



## **Aula 07 – Circuitos Síncronos**

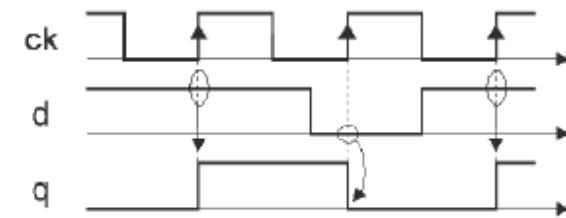
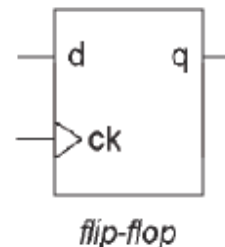
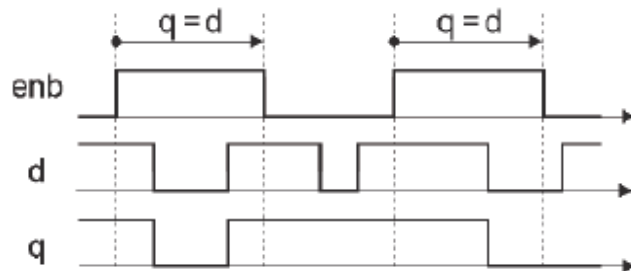
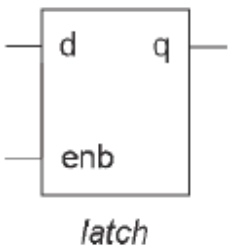


## Tópicos da aula

- **Conceitos de sincronismo**
- **Flip-flops**
- **Registradores**
- **Máquinas de estado**



## Conceitos iniciais



Operação de um *latch* e um *flip-flop*.



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## Conceitos iniciais

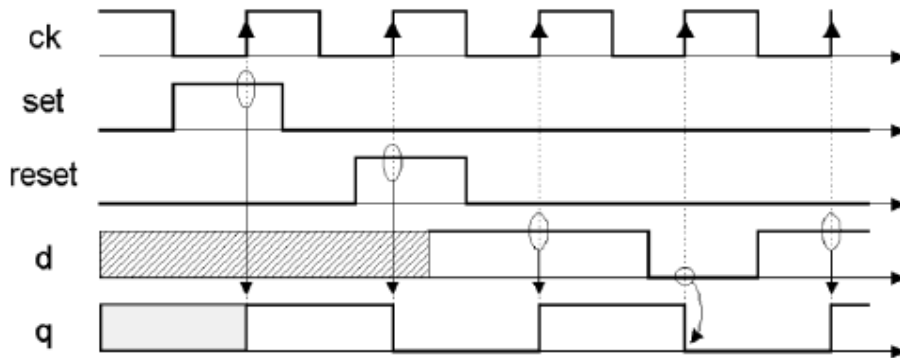
```
(ck'EVENT AND ck ='1')           -- borda de subida  
(ck'EVENT AND ck ='0')           -- borda de descida  
(NOT ck'STABLE AND ck ='1')      -- borda de subida  
(NOT ck'STABLE AND ck ='0')      -- borda de descida
```

Teste da ocorrência de bordas de subida e descida.

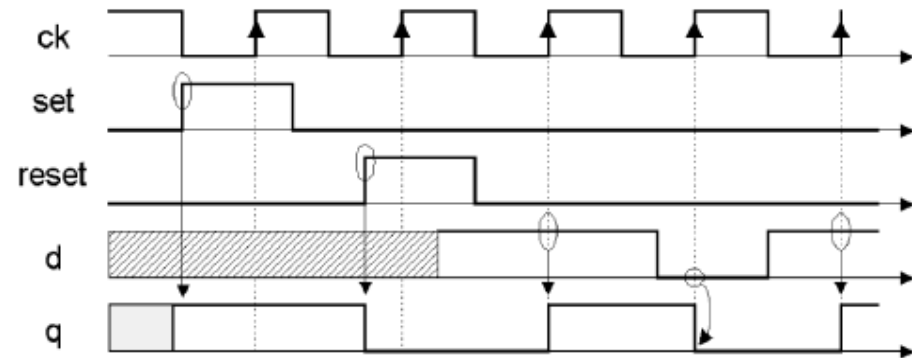


## Conceitos iniciais

Inicialização síncrona



Inicialização assíncrona



Exemplos de operações de inicialização em *flip-flops*.



## Exercícios

- ❏ **Implemente um Flip-flop tipo D com reset síncrono**
- ❏ **Implemente um Flip-flop tipo D com reset assíncrono**



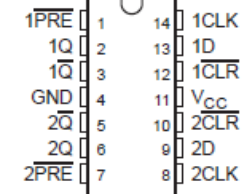
## Exercícios

### 74AC11074 DUAL POSITIVE-EDGE-TRIGGERED D-TYPE FLIP-FLOP WITH CLEAR AND PRESET

SCAS499A - DECEMBER 1986 - REVISED APRIL 1986

- Center-Pin  $V_{CC}$  and GND Configurations Minimize High-Speed Switching Noise
- EPIC™ (Enhanced-Performance Implanted CMOS) 1- $\mu$ m Process
- 500-mA Typical Latch-Up Immunity at 125°C
- Package Options Include Plastic Small-Outline (D) and Thin Shrink Small-Outline (PW) Packages, and Standard Plastic 300-mil DIPs (N)

D, N, OR PW PACKAGE  
(TOP VIEW)



#### description

This device contains two independent positive-edge-triggered D-type flip-flops. A low level at the preset ( $\overline{PRE}$ ) or clear ( $\overline{CLR}$ ) input sets or resets the outputs regardless of the levels of the other inputs. When  $\overline{PRE}$  and  $\overline{CLR}$  are inactive (high), data at the data (D) input that meets the setup-time requirements are transferred to the outputs on the low-to-high transition of the clock (CLK) pulse. Clock triggering occurs at a voltage level and is not directly related to the rise time of the clock pulse. Following the hold-time interval, data at the D input may be changed without affecting the levels at the outputs.

The 74AC11074 is characterized for operation from -40°C to 85°C.

FUNCTION TABLE

INPUTS				OUTPUT	
$\overline{PRE}$	$\overline{CLR}$	CLK	D	Q	$\overline{Q}$
L	H	X	X	H	L
H	L	X	X	L	H
L	L	X	X	H <sup>†</sup>	H <sup>†</sup>
H	H	↑	H	H	L
H	H	↑	L	L	H
H	H	L	X	Q <sub>0</sub>	$\overline{Q}_0$

<sup>†</sup> This configuration is nonstable; that is, it does not persist when  $\overline{PRE}$  or  $\overline{CLR}$  returns to its inactive (high) level.



## Registradores

- ❏ Podem ser entendidos como uma sequência de flip-flops tipo D em paralelo
- ❏ Importantes como forma de memorização de dados





## Exercícios

- ❏ **Implemente um registrador com carregamento (LOAD) assíncrono**
- ❏ **Implemente um registrador com carregamento (LOAD) síncrono**



## Máquinas de Estados

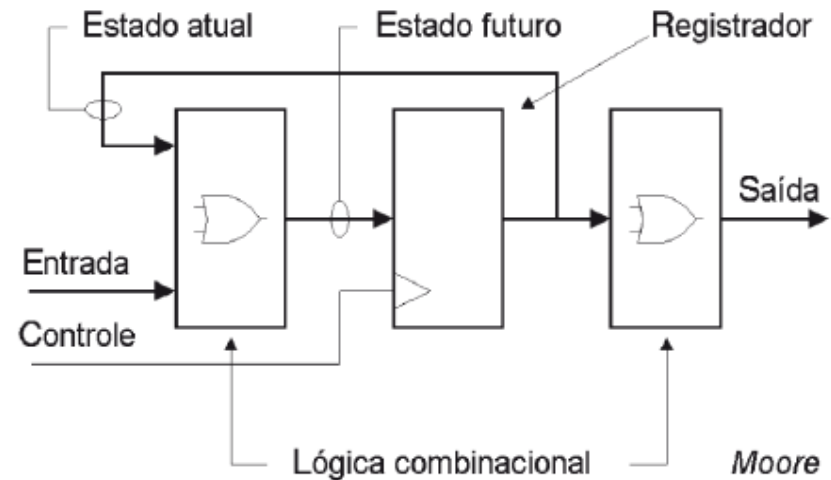
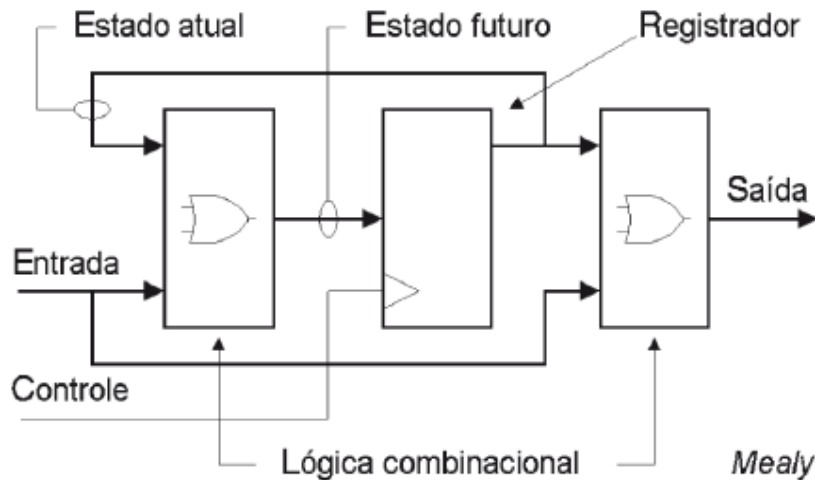
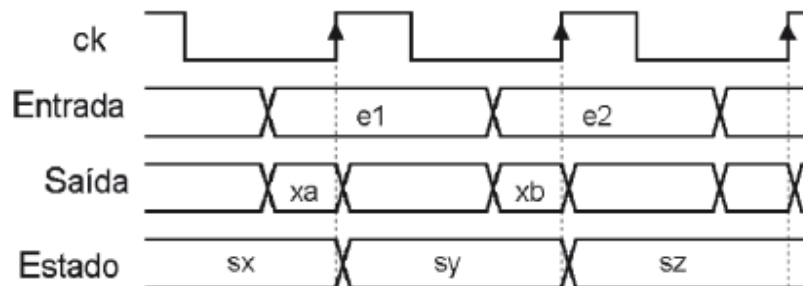
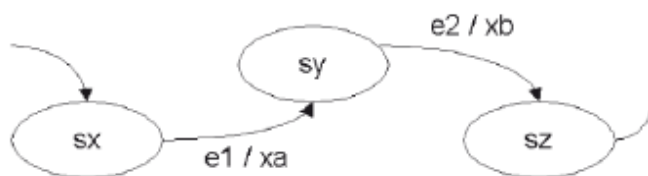


Diagrama de blocos de máquinas de estados.

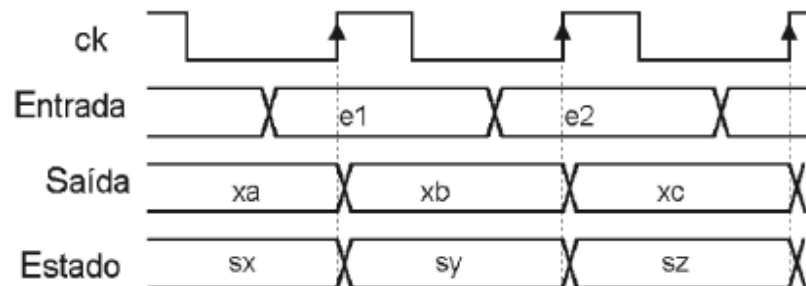


## Máquinas de Estados

*Mealy*



*Moore*



Exemplo: diagrama de estado e carta de tempo de máquinas *Mealy* e *Moore*.



```
75 U_MACHINE : process(i_CLK, i_RST)
76 begin
77     if (i_RST = '1') then
78         w_EN      <= '0';
79         w_CLR_BUSY <= '1';
80         w_STATE   <= st_IDLE;
81
82     elsif rising_edge (i_CLK) then
83         case w_STATE is
84             when st_IDLE =>
85                 w_CLR_BUSY <= '0';
86
87                 if (i_REQ = '1') then
88                     w_EN      <= '1';
89                     w_STATE   <= st_UPDATE;
90                 else
91                     w_STATE   <= st_IDLE;
92                 end if;
93             when st_UPDATE =>
94                 w_EN <= '0';
95                 if (w_BUSY = '1') then
96                     w_CLR_BUSY <= '1';
97                     w_STATE <= st_IDLE;
98                 else
99                     w_STATE <= st_UPDATE;
100                 end if;
101             when others =>
102                 w_STATE <= st_IDLE;
103         end case;
104     end if;
105 end process U_MACHINE;
```



## Exercícios

- ❏ **Implemente uma máquina de estados que opere como cronômetro e apresente as seguintes funcionalidades: (1) START, (2) STOP, (3) RESTART**



## **FIM AULA VII**