


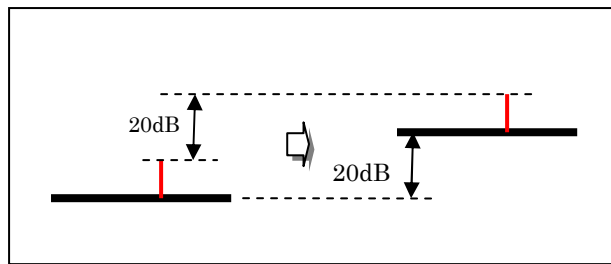
## Low noise amplifier MAP301/302

### «Relation between noise level and noise figure NF»

For example, the input signal is amplified 20dB when it passes an amplifier of 20dB gain.

This is understandable. How about a noise ?  This cannot be understood well.

That is, the appearance of signal is same if a noise is also amplified 20dB when a signal is amplified 20dB ?



**It's wrong.** Let's consider the definition of noise figure NF.

NF is a ratio of input S/N to output S/N.

$$NF(dB) = 20 \log \left[ \frac{(S_i/N_i)}{(S_o/N_o)} \right]$$

$S_i, S_o$  : signal level of input and output

$N_i, N_o$  : noise level of input and output



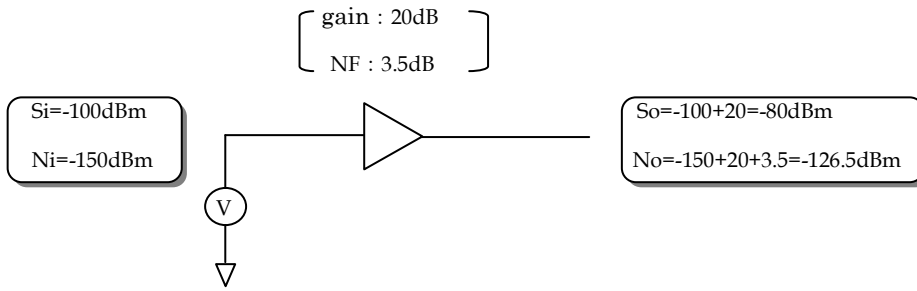
#### < Meaning of NF >

- ① A ratio of input S/N to output S/N.
- ② Output S/N is reduced only NF(dB) from input S/N.
- ③ Output noise  $N_o = N_i + G + NF$  ..... G, NF and  $N_i$  should be dB.

**Let's explain concretely.**

- Input signal level  $S_i = -100$ dBm
- Input noise level  $N_i = -150$ dBm
- Amplifier gain = 20dB
- NF of amplifier = 3.5dB

With the above conditions, the output will be as shown in the figure below because of < Meaning of NF > ③ mentioned above.

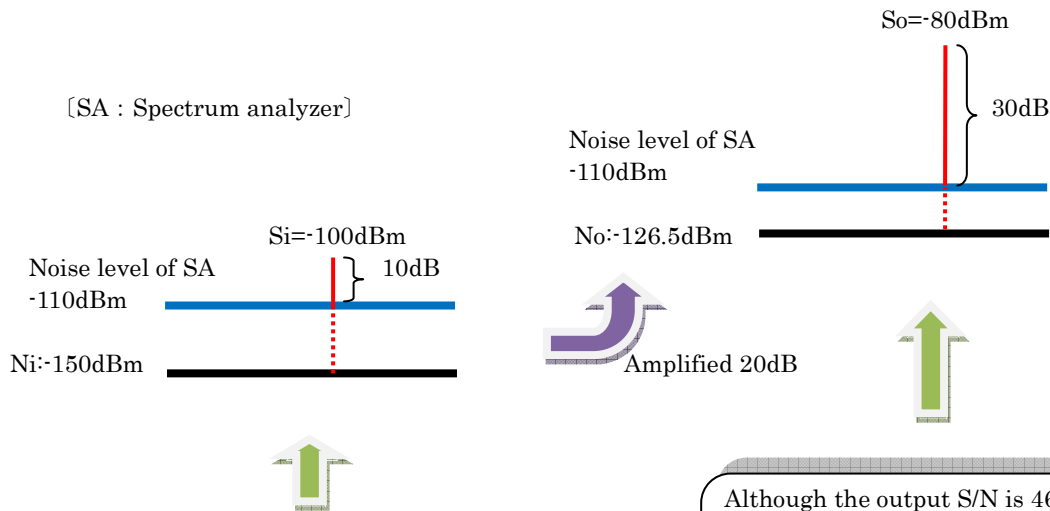


$\left\{ \begin{array}{l} \text{Input S/N} = -100 - (-150) = 50 \text{ dB} \\ \text{Output S/N} = -80 - (-126.5) = 46.5 \text{ dB} \end{array} \right.$   
 $\therefore \text{NF} = (\text{Input S/N } 50\text{dB}) - (\text{Output S/N } 46.5\text{dB})$   
 $= 3.5\text{dB}$

Indeed, <Meaning of NF> ② is established.

**Output S/N is reduced only NF (dB) from input S/N.** This's an important point.

Then, the signal and noise at input and output shall be observed with a spectrum analyzer.  
 The noise level of a spectrum analyzer assumes -110dBm.



Although the input S / N is 50dB, S/N gets worse to 10dB when observed with a spectrum analyzer. Only 10dB from noise level is visible.

Although the output S/N is 46.5dB, S/N gets worse to 30dB when observed with a spectrum analyzer. However, it's 20dB better than input S / N.

**When observed with a spectrum analyzer, the appearance of spectrum is related greatly to that noise level.**

