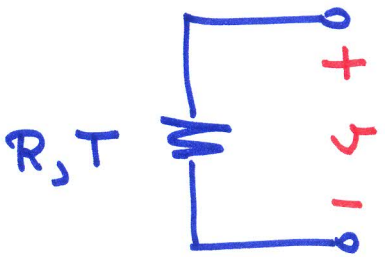
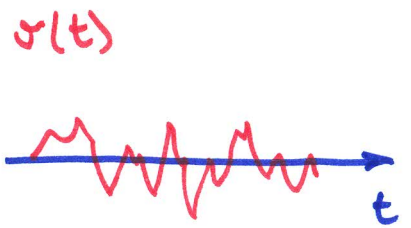
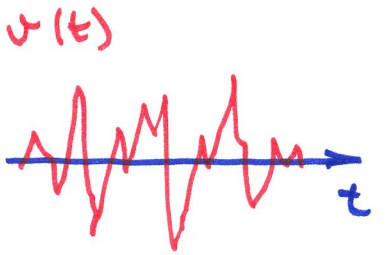
Ruido





$T = T_1$

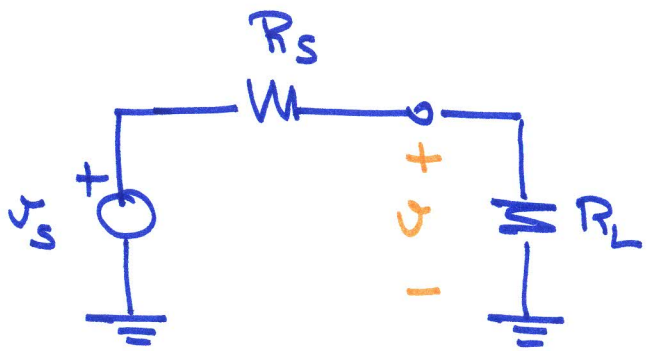


$T = T_2 > T_1$

$$\overline{v^2} = \underbrace{4KTR}\,\Delta f \quad ; \quad \bar{v} = 0$$

↑ densidad espectral de potencia de ruido térmico

Potencia disponible



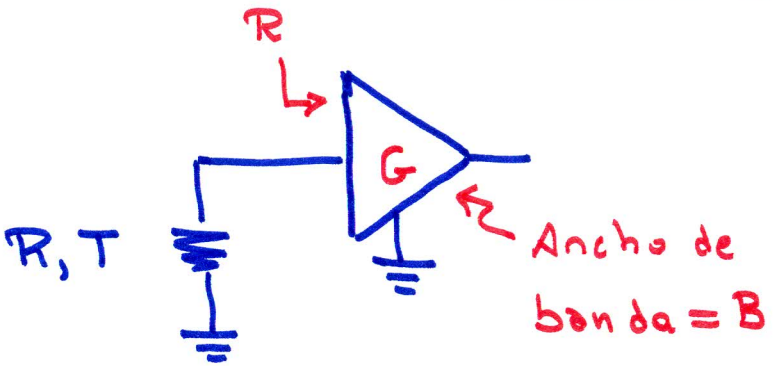
$$p(t) = \frac{v^2(t)}{R_L}$$

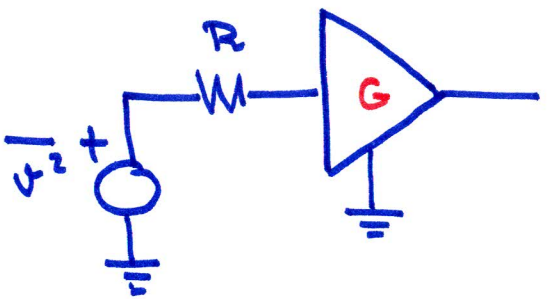
$p(t)$ es máxima si $R_L = R_S \Rightarrow v = \frac{v_s}{2}$

$$p(t)_{max} = \frac{v_s^2}{4R_L} \Rightarrow P \equiv \overline{p(t)}_{max} = \frac{\overline{v_s^2}}{4R_L}$$

potencia disponible

Ruido en amplificadores





Potencia disponible a la entrada: $N_i = \frac{\overline{v^2}}{4R} = KTB$

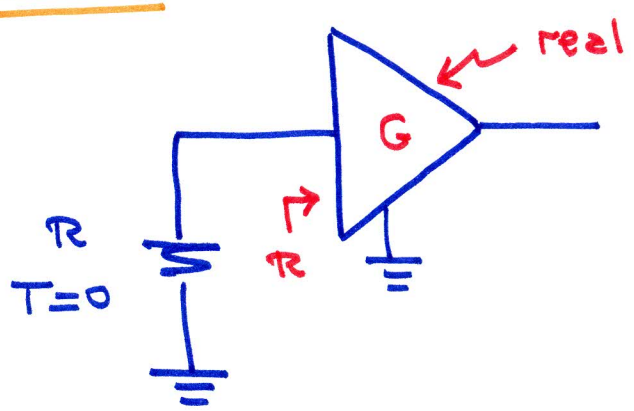
no depende de R

Potencia disponible a la salida: $N_o = G N_i + N_{emp}$

$$\left(\frac{S}{N}\right)_o = \frac{G S_i}{G N_i + N_{amp}} < \left(\frac{S}{N}\right)_i$$

Temperatura de ruido

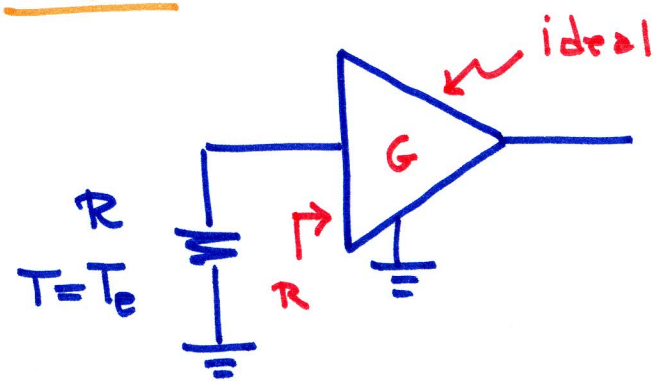
Caso 1



N_o producido por el amplificador

↑ potencia de ruido disponible a la salida.

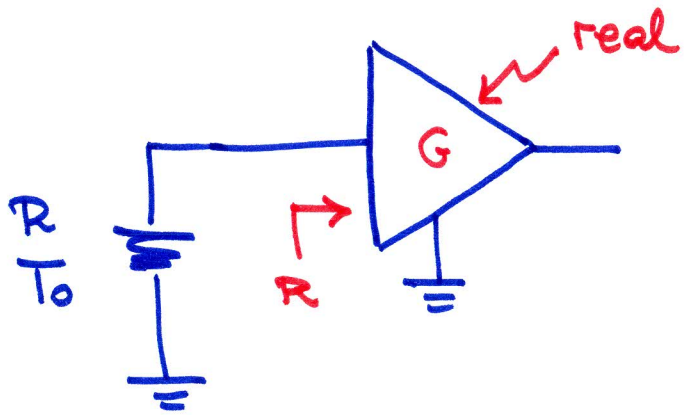
Caso 2



$$N_o = \underbrace{K T_e B}_{\text{potencia de ruido a la entrada}} \cdot G$$

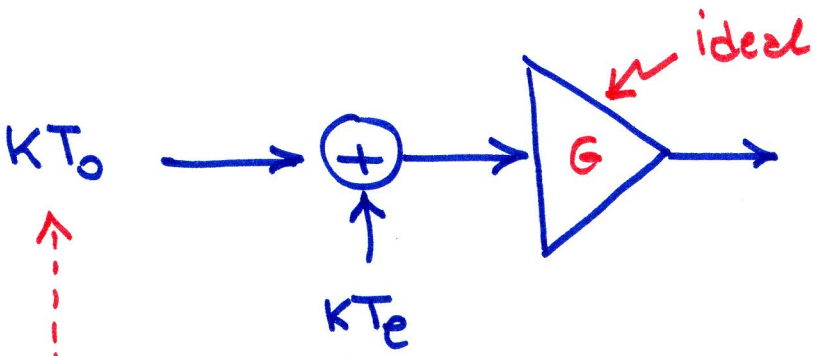
$T_e \equiv$ temperatura equivalente de ruido

Caso 3



$$N_o = K\,(T_o + T_e)\,B\,G$$

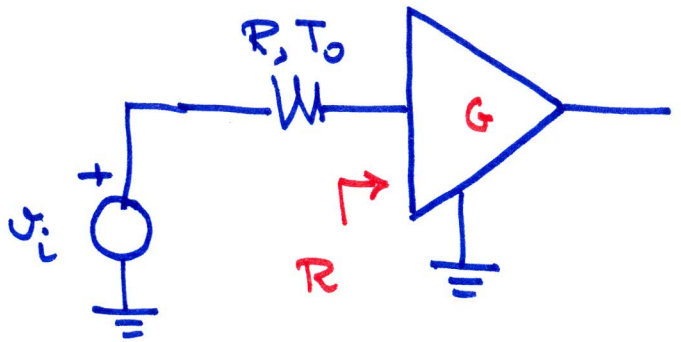
Sistema equivalente:



$$N_o = K\,(T_o + T_e)\,B\,G$$

densidad espectral de potencia disponible

Caso 4



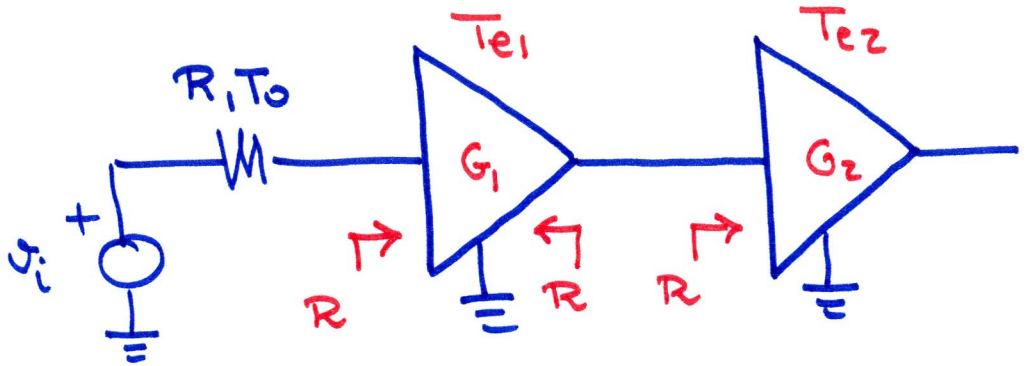
Señal $\quad S_o = G\,S_i$

Ruido $\quad N_o = GK(T_o + T_e)B$

$$\left(\frac{S}{N}\right)_o = \frac{S_i}{KT_oB}\;\frac{1}{1+T_e/T_o}$$

$$= \left(\frac{S}{N}\right)_i \frac{1}{1+T_e/T_o} \xrightarrow[T_e \ll T_o]{} \left(\frac{S}{N}\right)_i$$

Caso 5



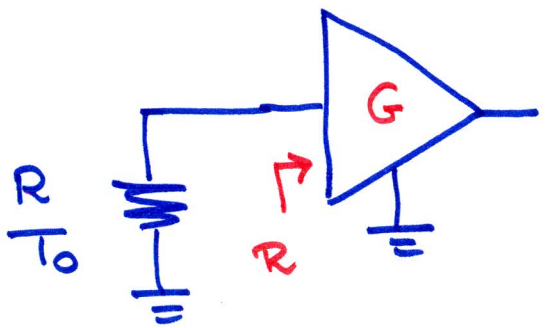
Amplificadores con ancho de banda B

$$N_o = G_1 G_2 K T_o B + G_1 G_2 K T_{e1} B + G_2 K T_{e2} B$$

$$= G_1 G_2 K B \left\{ T_o + T_{e1} + \frac{T_{e2}}{G_1} \right\}$$

Interesa que $T_{e1} \ll T_o$ y que $G_1 \gg 1$

Figura de ruido



$$N_o = \underbrace{K T_o B G}_{N_i \cdot G} + \underbrace{K T_e B G}_{N_{amp}}$$

$$F \equiv \frac{\text{Ruido a la salida}}{\text{Ruido de entrada amplificado}} = \frac{N_o}{G N_i}$$

$$= 1 + \frac{T_e}{T_o}$$

$$\Rightarrow \quad \left(\frac{S}{N}\right)_o = \frac{1}{F} \left(\frac{S}{N}\right)_i$$