BY MARTIN SMAHA

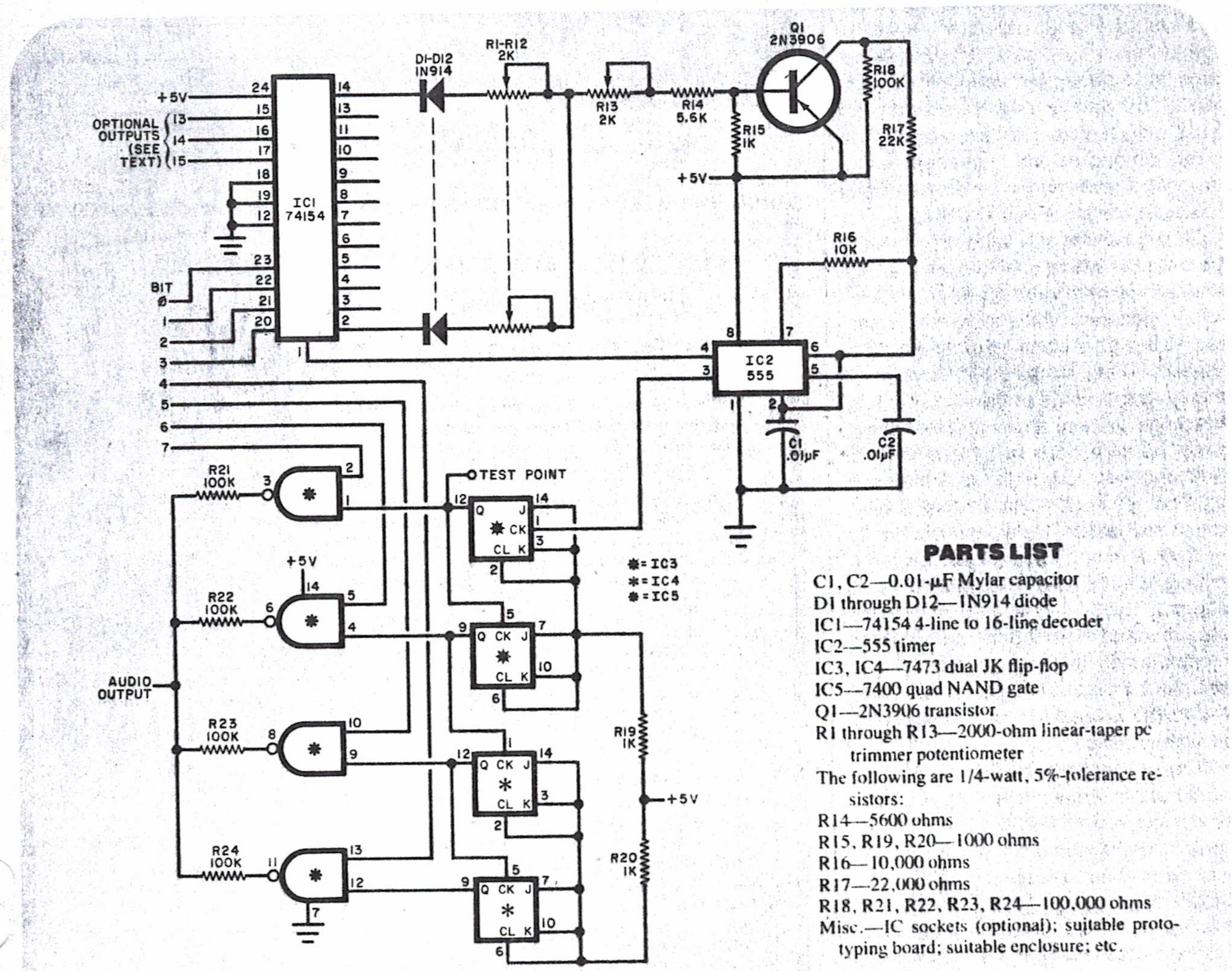
Build a COMPUTER MUSIC BOX PERIPHERAL

Low-cost, 12-tone, 4-octave music generator also produces test signals.

JUDGING from the many commercial plug-ins available, computer-generated music appears to be the "in" thing today. If you have found the single-bit method is too limited and the digital/analog converter approach too expensive, the low-cost (less than $30) Music Box described here may be just for you.

The Music Box has a 12-note, four-octave range. It can be used with any computer that has a parallel output port. And to simplify its use, no strobes or other handshake signals are required.

The Music Box circuit is not limited to making music. It can easily be pro-



PARTS LIST

C1, C2—0.01-µF Mylar capacitor
D1 through D12—1N914 diode
IC1—74154 4-line to 16-line decoder
IC2—555 timer
IC3, IC4—7473 dual JK flip-flop
IC5—7400 quad NAND gate
Q1—2N3906 transistor
R1 through R13—2000-ohm linear-taper pc trimmer potentiometer
The following are 1/4-watt, 5%-tolerance resistors:
R14—5600 ohms
R15, R19, R20—1000 ohms
R16—10,000 ohms
R17—22,000 ohms
R18, R21, R22, R23, R24—100,000 ohms
Misc.—IC sockets (optional); suitable prototyping board; suitable enclosure; etc.

As bits 0 through 3 from computer change, the vco changes frequency. Other four bits (4 through 7) determine the octave of the audio output.

grammed to generate a mix of tones, up to a total of 16, for use as test and remote-control signals.

Circuit Operation. The circuit (see schematic diagram) can be broken down for discussion purposes into three major subsections: note decoder/selector, voltage-controlled oscillator (vco), and octave decoder/selector.

The note decoder/selector consists of integrated circuit *IC1*, a 4-line to 16-line decoder. As the four control bits from the computer (bits 0, 1, 2, and 3) are entered into *IC1*, one of the 16 output lines is driven low. When the output line goes low, it allows its associated diode (*D1* through *D12*) and series potentiometer (*R1* through *R12*) to control the voltage and, hence, the frequency of the vco made up of *IC2*, *Q1*, and their associated components. Since only 12 tones per octave are used in music, output lines 13, 14, and 15 of *IC1* (pins 15, 16, and 17) are not used. (These three lines can be used to control an external device, as we will discuss later.) When *IC1*'s output 0 at pin 1 is low, the vco is cut off to provide a no-note condition.

Timer *IC2* is configured as an oscillator, with transistor *Q1* serving as a voltage-controlled resistor that works in conjunction with frequency-determining capacitor *C1*. By varying the bias applied to the base of *Q1*, the output frequency of the vco system can be made to vary.

Resistor *R18* determines the low- and *R16* and *R17*, the high-frequency ends of the range. Capacitor *C1* can be changed to select the desired frequency range. The output of the oscillator at pin 3 is fed to the flip-flops in *IC3* and *IC4* for octave generation.

The four octaves of square waves generated by *IC3* and *IC4* are summed with the four octave-control bits (bits 4, 5, 6, and 7) by the four AND gates in *IC5*. The resulting selected octaves are mixed in *R21* through *R24* for application to an external audio system. Any combination of four octaves can be selected simply by changing the status of bits 4 through 7. If all octave bits are low, no tone appears at the output. Note that no status signals are required.

Since the audio output consists of square waves, it is not difficult to introduce various types of filters to create different sounds.

Construction. The entire circuit can be assembled on any prototyping board that can be connected to the parallel output port of the computer in which the Music Box is to be used. The power for the Music Box can be taken from the +5-volt and ground lines in the computer. Alternatively, you can use an external power supply rated at 100 mA minimum. In either case, a common ground must be used between the Music Box and computer.

You can use sockets for the IC's if you wish and small board-mounted trimmer potentiometers for *R1* through *R13*.

Calibration. Although the Music Box was designed for use with a computer, it does not require a computer for calibration. All you need is a 5-volt dc power source and an audio system. A frequency counter will simplify calibration but is not a necessity.

Before applying power to the Music Box, set *R1* through *R12* to their maximum series resistance and *R13* to its center of rotation. If you have a frequency counter, connect it to the TEST POINT. Otherwise, connect the output of the Music Box to an amplifier/speaker combination so that the pitch of the output signal can be compared with the sound of a known musical instrument.

Using temporary jumpers to the +5-volt (1) and ground (0) lines, set the control bits to the values given in Table I and adjust the corresponding trimmer potentiometer (*R1* through *R12*) to obtain the indicated frequency (or the correct tone when compared with the sound from a musical instrument). If the entire range cannot be obtained, readjust *R13* and perform the above procedure again.

TABLE I—THE WELL-TEMPERED MUSICAL SCALE

Control bit 76543210	Frequency (Hz)	Note 5th Octave
10000000	0	Off
10000001	523.25	C
0010	554.37	C#
0011	587.33	D
0100	622.25	D#
0101	659.26	E
0110	698.46	E#
0111	739.99	F
1000	783.99	G
1001	830.61	G#
1010	880.00	A
1011	932.33	A#
1100	987.77	B

TABLE II—TEST VALUES

Note	Number value (n)
Off	0
C	1
C#	2
D	3
D#	4
E	5
E#	6
F	7
G	8
G#	9
A	10
A#	11
B	12
Octave	**Number value**
5	n + 128
4	n + 64
3	n + 32
2	n + 16

Note: B_5 is the highest note (n=140)
C_2 is the lowest note (n=17)
C_5 is middle C
A_4 is A_{440}

Operation and Use. Since there is no data latch, the Music Box tracks the data that appears at the parallel output port. Connect the common ground and eight data lines between the Music Box and the output port. To test the system, execute an output of the number value that corresponds to that note as given in Table II.

The software program you write will depend on the music requirements. Arrays can be used to store melody information and loops can be used to control the length of the note.

The four-octave range of the circuit can be shifted by halving the value of *C1* to raise the pitch one octave or it can be doubled to lower the pitch one octave.

Other Uses. The three decoded outputs from *IC1* at pins 15, 16, and 17 can be used to trigger a percussive device (such as the "Cabonga" featured in the August 1977 issue of POPULAR ELECTRONICS) or to latch an external control device. These decoded output signals are TTL level. If music is not what you want, you can use the circuit to provide 16 preadjusted tones for use in testing or remote-control applications (see "Computer Bits," August 1977). To obtain all 16 tones, you must add diodes and potentiometers to the circuit as shown for the other outputs. ◇