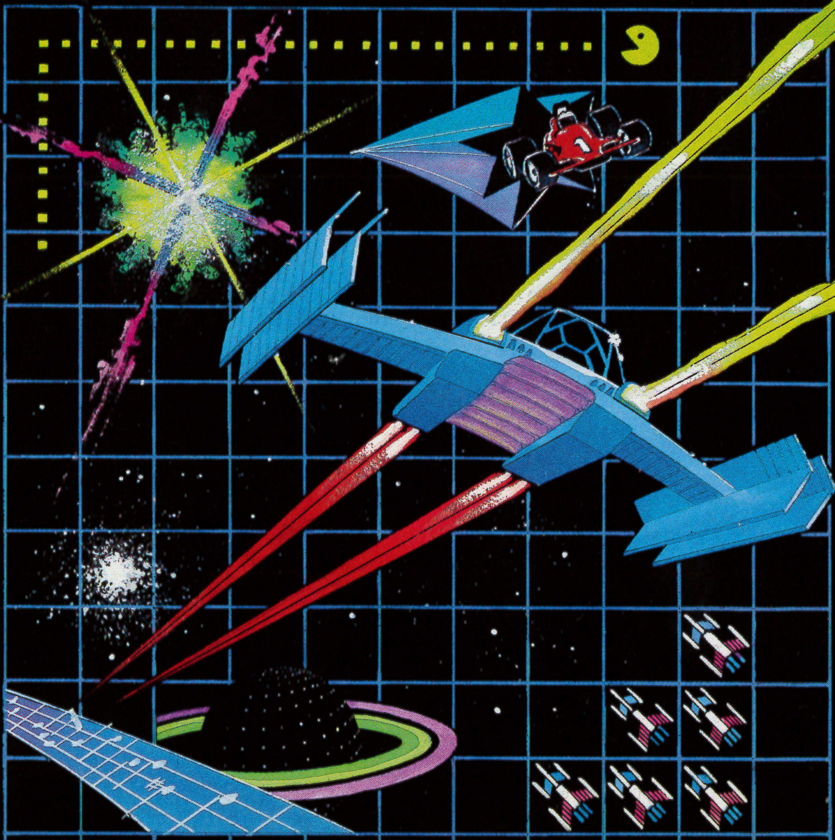
TEACH YOURSELF



BASIC GAMES PROGRAMMING

GRANDSTAND

FOR USE WITH
16 OR 32K SEGA SC-3000

SEGA®

Basic Games Programming

Introduction

The Sega SC3000 has been with us a short while now, and some excellent programs are emerging sporting excellent graphics and sound, Dollar for dollar the SC3000 beats most home micro's as far as graphic and sound capabilities are concerned. The reason for this is that Sega have been in the Video Game industry a long time and have many years of experience behind them in dealing with such matters.

This book and program will show you how to develop programming skills in games writing by producing stunning graphics and sound. The book and program are meant to run hand-in-hand, therefore, it is important that you always cross reference.

The book contains numerous exercises and programs for you to experiment with.

One final note, when experimenting with graphics and sound remember to always say to yourself ''What would happen if . . . .?'', try altering a few variables, add a few lines, delete a few lines, you may amaze yourself with what results you get!

ENJOY YOURSELF

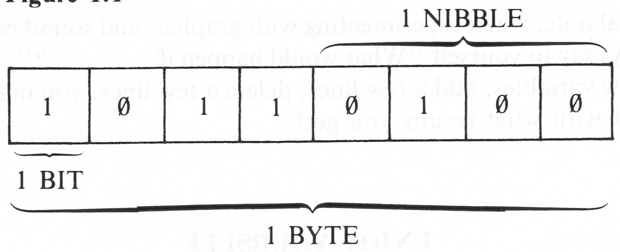
CHAPTER ONE

Sprites and Graphics

HOW TO WORK IN BINARY, HEXADECIMAL AND DECIMAL

All data in a computer is stored as groups of **bits.** A bit stands for **Binary digit** (a "Ø" or "1"). Because of the limitations of conventional electronics, the only practical representation of information uses two state logic (the representation of the state "Ø" or "1"). The two states of logic circuits are "on" and "off". These are represented by "Ø" and "1" respectively, this is termed, "Binary Logic." As a result, virtually all information stored today in home micros is in the form of a group of **8 bits.** A group of 8 bits is called **byte.** A group of 4 bits is called a **nibble.**

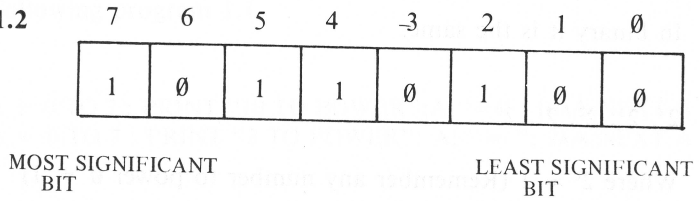
Figure 1.1



BINARY — DECIMAL

Representing a number in this 8-bit form is not quite straight forward, and is extremely important that you grasp the principals, as this is used a lot in Sprite — work. The bits in a byte are numbered and named as follows:

Figure 1.2



The numbering system may look a little bit stupid being Ø-7, why isn't it 1-8?

The answer is quite straightforward, look at the number 18Ø (decimal). "18Ø" represents:

```
  1 × 1ØØ = 1ØØ
+ 8 ×  1Ø =  8Ø
  Ø ×   1 =   Ø
-------------------
          = 18Ø
```

Note that 1ØØ = 1Ø^{2} or 1Ø × 1Ø (also 1Ø squared)
1Ø = 1Ø^{1} or 1Ø
1 = 1Ø^{0} or 1 (any number to power Ø = 1)

also 1Ø^{1} = 1;1Ø^{1} = 1Ø;1Ø^{2} = 1ØØ (1Ø × 1Ø × 1Ø);1Ø^{4} = 1Ø,ØØØ (1Ø × 1Ø × 1Ø × 1Ø) etc ...

As I am sure you know decimal is to the base ten: all numbers are represented as base ten, but in binary numbers are represented in base 2 (binary = **bi** meaning two). Now back to the original question; why is the numbering Ø-7 and not 1-8? Remember the numbering system in decimal is:

1Ø^{4}, 1Ø^{3}, 1Ø^{2}, 1Ø^{1}, 1Ø^{0}

In binary it is the same:

2^4, 2^3, 2^2, 2^1, 2^0

Where $2^0 = 1$ (Remember any number to power Ø = 1)

$2^1 = 2$

$2^2 = 4 \quad (2 \times 2)$

$2^3 = 8 \quad (2 \times 2 \times 2)$

$2^4 = 16 \; (2 \times 2 \times 2 \times 2)$

.

.

.

$2^7 = 128$

Look at the powers of 2. Ø, 1, 2, 3, 4 . . . . 7 (ie. 2^0, 2^1, 2^2, 2^3, 2^4 . . . . . 2^7) which is Ø-7.

To recap

1Ø^0 = 1	, 2^0 = 1
1Ø^1 = 1Ø	, 2^1 = 2
1Ø^2 = 1ØØ	, 2^2 = 4
1Ø^3 = 1ØØØ	, 2^3 = 8
1Ø^4 = 1ØØØØ	, 2^4 = 16
1Ø^5 = 1ØØØØØ	, 2^5 = 32
1Ø^6 = 1ØØØØØØ	, 2^6 = 64
1Ø^7 = 1ØØØØØØØ	, 2^7 = 128

Before continuing note the difference between I and 1 as this will need to be accurately copied in each program.

Try the following program 1.1

```
10 CLS
20 FOR A = 0 TO 7 : PRINT "10 TO POWER";A;"=" ; 10∧A:NEXT A
30 FOR A = 0 TO 7 : PRINT "2 TO POWER"; A; "= "; 2∧A:NEXT A
```

Ignore any extra decimal places, these are just small inaccuracies caused by the arithmetic unit in the computer (nothing serious!)

So now we can represent a number in binary.

Fig 1.3

2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
1	Ø	1	1	Ø	1	Ø	Ø
7	6	5	4	3	2	1	Ø

No doubt you are asking yourself, "what is this "1Ø11Ø1ØØ" that is appearing in the byte"? Well that is the number 18Ø! (In binary **not** decimal)

NOTE 1Ø11Ø1ØØ Binary is **NOT** equal to 1Ø 11Ø 1ØØ decimal

18Ø in decimal is shown as

```
  1 × 1ØØ = 1ØØ
+ 8 ×  1Ø =  8Ø
+ Ø ×   1 =   Ø
──────────────
          = 18Ø
```

which is equal to

1 × 1Ø^2 = 1ØØ
+8 × 101^1 = 8Ø
+Ø × 1Ø^0 = Ø

= 18Ø

1Ø11Ø1ØØ in binary is shown as

1 × 128 = 128 (2^7)
+Ø × 64 = Ø (2^6)
+1 × 32 = 32 (2^5)
+1 × 16 = 16 (2^4)
+Ø × 8 = Ø (2^3)
+1 × 4 = 4 (2^2)
+Ø × 2 = Ø (2^1)
+Ø × 1 = Ø (2^0)

= 18Ø decimal

Therefore, 1Ø11Ø1ØØ is equal to 180, understand?

There is another example: What is "ØØØ1Ø1Ø1" binary in decimal?

Remember: The leftmost bit is the most significant = 2^7 = 128
The rightmost bit is the least significant = 2^0 = 1

and that	$2^0 = 1$	$2^3 = 8$	$2^6 = 64$
	$2^1 = 2$	$2^4 = 16$	$2^7 = 128$
	$2^2 = 4$	$2^5 = 32$	

Therefore ØØØ1Ø1Ø1 =

Ø × 128 = Ø
+Ø × 64 = Ø
+Ø × 32 = Ø
+1 × 16 = 16
+Ø × 8 = Ø
+1 × 4 = 4
+Ø × 2 = Ø
+1 × 1 = 1

= 21 decimal

The following program allows you to enter an 8-digit binary number and the decimal version is produced.

Program 1.2

```
1Ø INPUT"ENTER A BINARY # (LENGTH = 8)";B$
2Ø IF LEN (B$)<>8 THEN 1Ø
3Ø DATA 128, 64, 32, 16, 8, 4, 2, 1
4Ø RESTORE: T=Ø:FOR A = 1 TO 8: READ B: IFMID$(B$,A,1)="1"THEN
T=T+B
5Ø NEXT A
6Ø PRINT "DECIMAL=";T
```

LINE 1Ø The command input tells the computer to expect information from the keyboard operator, this information must be numeric, ie. Ø and 1. Whatever is inserted in quotation marks after the command will be displayed on screen as a prompt, the information is then stored in a memory location which is labeled by you, in this instance we have chosen B$.

LINE 2Ø Checks the length to make sure if the information is the required length ie. if the length of the information stored in location B$ is less than, 8, or greater than 8 then go back to line 1Ø and ask for the information again. If not then go on to the next part of the program.

LINE 3Ø Holds the data to be read and used by the program in sequence.

LINE 4Ø (see page 63-64 handbook). Restore. Tells the computer if it has read a full line of data previously, that it can go back and read a data line again from the beginning. T=Ø sets the value of variable T, to Ø. For A = 1 to 8 sets the value of A to firstly 1, then 2 and so on up to 8. Read B sends the program to the data line, where it reads the first piece of information (128) and loads it into the location called B. Next the program says the computer must look at aspecific part of the information stored as B$ which would have been entered as a mixture of 8 zero's and ones. This is done by using Mid B$ (see page 83) where you must tell the computer where it must start looking in the length of the string and where it must stop. In this case it starts looking at A and as A=1 to 8, A is first of all, 1, then it finishes looking there as the next number is also a 1 which means it only wants one number. therefore, IF the section we are looking for in B$ which is the first number of the 8 that are there = "1" then the number stored in T which was Ø is now to be added to whatever is stored in B, which is at the moment 128 if not leave T as it is.

LINE 5Ø Next A sends the program back to the part of the program where A was established, and as A was originally 1, it now becomes 2, and then continues along the line, reading B, having already read the 1st piece of data it goes to the next and replaces that new value in location B. (64) It now looks again at the list of numbers in B$ and as A now is 2, looks at the second digit in the row to see if that is a Ø or a 1, if it is a 1 then the number in B is added to the number in T. If it is a Ø, T stays as it is. This will continue until A reaches 8, when there are no more values left to be given to A, it continues to the next line.

LINE 6Ø The computer displays whatever is between quotation marks on screen, and displays whatever the ultimate value is stored at T.

NOTE: It is very important that you get into the habit of showing all preceding "Ø" 's in binary (eg. ØØØ1Ø1Ø1 **not** 1Ø1Ø1).

EXERCISES

1.1 How many bites are there in a nibble?
1.2 How many nibbles in a byte?
1.3 What two digits are used in binary?
1.4 What is "11111111" in decimal?
1.5 What is "ØØØØØØØØ" in decimal?
1.6 From the above two questions what are the minimum and maximum number that an 8 bit byte can represent?

ANSWERS ON PAGE 36

Decimal — Binary
Now that you know how to convert Binary to Decimal, lets see how decimal is changed to binary.

This is very simple indeed, as an example take the decimal number 49 to binary.

```
49 ÷ 2   =   24,   remainder   1   →   1
24 ÷ 2   =   12,   remainder   Ø   →   Ø
12 ÷ 2   =    6,   remainder   Ø   →   Ø
 6 ÷ 2   =    3,   remainder   Ø   →   Ø
 3 ÷ 2   =    1,   remainder   1   →   1
 1 ÷ 2   =    Ø,   remainder   1   →   1
```

The binary equivalent is 11ØØØ1 (read right-most column from bottom to top), but remember 11ØØØ1 is **not** correct as it contains only 6 digits, therefore, pad out with "Ø" 's → ØØ11ØØØ1:

therefore 49 decimal = ØØ11ØØØ1 binary. Easy!

The following program converts decimal binary.

PROGRAM 1.3

```
1Ø INPUT"ENTER A NUMBER (Ø-255):";N:N=INT (N)
2Ø B$="":N1=N:IF N <Ø OR N >255 THEN 1Ø
3Ø IF N1/2< =Ø THEN 6Ø
4Ø N$=STR$(N1 MOD 2):N1=INT(N1/2)
5Ø N$=RIGHT$(N$,1):B$=N$+B$:GOTO 3Ø
6Ø IF LEN (B$)< >8THENB$= "Ø"+B$:GOTO 6Ø
7Ø CLS:PRINT N;"=";B$
```

LINE 1Ø The computer prints a prompt for you to enter a number between Ø and 255, and waits for that number to be input. It sotes it as N. Then N = INT(N) rounds the number up or down in case a percentage number is put in ie. 11.75 would become 12.

LINE 2Ø Creates a location called B$ which at present must be left empty, then NI = N creates another location holding the same value as N. Then the line checks to make sure the number that is entered in the required range ie. between Ø and 255, if not it goes back to line 1Ø.

LINE 3Ø If the amount stored in NI when it is divided by 2 is less than or equal to Ø then cut out the rest of the program and jump straight to line 6Ø.

LINE 4Ø When data which is entered is stored in a box with a label $ it is not stored as a number, just a digit, therefore, if 1 was stored in A$ and 2 was stored in B$, the result of adding AS + B$ would be 12 not 3. The statement STR$ reverses this situation, and enables information stored as a number to be treated as a string, therefore, the operation in brackets is carried out first, which takes the number stored in NI divides it by 2, and the MOD, means that whatever the remainder is, is the amount required.

That amount is then stored as a string in N$ (See page 86). Next the number in NI is reduced by half, by dividing by 2, making sure the number is whole.

LINE 5Ø Because the remainder in any calculation divided by 2 is bound to be either Ø or 1, N$ will carry one of these values B$ also carries the value of Ø, which is now added to the value of N$, as the numbers are stored as strings B$ will now become either ØØ or 1Ø so you can see a binary number is being formed, the program is now sent back to line 3Ø where the process is repreated, and NI is continually halved until the amount is less than or equal to Ø.

LINE 6Ø Checks to make sure the binary value is 8 digits long if not another Ø is added to the left hand side until it is.

LINE 7Ø Clears the screen in readiness for the final result. The computer then displays the original decimal number which was typed in and stored in N, then prints the = then the binary conversion stored in B$.

ie. 255 = 11111111 or Ø =ØØØØØØØØ

EXERCISES

1.7 convert 27 decimal to binary.
1.8 Convert 252 decimal to binary and back to decimal.

ANSWERS ON PAGE 36

USING HEXADECIMAL (or Hex)

As binary is to base 2, and decimal is to base ten, hexadecimal is to base 16 (hexa — six, deci — 1Ø, 1Ø+6=16 hexadecimal).

IN base 2 the digits Ø and 1 are used,
in base 1Ø the digits Ø,1,2,3,4,5,6,7,8, and 9 are used,
in base 16 the digits Ø1,2,3,4,5,6,7,8,9,A,B,C,D,E and F are used

CONVERSION CHART FIG 1.4

DECIMAL	BINARY	HEXADECIMAL
Ø	ØØØØ	Ø
1	ØØØ1	1
2	ØØ1Ø	2
3	ØØ11	3
4	Ø1ØØ	4
5	Ø1Ø1	5
6	Ø11Ø	6
7	Ø111	7
8	1ØØØ	8
9	1ØØ1	9
1Ø	1Ø1Ø	A
11	1Ø11	B
12	11ØØ	C
13	11Ø1	D
14	111Ø	E
15	1111	F

In hex, a group of four bits (a nibble, remember?) is encoded as one hex digit (refer Fig 1.4) also (refer P117) of operators manual).

This makes converting a binary number to a hexadecimal number easy, as 1 byte of 8 bits is made up of 2 nibbles or 2 hex numbers. This is done as follows, take the number 49 (decimal).

49 decimal = ØØ11ØØØ1

ØØ11ØØØ1 is broken down into 2 nibbles

ØØ11 and ØØØ1

now looking at Fig 1.4, ØØ11 = 3 hex
and ØØØ1 = 1 hex

49 decimal = ØØ11ØØØ1 binary = 31 hex

Another example, 215 decimal

215 decimal = 11Ø1Ø111 = 11Ø1 Ø111

11Ø1 = D hex
Ø111 = 7 hex

215 decimal = 11Ø1Ø111 binary = D7 hex

As the above example shows, storing a number in hex form is actually quite memory efficient requiring only 2 digits to store and number from Ø-255.

The following program allows you to enter a number in decimal or hex or binary and then that number is converted to the other two number systems (eg. hex → decimal and binary). The Sega allows direct entry of hexadecimal, this is done by prefixing the number with &H.

eg D7 hex = &HD7, FBhex = &HFB ...... etc.

To convert Hex → decimal or Hex → binary, work in the opposite direction. eg. 6Bhex ⇒6Hex = Ø11Ø, Bhex = 1Ø11 ⇒Ø11Ø1Ø11 binary which is equal to 1Ø7 decimal.

PROGRAM 1.4

```
1Ø CLS
2Ø PRINT "IS DATA H)EX, D)ECIMAL OR B)INARY"
3Ø D$=INKEY$: IF D$=""THEN 3Ø
4Ø IF D$="H" THEN GOSUB  1ØØ:GOSUB 22Ø:GOTO8Ø
5Ø IF D$="D"THEN GOSUB 13Ø:GOSUB 22Ø:GOTO 8Ø
6Ø IF D$ = "B" THEN GOSUB 16Ø:GOTO 8Ø
7Ø GOTO 3Ø
8Ø CLS:PRINT"HEX....:";HEX$(N),,"DECIMAL:";N,,"BINARY:";B$
9Ø GOTO 2Ø
1ØØ INPUT"ENTER HEXADECIMAL # (&HØØ-&HFF)";N
11Ø IF N<&HØØ OR N>&HFF THEN 1ØØ
12Ø RETURN
13Ø INPUT"ENTER DECIMAL # (Ø-255)";N
14Ø IF N<Ø OR N>255 THEN 13Ø
15Ø RETURN
16Ø INPUT"ENTER BINARY # (8DIGITS)";B$
17ØIF LEN(B$)< >8 THEN 16Ø
18Ø DATA 128, 64, 32, 16, 8, 4, 2, 1
19Ø RESTORE: N=Ø:FOR A=1 TO 8:READ B:IF MID$(B$,A,1)="1"THEN
N=N+B
2ØØ NEXT A
21Ø RETURN
22Ø B$="":N1=N
23Ø IF N1/2< =Ø THEN 26Ø
24Ø N$=STR$(N1 MOD 2):N1 = INT (N1/2)
25Ø N$ = RIGHT$ (N$,1):B$=N$+B$:GOTO 23Ø
26Ø IF LEN (B$)<8 THEN B$="Ø" + B$:GOTO 26Ø
27Ø RETURN
```

LINE 3Ø INKEY$ tells the computer to wait until a specified key is pushed on the keyboard, (page 9Ø). If no key is pushed it continues to wait on that line.

LINE 4Ø If the key pushed is "H" (for hexidecimal) then the program will jump to a subroutine which resides on line 1ØØ (see page 54). When all the commands there are carried out it will return the program to this line to carry out the next command, which is to jump to another subroutine on Line 22Ø and then to jump to line 8Ø.

LINE 5Ø	If the key pushed is D (for decimal) the subroutines on lines 13Ø then 22Ø are carried out before going on to Line 8Ø.
LINE 6Ø	If B is pressed (for binary) subroutine on Line 16Ø is executed before going on to Line 8Ø.
LINE 7Ø	Should any other key be pressed the program returns to line 3Ø until one of the keys is pressed.
LINE 8Ø	This line will only be executed once the calculations in the subroutines have been carried out, as this is the line which they all eventually return to. It clears the screen before printing out the eventual values of the information stored as variables N and B$.
LINE 9Ø	Starts the program running again.
LINE 1ØØ	This is the subroutine which is executed when a number is to be converted from hex into decimal and binary. The screen will prompt for a value between & HØØ & Hff which it will store as N.
LINE 11Ø	Checks to see that the entry is within the required range which is not less than or greater than those asked for.
LINE 12Ø	Returns to line 4Ø where it then jumps to line 22Ø.

LINE 22Ø	To continue the way the program runs we must now follow on with explaining this line. B$ is created, with a value NIL, and the Hex value of N, is copied into NI, the routine which was explained in program 1-3 to convert a decimal figure into binary is now performed on the hex number held in NI. This program covers lines 23Ø, 24Ø, 25Ø, 26Ø, before returning to line 4Ø from line 27Ø. The fact that in this program the computer has a hex number instead of a decimal number to work with and continually halve, makes no difference. Because the computer recognises these two methods of counting in exactly the same way and is happy to calculate with either hex values or decimal values entered.
LINE 13Ø	Prints a prompt for and awaits the input of a figure between Ø-255, then stores that as value N.
LINE 14Ø	Checks to make sure it is within the range, if it is the program continues if not, the information is rejected and the prompt is displayed again.
LINE 15Ø	Returns the program to Line 5Ø, where it then jumps to line 22Ø where the same calculation is carried out as above.
LINE 16Ø-2ØØ	Performs the calculation as in 1.2 to convert binary to decimal before returning and going direct to line 8Ø.

To clarify line 8Ø, now further, the 1st print statement tells the computer to display everthing on that line which is between quotation marks, with whatever is stored in the variable which is after the semi-colon next too it. The two commas which divide the information inside the sets of quotation marks means information will be displayed on cc secutive lines. As mentioned before the computer will treat decimal numbers the same as Hex, therefore, the value held as N, will be displayed as hex when told to ie Hex$(n).

EXERCISES

1.9 Convert 91 decimal to hex to binary.
1.a Convert 1Ø11Ø11Ø to hex.
1.b Convert AB hex to binary to decimal.
1.c Write a small program to convert a hex number to decimal **without** using a direct approach. In other words imagine that hex is **not** directly convertable to decimal, ie the hex number is a string **not** numerical.

Also incorporate error trapping — make sure data is in range Ø-F. (HINT: Use the following line 1Ø DATA Ø,1,2,3,4,5,6,7,8,9,A,B,C,D,E,F and that if you are given a number say 9B, the decimal equivalent is 9 × 16 + B, = 9 × 16 + 11 = 155 decimal).

ANSWERS ON PAGE 36

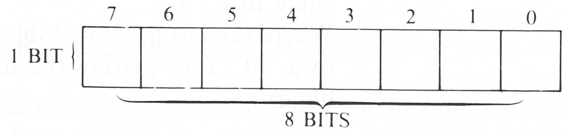
DESIGNING SPRITES AND GRAPHICS

You may be wondering what on earth binary, decimal and hex have got to do with Sprites!

Well first of all a formal definition of a Sprite: A Sprite is an array **(or matrix) of 8** × 8 dots, these dots can be placed anywhere within the matrix, therefore, defining a shape. This shape can be placed and moved all over the screen without interferring with the background, thus producing high-resolution movement. Sound like mumbo-jumbo? Not to worry, all will become clear!

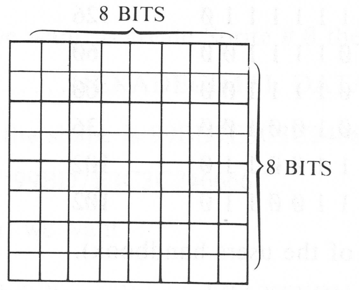
Remember what a Byte is? It's a matrix of 8 bits by 1 bit.

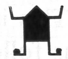
FIG 1.5



Now remember what I said a Sprite is, a matrix of 8 × 8 dots or bits. In other words 1 byte × 8 bytes, or 8 bytes one after the other, placed on top of each other.

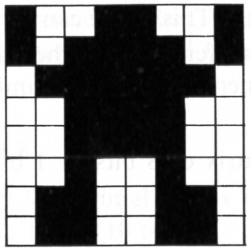
Fig 1.6



Now imagine we want to define a shape such as "  " (this is a purely abitary shape, you can define many million more).

First we transcribe the shape onto an 8 × 8 matrix.

FIG 1.7



Okay so far?
Now where there is a " ■ " this is equal to a "1"
Where there is a " □ " this is equal to a "Ø" thus getting the data into binary.

FIG 1.8	**BINARY**	**DECIMAL**	**HEX**
Therefore	1 Ø Ø 1 1 Ø Ø 1	153	99
	1 Ø 1 1 1 1 Ø 1	189	BD
	Ø 1 1 1 1 1 1 Ø	126	7E
	Ø Ø 1 1 1 1 Ø Ø	6Ø	3C
	Ø Ø 1 1 1 1 Ø Ø	6Ø	3C
	Ø Ø 1 Ø Ø 1 Ø Ø	36	24
	Ø 1 1 Ø Ø 1 1 Ø	1Ø2	66
	Ø 1 1 Ø Ø 1 1 Ø	1Ø2	66

(Refer to page 115 of the users handbook).

Now we have the information for the sprite, we must define it to the computer. This is done using the pattern command. The format for pattern is as follows:

PATTERN → S# Ø,"......data......" -for sprites

PATTERN → C# ,"......data......" -for user definable graphics

(explained later)

At the moment we are concerned only with Sprites. In our case we want to define sprite no.Ø (these are 32 different sprite no. (Ø-31), this giving us up to 32 different shapes which we can define ourselves, and it seems fairly logical to start at sprite no. Ø). This is done as follows:

PATTERN S# Ø,"99BD7E3C3C246666"

The data inside the quotation marks is the data for the shape, which we got from Fig 1.8, see all that hex data? Well all you do is join it all together to define the " " shape, and put it after a pattern statement.

TO RECAP

PATTERN S#=SPRITE NO, ".....HEXADECIMAL DATA....."

and in our case we want to create Sprite # Ø therefore we get:

PATTERN S# Ø".....HEXADECIMAL DATA....."

and the data for the shape is 99BD7E3C3C246666 therefore

PATTERN S# Ø,"99BD7E3C3C246666"

would define what we want

The number which follows the word **PATTERN** S#, can be any value you choose, up to 255, therefore, it is merely your title which gives the pattern a reference number which will later be assigned to a sprite to be used in the program.

Now that we have defined our sprite we must be able to move it around on the screen, define its colour etc. This is done using the sprite command (pretty obvious).

The parameters for the command are as follows:

Sprite Ø-31 Pattern No, (x-coord, y-coord), Pattern No, Colour

generally the screen No, and the Sprite number are the same.

Example; SPRITE Ø, (1ØØ,27), Ø, 13

Would put pattern Ø (the shape Ø onto Sprite Ø at co-ordinate 1ØØ,27 in a magenta colour.

NOTE: Sprites can only be used on the high-resolution screen (screen 2,2) and not on text screen (screen 1,1).

Now we have all this information let's write a small program to move a sprite.

```
1Ø SCREEN 2,2:CLS
2Ø PATTERNS# Ø,"99BD7E3C3C246666"
3Ø FOR I=Ø TO 255
4Ø SPRITE Ø,(I,96),Ø,13
5Ø NEXT I
6Ø GOTO 3Ø
```

LINE 1Ø Previously we have only worked in the text screen. We must now call the graphic screen (Drawing screen) using screen 2,2:CLS to clear the screen.

LINE 2Ø Draws our little frog shape which we call pattern Ø.

LINE 3Ø Sets the variable for I from Ø to 225.

LINE 4Ø Assigns our pattern to the sprite number Ø and positions it on the screen at I on the X axis which is currently Ø and 96 down and Y axis which is halfway down the screen.

LINE 5Ø Sends the program back and changes Y to 1, which then moves on to line 30 changing the position of the Sprite one place along the x axis, this continues until I=255, which means our frog moves right across the screen.

LINE 6Ø Sends the program back to the beginning where it once agains becomes Ø. To increase the speed of movement across the screen you use the step command on Line 30 ie.

FOR I =Ø to 255 STEP 2 or STEP 3 and so on. Ideally the step should be divisible into the maximum co-ordinate ie. 255.

To move the Sprite up the screen instead of across, try changing line 3Ø to FOR I = Ø to 191 and Line 4Ø to SPRITE Ø, (128,I),Ø,13.

Remember the co-ordinates for the X axis must not exceed 255 or For the Y axis 151 which is the maximum resolution.

PRECEDENCE OF SPRITES

If two sprites pass over each other, which Sprite takes precedence? ie. which one passes behind the other? Well try the following program.

PROGRAM 1.7

```
1Ø SCREEN 2,2:CLS
2Ø PATTERNS #Ø, "99BD7E3C3C246666":PATTERNS #1,
   "FFFFFFFFFFFFFFFF"
3Ø FOR I = Ø to 255
```

```
40 SPRITE 0, (I,96),0,1:SPRITE 1, (255-I,96),1,2
50 NEXT I
60 GOTO 30
```

LINE 60 Calls the graphic screen, and clears it.

LINE 20 Creates the Frog pattern 0 and a block pattern 1.

LINE 30 Sets the value of variable I.

LINE 40 Assigns the frog to Sprite 0 and the block to Sprite 1.

LINE 50 As the value of I increases the frog moves from left to right. Because Sprites with lower title numbers are senior to higher numbers the frog moves over the box, therefore, Sprite 0 is the most significant sprite, Sprite 31 is the least significant sprite.

Try the Following alteration to Program 1.7:

```
20 PATTERN$#1,"99BD7E3C3C246666":PATTERNS# 0,"FFFFFFFFFFFFFFFF"
```

This time the box has precedence. This is because Sprite# 0 has greater priority over Sprites#1, and Sprite#1 has priority over Sprite#2 etc....

It is extremely important that you understand the principle of priority and precedence.

So to sum up:

SPRITE#0 has priority over Sprite#1 has priority over Sprite#2 has priority over Sprite#3 has priority over Sprite#4 .... Sprite#30 has priority over Sprite#31.

UNDERSTAND? GOOD! (Read Page 121-122 Sega owners Handbook).

MAGNIFICATION, LARGER SPRITES AND THE MAG COMMAND

Once you have defined your sprite it is actually possible to double its size by using the MAG command. Normally MAG is set to 0, this means, "draw the sprite on the screen at normal size", but if you enter MAG 2, you can double the size, try this program.

PROGRAM 1.8

```
10 SCREEN 2,2:CLS
20 PATTERNS# 0,"99BD7E3C3C246666"
30 MAG 2: FOR I = 0 TO 191
40 SPRITE 0, (128,I),0,13
50 NEXT I
60 GOTO 30
```

LINE 10 Call high resolution screen. Clear Screen.

LINE 20 DEFINE SPRITE 0.

LINE 30-50 Cause the Sprite to double in size, move Sprite# 0, down centre of screen.

LINE 60 Repeat movement.

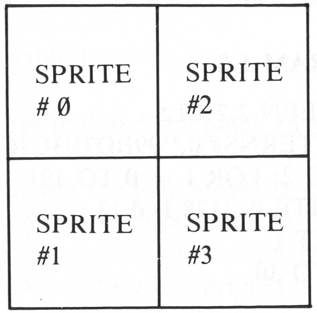
See how big the Sprite is? It has actually doubled in size! Not bad is it?! Try altering the MAG command in Line 30 to mag 0 to get back to normal size and re-run program to contrast the difference.

Now you are probably wondering, "Okay we have MAG 0 and MAG 2, but what has happened to MAG 1?". Well Mag 1 does exist and so does another Mag, MAG3. These two enable you to create one large sprite out of 4 little ones.

Basically it goes like this:

1 Draw out your image, roughly
2 Divide the image into four sectors
3 Draw four sprites out of the four sectors as follows:

FIGURE 1.9



4 Define all 4 sprites

5 Incorporate in program

Here is an example. I want to make a big alien, realizing this could not be done in one sprite I decided to join 4 sprites together.

Firstly draw out a rough idea of what you want: **FIGURE 1.A**

FIGURE 1.A

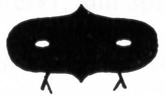
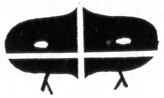


FIGURE 1.B



Now divide the little fellah into four areas FIGURE 1.B
The top left hand bit is turned into Sprite # Ø
The bottom left hand bit is turned into Sprite #1
The top right hand bit is turned into Sprite #2
The bottom right hand bit is turned into Sprite #3

The following program defines all four sprites and turns it into a big sprite.

```
1Ø SCREEN 2,2:CLS
2Ø PATTERNS # Ø,"ØØØ3Ø71F3F616D61"
3Ø PATTERNS#1,"7F3FØD183Ø78CCCC"
4Ø PATTERNS#2,"ØØCØEØF8FC86B686"
5Ø PATTERNS#3,"FEFCBØ18ØC1E3333"
6Ø MAG1:FOR I = Ø TO 255:SPRITE Ø,(I,96),Ø,4:NEXT I:GOTTO 6Ø
```

LINE 1Ø	Call high resolution screen and clear screen.
LINE 2Ø-5Ø	Define all 4 sprites.
LINE 6Ø	Set sprite size to 4 small size sprites joined together, and move dark blue sprite across centre of screen, then repeat.

Notice how in line 6Ø there is only one sprite command, this is because when the computer see's the MAG 1 command it thinks, "Ah,-ha sprite # Ø is actually sprites Ø,1,2 and 3 all joined trogether!" (Well it doesn't actually say that, but words to that effect!). Now this also works for all the sprites, as follow:

#Ø - #3 - called Sprite #Ø
#4 - #7 - called Sprite #4
#8 - #11 - called Sprite #8

#28 - #31 - called Sprite #28

Look at pp118-12Ø, user handbook.

Remember how when you had a single Sprite, you could double it's size using the MAG 2 command, well you can do the same with 4 sprites joined together using MAG 3, to find what it does alter line 6Ø in program 1.9 to MAG 3.

For other examples of sprites try the program on page 17Ø of the Users handbook. Also look at the examples of Sprites on the second screen of the "Basic Games Programming" tape. The first Sprite (the box) is an example of Mag Ø, the red sprite that goes from bottom right to top left is an example of Mag 1, and the blue sprite that rises to the top of the screen, and then goes to the bottom right is an example of MAG 3. The above part of the program lies between lines 25Ø-35Ø.

Once this page is over you are given a chance to design your own sprites by using the next point of the program called "Create-a-sprite".

You first enter whether you want to define a sprite or a user-definable graphic. What's a user definable graphic (UDG)? I here you say. Well a UDG is really a sprite to a certain extent in that you can define it, but that is where the similarity ends. A sprite is designed on an 8 × 8 matrix, a UDG is on a 6 × 8 matrix, notice how a sprite doesn't leave a trail behind it well a udg does, there are 32 sprites and 256 UDG's, a Sprite can only be printed on the high resolution screen, a UDG can go on either the text screen or the high-res screen, and finally the entire character set (see page: 154, 155 users handbook) is nothing more than a load of UDG's, and this means that you can define your own letters as you see fit, in exactly the same way as you would a Sprite. The only difference is in the PATTERN command.

Remember when we define a sprite we used the following format:

PATTERN S#Sprite No,"......Hex Data ......"

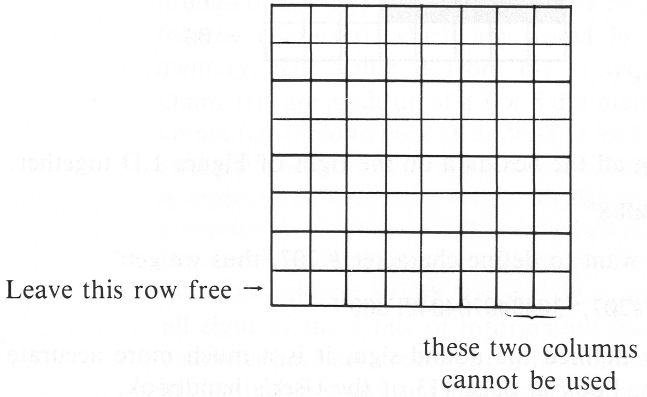
Well the only difference between the above format and that for the defining of UDG's is as follows:

PATTERN C#Character No, "......Hex Data ......"

So lets take an example. look at page 155 of the Users handbook. Now look at character No. 207, the pound sterling sign, "£", If you print the character on the screen (by using PRINT CHR$(207)) you will see it is not really a very accurate representation of the sign, so why not redefine it? Well this is how it is done it is exactly the same as defining

a sprite just that you use a 6 × 8 matrix instead of an 8 × 8 matrix. Also when it comes to defining a UDG that will be used on the text screen. It is important to leave the bottom line free as well as the rightmost column (see figure 1.C) free from any points ie. don't define these areas.

FIGURE 1.C



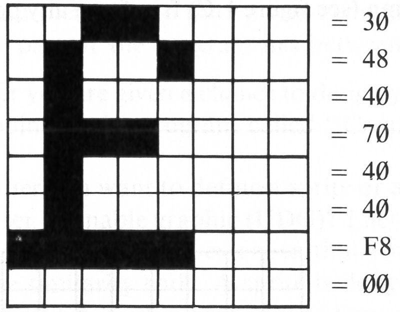
EXERCISE

1.D Why is the bit #2 column, and the bottom line kept clear? ie. no points are defined in these areas, they are left undefined. When might these be defined?

ANSWERS ON PAGE 36

Okay back to the original idea, re-defining the pound sign.

FIGURE 1.D



Now we string all the hex-data on the right of Figure 1.D together.

"3Ø484Ø7Ø4Ø4ØF8"

remember we want to define character # 207, thus we get:

PATTERN C#2Ø7,"3Ø484Ø7Ø4Ø4ØF8ØØ"

We have now defined the pound sign, it is a much more accurate representation. Look at page 113 of the User's handbook.

If you are interested try the following program. The computer stores the entire character set from address &H1ØCØ — &H17BF, when you hit RESET or on power-up, the computer re-defines the entire character set by referring to afore-mentioned addresses. (An address is just a "box" of information. The SC3000 has 32767 such "boxes" which it uses to run your programs, this area of memory is called the Read Only memory (Rom).

It is important that you press RESET before running the program.

PROGRAM 1.A

```
1Ø CLS:Z= 32
2Ø FOR A = &H1ØCØ TO &H17BF STEP 8: FOR B =Ø TO 7:N = PEEK (A + B):A$ = ""
3Ø N1 = N:IF N/2< =Ø THEN GOTO 5Ø
4Ø N$ = STR$(N1 MOD 2):N = INT(N/2):N$ = RIGHT$(N$,1):A$ = N$ + A$:GOTO 3Ø
5Ø IF LEN(A$) < 8 THEN A$ = "Ø" + A$:GOTO 5Ø
6Ø PRINT A$:NEXTB:PRINT CHR$(Z):Z = Z + 1:NEXT A
```

LINE 1Ø Clear the screen, Set variable Z to 32.

LINE 2Ø Set variable A, from a start point of &H1ØCØ to &H17BF in steps of 8. These steps represent the 8 bit gaps required for the characters which are stored in this area of memory. The value B from Ø-7 is required as the characters are made up of a 8 × 8 dot matrix. When the computer is told to peek an address, it looks at that location and reads the row of 8 bits which is there. A character is made up of 8 rows of 8 bits. PEEK (A + B) tells the computer to calculate A + B first, which in this case will increase A by one each time B increases. This will increase the ROM address &H1ØCØ to &H1ØC1, each time until all eight of the 8 bits of information making up each character have been read. This information is then stored in N, which is converted into Binary using the previously explained program from example 1.2, from lines 3Ø to 5Ø.

LINE 6Ø Prints out the binary for each byte of the character before sending the program back to look for the next bit of the character, when all eight lines of the binary for the first character in memory are printed, print CHR$(Z), whilst Z equals 32, will show that this is the start point of the character set. By referring to page 154 of the Sega manual you will see character number 33 is an exclamation mark!, therefore, this will be the next character to be found in memory and the next to be displayed in Binary form, as the computer jumps back to the beginning of the line 2Ø with next A.

The program will show you how the computer stores the information.

When using the Sprite-Editor (called create-a-sprite), there is another command not displayed. If you make a complete hash of a sprite whilst designing it, just press 'R' and all will be re-newed. When you have finished press CR and the data will be processed, then press any key and your sprite (or UDG) will be displayed.

LARGE CHARACTERS

When it comes to making headings in a program, it is always a good idea to have large lettering. This can be accomplished by using CHR$ (17). As an example try the following program. (Note: this will only work on the high-resolution screen).

PROGRAM 1.B

```
1Ø SCREEN 2,2:CLS
2Ø P$="SEGA SC3000."
3Ø COLOR 4:CURSOR 4Ø,4Ø:PRINT CHR$(17);P$
4Ø COLOR 6:CURSOR 4Ø,6Ø:PRINT CHR$(16);P$;P$
5Ø GOTO 5Ø
```

LINE 1Ø	Call high-resolution screen, clear the screen.
LINE 2Ø	Define P$, This is because in lines 3Ø and 4Ø, P$ is printed 3 times, so instead of using "Sega SC3000." 3 times, P$ is defined, this is less labourious and easier on memory.
LINE 3Ø	Print large P$ in blue.
LINE 4Ø	Print small P$ twice in red.

It is absolutely essential that when you want to go back to normal size print that you PRINT CHR$ (16) first, or the printing will be kept at double size. Look at the top two listings on page 19 of Sega Users Handbook.

COLOUR

No games program is complete without a splash of colour. Try the following program to see just how good the colour on the SC3000 is.

PROGRAM 1.C

```
1Ø SCREEN 2,2:CLS
2Ø FOR A=Ø TO 191: LINE (Ø,A)-(255,A),RND(1)*15:NEXT A
3Ø GOTO 2Ø
```

LINE 1Ø	Call graphic screen, clear screen.
LINE 2Ø	Draw lines across the screen from top to bottom in random colour between Ø and 15.
LINE 3Ø	Back to 2Ø and start again.

The best description of colour is given on pp91-1ØØ of the handbook. Just remember — when it comes to colour, use the right vivid colours, in the right places — **all** the time, it can really add that professional program look! Colour your sprites well, and have all the major features in different colours.

EXERCISE:

1.E Create a single 8 × 8 Sprite of a ball and make it move from (Ø,Ø) to (191,191) in a diagonal line, (make the ball light blue in colour).

1.F Create a large 16 × 16 sprite (MAG 1) of an alien and make it shake! (and make it blue).

ANSWERS TO CHAPTER 1 EXERCISES:

1.1 4 bits to a nibble
1.2 2 nibbles in a byte
1.3 "1" and "Ø" (one and zero)
1.4 255
1.5 Ø,Zero
1.6 Any interger in the range from Ø-255
1.7 27 dec = ØØØ11Ø11 BIN
1.8 252 dec = 111111ØØ BIN
1.9 91 dec = 5Bhex = Ø1Ø11Ø11 BIN
1.A 1Ø11Ø11Ø = B6 hex
1.B ABhex = 1Ø1Ø1Ø11 BIN = 171 dec
1.C
```
1Ø DATA Ø,1,2,3,4,5,6,7,8,9,A,B,C,D,E,F
2Ø RESTORE:INPUT"ENTER A HEX NUMBER(&HØØ-&HFF)":H$
3Ø IF LEN(H$)< >2 THEN GOTO 2Ø
4Ø FOR A=Ø TO 15:READ D$:IF MID$(H$,1,1)=D$ THEN GOTO 6Ø
5Ø NEXT: PRINT "ERROR IN DATA":END
6Ø RESTORE: FOR B=Ø TO 15: READ D$: IF MID$(H$,2,1)=D$ THENGOTO 8Ø
7Ø NEXT: PRINT"ERROR IN DATA':END
8Ø T=A*16+B:PRINT H$;"=";T
```
1.D These are kept clear so as to stop characters next to one-another, and those above and below touching. This makes the display much clearer. The only time they would be defined is in descenders (eg, lower case "g", "y" etc they have "tails" which descend below the line).
1.E
```
1Ø SCREEN 2,2:CLS:PATTERNS#Ø,"3C7EFFFFFFFF7E3C"
2Ø FOR A = Ø TO 191: SPRITE Ø, (A,A),Ø,5
```
1.F
```
1Ø SCREEN 2,2:CLS:PATTERN S#,"....Hex data.....":PATTERNS
   #1,".....":PATTERNS#2,".....":PATTERNS#3,".....":REM PUT
   YOUR OWN DATA IN.
2Ø MAG 1:SPRITE Ø, (2Ø,2Ø),Ø,7:GOTO 2Ø
```

CHAPTER TWO

Your S.C. 3000 has some of the best sound going! Most home micros have the sound output (usually a loudspeaker) within the computer. The S.C. 3000 has not. The main advantage of this is that when a manufacturer makes a computer, the quality of the internal loudspeaker is poor, thus leading to poor resolution of sound that is not steady, and generally is fairly quiet. The S.C. 3000 pumps sound through your T.V. Most T.V. manufacturers incorporate good quality speakers, and you also have the added bonus of a secondary volume control.

BEEP

The S.C. 3000 has two ways of manipulating sound, the simplest of which is BEEP.

The Beep command is followed by a number or no number. A full description and sample program is given on page 137 of the User manual.

SOUND

The next command, which is much more versatile, is the SOUND command. The parameters for sound are:

SOUND channel, frequency, volume

e.g. SOUND 1,1000,15 would cause a sound from channel 1 to be outputted at a 1,000 HZ and a maximum volume.

A good run down of the sound command is given on pages 138,139 of the Users handbook.

When you start on the sound effects of the "Basic Games Programming Cassette" you will hear the following:

An explosion, a Frogger jump, (this is the sound made by the frog when it jumps in the game of Frogger), a ping, a scale (actually one channel is getting higher, whilst the other is getting lower), and finally a really weird one.

LINE 950	holds data for explosion, don't worry about how this works yet.
LINE 970	holds data for jump.
LINE 990	holds data for ping.
LINE 1010	holds data for scale (notice how one goes up and one goes down).
LINE 1030	holds data for weird sound (this works by going through all four channels of the synchronous sound channel (channel 5)).

The next part of the program is "sound manipulation". This allows complete control over all the sound channels. Here follow some exercises to let you learn using the section on sound on cassette.

EXERCISES

2.1 Set Sound 1,110,15
Sound 2,111,15
Sound 3,112,15
Listen to that weird "droning" effect!

2.2 Hit "R" to reset (not reset key). Now move up to channel 4, set it to 4,0,15. Now alter the tone (that is the centre number which at the moment is set to 0) to 1, and then 2, then 3. On channel 3 you should get a funny, almost random buzz.

When the tone on channel 4 is set to 3, this is not the tone at all. The tone is set by channel 3! This is how it is done:-

Sound 4,3,15, Now go to channel 3. Press "C" (this allows the step of the tone i.e. how high you go in a single jump) and enter 200. Move the cursor so that the cursor is at "TONE" and hold down the "↑" key. Listen to the way the noise increases, then press "↓" and hear it decrease.

2.3 As in 2.2 but instead of channel 4, use channel 5.

2.4 Just generally play around with the routine. You really can create some very unusual sound effects.

Note: Channels 4 and 5 cannot be made to run simultaneously, although 1,2,3, and 4 can, as can 1,2,3, and 5.

Music and Sound Effects

Once you have mastered the sound command, try the following programs:-

Program 2.1 Death March

```
10 DATA 1,3,1,2,1,1,1,3,4,2,3,1,3,2,1,1,1,2,0,1,1,6
20 FOR A=0 to 10:READ B,C:SOUND 1,110 + (B*9),15: FORDE=0TO C*45:NEXT
   DE: SOUND 0: NEXT A
```

LINE 10 holds all the values relating to the frequency and the length of each note to be played.

LINE 20 For A = Ø to 1Ø means the sound will change 11 times, Read B,C will set B to the value of the first piece of data i.e. 1, and C to the Second i.e. 3, so that SOUND 1 will have a frequency level of 11Ø + 9 and a volume level 15. That note will have a duration which is set by the number of times the computer counts up what is held in the DE, which is the time 3 × 45 = 135, as soon as that is completed, it turns the sound off and goes on to the next A or next sound which will be the same frequency, as the value B will be 1 again. However, C becomes 2, so the duration will be shorter.

Program 2.2 A Little Ditty

```
1Ø DATA Ø,3,2,3,4,3,5,5,Ø,6,5,3,4,3,5,3,7,5,2,6,5,3,9,3.5,7,1.5,7,4,
5,4,5,3,5,3,4,3,2,4,4,4,5,9
2Ø FOR A=Ø TO 21:READ B,C:SOUND 1,140+(B*12),15:FOR DE
   = Ø to C*15:NEXT DE:SOUND Ø:NEXT A
```

Program 2.3 Random Tunes

```
1Ø DATA 319,379,239,319,379,239,319,379
2Ø DATA 179,358,284,179,358,284,179,358
3Ø DATA 319,426,253,319,426,253,319,426
4Ø DATA 338,426,284,338,426,284,338,426
5Ø DATA 284,379,451,284,379,251,284,379
6Ø DATA 301,379,253,301,379,253,301,379
1ØØ A=INT(RND(1)*6)+1
11Ø ON A GOSUB 1000,2000,3000,4000,5000,6000
12Ø FOR A=Ø to 7:READ B: SOUND 1,B,15 : FOR I = Ø TO
   4Ø:NEXT I,A:GOTO 1ØØ
```

```
1ØØØ RESTORE 1Ø : RETURN
2ØØØ RESTORE 2Ø : RETURN
3ØØØ RESTORE 3Ø : RETURN
4ØØØ RESTORE 4Ø : RETURN
5ØØØ RESTORE 5Ø : RETURN
6ØØØ RESTORE 6Ø : RETURN
```

LINES 1Ø-6Ø Set data for tunes.

LINE 1ØØ Set value of A to a random number between 1 and 6

LINE 11Ø On that number being = 1 gosub 1ØØ, if it is = 4, the 4th gosub address which is 4ØØØ, would be executed. This would restore only the data in line 4,ØØØ.

LINE 12Ø A now becomes Ø to 7 representing the 8 notes in each data line. B becomes the first piece of data read, which sets the frequency. I is the duration of each note, after all eight notes, the tune is restored from a new location.

LINES 1ØØØ-6ØØØ are the Restore Subroutines for the tunes.

When the above program is run , a myriad of random tunes are played.

Program 2.4 — For all you Dukes of Hazzard Fans!

```
1Ø DATA 1,2Ø,1,17,2,13,2,13,1,13,1,15,1,15,1,17,1,18,2,2Ø,2,2Ø,2,2Ø
 ,2,17
2Ø FOR I = Ø to 11:READ B,C: SOUND 1,120+C*5Ø,15:FOR T =
 Ø TO B*2Ø:NEXT T:SOUND Ø:NEXT I
```

Program 2.5 — This one is for all those with a pet Kangaroo!

```
1Ø DATA 5,1Ø,1.5,1Ø,2.5,1Ø,1.5,8,3.5,6,6,3,8,8,5,1,1.5,5,2.5,5,2.5,
 8,1.5,6,3.5,5,1Ø,6,5,1Ø,1.5,1Ø,2.5,1Ø,1.5,1Ø,1.5,8,3.5,6,6,3,8,8,5,1,1
 .5,5,2.5,8,1,6,3.5,6,3.5,8,6
2Ø FOR I = Ø to 11:READ B,C: SOUND 1,120+C*15,15:FOR DE =
 Ø TO B*1Ø:NEXT DE:SOUND Ø:NEXT I
```

Program 2.6 — For Anyone with Aussie blood!

```
10 DATA 392,100,392,75,392,25,392,100,330,100,523,100,523,75,523,
   25,494,100,440,100,392,100,392,50,392,50,440,100,392,50,392,50,
   392,100,349,50,330,50,294,100,262,50,294,50,330,100,330,50,330,
   50,294,100,294,50,294,50,262,50,294,50,330,50,262,50,220,50,247
11 DATA 50,262,100,196,100,262,50,330,50,392,100,349,50,330,50,294,
   100,294,50,294,50,262,200
20 FOR1=1TO45:READB,C:SOUND 1,B,15:FORD E=1TOC:NEX
T DE:SOUND0:NEXT1
30 SOUND0
```

CHAPTER THREE

Control

One you have designed your sprites and a colourful scenario for your game, the next thing to do is control all those "things that will be involved in the game. This usually means either using a joystic or the keyboard. The first program in the control section of "Basic Games Programming" includes the use of the keyboard. You control the sprite "x" (red in colour), by using the ,← ↓ ↑ → and keys, you move the sprite and at the same time, create a kaleidoscope effect. When you have finished, press "Q".

NOTE: do not go too near the edge as there is no error trapping within the program, and if you do go over the edge, you will force an error which would disrupt the program.

How To Use The Keyboard in Games:

Try this program. When you have entered it and run it, press the arrow keys on the right hand side of the keyboard.

Program 3.1

```
10 SCREEN 1,1:CLS
20 A$=INKEY$
30 IF A$=CHR$(28)THENB$="RIGHT":GOTO 80
40 IF A$=CHR$(29)THENB$="LEFT":GOTO 80
50 IF A$=CHR$(30)THENB$="UP":GOTO 80
60 IF A$=CHR$(31)THENB$="DOWN":GOTO 80
70 B$="NOTHING"
80 CURSOR 15,10:PRINT B$:GOTO 20
```

LINE 10 sets the program in the text screen and clears it.

LINE 2Ø	tells the computer to check which key is pressed and put the information in B$.
LINE 3Ø	If the key which is pressed is the same key as CHR$(28), which is the right arrow cursor key as indicated in Page 19 of the User Handbook, then put the word, "Right" in the B$, and jump to line 8Ø.
LINES 4Ø-6Ø	Check in the same way for the other three directional keys being pushed and store the relative directional words in B$.
LINE 7Ø	Puts the word Nothing into B$.
LINE 8Ø	Displays whatever is read as B$ centrally on Screen depending on which key, if any, has been pressed. See how it works? Using this principle, by increasing and decreasing the variables, it is possible to move things around the screen.

Try the next program

PROGRAM 3.2

```
1Ø SCREEN 1,1:CLS
2Ø X=2Ø:Y=12
3Ø A$=INKEY$
4Ø X=X-(A$=CHR$(28) )+(A$=CHR$(29) )
5Ø Y=Y-(A$=CHR$(31) )=(A$=CHR$(3Ø) )
6Ø CURSOR X,Y:PRINT "●":GOTO 3Ø
```

LINE 1Ø	Call text screen and clear it.
LINE 2Ø	Set x and y coordinates to centre of text screen.

LINE 3Ø	Load A$ with input from keyboard.
LINE 4Ø 5Ø	Increments/decrements x/y using Boolean logic (see below).
LINE 6Ø	Set print position to new x,y coordinates, print "●", continue.

When you run the program, you will probably realise that you can go off the edge of the screen, thus forcing a "statement parameter error" and stopping the program. The way to stop this happening is to set some limits on the values of x and y. Look at page 146 of the User's Handbook. You will notice that the screen has 38 digits in the horizontal direction (poition Ø — 37), and 24 digits in the longitudinal direction (position Ø — 23). By using this information we can set the limits on x and y. Remember I said that the screen goes from Ø — 39 in the horizonal direction, and that is all. Any other values smaller than Ø or greater than 39, would force an error. To prove this, enter the following as a direct command.

```
CURSOR 4Ø,1Ø
```

You will get a "statement parameter error", now try

```
Cursor -2,Ø
```

You will get the same (look at the rundown of the cursor command on pp 58-6Ø in the Users' Handbook we are only really interested in pp 58-59 at the moment), error as above. This is because the value of x is greater than 39, in the first example, and less than Ø in the second.

The same applied for the y coordinate, except the range is Ø-23.

Add the following lines to program 3.2 and you will get no errors.

```
42 IF x<Ø  THEN x = Ø
44 IF x>36 THEN x = 36
52 IF y<Ø  THEN y = Ø
54 IF y>22 THEN y = 22
```

Boolean Logic

Remember how in lines 4Ø and 5Ø of program 3.2, we got the following;-

```
x=x-(A$=CHR$(28) )+(A$=CHR$(29) )
y=y-(A$=CHR$(31) )+(A$=CHR$(30) )
```

This is an example of Boolean logic (named after George Boole (1815-1864)). The main facet of Boolean states:-

If something is true, the result is −1
If something is false, the result is Ø

If you do not understand this properly, then try the following program:-

Program 3.3

```
1Ø A$="HELLO"
2Ø PRINT A$= "HELLO"
```

LINE 1Ø Let A$="HELLO"

LINE 2Ø This is tricky bit. You are telling the computer to print, the value of A$ if it equals "HELLO". If it is true, then a result of -1 would be printed. If it is false, a result of Ø would be printed. Now we know that A$ = "HELLO", therefore the result of A$= "HELLO" is true and a result of -1 is printed.

Now try this:-

Program 3.4

```
1Ø Z = 42
2Ø PRINT z = 69
```

In this short program, you set Z to 42, you then ask the computer if Z is equal to 69, which it is not, therefore a Ø is printed (look at page 54 of Users handbook).

Now you are probably asking yourself "what on earth has all this got to do with games control?" Look very closely at this situation. You press down the "→" key, this is equal to CHR$(28) (look at page 19 of Users Handbook) line 4Ø of program 3.2 says

```
x=x-(A$=CHR$(28) )+(A$=CHR$(29) )
```

Now A$ holds CHR$(28)because you are pressing down "→" (look at line 3Ø)

If A$= CHR$(28), which it does, then a result of -1 is returned.

You agree that A$=CHR$(28), therefore it cannot equal CHR$(29), therefore if asked, "Does A$=CHR$(29)", the computer reply will be Ø (false). Understand? If not just re-read this part on Boolean algebra/logic.

Looking back at line 4Ø, we get this:-

```
x=x-(A$CHR$(28 )+(A$=CHR$(29) )
          ↓                  ↓

  This is true          This is False
 A$ does equal        A$ does not equal
    CHR$(28)              CHR$(29)
```

Therefore x=x-1 + Ø, the result is x=x+1 (when you subtract from a negative number (in this case -1) it is the same as adding the positive number e.g. 2- -4 is equal to 2 + 4 = 6.

So if you are holding down the "→" key, x will be added to by 1, the result of which is to move the cursor position, to the right.

Now imagine holding down the "←" key, A$ would equal CHR$(29), looking at line 4Ø we would get:-

x = x- (A$=CHR$(28)) + (A$=CHR$(29))

↓ ↓

This is false
A$ does not equal
CHR$(28)

This is true
A$ does equal
CHR$(29)

Therefore x = x - Ø + -1
Therefore x = z -1, because if you add a negative number, it is the same as adding a positive number e.g. 6 + -2 is equal to 6 - 2 = 4.

So if you are holding down the "←" key, x will be subtracted by 1, the result of which is to move the cursor position to the left. Get it? It's not all that hard to understand once you have got the basic concept. If would probably be better to re-read the subject. The same also works for A$=CHR$(3Ø) and A$=CHR$(31) ("↑" and "↓" respectively), except line 5Ø comes into play:

Y = Y-(A$=CHR$(31))+(A$=CHR$(3Ø))

↓ ↓

true (-1) if
A$=CHR$(31)

true (-1) if
A$=CHR$(3Ø)

Problem 3.1

What would happen if A$ does not equal CHR$(28) or CHR$(29) or CHR$(3Ø) or CHR$(31)? ie. you don't press "→","←","↑","↓"?

If you understand all the above on control, you know 99% of control using the keyboard!

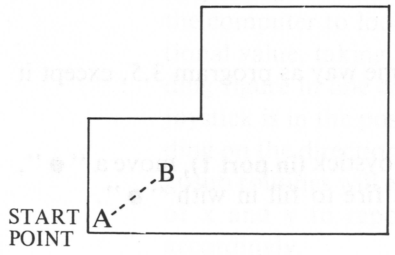
Use of Joysticks

For true control, you need a joystick. The S.C. 3ØØØ has the provision for two joysticks. These are located on the left of the computer.

The second part of the control section of "Basic Games Programming" involves the use of a joystick placed in **port 1**.

By directing the joystick in any direction, you can get the sprite "x" to move and leave a trail behind it. If you press the left fire button, you can erase dots by moving over the dots, and by pressing the right fire button, you can paint an area.

Here is an example:-



Once you have completed the box, and made sure it has no holes in its boundary, move the sprite within the box and press the right fire button. Voila! All filled in!

Note: It is absolutely necessary that the box is enclosed.
Problem 3.2 Why? (try it and find out)

Try the following program, and read page 149 of users' Handbook.

Program 3.5

```
10 SCREEN 1,1:CLS
20 A=STICK (1)
30 CURSOR 5,12:PRINT "VALUE OF STICK # 1:";A:GOTO 20
```

Program 3.5

10 call text screen and clear screen.
20 look for which direction the joystick 1 is being pushed, and store the relative value as A.
30 Prints on screen, whatever the value of A currently is, and continues to check for a change of value. This program is useful to check how sensitive the joystick you have actually is.

Program 3.5 deals with the actual stick, the next program deals with the trigger.

Program 3.6

```
10 SCREEN 1,1:CLS
20  A=STRIG(1):CURSOR  5,12:PRINT"VALUE  OF  TRIG-
GERS:";A:GOTO 20
```

Program 3.6 works in exactly the same way as program 3.5, except it reads the triggers and not the stick.

Try the following program. Use the joystick **(in port 1)**, move a "●", press the left fire to erase, the right fire to fill in with "●".

Program 3.7

```
10 SCREEN 1,1:CLS
20 X=20:Y=12:A$="●"
30 ON STICK (1) GOSUB 110,120,130,140,150,160,170,180
40 IF STICK(1)=1 THEN A$= " "
```

```
 60 IF x<0 THEN x=0
 70 IF x>36 THEN x=36
 80 IF y<0 THEN y=0
 90 IF y >21 THEN y=21
100 CURSOR x,y:PRINT "●":CURSOR x,y:PRINT A$:GOTO 30
110 y=y-1:RETURN
120 x=x+1:y=y-1:RETURN
130 x=x+1:RETURN
140 x=x+1:y=y+1:RETURN
150 y=y+1:RETURN
160 x=x-1:y=y+1:RETURN
170 x=x-1:RETURN
180 x=x-1:y=y-1:RETURN
```

LINE 20	stores values in x and y, and the graphic character of a dot in A$. You may substitute this for any symbol from the keyboard of your choice.
LINE 30	As per page 61-62 Users' Handbook. This command tells the computer to look at joystick 1, and gauges its positional value, taking that value it looks at the corresponding figure in line as being the gosub address. So if the joystick is in the position 4, it will GOSUB 140. Depending on the direction in which the joystick indicates, the gosub routines will either increase of decrease the values of x and y to reposition the dot's screen coordinate accordingly.
LINE 40	If the left hand trigger of joystick one is pushed (value 1), then a blank is to be inserted as A$, causing anything else to be erased.

LINE 5Ø If the right hand trigger is pressed, a dot is loaded into A$ again filling in the area on the screen.

LINE 6Ø-9Ø Error trapping to ensure the movement stays within required boundaries.

LINE 1ØØ Causes the dot to be printed at the x and y position on screen, or to erase anything if the left joystick was pushed.

LINES 11Ø-18Ø Variable movement calculations. All subroutines dependant on line 3Ø.

If you understand the concept of Boolean logic, the above program can be altered as follows:-

delete lines 11Ø-18Ø, and make line 3Ø:

```
3Ø A=STICK(1):x=x-(A=2)-(A=3)-(A=4)+(A=6)+(A=7)
+(A=8):y=y-(A=4)-(A=5)-(A=6)+(A=8)-(A=1)-(A=2)
```

As you can see, the use of Boolean logic, greatly reduces the number of lines needed, thus taking up less memory, and if you took a benchtest (computer jargon for testing speeds of programs), you would find that the program is faster.

Try the following program:-

Program 3.2

```
1Ø SCREEN2,2:CLS
2Ø A=5ØØ:B=Ø
3Ø SOUND 1,A,15
4Ø IF STRIG(1)=1 THEN A=A+2Ø:IF A>15ØØ THEN A=15ØØ
5Ø IF STRIG(1)=2 THEN A=A-2Ø:IF A<11Ø THEN A=11Ø
```

```
6Ø PSET(B,191-(A*.127) ),1:B=B+1:IF B>255 THEN
   CLS:B=Ø:GOTO 3Ø
7Ø GOTO 3Ø
```

LINE 1Ø **Call high resolution screen and clear it.**

LINE 2Ø Set original tone (A) to 5ØØ, and first position on screen (B) to Ø.

LINE 3Ø Make a sound set by A.

LINE 4Ø If left trigger is pressed increase sound, if A>15ØØ then limit it to 15ØØ.

LINE 5Ø If right trigger is pressed decrease sound, if A 11Ø then limit it to 11Ø.

} error trapping

LINE 6Ø Plot a point on the screen, the position of which is dependant on A and B, increase B by 1, if B>255 (i.e. off the edge of the screen) then clear the screen, set B to Ø and repeat.

LINE 7Ø Repeat.

CHAPTER FOUR

Games Programming as an Art

Manipulating the Screen

This chapter will deal with manipulation of the text screen, the reason for this is that the text screen is much easier to use than the high resolution screen, although I am sure that with a bit of ingenuity, you will be able to use the high -res screen efficiently.

Firstly, a bit of technological knowledge. The S.C. 3ØØØ contains a very special chip called a Video Display processor (VDP). This chip was created by Texas Instruments and its serial number is TI TMM9929A (bit of a mouthfull!) The information on both the text screen, and high resolution screens is stored in this chip. This is called Video Random Access Memory (VRAM).

Now we know where the screen is stored, so how do we access it? Imagine you have a friend called Bert J. Smith. This is a bit of information, okay? He lives at 1ØØ Knot Close, Williamstown, Mars. This is the address, okay? So if you wanted to store this information you might write:

Smith, Bert J,; 1ØØ Knot Close, Williamstown, Mars

Information   Address

In the VRAM, the way to access or store information is identical. The only difference is that the address is from &HØØØØ to &H3FFF (remember the &H means the numbers are hexidecimal), and the information is any number from &HØØ to &HFF. If you want to place

information in the video ram, you use the VPOKE command, which literally means "shoving information into the VRAM". The information for the text screen is held between address &H3CØØ and &H3FCØ. To try out the VPOKE command, do the following, clear the screen (by using CLS).

```
VPOKE &H3C26,&H2A
```

You will get a "*" in the top of the screen. What you have done is shoved the information (&H2A, which is a "*", look at page 156 of Users' Manual), into address &H3C26 (which is indeed the top right of the text screen). Okay, so now we have stored that information in VRAM, how do we get it out again? Well we can see it! It is that asterisk in the top right! The proper way about it is by using the VPEEK command. Remember we put &H2A (which is 42 in decimal) into address &H3C26, so in theory, if we VPEEK'ed &H3C26, we should get 42 in decimal) into address &H3C26, so in theory, if we VPEEK'ed &H3C26, we should get 42 decimal (or &H24). So now enter:

```
PRINT VPEEK &H3C26
```

And what do you get? 42!! Voila. Try other values of address and information, and refer to pp 143-148. We are interested mostly, in the left hand side of page 143 of the Users' Handbook and the top of page 144. The next small part is to explain the wierd diagram on page 148 of the User's Handbook.

Video Ram Map

A memory map is just a diagram showing what all the different addresses do. The diagram on page 148 is a map of the memory in the VDP.

Address Range	Description
&HØØØØ — &H17FF	Holds data for contents of the High Resolution Screen.

&H18ØØ — &H1FFF	If text screen is being used, this region holds data for characters to be used, i.e. PATTERN command alters these contents. If High-Res screen is being used, this region holds the data for sprites, also altered by PATTERN command.
&H2ØØØ — &H37FF	Holds the colours on the High-Res screen.
&H38ØØ — &H3AFF	An extension of &H18ØØ — &H1FFF (sort of !)
&H3BØØ — &H3BFCØ	Holds x,y coordinates and colours of all the sprites, altered by SPRITE command.
&H3CØØ — H&3FCØ	Holds data for contents of text screen, we have already manipulated this screen (remember we vpoked and vpeeked into this area).

Use of Vpoke and Vpeek

Now you are probably wondering why anyone would want to vpoke onto the screen. I mean it is much easier to print by using cursor x,y followed by a print statement. The reasons are very simple:-

1) BASIC is slow enough, but by Vpokeing and Vpeeking, you can speed up the game a little bit. It is much quicker than using cursor and print.

As a rule of thumb: If objects on the screen don't move, print them onto the screen. If an object does move, Vpoke them onto the screen.

2) Imagine in a game of Pacman*, the only way to stop the little man from going through a wall, is to look one square ahead. If it is not a wall, then the man can continue in that direction. If it is a wall he cannot get through. If you were Vpokeing the man onto the screen, then you could Vpeek the next square to see if it is a wall or not. On the other hand, if you were printing on the screen, there would be no simple way of looking one space ahead, thus making games writing impossible! Let's face it, if you don't know what is surrounding your man/ship/frog etc., how can you find out if you have eaten a power pill, been muched by a ghost, hit a wall, whether the bullet you shot has hit an alien or a base, whether your frog has been eaten by a crocodile, been hit by a truck, or got home, or whether Mario has been struck by a fire ball or picked up a hammer, or whether your ship has run into a lander or mutant, or picked up a humanoid? As I am sure you can see, the ability to look around you is extremely important, and this can only be done by Vpeek! (The above examples are taken from Pacman*, Space Invader*, Frogger*, Donkey Kong* and Defender*.

If Vokeing and Vpeeking seems a little complex, then the next thing to do is to use x and y coordintes for your little man (or woman or frog, or ship etc.,) then convert this to an address, then Vpeek that address. This can be done very simply by using the following formula. (This is for the text screen only).

Address (text screen) = Y*4Ø + x + &H3CØØ

Where x and y are the coordinates of your man etc., (This formula is given on the top of page 144 of the users' Handbook). An example of this is given in the game of "Maze Chase" in the "Basic Games Programming" Program. It is probably best to play the game a couple of times, before I describe how it works. If you have a joystick attached to port 1, then just use the stick to steer your man. If not, use the

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arrow keys. The baddie moves randomly (i.e. sometimes he may stay where he is, other times he may move), but he always comes straight for you!

Things to remember:-

"O" = CHR$ (235) = You
"●" = CHR$ (236) = Home
"■" = CHR$ (229) = Walls
"▩" = CHR$ (253) = Baddie (CHR$ (253) is originally " |" but this is redefined)

"x" = CHR$ (228) = You eat these

RUN DOWN OF GAME — MAZE CHASE

Begin by breaking into the "Basic Games Programming Cassette" (preferably once it is loaded in the computer, not with a hammer), by pushing the break key, then give the command LIST 169Ø — to show the program. Control the scrolling action with the space bar.

LINE 169Ø	This line sets up the control of our characters movements around the screen, and prints a prompt to find out whether we will use keyboard control or joystick.
LINE 17ØØ	Sets A$ as Inkey variable, if key Y is pushed, variable J becomes 2 and the program jumps to joystick control section from 173Ø onward.
LINE 171Ø	If N is PUSHED J becomes 1 and Line 173Ø will be executed as it will be true and the program jumps straight to Line 194Ø to commence the game controlled by the keyboard.

LINE 172Ø	Keeps the program scanning until a key is pushed.
LINE 194Ø	Call text screen, clear screen.
LINE 195Ø	Set titles for screen.
LINE 196Ø	Redefine character 253 (see page 155 Users' Handbook) as a pattern (UDG) and set up on screen instructions.
LINE 197Ø	Define pattern for the "x". Print instructions.
LINE 198Ø	Draws a small thick line representing a wall, sets variable S to Ø. S will become the variable holding the Score.
LINE 199Ø	At position one row across, 20 down display Score =
LINE 2ØØØ	Sets A as a slowly reducing value from 35 to 3Ø and print ○ which is representing you, at location 35 down 17 across, a sound like a footprint is then made, before the line goes back and changes the position of o one to the left as A is reduced in value, each change is accompanied by the footprint sound. A$ is then defined as ○ Five spaces away from the symbol which will chase us ▩, T = o to 1Ø causes a brief delay in each movement.
LINE 2Ø1Ø	Produces the same action as Line 2ØØØ, using the two characters in A$, making the appearance of a chase. The delay is shorter, therefore the movement is quicker.
LINE 2Ø2Ø	A$ appears to leave crosses behind as it moves across the screen, by printing x in the vacated cursor positions.

LINE 2030 The trail of x's is increased by adding to the length of A$, seven times as the value of a decreases.

LINE 2040 ○Now appears on screen and moves over the trail of x's, the sound changes as we eat the dots which are automatically erased. The value of S increases by 1 each time we move and is printed out in the location next to the word score on Screen. D stands for difficulty level, and sets the number of blocks to be set out in the maze, Score is reset to Ø.

LINE 2Ø6Ø Awaits a key to be pushed to continue.

LINE 2Ø7Ø Creates two different small sound scales played together, one increasing in tone, the other decreasing.

LINE 2Ø8Ø Builds a boundary wall all around the Screen with one solid block printed across the top, 17 rows printed with one block at the beginning of the line and one at the end. ie. Print "■ -------------- ■" and one solid line printed at the bottom.

LINE 2Ø9Ø (Refer Pg 134 Users' Manual) this lines sets a mathematical equation to randomly position the walls inside the playing area. We are defining this function as Q. The A in brackets in this instance, is merely a dummy argument and has no effect on the outcome. Once again the calculations within brackets must be carried out first. By referring to page 143 (Users' Manual), you will see &H3CØØ is the location of the top left hand corner of the text screen, the calculation will add to that hex address value, a random number between Ø and 1 multiplied by &H2DØ. This hex address corresponds to the size of the playing area, which is the full width we set for the border (1 to 17) so 4Ø × 18 = 72Ø, which is 2DØ in Hex. The reason we must add 2 at the end of the calculation is to stop blocks appearing outside the boundary. Because the boundary was PRINTED on Screen as characters, and because we can only display 38 characters across a line, the balance must be allowed for. Therefore this calculation each time it is carried out, will produce a different Hex Screen address, which will position a wall on the playing area.

LINE 21ØØ D sets the difficulty, it was previously 5Ø, now it becomes 1ØØ, so 1ØØ walls will be drawn to commence the game, variable z, counts from Ø to whatever the difficulty level is.

LINE 211Ø Variable x is loaded with the calculation stored in Function Q (the random address). VPEEK tells the computer to have a look to check whether it is less than or greater than 32. This refers to character 32 (Page 15A) which is an empty space. If not, then the space must be empty and the program continues if there is anything there, the computer goes back to the start of the line and chooses another random location, as the NEXT command has not yet been encountered, z will still be Ø and we will still have 1ØØ walls to place.

LINE 212Ø VPOKE puts into the screen location held in x, the character numbered 229 (page 155) which is a wall. NEXT send the computer back to For Z, which becomes 1 and another location is chosen on line 211Ø.

LINE 212Ø When all z's are used up, the program continues and z becomes Ø or dummy argument, one more random location is chosen, which providing it is empty, will on Line 214Ø, have character 236 representing "HOME" in the game, positioned on Screen.

LINE 215Ø x becomes a random value between 1 and 35 Y a number between 1 and 18. Representing coordinates within the playing area, P is then established as a Hex address using these random values. The coordinates are converted to Hex using the standard calculation shown on Page 144 of Users' Manual, the two is added to again put it inside the playing area. P is checked to ensure it is empty i.e. VPEEK (P + 2).

LINE 216Ø Our character is then printed out at the chosen x y coordinate. X and Y are then rounded to whole numbers.

LINE 217Ø 218Ø — Prints out the baddy shape at a different random screen location (remember this shape has been redefined).

LINE 219Ø D1 is loaded with a whole number = the difficulty level, divided by 5Ø, -1, this will give us level Ø,1,2, and so on as the game progresses. This is then printed on screen for information next to the current score, with 1Ø spaces between.

LINE 22ØØ Positions the instructions showing who is who at the bottom of the screen.

LINE 222Ø Checks keyboard and joysticks for the command to start the game by jumping to Line 115Ø.

LINE 225Ø Plays a chord to signal the start of the game and prints a blank line to erase the "Push any Key" print.

LINE 226Ø The current Score and difficulty level are displayed.

LINE 227Ø To give our character a reasonable chance of survival, the baddy is given only a 6Ø-4Ø chance of moving. This random choice will skip the baddy's movement routine if a number less than .4 is selected, slowing him down sometimes.

LINE 228Ø This works out using Boolean logic, which direction the baddie has to move to catch up with us. Firstly, a "x" is placed on the location of the baddy which is left as a trail (remember z,w, are the baddies coordinates, and "I" has been redefined as an x), then the coordinate x (remembering x, y, positions our character), is compared to the z coordinate of the baddie. If it is true that x is greater than y, the result is -1, causing the y coordinate to increase, causing the movement of the baddie to follow and home in our characters position.

LINE 229Ø Performs the same calculation to track our y coordinate compared to the baddies equivalent coordinate W.

LINE 23ØØ Checks to see whether we have been caught, i.e. x and z and y and w are the same. The death tune is played and the program jumps to the final routine. If not, continue.

LINE 231Ø The new positions of us and the baddie are displayed.

LINE 232Ø Remember Lines 17ØØ and 171Ø, where the value of J was established? If it is 2, then control is by joystijck, if it is 1, then it is keyboard. So at line 236Ø, the keyboard direction program is executed, at line 246Ø the joystick direction program.

LINE 233Ø When we have had our move, go back, alter the score if we have picked up a point, and give the baddie a chance to chase.

LINE 234Ø Prints the death line sequence, the final score S and screen prompt to press any key.

LINE 235Ø Jumps to the inkey routine on Line 1Ø6Ø to wait for a key to be pushed, then once it is, recommences the game from Lime 194Ø.

LINE 236Ø This is the keyboard movement subroutine, which looks for a direction key being pushed to alter the value of x and y. If no key is being pushed, the program immediately returns and the baddie is allowed to move.

LINE 237Ø-238Ø The Boolean logic equations for movement.

LINES 239Ø-242Ø Should a key have been pressed causing the value of x and y to increase, these will have so far only have been stored in X1 and Y1, before we can put ourselves in the new position on screen, we must check whether there is already a wall there or a power cross, or our home. So our new values of X1 and Y1 are converted to a hex screen address as P two is added again and that location is peek ed. If there is a wall there, the program returns to the

baddies turn without x and y actually being added to. If not, the current x, y position has a blank printed to erase our current position, the new value of X1 and Y1 are transferred into x, and y, and we reappear at that location.

LINE 243Ø-244Ø P is then checked again to see if our home or a power cross was stored in that location, altering our score or sending us to the victory routine.

LINE 245Ø Returns us to the baddies turn.

LINE 246Ø-248Ø Uses Boolean logic to check the joystick ports to determine direction.

LINE 249Ø Jumps to the Peek routine to check direction Score and home.

LINE 25ØØ-251Ø The victory tune, and congrats print.

LINE 252Ø Hit a key to go on.

LINE 253Ø Jump to Inkey loop, add 2Ø to score, go back to restart game and increase difficulty level.

Glossary

Address:	An area in memory. Data is stored in an address.
Binary:	A system of counting in "1" and "Ø", used by all computers. The "1"s and "Ø"s are represented in the computer by electrical impulses, either on or off.
Bit:	Binary digit, each bit represents a "1" or a "Ø". It is the smallest unit of memory.
Boolean Logic/ Algebra:	A concept invented by E. Boole in the 19th century. The concept states if something is true, let the result be -1, if false, let the result be Ø. Boolean logic is generally fast, and is good for game use.
Bug:	An error in a program.
Byte:	Eight bits, or two nibbles, can take a value of &HØØ-&HFF (Ø-255).
Decimal:	A system of counting. Used in everyday life, digits used are Ø,1 . . . . 9.
Error Trapping:	A method of limiting numbers or variables, so as to detect an error, and rectify it. If an error were to occurr, it would stop the program from running, so if the error is detected and rectified, the program will continue to function (read pp 162-165 of Users' Handbook for a list of all possible errors).

Graphic Screen:	Called up by using SCREEN 2,2 (or SHIFT/break pressed together), made up of 256 dots by 192 dots (Ø-255, Ø-191).
Hex, Hexadecimal:	A system of counting to base 16, digits used: "Ø" . . . "9", "A" . . . "F". Used in many applications in programming.
High Resolution Screen:	See Graphic Screen.
Machine Code:	The binary language that the computer understands directly. The BASIC language is converted into machinecode which the computer then executes. In the case of the SC 3ØØØ, the machine code used is Z-8Ø machine code.
Map:	As a road map shows house addresses, a memory map shows memory addresses, an example of a memory map is given on page 148 of the Users' Handbook.
Nibble:	4 Bits. Can take a value of &HØØ-&HØF (Ø-15).
Parameter:	The values which a command can take, e.g. the PATTERN command has two parameters, the first of which is a character no. or sprite no. (ranging from Ø-255 or Ø-31 respectively), the second is 8 hexadecimal numbers.
RAM:	Random Access Memory. Any memory into which you can "read" (PEEK) data or "write" (POKE) data from/to. See VRAM.

ROM:	Read Only Memory. Any memory in which information or instructions have been permanently fixed. Usually contains the BASIC language and other reference information.
Sprite:	A group of 8 × 8 dots, having 1 of 16 colours and a set of coordinates. They are moved independantly of the background and can only appear on the High-Res Screen.
Text Screen:	When computer is switched on, the text screen is on. It can be called using SCREEN 1,1 and is made up of 4Ø characters × 24 characters.
UDG	Similar to a sprite except is made up of 6 × 8 dots, and cannot be moved independantly of background.