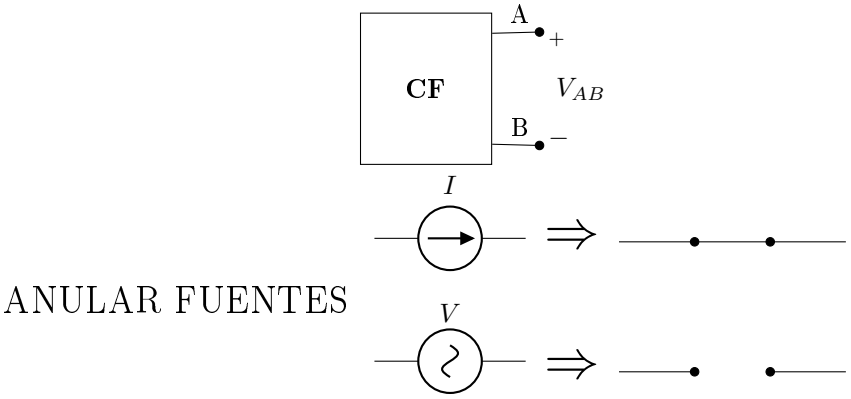
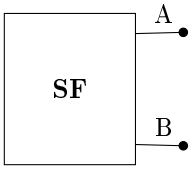
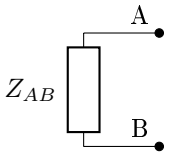
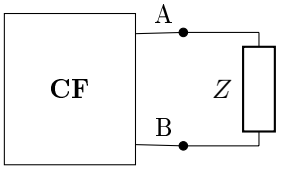


ANULAR FUENTES

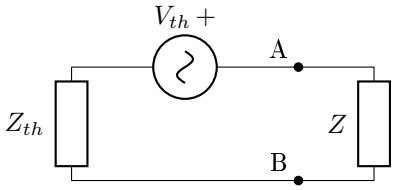


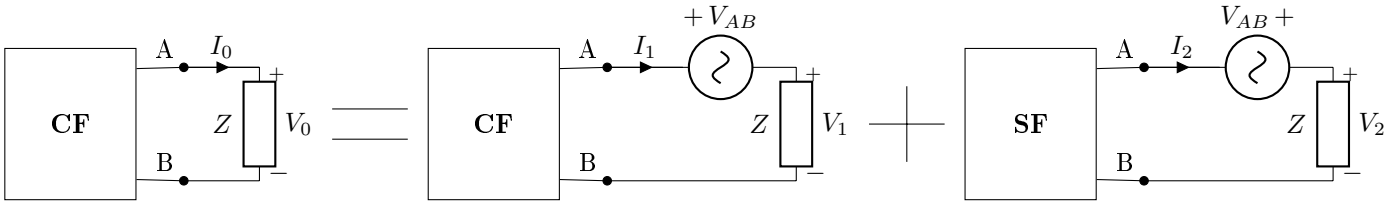
mido

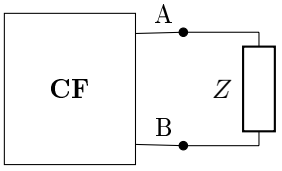




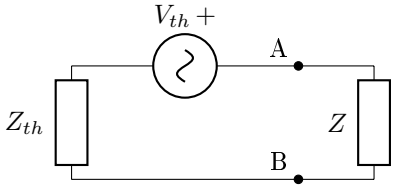
equivale a

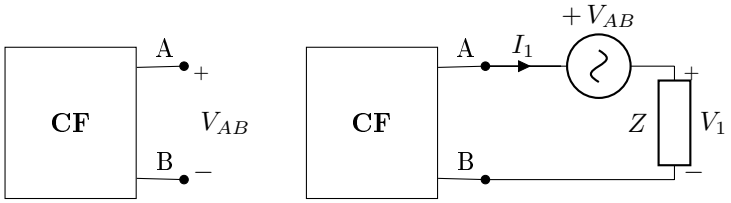


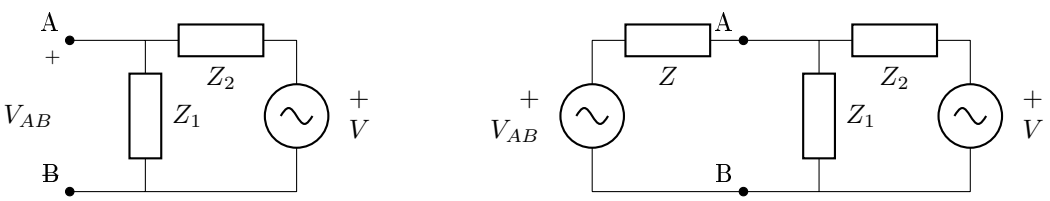


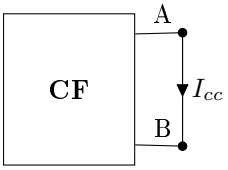


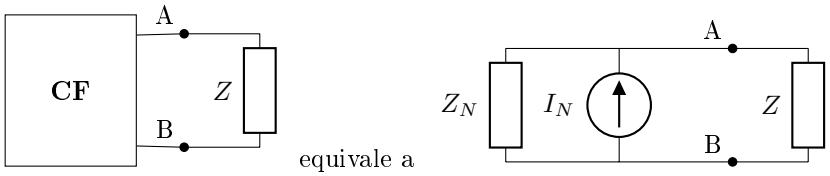
equivale a

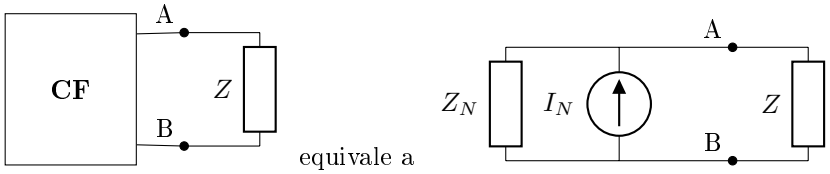


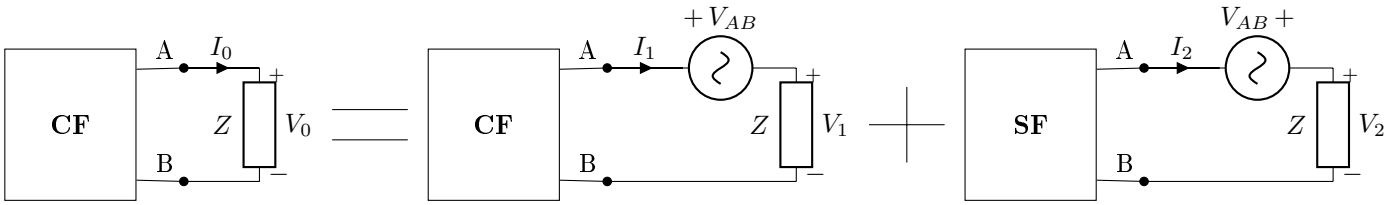




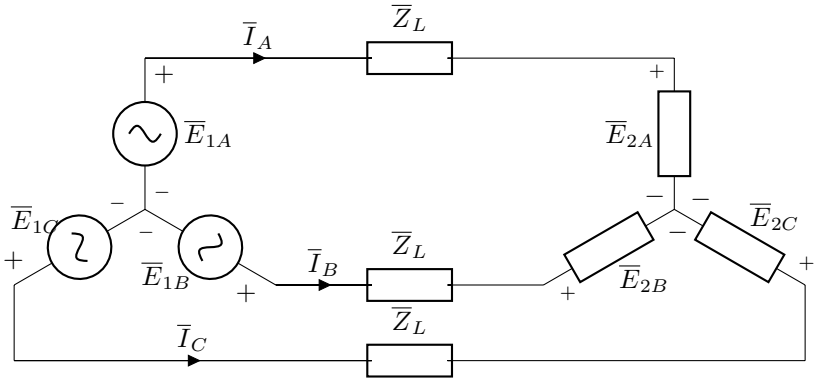


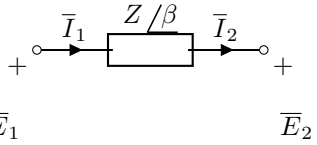

CF
A
B
Z
equivale a
Z_N
I_N

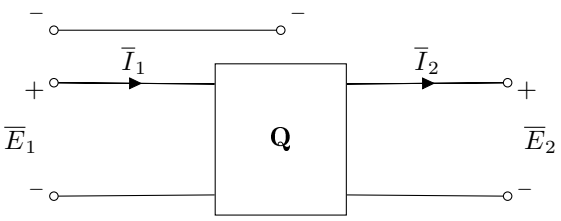

CF
A
B
Z
equivale a
Z_N
I_N

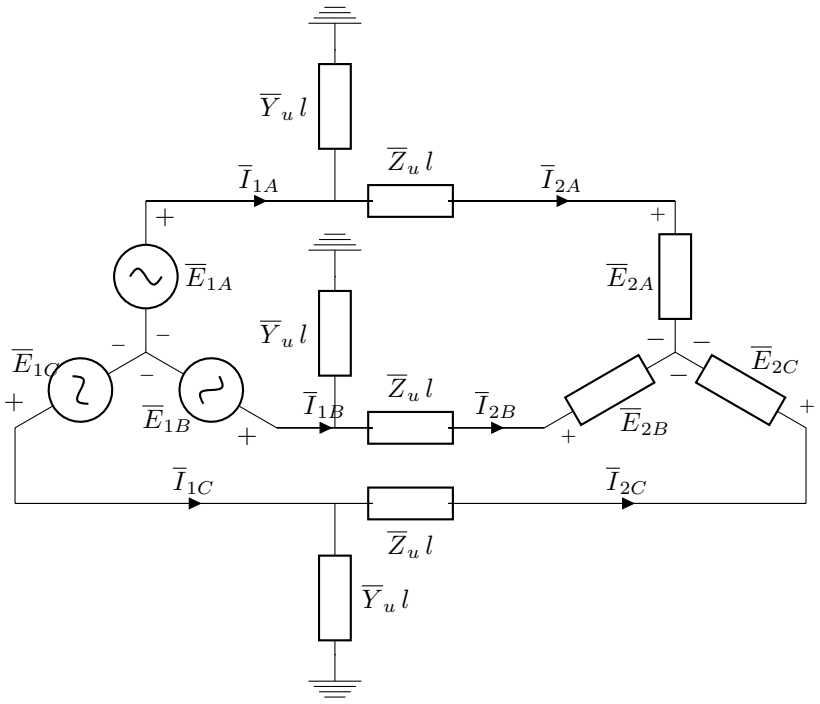

CF
A
I_0
Z
V_0
B
CF
$+V_{AB}$
I_1
V_1
SF
$V_{AB}+$
I_2
V_2

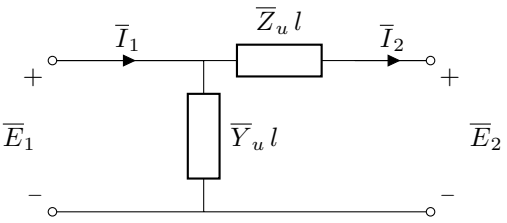
SEE

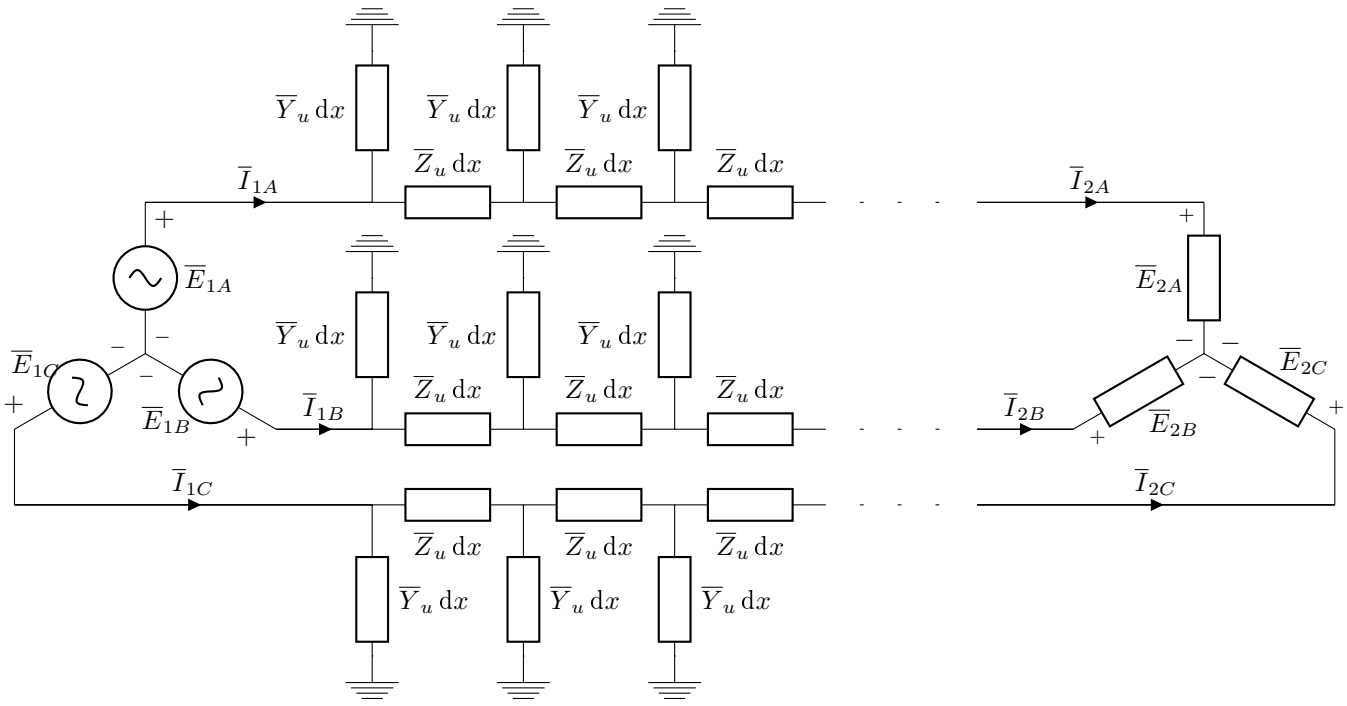

$\overline{I}_A$
$\overline{Z}_L$
$\overline{E}_{1A}$
$\overline{E}_{2A}$
$\overline{E}_{1C}$
$\overline{E}_{1B}$
$\overline{I}_B$
$\overline{Z}_L$
$\overline{E}_{2B}$
$\overline{E}_{2C}$
$\overline{I}_C$
$\overline{Z}_L$

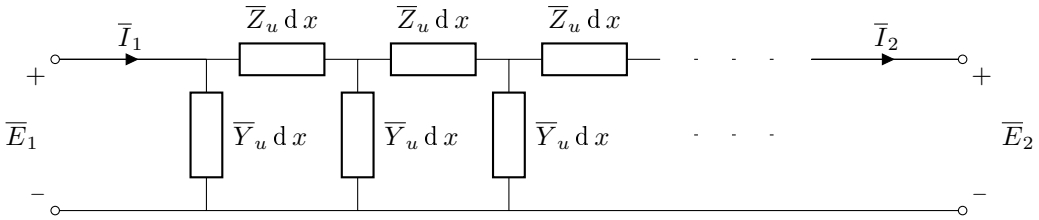

$\overline{I}_1$
$Z\angle\beta$
$\overline{I}_2$
$\overline{E}_1$
$\overline{E}_2$

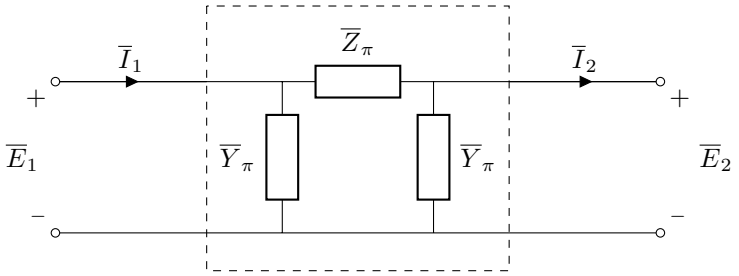

$\overline{I}_1$
$\overline{I}_2$
$\overline{E}_1$
Q
$\overline{E}_2$

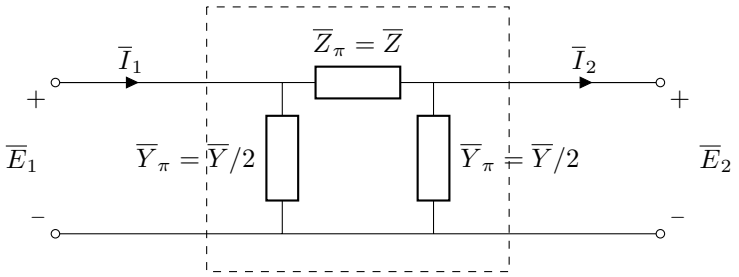

$\overline{Y}_u\,l$
$\overline{Z}_u\,l$
$\overline{I}_{1A}$
$\overline{I}_{2A}$
$\overline{E}_{1A}$
$\overline{E}_{2A}$
$\overline{Y}_u\,l$
$\overline{E}_{1C}$
$\overline{E}_{2C}$
$\overline{Z}_u\,l$
$\overline{I}_{1B}$
$\overline{I}_{2B}$
$\overline{E}_{1B}$
$\overline{E}_{2B}$
$\overline{I}_{1C}$
$\overline{I}_{2C}$
$\overline{Z}_u\,l$
$\overline{Y}_u\,l$

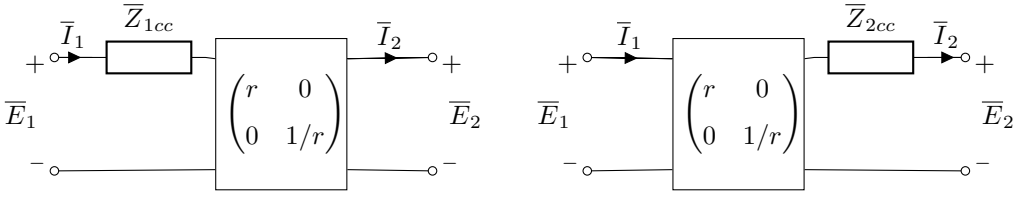

$\overline{I}_1$
$\overline{Z}_u\,l$
$\overline{I}_2$
$\overline{E}_1$
$\overline{Y}_u\,l$
$\overline{E}_2$

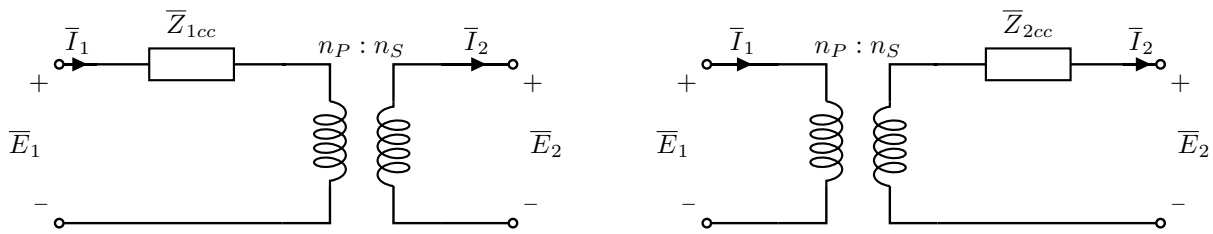

$\overline{Y}_u\,\mathrm{d}x$
$\overline{Z}_u\,\mathrm{d}x$
$\overline{I}_{1A}$
$\overline{I}_{1B}$
$\overline{I}_{1C}$
$\overline{E}_{1A}$
$\overline{E}_{1B}$
$\overline{E}_{1C}$
$\overline{I}_{2A}$
$\overline{I}_{2B}$
$\overline{I}_{2C}$
$\overline{E}_{2A}$
$\overline{E}_{2B}$
$\overline{E}_{2C}$

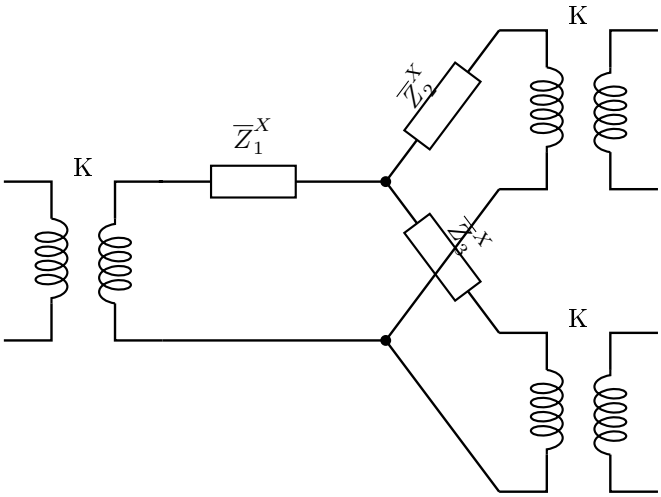

$\overline{Z}_u\,\mathrm{d}\,x$
$\overline{Y}_u\,\mathrm{d}\,x$
$\overline{I}_1$
$\overline{I}_2$
$\overline{E}_1$
$\overline{E}_2$


$\overline{Z}_\pi$
$\overline{Y}_\pi$
$\overline{I}_1$
$\overline{I}_2$
$\overline{E}_1$
$\overline{E}_2$

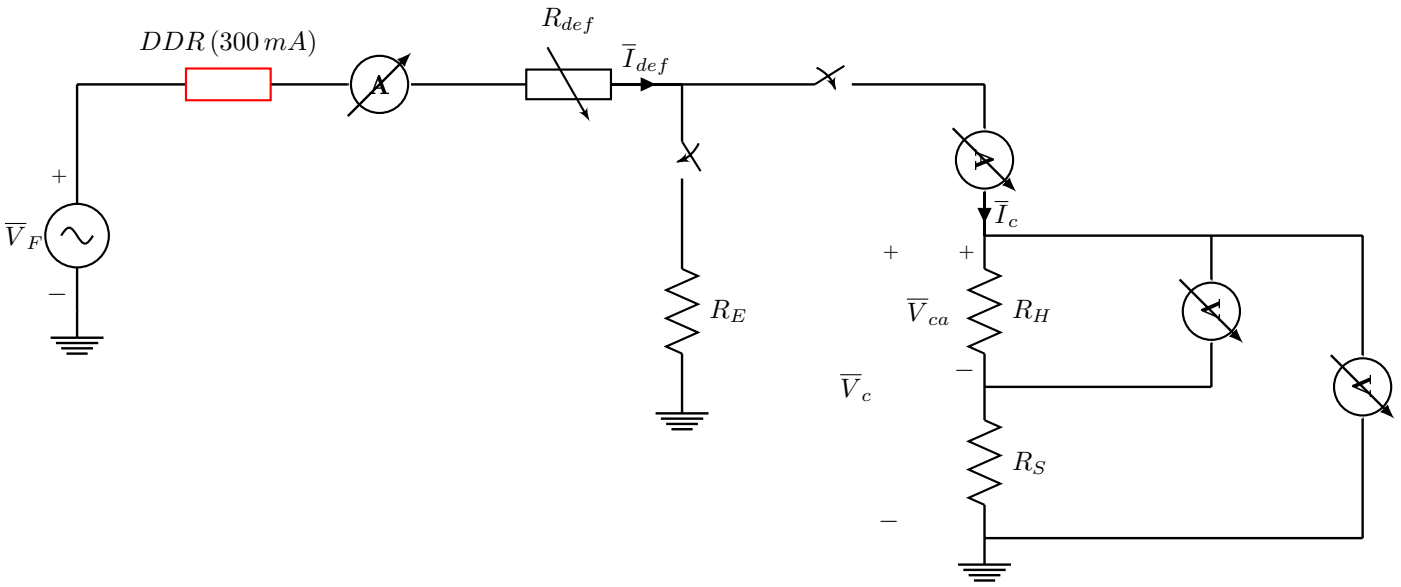

$\overline{Z}_\pi = \overline{Z}$
$\overline{Y}_\pi = \overline{Y}/2$
$\overline{I}_1$
$\overline{I}_2$
$\overline{E}_1$
$\overline{E}_2$


$\overline{Z}_{1cc}$
$\overline{Z}_{2cc}$
$\begin{pmatrix} r & 0 \\ 0 & 1/r \end{pmatrix}$
$\overline{I}_1$
$\overline{I}_2$
$\overline{E}_1$
$\overline{E}_2$

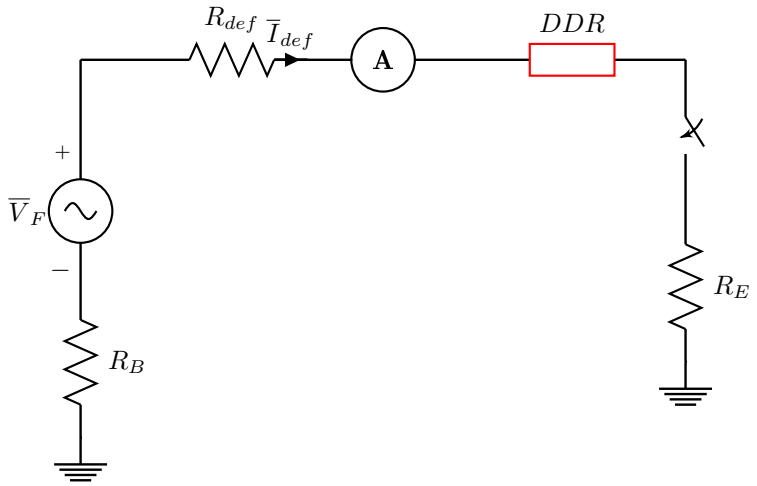

$\overline{Z}_{1cc}$
$\overline{Z}_{2cc}$
$n_P : n_S$
$\overline{I}_1$
$\overline{I}_2$
$\overline{E}_1$
$\overline{E}_2$


K
$\overline{Z}_1^X$
$\overline{Z}_2^X$
$\overline{Z}_2^Y$
K
K

CdeIEBT


$DDR\,(300\,mA)$
R_{def}
$\overline{I}_{def}$
$\overline{V}_F$
R_E
$\overline{I}_c$
$\overline{V}_{ca}$
R_H
$\overline{V}_c$
R_S

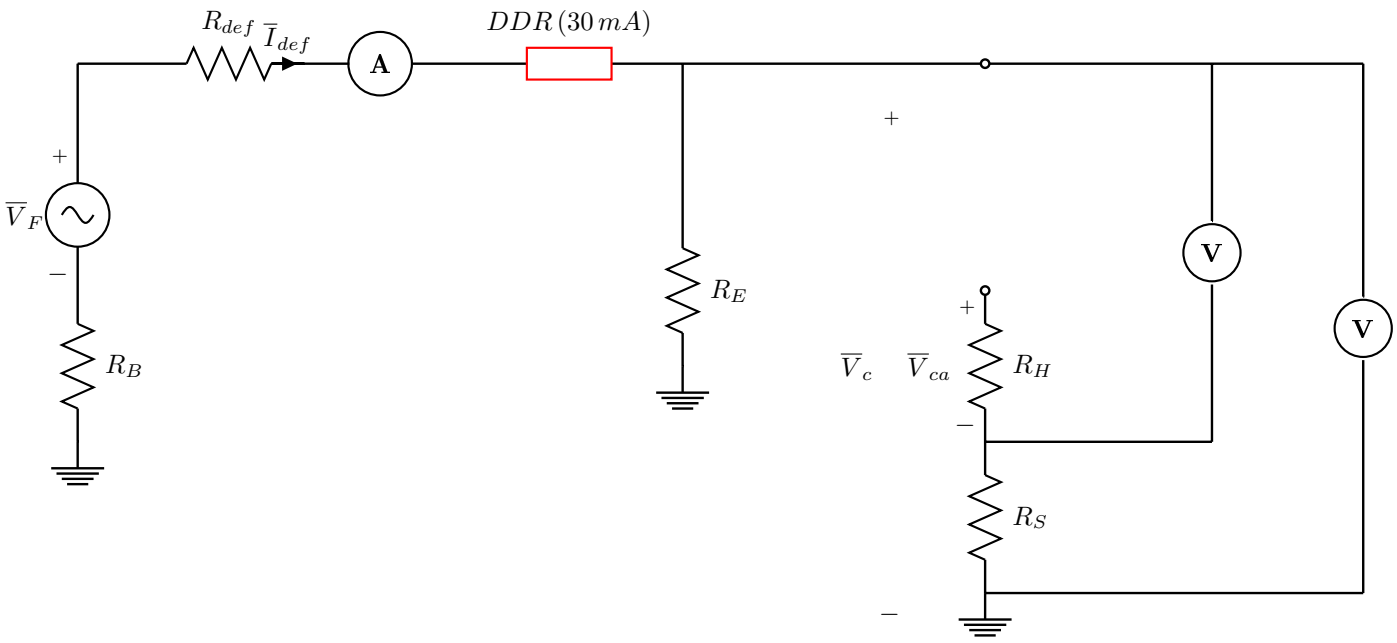
Si no toca un humano, $R_H = \infty$ y variando I_d y R_{def}

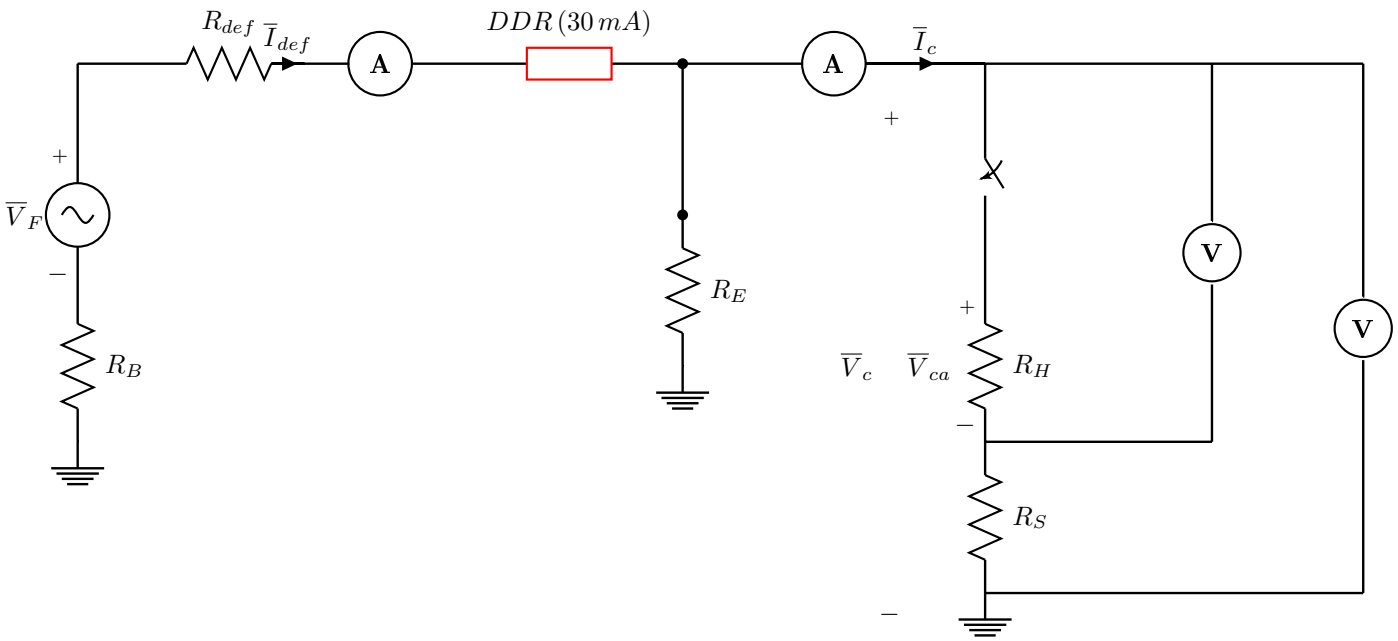


Sustituyendo con DDR de sensibilidad 30 mA ó 300 mA, el disparo es seguro si R_{def} vale:

$$
R_{def} = U_F/Id - (R_B + R_E) \begin{cases}
\xrightarrow[Id \geq 30\,mA = I_{\Delta n}]{} \begin{cases}
\xrightarrow[Id \geq 30mA = I_{\Delta n}]{R_E = 3\,\Omega} & R_{def} \leq 230/(30 \cdot 10^{-3}) - (30 + 3) = 7{,}6337\,k\Omega \\
\xrightarrow[Id \geq 30mA = I_{\Delta n}]{R_E = 9\,\Omega} & R_{def} \leq 230/(30 \cdot 10^{-3}) - (30 + 9) = 7{,}6277\,k\Omega \\
\xrightarrow[Id \geq 30mA = I_{\Delta n}]{R_E = 35\,\Omega} & R_{def} \leq 230/(30 \cdot 10^{-3}) - (30 + 35) = 7{,}6017\,k\Omega \\
\xrightarrow[Id \geq 30mA = I_{\Delta n}]{R_E = 790\,\Omega} & R_{def} \leq 230/(30 \cdot 10^{-3}) - (30 + 790) = 6{,}8467\,k\Omega \\
\xrightarrow[Id \geq 30mA = I_{\Delta n}]{R_E = \infty\,\Omega} & R_{def} \leq 230/(30 \cdot 10^{-3}) - (30 + \infty) = -\infty\,\Omega
\end{cases} \\
\xrightarrow[Id \geq 300\,mA = I_{\Delta n}]{} \begin{cases}
\xrightarrow[Id \geq 300mA = I_{\Delta n}]{R_E = 3\,\Omega} & R_{def} \leq 230/(300 \cdot 10^{-3}) - (30 + 3) = 733{,}6667\,\Omega \\
\xrightarrow[Id \geq 300mA = I_{\Delta n}]{R_E = 9\,\Omega} & R_{def} \leq 230/(300 \cdot 10^{-3}) - (30 + 9) = 727{,}6667\,\Omega \\
\xrightarrow[Id \geq 300mA = I_{\Delta n}]{R_E = 35\,\Omega} & R_{def} \leq 230/(300 \cdot 10^{-3}) - (30 + 35) = 701{,}6667\,\Omega \\
\xrightarrow[Id \geq 300mA = I_{\Delta n}]{R_E = 790\,\Omega} & R_{def} \leq 230/(300 \cdot 10^{-3}) - (30 + 790) = -53{,}3333\,\Omega \\
\xrightarrow[Id \geq 300mA = I_{\Delta n}]{R_E = \infty\,\Omega} & R_{def} \leq 230/(300 \cdot 10^{-3}) - (30 + \infty) = -\infty\,\Omega
\end{cases}
\end{cases}
$$

$$
\begin{array}{rcccl}
I_{def} & = & \dfrac{U_F}{R_B + R_{def} + R_E} & = & \dfrac{230}{820 + R_{def}} \\
V_c & = & I_{def} \cdot R_E & = & I_{def} \cdot 790
\end{array}
\begin{cases}
R_{def} = 0\,\Omega \Rightarrow \begin{cases} I_{def} = \dfrac{230}{820 + 0} = 0{,}2805\,A \\ V_c = 0{,}2805 \cdot 790 = 221{,}50\,V \end{cases} \\
R_{def} = 5\,k\Omega \Rightarrow \begin{cases} I_{def} = \dfrac{230}{820 + 5000} = 0{,}0395\,A \\ V_c = 0{,}0395 \cdot 790 = 31{,}22\,V \end{cases} \\
R_{def} = 10\,k\Omega \Rightarrow \begin{cases} I_{def} = \dfrac{230}{820 + 10000} = 0{,}0213\,A \\ V_c = 0{,}0213 \cdot 790 = 16{,}7930\,V \end{cases} \\
R_{def} = 15\,k\Omega \Rightarrow \begin{cases} I_{def} = \dfrac{230}{820 + 15000} = 0{,}0145\,A \\ V_c = 0{,}0145 \cdot 790 = 11{,}4855\,V \end{cases}
\end{cases}
$$


R_{def}
$\overline{I}_{def}$
A
$DDR\,(30\,mA)$
+
$\overline{V}_F$
−
R_B
R_E
+
V
V
$\overline{V}_c$
$\overline{V}_{ca}$
+
R_H
−
R_S
−



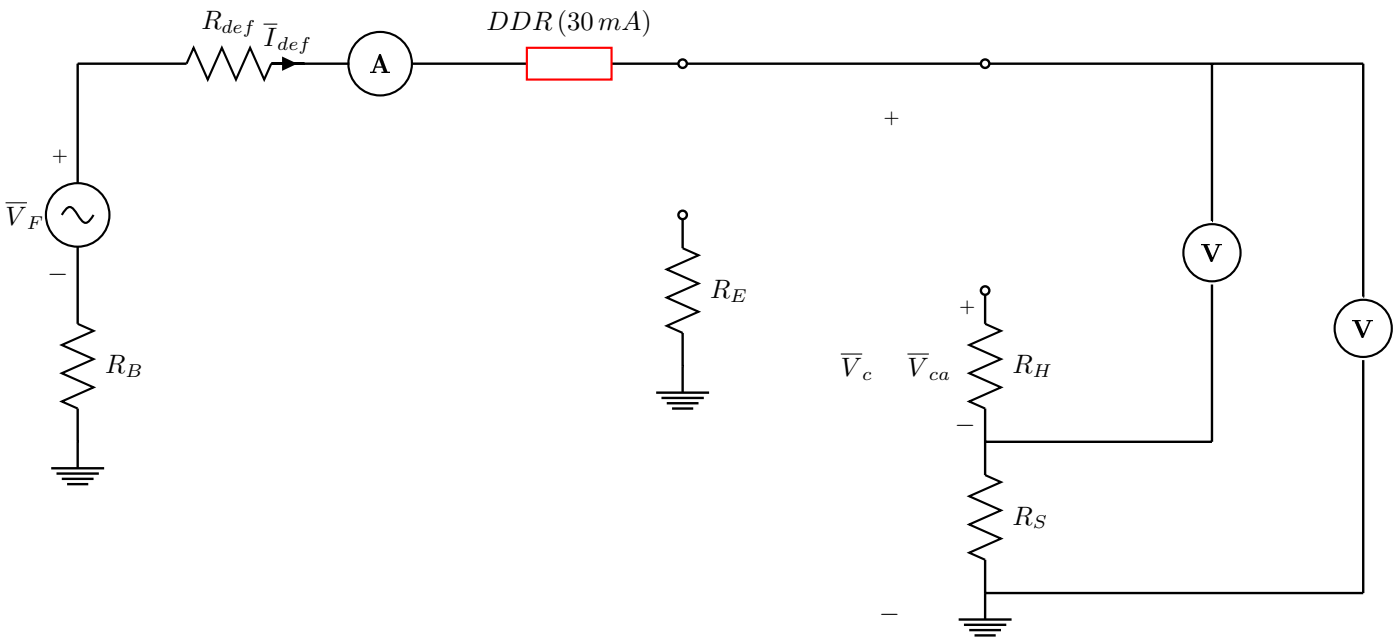
Sustituyendo con $R_B = 30\,\Omega$, $R_E = 790\,\Omega$, $R_H = 2500\,\Omega$ y variando R_{def} y R_S:

$$I_{def} = \frac{U_F}{R_B + R_{def} + \dfrac{R_E \cdot (R_H + R_S)}{R_E + (R_H + R_S)}}$$

$$V_c = I_{def} \cdot \frac{R_E \cdot (R_H + R_S)}{R_E + (R_H + R_S)}$$

$$I_c = \frac{V_c}{R_H + R_S}$$

$$V_{ca} = I_c \cdot R_H$$


R_{def}
$\overline{I}_{def}$
A
$DDR\,(30\,mA)$
+
$\overline{V}_F$
−
R_B
R_E
+
V
V
$\overline{V}_c$
$\overline{V}_{ca}$
R_H
−
R_S
−

Sustituyendo con $R_B = 30\,\Omega$, $R_H = 2500\,\Omega$ y variando R_{def} y R_S:

$$I_{def} = \frac{U_F}{R_B + R_{def} + R_H + R_S}$$

$$V_c = I_{def} \cdot (R_H + R_S)$$

$$V_{ca} = I_{def} \cdot R_H$$

El caso peor posible si se corta la puesta a tierra de las masas es con I_{def} justo por debajo de la sensiblidad del DDR y $R_s = 0$, ya que V_{ca} maxima y de valor 75 V:

$$R_{def} = \frac{U_F}{I_{def}} - (R_B + R_H + R_S) = \frac{230}{30 \cdot 10^{-3}} - (30 + 2500 + 0) = 5{,}14\,k\Omega$$

$$V_{ca} = I_{def} \cdot R_H = 30 \cdot 10^{-3} \cdot 2500 = 75\,V$$