DESIGNER'S NOTEBOOK

Low-voltage amplifier circuits

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DIGITAL AND ANALOG CIRCUITS EACH have their own unique set of design problems. Very often what is a major consideration in one field doesn't even appear in the other. There is, however, one problem that is common to both analog and digital circuits: the problem of tailoring real world signals so that they can be handled by whatever circuitry that is being designed to follow them.

The output of many real-world sensors (from microphones to keyboards to transducers) need a certain amount of conditioning before they can be reliably processed by either analog or digital circuitry. One of the most frequent problems that turns up is that the voltage level coming out of the input device is just too low to be used by the following circuitry. Because of that, those signals must be amplified to a usable level. This month we'll look at two general-purpose amplifier circuits. The first uses a single transistor and the other a CMOS IC. Either one can really come in handy when you're faced with the problem of low-voltage input signals. We'll look at the transistor amplifier first.

Transistor amplifier

Figure 1 shows a simple single-transistor amplifier that can be used anytime you need a boost for a signal that's in the microvolt range. That circuit can be assembled from the sort of spare parts that fall into the cracks of your parts box. Not only that, but the it uses so few parts that it takes up less space on a PC-board than an IC. In addition, the circuit has a flat frequency response across the audio spectrum and a gain of about 100 with the component values shown. None of the component values are particularly critical, therefore a wide range of substitutions can be made without seriously affecting the performance of the circuit.

The gain of the circuit can be lowered by dropping the value of feedback resistor R2. And the capacitor values shown can be changed if you don't happen to have those values on hand. Transistor Q1 is a small-signal high-gain NPN transistor: substitutions can be made here as well. A 2N2222 transistor can be used but it will give you a lower gain than the 2N3391 shown; again it's a matter of trial and error

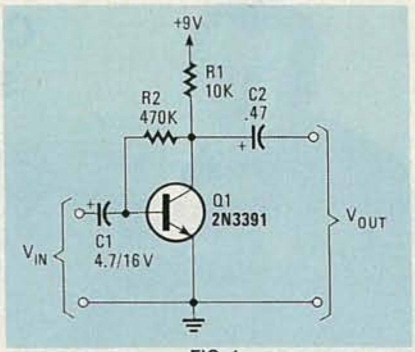

FIG. 1

on one hand, and how much gain you need on the other.

The circuit can be used anytime that a really low input signal needs to be boosted to a workable level. Anyone who has ever had to deal with the output level of a dynamic microphone (in the microvolt range) will find that little amplifier really handy because it will boost the mike's output signal level enough so that it can be fed into a standard line input. The other low-voltage amplifier circuit that we will look at uses CMOS inverters rather than a single transistor.

CMOS amplifier

The second amplifier circuit is shown in Fig. 2. It uses three sections of a CMOS 4049 hex inverter IC (but any CMOS inverter can be used). It features a high input impedance. It also features all the good things we've come to expect from CMOS: a wide power-supply range, high noise-immunity, an output that swings from ground to just about the supply rail, and so on. The response of the circuit can be easily tailored to satisfy a wide range of circuit conditions.

The gain of that circuit is determined solely by the ratio of the feedback resistor (R2) to the input resistor (R1). And the frequency response is a function of the input capacitor. Keep this circuit in mind, it can make life a lot easier when the output signal for the circuit you're designing needs a bit of amplification. Just round up three spare inverters and your problem is solved. The only thing to remember is that the output voltage won't be at ground potential when you remove the input signal. Since we're using the inverters in a linear mode, the output voltage will always return to V/2 (where V is the supply voltage). If that presents a problem you can always take care of it with a capacitor or some other scheme at the output. **R-E**

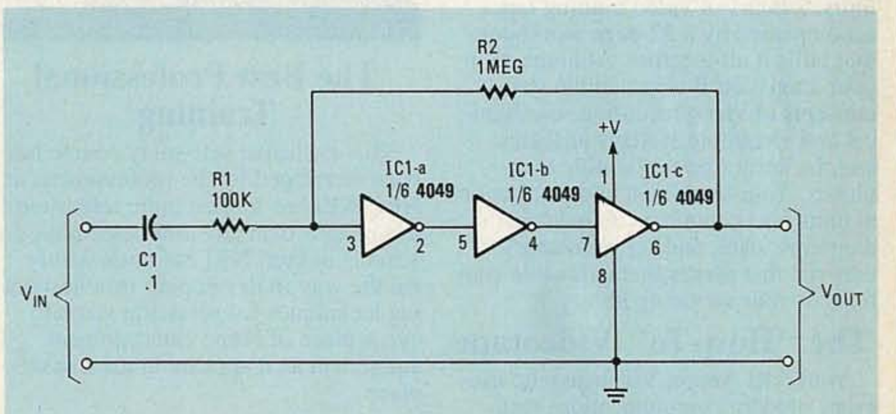

FIG. 2

"Dad, tell me about your deprived childhood ... no computers, videogames ..."