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What's All This "Free Amplifier" Stuff, Anyhow?

One of my friends was working on a story. She observed correctly that an "ideal" op amp would have infinite gain and common-mode rejection ratio (CMRR)—and zero I_B and V_{OS}— and zero price. She conceded she would never get rich selling those op amps!

But there is a zero-price op amp, and I have been using them for many years—over 40. Maybe you have too. Let's assume I have used three-fourths of an LM324 for three tasks, and that is working fine. Suddenly a need arises for *one more amplifier*. Hey, I could solve that problem by using the unused channel of that LM324. Will it work well? The signals aren't very tiny or fast.

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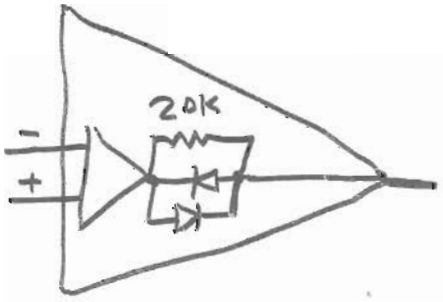
PRICE VERSUS COST

We know that the price is "free," but the cost probably isn't "zero." Connecting the "unused" channel may require other signals to be pushed around or aside, with the accompanying costs of new layout—and cross-talk—and delay. And what if the new amplifier doesn't work well?

So, we have found, we want to be skeptical. Asking an LM324 to do a low-pass filter on a 20-Hz signal can cause distortion of a mere –31 dB... if you don't know how to do it.

I mean, I hate to say it, but NSC's macromodels for an LM324-type amplifier do not show their inherent output distortion. I've tried to fix this... without much luck. Would you like me to show you how to model an LM324? See the figure. Even if you're talking about an unused chunk of a higher-performance amplifier, fancier and more linear than an LM324, then it may still cause problems. Beware of cross-talk.

Also, beware of poor layout. Myself, I never like to use quad op amps. I prefer to use dual op amps to get better layouts. It's true that two duals usually aren't priced as low as a quadruple amplifier, but design engineers have to use their own judgment on that.



Most LM324 macro-models don't include the inherent output nonlinearity. Make a new model, as shown, with about two diodes added, and this makes a reasonable model. To defeat this non-linearity, add a pull-down resistor to the negative supply, making the output run Class A, for small signals.

SO MANY CHOICES

NSC does sell several kinds of single op amps that are smaller than one-fourth of an SO-14. You may be able to add in one such amplifier, with less grief than applying one-fourth of an LM324. There are fast ones, low-power ones, and low-noise amplifiers in SOT23-5 and SC70 packages, or even smaller, such as a Micro SMD.

How about using one-fourth of an LM339 comparator as a "free" comparator? Comparators can provide even more trouble because the faster-moving outputs can couple as cross-talk. You have to be very careful in your engineering and layout. Even though the outputs of an LM339 are at the far end of the SO-14 from the inputs, you aren't safe.

How about using one-fourth of an LM324 as a comparator? I've seen people do that, but it's not as simple as it looks. Even with good hysteresis, it's slow and a pain.

I would generally recommend against that, unless your system can tolerate a slow rise time and some chance of the amplifier amplifying its own noise, as the signal passes the threshold. Hysteresis usually won't protect an amplifier from that.

Conversely, adding a couple R's and C's to one-fourth of an LM339 to make a slow amplifier is risky. I've seen it done, but it should not be done as a general deal. Small-package amplifiers will help you avoid more trouble.

Life ain't simple. It never was.

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