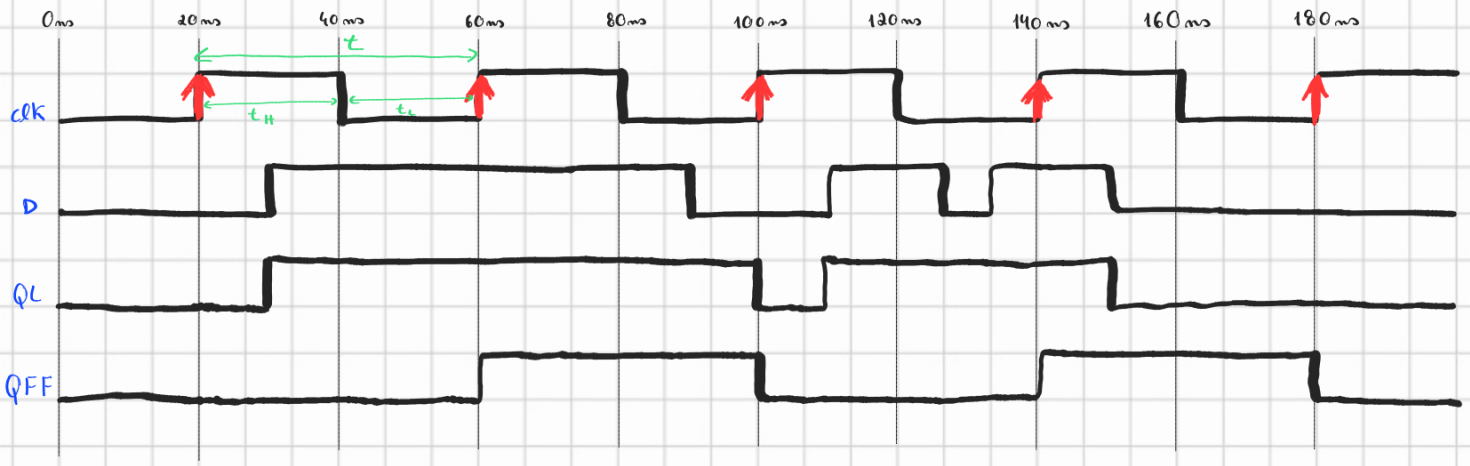
Aula 09 - 10

1



$t_p = t_H + t_L$, $t_H = t_L = 20\,ms \Rightarrow t_p = 40\,ms$

$f = \frac{1000}{40} = 25\,MHz$

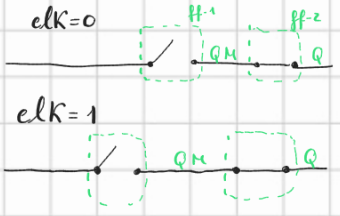
duty cycle $= \frac{t_H}{t_p} \times 100\% = \frac{20}{40} \times 100\% = 50\%$

2

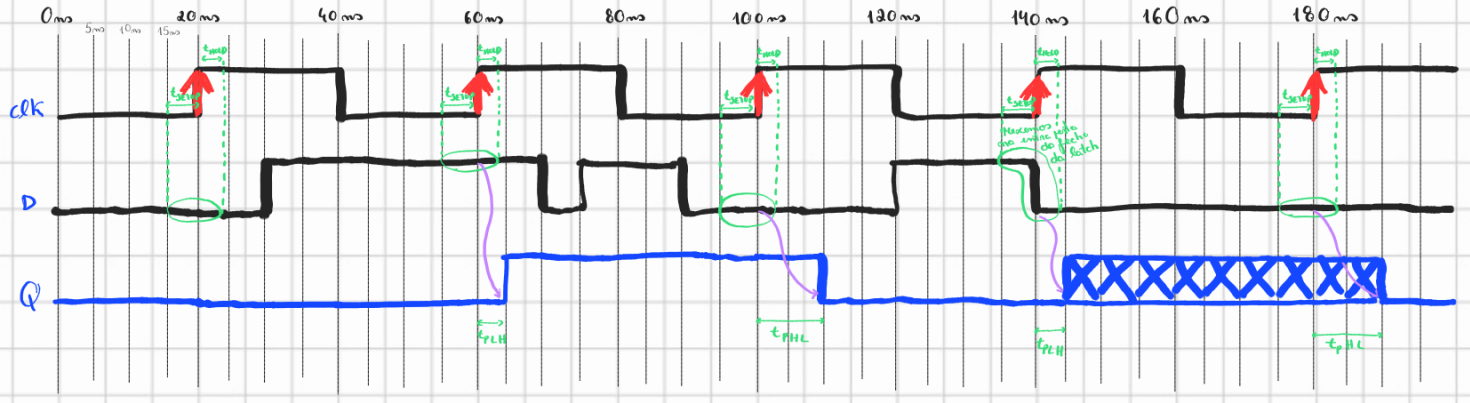
a) Negative - edge - triggered

b) Positive - edge - triggered

c) D Latch



3



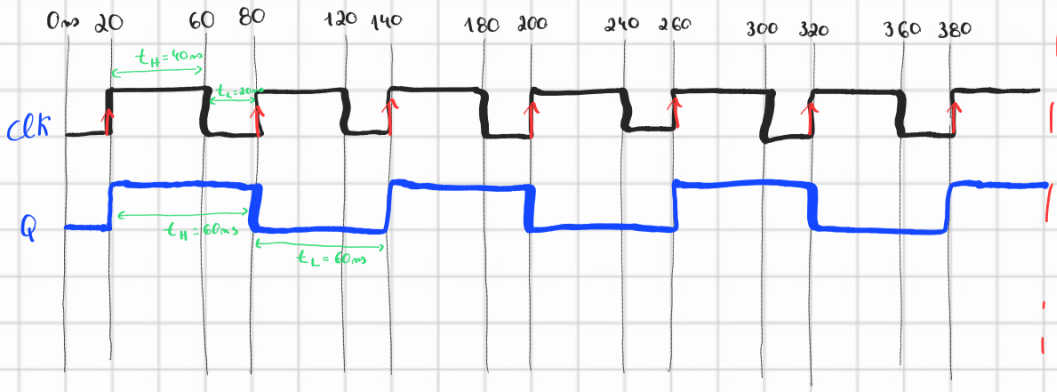
$t_{setup} = 5\,ms$

$t_{HOLD} = 3\,ms$

$t_{PHL} = 10\,ms$

$t_{PLH} = 5\,ms$

4



Sinais periódicos

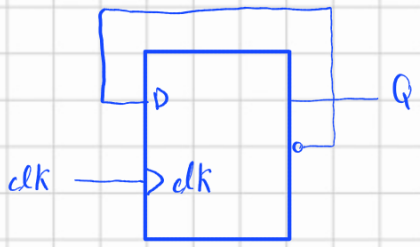
T → período

$f = \frac{1}{T}$

$T = 1\,ns \Rightarrow f = \frac{1}{1\times10^{-9}} = 1\times10^{9} = 1\,GHz$

$T = 1\,\mu s \Rightarrow f = \frac{1}{1\times10^{-6}} = 1\times10^{6} = 1\,MHz$

$T = 10\,ns \Rightarrow f = \frac{1}{10\times10^{-9}} = 1\times10^{8} = 100\,MHz$



O circuito é um divisor de frequências por um fator de 2 ⇒ o período é o dobro do clk ($Q^t = \bar{Q}$)

clk

$t_p = t_H + t_L = 60\,ms$

$f = \frac{1000}{t_p} = \frac{100\cancel{0}}{6\cancel{0}} \simeq 16{,}6\,MHz$

duty cycle $= \frac{t_H}{t_p} \times 100\% = \frac{4\cancel{0}}{6\cancel{0}} \times 100\% \simeq 66{,}6\%$

Q

$t_p = t_H + t_L = 60 + 60 = 120\,ms$

$f = \frac{1000}{t_p} = \frac{100\cancel{0}}{12\cancel{0}} \simeq 8{,}3\,MHz$

duty cycle $= \frac{t_H}{t_p} \times 100\% = \frac{6\cancel{0}}{12\cancel{0}} \times 100\% = 50\%$

$t_{SETUP} = 5\,ms$ $\quad t_{PHL} = 15\,ms$

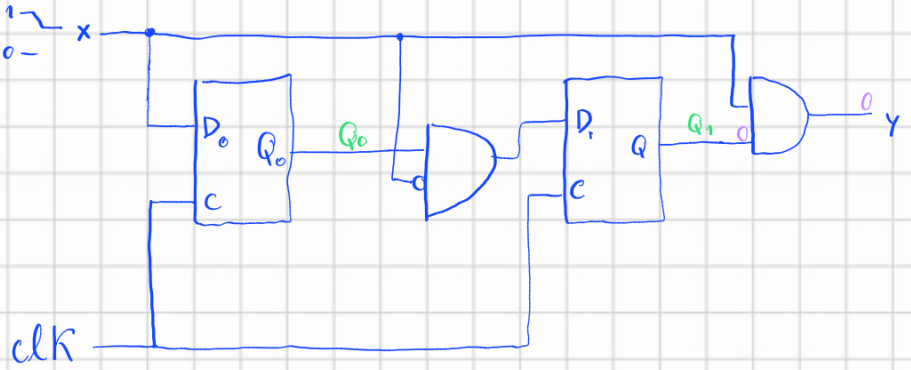
$t_{HOLD} = 3\,ms$ $\quad t_{PLH} = 10\,ms$

$t_{min} = t_{SETUP} + Max(t_{PHL}, t_{PLH})$

$= 5 + 15 = 20\,ms$

$f_{max} = \frac{1000}{t_{min}} = \frac{100\cancel{0}}{2\cancel{0}} = 50\,MHz$

5



a) Inputs: clk, X

Outputs: Y

b) $Y = x \cdot Q_1$

c) $Q_1^+ = \bar{x} \cdot Q_0$
$Q_0^+ = x$

d) Mealy

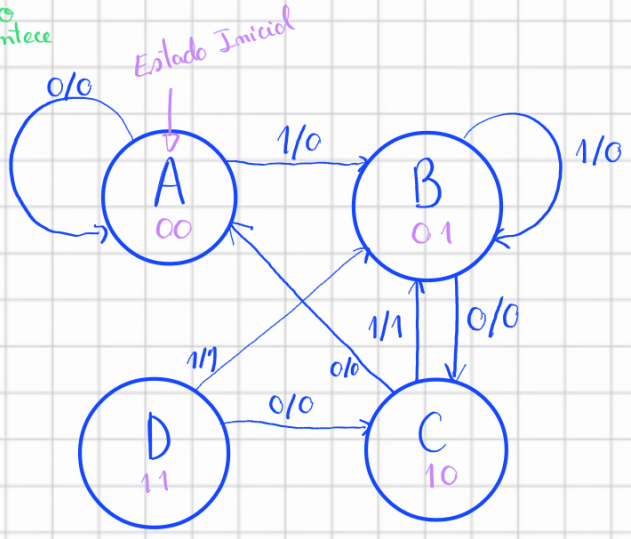
e)

	Q_1	Q_0	x	Q_1^+	Q_0	Y
A	0	0	0	0	0	0
	0	0	1	0	1	0
B	0	1	0	1	0	0
	0	1	1	0	1	0
C	1	0	0	0	0	0
	1	0	1	0	1	1
D	1	1	0	1	0	0
	1	1	1	0	1	1

Este estado nunca acontece

Q	x	Q^+	Y
A	0	A	0
A	1	B	0
B	0	C	0
B	1	B	0
C	0	A	0
C	1	B	1
D	0	C	0
D	1	B	1

f)



Legenda: x/Y

g) O circuito deteta a sequência 101 aceitando sobreposição

h)

$t_{setup} = 15ns$
$t_{Hold} = 5ns$
$t_{pHL} = 25ns$
$t_{pLH} = 20ns$

$f = 20\ MHz$

$f(MHz) = \frac{1000}{t(ns)} \Leftrightarrow t = \frac{1000}{20} ns \Leftrightarrow t = 50ns$

$t = t_{setup} + t_{HL} + t_{gate}$

$\Leftrightarrow 50 = 15 + 25 + t_{gate}$
$\Leftrightarrow t_{gate} = 10ns$

6

Conversor de binário para Gray

$Q_0^+ = X$
$Q_1^+ = Q_0$

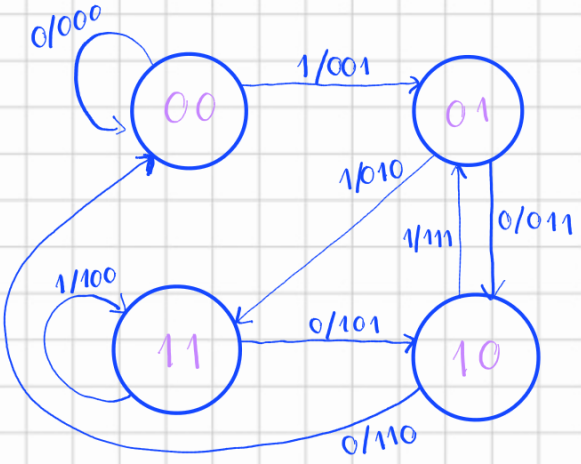
$Y_0 = X \oplus Q_0$ ⇒ Mealy machine!
$Y_1 = Q_0 \oplus Q_1$
$Y_2 = Q_1$

Q_1	Q_0	X	Q_1^+	Q_0^+	Y_2	Y_1	Y_0	
0	0	0	0	0	0	0	0	- 0
0	0	1	0	1	0	0	1	- 1
0	1	0	1	0	0	1	1	- 2
0	1	1	1	1	0	1	0	- 3
1	0	0	0	0	1	1	0	- 4
1	0	1	0	1	1	1	1	- 5
1	1	0	1	0	1	0	1	- 6
1	1	1	1	1	1	0	0	- 7

Código em binário

⇒ Gray Code

Quartus a Imprimir os resultados



Legenda: $X / Y_2 Y_1 Y_0$

→ Conversor de binário para Gray
- O "x" é a entrada
- Por exemplo:
  Estado = "10" ($Q_1 Q_0$) ⇒ Estado seguinte = "x01"
  X = "1"
  Binário = "101" ⇒ Gray = "111" ($Y_2 Y_1 Y_0$)

retira-se o mais significativo do anterior

$t_{setup} = 15\,ns$
$t_{HOLD} = 5\,ns$
$t_{PHL} = 25\,ns$
$t_{PLH} = 20\,ns$
$t_{gate} = 10\,ns$

for clk

$t_{min} = 15 + 25 = 40$

$f_{max} = \frac{1}{t} = \frac{1}{40ns} = \frac{1}{40 \times 10^{-9}} = 4 \times 10^8 = 400\,MHz$