



Noise in OA: comments

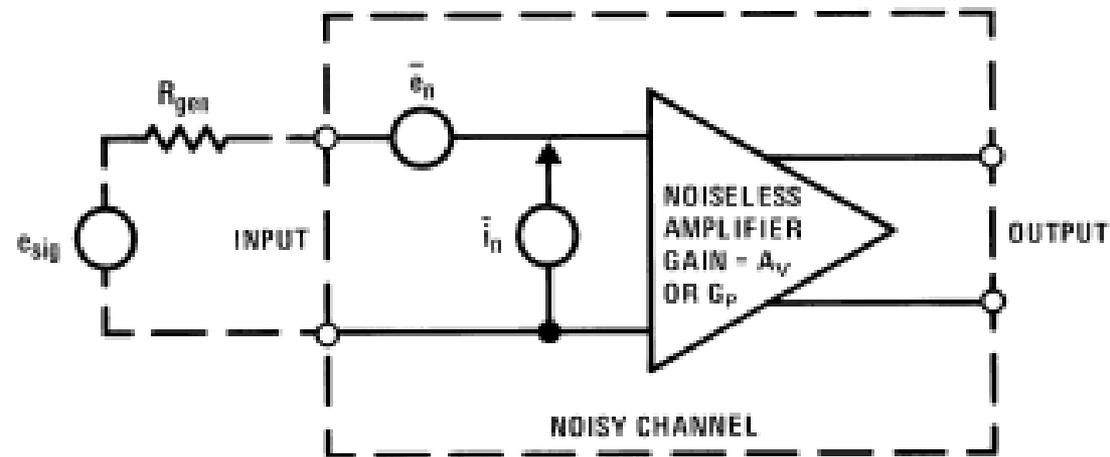
[AN-104; OP-27; OPA847]

To reduce output noise

do the following:

- band-limit the signal after the op amp to limit the final output noise
- reduce resistor values to lower thermal noise, but keep in mind that:
 - resistors connected to the input of *current-sensing amplifiers* act as current noise sources; *increase these resistor values to reduce thermal noise*

Contributions of e_n and i_n



(note: this is a slightly different model...)

$$\overline{e_N^2} = \overline{e_n^2} + \overline{e_R^2} + \overline{i_n^2 R_{gen}^2}$$

$$NF = 10 \log \frac{S_{in} \times N_{out}}{S_{out} \times N_{in}}$$

$$= 10 \log \frac{S_{in} G_p \overline{e_N^2}}{S_{in} G_p \overline{e_R^2}}$$

$$= 10 \log \frac{\overline{e_N^2}}{\overline{e_R^2}}$$

$$= 10 \log \frac{\overline{e_n^2} + \overline{e_R^2} + \overline{i_n^2 R_{gen}^2}}{\overline{e_R^2}}$$

$$NF = 10 \log \left(1 + \frac{\overline{e_n^2} + \overline{i_n^2} R_{gen}^2}{\overline{e_R^2}} \right)$$

- for small R_{gen} , noise voltage dominates
- for large R_{gen} , noise current becomes important

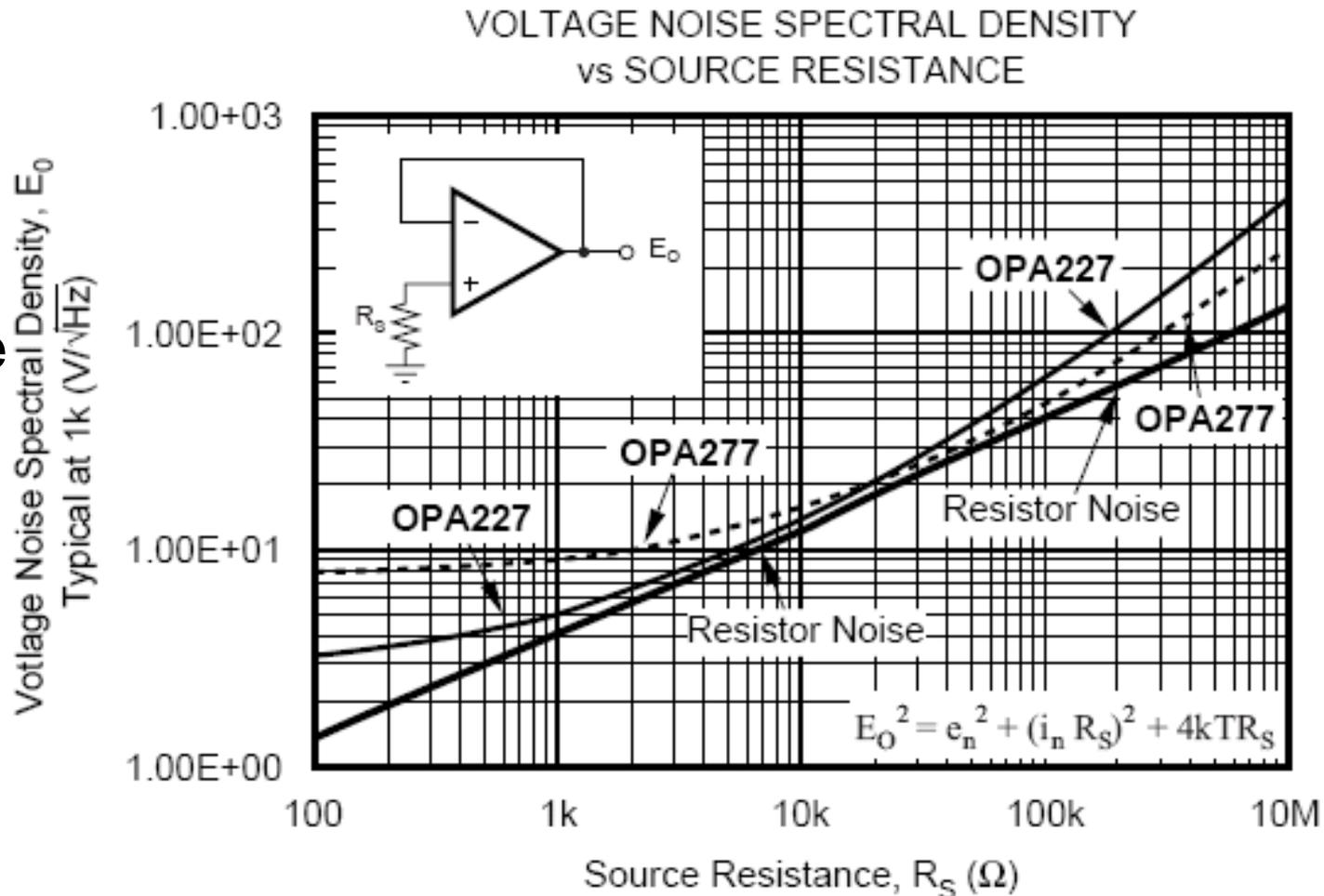
- prefer FET input amplifiers at high values of R_{gen}
 - FETs have essentially zero i_n

- note that for an NF value to have meaning, it must be accompanied by a value for R_{gen} as well as frequency

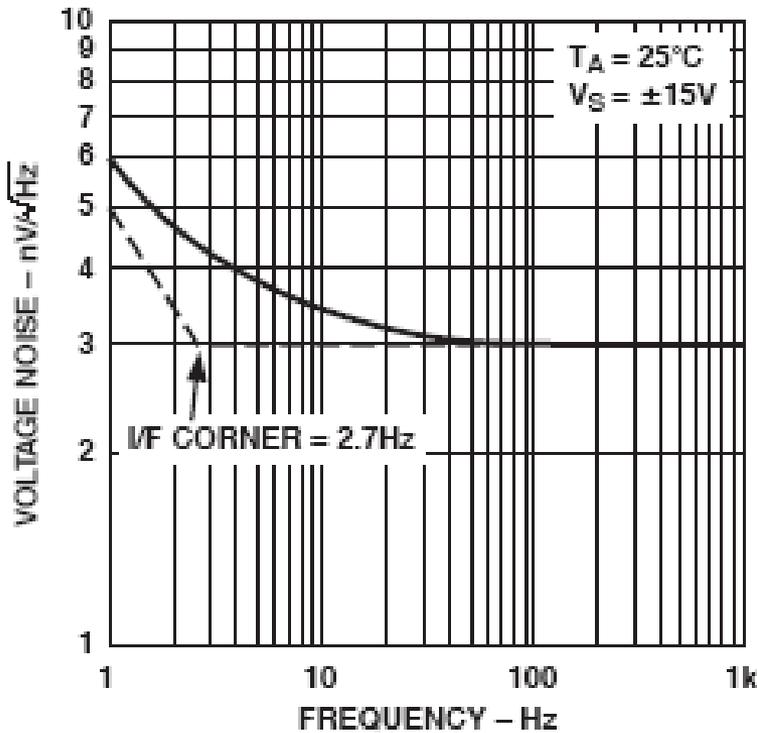
- In this example ($A_v=1$), the dependence on the source resistance is shown

OPA227: low e_n
 OPA277: low i_n

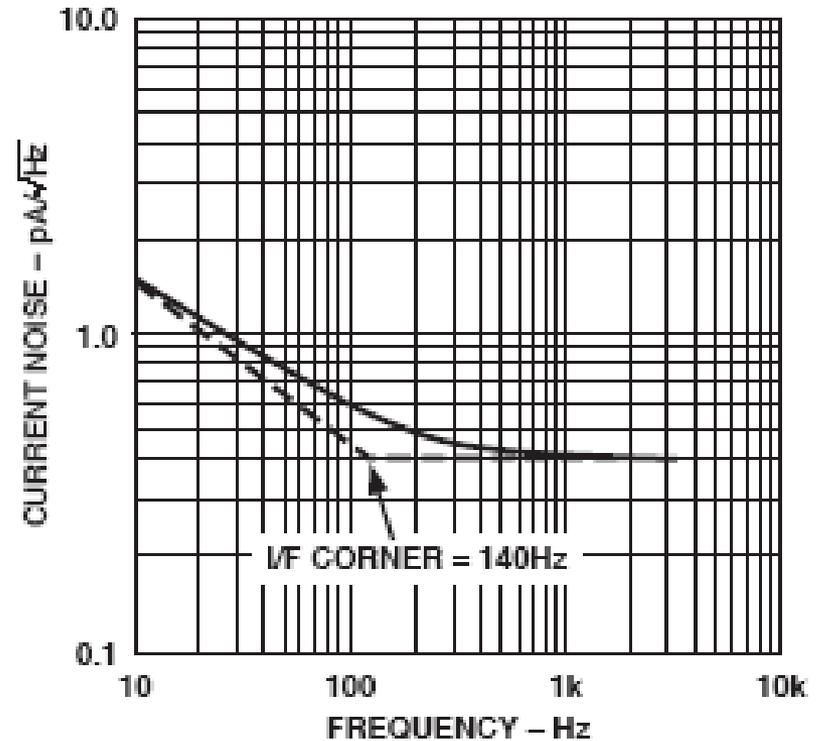
- i_n makes more noise on a larger R_s



Example: OP27



TPC 2. Voltage Noise Density vs. Frequency



TPC 8. Current Noise Density vs. Frequency

Example: OP27 at 1 KHz

- $R_S < 1 \text{ k}\Omega$: the OP27's low voltage noise is maintained

- $1 \text{ k}\Omega < R_S < 20 \text{ k}\Omega$: total noise increases, but is dominated by the resistor noise

- $R_S > 20 \text{ k}\Omega$: current noise starts to dominate.

- The crossover between the OP27, OP07, and OP08 noise occurs in the 15-40 k Ω region.

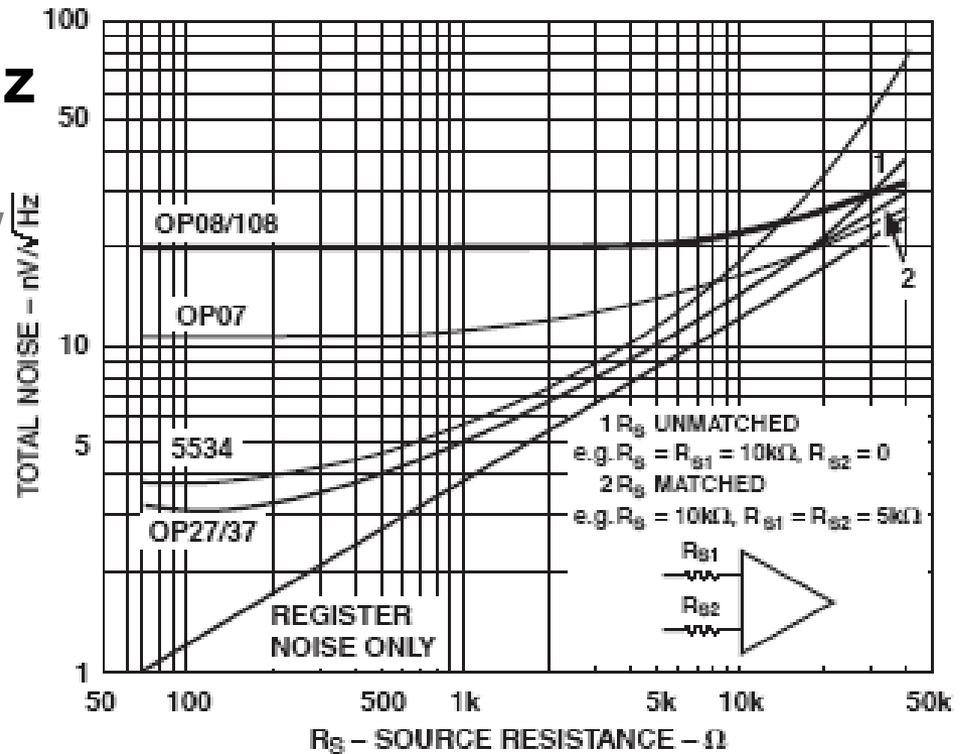


Figure 4. Noise vs. Source Resistance (Including Resistor Noise) at 1000 Hz

OP07, with respect to OP27, has

- higher e_n
- lower i_n

Example: OP27 at LF

- 0.1 Hz to 10 Hz: resistor noise is negligible and current noise becomes important because

- it is inversely proportional to the square root of frequency, and
- its corner frequency is higher than that of voltage noise

- Crossover with the OP07 occurs in the 3-5 k Ω range

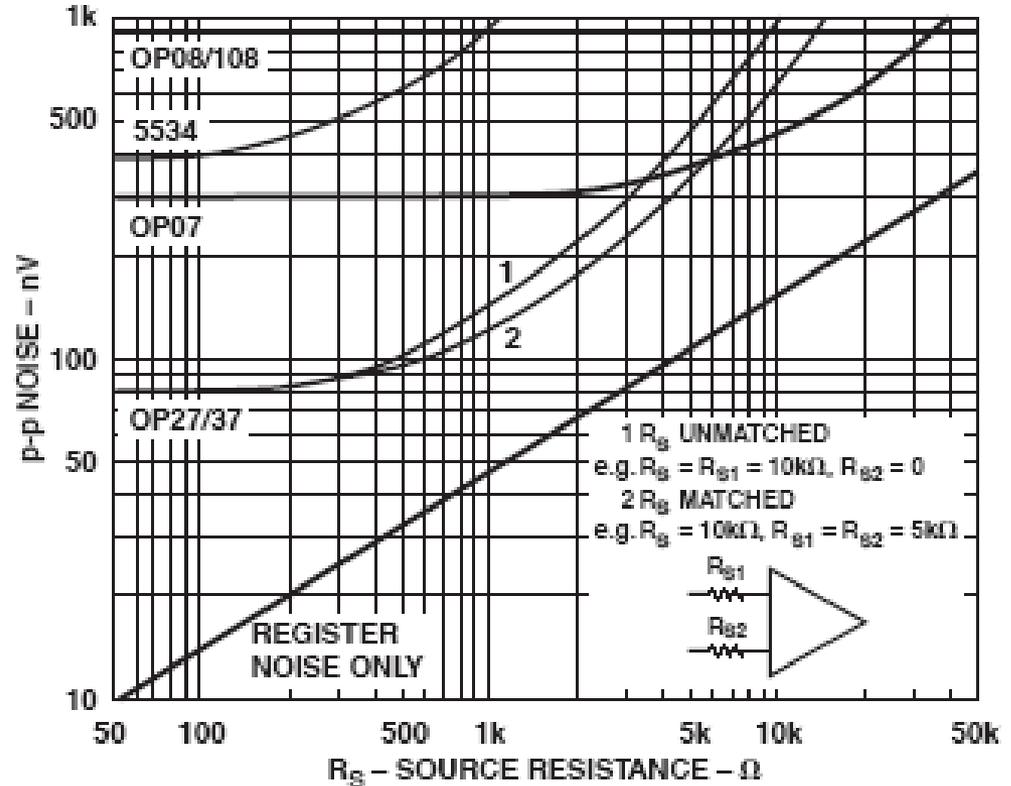


Figure 5. Peak-to-Peak Noise (0.1 Hz to 10 Hz) as Source Resistance (Includes Resistor Noise)