A single potentiometer adjusts op-amp's gain over bipolar range

An op-amp's gain level must often be adjusted over its full inverting and noninverting gain range. The simple circuit shown can provide bipolar gain control, and it uses only a single potentiometer. And the gain adjustment is linear —as linear as the pot used.

Pot R_3 varies the signal applied to both the inverting and noninverting amplifier inputs. When the wiper position (denoted by x) equals zero, the noninverting amplifier input is grounded. This also holds the voltage across R_2 at zero, so R_2 has no effect on operation. Now only R_1 and R carry feedback current, and the amplifier operates at a gain of $-n$.

At the other pot extreme, where $x = 1$, the input signal is connected directly to the noninverting input. Since feedback maintains a near-zero voltage between the amplifier inputs, the amplifier's inverting input will also be near the input signal level. Thus little voltage is across R_1. Also now the gain is $+n$.

However, the amplifier input resistance varies with the pot setting, as does the feedback current drawn by R_1. This variation can produce a source loading error that looks like a nonlinear gain function. The amplifier should be driven from a low-impedance source to minimize this effect.

Trouble can also come from input offset voltages, since the inverting and noninverting amplifier inputs both boost any offset to double that of the conventionally connected amplifier. Thus the circuit should be used with low-offset op-amps.

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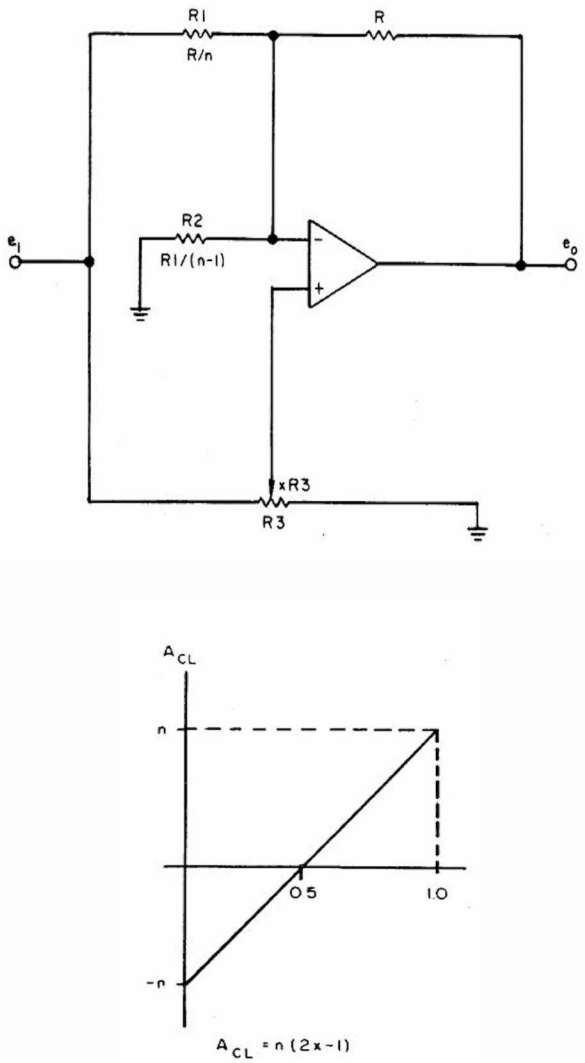

A single potentiometer controls the gain of an op amp over a bipolar range. The gain control is as linear as the pot.