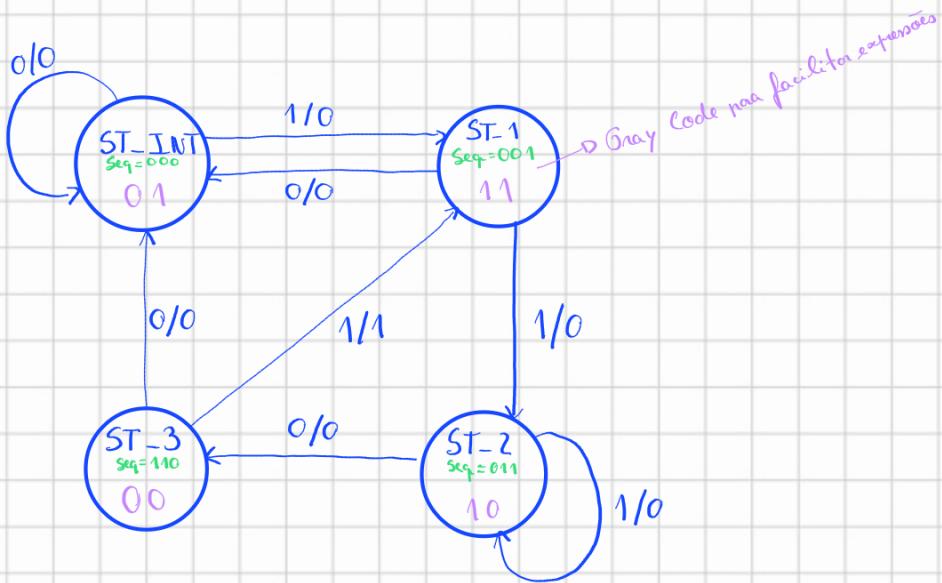


Aula 11-12-13

Neste exercício o estado inicial é 01

1

Sequence → "1101"



Legenda: X / Y

| | Q_1 | Q_0 | X | Q_1^+ | Q_0^+ | Y |
|--------|-------|-------|---|---------|---------|---|
| ST-3 | 0 | 0 | 0 | 0 | 1 | 0 |
| | 0 | 0 | 1 | 1 | 1 | 1 |
| ST-INT | 0 | 1 | 0 | 0 | 1 | 0 |
| | 0 | 1 | 1 | 1 | 1 | 0 |
| ST-2 | 1 | 0 | 0 | 0 | 0 | 0 |
| | 1 | 0 | 1 | 1 | 0 | 0 |
| ST-1 | 1 | 1 | 0 | 0 | 1 | 0 |
| | 1 | 1 | 1 | 1 | 0 | 0 |

$$Q_1^+ = X$$

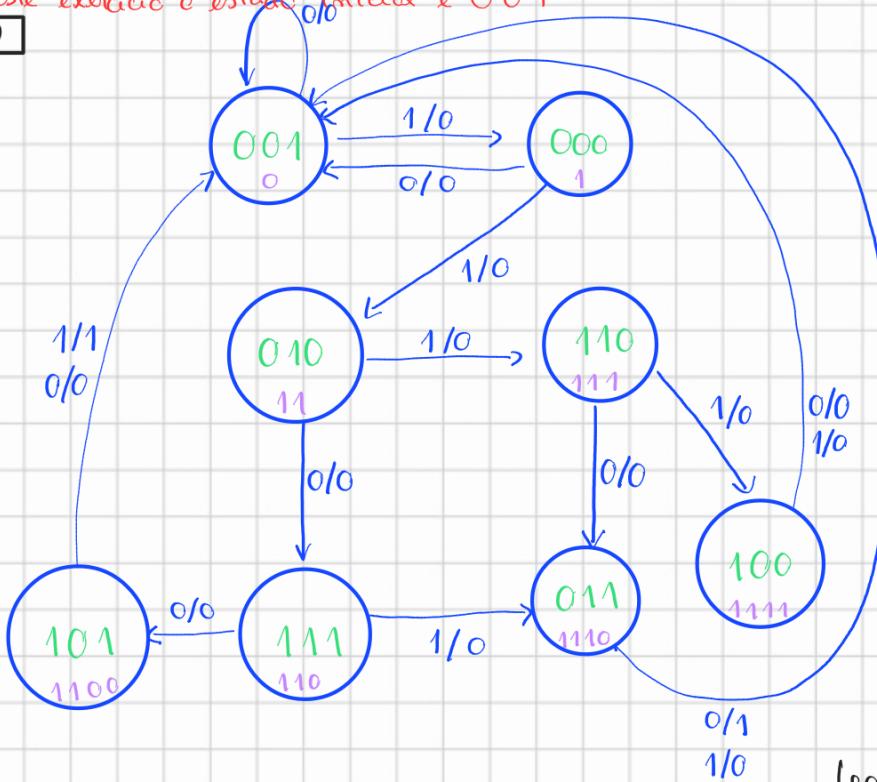
$$Q_0^+ = \overline{Q_1} + Q_0 \overline{X}$$

$$Y = \overline{Q_1} \cdot \overline{Q_0} \cdot X$$

| | 00 | 01 | 11 | 10 |
|---|----|----|----|----|
| 0 | 1 | 1 | 1 | 0 |
| 1 | 1 | 1 | 0 | 0 |

Neste exercício o estado inicial é 001

2



8 estados:

$$2^3 = 8 \Rightarrow 3 \text{ flip-flops}$$

| | |
|-------|---|
| 0 0 0 | ✓ |
| 0 0 1 | ✓ |
| 0 1 1 | ✓ |
| 0 1 0 | ✓ |
| 1 1 0 | ✓ |
| 1 1 1 | ✓ |
| 1 0 1 | ✓ |
| 1 0 0 | ✓ |

2 bits

2 bits

legenda: X/Y

| Q_2 | Q_1 | Q_0 | X | Q_2^+ | Q_1^+ | Q_0^+ | Y |
|-------|-------|-------|---|---------|---------|---------|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 |
| 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 |
| 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 |
| 0 | 1 | 0 | 0 | 1 | 1 | 1 | 0 |
| 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0 |
| 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 |
| 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 |
| 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 |
| 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 |
| 1 | 0 | 1 | 0 | 1 | 1 | 0 | 0 |
| 1 | 0 | 1 | 1 | 0 | 0 | 1 | 1 |
| 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 |
| 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 |
| 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 |
| 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 |

| Q_2^+ | $Q_2 Q_1$ | 00 | 01 | 11 | 10 |
|---------|-----------|----|----|----|----|
| $Q_0 X$ | | 00 | 01 | 11 | 10 |
| 00 | 00 | 0 | 1 | 0 | 0 |
| 01 | 01 | 0 | 1 | 1 | 0 |
| 11 | 10 | 0 | 0 | 0 | 0 |
| 10 | 11 | 0 | 0 | 1 | 0 |

$$Q_2^+ = \overline{Q_2} Q_1 \overline{Q_0} + Q_1 \overline{Q_0} x + [Q_2 Q_1 Q_0] \bar{x}$$

| Q_1^+ | $Q_2 Q_1$ | 00 | 01 | 11 | 10 |
|---------|-----------|----|----|----|----|
| $Q_0 x$ | | 00 | 01 | 11 | 10 |
| 00 | 00 | 0 | 1 | 1 | 0 |
| 01 | 01 | 1 | 1 | 0 | 0 |
| 11 | 10 | 0 | 0 | 1 | 0 |
| 10 | 11 | 0 | 0 | 0 | 0 |

$$Q_1^+ = Q_1 \overline{Q_0} \bar{x} + \overline{Q_2} \overline{Q_0} x + [Q_2 Q_1 Q_0] x$$

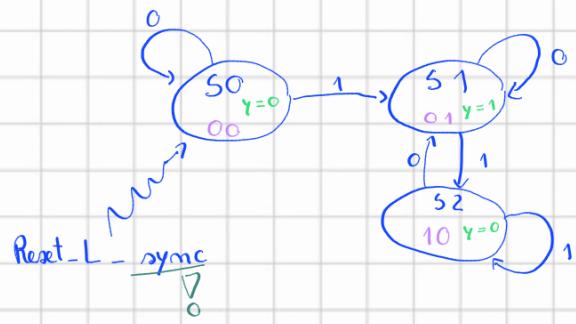
| Q_0^+ | $Q_2 Q_1$ | 00 | 01 | 11 | 10 |
|---------|-----------|----|----|----|----|
| $Q_2 x$ | | 00 | 01 | 11 | 10 |
| 00 | 00 | 1 | 1 | 1 | 1 |
| 01 | 01 | 0 | 0 | 0 | 1 |
| 11 | 10 | 0 | 1 | 1 | 1 |
| 10 | 11 | 1 | 1 | 1 | 1 |

$$Q_0^+ = \bar{x} + Q_1 Q_0 + Q_2 \bar{Q}_1$$

$$Y = \overline{Q_2} Q_1 Q_0 \bar{x} + Q_2 \overline{Q_1} Q_0 x$$

3

| $Q_1\ Q_0\ X$ | $Q_1^+\ Q_0^+$ | Y |
|---------------|----------------|-----|
| 0 0 0 | 0 0 | 0 |
| 0 0 1 | 0 1 | 0 |
| 0 1 0 | 0 1 | 1 |
| 0 1 1 | 1 0 | 1 |
| 1 0 0 | 0 1 | 0 |
| 1 0 1 | 1 0 | 0 |
| 1 1 0 | X X | X |
| 1 1 1 | X X | X |



$$Y = Q_0$$

| Q_0^+ | $Q_1\ Q_0$ | X | 00 01 11 10 |
|---------|------------|-----|-------------|
| 0 | 0 1 | X | 1 X 1 |
| 1 | 1 0 | X 0 | |

| Q_1^+ | $Q_1\ Q_0$ | X | 00 01 11 10 |
|---------|------------|-----|-------------|
| 0 | 0 0 | X 0 | |
| 1 | 0 1 | X 1 | |

$$Q_0^+ = X \bar{Q}_1 \bar{Q}_0 + \bar{X} Q_0 + \bar{X} Q_1$$

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

$$\begin{array}{r} 1001 \\ 0101 \end{array} \rightarrow \begin{array}{r} 0111 \\ 0110 \end{array}$$

4

Reset - asyinc

| $Q_2\ Q_1\ Q_0$ | $Q_2^+\ Q_1^+\ Q_0^+$ |
|-----------------|-----------------------|
| 0 0 0 | 0 0 1 |
| 0 0 1 | 0 1 1 |
| 0 1 1 | 0 1 0 |
| 0 1 0 | 1 1 0 |
| 1 1 0 | 1 1 1 |
| 1 1 1 | 1 0 1 |
| 1 0 1 | 1 0 0 |
| 1 0 0 | 0 0 0 |

| Q_2^+ | $Q_2\ Q_1$ | X | 00 01 11 10 |
|---------|------------|-----|-------------|
| 0 | 0 1 | 1 0 | |
| 1 | 0 0 | 1 1 | |

| Q_1^+ | $Q_2\ Q_1$ | X | 00 01 11 10 |
|---------|------------|-----|-------------|
| 0 | 0 1 | 1 1 | |
| 1 | 1 1 | 0 0 | |

$$Q_2^+ = Q_1 \bar{Q}_0 + Q_2 Q_0$$

$$Q_1^+ = Q_1 \bar{Q}_0 + \bar{Q}_2 Q_0$$

| Q_0^+ | $Q_2\ Q_1$ | X | 00 01 11 10 |
|---------|------------|-----|-------------|
| 0 | 1 | 0 1 | |
| 1 | 1 | 0 1 | |

$$Q_0^+ = \bar{Q}_2 \bar{Q}_1 + Q_2 Q_1$$

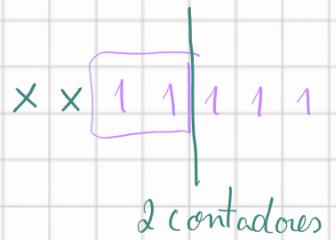
5

6

| | Q ₃ | Q ₂ | Q ₁ | Q ₀ |
|----|----------------|----------------|----------------|----------------|
| 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 1 |
| 2 | 0 | 0 | 1 | 0 |
| 3 | 0 | 0 | 1 | 1 |
| 4 | 0 | 1 | 0 | 0 |
| 5 | 0 | 1 | 0 | 1 |
| 6 | 0 | 1 | 1 | 0 |
| 7 | 0 | 1 | 1 | 1 |
| 8 | 1 | 0 | 0 | 0 |
| 9 | 1 | 0 | 0 | 1 |
| 10 | 1 | 0 | 1 | 0 |
| 11 | 1 | 0 | 1 | 1 |
| 12 | 1 | 1 | 0 | 0 |
| 13 | 1 | 1 | 0 | 1 |
| 14 | 1 | 1 | 1 | 0 |
| 15 | 1 | 1 | 1 | 1 |

7

$$t_{\min} = t_{\text{setup}} + \max(t_{LH}, t_{HL}) + t_{\text{gate}}$$



8

