4x JFET Buffer Amplifier Cuts Noise in Half

Jordyn Rombola and Chau Tran
Analog Devices, Inc.

In many electronic circuits, there is always a demand for a device to isolate or separate one circuit from another. This special device is called a buffer. A buffer is a unity-gain amplifier that has an extremely high input resistance and an extremely low output resistance. This means that the buffer can be modeled as a voltage controlled voltage source that has a gain of one. Since the buffer ideally has an infinite input resistance, there is no loading effect, so that $V_{IN} = V_{OUT}$. Furthermore, the output voltage from the buffer is insensitive to the load resistance because the idealized buffer has an output resistance that is essentially zero. By placing a unity-gain buffer between a digital-to-analog converter (DAC) and a load, one can easily solve the loading problem.

When adding a unity-gain buffer to a system, it is important to maintain accuracy and performance. The most important consideration is to calculate the added noise:

$$Noise (V_{RMS}) = \sqrt{\left(e_n^2 + (i_n R_f)^2\right)}$$

Where:

- $e_n$ = buffer input voltage noise density
- $i_n$ = buffer input current noise density
- $f$ = device input bandwidth (Hz)

In the circuit of Figure 1, each channel has extremely low current noise ($0.8 \text{ fA} / \sqrt{\text{Hz}}$) in comparison with voltage noise of ($13 \text{ nV} / \sqrt{\text{Hz}}$). Therefore, when one needs less added noise in the system, it is critical to reduce this voltage noise. The voltage noise can be reduced by placing multiple buffers in parallel. For example, two buffers in parallel reduce the voltage noise by $\sqrt{2}$, or all four buffers placed in parallel act as a buffer with $\frac{1}{2}$ the noise. The trade-offs to this method are increased bias current, current noise, and input capacitance but in this case, those results are negligible. Place a small resistor, such as 50 $\Omega$, between the outputs to avoid extra current flow due to the slight differences between each output. For less power sensitive applications, these 50 $\Omega$ resistors can be omitted to boost the available output current.

The circuit of Figure 1 is a new configuration of a buffer amplifier that reduces the voltage noise by a half. The AD8244 is a quad, JFET input, unity-gain buffer that is designed to exceed expectations. The 2 pA maximum bias current, near zero current noise, and 10 T$\Omega$ input impedance introduce almost no error, even with source impedances well into the megaohms. With its low voltage noise, wide supply range, and high precision, this device is also flexible enough to provide high performance anywhere a unity-gain buffer is needed, even with low source resistance.

**Figure 1.** The new AD8244 low noise buffer.

The Figure 2 plot is the comparison of the noise performance of a normal single-channel buffer and the new AD8244 buffer utilizing four channels in parallel.

**Figure 2.** The performance of the new AD8244 buffer: noise is $\frac{1}{2}$ of normal buffer.
About the Authors

Jordyn Rombola [jordyn.rombola@analog.com] is a product engineer in the Linear and Precision Technology (LPT) Group of Analog Devices. She joined ADI in January 2014, after finishing her bachelor’s degree in electrical and computer engineering from Worcester Polytechnic Institute (WPI).

Chau Tran [chau.tran@analog.com] joined Analog Devices in 1984 and works in the Linear and Precision Technology Group in Wilmington, MA. In 1990, he graduated with an M.S.E.E. degree from Tufts University. Chau holds more than 10 patents and has authored more than 10 technical articles.

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