Charge pump cuts compandor's attack time

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Integrated-circuit compandors such as the Signetics NE570 could be more effective in high-fidelity noise-reduction schemes if it were not for one built-in shortcoming: their slow attack time permits large input signals to overdrive the device's compressor and thereby create distortion. But by adding a quad operational amplifier, a diode, and a few resistors, the compandor's attack-to-decay ratio (which is internally set at 1:5) can be dynamically controlled. Specifically, the attack time can be decreased for a given decay period. This concept can be extended to any charge-storage circuit, such as a sample-and-hold module, to speed voltage-level acquisition for a given set of circuit parameters.

The NE570 contains a full-wave rectifier, a variable-gain stage, and other peripheral circuits. The rectifier converts an audio-input signal into a pulsating direct current, which is averaged by an external filter capacitor, C, connected to the compandor's C_{RECT} terminal. The average value of the signal determines the gain of the variable-gain stage.

The compandor's attack and decay times are inversely proportional to the value of the filter capacitor. Thus attack time could be reduced simply by substituting a smaller capacitor for C. But the circuit's purpose is to reduce attack time without using a smaller C, because the third-order harmonic distortion generated when the compandor processes low- and medium-amplitude signals increases as the value of C decreases. The effective capacitance of C during charging is reduced by using this circuit as a pump to charge C more quickly for large input signals, thereby shortening attack time without appreciably reducing the average capacitance of C.

The averaging capacitor is connected to the compandor's rectifier through a 150-ohm resistor, R. At low signal levels, the LM324 quad op amp is not active, so that R contributes only 0.2% additional distortion to what would normally be expected with C alone.

When the rectifier processes a large signal, the relatively large voltage drop across R activates the circuit. Differential amplifier A_1–A_3 generates a large voltage at the input to A_4. This causes A_4 to charge C through D_1 at its short-circuit value of 40 milliamperes. C is effectively charged at 40 volts per millisecond, which corresponds to an attack time of less than 0.1 ms.

The threshold of the enhanced attack rate, which is set by the quiescent 1.3-v drop across C and the 0.7-v drop across D_1, is approximately 0.1 v root mean square (−20 dBm) with respect to the rectifier input. □

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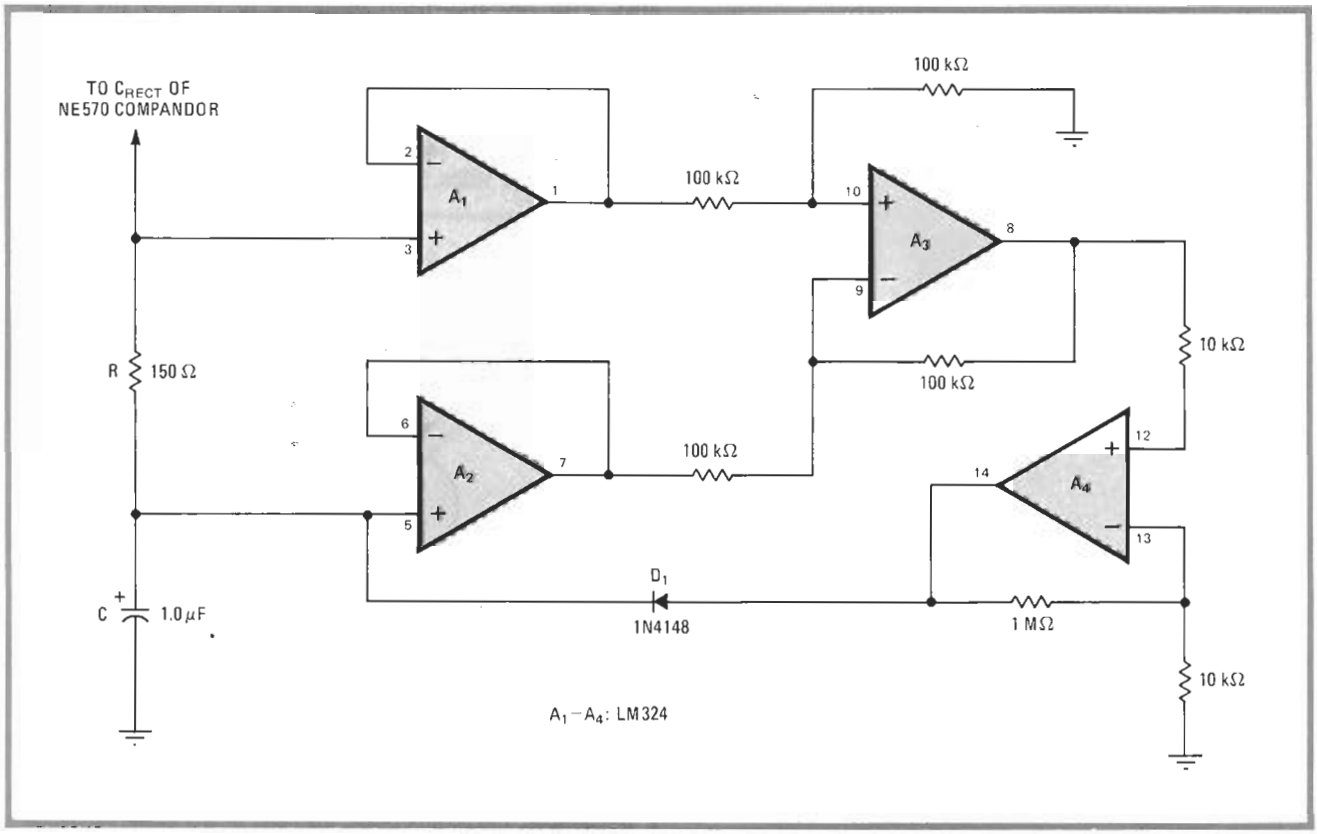

Dynamic. Circuit for decreasing NE570's attack time for large signals uses a quad operational amplifier for quick charging of compandor's averaging capacitor, C, in this way reducing its effective value. The fundamental waveform distortion from the compandor output is substantially reduced as a result, but third-harmonic distortion for low- and medium-amplitude signals is not substantially increased.