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

$$g_m = \frac{q \cdot I_c}{k \cdot T}$$

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

Gain $A$ is

$$A = g_m \cdot R_c = \frac{q \cdot I_c \cdot R_c}{k \cdot T} = \frac{q \cdot V_{REF}}{k \cdot T}$$

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.
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.

$$Z_{in} = R_f / (1 + A)$$

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