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Table of Contents

Chapter One — System Introduction and General Information

Chapter Two — Expressions

Chapter Three — Command Mode Statements

Chapter Four — Program Statements

Chapter Five — Strings

Chapter Six — Arrays

Chapter Seven — Functions

Chapter Eight — Special Features

Chapter Nine — Editing

Chapter Ten — BASIC-80 Disk File Operations

Chapter Eleven — Microsoft BASIC-80 Summary

Appendix A — Error Messages

Appendix B — ASCII Codes

Appendix C — Programming Hints

Appendix D — Assembly Language Subroutines

Appendix E — Random and Sequential I/O Programming Examples

Index

Tables

Table

Chapter One

System Introduction and General Information

OVERVIEW

This Chapter contains an "Installation Guide" and general reference information pertaining to the BASIC-80 Programming Language. BASIC-80 is one of the most extensive implementations of BASIC available for the 8080, 8085, and Z80 microprocessors.

The hardware and systems software requirements for BASIC-80 are presented in this Chapter.

This Chapter also contains a user-oriented explanation of the operating environment of BASIC-80.

INSTALLATION GUIDE

for the Microsoft BASIC-80 Interpreter

This brief guide will provide you with some useful information to help you get BASIC-80 working in your microcomputer environment.

Contents of the Diskette

The diskette you received contains the following files:

Microsoft BASIC-80 Interpreter Diskette

MBASIC.COM
PI.BAS

MBASIC.COM is the BASIC Interpreter. Its commands and functions are discussed in this Reference Manual. PI.BAS is a sample program written in BASIC which calculates the value of pi. PI.BAS is provided to help familiarize you with the workings of the interpreter.

Sample Output of PI.BAS

The listing provided below is sample output of the PI.BAS program.

BOUNDS ON PI — DOUBLE PRECISION BIONOMIAL THEOREM VERSION

N	SIDES	SIDE LENGTH	PI-LOWER BOUND	PI-UPPER BOUND
3	8	0.76536691188812	3.06146764755249	4.95931573036713
4	16	0.39018064737320	3.12144517898560	3.87800677621650
5	32	0.19603428244591	3.13654851913452	3.47739260077205
6	64	0.09813534468412	3.14033102989197	3.30237067197655
7	128	0.04908246546984	3.14127779006958	3.22030812114884
8	256	0.02454307302833	3.14151334762573	3.18054350336212
9	512	0.01227176748216	3.14157247543335	3.16096780640274
10	1,024	0.00613591633737	3.14158916473389	3.15125708966375
11	2,048	0.00306796119548	3.14159226417542	3.14641880958168
12	4,096	0.00153398059774	3.14159226417542	3.14400368450104
13	8,192	0.00076699029887	3.14159226417542	3.14279751177684
14	16,384	0.00038349514944	3.14159226417542	3.14219477240231
15	32,768	0.00019174757472	3.14159226417542	3.14189348940372
16	65,536	0.00009587385284	3.14159440994263	3.14174501554227
17	131,072	0.00004793689368	3.14159226417542	3.14166756506744
18	262,144	0.00002396846321	3.14159440994263	3.14163205998885
19	524,288	0.00001198423161	3.14159440994263	3.14161323485294
20	1,048,576	0.00000599211580	3.14159440994263	3.14160382236958

Interpreter Results

Diskette Use

DISKETTE LOADING

Refer to Figure 1-1A or 1-1B, open the disk drive latch, and insert the diskette so the diskette label faces the open latch. Then carefully close the drive latch.

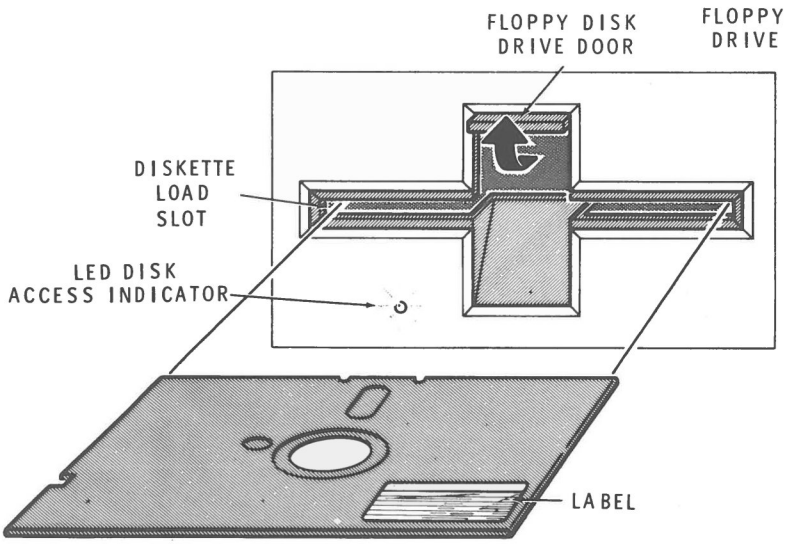


Figure 1-1A

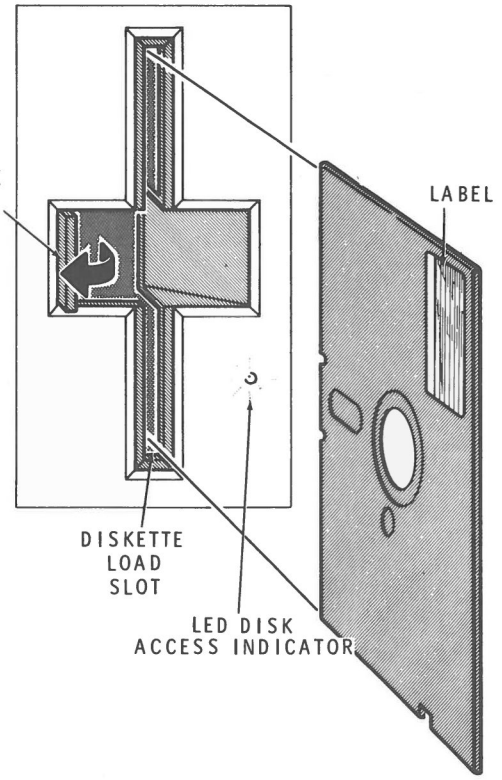


Figure 1-1B

DISKETTE HANDLING

Diskettes are easily damaged. Observe the following precautions when handling diskettes:

1. Keep the diskette in its storage envelope whenever it is not in use.

2. Keep the diskette away from magentic fields, including magnetic paper clip holders, magnetized scissors or screwdrivers, and heavy electrical equipment. Magnetic fields can distort the data recorded on the diskette.

3. Replace damaged or excessively worn storage envelopes.

4. Write only on the diskette label, and then only with a felt-tip pen. Do not use a pencil or ball-point pen, as these may damage the recording surface.

5. Keep the diskettes away from hot or contaminating material.

6. Do not expose the diskette to sunlight, liquids, or smoke.

7. Do not touch the diskette surface. Abrasions can alter stored data.

WRITE-PROTECTION

The diskette can be write-protected so that data cannot be written to it. (All distribution diskettes are shipped write-protected).

A 5.25-inch diskette has a **write-protect** notch on the side. When this notch is covered with a tab or opaque tape, no data can be written on the diskette. Figure 1-2A illustrates a write-protected 5.25-inch diskette. Figure 1-2B depicts a write-enabled 5.25-inch diskette.

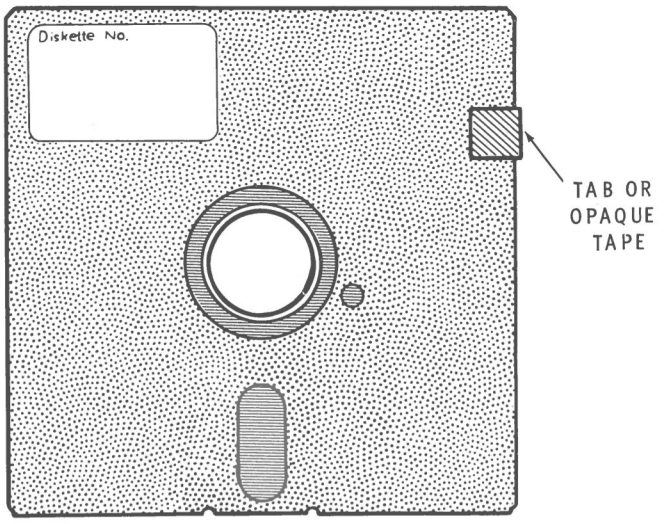


Figure 1-2A

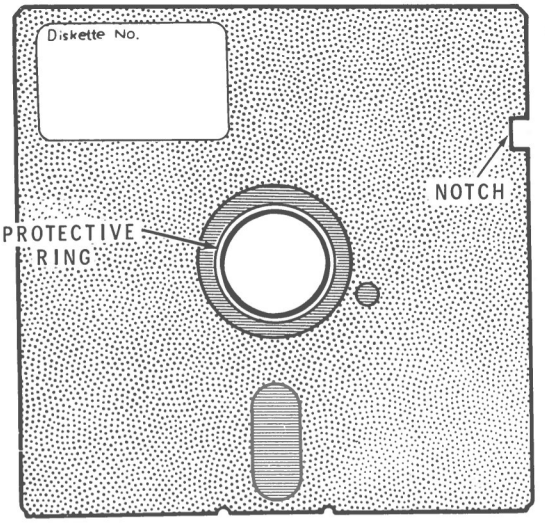


Figure 1-2B

Preparing Working Diskettes

To prepare working diskettes containing your BASIC-80 software and the CP/M Operating System, perform the following activities. (If you need more information on any activity, consult the Beginning Concepts, Start-Up Procedures, or Reference Guide section of your CP/M-85 manual.)

1. Power up your computer.
2. Perform bootstrap with CP/M Backup Disk I.
3. Initialize a blank diskette with the FORMAT utility.
4. Copy the CP/M Operating System to the formatted blank diskette with the SYSGEN activity.
5. Copy the files from your BASIC-80 Distribution Disk to the disk which just received the system using the PIP utility.

NOTE: All distribution diskettes are write-protected to ensure that you always have an accurate copy of the software. Therefore, duplicate the distribution diskettes and store them in a safe place. Use your copies for day-to-day use of the programs.

SYSTEM INTRODUCTION

Manual Scope

This BASIC-80 Reference Manual is your reference source for the BASIC-80 language. Its Chapters are organized in a functional manner. If, for example, you need information about strings, simply refer to Chapter Five, Strings.

Also included with the BASIC-80 package is an Installation Guide and a Reference Card. The Guide contains the information you needed to create a working copy of the BASIC-80 Interpreter. Keep the Reference Card handy, as it contains often needed information.

Hardware Requirements

The hardware required to run the BASIC-80 Interpreter is:

1. 8080, 8085, or Z80 microcomputer.
2. 48K of RAM.
3. One floppy disk drive.
4. Terminal device.
5. Optionally — a printer

This is the minimum hardware configuration. We recommend that you have more than one disk drive. If you plan to develop large programs, you will no doubt need a printer.

System Software Requirements

The BASIC-80 Interpreter is designed to run under CP/M version 2.0 and later.

Preparing the Diskette

The BASIC-80 Interpreter is distributed on 5.25" floppy disks. The Installation Guide furnished with this product contains the information you will need when you create your working diskette.

Never use your distribution copy of BASIC-80 except to make copies for your own use. Keep your distribution copy in a safe place. The Installation Guide contains more information about disk handling procedures.

Initialization of BASIC-80

BASIC-80 is distributed in an absolute binary format. BASIC-80 is stored on the disk with the file name MBASIC.COM. BASIC-80 can be directly loaded into memory and used. To load BASIC-80, type the following in response to the CP/M prompt:

```
MBASIC
```

This command will load MBASIC into memory. After MBASIC has been loaded into memory, a sign-on message will be displayed. The message should look similar to this:

```
BASIC-80 Rev. 5.22
[CP/M Version]
Copyright 1977-1982 (C) by Microsoft
Created: 19-MAR-82
15430 Bytes free
```

Note that the revision number, the creation date, and the number of free bytes might be different with your system.

A BASIC-80 program can be automatically executed when the file name is appended to the command string. For example, if you want to load the interpreter and run the program PI.BAS, you could use the following command string:

```
MBASIC△PI
```

The space between MBASIC and PI is required. (Throughout this manual, we will use the symbol △ to indicate a required space.) The default extension .BAS will be assumed. If the file name specified can not be found, the message "File not found" will be displayed, and you will be returned to the CP/M Command Mode.

GENERAL INFORMATION

Modes of Operation

After you have loaded the interpreter, BASIC-80 will type "Ok". This prompt signifies that BASIC-80 is in the Command Mode.

In the Command Mode, the BASIC-80 Interpreter will execute your instruction as soon as you terminate the entry with a RETURN. The commands and statements entered in Command Mode should not be preceded by line numbers. Results of arithmetic and logical operations may be displayed immediately and stored for later use, but the instructions themselves are lost after execution. This mode is useful for debugging and for using BASIC-80 as a "calculator" for quick computations that do not require a complete program.

If you begin a program line with a line number, BASIC-80 assumes that you wish to store this program line for execution at a later date. This is called the Intermediate or Program Mode. The program stored in memory will be executed if you enter the RUN command.

Line Format

Program lines in a BASIC-80 program have the following format (square brackets indicate optional):

nnnnn△BASIC-80△statement△[:BASIC-80 statement...]

At the programmer's option, more than one BASIC-80 statement may be placed on a line, but each statement on a line must be separated from the last by a colon.

A BASIC-80 program line always begins with a line number, ends with a carriage return, and may contain a maximum of 255 characters.

The △ character indicates that a space should be inserted.

It is possible to extend a logical line over more than one physical line by use of the terminal's LINE FEED key. LINE FEED lets you continue typing a logical line on the next physical line without entering a RETURN.

Line Numbers

Every BASIC-80 program line begins with a line number. Line numbers indicate the order in which the program lines are stored in memory and are also used as references for branching and editing. Line numbers must be in the range 0 to 65529. A period (.) may be used in EDIT, LIST, AUTO and DELETE commands to refer to the current line.

Line numbers can have blank spaces before them, after them, or between their digits. However, none of these spaces are mandatory.

If statements with duplicate line numbers are inserted into a program by you or if they are generated by a program, BASIC-80 will interpret only the statement with the last duplicate line number that occurs in the program. Preceding statements with the same line number will be disregarded.

Character Set

The BASIC-80 character set is comprised of alphabetic characters, numeric characters and special characters. The alphabetic characters are the upper case and lower case letters of the alphabet. The numeric characters are the digits 0 through 9.

BASIC-80 also recognizes the following special characters and terminal keys:

Character	Name
"	Quotation marks
	Blank
;	Semicolon
=	Equal sign or assignment symbol
+	Plus sign
–	Minus sign
*	Asterisk or multiplication symbol
/	Slash or division symbol
↑	Up arrow or exponentiation symbol
(	Left parenthesis
)	Right parenthesis
%	Percent
#	Number (or pound) sign
$	Dollar sign
!	Exclamation point
[	Left bracket
]	Right bracket
,	Comma
.	Period or decimal point
'	Single quotation mark (apostrophe)
:	Colon
&	Ampersand
?	Question mark
<	Less than
>	Greater than
\	Backslash or integer division symbol
@	At-sign
_	Underscore
DELETE	Deletes last character typed.
ESC	Escapes Edit Mode subcommands.
TAB	Moves print position to next tab stop. Tab stops are every eight columns.
LINE FEED	Moves to next physical line.
RETURN	Terminates input of a line.

Control Characters

The following control characters are in BASIC-80:

CTRL-A	Enters Edit Mode on the line being typed.
CTRL-C	Interrupts program execution and returns to BASIC-80 command level.
CTRL-G	Rings the bell at the terminal.
CTRL-H	Backspace. Deletes the last character typed.
CTRL-I	Tab. Tab stops are every eight columns.
CTRL-O	Halts program output while execution continues. A second Control-O restarts output.
CTRL-R	Retypes the line that is currently being typed.
CTRL-S	Suspends program execution.
CTRL-U	Deletes the line that is currently being typed.

To execute any of these control characters, hold down the CTRL key while simultaneously typing the letter. Thus, to execute CTRL-G, hold down the CTRL key while simultaneously typing the letter G.

BASIC-80 PROGRAMMING

This section will tell you how to write a BASIC-80 program and explain the unique features of the BASIC-80 programming environment. No attempt will be made to teach the subject of BASIC programming, but enough information will be provided so that you should be able to successfully use the BASIC-80 Interpreter.

Loading the BASIC-80 Interpreter

The BASIC-80 Interpeter, which must be loaded into your computer's memory before you can use it, is an absolute binary file. This means that it is in a form which can be directly executed by your computer. Before you can perform the procedures listed below, you must "boot-up" your computer. If you are not sure how to do this, refer to the appropriate operating system manual.

The CP/M file name used to reference the interpreter is MBASIC.COM. So, to load the BASIC-80 Interpreter into memory, type the following response to the prompt from CP/M:

```
A>MBASIC
```

(Do not type the A>, as this represents the prompt from CP/M. Do remember to terminate the line by pressing the RETURN key.)

This assumes that the file MBASIC.COM resides on the current default disk. If the file does not reside on the current default disk, type the drive name and then the file name. For example, if A: is the current default disk, and the BASIC-80 file resides on drive B:, you would use the following command to load BASIC-80:

```
A>B: MBASIC
```

After BASIC-80 is loaded into memory, a sign-on message will be displayed on your screen. The amount of free memory, as well as the BASIC-80 version number, will also be displayed. Take note of the amount of free memory, as this will no doubt be a crucial issue if you wish to write large, complex programs.

When BASIC-80 is loaded in the manner described above, it will make certain assumptions about the operating environment. BASIC-80 assumes that:

No more than 3 disk files will be open,
All available memory will be used,
Random record size is 128 bytes.

You can change these assumptions by using certain switches, which are explained below.

The number of disk files that can be open can range from 0-15. The /F: switch is used to specify the maximum number of files. BASIC-80 will establish a file buffer in memory for each file specified with the /F: switch. This will decrease the amount of free memory that you have to work with. For example, to set up five file buffers, you could use the following command:

A>MBASIC△/F:5

Note the space that is required between MBASIC and the /F:5. If you do not type this space, CP/M will assume that the switch is part of the file name.

You can also specify the highest memory location that BASIC-80 will use by typing the /M: switch. In some cases it is desirable to set the amount of memory well below the CP/M BDOS to reserve space for assembly language subroutines. In all cases, the highest memory location should be below the start of BDOS (whose address is contained in locations 6 and 7). If the /M: switch is omitted, all memory up to the start of BDOS is used.

NOTE: The number of files and the highest memory location numbers can be either decimal, octal (preceded by &O), or hexadecimal (preceded by &H).

You can also change the record size of a random file by using the /S: switch. The default record size is 128 bytes, and the maximum record size is 256 bytes. For example, to set the maximum record size to 200 bytes, you could use the following command:

A>MBASIC△/S:200

Any combination of these three switches can be used in a command line. For example:

A>MBASIC△PAYROLL.BAS

Use all memory and 3 files, load and execute PAYROLL.BAS

A>MBASIC△INVENT/F:6

Use all memory and 6 files, load and execute INVENT.BAS

A>MBASIC△/M:32768

Use first 32K of memory and 3 files.

After the BASIC-80 interpreter has been loaded into memory, a program may be written.

Writing a BASIC-80 Program

A BASIC-80 program is composed of lines of statements containing instructions to BASIC-80. Each of these program lines begins with a line number, followed by one or more BASIC-80 program statements. These line numbers indicate the sequence of statement execution, although this sequence may be changed by certain statements.

The format of a BASIC-80 program line is:

line number		statement keyword		statement text	line terminator
100	[optional space or tab]	LET	[optional space or tab]	X = X+1	<RETURN>

Every program line in a BASIC-80 program must begin with a line number, which must be a positive integer within the range 0 - 65529. This BASIC-80 line number is a label that distinguishes one line from another within a program. Thus, each line number in the program must be unique.

Each program line in a BASIC-80 program is terminated with a carriage return, which you can generate by pressing the RETURN key on your console device.

You could use consecutive line numbers like 1,2,3,4. For example:

```
1 X = 1
2 Y = 2
3 Z = X+Y
4 END
```

However, a useful practice is to write line numbers in increments of 10. This method will allow you to insert additional statements later between existing program lines.

```
10 X = 1
20 Y = 2
30 Z = X+Y
40 END
```

Another useful practice is to let BASIC-80 automatically generate line numbers for you. This is accomplished with the AUTO statement. The AUTO statement tells BASIC-80 to automatically generate line numbers. For example, if you type AUTO 100,10, then BASIC-80 will generate line numbers beginning with line number 100 and incrementing each line by 10. Then all you need to do is type the BASIC-80 program line after the generated line number.

Running a BASIC-80 Program

After a BASIC-80 program has been written, it is usually desirable to execute the program. The task can be accomplished by the RUN command. The following statement would tell BASIC-80 to execute the program currently in memory:

```
RUN
```

Execution begins at the lowest numbered line and continues with the next lowest numbered line (unless the sequence of execution was altered with a statement like the GOTO statement). The RUN command can also specify the first line number to be executed. For example, the following command would cause execution to begin with line number 100:

```
RUN△100
```

The RUN command can also be used to execute a BASIC-80 program that is currently residing on a disk file. For example, assume the file ALBUM.BAS resides on the current default disk. The following statement would be used to execute ALBUM.BAS:

```
RUN "ALBUM"
```

Note that no drive specification or file name extension was included in the file name string. In this case, the current default drive and the extension .BAS are assumed.

Also make sure that you always use only upper-case letters in the file name string. BASIC-80 must rely on CP/M to manipulate files for it, and most CP/M utilities cannot recognize any file whose name is stored in lower-case letters. Thus, storing a file under a lower-case file name can be very unpleasant, since CP/M cannot recognize the lower-case file name, and therefore cannot ERAse or RENname the file. Files whose names are stored in lower-case letters can be deleted only from within BASIC-80. This practice of using only upper-case letters in a file name applies to all BASIC-80 statements which require a file name to be specified.

This is not to say that there is anything intrinsically wrong in using lower-case letters in a file name; it is just that assigning lower-case file names may produce an undesirable result. You may want to use a lower-case file name to record a file in such a way that it cannot be easily renamed or erased. Thus, using lower-case file names can provide an extra level of protection for important programs.

Debugging a BASIC-80 Program

In some cases, a BASIC-80 program will not execute as you expected. This is usually a result of either a syntax error or a logic error. A syntax error is much easier to detect, as BASIC-80 will not only detect these syntax errors for you, but it will also point out the offending program line and invoke the Edit Mode. A logic error is much harder to detect, but several statements have been provided to make this a much more pleasant task.

When BASIC-80 detects a syntax error, it will automatically enter the Edit Mode at the line that caused the error. At this point, you may wish to press the L key in order to list this line. (L is a command to the BASIC-80 Editor. For more information about the Editor, see Chapter Nine, "Editing".)

Syntax errors usually result because of a misspelled keyword or an incorrectly structured program line. Remember that BASIC-80 requires all keywords to be delimited by a space. The easiest way to correct a syntax error is to rely heavily on the Reference Manual.

Anytime you have a syntax error, you should refer to the appropriate page in the Reference Manual. Use the Index to find the appropriate page. After you discover and correct your error, remember what you did wrong so you can avoid making the same mistake again.

Because of the interactive nature of BASIC-80, it is very convenient to debug a BASIC-80 program. Several statements have been provided to help you debug a BASIC-80 program. But your first step is to find out the nature of the "bug".

A program "bug" may cause the wrong values to be output. Maybe a program is branching to the wrong statement. The results of a calculation may be wrong, or even incomprehensible. A program "bug" might cause an error condition to be flagged. So you must discover what the program is doing before you can discover why the program is doing it.

Also keep in mind that, in most cases (99.99%), it is a bug in your program that is causing a problem. It is highly unlikely that the BASIC-80 Interpreter is at fault. This Interpreter represents one of the most comprehensive implementations of BASIC available for the 8080/8085/Z80, and is very reliable. So, it is best to always assume that a problem is caused by a user program bug.

Once you have decided what the program is doing, you can take steps to discover why it is not executing correctly. For example, assume that a program is branching to a line number different than where you want it to branch. The trace flag has been provided to trace the flow of a program. To enable the trace, the TRON statement is used, and to disable the trace, the TROFF statement is used.

The trace flag will print each line number as it is being executed. The line number will be enclosed in square brackets ([]). It is best to generate a hard copy listing of the program first so you can follow this listing while the trace is running.

Another important technique you can use is to set breakpoints in a program. You can use the STOP statement to temporarily terminate program execution, and then enter commands to print the values of various variables. You can also assign new values to these variables. Then you can continue program execution with a CONT command or a Command Mode GOTO.

Although you can print and change the values assigned to variables, you must not change the BASIC-80 program after you interrupted execution with a STOP statement. If you do change the program, all the previously stored variable values will be lost, and all open files will be closed.

Saving a BASIC-80 Program

When you have completed a BASIC-80 programming session, you will no doubt want to save a copy of your most current program on the disk. This is accomplished with the SAVE command. The general form of the SAVE command is:

SAVE "<filename>"

The <file name> must be a valid CP/M file name. If no device specification is given, the current default drive will be assumed. If no file name extension is given, the default extension of .BAS will be assumed. For example, if you wish to save a program called GAME.BAS, you could use the following statement:

SAVE "C:GAME.BAS"

Note that this file will be written on drive C:. The file name extension of .BAS could have been omitted, in which case it would have been supplied as the default. Make sure you always use upper case letters when specifying a file name. BASIC-80 will usually save files in a compressed binary format. A program can optionally be saved in ASCII format, but it takes more disk space to store it this way. To save a program in ASCII format, append an A to the end of the file name string. For example:

SAVE "C:GAME",A

This will save the file on drive C: in ASCII format with a file name of GAME.BAS. You can also save a program in a protected format so that it can not be listed or edited. Just append a P to the end of the file name string. For example:

SAVE "C:GAME",P

This file will be saved in an encoded binary format. When this protected file is later RUN or (LOADed), any attempt to LIST or EDIT this progam will fail.

Loading a BASIC-80 Program

When you begin a BASIC-80 programming session, you may want to load a program from the disk into memory. This is accomplished with the LOAD command. The general form of the LOAD command is:

LOAD "<filename>"

For example, if you wanted to load the program PAYROL.BAS, you could use the command:

LOAD "PAYROL"

Note that the file name extension was omitted. BASIC-80 will assume a file name extension of .BAS. Also note that the drive specification was omitted. In this case, the current default drive will be assumed.

You must specify the file name using only upper case letters. This applies to all string constants or variables that contain file names.

It is also possible to execute a program with the LOAD command. In this case, an R is appended to the end of the file name string. For example:

LOAD "PAYROL",R

This form of the LOAD command will load a program into memory and execute it as if a RUN command had been typed. All currently open files will remain open for use by the program.

Listing a BASIC-80 Program to a Hard Copy Device

At some point during your programming effort, you may want a hard copy listing of a BASIC-80 program. A BASIC-80 program is listed to a hard copy device in much the same manner as it is listed to a console device. Use the LLIST command.

The general form of the LLIST command is :

```
LLIST
```

This will list the current program on the hard copy device. It is also possible to specify the range of line numbers to be listed. For example in order to list a single line, you can use the command:

```
LLIST 100
```

This will list only the line number 100. A range of line numbers can also be specified:

```
LLIST 100-500
```

This will list line numbers 100 through 500, inclusive.

The LLIST command will direct the output to the CP/M LST: device. This logical device can be assigned to several different physical devices. Refer to your CP/M manual for information about this process.

Chapter Two

Expressions

OVERVIEW

An expression is a group of symbols to be evaluated by BASIC-80. Expressions are composed of numeric or string variables, numeric or string constants, and function references. These operands can stand alone, or they can be combined by arithmetic, logical, or relational operators. This chapter explains the various rules for constructing and evaluating expressions.

CONSTANTS

Constants are the actual values BASIC-80 uses during execution. There are two types of constants: string and numeric.

String Constants

A string constant is a sequence of up to 255 alphanumeric characters enclosed in double quotation marks. The following are examples of string constants:

```
"HELLO"
"25,000.00"
"Number of Employees"
```

Numeric Constants

Numeric constants are positive or negative numbers. Numeric constants in BASIC cannot contain commas. There are five types of numeric constants:

INTEGER CONSTANTS

Integer constants are whole numbers between −32768 and +32767. Integer constants can not have decimal points.

FIXED POINT CONSTANTS

Fixed point constants are positive or negative real numbers, that is, numbers that contain decimal points.

FLOATING POINT CONSTANTS

Floating point constants are positive or negative numbers represented in exponential form (similar to scientific notation). A floating point constant consists of an optionally signed integer or fixed point number (the mantissa) followed by the letter E and an optionally signed integer (the exponent). The allowable range for floating point constants is 10^{-38} to 10^{+38}.

Examples:

```
235.988E-7 = .0000235988
2359E6     = 2359000000
```

(Double-precision floating point constants use the letter D instead of E.)

HEX CONSTANTS

Hexadecimal constants are hexadecimal numbers with the prefix &H.

Examples:

```
&H76
&H32F
```

OCTAL CONSTANTS

Octal constants are octal numbers with the prefix &O or &.

Examples:

```
&0347
&1234
```

SINGLE AND DOUBLE-PRECISION NUMERIC CONSTANTS

Fixed and floating point numeric constants may be either single-precision or double-precision numbers. With double-precision, the numbers are stored with 16 digits of precision, and printed with up to 16 digits.

A single-precision constant is any numeric constant that has:

1. Seven or fewer digits, or,
2. Exponential form using E, or,
3. A trailing exclamation point (!).

A double-precision constant is any numeric constant that has:

1. Eight or more digits, or,
2. Exponential form using D, or,
3. A trailing number sign (#).

Examples:

Single-Precision Constants	Double-Precision Constants
46.8	345692811
-7.09E-06	-1.09432D-06
3489.0	3489.0#
22.5!	7654321.1234

VARIABLES

Variables are names which represent values that are used in a BASIC-80 program. The value of a variable may be assigned explicitly by the programmer, or it may be assigned as the result of calculations in the program. Before a variable is assigned a value, its value is assumed to be zero.

Variable Names and Declaration Characters

BASIC-80 variable names can contain up to 40 characters, all of which are significant. The characters allowed in a variable name are letters and numbers, and the decimal point is also allowed in a variable name. The first character must be a letter.

A variable name may not be a reserved word. BASIC-80 will allow embedded reserved words to be part of a variable name. If a variable begins with FN, it is assumed to be a call to a user-defined function. Reserved words include all BASIC-80 commands, statements, function names, and operator names.

Variables may represent either a numeric value or a string. String variable names are written with a dollar sign ($) as the last character. For example: A$ = "SALES REPORT". The dollar sign is a variable type declaration character; that is, it "declares" that the variable will represent a string.

Numeric variable names may declare integer, single-precision, or double-precision values. The type declaration characters for these variable names are as follows:

%	Integer variable
!	Single-precision variable
#	Double-precision variable

The default type for a numeric variable name is single-precision.

Examples of BASIC-80 Variable Names:

PI#	Declares a double-precision value.
MINIMUM!	Declares a single-precision value.
LIMIT%	Declares an integer value.

There is a second method by which variable types may be declared. The BASIC-80 statements DEFINT, DEFSTR, DEFSNG and DEFDBL may be included in a program to declare the types for certain variable names. These statements are described in detail in Chapter Four, "Program Statements."

Array Variables

An array is a group or table of values referenced by the same variable name. Each element in an array is referenced by an array variable that is subscripted with integers or integer expressions. An array variable name has as many subscripts as there are dimensions in the array.

For example, V(10) would reference a value in a one-dimensional array, T(1,4) would reference a value in a two-dimensional array, and so on. The maximum number of dimensions in an array is 255. The maximum number of elements per dimension is 32767. See Chapter Six, "Arrays," for more information.

TYPE CONVERSIONS

When necessary, BASIC-80 will convert a numeric constant from one type to another. The following rules and examples illustrate these type conversions.

If a numeric constant of one type is set equal to a numeric variable of a different type, the number will be stored as the type declared in the variable name. (If a string variable is set equal to a numeric value or vice versa, a "Type mismatch" error occurs.)

Example:

```
10 A% = 23.42
20 PRINT A%
RUN
 23
```

During expression evaluation, all of the operands in an arithmetic or relational operation are converted to the same degree of precision as the most precise operand. Also, the result of an arithmetic operation is returned to this degree of precision.

Example:

```
10 D# = 6#/7
20 PRINT D#
RUN
 .8571428571428571
```

In the above example, the arithmetic was performed in double-precision and the result was returned in D# as a double-precision value.

```
10 D = 6#/7
20 PRINT D
RUN
 .857143
```

In this example, the arithmetic was performed in double-precision and the result was returned to D (a single-precision variable); thus rounded and printed as a single-precision value.

When a fixed point value is converted to an integer, the fractional portion is rounded.

Example:

```
10 C% = 55.88
20 PRINT C%
RUN
 56
```

If a double-precision variable is assigned a single-precision value, only the first seven digits, rounded, of the converted number will be valid. This is because only seven digits of accuracy were supplied with the single-precison value.

The absolute value of the difference between the printed double-precision number and the original single-precision value will be less than 6.3E-8 times the original single-precision value.

Example:

```
10 A = 2.04
20 B# = A
30 PRINT A;B#
RUN
 2.04    2.039999961853027
```

EXPRESSIONS AND OPERATORS

An expression may be simply a string or numeric constant, or a variable, or it may combine constants and variables with operators to produce a single value.

Operators perform mathematical or logical operations on values. The operators provided by BASIC-80 may be divided into four categories:

1. Arithmetic
2. Relational
3. Logical
4. Functional

Arithmetic Operators

The arithmetic operators, in order of precedence, are:

Operator	Operation	Sample Expression
^	Exponentiation	X^Y
–	Negation	–X
*	Multiplication	X*Y
/	Floating Point Division	X/Y
\	Integer Division	X\Y
+	Addition	X+Y
–	Subtraction	X–Y

Table 2-1
Arithmetic Operators.

To change the order in which operations are performed, use parentheses. Operations within parentheses are performed first. Inside parentheses, the usual order of operations is maintained.

Thus, the expression:

```
A*(Z-((Y+R)/T))^J+VAR
```

is evaluated in the following sequence:

```
Y+R = e1
(e1/T) = e2
Z-e2 = e3
e3^J = e4
A*e4 = e5
e5+VAR = e6
```

INTEGER DIVISION AND MODULUS ARITHMETIC

Two additional arithmetic operators are available in BASIC-80, integer division and modulus arithmetic.

Integer division is denoted by the backslash (\). The operands are rounded to integers (must be in the range -32768 to 32767) before the division is performed, and the quotient is truncated to an integer. For example:

```
10\4 = 2
25.68\6.99 = 3
```

The precedence of integer division is just after multiplication and floating point division.

Modulus arithmetic is denoted by the operator MOD. It gives the integer value that is the remainder of an integer division. For example:

```
10.4 MOD 4 = 2 (10\4=2 with a remainder 2)
25.67 MOD 6.99 = 5 (26\7=3 with a remainder 5)
```

The precedence of modulus arithmetic is just after integer division.

OVERFLOW AND DIVISION BY ZERO

If, during the evaluation of an arithmetic expression, an operation that divides by zero is encountered, the "Division by zero" error message is displayed. The interpreter also inserts the machine infinity value, (1.70141E +38) with the sign of the numerator as the result of the division, and execution continues.

If the evaluation of an exponentiation results in zero being raised to a negative power, the "Division by zero" error message is displayed, positive machine infinity is supplied as the result of the exponentiation, and execution continues.

If overflow occurs, the "Overflow" error message is displayed, machine infinity with the algebraically correct sign is supplied as the result, and execution continues.

Relational Operators

Relational operators are used to compare two values. The result of the comparison is either "true" (−1) or "false" (0). This result may then be used to make a decision regarding program flow.

Operator	Relation Tested	Expression
=	Equality	X=Y
<>	Inequality	X<>Y
<	Less than	X<Y
>	Greater than	X>Y
<=	Less than or equal to	X<=Y
>=	Greater than or equal to	X>=Y

Table 2-2
Relational Operators.

(The equal sign is also used to assign a value to a variable.)

When arithmetic and relational operators are combined in one expression, the arithmetic is always performed first. For example, the expression

```
X+Y < (T-1)/Z
```

is true if the value of X plus Y is less than the value of T-1 divided by Z.

Examples:

```
IF SIN (X)<0 GOTO 1000
IF I MOD J <> 0 THEN K=L+1
```

Logical Operators

Logical operators perform bit manipulation, tests on multiple relations, or Boolean operations. The logical operator returns a bitwise result which is either "true" (not zero) or "false" (zero). In an expression, the precedence of logical operations follows arithmetic and relational operations. Logical operators convert their operands to integers and return an integer result. Operands must be in the range −32768 to 32767* or an "Overflow" error occurs.

The outcome of a logical operation is determined as shown in the following table. The operators are listed in order of precedence.

OPERATOR	EXAMPLE	EXPLANATION
NOT	NOT A	The logical negative of A. If A is true, NOT A is false.
AND	A AND B	The logical product of A and B. A AND B has the value true only if A and B are both true. A AND B has the value false if either A or B is false.
OR	A OR B	The logical sum of A and B. A OR B has the value true if either A or B or both is true. A OR B has the value false only if both A and B are false.
XOR	A XOR B	The logical exclusive OR of A and B. A XOR B is true if either A or B (but not both) is true. Otherwise, A XOR B is false.
IMP	A IMP B	The logical implication of A and B. A IMP B is false if and only if A is true and B is false; otherwise the value is true.
EQV	A EQV B	A is logically equivalent to B. A EQV B is true if A and B are both true or both false. Otherwise, A EQV B is false.

Table 2-3
Logical Operators

* When you use variables with any of the logical operators, declare the variable as type integer by using either the "%" type declaration character or the DEFINT statement (See Page 4-2 for a discussion of DEFINT).

NOT	
X	NOT X
1	0
0	1

AND		
X	Y	X AND Y
1	1	1
1	0	0
0	1	0
0	0	0

OR		
X	Y	X OR Y
1	1	1
1	0	1
0	1	1
0	0	0

XOR		
X	Y	X XOR Y
1	1	0
1	0	1
0	1	1
0	0	0

IMP		
X	Y	X IMP Y
1	1	1
1	0	0
0	1	1
0	0	1

EQV		
X	Y	X EQV Y
1	1	1
1	0	0
0	1	0
0	0	1

Table 2-4
Truth Table for Logical Operators.

Logical operators work by converting their operands to sixteen bit, signed, two's-complement integers in the range −32768 to +32767. (If the operands are not in this range, an error results.) If both operands are supplied as 0 or −1, logical operators return 0 or −1. The given operation is performed on these integers in bitwise fashion; i.e., each bit of the result is determined by the corresponding bits in the two operands. In binary arguments, bit 15 is the most significant bit, and bit 0 is the least significant bit.

Thus, it is possible to use logical operators to test bytes for a particular bit pattern. For instance, the AND operator maybe used to "mask" all but one of the bits of a status byte at a machine I/O port. The OR operator may be used to "merge" two bytes to create a particular binary value. The following examples will help demonstrate how the logical operators work. (In all of the examples below, leading zeros on binary numbers are not shown.)

Examples:

63 AND 16=16

63 = binary 111111 and 16 = binary 10000, so 63 and 16 = 16

15 AND 14=14

15 = binary 1111 and 14 = binary 1110, so 15 AND 14 = 14 binary 1110)

−1 AND 8=8

−1 = binary 1111111111111111 and 8 = binary 1000, so −1 AND 8 = 8

4 OR 2=6

4 = binary 100 and 2 = binary 10, so 4 OR 2 = 6 (binary 110)

10 OR 10=10

10 = binary 1010, so 1010 OR 1010 = 1010 (decimal 10)

−1 OR −2=−1

−1 = binary 1111111111111111 and −2 = binary 1111111111111110,

so −1 OR −2 = −1. The bit complement of sixteen zeros is sixteen ones, which is the two's complement representation of −1.

NOT X=−(X+1)

The two's complement of any integer is the bit complement plus one.

6 IMP 2 =−5

6 = binary 110 and 2 = binary 10, so 6 IMP 2 = −5

3 EQV 4 = −8

3 = binary 11 and 4 = binary 100, so 3 EQV 4 = binary −8.

LOGICAL OPERATORS IN RELATIONAL EXPRESSIONS

Just as the relational operators can be used to make decisions regarding program flow, logical operators can connect two or more relations and return a true or false value to be used in a decision.

Examples:

```
IF D<200 AND F<4 THEN 80
IF I>10 OR K>0 THEN 50
IF NOT P THEN 100
```

The result of evaluating a relational expression will be either true (−1) or false (0). This result will then be used as the operand for the logical operator.

Functional Operators

A function is used in an expression to call a predetermined operation that is to be performed on an operand. BASIC-80 has "intrinsic" functions that reside in the system, such as SQR (square root) or SIN (sine). All of BASIC-80's intrinsic functions are described in Chapter Seven, "Functions."

BASIC-80 also allows "user-defined" functions that are written by the programmer. The proper format for constructing and referencing user-defined functions is described in Chapter Seven, "Functions."

Chapter Three

Command Mode Statements

OVERVIEW

Whenever the "Ok" prompt is displayed on the console, BASIC-80 is in the Command Mode. In this Mode, BASIC-80 will respond to a command as soon as it is entered.

Several commands are useful in Command Mode. These are:

AUTO	FILES	MERGE	RESET
CLEAR	KILL	NAME	RUN
CONT	LIST	NEW	SAVE
DELETE	LLIST	RENUM	SYSTEM
EDIT	LOAD		

All of the commands (except CONT) may also be used within a program.

> NOTE: Many of these statements enable you to access disk files. When accessing disk files, remember that BASIC-80 files can be saved to the disk in either upper case or lower case letters. Hence, if you are accessing a saved BASIC-80 program file, specify the appropriate letter case.

COMMAND MODE STATEMENTS

AUTO (enable automatic line numbering)

Form: AUTO△[<line number>],[<increment>]

The AUTO command will turn on the automatic line numbering function. The AUTO command allows you to enter the program text, without line numbers since the line numbers will be generated automatically.

AUTO begins numbering at <line number> and increments each subsequent line number by <increment>. If no line number or increment is specified, the default value of 10 is supplied. If <line number> is followed by a comma but <increment> is not specified, the last increment specified in an AUTO command is assumed.

If AUTO generates a line number that is already being used, an asterisk is printed after the number to warn the user that any input will replace the existing line. However, typing a carriage return immmediately after the asterisk will save the line and generate the next line number.

AUTO is terminated by typing CTRL-C. The line in which CTRL-C is typed is not saved. After CTRL-C is typed, BASIC-80 returns to the Command Mode.

Examples:

`AUTO 100,50`	Generates line numbers 100,150,200 ...
`AUTO`	Generates line numbers 10,20,30,40 ...
`AUTO 500`	Generates line numbers 500,510,520 ...

CLEAR (initialize variables)

Form: CLEAR,[<expression1>],[<expression2>]

The CLEAR command will set all numeric variables to zero and all string variables to null. The CLEAR command can optionally be used to set the high memory limit and the amount of stack space that is available to BASIC-80.

<expression1> is a memory location (expressed in decimal) which, if specified, sets the highest memory location available for use by BASIC-80.

<expression2> sets aside stack space for use by BASIC-80. The default is 256 bytes or one-eighth of the available memory, whichever is smaller.

Examples:

```
CLEAR
```

Sets all numeric variables to zero and all strings to null.

```
CLEAR ,32768
```

Sets 32768 as the highest memory location for use by BASIC-80.

```
CLEAR , ,2000
```

Allocates 2000 bytes for stack space.

```
CLEAR,32768,2000
```

Sets 32768 as the highest memory location for use by BASIC-80 and allocates 2000 bytes for stack space.

CONT (continue program execution)

Form: CONT

The CONTinue statement is used to resume execution of a program after a CTRL-C has been typed, or a STOP or END statement has been executed. The CONTinue statement can also be used to resume execution after an error.

Execution will resume at the line after the break. If the break occurred after a prompt from an INPUT statement, execution continues with the reprinting of the prompt (? or prompt string).

CONT is usually used in conjunction with STOP for debugging. When execution is stopped, variable values may be examined and changed using Command Mode statements. Execution may be resumed with CONT or a Command Mode GOTO, which resumes execution at a specified line number.

If any changes are made to the program during the break, CONT becomes invalid and the error message "Can't continue" will appear on your screen.

DELETE (delete program lines)

Form: DELETE△[<line number>]-<line number>

or

DELETE△<line number>-[<line number>]

The DELETE statement is used to delete program lines from memory.

BASIC-80 will always return to Command Mode after a DELETE is executed. If <line number> does not exist, an "Illegal function call" error occurs.

Examples:

`DELETE 40`	deletes line 40
`DELETE 40-100`	deletes lines 40-100, inclusive
`DELETE -40`	deletes all lines up to and including line 40

EDIT (enter Edit Mode)

Form: EDIT△<line number>

The EDIT statement will enter the Edit Mode at the specified line number.

In Edit Mode, it is possible to edit portions of a line without retyping the entire line. Upon entering Edit Mode, BASIC-80 types the line number of the line to be edited. Then it types a space and waits for an Edit Mode subcommand.

The Edit Mode subcommands may be categorized according to the following functions:

1. Moving the cursor.
2. Inserting text.
3. Deleting text.
4. Finding text.
5. Replacing text.
6. Ending and restarting Edit Mode.

The Edit Mode subcommands are not displayed on the terminal device. Some of the Edit Mode subcommands may be preceded by an integer which causes the command to be executed that number of times. When a preceding integer is not specified, it is assumed to be one.

The Edit Mode subcommands are explained in Chapter Nine, "Editing."

FILES (list names of files)

Form: FILES ["<filename>"]

The FILES command is used to list the names of files residing on the disk.

"<filename>" must follow the normal CP/M naming conventions. If <filename> is omitted, all the files on the default drive will be listed. "<filename>" is a string which may contain question marks (?) to match any character in the file name or extension. An asterisk (*) can be used to match any primary file name or extension.

Examples:

```
FILES              list all file names on current default disk

FILES "*.BAS"      list all file names with extension .BAS

FILES "B:*.*"      list all file names on drive B:
```

KILL (delete file from disk)

Form: KILL "[<drivename>:]<filename>"

The KILL statement deletes the specified file from the specified disk drive.

The <drivename> can be any valid drive in your hardware environment. If not specified, the interpreter assumes the default drive.

The <filename> must be specified. It must include the primary name and extension (if any) of the file, and it must follow CP/M file naming conventions. This file may be a program file, a sequential data file, or a random access data file. If the file is a data file, it must be closed before it is deleted with KILL.

LIST (list program on terminal)

Form: LIST△[<line number>]-[<line number>]

The LIST command is used to list all or part of the program currently in memory. The listing will be displayed on the terminal device.

BASIC-80 will always return to Command Mode after a LIST is executed.

If the line numbers are omitted, the entire program is listed beginning at the lowest line number. The listing is terminated by either typing CTRL-C or by reaching the end of the program.

If one line number is specified, then only this line will be displayed on the terminal device.

Examples:

`LIST`	List the entire program.
`LIST 500`	List line number 500.
`LIST 150-`	List all lines from 150 to the end of the program.
`LIST -100`	List all lines from the lowest number through 100.
`LIST 150-400`	List lines 150 through 400, inclusive.

LLIST (list program on line printer)

Form: LLIST△[<line number>]-[<line number>]

The LLIST command will list all or part of the program currently in memory. The listing will be printed on the line printer. The options for LLIST are the same as LIST. BASIC-80 will always return to the Command Mode after an LLIST is executed.

LLIST will assume that you have a 132-character wide printer.

Examples: See the examples for LIST

LOAD (load program file from disk)

Form: LOAD "<filename>"[,R]

The LOAD command is used to load a file from the disk into memory.

"<filename>" is the CP/M file name associated with the program file. The default extension .BAS will be supplied.

LOAD closes all open files and deletes all variables and program lines currently residing in memory before it loads the designated program.

The R option can be used to RUN the program after it has been LOADed. If the R option is used, all open files will be left open.

The R option may be used to chain several programs (or segments of the same program). Information may be passed between the programs using temporary disk data files.

Example:

```
LOAD "STARTRK",R

LOAD "B:GAME1.BAS"
```

NOTE: BASIC-80 will not map a file name to upper case. Thus, all of the statements which specify a CP/M file name should have the file name expressed in upper case letters. If a lower case file name is created in the directory, it can then only be accessed with BASIC-80.

MERGE (merge program)

Form: MERGE "<filename>"

The MERGE command will merge a disk program file into the program currently in memory.

"<filename>" is the CP/M file name associated with the disk file that you wish to be inserted. The default file name extension .BAS will be supplied. The file must have been saved in ASCII format. If the file is not in ASCII format, a "Bad file mode" error occurs.

If any lines in the disk file have the same line numbers as lines in the program in memory, the lines in the file being inserted from the disk will replace the corresponding lines in memory. Merging may be thought of as "inserting" the program lines on the disk into the program in memory.

BASIC-80 will always return to the Command Mode after executing a MERGE command.

Examples:

MERGE "PROG1"	will insert the file PROG1.BAS from the default disk drive into the program in memory.
MERGE "B:TEST.BAS"	will insert the file TEST.BAS from disk drive B into the program in memory.

NOTE: After the MERGE command has been used, the line numbers that were merged into the file will be arranged in numeric sequence, whether they fit before, after, between, or over the lines of the program originally in memory.

NAME (change name of disk file)

Form: NAME "[<drive>:]<oldfile>" AS "[<drive>:]<newfile>"

The NAME statement renames the specified file residing on the specified drive.

The <drive> can be any valid drive in your hardware environment. If you specify drives, you must specify the same drive with both the <oldfile> and the <newfile>. If you do not specify either drive, the interpreter assumes the default drive.

The <oldfile> must be specified. It must include the primary name and extension (if any) of a file that currently exists on the specified (or default) drive, and it must follow CP/M file naming conventions. This file may be a program file, a sequential data file, or a random access data file.

The <newfile> must be specified. It must include the primary name and extension (if any) that you would like to replace the current name of <oldfile>. It must also follow CP/M file naming conventions.

NEW (delete current program)

Form: NEW

The NEW command is used to delete the program currently in memory and clear all variables. After a NEW command has been executed, all numeric variables are set to zero and all string variables to null.

BASIC-80 will always return to Command Mode after a NEW is executed.

RENUM (renumber program lines)

Form: RENUM△[<new number>],[<old number>],[<increment>]

The RENUM command will renumber program lines.

<new number> is the first line number to be used in the new sequence. The default is 10. <old number> is the line in the current program where renumbering is to begin. The default is the first line of the program. <increment> is the increment to be used in the new sequence. The default increment is 10.

The RENUM command will also change all line number references within GOTO, THEN, ON/GOTO, ON/GOSUB and ERL statements to reflect the new line numbers. If a nonexistent line number appears after one of these statements, the error message "Undefined line xxxxx in yyyyy" is printed. The incorrect line number reference (xxxxx) is not changed by RENUM, but line number yyyyy may be changed.

RENUM can not be used to change the order of program lines or to create line numbers greater than 65529. In these cases, an "Illegal function call" error will result.

Examples:

```
RENUM
```

Renumber the entire program. The first new line number will be 10. The line numbers will be incremented by 10.

```
RENUM 300,,50
```

Renumber the entire program. The first new line number will be 300. Lines will increment by 50.

```
RENUM 1000,900,20
```

Renumber the lines from 900 up so they start with line number 1000 and increment by 20.

RESET (change diskette)

Form: RESET

The RESET command enables you to exchange a new disk for the disk in the current default drive. RESET cannot be used with a drive name argument. Any attempt to supply a drive name argument will generate a "Syntax error".

The RESET command should be issued only after you replace the old default disk with the new default disk. If you issue a RESET command before switching disks, BASIC-80 will read the directory information off of the old disk.

The only effect of the RESET command is to read the directory information off of the new disk and into memory. RESET does not close open files.

Example:

```
RESET
```

RUN (execute program)

Form 1: RUN△[<line number>]

Form 1 of the RUN command is used to execute a program currently in memory.

If <line number> is specified, execution begins on that line. A RUN command without the <line number> will start execution at the lowest line number. BASIC-80 will always return to Command Mode after a RUN is executed.

Example:

`RUN 10`	Executes the program currently in memory. Execution starts at line number 10.
`RUN`	Executes the program currently in memory. Execution starts at the lowest numbered line.

Form 2: RUN "<filename>"[,R]

Form 2 of the RUN command is used to load a BASIC-80 program from disk into memory and run it. The R is optional and if used will leave all data files open.

"<filename>" is the name of the file on the disk. The default extension is .BAS. "<filename>" must be a valid CP/M file name enclosed in quotation marks.

RUN closes all open files and deletes the current contents of memory before loading the designated program. However, with the R option, all data files will remain open.

Example:

`RUN "PROG1"`	Loads and executes PROG1.BAS
`RUN "B:GAME",R`	Loads and executes B:GAME.BAS leaving all data files open.

SAVE (write program to disk)

Form: SAVE "<filename>",A

SAVE "<filename>",P

SAVE "<filename>"

The SAVE command will write to a disk file the program that is currently in memory.

"<filename>" is a string enclosed in quotes that conforms to the CP/M requirements for file name construction. The default extension .BAS is supplied. If <filename> already exists, the file will be written over.

The A option will save the file in ASCII format. Otherwise, BASIC-80 will assume the compressed binary format. ASCII format takes more space on the disk, but some disk commands require that the files be in ASCII format. For example, the MERGE command requires an ASCII format file.

The P option will protect the file by saving it in an encoded binary format. When a protected file is later RUN or (LOADed), any attempt to list or edit it will fail.

Examples:

```
SAVE"COM2",A

SAVE"PROG",P
```

SYSTEM (perform CP/M warm boot)

Form: SYSTEM

The SYSTEM command will close all files and then perform a CP/M warm boot. Because CTRL-C will always return to BASIC-80 Command Mode, the SYSTEM command must be used to return to CP/M.

Example:

```
SYSTEM
A>    (prompt from CP/M,
       assuming A: is the current default disk)
```

Chapter Four

Program Statements

OVERVIEW

The program statements available to the BASIC-80 programmer can be divided into four functional groups: Data type definition, Assignment and allocation, Control, and I/O (Non-disk). This Chapter will explain the various program statements in these four groups.

Note: These program statements can also be used as Command Mode statements.

DATA TYPE DEFINITION

A DEF statement declares that the variable name beginning with a certain range of letters is of the specified data type. However, a type declaration character always takes precedence over a DEF statement.

If no data type declaration statements are encountered, BASIC-80 assumes all variables without declaration characters are single precision variables.

DEFINT (declare variable as integer)

Form: DEFINT△<letter range>

The DEFINT statement is used to declare a range of variable names as integer data types.

An integer data type will take up less memory than a single-precision or double-precision data type. However, a variable declared as an integer data type can only be assigned values in the range −32768 through +32767 inclusive.

Example:

```
DEFINT I-N
```

All variables beginning with the letters I,J,K,L,M, and N will be integer variables.

DEFSNG (declare variable as single-precision)

Form: DEFSNG△<letter range>

The DEFSNG statement is used to declare a range of variable names as single-precision data types.

Single-precision variables are stored with seven digits of precision and they are printed with six digits of precision.

Example:

```
DEFSNG A-D
```

All variables beginning with the letters A,B,C, and D will be single-precision variables.

DEFDBL (declare variable as double-precision)

Form: DEFDBL△<letter range>

The DEFDBL statement is used to declare a range of variable names as double-precision data types.

Double-precision variables are stored with 16 digits of precision and they are printed with 16 digits of precision.

Examples:

`DEFDBL X-Z,A`	All variables beginning with the letters X, Y, Z and A will be double-precision variables.

DEFSTR (declare variable as string)

Form: DEFSTR△<letter range>

The DEFSTR statement is used to declare a range of variable names as string data types.

A string is a sequence of characters — letters, blanks, numbers, and special characters — up to 255 characters long.

Example:

`DEFSTR S`	All variables beginning with the letter S will be string variables.

ASSIGNMENT AND ALLOCATION STATEMENTS

DIM (set-up array)

Form: DIM△<list of subscripted variables>

The DIMension statement is used to set up the maximum values for array variable subscripts and allocate storage accordingly.

If an array variable name is used without a DIM statement, the maximum value of its subscript(s) is assumed to be 10. If a subscript is used that is greater than the maximum specified, a "Subscript out of range" error occurs. The minimum value for a subscript is always 0, unless otherwise specified with the OPTION BASE statement.

The DIM statement sets all the elements of the specified arrays to an initial value of zero.

Example:

```
10 DIM A(20)
20 FOR I = 0 TO 20
30 A(I) = I+1
40 NEXT I
```

OPTION BASE (set minimum value for array subscript)

Form: OPTION△BASE△n

The OPTION BASE statement is used to declare the minimum value for array subscripts. The default base is 0. This may be changed to 1. The OPTION BASE statement must be executed before the DIM statement is executed. If an OPTION BASE statement appears after an array has been DIMensioned, a "Duplicate definition" error will result.

Example:

```
OPTION BASE 1
```

For more information on array storage allocation, see Chapter Six, "Arrays."

NOTE: An OPTION BASE statement can be executed only once during a single run of a BASIC-80 program. If BASIC-80 encounters more than one OPTION BASE statement in a single program, the "Duplicate definition" error message will be displayed.

This message will be displayed even if the path of your program leads to the **same** OPTION BASE statement more than once due to an execution loop. However, you **can** safely insert more than one OPTION BASE statement into a program if each statement resides in a different branch of the program, and if only one of these branches is accessible during a single run of the program.

ERASE (remove array from program)

Form: ERASE△<list of array names>

The ERASE statement is used to remove an array from a program. Arrays may be redimensioned after they are ERASEd, or the previously allocated array space in memory may be used for other purposes.

If an attempt is made to redimension an array without first ERASEing it, a "Duplicate Definition" error occurs. If an attempt is made to ERASE an array that has not been defined in a DIM statement, an "Illegal function call" error will result.

Example:

```
10 DIM A(40)
20 ERASE A
30 DIM A(50)
```

LET (assign value to a variable)

Form: LET△<variable> = <expression>

The LET statement is used to assign the value of an expression to a variable.

Note that the word LET is optional, as the equal sign is sufficient when assigning an expression to a variable name.

Example:

```
10 LET D = 12
20 LET SUM = X + Y + Z

    or

10 D = 12
20 SUM = X + Y + Z
```

REM (insert remark)

Form: REM△<remark>

The REM statement allows explanatory remarks to be inserted in a program.

REM statements are not executed but are output exactly as entered when the program is listed.

REM statements may be branched into (from a GOTO or GOSUB statement), and execution will continue with the first executable statement after the REM statement.

Remarks may also be added to a line by preceding the remark with a single quotation mark.

Example:

```
10 REM THIS IS A REMARK
20 ' THIS IS ALSO A REMARK
```

SWAP (exchange variable values)

Form: SWAP△<variable>,<variable>

The SWAP statement is used to exchange the values of two variables.

Any type variable may be swapped (integer,single-precision, double-precision, string), but the two variables must be of the same type or a "Type mismatch" error results.

Example:

```
10 A$=" ONE ":B$="FOR":C$="ALL"
20 PRINT A$;B$;C$
30 SWAP A$,C$
40 PRINT A$;B$;C$
RUN
ONE FOR ALL
ALL FOR ONE
Ok
```

CONTROL STATEMENTS

Two types of control statements are available to the BASIC-80 programmer. One type affects the sequence of execution, and the other type is used for conditional execution.

Sequence of Execution

The sequence of execution statements are used to alter the sequence in which the lines of a program are executed. Normally, execution begins with the lowest numbered line and continues, sequentially, until the highest numbered line is reached.

The sequence of execution statements allow the BASIC-80 programmer to execute the lines of a program in any sequence the program logic dictates.

END (terminate program execution)

Form: END

The END statement will terminate program execution, close all files, and return to Command Mode.

END statements may be placed anywhere in the program to terminate execution. Unlike the STOP statement, END does not cause a BREAK message to be displayed. An END statement at the end of a program is optional. BASIC-80 will always return to Command Mode after an END is executed.

Example:

```
520 IF K>1000 THEN END
```

FOR/NEXT (repetitive execution loop)

Form: FOR△<variable> = X TO Y [STEP Z].
.
.
NEXT△[<variable>]

where X,Y and Z are constants, variables, or numeric expressions.

The FOR/NEXT statement will allow a series of instructions to be performed in a loop a given number of times.

<variable> is used as the loop counter. The first numeric expression (X) is the initial value of the counter. The second numeric expression (Y) is the terminal value of the counter. The third numeric expression (Z) is the incremental value for the loop counter.

Before the FOR/NEXT loop is executed, these three numeric values are evaluated. First, the terminal value is evaluated. Then the initial value is evaluated. The loop counter is then set equal to the initial value.

Any attempt to change these three values during the execution of the loop will have no effect. However, the loop counter must not be changed or the loop will not operate as expected.

After the numeric values are evaluated, a check is performed to see if the initial value of the loop exceeds the terminal value. If the initial value of the loop exceeds the terminal value, the loop will not be executed. (If the STEP value is negative, the initial value must be greater than the terminal value or the loop will not be executed.)

The program lines following the FOR are executed until the NEXT statement is encountered. Then the loop counter is incremented by the amount specified by STEP. A check is performed to see if the value of the loop counter is now greater than the terminal value.

If it is not greater, BASIC-80 branches back to the statement after the FOR statement and the process is repeated. If the value of the loop counter is greater than the terminal value, execution continues with the statement following the NEXT statement. The statements between the FOR and the NEXT statements constitute the range of the FOR/NEXT loop.

If STEP is not specified, the incremental value is assumed to be one. If STEP is a negative value, the loop counter is decremented each time through the loop. The loop is executed until the loop counter is less than the final value.

Examples:

```
10 FOR J = 5 TO 1 STEP -1
20 PRINT J;
30 NEXT J
RUN
 5 4 3 2 1
Ok
```

The statement in the range of this loop will be executed five times. In this example, 5 is the initial value, 1 is the terminal value, and −1 is the incremental value. Note that the initial value is greater than the terminal value. This is valid because the incremental value is negative. Also note that the variable J could have been omitted from the NEXT statement in line 30.

```
10 FOR J = 5 TO 1
20 PRINT J;
30 NEXT J
RUN
Ok
```

In this example, the statement in the range of the loop will not be executed because the initial value is greater than the terminal value. The STEP value has been omitted, so it is assumed to be 1.

```
10 I = 5
20 FOR I = 1 TO I+5
30 PRINT I;
40 NEXT
RUN
 1  2  3  4  5  6  7  8  9  10
Ok
```

In this example, the loop executes 10 times. The terminal value for the loop is evaluated first. The terminal value (I+5) is 10. Next, the initial value is evaluated. The initial value is 1. The loop counter is then set equal to the initial value. Because the STEP value has been omitted, the incremental value is assumed to be 1.

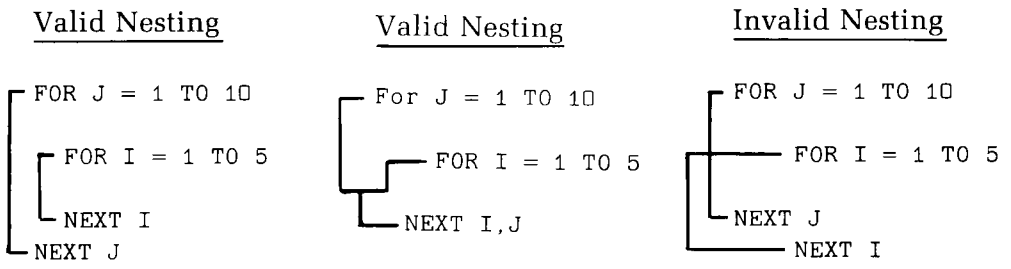
Nested Loops

FOR/NEXT loops may be nested. That is, a FOR/NEXT loop may be placed within the range of another FOR/NEXT loop.

When loops are nested, each variable name should be assigned only one value. If more than one value is assigned to a single variable name, only the inner most value will be interpreted; any outer values will be disregarded.

If nested loops have the same end point, a single NEXT statement may be used for all of them. If a single NEXT statement is used, the order in which the variables should be specified must be exactly the opposite of the order in which these variables were specified in the corresponding FOR statements.

The variable in a NEXT statement may be omitted, in which case the NEXT statement will match the most recent FOR statement. If a NEXT statement is encountered before its corresponding FOR statement, a "NEXT without FOR" error message is issued and execution is terminated.



Note that with the valid nesting, the range of the inner loop is completely contained within the range of the outer loop.

GOSUB/RETURN (branch to subroutine)

Form: GOSUB△<line number>

.
.
.

RETURN

The GOSUB/RETURN statement is used to branch to and return from a subroutine.

<line number> is the first line of the subroutine.

A subroutine may be called any number of times in a program, and a subroutine may be called from within another subroutine. Such nesting of subroutines is limited only by available memory.

The RETURN statement in a subroutine causes BASIC-80 to branch back to the statement following the most recent GOSUB statement. A subroutine may contain more than one RETURN statement.

Subroutines may appear anywhere in the program, but it is good programming practice to separate the subroutine from the main program. To prevent inadvertant entry into the subroutine, it may be preceded by a STOP, END, or GOTO statement that directs program control around the subroutine.

Example:

```
10 GOSUB 40
20 PRINT "BACK FROM SUBROUTINE"
30 END
35 REM
40 REM THIS IS THE SUBROUTINE
45 REM
50 PRINT "SUBROUTINE";
60 PRINT " IN ";
70 PRINT "PROGRESS"
80 RETURN
RUN
SUBROUTINE IN PROGRESS
BACK FROM SUBROUTINE
Ok
```

GOTO (unconditional branch)

Form: GOTO△<line number>

The GOTO statement will branch unconditionally out of the normal program sequence and continue execution at the specified line number.

If <line number> is an executable statement, that statement and those following are executed. If it is a nonexecutable statement, execution proceeds at the first executable statement encountered after <line number>.

If <line number> has not been previously defined, an "Undefined line number" error will be displayed.

Example:

```
10 GOTO 30
20 PRINT "LINE 20"
30 PRINT "LINE 30"
40 END
RUN
LINE 30
Ok
```

ON/GOTO and ON/GOSUB (evaluate and branch)

Forms: ON△<expression>△GOTO△<list of line numbers>

ON△<expression>△GOSUB△<list of line numbers>

The ON/GOTO and the ON/GOSUB statements are used to branch to one of several specified line numbers, depending on the value returned when an expression is evaluated. The result of evaluating <expression> must be positive and less than 255. If the value of <expression> is non-integer, the fractional portion is rounded.

The value of <expression> determines which line number in the list will be used for branching. For example, if the value of the expression is three, the third line number in the list will be the destination of the branch.

If the value of <expression> is zero or greater than the number of line numbers in the list, BASIC-80 will continue with the next executable statement. If the value is negative or greater than 255, an "Illegal function call" error occurs.

In the ON/GOSUB statement, each line number in the list should be the first line number of a subroutine.

Example:

```
10 L=4
20 ON L GOTO 50,60,70,80
30 END
50 PRINT "LINE 50":GOTO 90
60 PRINT "LINE 60":GOTO 90
70 PRINT "LINE 70":GOTO 90
80 PRINT "LINE 80":GOTO 90
90 STOP
RUN
Break in 80
LINE 80
Ok
```

In this example, L=4, thus causing a branch to the fourth line number in the list. The fourth line number in the list is 80. If L >4 or if L=0, then the program would have branched to line number 30.

STOP (suspend execution)

Form: STOP

The STOP statement is used to terminate program execution and return BASIC-80 Command Mode.

STOP statements may be used anywhere in a program to terminate execution. When a STOP is encountered, the following message is printed:

```
Break in line nnnnn
```

Unlike the END statement, the STOP statement does not close any files.

BASIC-80 will always return to the Command Mode after a STOP is executed. Execution can be resumed by issuing a CONT command.

Example:

```
10 PRINT "LINE 10"
20 STOP
30 PRINT "LINE 30"
40 END
RUN
LINE 10
BREAK IN 20
Ok
CONT
LINE 30
Ok
```

Conditional Execution

The conditional execution statements are used to optionally execute a statement or series of statements. The statement or series of statements will be executed if a certain condition is met.

IF/THEN/ELSE (conditional execution)

Form:

IF△<expression>△THEN△[<statement(s)>]△ELSE△[<statement(s)>]

IF△<expression>△GOTO△[<line number>]△ELSE△[<statement(s)>]

The IF/THEN/ELSE statement is used to make a decision regarding program flow based on the result returned by an expression.

If the result of <expression> is true (not zero), the THEN clause is executed. THEN may be followed by either a line number for branching or one or more statements to be executed. If multiple statements are to be executed, they must be separated by colons (:).

If the result of <expression> is false (zero), the THEN clause is ignored and the ELSE clause, if present, is executed. ELSE may be followed by either a line number for branching or one or more statements to be executed. If multiple statements are to be executed, they must be separated by colons (:).

NOTE: BASIC-80 enables you to specify THEN or ELSE clauses without any accompanying statements. BASIC-80 also enables you to specify the GOTO clause without an accompanying line number.

If you are concerned that an IF/THEN/ELSE statement will become too long, you can display the ELSE clause on the following physical line by entering a line feed (press the LINE FEED key) before entering the ELSE clause in this statement. However, do not enter a carriage return or precede the ELSE clause with a line number.

The keyword THEN can optionally be replaced with a GOTO statement. In this case, if the result of the expression is true, the program will branch to the statement number specified in the GOTO statement.

Examples:

```
IF I THEN PRINT "I IS NOT ZERO" ELSE PRINT "I IS ZERO"
```

This statement will print "I IS NOT ZERO" if the value of I is not zero. If the value of I is zero, the message "I IS ZERO" will be printed.

```
IF X=A GOTO 100 ELSE PRINT "NOT EQUAL"
```

This statement will branch to line number 100 if X = A. If X is not equal to A, the message "NOT EQUAL" will be printed.

```
IF IOFLAG THEN PRINT A$ ELSE LPRINT A$
```

This statement causes printed output to go either to the terminal or the line printer depending upon the value of a variable (IOFLAG). If IOFLAG is zero, output goes to the line printer. If IOFLAG is not zero, output goes to the terminal.

Additional Considerations

When an IF/THEN statement is followed by a line number in the Command Mode, an "Undefined line number" error results unless a statement with the specified line number had previously been entered in the Indirect Mode.

When using IF to test equality for a value that is the result of a floating point computation, remember that the internal representation of the value may not be exactly the same as the printed value. Therefore, the test should be against the range over which the accuracy of the value may vary. For example, to test the single-precision variable A against the value 1.0, use:

```
IF ABS (A-1.0)<1.0E-06 THEN . . .
```

This test returns TRUE if the value of A is 1.0 with a relative error of less than 1.0E-6.

Nesting of IF Statements

IF/THEN/ELSE statements may be nested, but make sure that the same number of IF's and ELSE's are used. Each ELSE will be matched with the closest unmatched THEN. In the following example, the operator was able to include the ELSE statements in line 20 by using line feeds.

Example:

```
10 INPUT A
20 IF A=C THEN IF A=B THEN PRINT "A=B A=C"
<operator-typed LINE FEED>
     ELSE PRINT "A NOT = B"
<operator-typed LINE FEED >
       ELSE PRINT "A NOT = C"
30 PRINT A
```

This nested IF will first test to see if A=C. If A does not equal C, the second ELSE will be executed, the message "A NOT = C" will be printed and execution will be continued at line 30.

If A=C, the first THEN will be executed. This will result in another test. This time, A will be compared to B. If A does not equal B, the first ELSE will be executed. So, if A does not equal B, the message "A NOT = B" will be printed and execution will continue with line 30.

If A=B, the second THEN will be executed, resulting in the message "A=B A=C" being printed on the terminal. After printing this message, execution will continue at line 30.

WHILE/WEND (conditional execution)

Form: WHILE△<expression>

<loop statements>

WEND

The WHILE...WEND statement is used to execute a series of statements in a loop as long as a given condition is true.

If <expression> is not zero (that is,true), <loop statements> are executed until the WEND statement is encountered. BASIC-80 then returns to the WHILE statement and checks <expression>. If it is still not zero (true), the process is repeated. If the value of the expression is zero (false), execution resumes with the statement following the WEND statement.

WHILE/WEND loops may be nested to any level. Each WEND will match the most recent WHILE. An unmatched WHILE statement causes a "WHILE without WEND" error, and an unmatched WEND statement causes a "WEND without WHILE" error.

Example:

```
10 I = 1
20 WHILE I
30 PRINT "WHILE/WEND LOOP"
40 I = 0
50 WEND
60 END
RUN
WHILE/WEND LOOP
Ok
```

I/O Statements (Non-Disk)

DATA (store constants)

Form: DATA△<list of constants>

The DATA statement is used to store numeric and string constants. These constants are assigned to variables by using the READ statement.

DATA statements are nonexecutable and may be placed anywhere in the program. A DATA statement may contain as many constants as will fit on a logical line. Any number of DATA statements may be used in a program.

The READ statement will access the DATA statement in line number sequence. therefore, the data contained therein may be thought of as one continuous list of items, regardless of how many items are on a line or where the lines are placed in the program.

<list of constants> may contain numeric constants in any format, .i.e., fixed point, floating point or integer. (No numeric expressions are allowed in the list.)

String constants in DATA statements must be surrounded by double quotation marks only if they contain commas, colons or significant leading or trailing spaces. Otherwise, quotation marks are not needed.

The type (numeric or string) of variable given in the READ statement must agree with the type of the corresponding constants in the DATA statement.

DATA statements may be reread from the beginning by use of the RESTORE statement.

Example:

```
10 DATA 12.3, HELLO, "GOOD,BYE", 34
20 DATA 1,2,3,4,5
```

INPUT (input from terminal)

Form: INPUT [;<"prompt string">;] <list of variables>

The INPUT statement is used to input data from the terminal during program execution.

When an INPUT statement is encountered, program execution pauses and a question mark is printed to indicate that the program is waiting for data.

If <"prompt string"> is included, the string is printed before the question mark. The required data should then be entered at the terminal. (The question mark can be suppressed by putting a comma instead of a semicolon between the prompt string and the list of variables.)

If the keyword INPUT is immediately followed by a semicolon, then the carriage return typed by the user does not echo a carriage return/line feed sequence.

The data that is entered is assigned to the variable(s) given in the variable list. The number of data items supplied must be the same as the number of variables in the list. The data items input must be separated by commas.

The variable names in the list may be numeric or string variable names (including subscripted variables). The type of each data item that is input must agree with the type specified by the variable name. Strings input to an INPUT statement need not be surrounded by quotation marks.

Responding to an INPUT prompt with more or fewer data items than the program expects, or with an unexpected type of data (string data instead of numeric data), causes BASIC-80 to display the "Redo from start" error message. Responding with numeric data when the program expects string data will not cause the error message because BASIC-80 interprets inputted numeric data as if it were string data. No assignment of input values is made until an acceptable response is made.

Example:

```
10 INPUT"ENTER VALUE";X
20 PRINT X
30 END
RUN
ENTER VALUE? (you type) 5
 5
Ok
```

LINE INPUT (input entire line)

Form: LINE△INPUT [<;> <"prompt string">;] <string variable>

The LINE INPUT statement is used to input an entire line (up to 255 characters) to a string variable, without the use of delimiters.

The <"prompt string"> is a string literal that is printed at the terminal before input is accepted. A question mark is not printed unless it is part of the prompt string. All input from the end of the prompt string to the carriage return is assigned to <string variable>.

If the key words LINE INPUT are immediately followed by a semicolon, then the RETURN typed by the user to end the input line does not echo a carriage return/line feed sequence at the terminal.

A LINE INPUT may be escaped by typing CTRL-C. BASIC-80 will return to the Command Mode and type "Ok". A CONT command will resume execution at the LINE INPUT.

Example:

```
10 LINE INPUT"NAME?--";J$
20 PRINT J$
30 STOP
RUN
NAME?--(you type) JONES,JACK L.
JONES,JACK L.
BREAK IN 30
Ok
```

LPRINT (output data to line printer)

Form: LPRINT <list of expressions>

The LPRINT statement is used to print data on the line printer.

LPRINT defaults to a 132-character wide printer, unless you change this default with a "WIDTH LPRINT" statement. (See Page 7-22.)

LPRINT defaults to a 132-character wide printer.

PRINT (output data at terminal)

Form: PRINT <list of expressions>

The PRINT statement is used to output data to the terminal. (A question mark may be used in place of the keyword PRINT in a PRINT statement.)

If <list of expressions> is omitted, a blank line is printed. If <list of expressions> is included, the values of the expressions are printed at the terminal. The expressions in the list may be numeric and/or string expressions. String constants must be enclosed in quotation marks.

Print Positions

The position of each printed item is determined by the punctuation used to separate the items in the list. BASIC-80 divides the line into print zones of 14 spaces each.

In the list of expressions, a comma (,) causes the next value to be printed at the beginning of the next zone. A semicolon (;) causes the next value to be printed immediately after the preceding value. Typing one or more spaces between expressions has the same effect as typing a semicolon. Strings enclosed in quotes without separating spaces will be concatenated.

If a comma or a semicolon terminates the list of expressions, the next PRINT statement begins printing on the same line, spacing accordingly. If the list of expressions terminates without a comma or a semicolon, a carriage return is inserted at the end of the line. If the printed line is longer than the terminal width, BASIC-80 goes to the next physical line and continues printing.

NOTE: A number with spaces between its digits is still considered to be a single number.

Printed numeric values are always followed by a space. Positive numbers are preceded by a space. Negative numbers are preceded by a minus sign.

Single-precision numbers that can be accurately represented with 6 or fewer digits in the unscaled format are output using the unscaled format. For example, 10^(−6) is output as .000001 and 10^(−7) is output as 1E-7.

Double-precision numbers that can be accurately represented with 16 or fewer digits in the unscaled format are output using the unscaled format. For example, 1D-16 is output as .0000000000000001 and 1D-17 is output as 1D-17.

Examples:

```
10 X=5
20 PRINT X+5,X-5,X*(-5),X^5
30 END
RUN
 10            0           -25             3125
Ok
```

In this example, the commas in the PRINT statement cause each value to be printed at the beginning of the next print zone.

```
10 FOR X = 1 TO 5
20 J = J +5
30 K=K+10
40 ?J;K;
50 NEXT X
RUN
 5  10  10  20  15  30  20  40  25  50
Ok
```

In this example, the semicolons in the PRINT statement cause each value to be printed immediately after the preceding value. (Don't forget, a number is always followed by a space and positive numbers are preceded by a space.) In line 40, a question mark is used instead of the word PRINT.

READ (read values from DATA statement)

Form: READ△<list of variables>

The READ statement is used to read values from a DATA statement and assign them to variables.

A READ statement must always be used in conjunction with a DATA statement. READ statements assign the constant values contained in a DATA statement to the variables contained in the READ statement.

The assignment of values is on a one-to-one basis. READ statement variables may be numeric or string, and the data types of the values read from the data statements must agree with the variable types specified in the corresponding READ statement variable. If data types do not agree, a "Syntax error" will result.

A single READ statement may access one or more DATA statements (they will be accessed in order), or several READ statements may access the same DATA statement.

If the number of variables in <list of variables> exceeds the number of data constants in the DATA statements, an "Out of data" error will result.

If the number of variables specified is fewer than the number of elements in the DATA statements, subsequent READ statements will begin reading data at the first unread element. If there are no subsequent READ statements, the extra data is ignored.

To reread DATA statements from the start, use the RESTORE statement.

Example:

```
10 FOR I = 1 TO 10
20 READ A(I)
30 NEXT I
40 DATA 3,4,5,6,7,8,9,10,11,12
```

This program segment READs the values from the DATA statement into the array A. After execution, the value of A(1) will be 3, and so on.

RESTORE (reset data pointer)

Form: RESTORE[△<line number>]

The RESTORE statement is used to reset the data pointer in a DATA statement so that the data may be reread.

After a RESTORE statement is executed, the next READ statement accesses the first item in the first DATA statement in the program. If <line number> is specified, the next READ statement will access the first item in the DATA statement, at or following the specified line number.

Example:

```
10 READ A,B,C
20 RESTORE
30 READ D,E,F
40 DATA 57,68,79
```

This program segment will assign the constants 57,68,79 to the variables A,B,C. The RESTORE statement in line 20 will reset the DATA pointer so that the READ statement in line 30 will assign the constants 57,68,79 to the variables D,E,F.

WRITE (output data to terminal)

Form: WRITE[△<list of expressions>]

The WRITE statement is used to output data to the terminal.

If <list of expressions> is omitted, a blank line will be output. If <list of expressions> is included, the values of the expressions are output to the terminal. The expressions in the list may be numeric and/or string expressions, and they must be separated by commas.

When the printed items are output, each item will be separated from the last by a comma. Printed strings will be delimited by quotation marks. After the last item in the list is printed, BASIC-80 will insert a carriage return/line feed.

The WRITE statement outputs numeric values using the same format as the PRINT statement.

Example:

```
10 A=80:B=90:C$="BASIC-80"
20 WRITE A,B,C$
RUN
 80,90,"BASIC-80"
Ok
```

Chapter Five

Strings

OVERVIEW

A string is a sequence of characters — letters, blanks, numbers, and special characters — up to 255 characters long. A string constant is constructed by enclosing these characters in a set of double quotation marks. A string variable can be declared by simply adding the string declaration character, $, to the variable name. A statement can also declare a variable a string variable by using the DEFSTR statement.

Microsoft BASIC-80 provides complete facilities for manipulating strings. A string can be compared, PRINTed, concatenated with other strings , etc. Several functions for manipulating strings are also available to the BASIC-80 programmer.

This Chapter will cover the following subjects:

"String Input/Output"

"String Operations"

"String Functions"

STRING INPUT/OUTPUT

String constants can be input to a program in the same manner as numeric constants. The INPUT statement can be used. The string can usually be typed without quotes.

```
10 INPUT "YOUR NAME";J$
20 PRINT "HELLO ";J$
RUN
YOUR NAME? [you type] JOHN
HELLO JOHN
Ok
```

However, if you wish to input a string constant which contains commas or which contains leading or trailing blanks, the string must be enclosed in quotes. (When the INPUT statement is used.)

```
10 INPUT "YOUR NAME";J$
20 PRINT J$
RUN
YOUR NAME? [you type] "JONES, JOHN"
JONES, JOHN
Ok
```

The LINE INPUT statement can be used to input strings that contain any printable character. The string does not have to be enclosed in quotes when the LINE INPUT statement is used.

```
10 LINE INPUT "YOUR NAME";J$
20 PRINT J$
RUN
YOUR NAME [you type] JONES, JOHN
JONES, JOHN
Ok
```

STRING OPERATIONS

Strings may be concatenated using the + . For example:

```
10 X$="FIRST"
20 Y$=" AND "
30 Z$="LAST"
40 PRINT X$+Y$+Z$
RUN
FIRST AND LAST
Ok
```

Strings may be compared using the same relational operators that are used with numbers:

= <> < > <= >=

The strings are compared character-for-character from left to right. The ASCII codes for the character are compared, and the character with the lower ASCII value is considered to precede the other character.

For example, the string "Z$" precedes the string "Z*" because "$" (ASCII code - decimal 36) has a lower value than does "*" (ASCII code - decimal 42).

When strings of different lengths are compared, the shorter string is considered to precede the longer string. Every character, including blanks and any non-printing character is significant in a string comparision. For example, the string "AB" will precede the string "AB△" because of the trailing blank in the string "AB△".

A string constant must also be enclosed in double quotes whenever it is used in an assignment statement or in a comparison expression.

Example:

```
Z$="STRING CONSTANT"
IF Z$="NUMERIC CONSTANT" THEN STOP
```

STRING FUNCTIONS

The string functions available to the BASIC-80 programmer are:

Function	Definition
ASC(X$)	string to ASCII value conversion
CHR$(I)	ASCII value to string conversion
HEX$(X)	decimal to hexadecimal conversion
INKEY$	read one character from terminal
INPUT$(X,Y)	read characters
INSTR(I,X$,Y$)	search for substring
LEFT$(X$,I)	return leftmost characters
LEN(X$)	length of string
MID$(X$,I,J) MID$(X$,I,J)=Y$	return substring replace portion of string
OCT$(X)	convert decimal to octal
RIGHT$(X$,I)	return rightmost characters
SPACE$(X)	return string of spaces
STR$(X)	return string representation
STRING$(I,J) STRING$(I,X$)	build string
VAL(X$)	return numerical representation of the string

Table 5-1
String Functions

ASC (convert string to ASCII value)

Form: ASC(X$)

The ASC function will return a numerical value that is the ASCII decimal code of the first character of the string X$. If X$ is a null string, an "Illegal function call" error is returned.

Example:

```
10 X$="TEST"
20 PRINT ASC(X$)
RUN
 84
Ok
```

In the above example, the first letter of the string X$ is a T. The ASCII code for T is 84.

CHR$ (convert ASCII value to string)

Form: CHR$(I)

The CHR$ function will return a string whose one element has ASCII decimal code I. (ASCII codes are listed in "Appendix B.") CHR$ is commonly used to send a special character to the terminal. For instance, the BEL character could be sent by the statement; PRINT CHR$(7).

Example:

```
PRINT CHR$(66)
B
Ok
```

HEX$ (convert decimal to hexadecimal)

Form: HEX$(X)

The HEX$ function will return a string which represents the hexadecimal value of the decimal argument. X is rounded to an integer before HEX$(X) is evaluated.

Example:

```
10 INPUT X
20 A$ = HEX$(X)
30 PRINT X;" DECIMAL IS ";A$;" HEXADECIMAL"
RUN
? 32
 32 DECIMAL IS 20 HEXADECIMAL
```

INKEY$ (read one character from keyboard)

Form: INKEY$

The INKEY$ function will return either a one-character string containing a character read from the terminal or a null string if no character is pending at the terminal. No character is echoed and all control characters are passed through the program except for CTRL-C which terminates the program and returns BASIC-80 to the Command Mode.

Example:

```
10 X$ = INKEY$
20 IF X$=CHR$(32) THEN STOP
30 GO TO 10
```

This example would read from the keyboard until a space (ASCII decimal-32) was typed.

INPUT$ (read characters)

Form: INPUT$(X,Y)

The INPUT$ function will return a string of X characters, read from the terminal or from file number Y. If the terminal is used for input, no characters will be echoed and all control characters are passed through except CTRL-C, which is used to interrupt the execution of the INPUT$ function.

Example:

```
10 OPEN "I",1,"DATA.DAT"
20 IF EOF(1) THEN 50
30 PRINT INPUT$(1, 1)
40 GOTO 20
50 END
```

The above example will print all the characters in the file DATA.DAT

```
10 X$=INPUT$(1)
20 IF X$="P" THEN 500
30 IF X$="S" THEN 700 ELSE 10
```

This example would read one character from the keyboard. If the character is a P, program control would be transferred to line number 500. If the character is an S, control would be transferred to line number 700. If the character is neither an S nor a P, control would be transferred back to line number 10.

INSTR (search for substring)

Form: INSTR(I,X$,Y$)

The INSTR function will search for the first occurrence of string Y$ in X$ and return the position at which the match is found. Optionally, the offset I sets the position for starting the search. I must be in the range 1-255. If I>LEN(X$) or if X$ is null or if Y$ can not be found, INSTR will return 0. If Y$ is null, INSTR returns I or 1.

X$ and Y$ may be string variables, string expressions or string literals.

Example:

```
10 X$ = "ABCDEB"
20 Y$ = "B"
30 PRINT INSTR(X$,Y$);INSTR(4,X$,Y$)
RUN
    2 6
Ok
```

LEFT$ (return leftmost characters)

Form: LEFT$(X$,I)

The LEFT$ function will return a string comprised of the leftmost characters of X$. I must be in the range 0 to 255. If I is greater than the length of X$, the entire string (X$) will be returned. If I equals 0, the null string (length zero) is returned.

Example:

```
10 A$ = "BASIC-80"
20 B$ = LEFT$(A$,5)
30 PRINT B$
RUN
BASIC
Ok
```

LEN (return length of a string)

Form: LEN(X$)

The LEN function will return the number of characters in X$. Non-printing characters and blanks are counted.

Example:

```
10 X$ = "ABC DEF"
20 PRINT LEN(X$)
RUN
 7
Ok
```

MID$ (return substring)

Form: MID$(X$,I,J)

The MID$ function will return a string of length J characters from X$ beginning with the Ith character. I must be in the range 1 to 255; and J must be in the range 0 to 255. If J is omitted, or if there are fewer than J characters to the right of the Ith character, all right-most characters beginning with the Ith character are returned. If I is greater than the length of string X$, MID$ will return a null string.

Example:

```
10 A$="GOOD"
20 B$="MORNING EVENING AFTERNOON"
30 PRINT A$;MID$(B$,8,8)
RUN
GOOD EVENING
Ok
```

MID$ (replace portion of string)

Form: MID$(X$,I,J)=Y$

This form of the MID$ function will replace a portion of one string with another string.

The characters in string X$, beginning at position I, are replaced by the characters in string Y$. The variable J, which is optional, refers to the number of characters from string Y$ that will be used in the replacement. The variable I must be within the range 1 to the length of X$. Any other value causes the "Illegal function call" error message. The variable J must be in the range 0 - 255. The Y$ string can be null, but the X$ string must be assigned.

However, regardless of whether J is omitted or included, the replacement of characters never goes beyond the original length of X$.

Examples:

A$="1234567" at the beginning of each example

Statement	Resultant A$
`MID$(A$,3,4)="ABCDE"`	12ABCD7
`MID$(A$,5)="ABCDE"`	1234ABC
`MID$(A$,1,2)="A"`	A234567

OCT$ (convert decimal to octal)

Form: OCT$(X)

The OCT$ function will return a string which represents the octal value of the decimal argument. X is rounded to an integer before OCT$(X) is evaluated.

Example:

```
PRINT OCT$(24)
30
Ok
```

RIGHT$ (return rightmost characters)

Form: RIGHT$(X$,I)

The RIGHT$ function will return the right-most I characters of string X$. If I is greater than or equal to the length of the string X$, the function will return the entire string. If I equals 0, the null string (length zero) will be returned. The variable I must be in the range 0 to 255.

Example:

```
10 A$="DISK BASIC-80"
20 PRINT RIGHT$(A$,8)
RUN
BASIC-80
Ok
```

SPACE$ (return string of spaces)

Form: SPACE$(X)

The SPACE$ function will return a string of spaces of length X. The expression X is rounded to an integer and must be in the range 0-255.

Example:

```
10 FOR I = 1 TO 5
20 X$ = SPACE$(I)
30 PRINT X$;I
40 NEXT I
RUN
  1
   2
    3
     4
      5
Ok
```

STR$ (return string representation)

Form: STR$(X)

The STR$ function will return the string representation of X. For example, if X = 45.3, then STR$(X) equals the string " 45.3". A leading blank will be inserted before "45.3" to allow for the sign of X. Arithmetic operations may be performed on X, but not on the string STR$(X).

Examples:

```
PRINT STR$(100)
 100

PRINT STR$(-100)
 -100
```

STRING$ (build string)

Forms: STRING$(I,J)

or

STRING$(I,X$)

The STRING$ function will return a string of length I composed of the ASCII code J or the first character of X$. I and J must be in the range 0-255.

Examples:

```
PRINT STRING$(10,"*")
**********

PRINT STRING$(15,65)
AAAAAAAAAAAAAAA
```

VAL (return numerical representation)

Form: VAL(X$)

The VAL function will return the decimal numerical representation of the string X$. The VAL function will strip all leading blanks, tabs, and line feeds from the argument string.

If the first valid character of X$ is not +, - ,&, or a digit, then VAL(X$) = 0. The & is used to specify an octal value. The VAL function will convert this octal value to decimal when VAL(X$) is evaluated. If the string X$ contains both numeric and alphanumeric characters, only the leading numeric characters will be used in evaluating X$.

Examples:

```
PRINT VAL("100 FEET")
 100

PRINT VAL("FEET 100")
 0

PRINT VAL("&100")
 64

PRINT VAL(" -3")
-3
PRINT VAL("&H16")
 22
```

Chapter Six

Arrays

OVERVIEW

This Chapter explains the methods used to create and reference an array, which is simply an ordered list of data items. This list of data items can be a one-dimensional vertical array, or it can be a table of data items consisting of rows and columns.

These data items may be either string or numeric. Each one is referred to as an "element". To help illustrate the concept of arrays, an example is included in this Chapter.

This Chapter also contains several sample routines which can be used to manipulate arrays. These sample routines can be used to add, multiply, transpose and perform other useful operations on numeric arrays.

ARRAYS

Array Declarator

Before an array is referenced, it should be "declared" by use of an array declarator. The DIM statement is used to establish the maximum number of elements in an array. The general form of the DIM statement is:

DIM△<name>[(<integer expression>)]

where:

<name> is a valid BASIC-80 symbolic name

<integer expression> is any valid integer expression which when evaluated, will be rounded to a positive integer value. This positive integer value will then become the maximum number of elements associated with that specific array name. The maximum number of dimensions is 255. The maximum number of elements per dimension is 32767. When used, this expression must be enclosed in parentheses.

Examples:

```
DIM A(3),D$(2,2,2)
DIM Q1(R+T)
DIM Z#(100)
```

An array can also be declared without the use of the array declarator. When BASIC-80 encounters a subscripted variable that has not been defined with a DIM statement, it will assume a maximum subscript of 10. Thus, an array can be established without the use of the DIM statement.

If one or more variables is declared with the same name as an array name, the interpreter recognizes each name as a separate entity.

Example:

```
10 A%=1
20 A!=2
30 A#=3
40 A(5)=4
50 PRINT A%;A!;A#;A(5)
RUN
 1  2  3  4
```

Array Subscript

Each element of an array can be uniquely referenced by having an array subscript appended to the end of the array name. This array subscript is an integer expression which references a unique element of the array.

Examples:

```
A(1),D$(I,J,K)
Q1(2)
Z#(55)
```

Any attempt to reference an array element with a subscript that is negative will result in an "Illegal Function Call" error. References to subscripts which are larger than the maximum value established by a DIM statement and references which contain too many or too few subscripts will generate a "Subscript Out of Range" error.

OPTION BASE Statement

The minimum subscript for an array element is assumed to be 0. The array declarator A(10) actually establishes an 11-element array, A(0) - A(10). The OPTION BASE statement can be used to change this default minimum array subscript to 1. The following example illustrates the use of the OPTION BASE statement.

Example:

```
OPTION BASE 1
DIM A(10)
```

This program segment will establish a 10 element array, A(1) - A(10). The OPTION BASE statement must appear before any DIM statement or before any subscripted variable is referenced. An attempt to use the OPTION BASE statement after an array has already been established will result in a "Duplicate Definition" error.

Vertical Arrays

A vertical array is a 1-dimensional array. This type of array is established if a DIM statement with one subscript is used, or if BASIC-80 is allowed to establish the default array size. Assuming that the default array size of 11 elements has been established for the array A, BASIC-80 would allocate storage as follows:

Array element	Subscripted variable
Element #1	A(0)
Element #2	A(1)
Element #3	A(2)
Element #4	A(3)
Element #5	A(4)
Element #6	A(5)
Element #7	A(6)
Element #8	A(7)
Element #9	A(8)
Element #10	A(9)
Element #11	A(10)

Table 6-1
Array Storage Allocation.

The variable A(9) would refer to the tenth element of this vertical array. (Although, the OPTION BASE statement could be used to set the minimum subscript to 1, in which case A(9) would refer to the ninth element of the array.)

Multi-Dimensional Arrays

A multi-dimension array is declared in the same manner as a vertical array, except that both row and column size are declared. For example, to declare a 3 × 3 array, the following sequence of statements could be used:

```
OPTION BASE 1
DIM A(3,3)
```

After this program segment is executed, BASIC-80 would reserve nine storage locations for the array. (Note that the minimum subscript value was set to 1 with the OPTION BASE statement.)

Storage for the array would be allocated as follows:

Column	1	2	3
Row 1	A(1,1)	A(1,2)	A(1,3)
2	A(2,1)	A(2,2)	A(2,3)
3	A(3,1)	A(3,2)	A(3,3)

Table 6-2
Multi-Dimensional Array
Storage Allocation.

When reading from left to right, note that the second array subscript varies most rapidly. This is because BASIC-80 allocates array storage such that the right-most subscript varies the fastest.

String arrays can also be established in the same manner as numeric arrays. A string array is declared when the DIM statement is used.

```
DIM A$ (100)
```

This statement will establish a 101 element string array. To access an element of the array, append an array subscript to the end of the variable name.

```
A$ (20)="A STRING ARRAY"
```

MATRIX MANIPULATION

The following is a collection of subroutines which are very useful for manipulating a matrix. The subroutine line numbers may have to be changed to be compatible with your main program.

Matrix Input Subroutines

```
5000 'SUBROUTINE NAME -- MATIN2
5010 'ENTRY I% = # OF ROWS, J% = # OF COLUMNS
5020 DIM MAT(I%,J%)
5030 FOR K% = 1 TO I%
5040 PRINT "INPUT ROW #";K%
5050       FOR L% = 1 TO J%
5060       INPUT MAT(K%,L%)
5070 NEXT L%,K%
5080 RETURN
```

The above subroutine will accept data from the terminal and assign this data to the 2-dimensional array named MAT. Upon entry into this subroutine, the integer variable I% must contain the number of rows in the matrix, and J% must contain the number of columns.

```
5000 'SUBROUTINE NAME -- MATIN3
5010 'ENTRY        I% = SIZE OF DIMENSION #1
5020 '             J% = SIZE OF DIMENSION #2
5030 '             K% = SIZE OF DIMENSION #3
5040 DIM MAT(I%,J%,K%)
5050 FOR L% = 1 TO I%
5060      FOR M% = 1 TO J%
5070               FOR N% = 1 TO K%
5080 READ MAT(L%,M%,N%)
5090 NEXT N%,M%,L%
6000 RETURN
```

This subroutine is used to read data from a DATA statement and assign this data to the 3-dimensional array named MAT. Upon entry into this subroutine, the integer variable I% must contain the number of elements for dimension 1, J% must contain the number of elements for dimension 2, and K% must contain the number of elements for dimension 3. The data must also be contained in a valid DATA statement.

Scalar Multiplication (multiplication by a single variable)

```
5000 'SUBROUTINE NAME -- MATSCALE
5010 'ENTRY --      I% = SIZE OF DIMENSION #1
5020 '              J% = SIZE OF DIMENSION #2
5030 '              K% = SIZE OF DIMENSION #3
5040 '      A--ORIGINAL ARRAY
5050 '  X--SCALAR FACTOR
5060 '  B--NEW ARRAY
5070 FOR L% = 1 TO K%
5080   FOR M% = 1 TO J%
5090     FOR N% = 1 TO I%
6000     B(N%,M%,L%) = A(N%,M%,L%)*X
6010     NEXT N%
6020   NEXT M%
6030 NEXT L%
6040 RETURN
```

This subroutine will multiply each element in the 3-dimensional array A by the value assigned to X and produce a new 3-dimensional array B. Upon entry into this subroutine, I% must contain the size of dimension #1, J% must contain the size of dimension #2, K% must contain the size of dimension #3, and X must contain the value to multiply by (scalar factor). Both arrays A and B must also have previously been defined by a DIM statement.

Transposition of a Matrix

```
5000 'SUBROUTINE NAME -- MATTRANS
5010 'ENTRY I% = # OF ROWS, J% = # OF COLUMNS
5020 'TRANSPOSE A INTO B
5030 FOR K% = 1 TO I%
5040   FOR L% = 1 TO J%
5050   B(L%,K%) = A(K%,L%)
5060   NEXT L%
5070 NEXT K%
5080 RETURN
```

This subroutine will transpose the 2-dimensional matrix A into the 2-dimensional matrix B. Upon entry into the subroutine, I% must contain the number of rows and J% must contain the number of columns. Both array A and B must have been previously defined by a DIM statement.

Matrix Addition

```
5000 'SUBROUTINE NAME -- MATADD
5010 'ENTRY -- I% = SIZE OF DIMENSION #1
5020 '         J% = SIZE OF DIMENSION #2
5030 '         K% = SIZE OF DIMENSION #3
5040 'ARRAY A+B = C
5050 FOR L% = 1 TO K%
5060   FOR M% = 1 TO J%
5070     FOR N% = 1 TO I%
5080     C(N%,M%,L%) = B(N%,M%,L%) + A(N%,M%,L%)
5090     NEXT N%
6000   NEXT M%
6010 NEXT L%
6020 RETURN
```

This subroutine will add the elements of arrays A and B to produce a new array C. A,B, and C must have previously been defined by a DIM statement.

Matrix Multiplication

```
5000 ' SUBROUTINE NAME -- MATMULT
5010 'ENTRY -- ARRAY A MUST BE D1% BY D3% ARRAY
5020 '         ARRAY B MUST BE D3% BY D2% ARRAY
5030 '         ARRAY C MUST BE D1% BY D2% ARRAY
5040 FOR I% = 1 TO D1%
5050   FOR J% = 1 TO D2%
5060   C(I%,J%) = 0
5070      FOR K%= 1 TO D3%
5080      C(I%,J%)=C(I%,J%)+A(I%,K%)*B(K%,J%)
5090     NEXT K%
6000   NEXT J%
6010 NEXT I%
```

This subroutine will multiply the 2-dimensional array A by the 2-dimensional array B and produce C.

Chapter Seven

Functions

OVERVIEW

BASIC-80 provides a full set of intrinsic functions for use by the BASIC-80 programmer. One group of intrinsic functions is the arithmetic functions. These functions are referenced by a symbolic name; when invoked, they return a single value. This single value will be either an integer or single-precision data type. The arguments to the arithmetic functions are enclosed in parentheses.

BASIC-80 programmers also have a group of special functions that they may use. These special functions each have their own unique requirements for referencing.

Complete facilities for constructing and referencing user-written functions have also been included in BASIC-80.

ARITHMETIC FUNCTIONS

Several arithmetic functions are available for use by the BASIC-80 programmer. These arithmetic functions are:

FUNCTION	DEFINITION
ABS(X)	absolute value
ATN(X)	arctangent
CDBL(X)	convert to double-precision
CINT(X)	round to integer
COS(X)	cosine
CSNG(X)	convert to single-precision
EXP(X)	e to the power of X
FIX(X)	truncate supplied argument
INT(X)	largest integer <= X
LOG(X)	natural log of X
RND(X)	random number between 0 and 1
RANDOMIZE	reseed random number generator
SGN(X)	sign (+,- or 0) of X
SIN(X)	sine of X
SQR(X)	square root of X
TAN(X)	tangent of X

Table 7-1
Arithmetic Functions.

ABS (absolute value)

Form: ABS(X)

The ABS function returns the absolute value of the expression X.

Example:

```
PRINT ABS(7*(-5))
 35
Ok
```

ATN (arctangent)

Form: ATN(X)

The ATN function will return the arctangent of X. X must be expressed in radians. The result will be in the range −pi/2 to pi/2. The expression X may be any numeric type, but the evaluation of ATN is always performed in single-precision.

Example:

```
10 X = 3
20 PRINT ATN(X)
RUN
 1.24905
Ok
```

CDBL (convert to double-precision)

Form: CDBL(X)

The CDBL function will convert X to a double-precision number.

Example:

```
10 X = 454.67
20 PRINT X;CDBL(X)
RUN
 454.67  454.6700134277344
Ok
```

CINT (round to integer)

Form: CINT(X)

The CINT function will convert X to an integer. The fractional portion of X will be rounded to the nearest integer. If this function returns a result that is not in the range −32768 to 32767, an "Overflow" error will occur.

Example:

```
PRINT CINT(45.67)
 46
Ok
```

COS (cosine)

Form: COS(X)

The COS function will return the cosine of X. X must be expressed in radians. The calculation of COS is performed in single-precision.

Example:

```
10 X = 2 * COS( .4)
20 PRINT X
RUN
 1.84212
Ok
```

CSNG (convert to single-precision)

Form: CSNG(X)

The CSNG function will convert X to a single-precision number.

Example:

```
10 A# = 975.3421#
20 PRINT A#;CSNG(A#)
RUN
 975.3421  975.342
Ok
```

NOTE: The # is used to declare the values as double-precision data types.

EXP (e raised to a power)

Form: EXP(X)

The EXP function will return e raised to the power of X. e is the natural logarithm's base value (2.71828...). X must be <= 87.3365. If EXP overflows, the "Overflow" error message is displayed.

Example:

```
10 X = 5
20 PRINT EXP(X-1)
RUN
 54.5982
Ok
```

FIX (truncate supplied argument)

Form: FIX(X)

The FIX function will return the truncated integer part of X. The major difference between FIX and INT is that FIX simply removes any decimal portion of a number. INT will round a negative number to the next lowest number.

Examples:

```
PRINT FIX(58.75)
 58
Ok

PRINT FIX(-58.75)
-58
Ok
```

INT (convert to integer)

Form: INT(X)

The INT function will return the largest integer <=X. When a negative value is rounded, it will be rounded to the next smallest value.

Examples:

```
PRINT INT(99.89)
 99

PRINT INT(-12.11)
-13
```

LOG (natural logarithm)

Form: LOG(X)

The LOG function will return the natural logarithm of the supplied argument. X must be greater than zero. IF X is less than or equal to zero, an "Illegal function call" error message will be displayed.

Example:

```
PRINT LOG(45/7)
 1.86075
```

RND (random number generator)

Form: RND(X)

The RND function will return a random number between 0 and 1. The same sequence of random numbers is generated each time the program is executed unless the random number generator is reseeded. The RANDOMIZE statement is used to reseed the random number generator.

If X<0, the sequence of numbers will be restarted. X>0 or X omitted will generate the next random number in the sequence. X=0 will repeat the last number generated.

Example:

```
10 FOR I = 1 TO 5
20 PRINT INT(RND*100);
30 NEXT
RUN
 24  30  31  51  5
OK
```

RANDOMIZE (reseed random number generator)

Form RANDOMIZE <expression>

The RANDOMIZE statement is used to reseed the random number generator. <expression> is used as the random number seed value. If <expression> is omitted, BASIC-80 suspends program execution and asks for a value by printing:

```
Random Number Seed (-32768 to 32767)?
```

The value input is used as the random number seed.

If the random number generator is not reseeded, the RND function returns the same sequence of random numbers each time the program is executed.

To change the sequence of random numbers every time the program is executed, place a RANDOMIZE statement at the beginning of the program and change the argument with each run.

Example:

```
10 RANDOMIZE RND
20 FOR I=1 TO 5
30 PRINT (RND*100)
40 NEXT I
50 GOTO 10
```

The <expression> argument can also be derived by performing an operation (such as PEEK or INP) on an address or port value.

SGN (sign of expression)

Form: SGN(X)

The SGN function returns a result based on the numeric value of X.

If X<0, SGN(X) will return −1. If X=0, SGN(X) will return 0. If X>0, SGN(X) will return 1.

You can create an arithmetic IF statement using this function:

```
ON SGN(X)+2 GOTO 100,200,300
```

If X is negative, the program will branch to line number 100. If X is zero, the program will branch to line number 200. If X is positive, the program will branch to line number 300.

Example:

```
10 INPUT X
20 ON SGN(X)+2 GOTO 50,60,70
50 PRINT"NEGATIVE":GOTO 10
60 PRINT"ZERO":GOTO 10
70 PRINT"POSITIVE":GOTO 10
RUN
? -10
NEGATIVE
? 0
ZERO
? 10
POSITIVE
?
```

SIN (sine)

Form: SIN(X)

The SIN function will return the sine of X. X must be expressed in radians. SIN(X) is calculated in single-precision.

Example:

```
PRINT SIN(1.5)
 .997495
Ok
```

SQR (square root)

Form: SQR(X)

The SQR function will return the square root of X. X must be >=0. If X is less than zero, an "Illegal function call" error will be displayed.

Example:

```
10 X = 25
20 PRINT X,SQR(X)
RUN
 25          5
Ok
```

TAN (tangent)

FORM: TAN(X)

The TAN function will return the tangent of X. X must be in expressed in radians. TAN(X) will be calculated in single-precision. If TAN overflows, the "Overflow" error message will be displayed.

Example:

```
PRINT TAN(10)
 .64836
Ok
```

MATHEMATICAL FUNCTIONS

Some functions that are not intrinsic to BASIC-80 may be calculated as follows:

Function	BASIC-80 Equivalent
SECANT	SEC(X) = 1/COS(X)
COSECANT	CSC(X) = 1/SIN(X)
COTANGENT	COT(X) = 1/TAN(X)
INVERSE SINE	ARCSIN(X) = ATN(X/SQR(−X*X+1))
INVERSE COSINE	ARCCOS(X) = -ATN(X/SQR(-X*X+1))+1.570796
HYPERBOLIC SINE	SINH(X) = (EXP(X)-EXP(-X))/2
HYPERBOLIC COSINE	COSH(X) = (EXP(X)+EXP(-X))/2
HYPERBOLIC TANGENT	TANH(X) = (EXP(X)-EXP(-X))/(EXP(X)+EXP(-X))
HYPERBOLIC SECANT	SECH(X) = 2/(EXP(X)+EXP(-X))
HYPERBOLIC COSECANT	CSCH(X) = 2/(EXP(X)-EXP(-X))
HYPERBOLIC COTANGENT	COTH(X) = (EXP(X)+EXP(-X))/(EXP(X)-EXP(-X))

Table 7-2
Mathematical Functions

SPECIAL FUNCTIONS

Several special functions are available for use by the BASIC-80 programmer. These special functions are:

Function	Definition
FRE(X)	free memory space
INP(I)	input from port
LPOS(X)	position of print head
NULL(X)	set number of nulls
OUT I,J	output to port
PEEK(I)	read byte from memory
POKE I,J	write byte to memory
POS(X)	current cursor position
SPC(X)	print spaces
TAB(I)	tab carriage
VARPTR(X)	variable pointer
WAIT I,J,K	status of port
WIDTH I	set terminal line width
WIDTH LPRINT I	set printer line width

Table 7-3
Special Functions.

FRE (return amount of free memory)

Form: FRE(0) FRE(X$)

The FRE function will return the number of bytes in memory that are not being used by BASIC-80. The arguments to FRE are dummy arguments.

FRE(" ") forces some system housekeeping to consolidate a contiguous block of free memory before returning the number of free bytes. The housekeeping will take 1 to 2 minutes. Even if you do not use FRE, BASIC-80 will initiate housekeeping when there is not enough contiguous free memory for BASIC-80 to perform an operation.

Example:

```
PRINT FRE(0)
```

INP (input byte from I/O port)

Form: INP(I)

The INP function will return the byte read from port I. I must be in the range 0 to 255. INP is the complementary function to OUT.

Example:

```
10 A = INP(255)
```

LPOS (return position of print head)

Form: LPOS(X)

The LPOS function will return the current position of the line printer print head within the line printer buffer. This does not necessarily correspond to the actual physical position of the print head. X is a dummy argument.

Example:

```
100 IF LPOS(X)>60 THEN LPRINT CHR$(13)
```

NULL (set number of nulls)

Form: NULL <integer expression>

The NULL function sets the number of nulls that will be printed at the end of a line.

For 10 character-per-second tape punches, <integer expression> should be greater than or equal to 3.

For teletypes and teletype-compatible CRTs (when tapes are not being punched), then <integer expression> should be 0 or 1.

For 30 character-per-second hard copy printers, <integer expression> should be 2 or 3.

The default value of <integer expression> is 0.

Example:

```
Ok
Null 2
Ok
100 INPUT X
200 IF X<50 THEN STOP
300 PRINT X
400 GOTO 100
```

Because of the NULL function in the preceding example whenever the interpreter sends an end-of-line sequence (carriage return and line feed), two nulls are also sent.

OUT (output byte to I/O port)

Form: OUT I,J

The OUT statement will send a byte to an output port. I and J must be integer expressions in the range 0 to 255. The integer expression I is the port number, and the integer expression J is the data to be transmitted.

Example:

```
100 OUT 32,100
```

PEEK (examine contents of memory location)

Form: PEEK(I)

The PEEK function will return the byte read from memory location I. The value returned will be a decimal integer in the range 0 to 255. I must be in the range -32768 to 65535. PEEK is the complimentary function to the POKE function.

Example:

```
PRINT PEEK(34000)
 234
Ok
```

Note: You may not get the same result if you PEEK memory location 34000.

POKE (change contents of memory location)

Form: POKE I,J

The POKE function will change the contents of a memory location. If I or J is a floating point number, it is rounded to the nearest integer.

The integer expression I is the address of the memory location to be changed. I must be in the range -32768 to 65535.

The integer expression J is the value to be placed into memory location I. J must be in the range 0 to 255.

POKE and PEEK are useful for efficient data storage, loading assembly language subroutines, and passing arguments and results to and from assembly language subroutines.

Example:

```
POKE 34000,1
Ok
```

POS (return current cursor position)

Form: POS(I)

The POS function will return the current cursor position. The left-most position is 1. I is a dummy argument.

Example:

```
IF POS(I) > 60 THEN PRINT CHR$(13)
```

SPC (print blanks)

Form: SPC(I)

The SPC function is used to print blanks on the terminal or the line printer. The integer argument I specifies how many blanks are to be printed. I must be in the range -32768 to 32767. The SPC function may only be used with PRINT and LPRINT statements.

Example:

```
PRINT "OVER";SPC(15);"THERE"
OVER               THERE
Ok
```

TAB (tab carriage)

Form: TAB(I)

The TAB statement is used to space to position I on the terminal or line printer. If the current print position is already beyond space I, TAB goes to position I on the next line.

Position 1 is the left-most position, and width is the right-most position. I must be a number in the range 1 to 255. TAB may only be used with PRINT and LPRINT statements.

Example:

```
10 PRINT "NAME";TAB(10);"AMOUNT"
20 READ A$,B$
30 PRINT A$;TAB(10);B$
40 DATA "WILLIAMS","$20.00"
RUN
NAME      AMOUNT
WILLIAMS $20.00
```

VARPTR (variable pointer)

Form#1: VARPTR (<variable name>)
Form#2: VARPTR (#<file number>)

Form #1 of the VARPTR function is used to return an address-value which can be used to locate where the variable <variable name> is stored in memory. A value must have been previously assigned to <variable name> or an "Illegal function call" error will result.

Any type variable name may be used (numeric, string, array). The result returned will be an integer in the range -32768 to 32767. If a negative address is returned, add it to 65536 to obtain the actual address. This returned address (which we will refer to as A) has a different meaning depending upon on the data type of <variable name>.

NOTE: The results from these examples may vary depending on how much memory your system has, how much memory is being used for BASIC-80, etc.

If <variable name> is a string value:

A — Contains the length of the string.
A+1 — Contains the LSB (least significant byte) of the actual string starting address.
A+2 — Contains the MSB (most significant byte) of the actual string starting address.

The actual address where the string value is stored can be calculated by:

actual address = (value found at location A+2)*256 + (value found at location A+1)

This address will most likely be in high RAM where the string values are stored. If the string value is a constant (a string literal), this address will represent the area of memory where the program line containing the string is stored.

(Remember, A is only the address of this information, you must PEEK(A) to obtain the actual value.)

Example:

```
X$="ABC"  [you type]
Ok
PRINT VARPTR(X$)  [you type]
-23927
Ok
```

If <variable name> is an integer value:

A — Contains the LSB of the 2-byte integer
A+1 — Contains the MSB of the 2-byte integer

To display this information (in two's complement decimal representation), execute a PRINT PEEK(A) and a PRINT PEEK(A+1).

Example:

```
I% = 1000  [you type]
Ok
PRINT VARPTR(I%) [you type]
-29121
Ok
```

If <variable name> is a single-precision value:

A — Contains the LSB of value.
A+1 — Contains next MSB of value.
A+2 — MSB (most significant byte) with implied leading one. Most significant bit is the sign of the number.
A+3 — Exponent of value in excess 128 notation (128 is added to the exponent).

If <variable name> is a double-precision value:

A — Contains the LSB of value.
A+1 — Next MSB.
A+2 — Next MSB.
A+3 — Next MSB.
A+4 — Next MSB.
A+5 — Next MSB.
A+6 — MSB (most significant byte) with implied leading one. Most significant bit is the sign of the number.
A+7 — Exponent of value in excess 128 notation.

The double and single-precision numbers are stored in a normalized exponent form, so that a decimal is assumed before the MSB. The exponent is stored in excess 128 notation (128 is added to the exponent). The high order bit of the MSB is used as a sign bit. It is 0 if the number is positive or 1 if the number is negative.

Example:

```
10 A = 23.4
20 B#=23.12345678
30 PRINT VARPTR(A),VARPTR(B#)
RUN
-23888          -23880
Ok
```

Form#2 of the VARPTR function is used to return the address of the FIELD buffer for the specified random file.

Example:

```
10 OPEN "R",1,"OUT.DAT"
20 FIELD#1, 128 AS JUNK$
30 PRINT VARPTR(#1)
RUN
-2345
Ok
```

WAIT (monitor port)

Form: WAIT I,J,[K]

where I is the number of the port being monitored. The WAIT function is used to suspend program execution while monitoring the status of a machine input port.

The WAIT function causes execution to be suspended until a specified machine input port develops a certain bit pattern. The data read at the port is XOR'ed with the integer expression K, and then AND'ed with the integer expression J.

If the result is zero, BASIC-80 loops back and reads the data at the port again. If the result is non-zero, execution resumes with the next executable statement. If K is omitted, it is assumed to be zero. I,J, and K must be in the range 0 to 255. (Remember, all numbers are decimal unless preceded by &H, &O, or &.)

Example:

```
WAIT 20,6
```

Execution stops until either bit 1 or bit 2 of port 20 are equal to 1. (Bit 0 is least significant, bit 7 is most.) Execution resumes at the next statement.

```
WAIT 10,255,7
```

Execution stops until any of the most significant five bits of port 10 are equal to 1, or any of the least significant three bits are 0. Execution resumes at the next statement.

WIDTH (set line width)

Form: WIDTH [LPRINT] <integer expression>

The WIDTH function is used to set the printed line width for the terminal or line printer. The LPRINT option is used for the line printer width.

<integer expression> is the number of characters in the printed line. The default line width for the terminal is 80 and the default line width for the line printer is 132.

IF <integer expression> is 255 the line width is "infinite", that is, BASIC never inserts a carriage return. However, the position of the cursor or print head, as given by the POS or LPOS function, returns to zero after position 255.

Examples:

```
WIDTH 80
```
set terminal width at 80 characters.

```
WIDTH LPRINT 96
```
set printer width at 96 characters.

USER-DEFINED FUNCTIONS

Sometimes it is necessary to execute the same sequence of program statements or mathematical formulas in several different places. BASIC-80 allows you to define your own functions and then reference these functions in the same manner as the standard system functions, such as ABS, SIN, or SQR.

At times it may also be necessary to code a specific portion of a program in assembly language. Facilities have been provided for the BASIC-80 programmer to reference assembly language programs from a BASIC-80 program.

DEF FN (define function)

Form: DEF FN<name>(<variable list>) = expression

The DEF FN statement is used to define an implicit function.

<name> must be a legal variable name. This name, preceded by the FN becomes the function name. The entries in the variable list are "dummy" variable names. The dummy variables represent the argument variables or values in the function call.

Any number of arguments are allowed, and any valid expression may appear on the right side of the equal sign. The length of the function definition is limited to one logical line (255 characters).

User-defined functions may be of any type. The type of a function is specified by inserting one of the type declaration characters (%,!,#,or $) after the function name. If a type declaration character is not used, the definition (DEFSTR, DEFSNG, etc.) for that letter applies. If you have made no unique DEF's, then a numeric variable is assumed to be a single-precision data type.

If a type is specified for the function, the value of the expression is forced to that type before it is returned to the calling statement. If a type is specified in the function name and the argument type does not match, a "Type mismatch" error occurs. DEF FN is illegal in the Command Mode.

Example:

```
10 DEF FNAB(X,Y)=X+Y
20 SUM = FNAB(10,20)
30 PRINT SUM
RUN
 30
Ok
```

NOTE: If duplicate functions are defined, only the first will have effect.

ASSEMBLY LANGUAGE PROGRAMS

It is possible to invoke an assembly language program in either of two methods. The first method is to use the USR function, and the other method is with the CALL statement.

For more information, see Appendix D, "Assembly Language Subroutines."

DEF USR (define entry address for USR subroutine)

Form: DEF△USR<digit>=<expression>

The DEF USR statement is used to define the entry points for up to 10 assembly language subroutines.

The <digit> is the number of the assembly language subroutine. <digit> may be any number from 0-9. If <digit> is omitted, it is assumed to be 0.

The value of <expression> is the starting address of the assembly language subroutine in decimal, unless the number is preceded by a special base specification character. A hexadecimal number is specified with the prefix &H and an octal number is specified with the prefix &O or &.

Examples:

```
DEF USR1=&H22
DEF USR2=45000
DEF USR5=ADDRESS
```

USR (invoke assembly language subroutine)

Form: USR<digit>(X)

The USR function is used to invoke an assembly language subroutine. <digit> must be in the range 0-9 and corresponds to the digit supplied with the DEF USR statement. If <digit> is omitted, it is assumed to be zero. X is the argument to be passed to the assembly language subroutine.

Examples:

```
Z = USR1(B/2)

A = USR2(1.23)

C = USR5(ARG1)
```

NOTE: A detailed description of how to define and reference USR functions is contained in Appendix E.

CALL (call assembly language subroutine)

Form: CALL△<variable name>[(argument list)]

The CALL statement is used to call an assembly language subroutine.

<variable name> is assigned an address that is the starting point, in memory, of the assembly language subroutine. The address should be assigned before a CALL statement is executed. <variable name> may not be an array variable name. <argument list> contains the arguments that are passed to the assembly language subroutine.

The CALL statement generates the same calling sequence used by Microsoft's FORTRAN, COBOL and BASIC Compilers. This calling sequence is explained in Appendix D, "Assembly Language Subroutines."

Example:

```
110 MYROUT = &HD000
120 CALL MYROUT(I,J,K)
```

Chapter Eight

Special Features

OVERVIEW

BASIC-80 provides the programmer with several special features. One of these features, Error Trapping, is useful for detecting errors during program execution. Another feature is the PRINT USING statement. This statement allows the programmer to specify the format of both numeric and string output.

Another important feature is the Trace flag, which allows the programmer to follow, line-by-line, the execution of a program.

BASIC-80 also provides the facilities for overlay management. The CHAIN and COMMON statement are used for this function.

ERROR TRAPPING

BASIC-80 allows the programmer to write error detection and error handling routines which can attempt to recover from errors, or provide more complete explanations of the causes of errors. This facility has been added through the use of the ON ERROR GOTO, RESUME, and ERROR statements, and with the ERR and ERL variables.

ON ERROR GOTO (enable error trapping)

Form: ON△ERROR△GOTO△<line number>

The ON ERROR GOTO statement is used to enable error trapping and specify the first line of the error handling subroutine.

Once error trapping has been enabled, all errors detected, including Command Mode errors (e.g., Syntax errors), will cause a jump to the specified error handling subroutine. If <line number> does not exist, an "Undefined line number" error results.

To disable error trapping, execute an ON ERROR GOTO 0. Subsequent errors will print an error message and halt execution. An ON ERROR GOTO 0 statement that appears in an error trapping subroutine causes BASIC-80 to stop and print the error message for the error that caused the trap. We recommend that all error trapping subroutines execute an ON ERROR GOTO 0 if an error is encountered for which there is no recovery action.

If an error occurs during execution of an error handling subroutine, the BASIC error message is printed and execution terminates. Error trapping does not trap errors within the error handling subroutine.

Example:

```
10 ON ERROR GOTO 1000
```

RESUME (continue execution)

Forms: RESUME
RESUME 0
RESUME NEXT
RESUME△<line number>

The RESUME statement is used to continue program execution after an error recovery procedure has been performed.

Any one of the four formats shown above may be used, depending upon where execution is to resume:

RESUME or RESUME 0	Execution resumes at the statement which caused the error.
RESUME NEXT	Execution resumes at the statement immediately following the one which caused the error.
RESUME△<line number>	Execution resumes at <line number>.

A RESUME statement that is not in an error trap routine causes a "RESUME without error" message to be printed.

Error Trap Example:

```
100 ON ERROR GOTO 500
200 INPUT"WHAT ARE THE NUMBERS TO DIVIDE";X,Y
210 Z=X/Y
220 PRINT "QUOTIENT IS";Z
230 GOTO 200
500 IF ERR=11 AND ERL=210 THEN 520
510 STOP
520 PRINT"YOU CAN'T HAVE A DIVISOR OF ZERO!"
530 RESUME 200
```

ERROR (generate error)

Form: ERROR <integer expression>

The ERROR statement can be used either to simulate the occurrence of a BASIC-80 error, or to allow error codes to be defined by the user.

The value of <integer expression> must be greater than 0 and less than or equal to 255. If the value of <integer expression> equals an error code already in use by BASIC-80, the ERROR statement will simulate the occurrence of that error, and the corresponding error message will be printed.

To define your own error code, use a value that is greater than any used by BASIC-80's error codes. (It is preferable to use the highest available values, so compatibility may be maintained when more error codes are added to BASIC-80.) This user-defined error code may then be conveniently handled in an error trap routine.

If an ERROR statement specifies a code for which no error message has been defined, BASIC-80 responds with the message "Unprintable error". Execution of an ERROR statement for which there is no error trap routine causes an error message to be printed and execution to halt.

Example:

```
LIST
10 S = 10
20 T = 5
30 ERROR S + T
40 END
Ok
RUN
String too long in line 30
```

Or, in Command Mode:

```
Ok
ERROR 15          (you type this line)
String too long (BASIC-80 types this line)
Ok
```

ERR and ERL Variables

When an error handling subroutine is entered, the variable ERR contains the error code for the error, and the variable ERL contains the line number of the line in which the error was detected. The ERR and ERL variables are usually used in IF/THEN statements to direct program flow in the error trap routine.

If the statement that caused the error was a Command Mode statement, ERL will contain 65535. To test if an error occurred in a Command Mode statement, use IF 65535 = ERL THEN ... Otherwise, use

IF ERR = error code THEN ...

IF ERL = line number THEN ...

If the line number is not on the right side of the relational operator, it cannot be renumbered by RENUM. Because ERL and ERR are reserved variables, neither may appear to the left of the equal sign in a LET (assignment) statement.

When the error handling subroutine is entered, the variable ERR contains the error code for the error. The error codes and their meanings are listed on the next page. See Appendix A, "Error Messages," for a more detailed discussion of the error messages.

ERROR CODES

General Errors

CODE	ERROR
1	Next without for
2	Syntax error
3	Return without gosub
4	Out of data
5	Illegal function call
6	Overflow
7	Out of memory
8	Undefined line number
9	Subscript out of range
10	Duplicate definition
11	Division by zero
12	Illegal direct
13	Type mismatch
14	Out of string space
15	String too long
16	String formula too complex
17	Can't continue
18	Undefined user function
19	No resume
20	Resume without error
21	Unprintable error
22	Missing operand
23	Line buffer overflow
26	For without next
29	While without wend
30	Wend without while

Table 8-1
Error Codes.

Disk Errors

CODE	ERROR
50	Field overflow
51	Internal error
52	Bad file number
53	File not found
54	Bad file mode
55	File already open
57	Disk i/o error
58	File already exists
61	Disk full
62	Input past end
63	Bad record number
64	Bad file name
66	Direct statement in file
67	Too many files

Table 8-1 (Cont'd.)
Error Codes.

FORMATTED OUTPUT

The PRINT USING statement can be used to output information in a specific format. This feature is useful in such applications as printing payroll checks or accounting reports.

PRINT USING (format output)

Form: PRINT USING<string exp>;<list of expressions>

The PRINT USING statement is used to print strings or numbers using a specified format.

<list of expressions> is comprised of the string expressions or numeric expressions that are to be printed, separated by semicolons or commas. <string exp> is a string literal (or variable) that is comprised of special formatting characters. These formatting characters (see below) determine the field, and the format, of the printed strings or numbers.

String Fields

When PRINT USING is used to print strings, one of three formatting characters may be used to format the string field:

"!"

This specifies that only the first character in the given string is to be printed.

"\n spaces\"

This specifies that 2+n characters from the string are to be printed. If the backslashes are typed with no spaces, two characters will be printed; with one space, three characters will be printed, and so on. If the string is longer than the field, the extra characters are ignored. If the field is longer than the string, the string will be left-justified in the field and padded with spaces on the right.

Example:

```
10 A$="LOOK":B$="OUT"
20 PRINT USING "!";A$;B$
30 PRINT USING "\   \";A$;B$
40 PRINT USING "\     \";A$;B$;"!!"
RUN
LO
LOOK OUT
LOOK    OUT !!
```

"&"

The ampersand specifies a variable length string field. When the field is specified with "&", the string is output exactly as input.

Example:

```
10 A$="LOOK":B$="OUT"
20 PRINT USING "!";A$
30 PRINT USING "&";B$
RUN
L
OUT
Ok
```

Numeric Fields

When PRINT USING is used to print numbers, the following special characters may be used to format the numeric field:

"#"

A number sign is used to represent each digit position. Digit positions are always filled. If the number to be printed has fewer digits than positions specified, the number will be right-justified (preceded by spaces) in the field.

"."

A decimal point may be inserted at any position in the field. If the format string specifies that a digit is to precede the decimal point, the digit will always be printed (as 0 if necessary). Numbers are rounded as necessary.

Examples:

```
PRINT USING "##.##";.78
 0.78

PRINT USING "###.##";987.654
987.65

PRINT USING "##.##△△△";10.2,5.3,66.789,.234
10.20   5.30   66.79   0.23
```

In the last example, three spaces were inserted at the end of the format string to separate the printed values on the line.

"+"

A plus sign at the beginning or end of the format string will cause the sign of the number (plus or minus) to be printed before or after the number.

"−"

A minus sign at the end of the format field will cause negative numbers to be printed with a trailing minus sign. If the number is positive, a space will be printed.

Examples:

```
PRINT USING "+##.##△△";-68.95,2.4,55.6,-.9
-68.95   +2.40  +55.60   -0.90

PRINT USING "##.##-△";-68.95,22.449,-7.01
68.95- 22.45   7.01-
```

"**"

A double asterisk at the beginning of the format string causes leading spaces in the numeric field to be filled with asterisks. The ** also specifies positions for two more digits.

Example:

```
PRINT USING "**#.#    ";12.39,-0.9,765.1
*12.4    *-0.9    765.1
```

"$$"

A double dollar sign causes a dollar sign to be printed to the immediate left of the formatted number. The $$ specifies two more digit positions, one of which is the dollar sign. The exponential format cannot be used with $$. Negative numbers cannot be used unless the minus sign trails to the right.

Example:

```
PRINT USING "$$###.##";456.78
 $456.78
```

"**$"

The **$ at the beginning of a format string combines the effects of the above two symbols. Leading spaces will be asterisk-filled and a dollar sign will be printed before the number. **$ specifies three more digit positions, one of which is the dollar sign.

Example:

```
PRINT USING "**$##.##";2.34
***$2.34
```

","

A comma that is to the left of the decimal point in a formatting string causes a comma to be printed to the left of every third digit on the left side of the decimal point. A comma that is at the end of the format string is printed as part of the string. A comma specifies another digit position. The comma has no effect if used with the exponential (^^^^) format.

Examples:

```
PRINT USING "####,.##";1234.5
1,234.50
Ok

PRINT USING "####.##,";1234.5
1234.50,
Ok
```

"^^^^"

Four carets (or up-arrows) may be placed after the digit position characters to specify exponential format. The four carets allow space for E+xx to be printed. Any decimal point position may be specified. The significant digits are left-justified, and the exponent is adjusted. Unless a leading + or trailing + or - is specified, one digit position will be used to the left of the decimal point to print a space or a minus sign.

Example:

```
PRINT USING "##.##↑↑↑↑";234.56
 2.35E+02
Ok

PRINT USING ".####↑↑↑↑-";888888
 .8889E+06
Ok

PRINT USING "+.##↑↑↑↑";123
+.12E+03
Ok
```

"_"

An underscore in the format string causes the next character to be output as a literal character.

Example:

```
PRINT USING "_!##.##_!";12.34
!12.34!
```

The underscore itself may be a literal character by placing "__" in the format string.

Errors

If the number to be printed is larger than the specified numeric field, a percent sign (%) is printed in front of the number. If rounding causes the number to exceed the field, a percent sign will be printed in front of the rounded number.

Examples:

```
PRINT USING "##.##";111.22
%111.22
Ok

PRINT USING ".##";.999
%1.00
Ok
```

If the number of digits specified exceeds 24, an "Illegal function call" error will result.

TRACE FLAG

As a debugging aid, two statements are provided to trace the execution of program instructions.

TRON/TROFF (enable/disable trace flag)

Forms: TRON

TROFF

The TRON/TROFF statements are used to trace the execution of program statements.

As an aid in debugging, the TRON statement (executed in either the Command or Indirect Mode) enables a trace flag that prints each line number of the program as it is executed. The numbers appear enclosed in square brackets. The trace flag is disabled with the TROFF statement (or when a NEW command is executed).

Example:

```
TRON
Ok
LIST
10 K=10
20 FOR J=1 TO 2
30 L=K + 10
40 PRINT␣J;K;L
50 K=K+10
60 NEXT
70 END
Ok
RUN
[10] [20] [30] [40] 1 10 20
[50] [60] [30] [40] 2 20 30
[50] [60] [70]
Ok
TROFF
Ok
```

OVERLAY MANAGEMENT

BASIC-80 provides two statements, CHAIN and COMMON, which are useful for manipulating overlays. With these two statements, it is possible to merge several programs during the execution of a program, as well as pass several or all the variables to another program.

CHAIN (call overlay)

Form: CHAIN [MERGE] "<filename>"[,[<line number exp>] [,ALL][,DELETE<range>]]

The CHAIN statement is used to call a program and pass variables to it from the current program.

"<filename>" is the name of the program that is called.

Example:

```
CHAIN"PROG1"
```

<line number exp> is a line number or an expression that evaluates to a line number in the called program. It is the starting point for execution of the called program. If it is omitted, execution begins at the first line.

Example:

```
CHAIN"PROG1",1000
```

<line number exp> is not affected by a RENUM command.

With the ALL option, every variable in the current program is passed to the called program, and a line number must be specified in the CHAIN statement. If the ALL option is omitted, the current program must contain a COMMON statement to specify the variables that are passed.

Example:

```
CHAIN"PROG1",1000,ALL
```

If the MERGE option is included, it allows a subroutine to be brought into the BASIC program as an overlay. That is, a MERGE operation is performed with the current program and the called program. The called program must be an ASCII file if it is to be MERGEd.

Example:

```
CHAIN MERGE"OVRLAY",1000
```

After an overlay is brought in, it is usually desirable to delete it so that a new overlay may be brought in. To do this, use the DELETE option. The line numbers in the <range> of the delete are affected by the RENUM command.

Example:

```
CHAIN MERGE"OVRLAY",1000,DELETE 1000-5000
```

If the MERGE option is omitted, CHAIN does not preserve variable types or user-defined functions for use by the chained program. That is, any DEFINT, DEFSNG, DEFDBL, DEFSTR, or DEFFN statement containing shared variables must be restated in the chained program.

COMMON (pass variables)

Form: COMMON△<list of variables>

The COMMON statement is used to pass variables to a chained program.

The COMMON statement is used in conjunction with the CHAIN statement. COMMON statements may appear anywhere in a program, though we recommend that they appear at the beginning. The same variable cannot appear in more than one COMMON statement. Array variables are specified by appending "( )" to the variable name. If all variables are to be passed, use CHAIN with the ALL option and omit the COMMON statement.

Example:

```
100 COMMON A,B,C,D(),G$
 110 CHAIN "PROG3",10
        .
        .
        .
```

Chapter Nine

Editing

OVERVIEW

In Edit Mode, it is possible to edit portions of a line without retyping the entire line. Upon entering Edit Mode, BASIC-80 types the line number of the line to be edited. Then it types a space and waits for the Edit Mode subcommand.

Edit Mode subcommands are used to insert, delete, replace, or search for text within a line. The subcommands are not echoed to the terminal. Some of the Edit Mode subcommands may be preceded by an integer which causes the command to be executed that number of times. When an integer is not specified, it is assumed to be one.

Edit Mode subcommands may be categorized according to the following functions:

1. Moving the cursor.
2. Inserting text.
3. Deleting text.
4. Finding text.
5. Replacing text.
6. Ending and restarting Edit Mode.

If BASIC-80 receives an unrecognizable command or illegal character while in Edit Mode, it sounds the bell (CTRL-G) and the command or character is ignored. You can invoke the Edit Mode by typing:

EDIT△<line number>

Where <line number> is the number of the line to be edited. If no <line number> exists, an "Undefined line number" error will result.

The requested line number will be printed, followed by a space. The cursor will now be positioned to the left of the first character in the line.

Type in the following line:

```
100 FOR J = 1 TO 10:PRINT J:NEXT
```

This program line will be used to demonstrate the various Edit Mode commands.

MOVING THE CURSOR

n Space Bar

In Edit Mode, the Space Bar is used to move the cursor to the right. For example, using line 100 entered above, invoke the Edit Mode. The line number 100 should be displayed on your screen as such:

```
100
```

Now press the Space Bar. The cursor will move over one space. The first character of the program line will now be displayed. If this character was a blank, then a blank will be displayed on your screen. Keep pressing the Space Bar until the first non-blank character is displayed. At this point, the screen should look something like this (depending on the contents of this program line):

```
100 F
```

It is also possible to move over more than one space at a time. Just press a number key first, and then the Space Bar. For example, to move over five spaces, type 5 and then press the Space Bar once. The characters will be printed as you move over them.

```
100 FOR J=
```

(Your display may not look exactly like this, depending on how many blanks you inserted in the program line.)

BACK SPACE

In Edit Mode, the BACK SPACE key moves the cursor one space to the left. The characters are not deleted as you move over them. To return to our example,

```
100 FOR J=
```

if the cursor were positioned after the = sign, pressing BACKSPACE once should move the cursor under the = sign. Thus:

```
100 FOR J=
```

INSERTING TEXT

I (Insert)

The I command will insert text beginning at the current cursor position. The inserted characters are printed on the terminal. To terminate insertion, press the ESC key. If you press the RETURN during the insert command, the effect is the same as typing ESC and then RETURN.

Use the Space Bar to move past the 0 in the 10.

```
100 FOR J=1 TO 10
```

Now, suppose you want to change the 10 to 100. Press the I key (you don't have to terminate the entry with a RETURN). You are now in Insert Mode. To make the neccessary change, type a 0. The display should now look like this:

```
100 FOR J=1 TO 100
```

Now that you have made the change, press the ESC key and you will exit Insert Mode. Now press the RETURN to save all your changes and return to BASIC-80 Command Mode. Line 100 should look similiar to this:

```
100 FOR J=1 TO 100:PRINT J:NEXT
```

During an insert command, you can use the BACK SPACE key on the terminal to delete characters on the left of the cursor.

If you try to insert a character that will make the line longer than 255 characters, a bell will be heard and the 256th character will not be printed.

X (Extend Line)

The X command is used to extend the line. X moves the cursor to the end of a line. BASIC-80 then goes into the Insert Mode and allows text to be inserted as if an insert command had been given. When you are finished extending the line, press ESC or RETURN and you will be returned to BASIC-80 Command Mode.

For example, to extend line number 100, which you have been editing, invoke Edit Mode with line number 100. The screen will show:

```
100
```

Now press the X key. The entire line will be displayed and the cursor will be at the end of the line:

```
100 FOR J=1 TO 100:PRINT J:NEXT
```

You have been put into Insert Mode. Now you can add another program statement to the end of this line. For example, type :PRINT"ALL DONE" and a RETURN. The line has now been extended to include this statement. If you were to LIST 100, it should look like this:

```
100 FOR J=1 TO 100:PRINT J:NEXT:PRINT"ALL DONE"
```

DELETING TEXT

nD (Delete)

nD deletes n characters to the right of the cursor. The deleted characters are echoed between backslashes, and the cursor is positioned to the right of the last character deleted. If there are fewer than n characters to the right of the cursor, the remainder of the line will be deleted.

For example, enter Edit Mode with line number 100, which you have been editing. Now, using the Space Bar, move the cursor over to the end of the FOR statement. The screen should look something like this:

```
100 FOR J=1 TO 100:_
```

Now type 8D. This will delete eight characters to the right of the cursor. The screen should look something like this:

```
100 FOR J=1 TO 100:\PRINT J:\
```

(Note that the characters deleted are enclosed in backslashes.)

Now press RETURN and you will be back to the BASIC-80 Command Mode. If you LIST 100, you should notice that the PRINT J: statement has been deleted from the program line.

H (Hack and Insert)

H deletes all characters to the right of the cursor and then automatically enters Insert Mode. H is useful for replacing statements at the end of a line. For example, assume you wish to change the last statement of program line 100. First, you must enter Edit Mode with line number 100. Now move over to the NEXT statement with the Space Bar. The screen should look similar to this:

```
100 FOR J=1 TO 100:NEXT:_
```

Press the H key and then type STOP. Type a RETURN to save this change and you will also exit to BASIC-80 Command Mode.

Now list line number 100. If you've been following the editing changes in this Chapter, the line should look like this:

```
100 FOR J=1 TO 100:NEXT:STOP
```

FINDING TEXT

nS<ch>(Search)

The search subcommand searches for the nth occurence of <ch> and positions the cursor before it. The character at the current cursor position is not included in the search. If <ch> is not found, the cursor will stop at the end of the line. All characters passed over during the search are printed. NOTE: only characters to the right of the cursor are included in this search.

For example, using the current form of the sample line 100, enter Edit Mode with line 100. Next, type 2S: . This command will be used to search for the second occurrence of the colon character in program line 100. The display should look something like this:

```
100 FOR J=1 TO 100:NEXT_
```

At this point you can execute any command you wish. You could enter a counter variable after the NEXT statement by first entering Insert Mode and then typing a space and the variable J. Now hit ESC to exit Insert Mode. Finally, press RETURN in order to exit back to the BASIC-80 Command Mode. Now, if you were to list line number 100, it would look similar to this (assuming you followed the editing changes in this chapter):

```
100 FOR J=1 TO 100:NEXT J:STOP
```

nK<ch>(Search and "Kill")

The search and kill subcommand is similar to the search subcommand except that all the characters passed over in the search are deleted. The cursor is positioned before <ch> and all the deleted characters are enclosed in backslashes.

For example, invoke the Edit Mode with the current version of line 100. Now type 2K:. This command will delete all of the characters in the line up to the second occurrence of the colon. The screen should look similar to this:

```
100 \FOR J=1 TO 100:NEXT J\_
```

The second colon still needs to be deleted, so type D. The screen should then look similar to this:

```
100 \FOR J=1 TO 100:NEXT J\\:\
```

Now press RETURN and LIST line 100. It should look like this:

```
100 STOP
```

REPLACING TEXT

nC(Change)

The change subcommand changes the specified number of characters beginning at the current cursor position. If you type only a C without a preceding number, the computer assumes that you wish to change only one character. If you enter a number n before you type C, then it assumes that you wish to change the next n characters.

After you have entered n characters, the Change Mode will be exited. If you attempt to enter any more characters, the bell is sounded and the extra characters are ignored.

For example, first retype line 100 as:

```
100 FOR J=1 TO 100:PRINT J:NEXT
```

Next, enter Edit Mode with line 100. Your screen should look something like this:

```
100
```

Now let's assume that you want to change the terminal value in the FOR/NEXT loop from 100 to 150. You would have to move the cursor over to the first zero in 100. Use the Space Bar to move the cursor over. If you go too far, simply press the BACKSPACE key to move the cursor back.

```
100 FOR J=1 TO 1
```

Now type C. BASIC-80 will assume that you wish to change only one character. Type 5 and then press RETURN. The changed line should look like this:

```
100 FOR J=1 TO 150:PRINT J:NEXT
```

ENDING AND RESTARTING EDIT MODE

RETURN(Save changes and Exit)

After you press a RETURN, the remainder of the line is printed, the changes you made are saved, and the computer returns to the BASIC-80 Command Mode.

E(Save Changes and Exit)

The E subcommand has the same effect as RETURN, except that the remainder of the line is not printed.

Q(Cancel and Exit)

The Q subcommand returns to the BASIC-80 Command Mode without saving any of the changes that were made to the line during Edit Mode.

L(List Line)

The L subcommand lists the remainder of the line (saving any changes made so far) and repositions the cursor at the beginning of the line, still in the Edit Mode. L is usually used to list the line when you first enter Edit Mode. For example:

```
EDIT 100
100 .
<you type L>
<BASIC-80 responds:>
100 FOR J=1 TO 150:PRINT J:NEXT
100
```

A(Cancel and Restart)

The A subcommand lets you begin editing a line over again. It discards any changes made so far and restores the original line, repositioning the cursor at the beginning. In order to use the A subcommand,you must not be currently executing any other subcommand. If you are executing another command (such as Insert), press the ESC, and then press the A. In the following example, the operator first lists the original line, then makes changes in Insert Mode, then decides to start over, using the A subcommand to restore the original line:

```
EDIT 100
100 _
<operator types L>
100 FOR J=1 TO 150:PRINT J:NEXT
100
100 for J=1 TO 15 <operator types I and adds a zero>
<operator types ESC>
<operator types L>
100 FOR J=1 TO 1500:PRINT J:NEXT
100
<operator types A>
100
<operator types L; note how original line has been restored>
100 FOR J=1 TO 100:PRINT J:NEXT
100
```

OTHER EDIT MODE FEATURES

SYNTAX ERRORS

When it finds a syntax error during the execution of a program, BASIC-80 will automatically enter Edit Mode at the line that caused the error. For example:

```
10 K = 2(4)
RUN
Syntax Error in 10
Ok
10
```

When you finish editing the line and press RETURN (or the E subcommand), BASIC-80 reinserts the line. This causes all variable values to be lost, and all open files to be closed. To preserve the variable values for examination, first exit Edit Mode with the Q subcommand. BASIC-80 will return to the Command Mode, and all variable values will be preserved.

CTRL-A

To enter the Edit Mode on the line you are currently typing, type CTRL-A. BASIC-80 will respond with a carriage return, an exclamation point (!),and a space. The cursor will then be positioned at the first character in the line. At this point you may proceed by typing any Edit Mode subcommand.

CURRENT LINE EDITING

You may use the period (.) to denote the current line when you invoke the Edit Mode. So, the command:

```
EDIT .
```

will invoke the Edit Mode at the current line. The line number symbol (.) always refers to the current line.

Chapter Ten

BASIC-80 Disk File Operations

OVERVIEW

BASIC-80 provides several sets of statements for creating and manipulating program and data files.

The file manipulation commands are very useful for manipulating program files. Some of these commands can also be used with data files.

The file management statements are used to open and close data files, check for end-of-file, and to obtain information about the size of a file.

The sequential access statements are used to access sequential files. The sequential access file is easy to use, but the data must be accessed sequentially.

The random access statements are used to access and manipulate random access files. The random access file requires more program steps than the sequential access, but the records in the file can be read in any order.

FILE MANIPULATION COMMANDS

This is a review of the commands and statements that are useful for manipulating program and data files. These statements and commands are also discussed in Chapter Three, "Command Mode Statements".

FILES△["<filename>"]

The FILES command lists the names of the files that are residing on the current disk. If the optional <filename> string is included, the names of the files on any specified disk can be listed.

KILL△"<filename>"

The KILL command deletes the file from the disk. "filename" may be a program file, or a sequential or random access data file. If "filename" is a data file, it must be closed before it is killed.

LOAD△"<filename>"[,R]

The LOAD command loads the program from disk into memory. The R option runs the program immediately. LOAD always deletes the current contents of memory and closes all files before LOADing. If R is included, however, open data files are kept open. Thus programs can be chained or loaded in sections and can access the same data files.

MERGE△"<filename>"

The MERGE command loads the program from disk into memory but does not delete the current contents of memory. The program line numbers on disk are merged with the line numbers in memory. If two lines have the same number, only the line from the disk program is saved. After a MERGE command, the "merged" program resides in memory and BASIC-80 returns to Command Mode.

NAME△"<oldfile>" AS "<newfile>"

To change the name of a disk file, execute the NAME statement, NAME "oldfile" AS "newfile". NAME may be used with program files, random files, or sequential files.

RESET

RESET reads the directory information off of a newly inserted disk which you have exchanged for the disk in the current default drive. RESET does not close files that were opened on the former default disk. Therefore, use RESET only after you have closed any open files and replaced the current default disk.

RUN△"<filename>"[,R]

RUN "filename" loads the program from disk into memory and runs it. RUN deletes the current contents of memory and closes all files before loading the program. If the R option is included, however, all open data files are kept open.

SAVE△"<filename>"[,A]

The SAVE command writes to disk the program that is currently residing in memory. The A option writes the program in ASCII format. (Otherwise, BASIC uses a compressed binary format.)

Protected Files

If you wish to save a program in an encoded binary format, use the "Protect" option with the SAVE command. For example:

```
SAVE "MYPROG",P
```

A program saved this way cannot be listed or edited.

FILE MANAGEMENT STATEMENTS

BASIC-80 provides a full set of I/O statements to be used for disk file management. These statements are listed below:

Statement	Function
OPEN	Opens a disk file and assigns a file number to the disk file.
CLOSE	Closes a disk file and de-assigns the file number from the disk file.
EOF	Returns −1 (true) if the end of a file has been reached.
LOF	Returns the number of records present in the last extent accessed.
LOC	Returns the next record to be accessed for a random file and the total number of sectors accessed for a sequential file.

Table 10-1
File Management Statements.

The OPEN statement is used to assign a file number to a disk file name. Also, the OPEN statement is used to define the mode in which the file is to be used (sequential or random access).

The CLOSE statement performs the opposite function of the OPEN statement. It will de-assign the file number from a disk file name.

The EOF function will return −1 (true) if the end of a sequential file has been reached. The EOF function can also be used with random files to determine the last record number.

The LOF function will return the number of records present in the last extent accessed.

The LOC function, when used with a random file, will return the next record to be accessed. When used with a sequential file,it returns the number of records accessed since the file was opened.

These statements are discussed on the following pages. For a detailed programming example that utilizes these statements, see "Appendix F."

OPEN (open disk data file)

Form: OPEN "mode",[#]<filenumber>,"<filename>"[<,reclen>]

where:

"mode" is a string expression whose first character is one of the following mode specification strings:

O Specifies sequential output mode.
I Specifies sequential input mode.
R Specifies random input/output mode.

This string expression will be referred to as the "mode string".

<filenumber> is an integer expression which represents the file number associated with the file. This number will be used in subsequent I/O operations.

<filenumber> must not exceed the number of files that were set during the BASIC-80 initialization process. If no files were set during the initilization process, BASIC-80 will assume a maximum of 3. (See Chapter One, "System Introduction and General Information", for more information about this initialization process.)

"<filename>" is the fully qualified CP/M file name. No extensions are assumed, so the file name must include this information. If no drive is specified, the current default drive is assumed.

<reclen> is an integer expression which, if included, sets the record length for random files. The maximum record length is 256 bytes. The default record length is 128 bytes. If a record length greater than 128 bytes is desired, this length must also be specified when BASIC-80 is initialized. This record length option can only be used with random files. Any attempt to declare the size of a sequential record will result in a "Syntax error".

The OPEN statement is used to associate a file number with a file name. The OPEN statement also defines the mode in which the file will be used (sequential or random access). Subsequent I/O operations will reference the file number assigned to a file name. For example, assume that a file was opened using the following statement:

```
OPEN "I",2,"SAMPLE.DAT"
```

This statement will assign file number 2 to the file SAMPLE.DAT. Because no drive name was specified, BASIC-80 will assume that SAMPLE.DAT resides on the current default drive. The mode string for this file specifies "I" -- sequential input.

If SAMPLE.DAT does not exist on the current default disk, an error will be generated, since input can not be performed on a non-existent file. Now, to input data from this file, the following statement would be used:

```
INPUT#2,<variable list>
```

Note that this INPUT# statement references file number 2, and file number 2 was the number assigned to the file SAMPLE.DAT. (This is only a general form of the INPUT# statement. A detailed discussion of the INPUT# statement appears later in this Chapter.)

Now assume that the following OPEN statement is used:

```
OPEN "O",3,"B:OUTPUT.DAT"
```

This will assign file number 3 to the file OUTPUT.DAT. Since the file name does contain the drive specification B:, BASIC-80 will create this output file on drive B:. If this file already exists on drive B:, it will be destroyed, and all previous contents of the file will be lost. Now, to output data to this file, the following statement would be used:

```
WRITE#3,<variable list>
```

The WRITE# statement references file number 3, and file number 3 had been previously assigned to the file B:OUTPUT.DAT. So, the data specified in the <variable list> would be written to the file B:OUTPUT.DAT. (The WRITE# statement is discussed in more detail later in this Chapter.) A file can also be opened for random I/O. One OPEN statement can be used to open the file for both random input and random output. For example, the following statement will open a file for random I/O.

```
OPEN "R",1,"RANDOM.DAT"
```

The file, RANDOM.DAT, is opened for random I/O. If RANDOM.DAT does not exist, it will be created on the current default disk. Now, either random input or random output can be performed with this file. Note that no record size was specified with this OPEN statement. Therefore, BASIC-80 will assume the default record size of 128 bytes. A different record size can be specified with the OPEN statement. (But only for a random access file.)

For example, to open the file RANDOM.DAT for random access, and declare a record size of 32 bytes, the following statement would be used:

```
OPEN "R",1,"RANDOM.DAT",32
```

Now the record size would be 32 bytes. The CP/M sector size is 128 bytes. Therefore, four records would be stored in each CP/M sector. The record size can also be set during the initialization procedure with the /S switch. (See Chapter 1, "System Introduction and General Information," for the initialization procedure.)

It is important to note that the mode under which a file was opened must be the same as the mode in which the file is accessed. For example, consider the following statement:

```
OPEN "I",1,"TEST.DAT"
```

The file TEST.DAT has been opened for sequential input and assigned to file number 1. Now an attempt to perform output on this file would be invalid and would generate an error message. For example:

```
WRITE#1,"HELLO THERE"
```

This WRITE# statement references file number 1. The previously executed OPEN statement has set the mode for file number 1 as sequential input. So this WRITE# would be invalid and would generate an error message.

However, there is an exception to this rule. Under certain circumstances several sequential I/O statements may be used with a random file. The conditions for using these sequential I/O statements with random files are explained in the last part of this chapter.

CLOSE (close disk data file)

Form: CLOSE [#] [<filenumber>]

CLOSE # <filenumber >[,<filenumber>]...

The CLOSE statement is used to conclude I/O activity to a disk data file.

<filenumber> is the number under which the file was opened. A CLOSE with no arguments will close all open files.

Assume the following OPEN statement appears in a program:

```
OPEN "O",1,"ARTIST.DAT"
```

Now a sequential output statement may reference this file. When output to this file has concluded, it should be closed with the CLOSE statement.

```
CLOSE #1
```

This statement will disassociate file number 1 from the file ARTIST.DAT. Any reference to file number 1 would now be invalid. The file may then be reopened using the same or a different file number. For example:

```
OPEN "I",3,"ARTIST.DAT"
```

The file ARTIST.DAT is now associated with file number 3, and is opened for sequential input. Now, a sequential input operation with this file would be valid. When the input operation has concluded, this file should be closed with the CLOSE statement.

```
CLOSE #3
```

The file could again be reopened:

```
OPEN "R",3,"ARTIST.DAT"
```

The file number 3 has again been associated with the file ARTIST.DAT, but, this time the file has been opened for random I/O.

A CLOSE for a sequential output file writes the final buffer of output to the disk file. (This subject is covered in more detail later in this chapter.)

The END statement and the NEW command will close all disk files automatically. Any attempt to edit or modify a program will also automatically close all open disk files. (The STOP statement does not close disk files.)

EOF (check for end-of-file)

Form: EOF(<filenumber>)

<filenumber> is the file number assigned to a disk data file in a previously executed OPEN statement.

The EOF function will return -1 (true) if the end of a sequential file has been reached.

The EOF is useful for detecting when the end of a sequential file has been reached. The EOF function should be used in conjunction with the INPUT# statement and the LINE INPUT# statement to avoid "Input past end" errors.

The EOF function may also be used with random files. If a GET is done past the end of the last sector of the random file, the EOF function will return −1 (true). This may be used to find the size of a random file if record size equals sector size (128 bytes).

Example:

```
10 OPEN "I",1,"DATA"
20 IF EOF(1) THEN 100
30 INPUT#1,A$
40 GOTO 20
    .
    .
    .
100 PRINT "END-OF-FILE REACHED"
```

LOF (return number of records)

Form: LOF(<filenumber>)

<filenumber> is the file number assigned to a disk data file in a previously executed OPEN statement.

The LOF Function returns the number of sectors present in the last extent that was accessed. If the file does not exceed one extent, and record length equals sector length (128 bytes), then LOF returns the true length of the file. (Refer to the "CP/M Application Programmer's Manual" for more information on extents.)

Example:

```
110 IF NUM% > LOF(1) THEN PRINT "INVALID ENTRY"
```

LOC (return record number)

Form: LOC(<filenumber>)

<filenumber> is the file number assigned to a disk data file in a previously executed OPEN statement.

When used with a random file, the LOC function returns the current record number. The current record number is the number of the last record accessed via GET or PUT. The first time a particular file is accessed, the current record is 1. The largest possible record number is 32767.

When used with a sequential file, the LOC function returns the number of sectors (128 byte blocks) accessed since the file was opened.

Examples:

```
10 OPEN "I",1,"TEST.DAT"
20 OPEN "R",2,"RANDOM.DAT"
          .
          .
          .
200 PRINT"SECTORS READ--";LOC(1)
210 PRINT"NEXT REC#--";LOC(2)
```

BASIC-80 SEQUENTIAL I/O

Sequential files are easier to create than random files but are limited in flexibility and speed when it comes to accessing the data. The data that is written to a sequential file is stored, one item after another (sequentially), in the order it is sent and it must be read back in the same order. The data is stored as a stream of ASCII characters.

Sequential Access Statements

INPUT#	Input data from sequential file.
LINE INPUT#	Input entire line from sequential file.
PRINT# PRINT# USING	Write data to sequential file.
WRITE#	Write data to sequential file (with delimiters automatically inserted).

Table 10-2
Sequential Access Statement.

INPUT# (input data from sequential file)

Form: INPUT#<filenumber>,<variable list>

The INPUT# statement is used to read data items from a sequential disk file and assign them to program variables. The data will be read sequentially. When the file is opened, a pointer will be set to the beginning of the file. Each time data is read from the file, the pointer will advance. To start reading over from the beginning of a file, the sequential file must be closed and re-opened.

<filenumber> is the number used when the file was opened for input. <variable list> contains the variable names that the input data will be assigned to. (The input data types must match the types specified by the variable name. It is invalid to read a string data value into a numeric variable.)

Numeric Input

The data items in the file should appear just as they would if data were being typed in response to an INPUT statement. With numeric values, leading spaces are ignored.

The first character encountered that is not a space, carriage return, or line feed is assumed to be the start of a number. The number terminates on a space, carriage return, line feed, comma, or semicolon.

For example, assume the following data image exists on a disk file:

(note: the △ represents a blank or space - ASCII 32)

```
△△2.1234△-123.234△△456<carriage return>
```

Then the INPUT statement:

```
INPUT#1,X,Y,Z
```

or the sequence of INPUT statements:

```
INPUT#1,X:INPUT#1,Y:INPUT#1,Z
```

will assign the data values as follows:

```
X=2.1234
Y=-123.234
Z=456
```

The following discussion assumes the image on the disk is (note: the △ represents a blank or space - ASCII 32):

```
△△2.1234△-123.234,456<carriage return>
```

And the INPUT statement used to access the data is:

```
INPUT#1,X,Y,Z
```

The two blanks before the value 2.1234 are leading spaces; therefore, they are ignored. The next character encountered is a 2, and this is considered the start of the first numeric field.

The BASIC-80 I/O processor now scans for the terminator of the first numeric field. The blank between 2.1234 and −123.234 is this terminator. So when BASIC-80 encounters this blank, it assumes that the first numeric field has ended. This first numeric field is assigned to the first item in the variable list, the variable X.

The BASIC-80 I/O processor now scans for the beginning of the second numeric field. The minus sign (−) is considered the start of the second numeric field. The BASIC-80 I/O processor will scan for the terminator of the second numeric field. The comma between −123.234 and 456 is this terminator. So, when BASIC-80 encounters this comma, it assumes that the second numeric field has ended. This second numeric field is assigned to the second item in the variable list, the variable Y.

The BASIC-80 I/O processor now scans for the beginning of the third numeric field. The number 4 is considered the start of the third numeric field. The BASIC-80 I/O processor will then scan for the terminator of the third numeric field. The carriage return after 456 is this terminator. So when BASIC-80 encounters this carriage return, it assumes that the third numeric field has ended. This third numeric field is assigned to the third item in the variable list, the variable Z.

At this point, all three variables in the variable list have values assigned to them, so execution of the INPUT statement has been completed. Execution continues with the next statement.

String Input

When BASIC-80 scans the sequential data file for a string item, leading spaces, carriage returns, and line feeds are ignored. The first character encountered that is not a space, carriage return, or line feed is assumed to be the start of a string item.

This string is considered an unquoted string, and will terminate on a comma, carriage return or line feed (or after 255 characters have been read).

If this first character is a quotation mark, the string is considered a quoted string. The string item will consist of all characters read between the first quotation mark and the next quotation mark. Commas, blanks, and carriage return characters can be included in this string. A quoted string may not contain a quotation mark within the quoted string.

For example, assume the following data image exists on a disk file:

```
BENTON,HARBOR,MI"49022"<carriage return>
```

Then the statement:

```
INPUT#1,A$,B$,C$
```

would assign the data values as follows:

```
A$=BENTON
B$=HARBOR
C$=MI"49022"
```

Note that the comma is used as the terminator in the above example. All three strings are considered to be unquoted strings.

In the last string field, the quotation mark is considered as part of the string. This is because the string starts with the letter M and is terminated by a carriage return.

Assume a comma is inserted between MI and "49022". The disk image would then look like this:

```
BENTON,HARBOR,MI,"49022"
```

Now there are a total of four string fields. The first three are unquoted strings fields, and the last is a quoted string field. These four fields could be input with the following statement:

```
INPUT #1,A$,B$,C$,D$
```

the variable values would be assigned as follows:

```
A$=BENTON
B$=HARBOR
C$=MI
D$=49022
```

The variable D$ would not contain the quotation marks because the quotation marks were used to terminate the field, and as such they do not represent data values.

LINE INPUT# (input entire line from sequential file)

Form: LINE△INPUT#<filenumber>,<string variable>

The LINE INPUT# statement is used to read an entire line (up to 255 characters), without delimiters, from a sequential disk data file to a string variable.

<filenumber> is the file number assigned to the file with the OPEN statement. The file must be opened for sequential input (I mode). <string variable> is the variable name to which the input will be assigned.

LINE INPUT# reads all characters in the sequential file up to a carriage return. It then skips over the carriage return/line feed sequence, and the next LINE INPUT# reads all characters up to the next carriage return. (If a line feed/carriage return sequence is encountered, it is preserved.)

If no carriage return is found, LINE INPUT# will read until 255 characters have been read. These 255 characters will then be assigned to the string variable.

LINE INPUT# is especially useful if each field of a data file has been terminated with a carriage return, or if a BASIC-80 program saved in ASCII mode is being read as data by another program.

For example, assume the following program exists in a disk file:

```
10 OPEN "O",1,"LIST" <carriage return>
20 INPUT C$ <carriage return>
30 PRINT #1, C$ <carriage return>
40 CLOSE #1 <carriage return>
```

then the statement:

```
LINE INPUT#1,Z$
```

could be repetitively used to read each line in the program OPENed and CLOSEd above, one line at a time.

PRINT# AND PRINT# USING (write to sequential disk file)

Forms:

PRINT#<filenumber>,<list of expressions>

PRINT#<filenumber>,USING<string exp>;<list of expressions>

The PRINT# statement is used to write data to a sequential disk file.

<filenumber> is the number used when the file was opened for output. The expressions in <list of expressions> are the numeric and/or string expressions that will be written to the file.

PRINT# does not compress data on the disk. An image of the data is written to the disk, just as it would be displayed on the terminal with a PRINT statement. (The PRINT statement is discussed in Chapter Four, "Program Statements.") For this reason, take care to delimit the data on the disk so it will be input correctly from the disk.

In the list of expressions, numeric expressions should be delimited by semicolons.

For example:

```
PRINT#1,A;B;C;X;Y;Z
```

(If commas are used as delimiters, the extra blanks that are inserted between print fields will also be written to disk.)

String expressions must be separated by semicolons in the list. To format the string expressions correctly on the disk, use explicit delimiters in the list of expressions.

For example, let `A$="CAMERA"` and `B$="93604-1"`.

The statement:

```
PRINT#1,A$;B$
```

would write `CAMERA93604-1` to the disk. Because there are no delimiters, this could not be input as two separate strings. To correct the problem, insert explicit delimiters into the PRINT# statement as follows:

```
PRINT#1,A$;",";B$
```

The image written to disk is:

```
CAMERA,93604-1
```

which can be read back into two string variables.

If the strings themselves contain commas, semicolons, significant leading blanks, carriage returns, or line feeds, write them to disk surrounded by explicit quotation marks, CHR$(34).

For example, let A$="CAMERA, AUTOMATIC" and B$=" 93604-1". The statement:

```
PRINT#1,A$;B$
```

would write the following image to disk:

```
CAMERA, AUTOMATIC 93604-1
```

and the statement:

```
INPUT#1,A$,B$
```

would input "CAMERA" to A$ and "AUTOMATIC 93604-1" to B$. To separate these strings properly on the disk, write double quotes to the disk image using CHR$(34).

The statement:

```
PRINT#1,CHR$(34);A$;CHR$(34);CHR$(34);B$;CHR$(34)
```

writes the following image to disk:

```
"CAMERA, AUTOMATIC" "    93604-1"
```

and the statement:

```
INPUT#1,A$,B$
```

would input "CAMERA, AUTOMATIC" to A$ and " 93604-1" to B$.

The PRINT# statement may also be used with the USING option to control the format of the disk file. For example:

```
PRINT#1,USING"$$###.##,";J;K;L
```

The comma at the end of the format string serves to separate the items in the disk file. (For a complete discussion of the PRINT USING statement, refer to Chapter Eight, "Special Features.")

NOTE: The WRITE# statement will automatically insert the proper delimiters between data items in a sequential file.

WRITE#(write to sequential disk file)

Form: WRITE#<filenumber>,<list of expressions>

The WRITE# statement is used to write data to a sequential file.

<filenumber> is the number which was assigned to the file with an OPEN statement. The file must be open for sequential output (O mode). The expressions in the list are string or numeric expressions, and they must be separated by commas.

The difference between WRITE# and PRINT# is that WRITE# inserts commas between the items as they are written to disk and delimits strings with quotation marks. Therefore, it is not necessary for the user to put explicit delimiters in the list. A carriage return/line feed sequence is inserted after the last item in the variable list is written to the disk file.

Example: Let `A$="CAMERA"` and `B$="93604-1"`. The statement:

```
WRITE#1,A$,B$
```

writes the following image to disk:

```
"CAMERA","93604-1"
```

A subsequent INPUT# statement, such as:

```
INPUT#1,A$,B$
```

would input `"CAMERA"` to `A$` and `"93604-1"` to `B$`.

Note: The WRITE# statement is recommended for most applications using sequential output. Most problems arising from using sequential files are a result of not inserting the proper delimiters between data items. The WRITE# statement eliminates the need to be concerned with delimiting data items, thus eliminating most problems associated with sequential I/O.

In those cases where the WRITE# statement will not provide the flexibility needed for some unique sequential output application, use of the PRINT# or PRINT# USING statement should be considered. Care should be taken to insure that all the data items are separated by the proper delimiters.

Sequential Access Techniques

CREATING AND ACCESSING A SEQUENTIAL FILE

The following program steps are required to create a sequential file and access the data in the file:

Open the file for sequential output.

OPEN "O",#1,"DATA.DAT"

This step will associate the file number 1 with the file DATA.DAT. Because the O mode string was specified, the file will be opened for sequential output. Since no drive specification was included with the file name, the current default drive will be assumed.

If a file DATA.DAT already exists on the current default drive, contents of this file will be lost. This is due to the fact that, when a file is opened for sequential output, the BASIC-80 I/O processor will move the EOF marker to the beginning of the file. Thus, the previous contents of the file can no longer be accessed.

Write data to the file

WRITE#1,A$,B$,C$

This step assumes that some string value has been assigned to the string variables A$,B$ and C$. The WRITE# statement will write data to the file with delimiters, so it is not neccessary to insert any delimiters.

The PRINT# statement could have been used to write the data to this sequential file, but then it would have been necessary to insert delimiters between the data items. So for most applications using sequential output, it is more efficient to use the WRITE# statement.

Close the file

CLOSE#1

This statement will write any remaining data from the buffer to the disk file. Output to this file will then be terminated. The file must be closed before it can be reopened for sequential input.

Reopen the file for input

OPEN "I",#1,"DATA.DAT"

The file number 1 is again associated with the file DATA.DAT. This time, the file is opened for sequential input.

Read the data

INPUT#1,X$,Y$,Z$

The data will be read from the file DATA.DAT and assigned to the string variables X$,Y$ and Z$

NOTE: The above example ignores the role of the I/O buffer in the sequential I/O process. Actually, BASIC-80 reads and writes in 128-byte blocks. So each INPUT# or WRITE# statement may not necessarily require a disk access.

With sequential output, each WRITE# or PRINT# will place the data in the buffer area. When the buffer is filled with data, the data will actually be written to the disk file.

With sequential input, 128 bytes will be read and placed in the buffer area. Then the BASIC-80 I/O processor will sort through the data in the buffer to satisfy the INPUT# statement variable list.

ADDING DATA TO A SEQUENTIAL FILE

As soon as an existing sequential file is opened for output ("O" mode) ,the current contents of the file are destroyed. Thus, several program steps are required to add data to an exisiting sequential file. The following procedure can be used to add data to an existing file called "DATA.DAT"

Open "DATA.DAT" for sequential input

```
OPEN "I",1,"DATA.DAT"
```

This step associates file number 1 with the data file DATA.DAT. This file will be opened for sequential input. Since no drive specification was included with the file name, BASIC-80 will assume the current drive. If the file DATA.DAT can not be found on the current default drive, a "File not found" error will be generated.

Open a second file called "TEMP.TMP" for sequential output

```
OPEN "O",2,"TEMP.TMP"
```

The file, TEMP.TMP will be used as a temporary work file. After this process is completed, this file will be renamed and it will contain the original data as well as the newly created data.

Read in the data in "DATA.DAT" and write it to "TEMP.TMP"

```
INPUT#1,A$,B$,C$
WRITE#2,A$,B$,C$
```

This step must be repeatedly executed until all the data in file #1 is read.

Close "DATA.DAT" and kill it.

```
CLOSE#1
KILL"DATA.DAT"
```

This file is no longer needed, as the information from this file has been copied into the file TEMP.TMP

Write the new information to "TEMP.TMP"

```
WRITE#2,A$,B$,C$
```

The data assigned to the string variables A$,B$ and C$ will be written to the disk file.

Close the file

```
CLOSE#2
```

This step will terminate the output operation performed with this file.

Rename "TEMP.TMP" as "DATA.DAT"

```
NAME "TEMP.TMP" AS "DATA.DAT"
```

Now there is a file on disk called "DATA.DAT" that includes all the previous data plus the new data that was added to the file.

BASIC-80 RANDOM I/O

Creating and accessing random files requires more program steps than sequential files, but there are advantages to using random files. One advantage is that random files require less room on the disk because BASIC-80 stores them in a packed binary format. (A sequential file is stored as a series of ASCII characters.)

The biggest advantage to random files is that data can be accessed randomly, i.e., anywhere on the disk — it is not necessary to read through all the information, as with sequential files. This is possible because the information is stored and accessed in distinct units called records and each record is numbered.

All data stored in a random file must be a string data type.

To store numeric values in a random file, the numeric values must be converted to strings. Several functions have been provided to convert numeric values to strings. These functions, (MKI$,MKS$,MKD$), are explained later in this Chapter.

Random Access Statements

Statement	Function
FIELD	Set up random file buffer.
LSET	Move data to random buffer. (left-justified)
RSET	Move data to random buffer. (right-justified)
GET	Read random record.
PUT	Write random record.
MKI$	Make integer into 2-byte string.
MKS$	Make single-precision number into 4-byte string.
MKD$	Make double-precision number into 8-byte string.
CVI	Convert 2-byte string to integer.
CVS	Convert 4-byte string to single-precision number.
CVD	Convert 8-byte string to double-precision number.

Table 10-3
Random Access Statements.

FIELD (set up random file buffer)

Form:

FIELD#<filenumber>,<field width> AS <string variable>

The FIELD statement is used to allocate space for variables in a random file buffer.

<filenumber> is the number assigned to the random file in the OPEN statement. <field width> is the number of characters (bytes) to be allocated to <string variable>.

For example:

```
FIELD#1, 20 AS N$, 10 AS ID$, 40 AS ADD$
```

allocates the first 20 positions (bytes) in the random file buffer to the string variable N$, the next 10 positions to ID$, and the next 40 positions to ADD$. FIELD does **not** place any data in the random file buffer, but instead defines the fields in the random file buffer.

A FIELD statement can only reference a file which has been opened for random I/O (R mode). The FIELD statement must also be executed prior to performing any I/O operation with the random file.

The total number of bytes allocated in a FIELD statement must not exceed the record length that was specified when the file was opened. Otherwise, a "Field overflow" error occurs. (The default record length is 128.)

If a number smaller than 128 is specified for the record length, the BASIC-80 I/O processor will take care of blocking and deblocking the record. For example, if a record length of 32 bytes is specified in the OPEN statement, the BASIC-80 I/O processor will block 4 of these logical records per physical record (sector). The user program is not responsible for blocking and deblocking these logical records.

If a number greater than 128 is specified for the record length, the BASIC-80 I/O processor will also take care of blocking and deblocking the record. This number must be specified by using the /S switch when initializing BASIC-80. The largest record size allowed is 256 bytes.

Any number of FIELD statements may be executed for the same file, and all FIELD statements that have been executed are in effect at the same time. For example, the following FIELD statement could be used to define a 32-byte random buffer:

```
FIELD#1, 16 AS F1$,16 AS F2$
```

This FIELD statement would allocate the first 16 characters (bytes) of the random buffer to the variable F1$ and the next 16 characters (bytes) to the variable F2$. Then, another FIELD statement could be used to redefine the buffer:

```
FIELD#1,32 as BUFF$
```

So the variable BUFF$ would refer to all 32 characters in the buffer. F1$ would still refer to the first 16 characters and F2$ would still refer to the second 16 characters.

Do **not** use a fielded variable name in an INPUT or LET statement. Once a variable name is fielded, it points to a specific address in the random file buffer. If a subsequent INPUT or LET statement with that variable name is executed, the variable's pointer is moved to string space.

Examples:

```
FIELD#1,128 AS IBUFF$

FIELD#4,10 AS A$(1),10 AS A$(2),10 AS A$(3)

FIELD#2,I AS STUFF$
```

(Note: the variable I must be assigned an integer value prior to the execution of this statement.)

LSET/RSET (move data to random buffer)

Forms: LSET <fielded variable> = <string expression>

RSET <fielded variable> = <string expression>

The LSET/RSET statements are special assignment statements used to assign a string expression to a variable that has appeared in a FIELD statement (fielded variable).

The LSET/RSET statements are used to move data from memory to a random file buffer. This step is performed in preparation for a PUT statement. The only way to move data to a random buffer is by using the LSET/RSET statement.

If the <string expression> requires fewer bytes than were fielded to the <fielded variable>, LSET left-justifies the string in the field by adding spaces on the right. RSET is used to right-justify the string in the field by adding spaces on the left.

The only difference between LSET and RSET is the fact that LSET left-justifies the field and RSET right-justifies the field. If the string is too long for the field in both cases, characters are dropped from the right.

Numeric values must be converted to strings before they are LSET or RSET. Several special random I/O functions have been provided to perform this conversion. (Refer to the discussion of the MKI$, MKS$, and the MKD$ functions later in this Chapter.)

Examples:

```
150 LSET A$=MKS$(AMT)
160 LSET D$=DESC$
170 LSET V$="LEFT-JUSTIFY AND PLACE IN BUFFER"
180 RSET G$="RIGHT-JUSTIFY AND PLACE IN BUFFER"
```

String variables A$,D$,V$ and G$ must have appeared in a previously executed FIELD statement.

GET (read random record)

Form: GET [#]<filenumber>[,<record number>]

The GET statement is used to read a record from a random disk file into a random buffer. Before executing a GET statement, the file to be accessed must be opened for random I/O.

Additionally, the random file buffer must have been defined with a FIELD statement. If the random file buffer has not been defined, there will be no way to access the data after the GET has been executed.

<filenumber> is the number under which the file was opened. If <record number> is omitted, the current record is read into the buffer. The current record is the record number one greater than that of the last record accessed. The first time a particular file is accessed, the current record is 1. The largest possible record number is 32767.

If an attempt is made to GET a record whose number is higher than that of the last record number in the file, the buffer will be filled with NUL characters (ASCII Ø), although no error will be generated. The LOF function can be used to prevent this from occurring.

Examples:

```
GET#1,100

GET#2

GET FILE,IREC

GET#5,REC
```

PUT (write random record)

Form: PUT [#]<filenumber>[,<record number>]

The PUT statement is used to write a record from a random buffer to a random disk file. Before executing a PUT statement, the file to be accessed must be opened for random I/O.

Additionally, the random file buffer must have been defined with a FIELD statement. If the random file buffer has not been defined, there will be no way to move data into the buffer before executing the PUT statement.

<filenumber> is the number under which the file was opened. If <record number> is omitted, the current record is written. The current record is the record number one greater than that of the last record accessed. The first time a particular file is accessed, the current record is 1. The largest possible record number is 32767.

If the <record number> is higher than the end-of-file record number, <record number> becomes the new end-of-file record number. Space will be allocated on the disk to accommodate the new end-of-file record, as well as all lower numbered records.

Before executing a PUT statement, the data to be written to a disk file must be moved into the buffer area. The LSET/RSET statements are used to move the data to the random file buffer.

Examples:

```
PUT#1

PUT#2,43

PUT I,J-1

PUT I,4
```

MKI$, MKS$, MKD$ (make a numeric value into a string)

Forms: MKI$(<integer expression>)
MKS$(<single-precision expression>)
MKD$(<double-precision expression>)

The "make" functions, (MKI$, MKS$, MKD$) are used to convert numeric value to string value. Any numeric value that is placed in a random file buffer must be converted to a string.

The MKI$ function is used to convert an integer to a 2-byte string. The integer expression must be in the allowable range for integer values. If it is not, an "Illegal function call" error will be generated. Any fractional portion of the number will be truncated.

The MKS$ function is used to convert a single-precision number to a 4-byte string. The MKD$ function is used to convert a double-precision number to an 8-byte string.

These functions will not move the data to the random buffer. So after a numeric value is converted to a string, it still must be moved to the random file buffer. Additionally, the random file buffer must have been defined with a FIELD statement.

If the random file buffer has not been defined, there will be no way to access the data after the GET has been executed. The data must also be moved into the random buffer using LSET or RSET.

For example, to convert the integer variable IV% to a string and assign it to the field variable FV$, the following single program statement could be used:

```
LSET FV$ = MKI$(IV%)
```

The variable FV$ should have appeared in a previously executed FIELD statement.

Example:

```
90 AMT=(K+T)
100 FIELD #1, 8 AS D$, 20 AS N$
110 LSET D$ = MKS$(AMT)
120 LSET N$ = A$
130 PUT #1
```

CVI, CVS, CVD (Converting string to numeric form)

Forms: CVI (<2-byte string>)
CVS (<4-byte string>)
CVD (<8-byte string>)

The CVI, CVS and CVD functions are used to convert string values to numeric values. These functions are generally used to convert numeric values that have been read from a random disk file. Data is always stored in random files as a string data type. Therefore, a numeric value read from a random disk file must be converted from a string back into a number.

The CVI function converts a 2-byte string to an integer. If the length of the string is greater than 2 bytes, only the first two characters in the string will be used. If the length of the string is less than 2 bytes, an "Illegal function call" error will result.

The CVS function converts a 4-byte string to a single-precision number. If the length of the string is greater than four bytes, only the first four characters in the string will be used. If the length of the string is less than four bytes, an "Illegal function call" error will result.

The CVD function converts an 8-byte string to a double-precision number. If the length of the string is greater than eight bytes, only the first eight characters in the string will be used. If the length of the string is less than eight bytes, an "Illegal function call" error will result.

Examples:

```
PRINT CVS(A$)

A#=CVD(BUFF$)

I = I+CVI(I$)
```

Random Access Techniques

CREATING A RANDOM ACCESS FILE

The following program steps are required to create a random file.

OPEN the file for random access

```
OPEN "R", 1 "FILE.DAT",32
```

In this example, the mode string specifies "R" — random access. File number 1 is assigned to the file FILE.DAT. Since no drive specification was included with this file name, the current default drive is assumed. This example also specifies a record length of 32 characters (bytes). If the record length is omitted, the default record length is 128 characters (bytes).

Set up the random file buffer

```
FIELD#1, 20 AS VAR1$, 4 AS A$, 8 AS P$
```

Use the FIELD statement to allocate space in the random buffer for the variables that will be written to the random file. The FIELD statement references file number 1, which has been opened for random input. (It is invalid to FIELD a file which has been opened for sequential input or output.)

This FIELD statement will allocate the first 20 characters of the random file buffer for the variable VAR1$, the next four characters for the variable A$, and the next eight characters for the variable P$.

Move the data into the random buffer

```
LSET VAR2$=X$
LSET A$=MKS$(AMT)
LSET P$=TEL$
```

Use LSET to move the data into the random buffer. Numeric values must be made into strings when placed in the buffer. To do this, use the "make" functions: MKI$ to make an integer value into a string, MKS$ for a single-precision value, and MKD$ for a double-precision value.

In this program step, the single-precision variable AMT is first coverted to a string, and then it is assigned to the variable A$. The variable A$ has appeared in a previous FIELD statement. The FIELD statement was used to allocate four characters (bytes) to the variable A$.

Write data to disk

```
PUT#1
```

Write the data from the buffer to the disk using the PUT statement. No record number was specified with this PUT statement, so the current record number will be written. The current record is the record number one higher than the last record accessed. The first time a file is accessed, the current record is one.

Do not use a fielded string variable in an INPUT or LET statement. This causes the pointer for that variable to point into string space instead of the random file buffer.

ACCESSING A RANDOM ACCESS FILE

The following program steps are required to access a random file:

OPEN the file for random access

```
OPEN "R",#1,"FILE.DAT",32
```

This step will open the file "FILE.DAT" for random access. The file can now be accessed by referring to file number 1.

Set up random file buffer

```
FIELD#1, 20 AS VAR3$,4 AS A$, 8 AS P$
```

Use the FIELD statement to allocate space in the random buffer for the variables that will be read from the file. In this example, 20 characters (bytes) are allocated to the string variable VAR3$, four characters are allocated to the string variable A$, and eight characters are allocated to the string variable P$.

NOTE: In a program that performs both input and output on the same random file, you can often use just one OPEN statement and one FIELD statement.

Read data into buffer

```
GET#1
```

Use the GET statement to move the desired record into the random buffer. No record number was specified with this GET statement, so the current record number will be read. The current record is the record number one higher than the last record accessed. The first time a file is accessed, the current record is one.

Access data in the buffer

The data in the buffer may now be accessed by the program. Numeric values must be converted back to numbers using the "convert" functions: CVI for integers, CVS for single-precision values, and CVD for double-precision

```
PRINT VAR4$
AV=CVS(A$)
DP#=CVD(P$)
```

Additional Features

After a GET statement, INPUT# and LINE INPUT# may be used to read characters from the random file buffer. PRINT#, PRINT# USING, and WRITE# may also be used to put characters in the random file buffer before a PUT statement.

In the case of WRITE#, BASIC-80 pads the buffer with spaces (if necessary) and then inserts a carriage return. Any attempt to read or write past the end of the buffer causes a "Field overflow" error.

Chapter Eleven

Microsoft BASIC-80 Summary

OVERVIEW

This Chapter is a summary of the important concepts, ideas, keywords, etc. of the BASIC-80 programming language. The various intrinsic functions as well as the string functions are also included in this chapter.

Abbreviations

Abbreviation	Function
?	Use in place of PRINT.
'	Use in place of REM.
.	"current line";use in place of line number with LIST, EDIT, etc.

Data Type Declaration Characters

Character	Data Type	Examples
$	String	`ZDS$,WLW$`
%	Integer	`I%,VALUE%`
!	Single-Precision	`V!,FLAG!`
#	Double-Precision	`DP#,PL#`
D	Double-Precision (exponential notation)	`1.23456789D-12`
E	Single-Precision (exponential notation)	`1.23456E+23`

Arithmetic Operators

Operator	Operation Performed
+	Addition
-	Subtraction
*	Multiplication
/	Division (floating point)
\	Integer division
^	Exponentiation
MOD	Modular division

String Operator

Operator	Operation Performed	Example
+	concatenate (string together)	"A"+"B"+"C"

Relational Operators

Operator	Numeric Expressions	String Expressions
<	Less than	Precedes
>	Greater than	Follows
=	Equal to	Equals
<= or =<	Less than or equal to	Precedes or equals
>= or =>	Greater than or equal to	Follows or equals
<> or ><	Does not equal	Does not equal

Logical Operators

Operator	Function
NOT	Bitwise negation
AND	Bitwise disjunction
OR	Bitwise conjunction
XOR	Bitwise exclusive OR
IMP	Bitwise implication
EQV	Bitwise equivalence

Commands

Command/Function	Examples
AUTO△[<line number>],[<increment>]	
Enable automatic line numbering starting at <line number> and incrementing by <increment>.	AUTO AUTO 10 AUTO 5,5
CLEAR	
Set numeric values to zero, strings to null.	CLEAR
CLEAR,<expression>	
Same as CLEAR, but <expression> is used to set the high memory limit for use by BASIC-80.	CLEAR ,32768
CLEAR,<expression1>,<expression2>	
Same as CLEAR<expression> but <expression2> is used to set the amount of stack space for use by BASIC-80.	CLEAR,32768,2000
CONT	
Continues program execution after a BREAK or STOP.	CONT
DELETE△<line number>	
Deletes the specified line number in the current program.	DELETE 100
DELETE△-<line number>	
Deletes every line of the current program up to and including <line number>.	DELETE -500

Command/Function	Examples
DELETE△<line number>-<line number>	
Deletes all lines of the current program from the first line number through the second line number.	DELETE 10-1000
EDIT△<line number>	
Enter Edit Mode at the specified line number.	EDIT 100
FILES△["<filename>"]	
List names of files residing on the default or specified disk.	FILES "*.BAS"
LIST	
List the program currently in memory starting with the lowest numbered line.	LIST
LIST△<line number>	
List the specified line number.	LIST 100
LIST△<line number>-<line number>	
List all lines from the first line up to and including the second.	LIST 10-100
LLIST△[<line number>]-[<line number>]	
List all or part of the program currently in memory. The listing will be printed on the line printer. The options for the LLIST command are the same as for the LIST command.	LLIST LLIST 500 LLIST 150- LLIST -100 LLIST 150 — 400

Command/Function	Examples
LOAD <"filename">[,R]	
Load a program file from disk into memory. The R is optional, and if used will run the program after it is loaded.	`LOAD"B:GAME"` `LOAD"PROG.ASC",R`
MERGE "<filename>"	
Merges a disk file into a program in memory.	`MERGE"B:TEST.BAS"`
NAME "[<drive>:]<oldfile>" AS "[<drive>:]<newfile>"	
Renames a disk file.	
NEW	
Deletes the current program and clears all variables.	`NEW`
RENUM [<nn>],[<mm>],[<ii>]	

Renumbers program lines starting at line <mm>, as line <nn>, with increments of <ii>.	`RENUM`
	`RENUM 300,,5`
	`RENUM 1000,900,20`

RESET	
Changes disk in default drive.	`RESET`
RUN [<line number>]	
Executes the current program starting with specified line number. If <line number> is not specified, execution starts at the lowest line number.	`RUN 100` `RUN`
RUN <"filename">[,R]	
Loads a program from disk and executes it. R keeps all data files open.	`RUN "PROG1"` `RUN"B:GAME",R`

Command/Function	Examples
SAVE "<filename>",A SAVE "<filename>",P	

Saves the current program on disk. If A is used, the file is saved in ASCII format. If P is used, the file is saved in a protected format. If neither the P or A is used, the file is saved in a compressed binary format.	`SAVE"COM2",A`
	`SAVE"TEST1"`
	`SAVE"INVEN",P`

SYSTEM	
Closes all files and performs a CP/M warm start.	`SYSTEM`

Edit Mode Subcommands and Functions

Command	Function
RETURN	End editing and return to Command Mode.
[<i>]Space Bar	Move cursor <i> spaces to the right. (Defaults to 1.)
[<i>]Back Space	Move cursor <i> spaces to the left. (Defaults to 1.)
L	List remainder of program line and return cursor to the beginning of the program line.
X	List remainder of program line, move cursor to the end of the line, and go into Insert Mode.
I	Insert text beginning at the current position of the cursor. Use ESC to exit Insert Mode.
A	Cancel editing changes and return cursor to beginning of line.
E	End editing, save all changes and return to Command Mode.
Q	End editing, cancel all changes and return to Command Mode.
H	Delete remainder of line and then enter Insert Mode.
[<i>]D	Delete specified number of characters <i> beginning at current cursor position. (Defaults to 1.)
[<i>]C	Change (or replace) the specified number of characters <i> using the next <i> characters entered. (Defaults to 1.)
[<i>]S<c>	Move the cursor to the <i>th occurence of character <c>, counting from the current cursor position. (Defaults to 1.)
[<i>]K<c>	Delete all characters from the current cursor position up to the <i>th occurrence of character <c>. (Defaults to 1.)

Print Using Format Field Specifiers

Numeric Specifier	Function	Example
#	Numeric field.	###
.	Decimal point position.	##.##
+	Print leading or trailing signs (plus for positive numbers, minus for negative numbers).	+##.##
–	Print trailing sign only if value printed is negative.	##.##–
**	Fill leading blanks with asterisks.	**##.##
$$	Place dollar sign immediately to left of leading digit.	$$###.##
**$	Asterisk fill and floating dollar sign.	**$###.##
,	Use comma every three digits (left of decimal point only).	##,###.##
^^^^	Exponential format. Number is aligned so leading digit is non-zero.	#.##^^^^

String Specifier	Function	Example
!	Single character	!
\<spaces>\	2+ number of spaces in character field.	\ \
&	Variable length string field.	&

Literal Specifier	Function	Example
_	Literal character string field.	

Program Statements

Statement/Function	Examples
DATA TYPE DEFINITION	
DEFINT△<letter range>	
Declare range of variable names as integer data types.	`DEFINT I-N`
DEFSNG△<letter range>	
Declare range of variable names as single-precision data types.	`DEFSNG A-H,O-P`
DEFDBL△<letter range>	
Declare range of variable names as double-precision data types.	`DEFDBL X,Y,Z`
DEFSTR△<letter range>	
Declare range of variable names as string variables.	`DEFSTR A-C,Z`
ASSIGNMENT AND ALLOCATION	
DIM△<list of subscripted variables>	
Allocate storage for array.	`DIM A(20),B(12,2)`
OPTION△BASE△n	
Declare minimum value for array subscript. The default base is 0. This may be changed to 1.	`OPTION BASE 1`

Statement/Function	Examples
ERASE△<list of array names>	
Remove an array from the program.	`ERASE A,B`
LET△<variable> = <expression>	
Assign value of expression to variable.	`LET SUM = A+B+C`
REM△<remark>	
Insert remark into program.	`REM GRP IS GROSS PAY`
SWAP△<variable>,<variable>	
Exchange the values of two variables.	`SWAP A,B`

SEQUENCE OF EXECUTION

END	
Terminate program execution, close all files and return to Command Mode.	`100 END`
FOR△<V>=<X>△TO△<Y>[STEP△<Z>]	
Allows repetitive execution of a series of statements.	`FOR I = 1 TO 100`
GOSUB△<line number>	
Branch to subroutine beginning at <line number>.	`GOSUB 100`
GOTO△<line number>	
Branch to specified line number.	`GOTO 400`
NEXT△[<variable>]	
Terminates a FOR loop.	`NEXT I`

Statement/Function	Examples
ON△<expression>△GOTO△line1,...linek	
Evaluate expression. If INT(<expression>) equals one of the numbers 1-k, branch to appropriate line number. If it is not equal, go to the next statement.	`ON L1 GOTO 10,20,30`
ON△<expression>△GOSUB△line1,...linek	
Same as ON...GOTO except branch is to a subroutine.	`ON L GOSUB 300,400`
RETURN	
Terminates a subroutine. Branches to the statement following the most recent GOSUB.	`RETURN`
STOP	
Terminates program execution and returns to Command Mode.	`STOP`

CONDITIONAL EXECUTION

IF△<expression> THEN△<statement(s)> ELSE△<statement(s)>	
Evaluate <expression>: If true, execute THEN clause. If false, execute ELSE clause. (if present)	`IF A=0 THEN A=1` `ELSE A=0`

Statement/Function	Examples
WHILE△<expression> . <loop statements> . WEND	
Executes a series of statements in a loop as long as a given condition is true.	WHILE A=0 PRINT "ZERO" WEND

NON-DISK I/O STATEMENTS

INPUT [<;> <"prompt string">;]<list of variables>

Inputs data from the terminal during program execution.	INPUT "AGE";A

LINE△INPUT [<;> <"prompt string">;]<string variable>

Inputs an entire line (up to 255 characters) to a string variable, without the use of delimiters.	LINE INPUT J$

DATA△<list of constants>

Stores numeric and string constants. These constants are assigned to variables by using the READ statement.	DATA 34,23.1,45.0 DATA "HELLO","BYE"

PRINT△<list of expressions>

Outputs data on the terminal.	PRINT "HELLO" PRINT A$,Z,C

READ△<list of variables>

Reads data into specified variables from a DATA statement.	READ I,A,B READ A$,B$

Statement/Function	Examples
RESTORE [<line number>]	
Resets DATA pointer so that data may be reread.	`RESTORE`
LPRINT△<list of expressions>	
Prints data on the line printer.	`LPRINT "HELLO"`

String Functions

Function	Operation	Example
ASC(X$)	Returns ASCII code of first character in string argument.	`ASC("B")` `ASC(H$)`
CHR$(I)	Returns a one-character string whose character has the ASCII code of I.	`CHR$(66)` `CHR$(N)`
HEX$(X)	Converts a number to a Hexadecimal string.	`HEX$(100)` `HEX$(A)`
INKEY$	Reads one character from the keyboard.	`A$=INKEY$`
INPUT$(X,Y)	Reads X characters from the keyboard or from file number Y.	`INPUT$(1,1)`
INSTR(I,X$,Y$)	Returns the position of the first occurrence of Y$ in X$ starting at position I.	`INSTR(A$,",")`
LEFT$(X$,I)	Returns left-most I characters of the string expression X$.	`LEFT$(A$,1)` `LEFT$(C$,3)`
LEN(X$)	Returns length of string X$.	`LEN(A$)`
MID$(X$,I,J)	Returns string of length J characters from X$ beginning with the Ith character.	`MID$(X$,5,10)`

Function	Operation	Example
MID$(X$,I,J)=Y$	Replaces the characters in X$, beginning at position I, with the characters in Y$. J is the number of characters to use in the replacement.	`MID$(A$,1,2)="Z"`
OCT$(X)	Converts the numeric expression X to an octal string.	`OCT$(24)`
RIGHT$(X$,I)	Returns the right-most I characters of string X$.	`RIGHT$(X$,8)`
SPACE$(X)	Returns a string of X spaces.	`SPACE$(20)`
STR$(X)	Converts a numeric expression to a string.	`STR$(100)`
STRING$(I,J)	Returns a string of length I containing characters with the ASCII code J.	`STRING$(20,33)`
STRING$(I,X$)	Returns a string of length I containing the first character of string X$.	`STRING$(20,"!")`
VAL(X$)	Converts the string X$ to a numeric value.	`VAL("3.14")`

Arithmetic Functions

Function	Operation	Example
ABS(X)	Returns absolute value.	`ABS(-1)`
ATN(X)	Returns arctangent of X. (X must be in radians.)	`ATN(3)`
CDBL(X)	Converts X to double-precision.	`CDBL(A)`
CINT(X)	Converts X to an integer by rounding.	`CINT(46.6)`
COS(X)	Returns the cosine of X. (X must be in radians)	`COS(A+B)`
CSNG(X)	Converts X to single-precision.	`CSNG(V)`
EXP(X)	Returns e to the power of X.	`EXP(34.5)`
FIX(X)	Returns truncated integer portion of X.	`FIX(23.2)`
INT(X)	Returns largest integer not greater than X.	`INT(-12.11)`
LOG(X)	Returns the natural logarithm of X. X must be greater than zero.	`LOG(45/7)`
RND(X)	Returns a random number between 0 and 1.	`RND(0)`
SGN(X)	Returns -1 for negative X, 0 for zero X, +1 for positive X.	`SGN(C/A)`
SIN(X)	Returns the sine of X. (X must be in radians.)	`SIN(A*1.3)`
SQR(X)	Returns the square root of X. X must be non-negative.	`SQR(A*B)`
TAN(X)	Returns the tangent of X. (X must be in radians.)	`TAN(X+Y+Z)`

Special Functions

Function	Operation	Example
FRE(X)	Returns memory space not used by BASIC-80.	`FRE(0)`
INP(I)	Returns the byte read from port I.	`INP(255)`
LPOS(X)	Returns current position of line printer print head within the line printer buffer.	`LPOS(0)`
NULL(X)	Sets the number of nulls to be printed at the end of each line.	`NULL(3)`
OUT I,J	Sends byte J to port I.	`OUT 127,255`
PEEK(I)	Reads a byte from the specified memory address.	`PEEK(8192)`
POKE I,J	Puts byte J into memory location I.	`POKE(8192,200)`
POS(X)	Returns current cursor position.	`POS(1)`
SPC(I)	Prints I spaces on the terminal.	`PRINT SPC(5)`
TAB(I)	Moves cursor and/or print head to specified position.	`PRINT TAB(20)`
VARPTR(X)	Returns address of variable in memory.	`VARPTR(V)`
WAIT I,J[,K]	Status of port I is XOR'ed with K and AND'ed with J. Continued execution awaits non zero result.	`WAIT 21,1`
WIDTH I	Sets the terminal line width.	`WIDTH 80`
WIDTH LPRINT I	Sets the line printer width.	`WIDTH LPRINT 132`

Special Features

ERROR TRAPPING

Statement/Function	Example
ON△ERROR△GOTO△<line number>	
Enables error trapping and specifies the first line of the error trapping subroutine.	`ON ERROR GOTO 100`
RESUME△[<line number>]	

Continues program execution after an error recovery procedure has been performed.	`RESUME`
	`RESUME NEXT`
	`RESUME 100`

ERROR△<integer expression>	
Simulates the occurrence of an error, also allows error codes to be defined by user.	`ERROR 10`
ERL Error line number.	`PRINT ERL`
ERR Error code number.	`PRINT ERR`

TRACE FLAG

TRON Enables trace flag.	`TRON`
TROFF Disables trace flag.	`TROFF`

Statement/Function	Example
OVERLAY MANAGEMENT	
CHAIN [MERGE]"<filename>"[,[<line number exp>] [,ALL][,DELETE<range>]]	
Calls program and passes variables from the current program.	`CALL "PROG"`
COMMON△<list of variables>	
Pass variables to a chained program.	`COMMON A,B`

Disk Input/Output Statements

Statement/Function	Example
CLOSE[#][<filenumber>][,<filenumber>]	
Closes disk files. If no argument is supplied, all open files are closed.	`CLOSE #6`
FIELD# <filenumber>,<field size> AS <string variable>	
Allocates random buffer space to <string variable>, where <file number> is the random buffer referenced, and <field size> is the space reserved for a given <string variable>.	`FIELD #1,3 AS A$`
GET[#]<file number>[,<record number>]	
Transfers data from the <record number> of the random file <file number> to the random buffer. If <record number> is omitted, the next record is transferred.	`GET #1,I`
INPUT#<filenumber>,<variable list>	
Reads data from file <filenumber> and assigns the input to the elements of <variable list>.	`INPUT #3,A,B`
KILL△"<filename>"	
Deletes a disk file.	`KILL "A:GAME.BAS"`
LINE△INPUT#<file number>,<string variable>	
Read an entire line from a file <file number> and assigns it to <string variable>.	`LINE INPUT #1,A$`

Statement/Function	Example
LSET <fielded variable> = <string expression> Stores data in random file buffer, left justified.	`LSET A$="HELLO"`
OPEN "<mode>",[#]<filenumber>,<"filename"> Opens a disk file, where "<mode>" is the file type,<filenumber> is the I/O label, and <file name> is the disk directory entry.	`OPEN "O",1,"GM.DAT"`
PRINT#<file number>,<list of expressions> Writes data to a sequential disk file.	`PRINT #1,A$,B`
PUT [#]<filenumber>[,<record number>] Transfers data from the random file buffer to random file <file number>. If <record number> is omitted, the next record is written.	`PUT #2,3`
RSET <fielded variable> = <string expression> Stores data in a random file buffer, right justified.	`RSET B$="BYE"`
WRITE#<file number>,<list of expressions> Writes data to a sequential disk file. Delimiters are inserted between items in the I/O list.	`WRITE #2,A,B$`

Disk Input/Output Functions

Function	Operation	Example
CVD(X$)	Converts 8-character string to double precision number.	`A#=CVD(A$)`
CVI(X$)	Converts 2-character string to an integer.	`I%=CVI(I$)`
CVS(X$)	Converts 4-character string to single precision number.	`B=CVS(B$)`
EOF<file no.>	Returns true (−1) if a file is positioned at its end.	`IF EOF(1)`
LOC<file no.>	Returns next record number to read (random file). Returns number of sectors accessed (sequential file).	`X=LOC(1)`
MKD$(Z#)	Converts double-precision number to an 8-character string.	`A$=MKD$(A#)`
MKI$(I%)	Converts an integer to a 2-character string.	`I$=MKI$(I%)`
MKS$(B)	Converts a single-precision number to a 4-character string.	`B$=MKS$(B)`

Appendix A

Error Messages

After an error occurs, BASIC-80 returns to the Command Mode and types Ok. (Although overflow and division by zero errors will not cause BASIC-80 to stop execution.) Variable values and the program text remain intact, but you cannot continue the program with the CONT command. However, execution can be continued with a Command Mode GOTO.

The formats of error messages are:

Direct Statement	<error message>
Indirect Statement	<errror message> in nnnnn

where nnnnn is the line number where the error occurred. When an error occurs in a direct statement, no line number is printed.

The error messages are listed on the next few pages, along with the error number. If an error should occur for which there is no error code, BASIC-80 will print the message "Unprintable error".

GENERAL ERRORS

1 NEXT without FOR

The variable in a NEXT statement corresponds to no previously executed FOR statement.

2 Syntax error

A line has been encountered that contains some incorrect sequence of characters (such as unmatched parenthesis, misspelled statement or command, incorrect punctuation, etc.).

3 RETURN without GOSUB

A RETURN statement has been encountered before a GOSUB was executed.

4 Out of data

A READ statement was executed but all of the DATA statements in the program have already been read.

5 Illegal function call

The parameter passed to an arithmetic or string function was out of range. Illegal function calls can occur due to:

1. A negative array subscript (LET A(-1)=0).
2. An unreasonably large array subscript (>32767).
3. LOG with a negative or zero argument.
4. SQR with a negative argument.
5. A^B with A negative and B not an integer.
6. A call to a USR function before the address of a machine language subroutine has been entered.
7. Calls to MID$, LEFT$, RIGHT$, INP, OUT, WAIT, PEEK, POKE, TAB, SPC, STRING$, SPACE$, INSTR, or ON...GOTO with an improper argument.

6 Overflow

The result of a calculation was too large to be represented in BASIC-80's number format. If an underflow (i.e. a number is too small to be represented) occurs, zero is given as the result and execution continues without any error message being printed.

7 Out of memory

A program is too large, has too many variables, too many FOR loops, too many GOSUB's, or too complicated expressions.

8 Undefined line number

The line reference in a GOTO, GOSUB, IF...THEN...ELSE or DELETE was to a non-existent line.

9 Subscript out of range

An attempt was made to reference an array element which is either outside the dimensions of the array, or with the wrong number of subscripts.

10 Duplicate Definition

After an array was dimensioned, another dimension statement for the same array was encountered. The error often occurs if an array was given the default dimension of 10, and later in the program, the same array is specified in a DIM statement.

11 Division by zero

A division by zero has been encountered in an expression, or the evaluation of an expression results in zero being raised to a negative power. Machine infinity with the sign of the numerator is supplied as the result of the division, or positive machine infinity is supplied as the result of the involution, and execution continues.

12 Illegal direct

A statement that is illegal in Direct Mode has been entered as a Direct Mode command.

```
13        Type mismatch
```

A string variable has been assigned a numeric value or vice versa; a function that expects a numeric argument has been given a string argument or vice versa.

```
14        Out of string space
```

String variables have caused BASIC-80 to exceed the amount of free memory remaining. BASIC-80 will allocate string space dynamically, until it runs out of memory.

```
15      String too long
```

An attempt was made to create a string more than 255 characters long.

```
16        String formula too complex
```

A string expression was too long or too complex. The expression should be broken into smaller expressions.

```
17        Can't continue
```

An attempt has been made to continue a program that:

1. Has halted due to an error.
2. Has been modified during a break in execution.
3. Does not exist.

```
18        Undefined user function
```

A reference was made to a user-defined function which had never been defined.

```
19        No RESUME
```

BASIC-80 entered an error trapping routine, but the program ended before a RESUME statement was encountered.

```
20        RESUME without error
```

A RESUME statement was encountered, but no error trapping routine had been entered.

21 Unprintable error

An error message is not available for the error condition which exists. This is usually caused by an ERROR with an undefined error code.

22 Missing operand

During evaluation of an expression, an operator was found with no operand following it.

23 Line buffer overflow

An attempt has been made to input a line that has too many characters.

26 FOR without NEXT

A FOR was encountered without a matching NEXT.

29 WHILE without WEND

A WHILE statement has been encountered without a matching WEND.

30 WEND without WHILE

A WEND was encountered without a matching WHILE.

DISK RELATED ERRORS

50 Field overflow

An attempt was made to allocate more bytes than were specified for the record length of a random file.

51 Internal error

An internal malfunction has occurred in BASIC-80. Report conditions under which error occurred and all relevant data to Zenith Data Systems Customer Service.

52 Bad file number

A statement or command has referenced a file number that is not OPEN or is out of the range of numbers specified at initialization.

53 File not found

A LOAD, KILL, or OPEN statement referenced a file that did not exist.

54 Bad file mode

An attempt was made to perform a PRINT or WRITE on a random file, to OPEN an already open random file for sequential output, to perform a GET or PUT on a sequential file, to load from a random file, or to execute an OPEN statement where the file mode is not I,O, or R.

55 File already open

A sequential output mode is issued for a file that is already open; or a KILL is given for a file that is open.

57 Disk I/O error

An I/O error occured on a disk I/O operation. It is a fatal error, i.e., the operating system cannot recover from the error.

58 File already exists

The file name specified in a NAME statement is identical to a file name already in use on the disk.

61 Disk full

All disk storage space is in use.

62 Input past end

An INPUT statement is executed after all the data in the file has been INPUT, or for a null (empty) file. To avoid this error, use the EOF function to detect the end of file.

63 Bad record number

In a PUT or GET statement, the record number is either greater than the maximum allowed (32768) or equal to zero.

64 Bad file name

An illegal form is used for the file name with LOAD, SAVE, KILL, or OPEN.

66 Direct statement in file

A direct statement is encountered while an ASCII-format file is being loaded. The LOAD is terminated.

67 Too many files

An attempt is made to create a new file (using SAVE or OPEN) when all 255 directory entries are full.

RESERVED WORDS

Some words are reserved by BASIC-80 for use as statements, commands, operators, and so on, and therefore may not be used in variable or function names. The reserved words are listed below. Note that all intrinsic functions are considered to be reserved.

ABS	AND	ASC	ATN
AUTO	CALL	CHAIN	CINT
CDBL	CHR$	CLEAR	CLOSE
COMMON	CONT	COS	CSNG
CVD	CVI	CVS	DATA
DEF	DEFDBL	DEFINT	DEFSNG
DEFSTR	DELETE	DIM	EDIT
ELSE	END	EOF	EQV
ERASE	ERL	ERR	ERROR
EXP	FIELD	FILES	FIX
FN	FOR	FRE	GET
GOSUB	GOTO	HEX$	IF
IMP	INKEY$	INP	INPUT
INSTR	INT	KILL	LEFT$
LEN	LET	LINE	LIST
LLIST	LOAD	LOC	LOF
LOG	LPOS	LPRINT	LSET
MERGE	MID$	MKD$	MKI$
MKS$	MOD	NAME	NEW
NEXT	NOT	NULL	OCT$
ON	OPEN	OPTION	OR
OUT	PEED	POKE	POS
PRINT	PUT	RANDOMIZE	READ
REM	RENUM	RESET	RESTORE
RESUME	RETURN	RIGHT$	RND
RSET	RUN	SAVE	SGN
SIN	SPACE$	SPC( )	SQR
STEP	STOP	STR$	STRING$
SWAP	SYSTEM	TAB( )	TAN
THEN	TO	TROFF	TRON
USR	VAL	VARPTR	WAIT
WEND	WHILE	WIDTH	WRITE
XOR			

Appendix B

ASCII Codes

DECIMAL TO OCTAL TO HEX TO ASCII CONVERSION

I				II				III				IV			
DEC	OCT	HEX	ASCII	DEC	OCT	HEX	ASCII	DEC	OCT	HEX	ASCII	DEC	OCT	HEX	ASCII
0	000	00	NUL	32	040	20	SPACE	64	100	40	@	96	140	60	'
1	001	01	SOH	33	041	21	!	65	101	41	A	97	141	61	a
2	002	02	STX	34	042	22	"	66	102	42	B	98	142	62	b
3	003	03	ETX	35	043	23	#	67	103	43	C	99	143	63	c
4	004	04	EOT	36	044	24	$	68	104	44	D	100	144	64	d
5	005	05	ENQ	37	045	25	%	69	105	45	E	101	145	65	e
6	006	06	ACK	38	046	26	&	70	106	46	F	102	146	66	f
7	007	07	BEL	39	047	27	'	71	107	47	G	103	147	67	g
8	010	08	BS	40	050	28	(	72	110	48	H	104	150	68	h
9	011	09	HT	41	051	29	)	73	111	49	I	105	151	69	i
10	012	0A	LF	42	052	2A	*	74	112	4A	J	106	152	6A	j
11	013	0B	VT	43	053	2B	+	75	113	4B	K	107	153	6B	k
12	014	0C	FF	44	054	2C	,	76	114	4C	L	108	154	6C	l
13	015	0D	CR	45	055	2D	-	77	115	4D	M	109	155	6D	m
14	016	0E	SO	46	056	2E	PERIOD	78	116	4E	N	110	156	6E	n
15	017	0F	SI	47	057	2F	/	79	117	4F	O	111	157	6F	o
16	020	10	DLE	48	060	30	0	80	120	50	P	112	160	70	p
17	021	11	DC1	49	061	31	1	81	121	51	Q	113	161	71	q
18	022	12	DC2	50	062	32	2	82	122	52	R	114	162	72	r
19	023	13	DC3	51	063	33	3	83	123	53	S	115	163	73	s
20	024	14	DC4	52	064	34	4	84	124	54	T	116	164	74	t
21	025	15	NAK	53	065	35	5	85	125	55	U	117	165	75	u
22	026	16	SYN	54	066	36	6	86	126	56	V	118	166	76	v
23	027	17	ETB	55	067	37	7	87	127	57	W	119	167	77	w
24	030	18	CAN	56	070	38	8	88	130	58	X	120	170	78	x
25	031	19	EM	57	071	39	9	89	131	59	Y	121	171	79	y
26	032	1A	SUB	58	072	3A	:	90	132	5A	Z	122	172	7A	z
27	033	1B	ESC	59	073	3B	;	91	133	5B	[	123	173	7B	{
28	034	1C	FS	60	074	3C	<	92	134	5C	\	124	174	7C	|
29	035	1D	GS	61	075	3D	=	93	135	5D	]	125	175	7D	}
30	036	1E	RS	62	076	3E	>	94	136	5E	^	126	176	7E	~
31	037	1F	US	63	077	3F	?	95	137	5F	_	127	177	7F	DELETE

Control Character Definitions

NUL	Null: Tape feed,
SOH	Start of Heading; Start of Message
STX	Start of Text; End of Address
ETX	End of Text; End of Message
EOT	End of Transmission; Shuts off TWX machines
ENQ	Enquiry; WRU
ACK	Acknowledge; RU
BEL	Rings Bell
BS	Backspace
HT	Horizontal TAB
LF	Line Feed or Space (New Line)
VT	Vertical TAB
FF	Form Feed (PAGE)
CR	Carriage Return
SO	Shift Out
SI	Shift In
DLE	Data Link Escape
DC1	Device Control 1; Reader on
DC2	Device Control 2; Punch on
DC3	Device Control 3; Reader off
DC4	Device Control 4; Punch off
NAK	Negative Acknowledge; Error
SYN	Synchronous Idle(SYNC)
ETB	End of Transmission Block; Logical End of Medium
CAN	Cancel (CANCL)
EM	End of Medium
SUB	Substitute
ESC	Escape
FS	File Separator
GS	Group Separator
RS	Record Separator
US	Unit Separator

Refer to the chart on Page B-1. Note that any print control character defined above and listed in column I of the chart can be produced from the combination of CTRL and the alphabetical character in column III or IV which is on the same line and to the right of the print control character. That is, DLE is CTRL-P or ^P, BEL is CTRL-G or ^G, and so on.

Appendix C

Programming Hints

As your level of programming experience increases, you will eventually have to concern yourself with program efficiency. The two main resources you will have to conserve are: memory space and execution time. This Appendix has been included to aid in your programming effort.

CONSERVING MEMORY SPACE

To conserve memory space, make sure that you do the following:

Place multiple program statements on a single line.

BASIC-80 must keep track of each program line as well as the program line number. If you place multiple statements on a single line, less space will be used for program line overhead.

Remove all unnecessary REM statements.

When you use a REM statement, BASIC-80 will store the one-byte code which represents the REM keyword plus the ASCII representation of the actual remark. This can result in a lot of memory being used simply for remarks. (You will have to consider the trade-off of program documentation vs. memory space when you remove these REM statements.)

Use a subroutine call (GOSUB) only when a GOTO won't work.

The GOSUB statement should be used only when a routine must be called from several different places within the main program. If a routine is to be called from the same place every time, then use a GOTO. Each active GOSUB will consume memory space (to update the stack), but a GOTO will not.

Use as few parentheses in an expression as possible.

Structure your arithmetic expressions so they use as few parentheses as possible. Each time BASIC-80 has to evaluate an expression enclosed in parentheses, it will consume more memory space. BASIC-80 will also have to store the result of this evaluation in a temporary storage location, thus using more memory space.

Use integer variables whenever possible.

This is very important, as integer variables only consume two bytes of memory. A single-precision variable will take four bytes, and a double-precision will take eight bytes.

Dimension arrays sparingly.

Make sure that you only allocate as much space for an array as you will use. For example, if you allow BASIC-80 to establish the 11-element default array size, and then only use four of these elements, you have wasted more space than you have used. So always set the array size with a dimension statement, never let BASIC-80 assume the default size of 11 elements. (Unless your array size is only 11 elements.)

Split large programs into smaller modules.

BASIC-80 will allow you to CHAIN between programs, as well as pass variables between programs. This makes it very easy to write a large program as several small programs and pass variables between them.

Use DEF statements to declare variable types.

This will prevent you from having to use the type declaration characters, thus saving you one byte for every variable that is not a single-precision data type.

Reduce the number of simultaneously open data files.

Every data file requires a buffer area, so it is more efficient to use the same buffer for several different files. To do this, open the first file as file #1, and then access it as needed. Then close this file and open the second file as file #1. Although you will not be able to simultaneously access both files, you will still be able to access both files as needed.

Reduce the number of variables and arrays in a program.

You can accomplish this by reusing variables and arrays in a program when they are no longer needed. Or, you can establish one variable to be used as a FOR/NEXT counter, and then use it for every FOR/NEXT loop.

SAVING EXECUTION TIME

To save execution time make sure you do the following:

Define the most commonly used variables first.

The variables are placed in the BASIC-80 variable table as they are encountered. When a variable is referenced, the table is searched sequentially. Thus, if a variable is near the top of the table, it will take less time to access.

Use integer variables in FOR/NEXT loops.

This is very important and can result in a significant time savings. If you wish to try an experiment, set up a FOR/NEXT with a single-precision loop counter and time the execution. Then simply define the loop counter as an integer data type and time the execution again. (Make sure you set the loop for at least 10,000 iterations.) You will notice a significant difference in the execution times.

Use variables instead of constants in arithmetic expressions.

BASIC-80 uses a floating point decimal representation for numeric values. It takes less time for BASIC-80 to access a variable than to convert a constant to this representation. If you have a constant you are planning to use quite often in a program, assign it to a variable and use the variable instead.

This list is by no means exhaustive, but if you adhere to the above suggestions, you will be well on the way to generating efficient code.

Appendix D

Assembly Language Subroutines

BASIC-80 provides two methods for calling assembly language subroutines from a BASIC-80 program. The first method uses the USR function, which allows assembly language subroutines to be called in the same way BASIC-80's intrinsic functions are called. The second method uses the CALL statement, which generates the same calling sequence as the Microsoft FORTRAN, COBOL, and BASIC Compilers.

Since assembly language subroutines bypass some of the built-in safeguards of BASIC-80, calling assembly language subroutines renders BASIC-80 vulnerable to and defenseless against the errors in those subroutines. Therefore, write your subroutines with caution.

MEMORY ALLOCATION

When using assembly language subroutines with BASIC-80, an important consideration is memory space allocation. Memory space must be set aside for an assembly language subroutine before it can be loaded.

During initialization, enter the highest memory location minus the amount of memory needed for the assembly language subroutine(s). The /M switch can be used during initialization to set the top of memory. (See Chapter One, "System Introduction and General Information," for more information about the initialization procedure.) BASIC-80 uses all memory available from its starting location up, so only the topmost locations in memory can be set aside for user subroutines.

After an assembly language subroutine is called, the stack pointer is set up for eight levels (16 bytes) of stack storage. If more stack space is needed, BASIC-80's stack can be saved and a new stack set up for use by the assembly language subroutine. BASIC-80's stack must be restored, however, before the program returns from the subroutine.

The assembly language subroutine may be loaded into memory by means of the CP/M system monitor, or by using the BASIC-80 POKE statement. Assembly language subroutines may also be assembled with the MACRO-80 assembler and loaded using the LINK-80 linking loader. (These programs are not provided with BASIC-80, they must be purchased separately.)

USR FUNCTION CALLS

Before a USR function is called, the entry address for the USR subroutine must be defined in a DEF USR statement.

DEF USR
(define entry address for USR subroutine)

Form: DEF USR<digit>=<expression>

The DEF USR statement is used to define entry points for up to 10 assembly language subroutines.

The <digit> is the number of the assembly language subroutine. <digit> may be any number from 0-9. If <digit> is omitted, it it assumed to be 0.

The value of <expression> is the starting address of the assembly language subroutine. This address is assumed to be in decimal unless a special base specifier character is used. Hexadecimal numbers are specified with the prefix &H and octal numbers are specified with the prefix &O or &.

The format of the USR function call is:

USR[<digit>](argument)

where <digit> is from 0 to 9 and the argument is any numeric or string expression. <digit> specifies which USR subroutine is being called, and corresponds with the digit supplied in the DEF USR statement for that subroutine. If <digit> is omitted, USR0 is assumed. The address given in the DEF USR statement determines the starting address of the subroutine.

When the USR function call is made, register A contains a value that specifies the data type of the argument that was given. The value in A will be one of the following:

Value in A	Type of Argument
2	Two-byte integer (two's complement)
3	String
4	Single-precision floating point number
8	Double-precision floating point number

Table D-1
Register Values Used to Specify Data Types.

If the argument is a numeric data type, the [H,L] register pair will point to the Floating Point Accumulator (FAC) where the argument is stored. The FAC occupies eight bytes in memory — enough for a double-precision number.

NUMERIC STORAGE FORMAT

Integer Storage Format

An integer argument is stored as a 2-byte data value. The integer is stored in a two's complement representation.(In the following discussion, the Floating Point Accumulator will be referred to as the FAC.) An integer argument will be stored in the FAC as follows:

FAC-3 — Contains the lower 8 bits of the argument (the least significant byte)

FAC-2 — Contains the upper 8 bits of the argument (the most significant byte)

Single-Precision Storage Format

A single-precision argument is stored as a 4-byte data value. The first byte will be the exponent. The exponent will be stored in excess 128 (200 octal) notation. This means that 200 (octal) represents an exponent of 0, 201 (octal) represents an exponent of 1, 177 (octal) represents an exponent of -1, and so forth. A single-precision number will be stored in the FAC as follows:

FAC-3 — Contains the lowest eight bits of the mantissa.

FAC-2 — Contains the middle eight bits of the mantissa.

FAC-1 — Contains the highest seven bits of the mantissa with leading 1 suppressed (implied). Bit 7 is the sign of the number (0=positive, 1=negative).

FAC — Contains the exponent stored in "excess 128" (200 octal) format

Double-Precision Storage Format

A double-precision argument is stored using the same format as the single-precision number, only four more bytes are used to store the mantissa. A double-precision number is stored in the FAC in the same manner as a single-precision number, except:

FAC-7 through FAC-4 contain four more bytes of the mantissa (FAC-7 contains the lowest eight bits).
(least significant).

STRING STORAGE FORMAT

If the argument is a string, the [D,E] register pair points to three bytes called the "string descriptor". Byte 0 of the string descriptor contains the length of the string (0 to 255). Bytes one and two, respectively, are the lower and upper eight bits of the string starting address in string space.

CAUTION: If the argument is a string literal in the program, the string descriptor will point to the string within program text where the string appears. Be careful not to alter or destroy your program this way. To avoid unpredictable results, add +"" to the string literal in the program.

Example:

```
A$ = "BASIC-80"+""
```

This will force BASIC-80 to copy the string literal into string space and will prevent alteration of program text during a subroutine call.

Data Type Conversions

Usually, the value returned by a USR function is the same type (integer, string, single-precision or double-precision) as the argument that was passed to it. However, calling the MAKINT subroutine returns the integer in [H,L] as the value of the function, thus forcing the value returned by the function to be integer.

To execute MAKINT, use the following sequence to return from the subroutine:

```
MAKINT  EQU     105H        ;address of MAKINT for CP/M
        PUSH    H           ;save value to be returned
        LHLD    MAKINT      ;get address of MAKINT subroutine
        XTHL                ;save return on stack and
                            ;get back [H,L]
        RET                 ;return
```

Also, the argument of the function, regardless of its type, may be forced to an integer value of the argument in [H,L]. Execute the following subroutine:

```
FRCINT  EQU     103H        ;address of FRCINT for CP/M
        LXI     H           ;get address of subroutine
                            ;continuation
        PUSH    H           ;place on stack
        LHLD    FRCINT      ;get address of FRCINT
        PCHL
```

CALL STATEMENT

BASIC-80 user function calls may also be made with the CALL statement. The calling sequence used is the same as that in Microsoft's FORTRAN, COBOL and BASIC compilers.

The general format of the CALL statement is:

CALL <variable name>[(argument list)]

<variable name> is assigned an address that is the starting point in memory of the assembly language subroutine. The address should be assigned to <variable name> before a CALL statement is executed. <variable name> may not be an array variable name. <argument list> contains the arguments that are passed to the assembly language subroutine.

A CALL statement with no arguments generates a simple "CALL" instruction. The corresponding subroutine should return via a simple "RET." (CALL and RET are 8080/8085/Z80 opcodes – consult an 8080/8085/Z80 reference manual for details.)

A subroutine CALL with arguments results in a somewhat more complex calling sequence. For each argument in the CALL argument list, a parameter is passed to the subroutine. That parameter is the address of the low byte of the argument. Therefore, parameters always occupy two bytes each, regardless of data type.

The method of passing the parameters depends upon the number of parameters to pass:

A. If the number of parameters is less than or equal to 3, they are passed in the registers. Parameter 1 will be in HL, 2 in DE (if present), and 3 in BC (if present).

B. If the number of parameters is greater than 3, they are passed as follows:

   1. Parameter 1 in HL.

   2. Parameter 2 in DE.

   3. Parameters 3 through n in a contiguous data block. BC will point to the low byte of this data block (i.e., to the low byte of parameter 3).

Note that, with this scheme, the subroutine must know how many parameters to expect in order to find them.

Conversely, the calling program is responsible for passing the correct number of parameters. There are no checks for correct number or type of parameters.

If a subroutine expects more than three parameters, and needs to transfer them to a local data area, there is a system subroutine named $AT (located in the FORTRAN library, FORLIB.REL) which will perform the transfer. If you do not have FORTRAN, the $AT argument transfer subroutine is listed on Page D-9

$AT is called with HL pointing to the local data area, BC pointing to the third parameter, and A containing the number of arguments to be transferred (i.e., the total number of arguments minus 2). Your subroutine is responsible for saving the first two parameters before calling $AT.

For example, if a subroutine expects five parameters, it should use the following general procedure:

```
SUBR:   SHLD    P1          ;SAVE PARAMETER 1
        XCHG
        SHLD    P2          ;SAVE PARAMETER 2
        MVI     A,3         ;NO. OF PARAMETERS LEFT
        LXI     H,P3        ;POINTER TO LOCAL AREA
        CALL    $AT         ;TRANSFER THE OTHER 3 PARAMETERS
        .
        .
        .
        [body of subroutine]
        .
        .
        .
        RET                 ;RETURN TO CALLER
P1:     DS      2           ;SPACE FOR PARAMETER 1
P2:     DS      2           ;SPACE FOR PARAMETER 2
P3:     DS      6           ;SPACE FOR PARAMETERS 3-5
```

When parameters are accessed in a subprogram, remember that they are only pointers to the actual arguments passed.

It is entirely up to the programmer to insure that the arguments in the calling program correspond in number, type, and length with the parameters expected by the subprogram.

A listing of the argument transfer subroutine $AT follows.

```
00100    ;          ARGUMENT TRANSFER
00200    ;[B, C]    POINTS TO 3RD PARAMETER
00300    ;[H, L]    POINTS TO LOCAL STORAGE FOR PARAMETER 3
00400    ;[A]      CONTAINS THE # OF PARAMETERS TO XFER(TOTAL-2)
00500
00600
00700               ENTRY   $AT
00800    $AT:       XCHG                    ;SAVE [H,L] IN [D,E]
00900               MOV     H,B
01000               MOV     L,C             ;[H,L] = PTR TO PARAMETERS
01100    AT1:       MOV     C,M
01200               INX     H
01300               MOV     B,M
01400               INX     H               ;[B,C] = PARAM ADR
01500               XCHG                    ;[H,L] POINTS TO LOCAL STORAGE
01600               MOV     M,C
01700               INX     H
01800               MOV     M,B
01900               INX     H               ;STORE PARAM IN LOCAL AREA
02000               XCHG                    ;SINCE GOING BACK TO AT1
02100               DCR     A               ;TRANSFERRED ALL PARAMS?
02200               JNZ     AT1             ;NO, COPY MORE
02300               RET                     ;YES, RETURN
```

INTERRUPTS

Assembly language subroutines can be written to handle interrupts. All interrupt handling subroutines should save the stack, registers A-L, and the PSW. Interrupts should always be re-enabled before returning from the subroutine, since an interrupt automatically disables all further interrupts once it is received. It is also very important to choose the proper interrupt vector. With CP/M BASIC-80, all interrupt vectors are free.

Appendix E

Random and Sequential I/O Programming Examples

A directory application, such as a computerized telephone book, is a practical use of random files. The following two sample programs illustrate this technique. The first program, "DIRECTORY", accepts the data required to build the random file and a sequential directory file. The second program, "QUERY", retrieves the data from the directory file.

To fully understand this method of random I/O, you should look at what information is contained in the directory file. The directory file has a key created from putting together the individual's first and last names. The other field in the directory is the record number. The record number is used as an index, and points to that particular individual's entry in the random file.

When you run the "QUERY" program, you will supply the first and last name of a person. If it is a valid name (that is, if it is an entry in the directory), the record number will be used. This will point to the proper record in the random file, so the telephone number can be retrieved.

Note that these examples are NOT intended to be efficient examples of random file usage. They are designed to show how to use the random and sequential file commands.

The example does not show how to add to the data in the file once it has been created. This was done to keep the example simple. If you want to add more names to the file, you will need to modify or rewrite the build program.

As it stands, the build program assumes that there is no pre-existing directory file and starts building one. If it were changed to read in the old directory file, then new entries could be added. (Lines 50 to 80 in the query program read the file.)

If you want to do this, first open A:TABLE.EXT for input and read all of it into an array such as NP$ and SP. Then close the file, but reopen it for output before you write out the directory.

Again, this example is not designed to be efficient. An efficient program would put the directory as the first or last few records of the file A:RFILE.EXT. In addition, the directory would be kept in alphabetical order for efficient searching.

You will understand these examples best if you type them in and use them.

```
5 REM "DIRECTORY PROGRAM"
10 OPEN "O",1,"A:TABLE.EXT"
20 OPEN "R",2,"A:RFILE.EXT"
30 FIELD #2,12 AS LN$,9 AS SN$,12 AS SR$,<operator types LINE FEED>
     12 AS CI$, 10 AS SZ$,2 AS CD$,2 AS EX$,2 AS PN$
40 REC=REC+1
50 LINE INPUT "LAST NAME? ";N1$
60 LINE INPUT "FIRST NAME? ";N2$
70 LINE INPUT "STREET ADDRESS? ";N3$
80 LINE INPUT "CITY?" ";N4$
90 LINE INPUT "STATE ZIP? ";N5$
100 INPUT "PHONE NUMBER (XXX,XXX,XXXX) ";N%,N1%,N2%
110 LSET LN$=N1$:LSET SN$=N2$:LSET SR$=N3$:<operator types LINE FEED>
     LSET CI$=N4$:LSET SZ$=N5$
120 LSET CD$=MKI$(N%) :LSET EX$=MKI$(N1%)<operator types LINE FEED>
     :LSET PN$=MKI$(N2%)
130 KEY$=N1$+N2$
140 PRINT #1,KEY$;",",REC
150 PUT #2,REC
160 LINE INPUT "MORE INPUT (Y OR NO)";MI$<operator types LINE FEED>
     :IF MI$="Y" GOTO 40
170 CLOSE
180 END
```

Line Number	Explanation
10	Open directory file and label it "A:TABLE.EXT".
20	Open a random file and label it as "A:RFILE.EXT."
30	Reserve space in the random file buffer for directory entires. LN$=Last Name SN$=First Name SR$=Street Address CI$=City SZ$=State and Zip Code CD$=Area Code EX$=Telephone Exchange PN$=Last 4 digits of telephone number
40	Increment record number counter.
50 - 100	Accept input data.
110	Left-justify the string input for the random buffer.
120	Left-justify and convert integers to string values. (You must convert to strings before PUTting values into the buffer.)
130	Construct the key from first and last names.
140	Output data to the directory file. KEY$=Key for directory REC=Record number of random file
150	Put the record in the random buffer.
160	Check for more data.
170	Close all files.
180	End the program and return to MBASIC Command Mode.

```
5 REM "QUERY PROGRAM"
10 OPEN "I",1,"A:TABLE.EXT"
20 OPEN "R",2,"A:RFILE.EXT"
30 FIELD #2,12 AS LN$,9 AS SN$,12 AS SR$,12 AS CI$,<operator types LINE FEED>
     10 AS SZ$,2 AS CD$,2 AS EX$,2 AS PN$
40 IF EOF(1) THEN GOTO 90
50 CT=CT+1
60 INPUT #1,NP$(CT),SP(CT)
70 GOTO 50
80 INPUT "NAME (LAST,FIRST)";L$,F$
90 KEY$=L$+F$
100 FOR I%=1 TO CT
110 IF KEY$=NP$(I%) THEN GOTO 150
120 NEXT I%
130 PRINT "NO RECORD EXISTS":GOTO 170
140 GET #2,SP(I%)
150 PRINT LN$,SN$,CVI(CD$);"-";CVI(EX$);"-";CVI(PN$)
160 INPUT"MORE QUERIES? (Y OR N) ";M$:IF M$="Y" GOTO 90
170 CLOSE
180 END
```

Line Number	Explanation
20	Open directory file for input.
30	Open the random file.
40	Reserve space in random file buffer.
50	Check for end-of-file condition.
60	Increment directory record counter.
70	Read directory into string.
80	Loop back for EOF check.
90	Supply the name for which you want the telephone number.
100	Create key from the first and last names.
110	Set up loop to search for record in the directory.
120	Compare input key to directory key.
130	If no match on first comparison, try the next key.
140	If no match is found after comparing all keys, print the message.
150	If match is found, put the requested record in the random buffer.
160	After converting the requested record back to integer, print it.
170	Check for more queries.
180	Close all files.
190	End the program and return to Microsoft BASIC's prompt.

Index