OPTIMUM R_S FOR MINIMUM NOISE

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$$E_t^2 = 4KTBR_s$$ - Thermal noise of source R_s

$$F = 1 + \frac{E_n^2 + I_n^2 R_s^2}{E_t^2}$$ Noise Factor

$$\frac{dF}{dR_s} = 0 + 4KTBR_s\left(0 + 2I_n^2 R_s\right) - \left(E_n^2 + I_n^2 R_s\right) 4KTB$$

set $\frac{dF}{dR_s} = 0$

$$2I_n^2 R_s^2 - E_n^2 - I_n^2 R_s^2 = 0$$

$$I_n^2 R_s^2 = E_n^2$$

$$\boxed{R_{Sopt} = \frac{E_n}{I_n}}$$

Optimum F when $R_s = R_{sopt}$

$$F_{opt} = 1 + \frac{E_n^2 + I_n^2 R_s^2}{4KTBR_s} = 1 + \frac{E_n^2 + I_n^2\left(\frac{E_n^2}{I_n^2}\right)}{4KTB\left(\frac{E_n}{I_n}\right)}$$

$$= 1 + \frac{2E_n^2}{4KTB\left(\frac{E_n}{I_n}\right)}$$

$$\boxed{F_{opt} = 1 + \frac{E_n I_n}{2KTB}}$$

Note that an artificially high Temperature or Bandwidth makes F_{opt} appear good (small).