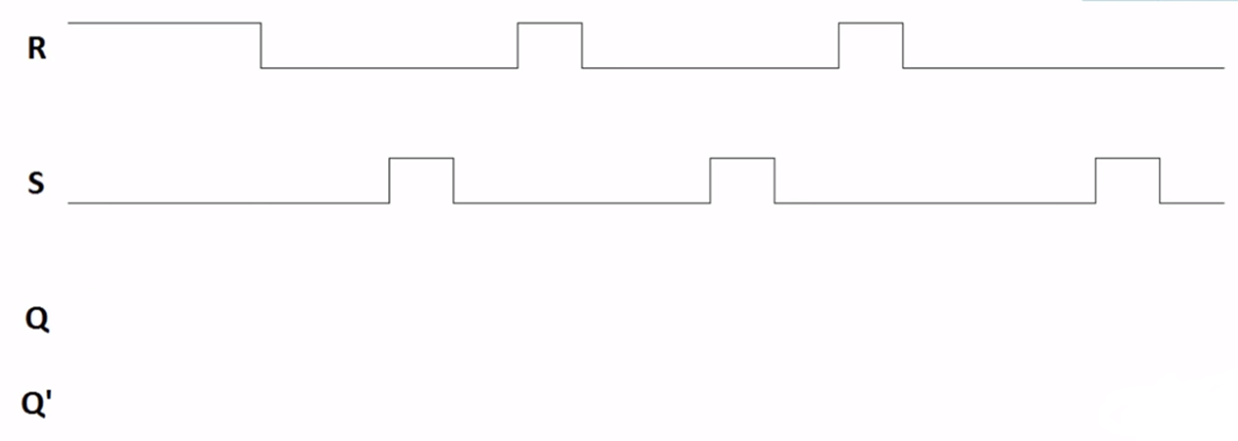
|  |
| --- |
| **LATCH ou Flip-Flop RS assíncrono** |

|  |  |
| --- | --- |
|  | A imagem representa um Flip-Flop com portas NAND  R significa RESET e S significa SET, ou seja, R Desliga a saída e S Liga a saída. |
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| Símbolo | Tabela de verdade |
|  | |  |  |  |  |  | | --- | --- | --- | --- | --- | | **R** | **S** | **Q** | **Q’** | Estado | | 0 | 0 | Qa (Q anterior) | Q’a (Q’ anterior) | Memória | | 0 | 1 | 1 | 0 | Set | | 1 | 0 | 0 | 1 | Reset | | 1 | 1 | 0 | 0 | Erro lógico | |

Completa o diagrama temporal

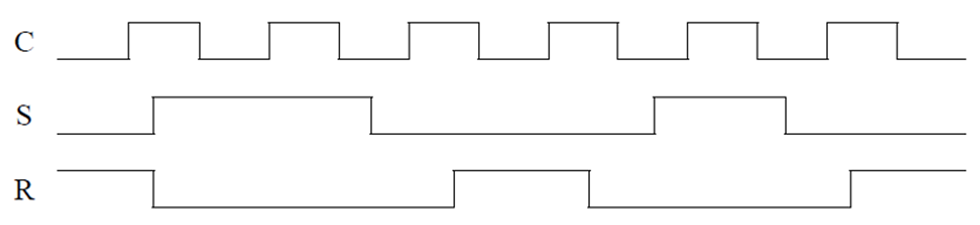


|  |
| --- |
| **LATCH ou Flip-Flop RS síncrono** |

|  |  |
| --- | --- |
| Circuito lógico | Descrição |
|  | A imagem representa um Flip-Flop com portas NAND  R significa RESET e S significa SET, ou seja, R Desliga a saída e S Liga a saída.  CLK significa Clock e permite habilitar ou desabilitar todo o circuito.  Este circuito entra em memória quando R=0 e S=0 ou quando CLK=0 |

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| --- | --- | --- |
| Símbolo |  | Tabela de verdade |
|  |  | |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | **Entradas** | | | **Saídas** | | **Estado** | | CLK | R | S | Q | Q’ | | 0 | x | x | Qa | Qa’ | Mem. | | 1 | 0 | 0 | Qa | Qa’ | Mem. | | 1 | 0 | 1 | 1 | 0 | Set | | 1 | 1 | 0 | 0 | 1 | Reset | | 1 | 1 | 1 |  |  | Erro | |

Completa o diagrama temporal



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| **LATCH D síncrono** |

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| Circuito lógico | Descrição |
|  | A imagem representa um Latch tipo D com portas NAND  R significa RESET e S significa SET, ou seja, R Desliga a saída e S Liga a saída. D significa Dado ou *data.*  CLK significa Clock e permite habilitar ou desabilitar todo o circuito.  Este circuito entra em memória quando R=0 e S=0 ou quando CLK=0 |
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| --- | --- | --- |
| Símbolo |  |  |
|  |  | |  |  |  |  |  | | --- | --- | --- | --- | --- | | **Entradas** | | **Saídas** | | **Estado** | | **CLK** | D | Q | Q’ | | 0 | X | Qa | Qa’ | Mem. | | 1 | 0 | 0 | 1 | Reset | | 1 | 1 | 1 | 0 | Set | |
|  |  |  |

Completa o diagrama temporal

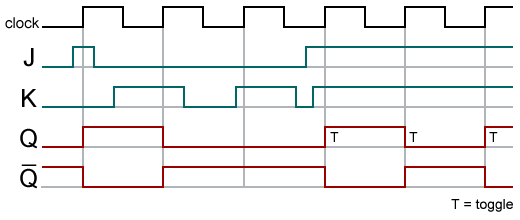
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| D |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| CLK |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Q | r | r | m | m | r | r | m | r | s | r | m | m | m | s | m | m | s | m | m | r |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Q’ |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| **Flip-Flop JK** |

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| --- | --- |
| Circuito lógico | Descrição |
|  | A imagem representa um Flip-Flop do tipo JK com portas NAND  J significa SET e K significa RESET, ou seja, K Desliga a saída Q e J Liga a saída Q. |
| CLK significa Clock e permite habilitar ou desabilitar todo o circuito.  Este circuito entra em memória quando J=0 e K=0 ou quando CLK=0  Quando J=1 e K=1 o circuito entra em Toggle ou Inversão. | |

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| Símbolo |  | Tabela de verdade |
|  |  | |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | **Entradas** | | | **Saídas** | | **Estado** | | CLK | J | K | Q | Q’ | | 0 | x | x | Qa | Qa’ | Mem. | | 1 | 0 | 0 | Qa | Qa’ | Mem. | | 1 | 0 | 1 | 0 | 1 | Reset | | 1 | 1 | 0 | 1 | 0 | Set | | 1 | 1 | 1 | Qa’ | Qa | Inversão  *toggle* | |

Completa o diagrama temporal



Completa o diagrama temporal

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| J | 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| K | 0 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| CLK | 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Q | 1 |  |  |  |  |  |  |  | T | T | T | T | T |  | T |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Q’ | 0 |  |  |  |  |  |  |  | T | T | T | T | T |  | T |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| **Flip-Flop JK ms** |

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| Circuito lógico | Descrição |
|  | A imagem representa um Flip-Flop do tipo JK MS (M= Master e S= Slave) com portas NAND  J significa SET e K significa RESET, ou seja, K Desliga a saída Q e J Liga a saída Q. |
| CLK significa Clock e permite habilitar o MASTER e Desabilitar o SLAVE ou Desabilitar o MASTER e Habilitar o Slave.  Este circuito entra em memória quando J=0 e K=0 ou quando CLK=0 ou CLK=1  Os FFjkMS funcionam na subida ou descida do Clok. Um FF que funciona pela borda de subida diz-se de transição positiva, um FF que funciona na borda de descida diz-se de transição negativa | |

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| --- | --- |
| Símbolo | Tabela de verdade |
|  | |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | **Entradas** | | | **Saídas** | | **Estado** | | CLK | J | K | Q | Q’ | | 0/1 | x | x | Qa | Qa’ | Mem. | | ˄ | 0 | 0 | Qa | Qa’ | Mem. | | ˄ | 0 | 1 | 0 | 1 | Reset | | ˄ | 1 | 0 | 1 | 0 | Set | | ˄ | 1 | 1 | Qa’ | Qa | Inversão  *toggle* | |

Completa o diagrama temporal

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| J |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |
| K |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |
| CLK |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |
| Q |  |  | T |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |
| Q’ |  |  |  |  |  |  |  |  |  |

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| **Flip-Flop JK ms, com base em FF rs. FINAL** |

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| --- | --- |
| Tabela de verdade e mapa de Karnaugh | |
| |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | **Entradas** | | | | **Saídas** | | | Posição | J | K | Qa | s | r | | 0 | 0 | 0 | 0 | 0 | 1 | | 1 | 0 | 0 | 1 | 1 | 0 | | 2 | 0 | 1 | 0 | 0 | 1 | | 3 | 0 | 1 | 1 | 0 | 1 | | 4 | 1 | 0 | 0 | 1 | 0 | | 5 | 1 | 0 | 1 | 1 | 0 | | 6 | 1 | 1 | 0 | 1 | 0 | | 7 | 1 | 1 | 1 | 0 | 1 | |  |
| Expressões boleanas encontradas para S e R.  S=K’Qa+JQa’  R=S’ | |

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| Completa o diagrama temporal | | |
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| Completa o diagrama temporal | | |
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| **Flip-Flop JK ms, com base em (FF rs) com CLEAR PRESET (CLR PR)** |
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|  |
| A imagem representa um Flip-Flop do tipo Flip-Flop JK ms, com base em (FF rs) com CLEAR PRESET (CLR PR) com portas NAND |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Tabela de verdade   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | **Entradas** | | | | | | **Saídas** | | **Estado** | | | | CLK | J | K | **PR’** | **CLR’** | Q | | Q’ |  |  |  | | x | x | x | 0 | 0 | 1 | | 1 | Erro | | | x | x | x | 0 | 1 | 1 | | 0 | Set | | | x | x | x | 1 | 0 | 0 | | 1 | Reset | | | 0/1 | x | x | 1 | 1 | Qa | | Qa’ | Mem. | | | ˄ | 0 | 0 | 1 | 1 | Qa | | Qa’ | Mem. | | | ˄ | 0 | 1 | 1 | 1 | 0 | | 1 | Reset | | | ˄ | 1 | 0 | 1 | 1 | 1 | | 0 | Set | | | ˄ | 1 | 1 | 1 | 1 | Qa’ | | Qa | Inversão  *toggle* | | | Clear = CLR faz RESET ao circuito  Preset = PR faz SET ao circuito | | |
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Completa o diagrama temporal

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