A cricket-song simulator using the 68705 single-chip microcomputer

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A cricket-song simulator is described. The device uses a waveform generator to produce a song carrier frequency that is modulated by the 68705 microcomputer. Sixteen different songs can be stored in memory.

The cricket song simulator described here was developed from a 6502-based system previously described by Campbell and Loher (1983). It was designed to generate simulated cricket songs, with specific parameters required for a series of field and laboratory experiments, but it can be used for a variety of purposes for which a particular pulsed output pattern is required. Walker (1982) has used a similar device in conjunction with sound traps for monitoring migrations of crickets. In the system described here, an 8038 waveform generator produces the song carrier frequency that is modulated by the 68705 microcomputer. The output is amplified with a 386 audio amplifier, and the simulated song is transmitted from a piezoelectric tweeter. Up to 16 different songs (0-15) can be stored in computer memory as song tables, and each song can be selected by means of four toggle switches that specify the song number in binary.

Use of the 68705 has a number of advantages. It has the essentials of a complete microcomputer, such as input/output ports, a CPU, and RAM. In addition, there is user-programmable EPROM and a bootstrap program in ROM that is used for easy EPROM programming. All of these features are on one chip, so there are obvious benefits if compactness and low costs in a dedicated system are considerations. Another advantage of the 68705 is that the EPROM is nonvolatile and the device functions immediately on power-up without the need for loading a program. Also, the program is not lost in the event of a power failure.

The 68705 is available in both HMOS (MC68705P3), which requires a relatively high operating current but is well suited to operation using a power supply, and in CMOS (MC1468705F2), which is suitable for battery operation. The instruction set is the same for both, but unfortunately the pin configurations and the bootstrap routines are not. The HMOS 68705 is used in the unit described here; however, it should be relatively simple to make the necessary modifications if a CMOS battery-operated system is required. Full technical data for both chips are available from Motorola distributors.

SONG TABLES

The song tables are the means by which the user specifies the parameters of the simulated songs required. The tables are in hexadecimal notation and control the durations of consecutive output levels of the song modulator. The initial level is set LO, the second level HI, the third, LO, and so forth. Although the duration of each level is specified by the table elements, as in the earlier version (Campbell & Loher, 1983), the level (HI or LO) is not. This makes the song tables shorter and simpler to write. For example, initial elements 06 06 in a table would produce a pulse of duration 6 unit intervals LO and 6 unit intervals HI. The unit interval is the same for both versions (1,160 μ sec).

A segment of the table consists of one or more elements demarked by an FE flag and followed by the number of repeats of the segment required by the user. Thus 06 06 FE 0C would produce 12 pulses with a periodicity of $(6 \times 1,160) \times 2 \mu$ sec. The first segment can be followed by a second, a third, and so forth, each demarked by an FE flag and the number of repeats required.

All the segments of a table constitute the phrase, the end of which is denoted by an FF flag. The phrase is repeated indefinitely: for example, 20 20 FE 06 10 10 FE 1E A0 FE 01 FF. This represents a complete song

Figure 1. Simulations of the calling songs of two field crickets: (a) *Teleogryllus commodus* and (b) *Teleogryllus oceanicus*.

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Examples

Table 1 includes the program (0200-02D1) and the pointers for the starting addresses for the song tables of Song 0 (*T. commodus*) and Song 1 (*T. oceanicus*) at 02E0,02E1 and 02E2,02E3 (low order first). The song tables for these two songs are at 0300-030B and 030C-0319. The last two locations, 07FE and 07FF (in the last line of Table 1), contain the reset vectors that point to the starting address of the program. The starting address pointers for all 16 song tables, if all are used, are specified by the user between 02E0 and 02FF, and data for the song tables are entered between 0300 and 03FF.

EPROM PROGRAMMING THE 68705

The song simulator program (Table 1), the song tables and addresses, and the reset vectors are transferred from an external 2716 EPROM to the 68705 EPROM using the bootstrap ROM of the 68705. The circuit diagram for the hardware required for the transfer and an explanation of its operation are provided in the Motorola data sheets; therefore, details are not included here.

Programming the external 2716 EPROM was achieved using a Jason-Ranheim "Promenade" programmer.¹ This fits into the user port of the Commodore-64 computer and is controlled by software that comes with the device. The

procedure is to transfer the song simulator program plus ancillary data as a block stored anywhere convenient in the C-64 user RAM (e.g., 2000-27FF) to the 2716 EPROM. The "Promenade" manual describes various ways of doing this. Transferring the program and data into the C-64 user RAM is probably most easily done by using a monitor.

HARDWARE

The hardware schematic is given in Figure 2. We used a Kambrook programmable timer to switch the song simulator on and off at specified times. It is available at many retail outlets as a digital time switch for domestic appliances. It was chosen because it has a 12-V dc supply, an LCD clock with battery backup, up to eight time settings, and, most importantly, a TTL output from the control chip. The song simulator hardware is housed in a small jiffy box glued over the power-out socket (not required) of the Kambrook timer to provide a very compact unit measuring about 8×6×15 cm. The TTL line from the timer is wired to PB3 of the 68705. The pull-up on this line, shown in Figure 2, might not be necessary, depending on the characteristics of the timer. The 12-V supply line is used to run the 8038 waveform generator and the 386 audio amplifier. This is sufficient to give a modu-

Figure 2. Schematic for the cricket-song simulator.

lated sine wave output of about 9 V peak to peak without clipping. VCC of the 68705 requires a 5-V supply, which is obtained via a 5-V regulator from the 12-V supply. The 8038 has been wired to provide a frequency range of approximately 2-6 kHz using VR1.

REFERENCES

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NOTE

1. The "Promenade" EPROM programmer is currently available from Jason-Ranheim, 580 Parrott Street, San Jose, CA 95112.

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