Limiting amplifier is digitally programmable

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Amplitude limiters are necessary in many systems, such as radar and FM receivers, for which the system cannot allow the amplitude of the signal to exceed the given positive, negative, or both limits. In the circuit in **Figure 1**, amplifier IC_{4B}'s maximum output is digitally programmable over ±2 to ±10V in 2^n steps, where n is the number of bits of the DAC. IC_1, a precision 10V reference, provides a full-scale reference current, $I_{REF}=V_{REF}/R_1=2$ mA, to IC_2, a multiplying DAC.

IC_3's output voltage, V_L, is the sum of the product of the digital word and unipolar reference voltage and IC_1's dc offset as follows:

$$V_L = \left(\frac{V_{REF}}{R_1} \bullet \frac{N}{2^n} \bullet R_2\right) + \frac{R_4}{R_3 + R_4} \bullet V_{REF},$$

where N can assume values of 0 to 2^n–1.

When all digital inputs are set to a logic low, N=0,

$$V_{L(MIN)} = \frac{R_4}{R_3 + R_4} \bullet V_{REF}.$$

For the values of R_3, R_4, and V_{REF} in this example, $V_{L(MIN)}$=1V. When all the digital inputs are set to logic high (n=8, and N=255),

$$V_{L(MAX)} = \frac{V_{REF}}{R_1} \bullet \frac{2^n - 1}{2^n} \bullet R_2 + \frac{R_4}{R_3 + R_4} \bullet V_{REF}$$
$$= \frac{V_{REF}}{R_1} \bullet \frac{255}{256} \bullet R_2 + 1V.$$

For the values of R_1 and R_2, $V_{L(MAX)} \approx 9V$.

Within the limiting levels, the amplifier does not modify its input signal but provides a gain of $A_V=-R_6/R_5$. As V_{OUT} rises above V_L+1V—adding 1V overcomes the potential drops of the base-emitter junctions of Q_1 and D_1—the base-emitter junction of Q_1 becomes forward-biased, allowing the collector current to flow to the summing node, thus limiting V_{OUT}. A similar action occurs with Q_2 and D_2 as V_{OUT} goes below $-V_L$–1V.

You can thus program the limiting levels or the maximum output voltage of the amplifier symmetrically over $V_{L(MIN)}$+1V to $V_{L(MAX)}$+1V with a resolution of $[(V_{L(MAX)}+1)-(V_{L(MIN)}+1V)]/2^n$V in accordance with the 8-bit digital-input binary word. The circuit becomes a programmable positive/negative limiting amplifier if you remove the appropriate diode-transistor pairs from the feedback. (DI #2201) e

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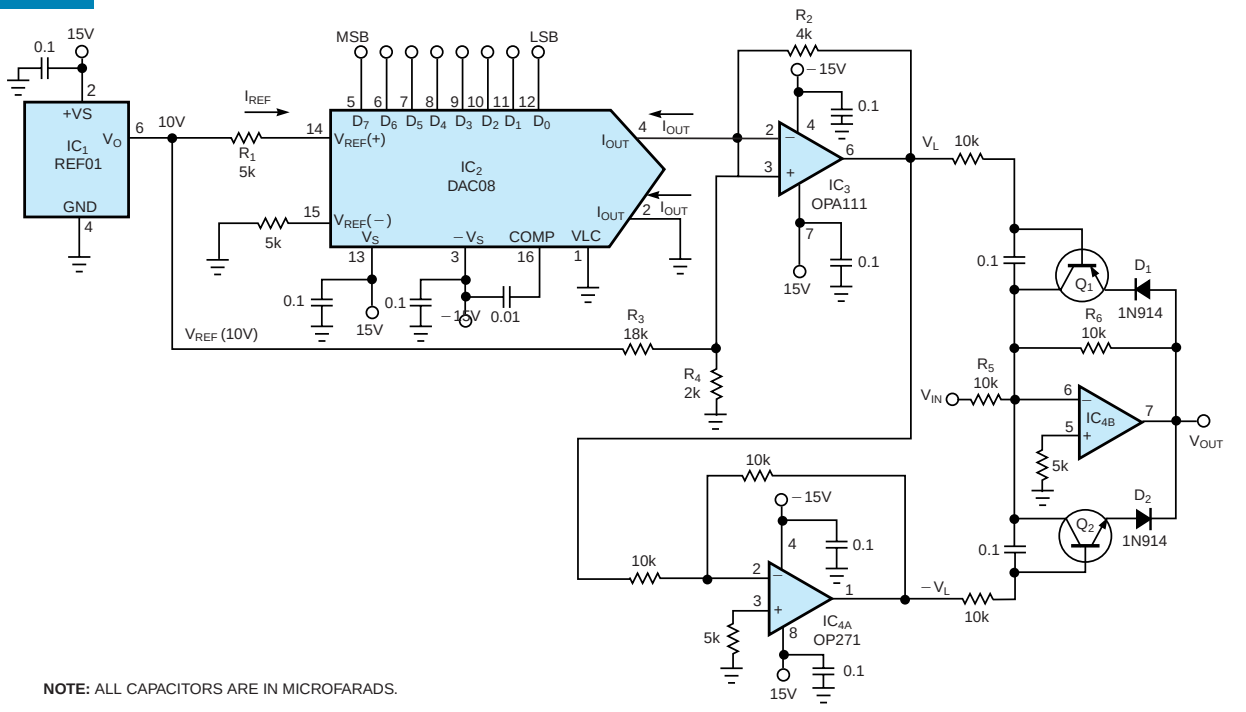
FIGURE 1



The maximum output of this amplitude limiter is digitally programmable over ±2 to ±10V in 2^n steps, where n is the number of bits of the DAC.