You are to design a two-input portable PA amplifier that will deliver .5 watts average power into a 4-ohm load with no obvious distortion. One input will be from a D/A circuit described below and the second input will accept a high-level (1 volt) signal. Frequency response: 30Hz to 20kHz ?3 dB. The amplifier should be designed to minimize battery current. Also, parts count should be kept low to minimize cost. Two voltage sources (Vcc) may be used.

Design a 5-bit D/A converter and use a counter circuit (a pair of 74LS193 counters work well) to generate a saw-tooth waveform. The circuit will function satisfactorily (no obvious distortion) with a 1 ms period (counter clock is 64 kHz). Output linearity is to be within 1 LSB (least significant bit) of full scale (1/32 of full scale) measured with a digital voltmeter. See pages 860-864 for possible circuits. You might also consider the circuit below which can easily be expanded to 5 bits (or more!):

If enhancement-mode NMOS transistors are used as switches here, counter outputs may be directly tied to the gates.