Resistor matrix orchestrates electronic piano/tone generator

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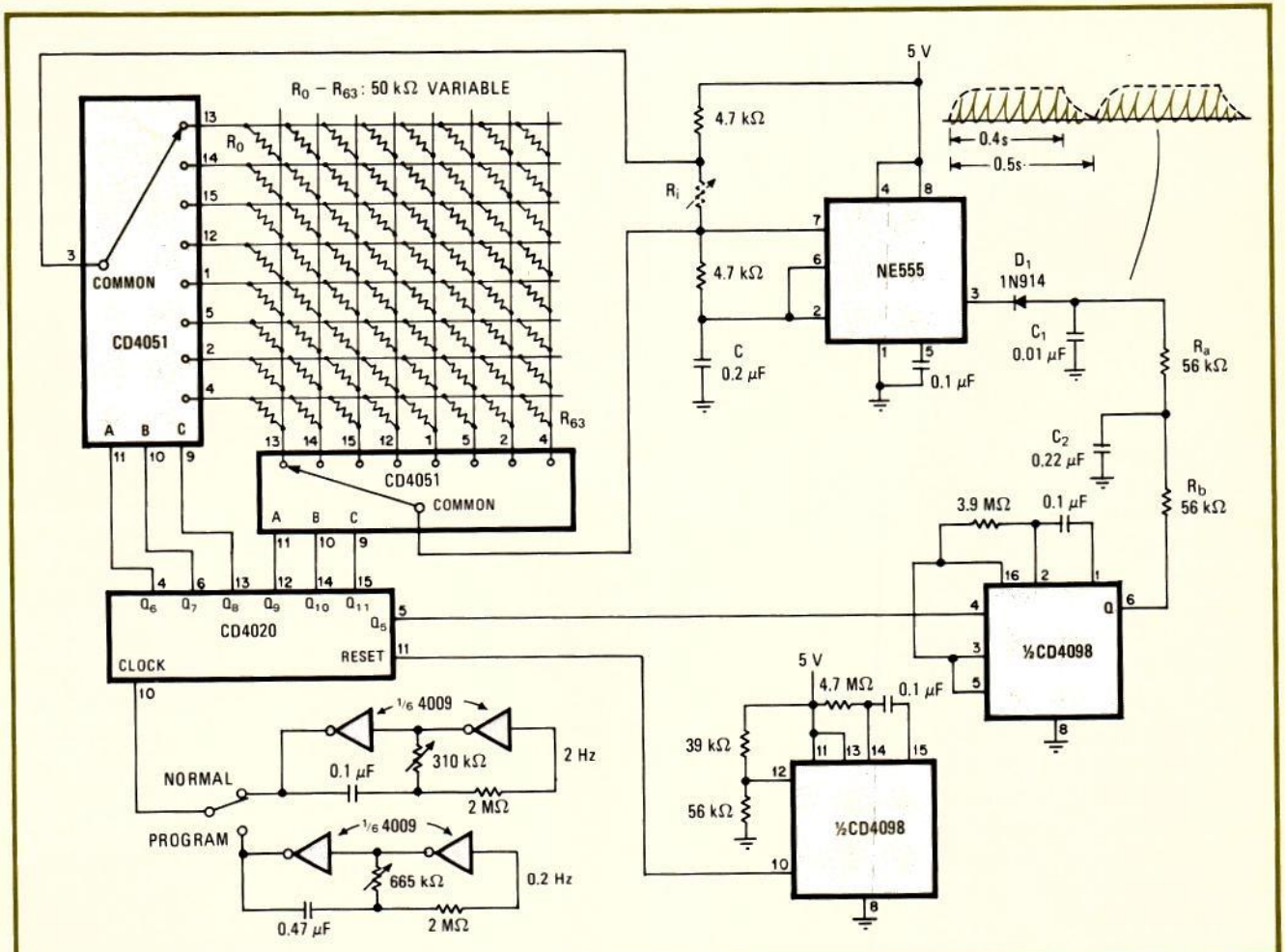
Combining an eight-by-eight-resistor matrix that is programmed to generate 64 different frequencies with control circuits that send each tone in sequence for half-second intervals, this unit makes a tuneful electronic music box. It can also serve as a programmable tone generator for testing purposes, in which case the number of tones may be extended to 512.

In this circuit, the resistor timing element in an astable multivibrator is periodically switched to a new value every half second with the aid of a multiplexer circuit. Serving as the multivibrator (or tone generator) is the versatile 555 timer, which can generate frequencies over a range of 100 hertz to 5 kilohertz.

Timing resistors are switched into the R_iC network with the aid of two CD4051 multiplexers, as shown. Each device has three address ports that are updated by a 4020 counter, which is in turn stepped by an oscillator normally running at 2 Hz. If, for example, all outputs of the 4020 are low, the common ports of the 4051s will be



Tuning up. Music box/tone generator uses programmable resistor matrix to generate 64 tones in sequence, each for a 0.5-second period. Oscillator clocks 4051s, which in turn place each of 64 resistors in timing network of 555. Output of timer is shaped by a 4098 one-shot and suitable integrator network for click-free output during switching. Matrix can be programmed in 10 minutes if counter is available.

connected to row 1, column 1, of the matrix and R_0 will be in the 555's timing loop. As the counter steps through all locations, R_1–R_{63} in turn set the frequency of the 555.

The output of the 555 is a train of square waves. To avoid the key clicks that occur each time the frequency of a tone is changed, the square wave is rounded off, being converted to a sawtooth wave with D_1, R_aC_1, and R_bC_2. Note that the 4098 monostable multivibrator connected to R_b aids greatly in controlling the attack-delay characteristic of each waveform at the output; it applies a gradual turn-on bias to D_1 initially and then a turn-off bias after about 0.4 second. This 4098 is driven by the 4020. R_b and C_2 integrate the 4098's output pulse, then C_2 discharges, enabling the device to bias the diode as described. A second 4098 one-shot is used to reset the 4020 so that resistor R_0 will be immediately accessed on power-up.

Programming of the resistor values can be tedious, but with practice it can be done in 10 minutes. A frequency counter connected to the output of the 555 is helpful. Despite the harmonics in the 555's output, the counter will read the fundamental frequency of a given tone.

First, it is necessary to switch to the program clock. This clock will advance the 4020 counter once every 5 seconds and gives the user time to adjust each R_i for the particular output frequency desired during that span. Two passes over the 64 tones should be adequate.

If a counter is not available, a piano or tuning fork will be needed and tuning will have to be done by ear, requiring an extremely long programming time. Means will also have to be found to single-step the 4020.

For more demanding applications, the number of tones can be expanded to 512 by adding another CD4051 and the appropriate number of resistors. □