Technical report



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.

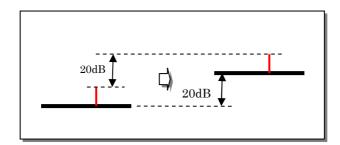
This is understandable.

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. $NF(dB) = 20log \ [\,(Si/Ni) \ / \ (So/No)\,]$

Si,So: signal level of input and output

Ni,No: 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 No=Ni+G+NF G,NF and Ni should be dB.

Let's explain concretely.

Input signal level Si=-100dBm

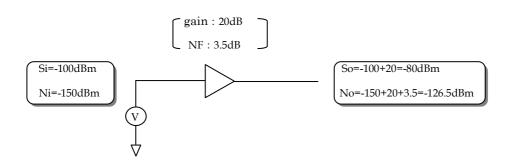
Input noise level Ni=-150dBm

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.

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Input S/N=-100-(-150)=50 dB

Output S/N=-80-(-126.5)=46.5 dB

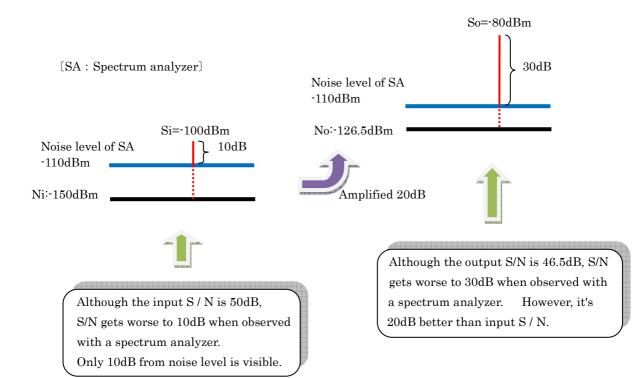
$$\therefore NF = (Input S/N 50dB) - (Output S/N 46.5dB)$$

$$= 3.5dB \qquad Indeed, < Meaning of NF > ② is established.$$

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.



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



Case Study:

To verify the effect of the pre-amplifier, following connection of the signal generator, the pre-amplifier MAP301/302 and signal analyzer MSA538 is established. We made the measurement of the signal to noise ration and gain for each signal path. The setting of equipments is as follows.

Signal Generator Frequency: 100 MHz

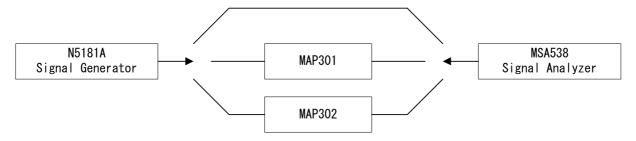
Output Level: -92 dBm

Signal Analyzer Center Frequency: 100 MHz

Span: 20 MHz

Reference Level: -30 dBm

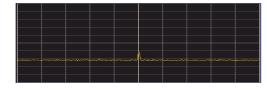
 $\begin{array}{ll} RBW: & 100 \ kHz \\ VBW: & 30 \ kHz \end{array}$



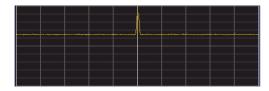
The measurement results are shown in bellow.

Connection	Gain [dB]	S/N Ratio [dB]
No Amplifier	0	10
MAP301	52	27
MAP302	21	21

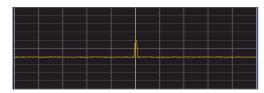
No Amplifier



MAP301



MAP302



It is confirmed that we can improve the $S\!/N$ ratio by using appropriate pre-amplifier.