Technical Info

SA Series Ultra-low Noise Amplifiers

In this document, we introduce two technologies, bias stabilization technology and active input impedance to achieve low noise characteristics employed in SA-230F5 and SA-430F5.

Bias-stabilization technology

The bias condition is temperature dependant. To solve this problem, inserting a resistor in the emitter of the input transistor is a solution, but that resistor would generate noise. The bias stabilization technology can stabilize the bias without using the resistor.
Fig. 1 shows the basic amplification circuitry of SA-230F5. By DC servo of a differential integrator, the collector current I_C of the input transistor is $I_C = V_{REF} / R_C$.
The transconductance g_m of the circuit in Fig. 1 is

$$g_m = \frac{q \cdot I_E}{k \cdot T} \cong \frac{q \cdot I_C}{k \cdot T}$$

Where k is the Boltzmann constant, q is the elementary charge, and T is the absolute temperature.
Gain A is

$$A = g_m \cdot R_C = \frac{q \cdot I_C}{k \cdot T} \cdot R_C = \frac{q \cdot V_{REF}}{k \cdot T}$$

According to this equation, the gain is inversely proportional to the absolute temperature. If V_{REF} is proportional to absolute temperature, the gain A will not depend on temperature. It is possible to make V_{REF} proportional to temperature by using a dedicated I_C or a resistor with a temperature coefficient.
if $V_{REF} = \alpha \cdot T$, the gain A is

$$A = \frac{q \cdot \alpha \cdot T}{k \cdot T} = \frac{q}{k} \cdot \alpha$$

Then, it will not be temperature dependant.

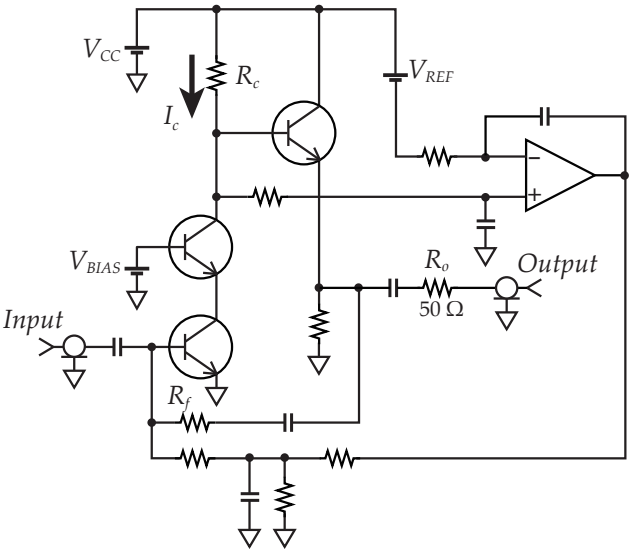

Figure 1.
Basic Amplification Circuitry of SA-230F5

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Active input impedance

The active input impedance can be matched in a wide frequency range rather than at a point in conjugate matching. In addition, the noise figure which could be up to 3 dB by a termination resistor, can be less than 3 dB.

The input impedance of the circuit whose input and output of the inverting amplifier are connected by resistor R_f as shown in Fig. 2 can be calculated as $Z_{in} = R_f / (1 + A)$.
This value depends on the gain.

Because a stable gain can be achieved by the bias stabilization technology mentioned above, the stable input impedance can be kept.

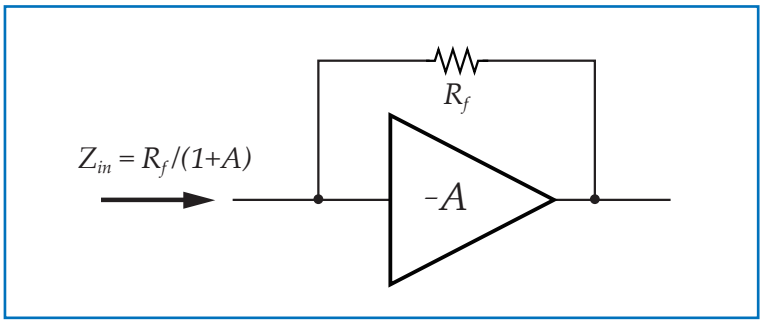

Figure 2. Active Input Impedance

Utilizing these two technologies, the SA-230F5 achieves ultra low-noise characteristics in a wide range as shown in Fig 3.

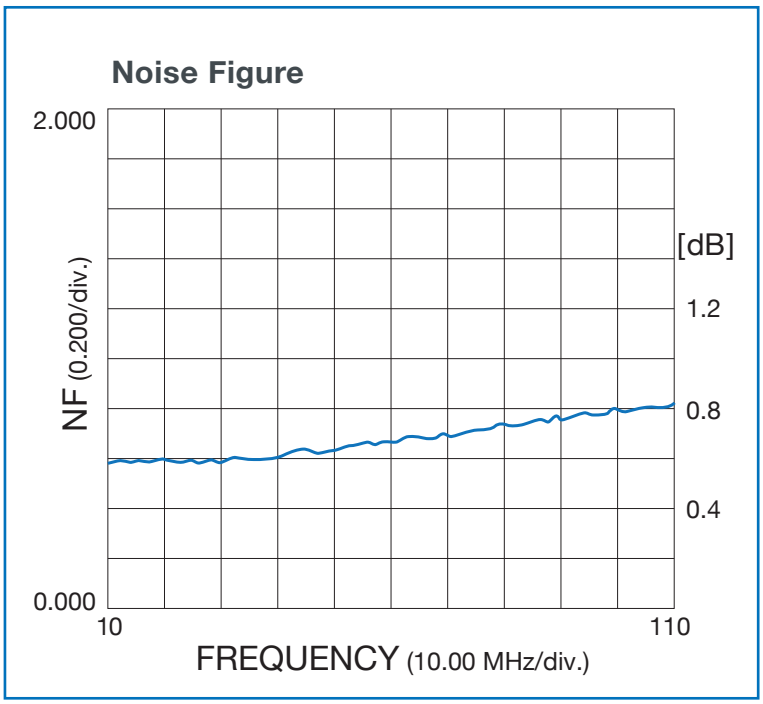

Figure 3. Noise Figure of SA-230F5