

Rarely Asked Questions

Strange stories from the call logs of Analog Devices

Is amplifier headroom cramping your style?

Q: When running on a single supply, my op amp's output is highly distorted. Could this be some kind of headroom issue?

A: Headroom is definitely one of many reasons why the output could be distorted. For those of you new to the term, headroom is a measure of how close the input and output of an amplifier can swing to the supply rails. You may also hear the term *footroom*, which refers to distance from the negative supply, but headroom commonly applies to both rails. Therefore an amplifier with ± 0.8 V of headroom can swing to within 0.8 V of the supplies.

Fortunately, an amplifier's headroom requirements can quickly be determined from the datasheet specifications or performance plots. Input headroom is the difference between the input common-mode voltage range (ICMVR) and the supply voltage. Output headroom is the difference between the output voltage swing and the supply voltage. Exceeding the ICMVR or asking the amplifier to deliver more than the specified output swing will certainly distort the output signal.

Running on a single supply can further complicate matters. Just about every amplifier can be run on a single supply. The amplifier doesn't care if a single 10 V supply or dual ± 5 V supplies are used; it sees 10 V across its supply pins in both cases. There is a difference at the input, however. With symmetrical bipolar supplies, the mid-supply voltage is zero; with a single supply, the mid-supply voltage is half of the supply voltage.

For ground-referenced signals, bipolar supplies are preferred because both are



referenced to ground (mid-supply). In single-supply applications, the input signal must be offset to match the mid-supply voltage in order to maximize amplifier headroom and minimize power dissipation. This can be either done at the signal source or at the amplifier input. At the amplifier input, ac coupling may be required and a new mid-supply bias voltage must be established, increasing the circuit complexity.

One alternative to this problem is to use a "true" single-supply amplifier. The ICMVR of these amplifiers includes the negative rail, helping to alleviate ICMVR issues. A second alternative is to use rail-to-rail amplifiers, which have inputs and outputs that can swing within a few millivolts of the supply rails. A third alternative is to use an amplifier that includes a charge pump to internally generate the negative rail.

So if your amplifier design leaves you feeling a bit cramped, kick off your shoes and relax. There are many ways to find a little more headroom or footroom.

**To Learn More About
Amplifier Headroom**

<http://dn.hotims.com/27759-101>



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