include a calculation that will set the number of repeats required to produce a tone for a set duration, no matter what the frequency of the tones. If we make the unit of duration 1/50th of a second then the number of repeats for a given delay value is: $1000000 \div (50 \times (271 + 75 \times delay))$. To calculate this in machine code would be difficult and slow so instead we can set up a look-up table from BASIC, giving a value from the above formula for each value of delay (i.e. from 1 to 109). The machine code routine then simply has to look up the repeat value and store it in a decrementer, to produce a tone lasting for 1/50th of a second.

Commodore owners with an assembler can type in the source code listing and assemble it to produce an object program that can be saved. The calling program will load back the object program from disk or cassette and set up the look-up tables. Type this in and run it. Type NEW and enter the sample BASIC program that gives the various location addresses used by the machine code program. RUN this program with the buffer box and D/A converter set up as shown on page 732. If you do not have an assembler, then type in and run this BASIC loader before running the calling program. If you use the BASIC loader then lines 45 and 50 of the calling program can be omitted.

BBC owners can simply type in the BBC version as written and RUN.

```
10 REM BASIC LOADER FOR FREQ/AMP PROGRAM
20 :
30 FOR I=49801 TO 49911
40 READ A:POKEI,A
50 CC=CC+A
60 NEXT I
70 READ CS:IF CC<>CS THENPRINT
   "CHECKSUM ERROR":STOP
100 DATA172,134,194,208,8,169,0,141
110 DATA204,194,76,174,194,169,15,141
120 DATA204,194,162,15,172,134,194,189
130 DATA0,194,24,106,157,15,194,136
140 DATA208,248,202,16,239,120,169,0
150 DATA141,133,194,174,135,194,189,30
160 DATA194,172,136,194,240,7,10,46
170 DATA133,194,136,208,249,141,1,132
180 DATA194,162,0,189,15,194,172,135
190 DATA194,136,208,253,141,1,221,232
200 DATA224,15,208,239,173,132,194,56
210 DATA233,1,141,132,194,173,133,194
220 DATA233,0,141,133,194,208,218,169
230 DATA0,205,132,194,208,211,88,96
240 DATA16186:REM*CHECKSUM*
```

```
10 REM **** CALLING PROGRAM ****
20 REM ****        AND        ****
30 REM ****   TABLE SET UP    ****
40 :
45 DN=8:REM IF CASSETTE DN=1
50 IF A=0 THEN A=1:LOAD"FREQ.HEX",DN,1
60 :
70 REM **** SET UP SHAPE TABLE ****
75 :
80 S=15:TB=12*4096+2*256
90 FOR I=0 TO S-1
100 Y=127*SIN(X)+127
110 POKE TB+I,Y
120 X=X+2/S
130 NEXT I
140 :
150 REM **** SET UP FREQ/DELAY TABLE ****
160 :
170 TB=TB+2*S
180 FOR D=0 TO 101
190 TV=10^6/(50*(271+75*D))
200 POKETB+D,TV
210 NEXT D
```

```
;*******************
;*******************
;++                  ++
;++    CBM 64        ++
;++   FREQUENCY      ++
;++ AND AMPLITUDE    ++
;++  GENERATION      ++
;++                  ++
;*******************
;*******************
;
STEPS  = 15     ;NO. OF STEPS PER WAVE CYCLE
PORT   = 56577
;
*=       $C200
SHAPTB *=*+STEPS      ;WAVE SHAPE TABLE
AMPTAB *=*+STEPS      ;AMPLITUDE TABLE
LOOPTB *=*+102        ;FREQ/DELAY TABLE
COUNT  *=*+2          ;LOOP COUNTER
DIVISN *=*+1          ;DIV OF WAVE FACTOR
DELAY  *=*+1          ;DELAY FACTOR
TIME   *=*+1          ;NOTE DURATION FACTOR
;
;++++ SET AMPLITUDE TABLE ++++
;
       LDY DIVISN
       BNE CONT
       LDA #<SHAPTB    ;MODIFY PROGRAM
       STA NEXVAL+1    ;TO LOAD SHAPTB
       JMP INITC
CONT
       LDA #<AMPTAB
       STA NEXVAL+1
       LDX #STEPS
NEXT
       LDY DIVISN
       LDA SHAPTB,X
MORE
       CLC
       ROR A
       STA AMPTAB,X
       DEY
       BNE MORE
       DEX
       BPL NEXT
;
;++++ SET COUNT VALUE ++++
;
INITC
       SEI
       LDA #$00
       STA COUNT+1     ;INIT COUNT HIBYTE
       LDX DELAY
       LDA LOOPTB,X
       LDY TIME
       BEQ NOMULT
MULT
       ASL A
       ROL COUNT+1
       DEY
       BNE MULT
NOMULT
       STA COUNT
;
;++++ MAIN PROGRAM LOOP ++++
;
MAIN
       LDX #$00
NEXVAL
       LDA AMPTAB,X
       LDY DELAY
MORDEL               ;DELAY LOOP
       DEY
       BNE MORDEL
;
       STA PORT
       INX
       CPX #STEPS
       BNE NEXVAL
;
;++++ DECREMENT COUNT ++++
;
       LDA COUNT
       SEC
       SBC #$01
       STA COUNT
       LDA COUNT+1
       SBC #$00
       STA COUNT+1
       BNE MAIN
       LDA #$00
       CMP COUNT
       BNE MAIN
       CLI
       RTS
```

```
15REM ****************************
20REM **                        **
25REM **           BBC          **
30REM ** FREQUENCY & AMPLITUDE  **
40REM **       GENERATION       **
50REM **                        **
60REM ****************************
90MODE 7
95steps=15:port=&FE60
97ddr=&FE62:?ddr=255:REM ALL OUTPUT
100HIMEM=HIMEM-&101:REM RESERVE TABLE SPACE
110shape_table=HIMEM+1
112amplitude_table=shape_table+steps
114loop_table=amplitude_table+steps
115PROCset_tables
120PROCassemble_code
140REM **** BASIC TEST PROGRAM ****
160CLS
170PRINT:INPUT"AMPLITUDE FACTOR 0-7";AF
```

```
180IF AF<0 OR AF>7 THEN 170
190?div_factor=AF
200PRINT:INPUT"DELAY FACTOR 1-101";DF
210IF DF<1 OR DF>101 THEN 200
220?delay_factor=DF
230PRINT:INPUT"DURATION FACTOR 0-15";TF
240IF TF<0 OR TF>15 THEN 230
250?time_factor=TF
265REPEAT
270CALL freq
280A$=GET$
290UNTIL A$="X"
300GOTO 160:REM RESTART
900END
999:
1000DEF PROCassemble_code
1005DIM MC% &FF
1010FOR opt%=0 TO 3 STEP 3
1020P%=MC%
1030count=P%:P%=P%+2
1040div_factor=P%:P%=P%+1
1050delay_factor=P%:P%=P%+1
1060time_factor=P%:P%=P%+1
1070[
1075OPT opt%
1080\****  SET AMPLITUDE TABLE ****
1090\
1095.freq
1100      LDY div_factor
1110      BNE cont
1120      LDA #shape_table MOD 256
1130      STA nexval+1
1140      JMP initc
1150\
1160.cont
1170      LDA # amplitude_table MOD 256
1180      STA nexval+1
1190      LDX #steps
1195.next
1200      LDY div_factor
1210      LDA shape_table,X
1220.more
1230      CLC
1240      ROR A
1250      STA amplitude_table
1260      DEY
1270      BNE more
1280      DEX
1290      BPL next
1300\
1310\**** SET COUNT VALUE ****
1320\
1330.initc
1340      SEI
1350      LDA #0
1360      STA count+1
1370      LDX delay_factor
1380      LDA loop_table,X
1390      LDY time_factor
1400      BEQ nomult
1410.mult
1420      ASL A
1430      ROL count+1
1440      DEY
1450      BNE mult
1460.nomult
1470      STA count
1480\
1490\**** MAIN PROGRAM LOOP ****
1500\
1510.main
1520      LDX #0
1530.nexval
1540      LDA amplitude_table,X
1550      LDY delay_factor
1560.mordel
1570      DEY
1580      BNE mordel
1590\
1600      STA port
1610      INX
1620      CPX #steps
1630      BNE nexval
1640\
1650\**** DECREMENT COUNT ****
1660\
1670      LDA count
1680      SEC
1690      SBC #1
1700      STA count
1710      LDA count+1
1720      SBC #0
1730      STA count+1
1740      BNE main
1750      LDA #0
1760      CMP count
1770      BNE main
1780      CLI
1790      RTS
1800]
1810NEXT opt%
1820ENDPROC
1999:
2000DEF PROCset_tables
2005x=0
2010FOR I=shape_table TO shape_table+steps-1
2020y=127*SIN(x)+127
2030? I=y
2040x=x+2*PI/steps
2050NEXT I
2060:
2070FOR delay=0 TO 101
2080loop_val=10^6/(50*(271+75*delay))
2090loop_table?delay=loop_val
2100NEXT delay
2120ENDPROC
```