Nothing generates quite so much interest in computers by raw beginners as a computer that makes noises. This is particularly true with children and especially if the computer can actually play its own tune on command. It can encourage them to take a serious interest in programming and/or computers in general.

Junior Synthesizer

make your computer play your favourite tunes

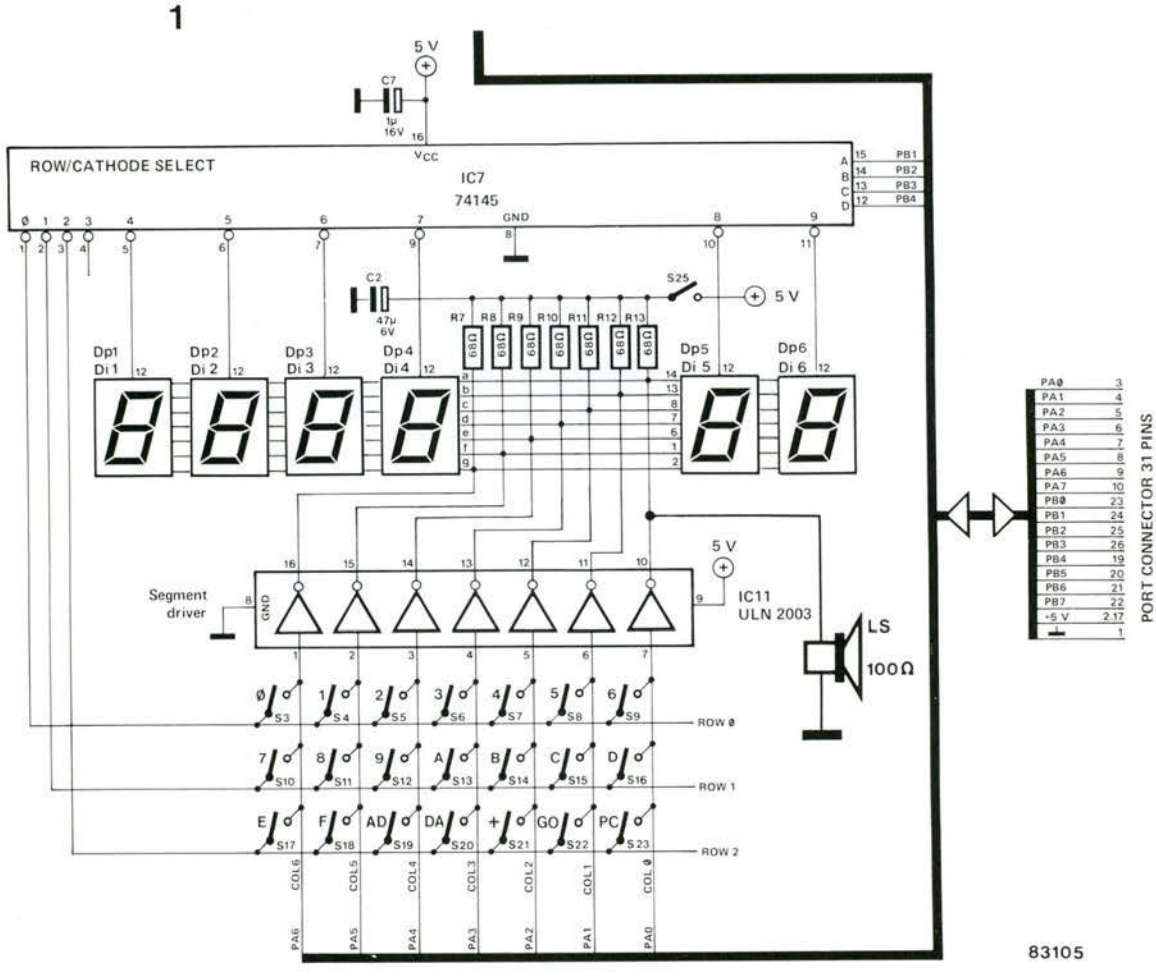
A. Bricart

When a flood of new musical instruments appeared that could be controlled by a microprocessor, some of the many Junior Computer owners must certainly have combined the two ideas. Actually this computer lends itself quite readily to controlling an analogue synthesizer. However, some people have probably not yet taught their computer to play music and so to make it easier we have written a program to turn your Junior Computer into a Junior Synthesizer.

A singing display

The only 'hardware' needed for this JC to JS conversion is a 100 Ω loudspeaker that is connected between one of the display driver outputs of IC11 and ground. No other special interface is needed as the only component used is connected directly to the existing circuit. The audio signal that feeds the loudspeaker is produced by the 6532 on the main board of the computer, and consists of a series of pulses whose frequency is determined by the software. The tune to be played is memorized in page $Ø3ØØ and is made up of a series of bytes, two of which are needed for each note to be played. The first is placed in an even address and corresponds to the pitch of the note; the second, corresponding to the duration of the note, is placed in the next odd address. The pitch depends on the frequency of the pulses, and the duration depends on how long the signal lasts.

1



There are four values of duration possible: minim, equal to two crotchets, each equal to two quavers which in turn are each equal to two semi-quavers. The durations are calculated from the computer clock which has a frequency of 1 MHz. For example, the note 'A' at 440 Hz has a pulselength of 2.28 ms. With a symmetrical waveform, the space lasts 1.14 ms. There is already a timing stage available in the computer (DELAY). So for our 'A', this delay has to be executed 81 times before inverting the logic level (81 x 14 $\mu s \approx 1.14$ ms). Thus the hexadecimal value of the pitch of this note is $51 (81 in decimal).

Because the program is very simple, only the $0300 page (up to $03FF) can be used to memorize a melody, so it can only have 127 notes at most. The tempo is fixed by the contents of location MULT ($0002) which can be changed to increase or decrease the speed of play. The rhythm is determined by the magnitude of the bytes in the uneven addresses, although, of course, the value of the durations also varies with the pitch of the notes.

When the processor finds the value $00 in an even address (pitch), it is silent for a certain length of time which is normally determined by the contents of the immediately following uneven address. If on the other hand, the value $00 is in an uneven address the tune is stopped and starts again from the beginning.

In the example given here, the Junior plays the Menuet du Bourgeois Gentilhomme by J. B. Lully, but with a little experimentation you can probably make it play 'Chopsticks' as well!

Table 1

Note	Hz	pitch code	duration code			
E	1318.5	1B			84	42
D#	1244.5	1D		F9	7C	3E
D	1174.6	1E		EB	76	3B
C#	1108.7	20		DE	6F	37
C	1046.5	22		D1	68	34
B	988	24		C6	63	31
A#	932.3	26		BA	5D	2F
A	880	29		B0	58	2C
G#	830.6	2B		A6	53	2A
G	784	2E		9D	4E	27
F#	740	30		94	4A	25
F	698.4	33		8C	46	23
E	659.2	36		84	42	21
D#	622.2	39	F9	7C	3E	1F
D	587.3	3D	EB	75	3B	1D
C#	554.3	41	DE	6F	37	1C
C	523.2	44	D1	69	34	1A
B	494	48	C6	63	31	19
A#	466.1	4D	BA	5D	2F	17
A	440	51	B0	58	2C	16
G#	415.3	56	A6	53	2A	15
G	392	5B	9D	4E	27	14
F#	370	61	94	4A	25	12
F	349.2	66	8C	46	23	11
E	329.6	6C	84	42	21	10
D#	311.1	73	7C	3E	1F	10
D	293.6	79	75	3A	1D	0E
C#	277.2	81	6F	37	1C	0E
C	261.6	89	69	34	1A	0D
B	247	91	63	31	19	0C
A#	233.1	99	5D	2F	17	0C
A	220.6	A2	58	2C	16	0B
G#	207.6	AC	53	2A	15	0B
G	196	B6	4E	27	14	0A
		00	E0	70	38	1C
			00			

Table 1. The codes for the pitch and duration of the notes shown here can make the Junior Computer play your favourite tune.

```
JUNIOR

M
HEXDUMP: 200,25D
      0  1  2  3  4  5  6  7  8  9  A  B  C  D  E  F
0200: A9 7F 8D 81 1A A9 08 8D 82 1A A9 00 85 00 A9 02
0210: 85 02 A6 00 BD 01 03 85 01 F0 E5 A9 40 8D 80 1A
0220: 20 53 02 A6 00 BC 00 03 F0 08 A9 BF 8D 80 1A 20
0230: 50 02 C6 01 D0 E5 C6 02 D0 D8 E6 00 E6 00 A2 FF
0240: CA EA EA EA D0 FA 4C 0E 02 00 00 00 00 00 00 00
0250: A6 00 BC 00 03 A2 02 CA D0 FD 88 D0 F8 60
```

Table 2. This is the program which uses the 6532 and the display driver to generate an audio signal that is heard through the loudspeaker. No physical alteration to the existing circuit is needed.

```
JUNIOR

M
HEXDUMP: 300,36B
      0  1  2  3  4  5  6  7  8  9  A  B  C  D  E  F
0300: 51 58 3D EA 41 DE 3D 75 36 84 51 58 48 63 5B 9C
0310: 61 4A 5B 4E 6C 84 61 94 79 3A 51 58 3D EA 41 DE
0320: 3D 75 36 84 51 58 48 63 5B 9C 61 4A 5B 4E 6C 84
0330: 61 94 79 3A 61 94 5B 4E 51 B0 51 58 48 63 48 63
0340: 56 53 51 B0 51 58 3D EA 48 63 41 6F 41 6F 51 58
0350: 3D 75 3D 75 48 63 41 DE 3D 75 51 58 48 63 5B 9C
0360: 61 4A 5B 4E 6C 84 79 74 00 70 00 00
```

Table 3. The sequence reproduced here corresponds to the notes and rhythm of the Menuet du Bourgeois Gentilhomme by Lully. The even addresses contain the pitches and the uneven addresses are the durations of the notes. Note that in some cases the durations are not exactly minims. The $00 at $036B acts as a repeat bar. It indicates that the piece is to be replayed from the start.