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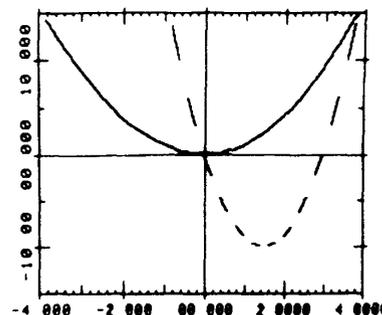
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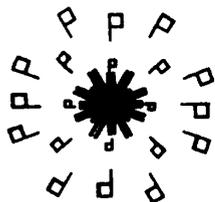
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Harmonic Analysis For the Apple

Fourier Analysis is a powerful tool in many fields, but the number of calculation is requires makes it very laborious to perform by hand. A program in Applesoft Floating Point BASIC lets the APPLE II do the work.

Charles B. Putney
1085 Unguowa Road
Fairfield, CT 06430

One of the most important tools of modern technology is the oscilloscope. They can be found everywhere from your local auto repair shop to the hospital operating room and by the thousands in laboratories around the world. The people that use them know that the shape of the squiggly line which appears on the scope screen can tell whether their 'patient' is sick or well and if the former, what to do about it. Sometimes, however, simple visual study of a scope picture does not provide enough information. In this case, the modern day scientist or engineer can resort to quite sophisticated (and expensive) equipment to automatically dissect the picture and to spew out all sorts of numerical data concerning same. This effortless analysis of wave forms is a fairly recent technical development. It was not always quite so easy.

Before the advent of modern electronic computer technology, the analysis of a particular wave form was an all day or all week affair. First, one started with a graph of the function which was scaled to cycle every revolution of 360°. This was divided into equal angular steps and through careful measurements a table of x,y coordinates for each step on the curve was developed. The curve shown in Figure 1 illustrates a representative plot of data which could have been collected from the vibrations of a gasoline engine, torque variations of a synchronous motor or some other physical phenomenon.

The next step was to calculate the coefficients of the terms of a Fourier series. This calculation is a repetitive 'number crunching' exercise and was best done by two or more people armed with mechanical calculators. The team approach was advisable because, with the hundreds or even thousands of calculations required, mistakes were inevitable. At this point, numbers were available for the design of counterbalance weights for your engine, reshaping of poles of the synchronous motor, etc.

The mathematical proof of the fact that any single valued periodic function, such as the one in Figure 1, can be defined by an infinite series and the method for calculation of the coefficients for the terms of the series was developed by Jean Fourier, a French mathematician (1768-1837). The series which he investigated and which is given his name is:

$$Y = a_0 + a_1(\sin X) + b_1(\cos X) \\ + a_2(\sin 2X) + b_2(\cos 2X) \\ + a_3(\sin 3X) + b_3(\cos 3X) \\ + a_4(\sin 4X) + b_4(\cos 4X) \\ + a_5(\sin 5X) + b_5(\cos 5X) \\ + \dots \dots \dots \text{etc.}$$

It is easy to see that, if it is desired to carry a calculation for a Fourier series out to say the tenth harmonic, a lot of sines and cosines get into the action, in fact, ten of each for each point of the curve being investigated. The sheer magnitude of the pencil-pushing type calculation tasks that some of the mathematical geniuses of the past, such as Fourier, set before themselves staggers the imagination.

Fortunately, for most engineering problems, the relative significance of harmonics above the fifth are slight and most curves can be defined to sufficient accuracy by a Fourier series with a cut-off at this level. (One of my old text books describes a hydraulic penstock vibration problem involving the beat frequency between the 17th and 18th harmonics of the system!) The accompanying program, written in Applesoft II Floating Point BASIC, calculates a listing of coefficients of each term to the fifth harmonic and continues to show a calculated plot of the input data curve and all five harmonics within a couple of minutes. Admittedly, this does not match the speed of a fast Fourier transform system, but it sure beats the old way.

Harmonic analysis of the data listed for Figure 1 with this program yields the following information:

1. The curve is defined by the equation:

$$Y = 4.008 + 2.39 \sin(X) - 0.19 \cos(X) \\ - 0.49 \sin(2X) - 0.50 \cos(2X) \\ - 0.13 \sin(3X) + 0.12 \cos(3X) \\ + 0.23 \sin(4X) - 0.08 \cos(4X) \\ - 0.07 \sin(5X) + 0.07 \cos(5X)$$

2. The average of the curve is offset from zero about Y = 4.

If this data and results had been developed with respect to say a vibration problem, it could probably be safely assumed that if the second harmonic vibration component were taken care of, the system would be satisfactory. On the other hand, it might be desired to provide for a flexible mounting to absorb a deflection amounting to the difference between the curve average and the maximum deflection of 7.3. A vertical expansion of the plot of this curve can be obtained by subtracting 4 from the Y component of the input data. This will yield a graph balanced about the X axis as illustrated by the 'average line' in the figure.

Directions for running the program are pretty well built into the listing. After the initial instruction page, the form of the X or angular component must be inputted. (D for degrees or R for Radians followed by a RETURN) Then the data for each point of the curve being analyzed must be entered as X,Y (for example, Figure 1, Point 1 would be entered as 30,4.3 RETURN) until all points are in the computer, then enter Done, Done RETURN. If a mistake is made while entering any of the data points, the program must be restarted. Use a Control C to get out and start over with a RUN. Note, that zero degree X and the 360° X are the same from the definition of a periodic wave, so one or the other of these points should be entered but not both of them. It is not necessary to input the data points in order and any 360° span may be used (for example - 180° to + 180°). However, the plotted graph with this program will always come out starting at the zero position.

For those who don't have an APPLE, the program can be used as far as instruction 1225 without missing output of the real important results from the analysis, the term coefficients. While checking out this program, I recalculated examples from several old textbooks and without exception, I found at least one error in the answer listings in each one of them. Needless to say, this created big headaches for the students of that era.

μ

LIST

```

10 HOME : VTAB 5: HTAB 13: PRINT
   "HARMONIC ANALYSIS": PRINT
20 PRINT " THIS PROGRAM CALCULAT
   ES COEFFICIENTS OF FOURIER S
   ERIES TO THE FIFTH HARMONIC"

30 PRINT "OF PERIODIC FUNCTIONS
   F(Y)=F(X)"
40 PRINT "FUNCTIONS MUST MEET TH
   IS CRITERIA:"
50 PRINT : PRINT " (A)Y IS NO
   T INFINITE"
60 PRINT " (B)THERE IS ONLY O
   NE VALUE OF Y FOR EVERY VALU
   E OF X"
70 PRINT " (C)Y HAS ONLY A FI
   NITE NUMBER OF MAXIMA OR
   MINIMA"
100 PRINT
110 PRINT "MAKE A TABLE OF X,Y V
   ALUES PICKED FROM THE GRAPH
   FOR EACH SECTION"
120 PRINT "EVEN IF THE FIRST AND
   LAST HALVES OF THEGRAPH ARE
   SYMETRICAL, X,Y VALUES FOR
   ONEFULL CYCLE MUST BE ENTERE
   D"
122 PRINT "START DATA AT POINT #
   1 NOT POINT #0"
125 PRINT " HIT ANY KEY AND R
   ETURN TO CONTINUE": INPUT Q$

200 HOME : VTAB 2: PRINT "INPUT
   X,Y VALUES OF POINTS ON GRAP
   H UNTIL ALL INPUTTED. A
   FTER LAST ENTRY TYPE 'DON
   E,DONE'"

205 PRINT : PRINT "ARE X DATA PO
   INTS EQUAL STEPS DEGREES(D)
   OR RADIANS(R)?"
206 INPUT D$: IF D$ = "D" THEN R
   = 1
207 PRINT : PRINT " INPUT DATA A
   S X,Y"
210 INPUT X$,Y$
220 IF X$ = "DONE" THEN 1000
300 X = VAL (X$):Y = VAL (Y$)
301 REM CALCULATING SUMS OF COE
   FFICIENTS
305 A0 = Y + A0: IF R THEN X = (X
   / 360) * 6.28318
310 FOR I = 1 TO 5
320 A(I) = Y * SIN (I * X) + A(I
   )

330 B(I) = Y * COS (I * X) + B(I
   )
340 NEXT I
350 N = N + 1
360 IF T < ABS (Y) THEN T = ABS
   (Y)
390 GOTO 210
1000 A0 = (A0 / N): REM CALCULAT
   ING COEFFICIENT AVERAGES
1010 FOR I = 1 TO 5
1020 A(I) = (A(I) / N) * 2
1030 B(I) = (B(I) / N) * 2
1040 NEXT I
1100 HOME
1110 PRINT "TERMS OF THE FOURIER
   SERIES ARE:"
1120 PRINT : PRINT "TERM #1-(WIL
   L BE ZERO IF GRAPH IS": PRINT
   "SYMMETRICAL)"
1121 PRINT " ;A0
1122 PRINT "TERM #2":H = 1: GOSUB
   1200
1123 PRINT "TERM #3": GOSUB 1210
1124 PRINT "TERM #4":H = 2: GOSUB
   1200
1125 PRINT "TERM #5": GOSUB 1210
1126 PRINT "TERM #6":H = 3: GOSUB
   1200
1127 PRINT "TERM #7": GOSUB 1210
1128 PRINT "TERM #8":H = 4: GOSUB
   1200
1129 PRINT "TERM #9": GOSUB 1210

```

Tables I through IV list data points for various standard reference curves. It is interesting to go through them to see the harmonic patterns for each. For example, the triangular wave is an all odd harmonic system. The sawtooth wave, which is the basis for many electronic music generators, is the sum of all harmonics to infinity.

μ

Table I
Three Point Triangular

X°	Y
90	1
180	0
270	-1
360	0

Table II
Triangular

X°	Y
-160	-3
-140	-2
-120	-1
-100	0
-80	1
-60	2
-40	3
-20	4
0	5
20	4
40	3
60	2
80	1
100	0
120	-1
140	-2
160	-3
180	-4

Table III
Sawtooth

X°	Y
20	8
40	7
60	6
80	5
100	4
120	3
140	2
160	1
180	0
200	-1
220	-2
240	-3
260	-4
280	-5
300	-6
320	-7
340	-8
360	0

Table IV
Square

X°	Y
20	1
40	1
60	1
80	1
100	1
120	1
140	1
160	1
180	0
200	-1
220	-1
240	-1
260	-1
280	-1
300	-1
320	-1
340	-1
360	0

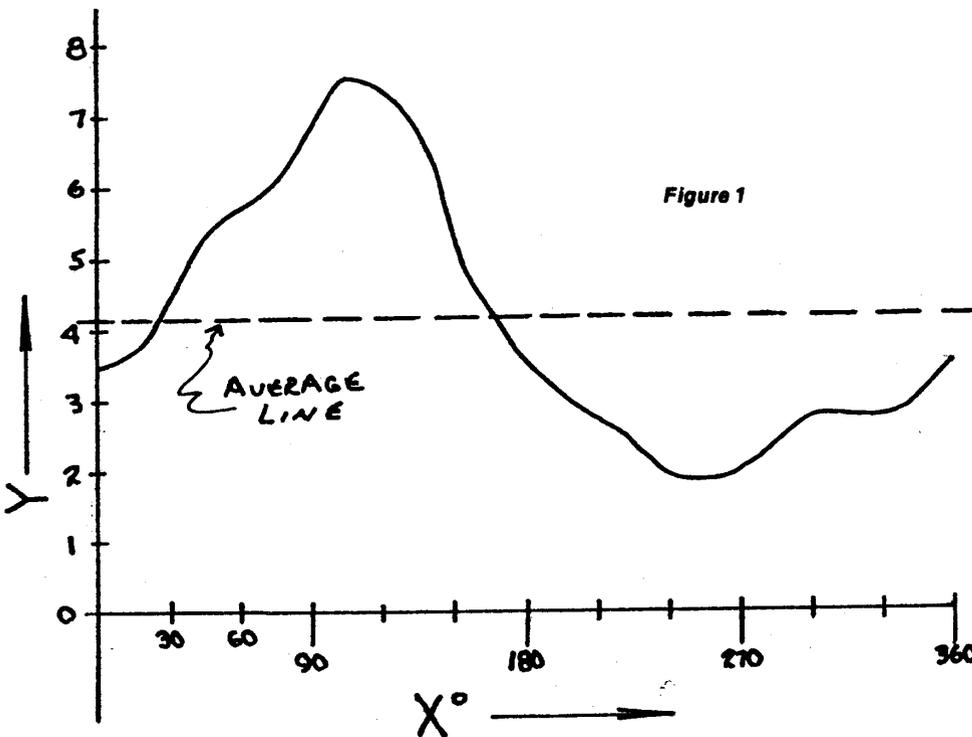


Figure 1

X°	Y	Ave Y
30	4.3	0.3
60	5.7	1.7
90	6.8	2.8
120	7.3	3.3
150	5.2	1.2
180	3.5	-0.5
210	2.7	-1.3
240	1.8	-2.2
270	1.9	-2.1
300	2.7	-1.3
330	2.7	-1.3
360	3.5	-0.5

```

1130 PRINT "TERM #10":H = 5: GOSUB
1200
1131 PRINT "TERM #11": GOSUB 121
0
1132 GOTO 1250
1200 PRINT "      ";A(H);" * SIN("
;H;"X)": RETURN
1210 PRINT "      ";B(H);" * COS("
;H;"X)": RETURN
1225 REM OK NON GRAPHICS TO HER
E ALSO CHANGE 1132 GOTO 1132

1250 INPUT "DO YOU WANT A PLOT Y
OR N? ";A$
1260 IF A$ = "N" THEN 6010
1290 S = 70:H = 0: REM SETTING I
NITIAL SCALE AND CALCULATION
CONSTANT TO ZERO

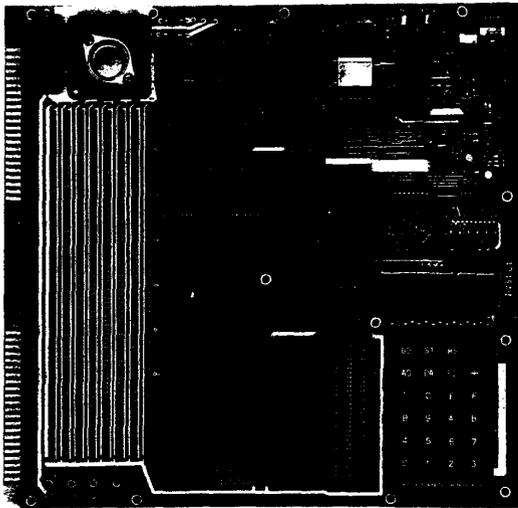
1300 PRINT : PRINT : PRINT "PLOT
OF INPUT DATA CALCULATED TO
FIFTH HARMONIC.      Y
AT 100= ";T: HGR
1301 HCOLOR= 3
1310 HPLOT 0,79 TO 279,79
1320 HPLOT 0,0 TO 0,159
1321 HPLOT 0,79 - S TO 5,79 - S
1322 HPLOT 0,79 + S TO 5,79 + S
1323 HPLOT 269,77 TO 269,81
1330 FOR K = 0 TO 269 STEP 4
1335 X = K / (.75 * 360) * 6.2831
8531
1340 Y = A0 + A(1) * SIN (X) + B
(1) * COS (X) + A(2) * SIN
(2 * X) + B(2) * COS (2 * X
) + A(3) * SIN (3 * X) + B(
3) * COS (3 * X) + A(4) * SIN
(4 * X) + B(4) * COS (4 * X
) + A(5) * SIN (5 * X) + B(
5) * COS (5 * X)
1350 Y = (1 / T) * Y * S
1355 IF ABS (Y) > 79 GOTO 6000
1360 HPLOT K,79 - Y
1390 NEXT K
1500 HCOLOR= 6
1510 PRINT : PRINT : PRINT "FIRS
T HARMONIC": GOSUB 1600
1520 PRINT : PRINT : PRINT "SECO
ND HARMONIC": GOSUB 1600
1530 PRINT : PRINT : PRINT "THIR
D HARMONIC": GOSUB 1600
1540 PRINT : PRINT : PRINT "FOUR
TH HARMONIC": GOSUB 1600
1550 PRINT : PRINT : PRINT "FIFT
H HARMONIC": GOSUB 1600
1580 GOTO 2000

1600 H = H + 1: REM ROUTINE FOR
PLOTTING HARMONICS
1610 FOR K = 0 TO 269 STEP 4
1620 X = K / (.75 * 360) * 6.2831
85
1630 Y = A(H) * SIN (H * X) + B(
H) * COS (H * X)
1640 Y = (1 / T) * Y * S
1645 IF ABS (Y) > 79 THEN 6000
1650 HPLOT K,79 - Y
1660 NEXT K
1670 RETURN
2000 HOME :H = 1: REM SETTING U
P COEFFICIENT TABLE
2010 VTAB 5: PRINT "
COEFFICIENT TABLE"
2020 PRINT : PRINT : PRINT "
SINES"," COSINES"
2031 PRINT : PRINT "FIRST HARMON
IC": GOSUB 2100
2032 PRINT : PRINT "SECOND HARMO
NIC": GOSUB 2100
2033 PRINT : PRINT "THIRD HARMON
IC": GOSUB 2100
2034 PRINT : PRINT "FOURTH HARMO
NIC": GOSUB 2100
2035 PRINT : PRINT "FIFTH HARMON
IC": GOSUB 2100
2040 PRINT : PRINT "CONSTANT = "
;A0;" Y AT 100 = ";T
2045 PRINT : PRINT "HIT SPACE BA
R FOR REVIEW"
2090 H = 0: GOTO 2200
2100 PRINT A(H),B(H)
2110 H = H + 1: RETURN
2200 REM REVIEW ROUTINE
2220 IF PEEK ( - 16384) < 127 THEN
2220
2230 POKE - 16368,0
2240 POKE - 16303,0
2270 IF PEEK ( - 16384) < 127 THEN
2270
2280 POKE - 16368,0
2290 POKE - 16304,0
3300 GOTO 2220
6000 PRINT "PLOT IS OFF SCALE. T
RYING AGAIN"
6002 S = S - 10: REM SHORTEN VER
TICAL SCALE
6004 FOR K = 1 TO 1000
6006 NEXT K
6008 GOTO 1300
6010 REM C.B.PUTNEY,
FAIRFIELD,CONNECTICUT
VER 3/1/79
6020 END

```

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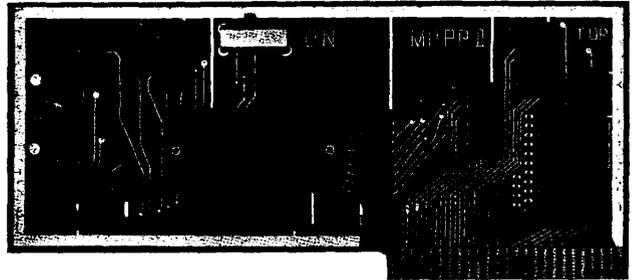
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Case of the Missing Tape Counter

The lack of a tape counter on the PET cassette tape unit has led to hours of frustration. The technique presented here provides a fairly automatic method of locating your files on the PET cassette.

William F. Pytlík
6828 Payne
Edwards, CA 93523

The PET has an excellent file management system. Unfortunately, since the PET does not have a tape counter, access to any file or program other than the first requires either an uncanny "touch" to find a file by using FAST FORWARD or an infinite amount of patience waiting for the file management system to find the program at 1-7/8 inches/second. The obvious solution is to use a large number of C-10 or C-5 cassettes. Of course, this solution is costly and requires one to store a large number of tapes.

Fortunately, the PET does have a real time clock and the ability to start and stop the cassette motor via BASIC POKE commands. These two capabilities, combined with the use of constant length files, allow ready access to any program or file on a user created tape.

The use of constant length files implies that every file or program on any cassette has the same space allocated to it regardless of how long the actual program is. This means that some of the tape on the cassette will not actually be used, but the method is much cheaper to use than using C-5/C-10 cassettes for each program/data file.

After experimenting, we found that a maximum FAST FORWARD time of ten seconds is adequate to store the largest program capable to be stored in the PET 8K memory. Of course, this is at the beginning of the tape. As the tape advances, more tape is actually wasted. Still, A C-90 cassette allows approximately 13 large programs or files to be stored and accessed via this method. Access time to the last file on a C-90 cassette is approximately two minutes.

The program shown is pretty self-explanatory and easy to enter.

Usage of this method requires that the program be saved as the first program on every cassette. To use the program, press SHIFT/RUN. After the program is loaded and run, DO NOT press STOP/EJECT on the cassette drive. The program will inquire which drive you are using by displaying:

```
ENTER CASSETTE 1 OR 2
```

After you enter the number only, the program will present a catalog of all files or programs on that tape. Dummy names

will be listed for unused file locations like:

```
PROGRAM 1  
PROGRAM 2
```

Although a C-90 cassette will hold 13 programs, we have chosen to use only ten.

Next, the program will ask if you wish to read or save a program by displaying:

```
READ OR CREATE PROGRAM/FILE --  
R OR C
```

The program will then ask which file you wish to read or write by displaying:

```
WHICH PROGRAM/FILE -- I.E. 1, 2, ...
```

If you have entered a number greater than 1, the machine will display:

```
PRESS F.FWD and HIT RETURN  
WHEN READY
```

(The program will skip the previous step if you ask for program/file number 1 because the tape is already in the correct position). If you enter R to read a file/program, the program will advance the tape to the correct position, stop, and display:

```
HIT STOP/EJECT AND LOAD AS  
USUAL
```

At this point, you simply load the selected program in the usual manner.

Similarly, if you entered C to create a new file/program, the tape will advance to the selected portion of the tape, stop, and display:

```
HIT STOP/EJECT  
TAPE IS NOW READY TO SAVE NEW  
PROGRAM/FILE
```

Now, you can save any program. If you wish to use descriptive names for your programs or files, just reload this program, change the names in the appropriate data statement, and resave the program as the first file on the cassette.

Since the length of a file allocation is determined by time in seconds (the number 10 in line 300 of the program), the user may change this number to accommodate any length file. Also, since each program occupies a unique well-defined location and the length allocated is for a maximum length file, there is no problem replacing one file/program with another.

We use this method on all our tapes. We also use the program as a subroutine in programs requiring access to other files, i.e., a recipe program. The use of the PET cassette drives becomes simple, quick, and enjoyable, and presents a solution to the case of the missing tape counter mystery.



```

10 REM THIS PROGRAM ALLOWS THE PET USER TO
20 REM ACCURATELY POSITION HIS CASSETTE FILES
30 REM BY USING THE FAST FORWARD FUNCTION OF
40 REM THE TAPE DRIVE.
50 REM
60 REM
70 PRINT " *** PROGRAM / FILE LOCATOR ***"
80 PRINT
90 INPUT "ENTER CASSETTE 1 OR 2";CA
100 READ X
110 DIM C$(X)
120 FOR I = 1 TO X
130 READC$(I)
140 PRINTC$(I)
150 NEXT I
160 PRINT:INPUT "READ OR CREATE PROGRAM / FILE -- R OR C";R$
170 INPUT "WHICH PROGRAM / FILE --I.E. 1,2,...";WP
180 IF WP = 1 THEN 240
190 REM STATEMENTS 200 AND 210 INITIALIZE THE MOTOR OFF
200 IF CA = 1 THEN POKE 59411,61
210 IF CA = 2 THEN POKE 59456,223
220 PRINT "PRESS F.FWD AND HIT RETURN WHEN READY"
230 REM STATEMENT 240 WAITS FOR RETURN TO BE DEPRESSED
240 GET A1$:IF A1$ = "" THEN 240
250 REM STATEMENTS 260 AND 270 TURN ON SELECTED MOTOR
260 IF CA = 1 THEN POKE 59411,53
270 IF CA = 2 THEN POKE 59456,207
280 T = TI
290 REM STATEMENT 300 WAITS FOR TAPE TO ADVANCE TO SELECTED FILE
300 IF TI<T+(10*60*(WP-1)) THEN 300
310 REM STATEMENTS 320 AND 330 TURN THE MOTOR OFF
320 IF CA = 1 THEN POKE 59411,61
330 IF CA = 2 THEN POKE 59456,223
340 PRINT
350 IF R$ = "R" THEN PRINT "HIT STOP/EJECT AND LOAD AS USUAL"
360 PRINT:IF R$ = "R" THEN 500
370 IF R$ = "C" THEN PRINT "HIT STOP/EJECT"
380 PRINT "TAPE IS NOW READY TO SAVE NEW PROGRAM/FILE"
390 REM CHANGE NUMBER IN STATEMENT 500 TO CHANGE THE MAX
400 REM NUMBER OF PROGRAMS PER CASSETTE
410 REM CHANGE NAMES IN STATEMENTS 510 THRU 600
420 REM TO YOUR PROGRAM NAMES
500 DATA 10
510 DATA "PROGRAM 1"
520 DATA "PROGRAM 2"
530 DATA "PROGRAM 3"
540 DATA "PROGRAM 4"
550 DATA "PROGRAM 5"
560 DATA "PROGRAM 6"
570 DATA "PROGRAM 7"
580 DATA "PROGRAM 8"
590 DATA "PROGRAM 9"
600 DATA "PROGRAM 10"
1000 END

```

The Basic Morse Keyboard

For the HAMS -- here is a way to use your system to make an ASCII keyboard perform as a Morse keyboard. Implemented on an OSI system, the program is in BASIC and should be readily convertible to other systems.

William L. Taylor
246 Flora Road
Leavittsburg, OH 44430

A computer, as with any appliance, should be a useful tool to aid the owner with his daily tasks, or to bring enjoyment.

Being an amateur radio operator and a computer hobbyist, I felt that the computer should aid the operator with his tasks either when operating the station or other activities. From this desire to have the computer as an assistant, I felt that one of the best uses for my computer was to aid me in sending and receiving of the Morse code. With this in mind I went to work developing a program that would allow me to use the ASCII keyboard as a "Morse Keyboard". The program and the interface information in this article will help other amateur radio operators, who own the OSI Challengers with a Model 500 CPU with the PIA port populated, get on the air with the "Morse Keyboard".

First, an explanation of my system is in order. My computer system consists of the system boards sold by Ohio Scientific Instruments. I have the Model 500 CPU with BASIC in ROM. The PIA port is populated with a 6820 PIA, and is addressed at the standard location on the 500 board. The address for the PIA is 63232 decimal or F700 hex on the 500 CPU board. The program was written to service the 6820 at this location. The BASIC program uses the B side of the 6820 as the output and PBO is the specific port. PBO of the PIA is connected to a tone oscillator board to generate the sidetone and a relay driver on the board is used to drive a 12 volt relay that keys the transmitter.

The "BASIC Morse Keyboard" program is written in MicroSoft BASIC and Assembly Language. The Assembly portion of the program is stored in DATA statements, and is entered into user memory with the READ and POKE functions of BASIC. On initialization, the DATA at line 1620 is READ and POKED into memory with the FOR NEXT loop at line 1605. This machine code store subroutine is called at line 15 at the beginning of the program. The machine code routine is stored at hex 0C00. This

machine code routine calls up the system monitor to get the ASCII code from the system keyboard. When a key is struck on the keyboard the ASCII equivalent of the letter or number is placed in the accumulator of the 6502 microprocessor. The ASCII character is then stored at hex OF00 where it will be available for the BASIC program to capture it with a PEEK statement. This PEEK statement is located at line 125 of the BASIC program.

The contents of hex OF00 will hold the present keyboard ASCII entry, and after being read with the PEEK statement the character will be stored in the A variable. The contents of variable A is now compared with the contents of a look up table to determine the offset to the Morse element table where the conversion to Morse elements are formed. The ASCII table starts at line 130. The Morse element table starts at line 1500.

The Morse equivalent of the ASCII character is loaded into the string variable A\$, and on return from the subroutine the program jumps to a subroutine at line 1000 where the elements of A\$ are separated into the dot-dash elements of Morse code. This separation is done by loading each separate element into D\$, and if the element is a 1 then a dot is generated in a subroutine at line 1200 through line 1220. If the element read into D\$ is the numeral 3 then a jump to the subroutine at line 1300 through 1320 causes a dash to be generated. After each character has been separated and sent to the PIA port the program returns to the input statement line 122. At statement line 122 a jump to the machine code subroutine is executed with the USR function of BASIC. The machine code subroutine causes a jump to the system monitor and the program will loop until a key is depressed on the keyboard.

The subroutine at line 1200 and 1300 generate the Morse elements (dots and dashes). This is done by turning on and off PBO for a duration of time. For example if a 1 was decoded in the routine at 1000 then PBO would be turned on (high) for the duration of time contained in the

loop at line 1205. This loop (FOR J= 1 TO X:NEXT J) is the dot length. The dot length time element is stored in variable X at line 106. When the loop has timed out then PBO will be brought low and a return executed. The next Morse element is identified and generated in either the subroutine at 1200 or 1300 depending if it is a dot or a dash. The dot length, dash length, and the length between characters are contained in variables at lines 102 through 109. The H variable at line 102 holds the information that identifies PBO and turns PBO on in the subroutines at 1200 and 1300. The R variable contents are used to turn PBO off. The variable at line 106 is the dot length. The variable at line 108 is the dash length. The variable at line 109 is the length between characters. This variable can be eliminated if desired. The variables X and R can be adjusted for any desired dot dash length. The routine at lines 10, 20 and 30 initialize the PIA. This initialization sets the B port as the output port. The value in variable G at 100 identifies the initial location of the PIA.

The object code subroutine for the program is stored at Hex 0C00. The object code contents are:

```
0C00 20
0C01 ED
0C02 FE
0C03 8D
0C04 00
0C05 0F
0C06 60
```

The tone oscillator board is a straight forward construction project requiring few components. The schematic in Figure 1 shows the schematic for the tone and relay driver board and the components that will be needed to construct the board. Pref board and a wire wrap socket can be used for the construction of the board or you can etch a board if you feel that would be a more desirable method. A printed circuit board layout was not included in this article because it was felt that the user could use any method that was thought best. The connections to the PIA port on the 500 CPU board can be any length of wire. I used ribbon wire and etched a small board that would mate with a Molex male 12

pin connector such as the connectors on the 480 backplane board. This male plug connects to the 500 CPU board at the B side port connector on the 500 CPU board. The power for the Tone board is taken from the computer except the 12 volt DC for the relay. This must be obtained from another source. Be sure that the external power source ground be connected to the tone board ground in order for the relay keying transistor to work correctly.

A note of warning must be given at this point. The memory size must be set to 3071 decimal when bringing up BASIC. This will be for the protection of the machine code routine that is stored above 0C00 Hex.

In conclusion, the program as written does not have any buffer so typing ahead is not possible. This leaves the program open for modifications, such as, installing the buffer. Also I have a version of the program that allows the operator to load ASCII into a memory zone and use this ASCII as preloaded message text. The program and the sidetone keyer works well on the OSI system used at my shack and I have had many pleasurable hours using the "Morse Keyboard" on CW. I wish you the same. Good luck.

μ

Figure 1

The author wishes to give particular recognition to the article entitled:

"The Morse Master"

which appeared in the January 1979 issue of 73 Magazine, written by William A. Thornburg.

The article provided the concepts upon which this program is based, and gave a program listing for the H8 microcomputer.

Tone Oscillator and Driver Board Parts List

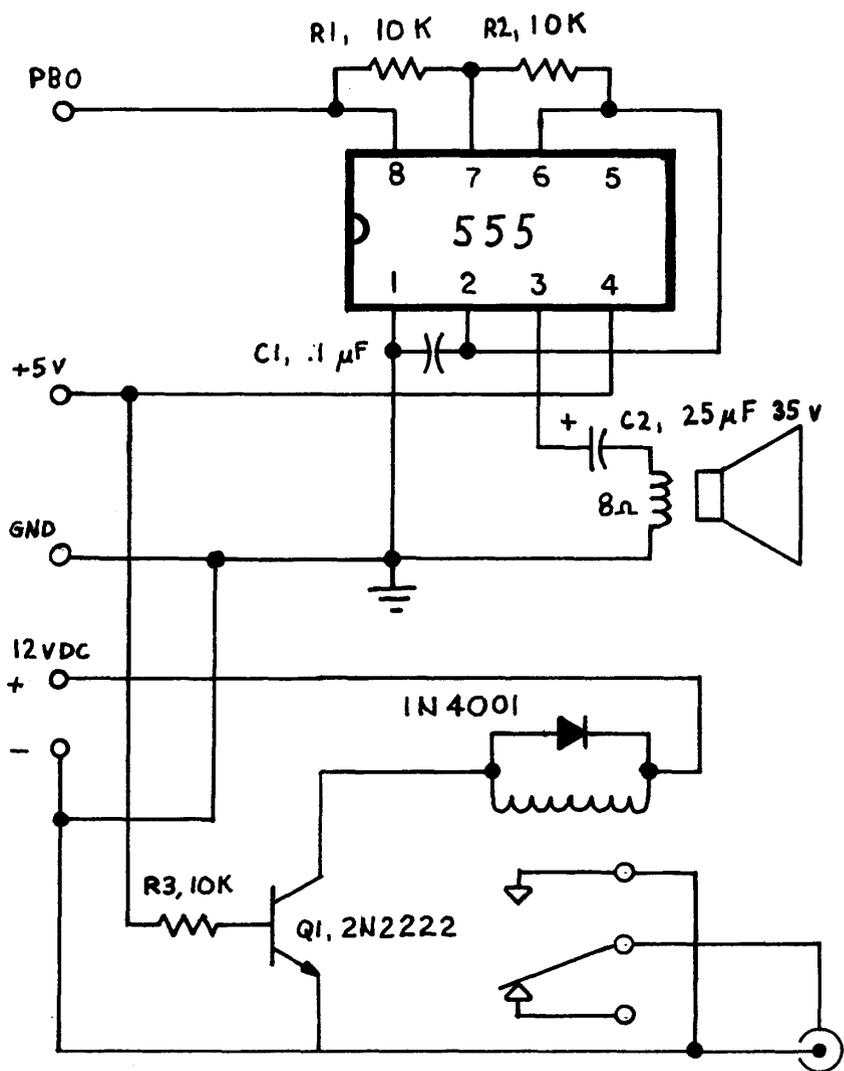
- 1 1N4001 Diode
- 1 Pref board .100 by .100 hole centers
- 1 555 Timer IC
- 1 8 Pin wire wrap socket (or 14 pin)
- 1 .1 MF Disc capacitor
- 1 50 MF Electrolytic capacitor
- 3 10K ½ Watt Resistors
- 1 2N2222 NPN Transistor
- 1 8 Ohm speaker
- 1 12 Volt DC relay
- 1 Male Molex 12 Pin plug KK156
- 1 Wire wrap wire 32 Gauge (if used)
- 1 Hand wire wrap tool (if used)

Radio Shack 276-1394
Radio Shack 276-1723

Radio Shack 40-245
Radio Shack 275-003

Misc. Wire for connection to computer and external 12 volt power supply. Solder

Note: A 14 pin IC socket can be used for the 555. Only use 8 of the pins. I used a Sigma #62R23-2600 relay for RY1.



```

1 REM MORSE KEYBOARD FEB 1979
2 PRINT" MORSE CODE KEYBOARD"
3 PRINT:PRINT:PRINT:PRINT
5 " *****READY*****"
10 X=63232
15 GOSUB 1600
20 POKE X+1,0:POKE X+3,0: POKE X,0:POKE X+2,255
30 POKE X+1,04:POKE X+3,04
100 G=63232
102 H=1
104 R=0
106 X=25
108 T=100
109 F=150
110 POKE 11,0:POKE 12,12
122 X=USR(X)
125 A=PEEK(3840)
130 IF A= 65 THEN GOSUB 1500
131 IF A= 66 THEN GOSUB 1501
132 IF A= 67 THEN GOSUB 1502
133 IF A= 68 THEN GOSUB 1503
134 IF A= 69 THEN GOSUB 1504
135 IF A= 70 THEN GOSUB 1505
136 IF A= 71 THEN GOSUB 1506
137 IF A= 72 THEN GOSUB 1507
138 IF A= 73 THEN GOSUB 1508
139 IF A= 74 THEN GOSUB 1509
140 IF A= 75 THEN GOSUB 1510
141 IF A= 76 THEN GOSUB 1511
142 IF A= 77 THEN GOSUB 1512
143 IF A= 78 THEN GOSUB 1513
144 IF A= 79 THEN GOSUB 1514
145 IF A= 80 THEN GOSUB 1515
146 IF A= 81 THEN GOSUB 1516
147 IF A= 82 THEN GOSUB 1517
148 IF A= 83 THEN GOSUB 1518
149 IF A= 84 THEN GOSUB 1519
150 IF A= 85 THEN GOSUB 1520
151 IF A= 86 THEN GOSUB 1521
152 IF A= 87 THEN GOSUB 1522
153 IF A= 88 THEN GOSUB 1523
154 IF A= 89 THEN GOSUB 1524
155 IF A= 90 THEN GOSUB 1525
156 IF A= 48 THEN GOSUB 1526
157 IF A= 49 THEN GOSUB 1527
158 IF A= 50 THEN GOSUB 1528
159 IF A= 51 THEN GOSUB 1529
160 IF A= 52 THEN GOSUB 1530
161 IF A= 53 THEN GOSUB 1531
162 IF A= 54 THEN GOSUB 1532
163 IF A= 55 THEN GOSUB 1533
164 IF A= 56 THEN GOSUB 1534
165 IF A= 57 THEN GOSUB 1535
166 IF A= 46 THEN GOSUB 1536
167 IF A= 63 THEN GOSUB 1537
168 IF A= 64 THEN GOSUB 1538
169 IF A= 47 THEN GOSUB 1539
170 IF A= 44 THEN GOSUB 1540
172 GOSUB 1000
175 FOR I= 1 TO F : NEXT I
180 FOR M= 1 TO G9: NEXT M
190 GOTO 122

```

```

1000 L= LEN (A$)
1005 FOR I= 1 TO L
1010 R$=MID$ (A$,I,1)
1015 IF R$= "1" THEN GOSUB 1200
1020 IF R$= "3" THEN GOSUB 1300
1025 NEXT I
1030 GOTO 1320
1200 POKE G+2,H
1205 FOR J= 1 TO X: NEXT J
1210 POKE G+2,R
1215 FOR J= 1 TO X: NEXT J
1220 RETURN
1300 POKE G+2, H
1305 FOR J= 1 TO X: NEXT J
1310 POKE G+2, R
1315 FOR J= 1 TO X: NEXT J
1320 RETURN
1500 A$= "13": RETURN
1501 A$= "3111":RETURN
1502 A$= "3131":RETURN
1503 A$= "311" :RETURN
1504 A$= "1" :RETURN
1505 A$= "1131":RETURN
1506 A$= "331" :RETURN
1507 A$= "1111":RETURN
1508 A$= "11" :RETURN
1509 A$= "1333":RETURN
1510 A$= "313" :RETURN
1511 A$= "1311":RETURN
1512 A$= "33" :RETURN
1513 A$= "31" :RETURN
1514 A$= "333" :RETURN
1515 A$= "1331":RETURN
1516 A$= "3313":RETURN
1517 A$= "131" :RETURN
1518 A$= "111" :RETURN
1519 A$= "3" :RETURN
1520 A$= "113" :RETURN
1521 A$= "1113":RETURN
1522 A$= "133" :RETURN
1523 A$= "3113":RETURN
1524 A$= "3133":RETURN
1525 A$= "311" :RETURN
1526 A$= "33333" :RETURN
1527 A$= "13333" :RETURN
1528 A$= "11333" :RETURN
1529 A$= "11133" :RETURN
1530 A$= "11113" :RETURN
1531 A$= "11111" :RETURN
1532 A$= "31111" :RETURN
1533 A$= "33111" :RETURN
1534 A$= "33311" :RETURN
1535 A$= "33331" :RETURN
1536 A$= "131313":RETURN
1537 A$= "113311":RETURN
1538 A$= "31113" :RETURN
1539 A$= "31131" :RETURN
1540 A$= "331133":RETURN
1600 FOR R= 3072 TO 3078
1605 READ Q: POKE R,Q: NEXT R
1610 RETURN
1620 DATA 32,237,254,141,0,15,96

```

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A SYM-phony in Stereo

All you Symmers who are frustrated because you can not play the music from Star Wars on your systems -- take heart. Here is a program that not only plays music, but plays it in STEREO!

Phillip M. Rinard
2019 Park Ave.
Emporia, KS 66801

Excellent tune player programs for computers abound, but some features of the SYM-1 make it easy to generate stereo music and may be of interest to SYM-1 owners. Such a program also illustrates some of the uses of the on-board UART's (a SY6532 and two SY6522's) and some of the SUPERMON monitor routines. The listing explains the procedures of the program, but a few comments here may be helpful. With no attempt at making use of the memory at the greatest efficiency, each stereo note consists of five bytes: the duration is given by the first byte, then two bytes give the frequency for each of the two stereo tones having that duration. For the program given, the duration is in multiples of about 0.01 second and is timed by counting down in the 6532. The frequency bytes are placed into the latches of the 6522's for use in the timer 1, free-running mode. The 6522's timers generate square-wave outputs with a frequency based on the contents of the latches. The 6532 timer computes when the next 5 bytes should be

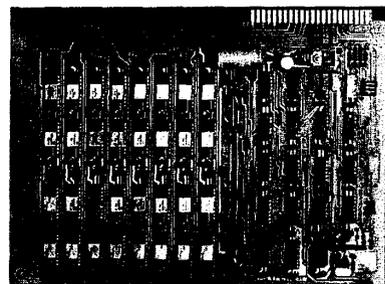
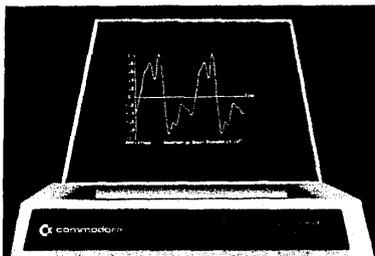
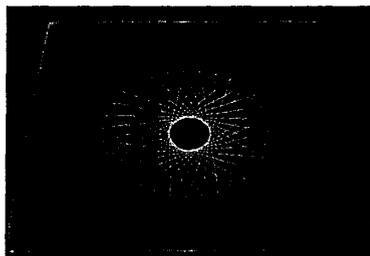
read and new values placed in the latches.

Two subroutines allow for repeating all or part of the tune. A duration byte of \$FF causes a return to the beginning of the tune for a single repeat of the tune up to that point. Upon reading the \$FF a second time, the repeat is ignored and the rest of the tune played. If the duration is \$00, the tune is over, but immediately begun again as if for the first time. The output port AA used by the 6522 #3 is buffered and thus can drive a speaker after putting about a 200 Ohm resistor between two points of the rightmost buffer's PC holes. As shown on page 4-12 of the SYM Reference Manual, these are points 4 and the one between and below points C and 7. The A port can be buffered by one of the three remaining on-board buffers (or one of your own off the board). Place another 200 Ohm resistor in another set of PC board holes and place the input signal from port A on the exposed wire of the

on-board resistor immediately above the transistor. The outputs to both speakers are then available from port AA (see page 4-11 of the SYM Reference Manual for exact pin numbers).

As an illustration of the stereo player, a listing of data for the "Star Wars" music is given. The "notes" of zero frequency provide brief intervals of silence between notes to more realistically imitate a musical instrument. This program and data fit into the 1K of on-board memory provided from the factory. Sockets for 3K more memory are present, as is a socket for a third 6522. If more of this memory is used for extended tunes, then additional programming is necessary similar to that in locations 1B through 21 where "starting" addresses are changed so that as the Y register increments up to 255 the proper note is retrieved. Obviously, an enthusiast could expand on this type of program with the SYM-1 capabilities. μ

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 RTIME * \$A404

D
U
R
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T
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F
R
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Q
F
R
E
Q
ONE TWO

J000 ORG \$0000

0000 00 LOW = \$00 LOW POINTER
 0001 00 HIGH = \$00 HIGH POINTER
 0002 00 REPEAT = \$00 REPEAT COUNTER

TUNE TABLE POINTERS

0003 00 TUNES = \$00 OFFSET FOR FIRST TUNE
 0004 70 FIRST = \$70 FIRST TUNE LOW
 0005 02 = \$02 FIRST TUNE HIGH 0270
 0006 70 SECOND = \$2F SECOND LOW
 0007 03 = \$03 SECOND HIGH 032F
 0008 FF END = \$FF END OF TUNE TABLE

MAIN PROGRAM

0200 ORG \$0200

0200 20 86 8B MAIN JSR ACCESS ALLOW WRITING TO SYSTEM RAM
 0203 A9 C0 LDAIM \$C0 SET ACR6,7 = 1
 0205 8D 0B A0 STA ACR FOR TIME 1, FREE RUNNING
 0208 8D 0B AC STA ACRX WITH OUTPUT ENABLED
 020B A9 7F LDAIM \$7F DISABLE IRQ
 020D 8D 0E A0 STA IER WITH

270	05	00	00	00	00
275	60	BC	03	DA	0B
27A	05	00	00	00	00
27F	30	FC	04	F7	09
284	05	00	00	00	00
289	07	ED	05	DA	0B
28E	05	00	00	00	00
293	07	A7	06	4C	0D
298	05	00	00	00	00
29D	07	77	07	EE	0E
2A2	07	00	00	00	00
2A7	60	BC	03	DA	0B
2AC	05	00	00	00	00
2B1	30	FC	04	F7	09
2B6	05	00	00	00	00
2BB	07	ED	05	DA	0B
2C0	05	00	00	00	00
2C5	07	A7	06	4C	0D
2CA	05	00	00	00	00
2CF	07	77	07	EE	0E
2D4	07	09	00	00	00
2D9	60	BC	03	DA	0B
2DE	05	00	00	00	00
2E3	30	FC	04	F7	09
2E8	05	00	00	00	00
2ED	07	98	05	E1	08
2F2	05	00	00	00	00
2F7	07	ED	05	E9	07
2FC	05	00	00	00	00
301	07	98	05	E1	08
306	05	00	00	00	00
30B	60	A7	06	F7	09
310	20	00	00	00	00
315	07	FC	04	00	00
31A	05	00	00	00	00
31F	07	FC	04	00	00
324	05	00	00	00	00
329	07	F7	09	F7	09
32E	FF				



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Sorting with the APPLE II

Part I

The first of a series of articles which will deal with sorting in general and on the APPLE II in particular. This installment presents some background material, a comparison of three sorting techniques, and a program for implementing the Shell-Metzner sort.

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Tolland, CT 06084

Whether you are maintaining complex data bases, compiling mailing lists, or simply keeping track of your checkbook, at some time you will need to sort records. There are a multitude of sorts available — from the agonizingly slow one in the APPLE CHECKBOOK program, through the relatively fast BASIC sort, to my exceedingly fast (by a factor of 200) machine language sort. What makes a sort fast, and which sort is the fastest? These are the questions I will cover in my series on exploring sorting with the APPLE II.

Background

There have been many magazine articles written on sorting. The ones I based my initial investigation on were those in the Nov-Dec 1976 issue of CREATIVE COMPUTING covering the SHELL-METZNER, bubble, delayed replacement, and heapsorts, and the JAN-FEB 1978 issue of the same magazine on the Butterfly-Hart sort. The first article found the Shell-Metzner and heapsorts to be a vast improvement over the bubble and delayed replacement sorts. The second article found the Butterfly-Hart to be even faster. The Shell-Metzner and heapsort are replacement-type sorts; that is, the records are compared to one another and replace each other according to some unique algorithm. They are relatively small in size and don't rely on much extra storage for their processing. The Butterfly-Hart is a linked list sort. A tree structure is built from the records and broken down into several smaller sorted lists. These lists are then merged to form the final result. This sort is much faster for large numbers of records, but is quite complex and requires extra storage to hold the lists and tree structure. For more details on how these sorts operate, I leave you to refer to the original articles.

I programmed each of these sorts in INTEGER BASIC and compared them by sorting various numbers of random ten character strings. Below were the results.

Table I — Sorting in BASIC

	SORTED WORDS			
SORT	10	100	500	1000
SHELL-METZNER	1	34	268	647
BUTTERFLY-HART	2	38	266	606
HEAPSORT	1	35	261	600

(All sorting times in seconds)

For further exploration, I decided to use the Shell-Metzner sort because it was easiest to program and most compact. Many things had to be taken into account before implementing this sort in INTEGER BASIC. Because of the limited string support in this BASIC, it is easier to store records to be sorted in memory between the upper end of the data variables and the lower end of the program area, accessing them with PEEK's and POKE's. At first, as I sorted these records, I exchanged the actual records in memory when necessary. This becomes very time consuming because for exchanging two 10 character records, you must move 30 bytes (10 to a work area, 10 from one record to the other, and 10 from the work area back to the other record). A much more elegant technique is to store the address of each record as a member of an array. When an exchange is necessary, you need only exchange the addresses in the array, a total move of 6 bytes (2 + 2 + 2) for any size record. When the sort is complete, the addresses of the sorted records can be found sequentially in the array. The first member of the array will point to the lowest sorted record, and the last member to the highest sorted one. The records can be read out in the proper order quite simply, and can easily be sorted in reverse order simply by reading the array backwards. The beauty of this method is that the records have never actually moved and can be read in the original order as simply as the sorted order. This reduction alone increases the

speed of the sort by a factor of three for a 100 record sort, and exponentially above that.

My BASIC version is divided into several parts. The first part generates random character strings in memory, depending on the record size and count entered. This is for benchmark tests and can be replaced with your own I/O routine for your application. Line 140 actually puts the random characters in memory, so replacing this line with a REM after your first run allows you to test other sorting methods while using the same records. The second part merely initializes the memory pointer array and prints the unsorted strings. This can also be included in your I/O routine. The third part is the actual SHELL-METZNER sort. The routine can be easily changed if you wish to sort numbers in an array instead of strings in memory. Finally, there is a routine to print the results, and a handy routine from CALL-APPLE for finding the address of a variable in the data area.

SWEET-16 for Size

Never being satisfied, I decided to continue another step and try to program the sort routine in SWEET-16 (as all you APPLE people know, a 16 bit interpreter implemented in ROM). An excellent article in the NOV 1977 issue of BYTE (or the BEST OF BYTE VOL 1) was my source for SWEET-16 information. SWEET-16 was 4 to 9 times faster than the BASIC sort, and very compact due

to the powerful instruction set. But due to difficulty in implementing, and because the machine language routine was several orders of magnitude faster, I am not including this material. Don't feel bad. Because I know of no SWEET-16 assembler, writing this program was actually harder than the machine language version.

Machine Language for Speed

The machine language implementation of SHELL-METZNER was not difficult, because I was almost translating directly from each BASIC statement into equivalent functions in machine code. As you can see by the listing in Figure 2, I made extensive use of PAGE ZERO addressing, both to cut down on code and increase speed. I left in BASIC all the I/O routines and setup necessary to prepare the sort, since this is quite easy in BASIC and I already had the program written from the first problem. The actual sort algorithm is the only part I programmed in machine code. Thus we get the benefit of BASIC for I/O, printing, etc. in 1% of the execution, and the machine code speed for the repetitive looping in 99% of the execution. Using this machine language sort is relatively easy. The BASIC routine in Figure

3 sets up the variables needed by the sort and calls the machine language routine. It can be substituted for the sort routine in the BASIC version in Figure 1 (lines 1000-1900). The sort routine itself (in Figure 2) is loaded at address 300-3C2. This routine is easily relocatable to any other address (say 800 if you are using 300 for another routine). All you need to do is load it where desired and change the last two instructions (2 JMP commands) to reflect your new location. You must, of course, change the CALL in your BASIC program also. Below is a comparison of my three different implementations of the Shell-Metzner sort.

The maximum number of records you can sort is easily determined by taking the memory size between data high and program low and dividing it by the record size + 2 (the size of the array element needed to hold the pointer to the record). I find with a 32K machine running DOS, I have 18K free. More memory is available if you want to lose DOS of course. Machine language routines may be more trouble to implement, but with an increase in speed over BASIC by a factor of 200, you cannot ignore them. In Part II I will continue my investigation by exploring sorting APPLESOFT character strings with multiple keys. Until then, happy sorting!

μ

Table II — Comparison of Three Methods

METHOD	SORTED WORDS X WORD LENGTH		
	500 X 10	1000 X 10	3600 X 3
BASIC	268	746	4200 (70 min)
SWEET-16	46	158	—
MACHINE	1	3	21

(All sorting times in seconds)

Figure 1

```

10 REM *****
20 REM *   SHELL-METZNER SORT   *
30 REM *   BY GARY FOOTE     *
40 REM *****
50 CALL -936: PRINT : PRINT "SHELL-METZNER SORT": PRINT
60 INPUT "ENTER RECORD COUNT AND LENGTH",NUM,LEN
70 DIM A$(255),A(NUM)
80 I=J=K=L=M=X=T=Z=LL=II=LM=HM=ADDR=W: REM SAVE SPACE FOR VARIABLES
90 LM=PEEK(204)+PEEK(205)*256:HM=PEEK(202)+PEEK(203)*256
95 REM
100 REM ***** FILL MEMORY WITH DATA *****
105 REM
110 PRINT : PRINT "CREATING RANDOM STRINGS"
120 IF LM+LEN*NUM<HM THEN 140
130 PRINT "TOO MUCH DATA!": END
140 FOR X=1 TO LEN*NUM: POKE LM+X, RND(26)+193: NEXT X
150 REM
200 REM ***** INITIALIZE MEMORY POINTER ARRAY *****
205 REM
210 A$="A$": GOSUB 4000
220 FOR X=1 TO NUM:A(X)=(X-1)*LEN+LM+1
230 T=A(X): GOSUB 3000
240 NEXT X
250 REM

```

```

1000 REM ***** SORT ROUTINE *****
1010 REM
1100 PRINT : PRINT "STARTING SORT"
1200 N=NUM:M=N
1300 M=M/2: IF M=0 THEN 1900:K=N-M:J=1
1400 I=J
1500 L=I+M:II=A(I):LL=A(L)
1600 FOR X=0 TO LEN-1:W=PEEK (II+X)-PEEK (LL+X): IF W<0 THEN 1800: IF
W>0 THEN 1700: NEXT X: GOTO 1800
1700 T=A(I):A(I)=A(L):A(L)=T:I=I-M: IF I>=1 THEN 1500
1800 J=J+1: IF J>K THEN 1300: GOTO 1400
1900 PRINT : PRINT "ENDING SORT"
1910 REM
2000 REM ***** PRINT RESULTS *****
2005 REM
2010 A$="A$": GOSUB 4000
2020 FOR X=1 TO NUM
2030 T=A(X): GOSUB 3000
2040 NEXT X
2050 END
2060 REM
3000 REM ***** STRING PRINT ROUTINE *****
3005 REM
3010 FOR Z=0 TO LEN-1
3020 POKE ADDR+Z, PEEK (T+Z): REM ARRAY A$
3030 NEXT Z: POKE ADDR+Z,30
3040 PRINT X,A$
3050 RETURN
3060 REM
4000 REM ***** FIND VARIABLE'S ADDRESS
4005 REM
4010 ADDR=PEEK (74)+PEEK (75)*256-1:K=LEN(A$):J=PEEK (204)+PEEK (205
)*256-1:L=0: IF A$(K,K)#" $" THEN 4020:K=K-1:L=1
4020 FOR I=1 TO K: IF ASC(A$(I))#PEEK (ADDR+I) THEN 4040: NEXT I
4030 IF PEEK (ADDR+I+L)>1 THEN 4040:ADDR=ADDR+K+4+L: RETURN
4040 FOR I=1 TO 100: IF PEEK (I+ADDR)>1 THEN NEXT I:I=ADDR+I+1:ADDR=PEEK
(I)+PEEK (I+1)*256-1
4050 IF ADDR<J THEN 4020: PRINT "VARIABLE ";A$;" NOT FOUND": END

```

Figure 2

```

1000 REM ***** SORT ROUTINE *****
1010 REM
1100 PRINT : PRINT "STARTING SORT"
1200 A$="A": GOSUB 4000
1300 POKE 0,ADDR MOD 256: POKE 1,ADDR/256: REM STORE ARRAY ADDRESS
1400 POKE 2,LEN: REM STORE RECORD LENGTH (MUST BE < 256)
1500 POKE 4,NUM MOD 256: POKE 5,NUM/256: POKE 6,NUM MOD 256: POKE 7,NUM/
256: REM STORE NUMBER OF RECORDS
1600 CALL 768: REM CALL SORT ROUTINE
1700 PRINT : PRINT "ENDING SORT"

```

Figure 3

```

1000 *-----*
1010 *      SHELL-METZNER SORT      *
1020 *      BY GARY A. FOOTE      *
1030 *      COPYRIGHT 1979        *
1040 *      COMMERCIAL RIGHTS RESERVED *
1050 *-----*
1060 *
1070 *      VARIABLES AND CONSTANTS
1080 *
1090 * ALL VARIABLES ARE TWO BYTES.
1100 * THE LISTED NAME IS THE LOW ORDER BYTE.
1110 * THE NAME+1 IS THE HIGH ORDER BYTE.
1120 * EX.  I   = LOW ORDER BYTE
1130 *      I+1 = HIGH ORDER BYTE
1140 *
1150 ADRA .EQ $00      ARRAY A ADDRESS
1160 LEN  .EQ $02      RECORD LENGTH
1170 N    .EQ $04      NUM OF RECORDS
1180 M    .EQ $06      M
1190 I    .EQ $08      I (RECORD I)
1200 L    .EQ $0A      L (RECORD L)
1210 J    .EQ $0C      J
1220 K    .EQ $0E      K
1230 PTRI .EQ $10      PTR TO ADDR OF A(I)
1240 PTRL .EQ $12      PTR TO ADDR OF A(L)
1250 ADRI .EQ $14      ADDR OF REC A(I)
1260 ADRL .EQ $16      ADDR OF REC A(L)
1270 *
1280 *      SORT ROUTINE
1290 *
1300      .OR $300
0300 = 46 07 1310 SORT LSR M+1      M = M / 2
0302 = 66 06 1320      ROR M
0304 = D0 05 1330      BNE SRT1      IF M = 0
0306 = A5 07 1340      LDA M+1
0308 = D0 01 1350      BNE SRT1      THEN
030A = 60      1360      RTS          DONE!
030B = 38      1370 SRT1 SEC
030C = A5 04 1380      LDA N          K = N - M
030E = E5 06 1390      SBC M
0310 = 85 0E 1400      STA K
0312 = A5 05 1410      LDA N+1
0314 = E5 07 1420      SBC M+1
0316 = 85 0F 1430      STA K+1
0318 = A9 01 1440      LDA #1      J = 1
031A = 85 0C 1450      STA J
031C = A9 00 1460      LDA #0
031E = 85 0D 1470      STA J+1
0320 = A5 0C 1480 SRT2 LDA J          I = J
0322 = 85 08 1490      STA I
0324 = A5 0D 1500      LDA J+1
0326 = 85 09 1510      STA I+1

```

0328- 18	1520	SRT3	CLC	
0329- A5 08	1530		LDA I	L = I + M
032B- 65 06	1540		ADC M	
032D- 85 0A	1550		STA L	
032F- A5 09	1560		LDA I+1	
0331- 65 07	1570		ADC M+1	
0333- 85 0B	1580		STA L+1	
0335- A5 09	1590		LDA ADRA	INITIALIZE PTRS
0337- 85 10	1600		STA PTRI	TO ARRAY A
0339- 85 12	1610		STA PTRL	ADDRESS
033B- A5 01	1620		LDA ADRA+1	
033D- 85 11	1630		STA PTRI+1	
033F- 85 13	1640		STA PTRL+1	
0341- A0 02	1650		LDY #2	
0343- 18	1660	SRT4	CLC	
0344- A5 10	1670		LDA PTRI	PTR TO A(I) =
0346- 65 08	1680		ADC I	ADDR ARRAY A +
0348- 85 10	1690		STA PTRI	2 * I
034A- A5 11	1700		LDA PTRI+1	
034C- 65 09	1710		ADC I+1	
034E- 85 11	1720		STA PTRI+1	
0350- 18	1730		CLC	
0351- A5 12	1740		LDA PTRL	PTR TO A(L) =
0353- 65 0A	1750		ADC L	ADDR ARRAY A +
0355- 85 12	1760		STA PTRL	2 * L
0357- A5 13	1770		LDA PTRL+1	
0359- 65 0B	1780		ADC L+1	
035B- 85 13	1790		STA PTRL+1	
035D- 88	1800		DEY	DO 2 TIMES
035E- D0 E3	1810		BNE SRT4	(PTR DISP IS 2 BYTES)
0360- B1 10	1820		LDA (PTRI),Y	II = A(I)
0362- 85 14	1830		STA ADRI	
0364- B1 12	1840		LDA (PTRL),Y	
0366- 85 16	1850		STA ADRL	
0368- C8	1860		INY	
0369- B1 10	1870		LDA (PTRI),Y	LL = A(L)
036B- 85 15	1880		STA ADRI+1	
036D- B1 12	1890		LDA (PTRL),Y	
036F- 85 17	1900		STA ADRL+1	
0371- 88	1910		DEY	
0372- B1 14	1920	SRT5	LDA (ADRI),Y	COMPARE ONE BYTE IN
0374- D1 16	1930		CMP (ADRL),Y	RECORDS I & L
0376- 90 31	1940		BCC SRT8	I < L
0378- D0 07	1950		BNE SRT6	I > L
037A- C8	1960		INY	I = L
037B- C4 02	1970		CPY LEN	END OF RECORD?
037D- D0 F3	1980		BNE SRT5	NO, NEXT BYTE
037F- F0 28	1990		BEQ SRT8	RECORDS EQUAL
0381- A0 00	2000	SRT6	LDY #0	
0383- A5 14	2010		LDA ADRI	A(I) <-> A(L)
0385- 91 12	2020		STA (PTRL),Y	
0387- A5 16	2030		LDA ADRL	
0389- 91 10	2040		STA (PTRI),Y	
038B- C8	2050		INY	
038C- A5 15	2060		LDA ADRI+1	

```

038E- 91 12      2070      STA (PTRL),Y
0390- A5 17      2080      LDA ADRL+1
0392- 91 10      2090      STA (PTRI),Y
0394- 38         2100      SEC
0395- A5 08      2110      LDA I           I = I - M
0397- E5 06      2120      SBC M
0399- 85 08      2130      STA I
039B- A5 09      2140      LDA I+1
039D- E5 07      2150      SBC M+1
039F- 85 09      2160      STA I+1
03A1- 90 06      2170      BCC SRT8
03A3- D0 83      2180 SRT7 BNE SRT3      IF I > 0 THEN STR3
03A5- A5 08      2190      LDA I
03A7- D0 FA      2200      BNE SRT7
03A9- E6 0C      2210 SRT8 INC J           J = J + 1
03AB- D0 02      2220      BNE SRT9
03AD- E6 0D      2230      INC J+1
03AF- A5 0F      2240 SRT9 LDA K+1
03B1- C5 0D      2250      CMP J+1          IF J > K
03B3- 90 0B      2260      BCC JMP2        THEN SORT
03B5- D0 06      2270      BNE JMP1        ELSE SRT2
03B7- A5 0E      2280      LDA K
03B9- C5 0C      2290      CMP J
03BB- 90 03      2300      BCC JMP2
03BD- 4C 20 03   2310 JMP1 JMP SRT2    CHANGE IF RELOCATED
03C0- 4C 00 03   2320 JMP2 JMP SORT    CHANGE IF RELOCATED
                2330      .EN

```

:\$300.3C2

```

0300- 46 07 66 06 D0 05 A5 07
0308- D0 01 60 38 A5 04 E5 06
0310- 85 0E A5 05 E5 07 85 0F
0318- A9 01 85 0C A9 00 85 0D
0320- A5 0C 85 08 A5 0D 95 09
0328- 18 A5 08 65 06 85 0A A5
0330- 09 65 07 85 0B A5 00 85
0338- 10 85 12 A5 01 85 11 85
0340- 13 A0 02 18 A5 10 65 08
0348- 85 10 A5 11 65 09 85 11
0350- 18 A5 12 65 0A 85 12 A5
0358- 13 65 0B 85 13 88 D0 E3
0360- B1 10 85 14 B1 12 85 16
0368- C8 B1 10 85 15 B1 12 85
0370- 17 88 B1 14 D1 16 90 31
0378- D0 07 C8 C4 02 D0 F3 F0
0380- 28 A0 00 A5 14 91 12 A5
0388- 16 91 10 C8 A5 15 91 12
0390- A5 17 91 10 38 A5 08 E5
0398- 06 85 08 A5 09 E5 07 85
03A0- 09 90 06 D0 83 A5 08 D0
03A8- FA E6 0C D0 02 E6 0D A5
03B0- 0F C5 0D 90 0B D0 06 A5
03B8- 0E C5 0C 90 03 4C 20 03
03C0- 4C 00 03

```

SYMBOL TABLE

ADRA	0000	LEN	0002	N	0004
M	0006	I	0008	L	000A
J	000C	K	000E	PTRI	0010
PTRL	0012	ADRI	0014	ADRL	0016
SORT	0300	SRT1	0308	SRT2	0320
SRT3	0328	SRT4	0343	SRT5	0372
SRT6	0381	SRT7	03A3	SRT8	03A9
SRT9	03AF	JMP1	03BD	JMP2	03C0

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Streamlining the C2-4P

Here are three modifications you can make to your OSI C2-4P to raise its speed, increase the cassette throughput, and add reverse video to the display.

James L. Cass
19559 Tulsa Street
Northridge, CA 91326

I am concerned by the paucity of articles on OSI computers in MICRO and hope that this will reverse the trend. I feel that the Challenger 2-4P running speed and ease of modification more than offset its shortcomings. I will describe three modifications I have made, mainly, raising the CPU clock rate, raising the cassette data rate, and reversing the video presentation.

Raising the CPU Clock Rate

My computer is happily working with a clock frequency a little under 2 MHz (1.9648 actual, 1.96608 nominal) in place of half that, which is the way it was delivered. The CPU clock is taken from the video timing chain, which uses a crystal oscillator near 12 MHz, a divide by three, and then a series of binary dividers to form 15,360 and 60 Hz sync pulses. It was only necessary to move the CPU clock takeoff one stage higher in the timing chain. To do this, move the jumper wire coming from bus pin #18 off IC #E4 pin #13, and onto pin #14. If you intend to make this change, use a small, low power, preferably grounded soldering iron, as recommended for all IC work. Another word of caution: make a long, thorough shakedown run of several operational programs looking for dropped bits from memory. I did this since I have two RAM chips marked "550" (presumably not fast enough to qualify as 450 nsec.), but there was absolutely no hint of dropped bits. Instead, I have very snappy video display operation, slightly fast keyboard repeat, and, best of all, running times cut in half. A machine language LIFE program updates a full screen of 1792 cells 14 times a second!

Doubling the Bit Rate

I successfully doubled the bit rate of my cassette interface from 300 to 600 baud, after speeding up my CPU. I naturally tried 1200 baud; while it seemed to read properly, the load program seemed to choke up on very long (64 to 71 character) lines sometimes and miss the CR and next line. The 555 IC oscillator frequency is doubled from 4800 to 9600 Hz by substituting a 0.01 mfd capacitor for the 0.022 and then adjusting the trimpot.

A frequency counter is a big help, if not essential. Since the tone frequencies should remain at 1200 and 2400 Hz, an extra divider is needed. The unused half of the 7474 already in the interface works nicely, or you can install a 74163 in the convenient prototyping vacant space, and get several baud rates for printers and the like. Rate selection can be conveniently brought to a switch mounted to the left of the keyboard. Figure 1 shows the circuit using the 7474.

I have found "reversed" video to be much easier to view for extended periods. Also, the black "reversed" characters have less apparent intensity variation, that is, they look even. The reversed video connection is indicated in the schematics, but there is no provision made in the printed wiring, so that it is necessary to cut a printed conductor. The junction of R 11 and R 23 is

moved from Pin 8 to Pins 9-10-11 of the IC at D4. I installed a switch near the keyboard with short, direct small wires, but find that I could have left the wiring at "reversed" with no loss.

Conclusions

Doubling the CPU clock rate and hence the speed of the C2-4P is quite easy to do. The main risk is that some 2114 type RAM chips may be too slow. The data rate in the cassette interface can be doubled to 600 baud, but only with some effort and decrease in reliability; 1200 baud does not work. Reversing the video to display black characters on white is relatively simple and the reversed video format is preferred by everyone. Cassette speed selection and normal-reverse video are conveniently brought to switches installed near the keyboard.

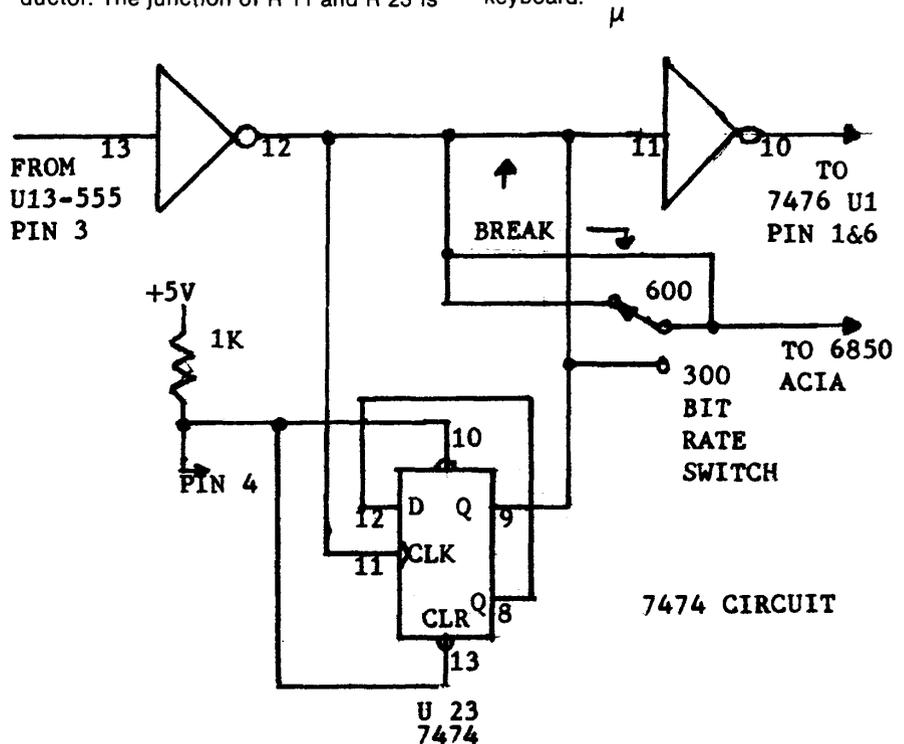


Figure 1

6502 INFORMATION RESOURCES UPDATED

A list of regular publications which have material of interest to 6502 users.

William R. Dial
438 Roslyn Ave.
Akron, OH 44320

Did you ever wonder just what magazines were the richest sources of information on the 6502 micro-processor, 6502-based microcomputers, accessory hardware and software? For several years this writer has been assembling a bibliography 6502 references related to hobby computers and small business systems. The accompanying list of magazines has been com-

plied from this bibliography. At the top of the list are several publications which specialize in 6502-related subjects. An attempt has been made to give up-to-date addresses and subscription rates for the magazines cited. Subscription rates are for U.S. Other countries normally are higher.

MICRO

\$15.00 per year

MICRO

P.O. Box 3

S. Chelmsford, MA 01824

6502 USER NOTES

\$13.00 per 6 issues

Eric Rehnke

P.O. Box 33093

Royalton, OH 44133

OHIO SCIENTIFIC — SMALL SYSTEMS JOURNAL

\$6.00 per year (6 issues)

Ohio Scientific

1333 S. Chillicothe Rd.

Aurora, OH 44202

PET GAZETTE

Free bi-monthly (Contributions Accepted)

Microcomputer Resource Center

1929 Northport Drive, Room 6

Madison, WI 53704

Robert Purser's REFERENCE LIST OF COMPUTER CASSETTES

Nov. 1978 \$2.00/ Feb 1979 \$4.00

Robert Purser

P.O. Box 466

El Dorado, CA 95623

THE PAPER (PET)

\$15.00 per year (10 issues)

The PAPER

P.O. Box 43

Audubon, PA 19407

THE CIDER PRESS (APPLE)

Scot Kamins

Box 4816

San Francisco, CA 94101

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Kilobaud Magazine

Peterborough, NH 03458

BYTE

\$18.00 per year

Byte Publications, Inc.

70 Main St.

Peterborough, NH 03458

DR. DOBB'S JOURNAL

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Menlo Park, CA 94025

ON-LINE

\$3.75 per year (18 issues)

D. H. Beetle

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Los Gatos, CA 95030

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(formerly PEOPLE'S COMPUTERS)

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Box E

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INTERFACE AGE

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 Cerritos, CA 90701

POPULAR ELECTRONICS

\$12.00 per year
 Popular Electronics
 One Park Ave.
 New York, NY 10016

PERSONAL COMPUTING

\$14.00 per year
 Benwill Publishing Corp.
 1050 Commonwealth Ave.
 Boston, MA 02215

73 MAGAZINE

\$15.00 per year
 73, Inc.
 Peterborough, NH

CREATIVE COMPUTING

\$15.00 per year
 Creative Computing
 P.O. Box 789-M
 Morristown, NJ 07960

SSSC INTERFACE

Southern California Computer Soc.
 1702 Ashland
 Santa Monica, CA 90405

EDN (Electronic Design News)

\$25.00 per year
 Cahners Publishing Co.
 270 St. Paul St.
 Denver, CO 80206

RADIO ELECTRONICS

\$8.75 per year
 Gernsback Publications, Inc.
 200 Park Ave., South
 New York, NY 10003

QST

\$12.00 per year
 American Radio Relay League
 225 Main St.
 Newington, CT 06111

IEEE Computer

IEEE
 345 E. 47th St.
 New York, NY 10017

POLYPHONY

\$4.00 per year
 PAIA Electronics, Inc.
 1020 W. Wilshire Blvd.
 Oklahoma City, OK 73116

RAINBOW (APPLE)

\$15.00 per year
 Rick Simpson and Terry Landereau, Editors
 P.O. Box 43
 Audubon, PA 19407

PET USER NOTES

\$5.00 per year (6 or more issues)
 PET User Group
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CONTACT — User Group Newsletter

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 Cupertino, CA 95014
 (408) 996-1010

SOUTHEASTERN SOFTWARE NEWSLETTER (APPLE)

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 6708 39th Ave. SW
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The Color Gun for the Apple II

With some quite inexpensive hardware, you can turn your APPLE II into a color detector -- a device which will automatically determine the colors of any object.

Neil D. Lipson
29 S. New Ardmore Ave.
Broomall, PA 19008

Shortly after I developed my light pen for the Apple back in May, 1978, I began thinking about other devices that could be hooked up to the paddle inputs. One idea was making a "color gun" which when pointed at an object would tell you the color. The idea is similar to that of the operation of a television transmitter. Color is broken down into three main colors, which are red, blue, and yellow. Therefore by having three inputs into the Apple, into paddle 0, paddle 1, and paddle 2, we could in effect have a device that would "see" the three color breakdown ratios of any object. By further analysing this ratio, we could see different shades of color and with high quality color filters, we could make an extremely accurate device which could even give the exact color temperature of the object. One of the interesting aspects of this device that sets it apart from any other color temperature meter, is that you can calibrate it by pointing it at a piece of white paper to adjust for differences in the light source. Therefore, the color gun will work in any type of artificial lighting within certain parameters (you could not use it under a red light for example).

Building the Color Gun

To start off with, buy three sensitive cadmium sulphide photo cells (physically between 1/4 to 1/2 inch in diameter). If the cells are not equal in sensitivity, they can be equalized easily in software. This is illustrated in the listing. Merely point the gun at a white piece of paper (or at the light source itself if its not too bright) during the calibration procedure. The construction of the gun is very simple. Mount the three cells in a triangle about 2" for each side on a piece of wood or other material. Then place three filters over the cells, with red on paddle (0) cell, blue on paddle (1) cell, and yellow on paddle (2) cell. The purer the filter, the better. Photographic filters are the best, and will give the best results. However, red, blue or yellow clear plastic will work satisfactorily in most situations. Note the use of the REM statements in the program. These are for slowing down the paddle readings just a hair in order to avoid having the readings "overlap". The wiring diagram is shown in Figure 1.

Mount the entire setup in some type of barrel or cylinder about 4 inches long, with the inside of the barrel painted white, and glue everything together and seal against light leaks. Plug it into the game paddle after the wiring is complete and you ready to go. For the pin numbers of the paddles, consult your red manual.

The Color Gun Program

Type the program into the Apple in Applesoft 2 and run. The gun will only recognize 6 colors, and when it isn't sure what the color is, it will give you two colors (one primary color and one secondary). This should not happen if the colors are absolutely pure, but most colors are not, so expect this situation more often. Notice the correction algorithm in statement 70 in the program to correct for the blue cell. The cells that I used were somewhat more sensitive to blue than the other colors (which is common of cadmium sulfide). This was noticed when the color gun kept saying "orange" (the compliment of blue). The correction

algorithm eliminates most of this problem. If the gun acts strangely, run it again until it gets a good calibration. It sometimes takes more than one run to get it working properly (usually because it is confused by a bright color nearby).

By fine tuning the software, and using more exact ratios, you can determine many other colors. Given enough ratios to choose from, you can give the color temperature of the object (with high quality cells and filters). The typical photographic filters you can use are the yellow (K2), the red (25 or 25A) and the blue (47). These may be varied if desired to meet the spectral response of the particular cell you buy. You could even use different colors in the filters as long as you adjust the software accordingly. Buy the smallest filter you can (it only has to cover about 1/2 inch diameter), but make sure there is no light leak from the sides of the cells. If you follow these instructions, the gun will work perfectly the first time around. Have fun!

μ

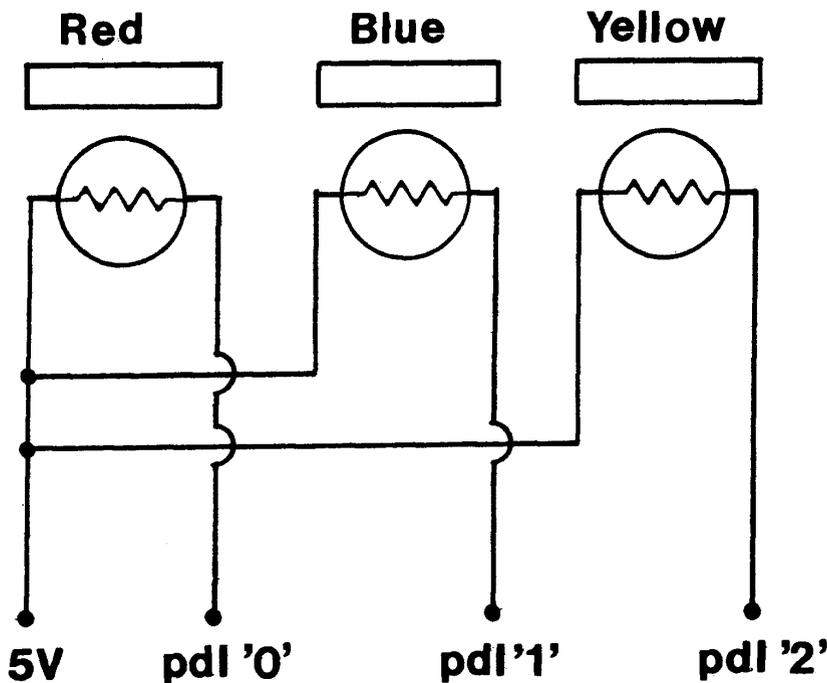


Figure 1

```

1 CALL -936
2 VTAB 10: HTAB 10: PRINT "COLOR
  GUN BY NEIL D. LIPSON"
3 HTAB 15: PRINT "COPYRIGHT 1979
  "
4 HTAB 12: PRINT "ALL RIGHTS RES
  ERVED": FOR I = 1 TO 2000: NEXT
  I
5 REM '0' RED
6 REM '1' BLUE
7 REM '2' YELLOW
10 CALL - 936
15 REM YELLOW,BLUE,RED
20 PRINT : PRINT : PRINT : PRINT

25 GOSUB 1000
30 CALL - 936: PRINT : PRINT
32 A = PDL (0)
35 REM
40 B = PDL (1)
45 REM
50 C = PDL (2)
55 REM
60 A = A * A1
61 B = B * B1
62 C = C * C1
70 B = B / 1.5
100 PRINT "RED CELL = ";A
110 PRINT "BLUE CELL = ";B
115 PRINT "YELLOW CELL = ";C
116 PRINT : PRINT
117 PRINT "THE COLOR IS:": PRINT

118 PRINT "*****
  "
121 IF C < B AND C < (A) THEN PRINT
  "YELLOW"
123 IF A < B AND A < C THEN PRINT
  "RED"
124 IF A > B AND A > C THEN PRINT
  "GREEN"
125 IF B > A AND B > C THEN PRINT
  "ORANGE"
126 IF C < A AND C > B THEN PRINT
  "PURPLE"
129 IF B < C AND B < (A) THEN PRINT
  "BLUE"
130 PRINT "*****
  "
131 FOR X = 1 TO 2300: NEXT X
140 GOTO 30
200 END

```

```

100 CALL - 936: PRINT
1010 PRINT "POINT GUN AT A WHITE
  SHEET OF PAPER"
1020 FOR I = 1 TO 1500: NEXT I
1030 A1 = PDL (0)
1035 REM
1040 B1 = PDL (1)
1045 REM
1050 C1 = PDL (2)
1055 PRINT "A1=";A1
1056 PRINT "B1=";B1
1057 PRINT "C1=";C1
1060 D1 = A1 * B1 * C1
1070 A1 = D1 / A1
1080 B1 = D1 / B1
1090 C1 = D1 / C1
1100 PRINT "CORRECTION FACTOR FO
  R RED = ";A1
1110 PRINT "CORRECTION FACTOR FO
  R BLUE = ";B1
1120 PRINT "CORRECTION FACTOR FO
  R YELLOW = ";C1
1125 FOR I = 1 TO 2000: NEXT I
1130 RETURN
10000 END

```

EPROM PROGRAMMER



Software available for F-8, 6800, 8080, 8085, Z-80, 6502, KIM-1, 1802.

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CURVE FIT

Will take any number of data points in any fashion, and give you the choice of having the computer choose the best curve fit, or you may choose yourself what type of fit you desire. The four given are log curve fit, exponential curve fit, least squares, and power curve fit. The results are then graphed. Written by Dave Garson, requires 16K memory.

CALENDAR

This program will perform two functions: days between dates (any two dates) or a perpetual calendar. If the calendar is chosen, it will automatically give the successive months by merely hitting the return key. May be used with or without a printer. Written by Ed Hanley, requires 16K memory.

STARWARS

The original and best starwars game, written by Bob Bishop. You fire upon the tie fighter after aligning the fighter in your crosshairs. This is a high resolution game in color that uses the paddles. Requires 16K memory.

ROCKET PILOT

This is an exciting game where you are on a planet taking off with your rocket ship, trying to fly over a mountain. The simulation of the rocket blasters actually accelerates you up, and if you are not careful, you will run out of sky. The contour of the land changes each time you play the game. Written by Bob Bishop, requires 16K memory.

SPACE MAZE

This game puts you in a maze with a rocky ship, and you try to "steer" out of it with your paddles or joystick. It's a real challenge. It is done in high resolution graphics in color, done by Bob Bishop. Requires 16K memory.

SAUCER INVASION

This program was written by Bob Bishop. You are being invaded by a flying saucer and you can shoot at it with your missile and control the position with your paddle. Requires 16K memory.

MISSILE-ANTI-MISSILE

Missile-Anti-Missile is a high resolution game. The viewer will see a target appear on the screen, followed by a 3-dimensional digital drawing of the United States. Then a small submarine appears. The submarine is controlled by hostile forces (upon pressing the space bar) which launches a pre-emptive nuclear strike upon the United States (controlled by paddle No. 1). At the time that the missile is fired from the submarine, the United States launches its own anti-missile (the anti-missile is controlled by paddle No. 0). There are many levels of play depending upon the speed. Written by Dave Moteles and Neil Lipson. Requires 16K memory.

MORSE CODE

This program allows the user to learn morse code by the user typing in letters, words or sentences in english. Then the dots and dashes are plotted on the screen. At the same time sounds are generated to match the screen's output. Several transmission speed levels are available. Written by Ed Handley. Requires 16K memory.

POLAR COORDINATE PLOT

A high resolution graphics program which provides the user with 5 primary classic polar coordinate plots and a method by which the user can insert his own equation. When the user's equation is inserted into the program it will plot on a numbered grid and then immediately after plotting, flash, in a table form, the data needed to construct such a plot on paper. The program takes 16K of memory and ROM board. Written by Dave Moteles.

UTILITY PAK 1

This is a combination of 4 programs: (by Vince Corsetti)

Integer to Applesoft Conversion - this program will convert any integer basic program to an applesoft program. After you finished, you merely correct all of those syntax errors that occur with applesoft only.

Disk Append - will append any two integer programs from a disk into one program.

Integer Basic Copy - allows you to copy an integer basic program from one disk to another by merely hitting return. Useful when copying the same program many times.

Update Applesoft - will correct Applesoft on the disk to eliminate the heading that always occurs when it is initially run.

Binary Copy - this program copies a binary file from one disk to another by merely hitting return. It automatically finds the length and starting address of the program for your convenience.

BLOCKADE

Two people try to block each other by buildings walls and blocking the other. An exciting game written in integer basic for 16K. Written by Vince Corsetti.

TABLE GENERATOR

Is a program which forms shape tables with ease. Shape tables are formed from directional vectors and the program also adds other information such as starting address, length and position of each shape. The table generator allows you to save the shape table in any usable location in memory. It is an applesoft program. Written by Summary Summers. Price: \$9.95

All Programs \$9.95 EACH

All Programs are 16K unless specified.

HARDWARE:

LIGHT PEN

Includes 5 programs. Light Meter, which gives you reading of light every fraction of a second from 0 to 588. The light graph will graph the value of light hitting the pen on the screen. The light pen will "draw" on the screen points which you have drawn and then connect them. It will also give the coordinates of the points if desired, drawn in hi-res. The fourth program will do the same except draw it in hi-res. The fifth program is a utility program that allows you to place any number of points on the screen for use in menu selection or in games, and when you touch this point, it will choose it. It is not confused by outside light, and uses artificial intelligence. Only the hi-res light pen requires 48K and ROM card. Written by Neil D. Lipson.

Light Pen supported by 5 programs . . . \$34.95

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ASK the Doctor — Part V

Reading KIM Tapes on the AIM and SYM

The Doctor discusses some problems that arise in trying to load KIM format cassette tapes on the AIM or SYM, and "with a little help from his friends" presents a short routine to get by the SYM "2F" loading bug and a sub-routine which mimics the KIM SCANDS routine on the SYM.

Robert M. Tripp, Ph.D.
The Computerist, Inc.
P.O. Box 3
So. Chelmsford, MA 01824

Reading KIM Tapes with the AIM

The AIM 65 has two speeds for reading the KIM format tapes. The normal KIM tape records at about 8 1/3 characters per second. Early in KIM history, Jim Butterfield published "Hypertape", a program that permits KIM formats to be written at higher rates: 2 times, 3 times and even 6 times the normal KIM rate — and still be read by the regular KIM monitor and hardware with no changes! The AIM 65 people recognized the value of the higher speed KIM rates and made their monitor capable of loading either 1 time or 3 times KIM tapes. (The full 6 times would have been very nice, but I guess we can't have everything.) The AIM documentation is very vague about using these KIM formats. To use the KIM loader, you must first set a "user alterable" RAM location A408 as follows:

C7 for normal AIM format tapes
5A for normal KIM format tapes
5B for 3 times KIM format tapes

On power up, C7 is automatically set, so that the AIM format is the default, as one would expect. The A408 location must be set by the user manually to the correct KIM speed value before calling on the tape load or dump routines. This must be reset either manually or by a power up reset to return to the AIM format. If you do not have the correct value in A408 for what you are trying to do, it will not work and, in general, will not give you any indication that it is not working. The KIM Loader/or Dumper is invoked by specifying "K" as the I/O device.

Now that you finally understand how to use the AIM to load a KIM tape, you set A408 to 5A for a regular KIM tape which has your favorite program and run the AIM Load specifying K for the input device, the program identifier that you used when you recorded the tape as the file name, and the correct tape unit. You sit back and wait for the load to complete. But what's this! The AIM is suddenly in some strange state! It may be saying "OUT =" which does not make sense, or even worse may be dumping

reams of paper out of the printer! What happened? What happened was that your typical KIM program which uses all available memory on the KIM — locations 0000 to 03FF — has found a small problem with the AIM KIM format load program. The problem is the STACK. The programmers who developed the KIM monitor were super-smart in realizing that, given the very limited on-board memory of the KIM, users would often want to load ALL of the RAM, from 0000 to 03FF, right over page zero and page one — stack all. They made the KIM load and dump routines work without using page zero or page one in any way that would not interfere with data in those pages. You might want to examine this code sometime in the KIM monitor listings, as it is quite instructive. The AIM programmers were only smart about the KIM format — not super-smart. They gave the multiple speeds, but did not write the loader is such a way that it could load over the page one stack. So, the loader works fine until it hits the stack that is being used by the loader itself. Then, it **SELF DESTRUCTS!** It over-writes a return address in the stack and then returns to "never-never-land". Where it goes will depend on the byte of data that over-writes the stack. I do not know of any simple solution to this problem. You can, of course, divide your KIM program into two portions: 0000 to 01F0 (or thereabouts — I think it bombs at about 01FB but have not done any detailed testing), and 0200 and up. This assumes that you have access to a KIM. If not, my friend, I am afraid you have a real problem.

Reading KIM Tapes with the SYM

The SYM monitor bug which causes loading of KIM tapes to abort when it encounters a "2F" has been documented in previous columns, is "cured" by Skov's program, and is fixed in the new SYM SY1.1 version of the monitor. It will not be discussed here. With the "2F" bug fixed, the SYM still has problems with reading KIM format tapes. The problem is the same as discussed with the AIM above. It can NOT load over the end of the page one stack. The SYM has an

additional, related problem. It can not read over the last two bytes in page one either. These two bytes are used by the load routine as the indirect pointer to the next location to be loaded. Once your KIM formatted tape hits them — Good-bye! So, we have here the same problem, and the same solution. To load KIM tapes into a SYM, they must be loaded in three segments: 0000 to 00FD, 0100 to (about) 01FC, and 0200 and up. I thought I had a great idea to get around this problem. I dumped my KIM tapes with everything shifted up to start at 0200, with the intention of using a simple SYM Block-move command to relocate them down to their proper addresses. That is, the KIM tape would be set to load from 0200 to 05FF and then be moved down to 0000 to 03FF. Good idea, right? Well, it may be a good idea, but it doesn't work. Block-move has the exact same problems as the tape load: it uses the last two locations in page zero as well as subroutines which require access to the page one stack!

AIM/SYM/KIM Tape Summary

While there are obviously some problems in using the KIM format tapes on the SYM and AIM, this format is the only one which is compatible between the three machines, and should be used as a common medium of exchange for programs and data between them. To be "universal" the tapes should be written at the normal KIM speed and should start at location 0200 or above. I am sure that there will be SYM and AIM versions of Hypertape published soon, perhaps in MICRO. Maybe someone will even have the time to come up with a KIM LOAD program for the SYM and the AIM that can be tacked on the front of a tape to be exchanged — in normal speed — and which once loaded will permit the loading of KIM format programs and data into any address (except for those occupied by the loader itself which should be out-of-the-way somewhere), and at the higher speeds. Until then, keep the AIM and SYM loading problems in mind as you make plans to transfer your programs and data from one of the ASK family members to another.

μ

SYM "2F" BUG KILLER

A Solution to the SYM "2F" Bug

CODE IS COMPLETELY
RELOCATABLE.

20 86 8B	START	JSR	ACCESS	ACCESS *	\$8B86
20 78 8C		JSR	LOADT	LOADT *	\$8C78
B0 01		BCS	TWOF	CHKT *	\$8E78
60		RTS		CHAR *	\$00FC
A9 2F	TWOF	LDAIM	\$2F	SUCCESSFUL LOAD	
20 78 8E		JSR	CHKT	2F ERROR	
A0 00		LDYIM	\$00		
91 FE		STAIY	\$00FE		
E6 FE		INC	\$00FE	BUMP POINTERS	
D0 02		BNE	OKAY		
E6 FF		INC	\$00FF	BUMP HIGH	
A5 FC	OKAY	LDA	CHAR		
20 3F 8D		JSR	\$8D3F		
B0 EA		BCS	TWOF		
60		RTS			

The problem around SYM-1, with KIM-tape compatability, I solved, at first, by writing a small program, that controls the loading. When loading terminates because of a "2F" in the data stream, it can be assumed that it will result in a checksum error too. What the program does, is simply store the "2F" that was the probable cause and then reenter the tape reading as though there had not been an error.

Submitted by

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SYM STATIC DISPLAY

SYM Static Display

SYM REFERENCES

ACCESS * \$8B86
 SCAND * \$8906
 SEGSM * \$8C29
 DISBUF * \$A63F

This program is a utility for the SYM-1 that I have found useful in adapting routines for the KIM. It loads the DISBUF from three locations, F5 to F7, corresponding to the three display locations, F9 and FB, used in the KIM monitor. It ends with a JMP SCAND, and thus can be used to replace a JSR SCANDS command as used in a KIM routine. It gives a static display.

COMPLETELY RELOCATABLE

```

20 86 8B  STATIC JSR   ACCESS ENTER HERE UNLESS ACCESS
AO 03      ALTNTR LDYIM $03  ALREADY SET.  SET UP FOR
B9 F4 00  MOVE   LDAY  $00F4 3 NUMBERS. GET NUMBER INTO A
4A        LSRA           SHIFT
4A        LSRA           LEFT
4A        LSRA           FOUR
4A        LSRA           TIMES
AA        TAX            PUT RESULT IN X
98        TYA           Y HAS NUMBER INDEX
0A        ASLA          MULTIPLY BY 2
A8        TAY           PUT BACK INTO Y
BD 29 8C  LDAX   SEGSM  GET CORRECT SEGMENT CODE
99 3E A6  STAY   DISBUF -01 PUT INTO DISPLAY BUFFER
98        TYA           GET INDEX BACK
4A        LSRA          DIVIDE BY 2
A8        TAY           PUT BACK
B9 F4 00  LDAY   $00F4  NUMBER INOT A
29 0F      ANDIM $0F    MASK
AA        TAX            RESULT INTO X
98        TYA           GET INDEX
0A        ASLA          MULTIPLY BY 2
A8        TAY           PUT BACK
BD 29 8C  LDAX   SEGSM  GET SEGMENT CODE
99 3F A6  STAY   DISBUF PUT INTO DISPLAY BUFFER
88        DEY           DECREMENT INDEX
88        DEY           TWICE
FD 06      BEQ    EXIT  IF HAVE LOADED 6 DIGITS, EXIT
98        TYA           NOT DONE, GET INDEX
4A        LSRA          DIVIDE INDEX BY 2
A8        TAY           PUT BACK
18        CLC           PREPARE TO GO TO MOVE
90 D3      BCC    MOVE  GO!
4C 06 89  EXIT   JMP    SCAND LIGHT UP DISPLAY AND RETURN
    
```

NOTES:

F7 CORRESPONDS TO KIM POINTH AT FB
 F6 CORRESPONDS TO KIM POINTL AT FA
 F5 CORRESPONDS TO KIM INH AT F9

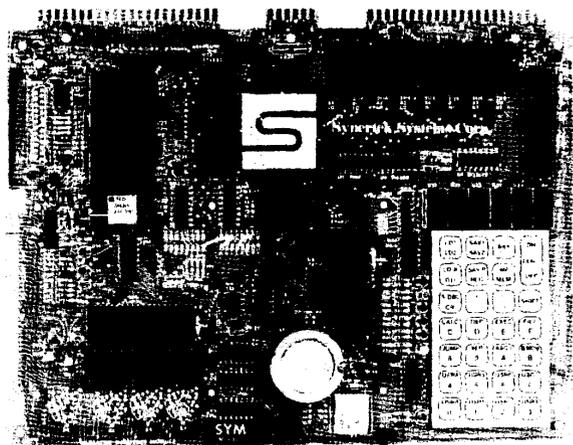
Y KEEPS TRACK OF LOCATION IN DISBUF
 WHEN MULTIPLIED BY 2,
 AND LOCATION IN F5-F7 WHEN NOT.

Submitted by

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Computer-Determined Parameters for Free-Radical Polymerization

Don't let the title scare you. If you are using your system for complex equation solving, the general techniques presented will be useful -- even if the particular example is not your cup to tea.

Dr. L.S. Reich
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W. Orange, NJ 07052

During the formation of polymers by so-called free-radicals, the following lengthy and "sensitive" equation is generally valid,

$$W(R) = AZ^2RP^{R-1} + ((1-A)/Z)^2R(R-1)P^{R-2} \quad (1)$$

where, $W(R)$ = weight-fraction of polymer possessing size R ; A and P are parameters; and, $Z = 1-P$ (A or P cannot exceed unity). Various methods have been previously attempted to solve eqn. (1) for the parameters, A and P , which are of theoretical and practical importance. Thus, approximate graphical procedures have been employed (Smith et al., *J. Polym. Sci.*, Pt. A-2, 4, 365 (1966); *J. Phys. Chem.*, 72, 216 (1968); *Ibid.*, 72, 2933 (1968)) as well as more direct approaches (Reich et al., *J. Appl. Polym. Sci.*, 17, 3709 (1973)). The purpose of this article is to present a novel trial-and-error computer program whereby parameters A and P (or Z) can be readily obtained from eqn. (1). **Although eqn. (1) applies to polymers, the solution of eqn. (1) involves mathematical procedures which are common to various scientific disciplines and the program presented should therefore be of general interest.**

Prior to running this program, $W(R)$ - R data is entered in line #200. An initial (trial) value of P (PO) is entered in line #65. Since P is generally close to unity, an arbitrary initial value of P should be selected between .995-.999 (regardless of which value is chosen, the computer will search for the correct value in order to obtain final values of A and P).

From eqn. (1), it can be readily seen that a least squares treatment of the data ($Y = A1 + A2X$) where, $Y = W(R)/(1-P)^{R-1}$ and $X = (R-1)/P$, will afford best values of intercept ($A1$) and slope ($A2$) where, $A1 = A$ and $A2 = (1-A)Z/2$ (the least squares procedure is given in line #'s 75-120). Then (cf. line #140),

$$Z = 2A2/(1-A1) \quad (2)$$

Under the conditions used, more than one solution for Z is possible. However, there can only be one unique physically real solution for A and for Z (or $1-P$). The physically unreal solution for Z affords

values of $A > 1$ (which is theoretically impossible). By using line #163, when $A > 1$, PO is lowered in order to achieve conditions whereby a physically real value of A may be obtained. Other limitations that must be met are: P cannot be greater than unity (see line #150); $A1$ cannot be less than zero (#170). Another condition (arbitrary) to be met is (line #156), $1-PO > = Z$. This ensures that prior to a series of iterative calculations to determine final parameter values, the initial value of P is such that $1-PO > = Z$. Then, values of P are gradually increased (line #180) until the following conditions (3) hold (line #'s 160, 168), at which time, A , Z , and the correlation coefficient (from the least squares calculation of $A1$ and $A2$) are displayed (line #168),

$$ABS(R) > .9 \quad (3a)$$

$$\text{and, } 1-P > = Z \text{ or } ABS(1-P-Z)/Z < = 4E-04 \quad (3b)$$

Since eqn. (1) is sensitive to changes in data, i.e., small changes in data can result in relatively large changes in A , there is a requirement that correlation coefficient (R) be above .9 (3a). Thus, even though (3b) is satisfied, if (3a) is not, then the screen will display the statement that the data is not accurate enough (in order to afford reasonably significant values) (line #165). In (3b), the second term involving the absolute value may not apply sometimes, but Z -trial values will generally decrease faster than Z -calculated values to that $1-P < = Z$ halts further iterations and final parameter values are displayed. Further, because of the sensitivity of eqn. (1), when A -values are between .05 and 0, then A is considered to possess a zero value (line #'s 165, 1000). Insufficiently accurate data may also cause relatively large negative $A1$ -values (#165) and endless loops (iterations) to occur. After 200 such iterations, the screen will display a statement that the data may not be accurate enough (to achieve closed parameter values) (line #155). However, it is also possible that due to an unfortunate choice of a PO value in line #65, more than 200 iterations will be required prior

to the display of final values. Hence, the additional statement in line #155 that another value of PO should be entered in line #65 (and another run attempted). If another run is made and a similar situation arises then omitting $W(R)$ - R data at low values of R and/or at very high values of R may afford closed parameter values (the former $W(R)$ - R values generally lie along the steepest part of a distribution curve and are subject to errors in $W(R)$ while the latter values lie along a relatively flat portion of the curve and are subject to errors in R). From the preceding, data in #200 must be derived from precise experimental techniques, which are available, e.g., gel permeation chromatography, due to eqn. (1) sensitivity to relatively small inaccuracies in data (which are prone to occur at the tail ends of a distribution curve).

Prior to the display of final results, values of Z (trial) and Z (calcd.) will be compared in tabular form on the screen (line #'s 68, 155) in order to apprise the viewer of the status of the iterative calculations in progress. After final parameter values have been displayed, values of $W(R)$ (obsd.) and $W(R)$ (calcd.) are compared in tabular form (line #'s 190, 500-520).

Explanatory REM statements are to be found in line #'s 9, 64, 105, 130, 152, 158 and ca. 3-3.5K bytes are required depending upon the amount of data entered (the data is limited to 19 $W(R)$ - R pairs). Apple-soft II Basic in ROM was employed and a run, as given in the Program Example section, required ca. 1 min. but this can vary considerably depending upon the accuracy of the data and the initial choice of the PO value (more iterations are necessary when the PO value is further away from the true P value). Finally, it may be noted that the parameter Values A and Z can be used to estimate various pertinent quantities. e.g., the so-called weight-average degree of polymerization of a polymer which is equal to $(3-A)/Z$.

Program Listing

```
5 PRINT "THIS PROGRAM ALLOWS THE PRECISE CALCULATION OF
MOLECULAR WEIGHT DISTRIBUTION PARAMETERS, 'A' & '1-P',
FOR FREE-RADICAL POLYMERIZATION. WEIGHT-FRACTION VS.
DEGREE OF POLYMERIZATION (DP) DATA IS ENTERED IN LINE
#200. ";
6 PRINT "THE INITIAL VALUE OF 'P' (ARBITRARILY CHOSEN BETWEEN
.995-.999) IS ENTERED IN LINE 65. CA. 3-3.5K BYTES ARE
REQUIRED AND EXPLANATORY 'REM' STATEMENTS ARE IN LINE #'S
9, 64, 105, 130, 152, 158.": STOP
9 REM #'S 10-60 ALLOW THE FORMATION OF THE ARRAY W(J,K) FOR
WT.-FRACTION VS. DP DATA IN LINE #200
10 DIM W(20,2)
20 FOR J = 1 TO 50
30 FOR K = 1 TO 2: READ W(J,K)
40 IF W(J,1) = 0 THEN 60
50 NEXT K,J
60 J = J-1
64 REM #65 LISTS THE INITIAL VALUE OF 'P' & #'S 70-100 ALLOW
FOR A LEAST SQUARES TREATMENT OF THE DATA
65 PO = .99745
68 PRINT; PRINT"Z-VALUES (TRIAL)"; TAB (21); "Z-VALUES (CALCD.)":
PRINT "-----"; TAB (21); "-----"
70 P = PO
75 FOR I = 1 TO J
80 Y = W(I,1)/(W(I,2)^(W(I,2) -1)*(1-- P)^2): X = (W(I,2) -1)/P
90 XY = XY + X*Y: XX = XX + X*X: SX = SX + X: SY = SY + Y:
YY = YY + Y*Y
100 NEXT
105 REM IN #'S 110, 120 ARE GIVEN THE LEAST SQUARE SLOPE (A2),
INTERCEPT (A1), & THE CORRELATION COEFF. (R)
110 A2 = (J*XY - SX*SY)/(J*XX - (SX)^2): A1 = (SY/J) - A2*(SX/J)
120 R = (XY - J*(SX/J)*(SY/J))/(SQR(XX - SX*(SX/J))*SQR(YY - SY*
(SY/J)))
130 REM #'S 140, 150 ALLOW THE CALCULATION OF Z AND THE ADJUSTMENT
OF PO IF Z<0
140 Z = 2*A2/(1 - A1)
150 IF P>1 OR Z<0 THEN PO = PO- .00001: XX = 0: SX = 0:
SY = 0: YY = 0: GOTO 70
152 REM #155 INDICATES A POSSIBLE ENDLESS LOOP & #156 LOWERS THE
INITIAL VALUE OF PO IN LINE #65 IF 1-PO<= Z
155 PRINT 1-P; TAB(21); Z: PC = PC + 1: IF PC>200 THEN PRINT:
PRINT "THE PROGRAM IS GOING THRU AN ENDLESS LOOP? THE DATA
MAY NOT BE ACCURATE ENOUGH! TRY ANOTHER VALUE OF PO IN #65
& SEE IF THERE IS ANY CHANGE!": END
156 IF 1-PO<Z OR Z<0 THEN PO = PO - .00001: XX = 0: XY = 0: YY = 0:
SX = 0: SY = 0: GOTO 70
158 REM #163 LOWERS PO VALUE IF A1>1 & #'S 160, 165, 168, 180
ALLOW FOR THE CALCULATION OF FINAL VALUES OF 'A' & '1-P' SHILE
#170 ACCOUNTS FOR VALUES OF A1<0
160 IF 1-P<=Z OR ABS(1-P-Z)/Z<= 4E-04 THEN A = A1
163 IF A1>1 THEN PO = PO - .00001: XX = 0: XY = 0: YY = 0: SX = 0:
SY = 0: GO TO 70
```

```

165 IF (ABS(R)<.9 OR A1<-.05) AND (1-P<= Z OR ABS(1-P-Z)/Z<= 4E-04)
    THEN PRINT: PRINT "DATA IS NOT ACCURATE ENOUGH": END
168 IF ABS(R)>.9 AND (1-P<= Z OR ABS(1-P-Z)/Z = 4E-04) THEN PRINT:
    PRINT "VALUES OF 'A' & '1-P' = "; : GOSUB 1000: PRINT A" AND
    "Z" ; AND, CORRELATION COEFF. = "; : PRINT CC: GOTO 190
170 IF A1<0 THEN 180
180 P = P + .00001 : XX = 0: YY = 0: SX = 0: SY = 0:
    GOTO 75
190 PRINT: PRINT " W(X),OBSD.";TAB(20); "W(X) ,CALCD.":
200 DATA 7.45E-04,400, 7.62E-04,600,7.3E-04,700,4.41E-04,
    1200,2.9E-04,1500,1.3E-04,2000,2.1E-05,3000
210 DATA 0
500 FOR I = 1 TO J
510 W = (A1 + A2*(W(I,2)-1)/P)*W(I,2)*P^(W(I,2)-1)*(1-P)^2
520 PRINT TAB(4); W(I,1); TAB(20); INT(W*1E06 + .5)/1E06:
    NEXT I: END
1000 IF A<0 AND A>-.05 THEN A = 0: A1 = 0
1010 A = INT(A*100 + .5)/100: Z = INT(Z*1E06 + .5)/1E06:
    CC = INT(R*1E04)/1E04
1020 RETURN

```

Program Example

```

COMMAND: RUN -----> STATEMENTS 5, 6, and "BREAK IN 6"
COMMAND: CONT ----->

```

<u>" Z-VALUES (TRIAL)</u>	<u>Z-VALUES (CALCD.)</u>
2.54999986E-03	2.49794192E-03
2.53999978E-03	2.49536302E-03
2.52999971E-03	2.49275496E-03
2.51999963E-03	2.49012109E-03
2.50999955E-03	2.48747276E-03
2.49999948E-03	2.48481487E-03
2.48999941E-03	2.48216115E-03
2.47999933E-03	2.47951866E-03

W(R) vs. R data for the polymer, polystyrene (from gel permeation chromatography techniques), was entered in line #200 and an arbitrary value of PO = .99745 in line #65. Then a run was carried out as follows,

VALUES OF 'A' & '1-P' = .65 AND 2.48E-03; AND,
CORRELATION COEFF. = .9999

<u>W(X),OBSD.</u>	<u>W(X),CALCD.</u>
7.45E-04	7.53E-04
7.62E-04	7.6E-04
7.3E-04	7.24E-04
4.41E-04	4.4E-04
2.9E-04	2.9E-04
1.3E-04	1.3E-04
2.1E-05	2.1E-05 "

AIM 6522 Based Frequency Counter

The AIM 65 obviously is going to find its way into the electronics laboratory. Here it is used as a frequency counter.

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The program listed performs as a six-digit frequency counter. It will count at least as fast as 450 kHz, perhaps faster. A simple interface circuit is shown in Figure 1. Although the signal to be measured could be connected directly to the PB6 pulse counting pin of the 6522, I prefer not to connect strange and unknown signals directly to the computer. In any case, the signal pulses to be counted should really be shaped into the form of a square wave before they appear at PB6.

The counter uses timer T1 in a free-running mode with 50,000 clock cycles between settings of its interrupt flag. The timer T1 is not allowed to interrupt the 6502, rather its interrupt capability is disabled and the flag is "watched" by reading the interrupt flag register, IFR. With $\$14 = 20_{16}$ intervals of 50,000 clock cycles apiece, one gets a total interval of one second. $\$14$ is located in $\$0000$. The T1 timer is loaded with instructions starting at $\$0230$. Note that the number I used is less than 50,000 because my AIM 65 crystal is slow by 244 parts in one million cycles. You may wish to make adjustments with this number also, depending on your system's clock frequency.

The frequency counter works as follows. Timer T2 in its pulse counting mode is initially loaded with $\$FFFF = 65535$. Once it is loaded, timer T1 is started and PB0 is brought to logic 0 to allow the NAND gate to let pulses through. At the end of the timing interval, described in the preceding paragraph, the gate is closed, the timer T2 is read, the result is subtracted from $\$FFFF$, this number is converted from HEX to BCD, and it is added to the display locations using the ADC instruction in the decimal mode. If, at any time the T2 timer counts through zero, an interrupt request (IRQ) occurs and the display registers are incremented by $65536 = \$FFFF + 1$, T2 is reloaded with $\$FFFF$, and counting continues. At the end of one second, the total number of counts is displayed by the display subroutine, which, by the way, is identical to the 24-hour clock display routine in the February 1979

issue of MICRO. It is a bit unfortunate that the 6522 designers did not allow the T2 timer to continue producing interrupts without reloading it, because in the time interval between the interrupt request and the reloading of the T2 timer (starting at instruction $\$0296$ in the interrupt routine), a few counts or pulses on PB6 might be missed. This would only be of concern at large counting rates.

The HEX to BCD conversion routine starts at address $\$025D$ and ends at address $\$028E$. The 16-bit number representing the number of counts in timer T2 is stored in locations $\$0010$ and $\$0011$. If $\$PQRS$ represents this number, then

$$\$PQRS = (P.4096_{16}) + (Q.256_{16}) + (R.16_{16}) + (S.1)$$

If the calculation on the right-hand side of the above equation is done in the decimal mode, the $\$PQRS$ will be converted to BCD. In other words, 4096 is added to itself P times, 256 is added to

itself Q times, 16 is added to itself R times, and 1 is added to itself S times, all in the decimal mode. These results are all added together, giving a BCD number. Better routines exist, I am sure, but this one isn't too slow. Note that P, Q, R, and S are each one nibble of the 16-bit number obtained from timer T2. (Has anyone yet suggested calling 16-bit numbers "gobbles," giving nibbles, bytes, and gobbles?) The table starting a $\$0300$ must be loaded into memory for the HEX to BCD conversion to work.

The symbol table given may help you if you wish to modify the program or if you want to change it to run on a microcomputer other than the AIM 65. Also, I would be interested in knowing an exact upper limit for the frequency at which it will operate and in any further improvements to the rate at which it will count. Currently I do not have enough time to do this experimentation myself.

μ

Table I
ADDRESS TABLE FOR THE AIM 65 FREQUENCY COUNTER

$\$A000$	= PBD (ORB)
$\$A002$	= PBDD (DDRB)
$\$A004$	= T1L-L (Read)
$\$A005$	= T1L-H
$\$A006$	= T1L-L (Write)
$\$A008$	= T2L-L
$\$A009$	= T2C-H
$\$A00B$	= ACR
$\$A00D$	= IFR
$\$A00E$	= IER
$\$A404$	= IRQL
$\$A405$	= IRQH
$\$0000$	= Count-to-twenty register
$\$0001$	= Display register, low-order byte
$\$0002$	= Display register, middle-order byte
$\$0003$	= Display register, high-order byte
$\$0010$	= PQ = Low-order byte of count from timer T2
$\$0011$	= RS = High-order byte of count from timer T2
$\$0340$	= Starting address of display subroutine
$\$0295$	= Starting address of IRQ routine

```

0200 A9 LDA #95
0202 8D STA A404
0205 A9 LDA #02
0207 8D STA A405
020A A9 LDA #A0
020C 8D STA A00E
020F A9 LDA #01
0211 8D STA A000
0214 8D STA A002
0217 A9 LDA #60
0219 8D STA A00B
021C A9 LDA #14
021E 85 STA 00
0220 A9 LDA #FF
0222 8D STA A008
0225 8D STA A009
0228 A9 LDA #00
022A 85 STA 01
022C 85 STA 02
022E 85 STA 03
0230 A9 LDA #42
0232 8D STA A006
0235 A9 LDA #C3
0237 8D STA A005
023A 0E DEC A000
023D A0 LDA A004
0240 06 DEC 00
0242 2C BIT A00D
0245 50 BVC 0242
0247 A5 LDA 00
0249 D0 BNE 023D
024B EE INC A000
024E 38 SEC
024F A9 LDA #FF
0251 ED SBC A008
0254 85 STA 10
0256 A9 LDA #FF
0258 ED SBC A009
025B 85 STA 11
025D A2 LDX #03
025F A5 LDA 10
0261 29 AND #0F
0263 F0 BEQ 027F
0265 A8 TAY
0266 18 CLC
0267 F8 SED
0268 A5 LDA 01
026A 7D ADC 0300, X
026D 85 STA 01
026F A5 LDA 02
0271 7D ADC 0304, X
0274 85 STA 02
0276 A5 LDA 03
0278 69 ADC #06

```

```

027A 85 STA 03
027C 88 DEY
027D D0 BNE 0266
027F CA DEX
0280 30 BMI 028E
0282 A0 LDY #04
0284 46 LSR 11
0286 66 ROR 10
0288 88 DEY
0289 D0 BNE 0284
028B 4C JMP 025F
028E D8 CLD
028F 20 JSR 0340
0292 4C JMP 021C
0295 48 PHA
0296 A9 LDA #FF
0298 8D STA A009
029B F8 SED
029C 18 CLC
029D A5 LDA 01
029F 69 ADC #36
02A1 85 STA 01
02A3 A5 LDA 02
02A5 69 ADC #55
02A7 85 STA 02
02A9 A5 LDA 03
02AB 69 ADC #06
02AD 85 STA 03
02AF D8 CLD
02B0 68 PLA
02B1 40 RTI

```

```

0340 A5 LDA 01
0342 85 STA 04
0344 A5 LDA 02
0346 85 STA 05
0348 A5 LDA 03
034A 85 STA 06
034C A2 LDX #13
034E 8A TXA
034F 48 PHA
0350 A0 LDY #04
0352 A5 LDA 04
0354 29 AND #0F
0356 18 CLC
0357 69 ADC #30
0359 09 ORA #80
035B 20 JSR EF7B
035E 46 LSR 06
0360 66 ROR 05
0362 66 ROR 04
0364 88 DEY
0365 D0 BNE 035E
0367 68 PLA
0368 AA TAX
0369 CA DEX
036A E0 CPX #0E
036C B0 BCS 034E
036E 60 RTS

```

```

<M>=0300 96 56 16 01
< > 0304 40 02 00 00

```

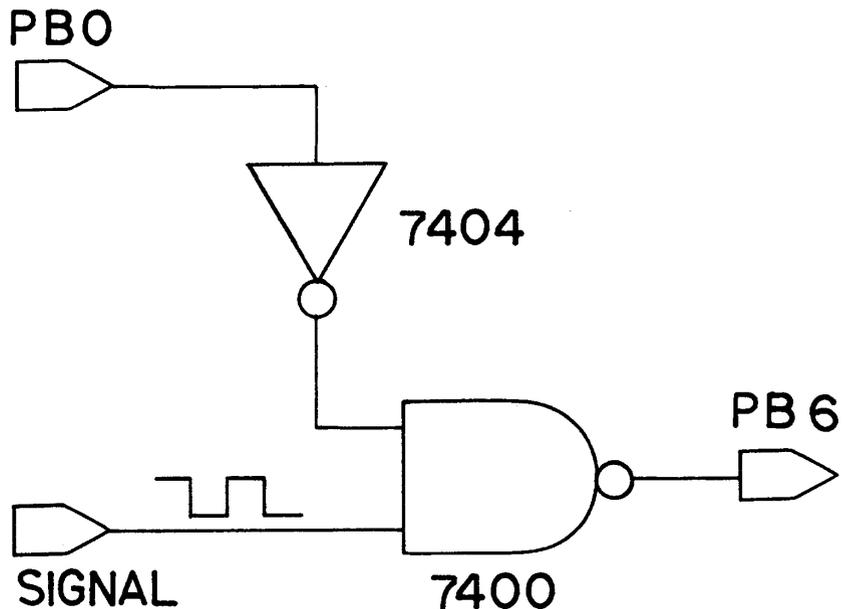


Figure 1

Interface Circuit for the AIM 65
Frequency Counter Using the 6522 VIA

KIM — The Tunessmith

A number of programs have been offered which permit you to play music on your micro. The program presented here also permits you to compose music on your KIM, as well as save it and play it back.

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Have you ever wanted to compose music, but knew nothing about how to go about doing it? Do you lack a musical instrument and have a tune going through your head and don't know what should go after the first few notes? Well here is a program for a basic KIM-1 that will help you compose a tune, and you don't even have to know how to read or write music.

I have really never learned how to play a musical instrument, and I never have time to practice. Yet every once in a while I want to try out a few notes going on in my head, or I just want to see how a couple of notes sound together, to see if they have any effect on me. So what I did was to develop a program that uses a basic KIM-1 and the speaker circuit shown on page 57 of the KIM-1 User Manual that plays a tune I compose one note at a time. I use the keypad as data entry to place into the program notes of two octaves, including sharp notes, with four possible lengths and a rest or no note. I used the lettered keypads as well as the 9 which looks like a small G for all the notes which are seven in number, basically A B C D E F and G.

Tunessmith Operation

Once you start the program, you press one of the note letters. It will sound the appropriate note. If you want the sharp for that note, if it has one (B and E do not), press 5. To get the upper octave of the note you want you press 7, and if you want the upper octave sharp of the note, press 5 first, then 7. The keys 1, 2, 4, and 8 will give you a whole note (1), a half note (2), a quarter note (4), and an eighth note (8). After you choose your note, you choose your length. If you don't want the note, start again, only this time the length is not automatically a half note as it would be when you first start out, you'll have to change it to what you want.

Now that you have your nice note that sounds just right, press 3. This will save the note and place it in a tune table. To know that the note is indeed saved, the display will flash a **SAVE**. You have to hold the 3 key down until the **SAVE** is seen, though. Now the chosen note will be played and you can pick another note, or a rest which is 0. The procedure is the same for a possible 72 note tune. If you like your tune and want to write it down, press the + key. The display will show you the first note of the tune, and every time you hit the 3 key, the next will be displayed. If you want to start again, press the DA (Do Again) key.

The Tunessmith Program

We can go over the program now. Table I is a listing of the keypad numbers and what they represent. The main program starts at 0200 and initialization goes on to 021A. From 021C to 0228 we test the keypad and 022A to 022E we test for the first time through the program. This step eliminates any noise in the speaker while choosing the first note. 0230 to 0236 gets the program to step through all the notes, and 0238 to 023D delays the program, not only to give you more time to choose a note, but also to put a space between the beginning and ending of the tune. 0242 to 0248 is for the beginning silence. 024A thru 0263 loads the note you have chosen into a temporary location. 0265 to 026E will jump to all the subroutines which we'll explain in a minute. 0271 thru 027B tests for the save key, which you press if you want that particular note. From 027B to 0283 we test for the DA key. 0285 to 028F will cause the program to jump to the routine which will allow us to see what notes we have so that they can be written down and saved for the "Top Ten". 0295 to 02A9 sets the save flag, resets the note counter, and because the program goes deep into the stack territory, resets the stack pointer to avoid trouble.

The Get High subroutine is the first one we come to. From 0356 to 035E we test to see if we want a high note. If we don't, we return from the subroutine. If yes, we'll first test to see if it's to be a sharp note that is to go to the next octave. If it is, then from 0366 to 036A we'll load the high sharp note into the temporary location, otherwise from 036F to 0373 we'll load just the next octave note. The Get Sharp subroutine is similar and the Get Length subroutine is simple enough.

The Play Tune subroutine is next. From 0300 to 0306 we set up the first note, then we play it. This is the unsaved note we are trying out. Then we'll test for a save flag from 0313 to 0317, and test for a note or notes in the tunetable up to 031D. If there is one or more notes in the tunetable, from 031F to 0330 we'll play them. If we had a save for the temporary note, we reset the save flag, store a rest so we don't hear the saved note twice, then load the note into the next position of the tunetable, and we'll also put our chosen length into the length table; all this from 0333 to 0345. Since we saved the note, not only do we need some indication that it was saved, we also need to indicate that our finger is on the 3 keypad long enough for the program to catch the keypad entry, so at 0347 we go to the subroutine that displays a big red "SAVE". At 034A we play all our notes again, and then go back to the main program to get another note, then back here again so we always hear our tune.

In the Tone subroutine, at 02DD and 02DF we set the ports to outputs; and at 02E2 and E4 we start KIM's internal timer. We load the note frequency, and when it runs down we change the output to its other state, whatever it was. If you hook a speaker circuit on the port as in the KIM manual, a note will be produced as we repeat this procedure every time the timer times out at 02EF; and if we do

0019	4C	=	\$4C	D SHARP, E FLAT
001A	01	=	\$01	NO NOTE
001B	3F	=	\$3F	F SHARP, G FLAT
001C	00	=	\$00	UNUSED
001D	00	=	\$00	
001E	00	=	\$00	
001F	00	=	\$00	
0020	02	DELTIM =	\$02	DELAY TIME
0021	00	TIMED =	\$00	
0022	00	TIMEC =	\$00	
0023	00	SAVFLG =	\$00	SAVE FLAG
0024	00	TLENTH =	\$00	TEMP. LENGTH
0025	00	NOTPTR =	\$00	NOTE POINTER
0026	00	KEYPTR =	\$00	KEY POINTER
0027	00	TNOTE =	\$00	TEMP NOTE
0028	00	HIFLG =	\$00	HIGH FLAG
0029	00	SHPF LG =	\$00	SHARP FLAG
002A	00	NOTNUM =	\$00	NOTE NUMBER
002B	00	PRMNOT =	\$00	PERMANENT NOTE
002C	00	FSTFLG =	\$00	FIRST TIME FLAG
002D	00	PLENTH =	\$00	PERM. LENGTH
002E	00	TNTNUM =	\$00	TEMP. NOTE NUMBER
002F	00	NEXNOT =	\$00	NEXT NOTE
0030	00	DELAYA =	\$00	DELAY A
0031	00	DELAYB =	\$00	DELAY B
0032	00	PNTPTR =	\$00	PERM. NOTE POINTER
0033	00	DELAYC =	\$00	DELAYC
0034	00	TTBPTR =	\$00	TUNETABLE POINTER
0035	00	NTBPTR =	\$00	NOTE TABLE POINTER
0036	00	NOTCNT =	\$00	NOTCNT NOTE COUNT
0037	00	DNTCNT =	\$00	DISPLAY NOTE COUNT
0038	00	TEMNOT =	\$00	TEMP. NOTE
0039	00	TEMLN =	\$00	TEMP. LENGTH
003A	00	COUNT =	\$00	
003B	00	DFOUR =	\$00	
003C	00	DTHREE =	\$00	
003D	00	DTWO =	\$00	
003E	00	DONE =	\$00	
003F	00	LNTPTR =	\$00	LENGTH POINTER
CONSTANTS				
0040	01	KEYLNT =	\$01	(1) WHOLE NOTE
0041	02	=	\$02	(2) HALF NOTE
0042	04	=	\$04	(4) QUARTER NOTE
0043	08	=	\$08	(8) EIGHTH NOTE
0044	20	LNTH =	\$20	LENGTH
0045	10	=	\$10	
0046	08	=	\$08	
0047	04	=	\$04	
0048	86	LNSHP =	\$86	(1) LENGTH SHAPE
0049	DB	=	\$DB	(2)
004A	E6	=	\$E6	(4)
004B	FF	=	\$FF	(8)
004C	BD	NTSHP =	\$BD	(G) LETTER SHAPES
004D	F7	=	\$F7	(A)
004E	FC	=	\$FC	(B)
004F	B9	=	\$B9	(C)
0050	DE	=	\$DE	(D)
0051	F9	=	\$F9	(E)
0052	F1	=	\$F1	(F)
0053	00	LETNUM =	\$00	LETTER NUMBER

display lit. If we hit the 3 key we jump to a delay which blanks the display. This lets us know a new note has entered the circuits so that we can distinguish two or more same notes in a row. Finally we reset the stack pointer again and display the next note. If we want to start again at any time, we hit the DA key and off we go to the beginning again. By the way, the delay subroutine we go to is a good delay to get very long times. It uses the KIM-1's internal timer.

So that's it. I know it is a long program, because of all the explanation, but I want as much understanding as possible, because of the possibilities it holds. The simple tone generation can be replaced with a D/A converter, an erase note mode can be implemented, a larger scale with more lengths and other variables can be developed, and so on. There is no limit. But for a beginning, with a small computer, all you potential Bachs, here it is, go to it.

μ

Table 1 — Keypad Representations

A = A note
B = B note
C = C note
D = D note
E = E note
F = F note
9 = G note
0 = rest
1 = whole note
2 = 1/2 note
4 = 1/4 note
8 = 1/8 note
5 = sharp
7 = upper octave
3 = save or display next note
DA = Do Again
+ = Display notes

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0054	OF	=	\$0F	
0055	OD	=	\$0D	
0056	OB	=	\$0B	
0057	O9	=	\$09	
0058	00	LETTER	=	\$00 LETTER SHAPES
0059	F9	=	\$F9	
005A	BE	=	\$BE	
005B	F7	=	\$F7	
005C	ED	=	\$ED	

005D	TUNTBL	*	\$0060	TUNE TABLE
005D	LNTTBL	*	\$00A8	LENGTH TABLE

DISPLAY NOTE ROUTINE

0100		ORG	\$0100	
0100	A9	01	DISNTS	LDAIM \$01 RESET DISPLAY NOTE COUNT
0102	85	37		STA DNTCNT
0104	A5	37	NXTNOT	LDA DNTCNT TEST FOR END
0106	C5	36		CMP NOTCNT
0108	D0	03		BNE BEGIN
010A	4C	E1	01	JMP DOAGNB
010D	A6	37	BEGIN	LDX DNTCNT STORE NOTE
010F	B5	60		LDAZX TUNTBL AND LENGTH
0111	85	38		STA TEMNOT
0113	B5	A8		LDAZX LNTTBL
0115	85	39		STA TEMLEN
0117	A2	00		LDXIM \$00
0119	A5	38	RPT	LDA TEMNOT TEST FOR TEST
011B	C9	01		CMPIM \$01
011D	F0	61		BEQ DISZER
011F	D5	00		CMPZX NOTE TEST FOR NOTE
0121	F0	04		BEQ SUB
0123	E8			INX
0124	4C	19	01	JMP RPT
0127	38		SUB	SEC TEST FOR FIRST GROUP
0128	8A			TXA
0129	E9	07		SBCIM \$07
012B	B0	0D		BCS NXGRPA
012D	B5	4C		LDAZX NTSHP STORE NOTE SHAPE
012F	85	3D		STA DTWO
0131	A9	C0		LDAIM \$C0
0133	85	3E		STA DONE
0135	85	3C		STA DTHREE
0137	4C	8A	01	JMP DISLEN
013A	38		NXGRPA	SEC TEST FOR SECOND GROUP
013B	8A			TXA
013C	E9	0E		SBCIM \$0E
013E	B0	13		BCS NXGRPB
0140	8A			TXA
0141	E9	06		SBCIM \$06 STORE NOTE SHAPE
0143	AA			TAX
0144	B5	4C		LDAZX NTSHP
0146	85	3D		STA DTWO
0148	A9	F6		LDAIM \$F6 STORE HI SHAPE
014A	85	3E		STA DONE
014C	A9	C0		LDAIM \$C0
014E	85	3C		STA DTHREE
0150	4C	8A	01	JMP DISLEN

0153 38	NXGRP	SEC	TEST FOR THIRD
0154 8A		TXA	GROUP
0155 E9 15		SBCIM \$15	
0157 B0 13		BCS NXGRPC	
0159 8A		TXA	
015A E9 0D		SBCIM \$0D	STORE NOTE SHAPE
015C AA		TAX	
015D B5 4C		LDAZX NTSHP	
015F 85 3D		STA DTWO	
0161 A9 ED		LDAIM \$ED	
0163 85 3C		STA DTHREE	
0165 A9 0D		LDAIM \$0D	
0167 85 3E		STA DONE	
0169 4C 8A 01		JMP DISLEN	
016C 38	NXGRPC	SEC	STORE NOTE SHAPE
016D 8A		TXA	
016E E9 15		SBCIM \$15	
0170 AA		TAX	
0171 B5 4C		LDAZX NTSHP	
0173 85 3D		STA DTWO	
0175 A9 ED		LDAIM \$ED	STORE SHARP SHAPE
0177 85 3C		STA DTHREE	
0179 A9 F6		LDAIM \$F6	
017B 85 3E		STA DONE	
017D 4C 8A 01		JMP DISLEN	
0180 A9 BF	DISZER	LDAIM \$BF	STORE ZERO SHAPE
0182 85 3D		STA DTWO	
0184 A9 0D		LDAIM \$0D	
0186 85 3E		STA DONE	
0188 85 3C		STA DTHREE	
018A A2 00	DISLEN	LDXIM \$00	
018C A5 39	RPTB	LDA TEMLEN	TEST FOR LENGTH
018E D5 44		CMPZX LNTH	
0190 F0 04		BEQ GTSHP	
0192 E8		INX	
0193 4C 8C 01		JMP RPTB	
0196 B5 48	GTSHP	LDAZX LNSHP	STORE LENGTH SHAPE
0198 85 3B		STA DFOUR	
019A A9 80	DIS	LDAIM \$80	LOAD DISPLAY
019C 85 33		STA DELAYC	LIGHT TIME
019E A9 7F		LDAIM \$7F	SET DIRECTION REGISTER
01A0 8D 41 17		STA SADD	
01A3 A2 04	RPTC	LDXIM \$04	SET UP 4 LETTERS
01A5 A0 FF	LITE	LDYIM \$FF	AND DISPLAY
01A7 B5 53		LDAZX LETNUM	LIGHT LETTERS
01A9 8D 42 17		STA SBD	
01AC B5 3A		LDAZX COUNT	
01AE 8D 40 17		STA SAD	
01B1 88	WAIT	DEY	DELAY
01B2 D0 FD		BNE WAIT	
01B4 CA		DEX	GET NEXT LETTER
01B5 10 EE		BPL LITE	
01B7 A4 33		LDYZ DELAYC	DELAY
01B9 88		DEY	
01BA 84 33		STYZ DELAYC	
01BC D0 E5		BNE RPTC	
01BE 20 40 1F		JSR KEYIN	TEST FOR NEXT NOTE
01C1 20 6A 1F		JSR GETKEY	
01C4 C9 03		CMPIM \$03	
01C6 F0 0C		BEQ NEXT	
01C8 20 40 1F		JSR KEYIN	TEST FOR START AGAIN
01CB 20 6A 1F		JSR GETKEY	
01CE C9 11		CMPIM \$11	

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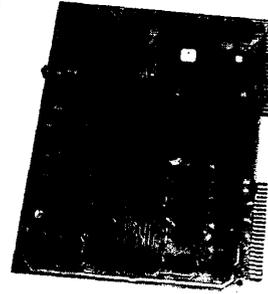
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MICRO

01D0 F0 OF
01D2 D0 C6

BEQ DOAGNB
BNE DIS

01D4 20 AC 02 NEXT
01D7 E6 37
01D9 A2 FF
01DB 9A
01DC EA
01DD EA
01DE 4C 04 01

JSR DELAY
INC DNTCNT INCREMENT DISPLAY NOTE
LDXIM \$FF COUNT. RESET STACK
TXS POINTER
NOP PADDING
NOP
JMP NXTNOT

01E1 A9 00
01E3 85 36
01E5 4C 00 02

DOAGNB LDAIM \$00
STA NOTCNT
JMP NUTUNE

15 16 17

MAIN PROGRAM

0200

ORG \$0200

0200 A9 00
0202 85 23
0204 85 2A
0206 85 2C
0208 A9 01
020A 85 60
020C 85 A8
020E 85 27
0210 A9 10
0212 85 24
0214 A9 06
0216 85 25
0218 A9 0F
021A 85 26
021C 20 40 1F
021F 20 6A 1F
0222 C5 26
0224 F0 2D
0226 C9 00
0228 F0 20
022A A5 2C
022C C9 00
022E F0 12
0230 C6 26
0232 C6 25
0234 10 02
0236 30 DC

NUTUNE LDAIM \$00 INITIALIZE TUNE
STA SAVFLG
STA NOTNUM
STA FSTFLG
LDAIM \$01
STA TUNTBL
STA LNTTBL
STA TNOTE
LDAIM \$10
STA TLENTH
NUNOTE LDAIM \$06 INITIALIZE NOTE
STA NOTPTR
LDAIM \$0F
STA KEYPTR
PLAYB JSR KEYIN TEST KEYPAD FOR NOTE
JSR GETKEY
CMP KEYPTR
BEQ GTNOTE
CMPIM \$00 FOR REST
BEQ GTREST
LDA FSTFLG TEST FOR FIRST TIME
CMPIM \$00
BEQ NOPLAY
DEC KEYPTR SET UP FOR NEXT NOTE
DEC NOTPTR
BPL DELYA
BMI NUNOTE

0238 A6 30
023A CA
023B 86 30
023D D0 DD
023F 4C 65 02

DELYA LDXZ DELAYA DELAY
DEX
STXZ DELAYA
BNE PLAYB
JMP SVNOTE

0242 C6 26
0244 C6 25
0246 10 D4
0248 30 CA

NOPLAY DEC KEYPTR SET UP FOR NEXT NOTE
DEC NOTPTR
BPL PLAYB
BMI NUNOTE

024A A9 01
024C 85 2C
024E 85 27
0250 4C 65 02

GTREST LDAIM \$01 LOAD REST
STA FSTFLG
STA TNOTE
JMP SVNOTE

```

0253 A9 01      GTNOTE LDAIM $01   LOAD FIRST NOTE FLAG
0255 85 2C      STA   FSTFLG
0257 A6 25      LDZX  NOTPTR  LOAD CHOSEN NOTE
0259 A9 00      LDAIM $00
025B 85 28      STA   HIFLG
025D 85 29      STA   SHPFLG
025F B5 00      LDAZX NOTE
0261 85 27      STA   TNOTE
0263 86 32      STXZ  PNTPTR
0265 20 56 03  SVNOTE JSR   GETHI   GET HIGH NOTE
0268 20 86 03  JSR   GETSRP  GET SHARP NOTE
026B 20 DA 03  JSR   GTLNTH  GET LENGTH
026E 20 00 03  JSR   PLATUN  PLAY NOTE
0271 20 40 1F  JSR   KEYIN   TEST TO SAVE NOTE
0274 20 6A 1F  JSR   GETKEY
0277 C9 03      CMPIM $03
0279 F0 16      BEQ   SAVE
027B 20 40 1F  JSR   KEYIN   TEST OFR START OVER
027E 20 6A 1F  JSR   GETKEY
0281 C9 11      CMPIM $11    DA = DO AGAIN
0283 F0 13      BEQ   DOAGN
0285 20 40 1F  JSR   KEYIN   TEST FOR DIPLSAY NOTER
0288 20 6A 1F  JSR   GETKEY
028B C9 12      CMPIM $12    = +
028D F0 15      BEQ   DNOTES
028F D0 8B      BNE   PLAYB

```

```

0291 A9 01      SAVE  LDAIM $01   SAVE NOTE
0293 85 23      STA   SAVFLG
0295 4C 14 02  JMP   NUNOTE

```

```

0298 A9 00      DOAGN LDAIM $00   RESET NOTE COUNTER
029A 85 36      STA   NOTCNT
029C A2 FF      LDZX  $FF   RESET STACK POINTER
029E 9A         TXS
029F EA         NOP        PADDING
02A0 EA         NOP
02A1 4C 00 02  JMP   NUTUNE

```

```

02A4 A2 FF      DNOTES LDZX  $FF   RESET STACK POINTER
02A6 9A         TXS
02A7 EA         NOP
02A8 EA         NOP
02A9 4C 00 01  JMP   DISNTS JUMP TO DISPLAY NOTES

```

DELAY SUBROUTINE

```

02AC A5 20      DELAY LDA   DELTIM GET DELAY VALUE
02AE 85 21      STA   TIMED
02B0 A9 FF      DELA  LDAIM $FF   LOAD TIMER
02B2 8D 04 17  STA   TIMER
02B5 2C 07 17  TEST  BIT   TTIMER TEST TIMER
02B8 10 FB      BPL   TEST   BRANCH IF NOT RUN OUT
02BA C6 22      DEC   TIMEC  REDUCE TIME VALUE
02BC D0 F2      BNE   DELA   START AGAIN
02BE C6 21      DEC   TIMED  REDUCE DELAY VALUE
02C0 D0 EE      BNE   DELA  BRANCH IF NOT DNOE
02C2 60      RTS

```

```

02DD          ORG   $02DD

```

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by Commodore

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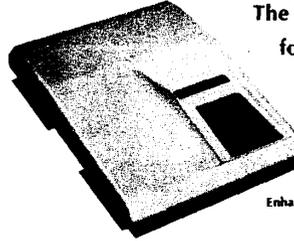
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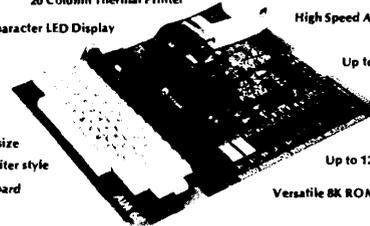
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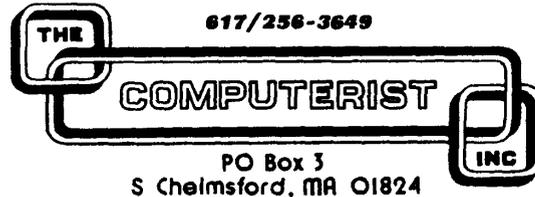
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MICRO

```

02DD A9 01      TONE  LDAIM $01  OPEN PORT
02DF 8D 01 17   STA  PADD
02E2 A9 20      SOUND LDAIM $20  START TIMER
02E4 8D 0F 17   STA  STIMER
02E7 A6 2B      NOTEX LDXZ PRMNOT NOTE FREQUENCY
02E9 CA         NWAIT DEX
02EA D0 FD      BNE  NWAIT
02EC EE 00 17   INC  PAD    TOGGLE OUTPUT
02EF A9 80      LDAIM $80  TEST COUNTER
02F1 2C 07 17   BIT  TTIMER
02F4 30 03      BMI  TIMEOUT
02F6 4C E7 02   JMP  NOTEX
02F9 C6 2D      TIMEOUT DEC  PLENTH NOTE LENGTH
02FB D0 E5      BNE  SOUND
02FD 60         RTS
    
```

PLAY TUNE SOBROUTINE

```

0300                                ORG  $0300

0300 A5 2A      PLATUN LDA  NOTNUM SET UP FIRST NOTE
0302 85 2E      STA  TNTNUM
0304 A9 00      LDAIM $00
0306 85 2F      STA  NEXNOT
0308 A5 27      LDA  TNOTE  PLAY NOTE
030A 85 2B      STA  PRMNOT
030C A5 24      LDA  TLENTH
030E 85 2D      STA  PLENTH
0310 20 DD 02   JSR  TONE
0313 A5 23      LDA  SAVFLG TEST FOR SAVE
0315 C9 01      CMPIM $01
0317 F0 1A      BEQ  SAVEX
0319 A5 2A      LDA  NOTNUM TEST FOR NOTE
031B C9 00      CMPIM $00 (NOT REQUIRED)
031D F0 13      BEQ  RETURN
031F A6 2F      PLAYC LDXZ NEXNOT LOAD NEXT NOTE
0321 B5 60      LDAZX TUNTB
0323 85 2B      STA  PRMNOT
0325 B5 A8      LDAZX LNTTBL LOAD NEXT LENGTH
0327 85 2D      STA  PLENTH
0329 20 DD 02   JSR  TONE  PLAY NOTE
032C E6 2F      INC  NEXNOT SET UP FOR
032E C6 2E      DEC  TNTNUM NEXT NOTE
0330 10 ED      BPL  PLAYC
0332 60         RETURN RTS

0333 A9 00      SAVEX LDAIM $00  RESET SAVE FLAG
0335 85 23      STA  SAVFLG
0337 A9 01      LDAIM $01  NO PLAY
0339 85 27      STA  TNOTE
033B E6 2A      INC  NOTNUM LOAD NOTE INTO
033D A6 2A      LDXZ NOTNUM TUNETABLE
033F A5 2B      LDA  PRMNOT
0341 95 60      STAZX TUNTB
0343 A5 24      LDA  TLENTH LOAD LENGTH
0345 95 A8      STAZX LNTTBL INTO LENGTH TABLE
0347 20 AA 03   JSR  DISPLY
034A 4C 00 03   JMP  PLATUN
    
```

0356

ORG \$0356

GET HIGH SUBROUTINE

```

0356 20 40 IF  GETHI JSR  KEYIN  TEST FOR HIGH NOTE
0359 20 6A IF  JSR   GETKEY
035C C9 07      CMPIM $07
035E D0 15      BNE   RETRNB
0360 A5 29      LDA   SHPFLG TEST SHARP NOTE
0362 C9 00      CMPIM $00 (NOT REQUIRED)
0364 F0 09      BEQ   LOADHI
0366 A6 32      LDZX  PNTPTR LOAD HIGH SHARP NOTE
0368 B5 15      LDAZX HISHRP
036A B5 27      STA   TNOTE
036C 4C 75 03   JMP   RETRNB (COULD HAVE BEEN RTS)
036F A6 32   LOADHI LDX  PNTPTR LOAD HIGH NOTE
0371 B5 07      LDAZX HINOTE
0373 B5 27      STA   TNOTE
0375 60      RETRNB RTS
    
```

0386 ORG \$0386

GET SHARP SUBROUTINE

```

0386 20 40 IF  GETSRP JSR  KEYIN  TEST FOR SHARP NOTE
0389 20 6A IF  JSR   GETKEY
038C C9 05      CMPIM $05
038E D0 0A      BNE   RETRNC
0390 A9 01      LDAIM $01 LOAD SHARP FLAG
0392 B5 29      STA   SHPFLG
0394 A6 32      LDZX  PNTPTR LOAD SHARP NOTE
0396 B5 0E      LDAZX SHPNOT
0398 B5 27      STA   TNOTE
039A 60      RETRNC RTS
    
```

03AA ORG \$03AA

DISPLAY SAVE SUBROUTINE

```

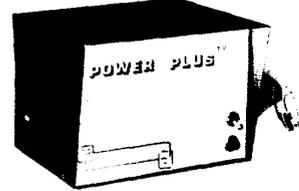
03AA A9 80  DISPLY LDAIM $80 LOAD DISPLAY
03AC B5 33  STA  DELAYC LIGHT TIME
03AE A9 7F  LDAIM $7F SET DIRECTION REGISTER
03B0 8D 41 17 STA  SADD
03B3 A2 04  REPEAT LDZX  $04 SET UP 4 LETTERS
03B5 A0 FF  LIGHT  LDYIM $FF AND DELAY
03B7 B5 53  LDZXZ LETNUM LIGHT LETTERS
03B9 8D 42 17 STA  SBD
03BC B5 58  LDZXZ LETTER
03BE 8D 40 17 STA  SAD
03C1 88      WAITY DEY  DELAY
03C2 D0 FD  BNE  WAITY
03C4 CA      DEX  GET NEXT LETTER
03C5 10 EE  BPL  LIGHT
03C7 A4 33  LDY  DELAYC DELAY
03C9 88      DEY
03CA 84 33  STY  DELAYC
03CC D0 E5  BNE  REPEAT
03CE A5 36  LDA  NOTCNT TEST FOR 72 NOTES
03D0 C9 48  CMPIM $48 48 HEX = 72 DECIMAL
03D2 D0 03  BNE  INCNOT
03D4 4C 00 01 JMP  DISNTS
    
```

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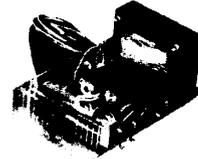


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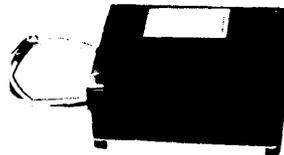
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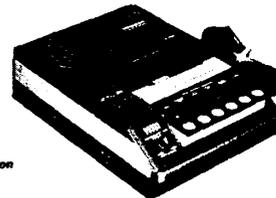
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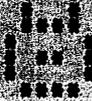
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MICROBBS

LIFESAVER - MICRO 11

11:10 There should be vertical characters in lines 230 to 290 similar to those in line 220. Also, each line needs a " " at the end. Line 310 should read "homeGOTO" not "home GOTO". The correct pattern for the Cheshire Cat is:



AN APPLE II PROGRAM EDIT AID

11:5 Line 32630 should read J=ASC ... not I=ASC ...

"And here is an addition to make the program run smoother: Add the following lines so that when the screen fills up with text, the Apple will pause and display an "e" in the lower right-hand corner. This will prompt you to hit any key and Apple will clear the screen and continue wherehit left off. This process will continue until until there are no more occurrences of the search item.

Change: 32690 IF PEEK(37)<18 THEN 32700

Add: 32692 VTAB 23:TAB 39:PRINT"e" 32695 KEY=PEEK(-16384): IF KEY <127 THEN 32695 32697 POKE -16368,0: CALL -936

David B. Garson 5163 Willow Wood Road Rolling Hills Estates, CA 90274

The Ultimate PET Renumber

11:37 A few listing errors:

- 1F15 88 DEY was C8
1F49 A5 0A LDAZ was A9 0A
1F4B F0 2F BEQ INSF was F0 17

MICRO

03D7 E6 36 INCNOT INC NOTCNT INCREASE NOTE COUNT
03D9 60 RTS

GET LENGTH SUBROUTINE

03DA A9 03 GTLNTH LDAIM \$03 LOAD LENGTH POINTER
03DC 85 3F STA LNTPTR
03DE 20 40 IF KEYST JSR KEYIN TEST KEYPAD FOR
03E1 20 6A IF JSR GETKEY LENGTH
03E4 A6 3F LDZX LNTPTR
03E6 D5 40 CMPZX KEYLNT
03E8 F0 05 BEQ LODLNT
03EA C6 3F DEC LNTPTR
03EC 10 F0 BPL KEYST
03EE 60 RTS
03EF B5 44 LODLNT LDAZX LNTH LOAD LENGTH
03F1 85 24 STA TLENTH
03F3 60 RTS

SYMBOL TABLE 2000 228E

Table with 4 columns of symbols and addresses: NOTE 0000, DELTIM 0020, TLENTH 0024, HIFLG 0028, FSTFLG 002C, DELAYA 0030, TTBPTR 0034, TEMNOT 0038, DTHREE 003C, KEYLNT 0040, LETNUM 0053, DISNTS 0100, SUB 0127, DISZER 0180, DIS 019A, NEXT 01D4, PLAYB 021C, GTNOTE 0253, DNOTES 02A4, TONE 02DD, TIMEOUT 02F9, SAVEX 0333, GETSRP 0386, LIGHT 03B5, KEYTST 03DE, TIMER 1704, SADD 1741, GETKEY 1F6A, HINOTE 0007, TIMED 0021, NOTPTR 0025, SHPFLG 0029, PLENTH 002D, DELAYB 0031, NTBPTR 0035, TEMLEN 0039, DTWO 003D, LNTH 0044, LETTER 0058, NXTNOT 0104, NXGRPA 013A, DISLEN 018A, RPTC 01A3, DOAGNB 01E1, DELYA 0238, SVNOTE 0265, DELAY 02AC, SOUND 02E2, PLATUN 0300, GETHI 0356, RETRNC 039A, WAITY 03C1, LODLNT 03EF, TTIMER 1707, SBD 1742, SHPNOT 000E, TIMEC 0022, KEYPTR 0026, NOTNUM 002A, TNTNUM 002E, PNTPTR 0032, NOTCNT 0036, COUNT 003A, DONE 003E, LNSHP 0048, TUNTBL 0060, BEGIN 010D, NXGRPB 0153, RPTB 018C, LITE 01A5, NUTUNE 0200, NOPLAY 0242, SAVE 0291, DELA 02B0, NDTX 02E7, PLAYC 031F, LOADHI 036F, DISPLY 03AA, INCNOT 03D7, PAD 1700, STIMER 170F, PBDD 1743, HISHRP 0015, SAVFLG 0023, TNOTE 0027, PRMNOT 002B, NEXNOT 002F, DELAYC 0033, DNTCNT 0037, DFOUR 003B, LNTPTR 003F, NTSHP 004C, LNTTBL 00A8, RPT 0119, NXGRPC 016C, GTSHP 0196, WAIT 01B1, NUNOTE 0214, GTREST 024A, DOAGN 0298, TEST 02B5, NWAIT 02E9, RETURN 0332, RETRNB 0375, REPEAT 03B3, GTLNTH 03DA, PADD 1701, SAD 1740, KEYIN 1F40

THE MICRO SOFTWARE CATALOG: IX

Mike Rowe
P.O. Box 64
S. Chelmsford, MA 01824

Name: **MASTER CATALOG**
System: **Apple II with disk**
Memory: **32K (min)**
Language: **Applesoft II and machine language**
Hardware: **Apple II, Disk II**
Description: MASTER CATALOG creates a single alphabetized file and listing of each diskette catalog entry by program name, volume number, and program type. MASTER CATALOG will help you locate your programs. A machine language sort will speed the sort by program name or volume number.
Copies: **Just released**
Price: **\$8.00**
Includes: **Cassette and instructions**
Author: **Alan G. Hill**
Available from:
Alan G. Hill
12092 Deerhorn Dr.
Cincinnati, Ohio 45240

Name: **BASIC OPTIMIZER**
System: **Apple II**
Memory: **24K(min) Cassette version, 32K(min) Disk version**
Language: **Interger Basic**
Hardware: **STANDARD (DOS for Disk Version)**
Description: Restructures your basic program by eliminating all remarks, condensing code to long strings, eliminating unneeded line numbers and renaming numeric variables. In affect, the Optimizer creates a production program. You will get a 10% to 40% increase in the speed of execution by running your program through the Optimizer. Now you can write your program with all the remarks you need; give your variables meaningful names. After the program is done, let the Optimizer create a fast efficient production version.
Copies: **Just released**
Price: **\$19.95** for Cassette Version. **\$25.95** for Disk Version. Texas residents add 5% sales tax
Includes: **Cassette Version: Cassette and Instructions. Disk Version: Diskette with sample program and instructions.**
Author: **Bruce H. Barber**
Available from:
Bruce H. Barber
11803 Rosewood Drive
Houston, TX 77070

Name: **PET PILOT**
System: **PET**
Memory: **8K**
Language: **BASIC**
Hardware: **Student use: no extra hardware. Teacher use: cassette #2**
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Price: **\$12.00** postpaid in US (prepaid orders only)
Includes: **Teacher's Manual Cassette, Reference Card, Licence for 1 machine.**
Order Info: **Must be prepaid and include PET serial number.**
Author: **Dave Gomberg + Martin Kamp**
Available from:
Dave Gomberg + Martin Kamp
7, Gateview Court
San Francisco, CA 94116

Name: **Series One**
System: **PET**
Memory: **8K**
Language: **Not Specified**
Hardware: **Basic 8K PET or 16/32K Full-keyboard PET**
Description: Series One is a collection of 25 programs for the Commodore PET personal computer. For less than one collar each, Series One contains 16 games and 9 general programs. Games include Space Wars, Motorcycle Jump, Saucer Attack, Ping Pong, Bomb Squad, Crack the Safe, Bombs Away, Bite the Wall, Auto Race, Break Away, and six others. Other programs include Mortgage Loan, Perpetual Calendar, Elementary Math, Savings Account, Clock, and more. Most programs take full advantage of the graphics capability of the PET.
Copies: **Not Specified**
Price: **\$24.95**
Includes: **Not Specified**
Author: **Not Specified**
Available from: **Local PET Dealers, or, ADP Systems 95 West 100 South Logan, UT 84321**

Name: **An 8080 Simulator for the 6502 — KIM-1 Version**
System: **KIM-1**
Memory: **1K**
Language: **Assembly language.**
Hardware: **Unexpanded KIM-1 and (optionally) 8 switches, 1 resistor**
Description: Executes the full 8080 instruction set as though KIM were an 8080-based computer. Supports single-step, trace and run modes and allows monitoring and modification of all internal 8080 registers. User definable input and output ports, breakpoints and access to 6502 subroutines directly from 8080 programs. Up to 224 bytes of 8080 programming space available on an unexpanded KIM-1. Also simulates 8080 interrupts. An excellent training aid for 8080 programming and useful for debugging 8080 code as well as for running non-time dependent 8080 application software. Can be relocated in ROM.
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Includes: KIM-1 format cassette tape, User Manual, Assembly Source and Object Listings and 8080 Time-Of-Day Clock Demo.
Order Info: Send check or money order.
Author: **Dann McCreary**
Available from:
Dann McCreary
Box 16435-M
San Diego, California 92116

Name: **Light Pen No. 4**
System: **Apple**
Memory: **16K and ROM Board, and Light Pen**
Language: **Apple II Soft**
Description: Program allows user to plot points on the screen in Low-Res, then converts the data to Hi-Res. Plot can be in colors.
Price: **\$34.95 + \$1.00 postage & handling (PA res. add 6% sales tax)**
Includes: Light Pen and 4 other support programs
Copies: **20**
Author: **Neil D. Lipson**
Available from:
Progressive Software
P.O. Box 273
Ply. Mtg., PA 19462

Name: **Morse Code**
System: **Apple**
Memory: **16K**
Language: **Integer Basic**
Description: Program allows user to learn morse code by typing English into computer and having morse code dots and dashes appear on the screen and hearing the beeps (audio) at the same time. Program has transmission speed control.
Copies: **10**
Price: **\$9.95 + \$1.00 postage & handling (PA residents add 6% sales tax)**
Includes: Cassette with instructions
Author: **Ed Hanley**
Available from:
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P.O. Box 273
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Name: **GRAFAX**
System: **OSI Challenger IIP**
Memory: **4k (6k optional with buffer)**
Language: **BASIC and machine language**
Hardware Required: **Challenger II(50X cpu,540 video with graphics rom, polled keyboard)**
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Author: **Mark Bass**
Available from:
Mark Bass
269 Jamison Drive
Frankfort, Illinois 60423

Name: **Polar Coordinate Plot**
System: **Apple**
Memory: **16K and ROM Board**
Language: **Apple II Soft**
Description: A high resolution graphics program which plots polar coordinate equations (4 classic equations and user's own equation). After plot is completed, data (in cartesian and polar coordinate system) will appear on the screen in a summary table form so that the plot can be easily duplicated.
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Author: **T. David Moteles**
Available from:
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Language: **Applesoft II**
Hardware: **Apple II, Disc II**
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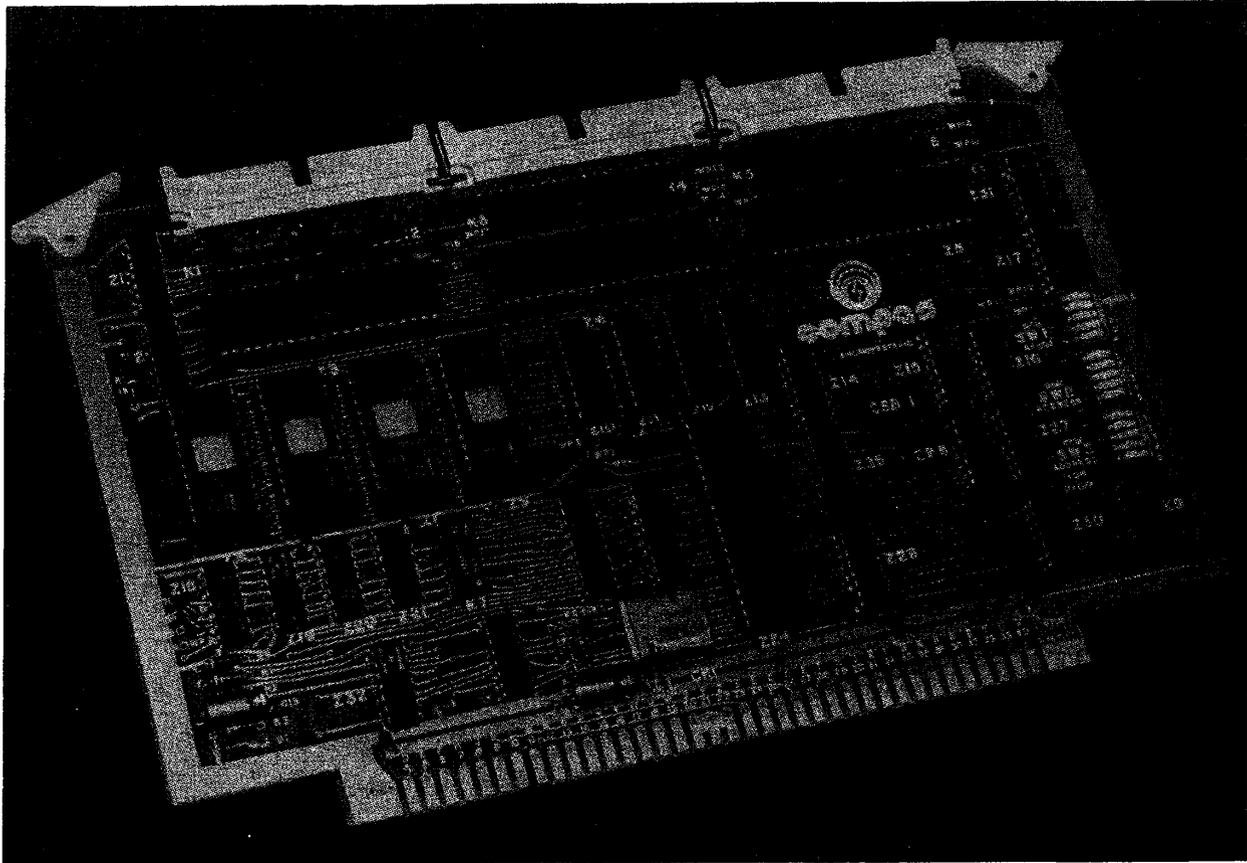


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Sym-1: Speak To Me

If you want your computer to carry on some snappy dialog, you are a real dreamer. But, here are some techniques to get you started with limited speech for your micro.

Jack Gieryic
2041 138th Ave. N.W.
Andover, MN 55303

In the February issue of KILOBAUD I came across an interesting article by Robert Bishop. In this article the tape recorder input line was used to sample a voice signal and the tape recorder output line was set high or low depending on the sample. Hopefully the resulting square wave pattern contained enough of the voice's original fundamental to reproduce an understandable signal. A primitive form of speech synthesis indeed but this idea did start the wheels rolling in my head.

Since we are dealing with square waves and not discrete samples at various amplitudes, I thought the sampling frequency would need to be much higher than the theoretical two times the reproduceable frequency. I wrote the accompanying short program which results in slightly over 40,000 samples per second. That's about the limit of the SYM-1 and I figured that should do it for voice. I used my stereo receiver to further help as it has reasonably good amplifiers. I put my cassette deck on record-pause and plugged in a microphone. The tape deck output went to the SYM for sampling on the SYM's normal tape input line. The SYM's tape output line was connected to one of the tape recorder inputs on the stereo receiver.

At this point I began executing the program and listened to the fruits of my labor — sour as they were. The resulting sound reminded me of a small speaker driven to distortion although it was understandable. The recording level control was critical. Remember the SYM sees either a "1" or a "0". The input signal must vary enough to trip the input line. If the volume is too high then too many 1's will be "seen." If the volume is too low then nothing will be heard as the input line will remain a zero. Whistling across (not into) the microphone produced good results. Playing some of my music tapes also was interesting. Only the foreground sounds were "reproduced." The background sounds didn't have enough volume to trip the logic level.

Primitive as this is, it is good enough to use for computer — to-user communications. However, this will require enormous amounts of memory which places a damper on things. The sampling rate of my program would fill 5K of memory in about 1 second. An option would be to reduce the sampling rate. I did this but the results were very poor. Remember this method is using a square wave. At a 10,000 sample/second rate too little information remained and harmonics from the square waves interfered. Change location '225 and '231 to hex 33 and see for yourself. By changing location '234 you can vary the sampling rate. "Ed" will result in 10,000 sample/second. Try "do" and whistle into the microphone. You'll hear the unwanted harmonics so abundant in a square wave.

I had thought of plagerizing the system's tape record/playback routines in order to store the square wave on tape instead of using memory. However, in the high speed format I could only store about 1500 bits per second (185 8 bit characters per second) which is far too

low a sampling rate to be useful. Perhaps a floppy disk would have a high enough data transfer rate to be of some use. This is food for thought.

If any of you are still seriously interested then I would suggest an 8 bit analog-to-digital convertor to digitize the data. The data could then be sent through an 8 bit digital-to-analog converter to reproduce the signal. Much lower sampling rates on the order of 5,000 to 8,000 samples/second could be used for voice. However, even at 5,000 8 bit samples per second you would still consume 5K memory in one second.

The approach of recording all characteristics of speech for either recognition or future reproduction deserves a reassessment. Perhaps there is some key remaining to be discovered which will enable the computer to use speech with a very limited amount of data. Software may need a greater hardware assist in order to accomplish what seems to be a difficult task. The near future may provide the answer.



BUAP!

SYM SPEAK TO ME

BY JOHN GIERYIC
MAY 1979

PAGE ZERO EQUATE

023B MASK * \$0001

SYM REGISTER EQUATES

023B VORBX * \$A000 VIA OUTPUT REGISTER B
023B VDDR8 * \$A002 VIA DATA DIRECTION REGISTER B
023B ORB * \$A402 6532 OUTPUT REGISTER B
023B DDRB * \$A403 6532 DATA DIRECTION REGISTER B

0200 ORG \$0200

0200 A9 07 START LDAIM \$07 SET UP MASK
0202 85 01 STA MASK
0204 A9 00 LDAIM \$00 SET DATA DIRECTION FOR INPUT
0206 8D 02 A0 STA VDDR8 IN VIA
0209 A9 BF LDAIM \$BF SET DATA DIRECTION FOR OUTPUT
020B 8D 03 A4 STA DDRB 6532
020E A9 07 LDAIM \$07 TURN BIT ON - OUTPUT
0210 8D 02 A4 STA ORB 6532

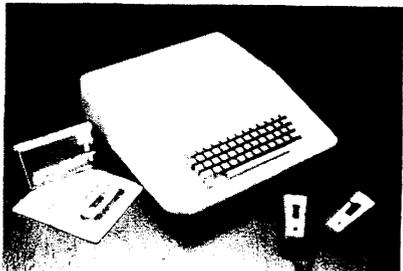
0213 AD 00 A0 LOOPA LDA VORBX SAMPLE VIA INPUT
0216 29 40 ANDIM \$40
0218 F0 0D BEQ LOOPB IF ZERO, GO CLEAR BIT
021A AD 02 A4 LDA ORB IF NOT ZERO, SET BIT
021D 29 F8 ANDIM \$F8
021F 45 01 EOR MASK
0221 8D 02 A4 STA ORB OUTPUT
0224 4C 13 02 JMP LOOPA

CHANGE ABOVE TO JMP DELAY TO CHANGE THE
SAMPLE RATE FROM 40,000 TO 10,000 CPS
LOCATION 224 = 33
ALSO CHANGE LOCATION 231.

0227 AD 02 A4 LOOPB LDA ORB CLEAR BIT
022A 29 F8 ANDIM \$F8
022C EA NOP FOR TIMING
022D 8D 02 A4 STA ORB OUTPUT
0230 4C 13 02 JMP LOOPA

CHANGE ABOVE TO JMP DELAY TO CHANGE THE
SAMPLE RATE FROM 40,000 TO 10,000 CPS
LOCATION 231 = 33
ALSO CHANGE LOCATION 224.

0233 A2 ED DELAY LDXIM \$ED 96. MICROSECOND DELAY
0235 E8 LOOPC INX
0236 D0 FD BNE LOOPC
0238 4C 13 02 JMP LOOPA



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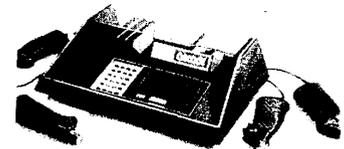
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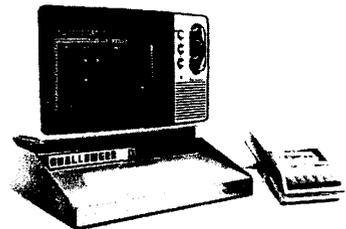
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Reading Pet Cassettes Without a Pet

If you have ever wanted to read a program from a cassette written for one 6502 based microcomputer on another type, here is an example which uses a SYM-1 to read a PET cassette. The concepts can be generalized to work with almost any combination of micros.

David P. Kemp
1307 Beltram Court
Odenton, MD 21113

One of the basic problems in obtaining microcomputer software is not that it doesn't exist but that it was written for a machine other than the one it is to be used on. Small programs can be typed in by hand if a hex listing is available, but larger programs are generally distributed on audio cassettes. By virtue of their popularity, the Apple II and PET have the largest pools of published software on cassette, but that doesn't mean that owners of less well established microcomputers like the SYM-1 cannot take advantage of existing programs written for these machines.

All 6502 based microcomputers except the KIM use very simple cassette interface hardware and let the processor do all the work of formatting, encoding and decoding cassette data. This approach has the dual advantages of reducing parts count and increasing flexibility and

it means that with suitable software, users of any particular machine can read cassettes written for any other machine (Apple, PET, OSI, AIM, or SYM). This particular program runs on the SYM-1 and reads cassettes written by the PET. It is quite unsophisticated, and doesn't know the difference between various block types such as Beginning of File, End of File, Program, and Data blocks, and it does not strip off countdown bytes or verify checksums. It does check byte parity and will flag any errors; it has been my experience that if there are no parity errors, then the data is OK.

Because the task of converting software from one machine to another is non-trivial, it is assumed that only experienced programmers will have occasion to use **PETCAS**, thus no attempt will be made to explain the program's operation or PET cassette format in detail; however

one feature of the program deserves some comment -- the tuning display. If an oscilloscope and a D/A converter are available, the display simplifies setting up the program and the recorder controls. With the program running and a PET cassette playing, the scope trace should fall into three distinct levels corresponding to the three possible time periods between active transitions on the tape. If the display is not well clustered or the routine will not work, try exchanging the instructions at locations \$6C and \$66. (In PET cassettes polarity is significant and this modification effectively reverses the audio signal polarity).

Despite its small size, the program works quite well -- it was originally written to read a third generation analog dubbing of an 8K program, and it accomplished that task in one pass without an error. μ

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PET CASSETTE READ ROUTINE FOR SYM-1

BY DAVE KEMP
 JANUARY 1979

PETCAS READS A PET FORMAT CASSETTE RECORD
 AND STORES THE DATA IN A BUFFER STARTING AT
 \$200. TO RUN IT, TYPE:

.G 0

CONTROL IS RETURNED TO SUPERMON AFTER THE
 FIRST COPY OF THE DATA HAS BEEN READ.
 LOCATIONS ADH AND ADL POINT TO THE NEXT
 FREE BUFFER LOCATION (LAST BYTE READ + 1).

0075	ADL	*	\$00F0	BUFFER POINTER
0075	ADH	*	\$00F1	
0075	TCNT	*	\$00F2	GETBIT TEMPORARY
0075	TPAR	*	\$00F3	PARITY GENERATOR TEMPORARY
0075	PECNT	*	\$00F4	PARITY ERROR COUNT
0075	PAR	*	\$00FE	PARITY ERROR MARKER VALUE ARBITRARY
0075	TAPE	*	\$A000	CASSETTE INPUT PORT (PB6)
0075	DIGANA	*	\$A001	DIGITAL TO ANALOG CONVERTER OUTPUT
0000			ORG	\$0000
0000	A9	02	PETCAS	LDAIM \$02 SET BUFFER ADDRESS TO \$0200
0002	85	F1		STA ADH
0004	85	F4		STA PECNT
0006	A9	00		LDAIM \$00
0008	85	F0		STA ADL
000A	20	2F	00	PETCA JSR GBYTE GET A BYTE
000D	30	03		BMI PETX
000F	4C	00	00	JMP PETCAS LEADER NOT STABLE YET
0012	C6	F4		PETX DEC PECNT BE SURE LEADER IS VALID
0014	D0	F4		BNE PETCA
0016	20	2F	00	PETCB JSR GBYTE GET BYTE
0019	30	FB		BMI PETCB LOOP UNTIL END OF LEADER
001B	B0	04		PETCC BCS PETCD DATA VALID ?
001D	A9	FE		LDAIM PAR NO - PARITY ERROR
001F	E6	F4		INC PECNT INCREMENT ERROR COUNT
0021	91	F0		PETCD STAIY ADL SAVE IT IN BUFFER
0023	E6	F0		INC ADL ADVANCE BUFFER POINTER
0025	D0	02		BNE PETCE
0027	E6	F1		INC ADH
0029	20	2F	00	PETCE JSR GBYTE GET ANOTHER BYTE
002C	10	ED		BPL PETCC CONTINUE IF DATA
002E	60			RTS EXIT IF SHORTS

GET A BYTE OF PET DATA

RETURN:

A = BYTE
 C = 0 IF PARITY ERROR
 N = 1 IF SHORTS
 X CLOBBBERED, Y = 0

```
002F A0 11    GBYTE LDYIM $11    SHORTS COUNT
0031 20 63 00 GBA   JSR   GETTR  GET TRANSITION TIME
0034 E0 40          CPXIM $40    START BIT ?
0036 B0 08          BCS   GBB     YES - GO GET BYTE
0038 E0 2C          CPXIM $2C    SHORTS ?
003A B0 F3          BCS   GBYTE  NO - START COUNTING AGAIN
003C 88            DEY           YES - DECREMENT COUNT
003D 10 F2          BPL   GBA
003F 60            RTS
```

```
0040 A0 09    GBB   LDYIM $09    BIT COUNT
0042 84 F3          STY   TPAR   INITIALIZE PARITY
0044 20 63 00          JSR   GETTR  GET OTHER HALF OF START BIT
0047 20 58 00 GBC   JSR   GETBIT GET A DATA BIT
004A 90 02          BCC   GBD
004C E6 F3          INC   TPAR   ADJUST PARITY
004E 6A          GBD   RORA          PACK IT
004F 88            DEY           DONE ?
0050 D0 F5          BNE   GBC    NO
0052 2A            ROLA          YES - ADJUST DATA
0053 49 FF          EORIM $FF
0055 46 F3          LSR   TPAR   PUT PARITY IN C
0057 60            RTS
```

GET A DATA BIT

RETURN:

C = BIT
 X CLOBBBERED, A & Y UNCHANGED

```
0058 20 63 00 GETBIT JSR   GETTR  GET FIRST TRANSITION
005B 86 F2          STX   TCNT   SAVE IT
005D 20 63 00          JSR   GETTR  GET SECONT TRANSITION
0060 E4 F2          CPX   TCNT   GENERATE BIT IN C
0062 60            RTS
```

GET A TRANSITION PERIOD

RETURN:

X = PERIOD
 A & Y UNCHANGED

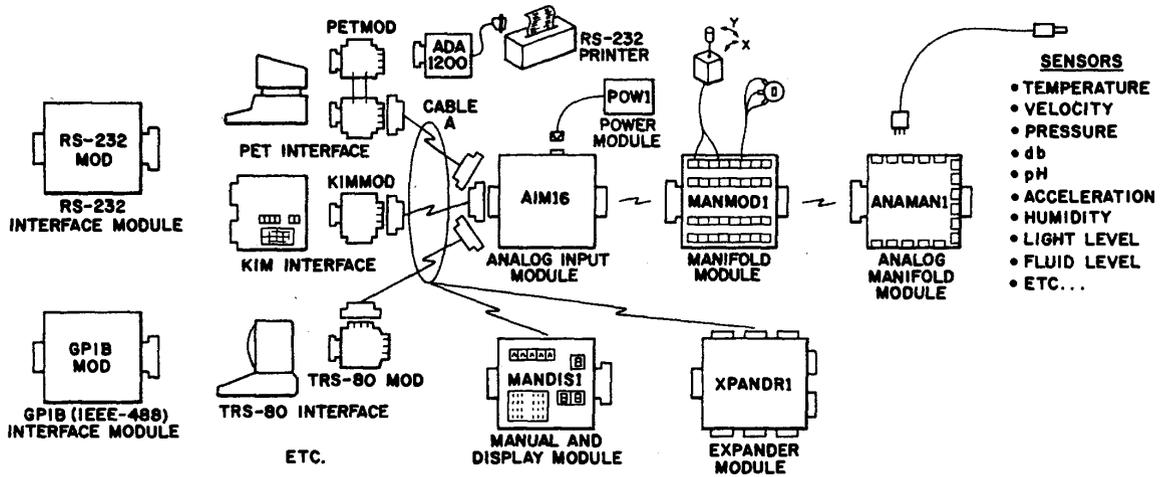
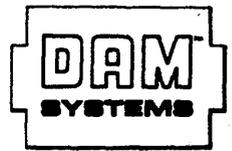
```
0063 A2 00    GETTR LDXIM $00    INIT COUNTER
0065 2C 00 A0 GETA   BIT   TAPE
0068 E8          INX           INCREMENT COUNTER
0069 70 FA          BVS   GETA   LOOP WHILE HIGH
006B 2C 00 A0 GETB   BIT   TAPE
006E E8          INX
006F 50 FA          BVC   GETB   LOOP WHILE LOW
0071 8E 01 A0          STX   DIGANA OUTPUT TO D/A FOR TUNING
0074 60            RTS
```



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Supplies power for one AIM16 module.		24 inch cable with interface connector on one end and an OCON equivalent on the other.	
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For connecting analog inputs to the AIM16 - 20 pin card edge connector - solder eyelets.		Connects between the AIM16 and the computer interface. Allows manual or computer control of the AIM16. Displays channel number and data.	
OCON - Output Connector	\$9.95	GPIB MOD - GPIB (IEEE-488) Interface	TBA
For connecting the AIM16 to a computer - 20 pin card edge connector - solder eyelets.		Allows the DAM SYSTEMS MODULES to be used with the GPIB bus instead of a computer's other I/O ports.	
MANMOD1 - Manifold Module	\$59.95	RS232 MOD - RS232 Interface Module	TBA
Use in place of ICON. Screw terminal barrier strips for connecting josticks, potentiometers, voltage sources, etc. Eliminates the need for soldering. Plugs into the AIM16.		Allows the DAM SYSTEMS MODULES to be used with an RS-232 port or terminal.	
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Gives two IEEE ports, one user port and one DAM SYSTEMS interface port. Saves wear and tear on the PET's printed circuit board. Also called the PETSAR.		AIM162 Starter Set	\$259.00
		Includes one AIM162, one POW1, one ICON and one OCON.	
		PETSET1a	\$295.00
		Includes one PETMOD, one CABLE A24, one AIM161, one POW1 and one MANMOD1.	
		KIMSET1a	\$285.00
		Includes one KIMMOD, one CABLE A24, one AIM161, one POW1 and one MANMOD1.	

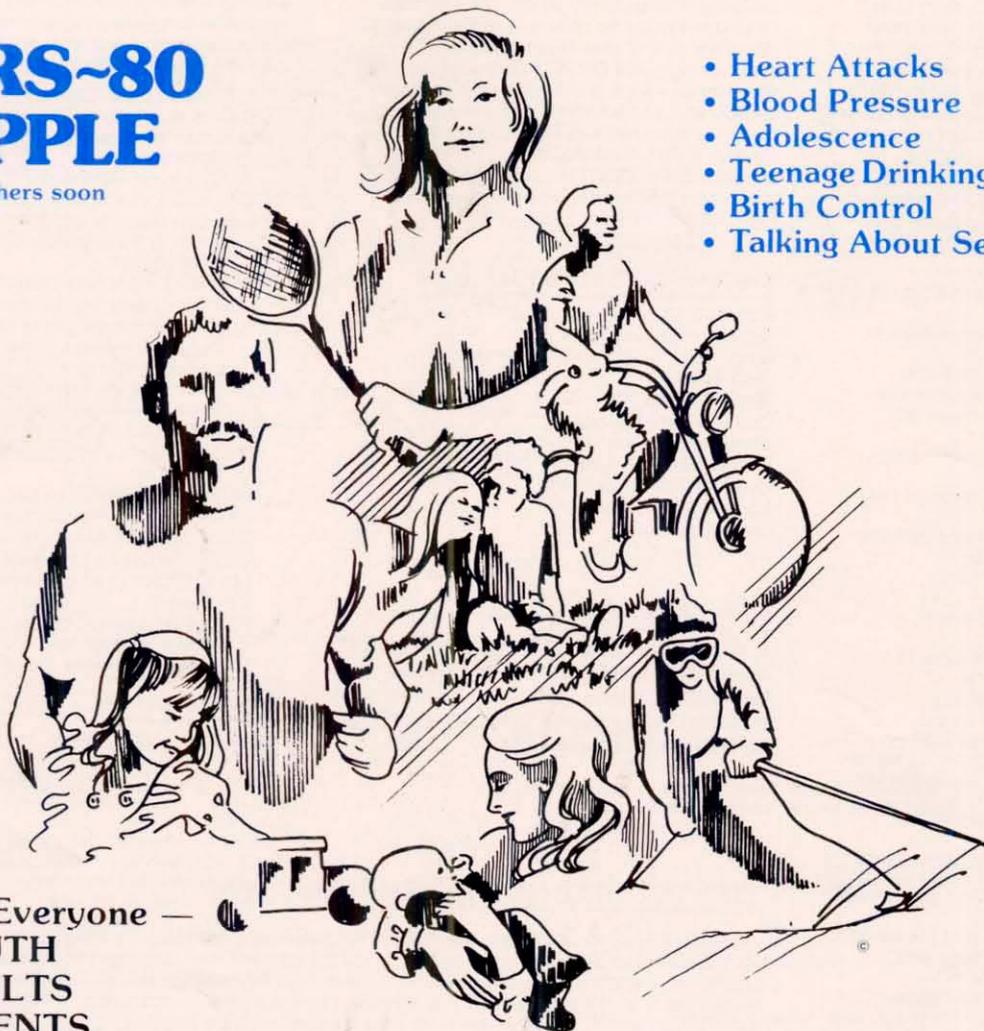
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