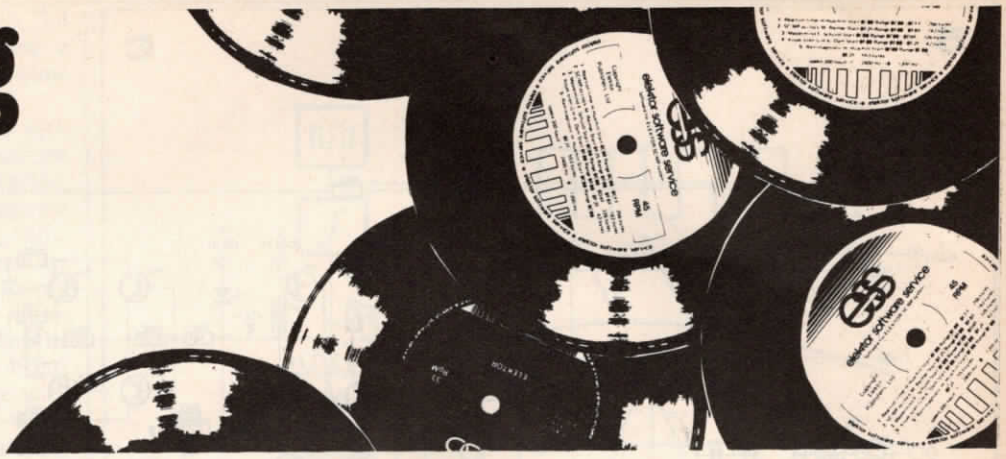
singing SC/MP



Talking computers are commonplace in Science Fiction, and once in a while a touch of comedy is added by introducing a singing 'brain'. In real life, talking computers are still in their infancy — a vocabulary of a few dozen words places them in the 'skilled' category.

Funnily enough, it's much easier to make an 'electronic brain' hum a tune! Even the relatively slow and dull-witted microprocessor can reproduce melodies with a high degree of accuracy. This is demonstrated in the SC/MP program described here. With Christmas in the air, a well-known tune was chosen: 'Silent Night'.

Programs for several other well-known tunes are also included on an ESS record. For interested readers, who are not (yet) the proud owners of a SC/MP system, the μP's rendition of these tunes is recorded 'live' on the B-side of the same disc.

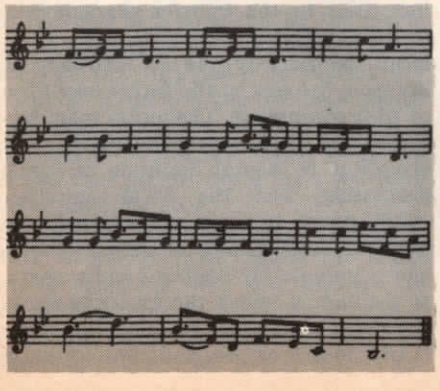
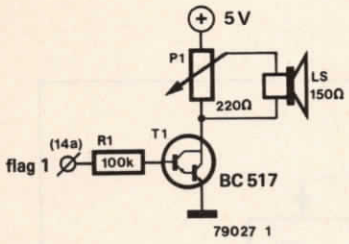


TABLE 1

0C00	$ 1	00	HALT	TAB 1	0C53	5A	TAB 2	0C81	C4 03
0C01		C401	LDI X'01			49			DC 01
0C03		C84B	ST COUNT 1			5A			C4 02
0C05		C84A	ST COUNT 2			78			C4 05
0C07		C453	LDI X'53			5A			C4 03
0C09		31	XPAL 1			49			DC 01
0C0A		C40C	LDI X'0C			5A			C4 02
0C0C		35	XPAH 1			78			C4 05
0C0D		C481	LDI X'81			25			EB 05
0C0F		32	XPAL 2			25			C4 03
0C10		C40C	LDI X'0C			39			D6 07
0C12		36	XPAH 2			32			83 08
0C13		C42F	LDI X'2F			32			57 06
0C15		C83B	ST COUNT 3			5A			EB 05
0C17	$ 3	C418	LDI X'18			49			DC 04
0C19		8F00	DLY X'00			49			DC 02
0C1B	$ 2	C402	LDI X'02			32			9D 05
0C1D		07	CAS			39			F7 01
0C1E		C400	LDI X'00			49			DC 02
0C20		8F00	DLY X'00			5A			C4 03
0C22		C400	LDI X'00			49			DC 01
0C24		07	CAS			5A			C4 02
0C25		C400	LDI X'00			78			C4 05
0C27		8F00	DLY X'00			49			DC 04
0C29		B825	DLD COUNT 1			49			DC 02
0C2B		9CEA	JNZ $ 3			32			9D 05
0C3D		C024	LD COUNT 1'			39			F7 01
0C2F		C81F	ST COUNT 1			49			DC 02
0C31		B81E	DLD COUNT 2			5A			C4 03
0C33		9CE6	JNZ $ 2			49			DC 01
0C35		08	NOP			5A			C4 02
0C36		B81A	DLD COUNT 3			78			C4 05
0C38		98C6	JZ $ 1			25			EB 05
0C3A		C501	LD@ 1 (1)			25			C4 03
0C3C		C8E9	ST DELAY			14			83 08
0C3E		02	CCL			25			93 02
0C3F		F432	ADI X'32			39			F7 02
0C41		C8DD	ST DELAY			32			9D 0A
0C43		C601	LD@ 1 (2)			19			F7 08
0C45		C809	ST COUNT 1			32			9D 05
0C47		C80A	ST COUNT 1'			5A			C4 01
0C49		C601	LD@ 1 (2)			78			6E 03
0C4B		C804	ST COUNT 2			5A			C4 03
0C4D		90CC	JMP $ 1			6D			AF 01
0C4F		00	4 counter bytes			8F			93 02
0C50		00				A9			6D 0C
0C51		00							
0C52		00							

1



2

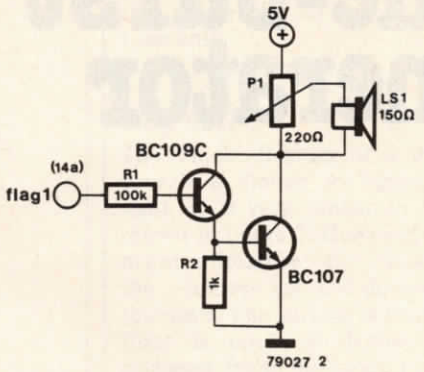


TABLE 2

Note	hex code	frequency
A#	C7	466
B	B8	494
C	A9	523
C#	9C	554
D	8F	587
D#	83	622
E	78	659
F	6D	698
F#	63	740
G	5A	784
G#	51	831
A	49	880
A#	41	932
B	39	988
C	32	1047
C#	2B	1109
D	25	1175
D#	1F	1245
E	19	1319
F	14	1397
F#	ØF	1480
G	ØA	1568
G#	Ø6	1661
A	Ø2	1760

Figure 1. Only three components are required for a 'loudspeaker interface'.

Figure 2. In case of availability problems, the BC 517 can, of course, be replaced by a standard Darlington configuration.

Table 1. Complete program listing for 'Silent Night'.

Table 2. Using the information given in this Table, it is a fairly easy matter to program the SC/MP for other melodies.

The SC/MP can, of course, sing quite happily to itself. However, if the performance is intended for the benefit of a human audience, a loudspeaker will be required. In computer jargon: a 'loudspeaker interface'. A suitable circuit was described in the recent 'Summer circuits' issue (July/August 1978, circuit no. 12, 'software Kojak siren'). It consists of a Darlington-transistor amplifier and a loudspeaker, connected to a 'Flag' output of the SC/MP (figure 1; an alternative circuit is given in figure 2). If the Flag is set and reset rapidly, a tone is produced; the more rapidly the Flag changes state, the higher the output frequency.

A melody consists of a succession of 'tones' with different frequencies. To make the SC/MP 'sing', it must be programmed to set and reset one of its Flags at a frequency that is determined by a list of numbers somewhere in its memory. Furthermore it must be told, by means of a second list of numbers, how long each note should last. In other words, a program is required that will combine two lists of numbers (one for tone pitch and one for tone duration) to produce a melody. A suitable program is given in Table 1.

The output frequency generated at any given moment is determined by a hexadecimal number XX as follows:

$$f = \frac{10^6}{556 + 8(XX)_{16}} \text{ Hz},$$

where XX is limited to the range $0 \leqslant XX \leqslant CD$ (hexadecimal!).

This limits the SC/MP's singing to two octaves, as shown in Table 2. To avoid the need for combersome calculations, this Table lists the possible notes, the corresponding hexadecimal numbers and the output frequencies. With this information, it is a relatively simple matter to draw up the first list (giving the frequencies of the consecutive notes) for any given melody.

As stated earlier, the duration of each note is determined by a number in a second list. In this program, the tone duration is entered as the number of periods the note is to last. Since this can lead to fairly large numbers, two bytes are reserved for each note, the total number being the *product* of the two numbers involved.

To give an example, assume that the tone required is the low D and that it is to last for 1/4 second. From Table 2, the low D corresponds to 8F and its frequency is 587 Hz. For it to last 1/4 second, 147 periods are required. In hexadecimal: $(93)_{16}$ periods. This is entered in the second list as 93 Ø1 (or Ø1 93), corresponding to $(93)_{16} \times (1)_{16}$.

Finally, the SC/MP has to be told the length of the tune, i.e. the number of notes. Or, to be more precise, the number of notes plus one. This value is entered in address ØC14.

In the program, TAB 1 (starting at position ØC53) is the list of notes required, and TAB 2 is the list of tone durations. The start address of the latter list is stored in ØCØE (lower address byte) and ØC11 (higher address byte).

As an example, the complete program listing for 'Silent Night' is given in Table 1. It is entered from address ØCØØ; this is also the start address. The program is started by operating the halt/reset key.

If other melodies are to be produced, the lists of numbers under TAB 1 and TAB 2 must be modified accordingly. Furthermore, as mentioned earlier, the start address of TAB 2 must be entered in positions ØCØE and ØC11, and the number of notes plus one is stored in ØC14.

The program described here is included, with 5 other well-known Christmas melodies and 'Mary had a little lamb', on the Elektor Software Service record ESS 002. The B-side of the same recording contains the SC/MP's 'real-time' rendition of the same tunes.

Litt: Experimenting with the SC/MP, Nov. 1977 . . . April 1978;
Software Kojak siren, July/August 1978.