

FAQs

Don Tuite
Analog/Power Editor

FREQUENTLY ASKED QUESTIONS

What applications require precision op amps?

Precision amplifiers originally evolved to fill the needs of the test and measurement community. This arena demanded test system elements with much more precision than the original instruments were intended to make. They also required a set of specifications and ways of verifying those specs that unquestionably demonstrated that superiority.

Today, precision amps are widely used in automotive and industrial applications, where they monitor the myriad sensors in the latest cars and manufacturing facilities. They're even showing up in power regulation in consumer products.

What is a precision op amp?

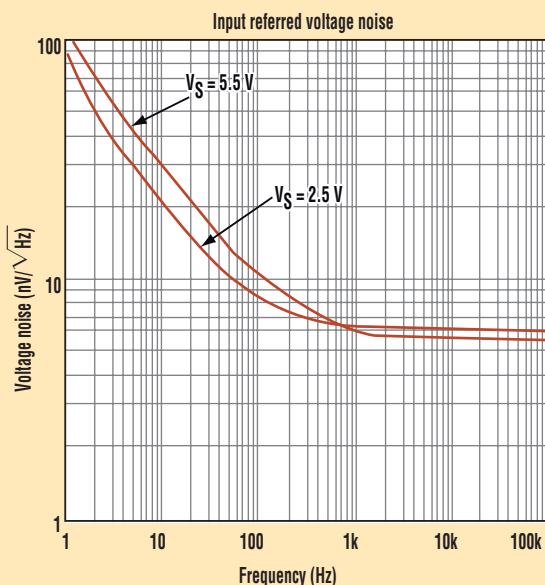
Precision op amps are defined by their datasheet characteristics, both typical and guaranteed maximum/minimum values. Key specifications are input offset voltage and offset current (V_{OS} and I_{OS}) and the temperature coefficient of V_{OS} (TCV_{OS}). Depending on the application, other critical specs include input bias current (I_B), input-referred voltage and current noise (e_n and i_n), open-loop gain (A_{VOL}), gain-bandwidth product (GBWP), and power-supply and common-mode rejection ratio (PSRR and CMRR).

How do operational characteristics define the performance of a precision op amp?

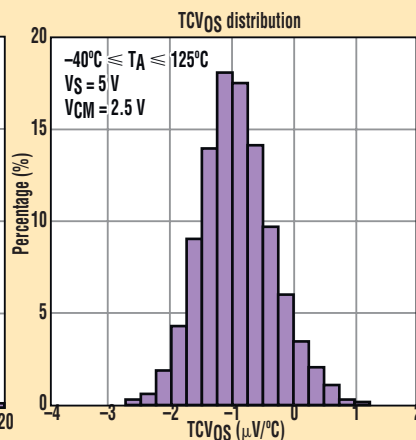
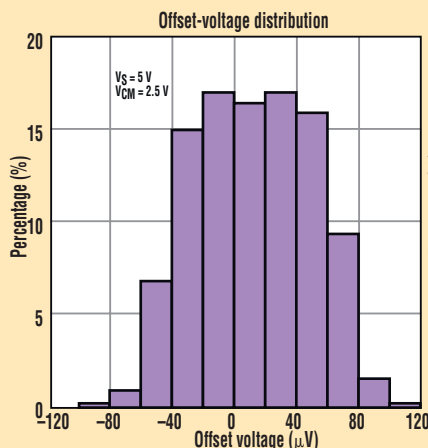
V_{OS} : The maximum input off-

set voltage enables circuit designers to define a room-temperature error budget for the application. Maximum values may be on the order of $\pm 150 \mu V$.

TCV_{OS} : Designers need to know the input offset voltage temperature coefficient for low-error-budget applications that are exposed to variable temperatures. This is particularly critical in automotive applications, but it may be just as important in portable industrial and medical apps. A CMOS precision op amp can have a



1. Low 1/f noise corner frequency is a key figure of merit for precision CMOS input op amps. In this case, it's around 1 kHz.



2. Datasheet distribution graphs provide more information about the variability of key performance characteristics. But expect lot-to-lot variations. The higher the sample size, the better.

guaranteed TCV_{OS} of 3 to 5 $\mu V/^\circ C$. For bipolar precision op amps, TCV_{OS} values can be half of that.

PSRR and CMRR: Both represent a measure of change in V_{OS} in the presence of power-supply ripple or battery voltage decay or a common-mode signal variation on the differential inputs. A precision op amp should have PSRR and CMRR values greater than 85 dB, minimum. AC PSRR depends on the measurement frequency.

Low-frequency noise: Low-frequency/high-gain sensor applications require CMOS precision op amps for the sake of their high impedance inputs. The sensors also require low $1/f$ noise characteristics from the operational amplifier (Fig. 1).

Looking at a precision-amp datasheet, guaranteed maximum or minimum values are much looser than the “typical” values. What does this imply?

It indicates a tradeoff between the number of samples tested and selling price. If a chip manufacturer characterizes every batch of chips to a tight performance range, the testing overhead would be astronomical. What system designers get from the guaranteed maximum or minimum values on a precision amp datasheet is a set of expectations they can realistically design to. Actual performance should be better. This is critical for systems with an error-budget constraint.

Is there any way to further assess the difference between typical and guaranteed performance values?

Datasheets may include V_{OS} and TCV_{OS} distribution graphs, which are histograms representing actual measurements (Fig. 2). Given an adequate sample size, they provide additional guidance on the unit-to-unit behavior or expectation within the application.

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product Q&As

National's Latest Precision Op Amps

LMP7701 Precision, CMOS Input, RRIO, Wide Supply Range Amplifier

The LMP7701 is ideal for sensor interface and other instrumentation applications. Its guaranteed offset voltage is less than $\pm 200 \mu V$, and its guaranteed input bias current is 300 fA.

The LMP7701 is built using National Semiconductor's VIP50 technology, which permits the combination of a CMOS

input stage and a 12-V common mode and supply voltage range. This allows the LMP7701 to be used in applications where conventional CMOS parts cannot operate.

The LMP7701 has a rail-to-rail input stage that significantly reduces the CMRR glitch commonly associated with rail-to-rail input amplifiers. This is achieved by trimming both sides of the complimentary input stage, reducing the difference between the NMOS and PMOS offsets. The amplifier's output swings within 40 mV of either rail to maximize the signal dynamic range.

For area-constrained pc boards and portable electronics, the LMP7701 is offered in a space-saving SOT23-5 package.



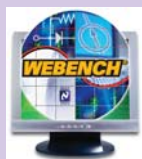
LMP7711 Precision, 17-MHz, Low-Noise, CMOS Input Amplifier

The LMP7711 is a low-noise, low-offset, CMOS input, rail-to-rail output precision amplifier with a high gain-bandwidth product and an enable pin.

Utilizing a CMOS input stage, the LMP7711 achieves an input bias current of 100 fA, an input referred voltage noise of 5.8 nV/ \sqrt{Hz} , and an input offset voltage of less than $\pm 150 \mu V$. It offers a 17-MHz high-gain bandwidth product, enabling accurate amplification at high closed-loop gains.

The LMP7711 has a 1.8- to 5.5-V supply-voltage range. Supply current is 1.15 mA. Once it has been placed in shutdown mode via the enable pin, the LMP7711 draws only 140 nA. These factors make it an ideal choice for portable low-power applications.

Built in National's advanced VIP50 process technology, The LMP7711 is offered in a six-pin TSOT23 package.



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