THE PROGRAMMABLE MUSIC BOX PART 2

How to add 256 words of memory, plus music box applications.

BY MITCHELL WAITE AND LARRY BROWN

In Part 1 of this article, we discussed the circuit and construction procedure for the basic programmable music box, which contains a 40-note static memory system. This month, we will describe a 256-word memory add-on that greatly expands the programmability and playing time of the music box.

Because the music box uses an unaddressed shift register for storage, increasing the size of the usable memory is simple. The add-on memory system is built around three dual 256-bit shift registers. The entire memory circuit can be assembled on a small printed circuit board and connected to the music box by a multiconductor cable.

About the Circuit. The complete schematic diagram of the memory extender is shown in Fig. 1. Note that a 16-conductor cable is used to connect the memory module to the main music box circuit board. This cable carries all the required power, clock and input/output data. (Power is obtained from the music box.)

The clock signal from the music box board is fed to *Q1*, *Q2*, and *Q3*, which shape the leading edge of the clock signal to match the requirements of memory chips *IC1*, *IC2*, and *IC3*. All three IC's are clocked simultaneously. Information is stored when the RECIRC input is disabled.

The data on input lines *I1* through *I6* changes with instructions from the music box. The memory is clocked once for each change. Output lines *O1* through *O6* feed the stored data back to the music box when a tune or melody is to be played.

Construction. In Fig. 2 are shown the actual-size etching and drilling and component placement guides for the memory extender module. Wire the board as shown, reserving installation of the IC's for last. Mount and solder into place IC sockets or Molex Soldercons® at the IC locations. Then connect the leads on one end of a length of 16-conductor cable to the pads labelled 1 through 16 on the memory module. Remove *IC1* from the basic music box, and solder the free ends of the cable to the same numbered pads in *IC1*'s location on the main circuit board which is located inside the music box.

Next, exercising the usual precautions for handling MOS devices, install *IC1*, *IC2*, and *IC3* in their sockets on the memory board. Check to make sure that all IC's, transistors, and

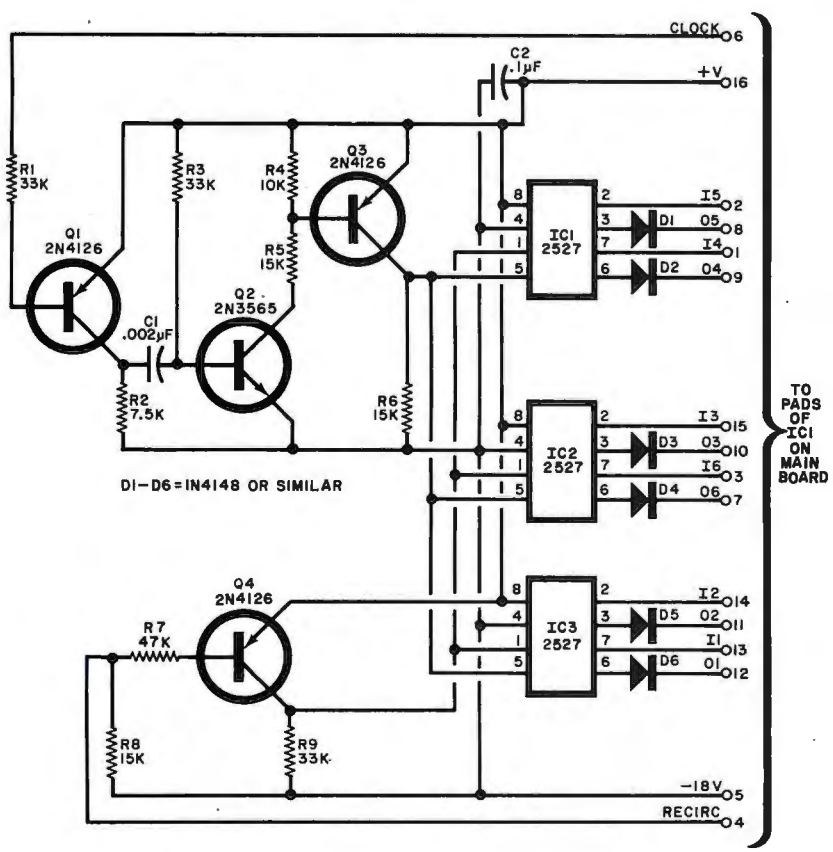


Fig. 1. Schematic of the memory extender. Numbered terminals are connected to main board in music box.

PARTS LIST

C1—0.002-µF, 100-volt Mylar capacitor
C2—0.1-µF, 50-volt Mylar capacitor
D1 through D6—1N4148 or similar diode
IC1 through IC3—2527 dual 256-bit shift register IC (Signetics)
Q1,Q3,Q4—2N4126 or similar transistor
Q2—2N3565 or similar transistor
The following resistors are ¼ watt, 5%.
R1,R3,R9—33,000 ohms
R2—7500 ohms
R4—10,000 ohms
R5,R6,R8—15,000 ohms
R7—47,000 ohms
Misc.—Printed circuit board; sockets or Molex Soldercons for IC's; 16-conductor cable; hookup wire; machine hardware; solder; etc.
Note: The following items are available from Cal Kit, P.O. Box 877, Sebastopol, CA 95472: Complete kit of memory extender module parts, including drilled and solder-plated pc board, flat 16-conductor cable, and mounting hardware, No. MC1-6 for $54.00, IC1, IC2, and IC3, No. MC1-8, for $43.00; three IC sockets, No. MC1-11, for $3.00; pc board No. MC1-7 for $8.00; telephone interface kit No. MC1-5 for $11.00. All items shipped postpaid and insured. California residents, please add 6% sales tax.

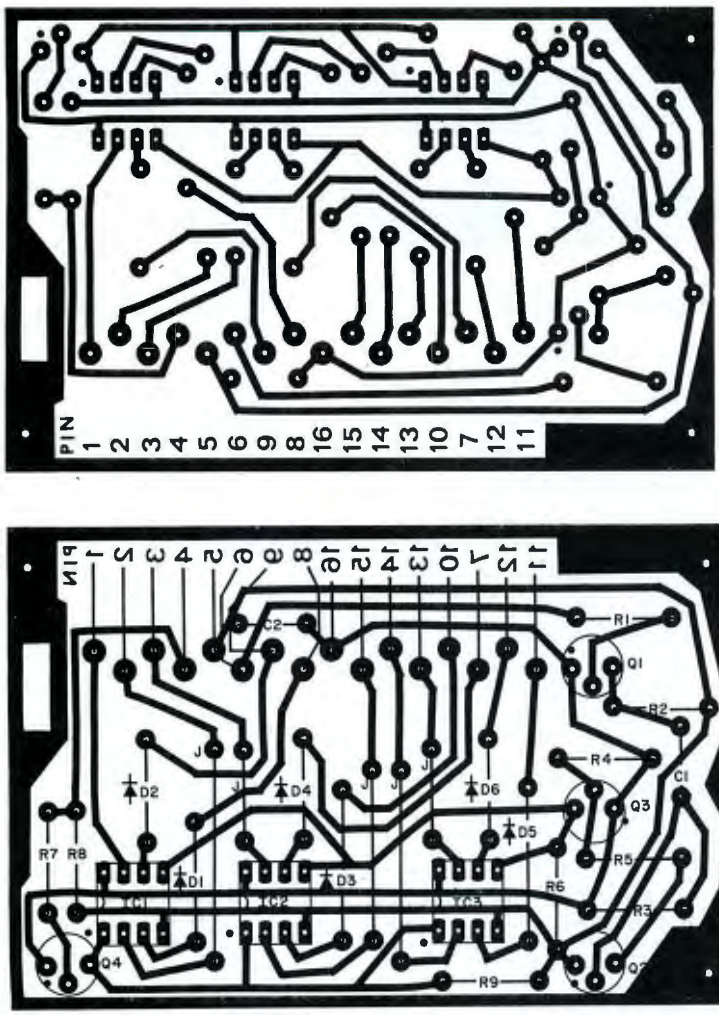


Fig. 2. Etching and drilling guide (top) and component layout.

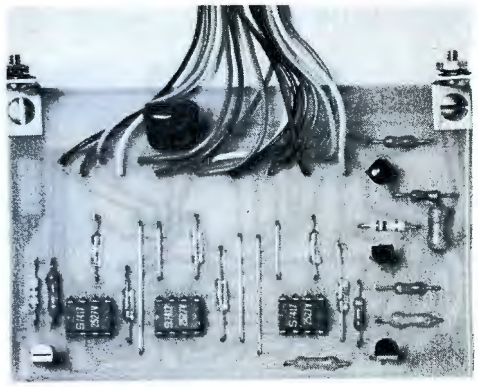


Photo of memory extender board.

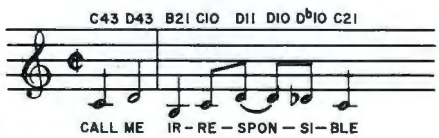
diodes are properly oriented. Turn over the circuit board and check all soldered connections. Reflow the solder around any connection that appears questionable. Finally, check the board's conductor pattern against the etching and drilling guide in Fig. 2, particularly between the closely spaced IC pads, for solder bridges.

Power requirements for the memory module are significantly greater than those for the original 40-note memory. If you decided to use battery power for the original music box, it will be necessary to use a heavier-duty battery when the memory extender is added. Switch to an Eveready No. 276 or RCA No. VS306 heavy-duty 9-volt battery, which should provide about 60 hours of useful life.

Operation. A set of programming forms can simplify writing and storing melodies in the music box, regardless of which version you build. Note that the addition of the memory extender module does not alter the manner in which the music box is programmed and played. It simply provides an expanded memory.

You can make your own programming form by laying out three horizontal rows of boxes numbered from 1 to 40 for the 40-word memory or from 1 to 256 when the memory extender is used. Label the top row NOTE, the middle OCTAVE, and the bottom SPACE. For simplicity, leave the OCTAVE and/or SPACE (remove) squares for each note blank if neither switch is to be depressed during programming and shade in the boxes where the switch or switches are to be closed.

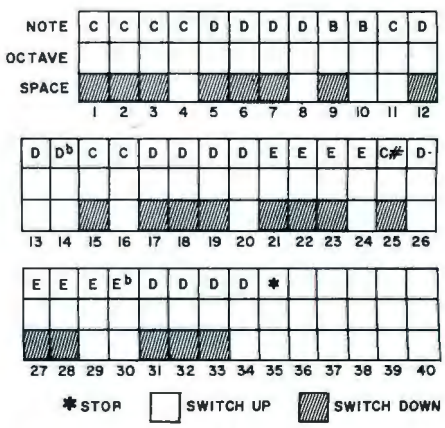
As an example of programming, let us use the first two measures of "Call Me Irresponsible." In sheet music form, they would look like this:



"Call Me Irresponsible" by Sammy Cahn and James Van Heusen. Copyright © 1962 & 1963 by Paramount Music Corp.

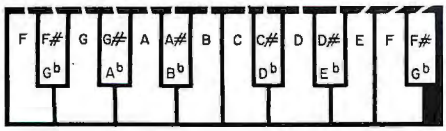
First, record each note above its symbol. Next, determine the duration of the shortest note. In our example, there are two half notes, one quarter note, four eighth notes, and a quarter note. This means that a memory "word" is worth one eighth note, the shortest note in the brief melody. A quarter note will then require two words of memory, a half note four words, and so on.

Determine how many words of memory each note requires and write this number beside the note's letter. In our example, "call" and "me" are half notes. Since a half note is the same duration as four eighth notes, the first number is a 4. The next note is for "ir. . ." (first syllable in "irresponsible"), which is a quarter note, or two eighth notes long. So, note B has a 2 after it. Continue to do this to all notes until you have used up the melody or run out of memory.



Program for "Call Me Irresponsible."

Now, determine where the spaces are to go. The first entry, C, is a half note. Since it requires four words to create a half note, the first three words have no space between them, which means the spaces should be removed by operating the SPACE REMOVE switch on the Music Box. To prevent the last word from running into the next note, your programming form should have a



Keyboard of the music box.

Program for "If I Were A Rich Man" from "Fiddler on the Roof."

"IF I WERE A RICH MAN"

N	*	D	C	D	C	B	B	G	G	G	S	B	C	D	C	D	C
O																	
S						▨		▨	▨								

B	C	D	E	F"	E	F"	E	D	D	D	D			
								▨	▨	▨				

▨ SWITCH DOWN □ SWITCH UP * STOP S=SPACE

F#',F' = LEFT F# OR F F#",F" = RIGHT F# OR F

blank in the SPACE row. You indicate this on your sheet music by entering a 3 after the "C4" entry. The entry "C43" is now interpreted as note C with four words of memory required and the first three spaces removed. Continue to calculate where to remove spaces for the rest of the notes in the melody. If a note is to be in the upper octave, indicate this by underlining the entry on the sheet music form.

In our example, the curved line between the two D notes on the scale forms the "spon" (of "irresponsible"), which means that the two notes are run together. Therefore, you must remove a space from the first D note.

All that remains now is to enter the data onto your programming form. We will use only the first note (C43) to illustrate how this is done; all other entries on the form are made in a similar manner. In the top row, enter a C in boxes 1 through 4. Since the note is not in the upper octave, leave blank the first four blocks in the second row. You want to remove the spaces between only the first three eighth notes, which means you have to fill in the first three boxes in the bottom row.

Programming this note is a relatively simple procedure. Touch the programming probe to the C key, press the SPACE REMOVE switch and hold it, press the WRITE & STEP switch three times, release the SPACE REMOVE switch, and press the WRITE & STEP switch once again. Proceed to the next note. Programming form for another tune is shown above.

Applications. With the memory extender added to the music box, some interesting programming possibilities are possible. You can, for example, write a long melody into the memory. Alternatively, you can write several shorter tunes, which can be played on demand by touching the keyboard probe to the START key or having a doorbell switch close the same circuit. If each tune starts with a "stop" code, only one melody will play each time the start circuit is activated.

Another way you can use the music box, in either version, is to program the tune you want and accompany it on another instrument or by singing the tune. This approach is better than using a tape recorder because the playback rate of the music box can be increased or slowed down *without changing the pitch*. (Any time you change the speed of a tape recorder, you also change the pitch.)

You can even use the music box as a variable-speed metronome, with or without accented beat. With a little imagination, it can be programmed to play the rhythm accompaniment to your music.

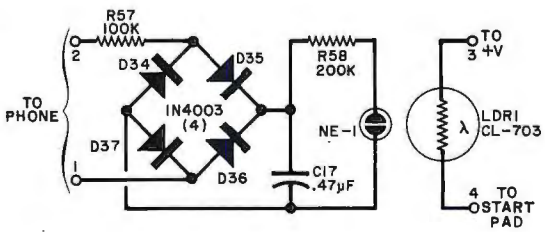
To use the music box as an unusual replacement for a conventional doorbell or chime system, locate and disconnect the doorbell's pushbutton switch leads at the transformer. Connect these two wires to the main circuit board in the music box via pads 36 (+V) and 35 (start). You can then feed the output of the music box to a power amplifier to obtain attention-getting volume.

If local laws permit, you can build the music box/telephone interface shown in Fig. 3. The actual-size etching and drilling guide and components placement diagram for this circuit are shown in Fig. 4. The telephone interface detects the 20-to-90-Hz ringing voltage that normally operates the phone's bell and uses this voltage to strike (ionize) neon lamp *I1*. The lamp is optically coupled, via a light-tight shield, to light-dependent resistor *LDR1*. The LDR is connected to the main board via pads 35 and 36. When the ringing signal occurs, the music box triggers on until the receiver is lifted off the hook or the ringing stops. Because the circuit has a high series resistance, it will not interfere with normal telephone operation. And the optical coupling eliminates any danger to the telephone system by accidental hookup of the power supply to the ac power line.

If you are a radio amateur, you can program short Morse code messages, such as a CQ followed by your call letters. By using a relay in the collector of the audio output circuit, you can key a transmitter.

You can wire two music boxes so that one clock controls both to allow you to play two-note chords in real time. If you have an electronic music synthesizer, you can use the output lines of the music box to drive the synthesizer's control circuits, creating some interesting sequences not possible with a conventional keyboard.◈

Fig. 3. Schematic for a telephone interface to go with the music box.



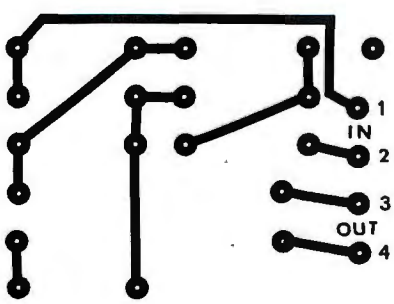


Fig. 4. Etching and drilling guide and component layout for the telephone interface.