RAQ's

Rarely Asked Questions

Strange stories from the call logs of Analog Devices

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Single Supply Amplifiers—They Sound Simple...are they?

Q. Running rail-to-rail op amps on a single supply sounds like a winning combination, but what drawbacks will I encounter when using amplifiers like this?

A. Single-supply and rail-to-rail outputs are a great combination, but there are a few parameters that warrant a second look. Your question doesn't specify whether you are talking about single-supply amplifiers (a particular class of amplifiers) or running a traditional op amp on single supply; we'll discuss both cases.

By definition, a true "single-supply" op amp operates on one supply, and the input common-mode voltage range of the amplifier includes the negative supply rail. Note that even though the input of the amplifier may be able to go to the negative rail and beyond it doesn't mean the output can. I'll say more about that when we talk about rail-to-rail outputs.

Any amplifier can be run on a single supply. Op amps don't have a ground pin and are equally happy when run on a bipolar supply as they are with a single supply. Additional bias circuitry is required when running an amplifier in this configuration, however. As a result, the amplifier's performance may suffer slightly in the following areas: lower bandwidth, degraded power supply rejection (PSR), and higher noise.

The term rail-to-rail output is a misnomer. While the amplifier output can get close to the supply rails, it never quite gets there. In bipolar amplifiers, the rail-to-rail output stage is typically a common emitter; therefore the closest the output can get to the rails is a saturated transistor drop Vcesat. The value of Vcesat is dependant on the amount of load current delivered by the amplifier. For low currents, the output can come to within tens of millivolts to the rail. For higher currents Vcesat can approach 0.5 V or more. Some new amplifiers now feature on-chip charge pumps to make up the Vcesat drop, allowing the output to truly swing all the way to the rail.

An amplifier output swinging close to the supply rail may appear fine when measured on an oscilloscope, but a network analyzer may reveal a different result. As the output swings closer to the rails, the output transistors no longer operate in the linear region. As a result, distortion is introduced. Distortion can occur several hundreds of millivolts away from the rails. Therefore when possible, try design in a little extra headroom from the rails; this will help improve the amplifier distortion performance.

We've only skimmed the surface on these topics. For in-depth application and product information, visit our website or click on the link below.

To Learn More About Single Supply Amplifiers

Go to: http://rbi.ims.ca/5726-100

Have a question involving a perplexing or unusual analog problem? Submit your question to: raq@reedbusiness.com

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