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1989
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5. Monthly entries must be received no later than the last day of the month in which a drawing will take place in order to participate in the month's drawing. Drawings will be held from December, 1988 through April 1989, inclusive. Final entries must be received by 4/30/89.
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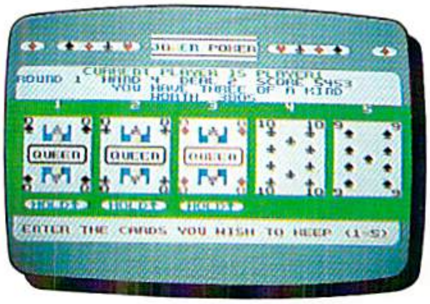

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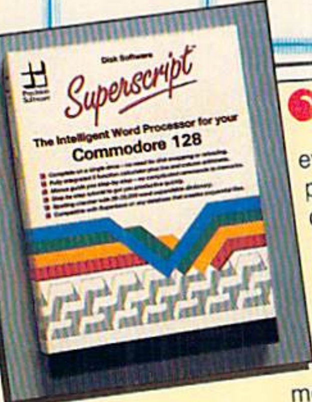

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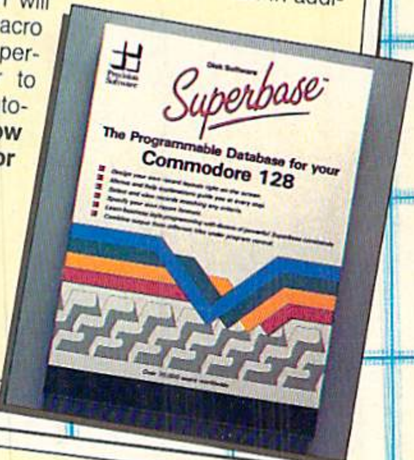

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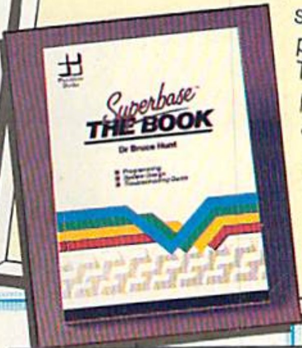

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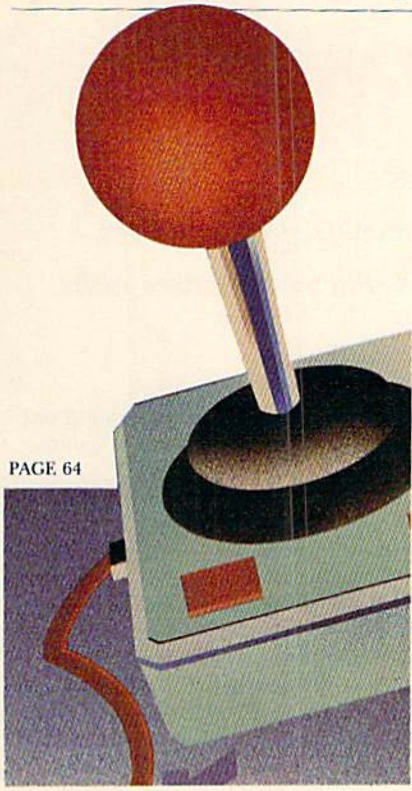
This computer prize (worth over $1400) comes complete with computer, peripherals and productivity software. It could be yours for free! All you have to do is fill out the entry form (see page 97). Send in your entry by March 1, 1989, for your chance to win this state-of-the-art computer system!

RUN magazine extends its appreciation to **Tussey Computer Products**, who served as supplier of the hardware prizes.

To enter, simply fill out the entry form or a facsimile on page 97. All entries must be postmarked by March 1, 1989. Only one entry per household. The odds of winning will depend on the number of entries received. Taxes and duties on the prize are the sole responsibility of the winner. No substitutions will be made for any of the prizes. The prize is guaranteed to be awarded. All federal, state and local laws apply. Void wherever prohibited by law. Open to residents of U.S., its possessions, Canada and Mexico. Anyone of any age may enter, but if won by a minor, the prize must be claimed by parent or legal guardian. Employees of IDG/Peterborough, its affiliates, subsidiaries, advertising and promotion agencies and the families of each are not eligible to enter. The winner will be selected in a random drawing held on March 31, 1989. *RUN* magazine will not be held responsible for lost, misdirected or late mail.

C O N T E N T S

SPECIAL ISSUE 1989



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FEATURES

DEPARTMENTS

ABC

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RUNNING RUMINATIONS

Our fifth annual Special Issue for Commodore 64 and 128 owners, programmers, non-programmers, experienced and novice users alike.

Imagine that you're a magazine editor assigned the task of producing one issue to address the needs of Commodore users. What information would you include?

That's the question we posed as *RUN* editors assembled to formulate plans for this year's special issue.

"Let's do a programming issue," suggested one software techie, busily coding a program to cheat on his taxes.

"Hey, don't forget games," yelled the resident game junkie, carefully polishing his collection of joysticks.

One wily veteran chimed in, "Remember, our readers have always regarded the Magic and Commodore Clinic columns as their favorite features. We mustn't exclude either of them."

"Hey, how about a contest to give someone a chance to win a complete 128D system?" said one part-time staff member under the age of 18 and void where prohibited by law.

"Why not make the programs in the magazine available on disk so readers don't have to type in listings?" said the bleary-eyed proofreader, recovering from an overdose of machine language code. "And," she added, "we could offer some bonus programs, as well, to fill up the disk."

"Anything else?" asked the editor, furiously taking notes.

"I'll be sure to contact only the top authors and programmers in the industry to contribute," said the assignments editor, looking at his watch to determine the time in the South China Sea.

"Don't forget our programmer's wall chart, which is a big hit each year!" remarked one resourceful editor who had wallpapered her bathroom with charts from previous years.

"Aw, I don't have room on my walls for another poster," grumbled one worker. "Let's try something different—something readers will really remember this issue by."

"I've got it!" cried a voice of reason in the midst of impending chaos. "A folding programming card that users can tear out of the magazine and easily refer to while computing!"

"Those ideas are great," said the grizzled editor, "but I insist on one thing: This issue must contain something for everyone. Target the articles to address new computer owners, experienced computerists, novices, programmers, non-programmers, dabblers and dynamos. There must be something here for everyone, no matter what their level of expertise."

So here you have it—our fifth annual Special Issue, full of fun and solid C-64 and C-128 information that you'll want to refer to throughout the year.

You'll learn some fundamental programming techniques and, at the same time, improve your programming skills. Answers to your Commodore computing questions. Never-before-published Magic tricks. Blockbuster programs, games, applications, utilities, tutorials. Plus, a chance to win a complete 128D computer system worth over $1400. And, the *piece de resistance*, our unique programmer's reference card that you can just tear out of the magazine and easily carry around in your shirt pocket.

For those who are familiar with our previous issues, you can expect more of the same quality editorial. For those who are new to *RUN*, welcome! You're in for a treat.

Dennis Brisson
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Magic

This is our fifth Special Issue Magic, containing some 50 Magic tricks. Unlike most of the previous Special Issues, where we included the best tricks from the year's regular issues of RUN, *this time all the tricks are brand new. So warm up your machine and bring some magic to the new year.*

◇

Compiled by TIM WALSH

LET'S TALK ABOUT the weather a moment. The summer of '88 will be remembered by New Englanders as the Thunderstorm Summer, with one storm following another from late June to late August. The frequent lightning also makes sitting at the computer and typing in Magic tricks a thrilling but dangerous sport.

As a storm approaches, most folks turn off their computer, television and other electrical devices, and if you don't, you should. Moreover, although you may keep your computer systems plugged into power strips equipped with on/off switches, even the best surge-protectors don't guarantee them immunity from lightning damage unless they're unplugged from the wall outlet.

Oh-oh. I see white flashes through the windows, so I must quickly save what I've written so far, and then unplug my system. I hope *RUN* readers will heed my hint when they read this Special Issue months from now.

—TIM WALSH, MAGIC COLUMNIST

1. C-64 Programming

C-64 Sight Saver

The C-64's 16 colors look great, but getting a favorite screen, border and character-color combination involves a time-consuming process of finding the right Poke commands and keypresses. That's why I wrote C-64 Sight Saver. Just load and run it before a programming session. You'll then be able to change the background, border and cursor colors at will by holding down the F1, F3 and F5 keys, respectively. A built-in delay allows about one second between color changes.

```
Ø REM C-64 SIGHT SAVER - MARC TEMANSON
                                        :REM*25Ø
1Ø FOR X=49152 TO 49223:READA:POKEX,A:NEXT
   :SYS 49152:NEW                       :REM*48
2Ø DATA 12Ø,169,192,141,21,3,169,13,141,2Ø
   ,3,88,96,165,162,2Ø1,Ø,24Ø,15        :REM*11
3Ø DATA 2Ø1,64,24Ø,11,2Ø1,128,24Ø,7,2Ø1,19
   2,24Ø,3,76,49,234,165,2Ø3,2Ø1,4:REM*1Ø3
4Ø DATA 24Ø,11,2Ø1,5,24Ø,13,2Ø1,6,2Ø8,21,7
   6,63,192,238,33,2Ø8,76,49,234        :REM*32
5Ø DATA 238,32,2Ø8,76,49,234,238,134,2,76,
   49,234,76,49,234                     :REM*232
```

—MARC TEMANSON, PEABODY, KS

Clearing 64 Graphic Areas

I wrote this versatile machine language routine to rapidly clear the C-64's hi-res screen in less than one second. Use it as a routine to clear the hi-res screen between loads. After running the program, poke the page number of the bit-mapped screen currently in memory in location 49153. The page number is determined by dividing the starting address by 256. For example, a screen with a starting address of 7168 requires the following command to be entered in Direct mode:

POKE 49153,28

If a page is not set, the program assigns a default page 32 address (memory location 8192).

```
Ø REM 64 HI-SPEED HI-RES SCREEN CLEARER -
   SAULO DE LUCENA COELHO               :REM*39
1Ø FOR I= 49152 TO 49197:READ A:B=B+A:POKE
   I,A:NEXT                             :REM*81
2Ø IF B <> 7171 THEN PRINT "ERROR IN DATA
   STATEMENTS":END                      :REM*14Ø
3Ø DATA 169,32,133,252,169,Ø,133,251,24,16
   5,252,1Ø5,31,133,254,16Ø             :REM*178
4Ø DATA Ø,152,145,251,24,165,251,1Ø5,1,133
   ,251,165,252,1Ø5,Ø,133               :REM*237
5Ø DATA 252,165,251,2Ø1,64,2Ø8,234,165,252
   ,197,254,2Ø8,228,96                  :REM*222
```

—SAULO DE LUCENA COELHO, BETHESDA, MD

64 Hi-Res Made Easy

High-resolution graphics performed from Basic on the C-64 is a concentrated study in peeking, poking, setting and clearing that tends to discourage all but the most ambitious programmers. Furthermore, unless you use a hi-res machine language utility, such as the above trick, setting up a hi-res screen from Basic is a slow process, requiring about 30 seconds. ►

ILLUSTRATED BY CHERYL GRIESBACH/STANLEY MARTUCCI

I wrote Hi-Res Set-Up and Clear for the C-64 to make the process more user-friendly and much faster. In fact, the first (main) program, like the above trick, clears a hi-res screen on the C-64 in less than one second, and also sets it up for use with other graphics programs. It can be appended to an existing Basic program or used as a stand-alone.

The second program is a short Basic program that shows when and how to activate the main program with a SYS 49152 and then plot a sine wave. Users can change the foreground and background colors of the hi-res screen, both of which share memory location 49205, which is currently a 16 for a black foreground and a white background. Try experimenting with various colors by poking different values into that location. You're certain to find uses for Hi-Res mode now that accessing it is much easier.

```
Ø REM 64 HI-RES SETUP PROGRAM - MIKE CORRI
  GAN                                :REM*77
1Ø T=Ø                               :REM*8Ø
2Ø FOR X=49152 TO 49216:READ A:POKE X,A:T=
   T+A:NEXT                          :REM*115
3Ø IF T <> 898Ø THENPRINT"ERROR IN DATA ST
   ATEMENTS...":END                  :REM*175
4Ø DATA 169,Ø,133,251,169,32,133,252,162,3
   1,16Ø,Ø,169                       :REM*237
5Ø DATA Ø,145,251,2ØØ,2Ø8,251,23Ø,252,2Ø2,
   16,246,173                        :REM*162
6Ø DATA 17,2Ø8,9,32,141,17,2Ø8,173,24,2Ø8,
   9,8,141,24                        :REM*2Ø9
7Ø DATA 2Ø8,169,Ø,133,251,169,4,133,252,16
   2,3,16Ø,Ø,169                     :REM*85
8Ø DATA 16,145,251,2ØØ,2Ø8,251,23Ø,252,2Ø2
   ,16,246,96                        :REM*162
9Ø REM - HIRES DEMO PROGRAM #2 BELOW
                                     :REM*223
1ØØ POKE 5328Ø,Ø:REM BLACK BORDER   :REM*32
11Ø SYS 49152:REM CLR SCREEN & ACTIVATE HI
    -RES MODE                        :REM*23
12Ø S=8192:REM STARTING POINT ON SCREEN
                                     :REM*238
13Ø FORX= Ø TO 319 STEP .5           :REM*4
14Ø Y=INT(6Ø+5Ø*SIN(X/1Ø)):REM CALCULATE Y
                                     :REM*24Ø
15Ø C=INT(X/8):REM CHARACTER POSITION
                                     :REM*25
16Ø R=INT(Y/8):REM ROW               :REM*213
17Ø L=Y AND 7:REM LINE               :REM*122
18Ø B=S+R*32Ø+8*C+L:REM BYTE         :REM*75
19Ø I=7-(X AND 7):REM BIT            :REM*112
2ØØ POKE B,PEEK(B) OR (2{UP ARROW}I):REM S
    ET BIT                           :REM*58
21Ø NEXT X                           :REM*6
22Ø GOTO 22Ø:REM FREEZE SCREEN       :REM*1Ø9
```

—Mike Corrigan, Carrollton, TX

Doodle! Displays Made Simple, Too!

You can display Doodle! screens in your own C-64 programs and not have to worry about fancy programming, Peeks, Pokes or Graphics modes. Just load in any Doodle! screen in either Direct or Program mode with the command:

LOAD "DDFILENAME",8,1

Next, activate my program from either Direct or Program mode. Whenever you want to display the screen, place a SYS 51200 in either (you guessed it) Program or Direct mode, and the Doodle! screen will appear.

For added convenience, this routine is designed so that pressing the space bar returns the computer to the exact point in the program where you left off.

```
Ø REM C-64 DISPLAY DOODLE! - JEREMIAH MANN
                                     :REM*98
1Ø FOR T=512ØØ TO 5124Ø:READ D:POKE T,D:CK
   =CK+D:NEXT                        :REM*92
2Ø IF CK<> 5Ø29 THEN PRINT"ERROR IN DATA S
   TATEMENTS":END                    :REM*189
3Ø PRINT"OK, TO DISPLAY DOODLE!, ENTER SYS
    512ØØ"                           :REM*18
4Ø DATA 169,59,141,17,2Ø8,169,12Ø,141,24,2
   Ø8,169,198,141,Ø,221,32,228       :REM*166
5Ø DATA 255,2Ø1,32,24Ø,3,76,15,2ØØ,169,2Ø,
   141,24,2Ø8,169,11,141,Ø,221       :REM*8
6Ø DATA 169,27,141,17,2Ø8,96         :REM*216
```

—Jeremiah Mann, Visalia, CA

2. C-128 Programming

Functional C-128 Function Keys

Any time Commodore 128 users want to work on a program, they can load such files from disk more easily with my DLoad Key Assignment program.

The program, when run, prompts you to enter a number between 1 and 10. Numbers 1 through 8 program the corresponding function key to load a file. Number 9 lets shift/run-stop load a file, and 10 tells the help key to load a file.

Once you've run the program and assigned a key, list the directory, move the cursor up to the filename you want to load and press your designated load key. The word DLoad appears, the filetype PRG disappears and the program loads. Change the value of L$ to "RUN" if you prefer to run a program rather than just load one.

```
Ø REM C-128 DLOAD KEY ASSIGNMENT - LEO BRE
  NNEMAN                             :REM*66
1Ø PRINTCHR$(147)"ENTER 1 THRU 1Ø TO PROGR
   AM"                               :REM*21
2Ø PRINT"A FUNCTION KEY, RUN/STOP OR HELP.
   ":INPUTA                          :REM*182
3Ø L$="DLOAD"+CHR$(34)+CHR$(27)+"O"+CHR$(2
   7)+CHR$(75)+CHR$(2Ø)+CHR$(2Ø)+CHR$(2Ø)+
   CHR$(13)                          :REM*1ØØ
4Ø L=LEN(L$):X=252:P=POINTER(L$)     :REM*183
5Ø BANK1:POKEX,PEEK(P+1)             :REM*5Ø
6Ø POKEX+1,PEEK(P+2):POKEX+2,1       :REM*164
7Ø BANK15:SYS 65381,X,A,L            :REM*1Ø9
8Ø BANK1:POKEX,PEEK(P+1)             :REM*84
9Ø POKE X+1,PEEK(P+2):POKEX+2,1      :REM*13Ø
```

—Leo Brenneman, Erie, PA

Re-initializing C-128 Function Keys

When you exit most C-128 programs, one or more function keys are either still re-defined to the program's definitions, or, more likely, they contain no definitions at all. You normally have three choices to restore the keys to their default C-128 definitions: Load a binary or Basic file of previously saved key definitions from disk, type in the definitions again, or reset the computer and lose the Basic program in memory. A fourth option is the best choice: Enter the following command in either Program or Direct mode:

BANK 15: SYS 49425: SYS 52526.

This is the same code used internally by the C-128 to install the default function key definitions on start-up or reset.

—MICHAEL MCGUIRE, COLORADO SPRINGS, CO

GETTING C-128 HI-RES INTO DOODLE!

C-128 hi-res graphics screens can easily be loaded into Doodle! and Doodle!-compatible programs. Make sure you're in Graphics 1 mode and have a drawing on the hi-res screen. Then, hold down the run-stop key to halt program execution. Now, because you're in Graphics 1 mode, you can't see the text you're about to type, but don't worry. Just carefully enter the following statement:

BSAVE"DDFILENAME",B0,P7168 to P16192 <press return>

Your hi-res screen is now saved to disk in Doodle! format and can be loaded as a standard Doodle! screen.

—ALFREDO PADILLA, CUDAHY, CA

BLOAD IT!

C-128 users with 1571 or 1581 drives have a wonderful speed advantage over 1541 users. Unfortunately, many great utilities, games, and applications work exclusively in 64 mode. Did you know that most machine language programs loaded in 128 mode will still be there once you switch to 64 mode? About the only exception are those containing zero page work areas and copy-protected commercial programs.

So, the next time you want to load in that long ML utility for the C-64, BLoad it in C-128 mode first, type GO64, then enter the SYS command to activate the program as you normally would. It'll be up and running in a fraction of the time.

—JOHN RYAN, BILOXI, MS

RESCUING C-128 PROGRAMS

One of the most valuable tricks long-time C-128 users know is the program-rescue technique with the run-stop key. Should your C-128 lock up while running a program in 128 mode, don't despair. Hold down the run-stop key and press the reset button. Unless memory is corrupted by the lock-up, you'll start up in the C-128's machine language monitor. Press X and return, then list your program. Most of the time, it will still be intact.

—DOUGLAS JOHNSON, LARGO, FL

SELECTIVE C-128 RUN-STOP DISABLE

If you write C-128 programs, you'll like using this simple but powerful command to enhance them. Just place these two lines at the beginning of your programs:

```
10 TRAP 15
15 IF ER=30 THEN RESUME
```

By placing the Trap command in line 10, the computer branches to line 15 whenever it encounters an error. The ER=30 in line 15 tells the computer when the run-stop key is pressed, without disturbing the program's execution. The run-stop/restore key combination is unaffected.

—JOHN P. ROBINSON, JACKSON, MO

MORE ON TRAPPING RUN-STOP

In the previous trick, the Trap command instructs the C-128 to detect errors, and it can also be a useful key press detector for the run-stop key. The following program shows how to configure the Trap statement so that when you press the run-stop key, it will abort a menu selection and send you back to the main menu. Try this technique in your next C-128 program.

```
Ø REM TRAPPING C128 RUN/STOP KEY PRESSES -
   JEROME E. REUTER                    :REM*186
5 TRAP 6Ø                              :REM*217
1Ø GOTO 3Ø                             :REM*136
2Ø PRINT"STOP KEY SENDS BACK TO MAIN MENU"
   :GOTO 5                             :REM*14
3Ø PRINT"CHOOSE 1, 2 OR 3"             :REM*76
4Ø DO:GETA$:LOOP UNTIL VAL(A$)>Ø AND VAL (
   A$) <4                              :REM*42
5Ø RUN                                 :REM*188
6Ø CLOSE 4:GOTO 2Ø                     :REM*54
```

—JEROME E. REUTER, LADSON, SC

2 COMPARING FILES

Most Commodore computerists know that Basic programs residing in memory can be compared—from Direct mode—with files on disk by using the Basic 2.0 Verify and Basic 7.0 DVerify commands. If you'd like to try this command, type in a short program, such as:

10 PRINT"LET'S VERIFY THIS PROGRAM"

Save it to disk with the filename TEST. Immediately following the save operation enter, in Direct mode:

VERIFY"TEST",8 (Note: C-128 users can type: DVERIFY"TEST")

You'll get a message on the screen stating either OK or, if you made changes to the program after the save, ?VERIFY ERROR. While this process works fine with Basic programs, it won't work with binary (machine language) or program files created on word processors.

However, C-128 users, regardless of their programming skill levels, can use their computer's built-in machine language monitor to make effective binary comparisons of either two binary files or two word processor program files on disk. Here's how:

Load in the first file to compare into free memory in bank 0, using the command:

BLOAD"FILENAME",B0,P(DEC("1300"))

Immediately load the second file in bank 1, using the command:

BLOAD"FILENAME",B1,P(DEC("1300"))

Now press the F8 key to access the ML monitor, and find the end of the first file in bank 0 by entering:

M 1300<return>

Keep pressing M and return until you see an area of empty memory designated by a screenful of repeating numbers. Then write down the last memory location containing data ►

from your first file, which, for demonstration purposes, is 15CA. Now enter:

C 1300 15CA 11300

The first file in memory locations 1300 to 15CA is compared with the second file in bank 1, location 1300 (bank 1 memory addresses are prefixed with a 1). Any memory location that does not correspond is listed on the screen. Practice a few times with this technique, and you'll wonder how you ever lived without your C-128's ML monitor.

—VIRGIL PETERSON, KITTERY, ME

SQUEEZING MORE INTO HELP

Commodore 128 programmers can redefine the help key as a function key. For example, the following two program lines reconfigure the help key to switch the 1571 disk drive to 1541 mode. Accessing the help key is performed via the BANK15: SYS 24812,,9,,, command in line 20.

```
10 A$=CHR$(34)
20 BANK 15:SYS24812,,9,,,"OPEN15,8,15,"+A$+"U0>M0"+
   A$+":CLOSE15"+CHR$(13)
```

—PETE LOWAS, HOT SPRINGS, AR

C-128 PIANO KEYPAD

Turn your C-128's numeric keypad into a piano with this short program. Use numbers 1 through 9 to play notes, the decimal point to insert rests and zero to replay your composition.

```
Ø REM KEYPAD PIANO - ANDREW WATZNAUER
                                       :REM*46
1Ø SCNCLR:PRINT"{2 CRSR DNs} 7:G 8:A 9:B
                                      :REM*11Ø
2Ø PRINT" 4:C 5:D 6:E                 :REM*185
3Ø PRINT" 1:F 2:G 3:A                 :REM*127
4Ø PRINT" Ø:PLAY .:REST                :REM*71
5Ø DIMA(2ØØ):FORN1= 1 TO 9            :REM*1Ø1
6Ø READN2$:N$(N1)=N2$                  :REM*87
7Ø NEXT                               :REM*2ØØ
8Ø DATA "Ø4QF","Ø4QG","Ø4QA","Ø4QC","Ø4QD"
   ,"Ø4QE","Ø3QG","Ø3QA","Ø3QB"       :REM*131
9Ø GETKEYA                            :REM*179
1ØØ IF PEEK(212)=82THEN N$(A)="R":GOTO 12Ø
                                      :REM*176
11Ø IFA=Ø THEN PLAY N3$                :REM*84
12Ø PLAY N$(A)                         :REM*99
13Ø N3$=N3$+N$(A)                     :REM*117
14Ø GOTO9Ø                             :REM*21
```

—ANDREW WATZNAUER, NEW EGYPT, NJ

C-128 HI-RES TEXT MODE

Commodore 128 owners are going to be in for a treat when they see this wild trick. It displays a hi-res image and lo-res text simultaneously on the 40-column screen. Type in the program, using *RUN*'s Checksum, save it and then run it to see an example of this technique in action.

When the demo is finished, delete line 40 and save it to disk under a different filename.

Now you can enter graphics commands and watch the effect instantly, without the usual split-screen. For example, at the ready prompt, enter: BOX 1,0,0,319,199.

The program works by toggling between Hi-Res mode and Text mode 60 times per second to give the illusion of both Text and Hi-Res mode sharing the same screen.

```
Ø REM C-128 GRAPHICS & TEXT - MARCO A. GON
  ZALEZ HAGELSIEB                      :REM*157
1Ø FOR I=2816 TO 2837:READD:POKE I,D:NEXT
                                      :REM*1Ø6
2Ø COLORØ,7:COLOR4,7:COLOR1,15:GRAPHIC1,1:
   GRAPHICØ:SCNCLR:PRINT"TEXT & GRAPHICS":
   CHARØ,Ø,2Ø                          :REM*137
3Ø SYS 2816                           :REM*153
4Ø FORI=5 TO 9ØSTEP 5:CIRCLE 1,16Ø,1ØØ,I,I
   /2,Ø,36Ø,I*2,1Ø:NEXT:REM DEMO LINE!
                                      :REM*244
5Ø DATA 12Ø,169,13,141,2Ø,3,169,11,141,21,
   3,88,96,169,1,69,216,133,216,76,1Ø1,25Ø
                                       :REM*98
```

—MARCO A. GONZALEZ HAGELSIEB
GUADALAJARA, JALISCO, MEXICO

C-128 WINNING FANFARE

Commodore 128 users might want to add this winning fanfare to their Basic 7.0 programs to signal victory after winning or attaining a high score.

```
Ø REM C-128 WINNING FANFARE - J.R. CHARNET
  SKI                                  :REM*42
2Ø TEMPO25:WS$="V1O5T9QCFAO6HCO5QAO6HC"
                                       :REM*94
3Ø PLAY WS$                            :REM*4'
```

—JOSEPH CHARNETSKI, PLAINS, PA

3. C-64 AND C-128 PROGRAMMING

C-64/128 CURSOR WITH GET OR GETKEY

Most budding C-64 programmers know how to flash the cursor with the Get command, but few know the techniques for flashing a cursor with the Get and Getkey commands on the C-128.

My program flashes the cursor in 64 mode and in both the 40- and 80-Column modes on the C-128. When you first run the program, it determines which computer it's operating in, then performs a Poke for a flashing cursor. Poke 204,0 makes a cursor flash in 64 mode, while Poke 2599,0 uses both the Get and Getkey commands to flash a cursor in the C-128's 40-Column mode. SYS 52591 also uses Get and Getkey to flash a cursor in the C-128's 80-Column mode.

```
Ø REM CURSOR WITH GET & GETKEY - LEO W. BR
  ENNEMAN                              :REM*91
1Ø IF PEEK(4Ø96Ø)THEN A=2Ø4:GOTO 4Ø:REM 64
   MODE                               :REM*253
2Ø IF RGR(.5)=Ø THEN A=2599:REM C128 4Ø-CO
   LUMN MODE                          :REM*129
3Ø IF RGR(.5)<>Ø THEN 5Ø:REM C128 8Ø-COLUM
   N MODE                             :REM*179
4Ø POKE A,Ø:GOTO 6Ø                   :REM*222
5Ø SYS 52591:REM 8Ø-COLUMN MODE ONLY
                                      :REM*191
```

```
60 PRINT"HERE'S GET WITH A CURSOR":REM*233
70 GETA$:IFA$=""THEN 70                :REM*33
```

—Leo W. Brenneman, Erie, PA

Improving Your Input

Anyone who's ever tried to place commas or colons in the text of a C-64 or C-128 Input statement knows the all-too-familiar Extra Ignored error message. That's because everything to the right of the comma or colon is truncated. Let's look at this problem by entering these three lines:

```
10 INPUT A$
20 PRINT "YOU ENTERED:"
30 PRINT A$
```

Now type in RUN. At the question-mark prompt, enter the following: A,B,C:D and press return. The following message will appear on the screen:

?EXTRA IGNORED YOU ENTERED: A

Now it's time for a little magic. Run the program again, except, at the question-mark prompt, enter "A,B,C:D". Using double quotes with Input statements means no more Extra Ignored messages!

—Steven E. Weigand, West Chester, PA

Catch-All Reset

Finally—a reset command for any Commodore 8-bit! No longer will you have to use 64 or 128 reset commands in your programs. By entering the following command in either Direct or Program mode, memory is cleared of Basic programs and the computer's start-up screen will appear:

```
SYS PEEK(65532)+256 * PEEK(65533)
```

To see the reset value of your computer, substitute the word PRINT for the word SYS in the above command.

—Robert V. Taylor, Little Rock, AR

Vertical Tabbing Made Easy

Though the C-64 and C-128 lack a Vertical Tab command, you can sometimes use Poke 214,X (X = screen line number minus one) for 64 mode, and, for 128 mode, Poke 235,X (X = screen line number minus one). For example, place the following command in your Basic program:

```
POKE 214,9:PRINT (or POKE 235,9:PRINT)
```

The cursor will appear at the beginning of line 10.

Bear in mind that while these are handy Pokes, they're not 100-percent reliable. Both the cursor's position at the time of execution and the design of your program can occasionally have an adverse effect on their operation. Also, remember that the Print command must follow both of these Pokes.

—E. Stuart Johnson, Athens, AL

No More Bland Print Statements!

Now you can get your C-64 and C-128 programs to print messages on the screen accompanied by all the clanging and clicking of those wonderful low-budget science fiction movie computers. Don't put it off any longer—add my program, Sci-Fi Telemessage to both your C-64 and C-128 programs and place your message in A$. No doubt Buck Rogers would. ►

```
Ø REM 64/128 SCI-FI TELEMESSAGE - RICHARD
  PENN                                :REM*186
1Ø INPUT"ENTER A MESSAGE";A$:REM OR USE '1
   Ø A$="SAMPLE TEXT"'                :REM*71
2Ø FOR L=54272 TO 54296:POKEL,Ø:NEXT
                                      :REM*2Ø
3Ø POKE 54296,15:POKE 54277,Ø:POKE 54278,2
   4Ø:POKE 54273,34:POKE 54272,75  :REM*35
4Ø POKE 54284,Ø:POKE 54285,24Ø:POKE 5428Ø,
   14:POKE 54279,24                :REM*39
5Ø FORT=1 TO LEN(A$):PRINTMID$(A$,T,1)"{CO
   MD @}{CRSR LF}";:X=X+1:IFX<2THEN 7Ø
                                   :REM*55
6Ø X=.:POKE 54276,17:POKE 54283,17:POKE 54
   276,16:POKE 54283,16            :REM*1Ø7
7Ø FORY=1TO2Ø:NEXT:NEXT:PRINT" "   :REM*176
```

—Richard Penn, Montreal, Quebec, Canada

64/128 Drop-Down Menus

Programmers who've longed to add the sleek look of a professional drop-down menuing system to their C-64 or C-128 programs will now find their dream come true. Here's a drop-down menuing system that'll work in both 64 and 128 modes! Type it in, using *RUN*'s Checksum program, save a copy, and then run it. It begins by printing a row of eight menu selections across the top of the screen. (Note: With slight modification, it could take full advantage of the width of the C-128's 80-column screen.)

Next, press a number from 1 to 8, and the corresponding menu selection drops down beneath the number chosen. Use the cursor keys to move between the options in the drop-down menu and select the option desired by pressing return. For demonstration purposes, the program then informs you of your selection. I'm sure you'll find this routine has almost unlimited potential in programs using menus.

```
Ø REM DROP-DOWN MENUS - J.R. CHARNETSKI
                                   :REM*82
1Ø POKE5328Ø,2:POKE53281,Ø:NS=24:DIMDM$(NS
   ):L$="{12 SPACEs}"              :REM*11
2Ø FOR I=1TONS:DM$(I)="OPTION "+CHR$(64+I)
   :NEXT:RV$="{CTRL 9}":HL$="{CTRL 2}":MC$
   ="{CTRL 7}"                     :REM*74
3Ø PRINTRV$HL$"{SHFT CLR}MENU: 1{2 SPACEs}
   2{2 SPACEs}3{2 SPACEs}4{2 SPACEs}5{2 SP
   ACEs}6{2 SPACEs}7{2 SPACEs}8{11 SPACEs}
   {CRSR LF}"CHR$(148)" ":GOTO 9Ø :REM*114
4Ø IF M THEN FOR J=1 TO 7:PRINTTAB(M+3)"{C
   RSR UP}"L$"{CRSR UP}":NEXT      :REM*18
5Ø M=X*3:N=M-2:S=N:FORJ=1TO7:PRINTTAB(M+3)
   RV$MC$L$:NEXT                   :REM*25
6Ø PRINT"{HOME}{CRSR DN}":FORJ=NTOM:IFS=J
   THENPRINTTAB(M+5)RV$HL$DM$(J)MC$:GOTO8Ø
                                   :REM*228
7Ø PRINTTAB(M+5)RV$DM$(J)          :REM*25
8Ø PRINT:NEXT                      :REM*225
9Ø GETA$:IFA$="{CRSR DN}"ANDMTHENS=S+1:ON-
   (S<=M)GOTO6Ø:S=N:GOTO 6Ø        :REM*63
1ØØ IF A$>"Ø" AND A$<"9" THENX=VAL(A$):GOT
    O4Ø                            :REM*123
11Ø IF A$<>CHR$(13)ORM=Ø GOTO 9Ø   :REM*76
12Ø REM USE ON S GOTO/GOSUB FOR BRANCHING
                                   :REM*211
13Ø PRINTHL$"{SHFT CLR}{CRSR DN}YOU SELECT
    ED "DM$(S)                     :REM*16
```

—Joseph Charnetski, Plains, PA

Illegal Quantity Error Trapping

The next time you get an Illegal Quantity Error message in a program such as *RUN*'s Checksum program, don't panic and rush to cancel your subscription because you think the program is full of bugs. Your computer is simply trying to tell you that you made a mistake in the numerical Data statements. Here's a sure-fire solution to the problem: Append the following six lines to the end of the program in question.

```
60000 AA = 0
60001 AA = AA + 1: READ AD
60002 IF INT(AB) <> AB THEN 60010
60003 IF AB < 0 OR AB > 255 THEN 60010
60004 GOTO 60001
60005 PRINT AA;AB:STOP
```

Once they're appended, enter RUN 60000, and this program begins checking your Data statements for missing commas, periods mistyped for commas and other errors. When it encounters a problem, it'll print both the number and the number's position (1,2,3, etc.) in the Data statements. List the program, make the correction, then enter RUN 60000 again to find more errors.

When OUT OF DATA ERROR appears on the screen—don't panic—it's merely a signal that all of the data elements have been checked. Delete lines 60000 through 60005 and save your program, which should then work well.

—John Wellner, Port Hueneme, CA

Resolving Illegal Quantity Errors

The Illegal Quantity Error message is usually produced by the presence of typing errors in Data statements. Over the years, Commodore computerists have swapped solutions to the message as native Texans swap chili recipes. Case in point: Magic Trick $49C (May 1988) showed C-64 users how to find the line containing the offending data number with the Direct mode command:

```
PRINT PEEK(63) + PEEK(64)*256
```

My addendum to this bit of Magic is a C-128 version of that command:

```
PRINT PEEK(65) + PEEK(66)*256
```

Like the C-64 version, it reveals the line number of the data statement in error. If neither of these tricks reveals the line causing the error, add the following two lines to the program in question:

```
1 READ A: IF A = INT(A) THEN 1
2 PRINT PEEK(63) + PEEK(64)*256
```

(Note: C-128 users must substitute PRINT PEEK(65) + PEEK(66)*256 in line 2.)

This process detects any periods mistakenly typed between data numbers. Once you've changed any periods that don't belong in a listing, you'll eventually see an Out of Data error in 1 message, but that's all right. Just finish off by deleting lines 1 and 2, and you should have a working version of your program.

—Helen Roth, Los Angeles, CA

Too Many GoTos and/or GoSubs?

In most Basic programs, computed GoTos and GoSubs must be placed in one line of code to work properly. But what if you have so many that you can't get them to fit on a line? Here's an easy solution: Put the additional GoTos or GoSubs on a second line and tell the computer to skip the first line if a variable exceeds a certain value. My program clearly demonstrates how this procedure is accomplished:

```
Ø REM EXTRA COMPUTED GOTO'S & GOSUBS - HEL
  EN ROTH                           :REM*38
1Ø INPUT"ENTER A NUMBER FROM 1 TO 6";N
                                    :REM*17
2Ø ON -(N>3) GOTO 7Ø               :REM*153
3Ø ON N GOTO 4Ø,5Ø,6Ø               :REM*87
4Ø PRINT"ONE":GOTO 1Ø              :REM*2ØØ
5Ø PRINT"TWO":GOTO 1Ø               :REM*58
6Ø PRINT"THREE":GOTO 1Ø             :REM*1Ø
7Ø ON N-3 GOSUB 9Ø,1ØØ,11Ø         :REM*161
8Ø END                             :REM*2Ø8
9Ø PRINT"FOUR":RETURN              :REM*152
1ØØ PRINT"FIVE":RETURN              :REM*49
11Ø PRINT"SIX":RETURN              :REM*249
```

—Helen Roth, Los Angeles, CA

4. Application Programs

8×8 Graph Paper

When you're designing custom characters using a font editor, you'll save yourself time and minimize frustration by designing your characters ahead of time on grids that match Commodore screen characters' 8×8 dot matrix. My program, 8×8 Graph Printer, allows virtually any printer to print a total of 48 8×8 graphs per 8½ × 11-inch page.

```
Ø REM 8 X 8 GRAPH PRINTER - J.R. CHARNETSK
  I                                :REM*212
1Ø PRINTCHR$(147)"POSITION PAPER, PRESS A
  KEY TO PRINT"                    :REM*226
2Ø GETK$:IFK$="" THEN 2Ø             :REM*3
3Ø NS=8:PRINTCHR$(147)"WORKING...":REM*123
4Ø OPEN4,4:CMD4:PRINT              :REM*255
5Ø FORA=1 TO NS:FORB=1 TO 8:FORC=1 TO 6
                                   :REM*183 ►
```

```
6Ø PRINTSPC(1-(C>1)*4);                 :REM*116
7Ø FORD=1 TO 8:PRINTCHR$(2Ø7);:NEXT
                                        :REM*24Ø
8Ø PRINTCHR$(165);:NEXT                   :REM*4
9Ø PRINTCHR$(8):PRINTCHR$(15);:NEXT
                                        :REM*146
1ØØ FORE=Ø TO 5:PRINTSPC(1-(E>Ø)*5);
                                         :REM*35
11Ø FORF=1 TO 8:PRINTCHR$(163);:NEXT:NEXT
                                        :REM*145
12Ø FORG=1 TO 3:PRINT:NEXT:NEXT         :REM*199
13Ø PRINT#4:CLOSE4:PRINT"{CRSR DN}ALL DONE
    "                                    :REM*89
```

—JOSEPH CHARNETSKI, PLAINS, PA

C-64 SCREEN SWEEPER

If a C-64 program you're writing needs a screen-clear routine, try this unconventional one. It uses a reversed graphics character that almost instantly covers the screen from top to bottom, then reverses the process to reveal the cleared screen.

```
Ø REM 64 SCREEN SWEEP - J.R. CHARNETSKI
                                         :REM*31
1Ø CH$="{SHFT +}":SW$="{CTRL 9}"   :REM*165
2Ø FORI=1 TO 4Ø:SW$=SW$+CH$:NEXT   :REM*148
3Ø SYS 58726:FORI=1 TO 25:PRINTSW$;:NEXT
                                         :REM*64
4Ø FORJ=1 TO 12:SYS59626:NEXT:SYS58692
                                         :REM*27
5Ø REM RETURN                            :REM*5Ø
```

—JOSEPH CHARNETSKI, PLAINS, PA

C-64 AUTO-RUN MADE EASY

Use the following program to make a two-block auto-run file that automatically runs your C-64 programs when it's loaded with the syntax LOAD"FILENAME",8,1. Type in this program using *RUN*'s Checksum, save it to disk, then run it. You'll first be prompted to enter the name of the two-block boot file. This is the file you'll load with the above syntax in order to auto-run the desired file. Enter the boot filename, and the program automatically saves itself to disk. Next, you'll be prompted to enter the filename of an existing program on disk that you want to auto-run.

While following this sequence seems a bit confusing, rest assured that it is easy to perform. You'll be able to auto-run Basic programs in no time.

```
Ø REM 64 AUTORUN MADE EASY - LARRY E. SUTT
  ER                                    :REM*165
1Ø FOR J=1 TO 5Ø:READX:CK=CK+X:NEXT:RESTOR
   E                                     :REM*94
2Ø IF CK<>6221 THENPRINT"ERROR IN DATA":EN
   D                                    :REM*152
3Ø INPUT"ENTER NAME OF BOOT FILE";BF$
                                        :REM*18Ø
4Ø INPUT"ENTER BOOT NAME";BN$        :REM*134
5Ø BN$=BN$+"*":FORJ=1TO15:BN$=BN$+"-":NEXT
                                         :REM*15
6Ø BN$=LEFT$(BN$,16)                     :REM*15
7Ø OPEN1,8,4,"Ø:"+BF$+",P,W":PRINT#1,CHR$(
   Ø);CHR$(1);                          :REM*187
8Ø FORT=256 TO 514:PRINT#1,CHR$(2);:NEXT
                                        :REM*186
9Ø FORT=1 TO 5Ø:READX:PRINT#1,CHR$(X);:NEX
   T                                     :REM*9Ø
1ØØ FORT=1 TO 16:PRINT#1,MID$(BN$,T,1);:NE
    XTT                                  :REM*73
11Ø CLOSE1:END                           :REM*26
12Ø DATA 169,Ø,32,144,255,169,2,166,186,16
    Ø,1,32,186,255,169,16                :REM*71
13Ø DATA 162,53,16Ø,2,32,189,255,162,255,1
    6Ø,255,169,Ø,32,213                 :REM*186
14Ø DATA 255,134,45,132,46,169,Ø,133,122,1
    69,8,133,123,32,96,166               :REM*32
15Ø DATA 76,174,167                      :REM*24
```

—LARRY E. SUTTER, STERLING HEIGHTS, MI

A DIFFERENT TYPE OF AUTO-RUN

Some machine language (ML) programs not only contain Basic programs that need to be loaded and run, but also require you to enter a SYS xxxxx command to activate the ML code. A classic example is the commercial pinball arcade game, David's Midnight Magic. Not only does DMM require a Basic boot program, but you must enter SYS 49152 to complete the loading process.

Below is an example of a C-64 Basic boot program that can be used to streamline the process of booting ML programs from disk without requiring the user to enter SYS commands to activate the program:

```
10 PRINT CHR$(147):PRINT:PRINT
20 PRINT"LOAD" CHR$(34) "FILENAME" CHR$ (34) ",8,1":
   REM ENTER ML FILENAME
30 PRINT: PRINT: PRINT: PRINT
40 PRINT "SYS xxxxx": REM ENTER REQUIRED SYS NUMBER
50 PRINT CHR$(19): POKE 198,2
60 POKE 631,13:POKE 632,13
```

After you type it in, save it to the disk containing the ML programs requiring SYS calls. Substitute the name of the ML file for the word FILENAME in line 20 and the SYS number for the xxxxx in line 40. This loader works by printing the commands on screen and activating them by automatically pressing return after each command is printed. Line 50 homes the cursor and tells the computer to expect two keypresses (up to 10 keypresses are possible). Line 60 delivers those keypresses (two returns).

—HELEN ROTH, LOS ANGELES, CA

LINE LOCKER

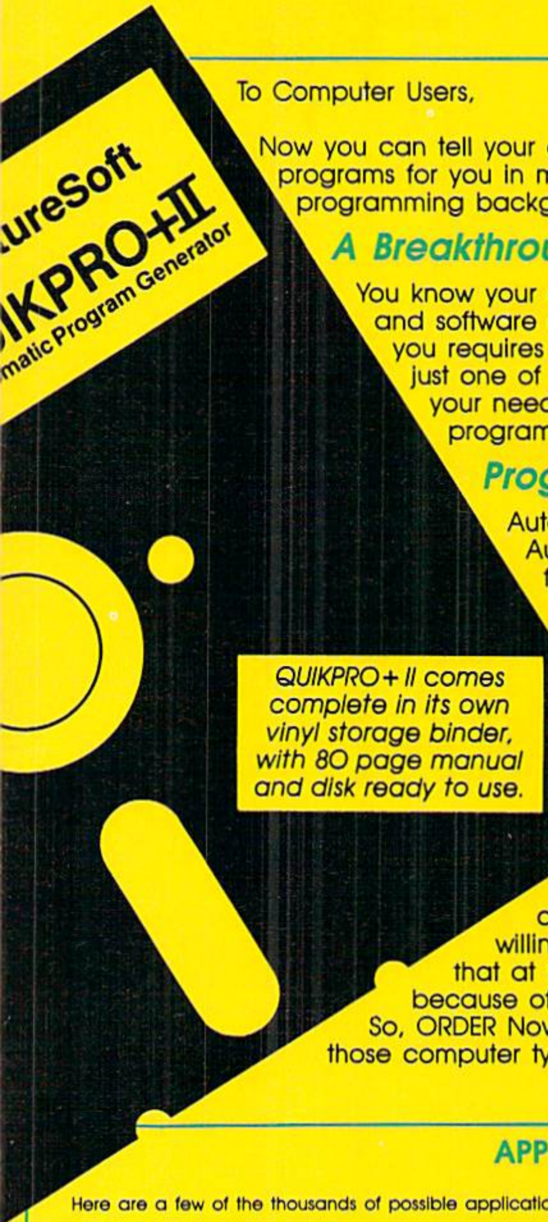
Teachers and classroom instructors who routinely give tests on computers are just one example of Commodore users who occasionally need to make Basic program code hidden from users to prevent unauthorized examination or alteration. Line Lock lets you modify C-64 and C-128 programs so that the List command will display only the line numbers, not the Basic code itself.

Type in and save Line Lock, then run it. Place the disk containing the file to be locked into the disk drive and, at the prompt, enter the current filename, a comma, and then the new filename. The new filename is a "locked" version of the first file, which remains unscathed.

Continued on p. 90.

SAVE! Over ½ OFF an AUTOMATIC PRO

for your IBM or Compatible, Tandy,



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Reservations
Property Control
Library Catalogues
Inventories
Key Employee Data

EDUCATIONAL USES
Student Records
Grade Records
Teacher Lists
School Lists
Program Design
Course Design
Tuition Data
Enrollment Data
Property/Equipment
Athletic Schedules
Player Statistics
Test Scores
Menus

HOME & HOBBY USES
Personal Records
Check Lists
Club Rosters
Telephone Directories
Recipe Files
Medical Information
Insurance Records
Tax Records
Christmas Gift Lists
Deposit Files
Due Dates
Mortgage Data
Travel Records

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TRS-80 or Apple Computers.

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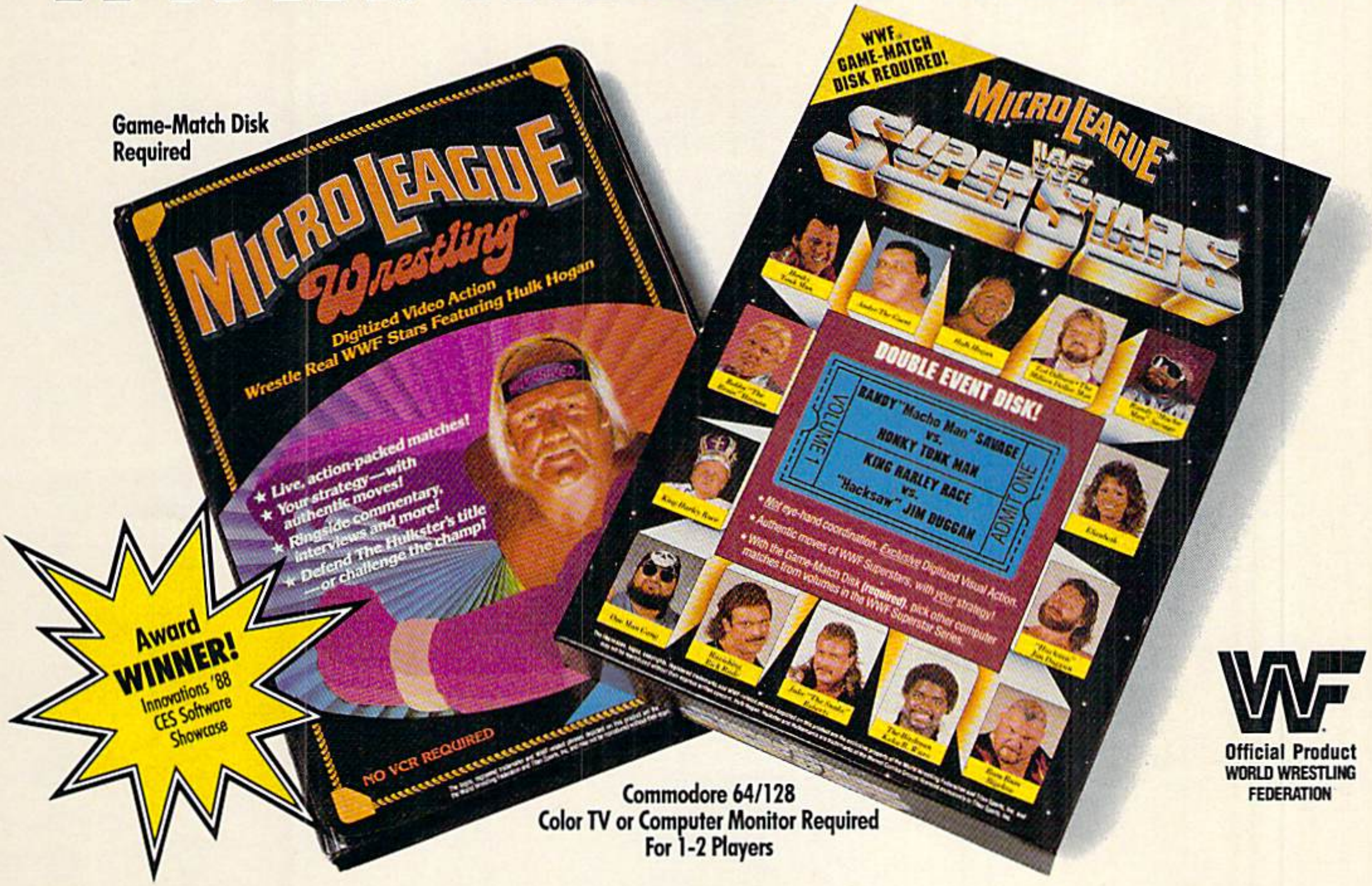

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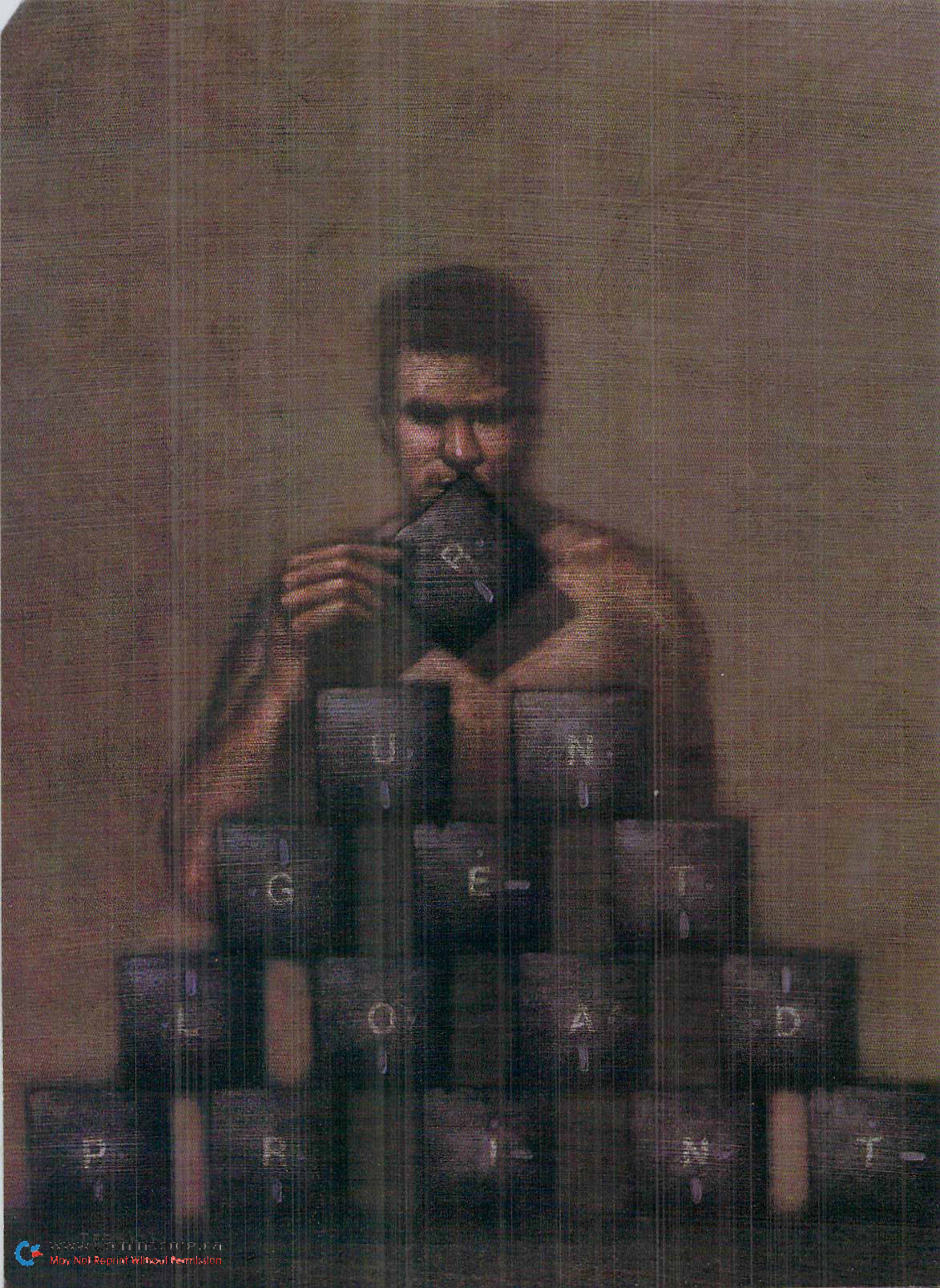
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Basic 101

The best way to get to know your computer is to take the programming plunge.

By ANNETTE HINSHAW

If you want to know your computer better, try a little programming. A few brushes with the dread "syntax error" will have a salutary effect on your understanding of how computers work, and that knowledge will transfer when you need to figure out why a program like a spreadsheet suddenly does something you don't expect.

This article introduces some programming fundamentals. The examples are in Basic, but the programming mechanisms are used in all computer languages. You can build on what you learn here with books and magazine articles devoted to teaching this important way to interface with a computer. If you belong to a users' group, that's another good place to look for help.

The only way to learn programming is to do it, so turn on your computer and, as you read, type in and try the examples. I don't have room for a detailed explanation of each computer command, so look up everything we cover in the user's manual that came with your machine. Try to relate what you read there to what you see happening on your screen.

In the examples, substitute your name every place you see "Annette." In the text of the article, <return> means to press the return key.

What Is a Program?

A program is a numbered list of instructions to the computer. Each instruction, also called a statement, is composed of computer commands in a specified order. You probably already use commands like Load, Run and Open.

When you load or run a program or open a channel to the disk drive, you're talking to your computer in Direct mode. As soon as you type the command and press return, the computer obeys the instruction and then forgets it. For example, type PRINT "ANNETTE" <return>. The computer will oblige, but to make it print the name again, you must retype the command.

In Program mode, statements are assembled into a program that the computer remembers, but it doesn't execute the commands until you run the program. Each statement in the program has a line number. Returning to our example, if you type 10 PRINT "ANNETTE" <return>, nothing happens unless you type RUN <return>. By giving the command a line number (10), you turned it into a program, which can be used over and over without retyping the line. To see your program, type LIST <return>.

Variables

Note that you have to type *exactly* what I say, or the program won't work correctly. For instance, if you leave out the quotation marks around the name, the computer will print a zero instead. Try it. How does ANNETTE become 0? Well, that takes a little explanation.

First of all, the computer deals with two kinds of data: numbers and strings. Numbers have specific meaning to the computer, which can manipulate them in computations. Strings, however, are merely sequences of characters (including numerals, letters or symbols) that the computer will faithfully reproduce on command, exactly as they were entered, without doing anything with them that you haven't specifically commanded. The computer recognizes as a string anything that is included within quotation marks, so you define a string by placing a sequence of characters in quotes.

For convenience in handling them within a program, both numbers and strings can be represented by letter symbols, which are called variables, because their value or content can change during program execution.

Number variable names can consist of one or two letters in any combination or any word not reserved by the computer language. To make a string variable name, add a dollar sign to the end of a number variable name—ANNETTE$, for instance. Look up "variables" in your manual to find the rules for naming them.

Back to our question. Since ANNETTE is not in quotes and has no dollar sign after it, the computer assumes it's a number variable name, not a string or a string variable name. Finally, if the computer hasn't been told the value of a number variable, it assigns a value of zero.

You can define a number variable by assigning it a value with a statement like ANNETTE = 10 <return>. Type that statement, followed by PRINT ANNETTE <return>, and the computer will return a ten.

In writing a program, it's important to distinguish carefully between number and string variable names. The computer gets upset if you ask it to do a ►

ILLUSTRATED BY WILLIAM PEEBLES

computation with a string variable or manipulate a number variable like a string. (These mistakes give a Type Mismatch error.)

Let's try a little program using variables. As you type it in, remember that even punctuation is important, and you must press return after each line.

```
10 INPUT "TYPE A NUMBER"; ZZ
20 INPUT "TYPE ANOTHER NUMBER"
   ; YY
30 PRINT ZZ + YY
40 INPUT "TYPE A NAME"; A$
50 INPUT "TYPE ANOTHER NAME"; B$
60 PRINT A$ + " " + B$
```

Now, run the program to see how it works. The Input commands display a ? prompt on the screen and instruct the computer to wait until the user types something ending with a return. The message in quotes appears in front of the question mark to tell the user what information is needed, and the user's input is stored in the variable named after the semicolon. This input is one place where quotes aren't necessary to define a string; if the variable name indicates a string (if $ follows the name), the computer stores the input as a string.

In lines 30 and 60, the computer uses the variables in Print statements. The user can type in different numbers and names each time the program is run, and the current values of the variables will always be the last ones typed. Notice the space between the quotation marks in line 60. It's needed to separate the strings in the output. Since a computer doesn't "understand" strings, you have to specify every character, even spaces.

You can change program lines or add more anytime you want. There are two ways to change a line. You can replace it by retyping it with the line number and pressing return, or you can edit it, with the help of the insert-delete key, and press return while the cursor is still on the corrected line. To view and edit any line that's not on the screen, type LIST <line number>.

If you run into a syntax error, check your typing. You have a misspelling, a punctuation mark missing or misplaced, or your commands are incomplete or in the wrong order. Remember, every character is significant.

You may also encounter a problem in what is called Quote mode; i.e., when the cursor is within a quote on a program line. In this situation, if you press a special key, such as a cursor key, the insert-delete key or a function key, the computer will print a graphics character instead of executing whatever the key is designed to do. This means that you in effect erase whatever is overprinted by the graphics characters when you try, for example, to move the cursor to a character you want to change. If you get snarled like this on a line in Quote mode, hold down the shift key as you press return; a shifted return does not store the line, so you get out of the fix and can retype the line in corrected form.

To add a new line, type it with a so-far unused line number that places it where it belongs, and press return. The computer automatically arranges lines by number, no matter when you enter them, so the next time you list your program, the new line will appear in its proper place.

Type these additional lines for the little program above, and then list the program:

```
32 AB = ZZ - YY + 219
33 PRINT AB
34 C$ = "THIS IS A TEST":PRINT C$
```

The new lines will appear between lines 30 and 40, and, when you run the program, they'll produce two more lines of output.

Notice that in line 34 the colon separates two statements. When you're programming, sometimes you may need to put two or more statements on the same line to save memory or to control program logic at a branch. Use the colon to do this.

If you want to save this program to disk, choose a filename and then type SAVE "filename",8 <return> in Direct mode on the C-64 or DSAVE "filename" <return> in the same mode on the C-128. Look up rules for filenames.

After you've saved the program, type NEW <return>. This command erases the program from the computer's memory and resets the variables to zero. Always NEW the memory before you begin another program to avoid getting lines from the old program entangled in the new.

Loops and Branches

Most programs are composed of tiny programs of one or more lines called subroutines, each of which accomplishes one specific operation. These operations, in turn, build and are built from a few fundamental programming mechanisms.

Two of the most important of these mechanisms are loops and branches, and they're closely related. Unless the computer is told otherwise, it executes program lines in numerical sequence, so if you want execution to go elsewhere than the next line, you must set up a branch operation. Statements used for branching include GoTo and If-Then-Else. (Else is not available in Basic 2.0 on the C-64.)

A loop is a special kind of branch that turns on itself, repeating one or more times. Just how often it repeats depends on what Basic statements you use and how you combine them. I can't show you here all the ways to set up a loop, but statements such as For-Next, GoTo, GoSub and, on the C-128, Do-Loop are used.

The simplest loop is an endless loop. Try this one:

```
10 PRINT "ANNETTE ";
50 GOTO 10
```

Pretty heady, isn't it, seeing your name march across the screen? Each time the computer comes to line 50, it's told to go to line 10 and start executing, which, of course, takes it to line 50 again. The only way to stop the program is to press the run-stop key.

The semicolon is what makes the computer continue printing on the same line. Ordinarily, the computer executes a return for every Print statement, but the semicolon suppresses the return. A comma in the same place moves the cursor to a predetermined column position. Try it.

An endless loop is boring after a while, so let's put a limit on this program. Type the following lines:

```
20 X = X + 1
30 PRINT X,
40 IF X = 100 THEN END
```

Now, when you run the program, the computer will print your name 100 times. Line 20 defines X as a counter, whose value increases by one each time through the loop. In the If statement in line 40, the computer tests to see if X is 100 yet. If not, the loop continues. When the value of X finally becomes 100, the computer does whatever follows THEN. You could, for example, say THEN GOTO 100 and start a new subroutine at line 100.

A For-Next statement is another way to set up a loop in Basic. NEW the memory, then type:

```
10 N$ = "ANNETTE"
20 FOR C = 149 TO 155
30 PRINT CHR$(C);
40 PRINT N$;C
50 NEXT
60 PRINT C
```

The loop starts with the For in line 20. The initial value of C—the counter for the loop—is the first of the two numbers following the equals sign. Unless you specify a different STEP (increment), the computer will add one to C's value each time execution reaches the Next statement in line 50—the end of the loop. As long as C remains less than the second number, execution will return from the Next statement to the For statement. In other words, the lines from FOR to NEXT are executed repeatedly until C = 156. Then the computer goes on to the line after NEXT. Each loop in this example changes the color of the characters displayed on the screen.

PUTTING IT ALL TOGETHER

Writing programs is a matter of putting operations such as loops and branches together in more or less complex patterns, and the most important consideration in programming is the sequence of these operations. One of the best ways to plan a program is to make a list of what you want your program to do—that is, *define your output.* Then draw a flowchart, a diagram of program logic that shows each operation, including branches, in order of execution.

For instance, before writing the simple dice-throwing program (see Listing 1), I identified three goals:

—To be able to "throw the dice" any number of times without typing RUN every time.

—To have the computer throw two six-sided dice.

—To have the computer tell me if I "won" (threw a 7 or 11) or "lost."

Each of these features calls for a specific operation. The first requires a loop with a branch point, where the alternatives are to play again or to quit. The second calls for using the random number generator to simulate dice. The third needs a test of the dice throw and a branch leading to the appropriate Print statement.

Study the flowchart (Figure 1) and then the program itself. The flowchart makes the sequence of the program logic apparent, even though you may not know the commands necessary to actually write the program. By the way, the REM statements in the listing are notes for the programmer; the computer ignores them.

The best way to learn Basic programming is to study working programs. Find short ones in magazines or books or in the public domain; then analyze every line. Look up each command and try to see how it contributes to the program; draw a flowchart of the program's logic and play with any statements you don't understand; and feel free to edit, delete and re-arrange lines. You can also insert Stop statements here and there, or add Print statements to make the computer display what happens when you use a function like RND(X). In other words, play with the program until its changed behavior tells you how each statement works and fits into the overall logic. If the program stops working, figure out why. If the computer freezes, just turn it off and reload.

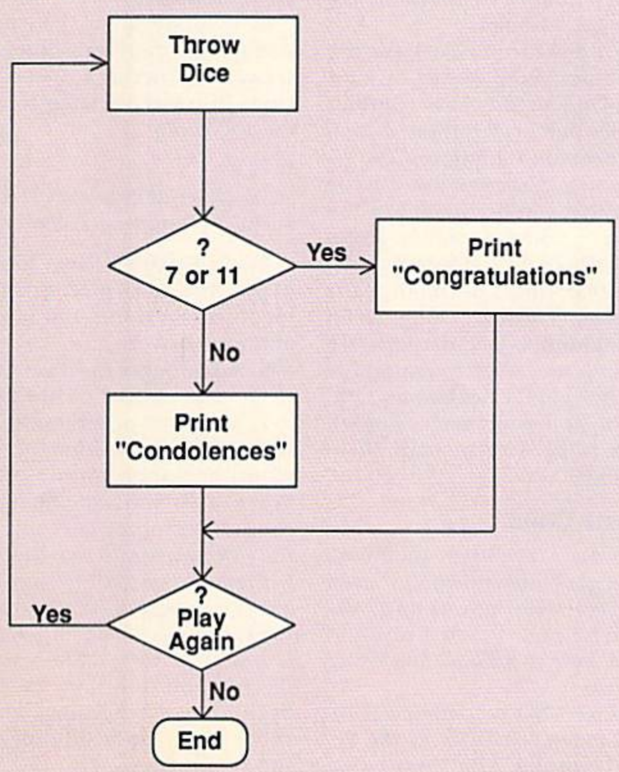
Keep this process up, and one day you'll either be a good programmer or you'll know that programming isn't your cup of tea. Whichever way it goes, you'll understand your computer a lot better, and you'll trust it a lot more. ■

Annette Hinshaw, founder of the Tulsa Area Commodore User's Group, has written extensively for computer magazines.

Listing 1. Dice game program.

```
5 REM DICE THROWING PROGRAM
10 REM CLEAR VARIABLES
20 CLR
25 REM THROW TWO SIX-SIDED DICE
30 DI = INT(RND(0)*6 + 1)
40 D2 = INT(RND(0)*6 + 1)
50 PRINT "DIE 1 = " D1;"DIE 2 = "D2
55 REM BRANCH IF NOT 7 OR 11
60 IF D1 + D2 = 7 OR D1 + D2 = 11 THEN GOTO 90
70 PRINT "TOO BAD!"
80 GOTO 100
90 PRINT "YOU WON!"
100 INPUT "WANT TO PLAY AGAIN (Y/N)";I$
105 REM TEST ANSWER ON REPLAY
110 IF LEFT$(I$,1)< >"Y" THEN END
115 REM LOOP BACK TO DICE THROW
120 GOTO 20
```

Figure 1. Dice game flowchart.



— The Secret —
Of Better Programming

Whether you're programming in Basic or machine language, these guidelines will help smooth the way.

◇

By JOHN RYAN

Writing a computer program, like writing a novel or magazine article, is an art, and, like a writer, each programmer develops his or her own style. However, all programmers can benefit from following basic guidelines, and, in this article, I'll present those I've found of help. If you follow them, too, you'll be well on your way toward the efficient production of interesting and smoothly running programs.

Planning

Programming is often ten percent passionate coding and 90 percent very tedious debugging. Good planning, however, if followed through to its logical conclusion, can even out these percentages.

Planning involves creating some type of map to follow. This map may be anything from simple notes on the logic for a particular section of your program to a formal flowchart for the entire thing. I don't think most projects require textbook-style flowcharting, but some sort of thoughtful overall mapping is surely necessary to avoid chaos if your program is to be at all complex.

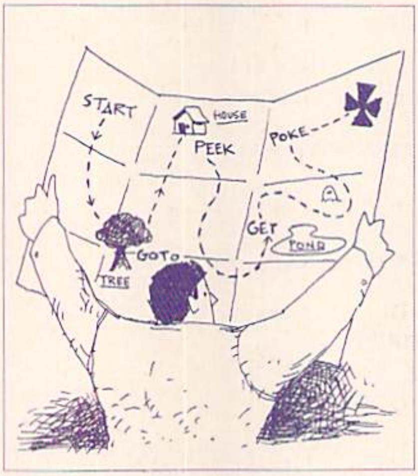
The following are the points that I usually sketch out before turning on my computer:

1. What is the finished program supposed to do? If it's a game, when does play end?

2. What are the main sections of the program? Score-keeping, sound routines, menus, joystick routines, mathematical calculations, text handling? Whatever they are, I write these down in the order they'll appear in the listing.

3. For games, what are the rules? I write down point values and assign variable names to them. If using a redefined character set, I assign the screen codes to be used.

4. I write down the memory addresses of all storage areas, whether they be for sprites, graphics screens or machine language variables.



5. Finally, I make sure I can write the program without being slowed by a lot of research. Do I already have routines written earlier that I can import? If not, what references am I going to need?

The foregoing describes just a basic list of items that can be helpful in the heat of battle. It could be several pages longer (I've filled several spiral notebooks with planning information for some projects). However long, keep your programming notes in a separate notebook and use scratch paper for quick logic flows and calculations. Otherwise, you'll find your neat program information filled with incomprehensible doodlings.

Writing the Code

If you've done adequate planning, you'll have a good idea how to proceed with coding. However, here again guidelines can be helpful. Below I've listed the steps that I use to make code writing more effective.

1. No matter what the language, define all the major variables at the beginning of the listing. Also, ensure that Dimension (DIM) statements are outside the main program loop, to avoid redimension errors.

2. Number lines by increments of at least ten. By doing so, you can make additions and corrections to your program without using a renumbering utility. Only when the program is finished and completely debugged will you need to use a renumbering utility or command to number the lines evenly.

3. You should *never* start a target subroutine or line with a Remark statement. Put the REM above the target line so it can be deleted to save memory and increase speed.

4. Keep two copies of your finished program, one liberally annotated and one pared down, with all the REM statements removed.

5. In addition to leaving out REM statements, there are other ways to increase a program's speed. Stay away from indexed variable loops, such as the following:

```
10 X=0
20 X=X+1: IF X<>1000 THEN 20
30 REM Continue execution here.
```

Instead, use For-Next loops as much as possible. Also, placing multiple statements on each line will save both time and memory.

6. Use integer variables for constants (A% = 100 instead of A = 100).

7. For large programs, it may be better to place subroutines and Data statements at the beginning of the listing. When a GoSub statement calls a subroutine beginning later in the program, the computer must search forward until it finds the target line number, and in a large program, the search time can really add up. If the target line number is less than the GoSub's line number, the program will start searching at the beginning of the listing, and, if the target is near the beginning, the search will be short.

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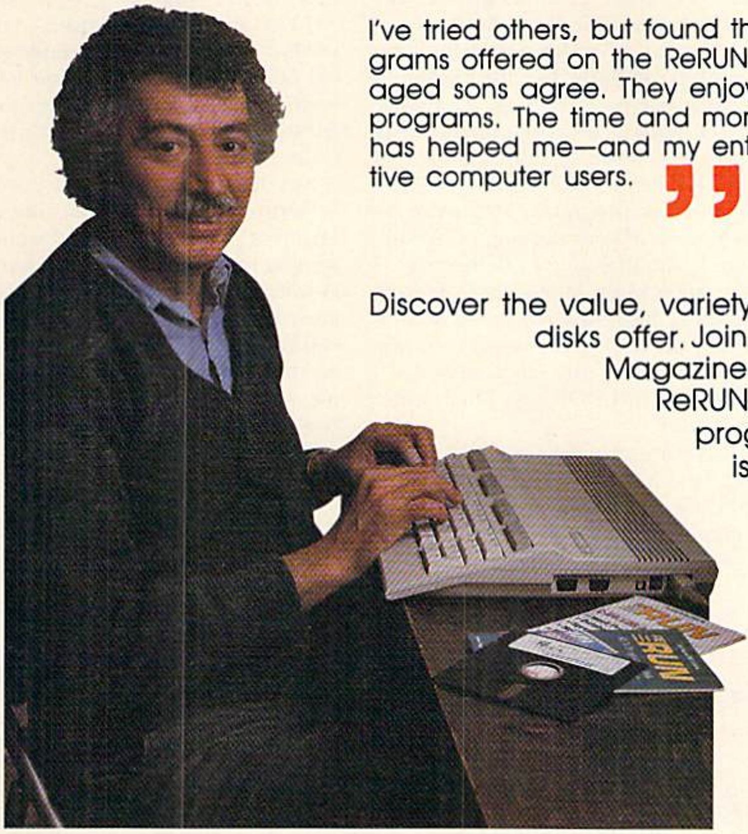

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ing delays by adding a FRE(0) command at the beginning of string-handling routines to force garbage collection before variable space becomes cluttered. Garbage collection occurs when there's no room for a new variable and everything must be shifted from the top of memory down to make room.

9. Save your program frequently during development, and make backup copies on a separate disk that's set aside for safekeeping. If you own a printer, also print out a listing of the finished program for your archives; paper lasts longer than disks!

10. Each time you work on a program, place the current date, time and version number in a REM statement at the beginning of the listing. Frequently, I find myself with several versions of a program and would have a difficult time knowing which was the most recent if I hadn't taken this precaution.

11. After you've finished your program, keep some sort of log (paper or disk) of its major routines, so you can find them to use in other programs. After a while, you'll be surprised at how many subroutines you'll have on tap.

Machine Language Programming

Here are some pointers specifically for writing machine language code:

1. "Top-down" programming may be acceptable for Basic, but it's hardly efficient for machine language. Use modular techniques, constructing your program from a series of subroutines, and make sure they're global enough to be used in other programs. Moreover, by passing most of your parameters to subroutines, you'll find that debugging is easier, since you'll know what registers or memory locations are being manipulated by the calling and target routines.

2. Use meaningful label names. To me, JOYSTICK'LOOP says much more than JLOOP.

3. Likewise, annotate your listing liberally. It can be a headache trying to determine what a particular routine was designed for after you haven't seen it for several months. Unlike Basic, machine language comments don't appear in the assembled object code and don't affect execution speed, so programmers have no excuse for not using them.

4. Start a module library of handy subroutines that can be .LIBed or .FILEed into new programs. Also, get used to using standard variable and Kernal names in the declaration table and saving them as a Library file to disk. In addition, use macros if your assembler system can handle them.

Needless to say, an entire book could be written on how to become a more effective programmer, and what works for you may not work for someone else. However, I've found that following these simple guidelines has let me concentrate more on actual coding and less on the mechanics of programming. For me, that has meant the difference between programs that work well and programs that merely work. ■

John Ryan is an air traffic control instructor and an advanced programmer in both Basic and machine language.

C-64 Sprite Basic

What was once tedium on the C-64 becomes a joy with the powerful new sprite commands in this language extension.

By CHARLES ORCUTT

As one of the outstanding aspects of graphics on the C-64 and C-128, sprites are used in programs in a variety of ways, from arcade games to the pointer found in "point and click" interfaces like GEOS. Since both computers have essentially the same VIC-II graphics chip, they have equal abilities when it comes to sprites.

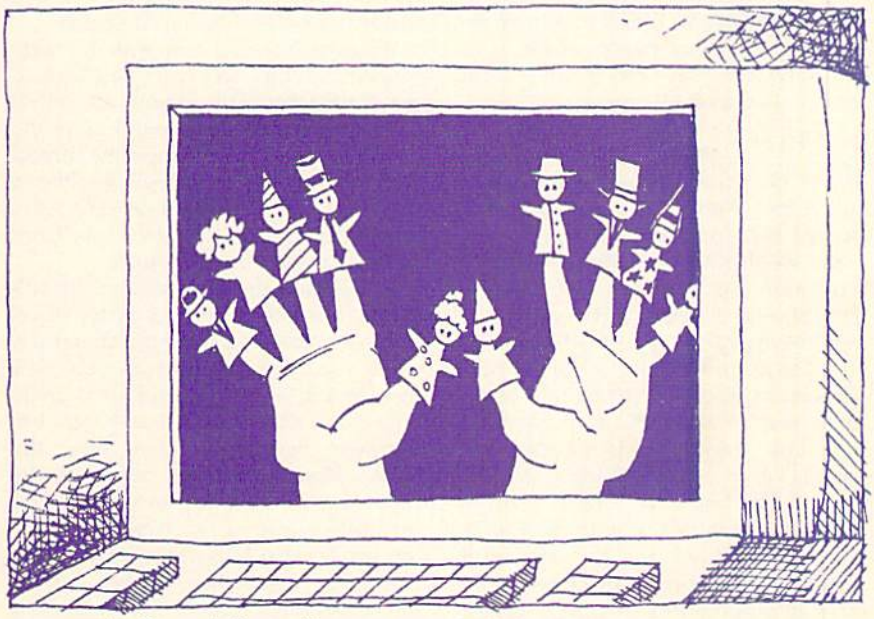
But there are differences between them when it comes to programming sprites. It is actually a little easier to program sprites from machine language on the C-64 than on the C-128, since you don't have to worry about things like shadow registers or multiple banks of RAM.

From Basic, however, sprite programming is far easier on the 128 than on the 64, since Basic 7.0 on the C-128 has many dedicated sprite commands, and the C-64's Basic 2.0 has none. C-64 Basic programmers must therefore resort to Peeks and Pokes, which are slow, cryptic and in most cases too complex for the average programmer. Of course, there are commercial Basic extensions that add sprite commands (Simons' Basic, Super Expander, Graphics Basic), but these cost money and limit the use of the programs to those who possess the extension that was employed.

Solution Extended

My solution was to write C-64 Sprite Basic, a small language extension that offers Basic programmers the most important abilities of the C-128's Basic 7.0 commands. Its great advantage is that a program that uses the language need only be copied to a disk, and anyone can run it.

There are four commands in the set. With them, you can define, move and even animate sprites with simple Basic commands. One of them allows your program to automatically branch to a subroutine whenever a collision occurs between sprites or between sprites and screen data.



Here are the new commands Sprite Basic makes available. The first is

SPRITE S#(1–8),On/Off(0/1),Color(1–16), Priority(0/1),XP(0/1),YP(0/1),Mode(0/1)

The Sprite command is used to define a sprite. The sprite number (S#) is from 1–8, not the 0–7 you may have used when poking in sprite information from Basic 2.0. The second parameter turns the sprite on (1) or off (0). The sprite's color is next, with values from 1 (black) to 16 (light gray).

Then comes the priority flag, which determines whether the sprite will appear in front of or behind any non-sprite data on the screen. You can also expand the sprite horizontally or vertically by placing a 1 in the appropriate XP or YP location. And, finally, you must indicate if the sprite is a normal, high-resolution, single-color sprite (Mode = 0), or a multicolor (Mode = 1).

All the various parameters in the Sprite command can differ for each of the eight sprites, so some can be high-resolution while others can be multicolor. Some can appear in front of screen data, others behind. The colors can be different, as can the X or Y expansion flags. It all depends on what you need in your program. As you can see, the Sprite command quickly and easily replaces the many different Pokes that would have been necessary to do the same things.

The second command is

SPRCOLOR MC1 (1–16),MC2 (1–16)

If any of the sprites in your program are multicolor, you need to use SPR- ►

COLOR to indicate which colors to use. Keep in mind that these colors are used by *all* your multicolor sprites. The only color unique to a single sprite is the one specified in the Sprite command itself.

The third command is

MOVSPR S#(1–8),X1,Y1[,X2,Y2,SPEED(1–8)]

MOVSPR is the real workhorse of the command set. If you've ever tried moving sprites by poking values into memory, you know how difficult it can be when you attempt to move past location 255. It requires a lot of complex peeking, poking, ANDing and ORing of memory locations. Well, you can forget all that, because MOVSPR handles it for you. There are two modes of use. If all you want is to place the sprite at some specific location, just use

MOVSPR S#,X,Y

where S# is the number of the sprite, and X and Y are the coordinates of its desired location on the screen.

But MOVSPR has another, more powerful animation feature. You can use the optional X2,Y2,SPEED parameters to move the sprite precisely from point X1,Y1 to point X2,Y2 at any of the eight allowable speeds. The thing that makes this aspect of MOVSPR so powerful is that while your sprite is moving, *Basic continues to process other parts of your program at the same time!* This is possible because this feature, which I call a sprite line, is executed on the interrupt, sixty times a second. One result is that you can automatically animate *all eight* sprites simultaneously!

Finally, there is the remarkable Collision command:

COLLISION TYPE (1/2),LINE #

When you are programming sprites, it is often useful to detect when one sprite has collided with another, or with some non-sprite data on the screen. With Basic 2.0, you would have to constantly peek memory locations, make a decision on what to do, and then branch your program to the line appropriate for handling it—altogether a complex, tedious and slow process. With the Collision command, however, you can tell the computer to monitor for collisions, and if it detects one, to go to a specified subroutine. It will execute the subroutine, then return to where it left off and continue on.

To use the Collision command, you should have it on a line by itself somewhere in your program, preferably in the main loop. (If you're using both types of collisions, they should both be on the same line.) In your subroutine that handles the collision, the *very first statement* must be a Collision command (i.e., COLLISION,1 or COLLISION,2), but must *not* be followed by any line number. This will turn off collision detection while you are in the subroutine, and it is an absolute requirement!

When you're finished with the subroutine, a return will carry you back to the main loop. The reason the initial Collision statement(s) should be in the main loop is so that they can be turned back on after the return from a collision subroutine. Note: Be very sure you *never* turn on sprite collision detection from within a collision subroutine!

You should understand that the collisions are handled via a raster interrupt, 60 times a second. Therefore, when you turn off collision detection in your subroutine, automatic branching ceases, although the computer continues to detect collisions. Since the Sprite Basic extension automatically clears the collision registers when you turn off collision branching, the registers are cleared to zero for a sixtieth of a second. If you then intend to peek the collision registers to determine which sprites have collided, you should first do some small amount of Basic in order to give the computer time to catch the next collision. Updating variables or a very small For-Next loop (1 to 10) is sufficient.

TIPS FOR USE

To use Sprite Basic, first type in Listing 1 (using *RUN*'s Checksum program). This is a Basic listing in the form of hexadecimal Data statements. Before running it, save it with some simple name, like Listing 1. Your disk drive will run for a time while Listing 1 generates the actual Sprite Basic program. This newly created binary file on your disk *is* the Sprite Basic extension.

To create programs with it, you first need to load and activate the Sprite Basic extension. This can be done with the following small boot program.

```
10 IF A = 0 THENA = 1:LOAD"SPRITE
   BASIC",8,1
20 SYS 49152
30 NEW
```

After running this, you can write the new commands, and the C-64 will understand what they are. In fact, it's a good idea to have lines 10 and 20 as the first two lines in all your Sprite Basic programs. (Some of the new commands won't work as intended unless the SYS 49152 is executed *within* the program.)

To help you get started, I've included a demo (Listing 2). It uses all the Sprite commands to generate a simple but entertaining arcade game. To use it, first type in Listing 1 and generate Sprite Basic as instructed above. Then load and activate the Sprite Basic extension and enter Listing 2. By studying this game, you'll find useful examples of all the Sprite Basic commands.

While Sprite Basic does just about everything you need, there are some things you still have to do the "old" way. For example, you still have to create your sprites with a sprite editor, and the sprite data will have to be poked into memory. You also need to poke the sprite pointer into the appropriate sprite register. (Sprite pointers indicate where in memory the sprite data has been poked. These pointers to the data are poked into locations 2040–2047 for sprites 0–7, respectively.)

Finally, you need to peek the collision registers to see what sprite has collided, if you need that information. There are two sprite collision registers. For sprite-sprite collisions, peek location 53278; for sprite-data collisions, peek location 53279. For further information, you should refer to the *C-64 Programmers Reference Guide.* R

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Listing 1. Language Generator program.

```
1Ø REM C64 HEX LOADER     :REM*24
2Ø OPEN 8,8,8,"SPRITE BASIC,P,W
   "                      :REM*23Ø
3Ø READ A$:IF A$="-1" THEN CLOS
   E8:END                 :REM*186
4Ø IF LEN(A$)<62 THEN 12Ø:REM*4
5Ø B$=MID$(A$,1,2Ø)+MID$(A$,22,
   2Ø)+MID$(A$,43,2Ø)     :REM*2Ø8
6Ø FOR I=1 TO 3Ø          :REM*214
7Ø C$=MID$(B$,(I*2)-1,2):H$=LEF
   T$(C$,1):L$=RIGHT$(C$,1)
                          :REM*137
8Ø H=VAL(H$):IF H$>"9" THEN H=A
   SC(H$)-55              :REM*56
9Ø L=VAL(L$):IF L$>"9" THEN L=A
```

```
    SC(L$)-55                :REM*73
100 BY=H*16+L:PRINT#8,CHR$(BY);
                             :REM*138
11Ø NEXT:GOTO 3Ø             :REM*191
12Ø IF LEN(A$)<21 THEN B$=A$:GO
    TO 15Ø                   :REM*72
13Ø IF LEN(A$)<42 THEN B$=LEFT$
    (A$,2Ø)+RIGHT$(A$,(LEN(A$)-
    21)):GOTO 15Ø            :REM*23Ø
14Ø B$=LEFT$(A$,2Ø)+MID$(A$,22,
    2Ø)+RIGHT$(A$,LEN(A$)-42)
                             :REM*113
15Ø FOR I=1 TO LEN(B$)/2:REM*1Ø
16Ø C$=MID$(B$,(I*2)-1,2):H$=LE
    FT$(C$,1):L$=RIGHT$(C$,1)
                             :REM*83
17Ø H=VAL(H$):IF H$>"9" THEN H=
    ASC(H$)-55               :REM*222
18Ø L=VAL(L$):IF L$>"9" THEN L=
    ASC(L$)-55               :REM*243
19Ø BY=H*16+L:PRINT#8,CHR$(BY);
                             :REM*49
2ØØ NEXT:GOTO 3Ø             :REM*16
3ØØ REM C64 SPRITE EXTENSION
                             :REM*72
31Ø DATA ØØCØA9ØØAØØØ99F5C6C8 D
    ØFA8DF3C6A9348DØ4Ø3 A9CØ8DØ
    5Ø3A9FA8DØ6Ø3            :REM*67
32Ø DATA A9CØ8DØ7Ø3A92F8DØ8Ø3 A
    9C18DØ9Ø3A9ØØ8DEØC6 2Ø8ØC56
    Ø2Ø9FC5A67AAØ            :REM*213
33Ø DATA Ø484ØFBDØØØ21ØØ7C9FF F
    Ø3EE8DØF4C92ØFØ3785 Ø8C922F
    Ø5524ØF7Ø2DC9            :REM*39
34Ø DATA 3FDØØ4A999DØ25C93Ø9Ø Ø
    4C93C9Ø1D8471AØØØ84 ØB88867
    ACAC8E8BDØØØ2            :REM*11Ø
35Ø DATA 38F99EAØFØF5C98ØDØ2F Ø
    5ØBA471E8C899FBØ1C9 ØØFØ383
    8E93AFØØ4C949            :REM*215
36Ø DATA DØØ285ØF38E955DØAØ85 Ø
    8BDØØØ2FØEØC5Ø8FØDC C899FBØ
    1E8DØFØA67AE6            :REM*2Ø1
37Ø DATA ØBC8B99DAØ1ØFAB99EAØ D
    ØB5FØØFBDØØØ21ØBD99 FDØ1C67
    BA9FF857A6ØAØ            :REM*89
38Ø DATA ØØB9BEC6DØØ2C8E8BDØØ Ø
    238F9BEC6FØF5C98ØDØ Ø4Ø5ØBD
    Ø99A67AE6ØBC8            :REM*2ØØ
39Ø DATA B9BDC61ØFAB9BEC6DØEØ F
    ØC61ØØF24ØF3ØØBC9FF FØØ7C9C
    CBØØ64C24A74C            :REM*255
4ØØ DATA F3A638E9CBAA8449AØFF C
    AFØØ8C8B9BEC61ØFA3Ø F5C8B9B
    EC63ØØ52Ø47AB            :REM*69
41Ø DATA DØF54CEFA62Ø79ØØDØØE A
    DEAC6FØØ9AE1EDØAE1F DØ2Ø13C
    52Ø73ØØ2Ø4BC1            :REM*14
42Ø DATA 4CAEA7C9CC9ØØ4C9DØ9Ø Ø
    62Ø79ØØ4CEDA738E9CC ØAAABDB
    7C648BDB6C648            :REM*217
43Ø DATA 4C73ØØ2Ø9EB7EØØ1FØØC E
    ØØ2FØØ82Ø9FC5A2ØE4C 37A48A4
    82Ø79ØØC92CDØ            :REM*198
44Ø DATA 3B6848ØDEØC68DEØC668 C
    9Ø1DØ1Ø2Ø73ØØA57A8D DCC6A57
    B8DDDC64CAFC1            :REM*36
45Ø DATA 2Ø73ØØA57A8DDEC6A57B 8
    DDFC6A5398DE1C6A53A 8DE2C62
    Ø8AAD2ØF7B76Ø            :REM*1Ø8
46Ø DATA 6838E93Ø49FF2DEØC68D E
    ØC66Ø2Ø9EB78A38C9Ø1 9ØØ7C9Ø
    9BØØ34CE2C1A2            :REM*126
47Ø DATA ØE4C37A48DE8C6A9Ø1CA F
    ØØ9ØA4CE7C1A2ØB4C37 A48DE7C
    62Ø79ØØC92CDØ            :REM*37
48Ø DATA F12Ø73ØØ2Ø8AAD2ØF7B7 A
    D12DØC9Ø9DØF9ADE8C6 38E9Ø1Ø
    AA88CE9C6A514            :REM*114
49Ø DATA 8DEDC699ØØDØADE7C649 F
    F2D1ØDØ8D1ØDØA5158D EEC6FØØ
    9ADE7C6ØD1ØDØ            :REM*143
5ØØ DATA 8D1ØDØ2Ø79ØØC92CDØ11 2
    Ø73ØØ2Ø9EB7ACE9C6C8 8A8DEFC
    699ØØDØ2Ø79ØØ            :REM*218
51Ø DATA C92CDØ732ØCDC2AD12DØ C
    9Ø9DØF92Ø73ØØ2ØEBB7 A5148DF
    ØC6A5158DF1C6            :REM*3Ø
52Ø DATA 8EF2C6ACE8C688B9ADC6 A
    A989DF5C6ADE7C69DF6 C62ØDDC
    5ADE7C6ØDF3C6            :REM*63
53Ø DATA 8DF3C62Ø79ØØC92CDØ1E 2
    Ø73ØØ2Ø9EB78A38C9Ø1 9Ø2ØC9Ø
    9BØ1C48ACE8C6            :REM*117
54Ø DATA 88B9ADC6AA689DF7C66Ø A
    CE8C688B9ADC6AAA9Ø1 9DF7C66
    ØA2ØE4C37A4AD            :REM*1Ø6
55Ø DATA E7C649FF2DF3C68DF3C6 6
    Ø2Ø9EB78A38E9Ø13Ø34 38C91ØB
    Ø2F8D25DØ2Ø79            :REM*143
56Ø DATA ØØC92CDØ142Ø73ØØ2Ø9E B
    78A38E9Ø13Ø1938C91Ø BØ148D2
    6DØ6Ø2Ø9EB78A            :REM*219
57Ø DATA 38C9Ø19ØØ7C9Ø9BØØ34C 1
    BC3A2ØE4C37A48DE8C6 A9Ø1CAF
    ØØ4ØA4C2ØC38D            :REM*189
58Ø DATA E7C649FF2D15DØ8D15DØ 2
    Ø79ØØC92CDØ132Ø73ØØ 2Ø9EB7E
    ØØ1DØØ9AD15DØ            :REM*249
59Ø DATA ØDE7C68D15DØ2Ø79ØØC9 2
    CDØ172Ø73ØØ2Ø9EB78A 38E9Ø13
    ØB738C91ØBØB2            :REM*183
6ØØ DATA ACE8C69926DØ2Ø79ØØC9 2
    CDØ1EADE7C649FF2D1B DØ8D1BD
    Ø2Ø73ØØ2Ø9EB7            :REM*162
61Ø DATA EØØ1DØØ9AD1BDØØDE7C6 8
    D1BDØ2Ø79ØØC92CDØ1E ADE7C64
    9FF2D1DDØ8D1D            :REM*22Ø
62Ø DATA DØ2Ø73ØØ2Ø9EB7EØØ1DØ Ø
    9AD1DDØØDE7C68D1DDØ 2Ø79ØØC
    92CDØ1EADE7C6            :REM*99
63Ø DATA 49FF2D17DØ8D17DØ2Ø73 Ø
    Ø2Ø9EB7EØØ1DØØ9AD17 DØØDE7C
    68D17DØ2Ø79ØØ            :REM*3Ø
64Ø DATA C92CDØ1EADE7C649FF2D 1
    CDØ8D1CDØ2Ø73ØØ2Ø9E B7EØØ1D
    ØØ9AD1CDØØDE7            :REM*143
65Ø DATA C68D1CDØ6ØAD19DØ8D19 D
    Ø29Ø1DØØ34C31EAADEØ C6FØ222
    9Ø1FØØDAD1EDØ            :REM*75
66Ø DATA FØØ8A9Ø18DEAC64C33C4 A
    DEØC629Ø2FØØAAD1FDØ FØØ5A9Ø
    28DEAC6ADF3C6            :REM*1Ø8
67Ø DATA DØØ34CA7C6AØØ78CEBC6 A
    98Ø8DECC68CEBC6ADEC C6FØEB2
    DF3C6DØØ94EEC            :REM*53
68Ø DATA C6881ØED4CA7C64EECC6 C
    EEBC6B9ADC6AABDF7C6 8DF4C6B
    DF8C685A7BDF9            :REM*55
69Ø DATA C685A8BDFAC685A62ØB1 C
    538BDF9C6DDFCC6DØ29 BDF8C6D
    DFBC6DØ21BDFA            :REM*229
7ØØ DATA C6DDFDC6DØ19BDF6C649 F
    F2DF3C68DF3C6ACEBC6 ADECC6D
    ØØ34CA7C64C45            :REM*255
71Ø DATA C42Ø6AC69Ø2CBDØ6C718 7
    DØØC79DØ6C7BDØ7C769 ØØ9DØ7C
    7BDF8C6187DØ1            :REM*131
72Ø DATA C79DF8C6BDF9C67DØ2C7 9
    DF9C62Ø6AC6FØØ2BØ1D BDØ4C71
    87DFEC69DØ4C7            :REM*143
73Ø DATA BDØ5C77DFFC69DØ5C7BD F
    AC6187DØ3C79DFAC6CE F4C6DØØ
    EACEBC6ADECC6            :REM*165
74Ø DATA DØØ34CA7C64C45C44C6B C
    4C9Ø2FØ1Ø2Ø5ØC5ADDC C6857AA
    DDDC6857B4C34            :REM*32
75Ø DATA C52Ø5ØC5ADDEC6857AAD D
    FC6857BA9ØØ8DEAC6AD E1C6853
    9ADE2C6853A2Ø            :REM*253
76Ø DATA 83A82Ø6BC5AD1EDØAD1F D
    Ø6ØAD1EDØAD1FDØA539 8DE3C6A
    53A8DE4C6A57A            :REM*36
77Ø DATA 8DE5C6A57B8DE6C66ØAD E
    3C68539ADE4C6853AAD E5C6857
    AADE6C6857B6Ø            :REM*251
78Ø DATA 78A9ØA8D12DØAD11DØ29 7
    F8D11DØA9818D1ADØA9 FF8D14Ø
    3A9C38D15Ø358            :REM*15Ø
79Ø DATA 6ØA98Ø8D1ADØ78A9318D 1
    4Ø3A9EA8D15Ø3586ØA5 A8FØØCB
    DF6C6ØD1ØDØ8D            :REM*9
8ØØ DATA 1ØDØ4CCCC5BDF6C649FF 2
    D1ØDØ8D1ØDØBDF5C6ØA A8A5A79
    9ØØDØA5A6C899            :REM*115
81Ø DATA ØØDØ6ØADEFC69DFAC6AD E
    DC69DF8C6ADEEC69DF9 C6ADF2C
    69DFDC6ADFØC6            :REM*134
82Ø DATA 9DFBC6ADF1C69DFCC638 B
    DFBC6FDF8C69DØ8C7BD FCC6FDF
    9C69DØ9C72Ø79            :REM*18Ø
83Ø DATA C69DØ1C7C9Ø1DØØ2A9ØØ 9
    DØ2C72Ø8CC6BDØ8C79D FEC6BDØ
    9C79DFFC638BD            :REM*156
84Ø DATA FDC6FDFAC69DØ8C7A9ØØ E
    9ØØ9DØ9C72Ø79C69DØ3 C72Ø8CC
    6BDØ8C79DØØC7            :REM*1ØØ
85Ø DATA BDFEC69DØ4C7BDFFC69D Ø
    5C7BDØØC79DØ6C7A9ØØ 9DØ7C76
    ØBDØ5C7DDØ7C7            :REM*77
86Ø DATA DØØ6BDØ4C7DDØ6C76ØBD Ø
    9C73ØØBFØØ3A9Ø16ØBD Ø8C7DØF
    86ØA9FF6ØBDØ9            :REM*225
87Ø DATA C71Ø1549FF9DØ9C7BDØ8 C
    749FF9DØ8C7FEØ8C7DØ Ø3FEØ9C
    76Ø68A868AA68            :REM*63
88Ø DATA 4ØØØ152A3F54697E93A8 6
    8C1CCC1D8C2Ø5C3434F 4C4C495
    3494FCE4D4F56            :REM*48
89Ø DATA 535ØD2535Ø52434F4C4F D
    2535Ø524954C5ØØØØØØ ØØØØØØ
    ØØØØØØØØØØØØ             :REM*239
9ØØ DATA ØØØØØØØØØØØØØØØØØØØ Ø
    ØØØØØØØØØØØØØØØØØØ ØØØØØØ
    ØØØØØØØØØØØØ             :REM*1
91Ø DATA ØØØØØØØ             :REM*93
92Ø DATA -1                  :REM*13
```

Listing 2. Sprite demo program.

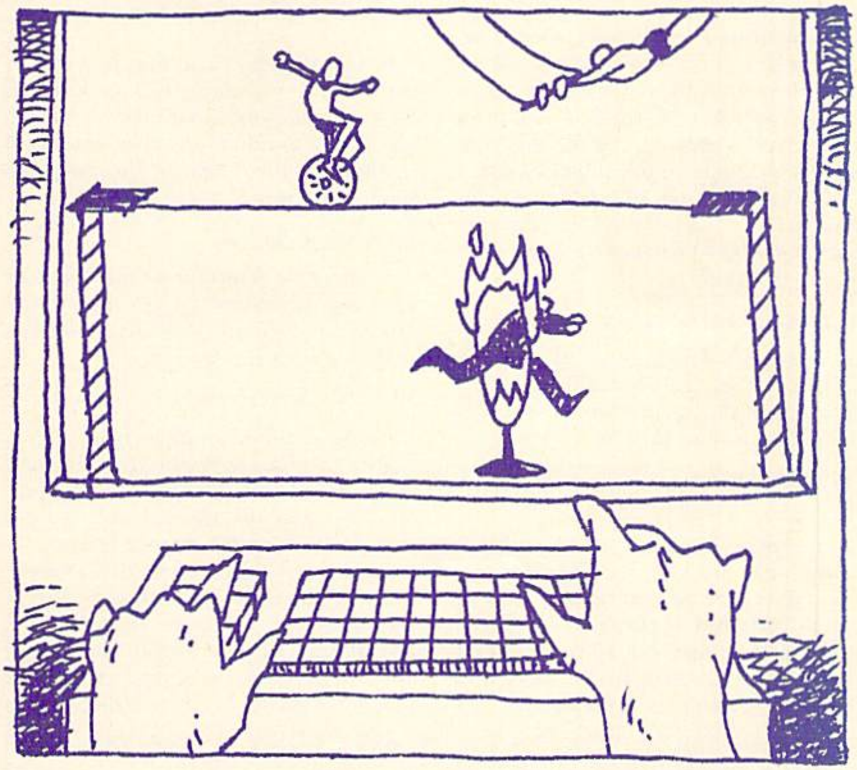
```
1Ø IF A=Ø THEN A=1:LOAD "SPRITE
   BASIC",8,1
2Ø SYS49152:REM INITIALIZE EXTE
   NSION
3Ø FORX=16128TO16383:READA:CK=C
   K+A:POKEX,A:NEXT
4Ø IFCK<>9111THENPRINT"ERROR IN
    DATA STATEMENTS":END
5Ø SID=54272:J=5632Ø:V=53248
6Ø GOSUB75Ø
7Ø POKESID+5,16Ø:POKESID+6,252
8Ø POKESID+24,15
9Ø POKESID+12,1Ø3:POKESID+13,2Ø
   4
1ØØ POKESID+8,4Ø
11Ø POKESID+19,Ø:POKESID+2Ø,253

12Ø POKESID+15,6Ø
13Ø POKE5328Ø,Ø:POKE53281,Ø
14Ø PRINT"{SHFT CLR}"
15Ø C1=5:C2=9:TL=1
16Ø POKE2Ø4Ø,252:REM CANNON
17Ø POKE2Ø41,255:REM PLANE 1
18Ø POKE2Ø42,253:REM MISSILE
19Ø SPRITE 1,1,6
2ØØ SPRITE 2,1,13,Ø,Ø,Ø,1
21Ø SPRITE 3,Ø,7,Ø,Ø,Ø,1
22Ø MOVSPR 1,16Ø,218
23Ø FORX=19TOØ STEP-1
24Ø POKE1Ø24+X,16Ø
25Ø POKE1Ø63-X,16Ø
26Ø POKE55296+X,2
27Ø POKE55335-X,2
28Ø POKE56256+X,3
29Ø POKE56295-X,3
3ØØ POKE1984+X,16Ø
31Ø POKE2Ø23-X,16Ø
32Ø NEXT
33Ø X=PEEK(V+3Ø):X=PEEK(V+31):R
    EM BE SURE ALL COLLIDES ARE
     CLEARED
34Ø R=INT(RND(1)*12Ø):P=P+1
35Ø IF P=16THEN66Ø
36Ø R2=INT(RND(1)*12Ø)
37Ø S1=INT(RND(1)*7)+2
38Ø POKESID+1,S1*3
39Ø SPRITE 2,1
4ØØ IFTL=1THENTL=2:POKE2Ø41,254
    :MOVSPR 2,Ø,6Ø+R,345,6Ø+R2,
    S1:GOTO42Ø
41Ø IFTL=2THENTL=1:POKE2Ø41,255
    :MOVSPR 2,345,6Ø+R,Ø,6Ø+R2,
    S1
42Ø POKESID+4,129
43Ø C=C+1:IFC=3ØTHENC=Ø:GOTO34Ø

44Ø IFC=15THENPOKESID+4,128
45Ø C1=C1+1:IFC1=17THENC1=1
46Ø C2=C2+1:IFC2=17THENC2=1
47Ø SPRCOLOR C1,C2
48Ø PRINT"{HOME}{CTRL 3}{CTRL 9
    }{6 SPACEs}PASSES"P" MISSED
    "S" HITS"H
49Ø COLLISION 2,72Ø:COLLISION 1
    ,73Ø
5ØØ IFPEEK(J)AND8THEN53Ø
51Ø IFFT=1THEN56Ø
52Ø FT=1:GOSUB62Ø:MOVSPR 1,X,21
    8,32Ø,218,2
53Ø IFPEEK(J)AND4THEN56Ø
54Ø IFFT=2THEN56Ø
55Ø FT=2:GOSUB62Ø:MOVSPR 1,X,21
    8,25,218,2
56Ø IFPEEK(J)AND16THEN43Ø
57Ø IFF=1THEN43Ø
58Ø IFF=ØTHEN F=1:GOSUB62Ø:MOVS
    PR 3,X,193,X,55,3:SPRITE 3,
    1:POKESID+11,129
59Ø GOTO43Ø:REM CONTINUE MAIN L
    OOP
6ØØ REM THIS SUBROUTINE MAKES A
     VARIABLE EQUAL TO A SPRITE
     POSITION
61Ø REM IF YOU MEAN TO DO SPRIT
    E 3 THEN IT IS X=PEEK(V+4)+
    PEEK((V+16)AND4)*64
62Ø POKE828,12Ø:POKE829,96:SYS8
    28:REM INTERRUPTS OFF
63Ø X=PEEK(V)+(PEEK(V+16)AND1)*
    256
64Ø POKE828,88:SYS828:REM INTER
    UPTS ON
65Ø RETURN
66Ø POKE5328Ø,7:POKE53281,9:PRI
    NT"{SHFT CLR}":FORX=1TO3:SP
    RITE X,Ø:NEXT:GOSUB75Ø
67Ø FORX=ØTO12:PRINT:NEXT
68Ø PRINT"{CTRL 8}YOU HIT"H"WIT
    H"S+H"SHOTS IN THE 15":PRIN
    T"PASSES OF THE ENEMY."
69Ø PRINT"PRESS FIRE FOR MORE O
    F THE SAME."
7ØØ IFPEEK(J)AND16THEN7ØØ
71Ø CLR:GOTO5Ø
72Ø COLLISION 2:SPRITE 3,Ø:F=Ø:
    MOVSPR3,X,193:S=S+1:POKESID
    +11,128:RETURN
73Ø COLLISION 1:H=H+1:SPRITE 2,
    Ø:SPRITE 3,Ø:MOVSPR 3,X,193
    :F=Ø:POKESID+1,Ø
74Ø POKESID+11,128:POKESID+18,1
    29:POKESID+18,128:RETURN
75Ø FORL=ØTO24:POKESID+L,Ø:NEXT
    :RETURN
76Ø REM CANNON DATA
77Ø DATAØØØ,Ø62,ØØØ,ØØØ,Ø65,ØØØ
    ,ØØØ,Ø62
78Ø DATAØØØ,ØØØ,Ø34,ØØØ,ØØØ,Ø34
    ,ØØØ,ØØØ
79Ø DATAØ34,ØØØ,ØØØ,Ø34,ØØØ,ØØØ
    ,Ø34,ØØØ
8ØØ DATAØØ1,255,192,ØØ1,255,192
    ,ØØ1,255
81Ø DATA192,ØØØ,162,128,ØØØ,162
    ,128,ØØØ
82Ø DATA162,128,ØØØ,162,128,ØØØ
    ,162,128
83Ø DATAØØØ,162,128,ØØØ,193,128
    ,ØØØ,128
84Ø DATA128,ØØ7,ØØØ,112,ØØ7,255
    ,24Ø,ØØØ
85Ø REM MISSILE DATA
86Ø DATAØØØ,ØØ8,ØØØ,ØØØ,ØØ8,ØØØ
    ,ØØØ,Ø42
87Ø DATAØØØ,ØØØ,Ø42,ØØØ,ØØØ,Ø42
    ,ØØØ,ØØØ
88Ø DATAØ42,ØØØ,ØØØ,Ø42,ØØØ,ØØØ
    ,Ø42,ØØØ
89Ø DATAØØØ,Ø42,ØØØ,ØØØ,Ø42,ØØØ
    ,ØØØ,Ø42
9ØØ DATAØØØ,ØØØ,128,128,ØØ2,132
    ,16Ø,ØØ2
91Ø DATA14Ø,16Ø,ØØ2,132,16Ø,ØØ2
    ,14Ø,16Ø
92Ø DATAØØØ,Ø55,ØØØ,ØØØ,Ø12,ØØØ
    ,ØØØ,ØØØ
93Ø DATAØØØ,ØØØ,ØØØ,ØØØ,ØØØ,ØØØ
    ,ØØØ,ØØØ
94Ø REM PLANE 1 DATA
95Ø DATAØØØ,ØØØ,ØØØ,ØØØ,ØØØ,ØØØ
    ,ØØØ,ØØØ
96Ø DATAØØØ,ØØØ,ØØØ,ØØØ,ØØØ,ØØØ
    ,ØØØ,ØØØ
97Ø DATAØØØ,ØØØ,ØØØ,ØØ2,ØØØ,ØØ8
    ,Ø1Ø,128
98Ø DATAØØ8,Ø4Ø,Ø32,222,17Ø,17Ø
    ,Ø1Ø,138
99Ø DATA128,ØØØ,ØØ2,ØØØ,ØØØ,ØØØ
    ,ØØØ,ØØØ
1ØØØ DATAØØØ,ØØØ,ØØØ,ØØØ,ØØØ,ØØ
     Ø,ØØØ,ØØØ
1Ø1Ø DATAØØØ,ØØØ,ØØØ,ØØØ,ØØØ,ØØ
     Ø,ØØØ,ØØØ
1Ø2Ø DATAØØØ,ØØØ,ØØØ,ØØØ,ØØØ,ØØ
     Ø,ØØØ,116
1Ø3Ø DATAØØØ,ØØØ,ØØØ,ØØØ,ØØØ,ØØ
     Ø,ØØØ,ØØØ
1Ø4Ø REM PLANE 2 DATA
1Ø5Ø DATAØØØ,ØØØ,ØØØ,ØØØ,ØØØ,ØØ
     Ø,ØØØ,ØØØ
1Ø6Ø DATAØØØ,ØØØ,ØØØ,128,ØØØ,ØØ
     2,16Ø,Ø32
1Ø7Ø DATAØØ8,Ø4Ø,Ø32,17Ø,17Ø,18
     3,ØØ2,162
1Ø8Ø DATA16Ø,ØØØ,128,ØØØ,ØØØ,ØØ
     Ø,ØØØ,ØØØ
1Ø9Ø DATAØØØ,ØØØ,ØØØ,ØØØ,ØØØ,ØØ
     Ø,ØØØ,ØØØ
11ØØ DATAØØØ,ØØØ,ØØØ,ØØØ,ØØØ,ØØ
     Ø,ØØØ,ØØØ
111Ø DATAØØØ,ØØØ,ØØØ,ØØØ,ØØØ,ØØ
     Ø,ØØØ,ØØØ
112Ø DATAØØØ,ØØØ,ØØØ,ØØØ,ØØØ,ØØ
     Ø,ØØØ,ØØØ
113Ø DATAØØØ,ØØØ,ØØØ,ØØØ,ØØØ,ØØ
     Ø,ØØØ,ØØØ
114Ø DATAØØØ,ØØØ,ØØØ,128,ØØØ,ØØ
     2,16Ø,Ø32
115Ø DATAØØ8,Ø4Ø,Ø32,17Ø,17Ø,18
     3,ØØ2,162
116Ø DATA16Ø,ØØØ,128,ØØØ,ØØØ,ØØ
     Ø,ØØØ,ØØØ
117Ø DATAØØØ,ØØØ,ØØØ,ØØØ,ØØØ,ØØ
     Ø,ØØØ,ØØØ
118Ø DATAØØØ,ØØØ,ØØØ,ØØØ,ØØØ,ØØ
     Ø,ØØØ,ØØØ
119Ø DATAØØØ,ØØØ,ØØØ,ØØØ,ØØØ,ØØ
     Ø,ØØØ,ØØØ
```

■

C-128 Sprite Action

Master the use of sprites with these high-level Basic 7.0 commands.

By ROB KENNEDY



Basic 7.0 is the most advanced Basic language in any Commodore 8-bit computer for many reasons, one of which is its advanced sprite commands. On the C-64, sprites take hours of designing with pencil and graph paper, consulting reference books and typing in Poke commands, but with the C-128, you can create detailed multicolored sprites within minutes, and animation in just a little longer.

The Sprite Editor

When I state that sprites can be created in minutes on the C-128, I'm not joking. Basic 7.0 has a command, SprDef, that activates a program for that specific purpose. Turn on your computer in 128 mode and 40 columns; then type SPRDEF and press return. Immediately, a large box will appear on the screen, along with a prompt asking which sprite you want to edit. Next, Type 1, and you'll see a 24-column × 21-line box containing a grid pattern, with, to its right, the sprite version of the same pattern. To clear the grid in both locations, press shift/clear-home.

Now find the little plus sign in the top-left corner of the box and try moving it around with the cursor keys. Other keys that control cursor position are the return key, which brings it to the beginning of the next line, and the home key, which brings it to the top-left corner of the box. Number keys 1–4 are used for drawing in the box. The 1 key erases, 2 draws in the standard color mode, and 3 and 4 draw in Multicolor mode.

Right now you're in the Standard mode, so you can draw with only one color. To change this color to any of the 16 colors available on the C-128, use the control and Commodore keys in conjuction with number keys 1–8.

Try drawing a shape in the box—just a simple one for now, like a rectangle. Notice, as you do so, that the sprite on the right is updated continually.

When drawing vertical lines, you'll probably find it cumbersome to hit a color key, then have to move down and left to get in position for pressing the next color key. The sprite editor provides a command, A, that alleviates this problem by keeping the cursor from advancing after you press a color key. With A activated, you only have to press the cursor-down key to move to the next position.

After you've finished drawing the rectangle, press the X key and notice that the width of the sprite on the right doubles. Then press the Y key, and the height will double. To save your sprite in memory, press the shift and return keys simultaneously.

When you're asked which sprite you want to edit next, enter 2 and you'll go back to the built-in grid pattern. Then press shift/clear-home to erase the pattern, C to copy another sprite into the box and 1 to designate sprite 1.

The copy command, by the way, is handy for setting up animation. After you draw the first shape and save it, copy it back into the box, make minor changes and save it again, continuing for all eight available sprites.►

RUN it right: **C-128, in 40-Column mode**

Now press run-stop and request sprite 2 at the prompt, noticing that your copied shape doesn't get saved. Any time you don't want to save a sprite, just press run-stop to return to the prompt.

To access Multicolor mode, press the M key. In this mode, you can draw with three colors, using the 2, 3 and 4 keys, and the cursor becomes a double plus sign. Although you get only half the resolution as in the standard mode, the extra colors will probably compensate. (If not, you can design several single-color sprites that overlap to create the illusion of a multicolor sprite with normal resolution. However, this approach is a waste of the sprites available to you.)

The M command and the A, X and Y commands I mentioned earlier are all toggles; in other words, they're turned on and off by alternately pressing the same key. In Table 1, you'll find a quick-reference list of all the commands available in the sprite editor.

Now draw a multicolor sprite and save it. Then exit the sprite editor by pressing return, instead of a sprite number, at the prompt.

Turning On a Sprite

Having created and saved a couple of sprites, you can display them on the screen with the Sprite command, which has the following format:

SPRITE <number,on/off,color,priority,X-expand,Y-expand,multicolor>

The sprite number ranges from 1 to 8 and the color from 1 to 16. The other parameters are turned off and on with values of 0 and 1, respectively. You're probably familiar with all these parameters except priority, which specifies a sprite's location in relation to the screen data. A value of 0 makes the sprite appear to be in front of the objects on the screen and a value of 1 makes it appear to be behind them.

Type the following line to turn on your first sprite, the rectangle:

SPRITE1,1,2,0,0,0

After it comes on the screen, try these variations:

SPRITE1,1,3,0,1,1 to turn on sprite 1, with red color and X and Y expansion.

SPRITE1,0,,,0,0 to turn off sprite 1 and cancel X and Y expansion.

SPRITE2,1,7,0,1,1,1 to turn on multicolor sprite 2, with blue color and X and Y expansion.

Notice the three commas in a row in the second variation. If you want to skip one or more parameters before specifying another one, you must still include all the commas for the computer's reference.

Moving a Sprite

Sprites are positioned and then are moved with two different formats of the MovSpr command. The format for positioning a sprite is:

MOVSPR <number,X,Y>

The sprite number ranges from 1 to 8. X and Y, which represent the horizontal and vertical coordinates of the upper-left corner of the sprite, range from 0 to 511 and 0 to 255, respectively.

Unlike coordinates on the hi-res screen, not all of these are visible. The corners of the visible area are at 24,50 (upper-left); 344,50 (upper-right): 24,250 (lower-left); and 344,250 (lower-right). As you're placing a sprite, keep in mind that its boundaries won't be visible against a blank background.

Now, place your second sprite on the screen with:

MOVSPR2,150,150

The format the MovSpr command takes for setting a sprite in motion is:

MOVSPR <sprite number,angle#,speed>

The angle, ranging from 0 to 360 degrees, is the direction in which the sprite will move. On the screen, zero degrees is up, 90 degrees is to the right, 180 degrees is down, and so on, just like compass directions on a north-oriented map. The speed can range from 0 to 15, with 15 the fastest. These speeds are fun to play with, and you'll enjoy watching your sprites zip about at speed 15. However, that's really too fast for Basic to handle, and you'll have a hard time keeping the sprites under control.

Type in the following line and watch your sprite move:

MOVSPR2,90#7

Then try changing the values. When you're done, stop the sprite and reposition it with:

MOVSPR2,0#0
MOVSPR2,150,150

Now notice the various colors in the sprite. One is the background color provided by the computer, and you set another in your initial Sprite command. The other two colors can be set with the Basic 7.0 SprColor command. Here's the format:

SPRCOLOR<multicolor1,multicolor2>

These two colors, along with the background color, will be common for all the sprites on the screen; the only color that can be unique is the one set with the Sprite command.

The following line will produce a red, white and blue sprite:

SPRCOLOR3,2

Try turning it into a flag and then experimenting with its colors. What would the Star-Spangled Banner look like flying across the screen in green?

Sprite Collisions

Since sprites can move, they frequently "collide" with each other and other objects on the screen. Basic 7.0 provides two commands for handling such events, and one is appropriately named Collision. It takes the following format:

COLLISION <type,line number>

Table 1. Sprite editor commands.

Command	Result
Cursor keys	Move the cursor around the grid.
Home key	Moves the cursor to the top-left corner of the grid.
Shift/clear-home key	Clears the grid and homes the cursor.
Return key	Moves the cursor to the beginning of the next line.
Run-stop key	Exits the current sprite-definition grid.
A	Toggles cursor advance on and off.
1	Erases data "under" the cursor.
2	Places foreground data "under" the cursor.
3 and 4	Place multicolor data "under" the cursor.
Control/1-8	Activate the first eight foreground colors.
Commodore/1-8	Activate the last eight foreground colors.
C	Copies sprite data between two sprites.
M	Toggles Multicolor mode on and off.
X	Toggles horizontal expansion on and off.
Y	Toggles vertical expansion on and off.

It acts like a Goto command, sending execution to a subroutine at the specified line number when a collision is detected. After the subroutine is done, you can revert to where you left off with a Return command.

The Collision command can handle three types of collisions:

1. Sprite-to-sprite.
2. Sprite-to-character.
3. Light pen.

In this tutorial, I'll deal with only the first two. Sprite-to-sprite is self-explanatory, but note that "character" in sprite-to-character doesn't necessarily mean a letter on the screen; it can also mean a graphics character on the hi-res screen.

The Collision command comes in handy for simple programs, but the slowness of Basic limits its usefulness for the following reason. When a collision is detected, the computer doesn't jump to the subroutine until it finishes executing the current command. During this time, the two sprites that collided can travel a good distance, because the computer automatically moves sprites during the hardware-interrupt interval. Because this interval is too short for Basic to handle, some people turn to the speed of machine language.

The second command available for handling sprite collisions is Bump. It has two possible modes:

1. Sprite-to-sprite.
2. Sprite-to-character.

Bump is difficult to understand at first, because it doesn't come out and say, for instance, that sprites 1 and 2 collided; it reports a 3 instead. Three? Bump treats the eight available sprites as bits in a byte, so they have the usual place values for bits: 1, 2, 4, 8, 16, 32, 64 and 128. The number the Bump command returns is the total of the place values of the sprites that collided. For example, if sprite 1 and sprite 8 collided, a value of 129 would be returned.

Listing 1 contains a short program that stages a sprite race to illustrate simple collision handling.

Listing 1. Sprite Race program.

```
100 SCNCLR:GRAPHIC
    1,1:BOX1,1,10,319,20,,1
110 SPRITE1,1,3:SPRITE2,1,7,,,,1:
    SPRCOLOR6,8
120 MOVSPR1,100,200:MOVSPR2,270,200
140 S(1) = INT(RND(1)*5) + 1:S(2) = INT
    (RND(1)*5) + 1:IFS(1) = S(2)THEN140
150 MOVSPR1,0#S(1):MOVSPR2,0#S(2)
155 COLLISION2:COLLISION2,170
160 GOTO160
170 A = BUMP(2):PRINTA
175 COLLISION2
180 MOVSPR1,0#0:MOVSPR2,0#0
190 IFBUMP(2) = 1THENPRINT"SPRITE
    ONE IS THE WINNER!"
200 IFBUMP(2) = 2THENPRINT"SPRITE
    TWO IS THE WINNER!"
210 GRAPHIC0
```

Line 100 draws the finish line for the race. Line 110 turns on your two sprites and sets the multicolor values for sprite 2. Line 120 positions the sprites, line 140 selects a random speed for each and line 150 sets them in motion.

In line 155, notice that the first Collision command has no line number. When the line number is omitted, a Collision command clears any previous collision values. The second Collision command in line 155 sends execution to line 170 when a sprite-to-character collision is detected. Line 160 is just an endless loop that repeats until a collision occurs.

Line 170, which begins the collision-handling subroutine, stores the value returned by the Bump command and prints that value. Line 175 clears all collision information, and line 180 stops the sprites. The computer determines the winner by checking the Bump value again in line 190 and, if necessary, line 200. Finally, the message is displayed by line 210.

The value of Bump is taken twice to illustrate a point. The Bump command is temperamental, and, if you run the program several times, you'll notice that the value stored in variable A isn't always correct for the winner. Sometimes it will be 3, which would mean that both sprites hit the background at the same time. That's why line 175 cancels any previous collision values and checks the values again. This is possible with this program because the sprites are frozen immediately.

Try experimenting with the Sprite Race program by adding more contestants or making other changes.

Animation

You can do animation on the C-128 with both hi-res graphics and sprites. However, the latter are more effective, because they provide a much more fluid transition between shapes.

Animation is created by rapid "flipping" through a series of pictures, each of which is slightly changed from the previous one. Because our eyes retain an image briefly after the object is gone, we don't detect the gap between pictures, but seem to see the sequence as continuous.

This illusion is easy to create on the C-128 because of the SprSav command, which lets you copy data between sprites and variables. The format for this command is:

SPRSAV <source,destination>

Both source and destination of the data can be either a sprite or a string variable. The latter stores a hi-res shape that has usually been saved with the SShape command. The shape can be recopied to the hi-res screen, or, more important for our purposes, to a sprite. The format is:

SHAPE<variable$,X,Y,X2,Y2>

The X and Y coordinates mark the top-left corner of the shape, while X2 and Y2 mark the bottom-right. Be careful not to make the shape too big—sprites can't handle shapes bigger than 24 × 21. You'll avoid any problems if you always use coordinates 0,0,23,20 when saving shapes that will be used with sprites. You'll also avoid problems by making sure you're not in a Multicolor graphics mode.

In the Olympic Spirit

Listing 2 contains a small program that shows simple animation: the Olympic rings spinning on their axes. Type in the program and then run it.

Listing 2. Olympic Ring program.

```
100 GRAPHIC1,1:COLOR0,1:
    COLOR4,1:COLOR1,2
110 WIDTH2
130 FORT = 10TO1STEP - 1
140 CIRCLE1,10,10,T,10
150 SSHAPE$(T),0,0,23,20
160 GRAPHIC1,1
170 NEXTT
190 A = 1:T = 2
200 MOVSPR1,100,100:MOVSPR2,
    115,100:MOVSPR3,130,100
205 MOVSPR4,107,115:MOVSPR5,122,115
210 DO
220 T = T + A:IFT = 10ORT = 1
    THENA = - A
230 FORB = 1TO5
240 SPRSAV$(T),B
250 SPRITEB,1,B + 1
260 NEXTB
270 LOOP
```

Line 100 sets up the graphics screen, and line 110 sets the pixel width to double the normal size. Line 130 creates a loop, and line 140 draws a circle that decreases in width with each loop. Line 150 is the key to this loop: It saves the shape drawn in line 140 for use in sprites. Line 160 clears the screen, and line 170 executes the loop until T equals ►

1. Line 190 sets variable A, the increment, and variable T, the pointer that indicates which shape to copy into the sprites' data registers. Then lines 200 and 210 position the sprites.

The endless loop in lines 210–270 is the heart of the program; it creates the animation. Within the loop, line 220 updates the shape pointer, and the For statement in line 230 starts an inner loop that copies the shape data into each of the five sprites used. Line 240 does the actual copying, with line 250 turning on the sprites. The operation in line 250 could have been placed in its own loop before line 210, but the program is shorter with it here. Line 260 ends the For-Next loop, while line 270 restarts the main loop.

When you run this program, you'll see five different-colored rings spinning on your screen. They'll continue spinning until you press run-stop/restore, followed by GRAPHIC0. Study the program and perhaps make a few changes, such as substituting the following lines:

```
140 BOX1,10-T,1,10+T,20
140 BOX1,10-T,1,10+T,20,36*T
140 CIRCLE1,10,10,T,10,,,36*T
```

Saving and Loading Sprites

After you've drawn some detailed sprites, save them to disk for later use. To save your sprites, type:

```
BSAVE"name",B0,P3584TOP4096
```

To reload them later, type in:

```
BLOAD"name",B0
```

Reading Sprite Parameters

If you're using your sprites in a program where they're constantly changing position, color, and so forth, you may want to find out what their current condition is. Three commands—RSprite, RSpPos and RSpColor—will tell you almost everything you want to know. The formats for these are:

```
RSPRITE <sprite,attribute>
RSPPOS <sprite,characteristic>
RSPCOLOR <register>
```

The sprite parameter is the number of the sprite for which you want the information, and the attribute parameter is the sprite attribute for which you want the value. The attribute values range from 0 to 5 for each of the six parameters available with the Sprite command. An example would be:

```
PRINT RSPRITE (1,1)
```

If a value of 1 was returned, the sprite was on.

Characteristic is the same as attribute, but for different parameters. Characteristic values can be 0 for the X location, 1 for the Y location and 2 for speed. Register values are 1 for multicolor 1 and 2 for multicolor 2.

Try different variations of the programs here. Start off simply, then work your way up, and soon you'll be doing things you never thought possible. ■

Rob Kennedy is a university student with several years' computing experience under his belt and several magazine articles to his credit.

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The Sound of Basic

Bells, whistles, siren sounds or beautiful music—let's hear it from your Commodore.

By BRUCE JAEGER

We Commodore owners sometimes forget how good we have it, especially when it comes to the sound and music capabilities of our machines. What was state-of-the-art sound when introduced by the C-64 is still impressive, and, while the C-128 didn't add another SID chip to give us six voices, it did give us some Basic sound and music commands that make working with sound a lot easier.

A SID Primer

Just like the old-time fiddler who said, "Sure, I know how to read music—but not enough to hurt my playing," you don't have to memorize everything there is to know about the SID chip to get great sounds and music out of your C-64 or C-128. However, a little knowledge will keep your experiments going in the right direction.

All sounds on the C-64 or C-128 are produced by the MOS 6581 SID (sound interface device). This chip has three independent voices that can make three different sounds at once. The SID is controlled by placing different values (whole bytes, or sometimes just certain bits in a byte) in specified memory locations called registers.

With the C-64, you have to place these values yourself, using memory-store operations from a machine language program or Poke commands from Basic. The Sound, Envelope, Volume and Play commands in the C-128's Basic 7.0 do these Pokes automatically, and I'll give you some examples that show how easily some very complex sound effects can be achieved. However, you can still create sounds the 64 way, as long as you're in bank 15. So, nothing you learn about sound on the C-64 has to go to waste with the C-128.

Be sure to read pages 457–469 in the *C-64 Programmer's Reference Guide* or pages 605–610 in the *C-128 Programmer's Reference Guide* for a detailed description of the SID chip and its control registers. Even if you're a C-128 owner, you'll probably want to buy the C-64 book; the 128 version is pretty skimpy on SID.

Characteristics of Sounds

A note's **frequency** is the number of cycles per second of its waveform, which produces the pitch of the note—in other words, how high or low the note sounds. A note with a greater frequency (or pitch) sounds higher than one with a lower frequency.

The pitch of each of the SID's three voices is specified by poking values into a two-byte register, in the low-byte, high-byte style familiar to 6502 programmers. Using two bytes is necessary because each byte can hold values only from 0 to 255, while frequency needs to range up into the thousands. The value stored in the high-byte register (Freq Hi) is multiplied by 256 and added to the number in the low-byte register (Freq Lo). For example, to store the number 440 in the frequency registers, you'd poke 1 into the high byte and 184 into the low byte: $1*256+184=440$.

Unfortunately, these values don't correspond to actual frequencies; 440 poked into a SID frequency register doesn't produce the 440-cycle-per-second (Hertz) A note. So, Commodore has included frequency conversion tables for your use in both the C-64 and C-128 programming guides.

Harmonics

We say a 440 Hz A note has a fundamental frequency of 440 Hz. That frequency is also called the **first harmonic**, because it's the most important component of the sound. However, on just about any instrument other than the purest of sine-wave generators you'll hear additional harmonics: a second harmonic of 880 Hz (twice that of the fundamental frequency), a third harmonic of 1320 Hz (three times the fundamental frequency), and so on.

The harmonics often get weaker as they increase in frequency. In fact, most of the time you're not really aware of any frequencies but the fundamental one until you remove the harmonics and hear how "thin" the sound becomes. Harmonics are just one of the reasons the same note sounds differently when played on a trumpet, violin or clarinet.

Waveforms

Commodore has used different mathematical combinations of harmonics to create three of the four **waveforms** the SID chip can produce: Pulse, Triangle and Sawtooth. The fourth waveform, Noise, was carefully designed to have no mathematically predictable sound at all!

Pretend there's a sound with a frequency of one vibration per second making your eardrums move. This frequency is far too low to actually hear, of course, but it will be easy to use for visualizing waveforms. Suppose the sound wave hits your right ear, instantaneously moves your eardrum to the left, waits a half-second, then instantaneously stops, releasing the eardrum to the right for the remaining half-second. A graphic representation of this "pulse" or "square wave" waveform might look like this:

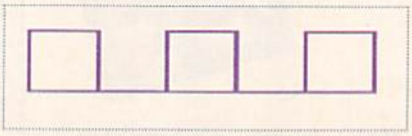

Figure 1. Graphic representation of the Pulse waveform.

(This is a theoretically perfect waveform; never mind for now the inertia of your eardrum, or of molecules, that ►

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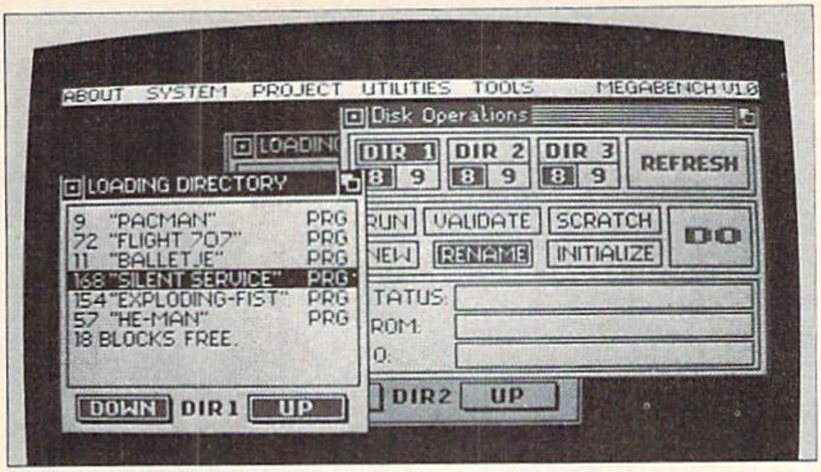

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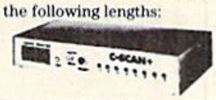

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makes a perfectly square waveform impossible.)

Now, suppose the sound wave hits your ear, gradually and evenly moves your eardrum to the left for a half-second, then gradually moves the eardrum back to the right. A graphic representation of this waveform is called a "triangle," because it looks like this:

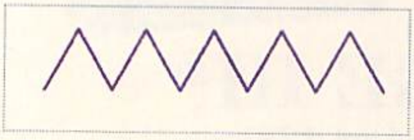

Figure 2. The Triangle waveform.

Next, suppose the sound wave hits your ear, gradually and evenly moves your eardrum to the left for a second, then stops, instantly releasing the eardrum back to the right. A graphic representation of this waveform is called a "sawtooth":

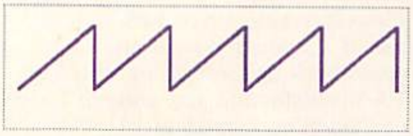

Figure 3. The Sawtooth waveform.

Finally, suppose the sound wave hits your eardrum with all sorts of random pulses. This Noise waveform might look like this:

Figure 4. The Noise waveform.

The C-64 program in Listing 1 demonstrates what each of these waveforms sounds like. You can run this program on a C-128 also, but precede it with a BANK 15 command. (Don't worry for now if you don't understand what all the Peek and Poke commands mean; I'll explain them later.)

The program in Listing 2 does the same thing, but it's designed for the C-128. Notice how much simpler it is.

Listing 1. Waveform comparison program (C-64).

```
10 REM WAVEFORMS (C64) :REM*249
20 SD=54272:PRINT CHR$(147)
                        :REM*143
30 GOSUB 150:REM RESET SID
                        :REM*199
40 POKE SD+2,100:POKE SD+3,1
                        :REM*232
50 POKE SD+24,15        :REM*165
60 POKE SD+6,240        :REM*186
70 POKE SD+1,50:POKE SD,1
                        :REM*159
80 FOR X=1 TO 4         :REM*207
90 READ WV,WV$:PRINT WV$
                        :REM*250
100 POKE SD+4,WV         :REM*62
110 POKE SD+4,PEEK(SD+4) OR 1:R
   EM START A/D/S CYCLE
                        :REM*247
120 FOR DELAY=1 TO 1000:NEXT DE
   LAY                  :REM*45
130 NEXT X:GOSUB 150:END
                        :REM*103
140 :                   :REM*198
150 FOR X=0 TO 23:POKE SD+X,0:N
   EXT:RETURN           :REM*119
160 :                   :REM*218
170 REM WAVEFORM DATA     :REM*6
180 DATA 16,TRIANGLE:REM BIT 4
                        :REM*198
190 DATA 32,SAWTOOTH:REM BIT 5
                         :REM*88
200 DATA 64,PULSE:REM BIT 6
                        :REM*134
210 DATA 128,NOISE:REM BIT 7
                        :REM*249
```

Listing 2. Waveform comparison program (C-128).

```
10 REM WAVEFORMS (C128):REM*216
20 PRINT CHR$(147):VOL 15
                        :REM*140
30 FOR X=1 TO 4         :REM*157
40 READ WV,WV$:PRINT WV$
                        :REM*172
50 SOUND 1,12000,35,0,0,0,WV,20
   48                   :REM*173
60 SLEEP 1:NEXT X        :REM*98
70 VOL 0:END             :REM*43
80 :                    :REM*138
90 REM WAVEFORM DATA    :REM*215
100 DATA 0,TRIANGLE       :REM*3
110 DATA 1,SAWTOOTH      :REM*73
120 DATA 2,PULSE         :REM*10
130 DATA 3,NOISE        :REM*223
```

VOLUME

The **volume**, or amplitude, of a sound is merely how loud it is. Let's say we have a sound with a Sawtooth waveform that looks like this:

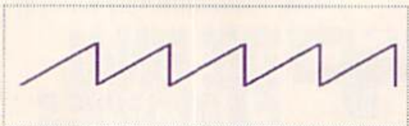

Figure 5. A sound created with the Sawtooth waveform.

The same note, louder, might appear like this:

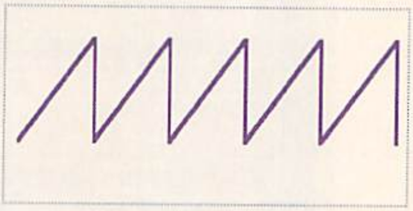

Figure 6. The same sound, only louder.

Note that the distances between the waves are the same in each case, so the two notes are of the same frequency. However, the amplitude of the second note is greater, so the note is louder.

ENVELOPE

The **envelope** of a note includes four different components of a note's tone: **attack**, or the time it takes the note to reach its peak volume; **decay**, or how soon it drops down to what might be called the note's average volume level; **sustain**, or how long it stays at that level; and, finally, **release**, or how long it takes for the sound to stop. Here's a graphic representation of how an envelope might look:

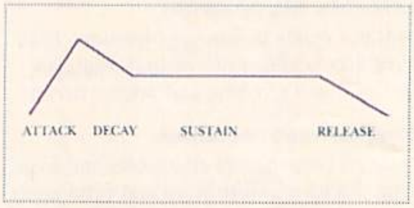

Figure 7. Representation of a sound's envelope.

Note that, unlike the previous diagrams, which showed a sound's frequency, this graph shows the relative volume, from when the note begins to when it dies off. If the sound were that of a hammer hitting a length of two-by-four, the attack and decay part of the envelope would be accentuated, with almost no sustain or release, because hammers and two-by-fours don't resonate very well. When a bow is drawn across a violin string, however, the attack is gentler, with almost no decay, and the sound sustains until the bow stops moving, at which point it releases at a rate that says much about the quality of the violin.

Listing 3 is a C-64 program you can use to play with setting rates of attack, decay, sustain and release. Try the values listed in Figure 8 and note the different results. The program will keep running until you input a negative number for Attack.

Listing 3. Envelope experiment program (C-64).

```
10 REM ENVELOPES (C64) :REM*174
20 SD=54272:PRINT CHR$(147)
                      :REM*143
30 GOSUB 240:REM RESET SID
                      :REM*200
40 POKE SD+24,15      :REM*175
50 INPUT "ATTACK (0-15) ";A
                       :REM*96
60 IF A<0 THEN END    :REM*111
70 INPUT "DECAY (0-15) ";D
                      :REM*122
80 INPUT "SUSTAIN (0-15) ";S
                       :REM*40
90 INPUT "RELEASE (0-15) ";R
                       :REM*22
100 AD=(A*16)+D        :REM*47
110 SR=(S*16)+R       :REM*124
120 POKE SD+5,AD:REM ATTACK/DEC
    AY                 :REM*97
130 POKE SD+6,SR:REM SUSTAIN/RE
    LEASE             :REM*149
140 POKE SD+1,25:POKE SD,1:REM
    FREQ               :REM*78
150 POKE SD+4,32:REM SAWTOOTH W
    AVEFORM           :REM*163
160 :                 :REM*218
170 POKE SD+4,PEEK(SD+4) OR 1:R
    EM START A/D/S     :REM*13
180 FOR DELAY=1 TO 1000:NEXT
                      :REM*147
190 POKE SD+4,PEEK(SD+4) AND 25
    4:REM RELEASE      :REM*10
200 :                   :REM*3
210 FOR DELAY=1 TO 1000:NEXT
                      :REM*245
220 RUN               :REM*103
230 :                  :REM*33
240 FOR X=0 TO 23:POKE SD+X,0:N
    EXT:RETURN        :REM*201
```

The C-128 has a built-in Envelope command for easily setting attack, decay, sustain and release, as well as for choosing waveforms and other things. Unfortunately, envelopes created with this command don't work with the C-128's Sound command; you can use them only with the Play command.

Besides letting you design your own envelopes, the C-128 comes with ten predefined envelopes for use with the Play command. Listing 4 demonstrates these built-in envelopes, which are supposed to sound like various musical instruments.

Listing 4. Built-in envelopes program for the C-128.

```
10 REM ENVELOPES (C128):REM*231
20 PRINT CHR$(147)     :REM*226
30 FOR X=0 TO 9        :REM*167
40 READ E$:PRINT E$     :REM*44
50 PLAY "T"+STR$(X)+"03 CDEFGAB
   04 C"               :REM*204
60 PRINT:SLEEP 1:NEXT X  :REM*3
70 :                   :REM*128
80 DATA PIANO,ACCORDIAN,CALLIOP
   E,DRUM,FLUTE        :REM*165
90 DATA GUITAR,HARPSICHORD,ORGA
   N,TRUMPET            :REM*38
100 DATA XYLOPHONE      :REM*12
```

You can use the Envelope command to redefine any of the built-in envelopes. The format is:

ENVELOPE number, attack, decay, sustain, release, waveform, pulse width

Number is the envelope number (0–9) you want to modify; attack, decay, sustain, and release have values from 0 to 15; waveform ranges from 0 to 3 (look at the Data statements in the C-128 Waveform program); and pulse width is a value from 0 to 4095 that affects only the Pulse waveform.

Listing 5. Defining envelopes program for the C-128.

```
10 REM ENVELOPE #,ATTACK,DECAY,
   SUSTAIN,RELEASE,WAVEFORM,PUL
   SE WIDTH            :REM*152
20 ENVELOPE 1,8,2,2,2,1,2000
                       :REM*122
30 PLAY "T1 03 CDEFGAB 04 C"
                        :REM*54
```

Listing 5 is a quick program you can use to try defining envelopes on the C-128. Run the program over and over, varying the values in line 20 (except for the first 1).

Filters

The SID can use filters to remove certain ranges of frequencies from a sound, to help you achieve the sound you want. Three types of filters are available: low-pass, high-pass and band-pass. To use them, you must set frequency cutoff points. A low-pass filter lets any frequency below the cutoff point through, so you hear just lower harmonics. A high-pass filter lets any frequency above the cutoff point through, so you hear just higher harmonics. With a band-pass filter, you set both high-frequency and low-frequency cutoff points, spaced so that the frequencies you desire would "fit" between them.

For more information on filters, refer to the section on filtering in the C-64 programming guide (page 199) and to the description of the Filter command in the C-128 guide.

Creating Sounds

Twenty-four bytes control the sounds coming out of the SID chip. These start at memory address 54272, to which variable SD is set in all the example programs in this article. The parameters these bytes define are listed in Table 1. For more detailed information on the SID-controlling bytes, refer to discus- ▶

Figure 8. Trial values for program in Listing 3.

Attack = 10 : Decay = 0 : Sustain = 0 : Release = 0
Attack = 0 : Decay = 10 : Sustain = 0 : Release = 0
Attack = 10 : Decay = 10 : Sustain = 10 : Release = 10
Attack = 15 : Decay = 1 : Sustain = 3 : Release = 3

Table 1. SID control bytes.

Voice 1	Voice 2	Voice 3
SD low frequency	SD + 7 low frequency	SD + 14 low frequency
SD + 1 high frequency	SD + 8 high frequency	SD + 15 high frequency
SD + 2 pulse data l	SD + 9 pulse data l	SD + 16 pulse data l
SD + 3 pulse data h	SD + 10 pulse data h	SD + 17 pulse data h
SD + 4 control register	SD + 11 control register	SD + 18 control register
SD + 5 attack/decay	SD + 12 attack/decay	SD + 19 attack/decay
SD + 6 sustain/release	SD + 13 sustain/release	SD + 20 sustain/release

SD + 21 filter cutoff frequency (low nibble)
SD + 22 filter cutoff frequency (high byte)
SD + 23 filter resonance control

SD + 24 Volume Control, Filter Control

Note: SD stands for memory address 54272.

sions of SID and the memory map in the C-64 programming guide.

Bits?

The Voice 1 Control register and the Volume and Filter Control registers are the most confusing, because individual bits, instead of bytes, control the SID. This isn't the place for a tutorial on the binary number system, but a little bit about it is necessary. Our familiar decimal system, based on the powers of 10, uses ten numerals, 0–9, with the actual value of each numeral in a number depending on its "place" in the number; e.g., units, tens, hundreds, etc. In the binary system, based on the powers of 2, there are just two numerals: 0 and 1. We use binary in computers because 0 can stand for "off" and 1 for "on," which lends itself nicely to electronic switching.

Every byte is made up of eight bits, with each bit either 1 (on) or 0 (off), depending on whether or not the bit "place value" is used in the number. Figure 9 shows the decimal value of each bit in the following binary number: 1 0 0 1 0 0 1 1. There's a 1 in the "128" column, a 1 in the "16" column, a 1 in the "2" column and a 1 in the "1" column. 128 + 16 + 2 + 1 = 147. Therefore, 10010011 in binary equals 147 in decimal.

Now, let's see why it's important to know about bits. Refer to Table 2 for a list of the bits controlled by the Control register for Voice 1 and Table 3 for the Volume Control, Filter Control register.

Basic has no direct way of turning a bit on or off. That must be done through And, Or, Peek or Poke commands. (Look up And and Or in your Basic references.) Let's say you want to set bit 5 of the Control register to turn on the Sawtooth waveform. You know that binary bit 5 has a decimal value of 32 (2↑5; check the binary table again), but you can't just poke a 32 into the register, because 32 in binary is 00100000, and all those 0s might turn off something you want on. So, to turn bit 5 on, you have to peek the value in the Control register, perform a logical Or operation with that value and 32, then poke the value back into the Control register. To turn bit 5 off, you'd peek the value in the Control register, perform an And operation with that number and the result of 255 – 32, and poke the new value back into the Control register. (If that doesn't make sense, write down the binary equivalents of the numbers on paper, and then try it again.)

Figure 9. Breakdown of a sample byte.

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
(128)	(64)	(32)	(16)	(8)	(4)	(2)	(1)
1	0	0	1	0	0	1	1

Table 2. Values in SID Voice 1 Control register.

Bit	Controls. . .
0	If 1, starts Attack/Decay/Sustain cycle If 0, starts Release cycle
1	If 1, synchronizes Voice 1 oscillator with Voice 3
2	If 1, ring modulates Voice 1 oscillator with Voice 3
3	If 1, disables Voice 1 If 0, enables Voice 1
4	If 1, selects Triangle waveform
5	If 1, selects Sawtooth waveform
6	If 1, selects Pulse waveform
7	If 1, selects Noise waveform

Table 3. Values in SID Volume Control, Filter Control register.

Bit	Controls. . .
0–3	Control volume, which can be set to any value from 0 to 15. (Go back to the binary chart and add up the possible values of bits 0, 1, 2 and 3. That's 1 + 2 + 4 + 8 = 15, the highest possible number that can be represented with three binary bits.)
4	If 1, selects the Filter Low-Pass mode.
5	If 1, selects Filter Band-Pass mode.
6	If 1, selects Filter High-Pass mode.
7	If 1, turns off Voice 3 output

Play Time

Don't worry if some of that went over your head; you can pick up the theory gradually while you play with variable values in other people's sound routines. Listings 6–9 provide a few such routines to start with.

Listing 6. C-64 siren program.

```
1Ø REM SIREN (C64)       :REM*127
2Ø SD=54272              :REM*19
3Ø GOSUB 37Ø:REM ENSURE ALL REG
   ISTERS RESET          :REM*23
4Ø POKE SD+3,1:REM SET HIGH PAR
   T OF PULSE WAVEFORM :REM*194
5Ø POKE SD+2,24Ø:REM SET LOW PA
   RT OF PULSE WAVEFORM :REM*19
6Ø POKE SD+24,15:REM VOLUME FUL
   L, FILTERS ALL OFF   :REM*73
7Ø REM SET ATTACK TO 1, DECAY T
   O 1                   :REM*147
8Ø POKE SD+5,(1*16)+1:REM ATTAC
   K/DECAY               :REM*182
9Ø REM SET SUSTAIN TO 15, RELEA
   SE TO 1               :REM*217
1ØØ POKE SD+6,(15*16)+1:REM SUS
    TAIN/RELEASE         :REM*1Ø3
11Ø POKE SD+4,64:REM CHOOSE PUL
    SE WAVEFORM          :REM*12Ø
12Ø :                    :REM*178
13Ø REM START ATTACK/DECAY/SUST
    AIN SEQUENCE IN CONTROL REG
    ISTER                :REM*33
14Ø REM (BY TURNING ON BIT 1)
                         :REM*8Ø
15Ø POKE SD+4,PEEK(SD+4) OR 1
                         :REM*237
16Ø :                    :REM*218
17Ø REM SIREN UP         :REM*14
18Ø FOR X=15 TO 85       :REM*22Ø
19Ø POKE SD,1:REM SOUND LOW FRE
    Q BYTE               :REM*15Ø
2ØØ POKE SD+1,X:REM HI FREQ / W
    E'RE CHANGING IT     :REM*195
21Ø GOSUB 34Ø:REM DELAY ROUTINE
                         :REM*155
22Ø NEXT X               :REM*12
23Ø :                    :REM*33
24Ø REM SIREN DOWN       :REM*245
25Ø FOR X=84 TO 1Ø STEP -1
                         :REM*149
26Ø POKE SD,1:REM SOUND LOW FRE
    Q BYTE               :REM*93
27Ø POKE SD+1,X:REM HI FREQ BYT
    E / WE'RE CHANGING IT
```

```
                              :REM*128
280 GOSUB 340:REM DELAY ROUTINE
                              :REM*193
290 NEXT X                    :REM*86
300 :                         :REM*103
310 GOSUB 370:REM RESET ALL REG
    ISTERS (SOUND OFF) :REM*205
320 END                       :REM*193
330 :                         :REM*133
340 REM DELAY LOOP            :REM*42
350 FOR DE=1 TO 2:NEXT DE:RETUR
    N                         :REM*58
360 :                         :REM*163
370 REM RESET ALL REGISTERS (EX
    CEPT VOLUME)              :REM*127
380 FOR X=0 TO 23:POKE SD+X,0:N
    EXT:RETURN                :REM*92
```

For Listing 6, a C-64 program that generates a siren sound, I'll explain the meaning of every operation:

Line 30 makes sure all SID registers are cleared by calling a subroutine that pokes a value of 0 into each register location except the Volume Control byte at SD + 24. (I've found that it's the Pokes into SD + 24 that cause all the nasty clicks some Basic sound programs have!)

Lines 40 and 50 poke values into SD + 2 and SD + 3 for use by the Pulse waveform, which is set later in the routine. You can poke any number from 0 to 255 into SD + 2 and any number from 0 to 15 into SD + 3. I just played around with these numbers until I found a combination I liked.

Line 60 sets the volume to full (15), and the rest of the 0s in the binary representation of 15 (00001111) turn off all the filtering options, which I didn't want. You can do pokes like this directly—without performing And or Or operations with values previously in the register—if you know exactly what you want the whole byte to be.

Line 80 sets Attack and Decay for Voice 1. The upper four bits (xxxx. . . .) of the byte at SD + 5 set the attack time (lower numbers are faster), and the lower four bits (. . . .xxxx) set the decay time. (Again, lower numbers are faster.) Half of a byte is called a nibble, by the way. To set Attack in the high nibble, you've got to take your 0–15 number and multiply it by 16, then add the product to your 0–15 value for Decay and poke the sum into SD + 5. Commodore surely made this tedious. . .

Line 100 does the same thing for Sustain and Release, only this time with SD + 6.

Line 110 chooses the Pulse waveform by setting bit 6 of the Control register at SD + 4. Again, I didn't bother to Or this value into SD + 4, because I wanted the rest of the bits set to 0.

Note: Be sure to set the Waveform register (SD + 4) just before turning on the sound (see line 150); something about the SID chip makes it "forget" the contents of that register. I don't know why, but I've noticed that this happens.

Line 150 starts things humming. SID can't make any sound at all until bit 1 of the Control register is turned on, to start the attack/decay/sustain cycle. I had to be careful here not to just poke a 1 into SD + 4, because that would have put a 0 in the bit 6 that I just set in line 110! So, I did an Or operation with the value resulting from peeking SD + 4 with the number 1, then placed the result back into SD + 4. (For sounds that have to be "released" to sound right, you'd turn bit 1 off with POKE SD + 4, PEEK(SD + 4) AND 254. The siren sound in my program doesn't need to be released, so I didn't include a release in the code.)

Even though bit 1 of the Control register has now been set, there's still no sound, because the values in the Voice 1 SD and SD + 1 frequency registers are still 0. (A frequency of 0 is very quiet!) This is changed in the Siren Up routine, which raises the sound, and the Siren Down routine, where the sound "swoops" down and stops.

Line 190 places a 1 in the frequency low byte, and line 200 places a changing value (X) in the frequency high byte. Every time the program goes through the two For-Next loops, the value in the high-byte register changes by 1, which is the same as changing the entire frequency value by 256. (Remember, the high byte is multiplied by 256, then added to the low byte, to yield the frequency number.)

Lines 210 and 280 just call a delay loop to stretch out the sound.

After you type in Listing 1 and save it, experiment by changing the values of the variables. Perhaps use a different waveform in line 110 or different levels of attack, decay, and such. You can also add one or two more voices to the siren by using the appropriate addresses to set up the sound registers in Voice 2 and/or Voice 3.

The C-128 Sound Command

The three little siren programs (Listings 7, 8 and 9) take advantage of the C-128's powerful Sound command, which can do in a line or two what requires a whole program on the C-64.

Listing 7. C-128 siren program #1.

```
10 REM SIREN (C128) #1   :REM*35
20 SOUND 1,15000,100,0,5000,100
   ,2                    :REM*35
30 SOUND 1,15000,100,1,5000,100
   ,2                    :REM*11
```

Listing 8. C-128 siren program #2.

```
10 REM SIREN (C128) #2   :REM*85
20 SOUND 1,18000,135,0,4000,100
   ,2                    :REM*71
30 SOUND 2,18000,135,0,4000,100
   ,2                    :REM*187
40 SOUND 1,18000,135,1,4000,100
   ,2                    :REM*161
50 SOUND 2,18300,135,1,4300,100
   ,2                    :REM*208
```

Listing 9. C-128 siren program #3.

```
10 REM SIREN (C128) #3   :REM*71
20 SOUND 1,18000,135,0,4000,100
   ,2                    :REM*71
30 SOUND 3,20000,235,2,10000,80
   0,1                   :REM*247
40 SOUND 1,18000,175,1,400,100,
   1                     :REM*60
```

The Sound command has the following parameters: voice, frequency, duration, step direction, minimum sweep ►

Table 4. Parameters of C-128 Sound command.

Voice	1–3
Frequency	0–65535
Duration	0–32767
Direction	0–2. 0 (the default)—sweeps the frequency upward as the sound continues; 1—sweeps the frequency lower as the sound continues; 2—oscillates
Minimum sweep frequency	Directs SID not to sweep below this value (default,0.)
Sweep value	Amount to sweep by; 0 means not to sweep at all, but play a steady frequency
Waveform	0–3. 0—Triangle; 1—Sawtooth; 2—Pulse; 3—Noise
Pulse width	0–4095 (For the Pulse waveform only)

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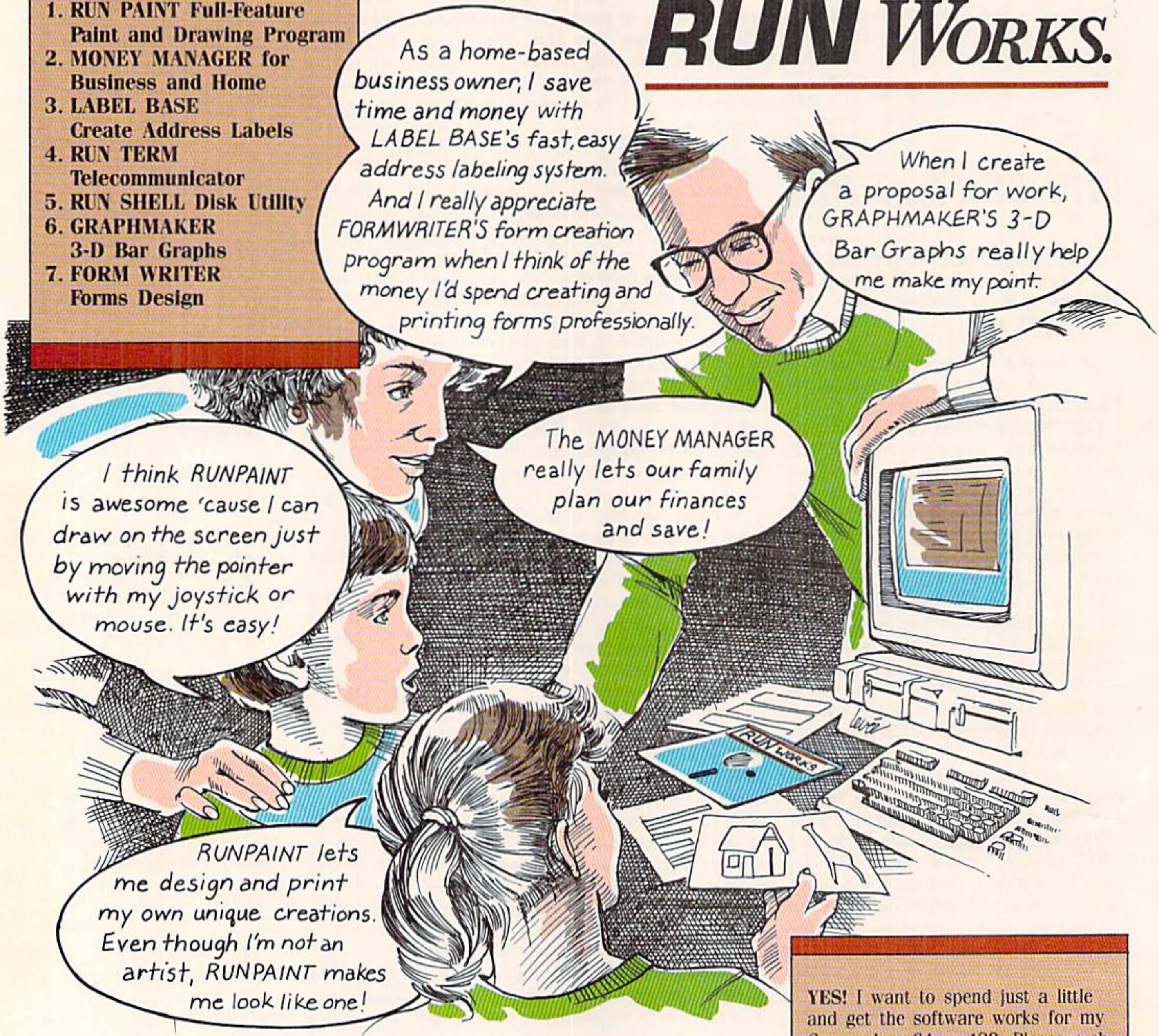

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frequency, sweep step value, waveform and pulse width.

The possible values for the various parameters are listed in Table 4.

Examining the values I used in the C-128 sirens should give you a good idea how these values work.

Back to Nature

The C-64 program in Listing 10 simulates the sound of a cricket. To transform the cricket into a frog, make the changes indicated below the listing.

Listing 10. Cricket program (C-64).

```
1Ø REM CRICKET (C64)     :REM*191
2Ø SD=54272               :REM*19
3Ø GOSUB 23Ø:REM RESET SID
                          :REM*2Ø3
4Ø POKE SD+24,15:REM FULL VOLUM
   E                      :REM*115
5Ø :                      :REM*1Ø8
6Ø GOSUB 11Ø:REM MAKE SOUND
                          :REM*1Ø8
7Ø DT=2Ø:GOSUB 2ØØ:REM DELAY
                          :REM*3Ø
8Ø GOSUB 11Ø:REM SOUND AGAIN
                          :REM*52
9Ø DT=1ØØØ:GOSUB 2ØØ:RUN:REM*24
1ØØ :                     :REM*158
11Ø REM ONE "CRICK" SOUND
                          :REM*95
12Ø FOR X=1 TO 2          :REM*235
13Ø POKE SD+1,254:REM FREQUENCY
                          :REM*135
14Ø POKE SD+4,16:REM TRIANGLE W
    AVEFORM               :REM*243
15Ø POKE SD+4,PEEK(SD+4) OR 1:R
    EM START SOUND        :REM*65
16Ø DT=5Ø:GOSUB 2ØØ:REM DELAY
                          :REM*184
17Ø POKE SD+4,PEEK(SD+4) AND 25
    4:REM RELEASE         :REM*62
18Ø NEXT:RETURN           :REM*87
19Ø :                     :REM*248
2ØØ REM DELAY ROUTINE     :REM*156
21Ø FOR DE=1 TO DT:NEXT:RETURN
                          :REM*225
22Ø :                     :REM*23
23Ø REM RESET ROUTINE     :REM*2Ø8
24Ø FOR X=Ø TO 23:POKE SD+X,Ø:N
    EXT:RETURN            :REM*2Ø1
```

For a frog sound:
Change line 130 to read: POKE SD + 1, 20
Add line 135: POKE SD, X*2
Change line 160 to read: DT = 30 : GOSUB 200

For a change of scene, listen to the surf sound generated by the program in Listing 11.

Listing 11. Sound of surf program (C-64).

```
1Ø REM SURF 64            :REM*147
2Ø SD=54272               :REM*19
3Ø GOSUB 17Ø:REM RESET SID
                          :REM*193
4Ø POKE SD+24,15:REM VOLUME
                          :REM*142
5Ø POKE SD+Ø,Ø:REM FREQ LOW
                          :REM*252
6Ø POKE SD+1,2ØØ:REM FREQ HIGH
                          :REM*176
7Ø A=1Ø:REM ATTACK=1Ø     :REM*187
8Ø D=12:REM DECAY=12      :REM*188
9Ø POKE SD+5,(A*16)+D:REM SET A
   TTACK/DECAY            :REM*7Ø
1ØØ POKE SD+4,128:REM SET NOISE
     WAVEFORM             :REM*9Ø
11Ø POKE SD+4,PEEK(SD+4) OR 1:R
    EM START              :REM*13Ø
12Ø REM WAIT FOR SOUND TO FINIS
    H                     :REM*88
13Ø FOR DELAY=1 TO 2ØØØ:NEXT DE
    LAY                   :REM*193
14Ø GOTO 5Ø:REM REPEAT    :REM*176
15Ø END                   :REM*23
16Ø :                     :REM*218
17Ø REM RESET SID         :REM*52
18Ø FOR X=1 TO 23:POKE SD+X,Ø:N
    EXT:RETURN            :REM*17
```

Then, to have Fourth of July at the beach, turn the waves into explosions by changing the Attack variable, A, in line 70 to 3. For a more rapid, machine-gun-like effect, shorten the delay loop in line 130.

Faster SID Reset

Listing 12 is a faster machine language program that resets all the SID registers except the Volume register. You should first run the program to poke the machine code into memory. Then, call the SID resetter with SYS 850 on a C-64 or with BANK 15: SYS 2816 on a C-128.

Listing 12. SID register reset program.

```
1Ø X=85Ø:REM FOR C64      :REM*182
2Ø IF FRE(Ø)<>(FRE(1) THEN X=28
   16:BANK 15:REM FOR C128
                          :REM*183
3Ø FOR J=X TO X+13:READ A:POKE
   J,A:NEXT               :REM*25
4Ø DATA 162,23,169,Ø,157:REM*84
5Ø DATA Ø,212,2Ø2,2Ø8,25Ø
                          :REM*3Ø
6Ø DATA 141,Ø,212,96      :REM*46
```

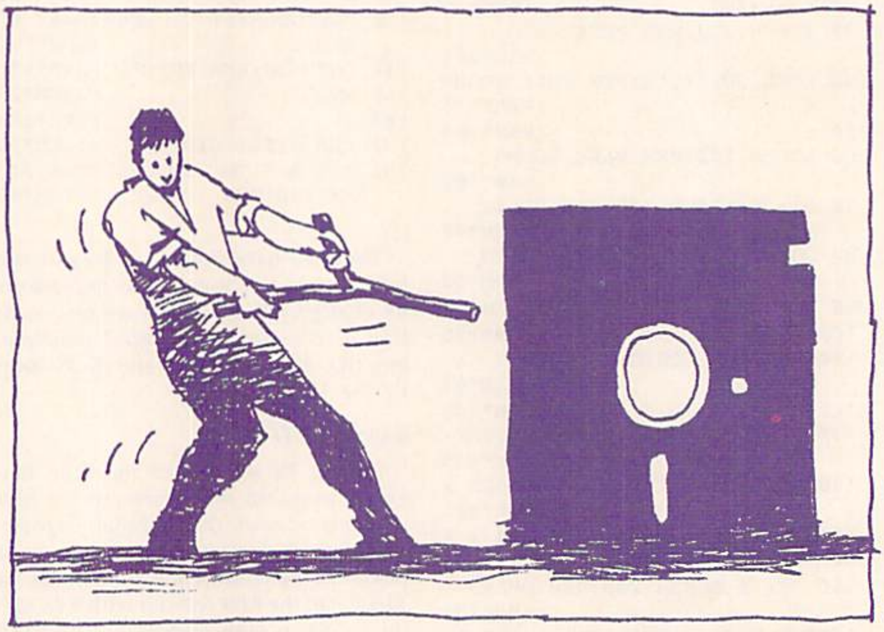
Sound good? I hope so. And I hope you get a bang out of concocting computer sounds for your own programs and trying them on your friends! ■

Bruce Jaeger has had scores of programs, articles and reviews published in many magazines, including RUN. *He also plays bluegrass fiddle with the Middle Spunk Creek Boys in his native Minnesota.*

It's All Relative

If you're writing C-128 programs, you'll want the speed and ease of use relative files can offer.

By ROB KENNEDY



Many owners of C-64s have probably tried using relative files, only to give up when they couldn't figure out the manual. Now, with the C-128, the problems are dissolved. Basic 7.0 includes many new commands that make relative files just as easy to use as sequential files, if not easier.

If you're new to computers or have never used files in programming, and you're wondering what relative files are, they are one of three main file types, the other two being sequential and program. A major distinguishing characteristic of both program and sequential files is that they are read from beginning to end. For example, let's say you had 100 addresses in a sequential file and you wanted to extract the information in address number 48. You'd have to read files 1–47 first, which could prove very slow. Relative files, on the other hand, can be read in any order, so they're a lot easier and faster to manipulate. If you want address 48, you just set the pointer to that location and get your information; you do not first have to read through files 1–47.

Creating Relative Files

Relative files are created on the C-128 with the DOpen command. Here's the format for the command, with brackets enclosing the descriptions of the parameter values you must supply:

```
DOPEN#[logical file number],"filename",
  L[record length],D[drive number],
  U[device number]
```

The logical file number ranges from 1 to 255. The record length is the number of characters you want in each record, with a maximum of 254. The drive number is 0 or 1 (this is optional; you only need to insert a value if you have a dual drive), and the device number (also optional) is usually 8.

To create a sample relative file that we'll call REL FILE, put a formatted disk into the drive and type the following line:

```
DOPEN#1,"REL FILE",L30
```

Each record in REL FILE will be 30 characters long, but you don't have to use them all.The computer will just pad out the unused space with null characters. Note that whenever you're reading from or writing to a relative file, you must use the same logical file number as when you created it. Also, you should view the directory to note the length.

When writing to a relative file for the first time, you'll get a Record Not Present error, because the record pointer is set at a record that hasn't yet been written to. To prevent this problem, determine how many records you want to store, add one and then write something to the extra record. Let's say you want a file holding the names of the 50 states and their capitals; you'd need 100 records. That means you'd write a "dummy" message at record 101.

Now type in DCLOSE on a separate line to close your file.

Next, type in the following program, noting that you don't have to specify the length of the file, because you did that when you created it:

```
5 REM ***PROGRAM ONE***
10 DOPEN#1,"REL FILE"
20 RECORD#1,101,1
30 PRINT#1,"FILE END"
40 PRINTDS$
50 DCLOSE
```

Now, run the program. Line 10 opens the file you created earlier, line 20 sets the record pointer (more on that later), and line 30 writes FILE END, the dummy message, to record number 101. Then line 40 displays the status of the disk error channel, and line 50 closes the file. It's always a good idea to display the disk error channel after reading from or writing to a relative file. Also, if you look at your directory, you'll notice ►

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that the file is much longer than before. This is the maximum length.

Writing to Relative Files

To write to a relative file, you have to open the file, set the record pointer and print to that record. Then, after you've printed the information, you should display the disk error channel and close the file.

Basic 7.0 provides several new commands for writing to relative files. One is the Record command, which sets the record pointer. Here's the format:

```
RECORD#[logical file number],[record
  number],[byte]
```

The logical file number is the same as the file number you opened with the DOpen command, which in turn is the same as the file number you used when creating the file. The record number designates the record in which you want to store information. If this were your first entry, you'd use record number 1; if it were the 25th state, you'd use record number 49 (remember, 24 states and capitals beforehand). The byte option tells where in the record you want to write (more about that later).

Now, let's write a little program for inputting the 50 states and capitals and then writing them into a relative file. Start with:

```
5 REM ***PROGRAM TWO***
10 DOPEN#1,"REL FILE"
```

This line will open the file you created earlier. The longest state name is South Carolina, with 14 characters (including the space), and the longest capital name is Oklahoma City, also with 14 characters. Normally, a record length would probably be about 15, but you'll need an extra 15 characters later on, so we'll keep the record length at 30. Be sure to set a sufficient record length whenever you're creating a file, because any data that doesn't fit will be lost.

Now add the following lines to your growing program:

```
20 FORT=1TO100STEP2
25 PN=PN+1
30 PRINT"STATE NUMBER";PN
40 INPUT"WHAT IS THE NAME";ST$
50 PRINT"CAPITAL NUMBER";PN
60 INPUT"WHAT IS THE NAME";CA$
```

Line 20 starts a loop that will be executed 50 times, lines 30 and 50 display which state and capital are about to be entered, and lines 40 and 60 get the next state and capital. The state is stored in string variable ST$, the capital in CA$.

Continuing on, type in these four lines:

```
70 RECORD#1,T,1
80 PRINT#1,ST$
90 RECORD#1,T+1,1
100 PRINT#1,CA$
```

The record pointer is set in lines 70 and 90, line 80 writes the state to that record and line 90 writes the capital to the next record. PRINT# is the command that does the actual writing. Here's its format:

```
PRINT#[file number],[print list]
```

The file number is the same as the file number opened by the DOpen command. The print list is what you want printed to the record, and it can be a string, a variable or a message in quotes. In our example, we're using a string. The next lines to enter are:

```
110 PRINTDS$
120 NEXTT
130 DCLOSE
140 END
```

Line 110 prints the disk error channel, in keeping with the rule always to check the channel status. Line 120 is the end of the loop, and when it's been executed 50 times, the file will be closed by line 130.

When you write to a relative file, a section of its contents will look something like the first example in Figure 1. The same information stored in a sequential file would look like the second example in the figure. In both cases, I've used 0s to represent null characters and %s to represent boundaries between records.

These examples show why a relative file is faster. In a sequential file, the records do not all have the same length, so the computer has no way to find a particular record except by reading through them all. With a relative file, every record is the same length, so the computer has reference points for finding particular ones.

Reading Relative Files

Now that you've written your information to a file, you want to get that information back. To do this, use almost the same program as for writing. The difference is an INPUT# command, which reads from a record instead of writing to it. Here's the format for the INPUT# command:

```
INPUT#[file number],[variable list]
```

The parameters are the same as for the PRINT# command.

Now, save your program, type in NEW and then enter the following lines:

```
5 REM ***PROGRAM THREE***
10 DO
20 INPUT"WHICH RECORD DO YOU
   WANT LOADED";RN
30 IFRN<1ORRN>99ORINT(RN/2)*2=
   RNTHEN20
40 DOPEN#1,"REL FILE"
50 RECORD#1,RN,1
60 INPUT#1,ST$
70 RECORD#1,RN+1,1
80 INPUT#1,CA$
90 PRINTDS$
100 DCLOSE
110 PRINT"THE CAPITAL OF ";
    ST$;" IS ";CA$;"."
120 INPUT"MORE(Y/N)";A$
130 IFA$<>"N"THENLOOP
140 END
```

Line 10 sets up a loop, and line 20 asks which record you want. To make your selection, type an odd number from 1 to 99—odd because states are only in odd-numbered records. Line 30

Figure 1. Samples of file contents.

```
Sample 1. Relative file:

        ALABAMA00000000%MONTGOMERY00000%ALASKA000000000
Record# 1---------------2---------------3---------------

Sample 2. Sequential file:

        ALABAMA%MONTGOMERY%ALASKA
Record# 1-------2----------3------

Sample 3. Relative file with records divided into fields:

        ALABAMA00000000MONTGOMERY00000%ALASKA000000000JUNEAU000000000
Field#  1---------------2--------------1---------------2--------------
Record# 1------------------------------3------------------------------
```

determines whether the value of RN is legal. If your typed value of RN is less than 1, greater than 99 or an even number, you'll be asked again.

Line 40 opens the file, lines 50 and 70 set the record pointers, and lines 60 and 80 get the information. Then line 90 displays the disk error channel, and line 100 closes the file. Finally, your information is displayed and you're asked if you want to get more. If so, execution loops back to the beginning; if not, the program ends.

Files, Records and Fields

So far, you've learned about files and records. Now to learn about fields. There are no special commands needed to manipulate fields; they're just other divisions within records, which you make yourself. Because your record length was set at 30 characters, you can store both a state and its capital in one record by making each field 15 characters long. When writing to your states file, add the capital to each state string, starting at character position 16 by using the Byte option in the Record command. The Record command lets you read from or write to a certain position in each record.

If you want to see this done, type in the following program, which will rewrite your file:

```
5 REM ***PROGRAM FOUR***
10 DOPEN#1,"REL FILE"
20 FORT=1TO100STEP2
30 RECORD#1,T+1
40 INPUT#1,CA$
50 RECORD#1,T,16
60 PRINT#1,CA$
70 PRINTDS$
80 NEXTT
90 DCLOSE
100 END
```

Then execute the program and, when it's finished, load a copy of the third program above, which reads a file, and make this change:

```
70 RECORD#1,RN,16
```

Now line 70 sets the record pointer for the capital in the same record as the state, but at a different character location—16. As a result, your relative file will look like the third example in Figure 1.

Notice that in this example I skipped over record #2. This is because, although the capital is still stored in that record, you aren't using it anymore. If you'd set up fields in the first place, there'd be no unused records.

To read this information, read the record normally. When the first string (the state) is found, the program will continue to line 70, where the record pointer is set to the second field. Line 80 will then get the capital.

This may seem like a lot of information to absorb in one sitting, but after you read over it a few times and experiment, you'll see how easy relative files actually are. You'll also find that, with simple modifications, the programs I've included here will take care of most of your relative file needs. ■

Rob Kennedy is a freelance programmer pursuing a degree in computer science.

Type-in Troubles?

YOU HAVE TYPED IN A *RUN* PROGRAM and are having some problems getting it to run. After a while, you feel like calling for help, but since we're not next door, it's expensive to call us. But we can share our experiences with you. Having heard from many users over the years about their difficulties with typing in listings, we've identified a few recurring problems that plague many people but are easy to fix. So read on and see if your problem is one of these. If so, perhaps the answers will help you find and correct the difficulty.

- You get an Out of Data in Line xxx message. This means that a program line was reading from Data statements and reached the end of the data before it was done reading. There are two possible problems.

One might be with the line that reads the data, usually a For... Next loop. Make sure you have the proper values for the loop, because if the listing has a loop of 0 to 150 and you've typed 0 to 160, you'll get the "Out of Data" message. If the loop is correct, then the problem lies in the Data statements themselves. One possibility is that you omitted a whole line of data. That's easy enough to find and correct. More likely, you may have skipped one or more individual data items or typed in a period instead of a comma, which causes two data values to be read as one number. Check your typing carefully against the listing.

- You get an Illegal Quantity Error in Line xxx. That means that you've read a number from a Data statement and tried to Poke it into a memory address. The error occurs because the number is larger than 255 (the largest value a memory address can contain), which means that somewhere in your Data statements you've made an error by typing in a number larger than 255. Again, this is easy to check for and correct. Just look in your Data statements for a number larger than 255. You might have added an extra digit, or perhaps you ran two numbers together (23456 instead of 234,56).
- You get a Syntax Error in Line xxx. This could be almost anything. What it tells you is that there is something wrong in the indicated line. Usually you've misspelled a Basic keyword or omitted some required character. List the line and examine it carefully.
- You get an Error in Data message. This occurs in programs that add up all the data as read, and, when finished, compares that sum with what it should be if all the data were typed in correctly. If it isn't the same, it means an error somewhere in typing the Data statements. Go back and check the data carefully, correct the mistake(s), save the new version and try again.

Finally, we urge everyone who intends to type in one of our listings to use *RUN*'s Checksum program, which is printed in each issue. This nifty little program will help you avoid every mistake we mentioned above, except that it won't detect the omission of a line. ■

—Lou Wallace

PART 1

Excuse the Interruption

These advanced machine language programming techniques let you take full advantage of the excitement interrupts can provide.

◇

By JIM HOSEK

Every sixtieth of a second, your C-64 stops whatever it's doing and, with no awareness on your part, performs a series of important housekeeping functions, such as scanning the keyboard, blinking the cursor, and updating the software clock (TI and TI$). The computer does this through an interrupt, a process as close to true multitasking as the C-64 ever gets.

By playing some tricks in machine language, it is possible to intercept the interrupt and divert it to tasks other than housekeeping. In fact, this is how many games and machine language utilities accomplish sprite animation, background music, split graphics and text screens and the simultaneous display of more than eight sprites.

Part 1 of this article both explains the function and use of interrupts in the C-64 operating system and tells you how to generate and employ them in your own programs. Part 2 deals with the use and programming of the CIA chips to generate interrupts in your programs. Part 3 explores the use of interrupts originating from the VIC-II chip and from outside the C-64.

The accompanying examples and programs do require some understanding of 6510 machine language and an assembler or monitor program, but the listings are annotated to help beginners. (For more extensive aid in understanding machine language programming, consult *Machine Language for Beginners* and *The Second Book of Machine Language*, published by COMPUTE! Books. For general information on programming, see the *Commodore 64 Programmer's Reference Guide*, Commodore Business Machines, Inc.

The Computer's Subconscious

Although a computer can't really think (not yet anyway), you might find it useful to consider the C-64's 6510 microprocessor as analogous to the human brain, and the running of a program as the process of conscious thought. In such a comparison, then, you can think of an interrupt as a subconscious activity.

For example, when you're walking down the street, you don't consciously think about every step you take or about keeping your balance. More likely, you're thinking about a business problem, what to get your wife for her birthday or where you're going for lunch. If you thought about every step you took, the chances are that you'd fall flat on your face. It's impossible to think of two things at once, so your brain learned early on to leave the process of walking to some low-level area of your subconscious, so you don't have to "think" about it.

Interrupts work in a similar manner. The C-64's housekeeping routine, occurring 60 times a second, essentially diverts the 6510 microprocessor from whatever it's doing, preserves the current contents of the registers and accumulator, performs its tasks, and then lets the program resume operation.

Interrupt Hardware Anatomy

It is the hardware component of the computer that generates interrupts, not the software, which involves the operating system and programs in ROM and RAM. The 6510 microprocessor has two sources of interrupts: the Interrupt Request (IRQ) line, and the Non-Maskable Interrupt (NMI) line. Both can receive interrupts from outside the C-64 through the expansion port. Internally, the two Complex Interface Adapter (CIA) chips and the Video Interface Controller (VIC-II) chip also generate interrupts. (See Figure 1).

The IRQ and NMI lines of the 6510 are normally high. That is, they have a +5V signal on them when they're inactive. In Figure 1, notice the squiggly lines with the words "Pull-up Resistor" next to them on both interrupt lines. These mini-circuits maintain the +5V signal. When any source drops to 0V, a voltage drop occurs across the pull-up resistor, and the voltage on the interrupt line also drops to 0V, generating an interrupt. This process is called an interrupt request.

IRQ interrupts come from the VIC-II chip, CIA 1 or pin 4 of the expansion port. CIA 1 is responsible for generating the IRQ request that occurs every sixtieth of a second in the 64's operating system by means of one of its built-in timers. NMI interrupts originate in the CIA 2, the restore key or pin D of the expansion port.

There are two parts to an interrupt. The first is the microprocessor or hardware part, occurring within the hardwired programming of the 6510 CPU. The second portion is the software routine that determines the source of the interrupt and then performs whatever task has been requested.

Although interrupt requests may occur on either the IRQ or NMI lines, the 6510 handles them differently. Figure 2 shows a simplified flowchart of the sequence of events that occurs in the C-64 in response to an IRQ or NMI interrupt request.

The IRQ Request

Whichever line carries the request, the 6510 finishes the operation it's currently working on before acknowledging the interrupt. When it detects an IRQ interrupt request, the 6510 first checks the interrupt-disable status bit ("I" bit) of the processor status register (P). By setting this bit to 1, you can tell the microprocessor that you don't want ►

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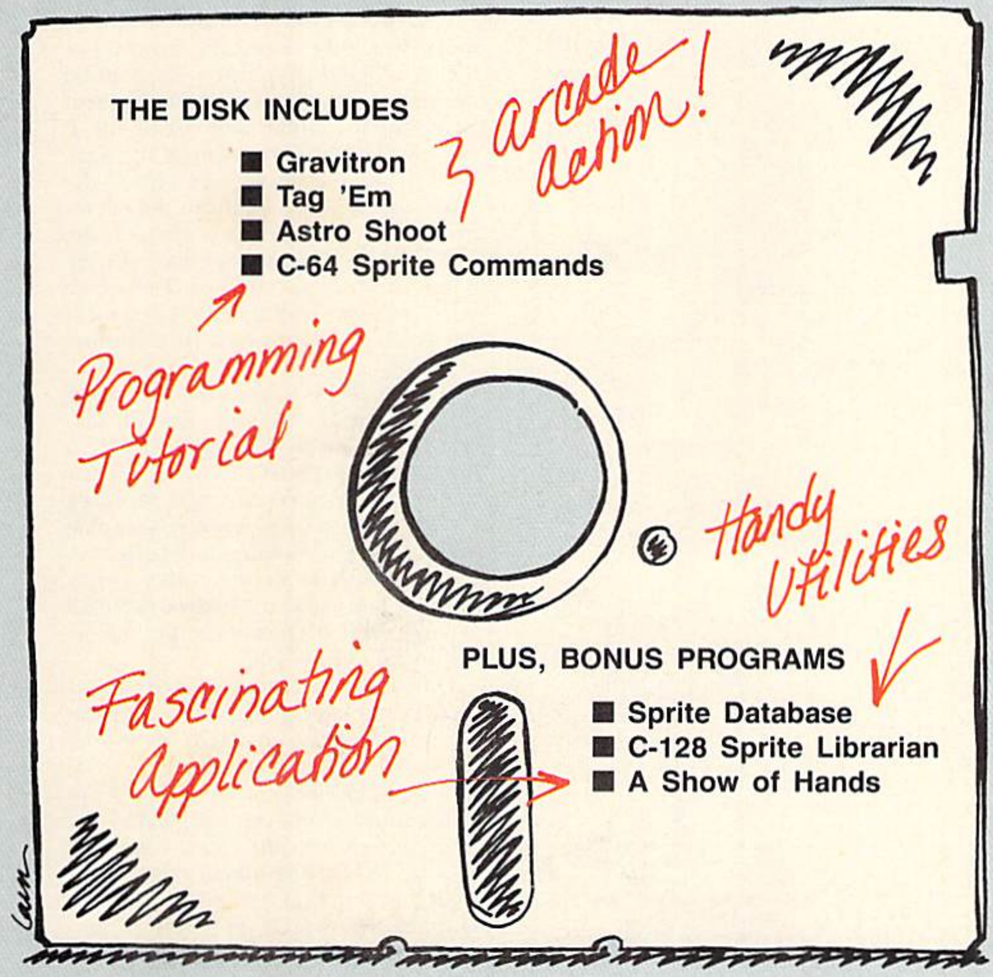

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any IRQ calls to occur now. The reasons you wouldn't want this to happen will be covered a little later. If you've set the bit to 1, the 6510 aborts the interrupt and executes the next instruction in the program.

You set the I flag by using the set interrupt-disable status (SEI) opcode ($78) and reset it with the clear interrupt-disable status (CLI) opcode ($58).

If the I flag is 0, then the interrupt sequence begins. The processor status register (P) and program counter (PC) are pushed onto the stack. This will tell the 6510 where in the program it left off to deal with the interrupt. The interrupt-disable status bit is set to 1 to prevent further IRQ requests from occurring.

Next, the program counter is loaded with the address stored at $FFFE–$FFFF in low-byte/high-byte format. In the C-64 operating system, this address is at the end of the Kernal ROM and points to address $FF48. At this point, the hardware portion of the interrupt sequence is finished until control is returned to the interrupted program.

Now the software routine at $FF48 takes over, first saving the contents of the .A, .X, and .Y registers by pushing them also on the stack. The routine next examines the break flag (B) of the P register. (Note: even though the contents of the P register were put on the stack, a copy still remains in the microprocessor.) If the B flag is set to 1, the interrupt routine knows it has encountered the BRK opcode (which uses the same pointer at $FFFE–$FFFF), and it hands control over to the BRK routine at $FE66.

If the B flag is 0, then the rest of the IRQ routine is executed, with an indirect JMP through a vector in RAM at locations $0314–$0315. This vector points to the necessary housekeeping routine (at $EA31), which is responsible for the cursor-blinking and keyboard-reading activities. Because this vector is in RAM, you can use it to divert control to your own IRQ routine. I'll discuss this technique shortly.

Before the interrupted program regains control, the .A, .X, and .Y registers are retrieved, unchanged, from the stack. The return-from-interrupt (RTI) opcode signals the end of the interrupt routine and sends control back to the 6510 routine. Like the return-from-subroutine (RTS) instruction, the PC is loaded with the return address that was saved on the stack. Unlike an RTS, however, the P register is also pulled off the stack.

In essence, the microprocessor is completely restored to the state it was in before the interrupt. The only evidence the program has that something happened is that a few memory locations may have changed and the keyboard buffer might contain another value. The IRQ request is almost like a Jump-to-Subroutine (JSR) command, except that an IRQ is called by hardware, not software, it always goes to the same place, and the contents of the P register are also preserved.

Figure 1. Interrupt lines and sources in relation to the 6510 CPU.

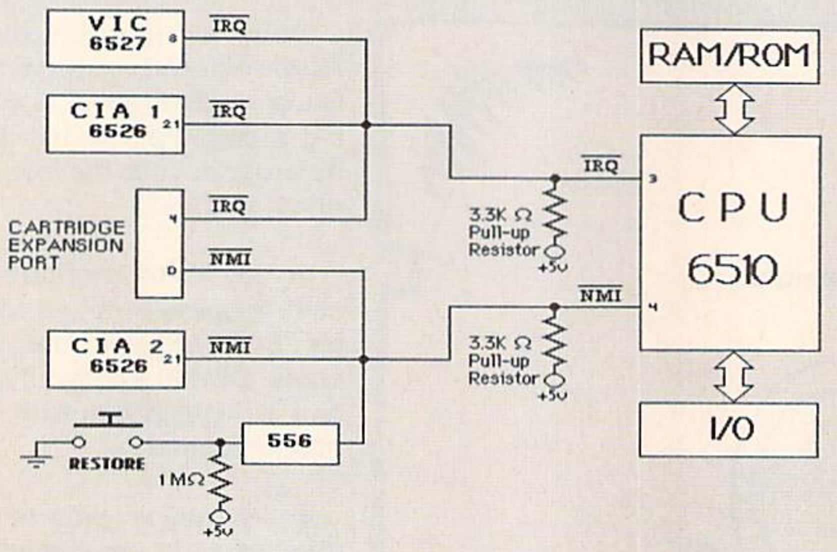
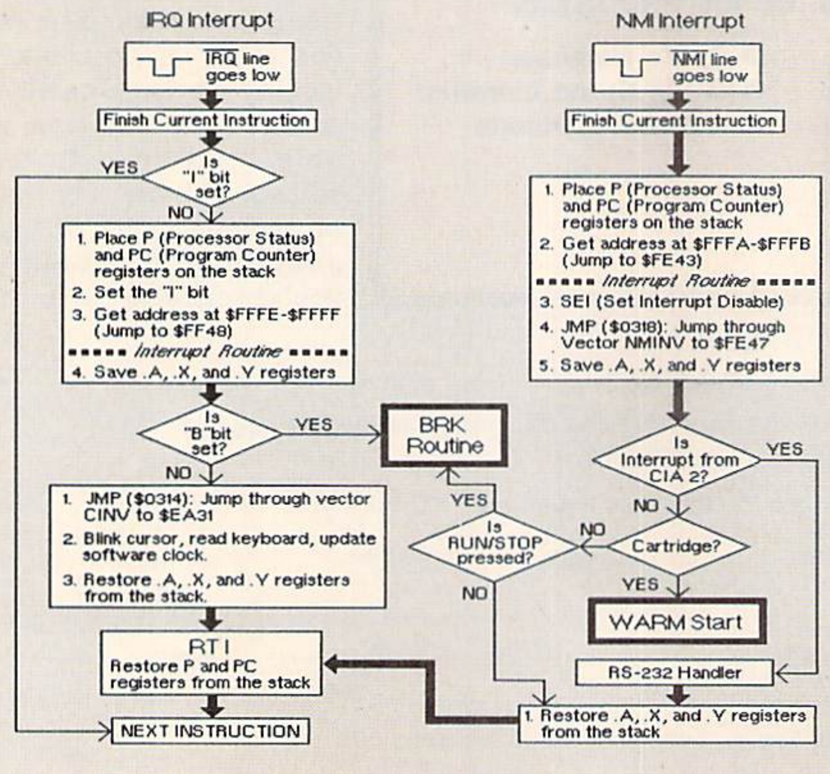


Figure 2. Flowchart of sequences triggered by IRQ or NMI interrupt requests.



The NMI Request

An NMI request is handled slightly differently. As its name (Non-Maskable

Interrupt) implies, an NMI request may occur whether or not the I flag is set. You might compare this to putting a phone call on hold in order to answer the other line. It is possible for an NMI to occur while an IRQ or even another NMI is being executed.

As with the IRQ request, the 6510 pushes the P and PC registers onto the stack, but, unlike the IRQ, it does not test or set the I flag. The CPU then looks to addresses $FFFA–$FFFB for the location of the NMI routine, which starts at $FF43. Here, also unlike the IRQ routine, it uses the SEI opcode to set the I flag to prevent IRQs from occurring, and the program jumps through a RAM vector at $0318–$0319, pointing to $FF47, *before* saving the .A, .X, and .Y registers. This fact is important to consider when you start diverting the NMI routine for your own purposes.

Next, the interrupt routine tries to discover the source of the interrupt. It looks at the interrupt control register (ICR) of CIA 2. If it finds the seventh bit set, it diverts control to the RS-232 input/output routine. Here, it checks the RS-232 interface to see if it's ready to send or receive more data. The NMI routine then ends like the IRQ, with the .A, .X, and .Y registers restored, and an RTI follows.

If CIA 2 was not the source of the interrupt, the routine assumes that it was the restore key. It checks locations $8004–$8008 for the Autostart ROM Cartridge code (CBM80), and if a cartridge is present, the routine is exited through the cartridge warm start vector at $8002–$8003.

If no cartridge is present, the routine checks the run-stop key, and, if that key has been pressed, it jumps to the BRK routine used by the BRK opcode. So pressing the run-stop/restore combination has the same effect as the 6510 encountering a BRK opcode.

If the run-stop key has not been pressed, the program jumps to the end of the routine, where the microprocessor registers are restored, and then to the RTI instruction, which, of course, returns control to the interrupted program.

OTHER INTERRUPT USES

The C-64 operating system also uses the IRQ interrupt for cassette tape operations by means of CIA 1. In essence, a tape Save or Load command will send the IRQ routine to another routine by means of the RAM vector discussed earlier. The CIA chip Timer A is reprogrammed from its normal sixtieth-of-a-second interrupt to work for the tape routine. After the operation is complete, the RAM vector and CIA chip revert to their former values.

The IRQ interrupt is also used during the power-up sequence to determine whether the American NTSC or the European PAL video system is in use. This is important in determining the setting of the sixtieth-of-a-second interrupt timer, since each system uses a different clock speed. The check is done by pro-

Listing 1. Character-cycling IRQ program.

```
         SEI                     ; Set interrupt Disable Flag
         LDA #<NEWIRQ            ; Get low-byte of NEWIRQ routine
         STA $0314               ; Store in RAM vector
         LDA #>NEWIRQ            ; Get low-byte of NEWIRQ routine
         STA $0315               ; Store in RAM vector
         CLI                     ; Clear Interrupt Disable Flag
         RTS                     ; Done
NEWIRQ
         INC $05A4               ; Increment character at center of
                                 ; screen
         JMP $EA31               ; Jump to regular IRQ routine
```

Listing 2. Color-changing NMI program.

```
         LDA #<NEWNMI            ; Set up for New MNI
         STA $0318
         LDA #>NEWNMI
         STA $0319
         RTS
NEWNMI
         INC $D020               ; Increment Border Color register
         INC $D021               ; Increment Background Color register
         JMP $FE47               ; Jump to regular NMI routine
```

Listing 3. Ball-Animation program.

```
         *= $C000                ; Start address
                                 ; Ball Animation
                                 ; Interrupt demo
         SEI                     ; Set Interrupt Disable Flag
         LDA #<NEWIRQ            ; Change IRQ RAM vector
         STA $0314
         LDA #>NEWIRQ
         STA $0315
         CLI                     ; Clear Interrupt Disable Flag
         LDX #$10                ; Set Sprite Location Registers
 ILOOP
         LDA SP,X                ; ($D000-D010) set to initial values
         STA $D000,X             ; From table SP
         DEX
         BPL ILOOP
         LDX #$07                ; Set Sprite Color Registers
 CLOOP
         LDA SC,X                ; ($D027-D02E) to values in table SC
         STA $D027,X
         LDA #$0B                ; and Sprite Pointers ($07F8-$07FF)
         STA $07F8,X             ; to sprite block 11
         DEX
         BPL CLOOP
         LDA #0                  ; Initialize other VIC registers
         STA $D017               ; X-expand
         STA $D01C               ; Multicolor
         STA $D01D               ; Y-expand
         STA $D020               ; Border Color (Black)
         STA $D021               ; Background Color (Black)
         LDA #$FF
         STA $D015               ; Sprite Enable Register
         LDX #$3F                ; Put Sprite Data in Block 11
                                 ; ($02C0-$02FF)
SLOOP
         LDA BALL,X              ; Data in Table BALL
         STA $02C0,X
         DEX
         BPL SLOOP
         JSR EXP                 ; (For further expansion)
         RTS
NEWIRQ
         NOP                     ; (For further expansion)
         NOP
         NOP
```

```
CONT
     LDX #$0F                  ; Set X to $0F - end of Sprite
                               ; Position
MLOOP
     TXA                       ; Main loop - save bit 0
                               ; (0=X value, 1=Y value)
      LSR                      ; Put in Carry Flag
      PHP                      ; Save Carry Flag
      TAY                      ; Set Mask Bit for MSB register
($D010)
      SEC
      LDA #0
BLOOP
      ROL
      DEY
      BPL BLOOP
      TAY                      ; Store Mask in Y register
      PLP                      ; Retrieve Carry Flag (Bit 0)
      LDA SD,X                 ; Get direction of corresponding
                               ; position register
      BPL REGINC               ; If increasing, go to RECINC
      DEC $D000,X              ; Decrease value of position register
      BNE NEXT                 ; If > 0 then do next register
      BCS NEXT                 ; If a Y-position, then do next
                               ; register
      TYA                      ; Get MSB register mask
      EOR $D010                ; Toggle appropriate bit of MSB
register
      STA $D010
      TYA                      ; Get MSB mask again
      AND $D010                ; Test appropriate bit of MSB register
      BEQ NEXT                 ; If not set then do next register
      LDA #$5B                 ; Load A with $5B (91), Put in X
position
      STA $D000,X              ; Register if sprite wraps around
                               ; left side
      JMP NEXT                 ; Next register
REGINC
      INC $D000,X              ; Increase value of position register
      BCS NEXT                 ; If a Y position, do next register
      BNE CHECKX               ; If not 0 check right edge of screen
      TYA                      ; Get mask bit
      ORA $D010                ; Set MSB
      STA $D010
      JMP NEXT                 ; Do next register
CHECKX
      LDA $D000,X              ; Get current X position
      CMP #$5B                 ; Compare to $5B (91)
      BNE NEXT                 ; If not 91 then do next register
      TYA                      ; Get mask
      AND $D010                ; Test MSB register
      BEQ NEXT                 ; If not at right edge, do
                               ; next register
      LDA #0                   ; Put sprite at left edge
      STA $D000,X
      TYA
      EOR $D010
      STA $D010
NEXT
      DEX                      ; Decrement X - point to next position
                               ; register
      BPL MLOOP                ; If not done, do again
      JMP $EA31                ; Go to KERNAL IRQ routine
SP
      .BYTE 155 90 205 95 255 130 250 175        ; Initial
                                                 ; positions
      .BYTE 205 205 155 210 110 170 105 135 0
SC
      .BYTE 8 9 10 11 12 13 14 15                ; Sprite colors
SD
      .BYTE 0 128 128 0 128 128 128 0            ; Direction
      .BYTE 0 0 128 128 0 128 0 0                ; 0=INC, 128=DEC
BALL
      .BYTE 0 0 0 1 255 128 7 31                 ; Sprite Data
      .BYTE 224 12 255 240 31 255 248 63
      .BYTE 15 252 126 15 254 124 15 254
      .BYTE 248 112 63 248 240 255 248 255
      .BYTE 255 248 240 255 248 112 63 124
      .BYTE 15 254 126 15 254 63 15 252
      .BYTE 31 255 248 15 255 48 7 248
      .BYTE 224 1 255 128 0 0 0 0
EXP
      RTS
```

gramming the VIC-II chip to generate a raster-compare IRQ if the raster screen line reaches 311, more lines than the NTSC system possesses. If a raster interrupt occurs, the timer is adjusted to the PAL standard. (I'll discuss raster-compare interrupts in greater depth in Part 3.)

As mentioned before, the CIA and VIC-II chips are the C-64's main sources of interrupts. You can program them to generate interrupt requests for many conditions, including an alarm function built into the CIA chips, the presence of an outside signal, or the switching of an optical transistor in the tip of a light pen connected to the VIC-II chip.

Programming Interrupts

The easiest way to get your own interrupt routine up and running is by diverting to your own routine the RAM vectors at $0314-$0315 for the IRQ interrupt and at $0318-$0319 for the NMI.

Listing 1 is a short program that uses the IRQ interrupt that the CIA chip generates. The first instruction is the SEI opcode. This, of course, sets the I flag of the P register to 1 and prevents any IRQ interrupts from occurring. Since you're changing the RAM vector, an IRQ interrupt halfway through might make the IRQ routine jump into limbo and crash.

Next, you load the address of the new IRQ routine into locations $0314-$0315 in low-byte, high-byte format. When this is finished, the I flag is cleared, and the set-up portion of the program is complete. From now on, the RAM vector will direct the IRQ routine to your routine at $C00D every sixtieth of a second.

The routine NEWIRQ simply increments location $05A4 (which is in the middle of the text screen), then jumps to the normal IRQ routine at $EA31.

Type in this program and compile it if you're using an assembler. If you're using a machine language monitor, just enter the opcodes, ignoring the labels. Then enter SYS 49152. You should see a space in the center of the screen cycling through all 256 characters of the character set about once every four-and-a-quarter seconds.

Try loading or saving a program. The speed at which the characters change during these operations will become slow and irregular. This is because the serial bus routines that perform these operations will occasionally set the interrupt disable during critical timing sequences. Pressing the run-stop/restore combination resets the RAM vector and stops the changing characters in the middle of the screen.

The program in Listing 2 is similar to that in Listing 1, except it intercepts the NMI-routine RAM vector. Note that you don't use the SEI and CLI instructions, simply because they have no effect on NMIs. There is some small risk that the computer will crash while altering this vector, but if no RS-232 device is present and you stay away from the restore key, there should be no problem. The second program sits right above the first.

The NEWNMI routine increments the border and background color registers of the VIC-II chip every time an NMI interrupt occurs; then it jumps to the normal NMI routine. Type in and compile the program, and then activate it by typing SYS 49171. Nothing should happen as yet. Now tap on the restore key a few times. (Do *not* hold down the run-stop key.) The screen will change colors with every tap.

Now try to get both new interrupt routines running by typing SYS 49152 again. Press the restore key a few times to convince yourself that both new routines are installed.

This is basically how you can utilize interrupts on the C-64. It is also possible to put your own vectors in memory at $FFFA-$FFFB and $FFFE-$FFFF by switching off the Kernal ROM and writing your own routines to handle the entire interrupt. But you'll probably find it much easier to have the Kernal ROM around to handle some of the customary chores of the interrupt.

Now What?

By now, you should be getting some ideas about ways to use interrupts in your own programs. Listing 3 is a short program that animates eight colored balls on the screen and has them flying all over. It runs on the IRQ interrupt, utilizing the sixtieth-of-a-second timer generated by CIA 1. Look through the listing carefully and try to understand what is being done and why. The setup portion is similar to program 1, but the NEWIRQ routine constantly affects the sprite location registers, thus creating the animation effect.

You activate the program by typing SYS 49152. Note that even while the balls are flying around, you can still type at the keyboard and even run or list other programs. The animation is done entirely in the background. You can also use this technique to run two programs at the same time, creating a multitasking effect. Such is the power of interrupts. R

PART 2

The CIA Chip

There are two CIA chips in the C-64: one wired to the 6510 microprocessor's IRQ line and the other to the NMI line. As mentioned in Part 1, interrupt requests can be generated through this mysterious, yet powerful, chip.

The CIA chip is like a miniature computer that runs alongside the 6510 CPU. Think of the CIA—or 6526, as Commodore calls it—as a peripheral processing unit (PPU). It doesn't depend on the 6510 for any of its functions, but helps support it, as well as the 64's operating system.

Like the 6510, the CIA chip can be programmed to a limited extent to carry out specific tasks. Its primary function, however, is to handle input/output tasks and thus help free up the 6510.

Unlike the 6510, the CIA cannot read or write directly from or to RAM and cannot read from ROM. Instead, it's programmed by reading or writing to its 16 internal registers. Table 1 gives a brief description of these registers, which, in the C-64, are accessed by means of memory locations $DC00-$DC0F (56320-56335) for CIA 1 and $DD00-$DD0F (56576-56591) for CIA 2.

The CIA chip uses the registers to communicate with the 64. Through the IRQ line, it can also tell the 6510 when one of its five sources of interrupts has been activated.

Interrupt Sources

Figure 3 shows the sources of interrupts from a CIA chip. Timer A on CIA 1 is set to give an interrupt every sixtieth of a second for the operating system's housekeeping routine. Timer B of CIA 1 is for serial bus timing. Timers A and B of CIA 2 are used for RS-232 I/O.

One interrupt source, the time-of-day (TOD) clock, isn't used by the C-64's operating system. Since the clock is part of the hardware, it's far more accurate than the software clock (TI and TI$) maintained by the sixtieth-of-a-second housekeeping routine, and it's not subject to disruption from disk operations. Because it's accurate to one-tenth of a second, in contrast to the software clock's one second, the TOD clock is used for applications that require critical timing.

The serial port, also unused by the C-64's operating system, is another source of interrupts. It generates an interrupt request after it has received eight bits of serial data or has finished sending eight bits. Then, it's up to the interrupt routine to read the data from the port's shift-register or load the register with the next eight bits to be sent.

The serial port is accessed at the user port through lines SP (CIA 1, pin 5; CIA 2, pin 7) and CNT (CIA 1, pin 4; CIA 2, pin 6).

The most powerful sources of interrupts are timers A and B. Each timer is a 16-bit counter, capable of counting microprocessor clock cycles or external pulses on line CNT of the user port. In addition, timer B can count the number of times that timer A goes to zero. This feature allows the timers to be used separately to generate interrupts of short intervals, or together for interrupts with intervals of up to 70 minutes.

The timers can also operate in Continuous or One-Shot mode. Either way, an interrupt can be generated every time the counter goes to zero.

In Continuous mode, the timer resets itself to the value stored in the timer latch register. Here, the timer can be compared to an electric clock's snooze alarm that wakes you up every five minutes. In One-Shot mode, the timer counts to zero and then stops.

The flag line can generate interrupts from outside the C-64. Because it doesn't connect directly to the IRQ or NMI line on the 6510, the flag is advantageous in that the interrupt routine can determine the source of the interrupt, and even turn off its ability to generate one.

CIA 1 has its flag line connected to SRQ IN for serial bus operations. CIA 2's flag line isn't used by the 64, but is available at pin B of the user port.

Getting Interrupts to the 6510

All five sources of interrupts can be detected by means of the interrupt control register (ICR $0D) of the CIA chip. For CIA 1, this register is located at $DC0D (56333), while CIA 2's is located at $DD0D (56589). The ICR also provides a means of determining which source's interrupts will actually generate an interrupt request on either the IRQ or NMI line.

Figure 4 illustrates how the ICR is set up. Its function depends on whether you're reading or writing to it. ►

Table 1. Complex Interface Adapter Register Map

REGISTER	ADDRESS	DESCRIPTION
PRA	$00	Port A: 8-bit bidirectional Peripheral Data Register
PRB	$01	Port B: 8-bit bidirectional Peripheral Data Register
DDRA	$02	Port A: Data Direction Register
DDRB	$03	Port B: Data Direction Register
TA LO	$04	Timer A: low byte
TA HI	$05	Timer A: high byte
TB LO	$06	Timer B: low byte
TB HI	$07	Timer B: high byte
TOD 10THS	$08	TOD clock: tenth of a second
TOD SEC	$09	TOD clock: seconds
TOD MIN	$0A	TOD clock: minutes
TOD HR	$0B	TOD clock: hours
SDR	$0C	Serial Data Port
ICR	$0D	Interrupt Control Register
CRA	$0E	Control Register A
CRB	$0F	Control Register B

Figure 3. Sources of interrupts from a CIA chip.

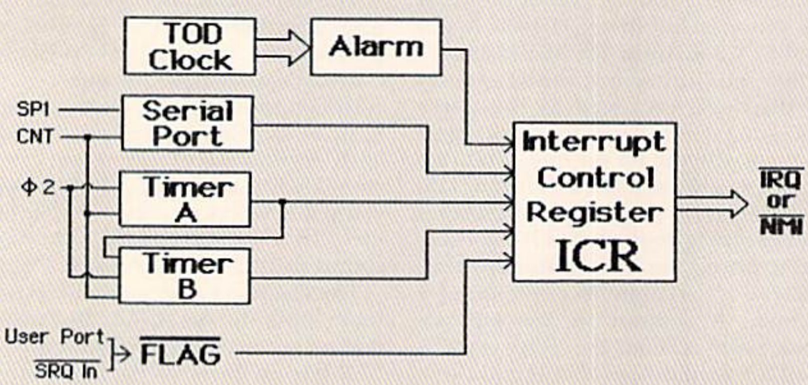
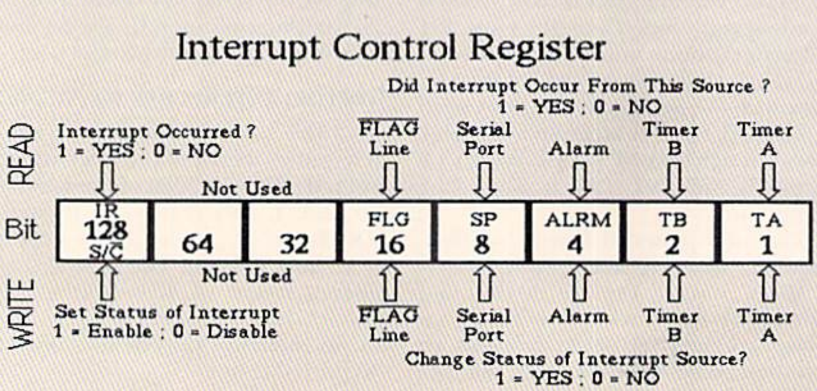


Figure 4. The interrupt control register.



When you're writing to it, you can enable or disable the interrupts from each of the five potential sources, depending on the setting of bit 7. You can program any source to generate interrupts, but the microprocessor will never see the interrupt request unless the appropriate bit of the ICR is set or enabled.

When bit 7 equals 1, then an interrupt is enabled or set if its corresponding bit is set to 1. For example, writing $81 (129, %10000001) to the ICR enables interrupts from timer A. The status of the other four sources remains unchanged. In order to disable or clear an interrupt, bit 7 must be set to 0, and the corresponding source's bit set to 1. Writing $1F (31, %00011111) disables all five sources of interrupts. The values of bits 5 and 6 have no effect during either operation.

When reading the ICR, the status of all the interrupt sources can be determined. Bit 7 is used to signal if an interrupt has occurred from one of the possible sources on the CIA chip.

The C-64 operating system checks bit 7 during the NMI interrupt routine to see if the interrupt was generated by the RS-232 interface (7 equals 1) or the restore key (bit 7 equals 0). Because the restore key is connected directly to the NMI line of the 6510 microprocessor, its interrupt bypasses CIA 2 and has no affect on the ICR.

Furthermore, the bit corresponding to the source of the interrupt from the CIA chip is also set. Therefore, if the interrupt from the TOD clock alarm is enabled, and the time in the alarm register matches it, an interrupt request is sent to the 6510 and the ICR register is set to $88 (136, %10001000). Note that when the ICR is read, its contents are set to zero, so if there's more than one source of an interrupt to check, a copy of the register should be saved to RAM.

Generating Interrupts

I'll now proceed to detail the methods of generating interrupts from the various sources mentioned above.

Time-of-day clock alarm—Getting the TOD clock alarm to generate an interrupt involves setting up an interrupt routine, changing the appropiate RAM vector and programming the CIA chip.

The TOD clock occupies registers $08–$0B of the CIA chip. In the 64, these are locations $DC08–$DC0B (56328–56331) for CIA 1, and $DD08–$DD0B (56584–56587) for CIA 2. These registers handle tenths of a second, seconds, minutes and hours. The hours register also contains an AM/PM flag.

Figure 5 shows how these registers are arranged. The values are stored as binary-coded decimals (BCD). This means that the first four and last four bits each represent one digit, from zero to nine. Therefore, a single byte can contain a value from zero to 99 instead of zero to 255, as is the case with ordinary binary. The decrease in range is compensated for by facility in reading and displaying program values.

With some of the registers, only part of a nibble (half a byte, or four bits) is used. In these cases, all necessary values for that digit can be represented by the space allowed.

Reading the registers returns the current time. The TOD clock has a built-in latching feature that freezes the time whenever the hours register is read. This prevents the time from "rolling over" after only part of it has been read. An analogy to this is the lap feature found on electronic stopwatches. When you press the lap button, the time display freezes so you can tell the speed of a runner during part of a race. Meanwhile, the stopwatch is keeping time internally. Pressing the button again shows elapsed time.

The TOD clock registers resume exhibiting the correct time after the tenths-of-a-second register is read. It's important to read this register last and the hours register first.

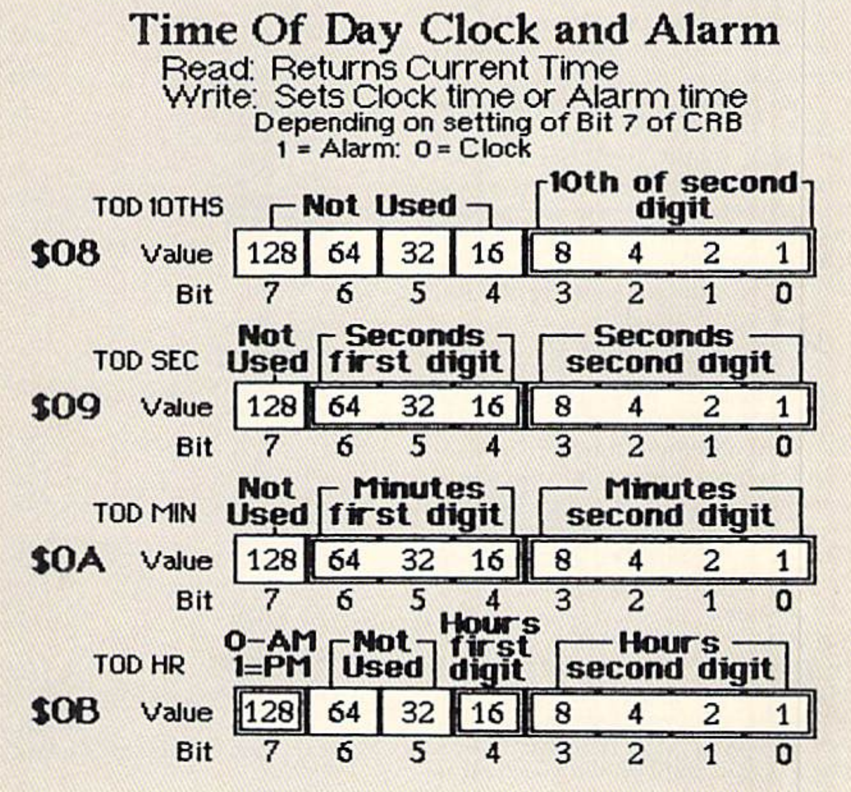
Setting the current and alarm time is done by writing to the registers. Once again, a latching function is in effect. The clock freezes when the hours register is written to, and starts with the new time when the tenths-of-a-second register is written to. Bit 7 of register $0F ($DC0F or $DD0F for CIA 1 or 2) tells the CIA chip if you're entering the current time or the alarm time. If the bit is set to 0, then the clock is set to the specified time; if it's set to 1, then the alarm time is set.

Listings 4 and 5 take care of all these tasks when setting up the CIA 1 alarm using the IRQ interrupt. Listing 4 is in machine language. It is responsible for changing the RAM vector at $0314–$0315, and it also contains the new interrupt routine.

The new routine first updates the time in the upper-right corner of the screen from the TOD clock registers (lines 1150–1680). It then checks the ICR of CIA 1 ($DC0D) for bits 7 and 2:

```
1660 LDA $DC0D
1670 AND #$84
1680 CMP #$84
1690 BEQ ALARM
1700 JMP $EA31
```

Figure 5. The time of day clock and alarm.



Listing 4. TOD clock alarm demo.

```
*=$C000
; ****ALARM CLOCK****
; TOD CLOCK ALARM DEMO
;
       SEI                      ; Set Interrupt Disable Flag
       LDA #<NEWIRQ             ; Change RAM IRQ Vector
       STA $0314
       LDA #>NEWIRQ
       STA $0315
       CLI                      ; Clear Interrupt Disable Flag
       RTS
NEWIRQ
       BIT $DC0B                 ; Test AM/PM flag
       BMI PM                    ; If not PM...
       LDA #$81                  ; Get a reverse "A"
       BNE APFLAG                ; Jump ahead
PM
       LDA #$90                  ; Get a reverse "P"
APFLAG
       STA $0427                 ; Put character in upper left corner
       LDA $DC0B                 ; Get first digit of HOURS
       AND #$10                  ;
       BEQ HOUR0                 ; Check if it is "0"
       LDA #$B1                  ; Get a reverse "1"
       BNE D1H                   ; Jump ahead
HOUR0
       LDA #$B0                  ; Get a reverse "0"
D1H
       STA $041D                 ; Put up first digit on screen
       LDA $DC0B                 ; Get second digit of HOURS
       AND #$0F                  ; Mask out bits 4-7
       ORA #$B0                  ; Add on #$B0 to get reverse number
       STA $041E                 ; Put up second digit
       LDA #$BA                  ; Get a reverse ":"
       STA $041F                 ; Put on screen
       LDA $DC0A                 ; Get first digit of MINUTES
       AND #$70                  ; Save bits 4-6
```

If the interrupt is not from the TOD clock alarm, then control is passed to the operating system's housekeeping routine. See how simple the BCD format of the TOD clock makes it to display the time?

If the interrupt is from the alarm, the routine uses the SID chip to generate an alarm sound. It flashes different colors on the screen and returns control to the program that was interrupted. Since the normal interrupt routine is not accessed, the registers must be restored from the stack before the RTI instruction is executed.

Listing 5 is in Basic. Using the filename "ALARM.IRQ", it loads Listing 4 into memory. It is also used to set the TOD clock and the alarm, and to enable the alarm interrupt. Once the necessary registers have been set, the program is no longer needed. Pressing the run-stop/restore resets the RAM vector and CIA chip and turns off the alarm, so *don't* hit this combination before the alarm sounds.

The program will ask you if you wish to set the clock time, or the alarm time or whether you want to quit. When entering the time, only the number keys, A, P, cursor right and return are active. Once the time appears as you want it set, press return.

Try setting the time and alarm several minutes apart to see how it works. Make sure you understand what every part of Listings 4 and 5 are doing and which of the CIA registers these programs are affecting.

Incidentally, GEOS owners, this is essentially how deskTop's clock and alarm work. GEOS also uses CIA 1's TOD clock.

Timers A and B—Programming the CIA chips' timers is a little more complicated. I'm limiting my discussion to their use as sources of interrupts while they're set to count internal microprocessor clock cycles. As previously mentioned, the timers can also count pulses from an external source on line CNT of the user port.

The two 16-bit counters that make up timers A and B are located in registers \$04–\$05 and \$06–\$07, respectively, in low-byte/high-byte format. These are addresses \$DC04–\$DC07 (56324–56327) for CIA 1, and \$DD04–\$DD07 (56580–56583) for CIA 2. Reading these registers returns the current value of the appropriate counter; writing to them loads the timer latch.

When started, the counters count down once every clock cycle. On the C-64, there are 1,022,730 cycles per second, based on the NTSC system. You

```
         LSR                        ; Shift right 4 bits
         LSR
         LSR
         LSR
         ORA #$B0                   ; Get reverse character
         STA $0420
         LDA $DC0A                  ; get second digit of MINUTES
         AND #$0F
         ORA #$B0
         STA $0421
         LDA #$BA
         STA $0422
         LDA $DC09                  ; Do the same for SECONDS
         AND #$70
         LSR
         LSR
         LSR
         LSR
         ORA #$B0
         STA $0423
         LDA $DC09
         AND #$0F
         ORA #$B0
         STA $0424
         LDA #$AE                   ; Get a reverse "."
         STA $0425                  ; Put on the screen
         LDA $DC08                  ; Get Tenth of seconds
         AND #$0F
         ORA #$B0
         STA $0426                  ; Put on screen
         LDA $DC0D                  ; Check ICR if interrupt
                                    ;   is from the Alarm
         AND #$84                   ; Check bits 7 and 2
         CMP #$84
         BEQ ALARM                  ; If both are set, sound alarm
         JMP $EA31                  ; Go to KERNAL IRQ routine
ALARM
         LDX #$10                   ; Setup for Alarm (16 loops)
         LDY #$00                   ; Set Delay Counters
         STY $02
         LDA #$20                   ; Set up SID chip
         STA $D400                  ; FREQ Lo
         STA $D401                  ; Freq Hi
         LDA #$0F
         STA $D418                  ; Volume
         LDA #$00
         STA $D406                  ; S/R
         LDA #$29
         STA $D405                  ; A/D
ALOOP1
         LDA #$11                   ; Main Alarm LOOP
         STA $D404                  ; Turn on Triangle Waveform
ALOOP2
         DEY                        ; Delay LOOP
         BNE ALOOP2
         DEC $02
         BNE ALOOP2
         DEC $D020                  ; Decrement border color
         DEC $D021                  ; Decrement background color
         LDA #$10                   ; Turn off voice 1
         STA $D404
         DEX                        ; Decrement LOOP counter
         BNE ALOOP1                 ; If not done, do it again
         PLA                        ; Restore registers from the stack
         TAY
         PLA
         TAX
         PLA
         RTI                        ; Return to program
```

Listing 5. Basic program that activates Listing 4.

```
1ØØ REM - TOD CLOCK ALARM DEMO                              :REM*2Ø6
11Ø REM                                                     :REM*253
12Ø L(1)=1:L(2)=9:L(4)=5:L(5)=9:L(7)=5:L(8)=9:L(1Ø)=9      :REM*219
13Ø POKE5328Ø,Ø:POKE53281,Ø:PRINT"{SHFT CLR}{CTRL 8}";     :REM*115
14Ø IFA=ØTHENPRINT"LOADING ALARM.IRQ":A=1:LOAD"ALARM.IRQ",8,1
                                                            :REM*178
15Ø SYS 49152                                               :REM*69
16Ø PRINT"{SHFT CLR}{3 CRSR DNs}{2 CRSR RTs}{CTRL 8}1. SET CLOC
    K TIME"                                                 :REM*81
```

```
17Ø PRINT"{2 CRSR RTs}{CRSR DN}2. SET ALARM TIME"      :REM*143
18Ø PRINT"{2 CRSR RTs}{CRSR DN}3. QUIT"                 :REM*8
19Ø GETB$:IFB$<"1"ORB$>"3"THEN19Ø                       :REM*53
2ØØ IFB$="1"THENCB=Ø:T$="CLOCK"                         :REM*49
21Ø IFB$="2"THENCB=128:T$="ALARM"                       :REM*48
22Ø IFB$="3"THENEND                                     :REM*176
23Ø PRINT"{CTRL 6}PLEASE ENTER THE "T$" TIME":H=1:AP$="A":M=Ø:S
    =Ø                                                  :REM*216
24Ø PRINT"{1Ø CRSR RTs}Ø1:ØØ:ØØ.ØA{11 CRSR LFs}";:TM$="Ø1:ØØ:ØØ
    .ØA":CP=1                                           :REM*187
25Ø PRINT"{CTRL 9}"MID$(TM$,CP,1)"{CTRL Ø}{CRSR LF}";   :REM*44
26Ø GETA$:IFA$=""THEN26Ø                                :REM*178
27Ø IFA$=CHR$(13)THEN38Ø                                :REM*85
28Ø IFA$="{CRSR RT}"THEN34Ø                             :REM*168
29Ø IFCP<11THEN32Ø                                      :REM*196
3ØØ IFA$<>"A"ANDA$<>"P"THEN26Ø                          :REM*119
31Ø GOSUB33Ø:GOTO26Ø                                    :REM*148
32Ø IFA$<"Ø"ORA$>CHR$(L(CP)+48)THEN26Ø                  :REM*135
33Ø TM$=LEFT$(TM$,CP-1)+A$+RIGHT$(TM$,11-CP)            :REM*162
34Ø PRINTMID$(TM$,CP,1);:CP=CP+1+11*(CP=11)             :REM*5Ø
35Ø IFCP/3=INT(CP/3)THENPRINT"{CRSR RT}";:CP=CP+1       :REM*174
36Ø IFCP=1THENPRINT"{11 CRSR LFs}";                     :REM*54
37Ø GOTO25Ø                                             :REM*189
38Ø POKE56335,CB                                        :REM*2Ø5
39Ø AP$=RIGHT$(TM$,1):H=VAL(MID$(TM$,1,1))*16+VAL(MID$(TM$,2,1)
    )                                                   :REM*232
4ØØ M=VAL(MID$(TM$,4,1))*16+VAL(MID$(TM$,5,1))          :REM*31
41Ø S=VAL(MID$(TM$,7,1))*16+VAL(MID$(TM$,8,1))          :REM*153
42Ø HP=-128*(AP$="P")+H:POKE56331,HP                    :REM*181
43Ø POKE5633Ø,M:POKE56329,S:POKE56328,VAL(MID$(TM$,1Ø,1))
                                                        :REM*96
44Ø IFB$="2"THENPOKE56333,136                           :REM*11Ø
45Ø GOTO16Ø                                             :REM*11
```

Listing 6. Interrupt-generator routine for Listing 3.

```
;NMI ROUTINE DEMO
;USING TIMERS A & B OF CIA2
;
EXP
        LDA #<NEWNMI        ;Change RAM NMI Vector
        STA $0318
        LDA #>NEWNMI
        STA $0319
        LDA #$FF            ;Set up CIA2 registers
        STA $DD04           ;Timer A LO
        STA $DD05           ;Timer A HI
        LDA #$2F
        STA $DD06           ;Timer B LO
        LDA #$00
        STA $DD07           ;Timer B HI
        LDA #$51
        STA $DD0F           ;CRB - Timer B counts Timer A
        LDA #$11
        STA $DD0E           ;CRA - Timer A counts clock cycles
        LDA #$82
        STA $DD0D           ;ICR - Enable Timer B interrupts
        RTS
NEWNMI
        SEI                 ;New NMI routine: Set
                            ;interrupt disable
        PHA                 ;Save Registers .A, .X, ,
                            ;and .Y to stack
        TXA
        PHA
        TYA
        PHA
        LDA $DD0D           ;Check ICR to see if interrupt
                            ;is from CIA2
        BPL RESTORE         ;If not got to KERNAL routine
        LDY #$0F            ;Rotate direction vectors of the balls
        LDX #$0E
        LDA $C0D7           ;Save last value to stack
        PHA
DLOOP
        LDA SD,X            ;Push other values up one
        STA SD,Y
        DEY                 ;Do next value
```

will find that you can calculate the time it takes in seconds for a counter to reach zero by taking the latch value (high byte * 256 + low byte) and dividing by 1,022,730.

Each of the counters also has a corresponding control register, CRA ($0E) and CRB ($0F). These are located at $DC0E–$DC0F (56334–56335) for CIA 1, and $DD0E–$DD0F (56590–56591) for CIA 2. Figure 6 outlines how these registers are set up.

These registers control other aspects of the CIA chip besides timers A and B: namely, the TOD clock (bit 7 of CRB) and the serial port. The only bits that are of concern in using the timers to generate interrupts are 0, 3, 4 and 5 of CRA and CRB, and bit 6 of CRB.

Bit 0 starts (1) or stops (0) the corresponding timer. Bit 3 selects One-Shot (1) or Continuous mode (0) as discussed earlier. Bit 4 forces the value in the time latch to be loaded into the corresponding timer.

Bit 5 of CRA selects whether timer A is counting microprocessor cycles or CNT pulses. Bits 5 and 6 of CRB determine what timer B will count. Figure 6 explains which values select which option for timer B.

Listing 6 is a machine language routine that sits at the end of the ball-animation program (Listing 3 in Part 1). It uses timers A and B on CIA 2 to generate an interrupt approximately every three seconds.

To do this, timer A latch is loaded with $FFFF and timer B latch with $002F. The control registers are set up so that timer A counts clock pulses and timer B counts timer A. The force-latch and start-timer bits are also set. The ICR is set to enable timer B interrupts.

At this time, NEWNMI is executed. An SEI instruction sets the interrupt disable flag in the processor status register. The registers are then pushed onto the stack (lines 2240–2280), and the ICR is checked to make sure that the interrupt came from CIA 2 (lines 2290–2300.) The 16 direction vectors for the eight balls are then shifted over one, causing the balls to travel in different directions.

Go through the program carefully to see how the CIA registers are being programmed, especially CRA and CRB. Try to calculate the exact time interval by using the formula stated above.

If you're using an assembler, compile the ball-animation program with Listing 6 added on. Note that line 2020 in Listing 3 is replaced with the new program lines. (*Be sure first to save an unchanged copy of Listing 3*, because Part 3 ►

of this article will modify it again, in a different way.)

Then type in SYS 49152 and watch what happens. Note that even though the NMI interrupt is being used, pressing the restore key has no effect because the interrupt routine checks to make sure that timer B of CIA 2 is the source of the interrupt.

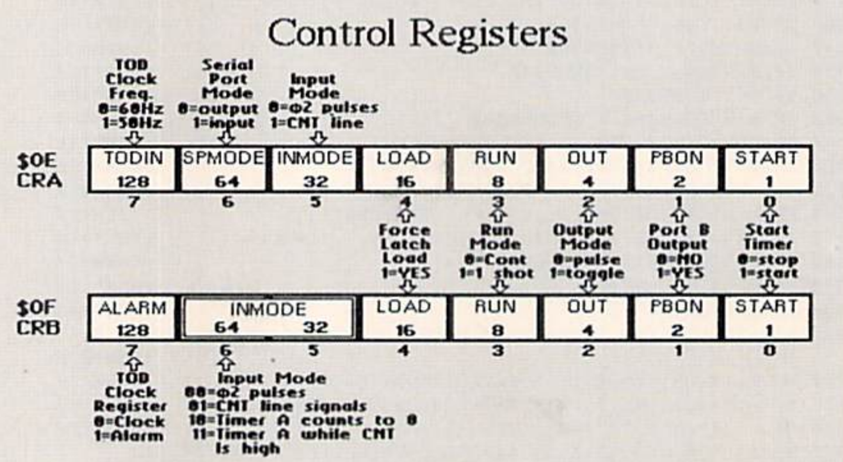
Serial Port—The serial port is accessed through registers SP ($0C) and CRA (see Figure 6). When you're sending data, timer A is also used to set the baud rate.

For more information on programming and using the CIA chip's serial port, consult the *Commodore 64 Programmer's Reference Guide*, Commodore Business Machines, Inc.; *Mapping the Commodore 64*, by Sheldon Leemon, COMPUTE! Books; and *GEOS Inside and Out*, by M. Tornsdorf and R. Kerkloh, Abacus Software, Inc., 1987.

Flag Line—Although CIA 1's flag line is already used internally by the 64's serial bus, CIA 2's flag line is available—on the user port at pin B—for whatever applications you can dream up. Ⓡ

```
        DEX
        BPL DLOOP           ;Check if done
        PLA                 ;Get last value from stack
        STA SD              ;Put at the beginning
        JMP $FEBC           ;Jump out through KERNAL NMI exit
RESTORE
        JMP $FE4C           ;Jump to RESTORE key routine
```

Figure 6. Control registers.



PART 3

RECAP

So far, you have learned what interrupts are, how the C-64's operating system uses them and how *you* can use them. We have explored the CIA chips and how you can program them to produce interrupt requests from a variety of sources.

We will now explore perhaps the most fascinating chip inside this tiny eight-bit computer, the Video Interface Controller (VIC-II) chip.

In addition to its graphics and sprite capabilities, the VIC-II can also generate IRQ interrupts from four possible sources, creating many unique and interesting video effects, such as split text and graphics screens, more than eight sprites at once and multiple border colors. Many commercial programs and games make use of these remarkable effects to produce seemingly impossible video displays.

THE VIC-II CHIP

Like the CIA chips, the VIC-II is a specialized peripheral processor unit (PPU) that generates the C-64's video display—whether text, graphics, sprites or any combination of them. Unlike the CIA, the VIC-II can directly address the RAM memory, although only 16K at a time. The RAM stores the text and bit-mapped graphics screens, color memory, character definitions and sprite definitions.

The VIC-II also uses 47 internal registers, which let you program the VIC-II and also communicate with the 6510 microprocessor. Table 2 briefly describes the registers, only a few of which are actually needed when dealing with interrupts, but all are important in generating the video effects.

Interrupts from the VIC-II chip appear on the 6510's IRQ or maskable interrupt line. In many ways, programming the VIC-II to produce interrupts is similar to using the CIA chips; however, there are some important differences.

WHERE VIC-II INTERRUPTS ORIGINATE

As mentioned earlier, there are four sources of interrupt requests from the VIC-II. Figure 7 shows where they originate. The first three relate to the actual video display, while the fourth deals with light pen data.

The first interrupt is the raster compare, which occurs when the current screen or raster line being displayed equals the value set in the raster-compare register.

Raster lines refer to the horizontal scan lines that make up the video display. To better understand them, you need to know a little bit about how your video display works. In order to create the text and graphics you see on the screen, an electron beam produced by the cathode ray tube (CRT) of the video display scans a total of 262 horizontal lines across the screen.

If you look closely, you can see the individual scan lines or raster lines. Although there are 262 lines on an American NTSC standard display screen, the VIC-II uses only 200 of them—lines 50 through 249—to create the text or graphics display. The rest of the lines make up the upper and lower borders.

In their trip across the screen, the scan lines are divided up into pixels making up the left border, 320 dots of horizontal resolution, then the right border. The screen display starts at pixel 24. Every one of these lines is updated 60 times a second.

It's similar to building a brick wall, 262 layers thick from top to bottom, every sixtieth of a second. By using different colored bricks in the proper locations, you can create a text or bit-mapped graphics screen, depending on where the screen-display information is coming from.

In the animation demonstrations we used earlier, you may have noticed some flickering of the sprites as they traveled around the screen. This happens when the interrupt to change their location occurs when a sprite is only halfway displayed, or while the MSB register is being altered. You can avoid this flickering by selecting a raster interrupt to change the positions while the electron beam is not on the display area. I'll demonstrate this use of the raster-compare interrupt later.

The second and third types of interrupts have to do with the sprites, or Movable Object Blocks (MOBs), as Commodore calls them. The VIC-II chip can detect when there is a collision between a sprite and the bitmapped graphics display, or between two sprites. Although a sprite is defined by a 24-by-21 rectangular grid, collisions only occur when a sprite's dot touches another sprite or a text character or part of the bitmapped graphics screen.

The fourth source of VIC-II interrupts is the light pen—a pen-shaped probe with a light-sensing device in the tip that is placed directly on the video display. When the scan line passes under the light sensor, the location of the light pen is stored in two of the VIC-II registers and an interrupt is generated.

The light-pen input is connected to the fire-button of control port 1. Therefore, this interrupt can also be activated by pressing the fire-button of a joystick plugged into the control port. In this case, the values of the light pen location registers would be meaningless.

How These Interrupts Get To the 6510

Like the CIA chips, all four sources of interrupts from the VIC-II are controlled by an internal register. Unlike the CIA chip, this is done through two registers instead of one. These are registers $19–$1A, which are located at $D019–$D01A (53273–53274). Figure 8 shows how they are set up.

The first is the interrupt flag register, which, like the ICR register of the CIA chip, signals when an interrupt has originated from the VIC-II chip and indicates which of the possible sources has generated the interrupt request. As shown in Figure 8, bit 7 will be set when any of the four sources generates an interrupt. The corresponding bits of the sources responsible will also be set.

When an interrupt occurs from a particular source, a latch, which prevents that interrupt from occurring again until the latch is cleared, is also set. This is done by writing 1 to the appropriate bit of the interrupt flag register.

The second register is the interrupt-enable register, which selects or enables a particular interrupt by setting the appropriate bit to 1. To clear or disable an interrupt, the appropriate bit must be set to 0.

For example, in a program to determine when a missile hits a spaceship, the interrupt for a sprite-to-sprite collision is enabled by writing a value of $04 to the interrupt-enable register ($1A). When the missile touches the spaceship, an IRQ interrupt will occur, and bits 7 and 2 of the interrupt flag register are set.

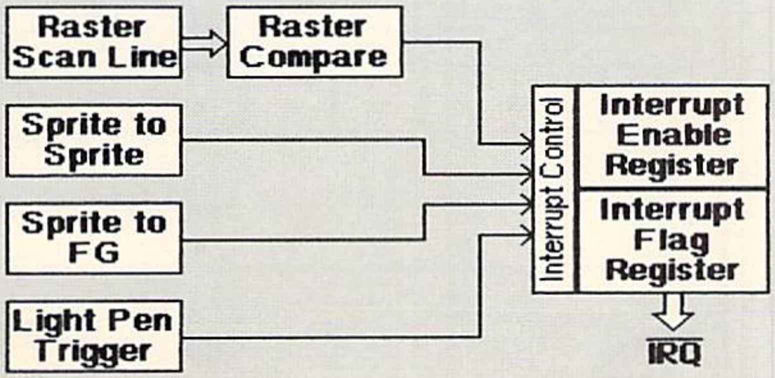
In addition, the appropriate bits of the sprite-to-sprite collision register ($1E) are set. This register, which is located at $D01E (53278), keeps track of which sprites are involved in a collision. ►

Table 2. Video interface controller register map.

Register	Address	Description
MOBXY	$00–$0F	Sprite position registers (0X, 0Y, 1X,...,7Y)
MSIGX	$10	Most significant bit of X-position registers
CNTY	$11	*Control register (bit 8 of raster-compare register)
RASTER	$12	*Read-raster scan line/write-raster compare register
LPX	$13	*Light pen X position (0–160)
LPY	$14	*Light pen Y position (0–199)
MOBEN	$15	Sprite enable register
CNTX	$16	Control register
MOBYEX	$17	Sprite vertical expansion register
MCR	$18	Memory control register
INTFLAG	$19	*VIC-II interrupt flag register
INTEN	$1A	*VIC-II interrupt enable register
MOBPR	$1B	Sprite-to-foreground display priority
MOBMC	$1C	Sprite multicolor mode enable register
MOBXEX	$1D	Sprite X-expand register
MOBMOB	$1E	*Sprite-to-sprite collision register
MOBFG	$1F	*Sprite-to-foreground collision register
EXTCOL	$20	Border color
BGCOL0	$21	Background color 0
BGCOL1	$22	Background color 1, multicolor 1
BGCOL2	$23	Background color 2, multicolor 2
BGCOL3	$24	Background color 3, multicolor 3
MOBMC0	$25	Sprite multicolor 0
MOBMC1	$26	Sprite multicolor 1
MOBCOL	$27–$2E	Sprite color registers

* Registers that are important in VIC-II interrupts.

Figure 7. Sources of interrupt requests from the VIC-II.



If two sprites make contact, the corresponding bits of the collision register are set to 1. A similar register ($1F) is used to monitor sprite-to-foreground collisions (see Figure 9).

Also, the sprite-to-sprite collision interrupt latch will be set, preventing any further sprite collisions from generating an interrupt. After the collision is handled by the interrupt routine, this latch should be cleared by writing a $04 to the interrupt flag register.

Figure 8. The interrupt-flag and interrupt-enable registers.

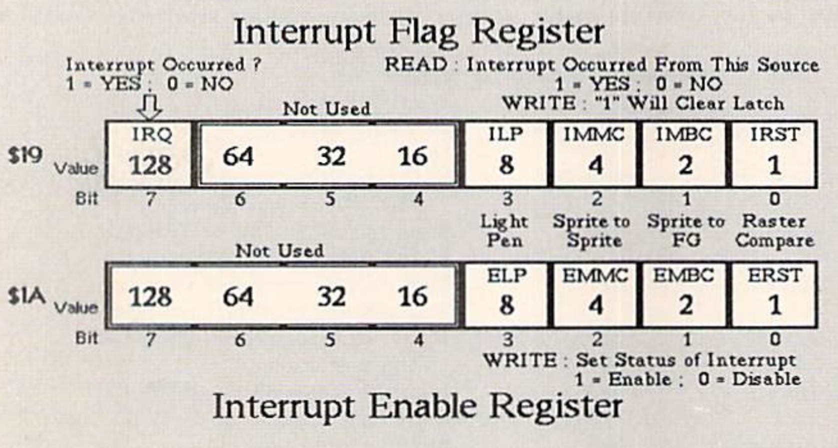


Figure 9. The sprite-to-foreground and sprite-to-sprite collision registers.

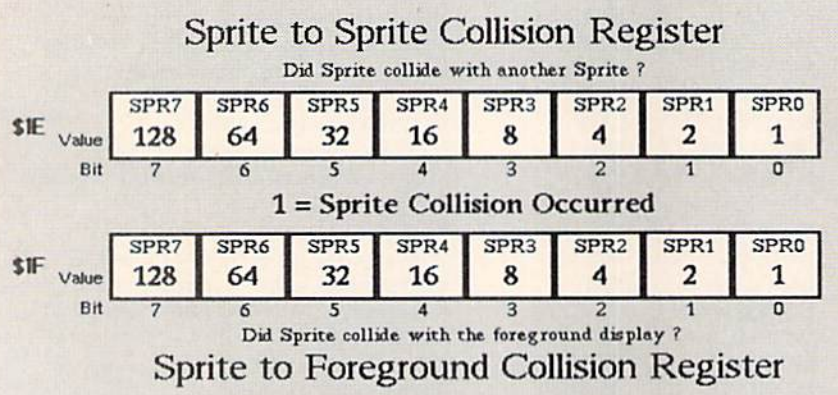
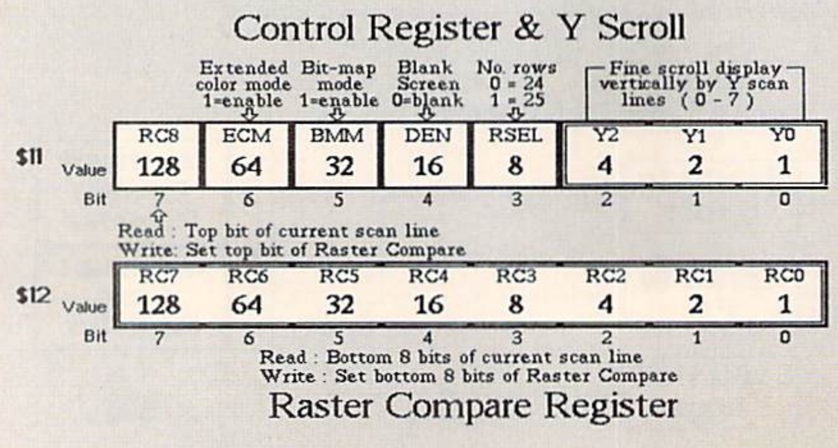


Figure 10. The Y scroll and control and raster-compare registers.



How These Interrupts Are Used

Raster-compare interrupt—Using raster-compare interrupts involves setting the raster-compare register to the appropriate value, enabling the interrupt using the interrupt-enable register and installing an interrupt handling routine by changing the IRQ RAM vector ($0314–$0315). Listing 7 demonstrates how the raster-compare interrupt can be used to create an unusual video effect.

Essentially, the screen is split into two halves. The bottom half is normal text. The top half displays text that waves back and forth by means of the horizontal fine-scroll register, while text at the bottom of the screen remains stationary.

The split is accomplished by setting a raster interrupt to occur at scan line 0, then again at line 154. The first interrupt loads the next value from the fine-scroll data at the end of the program and stores it in the horizontal fine-scroll and control register ($16), then sets the raster-compare register to generate the next interrupt at line 154. At this time, the fine scroll is set to 0, as is the raster-compare register.

Since the raster-compare register is only eight bits and there are 262 possible scan lines, a ninth bit must be used to select raster lines greater than 255. This bit is located in VIC-II register $11, bit 7 (see Figure 10).

The raster-compare register has a dual function. When it is read, it will return the value of the current scan line. This is useful to help avoid flickering of the screen display while areas of the bitmapped graphics screen are being changed. Make sure that you also check bit 7 of register $11 as well.

Examine Listing 7 carefully. It is important to understand that two raster-compare interrupts must occur during every update of the screen to accomplish the desired effect. Enter and assemble the program. To run it, just type in SYS 49152; then watch.

Listing 7 also demonstrates another use for the raster-compare interrupt. Essentially, instead of using timer A of CIA 1 to generate the sixtieth-of-a-second housekeeping interrupt, this now occurs at scan line 154. This works out fine, since the screen is also updated 60 times a second.

Lines 1150–1220 set up the raster interrupt and disable the interrupt from timer A of CIA 1. Its major effect is eliminating any flicker that may occur by having the timer A interrupt occur slightly before the raster-compare interrupt. When this happens, the raster-compare interrupt will not occur, since the interrupt-disable flag of the 6510 control register is set. This technique, which is useful in generating animation with sprites, is used in Listing 8.

Sprite-to-foreground and sprite-to-sprite collisions—Both of these interrupts are useful when you write game programs that use animated sprites. They let you detect when a sprite touches another sprite or the foreground—whether it be character graphics or bitmapped graphics—so you can take the appropriate action.

Although there are eight sprites, only two collision-detection interrupts exist. To determine which sprite is involved in the collision, the VIC-II uses two registers for sprite-to-sprite and sprite-to-foreground collisions ($1E and $1F, respectively). Each bit of the register corresponds to one of the eight sprites, as shown in Figure 10. By checking these registers, you can determine which of the sprites are involved in the collision.

However, reading these registers will clear their contents, so a copy should be saved if it is needed. These registers should be cleared before you expect a collision interrupt to occur, so that the collisions will be accurately detected.

Listing 8 is yet another modification to the ball-animation demo (Listing 3 in Part 1). Like Listing 6 in Part 2, it is designed to sit at the end of Listing 3 and uses the sprite-to-foreground collision interrupt to determine when a ball collides with a border set up around the screen by Listing 9. When a collision occurs, the ball's direction is changed, and it appears to be bouncing off the wall.

Note that lines 1390 through 1410 of the original Listing 3 will need to be changed to a JMP instruction. The new line should read:

```
1390 C04C 4C 30 C1 NEWIRQ
     JMP ICHECK
```

This lets the IRQ routine determine whether the interrupt is from the raster compare or from a collision. Line 2020 is replaced by the code in Listing 8, which sets up the VIC-II to generate the housekeeping interrupt at scan line 0 and contains the sprite-to-foreground collision-handling routine.

Since the animation and the collision both use the IRQ interrupt generated from the VIC-II chip, the program must determine which interrupt it is servicing by checking the interrupt flag reg-

Listing 7. An unusual visual effect using the raster-compare interrupt.

```
*= $C000
;
;      THE SHAKING SCREEN
; ***** RASTER COMPARE DEMO *****
;
       SEI                    ;Set Interrupt Disable Flag
       LDA #<NEWIRQ           ;Change IRQ RAM Vector
       STA $0314
       LDA #>NEWIRQ
       STA $0315
       CLI                    ;Clear Interrupt Disable Flag
       LDA #$00               ;Intialize counters and VIC-II chip
       STA $02                ;Set pointer to zero
       STA $D012              ;Set Raster Compare for scan line 0
       LDA #$1B
       STA $D011              ;Set top bit to 0
       LDA #$01
       STA $D01A              ;Enable Raster Compare Interrupt
       STA $DC0D              ;Disable Timer A interrupt from CIA 1
       RTS
NEWIRQ
       LDX $D012              ;Get value of current scan line
       BNE NORMAL             ;If not at scan line 0 normal display
SHIFT
       LDY $02                ;Get pointer to fine scroll data
       INY                    ;Increment pointer
       CPY #$0E               ;If at end of data ...
       BNE GETY
       LDY #$00               ;... then start again
GETY
       LDA YS,Y               ;Get fine scroll data
       STA $D016              ;Put in horizontal fine scroll
                              ;register
       STY $02                ;Save pointer
       LDA #$01
       STA $D019              ;Reset Raster Compare Interrupt Latch
       LDA #$9A               ;Load value of next Raster
                              ;Compare (154)
       STA $D012              ;Save to Raster Compare Register
       JMP $EA81              ;Exit interrupt routine through
                              ;the KERNAL
NORMAL
       LDA #$08               ;Set fine scroll to 0
       STA $D016              ;Save to horizontal fine
                              ;scroll register
       LDA #$01
       STA $D019              ;Reset Raster Compare Interrupt Latch
       LDA #$00               ;Load value of next Raster Compare (0)
       STA $D012              ;Save to Raster Compare Register
       JMP $EA31              ;Jump to KERNAL IRQ routine
YS
       .BYTE 8 9 10 11 12 13 14 15  ;Fine scroll data
       .BYTE 14 13 12 11 10 9
```

Listing 8. Demo that detects when a ball collides with a border.

```
;MODIFIED FLYING BALLS - BOUNCING BALLS
;WITH RASTER COMPARE GENERATED INTERRUPT
;AND SPRITE TO FOREGROUND COLLISION DETECTION
;
EXP
       LDA #$1B               ;Initialize VIC-II registers
       STA $D011              ;Control Register - 8th bit of
                              ;Raster Compare
       LDA #0
       STA $D012              ;Raster Compare Register
       LDA #$03
       STA $D01A              ;Interrupt Enable - ERST and EMBC
       STA $DC0D              ;Turn off Timer A interrupt from CIA 1
       RTS
ICHECK
       LDA $D019              ;Get Interrupt Flag Register
       AND #$02               ;Check if IMBC has occurred
       BNE COLLISION          ;If YES - then go to collision routine
       LDA #$01               ;If NO - Turn off Raster Compare Latch
       STA $D019
       LDA $D01F              ;Clear Sprite - Foreground
                              ;Collision Register
       JMP CONT               ;Jump to ball animation routine
COLLISION
       LDA $D01F              ;Get Sprite to Foreground
```

```
                                ;Collision Register
     LDY #$07                   ;Set Y to 7 - Sprite Number Pointer
     LDX #$00                   ;Set X to 0 - Sprite Collision Pointer
SHIFT
     ASL                        ;Check if collision occurred
                                ;with Sprite Y
     BCC NOCOLL                 ;If NO - try next Sprite
     PHA                        ;If YES -
     TYA
     STA CSPRITE,X              ;Save Sprite Number
     PLA
     INX                        ;Increment Sprite Collision Pointer
NOCOLL
     DEY                        ;Decrement Sprite Number Pointer
     BPL SHIFT                  ;If not all sprites checked,
                                ;do next one
     DEX                        ;Point to last sprite
                                ;collision detected
NEXTA
     LDA CSPRITE,X              ;Get Sprite Number
     TAY                        ;Put SN in Y
     PHA                        ;Save SN to the Stack
     LDA MASK,Y                 ;Get MSB mask for Sprite
     STA $FE                    ;Store in zero page location $FE
     PLA                        ;Get SN back off stack
     ASL                        ;Multiply by 2
     TAY                        ;Put new pointer in Y
     LDA $D000,Y                ;Get X location of Sprite
     PHA                        ;Save to the Stack
     CMP #$1C                   ;Check if collision is at left border
     BCS NOTLEFT                ;If not check right side
     LDA $FE                    ;Get MSB mask - Check MSB
                                ;Register to make
     AND $D010                  ;sure Sprite is at the left side
     BNE NOTLEFT                ;If NO then check right side
     LDA #0                     ;Change X direction of Sprite
     STA SD,Y                   ;Save to Sprite Direction data
NOTLEFT
     PLA                        ;Get X location back from stack
     CMP #$3D                   ;Check if at right border
     BCC NOTRIGHT               ;If NO - check top of screen
     LDA $FE                    ;Get MSB mask
     AND $D010                  ;Check MSB bit
     BEQ NOTRIGHT               ;If not at right - check top of screen
     LDA #$80                   ;Change X direction of Sprite
     STA SD,Y                   ;Save to Sprite Direction data
NOTRIGHT
     INY                        ;Point to Y value of Sprite Location
     LDA $D000,Y                ;Get Y value of Sprite Location
     CMP #$35                   ;Check if at top border
     BCS NOTTOP                 ;If NO - then check bottom of screen
     LDA #0                     ;Change Sprite Y Direction
     STA SD,Y
NOTTOP
     CMP #$E2                   ;Check if at bottom border
     BCC NOTBOTTOM              ;If NO - Leave
     LDA #$80                   ;Change Sprite Y Direction
     STA SD,Y
NOTBOTTOM
     DEX                        ;Decrement Sprite Collision Pointer
     BPL NEXTA                  ;If more sprites - Check next sprite
     LDA #$02                   ;Clear Sprite to Foreground
                                ;Interrupt Latch
     STA $D019
     JMP $EA81                  ;Jump to KERNAL IRQ exit routine
CSPRITE
     .BYTE 0 0 0 0 0 0 0 0 ;Sprites that collided
MASK
     .BYTE 1 2 4 8 16 32 64 128 ;Mask values
```

Listing 9. Creating the border for the demo.

```
10 REM{2 SPACEs}SCREEN BORDER SET UP FOR BOUNCING BALLS:REM*251
20 REM                                                 :REM*163
30 IFA=0THEN PRINT"{SHFT CLR}LOADING BBALLS.IRQ":A=1:LOAD"BBALL
   S.IRQ",8,1                                          :REM*140
40 PRINT"{SHFT CLR}{CTRL 2}{COMD A}{38 SHFT *s}{COMD S}";
                                                        :REM*16
50 FORX=1TO23:PRINT"{SHFT -}{38 SPACEs}{SHFT -}";:NEXT  :REM*82
60 PRINT"{COMD Z}{38 SHFT *s}{HOME}";:POKE2023,125     :REM*168
70 SYS49152                                            :REM*244
80 GOTO80                                              :REM*216
```

ister. This occurs in lines 2160–2180.

Enter Listing 8 and assemble it. Save a copy under the filename BBALLS.IRQ, then load up Listing 9 and type in RUN. The rest is magic. For a further exercise in working with VIC-II interrupts, try to modify the program to detect collisions between balls, and send them bouncing off each other as well.

Light pen interrupts—The final source of interrupts is the light pen. However, as discussed earlier, this interrupt can also be triggered by pressing the fire-button of a joystick plugged into control port 1.

When you use a light pen, the values of registers $13–$14 contain the screen position of the pen. These registers are located at $D013–$D014 (53267–53268). The horizontal position register ($13) is too small to hold all the possible values corresponding to the 320 horizontal pixel positions, so the VIC-II chip compromises by returning a value from 0 to 159, or every other pixel position.

With the proper amount of creativity, the possible effects that can be created with interrupts are endless. The ball-animation demo is just a simple example of what can be accomplished by accessing the hidden powers of the VIC-II video display chip. The rest is up to you.

External Interrupts

Throughout this article, I've introduced several ways of creating interrupts from outside the C-64.

The first is to directly connect to the IRQ and NMI lines of the 6510 microprocessor through the expansion port. Second, you can access the flag line of CIA 2 on the user port, which generates interrupt requests on the NMI line. This method has the advantage of being able to disable the interrupt via the ICR register, if desired. The third method is through the fire-button of the joystick 1 port, which activates the light-pen interrupt of the VIC-II chip, causing an interrupt request on the IRQ line. It also can be turned off and on by setting the appropriate bit of the interrupt-enable register.

The choice is yours as to what you actually connect up to generate these interrupts. This article contains all the fundamentals for generating and programming with interrupts. But the best way to learn about them is to play around with them yourself. ■

Jim Hosek, who has been programming for some ten years, is a veterinarian attached to the Veterinary Hospital of the University of Pennsylvania in Philadelphia.

Learn To Walk Before You RUN

WE RECEIVE MANY LETTERS from new Commodore owners who want to type in program listings from *RUN* and need help in getting started. To answer many of the questions novice users have, we present the following guidelines.

1. First, keep in mind that as a beginner you should enter only short Basic programs. Avoid machine language listings and lengthy Basic programs until you get the hang of what you're doing.

2. To help you catch mistakes in typing in listings, we publish *RUN*'s Checksum program elsewhere in this issue.

3. If you intend to save the program you're typing in on a brand new disk, you must format that disk. To do this, insert the disk in your drive and type:

OPEN15,8,15 <press return>
PRINT#15,"N0:NAME,##" <press return>

The ## is a two-character identifier that can be any combination of letters or digits. NAME can be any title for the disk that you choose, as long as it's 16 characters or less.

After entering the above lines, wait for a few minutes while the disk spins inside the drive. When the disk stops, the formatting is done. Then type:

CLOSE15 <press return>

In 128 mode on a C-128, you can shorten this procedure by typing:

HEADER "NAME,##" <press return>

Caution: The formatting process erases any material already on the disk, so if you're formatting a used disk, make sure it doesn't contain any programs you want to keep. See item 11 below, on reading the disk directory, if you need to find out what's on the disk.

4. Before you start typing in a program listing, your computer's memory needs to be empty. To make sure it is, turn the computer off, wait a few seconds, and turn it on again.

5. As you type in the listing, remember to press the return key after typing each line. This enters the line into memory.

6. If you want to review what you've entered, type LIST and press the return key; all the lines you've entered will scroll by. You can slow the scrolling on the C-64 by holding down the control key, and on the C-128 by pressing the no-scroll key. To view certain specific lines, type LIST, followed by the line numbers you want; then press the return key. For example, LIST 10–50 displays lines 10 through 50, and LIST 20 displays only line 20.

7. If you find an error in a line, delete the incorrect characters with the insert-delete key, then retype that portion and press return to enter the new line in memory.

8. Be sure to save the program to disk fairly often during the typing process. Otherwise, you could lose all your work if a power glitch wipes out your computer's memory. To save a partial or complete Basic program listing, type:

SAVE "NAME",8 <press return>

In 128 mode on a C-128, you can press F5, type in NAME and press the return key. Here, NAME is the filename you want the program to have, not the disk name you used when formatting.

Each time you save a revised program to the same disk, you must change its filename, or a disk error will occur, even if only one character is changed. An easy way to vary the filename is by adding version numbers to the end of the basic name (Program.1 and Program.2, for example). The numbers will also tell you which version is the latest.

9. If you wish to erase (scratch) unwanted programs from a disk, type:

OPEN15,8,15 <press return>
PRINT#15,"S0:filename" <press return and wait a few seconds>
CLOSE15 <press return>

In 128 mode on a C-128, you can type:

SCRATCH "NAME" <press return>

Be sure not to erase the final version!

10. Always save the final version of a program to two disks, so you have a backup copy in case one of the disks gets damaged. When saving to two different disks, you can use the same program name in each case.

11. To view a complete list of the filenames on a disk (i.e., read the disk directory), type:

LOAD "$",8 <press return>
LIST <press return>

In 128 mode on a C-128, you can just press F3.

12. When you know what program you want to load, next make sure you know *exactly* how its filename is spelled in the disk directory, including punctuation, special characters and spaces. A mistake in the filename will keep the load from working.

If the disk directory is still on the screen when you enter the Load command, you can refer to that for the spelling. If the directory will be gone from the screen by the time you enter the Load command, jot down the exact spelling of the filename for reference. Once you're sure of the filename, load the program by typing:

LOAD "NAME",8 <press return>

In 128 mode on a C-128, you can just press F2, type in the filename and press the return key.

13. After you've loaded the program, enter RUN to use it. ■

Tag 'Em

If your goal is to have yourself a ball, why not play Tag?

By JOHN FEDOR

Just grab the ball and run into the goal. That's all you have to do to score in Tag. Sound easy? Well, watch out! Your opponent tries to stop you—and to make goals of his own.

If your opponent tags you while you have the ball, you momentarily freeze in place. To prevent this, release the ball by pressing the fire-button before he tags you. The ball then continues moving in the direction it was going when released.

As you play, beware of the center, and keep in mind that the corners can be a little "sticky." The winner is the first player to reach five points, but you probably won't even notice how the scores are adding up, since you'll be having so much fun trying to "burn" your opponent.

The joystick in port 1 controls the player who is defending the goal on the left of the screen, and the joystick in port 2 controls the player defending the right-hand goal. Play begins when either gamer presses his fire-button. The music that accompanies Tag was composed by Ken Fountain. R

John Fedor is a college student with an avid interest in computers and math. On rainy days, he plays tag on his Commodore.

Listing 1. Tag program.

```
Ø REM TAG - JOHN FEDOR   :REM*34
1Ø POKE 5328Ø,12:POKE 53281,1
                          :REM*78
2Ø PRINT"{SHFT CLR}{CTRL 1}{2 C
   RSR DNs}"TAB(19)"A"   :REM*58
3Ø FORX=1TO17:PRINT"{HOME}{2 CR
   SR DNs}"TAB(X)" T"TAB(37-X)"
   G "                   :REM*153
4Ø FORQ=1TO25:NEXTQ,X    :REM*145
5Ø PRINT"{HOME}{5 CRSR DNs}"TAB
   (15)"JOHN FEDOR"      :REM*16
6Ø PRINT"{18 CRSR DNs}{4 SPACEs
   }PLEASE WAIT...LOADING IN DA
   TA...{HOME}"          :REM*199
7Ø FORX=49152TO51711:READA:POKE
   X,A:CK=CK+A:NEXTX:    :REM*245
8Ø IF CK<>231639 THEN PRINT "ER
   ROR IN DATA STATEMENTS...":E
   ND                    :REM*194
9Ø SYS 49152               :REM*1
1ØØ DATA 169,48,141,6Ø,3,141,61
    ,3,32,214,192,76,155,194,16
    2,Ø,189,244,199       :REM*5Ø
11Ø DATA 32,21Ø,255,232,224,5,2
    Ø8,245,141,32,2Ø8,141,33,2Ø
    8,133,251,133         :REM*119
12Ø DATA 253,169,4,133,252,169,
    216,133,254,162,Ø,16Ø,Ø,169
    ,1,145,253,169        :REM*216
13Ø DATA 16Ø,145,251,16Ø,39,169
    ,16Ø,145,251,169,1,145,253,
    24,165,251,1Ø5        :REM*19Ø
14Ø DATA 4Ø,133,251,133,253,165
    ,252,1Ø5,Ø,133,252,1Ø5,212,
    133,254,232,224        :REM*99
15Ø DATA 11,144,212,224,13,144,
    228,224,25,144,2Ø4,162,Ø,16
    9,16Ø,157,Ø,4         :REM*165
16Ø DATA 157,192,7,169,1,157,Ø,
    216,157,192,219,232,224,4Ø,
    2Ø8,235,162,Ø         :REM*235
17Ø DATA 189,238,198,157,128,63
    ,232,224,128,2Ø8,245,169,Ø,
    133,251,169,1Ø         :REM*97
18Ø DATA 133,252,24,166,252,16Ø
    ,12,32,24Ø,255,166,251,16Ø,
    Ø,189,11Ø,199,32      :REM*157
19Ø DATA 21Ø,255,232,2ØØ,192,16
    ,2Ø8,244,24,165,251,1Ø5,16,
    133,251,23Ø,252       :REM*173
2ØØ DATA 2Ø1,64,2Ø8,219,169,7,1
    41,184,217,141,224,217,141,
    223,217,141,7         :REM*14Ø
21Ø DATA 218,32,27,194,173,6Ø,3
    ,9,48,141,2Ø9,5,173,61,3,9,
    48,141,249,5,96        :REM*95
22Ø DATA 162,Ø,138,157,Ø,212,23
    2,224,24,2Ø8,248,169,15,141
    ,24,212,169,112       :REM*1ØØ
23Ø DATA 141,6,212,169,24Ø,141,
    13,212,169,17,141,19,212,16
    2,Ø,142,85,3,142      :REM*211
24Ø DATA 86,3,142,87,3,142,91,3
    ,142,92,3,142,93,3,232,142,
    88,3,142,89,3         :REM*172
25Ø DATA 142,9Ø,3,142,94,3,12Ø,
    173,2Ø,3,133,113,173,21,3,1
    33,114,169,193        :REM*167
26Ø DATA 141,21,3,169,45,141,2Ø
    ,3,88,96,2Ø6,94,3,173,94,3,
    24Ø,3,1Ø8,113,Ø       :REM*217
27Ø DATA 169,8,141,94,3,2Ø6,88,
    3,173,88,3,2Ø8,56,173,91,3,
    2Ø8,5,169,32,141      :REM*197
28Ø DATA 4,212,238,85,3,174,85,
    3,189,249,199,133,7,189,99,
    2ØØ,41,128,141        :REM*119
29Ø DATA 91,3,189,99,2ØØ,41,127
    ,141,88,3,166,7,189,2Ø6,2ØØ
    ,141,Ø,212,189          :REM*6
3ØØ DATA 219,2ØØ,141,1,212,169,
    33,141,4,212,2Ø6,89,3,173,8
    9,3,2Ø8,56,173         :REM*23
31Ø DATA 92,3,2Ø8,5,169,16,141,
    11,212,238,86,3,174,86,3,18
    9,232,2ØØ,133,7       :REM*177
32Ø DATA 189,51,2Ø1,41,128,141,
    92,3,189,51,2Ø1,41,127,141,
    89,3,166,7,189         :REM*23
33Ø DATA 2Ø6,2ØØ,141,7,212,189,
    219,2ØØ,141,8,212,169,17,14
    1,11,212,2Ø6,9Ø        :REM*19
34Ø DATA 3,173,9Ø,3,2Ø8,56,173,
    93,3,2Ø8,5,169,128,141,18,2
    12,238,87,3,174       :REM*181
35Ø DATA 87,3,189,127,2Ø1,133,7
    ,189,186,2Ø1,41,128,141,93,
    3,189,186,2Ø1,41      :REM*132
36Ø DATA 127,141,9Ø,3,166,7,189 ►
```

RUN it right: **C-64; Two joysticks**

ILLUSTRATED BY BOB SCOTT

```
,2Ø6,2ØØ,141,14,212,189,219
,2ØØ,141,15,212    :REM*2ØØ
37Ø DATA 169,129,141,18,212,173
,85,3,2Ø1,1Ø6,2Ø8,2Ø,162,15
,142,24,212,2Ø2    :REM*219
38Ø DATA 2Ø8,25Ø,12Ø,165,113,14
1,2Ø,3,165,114,141,21,3,88,
1Ø8,113,Ø,162,97    :REM*55
39Ø DATA 16Ø,225,173,68,3,2Ø1,1
,2Ø8,2,162,32,2Ø1,2,2Ø8,2,1
6Ø,32,142,223,5    :REM*137
4ØØ DATA 142,7,6,14Ø,184,5,14Ø,
224,5,96,174,4,2Ø8,224,27,2
Ø8,34,173,16,2Ø8    :REM*186
41Ø DATA 41,4,2Ø8,27,2Ø6,4,2Ø8,
2Ø6,Ø,2Ø8,32,128,197,173,4,
2Ø8,2Ø1,18,2Ø8    :REM*35
42Ø DATA 24Ø,238,61,3,1Ø4,1Ø4,3
2,142,194,76,155,194,174,2,
2Ø8,224,65,2Ø8    :REM*72
43Ø DATA 34,173,16,2Ø8,41,2,24Ø
,27,238,2,2Ø8,238,Ø,2Ø8,32,
128,197,173,2    :REM*9Ø
44Ø DATA 2Ø8,2Ø1,72,2Ø8,24Ø,238
,6Ø,3,1Ø4,1Ø4,32,142,194,76
,155,194,96,12Ø    :REM*67
45Ø DATA 165,113,141,2Ø,3,165,1
14,141,21,3,88,96,169,5,2Ø5
,6Ø,3,24Ø,5,2Ø5    :REM*225
46Ø DATA 61,3,2Ø8,3,32,214,192,
32,14,192,32,217,198,165,2,
41,16,2Ø8,247    :REM*69
47Ø DATA 162,Ø,189,174,199,32,2
1Ø,255,232,224,4Ø,2Ø8,245,2
4,162,24,16Ø,5    :REM*12
48Ø DATA 32,24Ø,255,162,Ø,189,2
14,199,32,21Ø,255,232,224,3
Ø,2Ø8,245,32,217    :REM*5
49Ø DATA 198,165,2,41,16,24Ø,24
7,173,6Ø,3,2Ø1,5,176,7
                        :REM*139
5ØØ DATA 173,61,3,2Ø1,5,144,6,3
2,172,198,32,142,194,32,14,
192,32,139,197    :REM*56
51Ø DATA 32,77,198,173,3Ø,2Ø8,2
Ø8,251,32,237,195,32,128,19
7,32,59,194,76    :REM*2Ø2
52Ø DATA 3,195,173,68,3,24Ø,1,9
6,173,16,2Ø8,41,1,133,2Ø,16
9,Ø,133,21,174    :REM*241
53Ø DATA Ø,2Ø8,172,1,2Ø8,173,62
,3,2Ø8,2,2Ø2,2Ø2,232,173,63
,3,2Ø8,2,136    :REM*218
54Ø DATA 136,2ØØ,224,Ø,2Ø8,9,17
3,62,3,24Ø,4,169,1,133,2Ø,2
24,255,2Ø8,9    :REM*195
55Ø DATA 173,62,3,2Ø8,4,169,Ø,1
33,2Ø,142,Ø,2Ø8,14Ø,1,2Ø8,1
73,16,2Ø8,41,6    :REM*55
56Ø DATA 5,2Ø,141,16,2Ø8,192,54
,2Ø8,7,169,1,141,63,3,23Ø,2
1,192,228,2Ø8    :REM*26
57Ø DATA 7,169,Ø,141,63,3,23Ø,2
1,165,2Ø,2Ø8,9Ø,224,26,2Ø8,
7,169,1,141,62    :REM*136
58Ø DATA 3,23Ø,21,224,1Ø8,2Ø8,1
5,192,12Ø,144,11,192,155,17
6,7,169,Ø,141    :REM*72
59Ø DATA 62,3,23Ø,21,224,238,2Ø
8,15,192,12Ø,144,11,192,155
,176,7,169,1    :REM*174
6ØØ DATA 141,62,3,23Ø,21,192,12
Ø,2Ø8,15,224,1Ø8,144,11,224
,239,176,7,169    :REM*168
61Ø DATA Ø,141,63,3,23Ø,21,192,
154,2Ø8,15,224,1Ø8,144,11,2
24,239,176,7    :REM*218
62Ø DATA 169,1,141,63,3,23Ø,21,
76,223,195,224,66,2Ø8,7,169
,Ø,141,62,3    :REM*221
63Ø DATA 23Ø,21,165,21,24Ø,9,16
2,32,142,4,212,232,142,4,21
2,96,2Ø6,69,3    :REM*95
64Ø DATA 173,69,3,24Ø,1,96,169,
2,141,69,3,173,1,22Ø,41,31,
73,31,133,251    :REM*157
65Ø DATA 162,2,134,252,134,253,
2Ø2,134,254,32,12Ø,196,173,
68,3,2Ø1,1,2Ø8    :REM*36
66Ø DATA 34,174,2,2Ø8,172,3,2Ø8
,142,Ø,2Ø8,14Ø,1,2Ø8,162,Ø,
173,16,2Ø8,41    :REM*1Ø7
67Ø DATA 2,24Ø,1,232,134,2,173,
16,2Ø8,41,254,5,2,141,16,2Ø
8,173,Ø,22Ø,11    :REM*142
68Ø DATA 31, 3,31,133,251,169,4
,133,252,133,253,74,133,254
,32,12Ø,196    :REM*23Ø
69Ø DATA 173,68,3,2Ø1,2,2Ø8,34,
174 4,2Ø8,172,5,2Ø8,142,Ø,2
Ø8,14Ø,1,2Ø8    :REM*113
7ØØ DATA 162,Ø,173,16,2Ø8,41,4,
24Ø,1,232,134,2,173,16,2Ø8,
41,254,5,2,141    :REM*35
71Ø DATA 16,2Ø8,96,166,254,189,
63,3,24Ø,3,76,85,197,173,16
,2Ø8,37,253    :REM*132
72Ø DATA 133,2,166,252,188,1,2Ø
8,189,Ø,2Ø8,17Ø,165,251,41,
1,24Ø,1,136    :REM*68
73Ø DATA 165,251,41,2,24Ø,1,2ØØ
,165,251,41,4,24Ø,1,2Ø2,165
,251,41,8,24Ø    :REM*67
74Ø DATA 1,232,224,Ø,2Ø8,1Ø,165
,251,41,8,24Ø,4,165,253,133
,2,224,255,2Ø8    :REM*12
75Ø DATA 1Ø,165,251,41,4,24Ø,4,
169,Ø,133,2,192,56,176,1,2Ø
Ø,192,227,144    :REM*63
76Ø DATA 1,136,165,2,2Ø8,79,224
,1Ø7,2Ø8,9,192,119,144,5,19
2,156,176,1    :REM*69
77Ø DATA 2Ø2,224,239,2Ø8,9,192,
119,144,5,192,156,176,1,232
,192,119,2Ø8,9    :REM*215
78Ø DATA 224,1Ø7,144,5,224,24Ø,
176,1,136,192,155,2Ø8,9,224
,1Ø7,144,5,224    :REM*221
79Ø DATA 24Ø,176,1,2ØØ,224,28,1
76,2Ø,192,134,144,15,192,14
1,176,11,173    :REM*255
8ØØ DATA 68,3,197,254,2Ø8,4,2Ø1
,2,24Ø,1,232,76,63,197,224,
65,144,2Ø,192    :REM*2Ø1
81Ø DATA 134,144,15,192,141,176
,11,173,68,3,197,254,2Ø8,4,
2Ø1,1,24Ø,23Ø    :REM*13
82Ø DATA 2Ø2,138,166,252,157,Ø,
2Ø8,152,157,1,2Ø8,165,253,7
3,255,45,16    :REM*162
83Ø DATA 2Ø8,5,2,141,16,2Ø8,173
,68,3,197,254,2Ø8,35,165,25
1,41,16,24Ø,29    :REM*64
84Ø DATA 166,254,169,32,157,65,
3,189,39,2Ø8,9,8,157,39,2Ø8
,162,32,142,11    :REM*243
85Ø DATA 212,232,142,11,212,169
,Ø,141,68,3,96,162,2,16Ø,Ø,
136,2Ø8,253    :REM*2Ø2
86Ø DATA 2Ø2,2Ø8,25Ø,96,173,2Ø,
3,133,113,173,21,3,133,114,
12Ø,169,197    :REM*Ø
87Ø DATA 141,21,3,169,162,141,2
Ø,3,88,96,32,15,195,32,27,1
94,162,Ø,222    :REM*181
88Ø DATA 64,3,189,64,3,2Ø1,255,
2Ø8,5,169,Ø,157,64,3,232,22
4,4,2Ø8,236    :REM*73
89Ø DATA 173,66,3,2Ø8,8,173,4Ø,
2Ø8,41,7,141,4Ø,2Ø8,173,67,
3,2Ø8,8,173,41    :REM*42
9ØØ DATA 2Ø8,41,7,141,41,2Ø8,17
3,3Ø,2Ø8,133,2Ø,165,2Ø,41,6
,2Ø1,6,24Ø,35    :REM*58
91Ø DATA 165,2Ø,2Ø1,3,2Ø8,1Ø,17
3,66,3,2Ø8,5,169,1,141,68,3
,165,2Ø,2Ø1,5    :REM*223
92Ø DATA 2Ø8,1Ø,173,67,3,2Ø8,5,
169,2,141,68,3,1Ø8,113,Ø,17
3,68,3,24Ø,248    :REM*7
93Ø DATA 162,32,142,11,212,232,
142,11,212,2Ø1,1,2Ø8,33,169
,16,141,67,3    :REM*58
94Ø DATA 169,48,141,66,3,169,32
,141,64,3,169,1Ø,141,4Ø,2Ø8
,169,14,141,41    :REM*214
95Ø DATA 2Ø8,169,Ø,141,68,3,1Ø8
,113,Ø,169,16,141,66,3,169,
48,141,67,3    :REM*2Ø4
96Ø DATA 169,32,141,65,3,76,41,
198,169,Ø,17Ø,157,64,3,232,
224,5,2Ø8,248    :REM*2Ø8
97Ø DATA 169,2,141,4Ø,2Ø8,141,6
9,3,162,6,142,41,2Ø8,232,14
2,39,2Ø8,173,4    :REM*17
98Ø DATA 22Ø,41,1,141,62,3,173,
5,22Ø,41,1,141,63,3,162,254
,142,249,7,142    :REM*113
99Ø DATA 25Ø,7,232,142,248,7,16
Ø,137,14Ø,3,2Ø8,14Ø,5,2Ø8,1
6Ø,1ØØ,14Ø,1    :REM*128
1ØØØ DATA 2Ø8,162,173,142,Ø,2Ø8
,162,28,142,2,2Ø8,162,64,1
42,4,2Ø8,169,4    :REM*216
1Ø1Ø DATA 141,16,2Ø8,169,7,141,
21,2Ø8,96,169,Ø,141,6Ø,3,1
41,61,3,162,Ø    :REM*124
1Ø2Ø DATA 138,157,Ø,212,232,224
,24,2Ø8,248,169,15,141,24,
212,169,5Ø,141,5    :REM*175
1Ø3Ø DATA 212,169,15,141,1,212,
169,57,141,12,212,169,5,14
1,8,212,96,173,Ø    :REM*222
1Ø4Ø DATA 22Ø,41,16,73,16,133,2
,173,1,22Ø,41,16,73,16,5,2
,133,2,96,Ø,Ø,Ø    :REM*3
1Ø5Ø DATA Ø,Ø,Ø,Ø,Ø,Ø,Ø,Ø,Ø,Ø,2
```

```
     52,Ø,1,254,Ø,3,135,Ø,3,3,Ø
     ,3,3,Ø,3,3,Ø,3,3   :REM*131
1Ø6Ø DATA Ø,3,135,Ø,1,254,Ø,Ø,2
     52,Ø,Ø,Ø,Ø,Ø,Ø,Ø,Ø,Ø,Ø,Ø,Ø
     ,Ø,Ø,Ø,Ø,Ø,Ø,Ø,Ø   :REM*125
1Ø7Ø DATA Ø,Ø,Ø,Ø,Ø,Ø,Ø,Ø,Ø,Ø,Ø
     ,Ø,Ø,Ø,Ø,Ø,Ø,Ø,Ø,Ø,Ø,Ø,12Ø
     ,Ø,Ø,252,Ø,Ø,252    :REM*74
1Ø8Ø DATA Ø,Ø,252,Ø,Ø,252,Ø,Ø,1
     2Ø,Ø,Ø,Ø,Ø,Ø,Ø,Ø,Ø,Ø,Ø,Ø,Ø
     ,Ø,Ø,Ø,Ø,Ø,Ø,Ø,Ø    :REM*49
1Ø9Ø DATA Ø,Ø,Ø,Ø,Ø,Ø,Ø,Ø,Ø,176
     ,195,195,195,195,195,195,1
     95,195,195,195     :REM*211
11ØØ DATA 195,195,195,195,174,1
     94,32,8Ø,76,65,89,69,82,32
     ,35,49,58,32,32    :REM*138
111Ø DATA 32,194,194,32,8Ø,76,6
     5,89,69,82,32,35,5Ø,58,32,
     32,32,194,173      :REM*127
112Ø DATA 195,195,195,195,195,1
     95,195,195,195,195,195,195
     ,195,195,189,19      :REM*9
113Ø DATA 29,84,65,71,45,74,79,
     72,78,32,7Ø,69,68,79,82,46
     ,32,32,8Ø,82,69    :REM*186
114Ø DATA 83,83,32,66,85,84,84,
     79,78,32,84,79,32,66,69,71
     ,73,78,77,85,83    :REM*178
115Ø DATA 73,67,32,67,79,77,8Ø,
     79,83,69,68,32,66,89,32,75
     ,69,78,32,7Ø,79    :REM*229
116Ø DATA 85,78,84,65,73,78,147
     ,5,8,142,Ø,Ø,Ø,4,5,6,5,3,5
     ,6,5,4,5,6,7,8,4   :REM*113
117Ø DATA 5,6,5,4,5,6,5,4,5,6,7
     ,8,8,8,8,12,1Ø,11,11,8,8,8
     ,12,1Ø,11,11,8,8   :REM*128
118Ø DATA 8,12,1Ø,11,11,8,Ø,8,Ø
     ,8,4,5,6,5,4,5,6,5,4,5,6,7
     ,8,4,5,6,5,4,5,6   :RFM*158
119Ø DATA 5,4,5,6,7,8,4,5,6,5,4
     ,5,6,5,4,5,6,7,8,4,5,6,5,4
     ,5,6,5,4,5,6,5,4   :REM*251
12ØØ DATA 1,8,1,1,1,1,1,1,1,1,1
     ,1,1,1,4,1,1,1,1,1,1,1,1,1
     ,1,1,1,4,136,13Ø       :REM*3
121Ø DATA 129,2,1,1,1,136,13Ø,1
     29,2,1,1,1,136,13Ø,129,2,1
     ,1,1,8,4,1,1,2,1   :REM*24Ø
122Ø DATA 1,1,1,1,1,1,1,1,1,1,1
     ,4,1,1,1,1,1,1,1,1,1,1,1,1
     ,4,1,1,1,1,1,1,1   :REM*153
123Ø DATA 1,1,1,1,1,4,1,1,1,1,1
     ,1,1,1,1,1,1,1,4,Ø,Ø,71,15
     2,71,12,233,97        :REM*14
124Ø DATA 1Ø4,143,48,143,24,21Ø
     ,Ø,5,5,6,7,7,8,9,1Ø,11,12,
     14,15,Ø,Ø,1,3,1    :REM*182
125Ø DATA 3,1,3,1,3,1,3,1,3,1,3
     ,1,3,4,4,4,8,6,7,7,4,4,4,8
     ,6,7,7,4,4,4,8,6    :REM*96
126Ø DATA 7,7,4,Ø,4,Ø,4,1,3,1,3
     ,1,3,1,3,1,3,1,3,1,3,1,3,1
     ,3,1,3,1,3,1,3,1     :REM*14
127Ø DATA 3,1,3,1,3,1,1,8,2,2,2
     ,2,2,2,2,2,2,2,2,2,2,2,2,2
     ,136,13Ø,1,2,1,1   :REM*122
128Ø DATA 1,136,13Ø,1,2,1,1,1,1
     36,13Ø,1,2,1,1,1,8,2,1,1,2
     ,2,2,2,2,2,2,2,2   :REM*138
129Ø DATA 2,2,2,2,2,2,2,2,2,2,2
     ,2,2,2,2,2,2,2,2,2,2,2,4,Ø
     ,Ø,4,4,4,4,4,4,5     :REM*35
13ØØ DATA 4,4,5,4,4,4,4,4,4,4,3
     ,3,3,4,4,4,4,4,4,4,3,3,3,4
     ,4,4,4,4,4,4,3,3     :REM*45
131Ø DATA 3,4,4,4,4,3,4,4,5,4,4
     ,5,4,4,5,4,4,4,Ø,1,2,2,2,2
     ,8,4,4,8,4,4,2,2   :REM*233
132Ø DATA 2,2,2,2,1,1,1,1,2,2,2
     ,2,2,2,1,1,1,1,2,2,2,2,2,2
     ,1,1,1,1,2,2,2,2   :REM*177
133Ø DATA 2,2,1,1,1,1,2,2,2,2,8
     ,8,4,4,8,4,4,8,4,4,8,2,2,4
     ,Ø                    :REM*29
```

■

Gravitron

Battle the pirate pilots by destroying their defense systems and fueling depots.

By CHARLES ORCUTT

Starbase Intelligence has discovered that pirate pilots from hostile spaceships are plotting to invade Earth to steal precious water. As an Earth-based pilot, you must attack the asteroids that provide shelter and sanctuary for the pirates. Once you eliminate the asteroids' automatic defense systems, your engineers can dismantle their fueling depots to keep the pirate ships from flying. That's the scenario for Gravitron, a smooth-scrolling arcade-style game for the C-64.

Listings 2 and 3 are Basic hex loaders that must be typed in, saved to disk and individually run to create machine language files. Listing 1 is the boot program that loads in and activates the files created by Listings 2 and 3.

Most of the game control is accomplished with a joystick in port 2. You can pause the action by pressing F7 and reset the game with F1. One caution: Gravitron is not compatible with all fast-load cartridges.

The Action

You move your ships by rotating them to face in the direction you wish to go and then applying thrusters. The forward thrusters are activated by pushing forward on the joystick, the vertical thrusters by pulling back on the joystick. To slow a ship down, rotate it 180 degrees and apply thrusters.

Asteroid defenses are destroyed by firing antimatter pellets at them with the fire-button on your joystick. You must be flying at a relatively low altitude for the pellets to work, and your ship will turn green to tell you when the altitude is appropriate.

The defensive machines on the asteroid surface are tricky. They don't move at the first two levels of play, but come to life later and seem to shift direction in a random manner. However, you'll learn that it's not random at all. To evade their firepower, increase your altitude, but keep in mind that *your* firepower will become ineffective, as well.

Of course, your thrusters consume fuel, so, even while you're trying to destroy the enemy defenses, you must use their fuel depots. Your ship will turn green when its tanks are low enough to be filled. To obtain fuel, maneuver the ship so it hovers above a fuel depot, then let it fall low enough to make contact. Don't fall too hard, though, or you'll destroy the ship. The longer you're in contact with a fuel tank, the more fuel you'll receive, as indicated by the horizontal bar at the bottom of the screen. A low-frequency bell indicates fueling is in progress; a high-frequency bell sounds when the tank is full.

Once you eliminate three enemy defenses, your engineers can land on the asteroid and dismantle its fuel depots. You must then move on to another asteroid. Each successive one offers a higher level of play, where the gravity is stronger. Of course, fighting the additional gravity means consuming more fuel. The program also generates a new graphics layout for each level. At every fourth level you complete, you get an extra ship if you currently have fewer than three.

At certain levels, you'll confront an indestructible surprise. It won't harm your ship while you're refueling, but it's a killer otherwise. On other levels, you'll encounter a "black hole," which blinks slowly until you're within its range. Then it blinks quickly and pulls your ship toward it with double gravity. You can best pull away from a black hole's destructive force by selecting a vector at a multiple of 90 degrees. In other words, point your ship directly to the right, down, left or up, and apply thrusters.

When you've lost all your ships, the game is over. Your score is calculated from the defenses you've destroyed, with defenses at higher levels yielding higher scores. The program saves the top ten scores in a disk file.

Programmers Only

Gravitron uses a technique known as smooth scrolling, which is done by changing the lower three bits of locations 53265 (vertical) and 53270 (horizontal). When an overflow value results from these changes, the main screen position pointer is updated in the appropriate direction. Then an algorithm copies the source data into the target screen area.

There are two different screen areas. At this point, the screen base location is changed, telling the VIC chip to look at a different area. I use $7800 and $7C00 as the screen locations. The screen is split at the bottom to allow the user to see various game variables, such as fuel, ships remaining, and so on. I use $7000 as the location for the background graphics, but the lower portion uses $6800 for the character set. This is needed to achieve a smooth transition between the game scene and the status indicators.

The indicators are static with respect to the scrolling game by means of a dual raster interrupt. This interrupt also changes screen and border colors, VIC character location and sprite color and priority.

There is a pseudo-random screen generator that operates every time you get to a new level. It selects from the graphics the imagery it will paste to the screen map zone. The map zone is layered in nine 1K blocks of memory and is configured to allow for vertical wrapping without any sign of flicker. That simply means that the top three screens are a replica of the bottom three. The

RUN it right: **C-64; joystick**

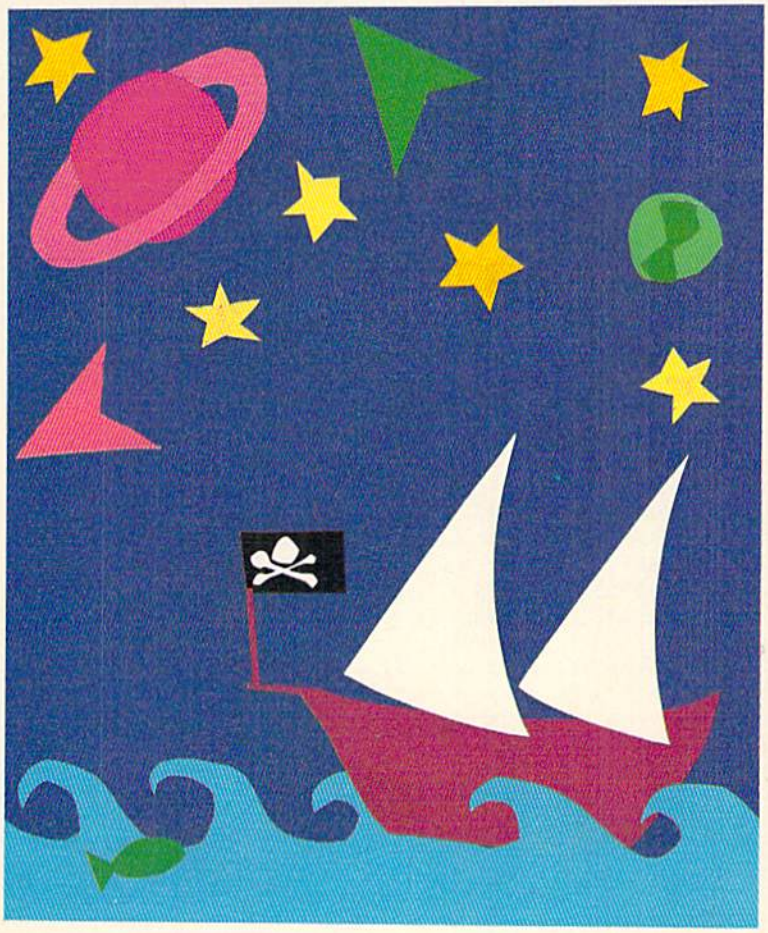
ILLUSTRATED BY JAN MULLER

generator uses a scheme to verify that repetition is minimized in the resulting map. It operates quickly enough to be invisible to the user, yet does a remarkable piece of art work each time it executes.

To destroy a sprite, I use a technique that has no name I'm aware of. It might well be called disintegration. It works by ANDing the sprite definition with numbers that are derived by a random generator. This was a memory conservation effort, but it results in a realistic destruction effect.

The ships (there are sixteen images for these) require only 32 bytes each to define, instead of the usual 64. This crunched the program by 512 bytes. The pellet sprite was made by clearing its zone and STAing three numbers in place. This saved memory, too. The whole program was made to be as memory-efficient as possible. Ⓡ

Charles Orcutt is an electronics technician and a self-taught Basic and machine language programmer. Gravitron's graphics were created by Dan Diamante.



Listing 1. Loader program.

```
5 IFA=ØTHENFORX=ØTO13:READA:POK
  EX+49152,A:NEXT        :REM*12Ø
1Ø IFA=ØTHENA=2:GOTO3Ø  :REM*227
15 IFA=2THEN65          :REM*253
2Ø IFA=3THEN75            :REM*9
25 IFA=4THEN85           :REM*24
3Ø PRINTCHR$(14)        :REM*126
35 POKE5328Ø,2:POKE53281,1:PRIN
   T"{SHFT CLR}"        :REM*235
4Ø PRINT"{1Ø CRSR DNs}":REM*189
45 PRINT"{9 SPACEs}";  :REM*14Ø
5Ø PRINT"LOADING ";    :REM*1Ø2
55 PRINT"{CTRL 1}.......";
                        :REM*195
6Ø A=2:LOAD"+GRAV ML",8,1
                         :REM*99
65 PRINT"{CTRL 1}......";
                        :REM*16Ø
7Ø A=3:LOAD"+GRAV CHARS",8,1
                        :REM*129
75 SYS49152             :REM*241
8Ø A=4                  :REM*147
85 SYS32768              :REM*44
9Ø DATA169,Ø,16Ø,Ø,153,253,118,
   153,Ø,119,2ØØ,2Ø8,247,96
                        :REM*157
```

Listing 2. Gravitron program.

```
Ø REM CREATE GRAVITRON ML
                        :REM*132
5 OPEN 8,8,8,"+GRAV ML,P,W"
                        :REM*188
1Ø READ A$:IF A$="-1" THEN CLOS
   E8:END                :REM*78
15 IF LEN(A$)<62 THEN 55
                        :REM*254
2Ø B$=MID$(A$,1,2Ø)+MID$(A$,22,
   2Ø)+MID$(A$,43,2Ø)   :REM*242
25 FOR I=1 TO 3Ø        :REM*181
3Ø C$=MID$(B$,(I*2)-1,2):H$=LEF
   T$(C$,1):L$=RIGHT$(C$,1)
                        :REM*2Ø9
35 H=VAL(H$):IF H$>"9" THEN H=A ►
```

```
   SC(H$)-55                    :REM*85
40 L=VAL(L$):IF L$>"9" THEN L=A
   SC(L$)-55                    :REM*136
45 BY=H*16+L:PRINT#8,CHR$(BY);
                                :REM*67
5Ø NEXT:GOTO 1Ø                 :REM*115
55 IF LEN(A$)<21 THEN B$=A$:GOT
   O 7Ø                         :REM*184
6Ø IF LEN(A$)<42 THEN B$=LEFT$(
   A$,2Ø)+RIGHT$(A$,(LEN(A$)-21
   )):GOTO 7Ø                   :REM*176
65 B$=LEFT$(A$,2Ø)+MID$(A$,22,2
   Ø)+RIGHT$(A$,LEN(A$)-42)
                                :REM*14Ø
7Ø FOR I=1 TO LEN(B$)/2:REM*221
75 C$=MID$(B$,(I*2)-1,2):H$=LEF
   T$(C$,1):L$=RIGHT$(C$,1)
                                :REM*14Ø
8Ø H=VAL(H$):IF H$>"9" THEN H=A
   SC(H$)-55                    :REM*56
85 L=VAL(L$):IF L$>"9" THEN L=A
   SC(L$)-55                    :REM*84
9Ø BY=H*16+L:PRINT#8,CHR$(BY);
                                :REM*148
95 NEXT:GOTO 1Ø                 :REM*16Ø
1ØØ REM GRAVITRON HEX DATA
                                :REM*95
1Ø1 DATA ØØ8Ø4CØ98ØØBØBØØØCØF Ø
    9A9Ø38DA6922Ø4A8C2Ø FF8FAØØ
    ØA9FF992Ø7B99               :REM*241
1Ø2 DATA 2Ø7FC8CØC8DØF5A9ØØAØ Ø
    599B8938810FAA9328D BE93A9Ø
    38DBF932Ø698E               :REM*127
1Ø3 DATA 2ØC58E2ØFD8D2ØFF8E2Ø 1
    38FA98E2ØD2FFAD16DØ 29F78D1
    6DØAD11DØ29F7               :REM*2Ø6
1Ø4 DATA 8D11DØA9Ø1AØØØ99ØØD8 9
    9ØØD999ØØDA99E8DAC8 DØF1A9A
    ØAØØØ99ØØØ499               :REM*153
1Ø5 DATA ØØØ599ØØØ699E8Ø6C8DØ F
    1AØ27A92Ø99EØØ5881Ø FACE699
    9DØ5EA9ØA8D69               :REM*5Ø
1Ø6 DATA 992ØØE81AØØØAE6C99E8 B
    DC393999ØD999Ø8DAC8 CØ5ØDØF
    5AØØØAE6C99E8               :REM*18
1Ø7 DATA E8BDC393994ØD9993ØDA C
    8CØ78DØF5AØØØAE6C99 E8E8E8B
    DC39399C8D899               :REM*26
1Ø8 DATA 8ØDAC8CØAØDØF5AØØØAE 6
    C99E8E8E8E8BDC39399 ØØD8992
    ØDBC8CØC8DØF5               :REM*87
1Ø9 DATA A2ØØE8DØFD38AD12DØC9 F
    C9ØF82Ø1981ADØØDC29 1ØFØØ6A
    5C5C93CDØ8Ø4C               :REM*12
11Ø DATA 5A81CE6C991ØØ5A9ØB8D 6
    C996ØCE6B991Ø2FA9Ø7 8D6B99A
    ØØØA2Ø1BDEØØ5               :REM*215
111 DATA 99EØØ5C8E8EØ28DØF4EE 6
    A99AC6A99B9D393C9FF DØØ7AØØ
    Ø8C6A99A96Ø38               :REM*19
112 DATA E94Ø8DØ7Ø6AD16DØ29F8 1
    86D6B998D16DØ6ØA993 2ØD2FF2
    ØFF8F2ØF98CA9               :REM*125
113 DATA 3F8D15DØ2ØBC8F2ØCD8C 2
    ØE38CADA6928DØF99A9 ØØ8DØCD
    Ø8DØDDØA9AØ8D               :REM*154
114 DATA 1ØDØA9ØØ85FBA94Ø85FC A
    2Ø6AØØØA9ØØ91FBC8DØ FBE6FCC
    A1ØF6A9Ø88D1C               :REM*111
115 DATA 4Ø8D224ØA91C8D1F4ØAØ 1
    FA2ØFA95Ø85FBA94Ø85 FCA9618
    5FDA99585FEB1               :REM*21
116 DATA FD91FB881ØF918A5FB69 4
    Ø85FBA5FC69ØØ85FC18 A5FD692
    Ø85FDA5FE69ØØ               :REM*147
117 DATA 85FEAØ1FCA1ØDAAØ1FB9 6
    19591FB881ØF8AØØØB9 6197998
    Ø44C8DØF7A9ØØ               :REM*25Ø
118 DATA 85FBA9CØ85FCAC7199B9 Ø
    399AØØØ91FB18A5FB69 Ø185FBA
    9ØØ65FC85FCEE               :REM*224
119 DATA 7199AD7199C9Ø5DØØFEE 7
    Ø99AD7Ø99C928FØØ8A9 ØØ8D719
    94CØ282AØØØA9               :REM*1
12Ø DATA 6Ø91FBA9ØØ85FBA96885 F
    CA2Ø7AØØØA9ØØ91FBC8 DØFBE6F
    CCA1ØF6AØØØB9               :REM*144
121 DATA 7Ø94C9FEFØØ799ØØ6FC8 4
    C55822ØB98DAØØ7B9C2 9299F87
    B99F87F881ØF4               :REM*7
122 DATA A9E48D1CDØ2ØF389ADBC 9
    329Ø38D5699A8B9B292 8DØ48Ø8
    DØ38ØB9B6928D               :REM*9Ø
123 DATA Ø68ØB9BA928DØ78ØB9BE 9
    28DØ88ØADØ78Ø8D23DØ ADØ68Ø8
    D22DØADØ38Ø8D               :REM*14
124 DATA 14998D21DØADØ48Ø8D2Ø D
    ØAØØØADØ88Ø99ØØD899 ØØD999Ø
    ØDA99E8DAC8DØ               :REM*2Ø5
125 DATA F1A9ØAAØØØ9948DBC8CØ 7
    8DØF8A9ØEAØ279948DB 881ØFA7
    8A9DØ8D12DØAD               :REM*27
126 DATA 11DØ297F8D11DØA9818D 1
    ADØA9538D14Ø3A98B8D 15Ø32ØØ
    D8AADØEDC29FE               :REM*41
127 DATA 8DØEDCAD1EDØ58AD12DØ 3
    8C9FB9ØF8AD7D99DØ7E 2Ø9FFFA
    5C5C9Ø3DØØF2Ø               :REM*16
128 DATA 1Ø9Ø2Ø9FFFA5C5C9Ø3DØ F
    72Ø1Ø9ØC9Ø4DØØ34CØ9 8ØAD679
    9FØ1ØCEBF93DØ               :REM*112
129 DATA Ø5A9Ø18DBD932Ø6C8F4C 5
    A81AD27DØ29ØFC9Ø5DØ 28AD689
    929Ø6C9Ø6DØ1F               :REM*122
13Ø DATA 2Ø5E8FAEBC932Ø698ECA 1
    ØFA2Ø318ECEA692DØØ8 A9Ø38DA
    6922Ø138F4C5A               :REM*71
131 DATA 81ADBD93FØØ92Ø4A8C2Ø 9
    Ø994CØ98Ø2Ø8584AD7D 99DØØ34
    C1183AD7C99C9               :REM*144
132 DATA Ø1FØØFC9Ø3FØ31C9Ø4FØ 4
    EC9Ø2FØ614C2484EE82 99AD829
    9C978DØ1918AD               :REM*55
133 DATA 819969788D8199AD8Ø99 6
    9ØØ8D8Ø99A9ØØ8D8299 2Ø858C4
    C2484CE82991Ø               :REM*174
134 DATA 1938AD8199E9788D8199 A
    D8Ø99E9ØØ8D8Ø99A977 8D82992
    ØAB8C4C248438               :REM*37
135 DATA AD8199E9788D8199AD8Ø 9
    9E9ØØ8D8Ø992ØAB8C4C 248418A
    D819969788D81               :REM*25Ø
136 DATA 99AD8Ø9969ØØ8D8Ø992Ø 8
    58CAD7B9949Ø48D7B99 2ØØD8AA
    D12DØC9Ø9DØF9               :REM*222
137 DATA AD7C99C9Ø1FØØFC9Ø2FØ 1
    6C9Ø3FØ1DC9Ø4FØ244C 7584A9Ø
    78D7F992ØF78B               :REM*56
138 DATA 4C7584A9Ø78D7E992ØØ4 8
    C4C7584A9ØØ8D7F992Ø F78B4C7
    584A9ØØ8D7E99               :REM*51
139 DATA 2ØØ48CAD18DØ491Ø8D18 D
    ØA9ØØ8D7D994C1183AD 1EDØ8D6
    899ADØ1DØ38C9               :REM*78
14Ø DATA 7D9Ø4DAD6899292ØDØØE A
    D68992941C941DØØ5A9 Ø18D679
    9A9Ø58D27DØAD               :REM*218
141 DATA 6899292ØDØØEAD689929 Ø
    9C9Ø9DØØ5A9Ø18D6799 AD68992
    921C921DØ1A2Ø               :REM*57
142 DATA 7F8DCE6D99DØ12A9Ø58D 6
    D99A9218DØBD44CEA84 A9Ø18D2
    7DØA92Ø8DØBD4               :REM*18Ø
143 DATA AD5699C9Ø3DØ1DAD15DØ Ø
    98Ø8D15DØ2Ø229DCE54 99DØØDA
    D14994918D14                :REM*251
144 DATA 99A9Ø78D5499AD5699DØ 1
    FAD15DØØ94Ø8D15DØ2Ø ØØ9DCE5
    59910ØFA93B8D               :REM*88
145 DATA 5599A9118D12D4A91Ø8D 1
    2D438ADBC93C9Ø39Ø3C AD5799F
    Ø1618ADØ4DØ69               :REM*28
146 DATA Ø18DØ4DØ9ØØ8AD1ØDØ49 Ø
    48D1ØDØ4C688538ADØ4 DØE9Ø18
    DØ4DØBØØ8AD1Ø               :REM*57
147 DATA DØ49Ø48D1ØDØAD5899FØ Ø
    6CEØ5DØ4C7685EEØ5DØ AD6699F
    Ø11ADØØDC29Ø3               :REM*213
148 DATA C9Ø3FØØ8A9818DØ4D44C 9
    185A98Ø8DØ4D4ADF87B 8DFC7B8
    DFC7FCEBE93CE               :REM*2Ø6
149 DATA BE93CEBE931ØØCA96338 E
    D59998DBE932Ø3D89AD 6699FØ1
    7ADØØDC29Ø2DØ               :REM*182
15Ø DATA 1Ø2Ø548DCE6E99DØØ8A9 Ø
    48D6E992Ø69892Ø9589 CE7999D
    Ø4BCE7799AD77               :REM*111
151 DATA 99CD5A99DØØ62Ø979C8D 7
    799AC7799B9F1988D79 994A38E
    9Ø38D72992ØE3               :REM*1Ø1
152 DATA 8CAD1ØDØ29Ø4ØA48AD1Ø D
    Ø29F78D1ØDØ68ØD1ØDØ 8D1ØDØA
    9Ø18D7899ADØ4               :REM*28
153 DATA DØ8DØ6DØADØ5DØ8DØ7DØ C
    E7299DØØ8AD15DØØ9Ø8 8D15DØA
    C7799B9A998FØ               :REM*155
154 DATA 13C9Ø1FØØ92ØC5872ØC5 8
    74C48862ØDA872ØDA87 B9BB98F
    Ø13C9Ø1FØØ92Ø               :REM*144
155 DATA EF872ØEF874C6Ø862ØFA 8
    72ØFA87AD7699DØ37AD ØØDC291
    ØFØØ34CØØ872Ø               :REM*224
156 DATA CD8CA9818D12D4A98Ø8D 1
    2D4ADF87B8D7599A8B9 F1984A4
    A8D7399A9Ø18D               :REM*216
157 DATA 7699ADØØDØ8DØ2DØADØ1 D
    Ø8DØ3DØCE7399DØØ8AD 15DØØ9Ø
    28D15DØAC7599               :REM*7Ø
158 DATA B9A998FØ2FC9Ø1FØ1738 A
    DØ2DØF9CD988DØ2DØBØ Ø8AD1ØD
    Ø49Ø28D1ØDØ4C               :REM*176
159 DATA EØ86ADØ2DØ1879CD988D Ø
    2DØ9ØØ8AD1ØDØ49Ø28D 1ØDØB9B
    B98FØ1BC9Ø1FØ               :REM*34
16Ø DATA ØD38ADØ3DØF9DF988DØ3 D
    Ø4CØØ8718ADØ3DØ79DF 988DØ3D
    ØADØ3DØ38C9CD               :REM*69
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161 DATA 9ØØ62ØCD8C4C3C8738AD Ø
    3DØC929BØØ62ØCD8C4C 3C87AD1
    ØDØ29Ø2FØØEAD         :REM*237
162 DATA Ø2DØ38C9459Ø112ØCD8C 4
    C3C87ADØ2DØ38C9ØFBØ Ø32ØCD8
    CCE8399DØ49A9         :REM*113
163 DATA Ø78D8399AD6699FØØDAD Ø
    ØDCA829Ø4FØ219829Ø8 FØØ34C8
    A87EEF87BEEF8         :REM*11
164 DATA 7FADF87B38C9119Ø21A9 Ø
    18DF87F8DF87B4C8A87 CEF87FC
    EF87BADF87B38         :REM*75
165 DATA C9Ø1BØØ8A91Ø8DF87F8D F
    87BAD6699FØ2FADØØDC 29Ø1DØ2
    82Ø548DACF87B         :REM*1Ø7
166 DATA 8C8F99CE8D99DØØ9B961 9
    88D8D992ØØ588CE8E99 DØØCACF
    87BB973988D8E         :REM*65
167 DATA 992Ø98882Ø6E882ØØ189 6
    Ø38ADØ6DØF9CD988DØ6 DØBØØ8A
    D1ØDØ49Ø88D1Ø         :REM*136
168 DATA DØ6ØADØ6DØ1879CD988D Ø
    6DØ9ØØ8AD1ØDØ49Ø88D 1ØDØ6Ø3
    8ADØ7DØF9DF98         :REM*151
169 DATA 8DØ7DØ6Ø18ADØ7DØ79DF 9
    88DØ7DØ6ØACF87BB985 98A829Ø
    8DØØ69829Ø4DØ         :REM*61
17Ø DATA 2D6ØAD8499C9Ø1FØ1ØCE 8
    599DØØ5A9Ø18D8599A9 Ø28D849
    96ØEE8599AD85         :REM*168
171 DATA 99C9ØADØØAA9Ø98D8599 A
    9ØØ8D84996ØAD8499C9 Ø2FØ1ØC
    E8599DØØ5A9Ø1         :REM*124
172 DATA 8D8599A9Ø18D84996ØEE 8
    599AD8599C9ØADØØAA9 Ø98D859
    9A9ØØ8D84996Ø         :REM*37
173 DATA AD8499C9Ø2FØØ5C9Ø1FØ 1
    Ø6ØCE8699DØØ9AD8599 8D86992
    ØA28A6ØCE8699         :REM*87
174 DATA DØØ9AD85998D86992Ø39 8
    A6ØACF87BB99798A829 Ø1DØØ69
    829Ø2DØ2D6ØAD         :REM*35
175 DATA 8799C9Ø1FØ1ØCE8999DØ Ø
    5A9Ø18D8999A9Ø28D87 996ØEE8
    999AD8999C9ØA         :REM*96
176 DATA DØØAA9Ø98D8999A9ØØ8D 8
    7996ØAD8799C9Ø2FØ1Ø CE8999D
    ØØ5A9Ø18D8999         :REM*98
177 DATA A9Ø18D87996ØEE8999AD 8
    999C9ØADØØAA9Ø98D89 99A9ØØ8
    D87996ØAD7A99         :REM*1Ø5
178 DATA 49Ø18D7A99AD8799C9Ø2 F
    ØØ5C9Ø1FØ156ØCE8B99 DØØEAD8
    9998D8B99AD7A         :REM*92
179 DATA 99FØØ32ØØ68B6ØCE8B99 D
    ØFAAD89998D8B99AD7A 99FØØ32
    Ø2F8B6ØAD8899         :REM*57
18Ø DATA C9Ø1FØ1ØCE8A99DØØ5A9 Ø
    18D8A99A9Ø28D88996Ø EE8A99A
    D8A99C9ØADØØA         :REM*184
181 DATA A9Ø98D8A99A9ØØ8D8899 6
    ØAD8899C9Ø2FØ1ØCE8A 99DØØ5A
    9Ø18D8A99A9Ø1         :REM*168
182 DATA 8D88996ØEE8A99AD8A99 C
    9ØADØØAA9Ø98D8A99A9 ØØ8D889
    96ØAD8899C9Ø2         :REM*141
183 DATA FØØ5C9Ø1FØ2A6ØCE8C99 D
    Ø23AD8A998D8C99CEØ9 DØEEØ1D
    ØADØ1DØ38C987         :REM*56
184 DATA 9ØØFA9878DØ1DØA98E8D Ø
    9DØA9Ø18D67996ØCE8C 99DØFAA
    D8A998D8C99EE         :REM*1Ø6
185 DATA Ø9DØCEØ1DØADØ1DØ38C9 7
    3BØØFA9738DØ1DØA9A2 8DØ9DØA
    9Ø18DBE936ØA9         :REM*43
186 DATA 3F8DØ2DDA9C68DØØDDA9 E
    D8D18DØA9DØ8D16DØA9 138D11D
    Ø6ØAØØØ2Ø118C         :REM*136
187 DATA A2ØØAØØØ2ØØØCØ18A5FB 6
    92885FBA9ØØ65FC85FC 18A5FD6
    97885FDA9ØØ65         :REM*155
188 DATA FE85FEE8EØ14DØDC6ØAD 7
    D99DØ6318ADØEDØ69Ø1 8DØEDØ9
    ØØ8AD1ØDØ498Ø         :REM*15
189 DATA 8D1ØDØ18ADØCDØ69Ø18D Ø
    CDØ9ØØ8AD1ØDØ494Ø8D 1ØDØ18A
    DØADØ69Ø18DØA         :REM*27
19Ø DATA DØ9ØØ8AD1ØDØ492Ø8D1Ø D
    Ø18ADØ4DØ69Ø18DØ4DØ 9ØØ8AD1
    ØDØ49Ø48D1ØDØ         :REM*35
191 DATA EE7F99AD7F99C9Ø8DØØD A
    9ØØ8D7F99A9Ø38D7C99 8D7D996
    ØAD7D99DØ5E38         :REM*185
192 DATA ADØEDØE9Ø18DØEDØBØØ8 A
    D1ØDØ498Ø8D1ØDØ38AD ØCDØE9Ø
    18DØCDØBØØ8AD         :REM*87
193 DATA 1ØDØ494Ø8D1ØDØ38ADØA D
    ØE9Ø18DØADØBØØ8AD1Ø DØ492Ø8
    D1ØDØ38ADØ4DØ         :REM*11Ø
194 DATA E9Ø18DØ4DØBØØ8AD1ØDØ 4
    9Ø48D1ØDØCE7F991ØØD A9Ø78D7
    F99A9Ø18D7C99         :REM*217
195 DATA 8D7D996ØAD7D99DØ23EE Ø
    FDØEEØDDØEEØBDØEEØ5 DØEE7E9
    9AD7E99C9Ø8DØ         :REM*141
196 DATA ØDA9ØØ8D7E99A9Ø48D7C 9
    98D7D996ØAD7D99DØ1E CEØFDØC
    EØDDØCEØBDØCE         :REM*114
197 DATA Ø5DØCE7E991ØØDA9Ø78D 7
    E99A9Ø28D7C998D7D99 6ØAD19D
    Ø8D19DØ29Ø1DØ         :REM*97
198 DATA Ø34C31EAAD12DØC9FDBØ 4
    2AØFD8C12DØAD18DØ29 FØØ9ØA8
    D18DØAD11DØ29         :REM*98
199 DATA F81869Ø78D11DØAD16DØ 2
    9F81869Ø38D16DØA9ØØ 8D21DØA
    ØØ79927DØ88DØ         :REM*2Ø4
2ØØ DATA FA8D25DØA9FF8D1BDØA9 Ø
    58D23DØ4CF18BAD11DØ 1829F86
    D7E998D11DØ18         :REM*96
2Ø1 DATA AD16DØ29F86D7F998D16 D
    ØAD18DØ29FØØ9ØC8D18 DØAØDØ8
    C12DØADØ38Ø8D         :REM*8
2Ø2 DATA 21DØAØØ7B9ØD999927DØ 8
    8DØF7A9ØF8D25DØA9ØØ 8D1BDØA
    DØ78Ø8D23DØ68         :REM*99
2Ø3 DATA A868AA684ØAD16DØ29F8 1
    86D7F998D16DØ6ØAD11 DØ29F81
    86D7E998D11DØ         :REM*1Ø4
2Ø4 DATA 6ØA9EF85FDA91885FEA9 Ø
    Ø85FBA978186D7B9985 FC18A5F
    D6D829985FDA5         :REM*141
2Ø5 DATA FE69ØØ85FE18A5FD6D81 9
    985FDA5FE69ØØ85FE18 A5FE6D8
    Ø9985FE6ØA98Ø         :REM*112
2Ø6 DATA 8D1ADØ78A9318D14Ø3A9 E
    A8D15Ø358A9ØØ8D2ØDØ 8D21DØA
    DØEDCØ9Ø18DØE         :REM*57
2Ø7 DATA DCA9ØØ8D15DØA9978DØØ D
    DA9158D18DØA91B8D11 DØA9C88
    D16DØ6ØAD8Ø99         :REM*239
2Ø8 DATA C918FØØ7AD8Ø99C917DØ 1
    738AD8199E97Ø8D8199 AD8Ø99E
    9ØØ8D8Ø9938E9         :REM*7Ø
2Ø9 DATA 178D8Ø996ØAD8Ø993ØØ5 A
    D8Ø99DØ1718AD819969 7Ø8D819
    9AD8Ø9969ØØ8D         :REM*13
21Ø DATA 8Ø991869178D8Ø996ØAD 1
    ØDØ29FD8D1ØDØAD15DØ 29FD8D1
    5DØA9ØØ8D7699         :REM*125
211 DATA 6ØAD1ØDØ29F78D1ØDØAD 1
    5DØ29F78D15DØA9ØØ8D 78996ØA
    9Ø18D6699A9E4         :REM*4Ø
212 DATA 8D987B8D987FAØØØA2EØ 8
    A99997B99997FE8C8CØ Ø5DØF3A
    ØØ5A9E899987B         :REM*233
213 DATA 99987FC8CØ1EDØF5A9E4 9
    9987B99987FC8CØ28DØ F5AØ279
    97Ø7B997Ø7F88         :REM*37
214 DATA 1ØF7AØ188C7499ACBF93 F
    ØØBA9FD99B77B99B77F 88DØF76
    ØCE6F99DØ25A9         :REM*196
215 DATA ØA8D6F99AC7499DØØ6A9 Ø
    Ø8D66996Ø38B99D7BE9 Ø1C9E4D
    ØØ5CE7499A9E9         :REM*31
216 DATA 999D7B999D7F6ØA9Ø18D 6
    699AC7499CØ18FØ23A9 2Ø8DØ7D
    4A94E8DØ8D4B9         :REM*82
217 DATA 9D7B1869Ø1C9E9DØØ8EE 7
    499AC7499A9E5999D7B 999D7F6
    ØA93Ø8DØ7D4A9         :REM*253
218 DATA 758DØ8D46Ø2ØF28DA9ØF 8
    D18D4A91Ø8DØØD4A927 8DØ1D4A
    9228DØ5D4A921         :REM*148
219 DATA 8DØ6D4A9118DØCD48DØD D
    4A9188D13D4A9888D14 D4A9A88
    DØED4A9618DØF         :REM*218
22Ø DATA D46ØAØ18A9ØØ99ØØD488 1
    ØFA6ØAØØØA2EC8A994A 7B994A7
    FC8E8EØF1DØF3         :REM*241
221 DATA AØØØA2EA8A99577B9957 7
    FC8E8EØF1DØF36Ø4A4A 4A4A6Ø2
    9ØF1869F1995Ø         :REM*46
222 DATA 7B995Ø7F6ØF8ADBA9338 C
    DC2939Ø2CDØ14ADB993 38CDC19
    39Ø21DØØ9ADB8         :REM*199
223 DATA 9338CDCØ939Ø16ADB993 8
    DC193ADB8938DCØ93AD BA938DC
    293D82ØC58ED8         :REM*41
224 DATA 6ØF818ADB8936DBB938D B
    8939Ø14ADB9931869Ø1 8DB9939
    ØØ918ADBA9369         :REM*185
225 DATA Ø18DBA93D8ADB89320Ø 8
    EAØØ42Ø258EADB893AØ Ø52Ø258
    EADB9932Ø2Ø8E         :REM*62
226 DATA AØØ22Ø258EADB993AØØ3 2
    Ø258EADBA932Ø2Ø8EAØ ØØ2Ø258
    EADBA93AØØ12Ø         :REM*78
227 DATA 258E6ØADCØ932Ø2Ø8EAØ 1
    32Ø258EADCØ93AØ142Ø 258EADC
    1932Ø2Ø8EAØ11         :REM*83
228 DATA 2Ø258EADC193AØ122Ø25 8
    EADC2932Ø2Ø8EAØØF2Ø 258EADC
    293AØ1Ø2Ø258E         :REM*153
229 DATA 6ØAØØØB9Ø8991869EØ99 6
    67B99667FC8CØØ5DØEF 6ØAD569
    9DØØAADBF93C9         :REM*2Ø5 ►
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230 DATA Ø3FØØ3EEBF932Ø1B9ØEE B
    C93ADBC93ØA8D5999F8 18ADBB9
    369Ø18DBB93D8            :REM*32
231 DATA ADBB9329ØFAØ1D2Ø258E A
    DBB932Ø2Ø8EAØ1C2Ø25 8E6ØA9F
    F8DØFD4A98Ø8D            :REM*251
232 DATA 12D4AD1BD46ØA98Ø85A3 A
    94485A42ØD48F4C8A8F 2ØD48FA
    9ØØ85A3A94Ø85            :REM*113
233 DATA A4ACF87B18A5A3694Ø85 A
    3A5A469ØØ85A488DØFØ 2ØCD8C2
    ØE38CAØ3FA2ØØ            :REM*79
234 DATA 8E2ØDØE8DØFA2Ø5Ø8F31 A
    391A3881ØFØAØ3FA2ØØ 8E2ØDØE
    8DØFAB1A3DØØ6            :REM*16
235 DATA 881ØF34CBB8F4C8A8F6Ø A
    ØØFB9A89399ØØDØ881Ø F72Ø8C9
    28DØ4DØ2Ø8C92            :REM*128
236 DATA 8DØ5DØ6ØA9Ø28DØ1D48D Ø
    8D48DØFD4A9228DØ5D4 8DØ6D48
    DØCD48DØDD48D            :REM*1Ø2
237 DATA 13D48D14D4A9818DØ4D4 8
    DØBD48D12D46ØAØØØB9 1599C9F
    FFØØ7995399C8            :REM*12Ø
238 DATA 4CØ19Ø6ØAØØØA264C8DØ F
    DE8DØFA6ØA9ØØ8D18D4 2Ø4A8CA
    9932ØD2FFA9Ø8            :REM*187
239 DATA 8D5C99AØØØAD5C9999ØØ 1
    ØCE5C991ØØ5A9Ø88D5C 99C8DØE
    DA9EF85FBA918            :REM*2
24Ø DATA 85FCA9FFAØØØA22391FB C
    8DØFBE6FCCA1ØF6EE5E 99AD5E9
    9C912DØ23A9EF            :REM*151
241 DATA 85FBA91885FCA95F85FD A
    93Ø85FEAØØØA2ØBB1FB 91FDC8D
    ØF9E6FCE6FECA            :REM*121
242 DATA 1ØF26Ø2Ø8D9Ø4C5A9ØAC 5
    E99A98885FBA91785FC E6FC18A
    5FB696885FBA5            :REM*67
243 DATA FC69ØØ85FC88DØEEA9ØØ 8
    D62992Ø88912ØE49Ø18 A5FB69Ø
    185FBA5FC69ØØ            :REM*216
244 DATA 85FCAØØ12Ø2E92A838A5 F
    BE97885FBA5FCE9ØØ85 FC88DØF
    ØAD629938C978            :REM*137
245 DATA BØØ34CAF9Ø6ØAØØ22Ø2E 9
    28D5F99AØØ28C6Ø99EE 6Ø99AC6
    Ø992Ø2E92C9FF            :REM*136
246 DATA FØ2B38E9Ø1CD5F99DØ3E 1
    869Ø18D5F99AAAØØØAD 6599C9F
    FDØØ38A91FB18            :REM*144
247 DATA A5FB69Ø185FBA5FC69ØØ 8
    5FC4CF19ØAØØØ2Ø2E92 AA186D6
    2998D62998A4A            :REM*2Ø1
248 DATA 1865FB85FBA5FC69ØØ85 F
    C6Ø1869Ø18D5F9918A5 FB69788
    5FBA5FC69ØØ85            :REM*166
249 DATA FCAC6Ø99882Ø2E928D61 9
    9AC6Ø992Ø2E9238ED61 998D619
    938A92ØED6199            :REM*39
25Ø DATA 8D619938A5FBED619985 F
    BA5FCE9ØØ85FC4CF19Ø 2Ø7492A
    ØØ22Ø2E928D5F            :REM*12Ø
251 DATA 99AØØ28C6Ø99A9FF8D65 9
    9A5FB8D6399A5FC8D64 99EE6Ø9
    9AC6Ø992Ø2E92            :REM*18
252 DATA C9FFFØ2B38E9Ø1CD5F99 D
    Ø2E1869Ø18D5F99AØØØ B1FBC9F
    FFØØ5A9ØØ8D65            :REM*2ØØ
253 DATA 9918A5FB69Ø185FBA5FC 6
    9ØØ85FC4CA791AD6399 85FBAD6
    49985FC6Ø1869            :REM*224
254 DATA Ø18D5F9918A5FB697885 F
    BA5FC69ØØ85FCAC6Ø99 882Ø2E9
    28D6199AC6Ø99            :REM*29
255 DATA 2Ø2E9238ED61998D6199 3
    8A92ØED61998D619938 A5FBED6
    19985FBA5FCE9            :REM*3Ø
256 DATA ØØ85FC4CA791A95Ø8DA7 9
    2A9928DA892AE5D99BD A992186
    DA7928DA792AD            :REM*1Ø8
257 DATA A89269ØØ8DA8926CA792 B
    9CA926ØB9DC926ØB9EC 926ØB9F
    F926ØB9ØB936Ø            :REM*53
258 DATA B937936ØB946936ØB95D 9
    36ØB996936Ø2Ø8C92AC 5B99B9Ø
    Ø1ØCD5D99FØF2            :REM*178
259 DATA AC5B99B9ØØ1Ø8D5D996Ø A
    9FF8DØFD4A98Ø8D12D4 AD1BD48
    D5B996ØA9EF85            :REM*3Ø
26Ø DATA FBA91885FC6ØØ3ØØØØØØ Ø
    4Ø8ØC1Ø14181C2ØØ9ØB Ø8ØCØ2Ø
    CØ9Ø6ØAØFØAØE            :REM*145
261 DATA ØFØ9ØFØ9Ø1ØØ12ØØØ113 1
    415Ø7Ø1FFØØØ1Ø2Ø3Ø4 Ø5Ø6Ø72
    1222324252 6FF           :REM*166
262 DATA ØAØ1Ø9ØAØBØCØDØEØF1Ø 1
    11213142EFFØ7Ø11516 1718191
    A1B1C1D343536            :REM*156
263 DATA 3738393AFFØ5Ø14Ø4142 4
    3444546626 3FF14Ø146 4748494
    A4B4C4D4E4F5Ø            :REM*14
264 DATA 5152535455565758596 5 6
    66768696A6B6C6D6E6F 7Ø71727
    3747576777879            :REM*58
265 DATA FFØ5Ø13A3B3C3D3E3F5A 5
    B5C5D5E5FFFØ6Ø27F8Ø 8182838
    485AØA1A2A3A4            :REM*135
266 DATA A5CØC1C2C3C4C5C6FF11 Ø
    2858788898A8B8C8D8E 8F9Ø919
    29394959697A7            :REM*166
267 DATA A8A9AAABACADAEAFBØB1 B
    2B3B4B5B6B7B8C7C8C9 CACBCCC
    DCECFDØD1D2D3            :REM*1Ø2
268 DATA D4D5D6D7D8FFØ6Ø1B8B9 B
    ABBBCBDBEBFD9DADBDC DDDEDFF
    FAE73AE73ØØØØ            :REM*124
269 DATA ØØØØAEA2144 6ØØØØØAC8 Ø
    ØØØØØØØØØØØ32Ø3ØØØØ ØØØ2ØAØ
    8Ø7ØDØ5Ø3ØEØ6            :REM*59
27Ø DATA ØAØ4Ø9Ø2ØAØ8Ø76Ø5255 4
    E6Ø4D414741 5A494E45 6Ø5Ø524
    F55444C596Ø5Ø            :REM*8Ø
271 DATA 524553454E54536Ø6E6E 6
    E6E6E6Ø475241564954 524F4E6
    Ø42596Ø434841            :REM*62
272 DATA 524C45536Ø4F52435554 5
    46Ø57495448 6Ø475241 5Ø48494
    35360 42596Ø44           :REM*32
273 DATA 414E6Ø4449414D414E54 4
    56E6Ø434F5Ø59524947 4854 6Ø7
    179787 86Ø4849           :REM*68
274 DATA 546Ø535Ø4143456Ø4F52 6
    Ø46495245 6Ø42555454 4F4E6Ø5
    Ø4F5254 6Ø726Ø           :REM*93
275 DATA 544F6Ø5Ø4C41596Ø6E6E 6
    E6E6EFFCØCFCFC3CFCF CFCFCCC
    CCCCCCCCCCCF3            :REM*226
276 DATA CØCFCFCFC3CFCFCØCFCF C
    FCFCFCFCFCØFFFFFFFF FFFFFFF
    F8Ø8Ø8Ø8Ø8Ø8Ø            :REM*38
277 DATA 8Ø8ØAØAØAØAØAØAØAØAØ A
    8A8A8A8A8A8A8A8AAAA AAAAAAA
    AAAAAØØØØØØØØ            :REM*226
278 DATA ØØØØØØØØ3333333F3333 3
    3333FØCØCØCØCØCØC3F ØF3Ø3Ø3
    ØØFØ3Ø33CØF3Ø            :REM*118
279 DATA 3Ø3Ø3Ø3Ø3ØØFØC333333 3
    33333ØC3C3333333F3C 33333F3
    Ø3Ø3Ø3C3Ø3Ø3F            :REM*242
28Ø DATA 2A2222222222222AØ828 Ø
    8Ø8Ø8Ø8Ø82A2AØ2Ø2Ø2 2A2Ø2Ø2
    A2AØ2Ø2Ø22AØ2            :REM*212
281 DATA Ø22A222222222AØ2Ø2Ø2 2
    A2Ø2Ø2ØØAØ2Ø22A2A2Ø 2Ø2Ø2A2
    2222A2AØ2Ø2Ø2            :REM*239
282 DATA Ø2Ø2Ø2Ø22A2222222A22 2
    22A2A2222222AØ2Ø2Ø2 3Ø3Ø3Ø3
    Ø3Ø3Ø3Ø3F3333            :REM*176
283 DATA 3333333333ØCFFFFBFBF A
    BFFFFFFFEØØØØØØØØØØ ØØ18ØØØ
    Ø18ØØØ1BD8ØØ1            :REM*158
284 DATA FF8ØØ1998ØØØ18ØØØØØØ Ø
    ØØØØØØØØØØØØØØØØØØØ ØØØØØØØ
    CØØØ318ØØØ7B6            :REM*5
285 DATA ØØØ7FEØØØ6CEØØØØØCØØ Ø
    ØØØØØØØØØØØØØØØØØØØ ØØØØØØØ
    ØØØØØØØ3ØØEØ             :REM*31
286 DATA Ø7Ø3CØØ7FEØØØØBCØØØ3 3
    8ØØØØØØØØØØØØØØØØØØ ØØØØØØØ
    ØØØØØØ78ØØØØF            :REM*198
287 DATA 81EØØFFFØØØ3F8ØØØ3FØ Ø
    ØØØØØØØØØØØØØØØØØØØ ØØØØØØØ
    ØØØØØØØØØ78Ø             :REM*215
288 DATA ØØØ7EØØØØ7FFEØØ7FFFØ Ø
    7EØØØØØØØØØØØØØØØØØ ØØØØØØØ
    ØØØØØØØØ18ØØØ            :REM*78
289 DATA Ø1EØØØØ7EØØØØ7FEØØØ7 F
    FCØØØØ7ØØØØØØØØØØØØ ØØØØØØØ
    ØØØØØØ3ØØØØØ             :REM*61
29Ø DATA 38ØØØ63ØØØØ7FØØØØ3FE Ø
    ØØØØ78ØØØØ1EØØØØØØØ ØØØØØØØ
    ØØØØØØØØØØØØØ            :REM*72
291 DATA ØØØØ1ØØØ323ØØØ3FFØØ Ø
    338ØØØØ1CØØØØØEØØØØ ØØØØØØØ
    ØØØØØØØØØØØØØ            :REM*249
292 DATA ØØØØØØØØ18ØØØ1998ØØ1 F
    F8ØØ1BD8ØØØ18ØØØØ18 ØØØØØØØ
    ØØØØØØØØØØØØØ            :REM*167
293 DATA ØØØØØØØØØØØØ8ØØØØØC4 C
    ØØØFFCØØØ1CCØØØ38ØØ ØØ7ØØØØ
    ØØØØØØØØØØØØØ            :REM*245
294 DATA ØØØØØØØØØØØCØØØØ1CØØ Ø
    ØØC6ØØØØFEØØØ7FCØØ1 EØØØØ78
    ØØØØØØØØØØØØØ            :REM*231
295 DATA ØØØØØØØØØØØØØØØØØØØØ Ø
    18ØØØØ78ØØØØ7EØØØ7F EØØ3FFE
    ØØEØØØØØØØØØØ            :REM*186
296 DATA ØØØØØØØØØØØØØØØØØØØØ Ø
    ØØØØØØØØØ1EØØØØ7EØ Ø7FFEØØ
    FFFEØØØØ7EØØØ            :REM*238
297 DATA ØØØØØØØØØØØØØØØØØØØØ Ø
    ØØØØØØØØØØØØØ1EØØ7 81FØØØF
    FFØØØ1FCØØØØF            :REM*33
298 DATA CØØØØØØØØØØØØØØØØØØØ Ø
    ØØØØØØØØØØØØØØØØØØØ ØØØ7ØØC
    ØØ3CØEØØØ7FEØ            :REM*8
```

```
299 DATA ØØ3DØØØØ1CCØØØØØØØØØ Ø
     ØØØØØØØØØØØØØØØØØØØ ØØ3ØØØØ
     Ø18CØØØ6DEØØØ          :REM*155
300 DATA 7FEØØ736ØØØ3ØØØØØØØØ Ø
     ØØØØØØØØØØØØØØØØØØØ ØØØØØØØ
     ØØØØØØØØØØØØØ          :REM*9
301 DATA ØØØØØØØØØØØØØØØØØØ28 Ø
     ØØØAAØØØ2968ØØA55AØ 3E96BCC
     FAAF3FFEBFFFF          :REM*52
302 DATA FFFFFFFFFF3FFFFCØFFF F
     ØØØ3CØØØØØØØØØØØØØØ ØØØØØØØ
     ØØØ2ØØØØ2AAØØ          :REM*134
303 DATA 2AAAA8Ø2AA8ØØC2ØCØ3Ø 3
     Ø3Ø15555Ø7FFFF45555 547FFFD
     D7F57DD7F7FDD          :REM*1Ø7
304 DATA 7F5FDD7F7FDD7F7FDD15 5
     5543FFFFC3FFFFC3FFF FCØØØØØ
     ØØ3ØØØØØØØØØØ          :REM*237
305 DATA ØØØØØØØØØØØØØØØØØØØØ Ø
     ØØØØØØØ28ØØØØBEØØØ2 D78ØØB5
     5EØ2D55782D55          :REM*6Ø
306 DATA 78ØB55EØØ2D78ØØØBEØØ Ø
     Ø28ØØØØØØØØØØØØØØØØ ØØØØØØØ
     ØØØØØØØØØ84ØØ          :REM*187
307 DATA ØØØØØØØØØØØØØØØØØØØØ Ø
     ØØØØØØØØØAA8ØØ2ØØ2Ø Ø83FØ82
     ØCØC223Ø43223          :REM*154
308 DATA 113223113223Ø4322ØCØ C
     2Ø83FØ8Ø2ØØ2ØØØAA8Ø ØØØØØØØ
     ØØØØØØØØØØØØØ          :REM*112
309 DATA ØØØ74Ø4Ø4Ø4Ø3Ø2Ø1Ø2 Ø
     3Ø4Ø4Ø4Ø3Ø2Ø1Ø2Ø3Ø4 Ø4Ø1Ø1Ø
     2Ø3Ø4Ø4Ø4Ø3Ø2          :REM*176
310 DATA Ø1Ø2Ø3Ø4Ø4Ø4Ø3Ø2Ø18Ø 8
     ØØ8Ø8Ø8Ø8Ø8Ø8Ø88ØØ4 Ø4Ø4Ø4Ø
     4Ø4Ø48Ø8ØØ1Ø1          :REM*2
311 DATA Ø1Ø18ØØ2Ø2Ø2Ø2Ø2Ø2Ø2 8
     ØØ1Ø1Ø1Ø1ØØØØ1Ø1Ø1 Ø1Ø1Ø1Ø
     1ØØØ2Ø2Ø2Ø2Ø2          :REM*194
312 DATA Ø2Ø2ØØØØØ2Ø2Ø2Ø2ØØØ1 Ø
     1Ø1Ø1Ø1Ø1Ø1ØØØ2Ø2Ø2 Ø2ØØØØØ
     2Ø3Ø4Ø5Ø4Ø3Ø2          :REM*226
313 DATA ØØØ2Ø3Ø4Ø5Ø4Ø3Ø2ØØØØ Ø
     3Ø3Ø2Ø1ØØØ1Ø2Ø3Ø3Ø3 Ø2Ø1ØØØ
     1Ø2Ø3Ø319ØBØD          :REM*54
314 DATA 111519161411ØF111416 1
     91511ØDØBB1FD91FBC8 1B1Ø1C1
     Ø1BØ1Ø1Ø5Ø1ØØ          :REM*138
315 DATA Ø6Ø2ØØØ3Ø5ØØØØØØØØØØ Ø
     4ØØØ8ØØØØØØØØØØØØØØ ØØØØØ1Ø
     ØØØØ3ØØØ7ØCØ5          :REM*194
316 DATA Ø4ØAØØØØØØØØ19ØØØØØ8 Ø
     Ø19Ø1ØØØØØØØ4Ø4177Ø ØØØ7Ø2Ø
     4Ø4Ø2ØØØ4Ø9Ø4          :REM*2Ø7
317 DATA Ø9Ø4Ø4Ø1FFØ3Ø5ØØØØØØ Ø
     ØØØØ4ØØØ8ØØØØØØØØØØ ØØØØØØØ
     ØØ1ØØØØØ3ØØØ7          :REM*2Ø3
318 DATA ØCØ5ØØØAØØØØØØØØ19ØØ Ø
     ØØ8ØØ19Ø1ØØØØØØØ4Ø4 177ØØØØ
     7Ø2Ø4Ø4Ø2ØØØ4          :REM*31
319 DATA Ø9Ø4Ø9Ø4Ø4Ø1A9ØØ8DAA 9
     D8DA39DA9ØB8DA49DA9 Ø28D2ØD
     ØA9ØØ8D21DØA9          :REM*181
320 DATA 932ØD2FF2ØE7FF2Ø3D9C 2
     Ø339CA9ØØ2ØD5FF2ØB7 FFC94ØF
     ØØ32Ø579CA993          :REM*195
321 DATA 2ØD2FFA9Ø1AØØØ99ØØD8 9
     9ØØD99ØØDA99E8DAC8 DØF1AØØ
     ØB9AC9DFØØ72Ø          :REM*245
322 DATA D2FFC84CDE992ØC79BAØ Ø
     3B1FD8DA59DC8B1FD8D A69DC8B
     1FD8DA79D2Ø43          :REM*176
323 DATA 9BCEA49DFØØBADA39DDØ 1
     B2ØD89B4CED99AØØØB9 Ø89EFØØ
     72ØD2FFC84C15          :REM*166
324 DATA 9A2Ø6B9B2Ø4F9C6ØA5FD 8
     DA89DA5FE8DA99DCEA4 9DFØ26A
     93Ø85FDA96Ø85          :REM*35
325 DATA FEA93685A3A96Ø85A4AØ Ø
     5B1FD91A3881ØF9CEA4 9DFØØ8A
     ØØ52ØF39B4C49          :REM*77
326 DATA 9AADA89D85FDADA99D85 F
     EAØØ2A9Ø191FD881ØFB AØØ3ADB
     A9391FDC8ADB9          :REM*149
327 DATA 9391FDC8ADB89391FD2Ø 6
     B9BAØØØB9D39DFØØ72Ø D2FFC84
     C889AADA89D85          :REM*Ø
328 DATA FDADA99D85FEE8DØFDC8 C
     Ø8ØDØF82Ø6B9BACAA9D ADA89D8
     5FDADA99D85FE          :REM*246
329 DATA B1FD498Ø91FDADØØDC29 1
     ØFØ63ADØØDCC97EFØØF C97DFØ1
     DC97BFØ29C977          :REM*239
33Ø DATA FØ384C9E9A18B1FD69Ø1 2
     97FC91BDØØ2A9Ø191FD 4C9E9A3
     8B1FDE9Ø1297F          :REM*189
331 DATA DØØ2A91A91FD4C9E9AB1 F
     D297F91FDCEAA9D1ØØ5 A9ØØ8DA
     A9D4C9E9AB1FD          :REM*23Ø
332 DATA 297F91FDEEAA9DADAA9D C
     9Ø3DØØ5A9Ø28DAA9D4C 9E9AACA
     A9DADA89D85FD          :REM*69
333 DATA ADA99D85FEB1FD297F91 F
     D2Ø4F9C2Ø6B9B2Ø189C 6ØF8ADB
     A9338CDA59D9Ø          :REM*28
334 DATA 1CDØ14ADB99338CDA69D 9
     Ø11DØØ9ADB89338CDA7 9D9ØØ6A
     9Ø18DA39DD8D8          :REM*218
335 DATA 6Ø2ØC79BA2Ø92ØØE9C2Ø D
     89BCA1ØF72ØC79BA2Ø9 AØØ3B1F
     D8DAB9D2Ø2Ø8E          :REM*235
336 DATA C82Ø479CADAB9DC82Ø47 9
     CAØØ4B1FD8DAB9DC8C8 2Ø2Ø8E2
     Ø479CADAB9DC8          :REM*41
337 DATA 2Ø479CAØØ5B1FD8DAB9D 2
     Ø2Ø8EC8C8C82Ø479CAD AB9DC82
     Ø479C2ØD89BCA          :REM*17Ø
338 DATA 1ØB86ØA92785FBA9Ø585 F
     CA9ØØ85FDA96Ø85FE6Ø 18A5FB6
     92885FBA9ØØ65          :REM*3Ø
339 DATA FC85FC18A5FD69Ø685FD A
     9ØØ65FE85FE6Ø38A5A3 E9Ø685A
     3A5A4E9ØØ85A4          :REM*8
34Ø DATA 38A5FDE9Ø685FDA5FEE9 Ø
     Ø85FE6ØAØØ2B1FD91FB 881ØF96
     Ø2ØE7FF2Ø3D9C          :REM*129
341 DATA 2Ø339CA9ØØ85A5A96Ø85 A
     6A23DAØ6ØA9A52ØD8FF 6ØA9ØBA
     238AØ9E2ØBDFF          :REM*14Ø
342 DATA 6ØA9ØØA2Ø8AØFF2ØBAFF 6
     Ø1829ØF693Ø91FB6ØAD ØØDC291
     ØDØF96Ø2Ø719C          :REM*216
343 DATA A2ØØAØØØBD9D9D99ØØ6Ø E
     8C8EØØ6DØØ2A2ØØCØ3C DØEE6ØA
     9Ø1A2Ø8AØØF2Ø          :REM*147
344 DATA BAFFA9ØØ2ØBDFF2ØCØFF A
     2Ø12ØC6FF2ØCFFF249Ø 5ØF92ØC
     CFFA9Ø12ØC3FF          :REM*2Ø4
345 DATA 6ØAD1ØDØ29Ø4DØØC38AD Ø
     ØDØCDØ4DØ9ØØ34CD59C 38ADØ1D
     ØCDØ5DØ9Ø1ØA9          :REM*58
346 DATA ØØ8D57998D5899A9Ø88D 5
     A99A9ØD6ØA9ØØ8D5799 A9Ø18D5
     899A9ØC8D5A99          :REM*1ØØ
347 DATA A9116Ø38ADØ1DØCDØ5DØ 9
     Ø12A9Ø18D5799A9ØØ8D 5899A9Ø
     48D5A99A9Ø96Ø          :REM*246
348 DATA A9Ø18D57998D5899A9ØØ 8
     D5A99A9Ø56Ø18ADØCDØ AC77997
     9CD988DØCDØ9Ø          :REM*42
349 DATA Ø8AD1ØDØ494Ø8D1ØDØ18 A
     DØDDØ79DF988DØDDØ6Ø CE5399F
     ØØ16ØA9Ø38D53          :REM*245
35Ø DATA 99AD1ØDØ298ØDØ1DADØE D
     Ø38C9EØBØ1538C97C9Ø 1Ø38ADØ
     FDØC9AFBØØ838          :REM*223
351 DATA C94B9ØØ32Ø529D6ØCEBE 9
     3CEBE93CEBE93AD1499 49Ø18D1
     49938ADØØDØCD          :REM*185
352 DATA ØEDØ9ØØ34C869D38ADØ1 D
     ØCDØFDØ9ØØ72Ø16882Ø A9886Ø2
     Ø16882ØD5886Ø          :REM*146
353 DATA 38ADØ1DØCDØFDØ9ØØ72Ø 4
     28882ØA9886Ø2Ø42882Ø D5886ØØ
     1Ø1Ø1ØØØØØØØØ          :REM*141
354 DATA ØØØØØØØØØØØØØØØØØ58E 2
     Ø2Ø2Ø494E5Ø55542Ø59 4F55522
     Ø494E49544941          :REM*167
355 DATA 4C532Ø57495448204A4F 5
     9535449434BØØØDØDØD ØDØDØDØ
     DØDØDØDØDØDØD          :REM*251
356 DATA ØDØDØDØDØDØDØD2Ø2Ø2Ø 2
     Ø2Ø2Ø594F552Ø484156 452Ø4D4
     144452Ø544845          :REM*4
357 DATA 2Ø544F5Ø2Ø54454E21ØØ Ø
     DØDØDØDØDØDØDØDØDØD ØDØDØDØ
     DØDØDØDØDØDØD          :REM*12Ø
358 DATA 2Ø2Ø2Ø2Ø2Ø2Ø2Ø2Ø2Ø2Ø 2
     Ø2Ø2Ø4E4F542Ø4F4E2Ø 544F5Ø2
     Ø54454EØØ4Ø3Ø          :REM*87
359 DATA 3A544F5Ø54454E4853
                             :REM*24
36Ø DATA -1                 :REM*218
```

Listing 3. Character Generator program.

```
Ø REM CREATE GRAVITRON CHARACTE
  RS                        :REM*236
5 OPEN 8,8,8,"+GRAV CHARS,P,W"
                            :REM*28
1Ø READ A$:IF A$="-1" THEN CLOS
   E8:END                   :REM*78
15 IF LEN(A$)<62 THEN 55
                            :REM*254
2Ø B$=MID$(A$,1,2Ø)+MID$(A$,22,
   2Ø)+MID$(A$,43,2Ø)       :REM*242
25 FOR I=1 TO 3Ø            :REM*181
3Ø C$=MID$(B$,(I*2)-1,2):H$=LEF
   T$(C$,1):L$=RIGHT$(C$,1)
                            :REM*2Ø9
35 H=VAL(H$):IF H$>"9" THEN H=A
   SC(H$)-55                :REM*85
4Ø L=VAL(L$):IF L$>"9" THEN L=A
   SC(L$)-55                :REM*136
```

```
45 BY=H*16+L:PRINT#8,CHR$(BY);
                           :REM*67
50 NEXT:GOTO 10           :REM*115
55 IF LEN(A$)<21 THEN B$=A$:GOT
   O 70                   :REM*184
60 IF LEN(A$)<42 THEN B$=LEFT$(
   A$,20)+RIGHT$(A$,(LEN(A$)-21
   )):GOTO 70             :REM*176
65 B$=LEFT$(A$,20)+MID$(A$,22,2
   0)+RIGHT$(A$,LEN(A$)-42)
                          :REM*140
70 FOR I=1 TO LEN(B$)/2:REM*221
75 C$=MID$(B$,(I*2)-1,2):H$=LEF
   T$(C$,1):L$=RIGHT$(C$,1)
                          :REM*140
80 H=VAL(H$):IF H$>"9" THEN H=A
   SC(H$)-55               :REM*56
85 L=VAL(L$):IF L$>"9" THEN L=A
   SC(L$)-55               :REM*84
90 BY=H*16+L:PRINT#8,CHR$(BY);
                          :REM*148
95 NEXT:GOTO 10           :REM*160
100 REM CHARACTER HEX DATA
                           :REM*67
101 DATA 0070000AA55002A1500 0
    0806A15259441010085 DF3C3F5
    55544 0055FA00         :REM*187
102 DATA 0157D7C100409F2A6F6F 8
    FCB000000FC6B0500F0 000000
    0C07F6A000000          :REM*74
103 DATA 000000C0A00000000000 0
    0000000000000000100 000000
    000A05A050000         :REM*148
104 DATA 00020924904000012A55 0
    0020A259040A8551F7A 7F5500
    00055FE00DA65          :REM*75
105 DATA 60600A540000AA550000 A
    B1F1C1C70601F05FF55 701C1F0
    58040F07F551C         :REM*247
106 DATA F755000000FF5507FD55 0
    000000F850F0500000 000000
    0000000000000         :REM*248
107 DATA 0155000000000000005555 0
    71F1F070000AA55F6FD 00C000
    0AA55AA550000         :REM*247
108 DATA 000A954000C07070000 F
    C570100000000000000 FF5500
    0000000000000         :REM*202
109 DATA 0000000000000000000 0
    000000000000000000 000000
    000000400000           :REM*72
110 DATA 00000000410000000000 0
    000C101000000000000 C2C000
    000000000BF2A         :REM*119
111 DATA 040000000000000BC1400 0
    000000000000000000 000000
    0000000000000         :REM*121
112 DATA 0000000000000000000 0
    000000000000000000 000000
    0000000000000          :REM*48
113 DATA 0000000000000000000 6
    018000000000000000 000000
    0000000000000         :REM*220
114 DATA 0000000000000000000 0
    000000000000000000 000000
    0000000000000          :REM*54
115 DATA 000002050000000000000 A
    A55000000000000000AA 5500010
    20A2590400000         :REM*206
116 DATA F0701A550000000000001 A
    658000000070707010C 0400000
    0000000000000         :REM*247
117 DATA 0A5500000000000000AA55 0
    000000000AA9570000 000000A
    B57F100000000         :REM*113
118 DATA 000FC5700151501050505 0
    100006A7FF0FFAA5500 AAFFC00
    005816 01ABFFF        :REM*117
119 DATA 000550 4102A9AA001550 0
    2AA5500FF0A4B0AAB55 000000C
    0C0C0C0000000         :REM*165
120 DATA 00000000000002A90000 0
    0000209A4500000000A A550000
    000000000AA55         :REM*181
121 DATA 075F00000000055FFFE00 0
    0000000055FF80000000 0000A8D
    6010000000000         :REM*144
122 DATA 02A95400000000000806A 1
    4000000000000AA55000 000000
    0AA5515000000          :REM*81
123 DATA 0000FFAA550000000000 C
    0BFAA1500000000000C0 A05C000
    0000000000000         :REM*220
124 DATA 00000000000003A90000 0
    0000000FF550000000000 0000FC5
    7000000000000           :REM*5
125 DATA 00FC09249000020904000 0
    00000AA55000000000101 09A4500
    00000FFF07C15          :REM*74
126 DATA 00010100000000005570C0 C
    0000707546661410100 0000000
    0000000000000         :REM*244
127 DATA 000000000000000500000 0
    0000000540000000000 0000000
    0000000000000         :REM*219
128 DATA 010000000000000005500 0
    00000000000540000000 0000000
    0000000000000          :REM*48
129 DATA 050101010000005554 7
    FFF7D54005554000FE 551054
    105000AA5641           :REM*77
130 DATA 4040000000000A06A1500 0
    000000002A95606 0601 0000AA5
    500008040 0A25        :REM*250
131 DATA 9040000000000FF556C6C 1
    8070100C07F150000FD 54000 4F
    4540000000000         :REM*234
132 DATA 060500000000000000AA55 0
    0000000000054000000 0000000
    0000000000000          :REM*98
133 DATA 00000100000000000000 5
    0000000000000000000 0000000
    0000000000000         :REM*190
134 DATA 0000000000000000000 0
    0000000000000000000 0000000
    0000000000000          :REM*10
135 DATA 00000000000000000000 0
    0000051000000000000 0055000
    000000000045          :REM*150
136 DATA 00000000000000560000 0
    00000000FFAA00000000 0000C0F
    0000000000000          :REM*79
137 DATA 000900000000000000A0 0
    0000000000000000000 0000000
    000A90000000           :REM*84
138 DATA 0000005500000000000000 0
    0550000000000000000FF 0000000
    0000000DF0000         :REM*135
139 DATA 0000000AAFD00000000 0
    000FE550000000000000 8075000
    00000000000054        :REM*133
140 DATA 000000000000000140000 0
    0000000001500000000 0000000
    6000000000000         :REM*203
141 DATA 0002000000000000000BC 0
    00000000000000000000 0000000
    0000000000000          :REM*23
142 DATA 00000000000000000000 0
    00000000000000000000 0000000
    0000000000000          :REM*18
143 DATA 00000000000000000000 0
    00000000000000000000 0000550
    40000001061B           :REM*68
144 DATA 5505061B6CB0C1C05055 A
    AFF005500551041041 0 104000 5
    4024111111004         :REM*120
145 DATA 0401B0B0BCAC6C5F0602 0
    0000000000000C0F05A01 0000000
    0806AA5540000          :REM*43
146 DATA 00002896540000000000 0
    0000501010100000000 FFF5F07
    F1F050129D755          :REM*58
147 DATA 00F8DA450000F5550000 8
    051401555000000000095 6B58400
    0000005451C00         :REM*192
148 DATA 5F0701175F550000F13C F
    CF055A9681BC57B1F1F 1F5F7FF
    F5F87E1B8E0B8         :REM*119
149 DATA E0F855FD5F07070 71757 5
    5C000C0C030C0FF6C6F 6A5B1B1
    A15000000C0C0          :REM*73
150 DATA FCAB9B1B0000000000000 0
    000000105000000000000 00AA550
    000000000500A9        :REM*255
151 DATA 550101071F7F0005FDEA E
    59090E5005555AA5500 0040004
    0E07A9F651A06          :REM*48
152 DATA 000000A0FC549 09 01B1B 0
    60100000000C0FFABAA 5500000
    000FAD5554000         :REM*214
153 DATA 00000181605A1505 0000 0
    55000AA55550000410 6 1B6F7C5
    00000B0F0C000         :REM*212
154 DATA 0000000015000000000 0
    00041000000000000000 8269140
    000000000AA55         :REM*227
155 DATA 000000000000949050000 0
    00000000000000000000 0000000
    0000000000000          :REM*71
156 DATA 1F0B0F0B0B0601000000 0
    00000C0BC6F00000000 0000000
    006010000000          :REM*135
157 DATA 0000D5B06C1B0606 0100 5
    5000000C0F054001345 0000000
    0000015400000         :REM*177
158 DATA 0000000006A1500000000 0
    0005B1500000000000000 0054040
    0000000000000          :REM*76
159 DATA 0000010500000001015 5 5
    40000005551010 10000 00005A8
    781806020000 0        :REM*237
160 DATA 95EA7F958080000056A9 F
    6542B02000070 1CC7B0 2000
                          :REM*208
161 DATA -1                :REM*19
```

■

Astro-Shoot

Test your marksmanship in this space-age shooting gallery.

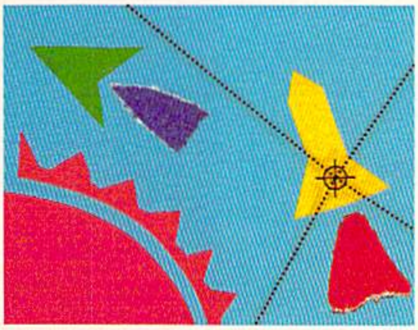
◇

By JOHN FEDOR

Two different types of targets—small and fast-moving, and large and slow-moving—elude you as you shoot from your spaceship in Break-Away. There are up to three large targets on the screen at a time. When you hit one, it breaks into two smaller targets of the same color. If you manage to shoot both of these smaller ones, another large target appears in one corner of the screen.

Since you're in a spaceship, once you start moving, you can't stop. Pressing the fire-button shoots in the direction you're facing, and any shots that don't hit a target are recorded as misses. The ship, controlled by a joystick in port 2, can bounce off the walls with no danger to it or your score.

The game ends when either 60 seconds have elapsed or your ship collides with a target. Then your score is calculated, with five points for each large target you've hit and ten points for each small one. However, your score is also decreased five points for every miss.



The right side of the screen displays game information, including your present score, your highest previous score, the number of shots you've missed and the time elapsed.

As you play, try to shoot at targets as their paths cross. You'll be more likely to hit them, and both will be recorded as hits. Also keep in mind that, because misses will decrease your score, constant shooting is unwise. Carefully planned shots, along with skillful maneuvering, will rack up the highest scores.

Break-Away uses six sprite shapes, which I've compiled to save 240 bytes and give you 30 fewer lines of code to type in. Four of the shapes display the ship going in the different directions; the other two are the targets. The bullet is a character graphic (the diamond), to eliminate any collisions between sprites other than your ship and the targets.

This game is fun to play, especially if you're trying to beat a friend. Just don't complain if you make rude comments about his or her flying and marksmanship, but then score a 0 yourself! R

John Fedor breaks away from his college studies with a round or two of this game.

Listing 1. Break-Away program.

```
1Ø POKE5328Ø,Ø:POKE53281,Ø:PRIN
   T"{SHFT CLR}{CTRL 2}BREAK-AW
   AY IS SETTING UP...PLEASE WA
   IT."                  :REM*96
2Ø FORX=49152TO51455:READA:POKE
   X,A:NEXT:SYS 49152    :REM*31
3Ø DATA 169,Ø,141,74,3,141,75,3
   ,141,76,3,32,87,195,32,141,1
   92,32,88,192,32      :REM*2Ø6
4Ø DATA 1Ø,193,32,246,197,173,3
   1,2Ø8,2Ø8,251,173,3Ø,2Ø8,41,
   1,2Ø8,244,32,76      :REM*143
5Ø DATA 196,32,175,196,32,216,1
   94,32,216,195,32,237,195,32,
   65,196,32,237        :REM*197
6Ø DATA 198,32,37,198,32,57,194
   ,32,72,199,173,85,3,24Ø,224,
   32,162,196,32,83     :REM*221
7Ø DATA 199,32,168,199,32,219,1
   99,76,11,192,162,Ø,138,157,1
   28,62,157,Ø,63       :REM*2Ø1
8Ø DATA 232,2Ø8,247,169,62,133,
   252,169,128,133,251,162,Ø,16
   Ø,Ø,189,29,2ØØ        :REM*67
9Ø DATA 145,251,2ØØ,232,192,24,
   2Ø8,245,24,165,251,1Ø5,64,13
   3,251,165,252        :REM*133
1ØØ DATA 1Ø5,Ø,133,252,2Ø1,64,2
    Ø8,226,96,169,Ø,141,21,2Ø8,
    141,16,2Ø8,141      :REM*1Ø7
11Ø DATA 23,2Ø8,141,27,2Ø8,141,
    28,2Ø8,141,29,2Ø8,169,255,1
    41,248,7,162,25Ø    :REM*141
12Ø DATA 142,249,7,232,142,25Ø,
    7,142,252,7,142,254,7,169,1
    43,141,Ø,2Ø8,169     :REM*2Ø
13Ø DATA 153,141,1,2Ø8,16Ø,Ø,16
    2,Ø,189,173,2ØØ,153,4,2Ø8,1
    89,176,2ØØ,153,5    :REM*244
14Ø DATA 2Ø8,2ØØ,2ØØ,2ØØ,2ØØ,23
    2,192,12,2Ø8,235,169,5,141,
    65,3,73,15,141       :REM*68
15Ø DATA 67,3,169,6,141,69,3,16
    9,6,141,41,2Ø8,141,42,2Ø8,1
    69,3,141,43,2Ø8     :REM*183
16Ø DATA 141,44,2Ø8,169,14,141,
    45,2Ø8,141,46,2Ø8,169,1,141
    ,39,2Ø8,169,85      :REM*125
17Ø DATA 141,21,2Ø8,96,169,144,
    32,21Ø,255,169,147,32,21Ø,2
    55,169,11,141,32     :REM*55
18Ø DATA 2Ø8,141,33,2Ø8,169,8,3
    2,21Ø,255,169,142,32,21Ø,25
    5,162,Ø,169,Ø       :REM*126
19Ø DATA 157,Ø,216,157,192,219,
    169,67,157,Ø,4,157,192,7,23
    2,224,3Ø,2Ø8,235    :REM*223
2ØØ DATA 162,Ø,134,251,134,253,
    169,4,133,252,73,216,133,25
    4,16Ø,Ø,152,145     :REM*153
21Ø DATA 253,169,66,145,251,16Ø
    ,29,145,251,169,Ø,145,253,2
    4,165,251,1Ø5,4Ø     :REM*37
22Ø DATA 133,251,133,253,165,25
    2,1Ø5,Ø,133,252,1Ø5,212,133
    ,254,232,224,24     :REM*179 ►
```

RUN it right: **C-64; joystick**

ILLUSTRATED BY IAN MULLER

```
230 DATA 208,215,169,112,141,0,4,162,110,142,29,4,202,142,192,7,169,125 :REM*32
240 DATA 141,221,7,162,0,160,30,24,32,240,255,162,0,189,179,200,32,210,255 :REM*131
250 DATA 232,224,10,208,245,162,1,160,34,24,32,240,255,169,66,32,210,255 :REM*13
260 DATA 169,89,32,210,255,162,2,160,30,24,32,240,255,162,0,189,189,200,32 :REM*186
270 DATA 210,255,232,224,10,208,245,162,8,160,30,24,32,240,255,162,0,189 :REM*137
280 DATA 199,200,32,210,255,232,224,10,208,245,162,12,160,30,24,32,240,255 :REM*39
290 DATA 162,0,189,209,200,32,210,255,232,224,10,208,245,162,18,160,32,24 :REM*143
300 DATA 32,240,255,162,0,189,225,200,32,210,255,232,224,5,208,245,162,22 :REM*58
310 DATA 160,32,24,32,240,255,162,0,189,219,200,32,210,255,232,224,6,208 :REM*16
320 DATA 245,162,0,169,1,157,134,217,157,22,219,157,38,218,157,182,219,232 :REM*46
330 DATA 224,10,208,239,32,57,194,32,89,194,32,121,194,32,171,194,96,162,0 :REM*144
340 DATA 160,3,185,70,3,74,74,74,74,9,48,157,136,5,232,185,70,3,41,15,9,48 :REM*255
350 DATA 157,136,5,232,136,208,229,96,162,0,160,3,185,73,3,74,74,74,74,9 :REM*171
360 DATA 48,157,40,6,232,185,73,3,41,15,9,48,157,40,6,232,136,208,229,96 :REM*79
370 DATA 173,77,3,74,74,74,74,9,48,141,24,7,173,77,3,41,15,9,48,141,25,7 :REM*165
380 DATA 169,46,141,26,7,173,78,3,74,74,74,74,9,48,141,27,7,173,78,3,41,15 :REM*164
390 DATA 9,48,141,28,7,96,173,82,3,74,74,74,74,9,48,141,185,7,173,82,3,41 :REM*37
400 DATA 15,9,48,141,186,7,173,81,3,74,74,74,74,9,48,141,187,7,173,81,3,41 :REM*235
410 DATA 15,9,48,141,188,7,96,206,60,3,173,60,3,240,1,96,169,8,141,60,3 :REM*128
420 DATA 173,0,220,41,15,73,15,133,2,41,1,240,15,173,84,3,41,12,9,1,141,84 :REM*49
430 DATA 3,169,255,141,248,7,165,2,41,2,240,15,173,84,3,41,12,9,2,141,84,3 :REM*105
440 DATA 169,253,141,248,7,165,2,41,4,240,15,173,84,3,41,3,9,4,141,84,3 :REM*177
450 DATA 169,254,141,248,7,165,2,41,8.240,15,173,84,3,41,3,9,8,141,84,3 :REM*22
460 DATA 169,252,141,248,7,174,0,208,172,1,208,173,84,3,32,137,195,141,84 :REM*136
470 DATA 3,140,1,208,142,0,208,96,162,1,142,60,3,142,61,3,142,62,3,142,63 :REM*203
480 DATA 3,169,0,141,71,3,141,72,3,141,73,3,157,76,3,232,224,11,208,248 :REM*86
490 DATA 169,96,141,77,3,169,5,141,65,3,141,67,3,141,69,3,96,133,2,41,1 :REM*151
500 DATA 240,1,136,165,2,41,2,240,1,200,165,2,41,4,240,1,202,165,2,41,8 :REM*128
510 DATA 240,1,232,224,32,176,8,162,31,165,2,73,12,133,2,224,248,144,8,162 :REM*217
520 DATA 248,165,2,73,12,133,2,192,56,176,8,160,55,165,2,73,3,133,2,192 :REM*225
530 DATA 235,144,8,160,235,165,2,73,3,133,2,165,2,96,206,63,3,173,63,3,240 :REM*106
540 DATA 1,96,169,4,141,63,3,169,250,133,251,76,255,195,206,62,3,173,62,3 :REM*115
550 DATA 240,1,96,169,12,141,62,3,169,251,133,251,162,0,134,252,134,253 :REM*240
560 DATA 166,252,189,250,7,197,251,208,38,189,65,3,133,2,164,253,185,4,208 :REM*54
570 DATA 170,185,5,208,168,165,2,32,137,195,134,2,166,252,157,65,3,152,164 :REM*1
580 DATA 253,153,5,208,165,2,153,4,208,230,252,166,253,232,232,134,253,224 :REM*22
590 DATA 12,208,197,96,162,4,160,0,136,208,253,202,208,250,96,173,20,3,133 :REM*161
600 DATA 113,173,21,3,133,114,169,0,141,86,3,120,169,196,141,21,3,169,104 :REM*177
610 DATA 141,20,3,88,96,238,86,3,173,86,3,201,3,208,39,169,0,141,86,3,120 :REM*8
620 DATA 248,56,173,78,3,233,5,141,78,3,173,77,3,233,0,141,77,3,208,13,173 :REM*146
630 DATA 78,3,208,8,169,1,141,85,3,32,162,196,32,121,194,32,171,194,108 :REM*223
640 DATA 113,0,120,165,113,141,20,3,165,114,141,21,3,88,96,206,61,3,173,61 :REM*201
650 DATA 3,240,3,76,113,197,169,6,141,61,3,173,79,3,133,251,173,80,3,133 :REM*245
660 DATA 252,208,3,76,113,197,160,0,169,32,145,251,173,64,3,133,2,41,1,240 :REM*166
670 DATA 13,56,165,251,233,40,133,251,165,252,233,0,133,252,165,2,41,2,240 :REM*247
680 DATA 13,24,165,251,105,40,133,251,165,252,105,0,133,252,165,2,41,4,240 :REM*246
690 DATA 13,56,165,251,233,1,133,251,165,252,233,0,133,252,165,2,41,8,240 :REM*191
700 DATA 13,24,165,251,105,1,133,251,165,252,105,0,133,252,165,251,133,253 :REM*91
710 DATA 165,252,73,220,133,254,169,0,145,253,177,251,201,32,240,44,120 :REM*92
720 DATA 248,24,173,81,3,105,1,141,81,3,173,82,3,105,0,141,82,3,216,88,162 :REM*207
730 DATA 32,142,4,212,232,142,4,212,169,0,141,64,3,141,79,3,141,80,3,76 :REM*122
740 DATA 113,197,169,90,145,251,165,251,141,79,3,165,252,141,80,3,173,0 :REM*82
750 DATA 220,41,16,73,16,133,2,240,86,173,83,3,208,81,173,80,3,208,76,56 :REM*242
760 DATA 169,255,237,248,7,170,189,251,200,141,64,3,56,173,0,208,233,24,74 :REM*147
770 DATA 74,74,141,79,3,56,173,1,208,233,50,74,74,74,168,169,4,141,80,3 :REM*19
780 DATA 192,0,240,20,24,173,79,3,105,40,141,79,3,173,80,3,105,0,141,80,3 :REM*218
790 DATA 136,208,232,162,128,142,4,212,232,142,4,212,32,216,197,165,2,141 :REM*20
800 DATA 83,3,96,173,79,3,133,251,173,80,3,133,252,160,0,177,251,201,32 :REM*149
810 DATA 240,11,169,0,141,64,3,141,79,3,141,80,3,96,162,0,138,157,0,212 :REM*65
820 DATA 232,224,24,208,248,169,15,141,24,212,169,38,141,5,212,169,32,141 :REM*99
830 DATA 1,212,169,116,141,12,212,169,18,141,8,212,169,83,141,19,212,169,6 :REM*203
840 DATA 141,15,212,96,173,31,208,41,252,133,2,208,1,96,173,79,3,133,251 :REM*22
850 DATA 173,80,3,133,252,160,0,169,32,145,251,173,31,208,140,80,3,140,79 :REM*117
860 DATA 3,169,4,133,251,132,252,165,2,37,251,240,7,173,21,208,37,2,208,3 :REM*78
870 DATA 76,223,198,162,32,142,11,212,232,142,11,212,166,252,189,250,7,201 :REM*62
880 DATA 250,240,43,169,250,157,250,7,157,251,7,189,65,3,73,15,157,66,3 :REM*23
890 DATA 138,10,168,185,4,208,153,6,208,185,5,208,153,7,208,165,251,10,13 :REM*206
900 DATA 21,208,141,21,208,76,194,198,165,251,73,255,45,21,208,141,21,208 :REM*78
910 DATA 120,248,24,173,71,3,105,5.141,71,3,173,72,3,105,0,141,72,3,173,73 :REM*63
```
►

```
920 DATA 3,1Ø5,Ø,141,73,3,216,8
    8,12Ø,248,24,173,71,3,1Ø5,5
    ,141,71,3,173,72    :REM*227
93Ø DATA 3,1Ø5,Ø,141,72,3,173,7
    3,3,1Ø5,Ø,141,73,3,216,88,6
    ,251,23Ø,252,165    :REM*1ØØ
94Ø DATA 252,2Ø1,6,2Ø8,1,96,76,
    78,198,173,21,2Ø8,41,12,2Ø8
    ,23,169,251,141     :REM*156
95Ø DATA 25Ø,7,169,32,141,4,2Ø8
    ,169,56,141,5,2Ø8,173,21,2Ø
    8,9,4,141,21,2Ø8    :REM*1Ø6
96Ø DATA 173,21,2Ø8,41,48,2Ø8,2
    3,169,251,141,252,7,169,32,
    141,8,2Ø8,169       :REM*2Ø4
97Ø DATA 235,141,9,2Ø8,173,21,2
    Ø8,9,16,141,21,2Ø8,173,21,2
    Ø8,41,192,2Ø8,23     :REM*97
98Ø DATA 169,251,141,254,7,169,
    32,141,12,2Ø8,169,247,141,1
    3,2Ø8,173,21,2Ø8    :REM*147
99Ø DATA 9,64,141,21,2Ø8,96,173
    ,3Ø,2Ø8,41,1,24Ø,3,141,85,3
    ,96,169,255,141     :REM*194
1ØØØ DATA 27,2Ø8,32,171,194,32,
     57,194,32,12,2ØØ,173,81,3,
     2Ø8,6,173,82,3     :REM*19Ø
1Ø1Ø DATA 2Ø8,1,96,12Ø,248,56,1
     73,81,3,233,1,141,81,3,173
     ,82,3,233,Ø,141    :REM*14Ø
1Ø2Ø DATA 82,3,56,173,71,3,233,
     5,141,71,3,173,72,3,233,Ø,
     141,72,3,173,73    :REM*189
1Ø3Ø DATA 3,233,Ø,141,73,3,216,
     176,184,169,Ø,141,71,3,141
     ,72,3,141,73,3      :REM*83
1Ø4Ø DATA 24Ø,171,173,76,3,2Ø5,
     73,3,144,24,24Ø,2,176,38,1
     73,75,3,2Ø5,72,3     :REM*9
1Ø5Ø DATA 144,12,24Ø,2,176,26,1
     73,74,3,2Ø5,71,3,176,18,17
     3,71,3,141,74,3    :REM*167
1Ø6Ø DATA 173,72,3,141,75,3,173
     ,73,3,141,76,3,96,32,89,19
     4,173,Ø,22Ø,41     :REM*153
1Ø7Ø DATA 16,24Ø,249,162,12,16Ø
     ,5,24,32,24Ø,255,162,Ø,189
     ,23Ø,2ØØ,32,21Ø    :REM*2Ø5
1Ø8Ø DATA 255,232,224,21,2Ø8,24
     5,173,Ø,22Ø,41,16,2Ø8,249,
     32,1Ø,193,173,Ø    :REM*249
1Ø9Ø DATA 22Ø,41,16,24Ø,249,96,
     32,65,196,32,65,196,162,Ø,
     16Ø,Ø,136,2Ø8       :REM*23
11ØØ DATA 253,2Ø2,2Ø8,25Ø,96,Ø,
     Ø,Ø,Ø,Ø,Ø,Ø,Ø,Ø,12,Ø,Ø,3Ø,
     Ø,Ø,12,Ø,Ø,Ø,Ø,Ø   :REM*187
111Ø DATA Ø,Ø,Ø,Ø,Ø,Ø,63,Ø,Ø,97
     ,128,Ø,2Ø4,192,Ø,222,192,Ø
     ,2Ø4,192,Ø,97      :REM*186
112Ø DATA 128,Ø,63,Ø,Ø,192,Ø,Ø,
     224,Ø,Ø,24Ø,Ø,Ø,255,128,Ø,
     255,128,Ø,24Ø,Ø    :REM*111
113Ø DATA Ø,224,Ø,Ø,192,Ø,Ø,255
     ,192,Ø,127,128,Ø,63,Ø,Ø,3Ø
     ,Ø,Ø,12,Ø,Ø,12,Ø   :REM*234
114Ø DATA Ø,12,Ø,Ø,Ø,Ø,Ø,1,128,
     Ø,3,128,Ø,7,128,Ø,255,128,
     Ø,255,128,Ø,7      :REM*17Ø
115Ø DATA 128,Ø,3,128,Ø,1,128,Ø
     ,12,Ø,Ø,12,Ø,Ø,12,Ø,Ø,3Ø,Ø
     ,Ø,63,Ø,Ø,127       :REM*49
116Ø DATA 128,Ø,255,192,Ø,Ø,Ø,Ø
     ,32,247,32,56,56,235,66,82
     ,69,65,75,45,65     :REM*95
117Ø DATA 87,65,89,74,79,72,78,
     32,7Ø,69,68,79,82,76,65,83
     ,84,32,83,67,79    :REM*131
118Ø DATA 82,69,72,73,71,72,32,
     83,67,79,82,69,77,73,83,83
     ,69,68,84,73,77     :REM*64
119Ø DATA 69,82,5,8Ø,82,69,83,8
     3,32,66,85,84,84,79,78,32,
     84,79,32,8Ø,76      :REM*67
12ØØ DATA 65,89,1,4,2,8,239
                        :REM*1Ø7
```
■

Commodore Clinic

Here's a panorama of 1988's most useful questions and answers in the areas of programming, software and hardware.

◇

By LOU WALLACE

PROGRAMMING

Q *I'm a 13-year-old programmer and I think your magazine is great! I'm writing a program and I want to know how to keep the listing from prying eyes.*

—BRIAN LEABY
N. BABYLON, NY

A On the C-64, use POKE 775,1 to disable program listing capability. To restore it, use POKE 775,167. On the C-128, use POKE 775,139 to disable and POKE 775,81 to restore.

Q *I accidentally used Save with Replace (SAVE "@0:FILENAME",8) on a C-64 program when I typed it in for the first time, not knowing I shouldn't have. Now I can't get the filename off the disk! Can you tell me how? Also, should I make a backup before scratching the program?*

—NANCYE A. KUSCHE
GLENDALE, AZ

A The easiest way is to simply rename the file. Use this command line in Direct mode:

```
OPEN 15,8,15, "R0:NEWFILENAME=
0:@0:FILENAME":CLOSE 15
```

Now you can scratch the old file without worrying about erasing the program with the filename "Filename".

Q *I've been looking for the* C-128 Programmer's Reference Guide *in every bookstore in town, but no one has heard of it. Does it really exist, and can you tell me where I can order one?*

—KEN JAMERSON
ZANESVILLE, OH

A Oh yes, it certainly exists and is perhaps the single most important programming reference available for the C-128 (I usually carry one in my briefcase—honest!). It's over 700 pages long, contains a complete Basic 7 encyclopedia, sections on machine language, graphics, sprites, sound and CP/M. It also covers programming the 8563 80-column chip, a device input/output guide, memory maps and nearly 100 pages of hardware specifications.

It's published by Bantam Computer Books and retails for $24.95. You can order a copy by calling 800-223-6834, extension 479. Its reference number is 34378-5, and they accept credit cards (VISA, MasterCharge and American Express). You can also get information for ordering by mail from that number.

Q *What is the difference between the space and shifted space characters?*

—JOSE RAMIREZ
GUADALAJARA, JALISCO, MEXICO

A The space character is a CHR$(32), while shifted space is a CHR$(160). They are different ASCII characters and should not be used interchangeably. For example, if you were typing in a *RUN* program listing and typed in a shifted space instead of a space, *RUN*'s Checksum program would generate an error, but the line would look perfectly correct to you, making it very difficult for you to debug.

Q *I'm writing a program and want to keep a few files open while the program is running. How many can I keep open at one time on a Commodore disk drive?*

—D. SCHWARTZ
SCOTTSDALE, AZ

A It depends on the drive you use. 1541s and 1571s have three available buffers to open up to three sequential files at once, or one relative file (which requires two buffers) and one sequential file (one buffer). The 1581 drive has seven buffers, so you can have more combinations of open files, but it's not a good idea to have more than two relative files open at once.

Q *I need information about both the inner workings of the C-128's ROM routines and those of the 1571 disk drives. Does Commodore sell documented ROM listings? If so, where can I find them and how much does it cost?*

—MARY SUE JENNINGS
TULSA, OK

A Commodore doesn't sell that information as far as I know, but you can get books with exactly that information from Abacus Software of Grand Rapids, Michigan (phone 616-241-5510). They have the *1571 Disk Drive Internals* ($19.95) and the *C-128 Basic 7.0 Internals* ($24.95), which has extensive documentation on ROM routines. Both are excellent reference books on the inner workings of 128 Basic and the 1571 ROMs. Abacus also publishes a number of books for the 64 and 128.

Q *I'm taking a course in Basic, and the class uses MS-DOS computers. However, I want to do my homework on my C-64. The problem is Basic 2.0 doesn't have any text-formatting abilities, and I need to have columns of decimal numbers to two significant digits, with the decimal points aligned. How can I do it?*

—M. WRIGHT
ODUM, GA

A It's not too difficult. All you need is a short routine to read in a number, truncate it to two digits to the right of the decimal, and convert it to a string. Once that's done, you can add extra zeros if the number has fewer than two significant digits, and pad it with ►

ILLUSTRATED BY DAVE CALVER


READIN'
WRITIN'
COMPUTIN'
THE
LAZY
BROWN
FOX
JUMPED
OVER
10 REM
20 POKE
30 S=542
60 NEXT:
80 PRINT"
100
110
PROFESSOR COMMODORE

enough space characters so all the numbers have the same number of digits. This short Basic program segment demonstrates one way to do it:

```
10 PRINT "X = ";:INPUT Y
20 GOSUB 50
30 PRINT Y,X$
40 GOTO 10
50 X = Y*100:X = INT(X):X = X/100
60 X$ = STR$(X):T = X - INT(X):IF  T = 0
   THEN X$ = X$ + ".00":GOTO 80
70 T = (X*10) - INT(X*10):IF  T = 0  THEN
   X$ = X$ + "0":GOTO 80
80 FOR J = 1TO(10 - LEN(X$)):X$ = " " + X$:
   NEXT
90 RETURN
```

In this example, the program asks you for a number and converts the number to a string with the proper number of digits. It then adds character spaces to the front of the number so the output is ten characters long, with the decimal points aligned. You can change the number of zeros the program adds to a number by changing the 10 in line 80. And the subroutine at lines 50–90 could be included in your programs.

However, while writing this, I discovered a bug in both the C-64 and C-128 math routines and thought I would pass it on to our readers. Apparently it involves round-off errors in floating-point math, but only affects certain numbers, for which I haven't as yet been able to find a pattern. It's easier to demonstrate than explain. In Direct mode, type in the following lines:

```
X = 33.4
Y = (X*10) - INT(X*10)
PRINT Y
```

What do you think the value of Y is? If you answer zero, you're right, but the answer you get is 1.1920929E – 07! Not quite right, that's for sure. If you had entered –33.4 for X, the value given for Y would have been a little less than 1, a very large error indeed. These errors are enough to cause programs to work incorrectly when they encounter one of the "magic" error-causing numbers, as in the small routine above. So be warned!

Q *I was intrigued by your numeric format program in the March 1988 Commodore Clinic. I've made some enhancements to it and corrected a couple of minor bugs that were due to the math bug you described. The result is an improved version you might be interested in passing on to your readers.*

```
10 PRINT "X = ";:INPUT Y
20 GOSUB 50
30 PRINT Y,X$
40 GOTO 10
50 X = Y*100:X = INT(X + .0001):X = X/100
60 X$ = STR$(X):T = X - INT(X):IF T = 0
   THEN X$ = X$ + ".00":GOTO 80
70 V$ = STR$(INT(X*10 + 0)):U =
   VAL(V$):S$ = STR$(X*10):R = VAL(S$)
75 Z = R - U:IF Z = 0 THEN X$ + X$ + "0"
80 FOR J = 1 TO (10 - LEN(X$)):X$ = " " +
   X$:NEXT
90 RETURN
```

—HERBERT WALLER
HICKSVILLE, NY

A Thanks, Herb. The original formatting program generated quite a few letters, and a number of readers sent along their own versions. Evidently a good many have also been experimenting with the math bug. If anyone solves the math-bug problem, drop us a line.

Q *I'm writing to you in reference to a "bug" in the Commodore math routines you discussed back in the March 1988 Clinic. The problem isn't a bug, but a consequence of the floating-point math routines. It results from rounding off, as you pointed out, and from the rounding of answers in the floating-point routines.*

*In your example, the rounding that contributes to the problem occurs in X*10 and is a result of the representation of decimal 0.4 in the binary floating-point system, which causes the shift of a 1 into bit 7 of the rounding byte. The results for the negative case are essentially the same except for the operation of the INT(. . .) function of Basic, which returns the closest integer value that is less than the argument. For negative numbers, this gives a (negative) integer that is larger in absolute value (magnitude without regard to sign) than the argument.*

—STUART RUDIN, PHD
SCOTTSDALE, AZ

A Thanks for the information. As I've stated before, this is something all Basic programmers who use floating-point routines should be aware of. Interestingly, this "math-bug" subject has generated more discussion than the alleged use of astrology in the White House. Still, the more we know about our computers, the better programmers and users we become.

Q *I just bought the January 1988 issue of* RUN, *and I ran into difficulty trying to use the new checksum. I get an Out of Data error in line 30. I checked each line to see if I'd made any typing errors but could find none.*

Please advise me, as I would like to type in the Calendar Maker program, among others in your magazine.

—JANIS SUNKEN
NEVADA, IA

A You probably made an error in typing, as *RUN*'s new Checksum program works very well. But, just to be sure, I typed it in myself from the listing in the January '88 issue. No problem! It worked as it should. Since I don't have a copy of your listing, I can't be sure what is wrong. But the computer has given us a good hint with the "Out Of Data error in line 30" message. That tells us the program was trying to read a value from the Data statements and ran out of data to read, which in turn means you left out a portion of a Data statement. That could be a missing comma, a period used in place of a comma, or perhaps even a complete line. Check the listing again carefully; I'm sure you will discover the problem.

Q *I know that Apple computers have a Basic command called Speed, which sets the speed of output to the screen or printer. And I have noticed that in Mediagenic's Hacker and Ghostbusters, the Speed command is available, but I cannot find any way of accessing it in CBM Basic. Does it exist on the C-64?*

—CHAD HAYNES
BECKLEY, WV

A No, there is no corresponding command for the C-64 (or the C-128). What the Mediagenic programs do is slow down or speed up the screen output itself. You can emulate it quite easily in your programs, too. Just put a small delay loop between outputs, thusly:

```
100 PRINT A$:FOR T = 1 TO DE:NEXT
110 GOTO 100
```

By increasing the value of the variable DE in line 100, you can slow down the speed of printing A$. If you decrease DE, it will print faster.

Q *How can I reprogram the C-128's shifted run key and the help key? Also, how can I keep a user from exiting a Basic 7.0 program with the stop key?*

—R. BURNS
CONCORD, NH

A The answers to both questions were published recently in the Best of Magic column in *RUN's Special Issue #4*. To disable run-stop/restore, use these Pokes:

```
POKE 792,51:POKE 793,255
```

As most 128 users know, the eight function keys can easily be reprogrammed with the Key command. But you can easily reprogram the shifted run and help keys with the following SYS commands:

```
RUN KEY
BANK 15:SYS DEC("60EC"),,8,,,"RUN KEY"
HELP KEY
BANK15:SYS DEC ("60EC"),,9,,,"HELP KEY"
```

Substitute your own commands for the words RUN KEY or HELP KEY to give you a total of ten programmable function keys.

Q *When I'm creating high-resolution graphics on my C-64, I have a problem positioning pixels of different colors next to each other—the first colored dot changes to the new color! Why does that happen, and what can I do about it?*

—LEE RUMSEY
LONG BEACH, CA

A The problem you're experiencing is known as "color bleed." The way C-64 (and C-128) graphics are generated by the VIC chip allows two colors per color cell, one foreground and one background color. The color cell is an 8×8-pixel matrix. So, any attempt to change even one dot within the 8×8 area results in all foreground pixels (or all background pixels, depending on which color you're using) changing to the current color. There's nothing you can do about it when using the hi-res 320×200 Graphics mode.

If you use Multicolor Graphics mode, you can have up to four different colors per cell, but there are also some drawbacks to using this mode. The screen resolution reduces to 160×200, giving a coarser display, and the color cell becomes horizontally smaller—a 4×8-pixel matrix. Each pixel has twice the width as in Hi-Res mode.

Q *What do you do when you've played one C-64 game, and you want to reset and play a different game without using the on/off switch? The reason I ask is that I want to use the switch as little as possible. Also, what is a Poke statement in a program for, and how do you use it in a C-64 program?*

—NGHIA LUONG
SANTA ANA, CA

A Sometimes you can press the run-stop/restore key combination, and then enter the command SYS 64738 to perform a "soft" reset. However, most games disable the run-stop/restore combination, so that a soft reset won't work. An alternative is to add a hardware reset switch similar to that of the C-128. The easiest way to do that is to use a plug-in cartridge (like Power Cartridge or Blowup). But even then, some games install themselves in memory like an autostart cartridge, so any attempt to reset the computer merely restarts the game. In that event, you can only turn the computer off, wait about five seconds and turn it back on.

The Poke command is a way for the Basic programmer to place a number into a specific memory location in the computer's memory. The number must be in the range 0–255, as 255 is the largest value that can be contained in one byte of memory. To use it, just type POKE, followed by the memory address, a comma and then the value to place in that address. For example, if you wanted to put the character A onto the C-64 screen, you could type:

```
POKE 1024,65
```

This places the ASCII value 65 (the code for letter A) into memory location 1024, which is the first character cell, for the upper-left corner of the C-64 screen.

Related to the Poke command is the Peek command. This does the opposite, reading the contents of a memory address. For example,

```
A = PEEK(1024)
```

assigns to variable A the ASCII value of the byte at address 1024.

Q *I've tried saving multicolor graphic screens (GRAPHIC 3) with my C-128 and have had no luck. All I can do is save the bitmap and one color; the other colors never show up right. According to Commodore, these colors are in the color memory area at 55296–56295. But saving that area of memory and reloading it has no effect on the colors of the images. Is there a way to save multicolor pictures from Basic, and if so, could you* please *let us in on the secret?*

—MORGAN HAUEISEN
HAMILTON, NJ

A Yes, it can be done from Basic, but if I tell you, you'll have to promise to keep our "secret" safe! There are three areas of memory you must save in order to completely reproduce a multicolor (GRAPHIC mode 3) screen on the C-128. The first is the area from 7168 to 16191, which contains the same color (7168–8191) and bitmap (8192–16191). You must also save the background color at 53281. (I also save the border at 53280.) And, as you know, the main color memory is at location 55296–56295. The trick is to be able to access that memory correctly, because in the C-128's multi-bank memory scheme, some areas are not accessible (even using the Bank command) without a little nudge. To demonstrate, I wrote a small program that creates a multicolor display, then saves it to disk. A second routine can be used to display the picture. You could easily use these as subroutines in your own programs for loading and saving pictures.

```
5 REM SAVE MULTICOLOR SCREEN
10 POKE 53280,7
20 COLOR 0,1:COLOR 1,2:COLOR
   2,3:COLOR 3,4
30 REM SAVE MC PICTURES
40 GRAPHIC3,1
50 REM CREATE SOMETHING
60 CIRCLE 1,40,100,35
70 CIRCLE 2,80,100,35
80 CIRCLE 3,120,100,35
90 REM SAVE IT
100 POKE 1,PEEK(1)AND254
110 BSAVE"BKGBDR",B13,P53280 TO
    P53282
120 BSAVE"CMEM",B15,P55296 TO
    P56296
130 BSAVE"SMEM - BMP",B0,P7168 TO
    P16192
140 GETKEY A$
150 GRAPHIC0
```

Once you've saved your pictures to disk, you can reload and display them with this routine:

```
10 REM RELOAD A SAVED MULTICOLOR
   PICTURE
20 GRAPHIC3,1
30 POKE 1,PEEK(1)AND254
40 BLOAD"BKGBDR",B13,P53280
50 BLOAD"CMEM",B15,P55296
60 BLOAD"SMEM - BMP",B0,P7168
70 GETKEY A$
80 GRAPHIC0
```

Q *I've written a C-128 program that needs to know the name of the 1571 disk so it will be able to print out the disk name, along with other data, to the printer. The trouble is, I can't figure out how to do it! Any ideas?*

—JOHN SCHUELER
SEDONA, AZ

A It's quite easy, and there are a number of ways to do it. The easiest is to open a channel to the drive and read the directory, just as you would a program. Here's a short Basic program that reads the disk name into a variable. With a little more work, it ►

could probably be used to read the entire disk directory, along with all the file types and file sizes.

```
10 REM READ A DISK NAME
20 OPEN 1,8,0,"$"
30 FOR I=0 TO 24
40 GET#1,A$:IF A$="" THEN A$=
   CHR$(0)
50 D$=D$+A$:NEXT
60 CLOSE 1
70 D$+MID$(D$,9,16)
80 PRINT D$
```

This works on any 1541, 1571 or 1581 drive. It reads in enough information to get just the disk name, then, using the MID$ function, it makes D$ equal to the data that's found between the double quotes at the top of your disk directory. This is the disk name, and it's always 16 characters long.

Q *What is the purpose of the REM* statements at the end of each line of code in programs listed in* RUN?

—Y. Rubinson
Des Plaines, IL

A They're used with *RUN*'s Checksum program, which catches errors you may type into a listing. Those REM* statements are followed by a number, called a checksum. Don't type in the REM* or the number that follows. Instead, when you have the Checksum program installed in memory and type in a program line, a number is printed to the screen. If the number matches the number following the REM*, you've correctly entered that line; if not, there's an error in the line that needs correcting. The Checksum program replaced our old Perfect Typist program in January 1988. It and the instructions for using it appear in every issue.

Q *I'm a beginning machine language programmer, and I'd like to learn how to write an interrupt-driven program for the C-64. Could you give me a simple example?*

—Jane Rockmyer
Cleveland, OH

A I sure can. Writing an IRQ routine is basically very simple. In theory, all you have to do is redirect the IRQ vectors at $0314 to the address of your routine. Then, every 60th of a second, your machine language program is executed. After each access, it should then send the computer on to the address of the regular IRQ routine. To demonstrate, I wrote a very simple program that changes the border and background colors to black and cyan, respectively. You can poke in a new value for the border color (53280) or the background color (53281), but all you'll get is a momentary flash, and the colors instantly return to black and cyan. Here's the machine language source code for the routine.

```
* = $C000                       ; the code is
                                  placed at 49152
                                  decimal
border = 53280
background = 53281
irqvec = $0314
irqold = $EA31                  ; this is the nor-
                                  mal address
                                  found in
                                  $0314/$0315
init     sei
         lda #<irq
         ldy #>irq
         sta irqvec
         sty irqvec+1
         cli
         rts
irq
         sta tempa              ; store a, x
                                  and y
         stx tempx
         sty tempy
         lda bdcolor            ; border color
         sta border
         ldx bkcolor            ; background
                                  color

         stx background
         lda tempa              ; restore a, x
                                  and y
         ldx tempx
         ldy tempy
         jmp irqold
tempa    .byt 0
tempx    .byt 0
tempy    .byt 0
bdcolor  .byt 0                 ; black border
bkcolor  .byt 3                 ; cyan back-
                                  ground
         .end
```

If you'd like to see what it does, just type in the short Basic loader below. Once run, it places the machine language routine at 49152 and activates it with a SYS call. The border becomes black and the background cyan. Try changing the colors with Pokes to 53280 (border) and 53281 (background). To get rid of the effect, press the run-stop/restore keys.

```
10 REM SIMPLE IRQ DEMO
20 REM LOU WALLACE
30 REM RUN MAGAZINE
40 AD=49152
50 READ A:IF A=-1 THEN SYS
   49152:END
60 POKE AD,A:AD=AD+1
70 GOTO 50
80 DATA 120,169,13,160,192,141,20,3
90 DATA 140,21,3,88,96,141,46
100 DATA 192,142,47,192,140,48,192
110 DATA 173,49,192,141,32,208,174
120 DATA 50,192,142,33,208,173,46
130 DATA 192,174,47,192,172,48,192
140 DATA 76,49,234,0,0,0,0
150 DATA 3,-1
```

Q *I have a C-128, 1541 and Okidata 120 printer. I'm pretty new to computing, and I can't figure out how to list a Basic 7.0 program to my printer. I've tried the Open command, but it isn't working quite right. What I need is explicit instructions!*

—G. Stojhovic III
Phoenix, AZ

A As Alf would say, "No problem!" All you need to do is load the Basic program, then, with your printer on, type the following in Direct mode. (Direct mode means just type it and press return.)

```
OPEN 4,4,7:CMD 4:LIST:PRINT#4:CLOSE 4
```

Your program will be printed on your printer, just as it appears on the screen. The only exceptions will be Quote-mode commands, which, depending on your printer's interface, will be translated into either ASCII sequences or graphics characters.

Q *Can Commodore 64 and 128 programs be converted to run on an IBM clone XT, with MS-DOS and GW Basic?*

—T. Wilder
Peterborough, NH

A If the programs are simple Basic programs, it is possible to convert them. However, if they use graphics, sprites, sound commands or any other machine-specific abilities, the conversion problems become significant, since IBM clones have limited sound, no sprites and different graphics resolutions. Also, you will have to rewrite any disk accesses, as they use different commands and techniques.

Q *Has the "garbage collecting" problem when using large arrays on the C-64 been corrected in the C-128?*

—R. S. DeFreitas
Lake Havasu City, AZ

A Yes, it has. Since the 128 has two 64K RAM banks, one is dedicated to the Basic text (bank 0) and the other to Basic variables (bank 1). On the 128, each string has a "pointer" to the variable using it, which makes garbage collection (which means to discard unused strings and compact the memory required to store them, freeing it for other uses) much, much faster than on the 64. Essentially, the 64 has to search the entire variable list for matches to the strings in order to perform garbage collecting. The 128's method is possible only because of the large amount of RAM available for variables. The 64 doesn't have that luxury, so it uses the slower but more efficient method.

Q *I've been writing an adventure game in Basic on my C-128. I've gotten to the stage where I'm able to play it, but after a certain number of entries, I get an Out of Memory message.*

My manual states, "Either there is no more room for program code and/or program variables, or there are too many nested Do, For or Gosub statements in effect."

I assume that there are too many For-Next loops, because my program uses these to determine its next action. I've tried using the Trap statement, but that only results in a computer lockup.

Have you any suggestions?

—R. JAKLITSCH
WICKLIFFE, OH

A There are a couple of possible problems. First, you may be out of variable memory. Even though there's a 64K bank in the 128 set aside for variables, it's not difficult to run out of memory, if you use enough variables. Consider this DIMension statement:

```
DIM A$(21414)
```

This allocates enough memory for 21,414 string variables in the array A$( ), leaving four bytes free. Increase it to 21,415, and you get an Out of Memory error message. You're probably not using arrays this large, but it takes only a few multidimensional arrays to eat up all your variable memory.

A more likely possibility is that you're out of stack space. The computer reserves a section of memory called a stack, where it holds information it will need later. It's called a stack because programmers like to think of it as a stack of values and addresses, with the most recent addition on the bottom. Whenever you use a Do-Loop, a Do-While, a For-Next loop or a Gosub in a program, an entry is placed on the stack so the computer can find its way back when executing the loop or subroutine. If you're jumping in and out of loops, or doing recursive calls of a subroutine, you can very quickly run out of stack space, resulting in an Out of Memory error. As an example, enter this one-line program and run it:

```
10 GOSUB 10
```

You'll find that almost as soon as you press return, it will print an Out of Memory error. This small program has filled the stack by repeatedly calling itself, and never reaching a Return statement, which would remove an entry from the stack.

Check your program again, and perhaps you will find that one of the above is causing the problem.

Q *I've been trying to join together two C-128 programs by using the command Concat "Part2" to "Part1". I've also renumbered the programs so they don't have overlapping line numbers. The problem is the C-128 keeps giving me a File Type Mismatch Error message. What am I doing wrong?*

—JAY GREEN
PAHOKEE, FL

A The C-128 is already telling you what is wrong with its error message. The error message means you've told your computer to merge two *program* files, yet Concat is used only for *data* files. To join programs together, you'll need some sort of append utility program, of which there are many. Check your local user's group library or BBS—you may find one there.

Q *I'm trying to program sprites from Basic on my C-64, and I'm having problems getting more than one sprite to come on at a time. Assuming the variable V (for VIC II) is equal to 53248, and S is the sprite I want to turn on (0–7), I can then turn on any sprites I want by issuing POKE V+21,2↑S. But when I try calling up a second sprite, the first one turns off.*

The line I use to turn them on is: POKE V+21,2↑0:POKE V+21,2↑1. This should turn on sprites 0 and 1, but instead, sprite 0 comes on for a second, turns off and then sprite 1 is on. What's going on?

—SHAWN ZOOWSKI
CLEVELAND, OH

A The problem is created by your use of two Pokes instead of one. V+21 is the Sprite Display Enable register, and each of the eight bits in that register determines if a sprite is on or off. If the bit equals 1, the sprite is on; if it equals 0, the sprite is off. So poking 2↑0 turns on sprite 0, 2↑1 turns on sprite 1, 2↑3 sprite 2, and so on. But by poking in each value one at a time, you turn off all the preceding values. Using POKE V+21,2↑0+2↑1 will allow you to turn on two sprites at once.

The flip side of the problem is how to turn off one sprite without turning off the others, which can be difficult if you don't know what others are on. Again, we can use the Poke statement, but this time we combine it with a Peek command. To turn off a sprite S with a value of 0–7, you'd enter POKE V+21,(PEEK(V+21) AND (255−2↑S)) in your program.

Take a look at what this rather cryptic line does. First, it uses the Peek command to get the contents of memory address (V+21). Then it performs the Boolean function AND on that value, using the expression (255−2↑S) as its argument. If S=0, then 255−2↑S=254. ANDing the value found at V+21 with 254 turns off bit 0 if it's on, and leaves it unaltered if it's off. Finally, this new number is poked back into memory location V+21. In general, we can use the above procedure to selectively turn off any bit in a byte.

The earlier example above for turning on two sprites at once is fine as far as it goes. But suppose we want to turn on a specific sprite without changing any of the others. We can use a variation of the Peek and Poke statement above, only this time using the Boolean OR function to selectively set a bit: POKE V+21,(PEEK(V+21) OR 2↑S). Again, S is a value between 0 and 7 that represents the eight sprites. This Poke will turn on any of the eight sprites, and have no effect on the others. You could use these two Pokes as subroutines, which you would call to turn on and off any sprite.

Q *Could you give me a short and simple example for performing basic disk commands? I'm a new owner, and the 1541 and 1571 manuals are quite confusing. I have to dig hard to find what I need!*

—JERRY GOLDSTEIN
NEW YORK, NY

A You're right about the manuals being confusing to the new owner. But, in general, it's a good idea for the beginner to study the manuals that come with the computer; they'll begin to make a lot more sense after a while.

In the following examples, the C-64 Basic 2.0 version is given first, followed by the C-128's Basic 7.0 syntax. I used the generic FILENAME or DISKNAME in all cases. Replace them with your own ►

file or disk name when you're using the examples. All commands assume you're using drive 8, but you could change them to work on other drives if that is necessary.

To read a directory:

C-64: LOAD "$",8<return>
LIST<return>
C-128: DIRECTORY

To load a program:

C-64: LOAD "FILENAME",8
C-128: DLOAD "FILENAME"

To save a program:

C-64: SAVE "FILENAME",8
C-128: DSAVE "FILENAME"

To verify a program in memory with one on disk:

C-64: VERIFY"FILENAME",8
C-128: DVERIFY"FILENAME"

To format a disk:

C-64: OPEN 15,8,15,"N0:DISKNAME, XX":CLOSE 15
C-128: HEADER "DISKNAME",XX

(Note: XX is any two numbers or characters to be used as a unique ID number.)

To erase a file:

C-64: OPEN 15,8,15,"S0:FILENAME": CLOSE 15
C-128: SCRATCH "FILENAME"

To rename a file:

C-64: OPEN 15,8,15,"R0:NEWFILE NAME = 0:OLDFILENAME":CLOSE 15
C-128: RENAME "OLDFILENAME" TO "NEWFILENAME"

To initialize a drive:

C-64: OPEN 15,8,15,"I0":CLOSE 15
C-128: DCLEAR

To validate a disk:

C-64: OPEN 15,8,15,"V0":CLOSE 15
C-128: COLLECT

To switch a 1571 to 1541 mode:

C-64 and C-128: OPEN 15,8,15,"U0>M0":CLOSE 15

Q *I'm writing a program on my C-64 and would like to know how to enter the cosine formula for the trigonometric solution of a triangle when the three sides are known: $\cos A = (b^2 + c^2 - a^2)/2bc$. Suppose the sides a, b and c are 8, 9 and 10, respectively.*

—C. J. ERKER
CLEVELAND, OH

A To employ trigonometric formulas (or any other mathematical expressions) in a program, you'd use Basic 2.0 syntax. For the example you give, you'd enter:

```
10 A = 8:B = 9:C = 10
20 CA = (B↑2 + C↑2 - A↑2)/(2*B*C):REM CA
   EQUALS COS OF ANGLE A
30 PRINT "COS A = ";CA
```

Q *I'd like to use my 1750 RAM expansion module with programs I'm writing to shift stored data to the REU, retrieve the data for use in the programs, put the data back into the unit so that I can use RAM memory for other work, and save the RAM data to disk for later use. Could you give me an example of how to do this?*

—ROBERT E. PORTER
CANFIELD, OH

A I'll give you two examples. The first is to use Commodore's official RAMDOS software, which simulates a high-speed disk drive. With a RAM drive you can quickly load and save your data between the program you're writing and the drive. You can even chain several programs together so they act as one. And it's done so fast that it's usually transparent to the user.

If you recently bought your RAM cartridge, the RAMDOS software was probably already on the disk that came with the unit. Earlier buyers of a 1700 or 1750 unit did not get it, as it wasn't completed until this year. Commodore has now released it for public use, and you'll find it on most commercial BBS networks, such as QuantumLink, GEnie and CompuServe. You'll also find it on many smaller BBSs, including *RUN*'s own RUNning Board (603-924-9704).

The second example is to use the Basic 7.0 commands Stash, Fetch and Swap to store and recall data from your programs. I've given the commands and their parameters below.

```
FETCH,#BYTES,INTSA,EXPSA,EXPB
STASH,#BYTES,INTSA,EXPSA,EXPB
SWAP,#BYTES,INTSA,EXPSA,EXPB
```

#BYTES—the number of bytes to Fetch, Stash or Swap

INTSA—the starting address (0–65535) of the computer's memory

EXPSA—the starting address (0–65535) of the expansion RAM

EXPB—the memory expansion bank number (0–1 for 1700, 0–7 for 1750)

The commands themselves are quite easy to understand, but you must know a great deal about the 128's memory organization in order to use them. I've written a sample program that stores the 128's 40-column graphics screen in the RAM expansion cartridge, waits for a keypress, then restores it.

```
10 GRAPHIC1,1:REM HIGH RESOLUTION
20 REM CREATE A SCREEN TO STORE
30 FOR I = 1 TO 16
40 C = INT(RND(1)*16) + 1
50 COLOR 1,C
60 X = INT(RND(1)*320)
70 Y = INT(RND(1)*200)
80 XR = INT(RND(1)*99) + 2
90 YR = XR*.769
100 CIRCLE 1,X,Y,XR,YR
110 NEXT I
120 STASH 9200,7168,0,0
130 GRAPHIC 1,1:REM CLEAR THE
    SCREEN
140 GETKEY A$:REM WAIT UNTIL A KEY
    IS PRESSED
150 FETCH 9200,7168,0,0:REM RESTORE
    THE SCREEN
160 GETKEY A$
170 GRAPHIC 0
```

This is just an example; there are other ways to write the program, depending on your needs, such as having different graphic or text screens, banks of sprites or function key definitions.

SOFTWARE

Q *A C-128 program I'm writing needs to know what disk drive it was loaded from and the amount of memory present. Short of the program asking the user, is there a way to tell what expansion RAM is present and which drive (8–11) should be used?*

—TOM MCDUNNEL
WEST PALM BEACH, FL

A Yes, there is. You can tell what drive was last accessed with a Peek to $BA, and by placing a line at the beginning of your program that Peeks that address, you'll know what drive to default to. Here's an example.

```
10 DN = PEEK(DEC("BA"))
20 BLOAD"SPRITES", B0,U(DN + 0)
```

The variable DN is set to the drive last used, so if you load and run this program from any drive, the sprite data is loaded from the same drive.

As for checking for 17XX RAM expansion cartridges, again, a small routine at the beginning of your program can handle that for you. For example:

```
10 A = 57094:POKE A,255:IF PEEK(A)
   < >255 THEN RX = 0:GOTO 30
20 POKE A,0:A = 57088:RX = 128: IF
   (PEEK(A) AND 16) THEN RX = 512
30 REM RX CONTAINS THE AMOUNT OF
   EXPANSION RAM PRESENT
```

This short routine will return the total amount of expansion RAM available in the variable RX. If you have a 1700, RX = 128, and if a 1750 is present, RX = 512. If the system is unexpanded, the value of RX will be 0.

Q *The Advanced OCP Art Studio saves the multicolor picture I created into one large 40-block file. How can I separate it into components that I can load directly in C-128 mode, and how can I load it once it's separated?*

—STEVE DELASSUA
FLORISSANT, MD

A The best method is to break down the multicolor picture file into four parts: a bitmap (8K), two color memories (1K each) and the background and border colors (two bytes). These can then be individually loaded into the areas of the C-128's memory that are necessary to display the picture. For this, I wrote two simple Basic 7.0 programs. The first (Listing 1) converts multicolor Advanced OCP Art Studio pictures into the four files. It prompts you for the name, then writes them out with the suffixes BM (bitmap), C1 (color memory 1), C2 (color memory 2) and C3 (background and border color).

The second listing, using Basic 7.0, loads and displays the picture, using the four files made with Listing 1. It can easily be used as a subroutine in your programs to display your pictures.

```
0 REM LISTING 1—CONVERT
10 PRINT "THIS CONVERTS ADVANCED
   ART STUDIO"
20 PRINT "MULTICOLOR MODE
   PICTURES TO FOUR FILES"
30 PRINT "THAT CAN BE LOADED FROM
   BASIC 7.0"
40 PRINT
50 PRINT "NAME (MPIC SUFFIX IS NOT
   NEEDED)"
60 INPUT F$
70 N$=F$+"{16 spaces}"
80 N$=LEFT$(N$,12):N$=N$+"MPIC"
90 BANK 0
100 BLOAD (N$),B0,P8192
110 BSAVE (F$+".BM"),B0,U8,P8192 TO
    P16192
120 BSAVE (F$+".C1"),B0,U8,P16192 TO
    P17192
130 BSAVE (F$+".C2"),B0,U8,P17208 TO
    P18208
140 BSAVE (F$+".C3"),B0,U8,P18208 TO
    P18210
150 BANK 15
```

```
0 REM LISTING 2 — DISPLAY
10 INPUT "PICTURE NAME";F$
20 GRAPHIC 3,1
30 POKE 1,PEEK(1) AND 254
40 BLOAD (F$+".BM"),B0,P8192
50 BLOAD (F$+".C1"),B0,P7168
60 BLOAD (F$+".C2"),B15,P55296
70 BLOAD (F$+".C3"),B13,P53280
80 GETKEY A$
90 GRAPHIC0
```

HARDWARE

Q *When the C-128 came out over a year ago, I thought that besides being able to use my C-64 games and programs on it, I could also take advantage of its 80 columns for word processing and its superior graphics to play better games. I'm having no problems using my 128 word processor, but I am having trouble with games.*

For example, while the 64 mode may be compatible with C-64 programs, the 1571 disk drive, apparently, is not. Many of my games do not work on the 128 in 64 mode when I use them with the 1571.

Since almost all computer outlet stores won't take back a program package that's been opened, it seems to me that it is up to the software manufacturers to alert the consumer to any quirks.

—SCOTT ANGSTREICH
CHERRY HILL, NJ

A The problem you're having with software loading is related to the problem with returning it to a store once it's been opened—software piracy. In an effort to stop the wanton copying of software (particularly games), manufacturers resort to various copy-protection schemes. Many of these techniques utilize specific areas of memory or specific routines within the 1541. If everything isn't just perfect (such as a printer not connected or a cartridge not plugged in or there's a full moon), the program won't load. Even if the drive is slightly out of alignment, it might not load. So you shouldn't be surprised that some software won't work on the 128 in 64 mode when you use a 1571.

However, there are a couple of tricks you can try to get your 1571 to load 1541-formatted programs. Sometimes the 1571 is still in 1571 mode, which might be the case, for example, if you started out in 128 mode and typed in GO 64. The drive may not have been set to 1541 mode when you entered GO 64. If that's the case, type in

```
OPEN 15,8,15,"U0>M0":CLOSE15
```

to reset the disk drive to single-sided, 1541 mode.

Another trick is to hold down the ►

Commodore key when you power up or reset the computer. That will take you directly to C-64 and 1541 modes.

If you're still experiencing problems, there may be subtle differences between the 1541 and 1571 ROMs. Take the 1571 ROM to a Commodore service center for upgrading. There will be a charge, however, since it is not a free upgrade.

Q *I hope you can help me with a problem with my C-128. When the computer is in 80-Column RGB mode, small squares appear on the screen in column 27. While they don't interfere with anything, they do not look very good when I'm using the screen! This does not occur in 40-Column mode. Any ideas about what is wrong?*

—THOMAS FORNEY
ANDERSON, IN

A It is very likely one of two things. Either you have a bad 8563 video display chip (which creates the 80-column display), or one of the two RAM chips for the 8563 (it has its own video RAM) is bad. Either way, it will require a trip to your local CBM service center. Since the RAMs are soldered to the mother board, replacing them is a job for a skilled electronic technician.

Q *About a year ago, I bought the new Commodore 1350 mouse, and I've been using it with programs like Pocket Writer 2 and GEOS 128. Now I hear about a new mouse called the 1351. What's the difference between them, and should I think about changing to the new version?*

—C. CALVET
GARDEN GROVE, CA

A The difference is like night and day. The 1350 really isn't a mouse, although it looks like one. In reality, it's a joystick in sheep's—er, mouse's—clothing. It's only able to report to the computer movement in eight directions, just like a joystick. The 1351 mouse, on the other hand, is a "true" mouse. It reports on movement in 256 directions. (The 1351 can also be used as a standard joystick if needed.) This makes it a perfect proportional controller, and it's one of the finest peripherals ever to come out of Commodore. With software designed to use it as a mouse, its movements are smooth and fluid. I've seen it priced at under $35—a bargain—and one I recommend.

Q *I recently received an SX-64 (an older, portable C-64 with built-in drive and five-inch color monitor). Do the comments I read about the C-64 and the 1541 drive also apply to my SX-64? Also, I was given some older programs like The Manager and The Printed Word. How do these compare with newer programs like Pocket Filer or Pocket Writer 2?*

—L. BOWLES
JACKSONVILLE BEACH, FL

A Yes, for the most part the SX and C-64/1541 are the same. The SX has a different default color on power up, though, and there may be some minor differences in the 1541 ROMs. As for the older software, if it's adequate for you, then you need nothing else. However, the newer software packages (especially Pocket Writer 2) are faster and have more features.

Q *While using my C-128 in C-64 mode, I formatted a disk on my 1571. The disk directory showed that I had 1328 blocks free. Does this mean my 1571 formatted both sides of the disk? I thought that happened only when you were in C-128 mode. Then, when I turned it over and tried to get a directory, it responded with Drive Not Ready. What does this mean?*

—J. P. STEVENS
EXETER, NH

A It means you've formatted both sides. Evidently your 1571 was still in 1571 mode, not 1541 mode. The 1571 can be used with the C-64, although it doesn't allow the high-speed data transfer in C-64 mode. However, you have a misconception about how the 1571 double-sided drive works. It is not the same as formatting a disk with the 1541, then turning it over and formatting it on the other side, which results in essentially two separate disks, each with its own directory. To get at the data on the back of this 1541-formatted disk, you must turn it over. However, when you format with the 1571 in 1571 mode, both sides of the disk are formatted at the same time. They share the same directory, and the drive can access the data on the back without turning over the disk. When you turned the disk over, it was in the drive upside down and the directory couldn't be found, as if the disk were unformatted. This resulted in the Drive Not Ready error.

Q *In the November 1987 issue of* RUN, *you ran a review on the software Basic 8. Reviewer John Premack states, "Upgrading to 64K requires swapping your machine's 4416 or 4164 RAM chips for a pair of 4464s." To me, this statement is confusing because there are two rows of 4164 RAM chips, not just a pair of chips. If only a pair of chips is to be replaced, then which pair? I'm interested in buying this software, but I'd also like to upgrade my C-128 at the same time. I think your articles should be a bit more technically accurate. Thanks for your help.*

—FRANCIS J. NAPERSKY
OWINGS, MD

A The 4164 RAMs John was referring to in his review of Basic 8 are those for the 8563 80-column video display chip. They're inside the small silver box on the motherboard (which also has the 8563 and Vic-II graphic chips). Please be aware that, since the chips are soldered to the motherboard, removing them and installing the two 4464 RAMs is not a job for the casual user, even if you've done soldering before. If you want the 64K for Basic 8 (and I recommend it), take the chips and sockets to a local Commodore service center. It shouldn't cost you more than $35 to install. Doing it yourself can lead to a damaged computer. (Note: C-128Ds already have the 64K of VDC RAM as well as the latest ROM chips. I've heard of people "upgrading" their C-128Ds when there is no need to do so.)

Q *I always buy single-sided disks to save money. When I want a double-sided disk, I make a little notch on the left side of the disk (from the front viewpoint) with an ordinary hole-puncher. Is this safe? If not, then what can I use to make a notch?*

—WILLIAM A. ELLERBE
DALTON, MA

A Using a hole puncher to notch a disk is fine, so you don't need a special gadget. But I wouldn't recommend what you are doing. When a disk is manufactured, both sides of the sheets are graded as to their quality. Only if a disk passes the standards for double-sided media is it used as a double-sided disk. The single-sided disk you're using is probably made from a batch that failed the quality standards for double-sided media, and is only reliable when the proper side is used. While you may be able to use many disks this way, sooner or later you'll lose some valuable data or programs. Since disks are now relatively inexpensive, it doesn't pay to take chances.

Q *I've read that the empty ROM socket in the C-128 is mapped into memory locations $8000–$FFFF, and that memory* *expansion is in the same locations. I had planned on buying the Basic 8 ROM chip and the 1750 RAM expansion unit for use with Basic 8 and GEOS 128. Will the ROM interfere with the REU?*

—F. KRANZ, JR.
SEYMOUR, WI

A There's no conflict between the Basic 8 ROM chip and the 1750 REU. The ROM is unused and transparent unless installed into memory during system startup by holding down the control key. It works well with the 1750 REU, and, when not activated, doesn't interfere with any known software.

Q *What is the best disk drive to use as a second drive?*

—M. R. HAUGE
SIERRA MADRE, CA

A It depends on your needs and your pocketbook. If you have a C-64 with a 1541 drive or a C-128 and a 1571, I would seriously consider the 1581 3½-inch drive. For less than $200, it stores over 800K and in 128 mode is very fast. If you want to stay with 5¼-inch drives, then a second 1541 or 1571 may be what you need. Or, if you have the money, you could get a hard drive.

Q *I have a C-64 and plan to upgrade to the C-128D. I've heard of the 1750 RAM expansion cartridge and am wondering if it works with the 128D. Also, does it work with GEOS, perhaps by allowing more of the program to remain in memory? If I get a 1581 drive, can I transfer my protected programs to it?*

—ANN BRANSTETTER
LAUREL, MT

A The 1750 adds an additional 512K of memory to the C-128, which is a really impressive upgrade. It does have its limits, though, because it doesn't directly increase the memory allowed for executable programs. Instead, it acts as a storage area for programs and data. However, because of its ability to make extremely high-speed direct memory transfers (DMAs) between the C-128 and the 1750, programs and data can be loaded into the RAM expansion unit and then transferred into the computer when needed. The usefulness of this becomes evident when using GEOS, as it can practically eliminate the bothersome (and slow) disk accesses you normally encounter.

The 1581 drive can also be used with GEOS 128 (although, at this writing, not with GEOS 64), providing very high speed with 800K storage. You can't copy most protected programs to the 1581, because it's quite different from the 1541 and 1571, but unprotected programs usually work with the 1581, and many protected programs (like GEOS 128) can use it for data storage.

Q *Several years ago I purchased some educational software from a company called Futurehouse, Inc. Their programs need a light pen called the Edumate Light Pen, but the company went out of business before I could order one. Do you know of a source for that light pen?*

—VIRGINIA HELBER
SCOTTSDALE, AZ

A No, Virginia, they are no longer available. However, another pen should work quite well. Two of the best are from Inkwell Systems (PO Box 85152 MB290, San Diego, CA 92138; 619-268-8792). One of these is the model 170-C, and it retails for $99.95. The other is the 184-C, which sells for $59.95. Both come with some demonstration programs.

Another good light pen is available from Tech Sketch, Inc. (40 Vreeland Ave., Totowa, NJ 07512; 201-256-0013). Their LP-10 costs $49.95 and comes with a high-resolution color drawing program.

Q *A few months ago I bought a 1750 RAM expander for my C-128. How can I use it as a disk drive to store programs? Also, is there a program that will help me make better use of this add-on device?*

—JOHN EACOTT
WOODSTOCK, ONTARIO, CANADA

A You can use the 1750 (as well as the 1700 and 1764) RAM cartridge as a high-speed disk drive by using the official Commodore RAMDOS software. It recently was released into the public domain by Commodore, so it should be accompanying RAM cartridges by now. However, if you didn't get it with the cartridge when you bought it, check your local user's group libraries as well as various online services or BBSs. It's also available for downloading from the RUNning Board BBS (603-924-9704) here at *RUN*.

Q *I have an SX-64 portable computer and would like to add on the new 1764 RAM expander. Is it compatible with the SX 1541 ROM? And, since the power supply on the SX is internal, how does one use the new* ►

power supply that comes with the expander, or is the power supply built into the SX capable of handling it?

—ALAN TREMBLAY
CHRISTOPHER LAKE, SASK., CANADA

A The official Commodore policy is that the 1764 is only for the C-64, and not compatible with the SX-64. However, unofficially I have been told the power supply on *most* SX-64s will allow you to use the RAM expander; but be warned that there is always the (small) possibility of damage. Another potential problem, and one more likely to occur with the SX-64 and 1764, comes from the VIC-II graphic chip. The VIC-II chip in some of the older SXs simply won't work with the 1764. If that happens, just have a new VIC-II chip installed in the SX.

Q *Does it matter which serial port of my 1541 I connect my 64 to?*

—JASON OEHRLI
HIGHLAND, CA

A You can use either port. The reason there are two serial ports is to "daisy chain" a printer or multiple disk drives.

Q *I have two questions. First, I've seen C-64 software available for SAT preparation. Is there any company that offers C-64-compatible software for preparing for the GRE (Graduate Record Examination)? Second, I'm thinking about getting the Educator 64 for classroom use. However, the ads don't specify what, if any, form of storage device it comes with or uses. Since it appears to be a C-64 in a CBM PET case, I was wondering if it uses a 1541 serial drive, as the C-64 does, or a 2031-style IEEE drive, like the PET?*

—JACK DAVIDSON
WABASH, IN

A I checked with Beth Jala, *RUN*'s Review Editor about GRE preparation software, but she wasn't aware of any for the C-64 or C-128. As for the Educator 64, it's a C-64 in an old style PET case, but it still uses standard 1541 disk drives. Unless the ad explicitly states it includes a drive, you should assume you must buy it separately.

Q *I own a C-128 and a 1541. I want to upgrade my drive, as well as buy a new monitor. What are the differences between the 1571 and 1581 drives, and the 1902 and 2002 monitors? I've noticed that the 1581 is less expensive than the 1571, but I'm told it has more storage! Is it completely compatible with 64 and 128 software?*

—MICHAEL GREENSTEIN
ORANGE PARK, FL

A The major difference between the 1571 and 1581 is the greatly increased disk storage capacity (350K vs. 800K) of the 1581. But you should realize that there are not yet many commercial programs available on the 3½-inch disks accommodated by the 1581. Another difference is the 1581's faster load times. Also, the 1581 can be partitioned, which lets you use subdirectories on your disks.

As for software compatibility, no, the 1581 is not completely compatible. Software with disk-based copy-protection schemes probably won't work. However, unprotected software or software that can use the 1581 as a secondary data drive should work well.

As for the 2002, it is Commodore's "universal" monitor. It has composite, RGBI and RGBA connections, allowing it to work with both the C-64 and the C-128. Commodore is no longer manufacturing the 1902, which is becoming very difficult to get.

The October 1987 issue of *RUN* reviews the C-128D, 1581 drive and the 2002 monitor. Refer to it for additional information.

Q *I recently read the Basic 8 review in the November 1987 issue of* RUN. *The review mentioned it was possible to replace the 128's 16K 80-column VDC RAMs with 64K. Is it also possible to replace them with 256K chips? If so, this would allow more than one hi-res screen in memory at a time. Perhaps the computer could be drawing in one screen and displaying a second. Would that be possible?*

—WILLIAM STOTTARD
PASCAGOULA, MS

A No, it's not possible to add 256K RAM to the 128 for 80-column display purposes. The 64K (using 120 nanosecond 4464 RAM chips) is the maximum it can be expanded to. But as for the possibility of having more than one screen in memory at a time, that is already quite possible when using Basic 8. You can have up to four monochrome screens in memory simultaneously (if you have 64K of VDC RAM), and Basic 8 is designed for drawing in one screen while looking at another (a technique called double buffering). With the 64K you can also have a large variety of different-size virtual screens, as well as variable size color displays.

By the way, while older C-128's came with only 16K of VDC RAM, the new C-128D has the full 64K video memory installed at the factory.

Q *I have a 64C, a Blue Chip BCD disk drive and a Magnavox CM 8501 Color Monitor 40. When I use Easy Script for word processing, I only get a maximum of 40 columns of text on the screen. If I were to switch monitors to a Magnavox 80-column monitor, would the display change to 80-column format? (Easy Script does have 80-column support.)*

—DAVID DE ROIA
TORRANCE, CA

A No. Switching to an 80-column monitor will not change your display. That's determined by the computer and its software. The C-64 uses only a 40-column text display, and changing monitors won't affect it at all. The 80-column format provided by Easy Script involves the use of scrolling the screen, but it still never displays more than 40 columns of text at a time.

There are two ways to get an 80-column display on the 64, but neither are very satisfactory solutions. One is to create a special character set using 4×8 pixel cells for the font, and using bit-map Graphics mode to display them. This is slower than Text mode, it's hard to read and very memory-intensive.

The other is to use an 80-column cartridge, which gives a true 80-column display. However, these are expensive and not supported by many software companies. Batteries Included (now out of business, but some of their product line is still available from Electronic Arts) at one time sold both an 80-column cartridge and a word processor, PaperClip, that supported it. The program is still available from Electronic Arts, but they don't carry any Batteries Included hardware. If you need customer assistance for a Batteries Included product, call 1-415-578-0316.

Q *I currently own a C-64, but I'm planning on purchasing a PC10-2 (Commodore's MS-DOS compatible computer). Is there any emulator available that would allow me to run my 64 software on the PC10?*

—PETE BUSHBAKER
DEARBORN HEIGHTS, MI

A No, it's not possible and is extremely unlikely ever to be so. In order for any computer to emulate the 64 (or any other computer) via software, it's necessary to translate all the 64's instructions and abilities into those of the computer emulating the 64, in this case your PC10. Since the PC10 is a relatively slow computer, the computational overhead would be so large that even if 64 programs could be made to work, they would run at one tenth or less of normal speed. Even on a high-speed computer like the Amiga, the 64 emulators available are so slow that they are essentially useless.

The only way it could be done is to have the 64 hardware (CPU, RAM, graphic and sound chips) on a board that could be inserted into the computer (like the Amiga's MS-DOS Bridge-Board). But the cost of such a board would probably be as much or more than a 64 by itself. The only practical method is that used by the 128, which is to have the 64 hardware installed as an integral part of the computer.

It has come to my attention that a fair number of 64 users are planning on upgrading to the Amiga in the belief that they will still be able to use their 64 software, using one of the commercially available Amiga C-64 emulators.

I checked with *RUN*'s sister publication, *AmigaWorld*, about this, conferring with Guy Wright, *AmigaWorld*'s editor-in-chief (who was at one time technical editor here at *RUN* and is still a 64 user). He was at that moment writing a review on C-64 emulators for *AmigaWorld*'s February 1988 issue.

After testing both the GO 64 and C-64 Emulator programs, he came to the general conclusion that both are so slow that even the programs that will run (and most do not) are far too slow to be usable. After watching a few demonstrations, I came to exactly the same conclusion. So, better forget about using your C-64 library on the Amiga.

To be fair, however, there are two other products available that allow you to use some 64/128 *hardware* on an Amiga. One is the C-View cable from C-Limited. This cable will connect your Amiga 500's RGB output to a 1702 or compatible composite monitor, giving you a readable color display. Another product is Access 64, which allows you to use your 1541/1571/1581 drives as well as MPS-801 compatible printers on an Amiga, in Amiga mode. It is not an emulator, but it does have some software for transferring datafiles (like word processing files) between the Amiga and the C-64.

Q *I need a hard drive for my C-128D. Can I use an IBM-style controller and interface for a Seagate ST-506 (5 meg), an ST-419 (15 meg) or an ST-225 (20 meg), preferably in RLL format? Will I be able to use the hard drive with GEOS or GEOS 128? I would rather not spend the $800 or $900 on the system Xetec offers.*

—JASON HULL
SPRINGDALE, AR

A That's a great idea, but, sad to say, one that's not possible (yet). To use any hard drive, software must be provided to drive it, to perform file management of extremely large numbers of programs or datafiles, and yet still be compatible with the majority of non-copy-protected software. This is what Xetec (and others) have done. So far, no one has developed a combination interface and software for off-the-shelf hard drives. But whoever does so will likely make a lot of money!

As for using a hard drive with GEOS, current GEOS software will not work with any hard drive for a CBM computer because of copy-protection problems.

Q *I have both the SFD-1001 and 1541 disk drives. The SFD drive is interfaced to the computer with the Skyles IEEE Flash 64 interface. My problem is finding a copy program that will let me copy programs from the 1541 to the 1001. Are there any commercial or public domain programs that do this?*

—DOUGLAS BREDA
PETERBOROUGH, NH

A Commodore guru Jim Butterfield wrote a popular program called Copy/All 64 that will work just fine. It's available from just about every user group library, local BBS or national telecommunications network around. It's also on the 1541 Test Demo disk that came with your 1541.

But if you need to copy entire disks, using a track and sector-type copier won't work. In order to get the larger capacity of the 1001 drive, it has to use a different disk format, one that's unfortunately incompatible with the 1541. So, whole disk backups are not possible. But, as mentioned, you can copy a disk one file at a time.

Other problems will arise when you try to run some software from the SFD-1001. Anything that uses the 1541 disk ROMs for faster loading or copy protection will not work correctly on the 1001. And some software may be incompatible with your IEEE interface and not run properly. ■

Lou Wallace, the author of Commodore Clinic and RUN*'s technical manager, is a prolific and expert graphics programmer.*

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From p. 14.

Although it locks C-128 programs, it must be run in 64 mode. Furthermore, locked programs can be modified by adding lines (which will appear when listed) and deleting existing lines. You can even add dummy do-nothing lines to really confuse the peeper; just be sure to precede them with a locked line containing a GOTO xxx that prevents the dummy lines from being executed.

```
Ø REM LINE LOCK - TOM HAYS            :REM*197
1Ø CK=Ø:FORL=49152 TO 49371:READD:CK=CK+D:
   POKE L,D:NEXT                         :REM*44
2Ø IF CK <> 34859 THENPRINT"ERROR IN DATA.
   ..":END                               :REM*83
3Ø INPUT"FILE TO CONVERT";P1$           :REM*161
4Ø INPUT"NEW FILE'S NAME";P2$           :REM*233
5Ø OPEN15,8,15:OPEN8,8,8,P1$+",P,R"
                                        :REM*25Ø
6Ø OPEN9,8,9,P2$+",P,W":SYS 49152:CLOSE8:C
   LOSE9:CLOSE15                        :REM*185
7Ø DATA 162,8,32,198,255,16Ø,Ø,32,2Ø7,255,
   153,224,192,141,221,192,2ØØ          :REM*135
8Ø DATA 32,2Ø7,255,153,224,192,141,222,192
   ,14Ø,22Ø,192,162,Ø,32,198,255          :REM*Ø
9Ø DATA 32,192,192,16Ø,4,169,Ø,153,224,192
   ,2ØØ,169,58,153,224,192,2ØØ          :REM*1Ø1
1ØØ DATA 153,224,192,2ØØ,153,224,192,2ØØ,1
    53,224,192,162,8,32,198,255          :REM*96
11Ø DATA 169,Ø,141,223,192,32,2Ø7,255,2Ø1,
    Ø,2Ø8,3,238,223,192,32,2Ø7,255 :REM*86
12Ø DATA 2Ø1,Ø,2Ø8,1Ø,238,223,192,173,223,
    192,2Ø1,2,24Ø,75,16Ø,2,32,2Ø7 :REM*174
13Ø DATA 255,153,224,192,2ØØ,32,2Ø7,255,15
    3,224,192,16Ø,9,32,2Ø7,255,153:REM*178
14Ø DATA 224,192,24Ø,4,2ØØ,76,116,192,14Ø,
    22Ø,192,2ØØ,152,24,1Ø9,221,192:REM*197
15Ø DATA 141,221,192,169,Ø,1Ø9,222,192,141
    ,222,192,16Ø,Ø,173,221,192,153:REM*165
16Ø DATA 224,192,2ØØ,173,222,192,153,224,1
    92,162,Ø,32,198,255,32,192,192 :REM*56
17Ø DATA 76,62,192,16Ø,Ø,169,Ø,153,224,192
    ,2ØØ,153,224,192,14Ø,22Ø,192      :REM*2
18Ø DATA 32,192,192,96,238,22Ø,192,162,9,3
    2,2Ø1,255,16Ø,Ø,185,224,192,32:REM*2Ø2
19Ø DATA 21Ø,255,2ØØ,2Ø4,22Ø,192,2Ø8,244,1
    62,3,32,2Ø1,255,96                  :REM*121
```

—Tom Hays, Gore, VA

5. Disk Drives, 1541/1571/1581

More Filename Examinations

Many newcomers (and a few old-timers) to Commodore computers probably don't realize how versatile the LOAD"$",8 statement really is. Did you know, for example, that appending a colon and ten question marks loads only those filesnames made up of ten characters? You type in the command as:

LOAD"$:??????????",8

Use eleven question marks for a list of eleven-character filenames, and so on.

Commodore 128 owners can use:

DIRECTORYU8,"??????????"

to display those files with ten characters. Finally, you can see a particular program on disk with the command:

LOAD"$:filename",8

or, in C-128 mode:

DIRECTORYU8,"filename".

—Tim Walsh, *RUN* Staff

1581 Filename Examination

When you load a program file using an asterisk wild card from either a 1541 or 1571 disk drive, filename information to the right of the asterisk is ignored, such as the N in the filename, R*N.

However, the 3½-inch 1581 disk drive interprets this type of filename differently. It does not ignore characters following the asterisk wild card, but instead loads the first file beginning with an R and ending with an N. The 1581 also works this way with C-128 disk commands such as BLoad and DLoad.

—Timothy J. Slate, Brattleboro, VT

Splat File Rescue

Nothing's worse than saving a program or file to disk, only to discover it's been converted into a splat, or open, file (marked by an asterisk) and will not load or read properly. After saving some valuable data to a sequential file, I was rudely informed by the disk directory that it had mysteriously evolved into a splat file.

In desperation, I used the Copy command to make a copy of the splat file. Eureka! My data was saved and so was my day! The only word of caution is to be sure there's sufficient space left on your disk before using this trick. Here's the Direct mode syntax for using the Copy command:

C-64: OPEN 15,8,15,"C0:NEWFILE=OLDFILE":CLOSE 15
C-128: COPY "OLDFILE" TO "NEWFILE"

—Bill Roepka, Tulsa, OK

Splat File Restoration

Commodore computers offer a rarely used and little-known M command that can also be used to restore the contents of a splat file. Here's the typical syntax:

OPEN 8,8,8,"0:FILENAME,S,M"

Unfortunately, not all splat files are restorable. If you find the file cannot be restored using the M command, or if you want to delete the splat file after examining its contents, don't risk corrupting your disk by trying to scratch it. Instead, remove the offending file with the Validate command as follows:

Basic 2.0: OPEN 15,8,15,"V":CLOSE 15
Basic 7.0: COLLECT

—Jonathan Penton, Norcross, GA

1541 Directory Hider

Keeping your disk directory hidden away from prying eyes is easy. Just type in my program, 1541 Directory Hider, save it to disk, then run it. Two prompts appear, asking you to hide or restore a directory. Select Hide, place the disk (notched) containing the directory you want to hide in the drive and let the program do its work.

To restore the directory, run the program again. Place a disk containing a hidden directory in the drive and select the Restore option.

```
Ø REM DIRECTORY HIDER - STEVE JOHNSON
                                          :REM*21Ø
1Ø PRINT"{SHFT CLR}":PRINTTAB(12)"MENU"
                                          :REM*14
2Ø PRINTTAB(12)"----"                     :REM*91
3Ø PRINTTAB(6)"(H)IDE DIRECTORY"   :REM*117
4Ø PRINTTAB(6)"(R)ECOVER DIRECTORY"
                                          :REM*232
5Ø GETB$:IFB$=""THEN5Ø                    :REM*5
6Ø IFB$="R"THENPRINT"{SHFT CLR}":GOTO16Ø
                                          :REM*151
7Ø IFB$="H"THEN9Ø                         :REM*25Ø
8Ø GOTO5Ø                                 :REM*21Ø
9Ø PRINT"{SHFT CLR}1541 DIRECTORY HIDER"
                                          :REM*3Ø
1ØØ PRINT"THIS HIDES YOUR DIRECTORY ONLY A
    FTER"                                 :REM*25Ø
11Ø PRINT"A DIRECTORY HAS BEEN LOADED FROM
     BASIC."                              :REM*19Ø
12Ø PRINT"IT WON'T WORK IF DIRECTORY IS LO
    ADED"                                 :REM*69
13Ø PRINT"USING OPEN STATEMENTS." :REM*145
14Ø PRINT"MAKE A BACKUP FIRST."       :REM*31
15Ø PRINT"{2Ø COMD Ts}"                   :REM*12
16Ø PRINT"INSERT DISK IN DRIVE 8"    :REM*Ø
17Ø PRINT"{2 CRSR DNs}PRESS [RETURN]
                                          :REM*254
18Ø FORX=1TO7:S$=S$+CHR$(Ø):NEXTX   :REM*88
19Ø GETA$:IFA$<>CHR$(13)THEN19Ø     :REM*216
2ØØ IFB$="R"THENGOSUB27Ø                  :REM*84
21Ø OPEN15,8,15:OPEN5,8,5,"#"             :REM*22
22Ø PRINT#15,"U1";5;Ø;18;Ø            :REM*215
23Ø PRINT#15,"B-P";5;164                  :REM*5Ø
24Ø PRINT#5,S$;:PRINT#15,"U2";5;Ø;18;Ø
                                          :REM*235
25Ø CLOSE5:INPUT#15,E,E$,T,S:CLOSE15
                                          :REM*1Ø2
26Ø PRINT"STATUS ->"E;E$;T;S:OPEN15,8,15,"
    I":CLOSE15:END                        :REM*48
27Ø S$="":S$=CHR$(16Ø)+"2A":FORX=1TO4:S$=S
    $+CHR$(16Ø):NEXTX:RETURN              :REM*131
```

—Steve Johnson, Sutter Creek, CA

1541C Rattle

Caution: The following trick is for experienced disk drive users, not novices. It may void your disk drive's warranty and can cause damage if performed incorrectly. If you're unsure how to perform this modification, take your 1541C to an authorized Commodore service center.

If you own a 1541C (the newest version) disk drive with the lever-type door catch, and it makes a rattling noise as though it's about to format a disk, you can cure it in short order. The jumper wire to the track-1 sensor was left uncut, so the sensor is turned off, but the 1541's DOS cannot detect its status. Cut jumper J-3, seal the end of the wire and the problem disappears.

—New Mexico User's Group Newsletter

Disk Reviving Made Simple

Did you ever receive a slightly crumpled computer disk in the mail and discover it would not load on your computer system? Later, after returning it to the manufacturer, you're informed that it worked perfectly on their equipment. The problem may not be with your disk drive, but quite possibly caused by the hole in the damaged disk slipping and sliding in the drive.

Commercial software manufacturers use powerful disk drives that could double as farm equipment, so the disk may not slip on its hub in their drives, while it does in yours.

Here's a little trick to revive crumpled disks. Lay the disk (in its jacket, of course) on a firm, flat surface and gently rub the four edges of the disk with the smooth side of a pen or pencil. More often than not, you'll have the disk turning freely and in readable condition.

—Matt Haug, Steinauer, NE

Disk Drive Identifier

Commodore 64 programmers who write disk backup or directory programs, or any others that need to detect which type of drive(s) is present, will appreciate my program, Disk Drive Identifier.

As a stand-alone program, this disk utility detects all active drives connected to your computer and prints the number of drives, their device numbers and model numbers. Moreover, this program works with most models of the Commodore 1541, 1571, 1581 and even some third-party 5¼-inch disk drives. Programmers are likely to find many other uses for this routine in their own programs.

```
Ø REM C-64 DISK DRIVE INDENTIFIER - CHRIS
  HAND                                    :REM*2Ø8
1Ø DR=Ø:FORX= 8 TO11:POKE 144,Ø      :REM*38
2Ø OPEN1,X,15                             :REM*1Ø4
3Ø POKE 144,Ø:POKE 78Ø,X:SYS 65457:REM*14Ø
4Ø POKE 78Ø,111:SYS 65427:SYS 65448:REM*8Ø
5Ø Z= ST:SYS 65454:IF Z<Ø THEN9Ø   :REM*1Ø9
6Ø CLOSE1:OPEN1,X,15,"UI"                 :REM*218
7Ø INPUT#1,EN$,EM$,ET$,ES$                :REM*192
8Ø U(DR)=X:U$(DR)=RIGHT$(EM$,4):DR=DR+1
                                          :REM*22Ø
9Ø CLOSE1:NEXT:DR=DR-1                    :REM*2Ø2
1ØØ PRINT"DRIVES ONLINE:"                 :REM*111
11Ø IF DR<Ø THENPRINT"NONE":END          :REM*4
12Ø FOR X=Ø TO DR:PRINT"{3 SPACEs}";U$(X),
    U(X)                                  :REM*174
13Ø NEXT                                  :REM*5
```

—Chris Hand, Churchville, NY

De-Selecting C-128 Auto-Boot

While the C-128's auto-boot file option is a handy feature, having it installed on your often-used disks can also lead to aggravation. Resetting the computer or simply turning it on makes the system try to load and run an auto-boot file on a disk in the drive. Furthermore, some programs autoboot when you exit them. An example of the latter occurs if you've ►

installed an auto-boot on RUN Script 128. Exiting the program with the disk in the drive causes RUN Script to re-boot.

Here's a simple solution to avoid booting an unwanted autoboot file: Don't reset the computer or turn it on with the autoboot disk in the drive. But if you do, press the run-stop/restore key combination the instant the Commodore message screen appears. You should get a clear screen and a flashing cursor. Then, in Direct mode, enter DCLOSE. Failing to do so gives you a "FILE OPEN" message the first time you press F3 for a directory.

—ROBERT V. TAYLOR, LITTLE ROCK, AR

DIRECTORY, PLEASE

When your C-64 has a Basic program in memory and you need to examine the disk directory without disturbing the program, enter the following command in Direct mode:

```
POKE 44, PEEK(46) + 1 LOAD"$",8 LIST
```

To remove the directory from memory and retrieve your Basic program, enter:

```
POKE 46, PEEK(44) – 1:POKE 44,8
```

Write these commands down and keep them close to your computer for quick reference.

—HELEN ROTH, LOS ANGELES, CA

FILE REPOSITIONER

Long-time Commodore users agree that it makes good programming sense to place your most frequently used files near the beginning of your disk directory. It not only makes loading easier, but also significantly faster on disks containing many files.

Unfortunately, repositioning files on a disk directory is not an easy process without a disk utility. If a file named Ants needs to occupy the first file position in the directory, but that slot is already occupied by a file called Bees, you're in for a little work. I wrote File Repositioner to make the process easier. The program runs in either 64 or 128 mode and is a handy utility that can be used with all of your disks.

After running the program, you're prompted to insert the disk containing the files to be repositioned. Make sure a write-protect tab is not on that disk. Next, you're prompted to enter the name of the file that you wish to switch positions with the second file. That's all there is to it, because the program takes care of all the rest!

```
Ø REM DIRECTORY RE-ARRANGER - DEAN YAMADA
  JR.                                :REM*48
1Ø PRINTCHR$(147):X=15:OPENX,8,X      :REM*9
2Ø PRINT"INSERT DISK CONTAINING FILES TO S
  WAP"                               :REM*32
3Ø PRINT"PRESS 'Q' TO QUIT"          :REM*158
4Ø PRINT"ENTER NAME OF FIRST FILE":INPUTN$
                                     :REM*251
5Ø IF N$="Q" THEN END                :REM*21Ø
6Ø PRINT#X,"CØ:MOVE=Ø:";N$           :REM*212
7Ø PRINT#X,"SØ:";N$                  :REM*164
8Ø PRINT#X,"RØ:";N$"=Ø:MOVE":PRINT:REM*115
9Ø PRINT"ENTER NAME OF 2ND FILE":INPUT A$
                                     :REM*217
1ØØ PRINT#X,"CØ:MOVE=Ø:";A$           :REM*25
11Ø PRINT#X,"SØ:";A$                  :REM*94
12Ø PRINT#X,"RØ:";A$"=Ø:MOVE":CLOSEX
                                     :REM*19
13Ø PRINT"ALL DONE!"                  :REM*71
```

—DEAN M. YAMADA, TEMPLE, TX

6. GENERAL HINTS AND TIPS

HELPFUL PRINTER HINTS

If you want to explore your printer's capabilities without the hindrance of your printer interface's limitations, then you should try printing with your interface set in Transparent mode. While this mode makes your printer a little less software-friendly, it allows a greater choice of densities when printing graphics and also prevents unwanted Commodore codes from interfering with your printer's output.

Transparent mode is accomplished on most printer interfaces by setting a DIP switch or two or by using the command:

```
OPEN 4,4,4:PRINT #4:CLOSE 4
```

or

```
OPEN 4,4,5: PRINT #4:CLOSE 4
```

If you're using a software package such as GEOS, you won't be able to use a Commodore-compatible printer driver; instead you'll have to activate your printer's driver or one that closely resembles it.

Another handy printer trick applies to anyone who experiences problems printing quotation marks in word processor documents. If you open a quotation mark, then experience a loss of left-margin space or other odd occurrences when printing, your printer may be receiving an extra code or two, triggered by the presence of the quotation mark.

You can fix this problem by getting out your printer manual and referencing the section on redefining characters. Redefine your printer's @ or £ sign into a set of quotation marks. Then, instead of using quotation marks in your document, substitute the @ or £ sign. When you print the document, the printer will print the @ or £ sign as a quotation mark.

—KEITH SILLS, NEW YORK, NY

MAGNIFYING THE TYPE

People, like myself, who are enjoying computing in their golden years may suffer from imperfect eyesight. I discovered a $4 magnifying bar at a drug store and have been happily using it ever since for typing in program listings from *RUN*. I place the bar over each line of the listing and it doubles the size of the print, making it much easier to read.

—CLYDE R. LOVELACE, KILAUEA, HI

FIXING TEMPERAMENTAL C-128S

Nearly every C-128 owner eventually encounters what I call the "Some-Keys-Ain't-Workin' Syndrome." This ailment, which only seems to affect older, flat 128s, can strike at any time. When it does, up to half the keys on the keyboard refuse to work, regardless of whether it's in 64 or 128 mode. It's usually caused by a loose keyboard ground wire.

If the computer's 90-day warranty has expired, don't pack it up for a ride to your nearest authorized Commodore service center. Instead, try this money-saving, five-minute trick that a Commodore technician showed me several years ago:

First, unplug all the cables from the computer. Next, flip it upside down and remove the Phillips screws holding the top and bottom cases together. Carefully separate the cases and unplug the LED power light connector.

At this point, you'll notice a short, thick, braided ground wire holding the keyboard to the green motherboard. That, fellow C-128ers, is the culprit. Loosen the ground wire at the motherboard with a Phillips screwdriver and re-tighten it to give the keyboard a better ground.

Now re-assemble the computer by first plugging the power light connector back in, then press the cases together, tighten the screws and plug all the cables back into the computer.

Your entire keyboard should work fine now. I've performed this quick repair on half-a-dozen or more C-128s, and only one of them failed to respond. Sometimes a trip to the service center for more extensive repairs is in order, but you should always try tightening the ground wire first.

—TIM WALSH, *RUN* STAFF

WHY AN AMIGA MONITOR?

Did you know that the original Amiga video monitor manufactured for several years by Commodore exclusively for the Amiga 1000 also makes a top-notch C-128 RGB/composite monitor? It sports a color RGB 80-column video port plus RCA plug-compatible chroma, luma and sound ports for your C-128's 40-Column mode.

While this monitor is no longer manufactured, my advice is to get one the way I did—by keeping an eye on the computer classifieds for a used Amiga and color monitor. Some Amiga owners might even be willing to sell the monitor separately from the computer. If so, you'd end up with a beautiful, reliable RGB color monitor for your C-128 at a fraction of the cost of a comparable new monitor.

—NINA OLSON, SAN ANTONIO, TX

MAILING LABEL OR DISK LABEL

Having trouble fitting a dozen or more filenames on disk labels? Can't seem to get the little rascals to stick to the disk? If so, make a quick trip to your local stationery or department store and get a small box of 1.5×3-inch mailing labels. Not only do they adhere more securely to disks, but they also offer apppreciably more space for filenames than conventional disk labels.

—PHILIP KINNEY, COLORADO SPRINGS, CO

MORE ON MAILING LABELS

Mailing labels are great time-savers for anyone who uses automatic teller machines (ATMs). Print a batch of mailing labels containing your name, account number and other ATM-required information. Ask for a few extra ATM envelopes at your bank and stick the labels to the envelopes. The result is that you waste no more time filling out envelopes at the ATM!

Another mailing label trick applies to anyone who prints them. Beware: Sooner or later a label might peel off the roll and lodge beneath your printer's platen (roller). Don't panic—you won't need to disassemble the printer. Just get a bottle of rubber cement solvent and dribble a teaspoon or so down beneath the platen, and the label should loosen and roll out. Have a pair of tweezers handy if the jammed label is stubborn. Clean the platen thoroughly with more solvent to remove any residue before continuing your printing chores.

—LONNIE BROWN, LAKELAND, FL ■

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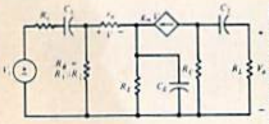

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RUN's Checksum

TYPE IN *RUN*'s CHECKSUM, which serves for both the C-64 and for the C-128 in either 40- or 80-Column mode, and save it to disk before running. When typing in a program from *RUN*, first load and run *RUN*'s Checksum. The screen will display a SYS number that deactivates and reactivates the Checksum. Always disable *RUN*'s Checksum before attempting to run another program. Note: You can abbreviate Basic keywords; spaces affect the checksum only when within quotes; and the order of characters affects the checksum.

With this new version, when you press return after typing in a program line, a one-, two-, or three-digit number from 0 to 255 appears in the home position. If this number matches the checksum value in the program listing, the line is correct. If the number that appears *doesn't* match the checksum value, compare the line with the magazine listing to find your error. Then move the cursor back up to the line and make your corrections. Now, after you press return, the correct checksum value should appear. Continue entering the listing until all the lines have been correctly typed. Then deactivate *RUN*'s Checksum, using the SYS number. Save the finished program.

All the graphics and control characters in the listings in *RUN* have been translated into understandable key combinations. They are the instructions you see inside the curly braces. For example, {SHIFT L} means you hold down the shift key while you press the L key. You do *not* type in the curly braces. What appears on the screen will look quite different from what is designated inside the braces. Here are some more examples:

{22 SPACEs}—press the space bar 22 times
{SHIFT CLR}—hold down the shift key and press the clr-home key
{2 CRSR DNs}—press the cursor-down key twice
{CTRL 1}—hold down the control key and press the 1 key
{COMD T}—hold down the Commodore logo key and press the T key
{FUNCT 1}—press the F1 key
{5 LB.s}—press the British pound key (*not* #) five times Ⓡ

Listing 1. *RUN*'s Checksum program. This program is available on *RUN*'s BBS for users to download.

```
10 REM RUN'S CHECKSUM 64/128 - BOB KODADEK
20 MO=128:SA=3328:IF PEEK(40960)THEN MO=64:SA=4
   9152
30 FOR I=0TO169:READB:CK=CK+B:POKE SA+I,B:NEXT
40 IFCK<>20651 THENPRINT"DATA ERROR!":END
50 POKESA+110,240:POKESA+111,38:POKESA+140,234
60 PRINTCHR$(147)STR$(MO)" RUN CHECKSUM":PRINT
70 PRINT"TO TOGGLE ON OR OFF, SYS"SA:IF MO=128
   THEN 100
80 POKESA+13,124:POKESA+15,165:POKESA+25,124:PO
   KESA+26,165
90 POKESA+39,20:POKESA+41,21:POKESA+123,205:POK
   ESA+124,189
100 POKESA+4,INT(SA/256):SYS SA:NEW
110 DATA 120,162,24,160,13,173,4,3,201,24,208,4
    ,162,13,160,67,142,4,3,140
120 DATA 5,3,88,96,32,13,67,152,72,169,0,141,0,
    255,133,176,133,180,166,22
130 DATA 164,23,134,167,132,168,170,189,0,2,240
    ,58,201,48,144,7,201,58,176
140 DATA 3,232,208,240,189,0,2,240,42,201,32,20
    8,4,164,180,240,31,201,34
150 DATA 208,6,165,180,73,1,133,180,230,176,164
    ,176,165,167,24,125,0,2,133
160 DATA 167,165,168,105,0,133,168,136,208,239,
    232,208,209,169,42,32,210
170 DATA 255,165,167,69,168,170,169,0,32,50,142
    ,169,32,32,210,255,32,210
180 DATA 255,169,13,32,210,255,104,168,96,104,1
    70,24,32,240,255,104,168
190 DATA 96,56,32,240,255,138,72,152,72,24,162,
    0,160,0,32,240,255,169
200 DATA 42,208,198
```

■

AUTHORS WANTED!

RUN IS ALWAYS on the lookout for programs and articles that contain interesting and useful ideas. For the most part, those ideas come from you, our readers. We rely on you to keep our files well stocked with articles and programs from which to choose.

What kinds of articles do we need? We are looking for programs—of all kinds, shapes, sizes and colors. We need useful applications for the home, small business and school. We need utilities, programmers aids, creativity software and games.

We are sure many of you have developed unique programs that you use every day. You may not realize that a whole community of users is waiting to read about and share your creations.

If you are not a programmer, don't despair. We still need you. The introduction of new Commodore products—GEOS, the 1351 mouse, the 17xx series of RAM expanders and the 1581 drive—has opened up a vast area of topics for you to write about. What commercial software packages do you use that support these devices? What are their strengths and weaknesses? Users and potential users need to know.

These are just suggestions; we're sure you can think of more. Consider this an invitation to share your knowledge and computing experiences with tens of thousands of other Commodore users. And you will be rewarded for your efforts.

To help you submit those articles and programs for publication, we provide the *RUN* author's guidelines. These information sheets give you an idea of what kinds of material we are looking for and take you step by step through the process of preparing your articles for submission.

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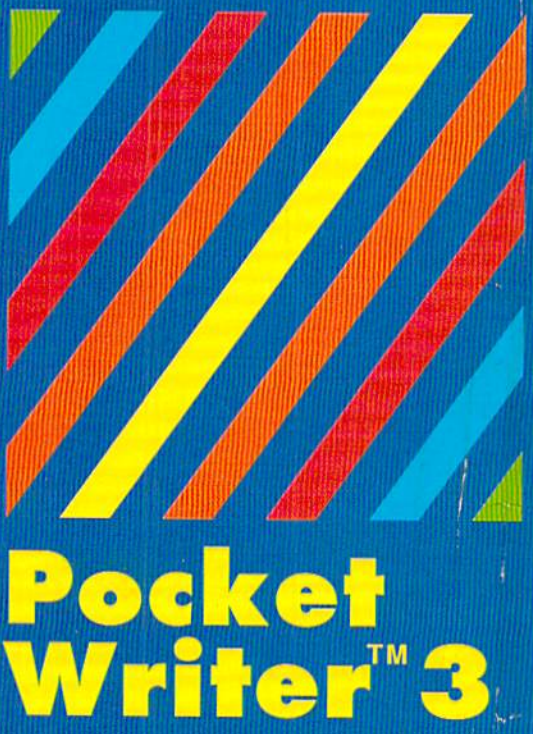

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