

PET User Notes

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NIM for PET

Jim Butterfield, Toronto

The AND, OR, and NOT relationships can be used for logical tests such as IF A=9 OR B=0 .. They can also be used for manipulation of binary numbers. For example, PRINT 7 AND 10 produces 2. If this isn't clear, you need to brush up on binary numbering and logical operators. In the meantime, you can still play NIM.

The "missing" logical operator, EOR, has been created as FNE. (line 110).

```
90 PRINT "cs NIM      J. BUTTERFIELD":IQ=.9
100 N=3      set-number of piles, e.g. 3
110 DEF FNE(X)=(A(J) OR E) AND (NOT (A(J) AND E))
                                exclusive OR
120 DIM A(N): INPUT "WANT INSTRUCTIONS";Z$
130 IF LEFT$(Z$,1)="N" GOTO 200
140 ? "PICK FROM";N;"PILES-AS MANY ITEMS AS"
150 ?"YOU LIKE FROM ANY PILE cd THEN I PLAY cd"
160 ?"YOU WIN IF YOU GET THE LAST ITEM cd"
170 ?"GOOD LUCK! cd HIT ANY KEY TO START"
180 GET Z$:IF Z$="" GOTO 180
200 FOR J=1 TO N
205 A(J)=INT(RND(1)*12+5)      generate random piles
210 IF J=1 GOTO 240
220 FOR K=1 TO J-1:IF A(J)=A(K) GOTO 205  avoid duplicates
230 NEXT K
240 NEXT J:M=0
300 T=0: ? "cs";      each move starts here
310 FOR J=1 TO N: ? CHR$(J+64);"=";A(J):T=T+A(J)
                                print and total piles
320 NEXT J: IF T=0 GOTO 700      if all gone, game over
330 M=M-1: IF M=0 GOTO 500      PET's move
360 ?"cd TAKE YOUR PICK--"
370 INPUT "PILE";Z$
380 P=ASC(Z$)-64:IF P < 1 OR P > N GOTO 370
390 INPUT "TAKE HOW MANY";Z
400 IF Z > A(P) THEN ? "THERE ARE ONLY";A(P) : GOTO 370
410 IF Z < 1 OR Z <> INT(Z) THEN ? "WHA ?": GOTO 370
                                illegal quantity
420 A(P) = A(P)-Z : GOTO 300
500 E=0 : F=0
510 FOR J=1 TO N
520 E=FNE(0):IF A(J) > F THEN F=A(J): J1=J  form EOR, all piles
530 NEXT J
540 FOR J=1 TO N
550 R=FNE(0): IF R<=A(J) GOTO 600  find a move
560 NEXT J : STOP      no moves? something wrong
600 IF R=A(J) OR IQ > RND(1) THEN J=J1:R=A(J)-1  dumb move?
610 ?"I PICK";A(J)-R;"UNITS FROM PILE ";CHR(J+64)
620 A(J)=R: FOR J=1 TO 2000: NEXT J: GOTO 300
                                pause before next display
700 W$="YOU":IF M=0 THEN W$="I"
710 ?"***, ",W$," WIN!"
720 IF M=0 GOTO 740
730 IQ=IQ*IQ : ? "I'LL PLAY BETTER"; : GOTO 750
740 IQ=SQR(IQ) : ? "I'LL TAKE IT EASIER";
750 ? " NEXT GAME... cd" : INPUT "ANOTHER GAME";Z$
760 IF LEFT$(Z$,1) <> "N" GOTO 200
```

cs=clear screen cd=cursor down r=reverse

[ed. note: NIM demonstrates several aspects of PET BASIC in addition to the logical operators. Jim used CHR\$ in line 310 to convert from numeric 1, 2, or 3 to A, B, or C. The reverse conversion ASC was used to translate alphabetic entry 1, 2, or 3 (if N=3). The program also cleverly adjusts its skill by changing the variable IQ (what else?)]

General Notes

Commodore recently began sending a "Revised Introduction to your PET" with PET shipments. The booklet is about the same as the previous version, but does omit the memory map and the edge connector designations. I hope Commodore gets some decent documentation out soon. I know they can do it -- the KIM and 6500 Hardware and Programming manuals are very good.

The PET main circuit board has changed several times since last year. Commodore has been using 2114 RAM's instead of their own 6550 chip, and is apparently going to be an alternate source for the Intel memory IC (the Commodore version will be the 6114, with additional plans to produce a 6316 16K RAM as an alternate source for the Intel 2316).

The Commodore printer (PET Formatting Printer) should be available in late July. Although the specifications are a little sketchy, the unit appears to be an excellent value at \$595. Features include 80 column width on 8 1/2 inch paper at 120 characters/second. All PET characters (upper case, lower case, and graphics) will print using a 7 by 8 dot matrix print head. The printer will be assigned physical address 4 on the IEEE-488 bus. The secondary address specified in the OPEN for the device will be used by the printer to determine how the data stream is processed. Some of the options are: print data exactly as received; print data per format; set up a format; and set number of lines per page. Characters may be double width (7 by 16). Formatting includes left, right, or decimal point alignment, as well as leading zero, floating dollar sign, and trailing minus sign.

Nothing much is happening as far as correction of system bugs with the exception of losing the cursor when hitting return. This can be corrected with a ROM replacement at a cost of \$10.

Commodore Software still isn't being distributed yet, although an announcement was mailed in April indicating the first batch release was imminent.

Several users have written that their keytop surfaces are wearing off on the more heavily used keys. Does anyone know a preventive measure for this? Also, many questions about adding a previously saved routine on cassette to a program in memory. Anyone have any ideas on this?

In general, comments about the PET have been very favorable. In fact, the response range seems to be favorable to ecstatic, with no one yet indicating they were dissatisfied.

Software

James Johnson, 9304 Emory Grv. Road, Gaithersburg, MD 20760 has a Blackjack program which he says permits 5 players, double down, split, and uses full PET graphics. He will sell this program on cassette for \$5.

C.M. Stuart & Co., 5115 Menefee Dr. Dallas, TX 75227 has developed a Casino Simulation Package containing Blackjack, Baccarat, Craps, and Roulette. All options available at the Casino of the MGM Grand Hotel in Las Vegas have been incorporated in the programs, which are available on cassette including complete rules at \$9.95 each or \$25 for all four.

Penninsula School Computer Project, Peninsula Way, Menlo Park, CA 94025 is selling 3 program tapes: (1) PILOT (CAI lan-

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guage) and 5 sample programs \$19.95 (2) Renumber, Lemon, Kal-
 eidoscope, WFSN \$14.95 (3) QUEST, DRAW (very nice expanded
 version) \$9.95. Write them with SASE for order form.

Andy Fraley, 1753 York Rd., Reading, PA 19610 has four
 action games with graphics for sale at \$5.95 each. They are
 Seawolf, Dogfight, Bomber, and Indy 500.

Several people suggested that we publish a PET software directory.
 If there is sufficient interest, we will attempt it. Mr. Elwood
 Anderson of Channel Data Systems, Goleta, CA suggested a format
 to include: cassette name; program names; publisher; author; price;
 memory req.; manual included; sold through (author, publisher,
 dealers, etc.); and brief program abstract. If you think this is a
 good idea, send your program info. We will publish as often as
 necessary to keep the listings current.

Hardware

International Technical Systems, Inc., Box 264, Woodbridge, VA
 22194 announced a PEM-8K memory expansion module at \$279.
 The 8K unit is assembled with case, power supply, and connecting
 hardware. ITS will include a 10K Mathematical/Financial software
 package with initial orders for PEM-8K.

Otherware

MJ Salisbury has a carrying case for PET which includes perman-
 ent foam cushioning material, removable hinged cover, and lock-
 ing latches. \$49.50 + shipping (COD). CASE, Box 6633, Oxnard,
 CA 93030.

Microsette, 777 Palomar Ave., Sunnyvale, CA 94086 has
 blank C-10 tapes in plastic box. Send \$1.00 for sample tape.

TIS, Box 921, Los Alamos, NM 87544 has a series of workbooks
 on using the PET computer. Write them for further information.

Francis T. Chambers, Rock House, Ballycroy, Westport, Co.
 Mayo, Ireland has a winning strategy for Othello (Reversi). Many
 of you have seen the Othello program from the BYTE article, and
 know it needs help to play well. Frank has written a complete
 description of his method, and will air mail a copy for \$5.

Software Exchange

Carl Bach, 1015 Saturn Springs Dr., Garland, TX 75041 has
 many game programs on cassette to exchange.

Microcomputer Resource Center, 5150 Anton Drive Room 212,
 Madison, WI 53719 is running a PET software exchange. Write
 them for submission format.

Errors in previous issue (V1, Issue 3)

page 1 -- line 12 in first paragraph should read 98 rather than 248.
 page 9 -- the PET Character Code table was furnished by Frank
 Campbell. The original sent by Frank did not reproduce well, so
 we retyped it at the last minute. In so doing, we switched two
 keyboard symbols in the third column. The 103/39 and the 108/44
 symbols should be interchanged.

Also, apologies to Jim Butterfield -- his Bagels program on
 page 6 has no indication of the continuation on page 11.

Programs on Tape

SEQUENCE -- you have to sort a character list
 STATECAPS -- quiz on states and capitals from 3/78 Kilobaud
 RACETRACK -- see listing in V.1, Issue 3 - RE McGee
 DEFLECTION -- F. Dunlap
 ADDITION -- math drill -- F. Dunlap, C. Pitcairn
 OTHELLO -- from 9/77 BYTE
 OTHELLO for 2 -- F. Dunlap
 BAGELS -- like Mastermind - J. Butterfield
 Cash Flow/Return on Investment - R. Goldsmith
 STAR TREK
 BLACKJACK -- D. Liem - nice graphics, humorous patter by dealer
 LIFE -- 40*25 F. Covitz
 LIFE -- 64*64 F. Covitz
 FILE LIST & SORT -- from Kilobaud. Modified by Robert Harvey
 TRAP -- trap the PET, avoid being trapped
 Super Mastermind -- JR Marcou
 Lunar Lander -- JR Marcou
 NIM -- J Butterfield
 QUBIC -- 3D TIC-TAC-TOE
 LIST MEMORY -- Charles Combs
 Machine Language Monitor -- a good version - similar to the one
 Commodore will be sending

TIME -- large clock display
 BIORYTHM -- Kenneth Finn - very concise code - plots with only
 30 BASIC statements
 KING -- business-social simulation or game
 BREAKOUT -- simple version of the arcade game
 SWATPLOT -- F. Campbell (see V.1 Issue 3) - plots in 80x50 format

\$2 for the first program including cassette and postage, \$1 for each
 additional -- max 4 per tape. Most of the programs will be listed
 in this newsletter, so the programs on tape service is available only
 to save you key entry time. It is priced to hopefully cover the cost
 of a part time person to copy and mail the tapes.

If you have a program to add to the list, please send it on tape.
 We will copy it and return your tape with several other programs.

Sensing Keys

Several people wrote that location 515 contained a key identifier
 code indicating whether a key is depressed during each monitor
 scan cycle. The value is 1 to 80 depending on the key, or 255 if
 no key is depressed.

10 K=PEEK (515): IF K=255 GOTO 10

Shift key depression can also be detected by checking location
 515 (value is 1 if the key is depressed, 0 if it is not).

PET Matrix-Decoded Keyboard

Value of key = row value + column value

64	!	"	#	\$	%	'	&	\	()	←	ho	↵	↵	del
48	Q	W	E	R	T	Y	U	I	O	P	↑	7	8	9	/
32	A	S	D	F	G	H	J	K	L	:	re	4	5	6	*
16	Z	X	C	V	B	N	M	,	;	?	re	1	2	3	+
0	sh	re	@	[]	space	<	>	st	sh	0	.	-	=	
	16	8	15	7	14	6	13	5	12	4	11	10	2	9	1

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6500 Programming and Hardware Manuals The 6500 Programming Manual is indispensable if you are interested in Machine Language programming.	\$6 each
Hewlett-Packard IEEE-488 condensed description of Interface Bus	\$1.50
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Basic Command Abbreviations

C. W. Hennig of University of Waterloo found two letter entry codes for most of the Commodore BASIC commands. Generally, the entry abbreviations consist of the first letter of the command followed by the shifted second letter i.e. Go is GOTO, Pr is PRINT#1, Ve is VERIFY, Sp is SPC(), etc. If you are not in the lower case mode (POKE 59468,14) you will see the graphic character associated with the shifted entry of the letter rather than the lower case letter itself (I/ instead of In for INPUT#). In either case when you LIST, you will see the unabbreviated BASIC word, just as ? expands to PRINT.

Mr. Neil Harris carried Carl Hennig's discovery a step further by finding several 3 character entry abbreviations for some of the BASIC words not having 2 character entries.

Commodore BASIC Abbreviations

Command/ Statement	Abbreviation	Command/ Statement	Abbreviation
LET	Le	NOT	No
READ	Re	RUN	Ru
PRINT	?	CLR	Cl
DATA	Da	LIST	Li
THEN	Th	CONT	Co
FOR	Fo	FRE	Fr
NEXT	Ne	TAB(Ta
DIM	Di	SPC(Sp
END	En	PEEK	Pe
GOTO	Go	POKE	Po
RESTORE	REs	USR	Us
GET	Ge	SYS	Sy
GOSUB	GOs	WAIT	Wa
DEF	De	LEFT\$	LEf
RETURN	REt	RIGHT\$	Ri
STOP	St	MID\$	Mi
STEP	STe	CHR\$	Ch
SGN	Sg	ASC	As
ABS	Ab	VAL	Va
SQR	Sq	STR\$	STr
RND	Rn	OPEN	Op
SIN	Si	CLOSE	CLo
COS	Co	SAVE	Sa
TAN	Ta	LOAD	Lo
ATN	At	VERIFY	Ve
LOG	Lo	PRINT#	Pr
EXP	Ex	INPUT#	In
AND	An	CMD	Cm

INPUT Without Data

In response to some of the questions on hitting RETURN without data being entered and having control return to the operating system, try one of these:

```
100 OPEN 1,0,1
200 INPUT#1,A$:PRINT
300 IF A$="" GOTO 200
```

If you hit return with no data, a null value is returned.

```
100 OPEN 1,0,1
200 INPUT#1 A:PRINT
```

In this example, return with no data enters 0. You can still return to the operating system if you enter non-numeric data (BAD DATA ERROR).

```
100 INPUT "ENTER VALUE: ";A$
200 IF A$="" THEN PRINT "cucu":GOTO 100
```

This method prints a character (in this case the shifted question mark) and then places the cursor on that character ready for input. If return without data, then you will go back for another try.

PET 2001

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T



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LIFE for the PET
Frank Covitz Lebanon, New Jersey

Since this is the first time I have attempted to set down a machine language program for the public eye, I will attempt to be as complete as practical without overdoing it.

The programs I will document here are concerned with the game of LIFE, and are written in 6502 machine language specifically for the PET 2001(8K version). The principles apply to any 6502 system with graphic display capability, and can be debugged (as I did) on non-graphic systems such as the KIM-1.

The first I heard of LIFE was in Martin Gardner's "Recreational Mathematics" section in Scientific American, Oct, Nov 1970, Feb 1971. As I understand it, the game was invented by John H. Conway, an English mathematician. In brief, LIFE is a "cellular automation" scheme, where the arena is a rectangular grid (ideally of infinite size). Each square in the grid is either occupied or unoccupied with "seeds", the fate of which are governed by relatively simple rules, i.e. the "facts of LIFE". The rules are: 1. A seed survives to the next generation if and only if it has two or three neighbors (right, left, up, down, and the four diagonally adjacent cells) otherwise it dies of loneliness or overcrowding, as the case may be. 2. A seed is born in a vacant cell on the next generation if it has exactly 3 neighbors.

With these simple rules, a surprisingly rich game results. The original Scientific American article, and several subsequent articles reveal many curious and surprising initial patterns and results. I understand that there even has been formed a LIFE group, complete with newsletter, although I have not personally seen it.

The game can of course be played manually on a piece of graph paper, but it is slow and prone to mistakes, which have usually disastrous effects on the final results. It would seem to be the ideal thing to put to a microprocessor with bare-bones graphics, since the rules are so simple and there are essentially no arithmetic operations involved, except for keeping track of addresses and locating neighbors.

As you know, the PET-2001 has an excellent BASIC interpreter, but as yet very little documentation on machine language operation. My first stab was to write a BASIC program, using the entire PET display as the arena (more about boundaries later), and the filled circle graphic display character as the seed. This worked just fine, except for one thing - it took about 2 1/2 minutes for the interpreter to go through one generation! I suppose I shouldn't have been surprised since the program has to check 8 neighboring cells to determine the fate of a particular cell, and do this 1000 times to complete the entire generation (40x25 characters for the PET display).

The program below is a 6502 version of LIFE written for the PET. It needs to be POKE'd into the PET memory, since I have yet to see or discover a machine language monitor for the PET. I did it with a simple BASIC program and many DATA statements (taking up much more of the program memory space than the actual machine language program!). A routine for assembling, and saving on tape machine language programs on the PET is sorely needed.

The program is accessed by the SYS command, and takes advantage of the display monitor (cursor control) for inserting seeds, and clearing the arena. Without a serious attempt at maximizing for speed, the program takes about 1/2 second to go through an entire generation, about 300 times faster than the BASIC equivalent! Enough said about the efficiency of machine language programming versus BASIC interpreters? BASIC is great for number crunching, where you can quickly compose your program and have plenty of time to await the results.

Program -- LIFE 40*25

Address	Op.	code	Byte 1,2	Addr.	Op.	B1	B2	Comments
MAIN	PHP	PHA	TXA	1900	08	48	8A	Save A,X,Y,S
	PHA	TYA	PHA	1903	48	98	48	
	TSX	TXA	PHA	1906	BA	8A	48	Clear dec. mode
	CLD			1909	D8			
GEN	JSR		INIT	190A	20	30	19	Repeat 255 times before quitting Restore S,Y,X,A Return to BASIC
	JSR		SCR-TEMP	190D	20	8A	19	
	JSR		TEMP-RCS	1910	20	E6	19	
	JSR		GENER	1913	20	00	1A	
	JSR		TEMP-SCR	1916	20	70	19	
	INCz		Times	1919	E6	38		
	BNE		GEN	191B	D0	F3		
	FLA	TAX	TXS	191D	68	AA	9A	
	FLA	TAY	PLA	1920	68	A8	68	
	TAX	PLA	PLP	1923	AA	68	28	
	JMP		BASICON	1926	4C	5B	C3	

Day of Week Routine
Earl H. Wuchter Catasauqua, PA

This routine will return the day of week for any given day from Mar 1, 1900 through Feb 29, 2000, and can be expanded to work for any date. The routine does not destroy the date, and may be used as a subroutine after the WDS array is initialized.

```

10 REM INITIALIZE ARRAY
12 DIM WDS(6)
14 DATA "SUN","MON","TUE","WED","THU","FRI","SAT"
16 FOR J=0 TO 6: READ WDS(J): NEXT
18 REM INPUT DATE
20 PRINT "ENTER MONTH, DAY, YEAR,": INPUT MN,DY,YR
22 REM WEEKDAY PGM BEGINS HERE. MAY BE A SUB
24 REM ADJUST YEAR TO BEGIN ON MAR 1
26 CY=YR*M=MN-2
28 IF M<1 THEN M=M+12: CY+CY-1
30 Y=CY-INT(CY/100)*100: REM Y=LAST TWO DIGITS
32 REM C=INT(CY/100) WHEN USING EXPANDED PGM
34 REM WD=(Y+Y/4+C/4-2*C+DY+(2.6*M-.2))MOD7
36 WD=Y+INT(Y/4)+1+DY+INT(2.6*M-.1999)
38 WD=WD-INT(WD/7)*7
40 PRINT WDS(WD);

```

Program notes:
REM line 34 shows (2.6*M-.2)
Code line 36 uses (2.6*M-.1999)
.2 is correct, but something less must be used because of the internal floating point roundoff.
REM line shows +C/4-2*C
Code line uses +1
For the years covered by this version, C is always equal to 19.
INT(19/4)-2*19=-34 -34 MOD7=+1
This simplifies the MOD function on line 38 by getting rid of the negative number. To expand the pgm for any year, break the year into C and Y after it is adjusted to begin on Mar 1. You will need a routine then (to replace line 38) that will handle negative numbers.

Address	Op.code	Byte 1,2	Addr.	Op.	B1	B2	Comments
INIT	LDXim	19	1930	A2	19		Read in 25dec init.
LOAD	LDax	Data-1	1932	BD	3A	19	values
	STAxz	1Fhex	1935	95	1F		Store them in p. zero
	DEX		1937	CA			
	BNE	LOAD	1938	DO	F8		
	RTS		193A	60			
<hr/>							
DATA	ScrL	ScrH	ChL	193B	00	80	00
	ChH	ScrLo	ScrHo	193E	15	00	80
	TempL	TempH	TempLo	1941	00	1B	00
	TempHo	Up	Down	1944	1B	D7	28
	Right	Left	Ur	1947	01	FE	D8
	Ul	Lr	Ll	194A	D6	29	27
	N	ScrLastL	ScrLastH	194D	00	E8	83
	RcsLo	RcsHo	Tmp	1950	00	15	00
	Times			1953	00		
<hr/>							
TEMP-SCR	JSR	RESTORE	1970	20	A6	19	Get init. addresses
LOAD	LDAiy	TempL	1973	B1	26		Fetch byte from Temp
	BNE	ONE	1975	D0	06		Branch if # 0
	LDAim	32dec	1977	A9	20		The symbol for blank
	STAiY	ScrL	1979	91	20		Dump it to screen
	BNE	NEXT	197B	D0	04		
ONE	LDAim	81dec	197D	A9	51		The "dot" symbol
	STAiY	ScrL	197F	91	20		Dump it to screen
NEXT	JSR	NEXTADDR	1981	20	BD	19	Fetch next addr.
	BEQ	LOAD	1984	F0	ED		
	JSR	RESTORE	1986	20	A6	19	Restore init addr's.
	RTS		1989	60			
<hr/>							
SCR-TEMP	JSR	RESTORE	198A	20	A6	19	Get init. addresses
LOAD	LDAiy	ScrL	198D	B1	20		Read data fr. screen
	CMPim	81dec	198F	C9	51		Is it a "dot"?
	BEQ	ONE	1991	F0	06		Branch if "dot"
	LDAim	00	1993	A9	00		Otherwise it's blank
	STAiY	TempL	1995	91	26		Store it
	BEQ	NEXT	1997	F0	04		Uncond. branch
ONE	LDAim	01	1999	A9	01		A "dot" was found
	STAiY	TempL	199B	91	26		Store it
NEXT	JSR	NEXTADDR	199D	20	BD	19	Fetch next addr.
	BEQ	LOAD	19A0	F0	ED		
	JSR	RESTORE	19A2	20	A6	19	Restore init addr's
	RTS		19A5	60			

RESTORE	LDAim	00	19A6	A9	00		Zero A,X,Y
	TAX	TAY	19A8	AA	A8		
	STAx	ScrL	19AA	85	20		Initialize ScrL,
	STAx	TempL	19AC	85	26		TempL,RcsL,ScrH,
	STAx	RcsL	19AE	85	39		TempH,RcsH
	LDAz	ScrHo	19B0	A5	25		
	STAx	ScrH	19B2	85	21		
	LDAz	TempHo	19B4	A5	29		
	STAx	TempH	19B6	85	27		
	LDAz	RcsHo	19B8	A5	36		
	STAx	RcsH	19BA	85	3A		
	RTS		19BC	60			
<hr/>							
NEXTADDR	INCz	TempL	19BD	E6	26		Get next low order
	INCz	ScrL	19BF	E6	20		byte address
	INCz	RcsL	19C1	E6	39		
	INX		19C3	E8			
	CFXz	ScrLastL	19C4	E4	33		Is it the last?
	BEQ	PAGECH	19C6	F0	0C		Is it the last page?
	CPXim	00	19C8	E0	00		Is it a page boundary?
	BNE	LOAD	19CA	D0	0E		If no , then not done
	INCz	TempH	19CC	E6	27		Otherwise advance to
	INCz	ScrH	19CE	E6	21		next page
	INCz	RcsH	19D0	E6	3A		
	BNE	LOAD	19D2	D0	06		Uncond. branch
PAGECH	LDAz	ScrLastH	19D4	A5	34		Check for last
	CMPz	ScrH	19D6	C5	21		page
	BEQ	DONE	19D8	F0	03		If yes, then done
LOAD	LDAim	00	19DA	A9	00		Return with A=0
	RTS		19DC	60			
DONE	LDAim	01	19DD	A9	01		Return with A=1
	RTS		19DF				
<hr/>							
TEMP-RCS	JSR	RESTORE	19E6	20	A6	19	Initialize addr's
LOAD	LDAiy	TempL	19E9	B1	26		Fetch data from Temp
	BNE	ONE	19EB	D0	06		If # 0, then it's alive
	LDAim	32dec	19ED	A9	20		The symbol for blank
	STAiY	RcsL	19EF	91	39		Store it in screen copy
	BNE	NEXTADDR	19F1	D0	04		Then on to next addr.
ONE	LDAim	81dec	19F3	A9	51		The "dot" symbol
	STAiY	RcsL	19F5	91	39		Store it in screen copy

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PET SOFTWARE

Address	Op. code	Byte 1,2	Addr.	Op. B1 B2	Comments
NEXTADDR	JSR	NEXTADDR	19F7	20 ED 19	Fetch next addr.
	BEQ	LOAD	19FA	FO ED	If A=0, then not done
	JSR	RESTORE	19FB	20 A6 19	Restore init. addr's
	RTS		19FF	60	

GEN	JSR	RESTORE	1A00	20 A6 19	Initialize addr's
AGAIN	JSR	NBR8	1A03	20 2F 1A	Fetch # of neighbors
	LDAiy	RcL	1A05	B1 39	Fetch current data
	CMPI	S1asc	1A05	C9 51	Is it a "got"?
	BEQ	OC	1A0A	FO OC	If yes, then branch
	LDAz	N	1A0C	A5 32	Otherwise it's blank
	CMPI	O3	1A08	C9 03	and we need to check
	BNE	NEXTADDR	1A10	DO 14	for a birth
BIRTH	LDAim	O1	1A12	A9 01	It gives birth!
	STAIy	TempL	1A14	91 26	Store it in Temp
	BNE	NEXTADDR	1A16	DO 0E	Uncond. branch
OCC	LDAz	N	1A18	A5 32	Fetch # of neighbors
	CMPI	O3	1A1A	C9 03	If it has 3 or 2
	BEQ	NEXTADDR	1A17	FO 08	neighbors, it survives
	CMPI	O2	1A1E	C9 02	
	BEQ	NEXTADDR	1A20	FO 04	
DEATH	LDAim	O0	1A22	A9 00	It died!
	STAIy	TempL	1A24	91 26	Store it in Temp
NEXTADDR	JSR	NEXTADDR	1A26	20 ED 19	Fetch next address
	BEQ	AGAIN	1A29	FO D8	If = 0, then not done
	JSR	RESTORE	1A2B	20 A6 19	Restore init. addr's
	RTS		1A2E	60	

NBR8	TVA	PHA	TXA	1A2F	98 48 8A	Save Y and X on stack
	PHA			1A32	48	
	LDAiy	O0		1A33	A0 00	Set Y and X = 0
	STYz	N		1A35	B4 32	
	LDAim	O0		1A37	A5 08	Check 8 neighbors
OPFS	LDAx	Offset-1		1A39	B5 29	Fetch offset data
	BPL	ADD		1A3B	10 15	Add if offset is pos.
	RORim	FF		1A3D	49 FF	Otherwise get set to
	STAZ	Temp		1A39	B5 37	subtract
	SEC			1A41	38	
	LDAz	RcL		1A42	A5 39	
	STCz	Temp		1A44	E5 37	Subtract to get the
	STAZ	CHL		1A46	B5 22	correct neighbor
	LDAz	RcH		1A48	A5 3A	address
	STAZ	CHH		1A4A	B5 23	
	RCS	EXAM		1A4C	B0 11	OK, find out what's
	DECz	CHH		1A4E	C6 23	Page cross. where
	BNE	EXAM		1A50	DO 0D	unc. branch
ADD	CLC			1A52	18	Get set to add
	ADCz	RcL		1A53	69 39	Add
	STAZ	CHL		1A55	B5 22	Store the low part
	LDAz	RcH		1A57	A5 3A	Fetch the high part
	STAZ	CHH		1A59	B5 23	Store it
	BCC	EXAM		1A5B	90 02	OK, what's there
	INCz	CHH		1A5D	E6 23	Page crossing
EXAM	LDAiy	CHL		1A5F	B1 22	Fetch the neighbor
	CMPI	S1asc		1A61	C9 51	data byte, and see
	BNE	NEXT		1A63	DO 02	if it's occupied
	INCz	N		1A65	E6 32	Accumulate # of nbrs.
NEXT	DEX			1A67	CA	
	BNE	OPFS		1A68		Not done
	PLA	TAX	PLA	1A6A	68 AA 68	Restore X,Y from stack
	TAY	RTS		1A6D	A8 60	

The program may be broken down into manageable chunks by sub-routining. There follows a brief description of the salient features of each section:

MAIN (hex 1900)

In a fit of overcaution (since this was the first time I attempted to write a P.E.T. machine language program) you will notice the series of pushes at the beginning and pulls at the end. I decided to save all the internal registers in the stack in page 1, and also included the CLD (clear decimal mode) just in case. Then follows a series of sub-routine calls to do the LIFE generation and display transfers. Notice that the all-capital symbols refer to specifically labelled addresses, and the first letter capitalized symbols refer to zero page locations. The zero page location, Times, is a counter to permit several loops through LIFE before returning. As set up, Times is initialized to zero (hex location 1953), so that it will loop 256 times before jumping back. This of course can be changed either initially or while in BASIC via the POKE command. The return via JMP BASICON (4C 8B C3) may not be strickly orthodox, but it seems to work OK.

INIT (hex 1930) and DATA (hex 193B)

This shorty reads in the constants needed, and stores them in page zero. Scr refers to the PET screen, Temp is a temporary working area to hold the new generation as it is evolved, and Rcs is essentially a copy of the PET screen data, which I found to be necessary to avoid "snow" on the screen during the read/write operations directly on the screen locations. Up, Down, etc. are the offsets to be added or subtracted from an address to get all the neighbor addresses. The observant reader will note the gap in the addresses between some of the routines.

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TEMP→SCR (hex 1970)

This subroutine quickly transfers the contents of Temp and dumps it to the screen, using a dot (81_{dec}) symbol for a live cell (a 1 in Temp) and a space (32_{dec}) for the absence of a live cell (a 0 in Temp).

SCR→TEMP (hex 198A)

This is the inverse of TEMP→SCR, quickly transferring (and encoding) data from the screen into Temp.

RESTORE (hex 19A6)

This subroutine fetches the initial addresses (high and low) for the Scr, Temp, and Rcs memory spaces.

NEXTADDR (hex 19BD)

Since we are dealing with 1000 bytes of data, we need a routine to increment to the next location, check for page crossing (adding 1 to the high address when it occurs), and checking for the end. The end is signaled by returning a 01 in the accumulator, otherwise a 00 is returned via the accumulator.

TEMP→RCS (hex 19E6)

The Rcs address space is a copy of the screen, used as mentioned before to avoid constant "snow" on the screen if the screen were being continually accessed. This subroutine dumps data from Temp, where the new generation has been computed, to Rcs.

GEN (hex 1A00)

We finally arrive at a subroutine where LIFE is actually generated. After finding out the number of neighbors of the current Rcs data byte from NBRS, GEN checks for births (CMPim 03 at hex addr. 1A0E) if the cell was previously unoccupied. If a birth does not occur, there is an immediate branch to NEXTADDR (the data byte remains 00). If the cell was occupied (CMPim 81_{dec} at hex 1A08), GEN checks for survival (CMPim 03 at hex 1A1A and CMPim 02 at hex 1A1E), branching to NEXTADDR when these two conditions are met, otherwise the cell dies (LDAim 00 at hex 1A22). The results are stored in Temp for the 1000 cells.

NBRS (hex 1A2F)

NBRS is the subroutine that really does most of the work and where most of the speed could be gained by more efficient programming. Its job, to find the total number of occupied neighbors of a given Rcs data location, is complicated by page crossing and edge boundaries. In the present version, page crossing is taken care of, but edge boundaries (left, right, top, and bottom of the screen) are somewhat "strange". Above the top line and below the bottom line are considered as sort of forbidden regions where there should practically always be no "life" (data in those regions are not defined by the program), but I have found that there has never been a case where 81's have been present (all other data is considered as "unoccupied characters"). The right and left edges are different, however, and lead to a special type of "geometry". A cell at either edge is not considered as special by NBRS, and so to the right of the right-edge location is the next sequential address. On the screen this is really the left edge location, and one line lower. The inverse is true, of course for left addresses of left-edge locations. Topologically, this is equivalent to a "helix". No special effects of this are seen during a simple LIFE evolution, since it just gives the impression of disappearing off one edge while appearing on the other edge. For an object like the "spaceship" (see Sci. Am articles), then, the path eventually would cover the whole LIFE arena. The fun comes in when a configuration spreads out so much that it spills over both edges, and interacts with itself. This, of course cannot happen in the infinite universe, so that some of the more complex patterns will not have the same fate in the present version of LIFE. Most of the "blinkers", including the "glider gun" come out OK.

This 40x25 version of LIFE can undoubtedly be made more efficient, and other edge algorithms could be found, but I chose to leave it in its original form as a benchmark for my first successfully executed program in writing machine language on the PET. One confession, however - I used the KIM-1 to debug most of the subroutines. Almost all of them did not run on the first shot! Without a good understanding of PET memory allocation particularly in page zero I was bound to crash many times over, with no recovery other than pulling the plug. The actual BASIC program consisted of a POKING loop with many DATA statements (always save on tape before running!).

[ed. note: Frank Covitz also sent a 64x64 version of LIFE which we will be printing next issue. Frank had to wade through deciphering PET structure with no machine language monitor. He said he might do this version of LIFE differently if he had to do it over, but regardless, many thanks to him. I think the resulting program is extremely good.]

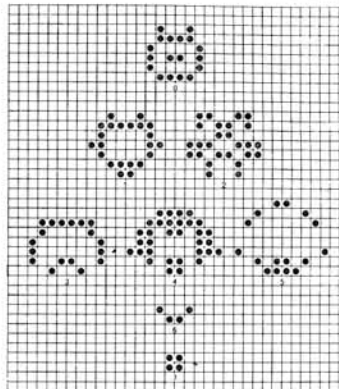
LIFE by Frank Covitz

```

5   A0=6459
10  FOR I=0 TO 307: READ A%:POKE A0+I,A%: NEXT I
20  RESTORE
30  PRINT "CLEAR SCREEN, THEN ENTER LIFE SEEDS (●),
    THEN 'HOME', 'GOTO 100'":END
100 POKE 1,59:POKE 2,25
110 X=USR(0)
120 GET C$
130 IF C$="S" THEN END
140 POKE 1,66
150 GOTO 110
6459 DATA 216,32,76,25,32,138,25
6466 DATA 32,230,25,32,0,26,32,112,25,96
6476 DATA 162,25,189,86,25,149,31,202
6484 DATA 208,248,96,0,128,0,21,0
6492 DATA 128,0,27,0,27,215,40,1
6500 DATA 254,216,214,41,39,0,232,131
6508 DATA 0,21,0,0
6512 DATA 32,166,25,177,38,208,6,169
6520 DATA 32,145,32,208,4,169,81,145
6528 DATA 32,32,189,25,240,237,32,166
6536 DATA 25,96,32,166,25,177,32,201
6544 DATA 81,240,6,169,0,145,38,240
6552 DATA 4,169,1,145,38,32,189,25
6560 DATA 240,235,32,166,25,96,169,0
6568 DATA 170,168,133,32,133,38,133,57
6576 DATA 165,37,133,33,165,41,133,39
6584 DATA 165,54,133,58,96,230,38,230,32,230
6592 DATA 57,232,228,51,240,12,224,0,208,14
6600 DATA 230,39,230,33,230,58,208,6,165,52
6608 DATA 197,33,240,3,169,0,96,169
6616 DATA 1,96,234,234,234,234,234,234
6624 DATA 32,166,25,177,38,208,6,169
6632 DATA 32,145,57,208,4,169,81,145
6640 DATA 57,32,189,25,240,237,32,166
6648 DATA 25,96
6656 DATA 32,166,25,32,47,26,177,57
6664 DATA 201,81,240,12,165,50,201,3
6672 DATA 208,20,169,1,145,38,208,14
6680 DATA 165,50,201,3,240,8,201,2
6688 DATA 240,4,169,0,145,38,32,189
6696 DATA 25,240,216,32,166,25,96,152
6704 DATA 72,138,72,160,0,132,50,162
6712 DATA 8,181,41,16,21,73,255,133
6720 DATA 55,56,165,57,229,55,133,34
6728 DATA 165,58,133,35,176,17,198,35
6736 DATA 208,13,24,101,57,133,34,165
6744 DATA 58,133,35,144,2,230,35,177
6752 DATA 34,201,81,208,2,230,50,202
6760 DATA 208,207,104,170,104,168,96

```

life seeds are shift Q



The 'spaceship' (Sci. Am articles) eventually would cover the whole LIFE arena. The fun comes in when a configuration spreads out so much that it spills over both edges, and interacts with itself.

PET Machine Language Programming
Raynor Taylor Charleston, SC

Try this little program

```
10 FOR A=6400 TO 6409
20 READ B
30 POKE A, B
40 NEXT A
50 SYS(6400)
60 DATA 162,0,138,157,80,129,232,208,249,96
70 END
```

Intrigued? Read on!

By just looking at the program in BASIC, you can see that the ten data elements are read and poked (written) into memory starting at decimal location 6400. These data elements make up a machine language subroutine that is executed by the statement in line 50. As you have probably already found out by running the BASIC program, the machine language subroutine causes all the printable characters to appear about half way down on the screen.

Below is a translation of the ten data elements into an easily read English-type format.

Step	Address in Memory Base 16	Instruction Codes Base 16	Mnemonic	Addressing Mode
#1	\$1900	A2 00	LDX	#\$00
#2	\$1902	8A	LP TXA	
#3	\$1903	9D 50 81	STA	\$8150, X
#4	\$1906	E8	INX	
#5	\$1907	D0 F9	BNE	LP
#6	\$1909	60	RTS	

The 6502 microprocessor in the PET, located at coordinates F-3 on the main board inside, basically has three registers -- A, X, Y. This program makes use of two, the A and X. Going through the program step by step, this is what happens:

Step	Effect
#1	Load zero into the X register
#2	Transfer X to A
#3	Store A at location \$8150+X (loc. \$8150 is the eight line on the screen)
#4	Add one to the X register
#5	Jump to step #2 if X does NOT equal zero (the X register starts all over at zero once the value of 256 is reached - thus this loop is repeated 256 times)
#6	Return to BASIC program

This machine language program uses only six of the 6502's 148 instructions. The six step program is also very small compared to the approximately 7000 step program in the PET's permanent memory. Nevertheless, the only way to learn about the PET's true brain is to write and experiment with small programs. A very helpful tool in writing machine language programs is the monitor. The monitor accepts your input, changes it into a computer readable form, and changes the computer's jibberish into the clear format illustrated above. You may find that some of your programs bomb -- that is just don't work and cause the computer to crash (go crazy) -- but don't worry, it happens to the best of us.

[ed. note: Raynor Taylor's program notes provide a good starting point if you haven't been exposed to machine language programming. His machine language program uses the X register as a counter, as an offset to determine the address in screen memory where the character will be stored, and as the character value itself. In step #5 the branch uses a relative address of -7 (1909-1902), or F9 in single byte 2 complement mode.

In the BASIC program, lines 10 through 30 store the DATA values in hexadecimal locations 1900 to 1909 (6400 to 6409 decimal). The program then branches to 6400 with the SYS(6400). The machine language routine executes and returns to the calling program. An approximate BASIC equivalent subroutine would be:

```
1000 I=0
1100 POKE 33104+I, I
1200 I=I+1
1300 IF I < 256 GOTO 1100
1400 RETURN
```

In Raynor's DATA statement line 60, he first had to convert the values in locations 1900 through 1909 to their decimal equivalent to obtain the data elements. To make this task easier, he has written a machine language monitor which he is selling for \$7.50 along with some sample programs (biorythm, pi calculation, a target game, and two others) and complete documentation. Write him at Qtrs 718, Charleston Naval Base, Charleston, SC 29408.]

Notes from Chuck Stuart Dallas, TX

PET Random Number Generator

Some mention was made in the first issue of PET User Notes about problems associated with the Random Number Generator (RNG). One problem that I have noticed that was not mentioned is the fact that, on power-up, the RNG always returns the same sequence of Random Numbers when any positive integer seed is used.

This becomes a problem when using the RNG in games and simulations because the sequence is predictable. For example, you come home each day after work, you turn your PET on and load in your favorite game, say Blackjack. It doesn't take long to realize that the first two hands dealt are always the same. And if these hands are played the same each day, then the second hands, etc., will also be the same.

Fortunately, by using the PET's TI\$ function, this predictability can be totally eliminated. The following line of code should be inserted just prior to the line that generates the random number for your program:

```
10 FOR I=1 TO VAL(RIGHT$(TI$,2)):R=RND(1):NEXT I
```

The odds against getting the same first number from power-up twice in a row are now 60 to 1. And the odds against getting the same first four cards in your favorite Blackjack game two days in a row are now 28,561 to 1. Your PET RNG will now generate truly random numbers, even just after power-up.

Floating Dollar Sign

Because of the leading space in front of any numeric character, some string manipulation is required in order to float a "\$" or anything else just to the left of a number in the PET. The following routine can be used for this purpose.

```
10 N=100
20 PRINT "I WON"; : GOSUB 100: PRINT " AT THE RACES."
30 END
100 X=1: IF N<=0 THEN X=0
110 PRINT "$"+RIGHT$(STR$(N), LEN(STR$(N))-X);
120 RETURN
```

RUN

I WON \$100 AT THE RACES.

Lines 100 through 120 float the dollar sign. 'X' is required because when a number is negative, a minus sign replaces the leading space.

Using the IEEE Port as a General Purpose Port

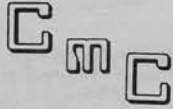
JR Kinnard Austin, TX

I think that many PET owners will find as I have that a single 8 bit user port is not satisfactory for many applications and that the IEEE-488 interface is too complex to use with home built hardware. Fortunately the IEEE port can be used very much like the User Port and has several advantages.

Data input to the IEEE DIO lines must be at TTL levels and is buffered into the 'A' side of an MCS6520 Peripheral Interface Adapter (PIA). Input data can be read from the DIO lines by a PEEK(59424). Data to be output on the DIO lines is buffered out of the 'B' side of the PIA. A POKE 59426, Data will transfer the data to the port. The DIO lines have a current sinking capability of 48 MA - much more than the 1.6 MA of the User Port. You must write all ones (255) into the output buffer before an input operation or a combination of input and output data will be read.

Output lines CA2 and CB2 are available from the PIA and are labeled NDAC and DAV, respectively, at the IEEE port. CA2 can be set to a low level by a POKE 59425,52 or to a high level by POKE 59425,60. CB2 can be controlled in the same way at address 59427.

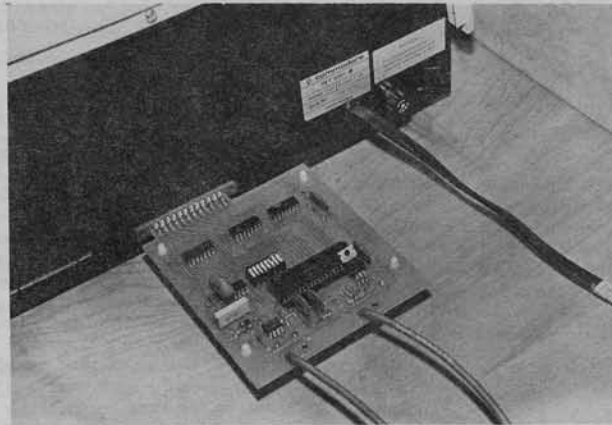
Two other output lines on the IEEE port are PB1 and PB3 from the MCS6522 that drives the User Port. PB1 is labeled NRFD and PB3 is ATN on the IEEE connector. Outputs to these lines are bits 1 and 3 (values 2 and 8) of the register at address 59456.



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7331

PET Plays MUSIC
Frank Alexander, 570 Juniata Ave., Swarthmore, PA 19081

JR Kinnard showed us how to use the 6522 shift register to make square waves with the PET. Well, once you have an audio oscillator you have the start of a music generator.

The program MUSIC sets up the 6522 as an oscillator, takes a note from DATA statements, interprets it as a setting for repetition-rate command (POKE 59464,R), and holds that note until a timing loop is finished.

You can take a piece of sheet music and write the DATA as note pairs, e.g. C#,2 is a quarter note; F,3 a dotted quarter; Z,0 a short rest; Z,8 a long rest; etc.

All you need for output is a simple loudspeaker & buffer amplifier connected to CB2 on the User Port of the PET. I used an ordinary tape recorder as a handy buffer. These are big signals, about 4 volts. The amplifier protects the PET from inductive kick-back at the ends of the sharp pulses from the 6522.

```

10 POKE 59467,16:REM SET FREE-RUNNING
12 INPUT "D(15,51,81...),T2(100)";D,T3
14 T2=T3
15 POKE 59466,D
17 POKE 59464,0
18 GOSUB 6800
20 READ R$,T
22 PRINT R$"...T" "D
25 IF R$="XX" THEN GOTO 900
30 GOSUB 10000
40 GOSUB 6000
90 GOTO 20

499 REM MUSIC NOTES & TIME
500 DATA C1,2,B,2,A,2,G,2,F,2,E,2
...
582 DATA C,2,C#,2,D,2,D#,2,E,3,Z,1
584 DATA C,1,D,1,E,1,F,2,E,2,D,2,C#,2,C,2,C#,2,D,2,Z,1
...
599 DATA XX,0
900 RESTORE
901 TEST=TEST+1:T2=INT(T2*.7)
902 ON TEST GOSUB 100,101,102,103,104,105,106,108,109
903 IF TEST>9 THEN GOTO 14
904 GOTO 15:REM ENDLESS VERSION
908 REM .. RUN 909 TO CLEAR SHIFT REG
909 PRINT PEEK(59467),"59467"
990 POKE 59464,221
995 POKE 59466,0
999 POKE 59467,0:END

```

```

6000 POKE 59464,R
6005 IF T<1 THEN GOTO 6020
6010 ON T GOTO 6100,6200,6300,6400,6600,6800,6900
6020 FOR T1=1 TO 2: NEXT T1: RETURN
6100 FOR T1=1 TO T2: NEXT: RETURN
6200 FOR T1=1 TO 2*T2:NEXT: RETURN
6300 FOR T1=1 TO 3*T2:NEXT: RETURN
6400 FOR T1=1 TO 4*T2:NEXT: RETURN
6600 FOR T1=1 TO 6*T2:NEXT: RETURN
6800 FOR T1=1 TO 8*T2:NEXT: RETURN
6900 FOR T1=1 TO 12*T2:NEXT:RETURN
6999 REM TONES, TIME SUB

```

```

10000 REM INTERPRETER SECTION
10010 IF R$="B0" THEN R=251
10020 IF R$="C" THEN R=237
10030 IF R$="C#" THEN R=224
10040 IF R$="D" THEN R=211
10050 IF R$="D#" THEN R=199
10060 IF R$="E" THEN R=188
10070 IF R$="F" THEN R=177
10080 IF R$="F#" THEN R=167
10090 IF R$="G" THEN R=157
10100 IF R$="G#" THEN R=149
10110 IF R$="A" THEN R=140
10120 IF R$="A#" THEN R=132
10130 IF R$="B" THEN R=124
10140 IF R$="C1" THEN R=117
10150 IF R$="C1#" THEN R=111
10160 IF R$="D1" THEN R=104
10170 IF R$="D1#" THEN R=99
10180 IF R$="E1" THEN R=93
10190 IF R$="F1" THEN R=88
10200 IF R$="F1#" THEN R=83
10210 IF R$="G1" THEN R=78
10220 IF R$="G1#" THEN R=73
10230 IF R$="A1" THEN R=69
10240 IF R$="Z" THEN R=0
10999 RETURN

```

```

100 D=81:RETURN
101 D=85:RETURN
102 D=10:RETURN
103 D=15:RETURN
104 D=20:RETURN
105 D=30:RETURN
106 D=40:RETURN
107 D=50:RETURN
108 D=5:RETURN
109 D=10:RETURN

```

[ed. note: For background for this music program refer to JR Kinnard's article on generating square waves (volume 1, issue 2). Frank's program asks for inputs at line 12 to define the wave and the overall song tempo. Frank's suggested values are 15, 51, or 85 for D, and 100 for T2 (tempo). The program basically loops (lines 20-90) reading the next note and duration pair from DATA statements beginning at 500, and ending when "XX" is read to indicate song end. Lines 901-904 and 100-109 are used to vary the tone and tempo, and could be omitted if you desire.

If you want to pursue Frank's music program, he will send you a cassette with sample songs, instruction sheet and a schematic of a single transistor amplifier for \$5.]

PET User Group
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Morton Grove, IL 60053

