# Arquitectura de Computadores I

# Introdução aos Circuitos MSI

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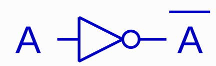
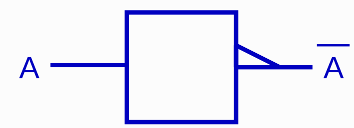
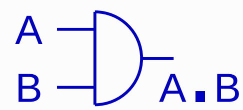
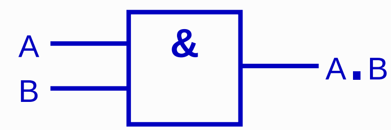
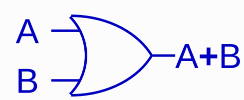
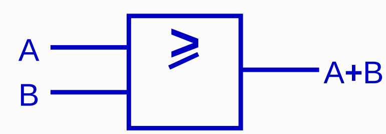
# Operações Lógicas Elementares

<table>
<tr><th>Operação Lógica</th><th>Simbologia Matemática</th><th>Tabela de Verdade</th><th>Simbologia Electrónica</th><th>Simbologia IEEE</th></tr>
<tr><td>NOT</td><td>$F=\overline{A}$</td><td><table><tr><th>A</th><th>$\overline{A}$</th></tr><tr><td>0</td><td>1</td></tr><tr><td>1</td><td>0</td></tr></table></td><td></td><td></td></tr>
<tr><td>AND</td><td>$F=A\cdot B$</td><td><table><tr><th>A</th><th>B</th><th>$A\cdot B$</th></tr><tr><td>0</td><td>0</td><td>0</td></tr><tr><td>0</td><td>1</td><td>0</td></tr><tr><td>1</td><td>0</td><td>0</td></tr><tr><td>1</td><td>1</td><td>1</td></tr></table></td><td></td><td></td></tr>
<tr><td>OR</td><td>$F=A+B$</td><td><table><tr><th>A</th><th>B</th><th>$A+B$</th></tr><tr><td>0</td><td>0</td><td>0</td></tr><tr><td>0</td><td>1</td><td>1</td></tr><tr><td>1</td><td>0</td><td>1</td></tr><tr><td>1</td><td>1</td><td>1</td></tr></table></td><td></td><td></td></tr>
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# Operações Lógicas não elementares

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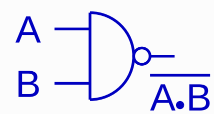
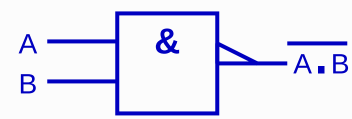
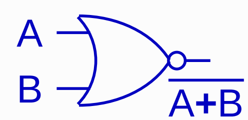
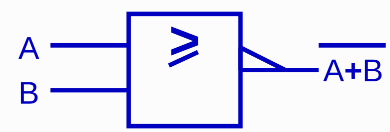
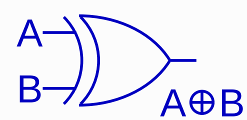
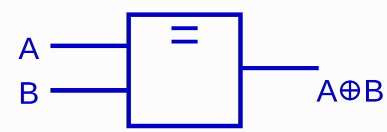
<tr><th>Operação Lógica</th><th>Simbologia Matemática</th><th>Tabela de Verdade</th><th>Simbologia Electrónica</th><th>Simbologia IEEE</th></tr>
<tr><td>NAND</td><td>$F=\overline{A \cdot B}$</td><td><table><tr><th>A</th><th>B</th><th>$\overline{A \cdot B}$</th></tr><tr><td>0</td><td>0</td><td>1</td></tr><tr><td>0</td><td>1</td><td>1</td></tr><tr><td>1</td><td>0</td><td>1</td></tr><tr><td>1</td><td>1</td><td>0</td></tr></table></td><td></td><td></td></tr>
<tr><td>NOR</td><td>$F=\overline{A + B}$</td><td><table><tr><th>A</th><th>B</th><th>$\overline{A + B}$</th></tr><tr><td>0</td><td>0</td><td>1</td></tr><tr><td>0</td><td>1</td><td>0</td></tr><tr><td>1</td><td>0</td><td>0</td></tr><tr><td>1</td><td>1</td><td>0</td></tr></table></td><td></td><td></td></tr>
<tr><td>EXOR</td><td>$F=A \oplus B$</td><td><table><tr><th>A</th><th>B</th><th>$A \oplus B$</th></tr><tr><td>0</td><td>0</td><td>0</td></tr><tr><td>0</td><td>1</td><td>1</td></tr><tr><td>1</td><td>0</td><td>1</td></tr><tr><td>1</td><td>1</td><td>0</td></tr></table></td><td></td><td></td></tr>
</table>

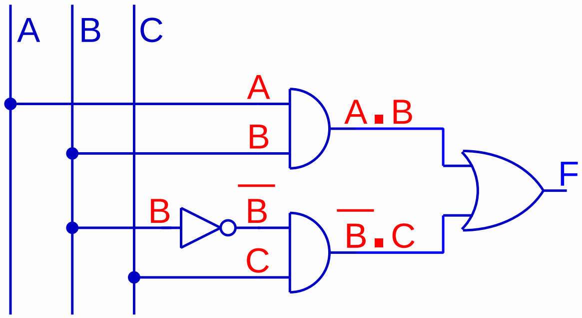
# Funções Boleans implementadas só com NAND

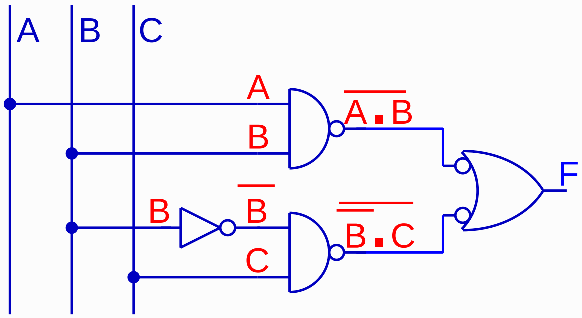
*Tiram-se a partir de funcções obtidas a partir dos '1s'* $\Longrightarrow$ **Soma de Produtos**

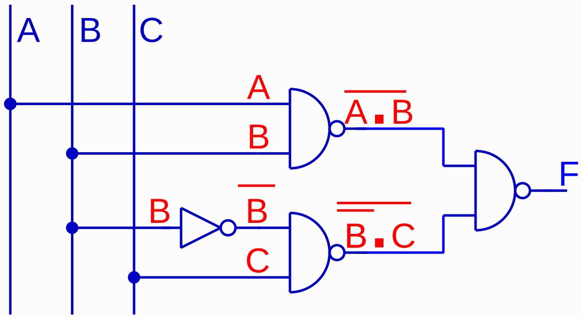
Teorema de D'Morgan $\overline{X+Y+Z+\ldots}=\overline{X}\cdot\overline{Y}\cdot\overline{Z}\cdot\ldots$

Exemplo de aplicação:

$$F = A\cdot B + \overline{B}\cdot C \overset{\text{Dupla Negação}}{=} \overline{\overline{A\cdot B + \overline{B}\cdot C}} \overset{\text{Teor. de D'Morgan}}{=} \overline{\overline{A\cdot B}\cdot\overline{\overline{B}\cdot C}}$$



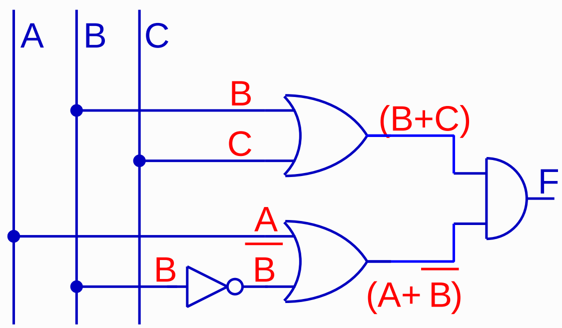
# Funções Boleans implementadas só com NOR

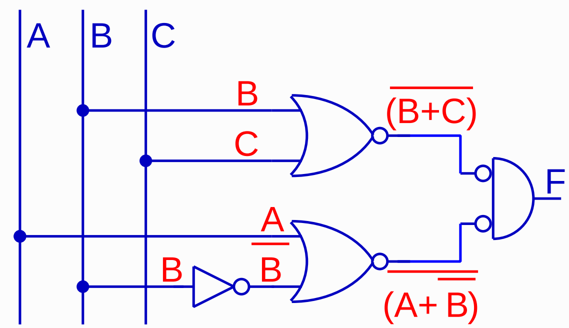
*Tiram-se a partir de funcções obtidas a partir dos '0s'* $\Longrightarrow$ **Produto de Somas**

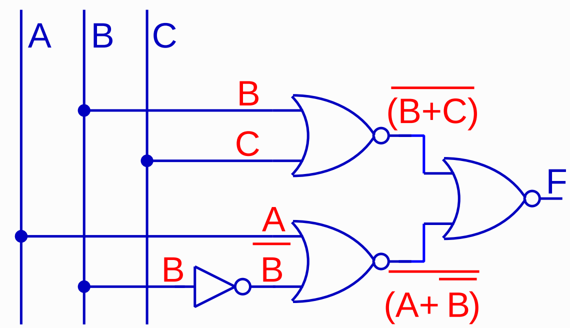
Teorema de D'Morgan $\qquad \overline{X\cdot Y\cdot Z\cdot\ldots}=\overline{X}+\overline{Y}+\overline{Z}+\ldots$

Exemplo de aplicação:

$$F = (B+C)\cdot\left(A+\overline{B}\right) \overset{\text{Dupla Negação}}{=} \overline{\overline{(B+C)\cdot\left(A+\overline{B}\right)}} \overset{\text{Teor. de D'Morgan}}{=} \overline{\overline{(B+C)}+\overline{\left(A+\overline{B}\right)}}$$



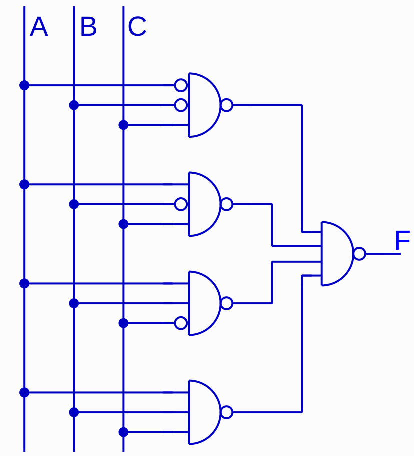
# Funções Boleans implementadas só com NAND ou NOR

## *A partir da primeira fórmula canónica* $\Longrightarrow$ Soma de Produtos

$$F = \overline{A}\cdot\overline{B}\cdot C + A\cdot\overline{B}\cdot C + A\cdot B\cdot\overline{C} + A\cdot B\cdot C =$$

$$\stackrel{\text{Dupla Negação}}{=} \overline{\overline{\overline{A}\cdot\overline{B}\cdot C + A\cdot\overline{B}\cdot C + A\cdot B\cdot\overline{C} + A\cdot B\cdot C}} =$$

$$\stackrel{\text{Teor. de D'Morgan}}{=} \overline{\overline{\overline{A}\cdot\overline{B}\cdot C} \cdot \overline{A\cdot\overline{B}\cdot C} \cdot \overline{A\cdot B\cdot\overline{C}} \cdot \overline{A\cdot B\cdot C}}$$

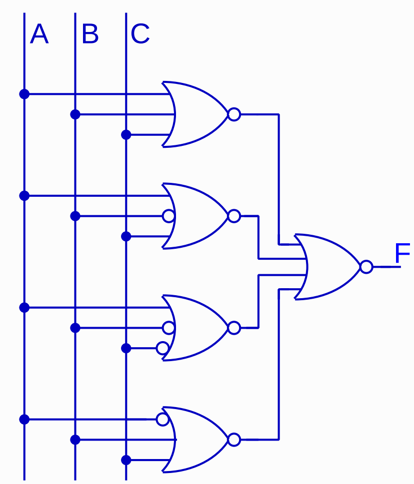



## *A partir da segunda fórmula canónica* $\Longrightarrow$ Produto de Somas

$$F = (A+B+C)\cdot(A+\overline{B}+C)\cdot(A+\overline{B}+\overline{C})\cdot(\overline{A}+B+C) =$$

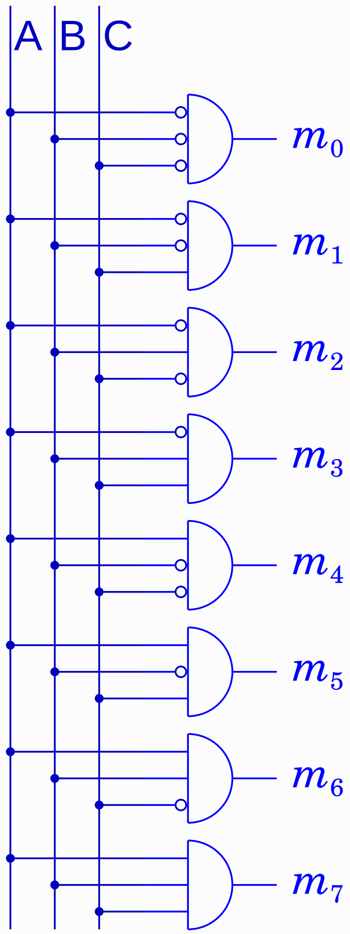
$$\stackrel{\text{Dupla Negação}}{=} \overline{\overline{(A+B+C)\cdot(A+\overline{B}+C)\cdot(A+\overline{B}+\overline{C})\cdot(\overline{A}+B+C)}} =$$

$$\stackrel{\text{Teor. de D'Morgan}}{=} \overline{\overline{(A+B+C)} + \overline{(A+\overline{B}+C)} + \overline{(A+\overline{B}+\overline{C})} + \overline{(\overline{A}+B+C)}}$$



# Descodificadores

*Descodificador* $\Longrightarrow$ **Selecciona uma saída que é correspondente a uma entrada**



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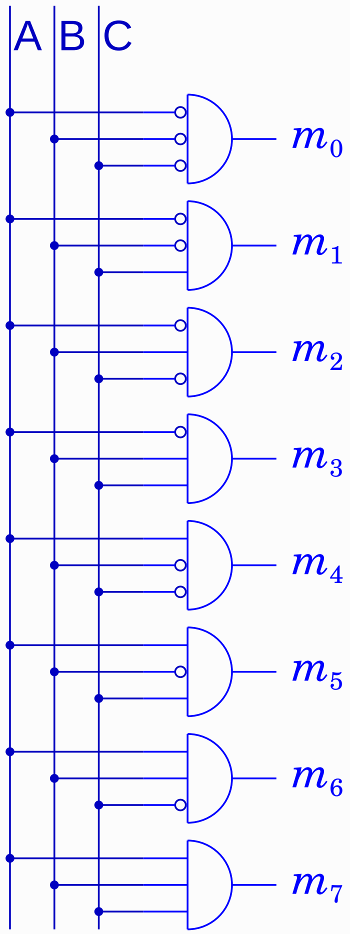


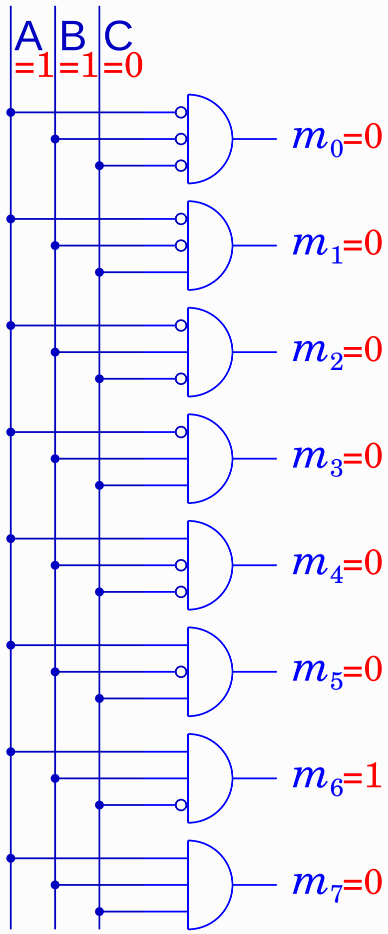

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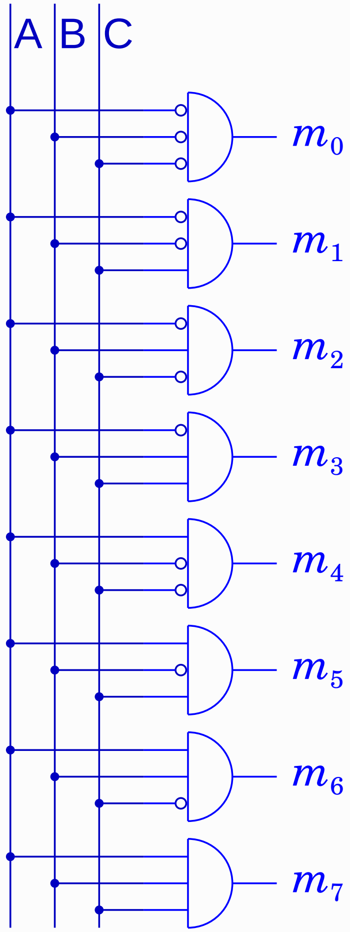
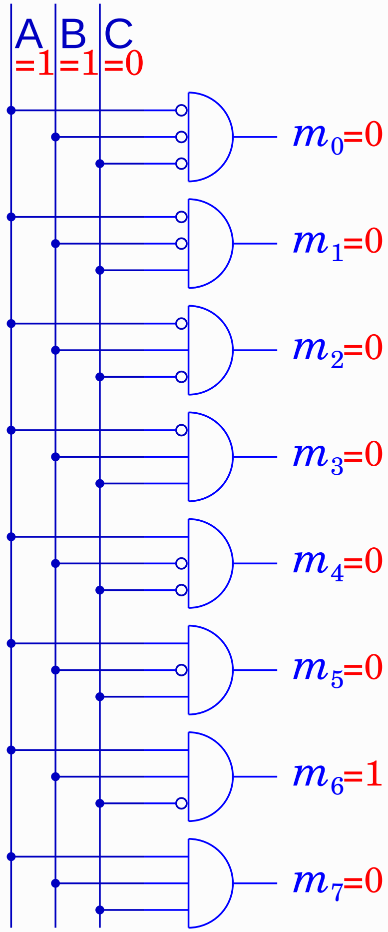
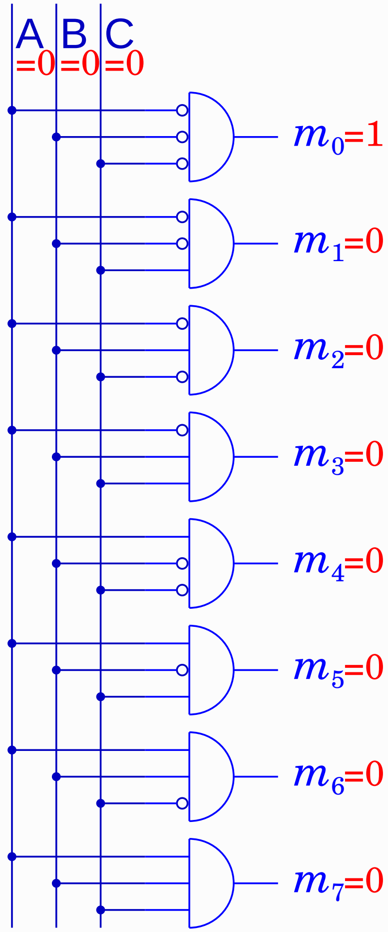
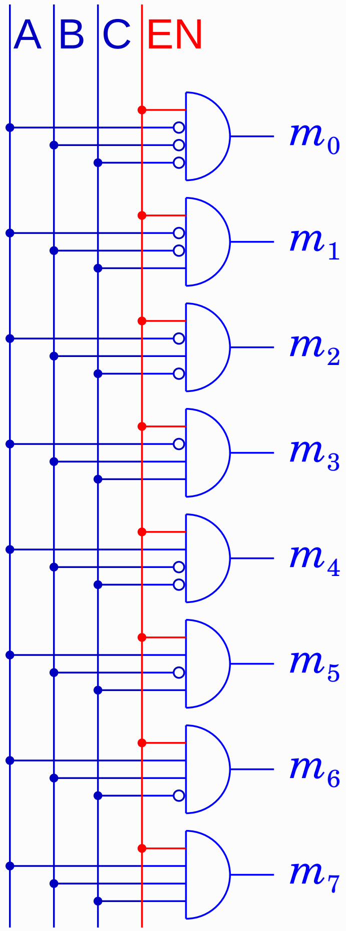


# Descodificadores com entradas de controlo

***Enable (EN)*** (activo em 1) $\Longrightarrow$ **Habilita ou não o funcionamento normal do descodificador**



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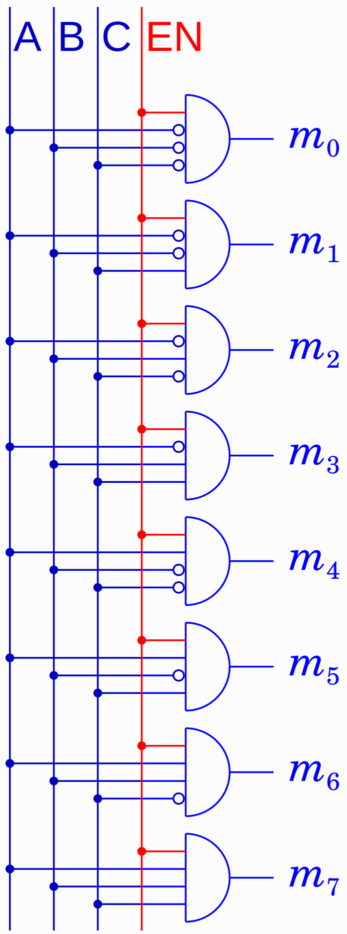


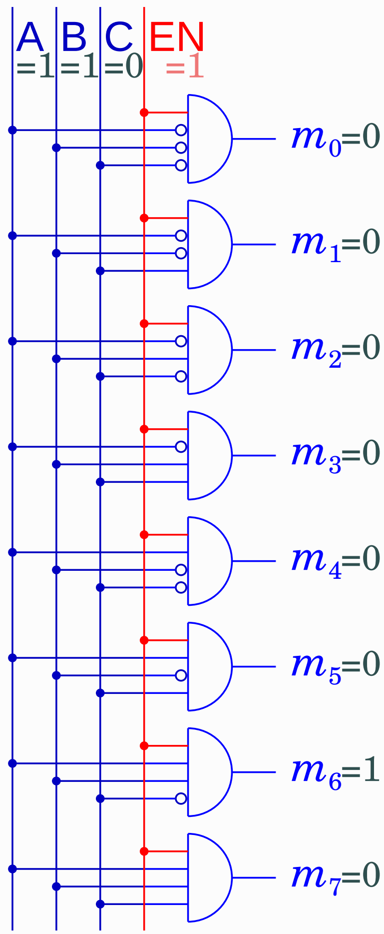

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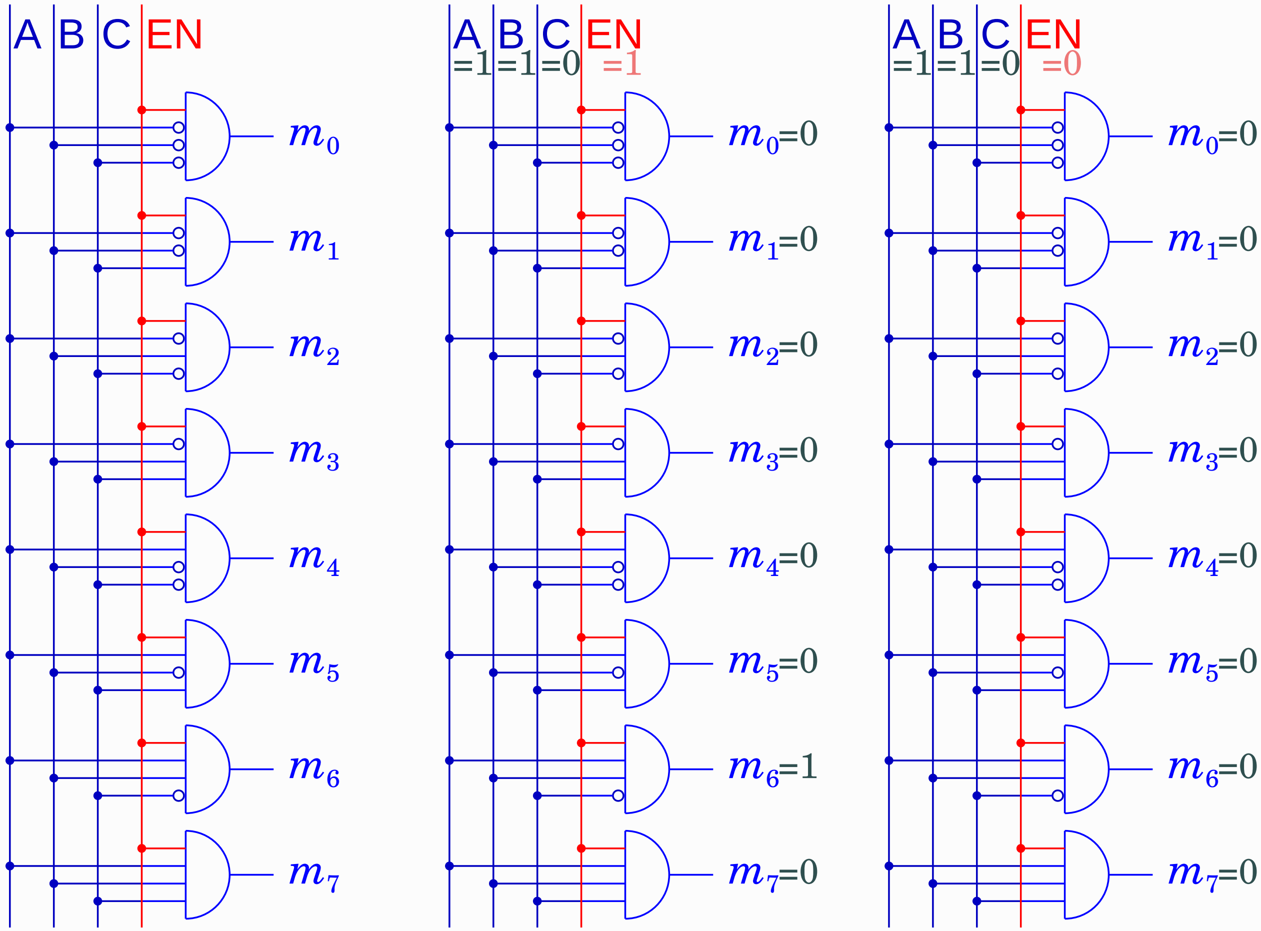
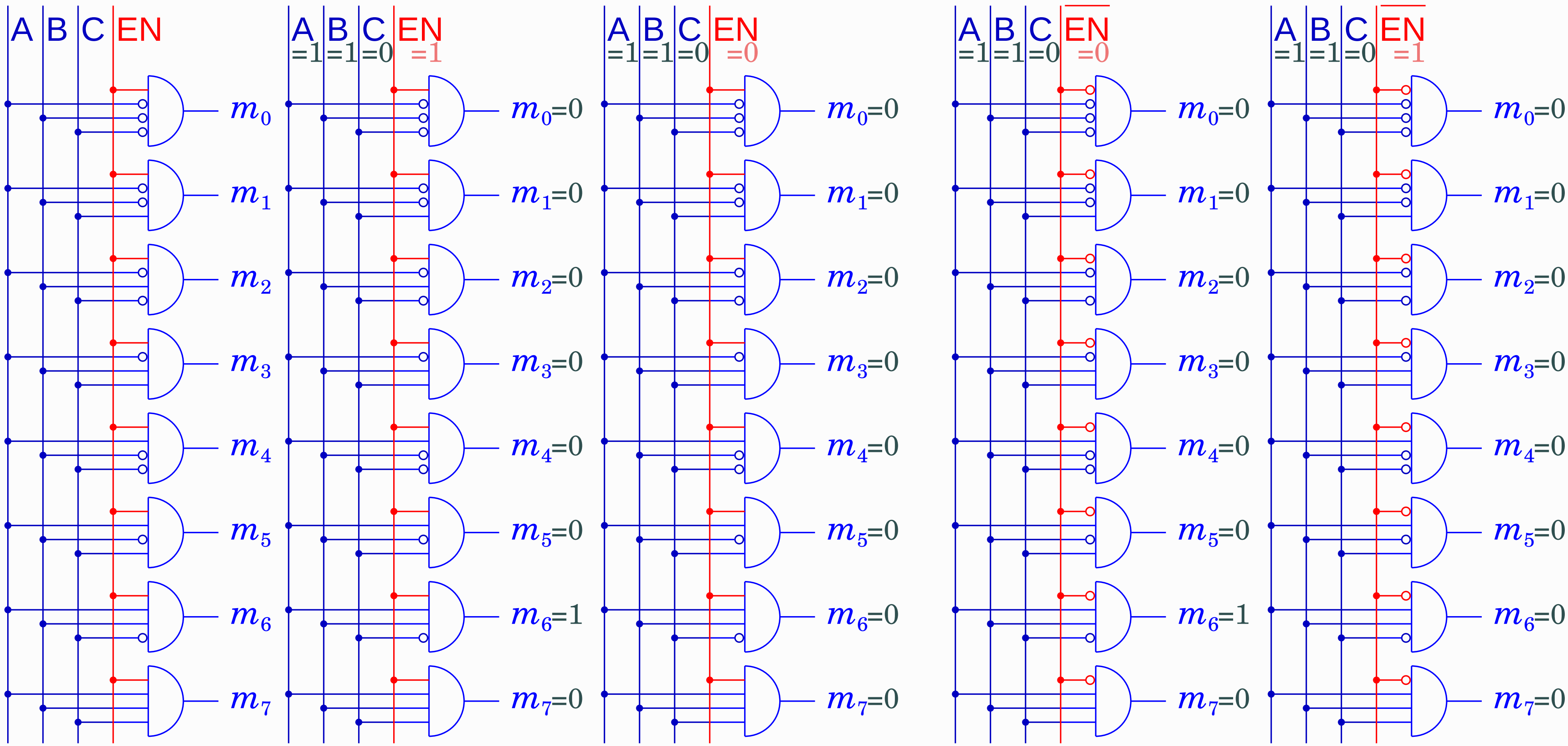


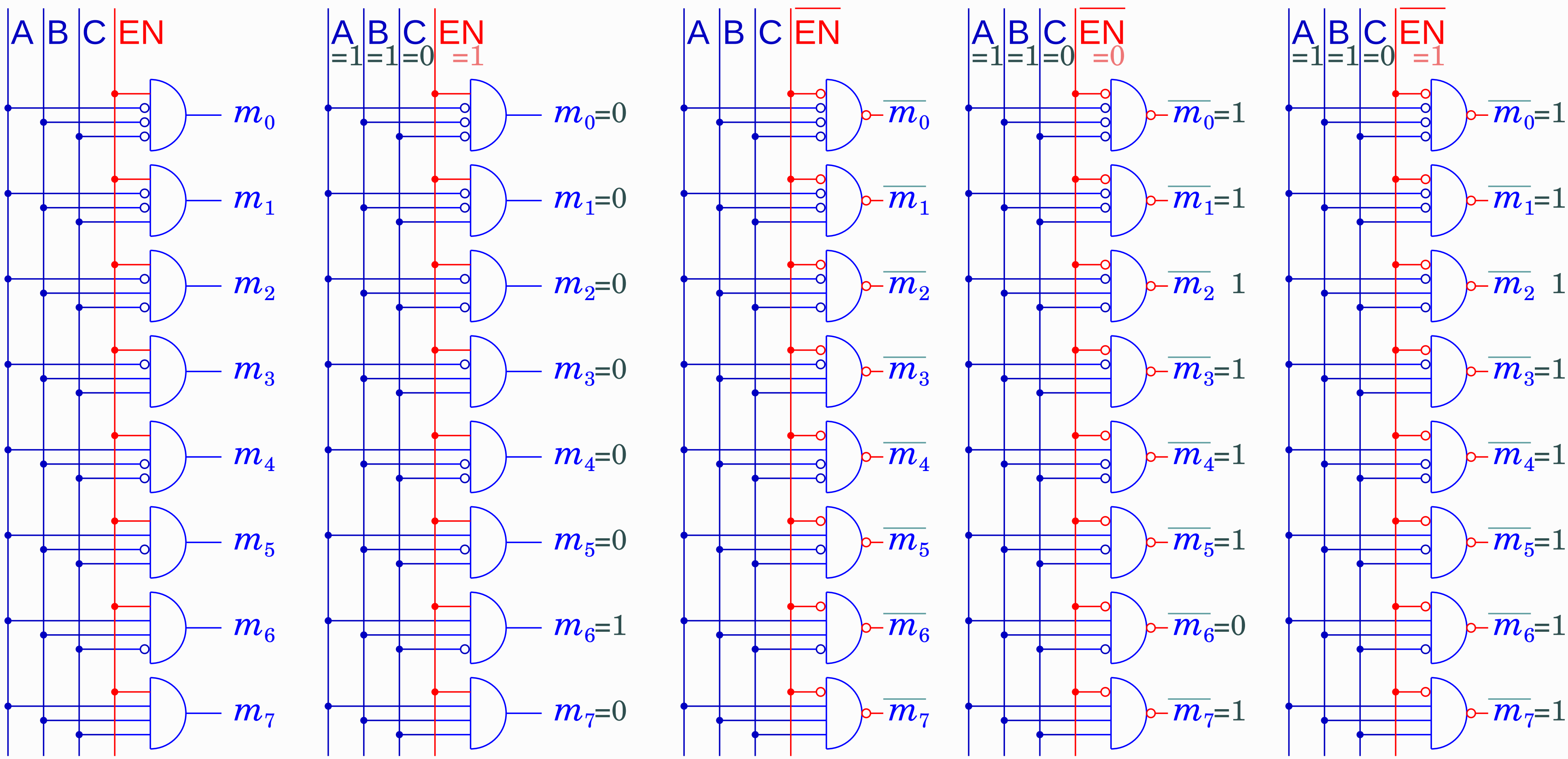
# Descodificadores com entradas de controlo

***Enable* ($\overline{EN}$)** (activo em 0) $\Longrightarrow$ **Habilita ou não o funcionamento normal do descodificador**

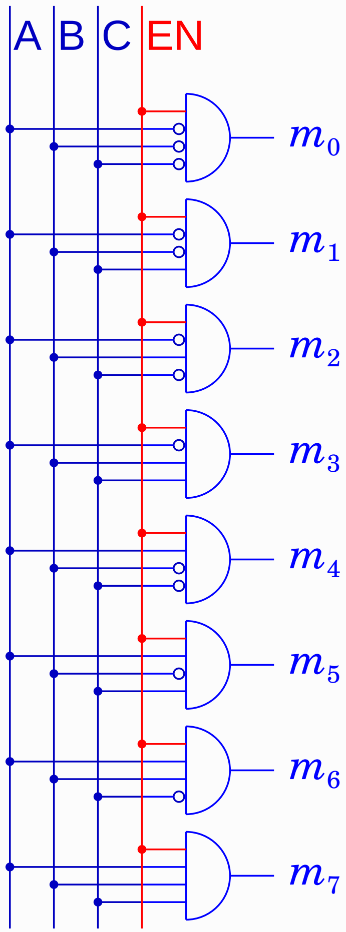


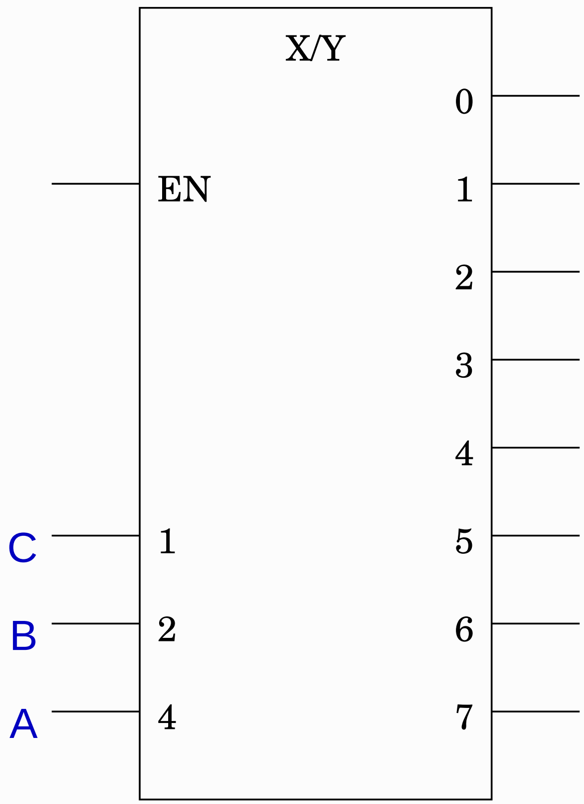
# Descodificadores - nível de actividade da saída

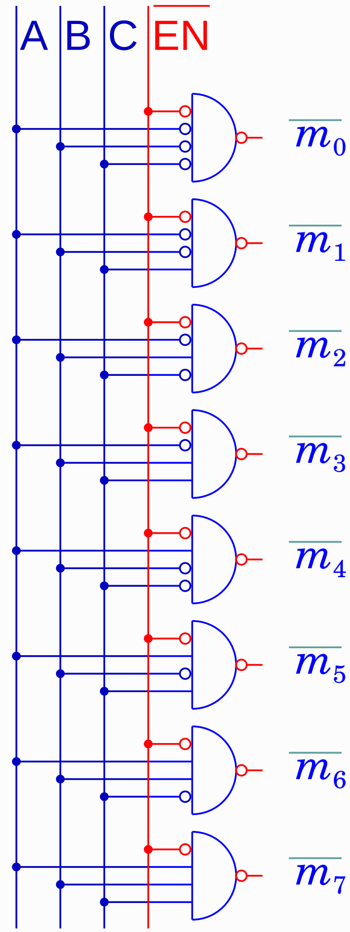
*Saídas activas em 1 ou em 0* $\Longrightarrow$ **Saída seleccionada aparece a 1 ou 0 lógico respectivamente**

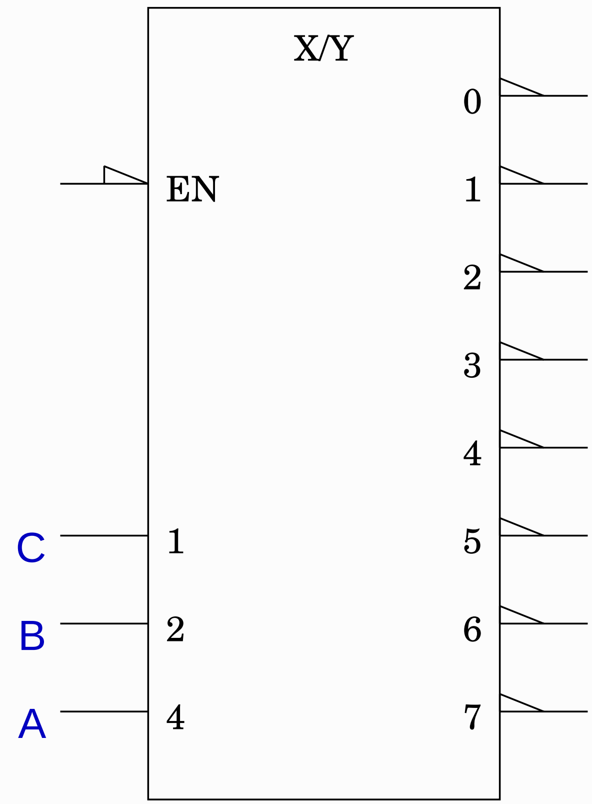


# Descodificadores - simbologia do IEEE

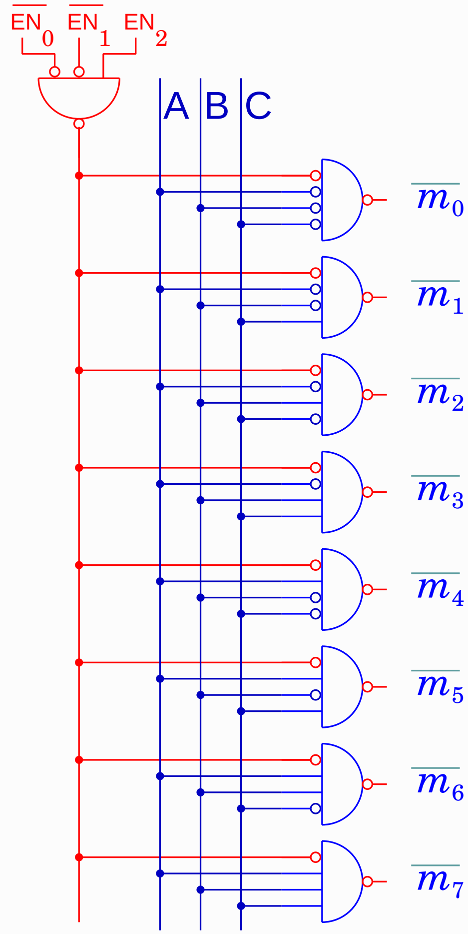


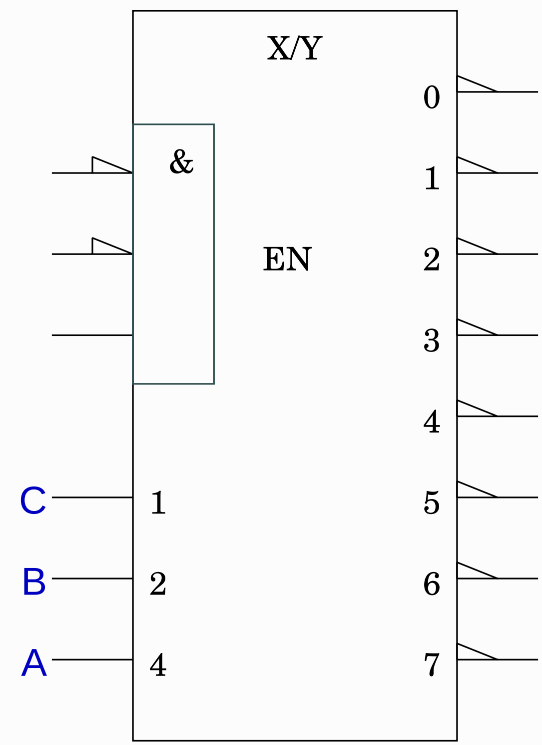



# Descodificadores - circuito ’138




*2 Enable activos em 0*
*1 Enable activo em 1*
*Saídas activas em 0*



# Conversores e codificadores

$$\mathbf{F} = m_1 + m_5 + m_6 + m_7 = \overline{\mathbf{A}}\cdot\overline{\mathbf{B}}\cdot\mathbf{C} + \mathbf{A}\cdot\overline{\mathbf{B}}\cdot\mathbf{C} + \mathbf{A}\cdot\mathbf{B}\cdot\overline{\mathbf{C}} + \mathbf{A}\cdot\mathbf{B}\cdot\mathbf{C}$$