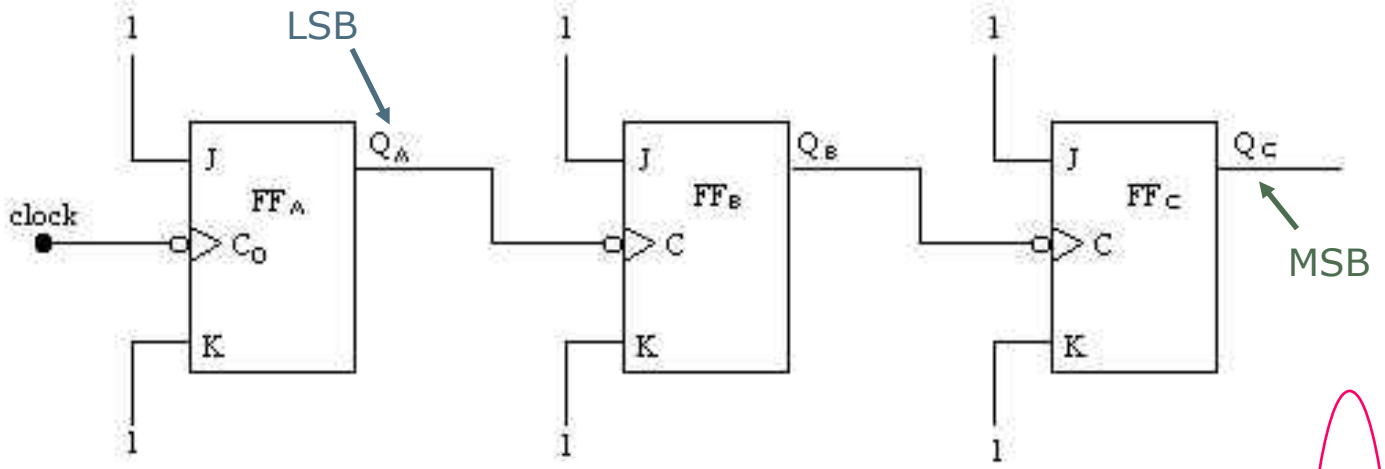

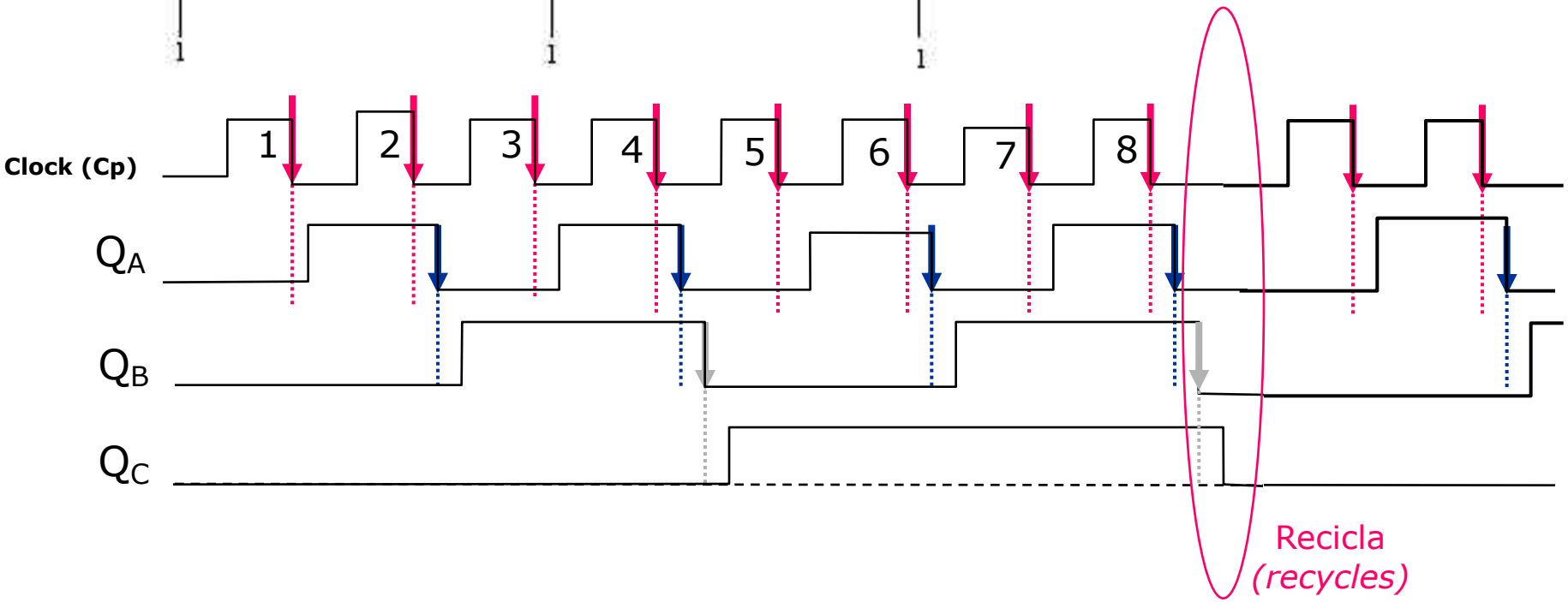

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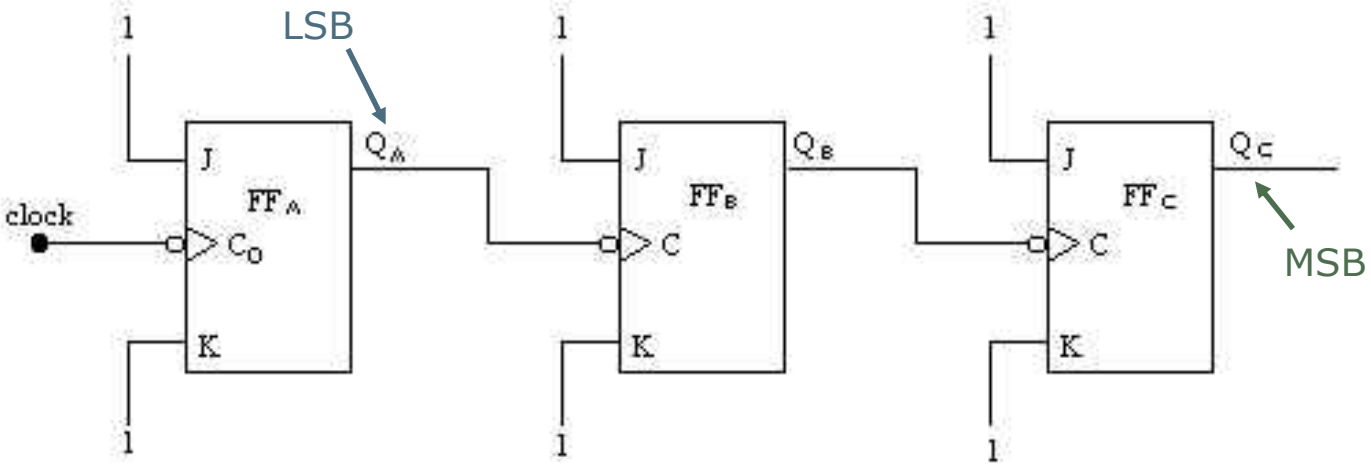
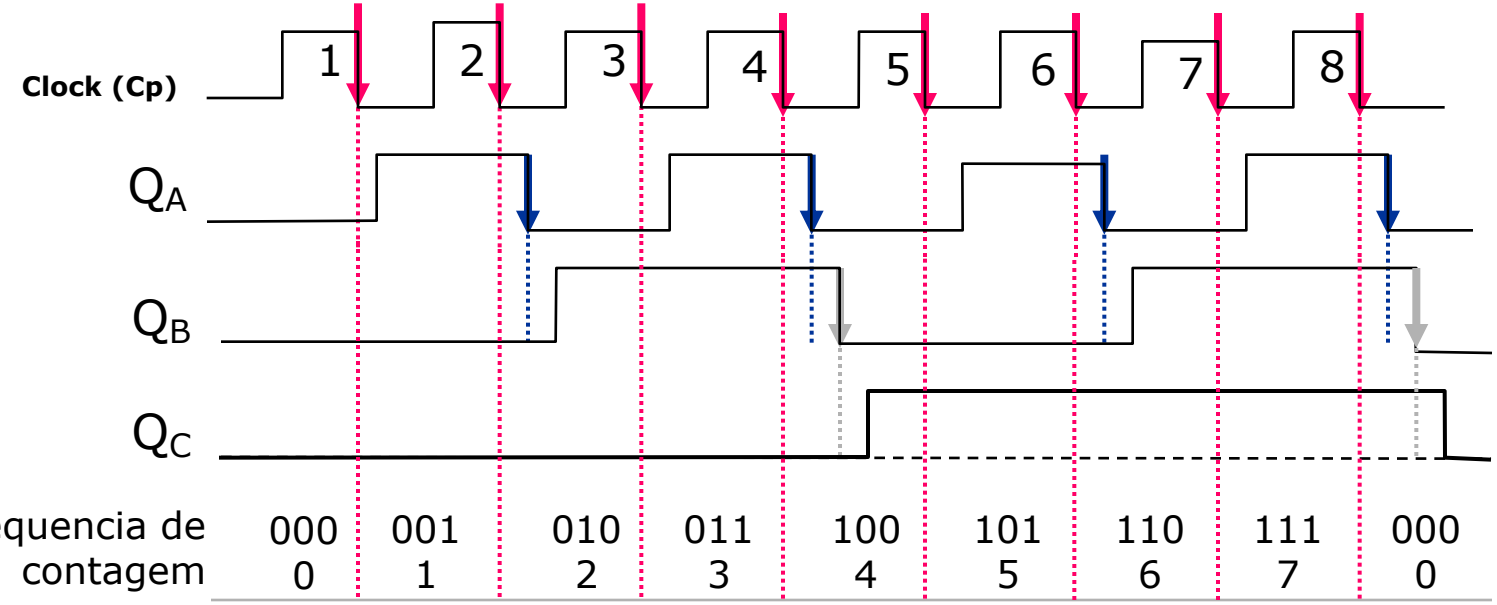
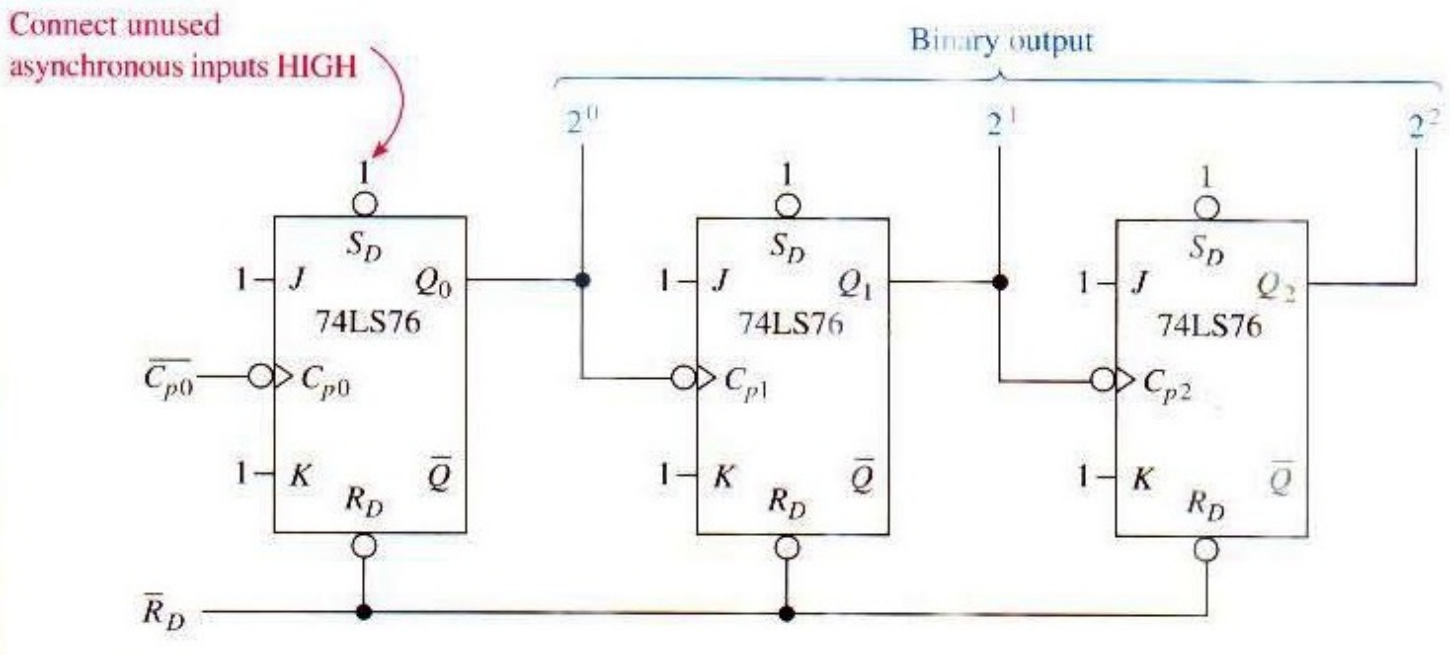
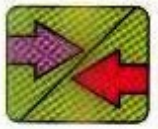




"Ripple Counter" (Contador Assíncrono):

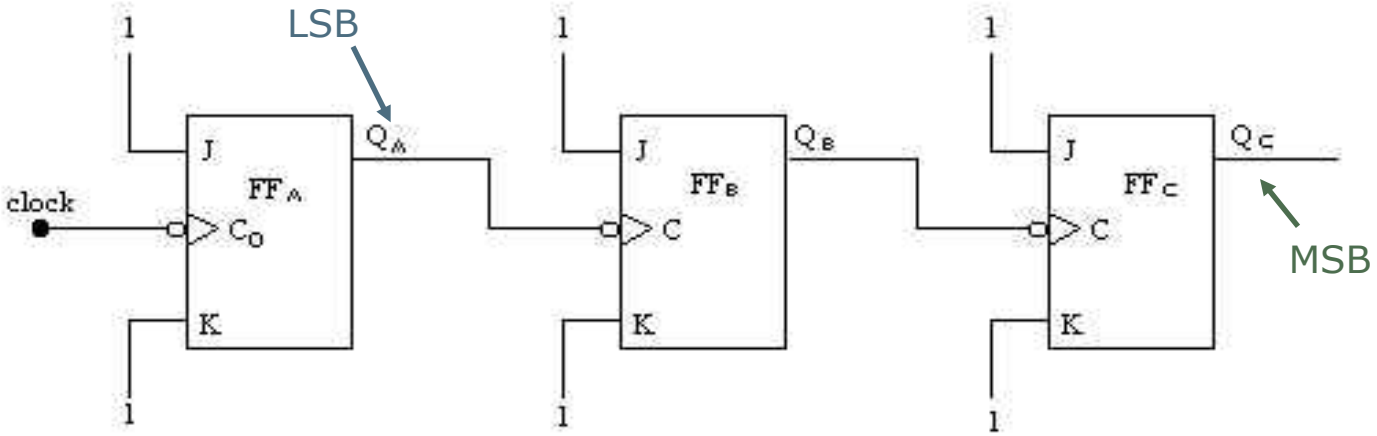




Common Misconception

Because counters are drawn left-to-right, the LSB of the binary output appears on the left, which is the opposite of what we are used to.

Exemplo1) Contador assíncrono crescente de módulo 8 (2^3): conta de 0 até 7:

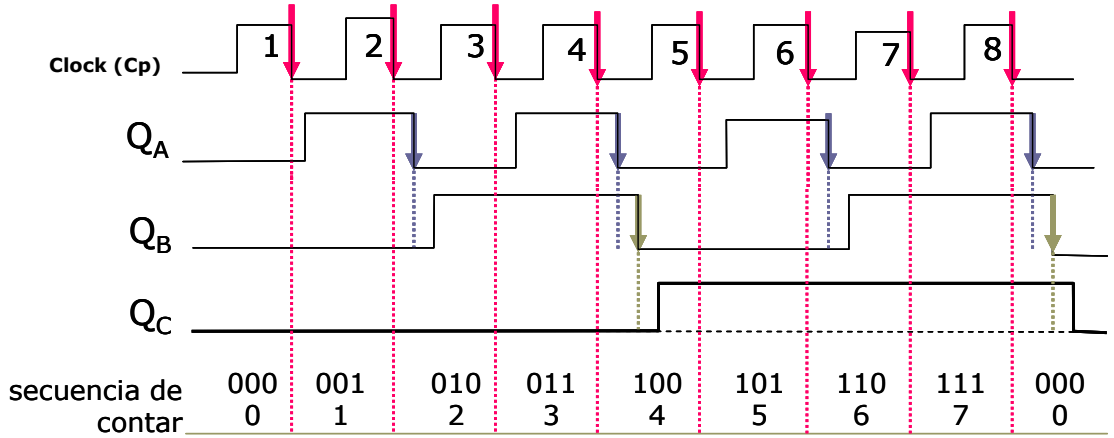


MSB LSB

Tabela de Contagem:

Pulso de Clock	Qc	Qb	Qa	Conta
(Inicialmente)	0	0	0	0
1	0	0	1	1
2	0	1	0	2
3	0	1	1	3
4	1	0	0	4
5	1	0	1	5
6	1	1	0	6
7	1	1	1	7
8	0	0	0	0
9	0	0	1	1
:	:	:	:	:

Recicla (*recycle*)



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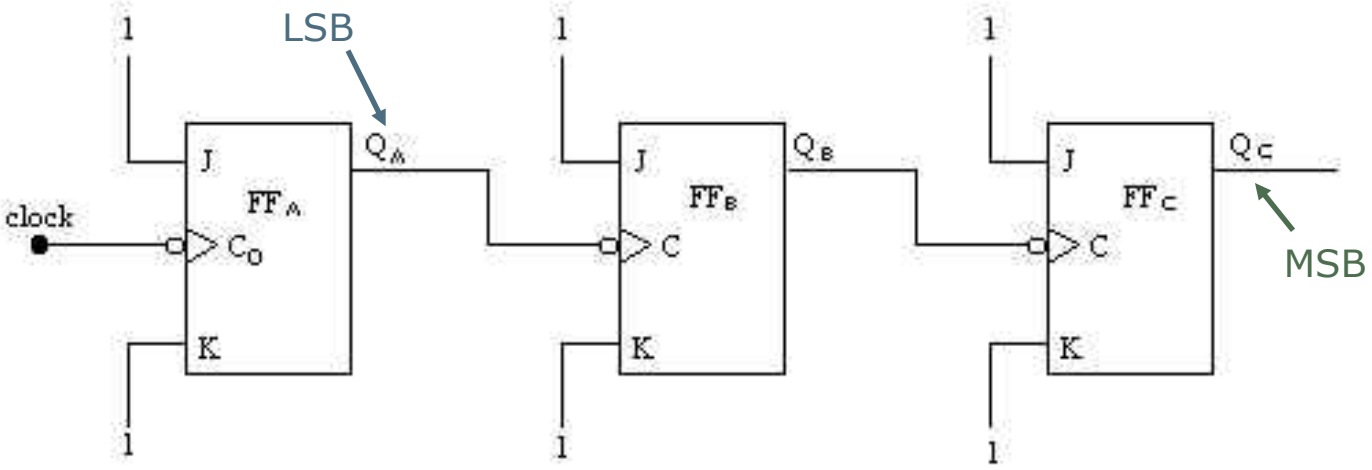

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Tabela de Contagem:

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(Inicialmente)	0	0	0	0
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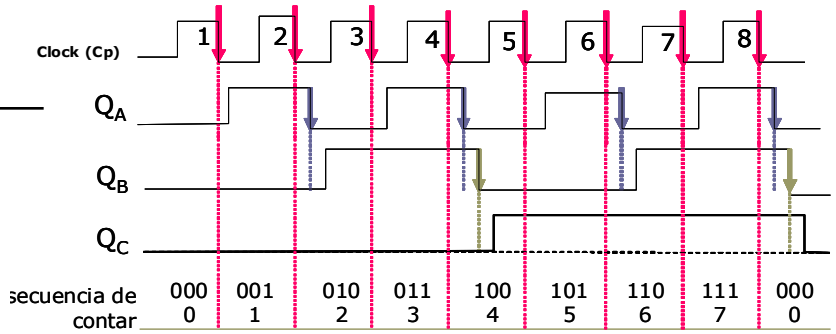
4	1	0	0	4
5	1	0	1	5
6	1	1	0	6
7	1	1	1	7
8	0	0	0	0
9	0	0	1	1
:	:	:	:	:

Recicla (*recycle*)



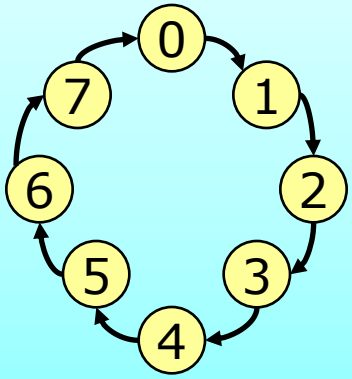
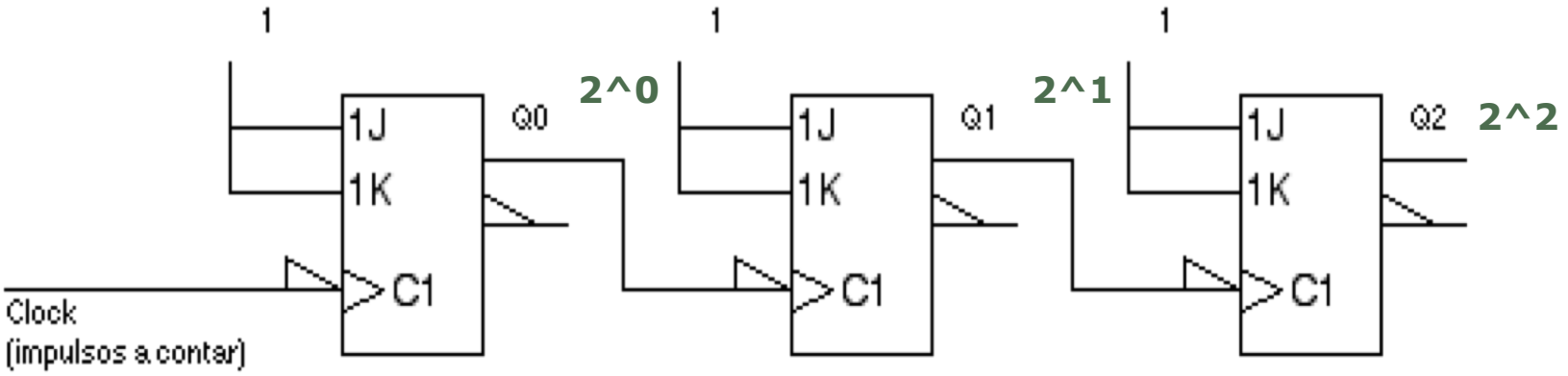
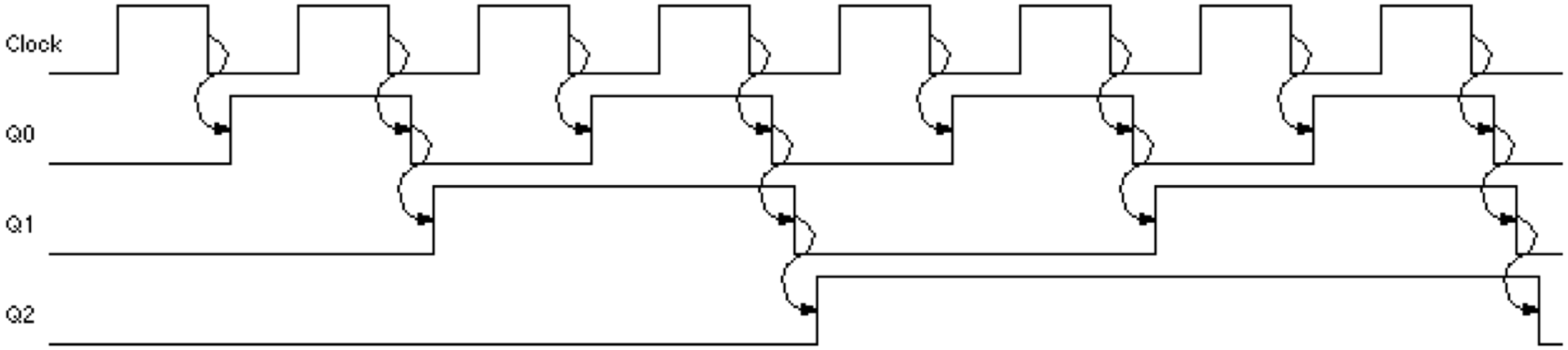


Diagrama de estados

Exemplo1) Contador assíncrono crescente de módulo 8 (2^3): conta de 0 até 7:

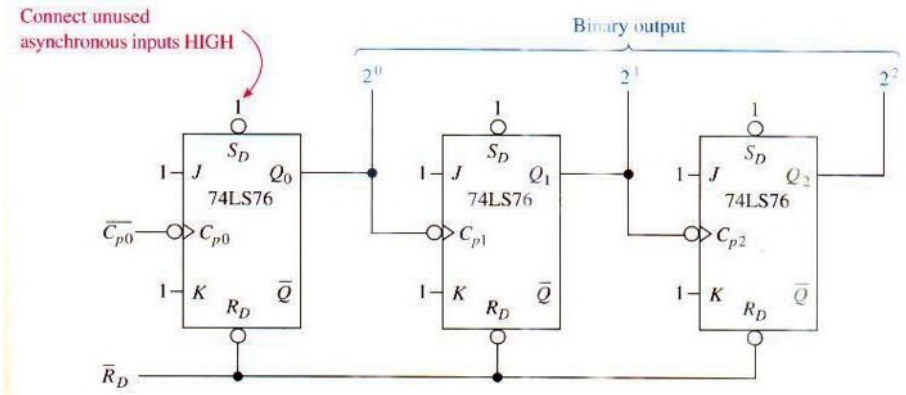


Outra forma de considerar o atraso de propagação dos FFs:



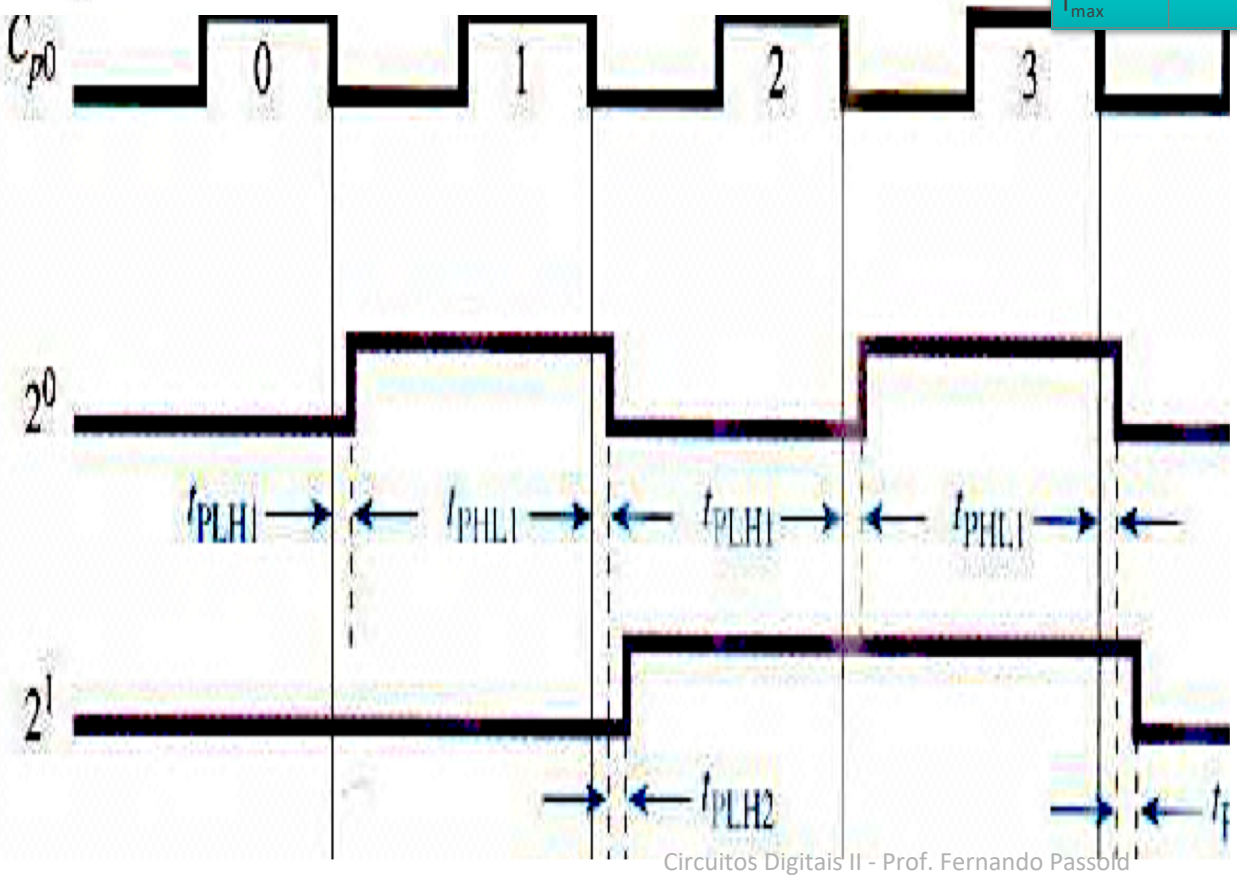
Este símbolo indica que a transição é uma consequencia da anterior.

"Ripple Counter" Effects
(Efeitos do Contador Assíncrono):



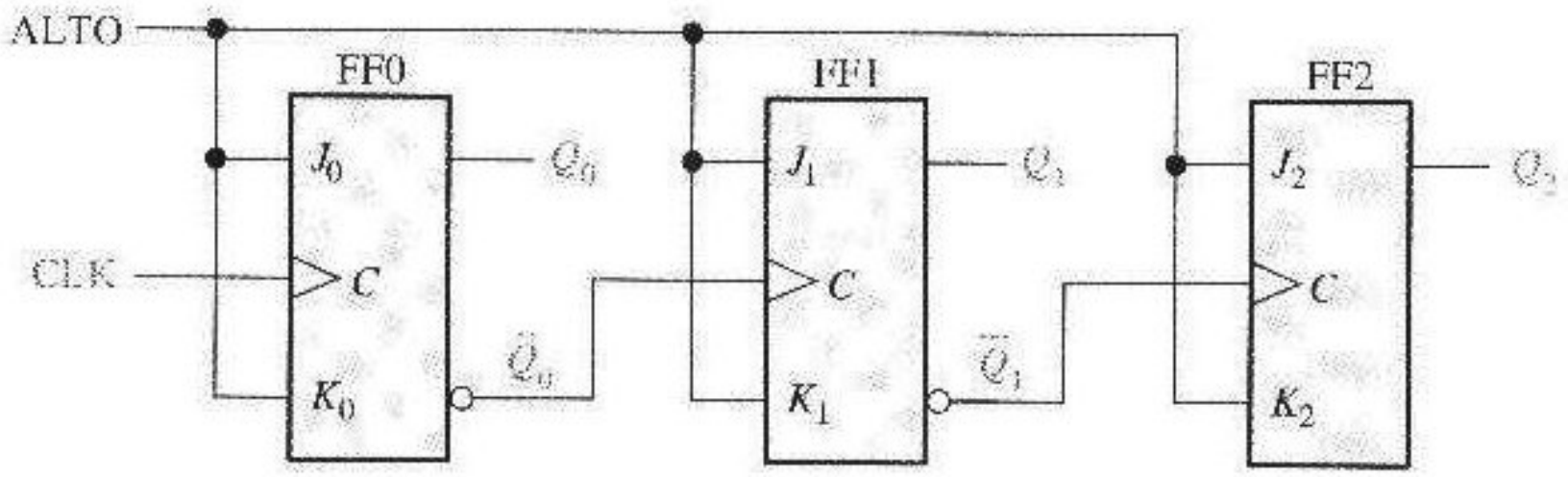
Exemplo para um circuito real:
Dados: p/ 74LS76

		Typ	Max	Min	Unit
t_{PLH} t_{PHL}	Clock, Clear, Set to Output	15	20		ns
t_s	Setup Time			20	ns
t_h	Hold Time			0	ns
f_{max}			45	30	MHz

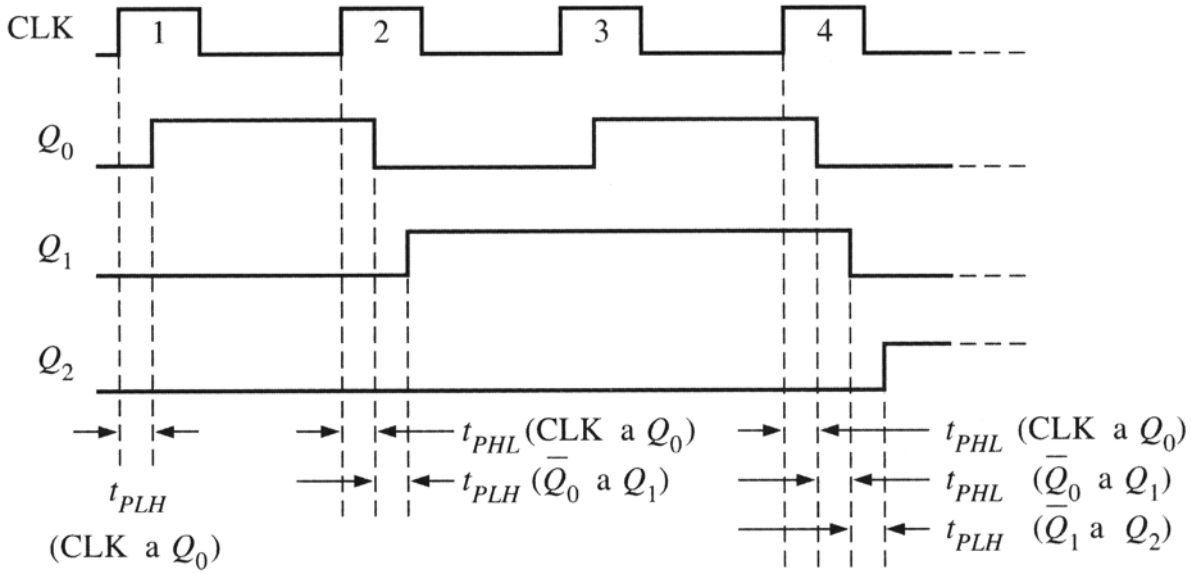


Detalhes:
Influência
Atrasos de
Propagação
(↘ Freq)

Exemplo 2) Outro contador asíncrono:



Atenção: notar que os FF's são ativados por borda de subida do sinal de *clock*.



$f_{MÁX}$ = ?

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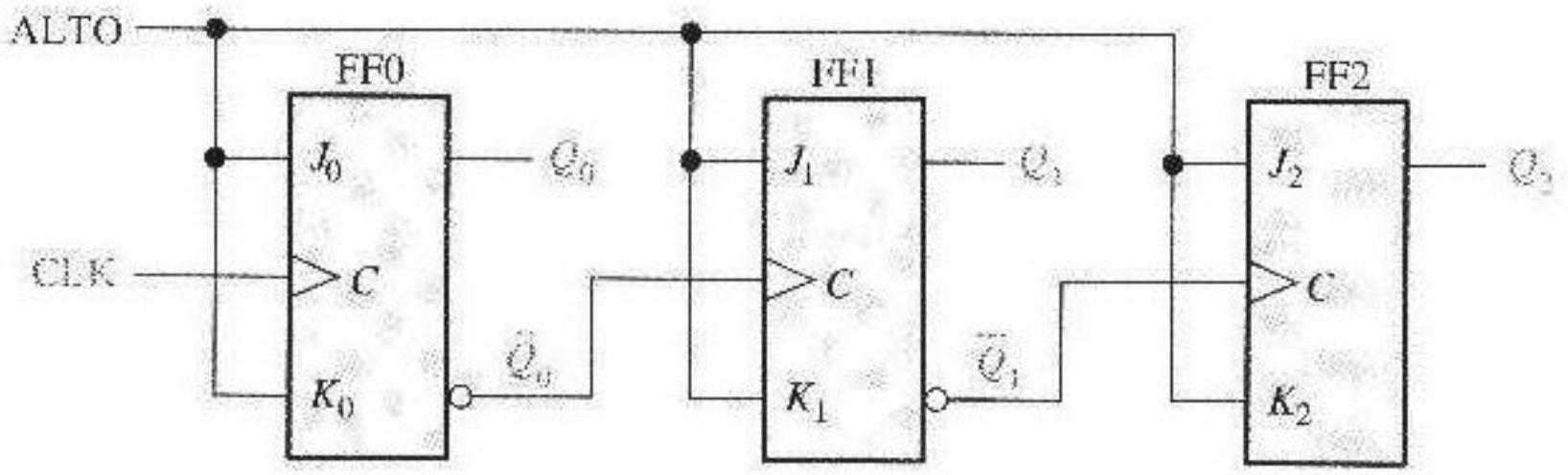

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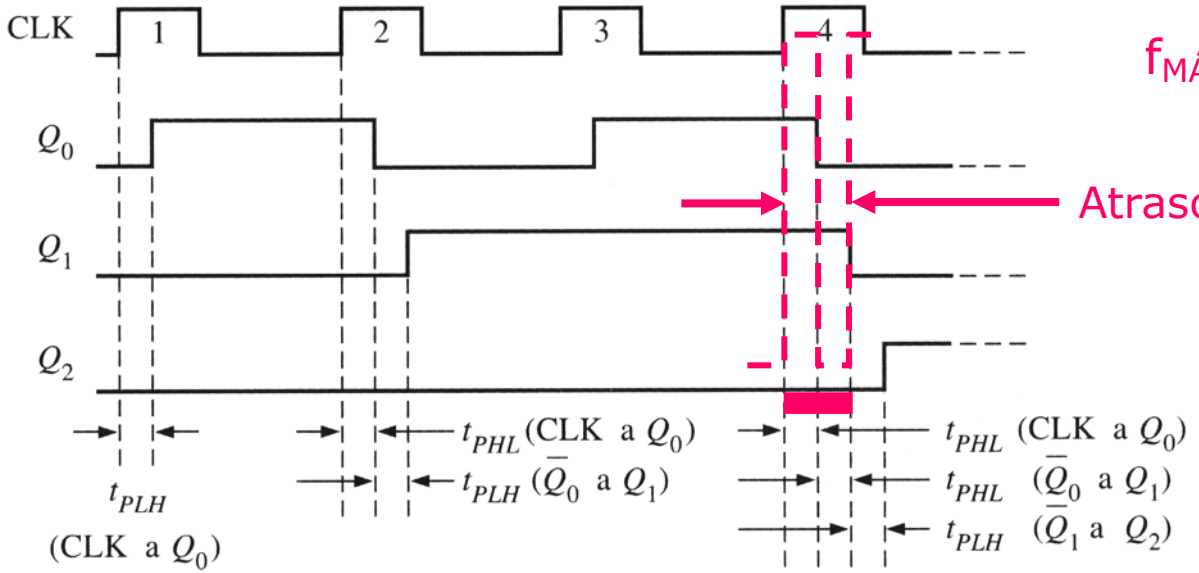


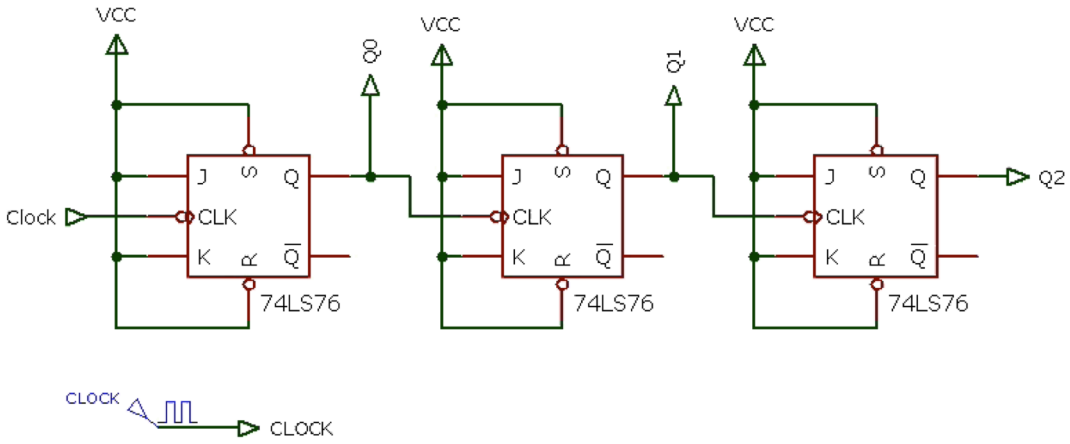
$f_{MÁX}$ = ?

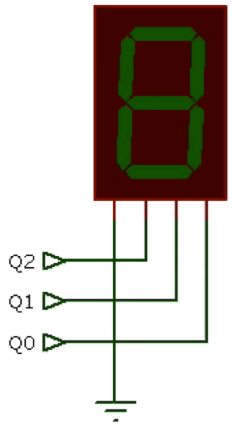
Atraso total = 2 x t_P

$$f_{MAX} = \frac{1}{2 \times t_P}$$

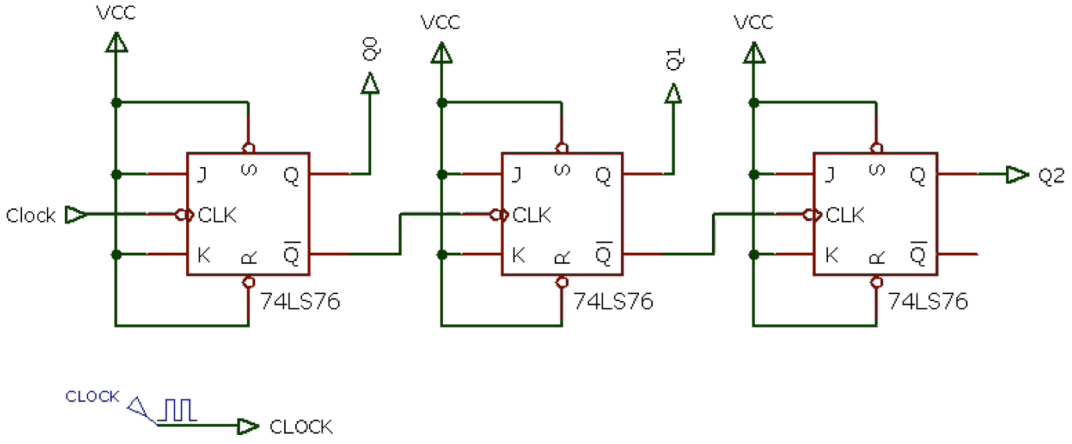
Exemplo Contadores Assíncronos:

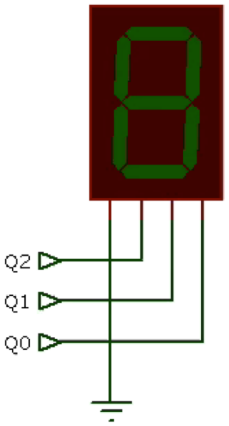
Crescente ☞



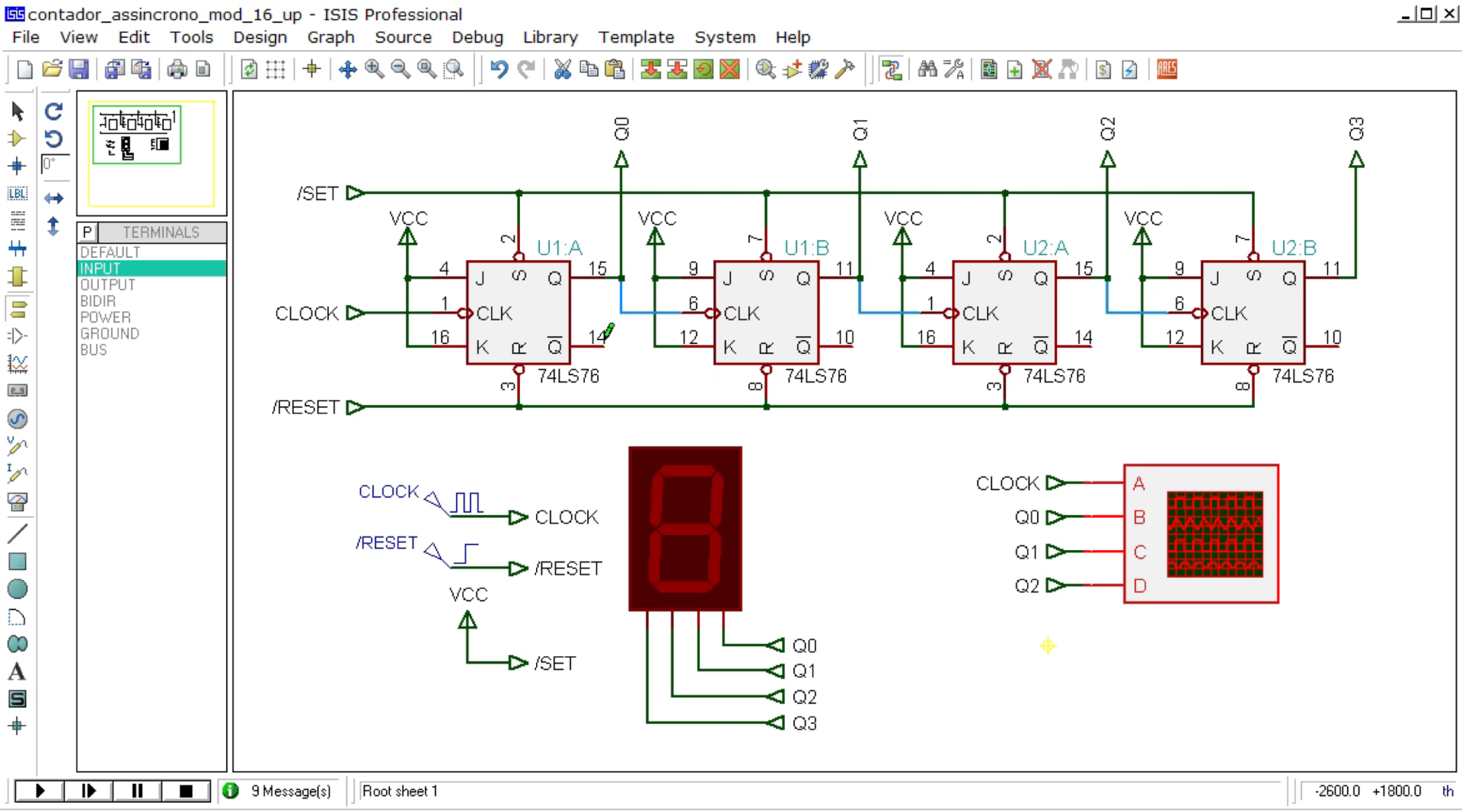


Decrescente ☞

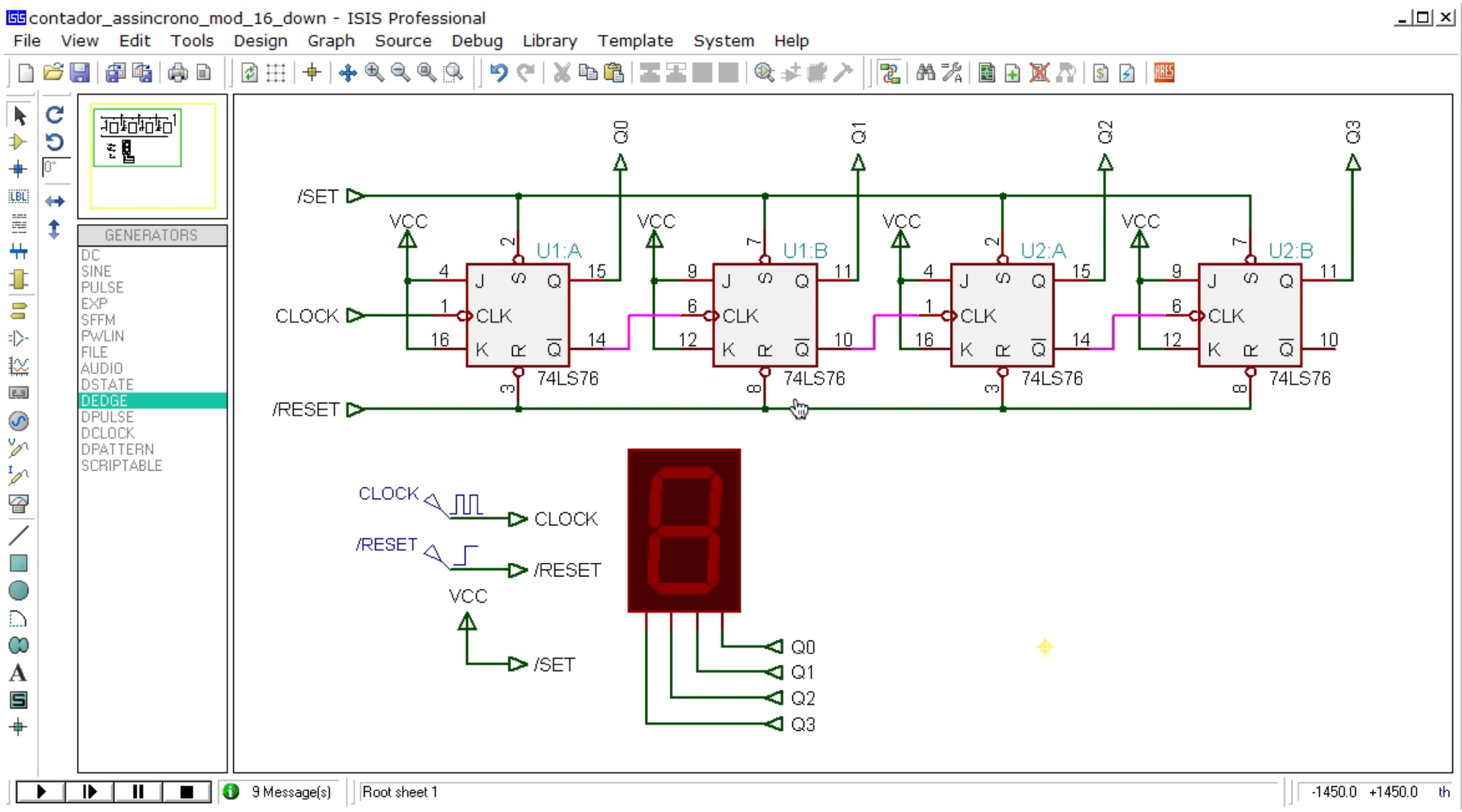




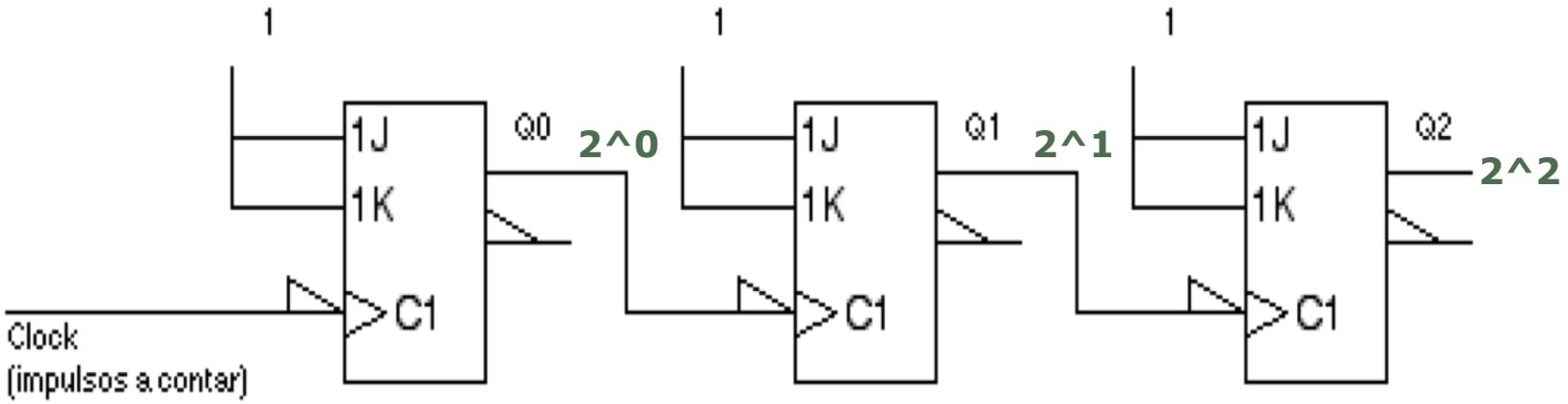
Contador assíncrono MOD-16 crescente:



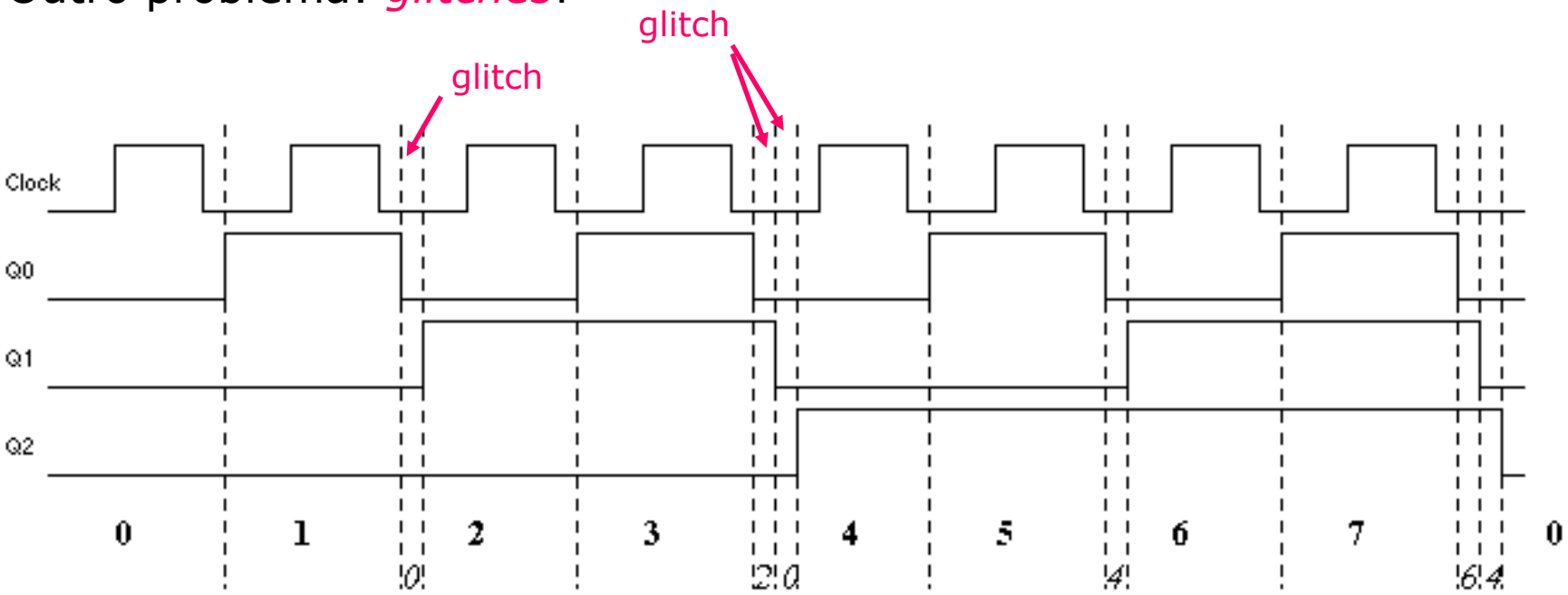
Contador assíncrono MOD-16 decrescente:



Exemplo 3) Contador asíncrono crescente de modulo 8 (2^3): conta de 0 até 7:



Outro problema: *glitches*!



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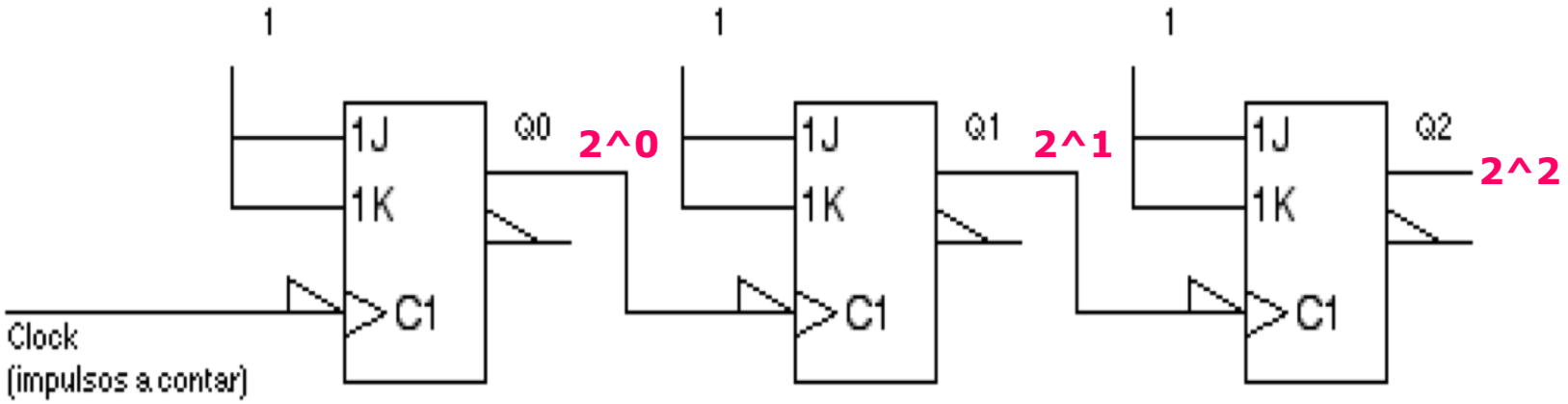


Outro problema: *glitches*!

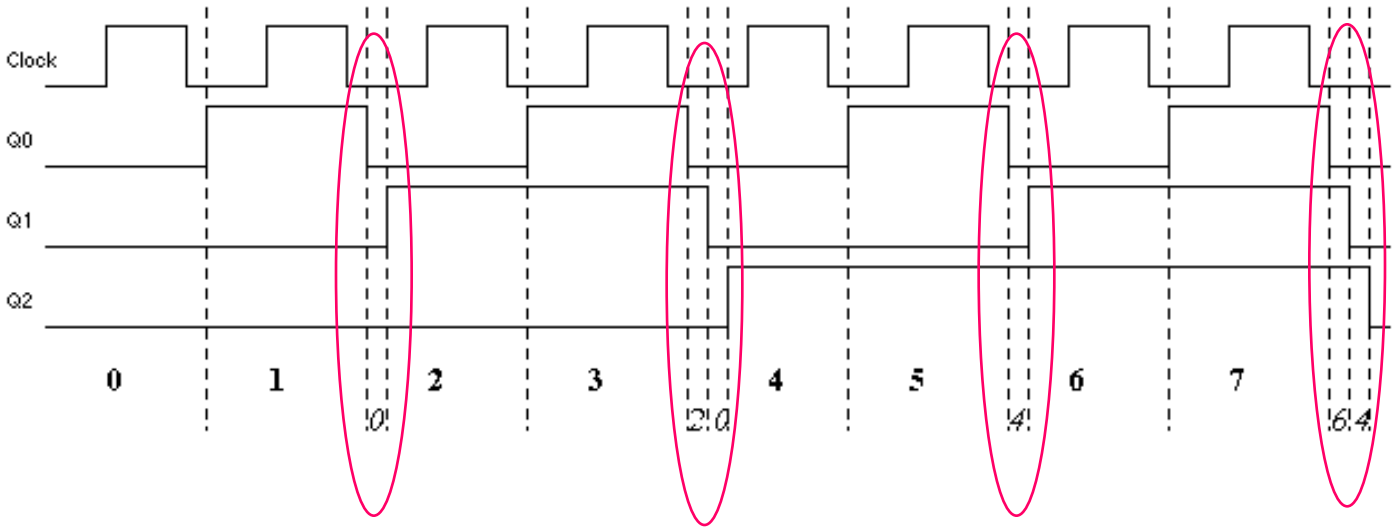


Tabela de Contagem:

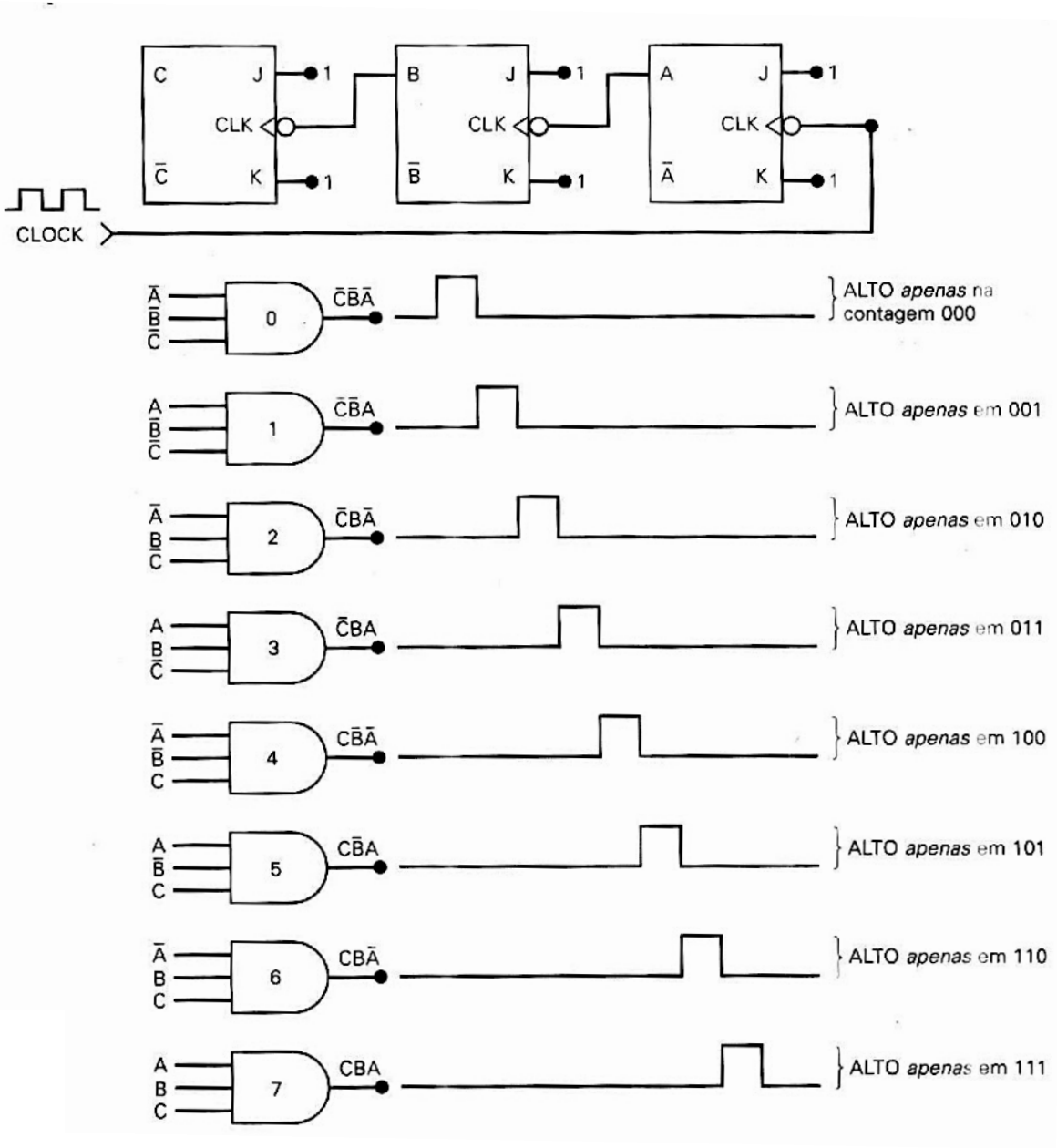
Clock	Qc	Qb	Qa	Contagem
0	0	0	0	0
1	0	0	1	1
2	**0**	**0**	**0**	**0**
2	0	1	0	2
3	0	1	1	3
4	0	1	0	2
4	**0**	**0**	**0**	**0**
4	**1**	**0**	**0**	**4**
5	1	0	1	5
6	**1**	**0**	**0**	**4**
6	1	1	0	6
7	1	1	1	7
8	0	0	0	0
9	0	0	1	1
:	:	:	:	:

Glitches: Estados de contagem transitórios.

Inconvenientes (desvantagens) de um circuito contador assíncrono:

Suponha que a saída deste contador seja decodificada.

Haverá problemas....



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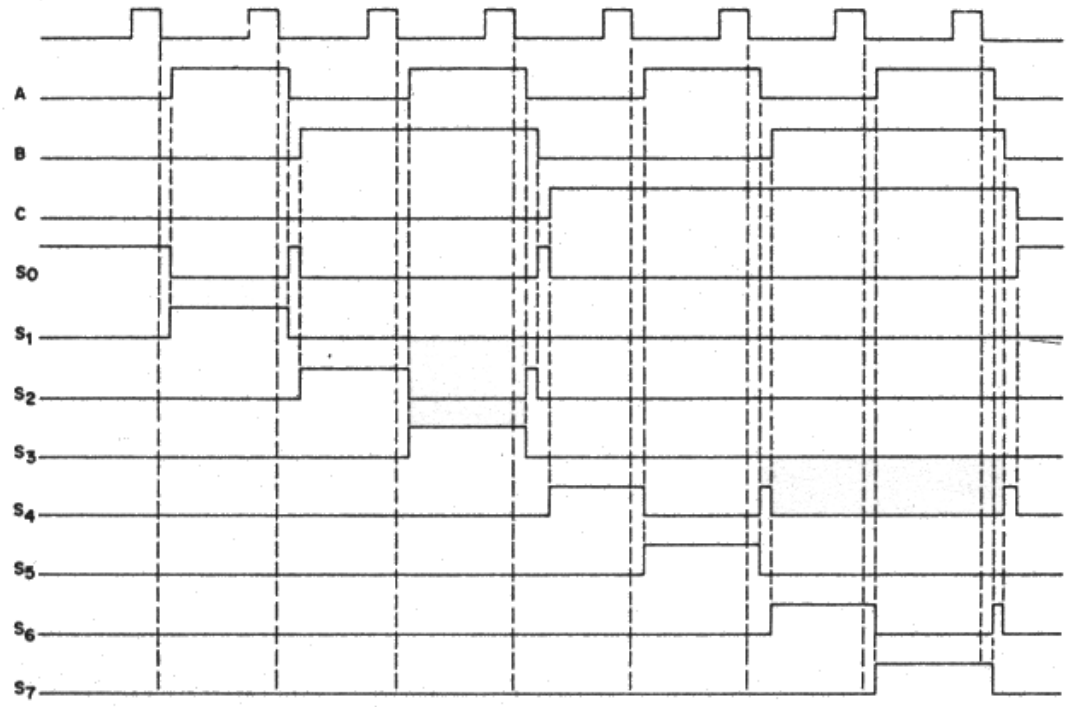
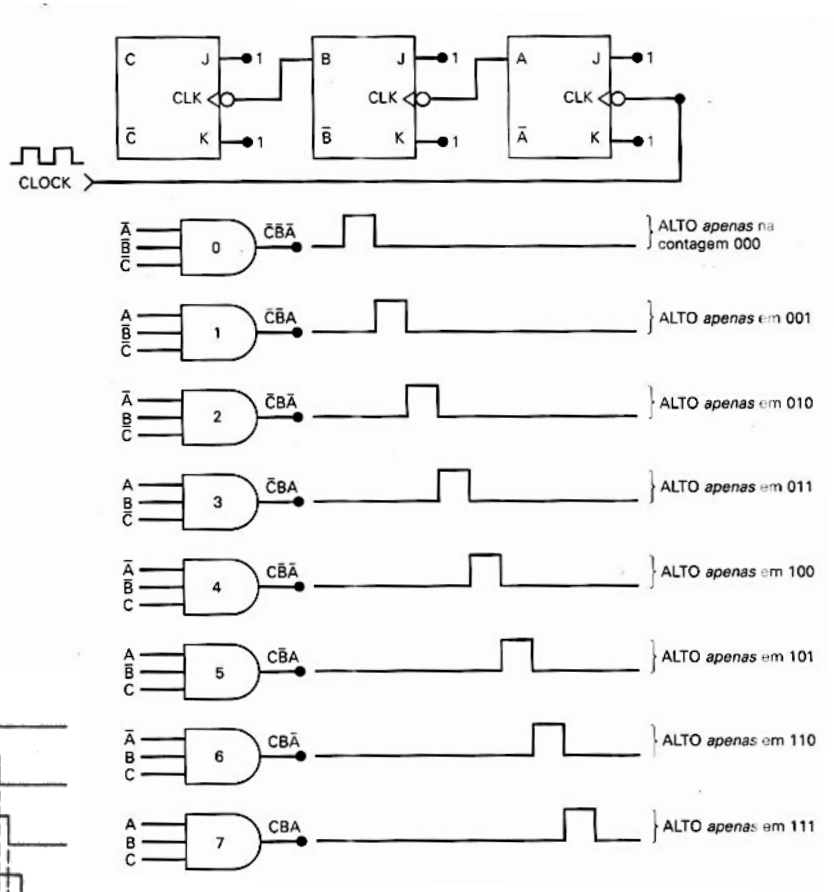
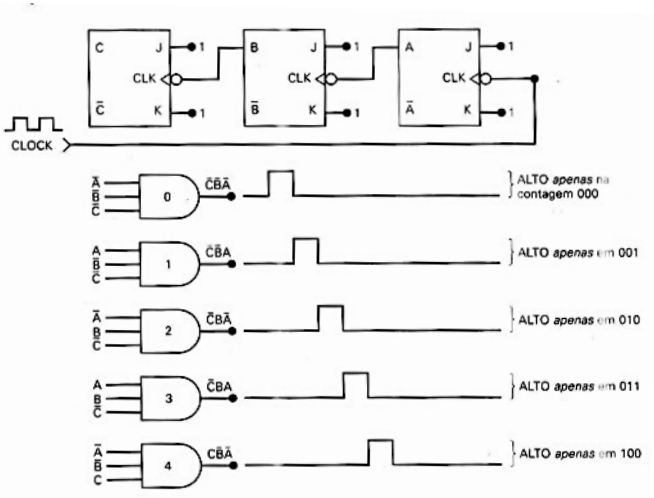




Inconvenientes (desvantagens) de um circuito contador assíncrono:

Tabela de Contagem:

Clock	Qc	Qb	Qa	Contagem
0	0	0	0	0
1	0	0	1	1
2	**0**	**0**	**0**	**0**
2	0	1	0	2
3	0	1	1	3
4	0	1	0	2
4	**0**	**0**	**0**	**0**
4	**1**	**0**	**0**	**4**
5	1	0	1	5
6	**1**	**0**	**0**	**4**
6	1	1	0	6
7	1	1	1	7
8	0	0	0	0
9	0	0	1	1
:	:	:	:	:



Suponha que a saída deste contador seja decodificada.

Haverá problemas....

Note que este circuito gera pulsos de decodificação falsos – "***glitches***" (figura 4.20).

Solução?

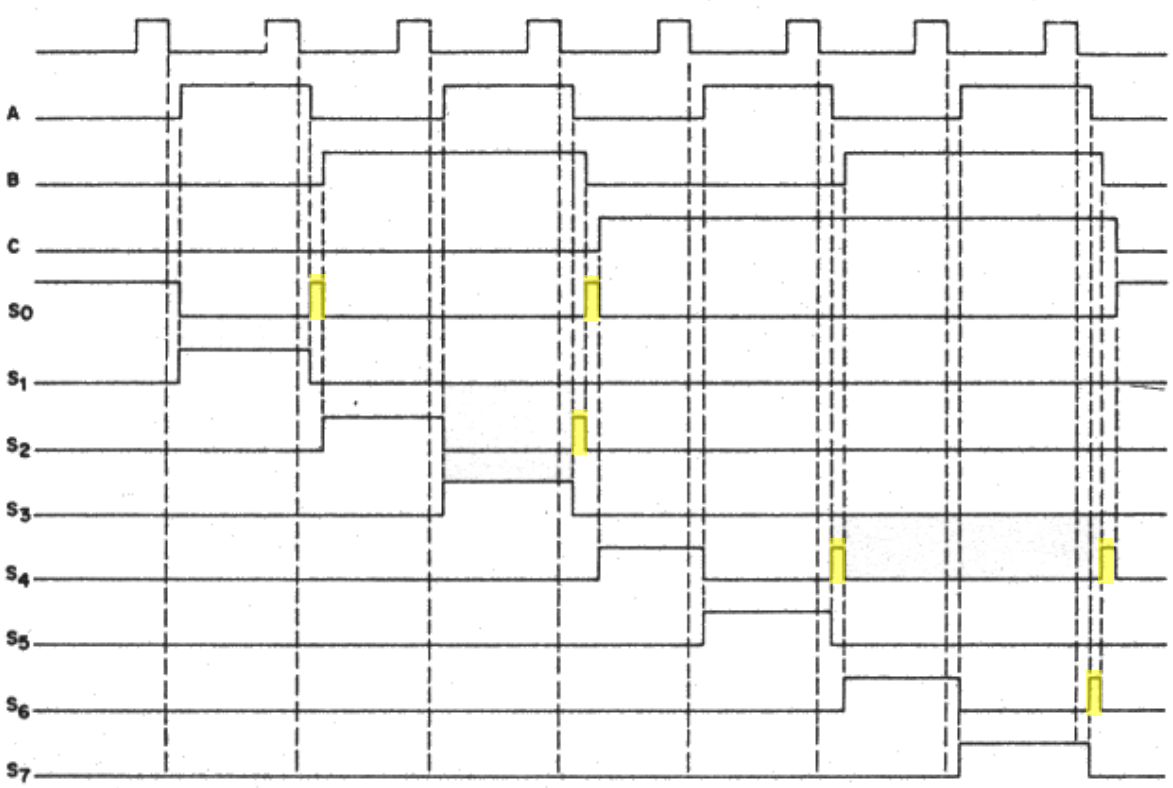


Figura 4.20

Inconvenientes (desvantagens) de um circuito contador assíncrono:

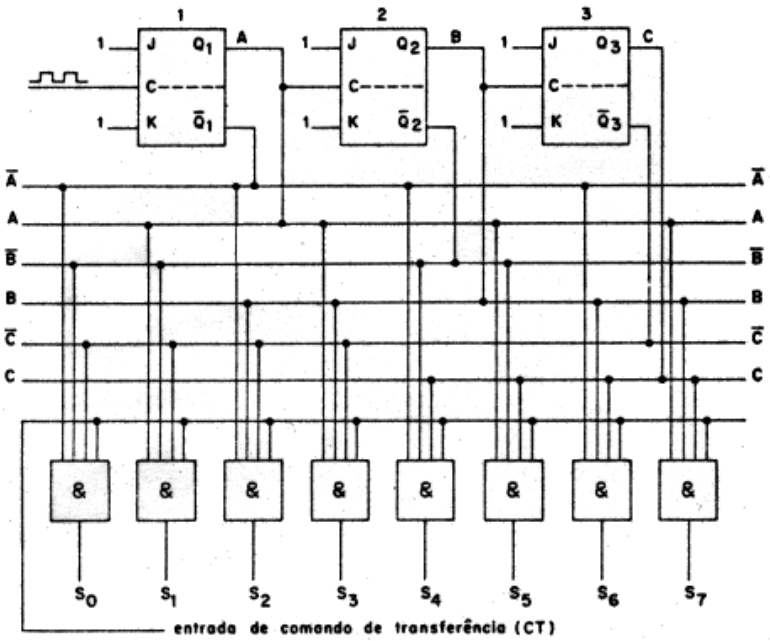
Suponha que a saída deste contador seja decodificada.

Haverá problemas....

Note que este circuito gera pulsos de decodificação falsos – "***glitches***" (figura 4.20).

Solução:

Agregar o sinal "CT" (Comando de Transferência), possivelmente em sincronismo com sinal de clock..



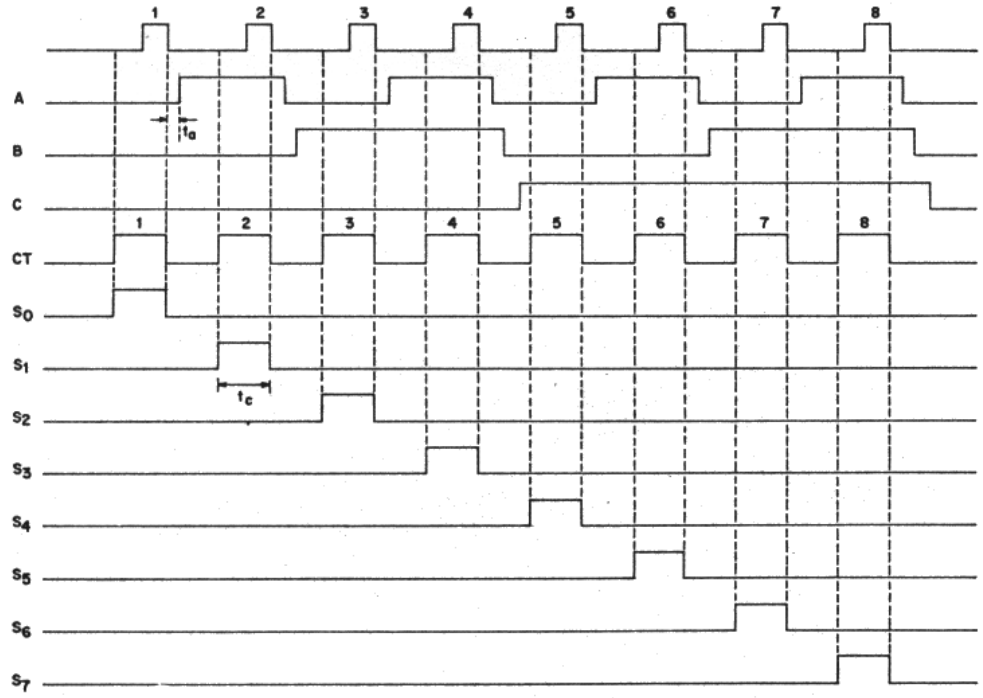
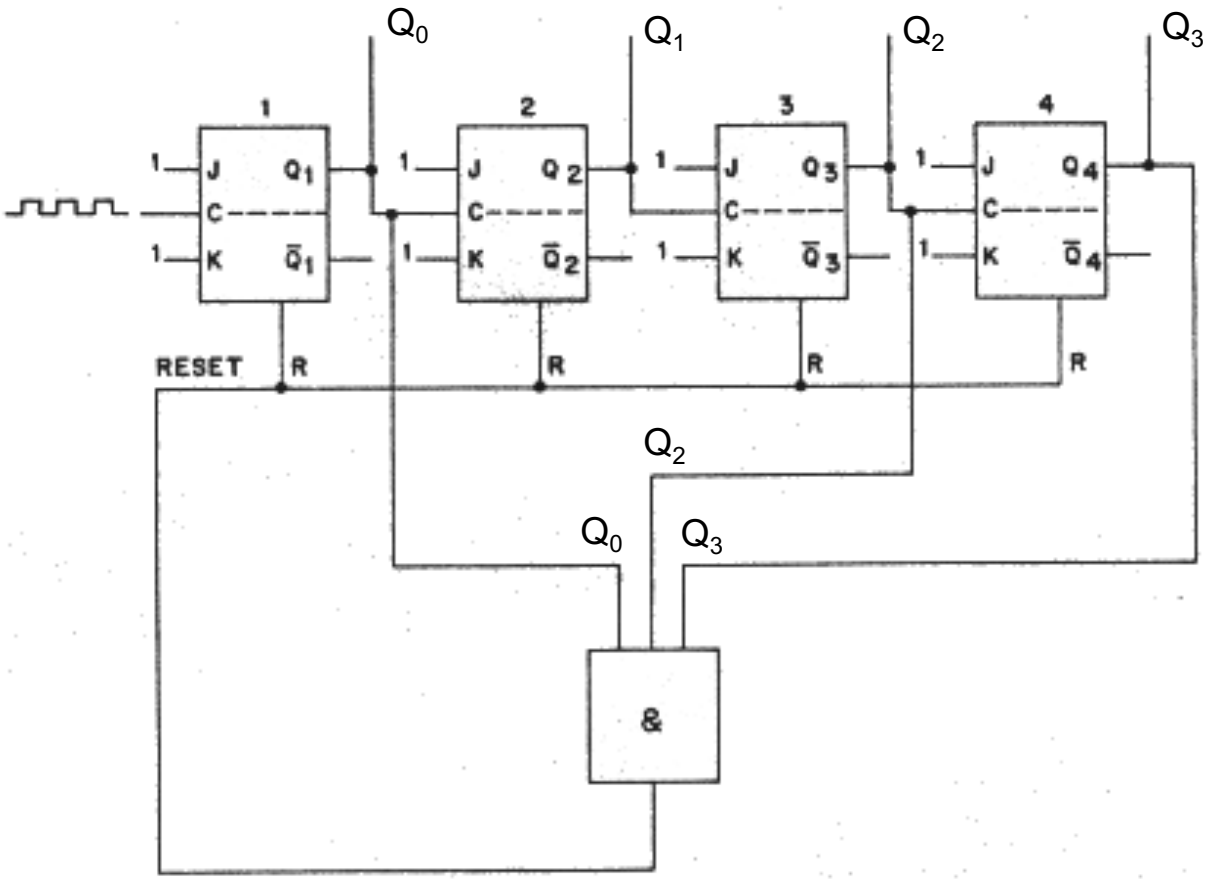


Figura 4.21

Exemplo:
Contador assíncrono modulo-13

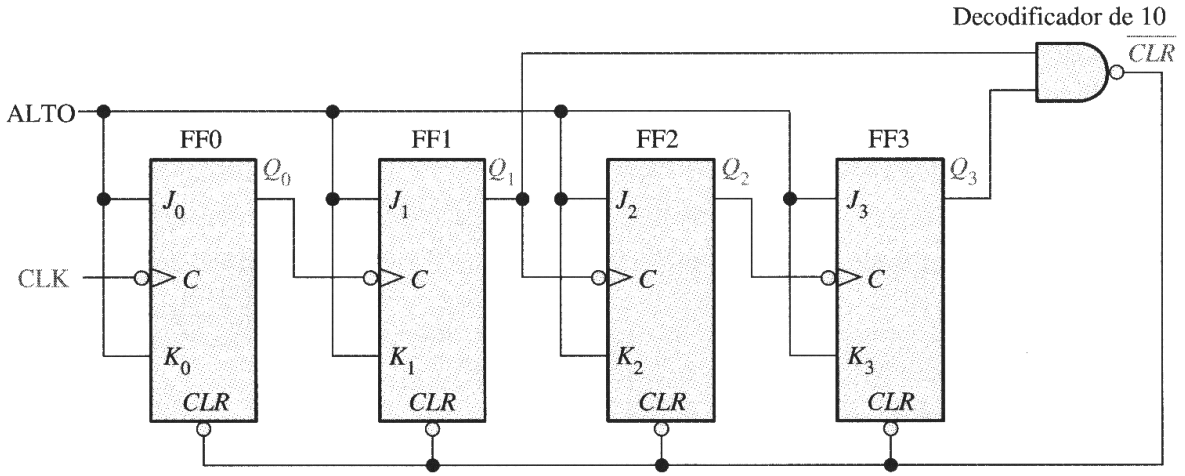


Note:

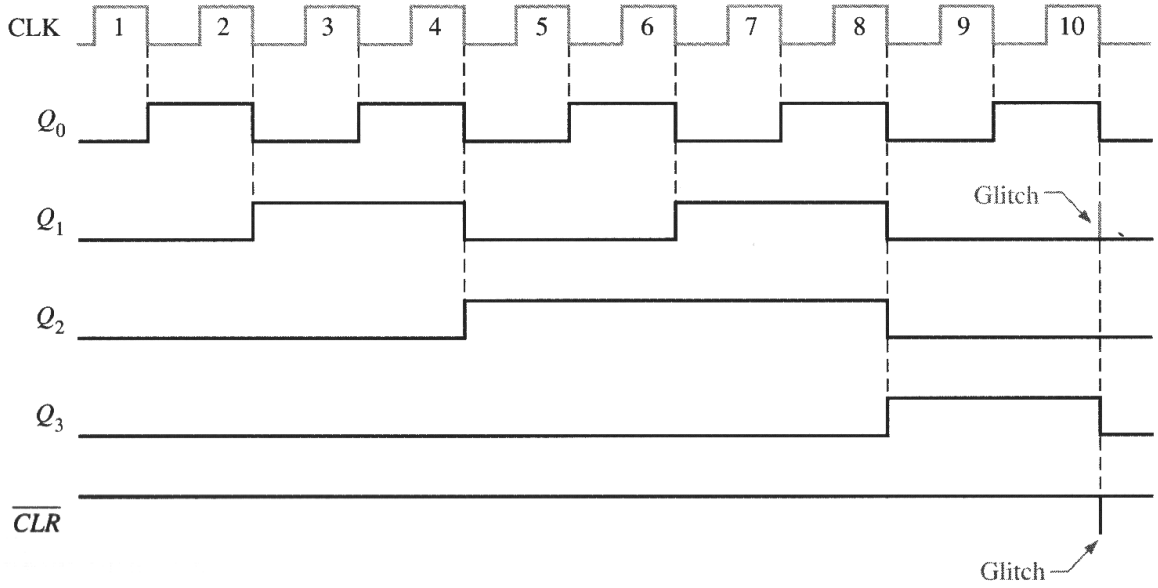
$Q_3\ Q_2\ Q_1\ Q_0$

$13_{(10)} = 1\ 1\ 0\ 1_{(2)}$

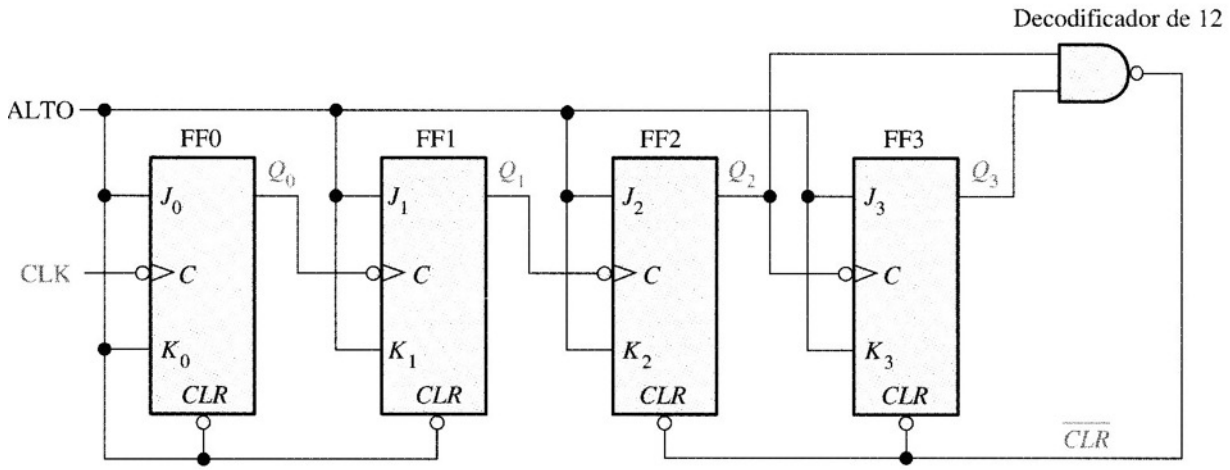
Exemplo 4) contador assíncrono módulo 10:



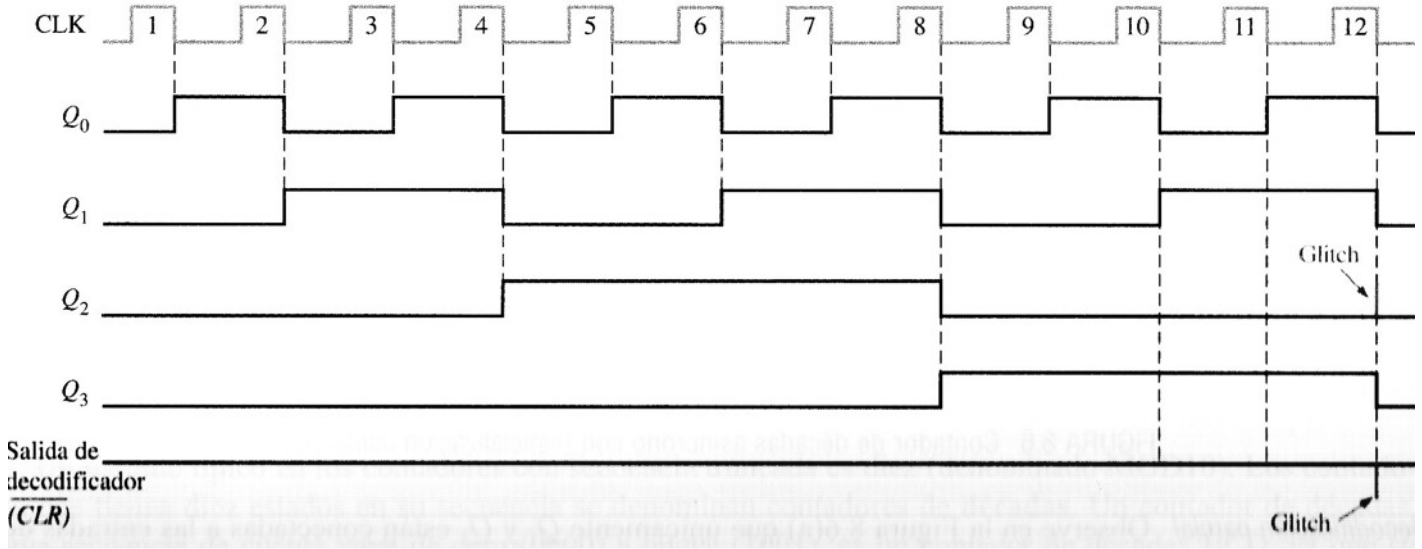
Note:
$10_{(10)} = 1010_{(2)}$



Exemplo 5) Contador assíncrono modulo 12:

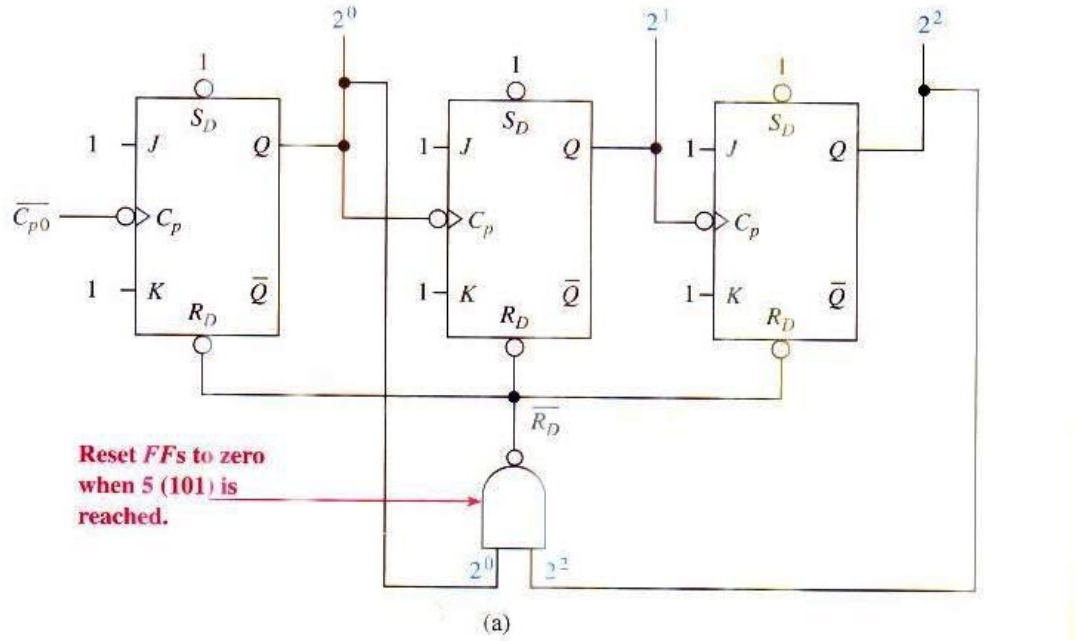


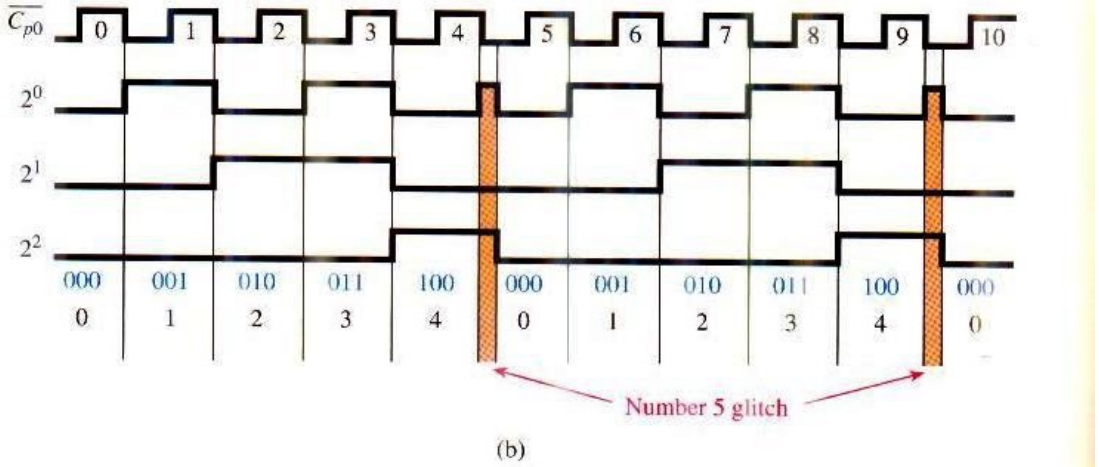
a)



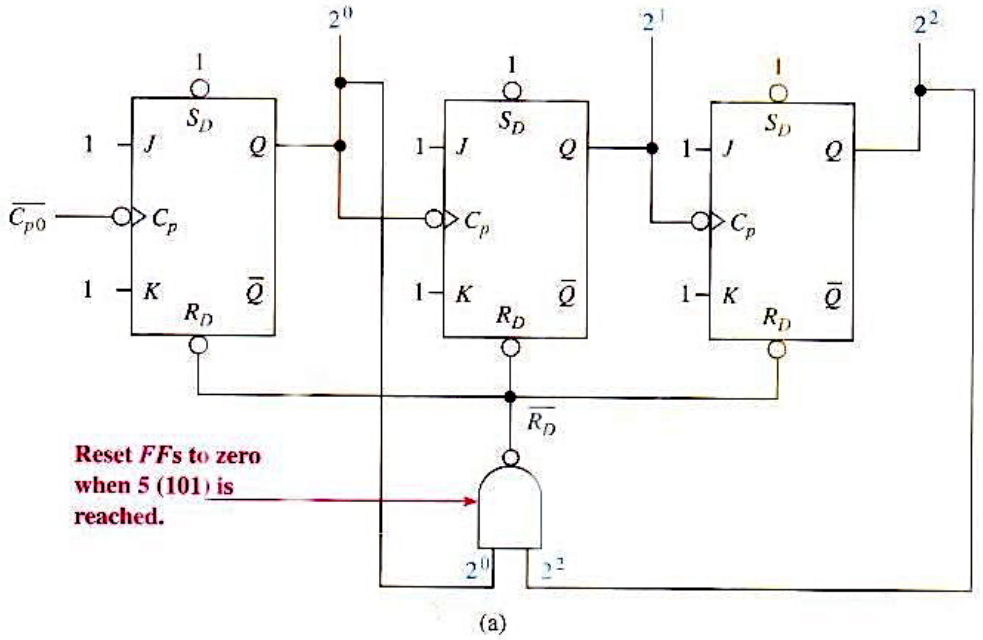
Note:
$12_{(10)} = 1100_{(2)}$

Exemplo 6: Contador Assíncrono de módulo-5

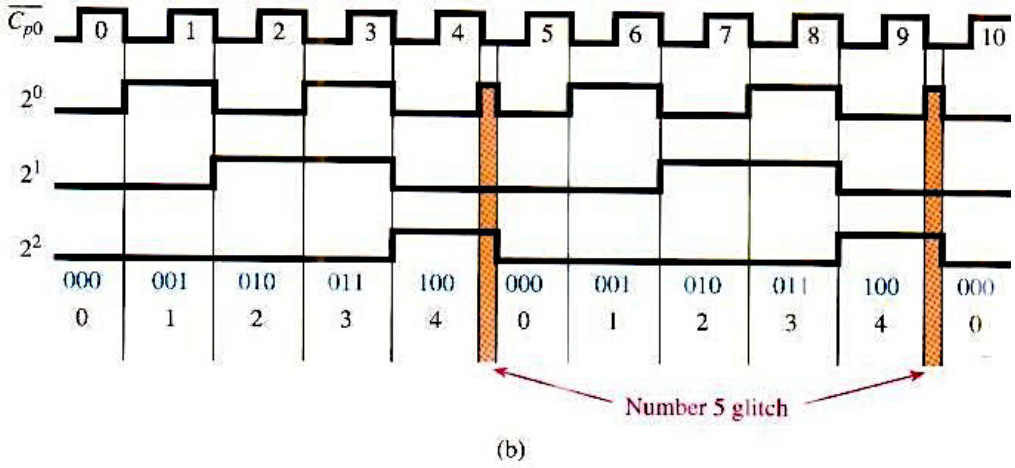




Exemplo 6: Contador Assíncrono de módulo-5

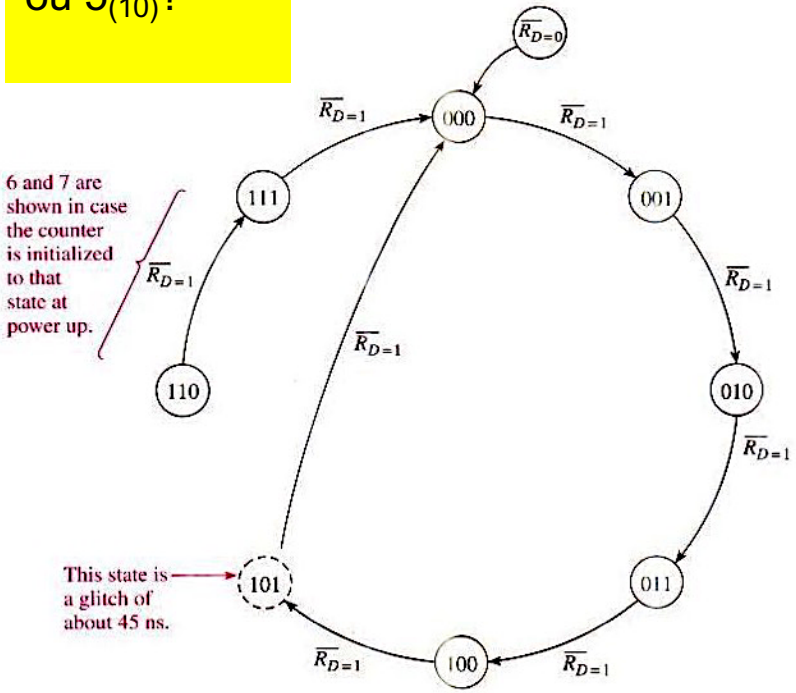


(a)



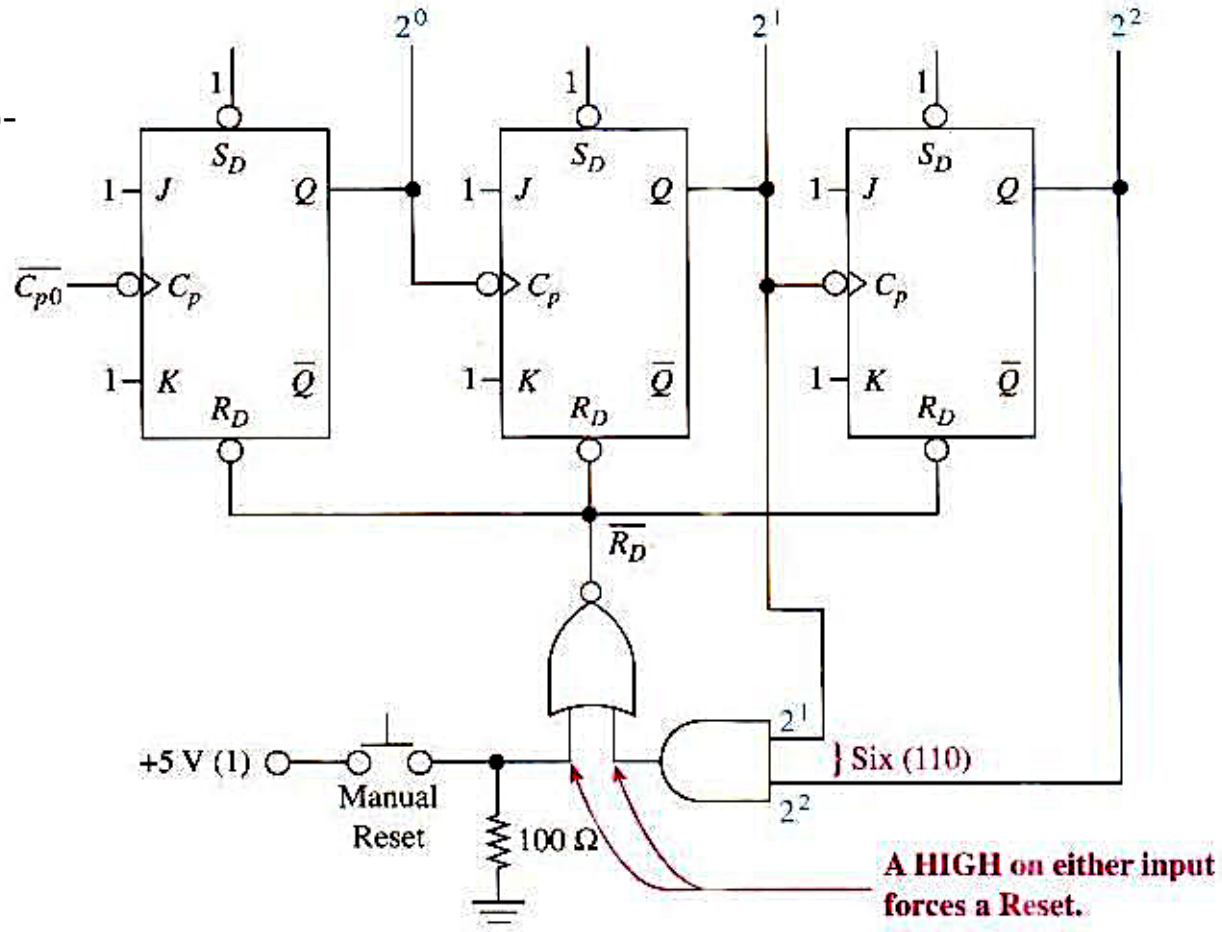
(b)

E se circuito iniciar nos estados $6_{(10)}$ ou $5_{(10)}$?



Exemplo 7:

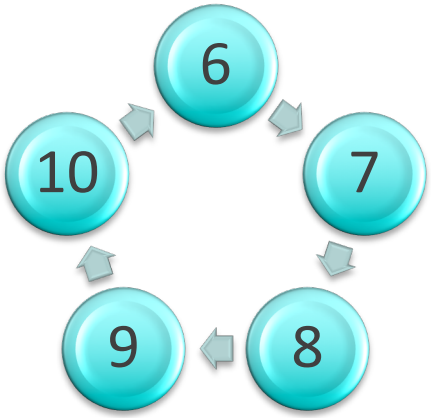
Contador assíncrono módulo-6 crescente resetável manualmente via botão externo.

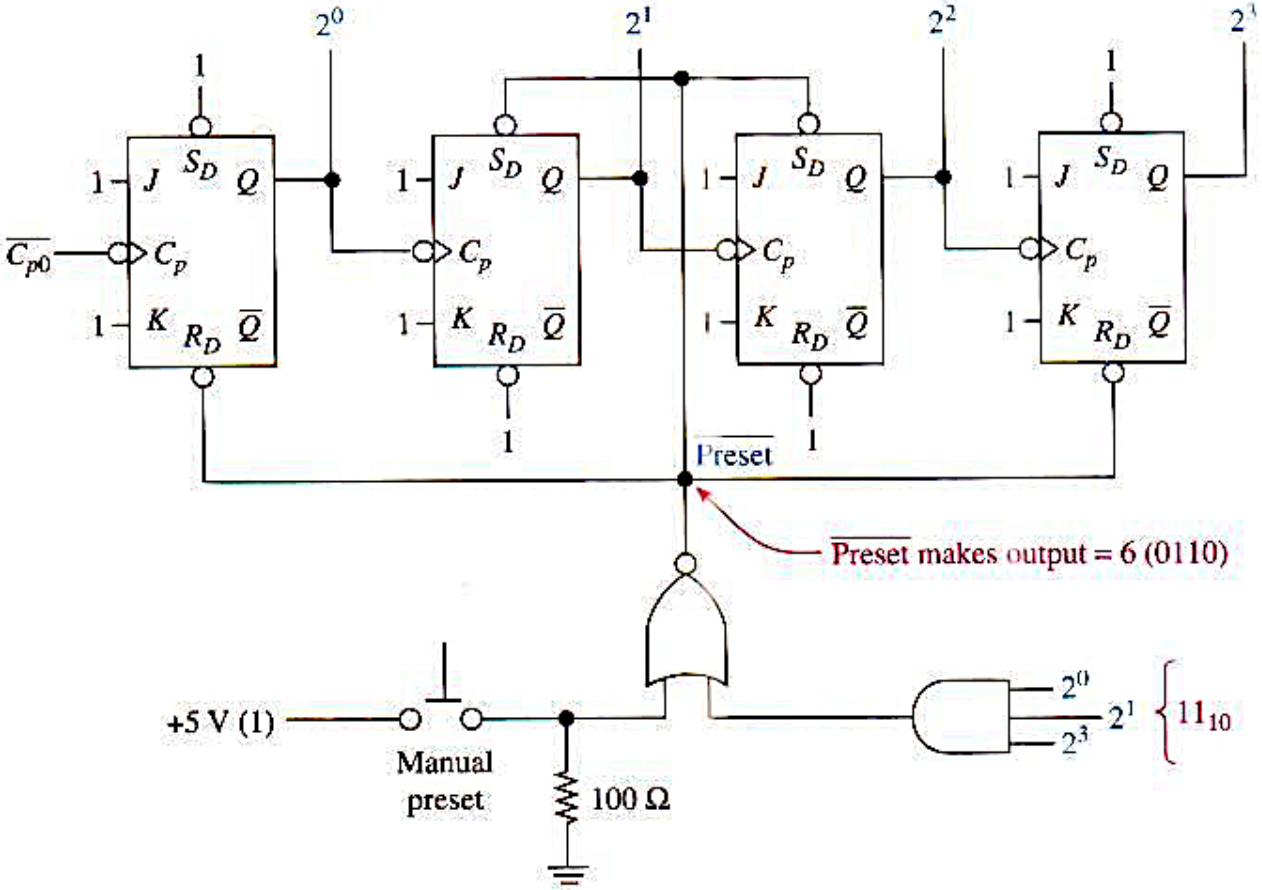


Questões extras:
- Por que o valor do resistor de "pull-down" é baixo?
- O que aconteceria se fosse usado um resistor de 10 KΩ?

Exemplo 8:

Contador crescente de módulo-5 que conta na sequência:





- O que acontece se os FFs iniciarem resetados?

Problema:

Projetar um contador que conte: 0-1-2-3-4-5 e que então se detenha e ative um Led.

Obs.: O processo só deve ser iniciando apertando-se um botão de “Start”.

Problema:

Projetar um contador que conte: 0-1-2-3-4-5 e que então se detenha e ative um Led.

Obs.: O processo só deve ser iniciando apertando-se um botão de “Start”.