NEWTECH MODEL 68 MUSIC BOARD USERS MANUAL

Rev.A Sept. 1977

I. General

The Model 68 Music Board was brought out in response to demand by SWTPC computer system owners for a music board similar to our S-100 bus compatible Model 6 Music Board.

The Model 68 has many possible applications: generating sound effects for computer games; playing along while you play your guitar or clarinet or trumpet; simulating train sounds for your model railroad; generating audible prompts from your computer while running other programs. The list goes on and on. Newtech welcomes your ideas and suggestions as well, and we'll be happy to pass them on to users, perhaps through the SWTPC newsletter.

The programs in this manual are a good introduction to computer-generated sound. The user can modify them as he learns how they work.

For those wishing to go beyond these programs, there is a growing body of literature on computer-generated music in the personal computing magazines. Although most of the articles are for processors other than the 6800, they are good reading for developing an appreciation of the general principles involved in computer music. Many of the programs offered can be readily translated for the 6800. To name just a few:

1. Wright, Malcolm, "Alphanumeric Music with Amplitude Control" (available from People's Computer Company, Menlo Park, California).

2. Chamberlain, Hal, "Computer Bits" in "Popular Electronics", vol.10#3, 116-119 (Sept.1976) and vol.10#4, 88-91 (Oct.1976).

3. Chamberlain, Hal, "A Sampling of Techniques for Computer Performance of Music" in "Byte", Vol.2#9, 62-83 (Sept.1977).

4. Siegel, Dorothy, "Scott Joplin on your Sci-Fi Hi-Fi", in "ROM", vol.1#4, 61-65 (Oct.1977) and "A Musical Smorgasboard", in "ROM",vol.1#5 (Nov.1977).

The Popular Electronics articles contain useful programs for Touch-tone synthesis and "weird" sound generation. The ROM articles contain a description of simplified versions of Newtech's Model 6 software, suggestions on how to modify them, and pre-coded listings for other music.

For those who wish to delve more deeply into the "roots"of computer music and the fundamentals of sound generation, the following may be of interest:

1. Helmholtz, H.L.F., <u>On the Sensations of Tone as a Physiological Basis for the Theory of Music</u> (Dover, New York, 1954).

2. Mathews, Max V., <u>The Technology of Computer Music</u> (M.I.T. Press, Cambridge, Mass., 1969).

II. THEORY OF OPERATION

A. Address Decoding:

The Model 68 Music Board is designed for use with the Southwest Technical Products Corporation 6800 computer system. It will work equally well at any I/O port address so long as the software used conforms to the slot selected. The programs provided herein use I/O slot 4 (address 8010H) but can be readily modified for a different I/O assignment. A Triple 3-Input NAND Gate, IC1, is used to derive a strobe from I/O#, Ø2 and R/W.

B. Data Latching:

When an instruction to write into the Model 68 I/O slot memory location is performed, the write data will appear on the data bus lines DØ through D7. The most significant 6 bits of this data, D7 through D2, will be latched by the Hex latch IC2.

C. Digital to Analog Conversion (DAC):

The data latched in IC2 is buffered by CMOS buffers. These buffers drive an R/2R ladder network with voltages very close to Ø volts and the +5 volt supply. The ladder network employs precision resisters and is minimally loaded by a high impedance voltage divider into the audio amplifier.

D. Audio Amplifier:

The analog output from the R/2R DAC ladder network is AC coupled through capacitor C7 and resistive divider network R14, R13 to an audio amplifier IC4. The output low pass filter R15 and C5 and capacitors C1 and C2 on the amplifier 8 volt supply, are required to maintain amplifier stability. The output of the R/2R ladder network can swing from Ø to 5 volts. The input to IC4 can thus range from near zero to 5 volts $\times$ 25K/(2M+25K) $\approx$ .062 volts peak to peak. The gain of IC4 is about 50 so its output will swing about 3.08 volts peak to peak. For a maximum amplitude square wave, output will thus be 3.08/2 $\approx$ 1.54 VRMS. The maximum direct power output to an 8 Ohm speaker will thus be $(1.54)^2/8 \approx .3$ Watt and peak speaker load current will be V/R=1.54/8=.19 Ampere.

This rather detailed explanation of the audio amplifier section has been given for two reasons. The first is to make its operation easy to understand. The second is that it is important to understand the limitations of the Model 68 and what it will and will not do. It WILL drive the 2" speaker on the Model 68 Music Board or, alternatively, a small external efficient 8 Ohm speaker. Of course, the Model 68 can be used as an input to an audio system. One of the things the Model 68 will NOT do (nor for that matter will any other music board designed to run off a hobbyist computer power supply), is replace a home high fidelity system power amplifier to drive large inefficient speaker systems.

The Model 68 Music Board audio amplifier IC and output capacitor C8 are conservatively rated to operate as supplied. But DO NOT ATTEMPT TO SOUP-UP THIS CIRCUIT TO PROVIDE HIGHER POWER OUTPUT. It would be dangerous, as the components are not rated for the increased stresses.

E. Power Supply:

The audio amplifier works off the SWTPC 8 volt unregulated supply. Capacitors C1 and C2 are required for improved high frequency supply regulation and for stability of the audio amplifier IC4.

IC5 inputs +8 volts unregulated from the SWTPC I/O bus and provides 5 volts regulated for the logic and DAC circuitry. Capacitor C2 on the regulator input is required for regulator stability and capacitors C3 and C4 for improved high frequency regulation.

III. USERS GUIDE

A. External Speakers:

Considerable improvement in sound quality can be readily achieved over the 2" speaker supplied with the Model 68 by using an external speaker.

When this is done, jumper JMPR1 should be removed (or cut) to disconnect the on-board speaker. The external speaker can be connected at J1. Excellent sound production has been achieved using very inexpensive 5" speakers.

B. Use with Audio System:

Best sound production is achieved when the Model 68 is connected to a high fidelity amplifier. An auxiliary input jack is likely your best choice.

CAUTION: The Model 68 is capable of producing a very wide range of frequencies extending from the subaudible through the entire audio range and up to the ultrasonic. You should use the common sense you would use with any other signal source, such as a record turntable or radio. Play too loud, particularly on the bass drive, and you can damage your speaker.

Additionally, your software can cause subaudible or ultrasonic range outputs from the Model 68 which you can only see on an oscilloscope and yet may be driving your speaker system. So, a good rule of thumb would be to first set up your amplifier and Model 68 volume controls for the test program given herein, or for some other program known to be in the audio range, and then NEVER substantially exceed those amplifier settings.

IV. SOFTWARE

A. General:

The software supplied herein represents a very small fraction of the applications possible for the Model 68. As a matter of fact, books devoted entirely to the subject of microcomputer music will undoubtedly appear in the near future. The intent here is to supply the Model 68 user with basic music and sound effects software. The serious student of computer music will find ways to elaborate on these routines and to create others himself.

One major goal of the software as written is to make the programs readily understandable. Readers may want to rewrite the programs with other goals in mind: minimizing memory requirements; maximizing execution speed; adding other features, etc..

B. SCORE68 and PLAY68:

The two music programs contained herein are named SCORE68 and PLAY68. SCORE68 is a BASIC program that uses alphanumeric notations of musical notes to produce a table of constants which, in turn, is used by the Assembly Language PLAY68 program to "play" the music. The calculation of constants is compatible with the SWTPC 0.8986MHz 6800 clock.

SCORE68 was written in SWTPC 8K BASIC (Rev. 2.0) and may require modification if you are using a different BASIC.

The music used in SCORE68 is "The Entertainer" by Scott Joplin. Other music can be coded and inserted as DATA statements instead of those used for the Joplin piece.

Each note in the music is specified by a four- or five-character string appearing as a DATA statement in SCORE68. For example, the first note of the music, a sixteenth-note "D", is specified as "Db3S".

Pitch is specified by the first three characters:

First character: "A","B","C","D","E","F","G"

Indicates pitch within an octave.

Second character: "#"(sharp), "!"(flat), " " (blank, or natural)

Indicates whether the pitch is raised or lowered (or neither) by a half-step.

Third character: "1","2","3"

Indicates the octave, with "1" the lowest of the three octaves starting at A=220Hz, "2" the second octave starting at A=440Hz, and "3" the third octave starting at A=880Hz. N.B. PLAY68 as written does not allow the use of the notes below C in octave 1.

Duration is specified by the fourth and fifth characters:

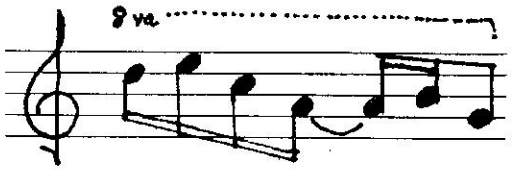
Fourth character: "S"(sixteenth), "E"(eighth), "Q"(quarter), "H"(half), "W"(whole)

Indicates relative length of each pitch.

Fifth character (optional): "."

Indicates increasing by half the duration of the note specified by the fourth character.

Thus, for example, the first six notes of "The Entertainer" used in SCORE68:



are coded as:

```
0830 DATA D 3S,E 3S,C 3S,A 3E,B 3S,G 2E
```

SCORE68 has a special end-of-score one-character string "X" which enters a zero pitch constant in the score to indicate the end of the music.

Tempo can be increased or decreased by changing the constant K6. The speed is proportional to K6, so doubling K6 would double the speed of the music.

Illegal characters in a note specification string will produce an error message and terminate score compilation. The error message would be of the form:

```
ERROR IN NOTE #1
DATA STRING "A#3P."
CHARACTER #4
```

In this example the fourth character is illegal. When the score is completely compiled without error messages, "SCORE COMPILATION COMPLETE" will be indicated.

The starting location of the score produced is specified by the variable U. Standard location is 2C00H (specified as 11264 in BASIC) but can be changed to any free memory location, provided the score location pointer in PLAY68 is made to agree.

Program execution starts at the first statement -- requiring you to simply type "RUN".

Roughly six to eight bytes of memory are required in the BASIC program for each note of music specified. PLAY68 requires three bytes for each note of music.

C. RAMP:

RAMP is a test routine for verifying proper operation of the Model 68 with the user's computer. Note that the Newtech Model 68 standard output port address is for I/O slot 4 (8010H). The Model 68 will work equally well in any other I/O slot so long as its driving software is made to agree with its address. Note also that RAMP is relocatable and can be run almost anywhere in memory. If there is ever doubt that the Model 68 is working the RAMP routine can be quickly entered and executerd using the MIKBUG*or other monitor program. Since RAMP loops forever, the user must reset or interrupt his computer to exit RAMP.

RAMP produces a 319Hz linear ramp of 64 discrete steps. (Note that the program outputs 256 values; however there are only 2^6=64 values output from the Model 68 since its 6-bit DAC doen't use the two least significant bits.) The linearity of the Model 68 can be verified on an oscilloscope by observing the monotonically increasing stepped waveform at the output of phono jack J1.

The ramp frequency is calculated as follows:

* SWTPC 6800 clock frequency = 1.7971/2 = 0.89855 MHz
  Each processor state is thus T = 1/F = 1/0.89855x10 = 1.11μs

* Each pass through the program takes 11 processor states.

* Each ramp takes 256 passes through the program.

* The total ramp time is thus:
  T_R = (1.11us/state) x (11 states/pass) x (256 passes/ramp)

  T_R = 3134 us/ramp

The ramp frequency $F_R = 1/T_R$ = 319Hz.

D. Phasor:

PHASOR is a sound effect program demonstrating one way to generate frequency sweeps. As written, the default parameter values in PHASOR will generate 13 rapid sweeps from very high to very low frequencies and then exit by jumping to the MIKBUG* monitor. The user can change the number of sweeps, starting sweep frequency, ending sweep frequency, sweep rate, and amplitude by changing, respectively, SWEEPN, FIRSTF, LASTF, RATE, and TOGGLE. Very interesting effects can be attained with a main control program setting these parameters and using PHASOR as a subroutine.

* MIKBUG is a registered Motorola trademark.

E. NOISE

NOISE is a sound effect program based upon digital low-pass filtering of digitally generated white noise.

The RNDM subroutine within NOISE implements a 16-bit maximal length pseudorandom number generator. Each time it is called, the most significant byte of the number generated is returned in Accumulator A. The main routine in NOISE uses table TBL to shape the amplitude envelope of the noise. By ANDing the noise generated, with a mask from TBL, only certain bits are allowed to change. For example, while ANDing with mask FFH allows all bits to change and thus maximum amplitude noise to be produced, ANDing with mask 3FH will keep the two most significant bits (A7 and A6) constant and thus allow only lower noise levels to be produced.

The DURA parameter in NOISE determines the number of noise samples used for each segment in the amplitude envelope specification TBL. Thus decreasing DURA will shorten the duration of the sound. The FREQ parameter in NOISE determines the time between random noise samples and thus the frequency band of the noise generated.

A great variety of sound effects can be achieved by changing the parameters in NOISE. By calling NOISE as a subroutine, a main program can vary the NOISE parameters dynamically. NOISE has been used to simulate the sound of locomotives, guns, snare drums, rockets, etc.

Model 68 Software Cassette
Rev. A Sept. 1977

TAPE COUNTER[1]	FILE NAME	FILE TYPE	MEMORY REQUIREMENTS	COMMENTS
0-22/28	STING	MIKBUG[2]	2B00H-2DFFH	STARTS 2B00H
30/38-48	PHASOR	MIKBUG	100H-1FFH	STARTS 100H
50/55-63	NOISE	MIKBUG	100H-1FFH	STARTS 100H
65/73-121	SCORE68[3]	BASIC	12K INCLUDING SWTPC 8K CASSETTE BASIC	16K FOR SWTPC DISK 8K BASIC
130/135-180	PLAY68[3]	CO-RES SOURCE	12K INCLUDING CASSETTE CO-RES ASSEMBLER	16K FOR SWTPC DISK SYSTEM
180/185-212	PHASOR	"	"	"
212/217-244	NOISE	"	"	"

(1) The tape counter designation 30/38-48 indicates that on Newtech's tape position counter an identifying voice track runs from 30 to 38 and the actual file runs from 38 to 48.

(2) MIKBUG file types are MIKBUG formated binary object tapes.
MIKBUG is a registered trademark of Motorola Inc.

(3) Users of non-SWTPC cassette based software and users writing very large music scores that use more memory will want to change SCORE68 and PLAY68 pointers referring to the location of PLAY68 and the musical score constants.

```
0010 REM SCORE68  REV.A SEPT. 1977
0020 REM COPYRIGHT (C) 1977
0030 REM NEWTECH COMPUTER SYSTEMS,INC.
0040 REM ALL RIGHTS RESERVED
0050 REM
0150 LET U=11264 : REM U DEFINES SCORE AREA IN MEMORY
0160 LET K1=2^(1/12)
0170 LET K6=1.2 :REM TEMPO CONTROL
0190 FOR V=1 TO 1000
0200 LET C=1
0210 READ Z$
0220 LET N=100
0225 LET A$=MID$(Z$,1,1)
0230 IF A$="A" THEN N=1
0240 IF A$="B" THEN N=3
0250 IF A$="C" THEN N=4
0260 IF A$="D" THEN N=6
0270 IF A$="E" THEN N=8
0280 IF A$="F" THEN N=9
0290 IF A$="G" THEN N=11
0300 IF A$="X" THEN GOTO 720
0310 IF N=100 THEN GOTO 760
0320 LET C=2
0330 LET M=100
0335 LET A$=MID$(Z$,2,1)
0340 IF A$="!" THEN M=N-1
0350 IF A$="#" THEN M=N+1
0360 IF A$=" " THEN M=N
0370 IF M=100 THEN GOTO 760
0380 LET C=3
0390 LET P=100
0395 LET A$=MID$(Z$,3,1)
0400 IF A$="1" THEN P=M
0410 IF A$="2" THEN P=M+12
0420 IF A$="3" THEN P=M+24
0430 IF P=100 THEN GOTO 760
0440 LET C=4
0450 LET T=100
0455 LET A$=MID$(Z$,4,1)
0460 IF A$="S" THEN T=16
0470 IF A$="E" THEN T=8
0480 IF A$="Q" THEN T=4
0490 IF A$="H" THEN T=2
0500 IF A$="W" THEN T=1
0510 IF T=100 THEN GOTO 760
0530 LET C=5
0540 IF MID$(Z$,5,1)="." THEN T=2*T/3
```

```
0550 REM CALCULATE CONSTANTS
0560 LET F1=220*(K1^(P-1))
0570 LET T1=10^6/(2*F1)
0580 LET K3=(T1*1.7971/2 -185)/6
0590 LET K4=F1/(K6*T)
0600 LET D3=INT(K4) : REM MAKE DURATION EVEN#
0610 LET D4=2*D3-2*INT(D3/2)
0620 LET D5=INT(D4/256) : REM CALC. 2 BYTES
0640 LET D7=D4-D5*256 : REM D7=LSB
0650 REM TRANSFER CONSTANTS TO SCORE AREA
0660 POKE( U+3*(V-1),INT(K3+.5))
0670 POKE( U+3*(V-1)+1,D5)
0680 POKE( U+3*(V-1)+2,D7)
0690 PRINT V;
0700 NEXT V
0710 STOP
0720 POKE( U+3*(V-1),0)
0730 PRINT
0740 PRINT "SCORE COMPILATION COMPLETE"
0750 STOP
0760 PRINT "ERROR IN NOTE #";V
0770 PRINT "DATA STRING ";Z$
0780 PRINT "CHARACTER #";C
0790 STOP
0810 REM
0820 REM "THE ENTERTAINER" BY SCOTT JOPLIN
0830 DATA D 3S,E 3S,C 3S,A 3E,B 3S,G 2E
0840 DATA D 2S,E 2S,C 2S,A 2E,B 2S,A 2S,A!2S
0850 DATA G 1Q,G 3E,D 1S,D#1S
0860 DATA E 1S,C 2E,E 1S,C 2E,E 1S,C 2Q.
0870 DATA C 3S,D 3S,D#3S
0880 DATA E 3S,C 3S,D 3S,E 3E
0890 DATA B 3S,D 3E
0900 DATA C 3Q.,D 1S,D#1S
0910 DATA E 1S,C 2E,E 1S,C 2E,E 1S,C 2Q.
0920 DATA C 2S,A 3S,G 2S
0930 DATA F#2S,A 3S,C 3S,E 3E,D 3S,C 3S,A 3S
0940 DATA D 3Q.,D 1S,D#1S
0950 DATA E 1S,C 2E,E 1S,C 2E,E 1S,C 2Q.
0960 DATA C 3S,D 3S,D#3S
0970 DATA E 3S,C 3S,D 3S,E 3E,B 3S,D 3E
0980 DATA C 3Q.,C 3S,D 3S
0990 DATA E 3S,C 3S,D 3S,E 3E,C 3S,D 3S,C 3S
1000 DATA E 3S,C 3S,D 3S,E 3E,C 3S,D 3S,C 3S
1010 DATA E 3S,C 3S,D 3S,E 3E,B 3S,D 3E
1020 DATA C 3Q,C 3S,E 2S,F 2S,F#2S
1030 DATA G 2E,A 3S,G 2E,E 2S,F 2S,F#2S
1040 DATA G 2E,A 3S,G 2E,E 2S,C 2S,G 1S
1050 DATA A 2S,B 2S,C 2S,D 2S,E 2S,D 2S,C 2S,D 2S
1060 DATA C 2E,X
9000 END
```

```
00100                           NAM     PLAY68   REV.A SEPT.1977
00110                           OPT     O,NOP
00120                   * COPYRIGHT (C) 1977 ALL RIGHTS RESERVED
00130                   * NEWTECH COMPUTER SYSTEMS,INC.
00140                   *
00150                   * PLAY68 STARTS AT THE BEGINNING OF THE MEMORY AREA
00160                   * DESIGNATED "SCORE" AND TRANSFERS INTO RAM LOCATION
00170                   * "PITCH" A 1-BYTE PITCH PARAMETER AND INTO RAM
00180                   * LOCATION"DURA" A 2-BYTE DURATION PARAMETER.  THE
00190                   * ROUTINE THEN CALLS SUBROUTINE PLAY TO OUTPUT TO
00200                   * THE MODEL 68 THE MUSICAL NOTE SPECIFIED BY THESE
00210                   * NOTE PARAMETERS.  PLAY68 CONTINUES TRANSFERRING
00220                   * NOTE PARAMETERS AND CALLING THE PLAY ROUTINE UNTIL
00230                   * A PITCH CONSTANT OF ZERO IS ENCOUNTERED WHICH
00240                   * INDICATES THE END OF THE MUSICAL SCORE.
00250                   *
00260 2B00                      ORG     $2B00
00270       2C00        SCORE  EQU     $2C00     SCORE AREA CAN BE CHANGED.
00280 2B00 8E 2B90             LDS     #STACK    INIT. STACK POINTER.
00290 2B03 CE 2C00             LDX     #SCORE    INIT. SCORE POINTER.
00300 2B06 FF 2B77             STX     PLACE
00310 2B09 FE 2B77  NEXT       LDX     PLACE
00320 2B0C 86 00               LDA A   #0        IF END OF SCORE LOOP HERE.
00330 2B0E A1 00               CMP A   X
00340 2B10 27 FE    HERE       BEQ     HERE      YOUR ENDING?
00350                   *    ELSE TRANSFER PARAMETERS FOR NEXT NOTE OR SCORE
00360                   *    INTO PLAY ROUTINE.
00370 2B12 A6 00               LDA A   X         LOAD PITCH.
00380 2B14 B7 2B7B             STA A   PITCH
00390 2B17 08                  INX
00400 2B18 A6 00               LDA A   X         LOAD DURATION MSB
00410 2B1A B7 2B75             STA A   DURA
00420 2B1D 08                  INX
00430 2B1E A6 00               LDA A   X         LOAD DURATION LSB.
00440 2B20 B7 2B76             STA A   DURA+1
00450 2B23 08                  INX
00460 2B24 FF 2B77             STX     PLACE     SAVE SCORE POINTER.
00470 2B27 8D 02               BSR     PLAY      CALL NOTE PLAYING ROUTINE.
00480 2B29 20 DE               BRA     NEXT      GO DO NEXT NOTE.
00490                   *    THE PLAY ROUTINE PLAYS ONE NOTE & RETURNS.
00500 2B2B CE 2B6C  PLAY       LDX     #TBL1     INIT. ENVELOPE POINTER.
00510 2B2E FF 2B79             STX     TBL1P     STORE ENV. POINTER.
00520 2B31 E6 00               LDA B   X         PUT AMPLITUDE VALUE IN B.
00530 2B33 FE 2B75             LDX     DURA      LOAD DURATION PARAMETER
00540                   *                         INTO INDEX REGISTER.
```

```
00550 2B36 BC E000 LOOP3   CPX     $E000     5-WASTE TIME (31 STATES)
00560 2B39 BC E000         CPX     $E000     5-
00565 2B3C BC E000         CPX     $E000     5-
00570 2B3F BC E000         CPX     $E000     5-
00580 2B42 BC E000         CPX     $E000     5-
00590 2B45 73 E000         COM     $E000     6-
00600 2B48 86 16   LOOP2   LDA A   #22       4-FIXED DELAY TO ADJUST
00610 2B4A 4A      LOOP4   DEC A             2- LOWEST NOTE TO 262HZ
00620 2B4B 26 FD           BNE     LOOP4     4- (MIDDLE C) WHEN PITCH
00630                      *                   PARAMETER=FE.
00640 2B4D B6 2B7B         LDA A   PITCH     4-LOAD PITCH PARAMETER.
00650 2B50 F7 8010         STA B   MOD68     5-OUTPUT TO MUSIC BOARD.
00660 2B53 4A      LOOP1   DEC A             2-DELAY AS PER PITCH PARAM.
00670 2B54 26 FD           BNE     LOOP1     4-
00680 2B56 53              COM B             2-COMPLEMENT WAVEFORM VALUE.
00690 2B57 09              DEX               4-DECREMENT DURATION COUNTER.
00700 2B58 26 DC           BNE     LOOP3     4-
00710 2B5A 7C 2B7A         INC     TBL1P+1   6-SET UP NEXT SEGMENT.
00720 2B5D FE 2B79         LDX     TBL1P     5-
00730 2B60 E6 00           LDA B   X         5-
00740 2B62 C1 01           CMP B   #$01      2-END OF ENVELOPE CHAR.=01.
00750 2B64 27 05           BEQ     RETRN     4-RETURN IF LAST SEGMENT.
00760 2B66 FE 2B75         LDX     DURA      5-RESET DURATION PARAMETER.
00770 2B69 20 DD           BRA     LOOP2     4-
00780 2B6B 39      RETRN   RTS
00790                      *
00800                      * AMPLITUDE ENVELOPE SPECIFICATION:
00810                      * MAXIMUM AMPLITUDE IS OUTPUT WHEN ACCUMULATOR B IS
00820                      * COMPLEMENTED FROM 00 TO FF AND BACK.  MINIMUM
00830                      * AMPLITUDE IS OUTPUT WHEN B IS COMPLEMENTED
00840                      * BETWEEN 80 AND 7F.  AN END OF ENVELOPE RECORD
00850                      * OF $01 MARKS THE END OF THE SPECIFICATION.
00860                      *
00870 2B6C FF      TBL1    FCB     $FF,$FF,$F0,$E0,$D0,$C0,$B0,$85,$01
      2B6D FF
      2B6E F0
      2B6F E0
      2B70 D0
      2B71 C0
      2B72 B0
      2B73 85
      2B74 01
00880                      *
00890 2B75 0002    DURA    RMB     2         DURATION CONSTANT.
00900      8010    MOD68   EQU     $8010     MUSIC BOARD IN I/O SLOT 4.
00910 2B77 0002    PLACE   RMB     2
00920 2B79 0002    TBL1P   RMB     2         TABLE POINTER
00930 2B7B 0001    PITCH   RMB     1         PITCH PARAMETER.
00940 2B7C 0014            RMB     20
00950      2B90    STACK   EQU     *
00960                      END
```

```
00100                          NAM     RAMP      REV.A SEPT.1977
00110                          OPT     NOP,O
00120                  * MODEL 68 MUSIC BOARD TEST ROUTINE.
00130                  * THIS ROUTINE PRODUCES A TRIANGULAR RAMP OF 319 HZ
00140                  * ON A 6800 COMPUTER SYSTEM RUNNING AT 0.89855 MHZ
00150        8010      MOD68   EQU     $8010     MUSIC BOARD IN I/O SLOT 4
00160                  *                         CAN BE CHANGED FOR OTHER SLOTS
00170 0100                     ORG     $0100
00180 0100 4C          RAMP    INC A             2-CALCULATE NEXT STEP.
00190 0101 B7 8010             STA A   MOD68     5-OUTPUT TO MUSIC BOARD.
00200 0104 20 FA               BRA     RAMP      4-LOOP
00210                          END
```

```
00100                          NAM    PHASOR   REV.A  SEPTEMBER 1977
00110                          OPT    NOP,O
00120                  * COPYRIGHT (C) ALL RIGHTS RESERVED
00130                  * NEWTECH COMPUTER SYSTEMS,INC.
00140                  *
00150 0100                     ORG    $0100
00160 0100 B6 0145 START  LDA A  SWEEPN   INIT. SWEEP COUNT
00170 0103 B7 0146        STA A  SWEEPS
00180 0106 86 00   NEXTS  LDA A  #0       EXIT IF SWEEPS COUNT=0.
00190 0108 B1 0146        CMP A  SWEEPS   ELSE DECREMENT COUNT &
00200 010B 27 35          BEQ    EXIT     DO ONE SWEEP.
00210 010D 7A 0146        DEC    SWEEPS
00220 0110 B6 0147        LDA A  FIRSTF   INIT.FREQ.PARAMETER.
00230 0113 B7 0149        STA A  FREQ
00240 0116 B6 014A        LDA A  RATE     GET SWEEP RATE PARAM.
00250 0119 4A      LOOP3  DEC A           DECREMENT IT.
00260 011A 26 10          BNE    LOOP1    IF N.E.0 BRANCH.
00270 011C 7C 0149        INC    FREQ     ELSE DECREASE FREQ.
00280 011F B6 0148        LDA A  LASTF    IF LOWEST FREQUENCY
00290 0122 B1 0149        CMP A  FREQ     THEN SWEEP IS DONE SO
00300 0125 27 DF          BEQ    NEXTS    GO NEXT SWEEP.
00310 0127 B6 014A        LDA A  RATE     ELSE RESTORE RATE PARAM.
00320 012A 20 05          BRA    LOOP2
00330 012C 63 00   LOOP1  COM    X        WASTE TIME.
00340 012E 63 00          COM    X
00350 0130 01             NOP
00360 0131 F6 0149 LOOP2  LDA B  FREQ     HALF-WAVE TIMEOUT
00370 0134 5A      LOOP4  DEC B
00380 0135 26 FD          BNE    LOOP4
00390 0137 73 014B        COM    TOGGLE   OUTPUT COMPLEMENT TO
00400 013A F6 014B        LDA B  TOGGLE   MUSIC BOARD.
00410 013D F7 8010        STA B  MOD68
00420 0140 20 D7          BRA    LOOP3
00430 0142 7E E0D0 EXIT   JMP    MIKBUG
00440      8010   MOD68  EQU    $8010    MUSIC BOARD ADDRESS.
00450 0145 0D     SWEEPN FCB    $0D      DESIRED # OF SWEEPS.
00460 0146 0001   SWEEPS RMB    1        TEMPORARY SWEEP COUNT
00470 0147 01     FIRSTF FCB    $01      STARTING SWEEP PARAM.
00480 0148 FF     LASTF  FCB    $FF      ENDING SWEEP PARAM.
00490 0149 0001   FREQ   RMB    1        TEMPORARY FREQ.PARAM.
00500 014A 01     RATE   FCB    $01      SWEEP RATE PARAMETER.
00510 014B 00     TOGGLE FCB    0
00520      E0D0   MIKBUG EQU    $E0D0
00530 014C 01             NOP
00540                     END
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00100                          NAM    NOISE    REV.A SEPT.1977
00110                          OPT    NOP,O
00120                  * COPYRIGHT (C) 1977 ALL RIGHTS RESERVED
00130                  * NEWTECH COMPUTER SYSTEMS,INC.
00140                  *
00150 0100                     ORG    $0100
00160 0100 CE 0157             LDX    #TBL     INIT. ENVELOPE POINTER.
00170 0103 FF 0166             STX    TBLP
00180 0106 86 02    LOOP2      LDA A  #$02     IF ENVELOPE IS
00190 0108 FE 0166             LDX    TBLP     COMPLETE RETURN.
00200 010B A1 00               CMP A  X
00210 010D 27 24               BEQ    EXIT
00220 010F FE 0166             LDX    TBLP     ELSE INC. ENV. POINTER.
00221 0112 08                  INX
00222 0113 FF 0166             STX    TBLP
00230 0116 B6 0163             LDA A  DURA     OUTPUT N RANDOM VALUES
00240 0119 B7 0168             STA A  DURAT    WHERE N=DURA.
00247 011C B6 0162 LOOP1       LDA A  FREQ     DELAY ACCORDING TO
00248 011F 4A      LOOP3       DEC A           FREQUENCY PARAMETER.
00249 0120 26 FD               BNE    LOOP3
00250 0122 8D 12               BSR    RNDM     :GET RANDOM NUMBER IN A.
00260 0124 FE 0166             LDX    TBLP     :SCALE AMPLITUDE ACCORDING
00270 0127 A4 00               AND A  X        : TO ENV. TABLE.
00280 0129 B7 8010             STA A  MOD68    :OUTPUT TO MUSIC BOARD.
00290 012C 7A 0168             DEC    DURAT
00300 012F 26 EB               BNE    LOOP1
00310 0131 20 D3               BRA    LOOP2    PROCESS NEXT AMPLITUDE.
00320 0133 7E E0D0 EXIT        JMP    MIKBUG   YOUR EXIT MAY DIFFER!
00330                  *
00340                  * RANDOM NUMBER GENERATOR.  GENERATES 16 BIT
00350                  * VALUE IN "NMBER".  RETURNS MOST SIGNIFICANT
00360                  * BYTE IN A.
00370 0136 B6 0164 RNDM        LDA A  MSB      EXCLUSIVE-OR SHIFT
00380 0139 46                  ROR A           REGISTER BITS 15,14,12&3.
00390 013A B8 0164             EOR A  MSB      15 & 14
00400 013D 46                  ROR A
00410 013E 46                  ROR A
00420 013F B8 0164             EOR A  MSB      12
00430 0142 46                  ROR A
00440 0143 B8 0165             EOR A  LSB      3
00450 0146 46                  ROR A
00460 0147 46                  ROR A
00470 0148 84 01               AND A  #$01     MASK BIT 0.
00480 014A 78 0165             ASL    LSB      SHIFT NMBER LEFT.
00490 014D 79 0164             ROL    MSB      SETTING BIT 0 ACCORDING
00500 0150 BB 0165             ADD A  LSB      TO EXCLUSIVE-OR CALC.
00510 0153 B7 0165             STA A  LSB
00520 0156 39                  RTS
00530                  *
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00540                   * AMPLITUDE ENVELOPE SPECIFICATION:
00550 0157 FF           TBL     FCB     $FF,$FF,$FF,$7F,$7F,$3F
      0158 FF
      0159 FF
      015A 7F
      015B 7F
      015C 3F
00560 015D 3F                   FCB     $3F,$1F,$0F,$07,$02
      015E 1F
      015F 0F
      0160 07
      0161 02
00570                   *
00579 0162 30           FREQ    FCB     $30         NOISE BAND PARAMETER.
00580 0163 FF           DURA    FCB     $FF         DURATION PARAMETER.
00590 0164 0001         NMBER   FDB     $01         SHIFT REGISTER.
00600      8010         MOD68   EQU     $8010       MUSIC BOARD I/O ADDRESS.
00610      E0D0         MIKBUG  EQU     $E0D0
00620 0166 0002         TBLP    RMB     2           ENVELOPE TABLE POINTER.
00630 0168 0001         DURAT   RMB     1           TEMPORARY DURATION COUNT.
00640      0164         MSB     EQU     NMBER       RANDOM NUMBER ROUTINE.
00650      0165         LSB     EQU     NMBER+1
00660 0169 01                   NOP
00670                           END
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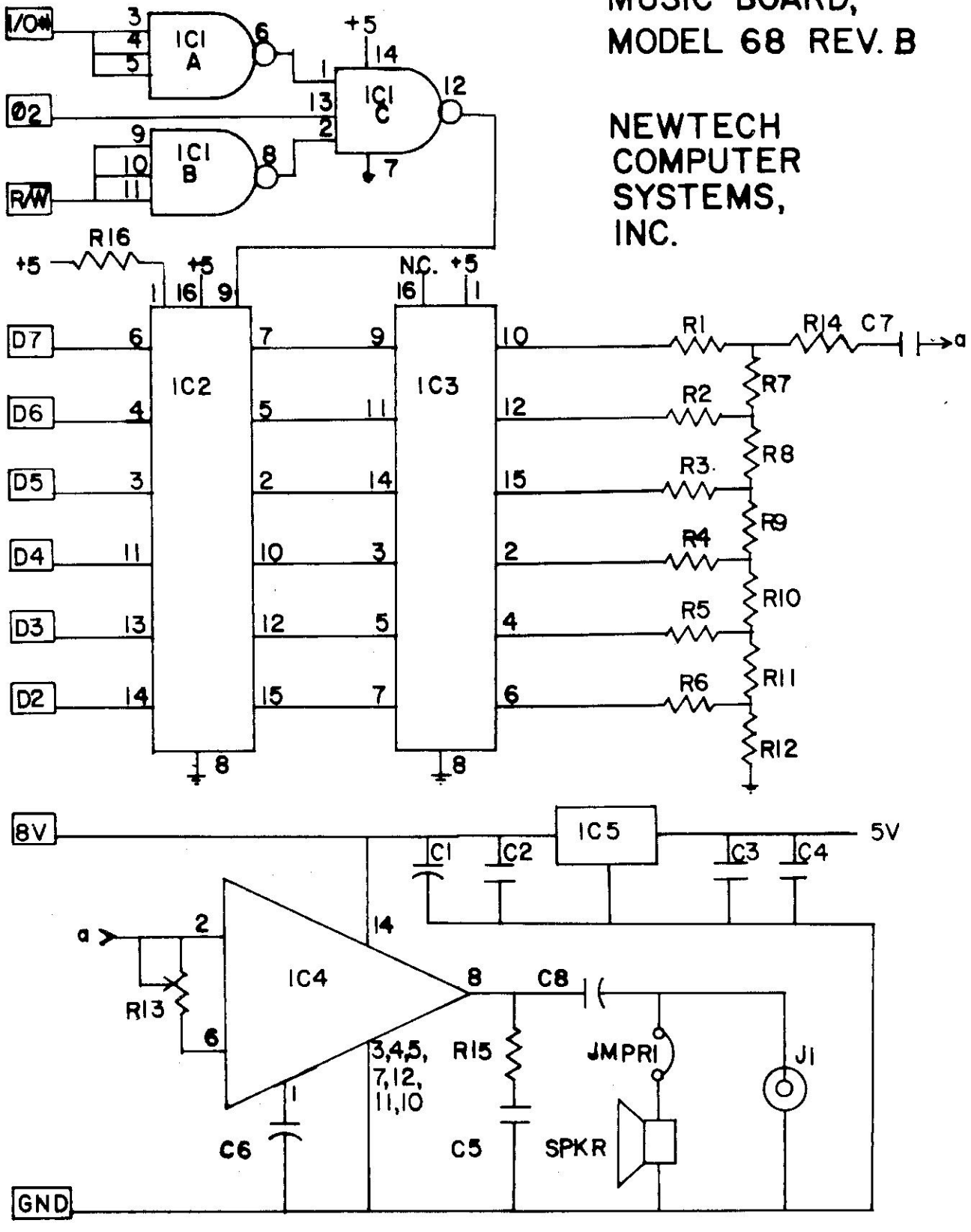
MUSIC BOARD, MODEL 68 REV. B

NEWTECH COMPUTER SYSTEMS, INC.



NEWTECH MODEL 68 MUSIC BOARD

Parts List

IC1	74LS10
IC2	74LS174
IC3	CD4050
IC4	LM380
IC5	78L05
R1-R5	Resistor, 20K Ohm 1%
R6	Resistor, 20K Ohm 5%
R7-R11	Resistor, 10K Ohm 1%
R12	Resistor, 10K Ohm 5%
R13	Resistor, Potentiometer, 25K Ohm
R14	Resistor, 2M Ohm 10%
R15	Resistor, 1 Ohm 10% 1/2 Watt
R16	Resistor, 4.7K Ohm 10%
C1	Capacitor, 1uF 35 Volt Tantalum
C2,C3, C4,C5,C7	Capacitor, 0.1uF 12 Volt disc
C6	Capacitor, 4.7uF 10 Volt Tantalum
C8	Capacitor, 220uF 25 Volt
SPKR	Speaker, 8 Ohm 0.2 Watt
J1	Phono Jack